STD9NM40N, STP9NM40N

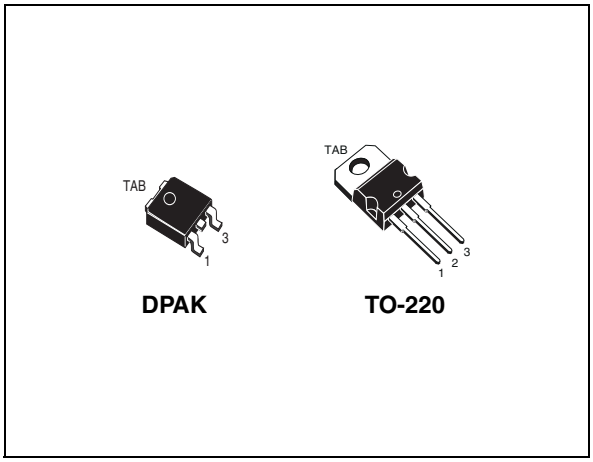
N-channel 400 V, 0.73 Ω typ., 5.6 A MDmesh™ II Power MOSFET in DPAK and TO-220 packages

Datasheet — production data

Features

Order codes	V_{DSS}@T_{JMAX}	$R_{DS(on)}$max.	I_D
STD9NM40N	450 V	< 0.79 Ω	5.6 A
STP9NM40N			

- 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

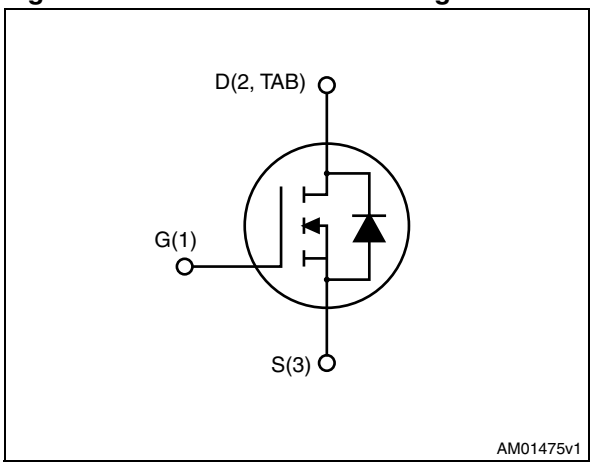


Table 1. Device summary

Order codes	Marking	Packages	Packaging
STD9NM40N	9NM40N	DPAK	Tape and reel
STP9NM40N		TO-220	Tube

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{DS}	Drain-source voltage	400	V
V_{GS}	Gate-source voltage	± 25	V
I_D	Drain current (continuous) at T_C = 25 °C	5.6	A
I_D	Drain current (continuous) at T_C = 100 °C	4.3	A
I_{DM}(1)	Drain current (pulsed)	22.4	
P_{TOT}	Total dissipation at T_C = 25 °C	60	W
dv/dt (2)	Peak diode recovery voltage slope	40	V/ns
T_{stg}	Storage temperature	- 55 to 150	°C
T_j	Max. operating junction temperature	150	°C

1. Pulse width limited by safe operating area.
2. I_{SD} ≤ 5.6 A, di/dt ≤ 400 A/µs, $V_{Peak} < V_{(BR)DSS}$, V_{DS}= 80% $V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameter	Value		Unit
		DPAK	TO-220	
$R_{thj\text{-}case}$	Thermal resistance junction-case max	2.08		°C/W
$R_{thj\text{-}pcb}$	Thermal resistance junction-pcb max	50		°C/W

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°C, I_D = I_{AR}, V_{DD} = 50 V)	140	mJ

2 Electrical characteristics

(T_C = 25 °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 mA	400			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = 400 V V_{DS} = 400 V, T_C = 125 °C			1 100	µA µA
I_{GSS}	Gate-body leakage current (V_{DS} = 0)	V_{GS} = ± 25 V			± 100	nA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	2	3	4	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 2.5 A		0.73	0.79	Ω

Table 6. 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	-	365 30 2.3	-	pF pF pF
$C_{oss(eq)}$(1)	Equivalent output capacitance time related	V_{DS} = 0 to 50 V, V_{GS} = 0	-	147.5	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz, I_D=0	-	5.4	-	Ω
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD} = 320 V, I_D = 5.6 A, V_{GS} = 10 V (see *Figure 17*)	-	14 3 7	-	nC nC nC

1. Coss 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
$t_{d(on)}$ t_r $t_{d(off)}$ t_f	Turn-on delay time Rise time Turn-off-delay time Fall time	V_{DD} = 200 V, I_D = 5.6 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 16*)	-	7 4.4 25 8.8	-	ns ns ns ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM} (1)	Source-drain current Source-drain current (pulsed)		-		5.6 22.4	A A
V_{SD} (2)	Forward on voltage	I_{SD} = 5.6 A, V_{GS} = 0	-		1.5	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 5.6 A, di/dt = 100 A/µs V_{DD} = 60 V (see *Figure 21*)	-	187 1.3 14		ns µC A
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 5.6 A, di/dt = 100 A/µs V_{DD} = 60 V, T_j = 150 °C (see *Figure 21*)	-	224 1.5 13		ns µC A

1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300 µs, duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for DPAK

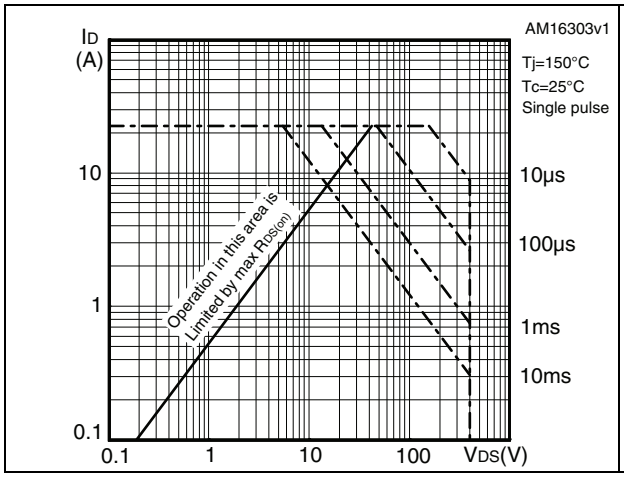


Figure 3. Thermal impedance for DPAK

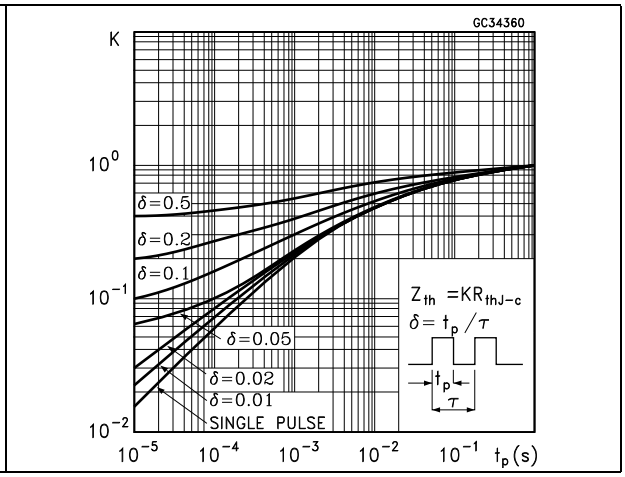


Figure 4. Safe operating area for TO-220

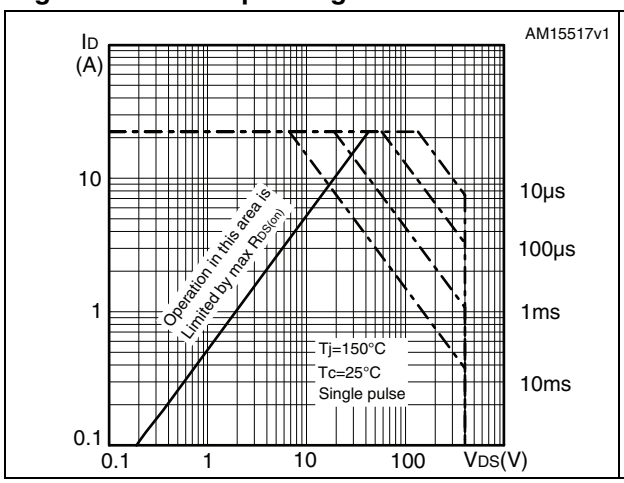


Figure 5. Thermal impedance for TO-220

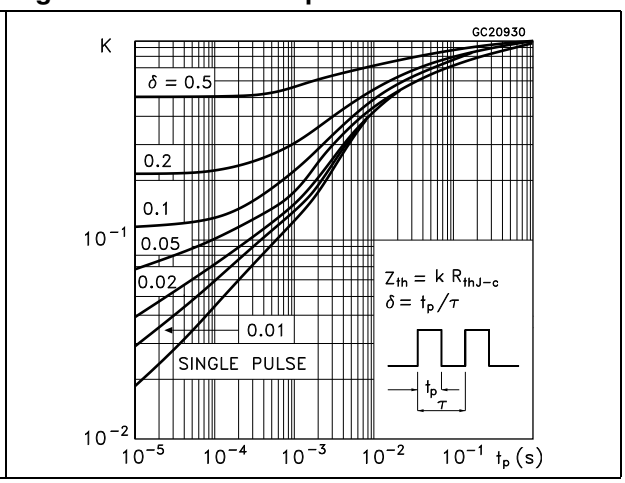


Figure 6. Output characteristics

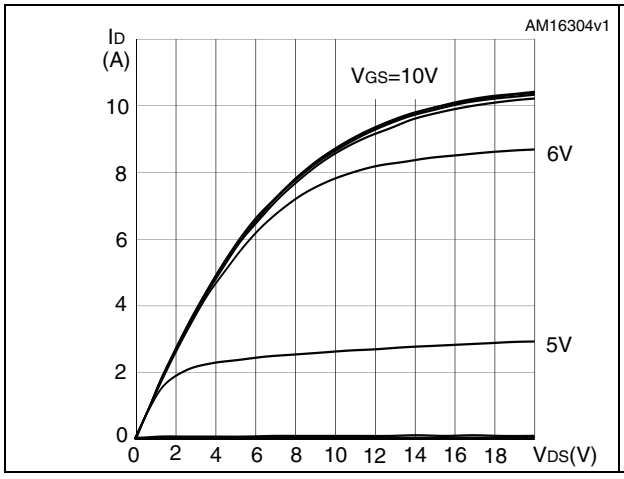


Figure 7. Transfer characteristics

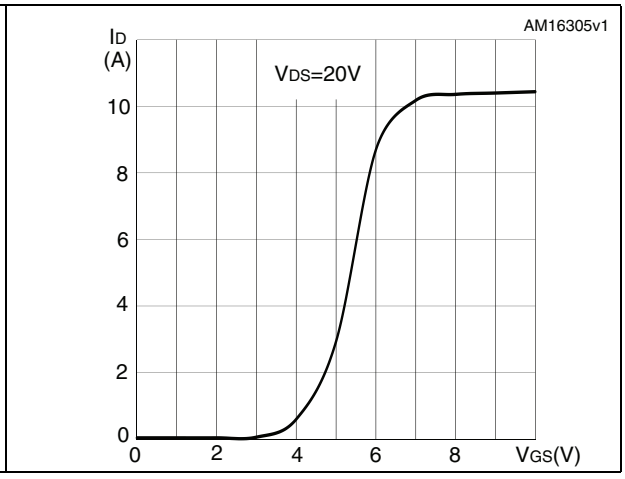


Figure 8. Static drain-source on-resistance

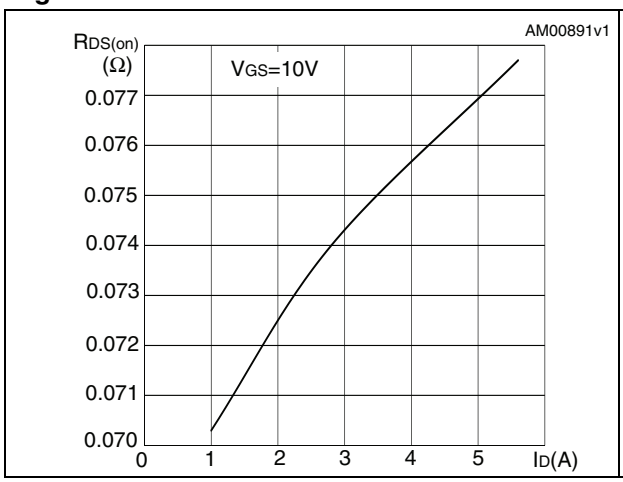


Figure 9. Gate charge vs gate-source voltage

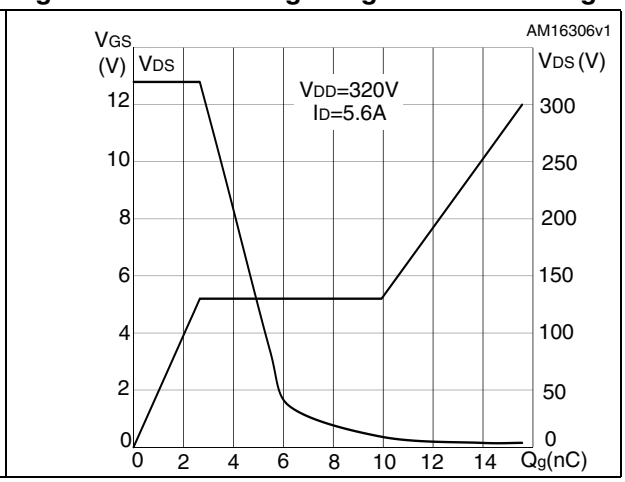


Figure 10. Capacitance variations

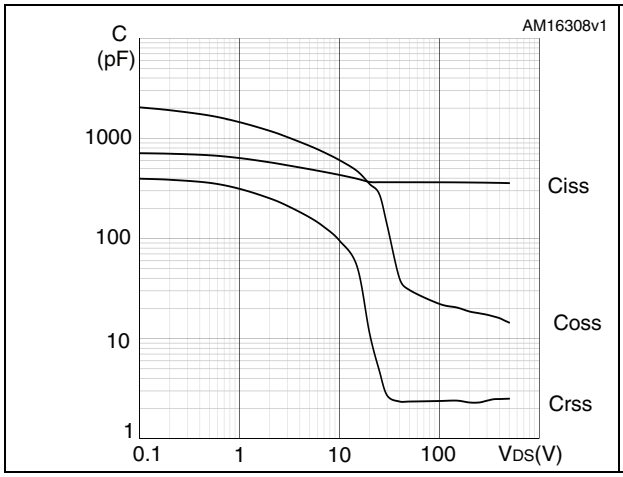


Figure 11. Output capacitance stored energy

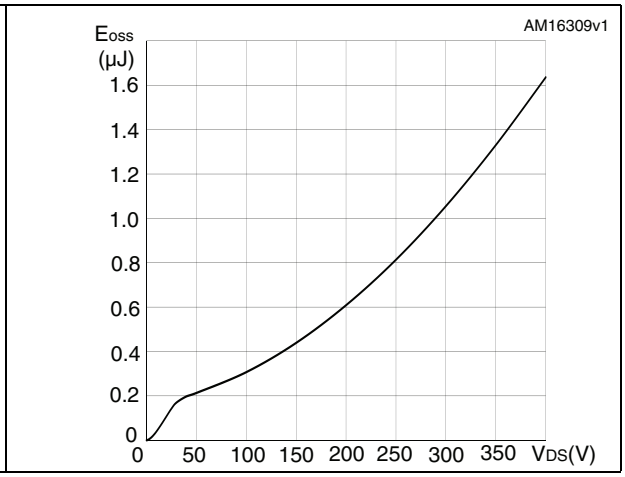


Figure 12. Normalized gate threshold voltage vs temperature

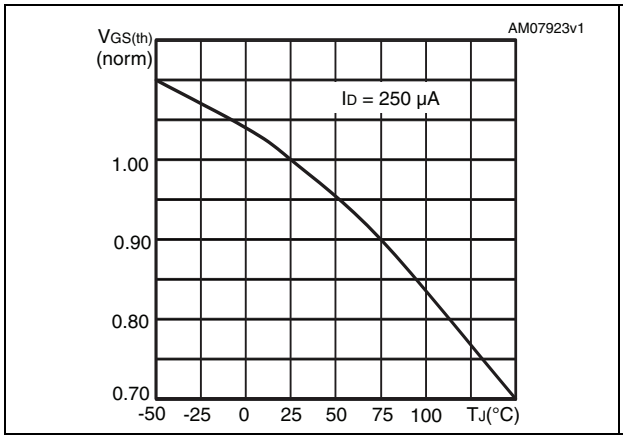


Figure 13. Normalized on resistance vs temperature

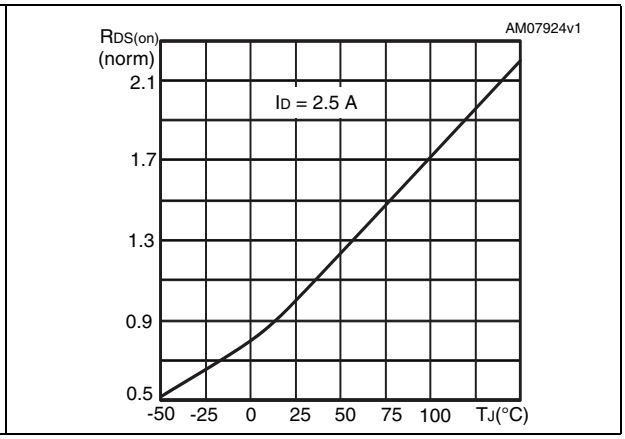


Figure 14. Normalized V_{DS} vs temperature

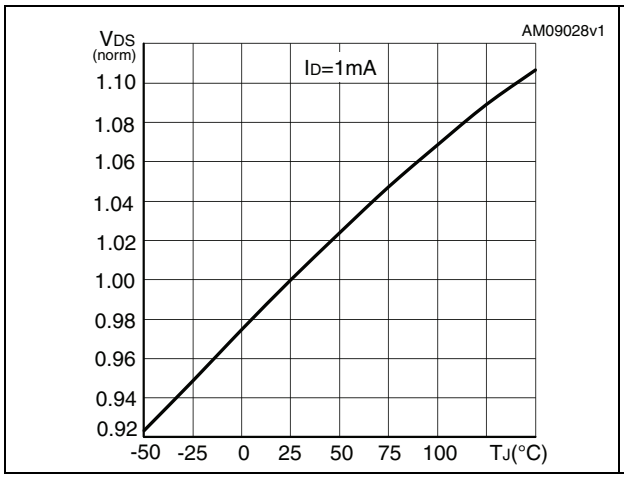
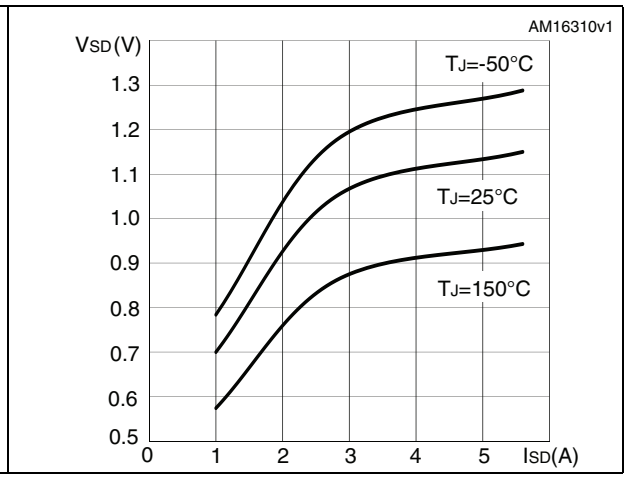


Figure 15. Source-drain diode forward characteristics



3 Test circuits

Figure 16. Switching times test circuit for resistive load

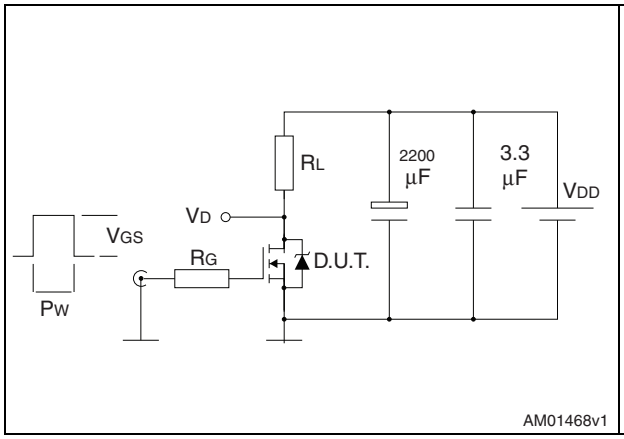


Figure 17. Gate charge test circuit

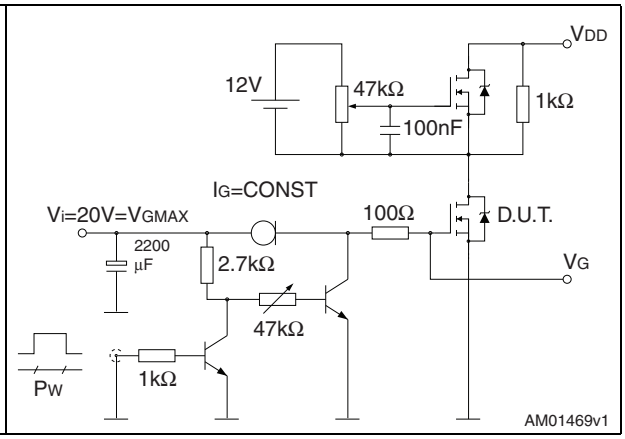


Figure 18. Test circuit for inductive load switching and diode recovery times

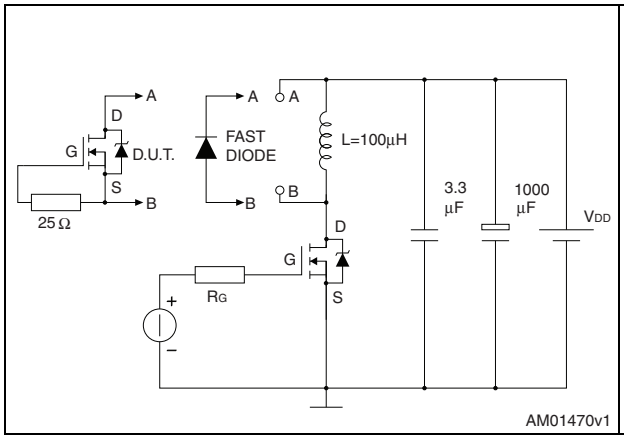


Figure 19. Unclamped inductive load test circuit

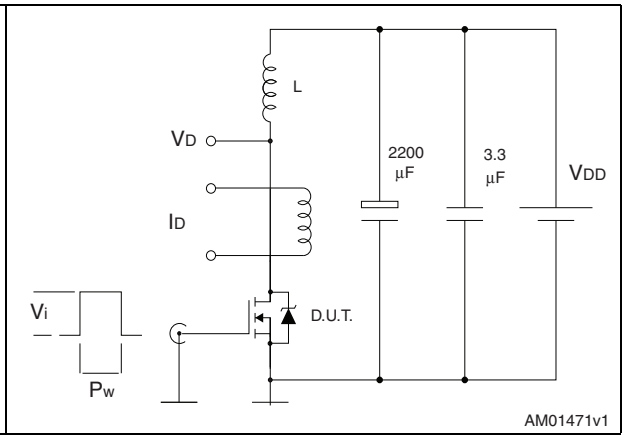


Figure 20. Unclamped inductive waveform

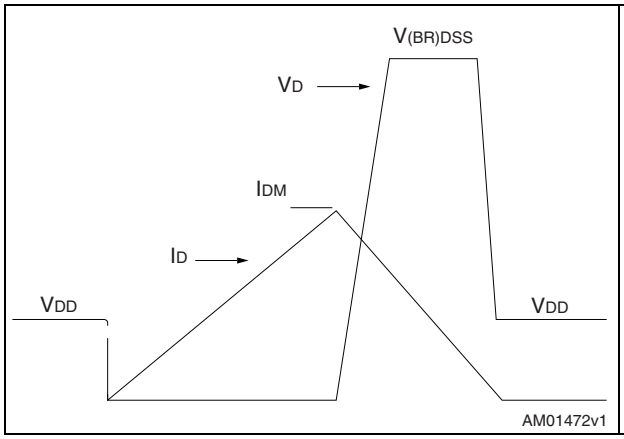
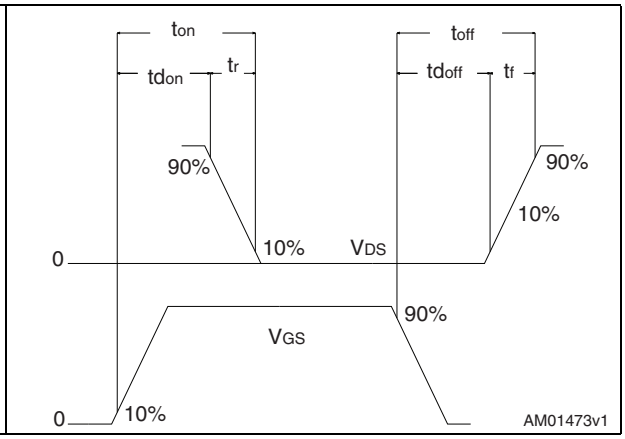


Figure 21. Switching time waveform



4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® 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.

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		
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0°		8°

Figure 22. DPAK (TO-252) drawing

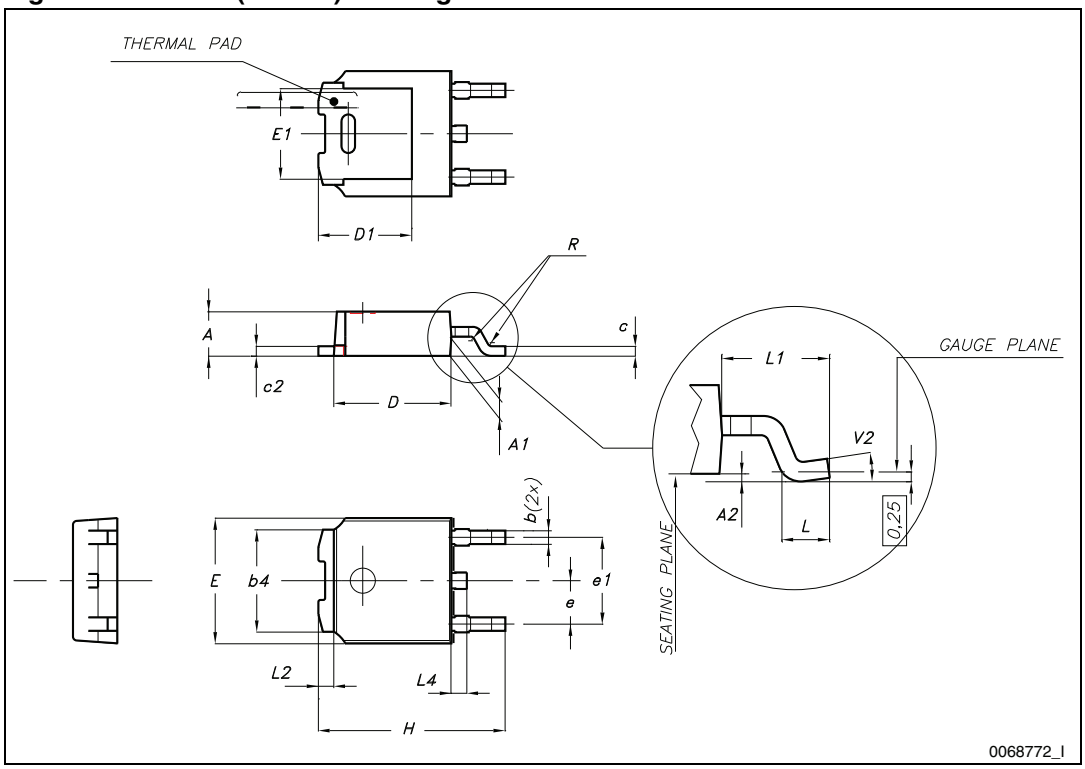
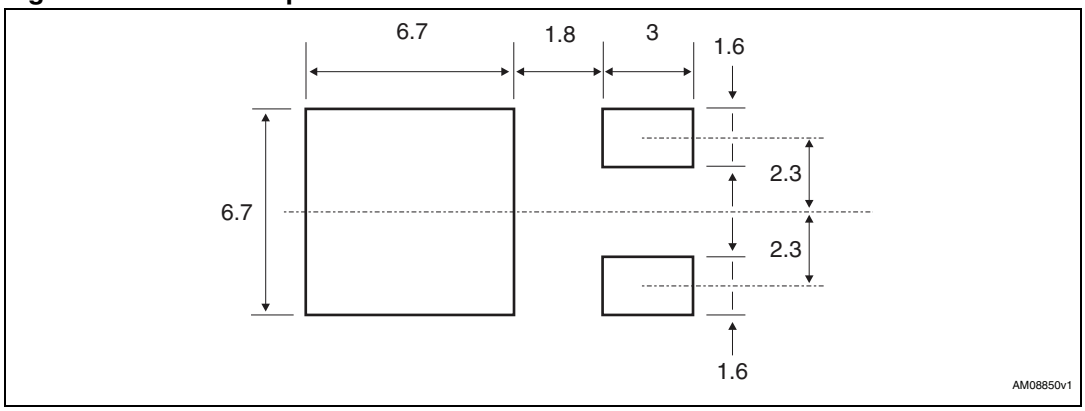


Figure 23. DPAK footprint[a]

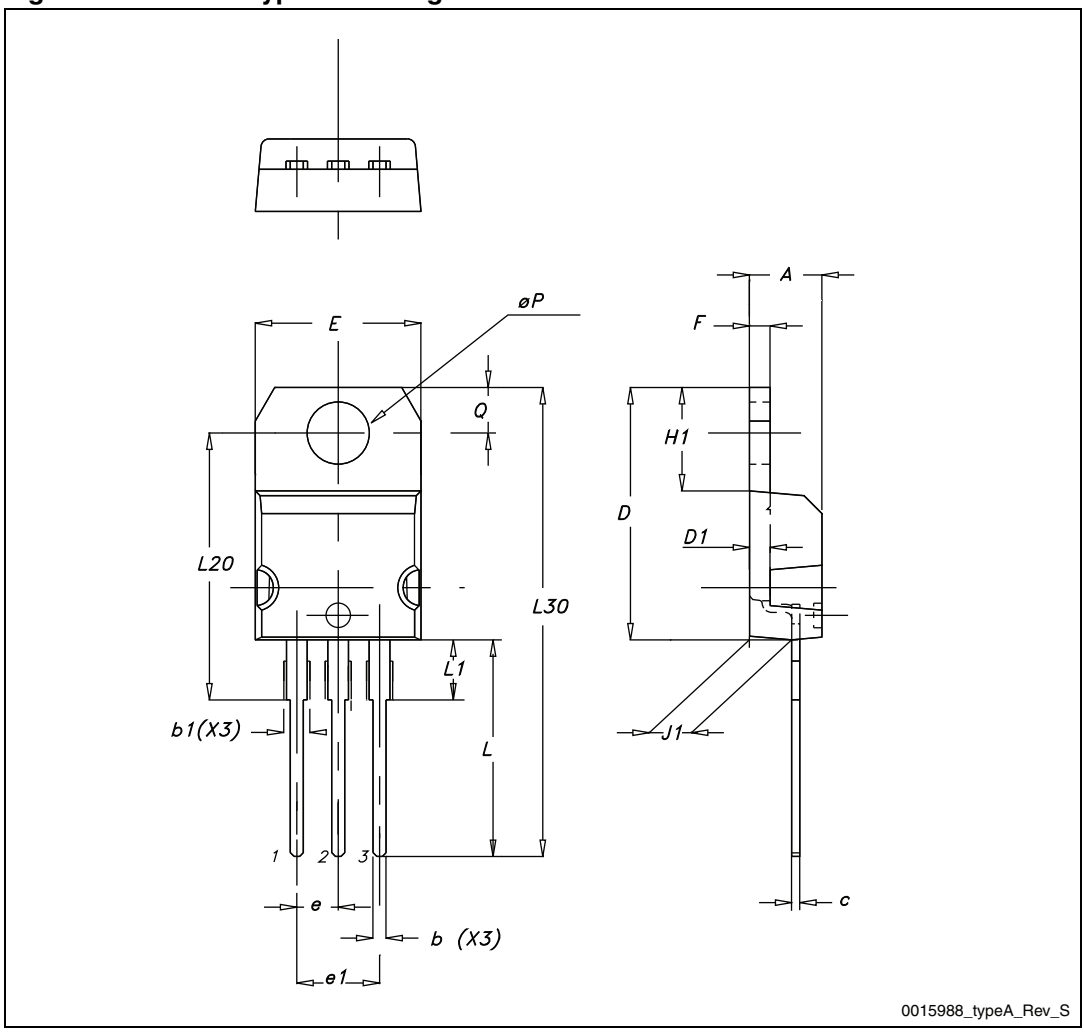


a. All dimensions are in millimeters

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	
∅P	3.75		3.85
Q	2.65		2.95

Figure 24. TO-220 type A drawing



5 Packaging mechanical data

Table 11. 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 25. Tape for DPAK (TO-252)

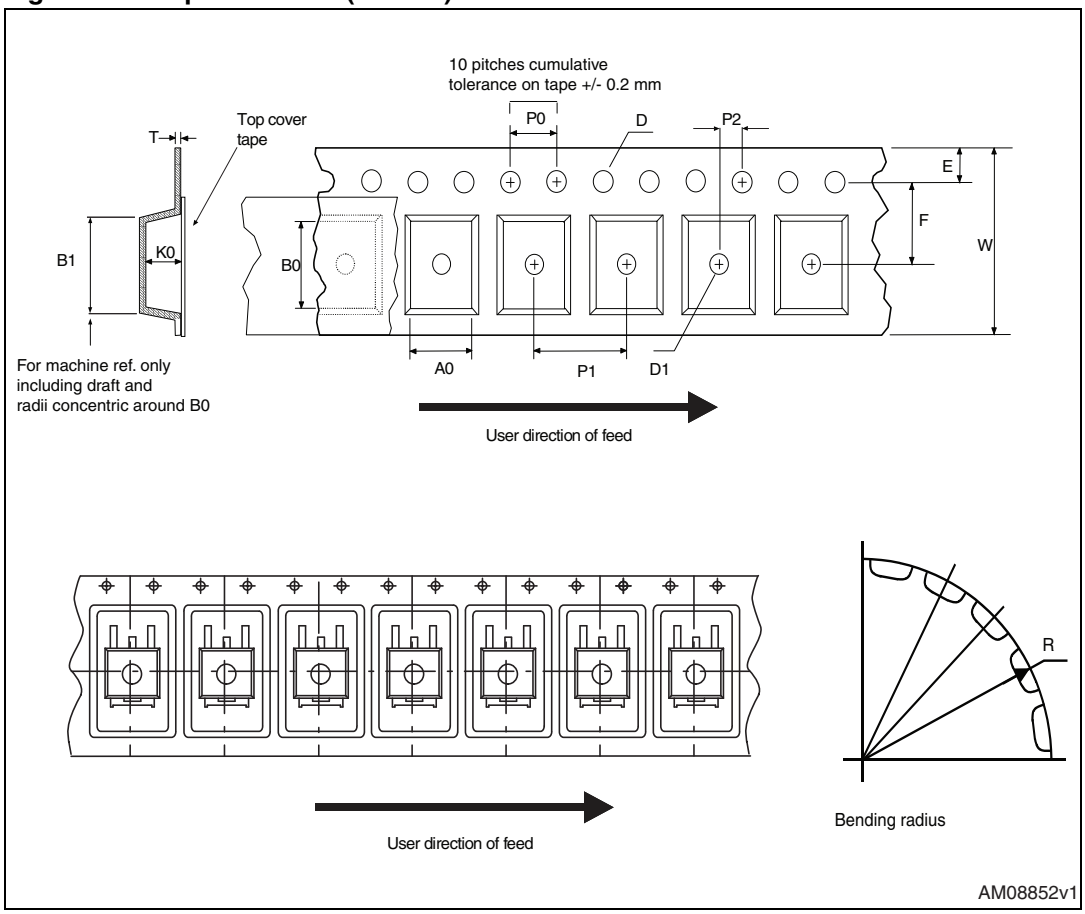
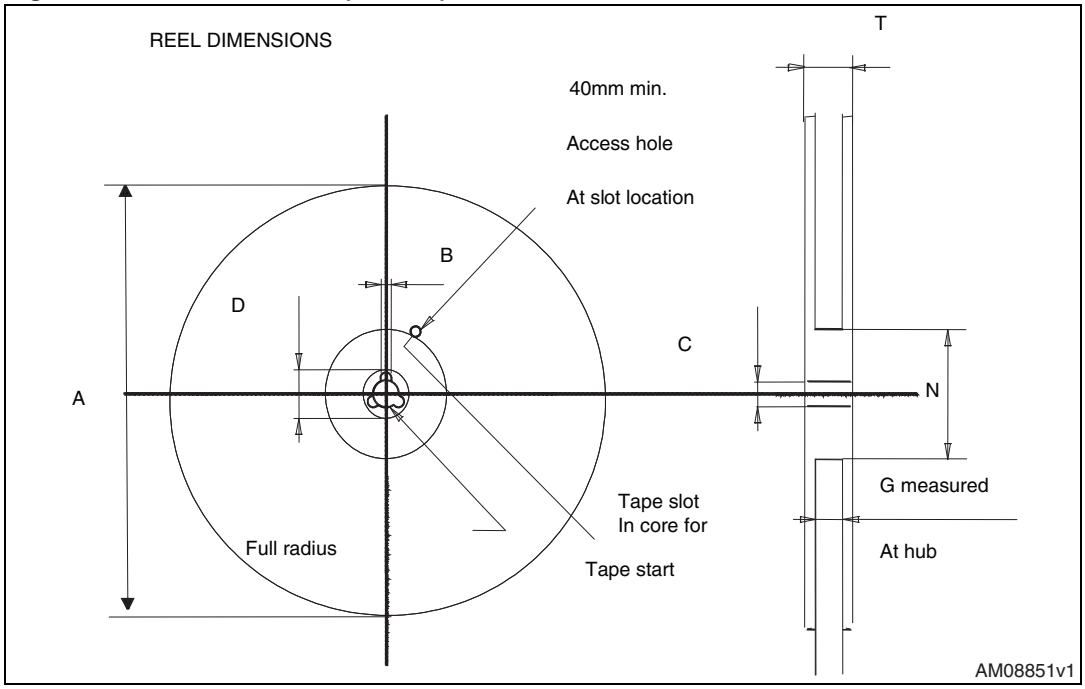


Figure 26. Reel for DPAK (TO-252)



6 Revision history

Table 12. Document revision history

Date	Revision	Changes
08-Oct-2012	1	First release.
14-Dec-2012	2	– Minor text changes – Added: TO-220 package