STB24N60M2, STI24N60M2, STP24N60M2, STW24N60M2

N-channel 600 V, 0.168 Ω typ., 18 A MDmesh II Plus™ low Q_g Power MOSFET in D^2PAK, I^2PAK, TO-220 and TO-247 packages

Datasheet – production data

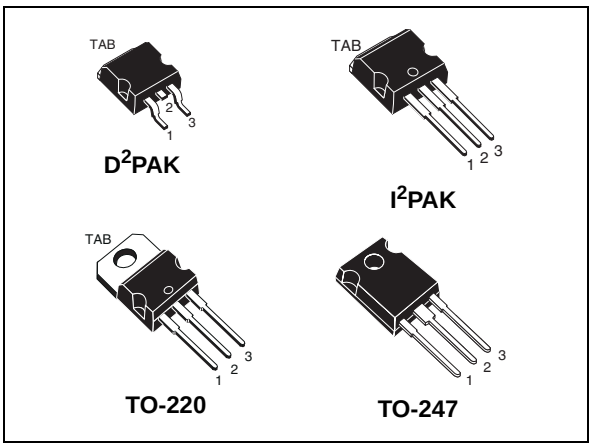
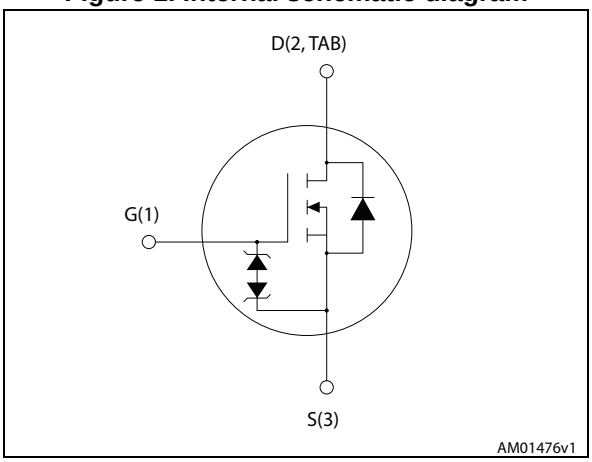


Figure 1. Internal schematic diagram



Features

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

- Extremely low gate charge
- Lower $R_{DS(on)}$ x 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	24N60M2	D^2PAK	Tape and reel
STI24N60M2		I^2PAK	Tube
STP24N60M2		TO-220	
STW24N60M2		TO-247	

Contents

1 Electrical ratings 3

2 Electrical characteristics 4

2.1 Electrical characteristics (curves) 6

3 Test circuits 9

4 Package mechanical data 10

5 Packaging mechanical data 18

6 Revision history 20

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{GS}	Gate-source voltage	± 25	V
I_D	Drain current (continuous) at T_C = 25 °C	18	A
I_D	Drain current (continuous) at T_C = 100 °C	12	A
I_{DM} (1)	Drain current (pulsed)	72	A
P_{TOT}	Total dissipation at T_C = 25 °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	°C
T_j	Max. operating junction temperature		

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

Table 3. Thermal data

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

1. When mounted on 1 inch² 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°C, I_D= I_{AR}; V_{DD}=50)	180	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	I_D = 1 mA, V_{GS} = 0	600			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = 600 V			1	µA
		V_{DS} = 600 V, T_C=125 °C			100	µA
I_{GSS}	Gate-body leakage current (V_{DS} = 0)	V_{GS} = ± 25 V			±10	µA
$V_{GS(th)}$	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 = 9 A		0.168	0.19	Ω

Table 6. Dynamic

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

1. $C_{oss\ eq.}$ 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 V, I_D = 9 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 16* and *21*)	-	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 A, V_{GS} = 0	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 18 A, di/dt = 100 A/µs V_{DD} = 60 V (see *Figure 18*)	-	332		ns
Q_{rr}	Reverse recovery charge		-	4		µC
I_{RRM}	Reverse recovery current		-	24		A
t_{rr}	Reverse recovery time	I_{SD} = 18 A, di/dt = 100 A/µs V_{DD} = 60 V, T_j = 150 °C (see *Figure 18*)	-	450		ns
Q_{rr}	Reverse recovery charge		-	5.5		µC
I_{RRM}	Reverse recovery current		-	25		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 D²PAK, I²PAK and TO-220

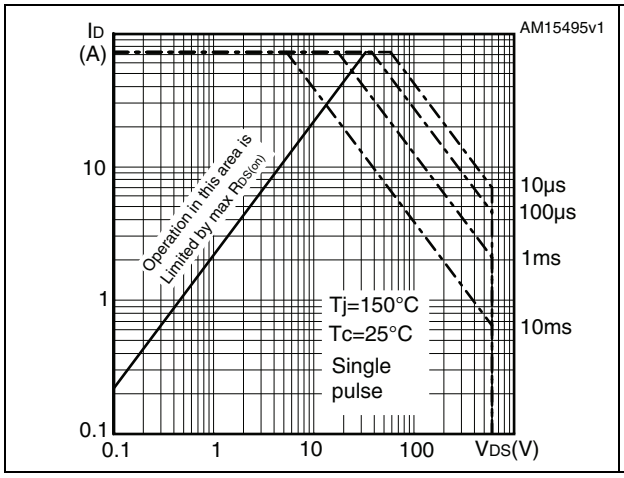


Figure 3. Thermal impedance D²PAK, I²PAK and TO-220

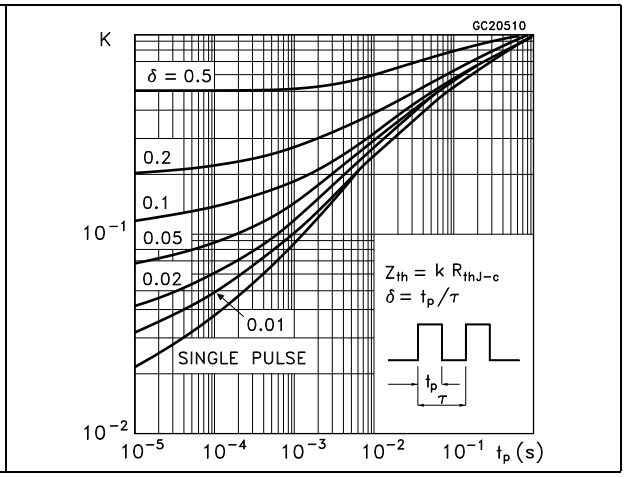


Figure 4. Safe operating area for TO-247

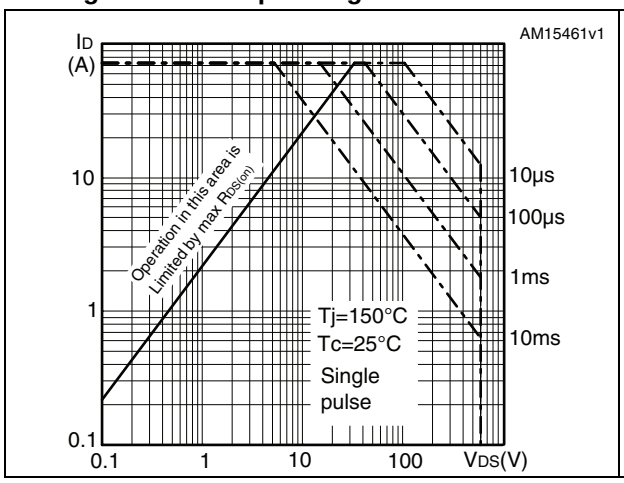


Figure 5. Thermal impedance for TO-247

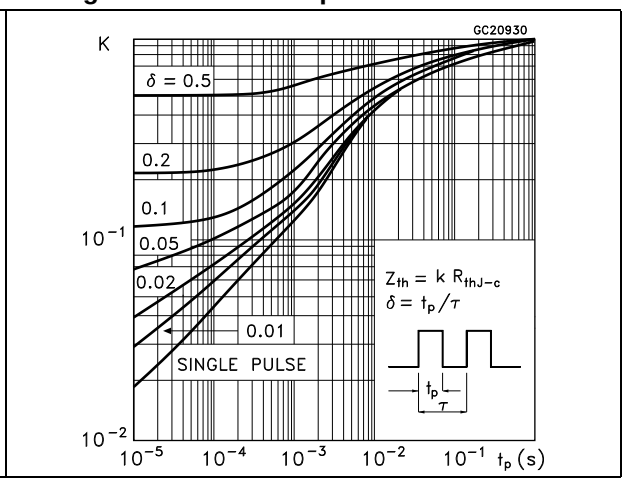


Figure 6. Output characteristics

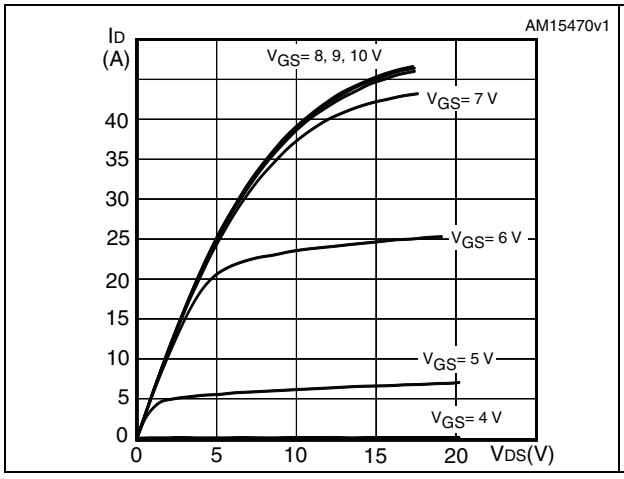


Figure 7. Transfer characteristics

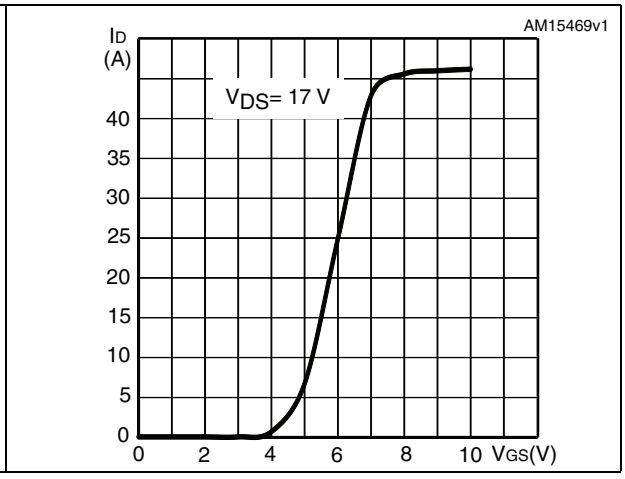


Figure 8. Gate charge vs gate-source voltage

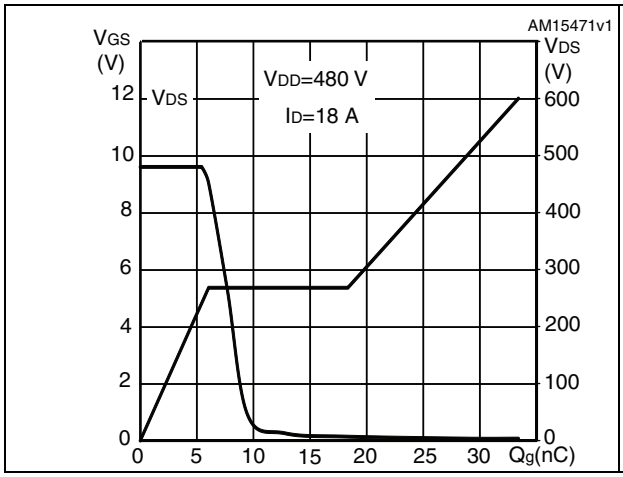


Figure 9. Static drain-source on-resistance

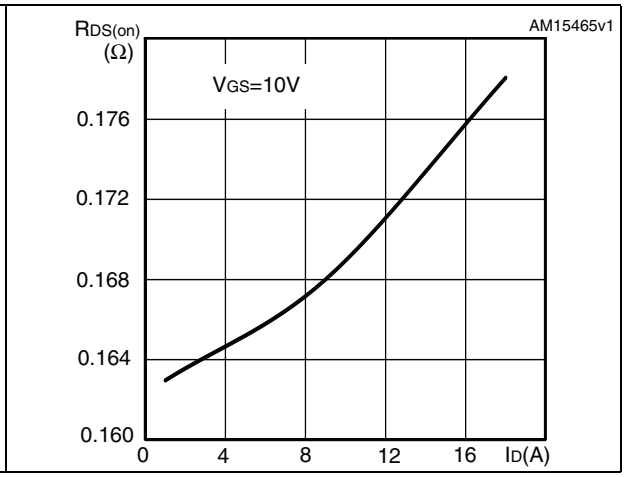


Figure 10. Capacitance variations

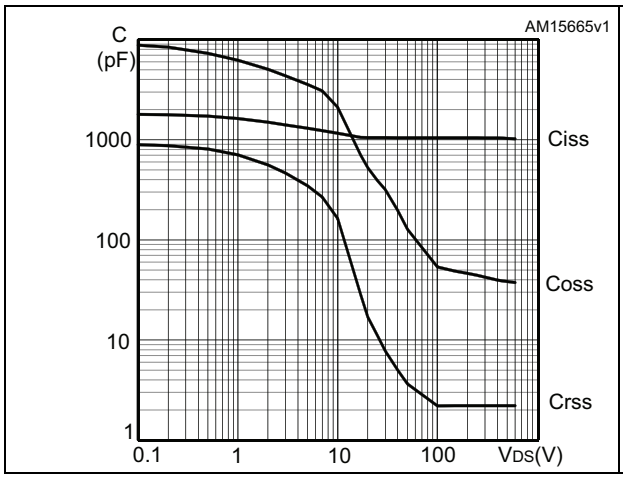


Figure 11. Output capacitance stored energy

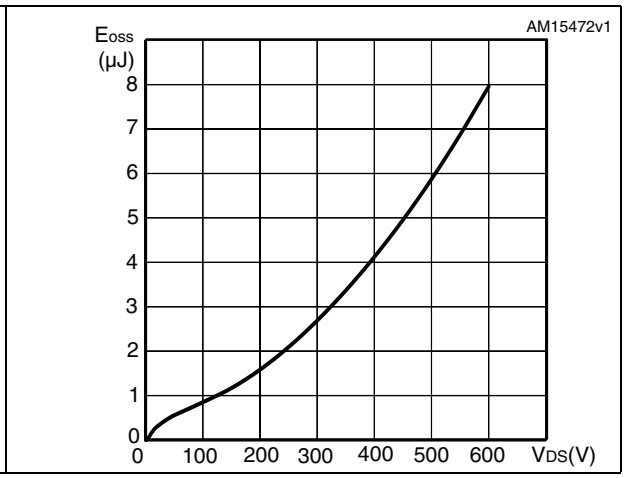


Figure 12. Normalized gate threshold voltage vs temperature

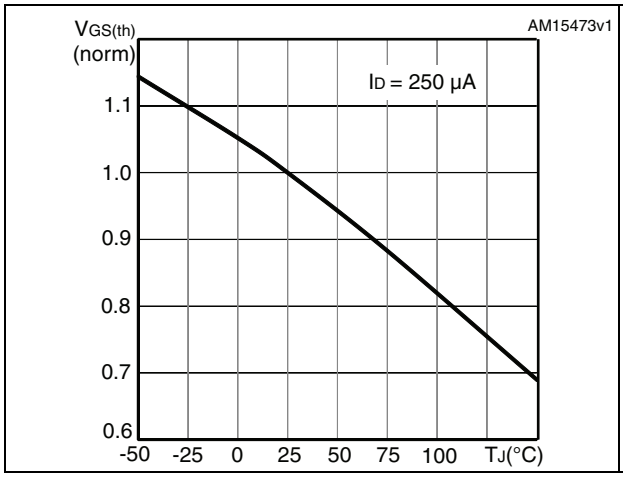


Figure 13. Normalized on-resistance vs temperature

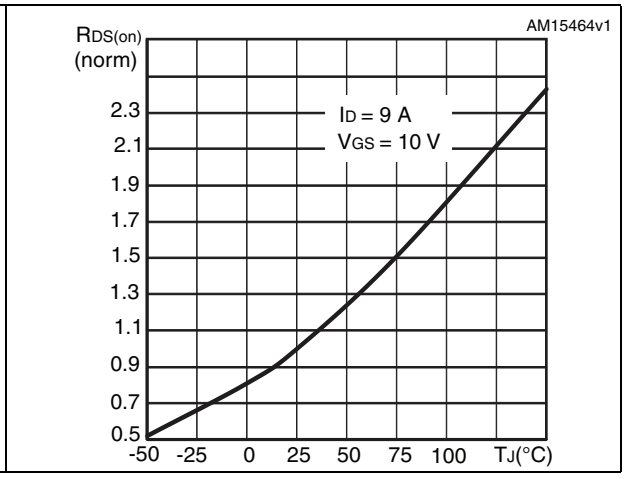


Figure 14. Source-drain diode forward characteristics

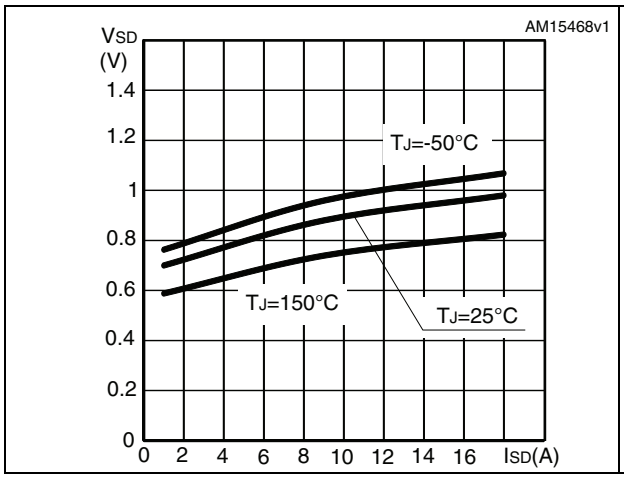
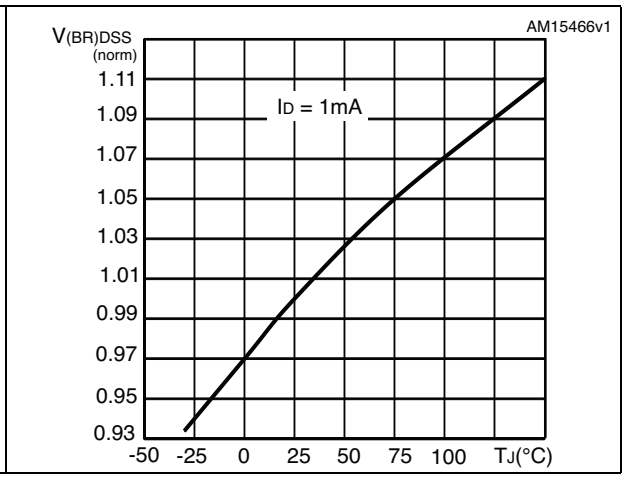


Figure 15. Normalized $V_{(BR)DSS}$ vs temperature



3 Test circuits

Figure 16. Switching times test circuit for resistive load

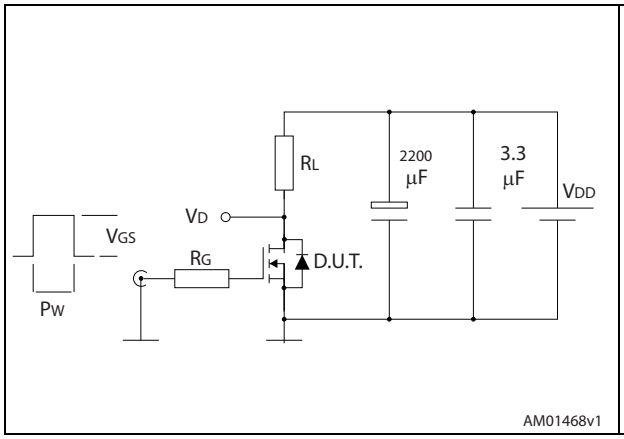


Figure 17. Gate charge test circuit

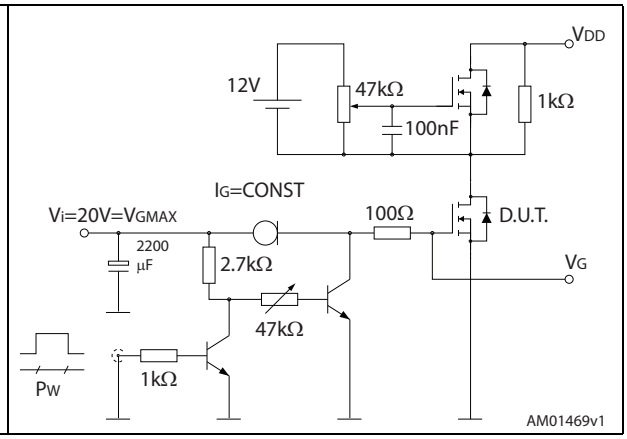


Figure 18. Test circuit for inductive load switching and diode recovery times

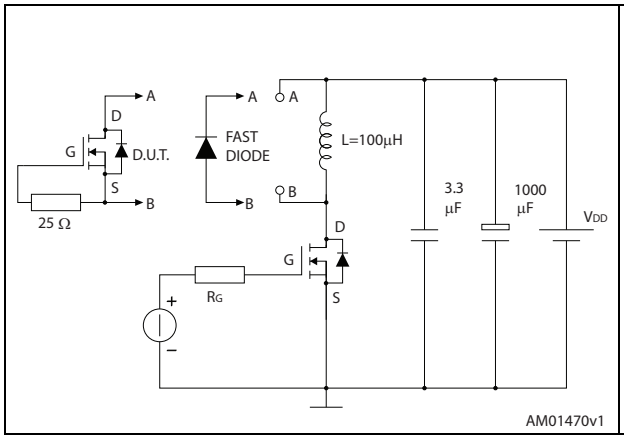


Figure 19. Unclamped inductive load test circuit

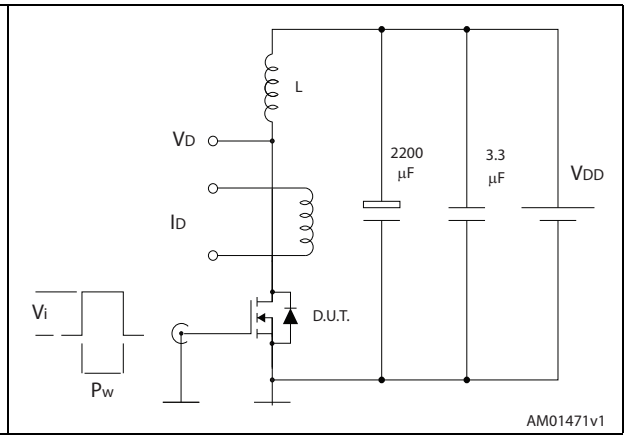


Figure 20. Unclamped inductive waveform

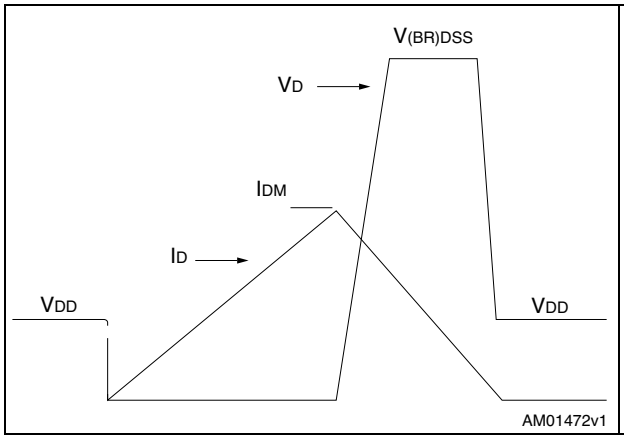
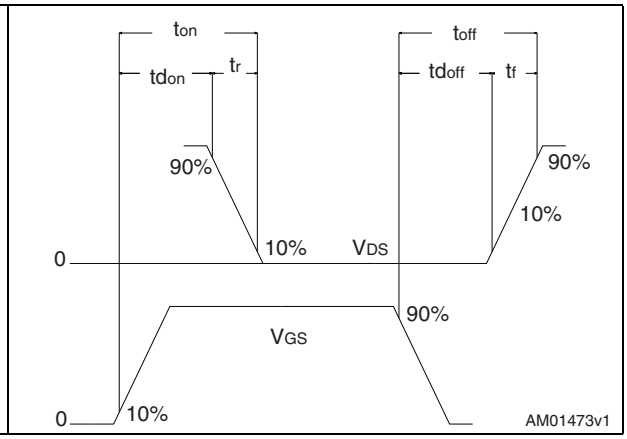


Figure 21. Switching time waveform



4 Package mechanical data

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.

Figure 22. D²PAK (TO-263) drawing

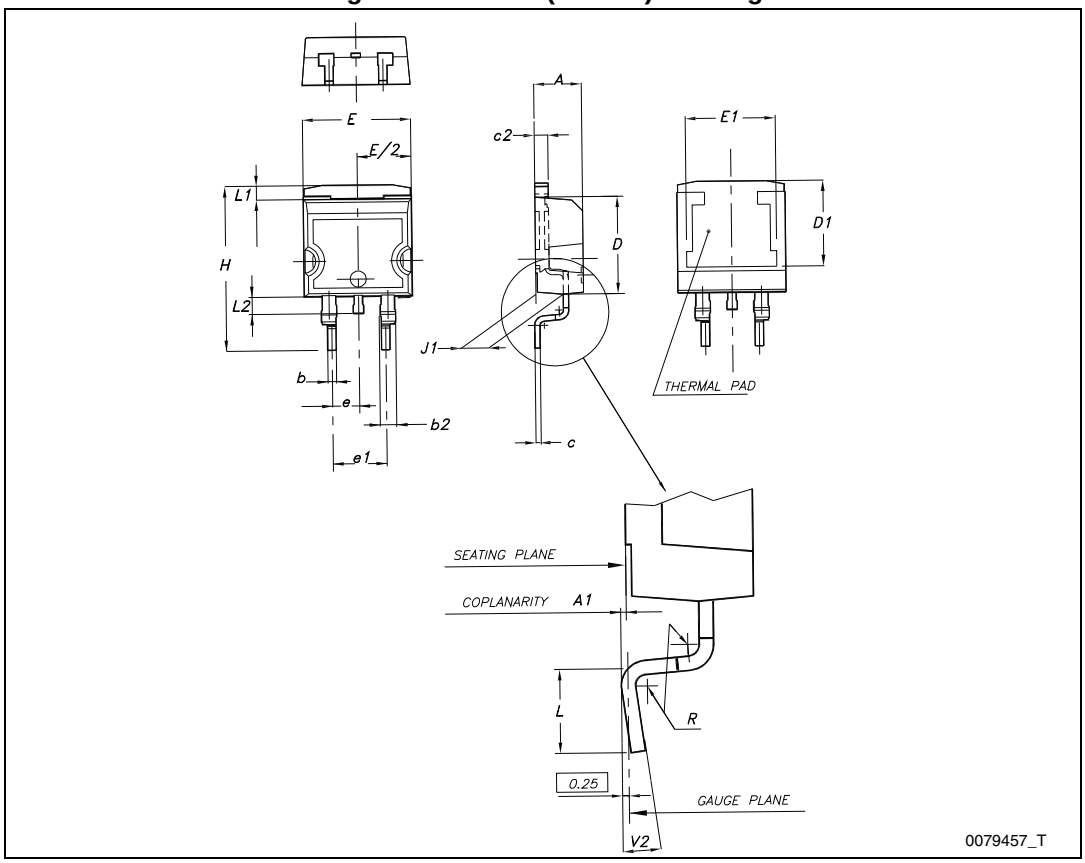


Table 9. D²PAK (TO-263) mechanical data

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. D²PAK footprint(a)

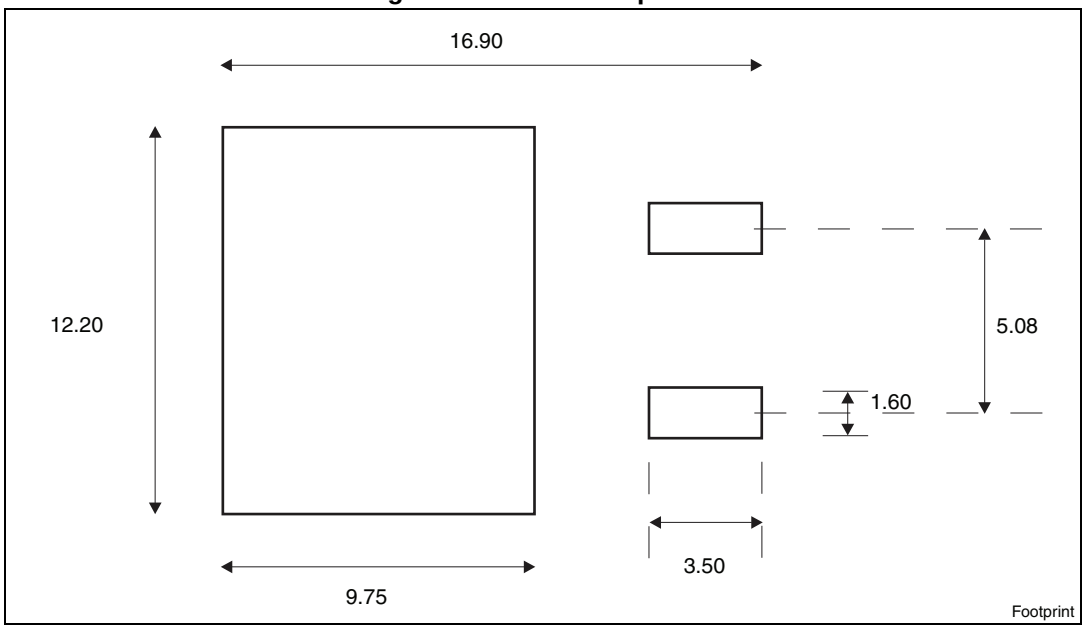
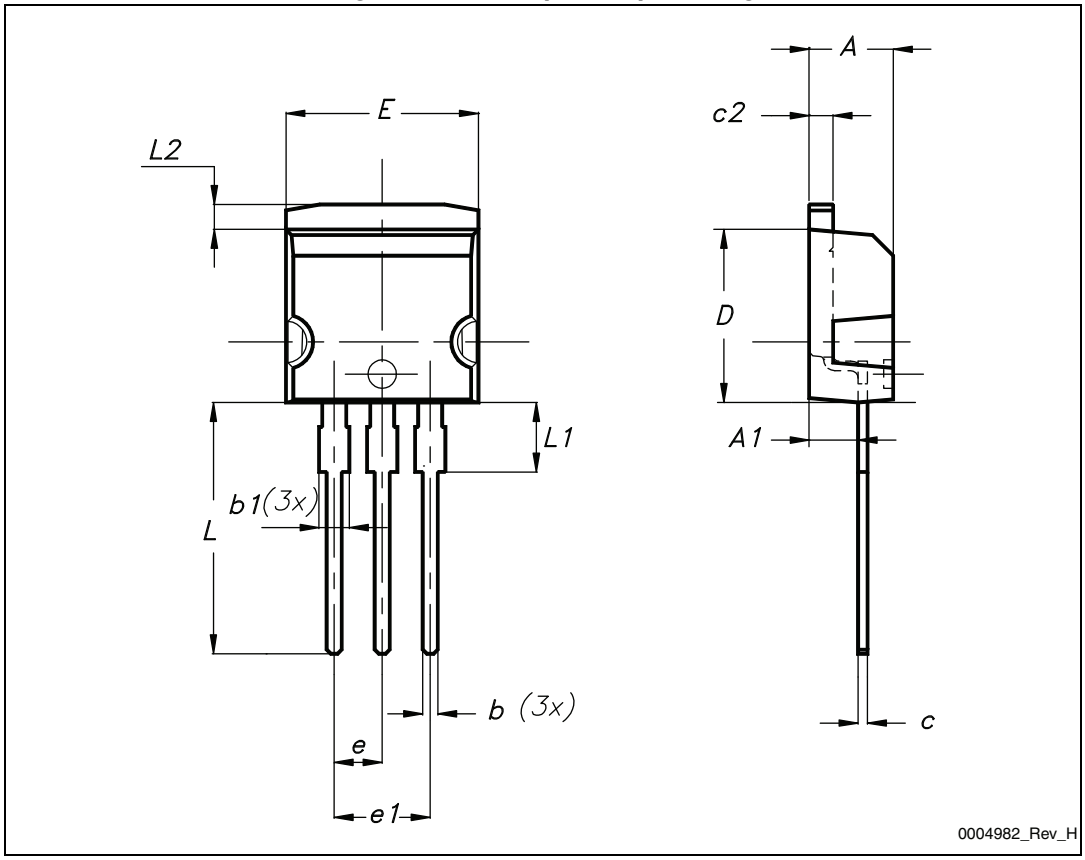


Figure 24. I²PAK (TO-262) drawing



a. All dimension are in millimeters

Table 10. I²PAK (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

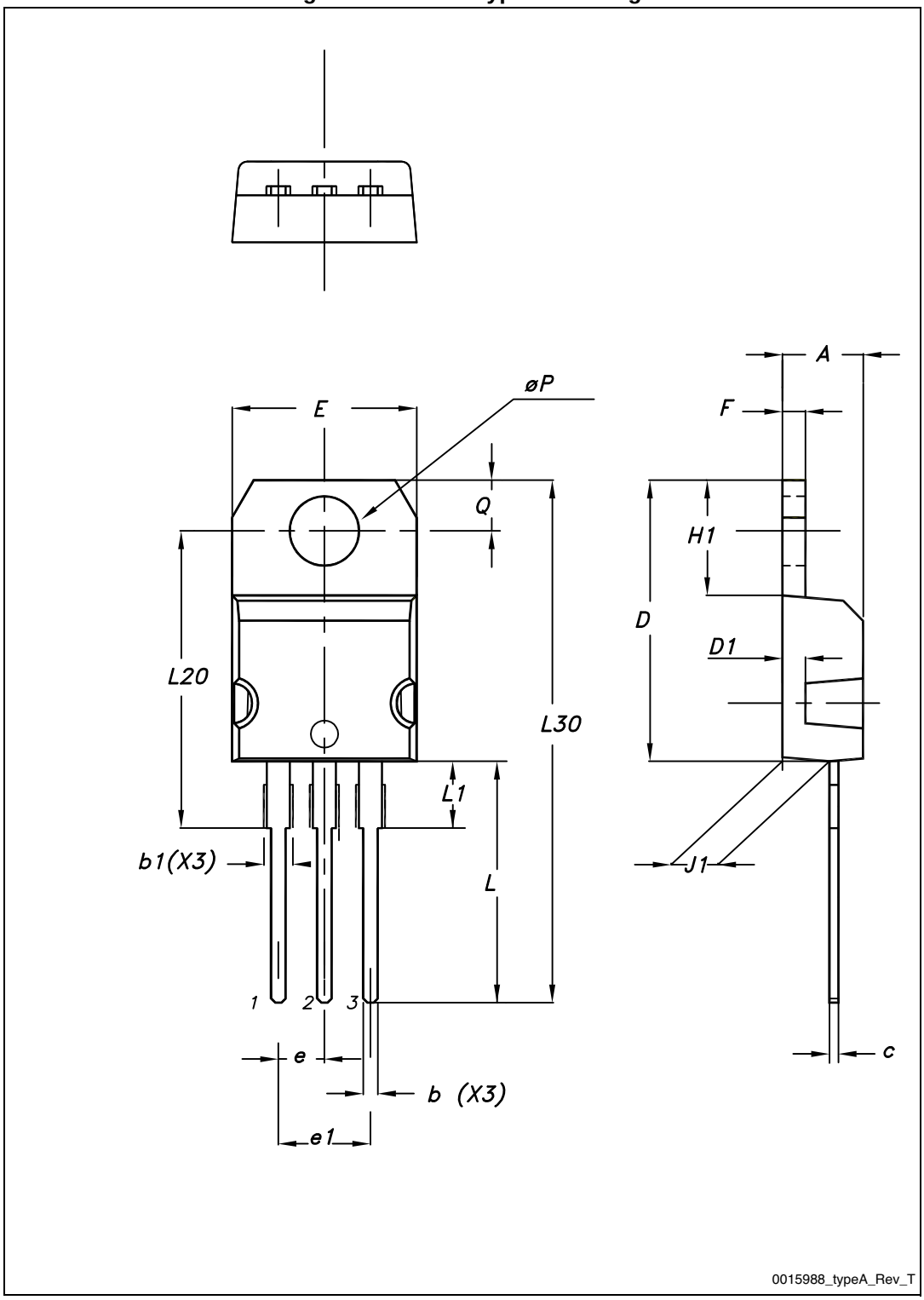


Table 11. TO-220 type A mechanical data

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	
∅P	3.75		3.85
Q	2.65		2.95

Figure 26. TO-247 drawing

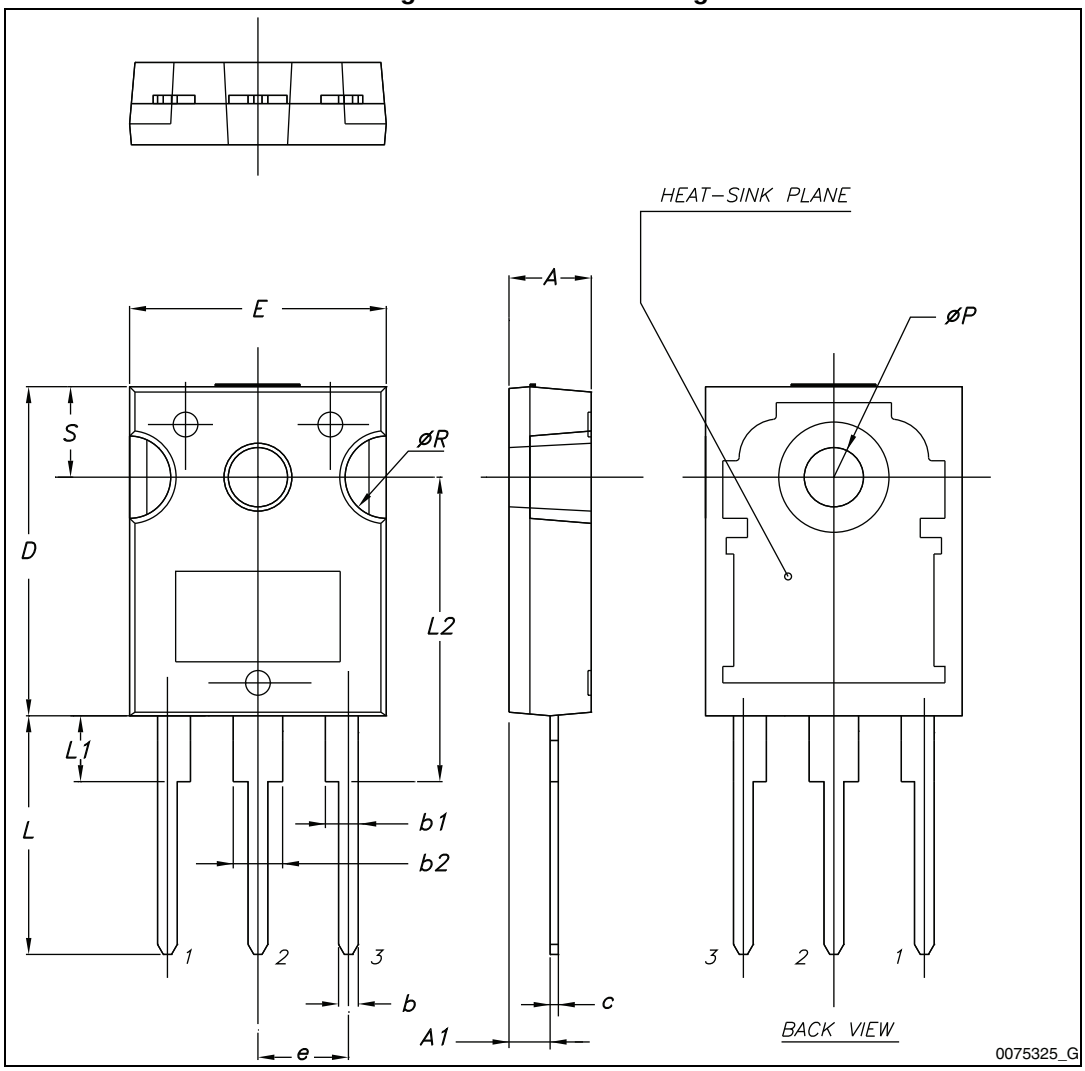


Table 12. TO-247 mechanical data

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	
∅P	3.55		3.65
∅R	4.50		5.50
S	5.30	5.50	5.70

5 Packaging mechanical data

Figure 27. Tape

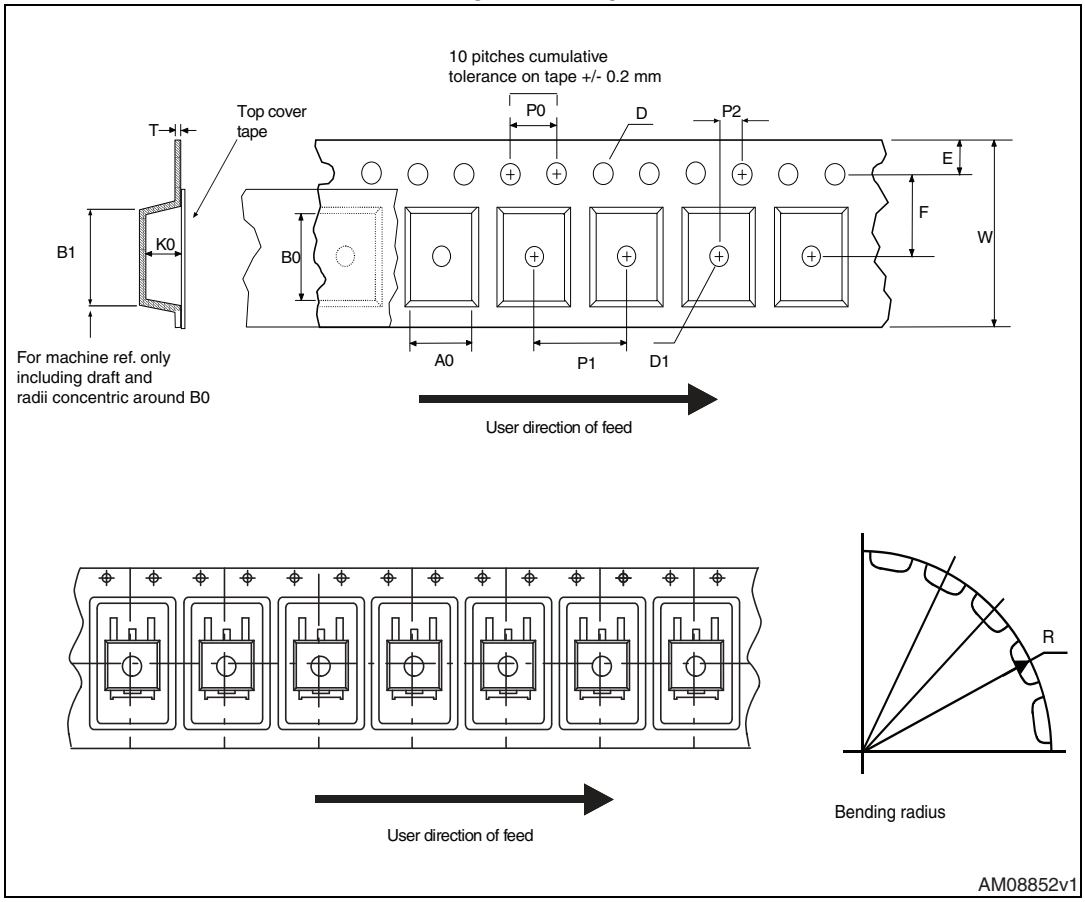


Figure 28. Reel

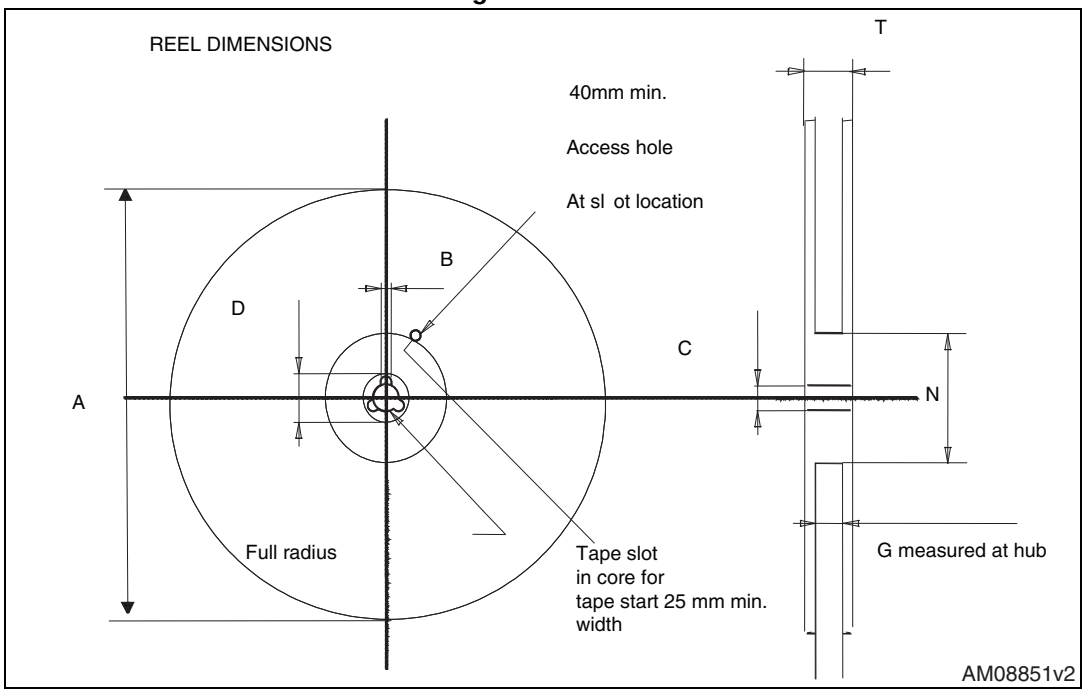


Table 13. D²PAK (TO-263) tape and reel mechanical data

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 *Table 2: Absolute maximum ratings*.
14-Jan-2013	3	Modified: *Figure 16* , *17*, *18* and *17*
28-May-2013	4	– Minor text changes – Updated: *Table 7* – Updated: *Table 11* and *Figure 25*
28-Feb-2014	5	– Minor text changes – Modified: title of *Figure 15*. – Modified: *Figure 16*, *17*, *18* and *19*