STB40N60M2, STP40N60M2, STW40N60M2

N-channel 600 V, 0.078 Ω typ., 34 A MDmesh M2 Power MOSFETs in D^{2}PAK, TO-220 and TO-247 packages

Datasheet – production data

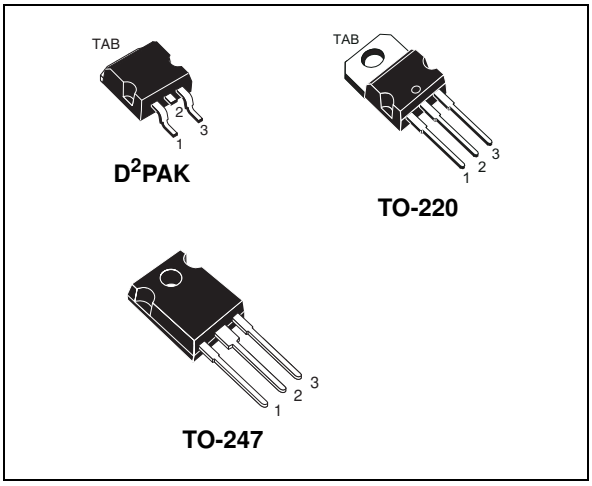
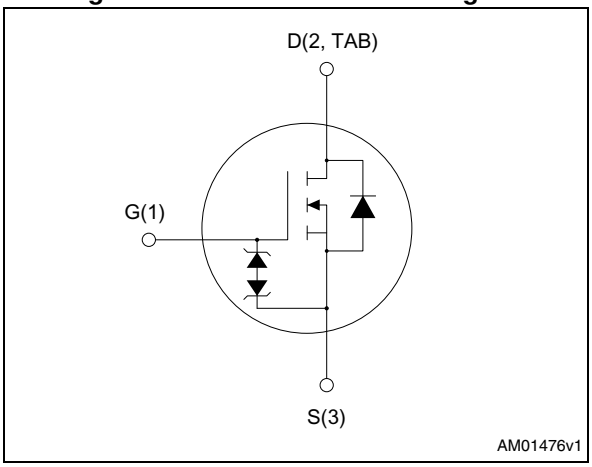


Figure 1. Internal schematic diagram



Features

Order code	V_{DS} @ T_{Jmax}	$R_{DS(on)}$ max	I_D
STB40N60M2	650 V	0.088 Ω	34 A
STP40N60M2			
STW40N60M2			

- Extremely low gate charge
- Excellent output capacitance (C_{oss}) profile
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications
- LLC converters, resonant converters

Description

These devices are N-channel Power MOSFETs developed using MDmesh™ M2 technology. Thanks to their strip layout and improved vertical structure, the devices exhibit low on-resistance and optimized switching characteristics, rendering them suitable for the most demanding high efficiency converters.

Table 1. Device summary

Order code	Marking	Packages	Packing
STB40N60M2	40N60M2	D^{2}PAK	Tape and reel
STP40N60M2		TO-220	Tube
STW40N60M2		TO-247	

Contents

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	34	A
I_D	Drain current (continuous) at T_C = 100 °C	22	A
I_{DM}(1)	Drain current (pulsed)	136	A
P_{TOT}	Total dissipation at T_C = 25 °C	250	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 range	- 55 to 150	°C
T_j	Operating junction temperature range		°C

1. Pulse width limited by safe operating area.
2. $I_{SD} \leq 34$ 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	TO-220	TO-247	
$R_{thj\text{-}case}$	Thermal resistance junction-case	0.50			°C/W
$R_{thj\text{-}pcb}$	Thermal resistance junction-pcb (1)	30			°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient		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})	6	A
E_{AS}	Single pulse avalanche energy (starting T_j =25°C, $I_D = I_{AR}$; V_{DD}= 50 V)	500	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	600			V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0, V_{DS} = 600 V			1	µA
		V_{GS} = 0, V_{DS} = 600 V, T_C = 125 °C (1)			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 = 17 A		0.078	0.088	Ω

1. Defined by design, not subject to production test

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	-	2500	-	pF
C_{oss}	Output capacitance		-	117	-	pF
C_{rss}	Reverse transfer capacitance		-	2.4	-	pF
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{DS} = 0 to 480 V, V_{GS} = 0	-	342	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz, I_D = 0	-	4.4	-	Ω
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 34 A, V_{GS} = 10 V (see *Figure 17*)	-	57	-	nC
Q_{gs}	Gate-source charge		-	10	-	nC
Q_{gd}	Gate-drain charge		-	25.5	-	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 = 34 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 16* and *Figure 21*)	-	20.5	-	ns
t_r	Rise time		-	13.5	-	ns
$t_{d(off)}$	Turn-off-delay time		-	96	-	ns
t_f	Fall time		-	11	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-	34		A
I_{SDM} (1)	Source-drain current (pulsed)		-	136		A
V_{SD} (2)	Forward on voltage	I_{SD} = 34 A, V_{GS} = 0	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 34 A, di/dt = 100 A/µs V_{DD} = 60 V (see *Figure 18*)	-	440		ns
Q_{rr}	Reverse recovery charge		-	8.2		µC
I_{RRM}	Reverse recovery current		-	37		A
t_{rr}	Reverse recovery time	I_{SD} = 34 A, di/dt = 100 A/µs V_{DD} = 60 V, T_j = 150 °C (see *Figure 18*)	-	568		ns
Q_{rr}	Reverse recovery charge		-	11.5		µC
I_{RRM}	Reverse recovery current		-	40.5		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 and TO-220

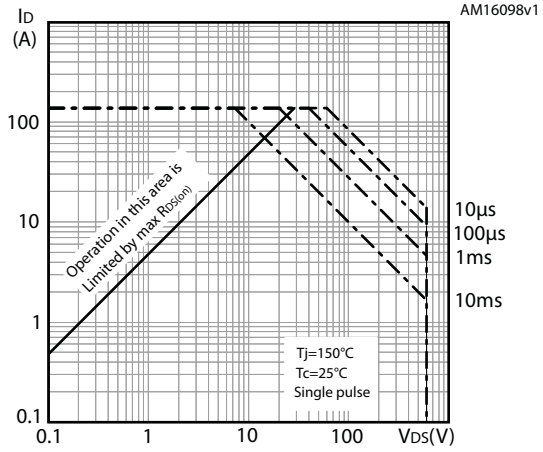


Figure 3. Thermal impedance D²PAK and TO-220

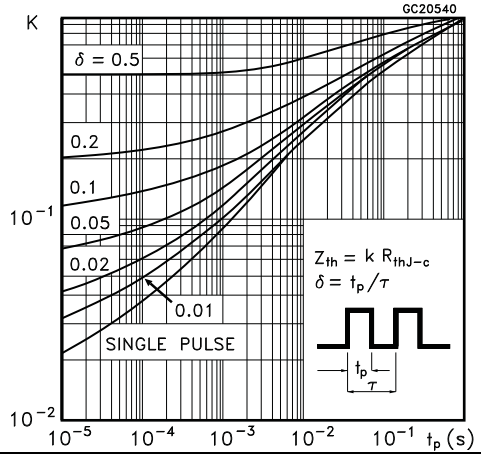


Figure 4. Safe operating area for TO-247

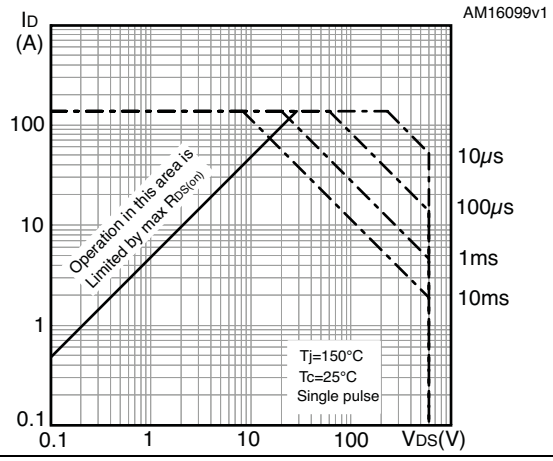


Figure 5. Thermal impedance for TO-247

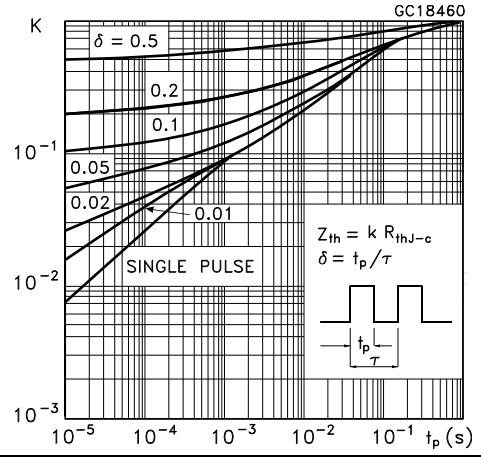


Figure 6. Output characteristics

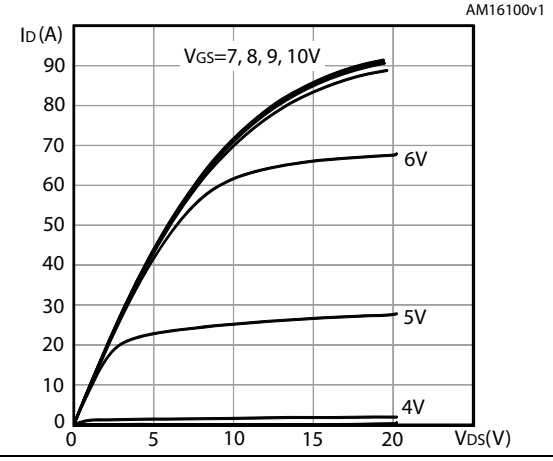


Figure 7. ransfer characteristics

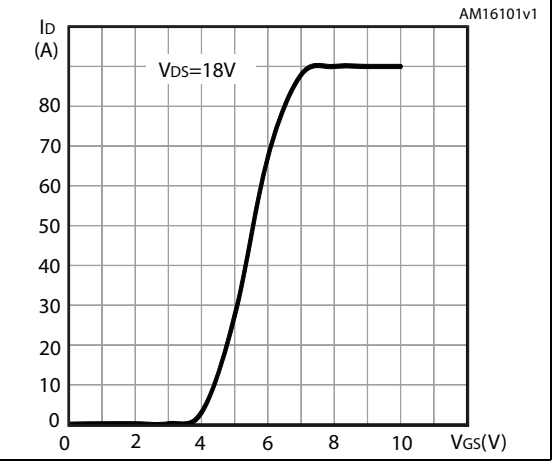


Figure 8. Gate charge vs gate-source voltage

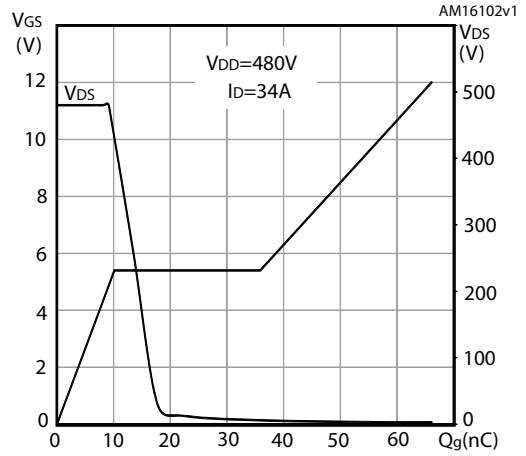


Figure 9. Static drain-source on-resistance

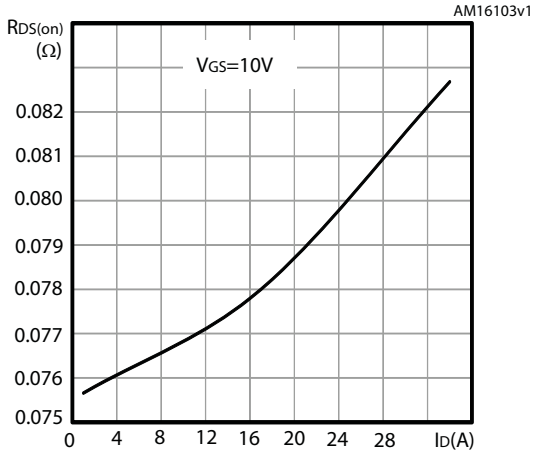


Figure 10. Capacitance variations

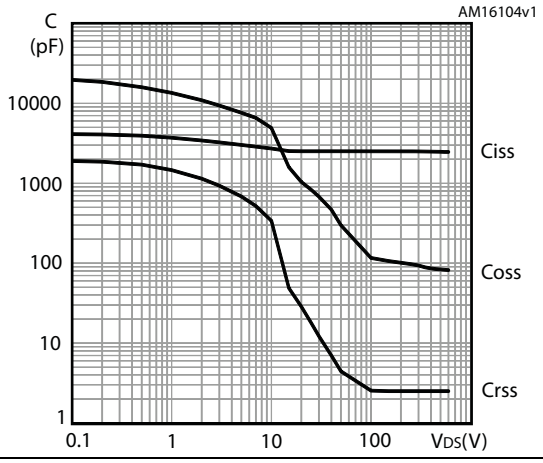


Figure 11. Output capacitance stored energy

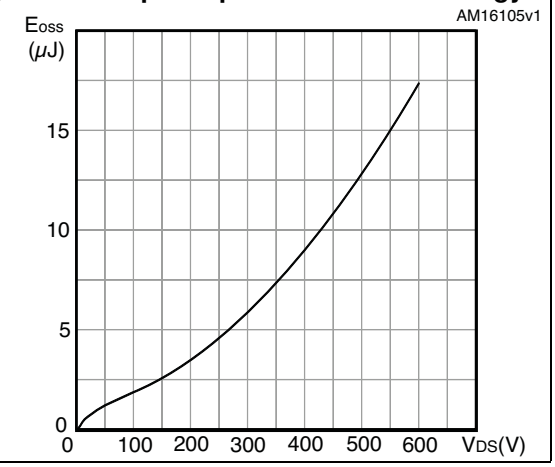


Figure 12. Normalized gate threshold voltage vs temperature

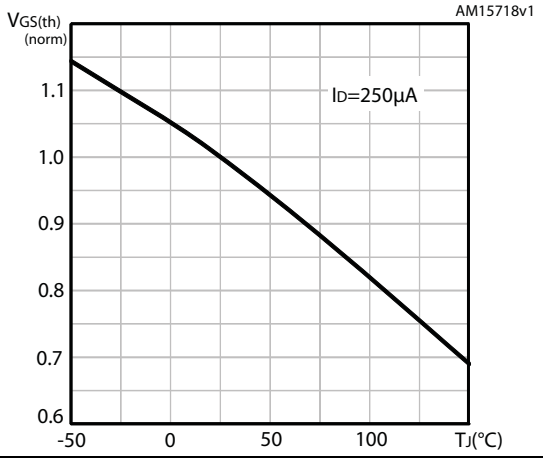


Figure 13. Normalized on-resistance vs temperature

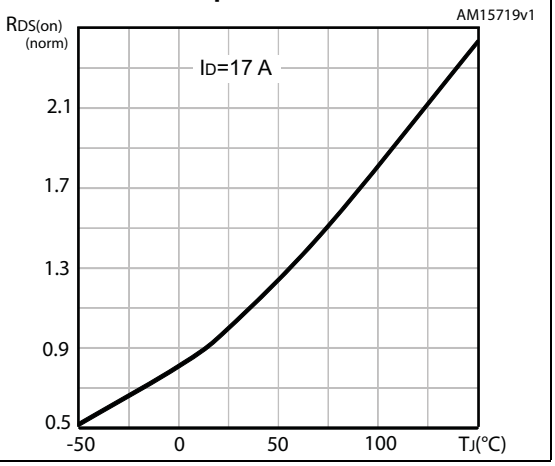


Figure 14. Normalized $V_{(BR)DSS}$ vs temperature

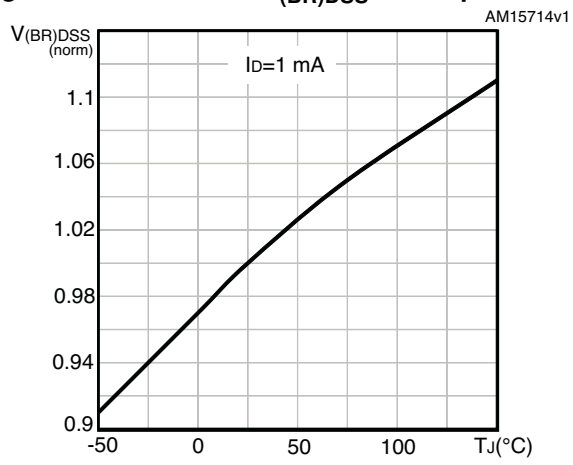
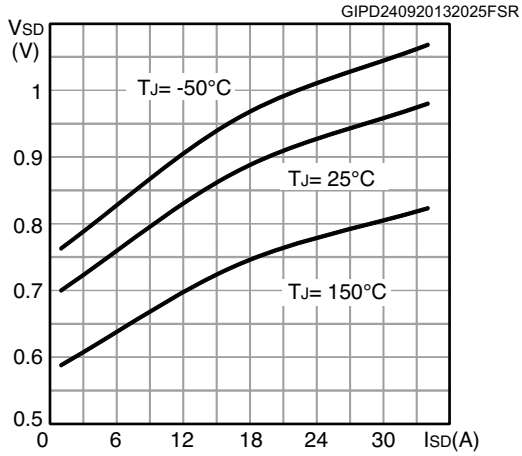


Figure 15. Source-drain diode forward vs temperature



3 Test circuits

Figure 16. Switching times test circuit for resistive load

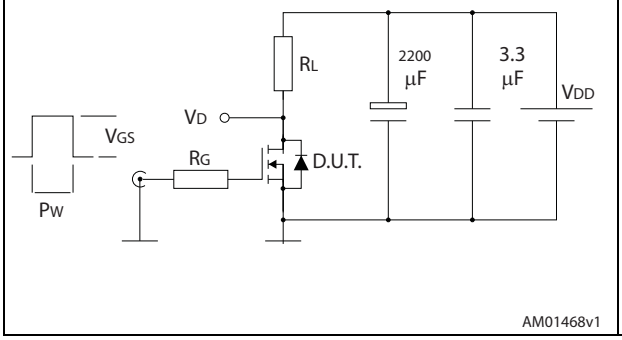


Figure 17. Gate charge test circuit

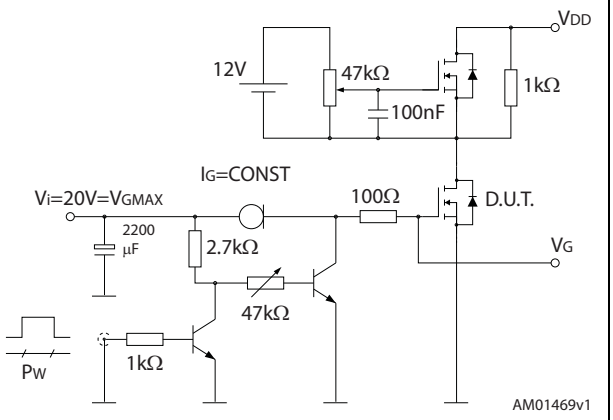


Figure 18. Test circuit for inductive load switching and diode recovery times

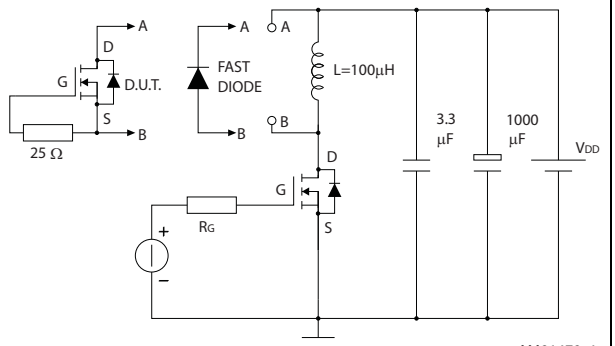


Figure 19. Unclamped inductive load test circuit

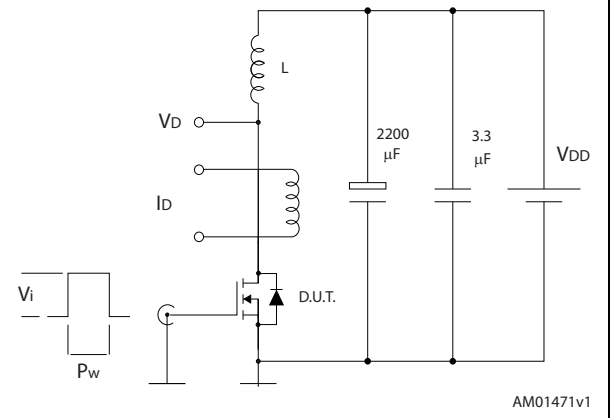


Figure 20. Unclamped inductive waveform

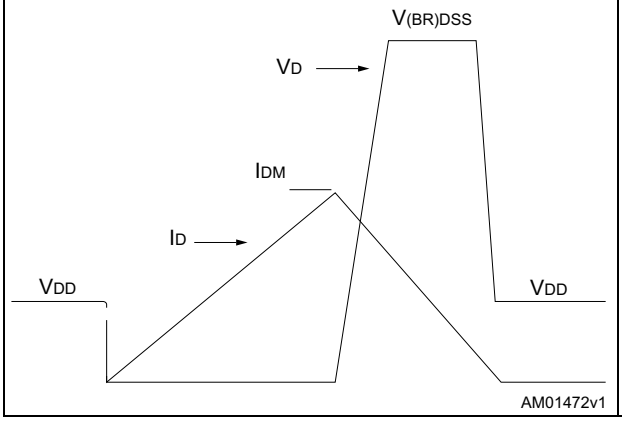
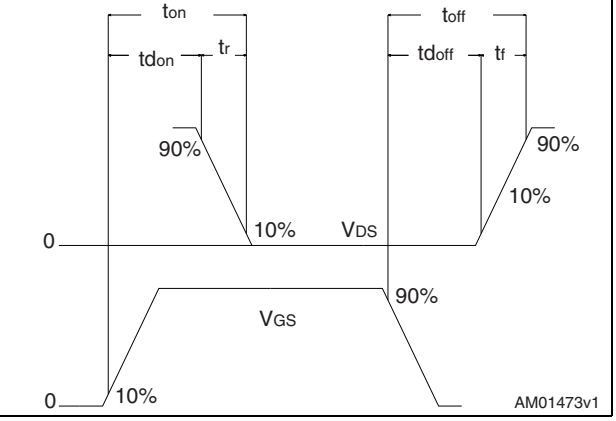


Figure 21. Switching time waveform



4 Package information

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.

4.1 D²PAK (TO-263) package information

Figure 22. D²PAK (TO-263) type A package outline

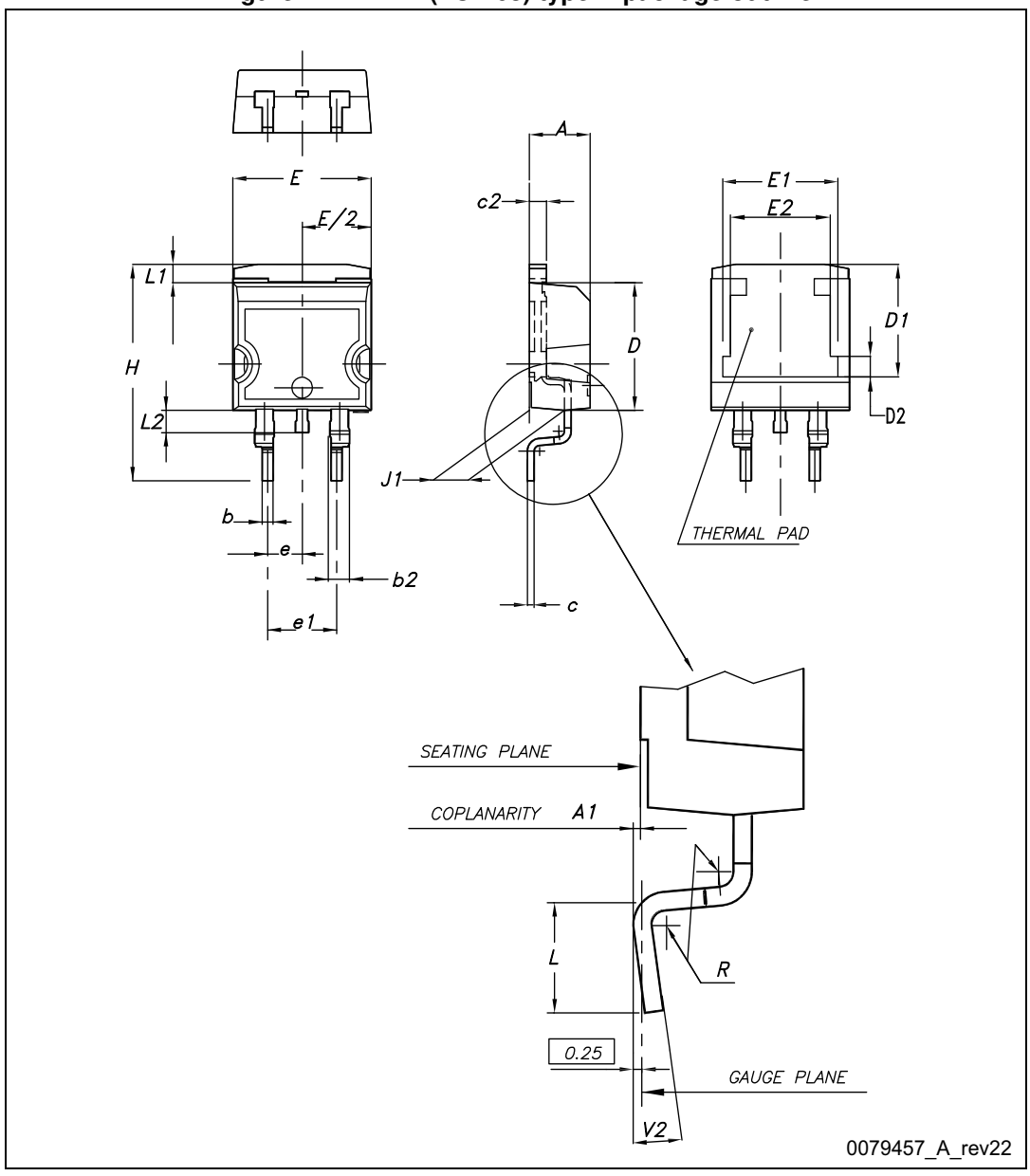
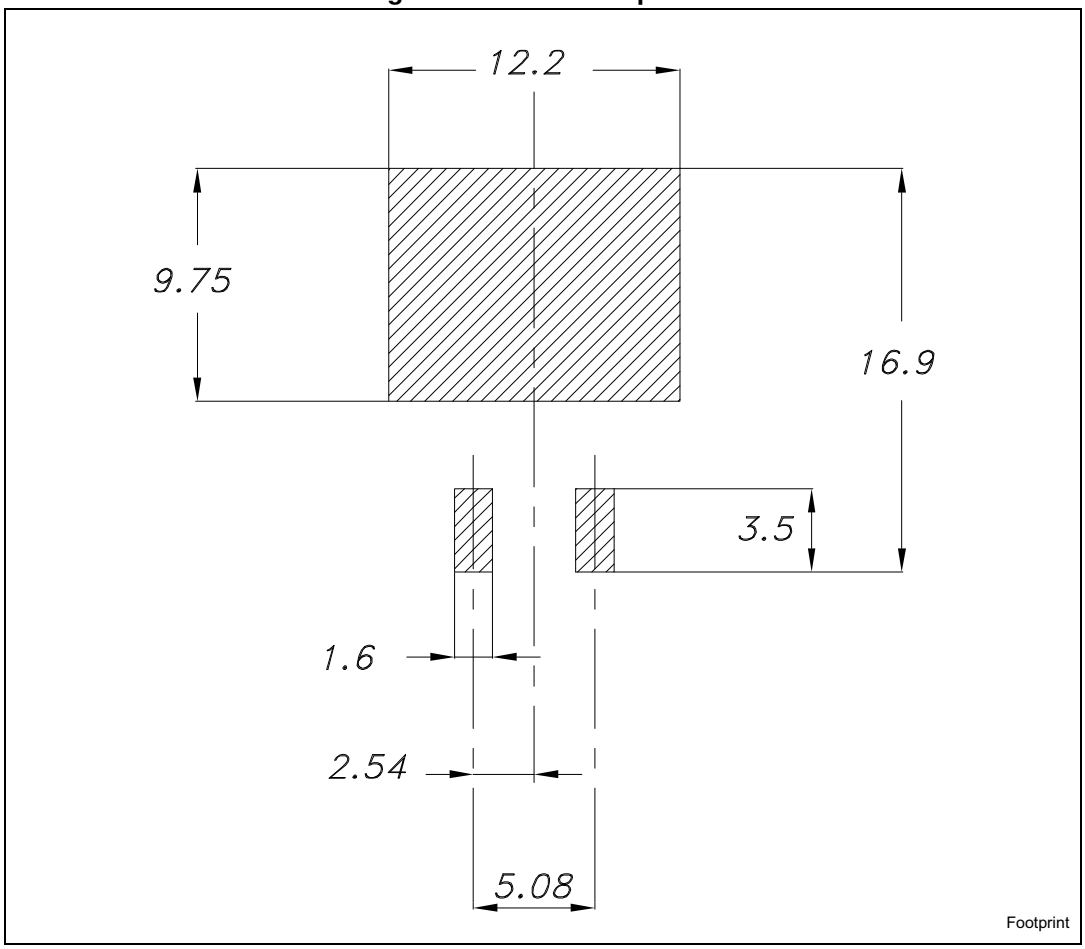


Table 9. D²PAK (TO-263) type A mechanical data

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	7.75	8.00
D2	1.10	1.30	1.50
E	10.00		10.40
E1	8.50	8.70	8.90
E2	6.85	7.05	7.25
e		2.54	
e1	4.88		5.28
H	15.00		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)



a. All dimension are in millimeters

4.2 TO-220 package information

Figure 24. TO-220 type A package outline

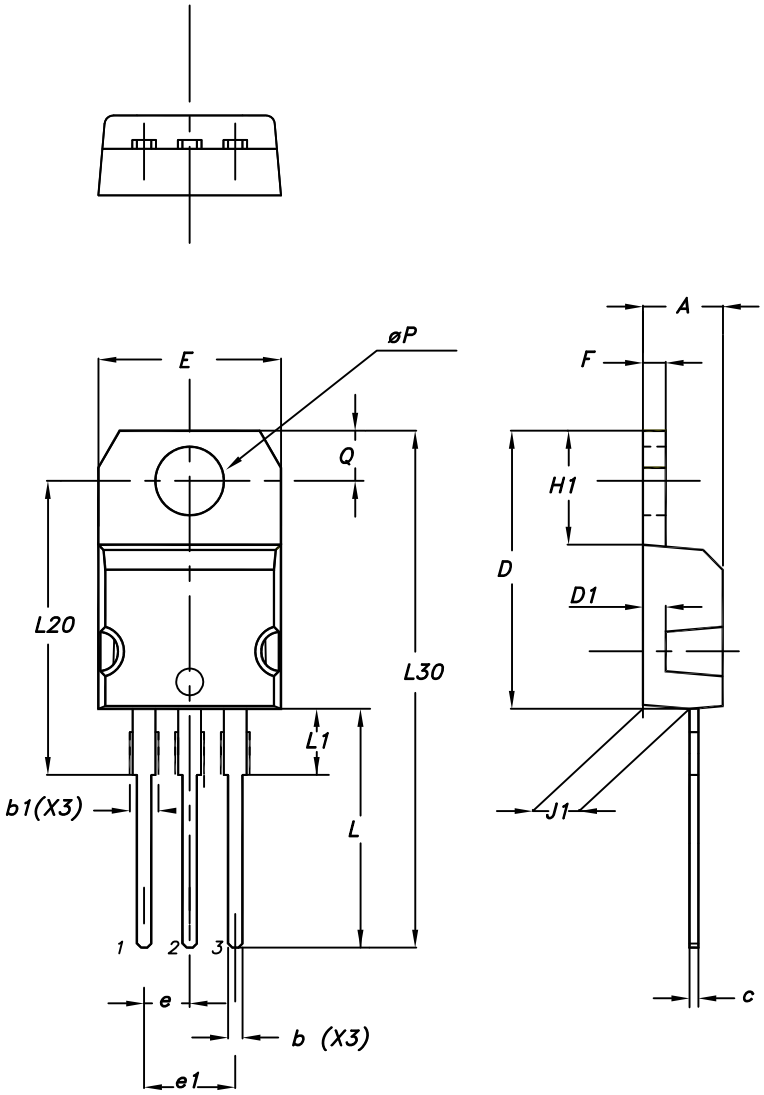


Table 10. TO-220 type A mechanical data

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	
øP	3.75		3.85
Q	2.65		2.95

4.3 TO-247 package information

Figure 25. TO-247 package outline

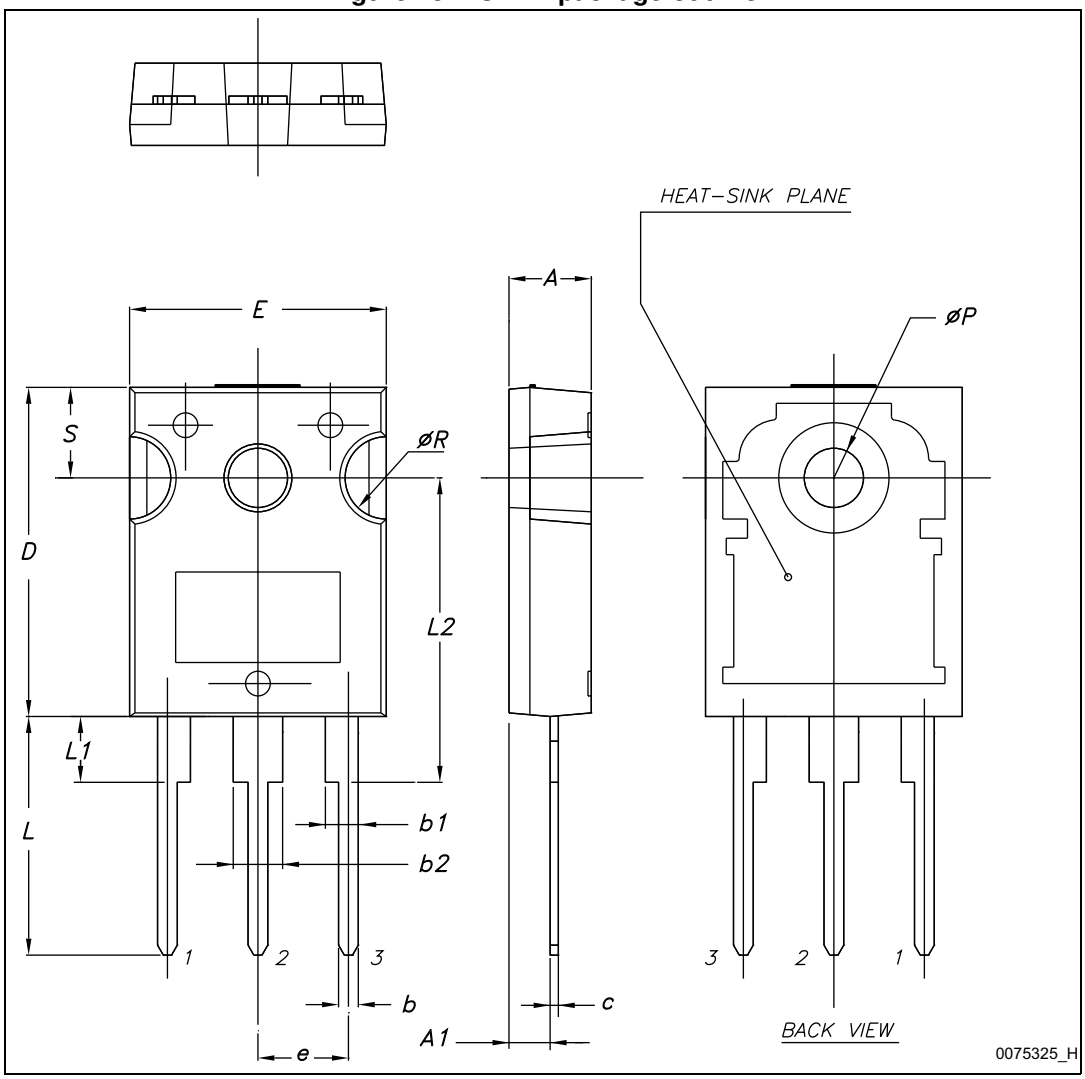


Table 11. TO-247 package mechanical data

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 Packing information

Figure 26. Tape

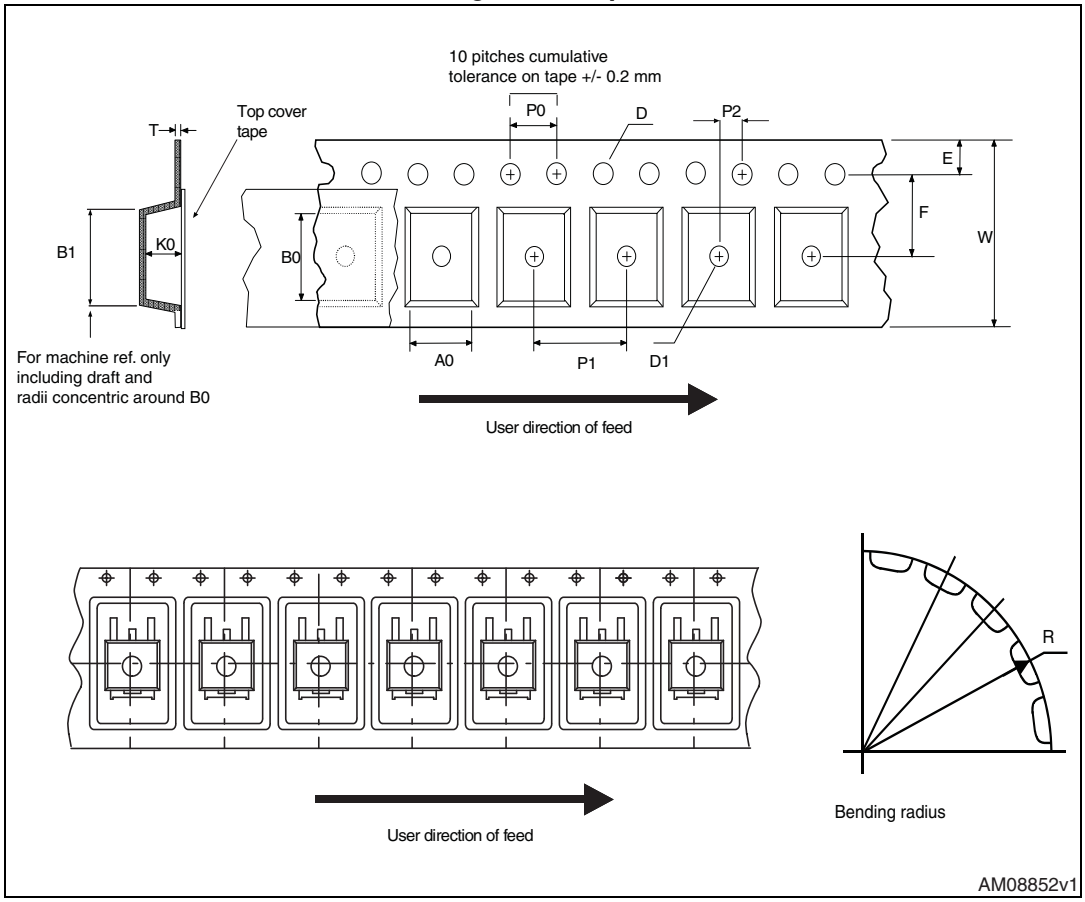


Figure 27. Reel

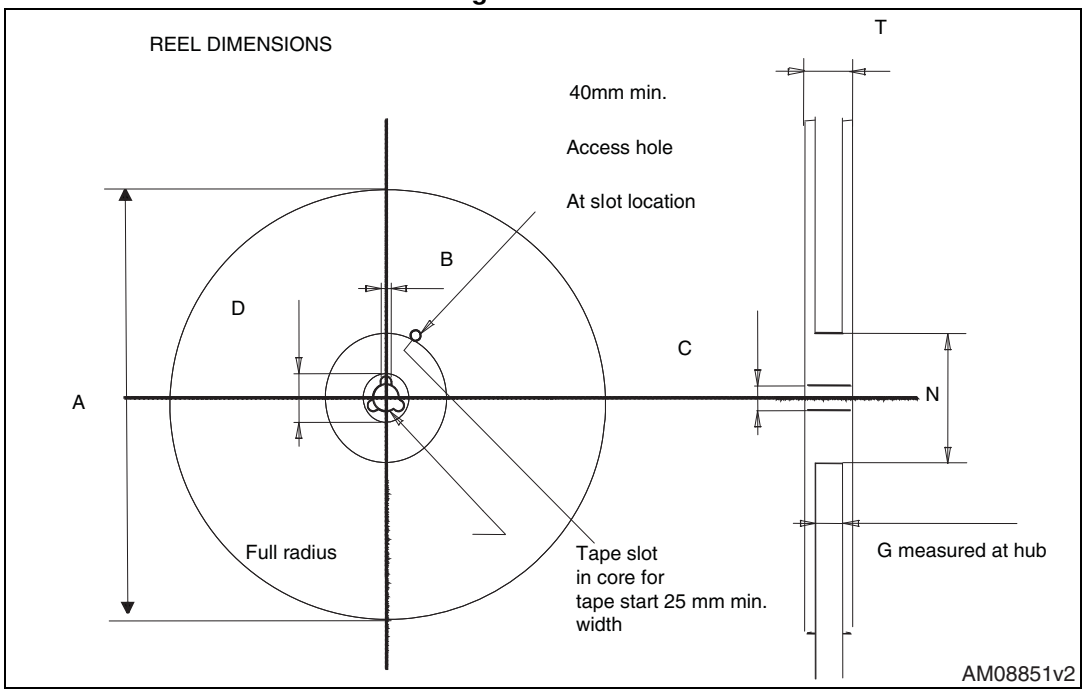


Table 12. D²PAK (TO-263) tape and reel mechanical data

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 13. Document revision history

Date	Revision	Changes
01-Jul-2013	1	First release.
23-Sep-2013	2	– Added: TO-220FP and I^2PAKFP packages – Inserted: V_{ISO} in *Table 2* – Modified: values in *Table 4*, the entire typical values in Table *6, 7* and *8* – Updated: *Section 4: Package mechanical data.* – Minor text changes
13-May-2014	3	– The part numbers STF40N60M2 and STFI40N60M2 have been moved to a separate datasheet – Minor text changes
09-Aug-2016	4	Updated title, features and description in cover page. Updated *Table 2: Absolute maximum ratings*, *Table 5: On /off states* and *Table 8: Source drain diode*. Updated *Section 4.1: D^2PAK (TO-263) package information* and *Section 4.2: TO-220 package information*. Minor text changes.