

N-channel 950 V, 0.275 Ω typ., 17.5 A MDmesh™ K5
Power MOSFETs in D²PAK, TO-220FP, TO-220 and TO-247

Datasheet - production data

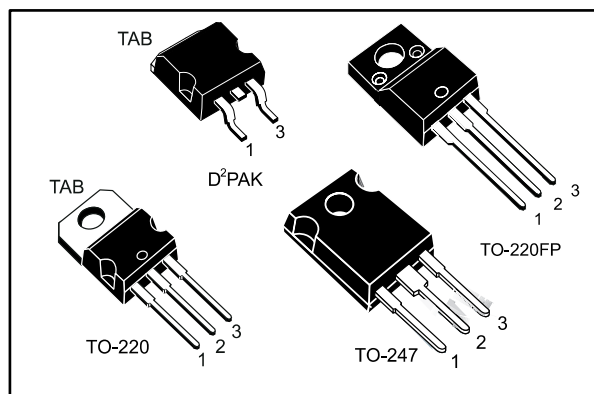
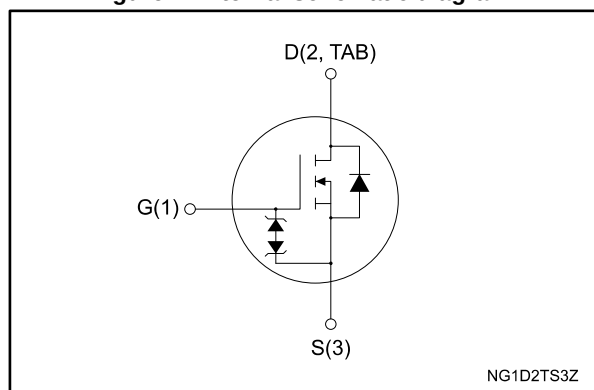


Figure 1: Internal schematic diagram



Features

Order code	V _{DS}	R _{DS(on)} max.	I _D	P _{TOT}
STB20N95K5	950 V	0.330 Ω	17.5 A	250 W
STF20N95K5				40 W
STP20N95K5				250 W
STW20N95K5				

- Industry's lowest R_{DS(on)} x area
- Industry's best FoM (figure of merit)
- Ultra-low gate charge
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

These very high voltage N-channel Power MOSFETs are designed using MDmesh™ K5 technology based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance and ultra-low gate charge for applications requiring superior power density and high efficiency.

Table 1: Device summary

Order code	Marking	Package	Packing
STB20N95K5	20N95K5	D ² PAK	Tape and reel
STF20N95K5		TO-220FP	Tube
STP20N95K5		TO-220	
STW20N95K5		TO-247	

Contents

1	Electrical ratings	3
2	Electrical characteristics	4
2.1	Electrical characteristics (curves)	6
3	Test circuits	9
4	Package information	10
4.1	D ² PAK package information	10
4.2	TO-220FP package information	13
4.3	TO-220 type A package information	15
4.4	TO-247 package information	17
4.5	D ² PAK packing information	19
5	Revision history	21

1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D ² PAK TO-220 TO-247	TO-220FP	
V _{GS}	Gate-source voltage	±30		V
I _D	Drain current (continuous) at T _C = 25 °C	17.5		A
I _D	Drain current (continuous) at T _C = 100 °C	11		A
I _D ⁽¹⁾	Drain current (pulsed)	70		A
P _{TOT}	Total dissipation at T _C = 25 °C	250	40	W
ESD	Gate-source human body model (R= 1,5 kΩ, C = 100 pF)	2		kV
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T _C = 25 °C)		2500	V
dv/dt ⁽²⁾	Peak diode recovery voltage slope	6		V/ns
dv/dt ⁽³⁾	MOSFET dv/dt ruggedness	50		
T _j	Operating junction temperature range	-55 to 150		°C
T _{stg}	Storage temperature range			

Notes:

(1) Pulse width limited by safe operating area.

(2) I_{SD} ≤ 17.5 A, di/dt ≤ 100 A/μs; V_{DS} peak ≤ V_{(BR)DSS}(3) V_{DS} ≤ 760 V

Table 3: Thermal data

Symbol	Parameter	Value				Unit
		D ² PAK	TO-220	TO-247	TO-220FP	
R _{thj-case}	Thermal resistance junction-case	0.5			3.1	°C/W
R _{thj-amb}	Thermal resistance junction-ambient		62.5	50	62.5	
R _{thj-pcb} ⁽¹⁾	Thermal resistance junction-pcb	30				

Notes:(1) When mounted on 1 inch² 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 _{jmax})	6	A
E _{AS}	Single pulse avalanche energy (starting T _j = 25 °C, I _D = I _{AR} , V _{DD} = 50 V)	200	mJ

2 Electrical characteristics

$T_C = 25\text{ }^{\circ}\text{C}$ unless otherwise specified

Table 5: On/off-state

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$, $I_D = 1\text{ mA}$	950			V
I_{DSS}	Zero-gate voltage drain current	$V_{GS} = 0\text{ V}$, $V_{DS} = 950\text{ V}$			1	μA
		$V_{GS} = 0\text{ V}$, $V_{DS} = 950\text{ V}$ $T_C = 125\text{ }^{\circ}\text{C}^{(1)}$			50	μA
I_{GSS}	Gate body leakage current	$V_{DS} = 0\text{ V}$, $V_{GS} = \pm 20\text{ V}$			± 10	μA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 100\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$, $I_D = 9\text{ A}$		0.275	0.330	Ω

Notes:

⁽¹⁾Defined by design, not subject to production test.

Table 6: Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$	-	1550	-	pF
C_{oss}	Output capacitance		-	140	-	pF
C_{rss}	Reverse transfer capacitance		-	1	-	pF
$C_{o(er)}^{(1)}$	Equivalent capacitance energy related	$V_{GS} = 0\text{ V}$, $V_{DS} = 0\text{ to }760\text{ V}$	-	65	-	pF
$C_{o(tr)}^{(2)}$	Equivalent capacitance time related			178	-	pF
R_g	Intrinsic gate resistance	$f = 1\text{ MHz}$, $I_D = 0\text{ A}$	-	3.5	-	Ω
Q_g	Total gate charge	$V_{DD} = 760\text{ V}$, $I_D = 17.5\text{ A}$ $V_{GS} = 10\text{ V}$ (see Figure 20: "Test circuit for gate charge behavior")	-	48	-	nC
Q_{gs}	Gate-source charge		-	9	-	nC
Q_{gd}	Gate-drain charge		-	32.5	-	nC

Notes:

⁽¹⁾ $C_{o(er)}$ is a constant capacitance value that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .

⁽²⁾ $C_{o(tr)}$ is a constant capacitance value that gives the same charging time as C_{oss} while V_{DS} is rising 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	$V_{DD} = 475\text{ V}$, $I_D = 9\text{ A}$, $R_G = 4.7\ \Omega$ $V_{GS} = 10\text{ V}$ (see Figure 19: "Test circuit for resistive load switching times" and Figure 24: "Switching time waveform")	-	18	-	ns
t_r	Rise time		-	9	-	ns
$t_{d(off)}$	Turn-off delay time		-	65	-	ns
t_f	Fall time		-	18	-	ns

Table 8: Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		17.5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		70	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 17.5\text{ A}$, $V_{GS} = 0\text{ V}$	-		1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 17.5\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$ (see Figure 21: "Test circuit for inductive load switching and diode recovery times")	-	513		ns
Q_{rr}	Reverse recovery charge		-	12		μC
I_{RRM}	Reverse recovery current		-	46		A
t_{rr}	Reverse recovery time	$I_{SD} = 17.5\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 21: "Test circuit for inductive load switching and diode recovery times")	-	670		ns
Q_{rr}	Reverse recovery charge		-	15		μC
I_{RRM}	Reverse recovery current		-	44		A

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

Table 9: Gate-source Zener diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)\text{ GSO}}$	Gate-source breakdown voltage	$I_{GS} = \pm 1\text{ mA}$, $I_D = 0\text{ A}$	30	-	-	V

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

2.1 Electrical characteristics (curves)

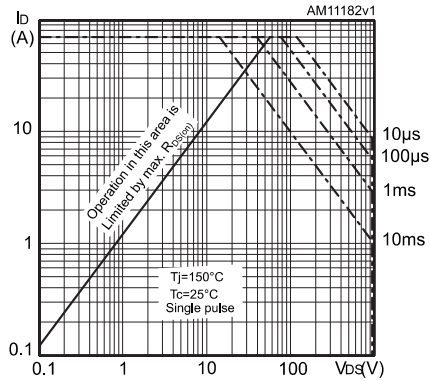
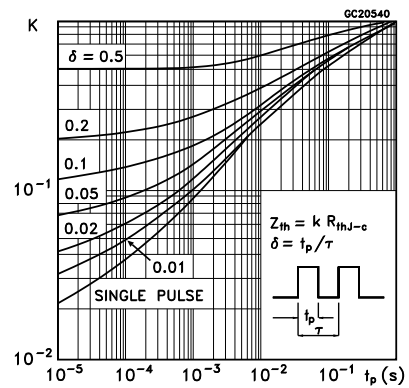
Figure 2: Safe operating area for D²PAK and TO-220Figure 3: Thermal impedance for D²PAK and TO-220

Figure 4: Safe operating area for TO-220FP

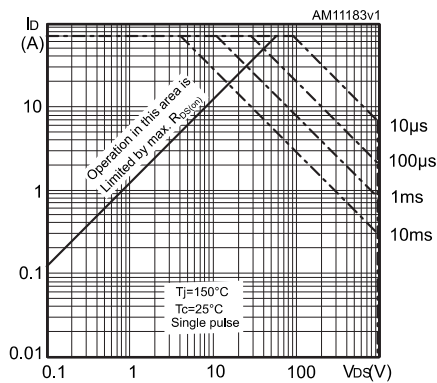


Figure 5: Thermal impedance for TO-220FP

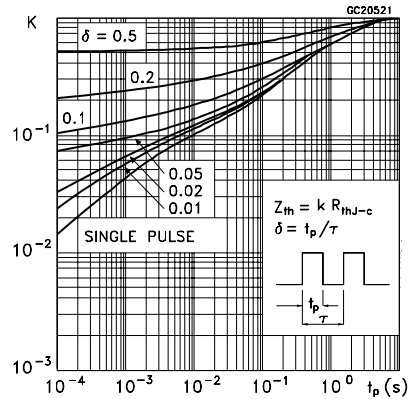


Figure 6: Safe operating area for TO-247

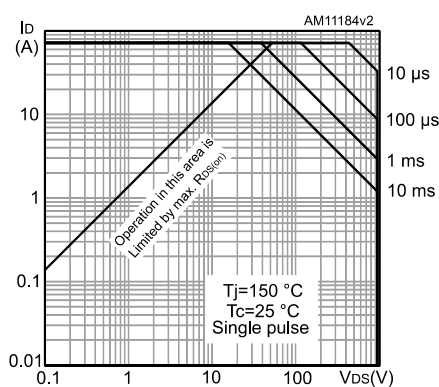


Figure 7: Thermal impedance for TO-247

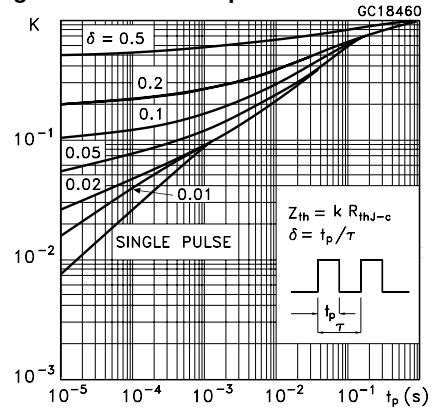


Figure 8: Output characteristics

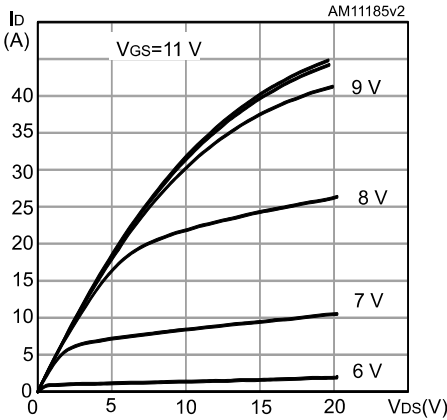


Figure 9: Transfer characteristics

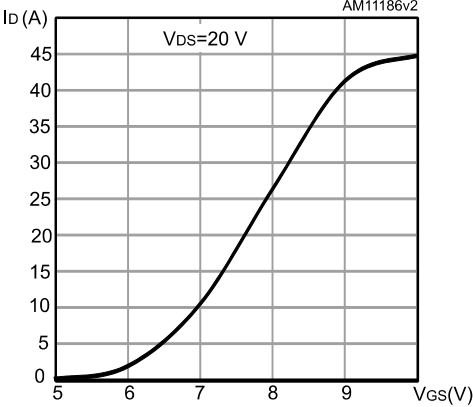


Figure 10: Gate charge vs gate-source voltage

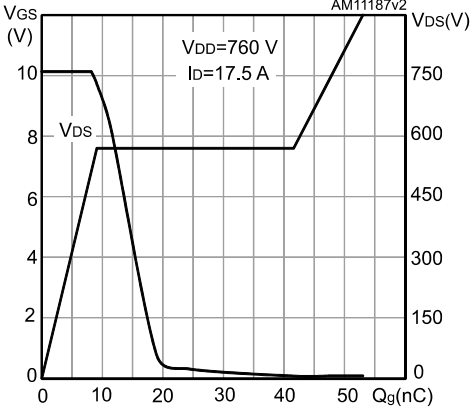


Figure 11: Static drain-source on-resistance

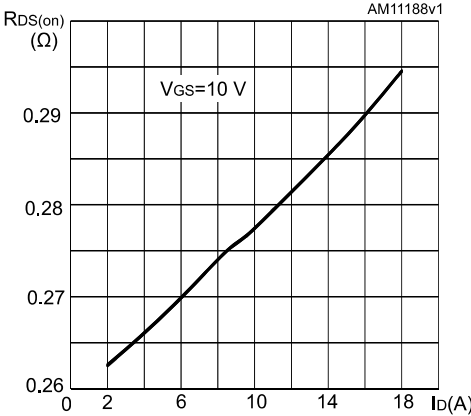


Figure 12: Capacitance variation

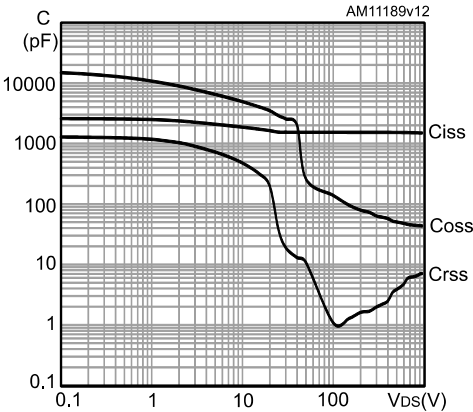


Figure 13: Output capacitance stored energy

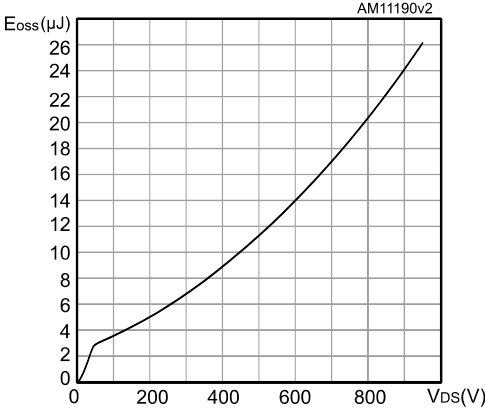
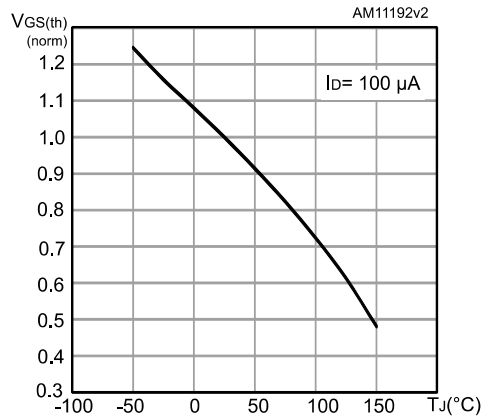
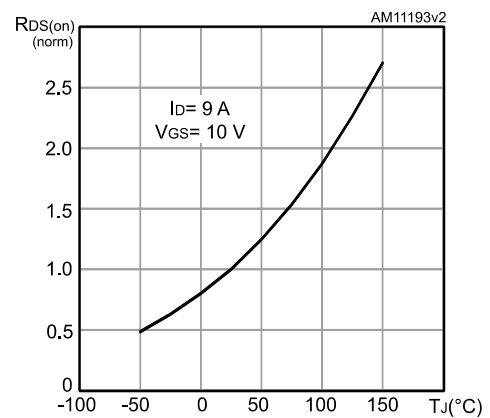
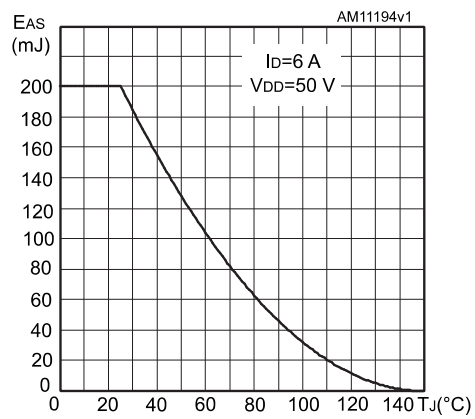
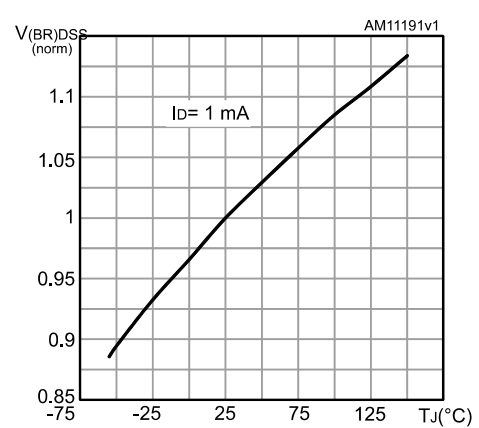
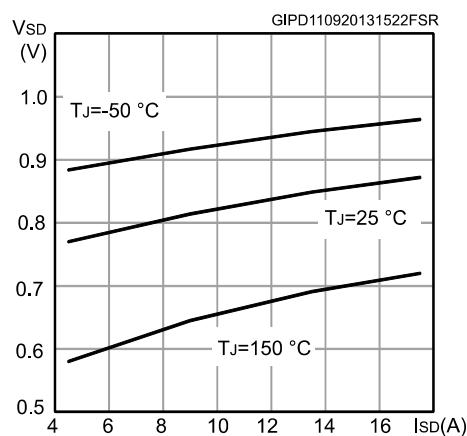
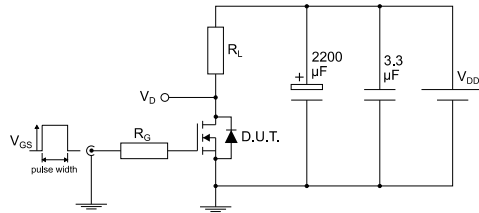


Figure 14: Normalized gate threshold voltage vs temperature**Figure 15: Normalized on-resistance vs temperature****Figure 16: Maximum avalanche energy vs. starting TJ****Figure 17: Normalized $V_{(BR)DSS}$ vs. temperature****Figure 18: Source-drain diode forward characteristics**

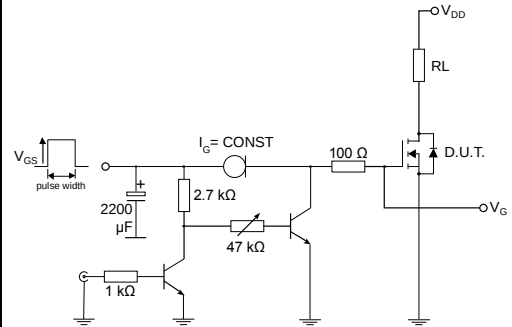
3 Test circuits

Figure 19: Test circuit for resistive load switching times



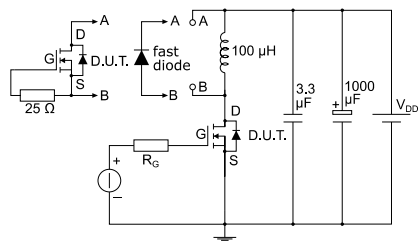
AM01468v1

Figure 20: Test circuit for gate charge behavior



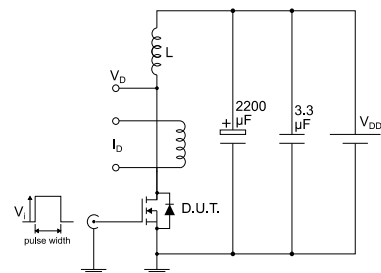
AM01469v10

Figure 21: Test circuit for inductive load switching and diode recovery times



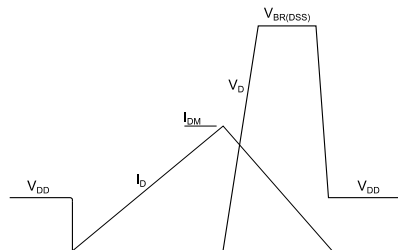
AM01470v1

Figure 22: Unclamped inductive load test circuit



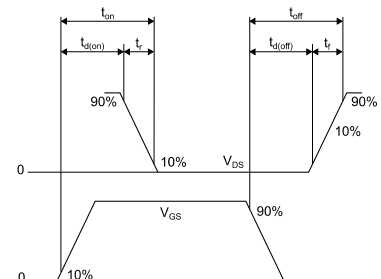
AM01471v1

Figure 23: Unclamped inductive waveform



AM01472v1

Figure 24: Switching time waveform



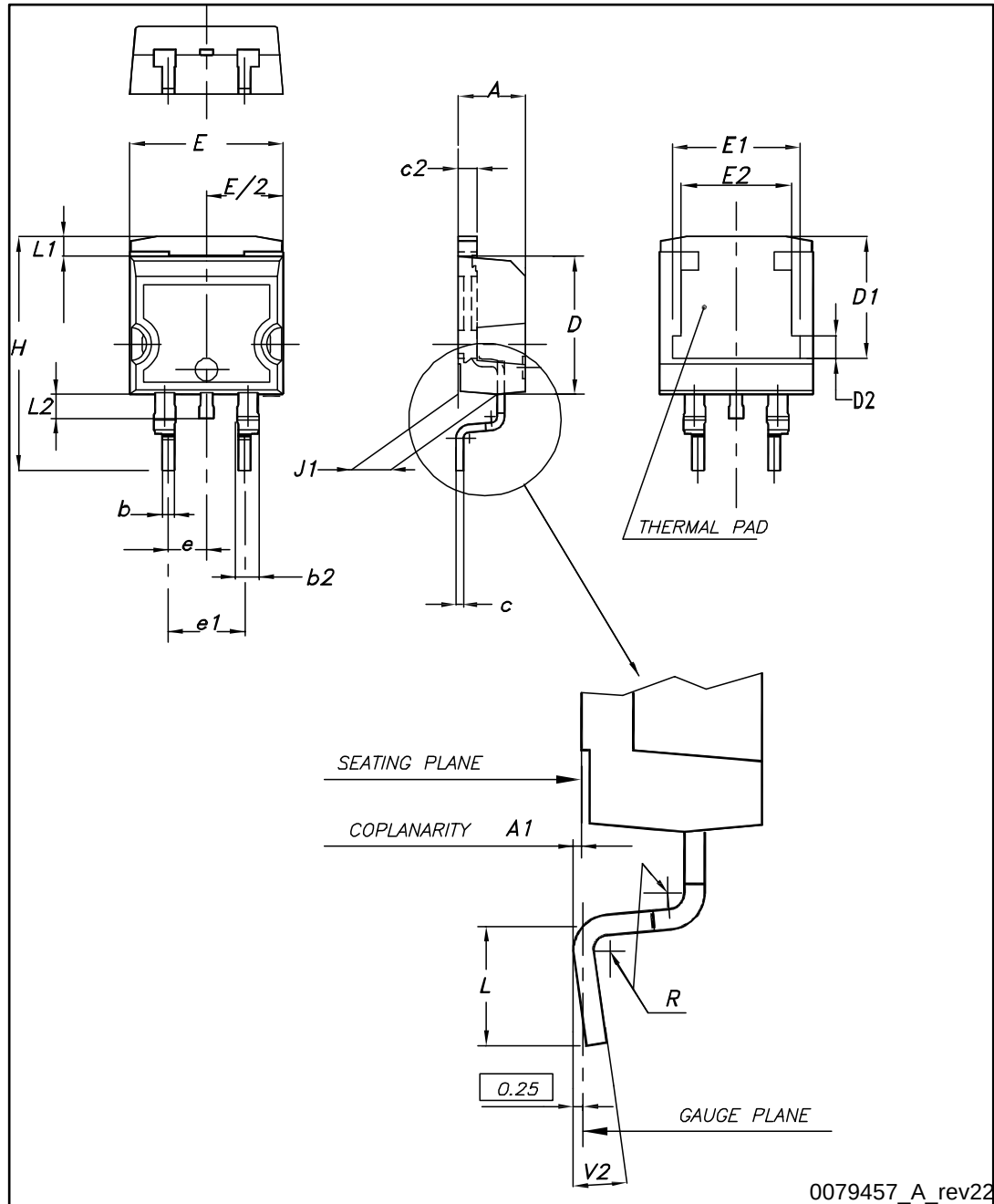
AM01473v1

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 package information

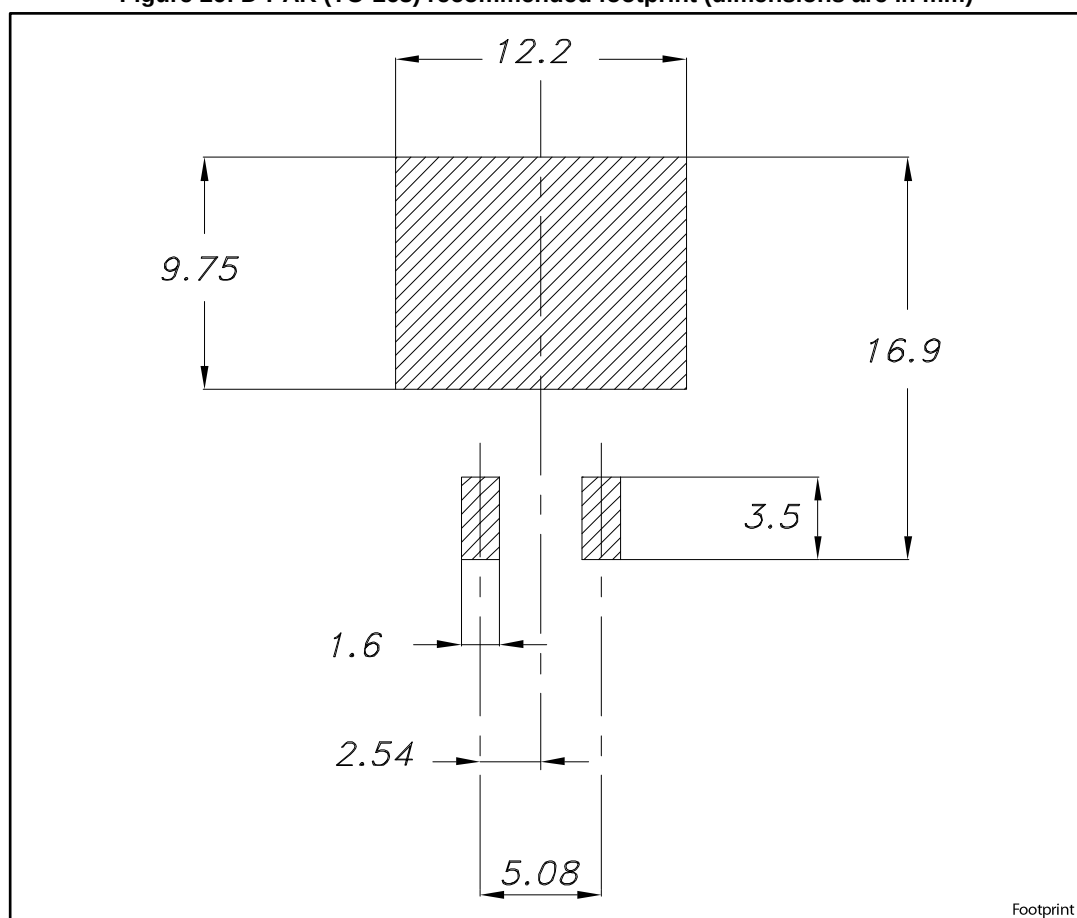
Figure 25: D²PAK (TO-263) type A package outline



0079457_A_rev22

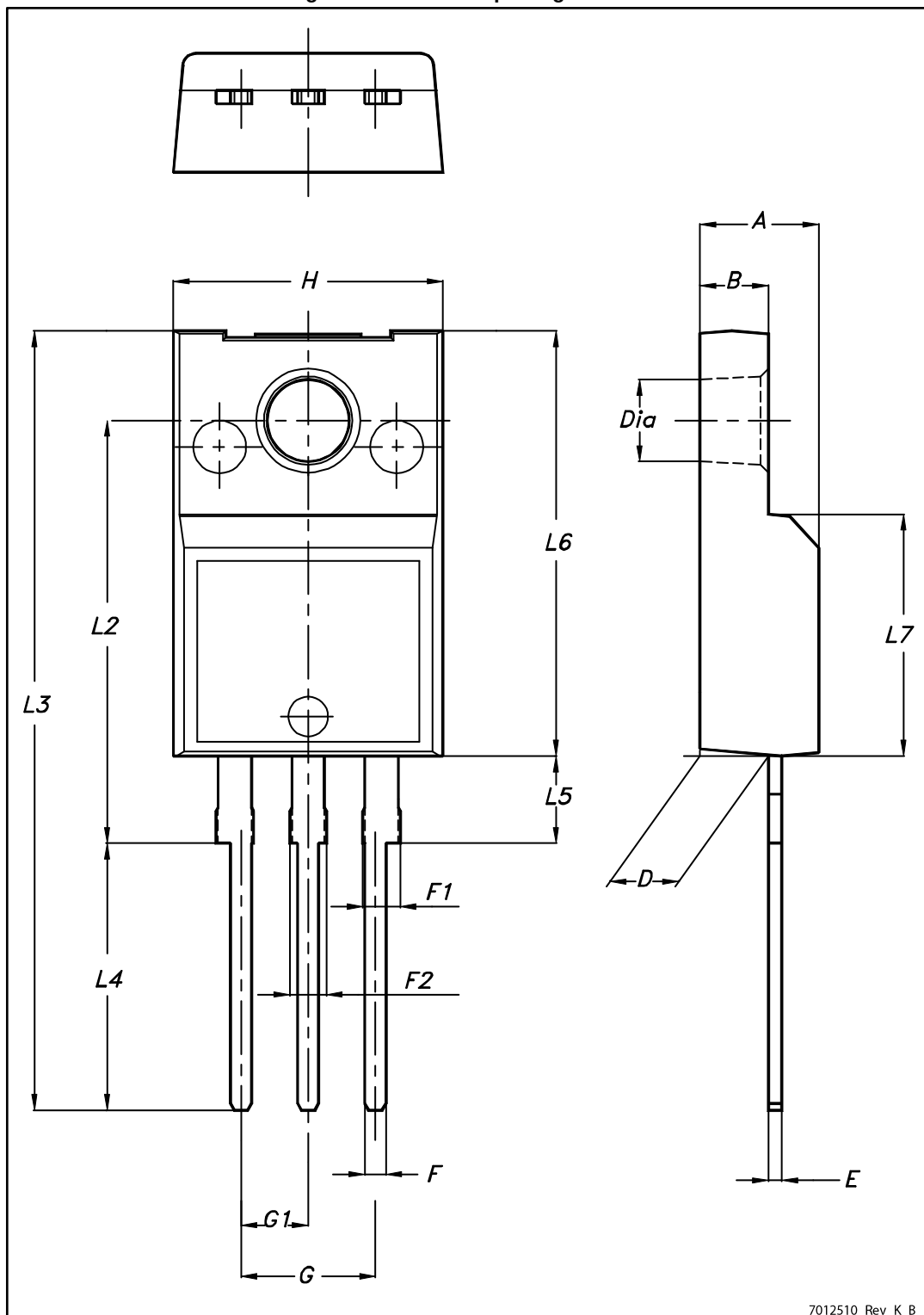
Table 10: D²PAK (TO-263) type A package mechanical data

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		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		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 26: D²PAK (TO-263) recommended footprint (dimensions are in mm)

4.2 TO-220FP package information

Figure 27: TO-220FP package outline



7012510_Rev_K_B

Table 11: TO-220FP package 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

4.3 TO-220 type A package information

Figure 28: TO-220 type A package outline

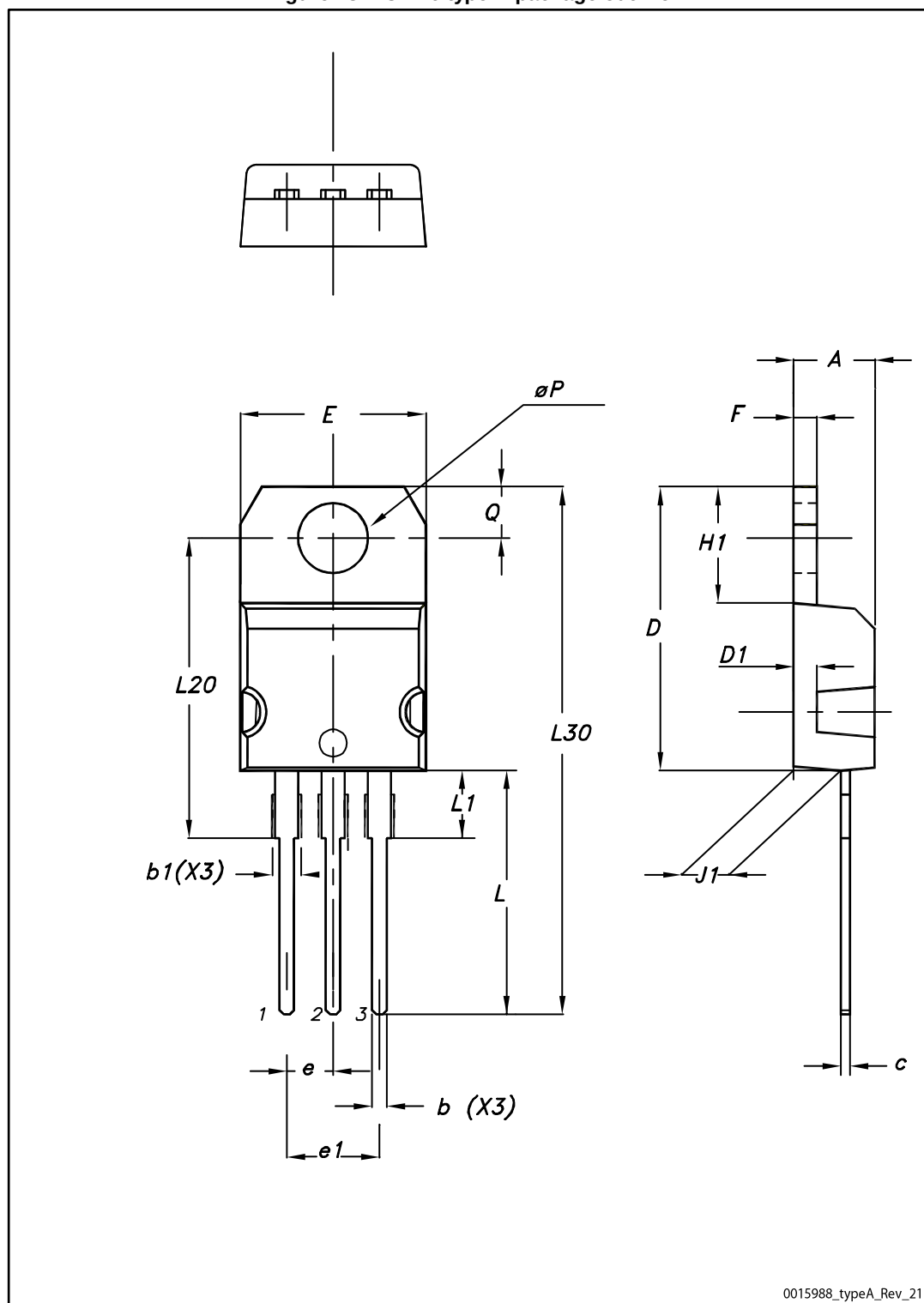


Table 12: TO-220 type A mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.55
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10.00		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	13.00		14.00
L1	3.50		3.93
L20		16.40	
L30		28.90	
øP	3.75		3.85
Q	2.65		2.95

4.4 TO-247 package information

Figure 29: TO-247 package outline

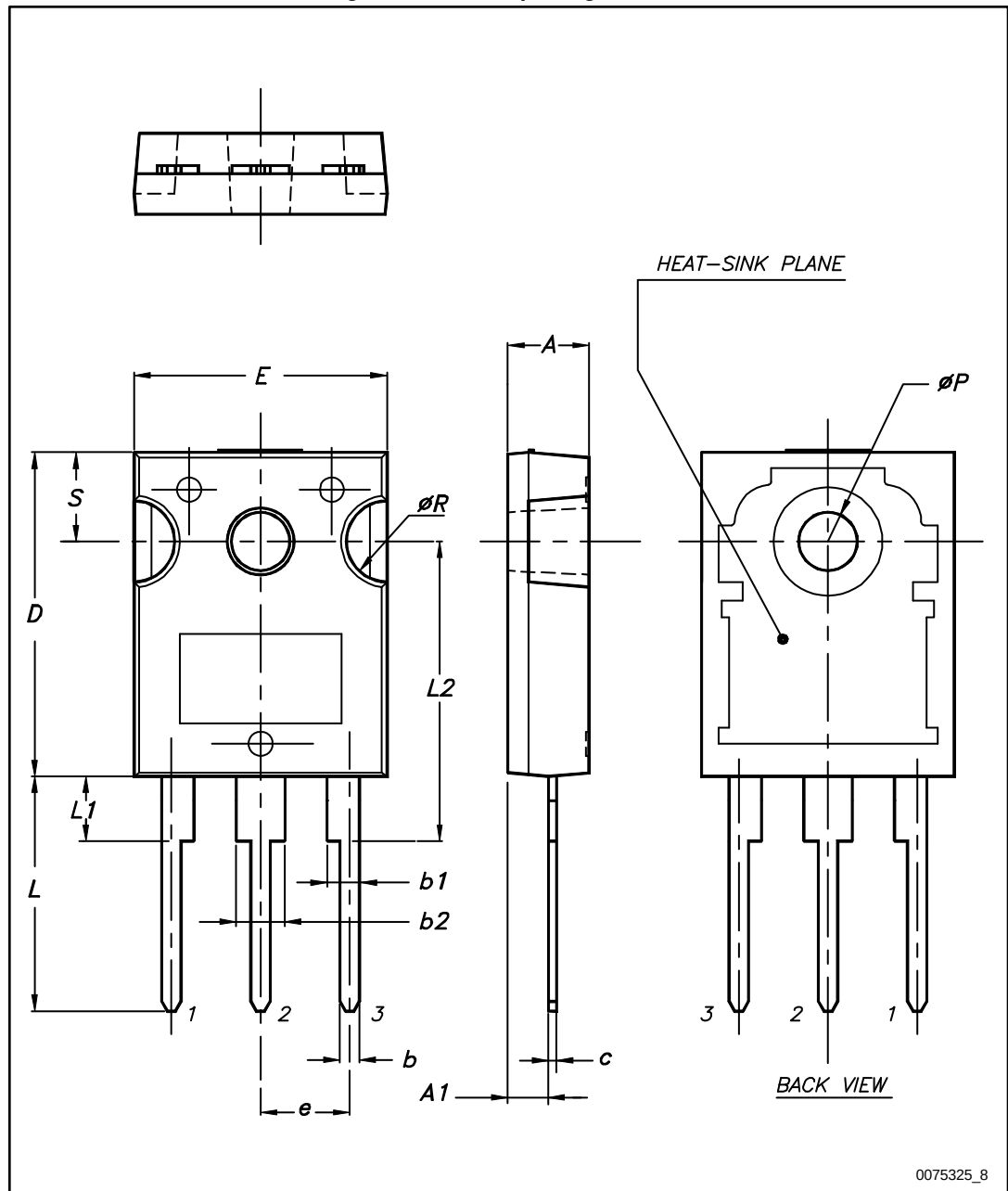


Table 13: TO-247 package mechanical data

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	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

4.5 D²PAK packing information

Figure 30: Tape outline

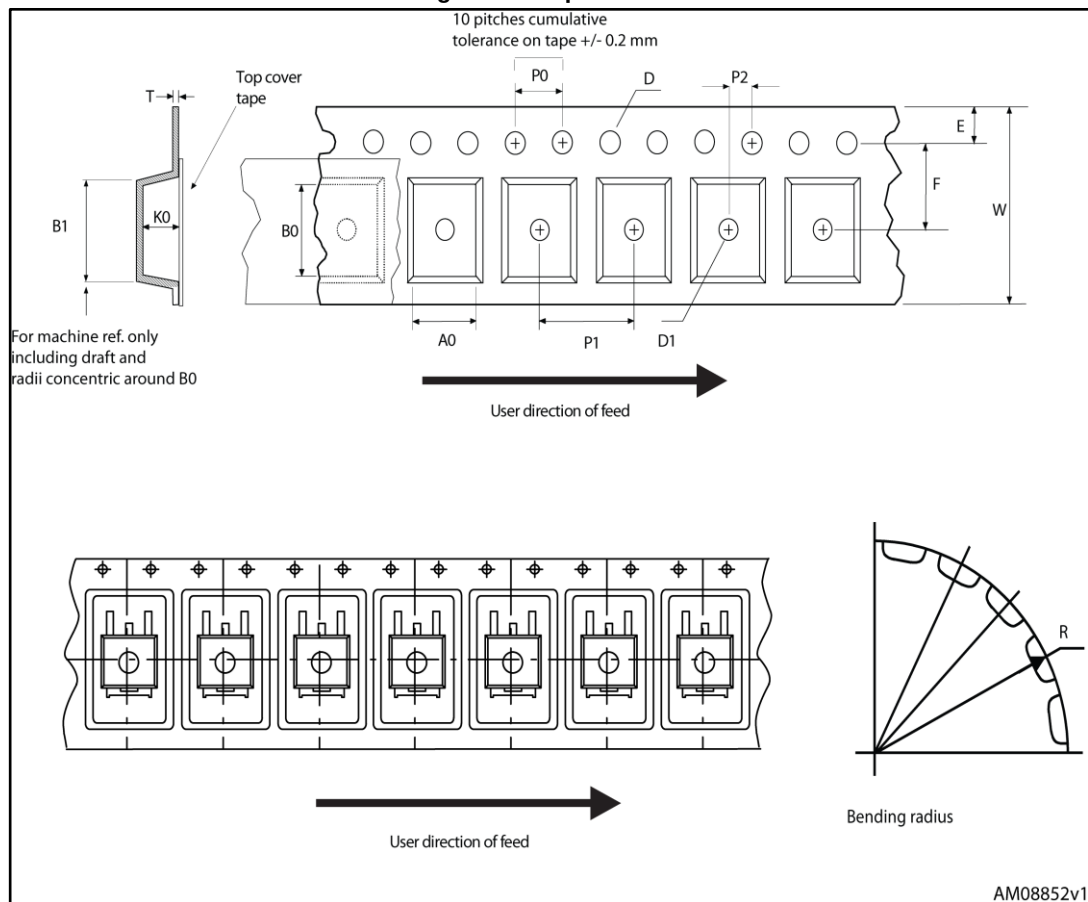
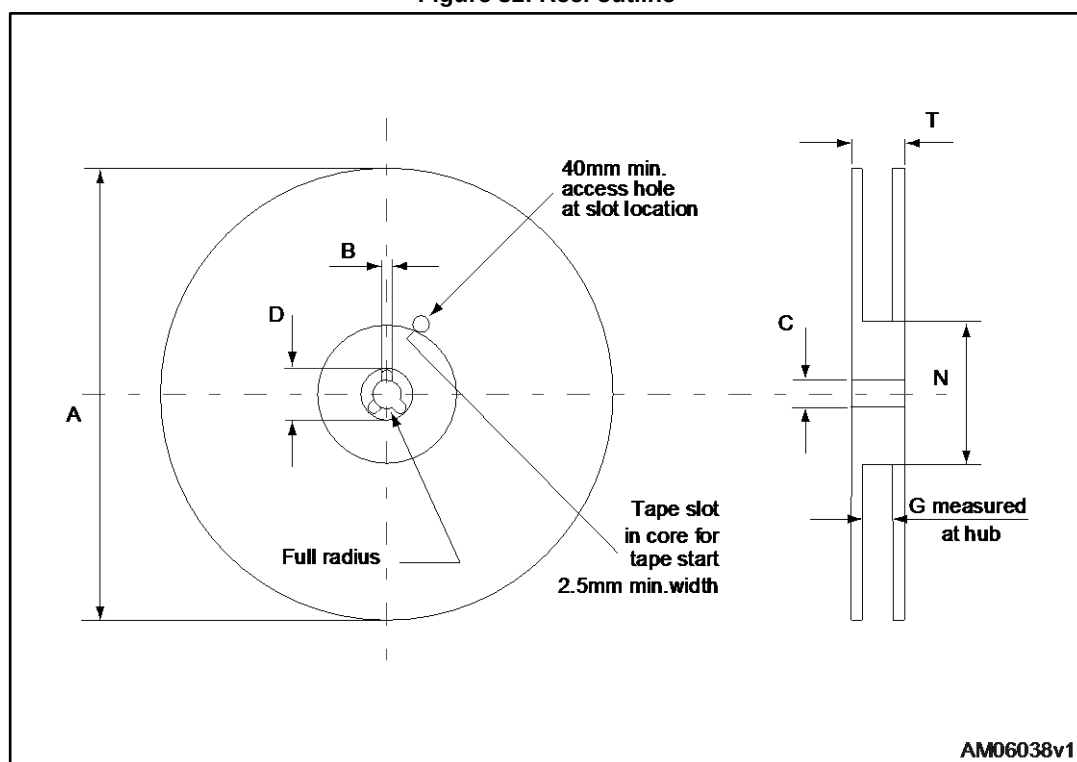


Figure 31: Reel outline

Table 14: D²PAK 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 quantity		1000
P2	1.9	2.1	Bulk quantity		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

5 Revision history

Table 15: Document revision history

Date	Revision	Changes
25-Nov-2009	1	First release.
12-Jan-2010	2	Corrected V_{GS} value in <i>Table 2: Absolute maximum ratings</i> .
22-Dec-2011	3	Inserted device in D ² PAK. Document status promoted from preliminary data to datasheet. Added: <i>Section 2.1: Electrical characteristics (curves)</i> Updated <i>Section 4: Package mechanical data</i> . Added <i>Section 5: Packaging mechanical data</i> . Minor text changes.
06-Jun-2012	4	<i>Figure 9: Transfer characteristics</i> has been updated.
16-Jan-2017	5	Updated title, features, description and schematic diagram in cover page. Minor text changes in <i>Section 1: "Electrical ratings"</i> and <i>Section 2: "Electrical characteristics"</i> . Updated <i>Section 2.1: "Electrical characteristics (curves)"</i> Updated package information section.

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST's terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers' products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2017 STMicroelectronics – All rights reserved