STB20N95K5, STF20N95K5, STP20N95K5, STW20N95K5

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
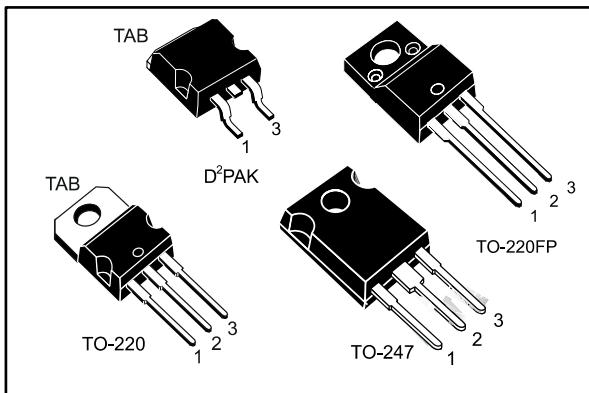
Figure 1: Internal schematic diagram
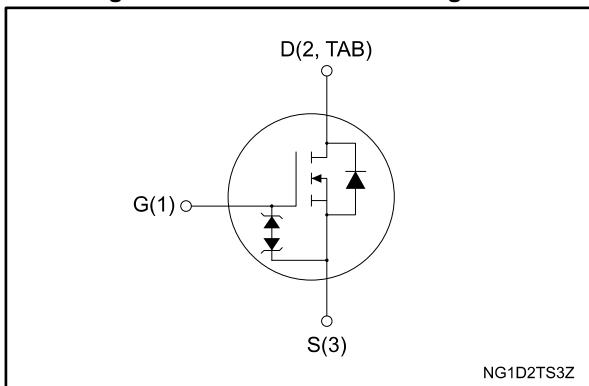
Features

Order code	V_{DS}	$R_{DS(on)}$ max.	I_D	P_{TOT}
STB20N95K5				250 W
STF20N95K5	950 V	0.330 Ω	17.5 A	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		D²PAK	Tape and reel
STF20N95K5	20N95K5	TO-220FP	
STP20N95K5		TO-220	Tube
STW20N95K5		TO-247	

www.st.com

Contents

1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D²PAK 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		V/ns
T_j	Operating junction temperature range	-55 to 150		°C
T_{stg}	Storage temperature range			°C

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
		D²PAK	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 °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 V, I_D = 1 mA	950			V
I_{DSS}	Zero-gate voltage drain current	V_{GS} = 0 V, V_{DS} = 950 V			1	μA
		V_{GS} = 0 V, V_{DS} = 950 V T_C = 125 °C[1]			50	μA
I_{GSS}	Gate body leakage current	V_{DS} = 0 V, V_{GS} = ±20 V			±10	μA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 100 μA	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 9 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 V, f = 1 MHz, V_{GS} = 0 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 V, V_{DS} = 0 to 760 V	-	65	-	pF
$C_{o(tr)}$[2]	Equivalent capacitance time related			178	-	pF
R_g	Intrinsic gate resistance	f = 1 MHz , I_D = 0 A	-	3.5	-	Ω
Q_g	Total gate charge	V_{DD} = 760 V,	-	48	-	nC
Q_{gs}	Gate-source charge	I_D = 17.5 A	-	9	-	nC
Q_{gd}	Gate-drain charge	V_{GS}= 10 V (see *Figure 20: "Test circuit for gate charge behavior"*)	-	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 V, I_D = 9 A, R_G = 4.7 Ω V_{GS} = 10 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 A, V_{GS} = 0 V	-		1.5	V
t_{rr}	Reverse recovery time	I_{SD} = 17.5 A, di/dt = 100 A/µs, V_{DD} = 60 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 A, di/dt = 100 A/µs V_{DD} = 60 V, T_j = 150 °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
$V_{(BR) GSO}$	Gate-source breakdown voltage	I_{GS} = ± 1 mA, I_D = 0 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-220
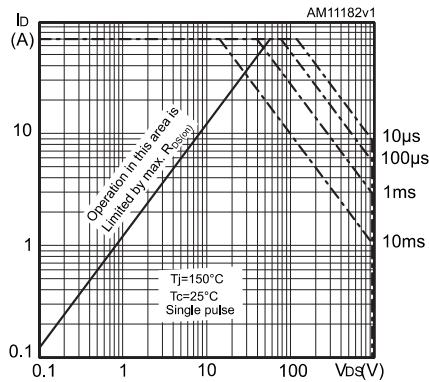
Figure 3: Thermal impedance for D²PAK and TO-220
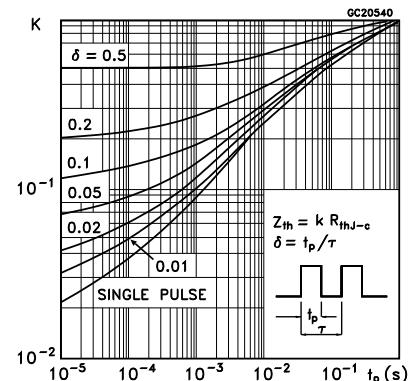
Figure 4: Safe operating area for TO-220FP
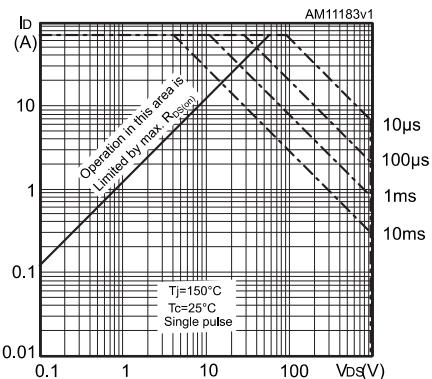
Figure 5: Thermal impedance for TO-220FP
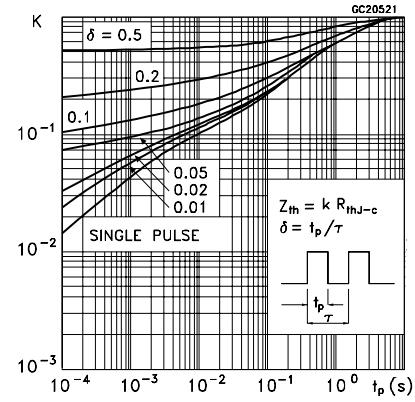
Figure 6: Safe operating area for TO-247
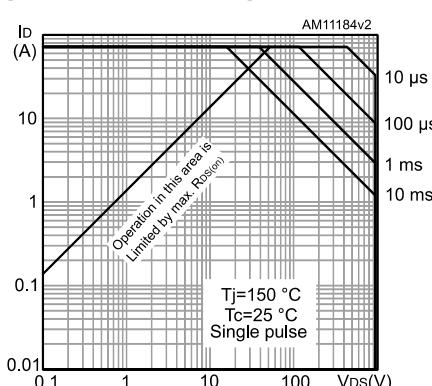
Figure 7: Thermal impedance for TO-247
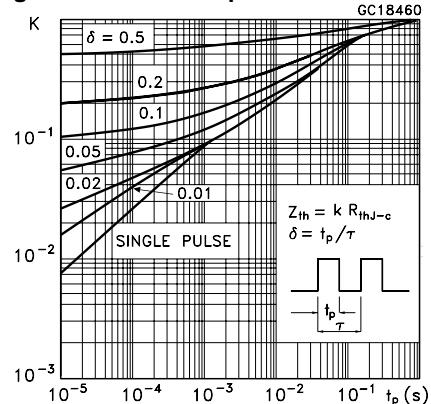
Figure 8: Output characteristics
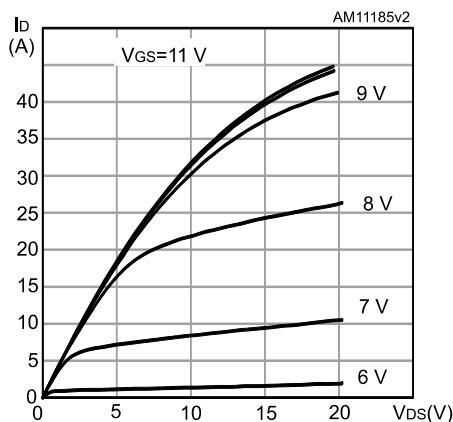
Figure 9: Transfer characteristics
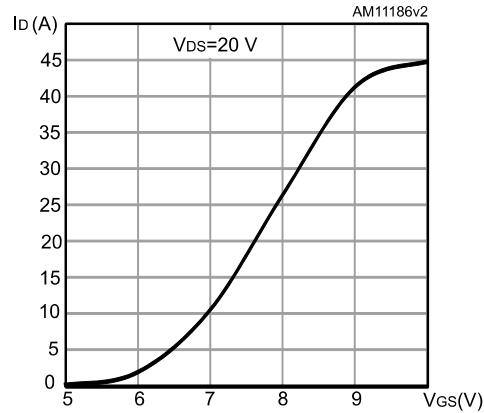
Figure 10: Gate charge vs gate-source voltage
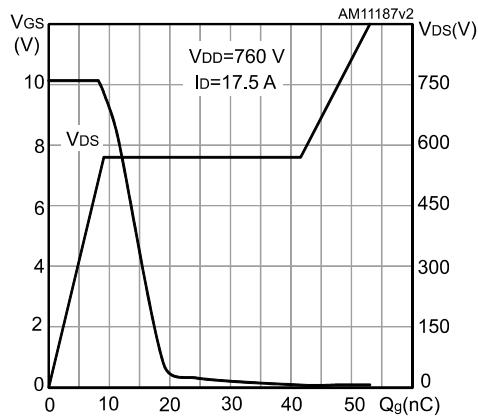
Figure 11: Static drain-source on-resistance
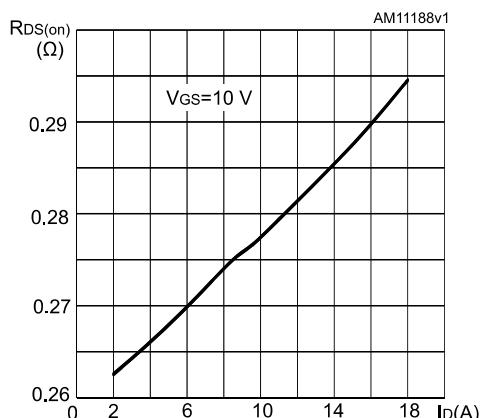
Figure 12: Capacitance variation
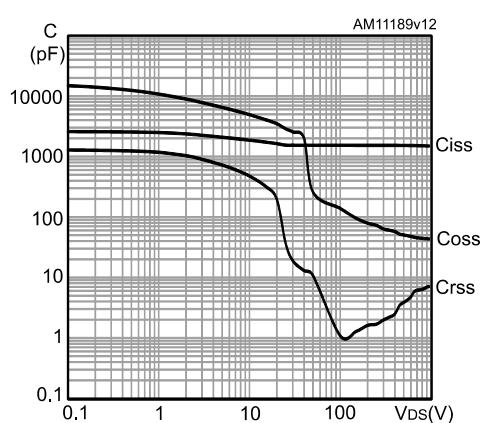
Figure 13: Output capacitance stored energy
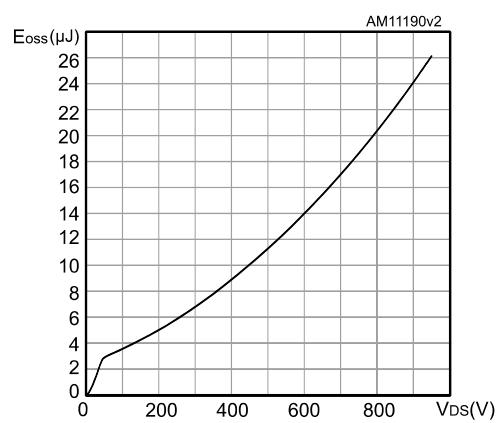
Figure 14: Normalized gate threshold voltage vs temperature
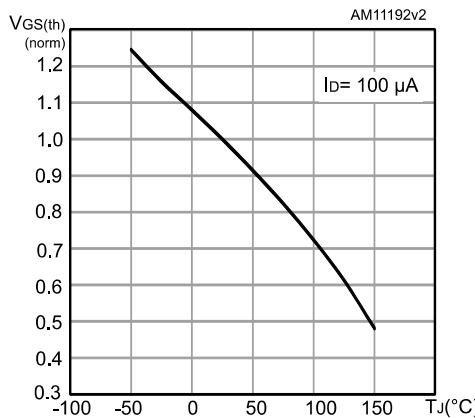
Figure 15: Normalized on-resistance vs temperature
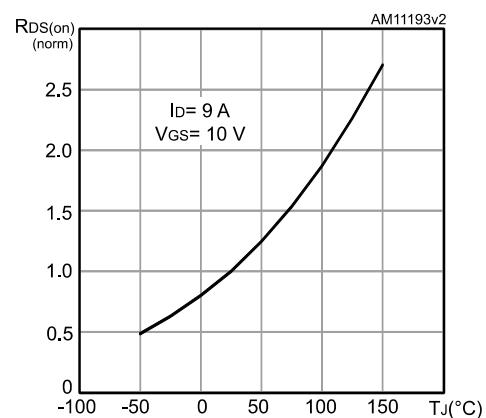
Figure 16: Maximum avalanche energy vs. starting T_J
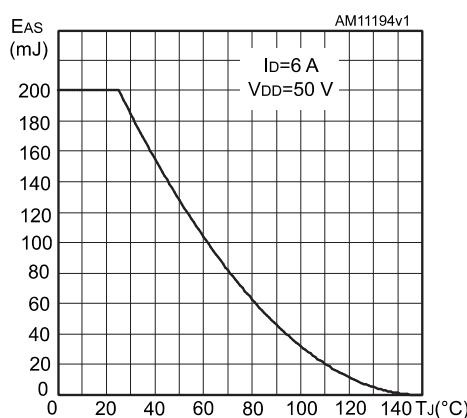
Figure 17: Normalized $V_{(BR)DSS}$ vs. temperature
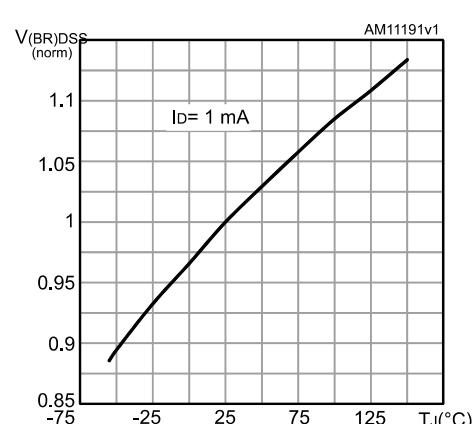
**Figure 18: Source-drain diode forward characteristics**
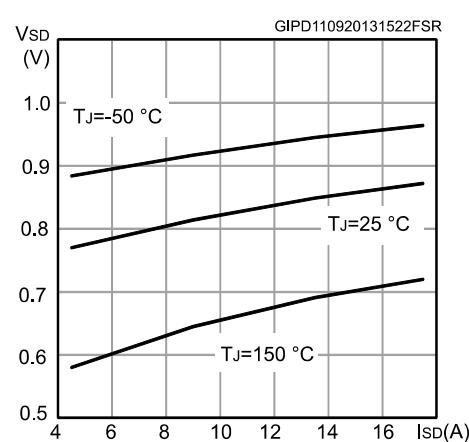
3 Test circuits

**Figure 19: Test circuit for resistive load switching times**
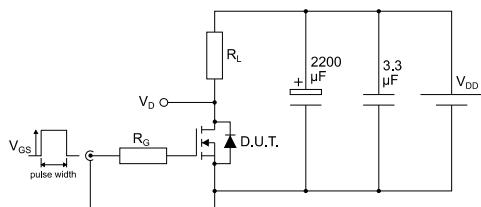
AM01468v1

**Figure 20: Test circuit for gate charge behavior**

AM01469v10

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

AM01470v1
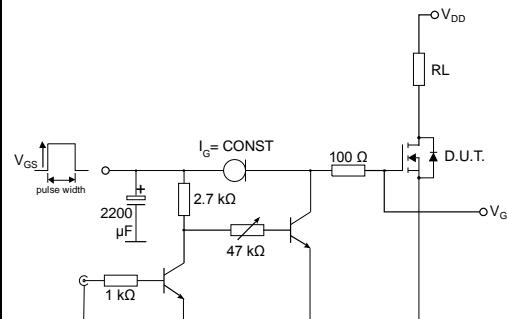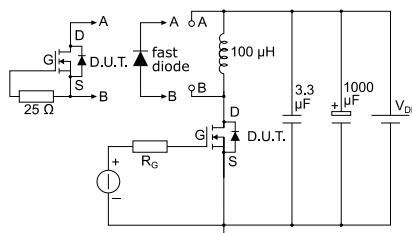
**Figure 22: Unclamped inductive load test circuit**

AM01471v1
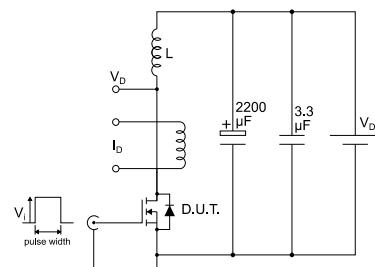
Figure 23: Unclamped inductive waveform

AM01472v1

Figure 24: Switching time waveform

AM01473v1
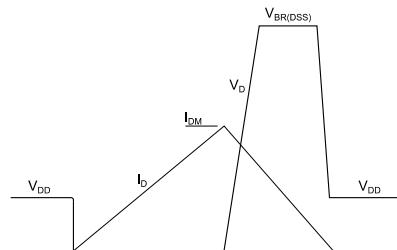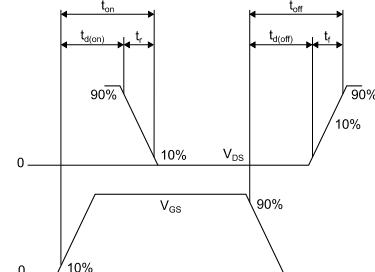
4 Package information

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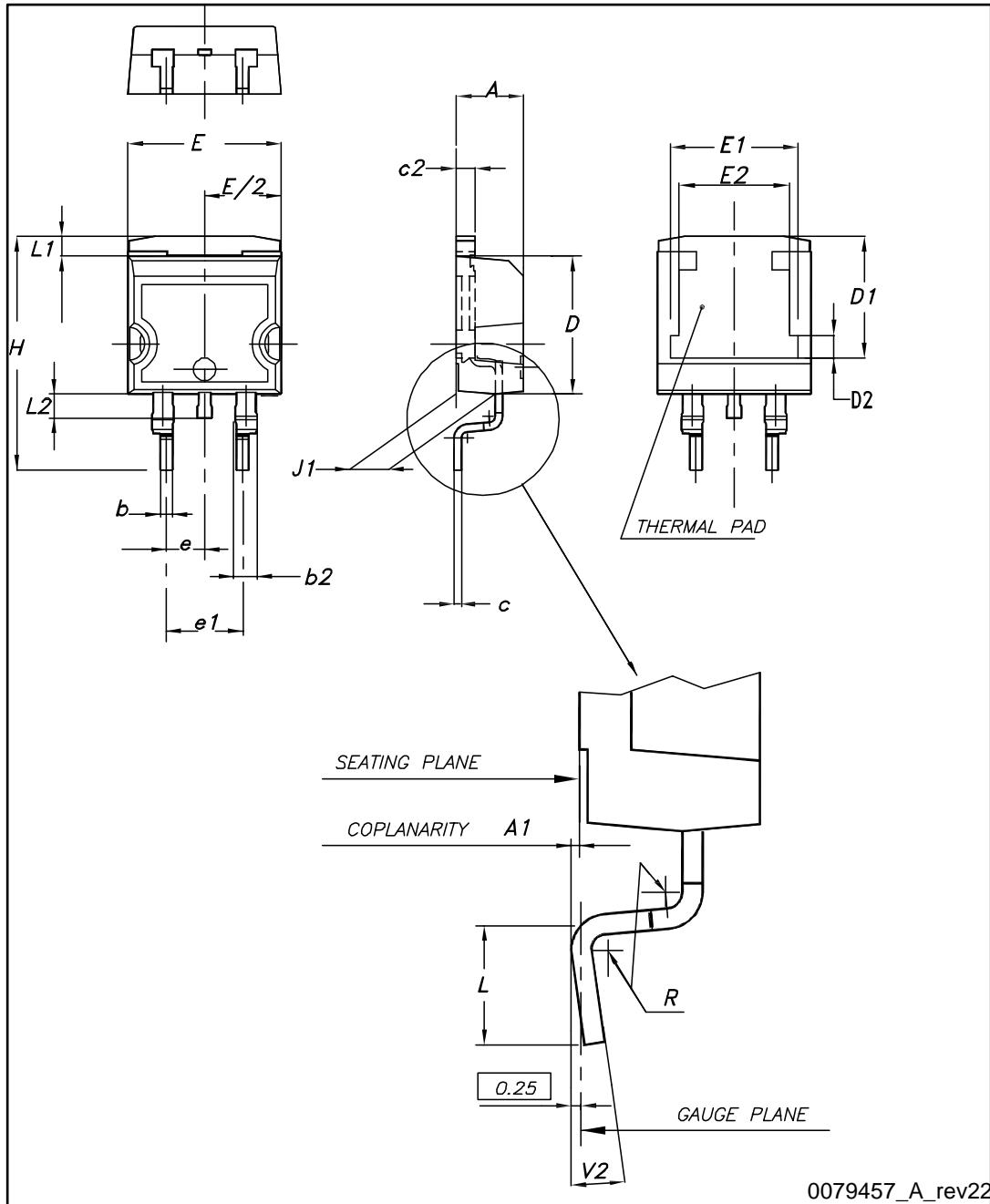
Table 10: D²PAK (TO-263) type A package mechanical data

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)

Footprint
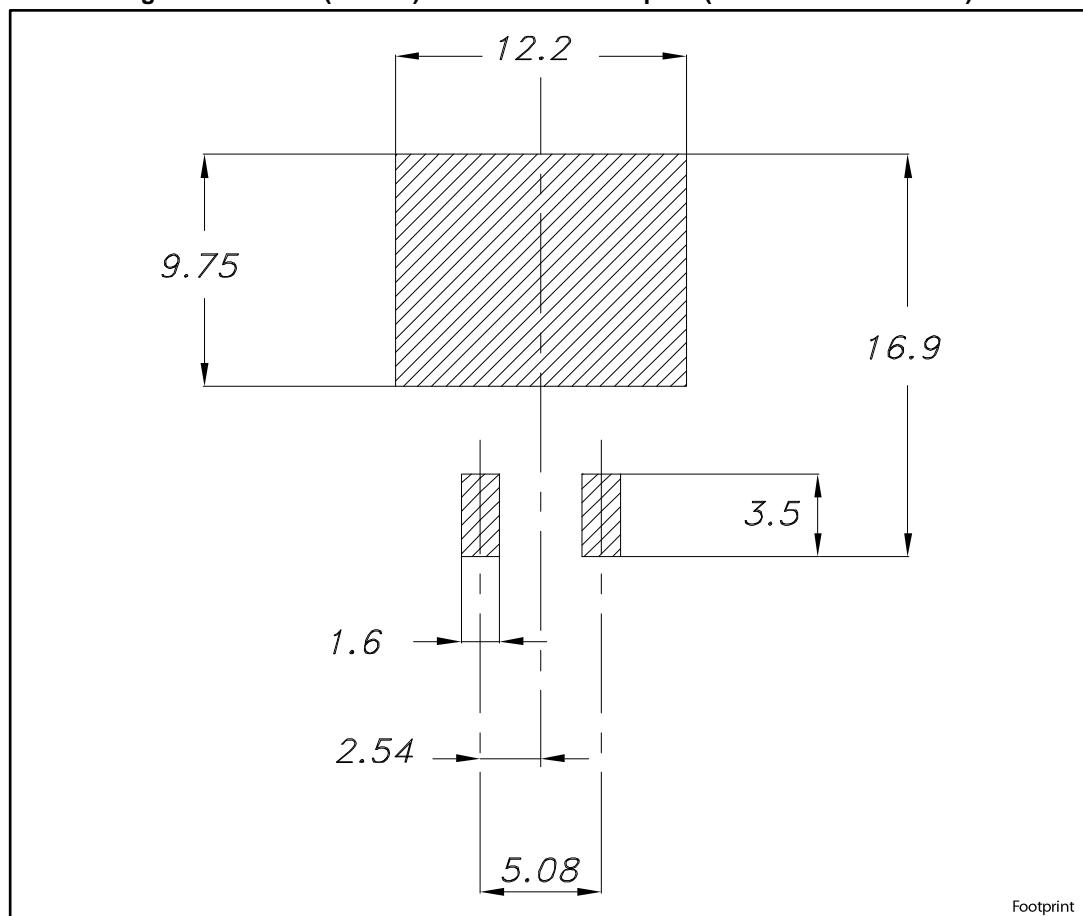
4.2 TO-220FP package information

Figure 27: TO-220FP package outline

7012510_Rev_K_B
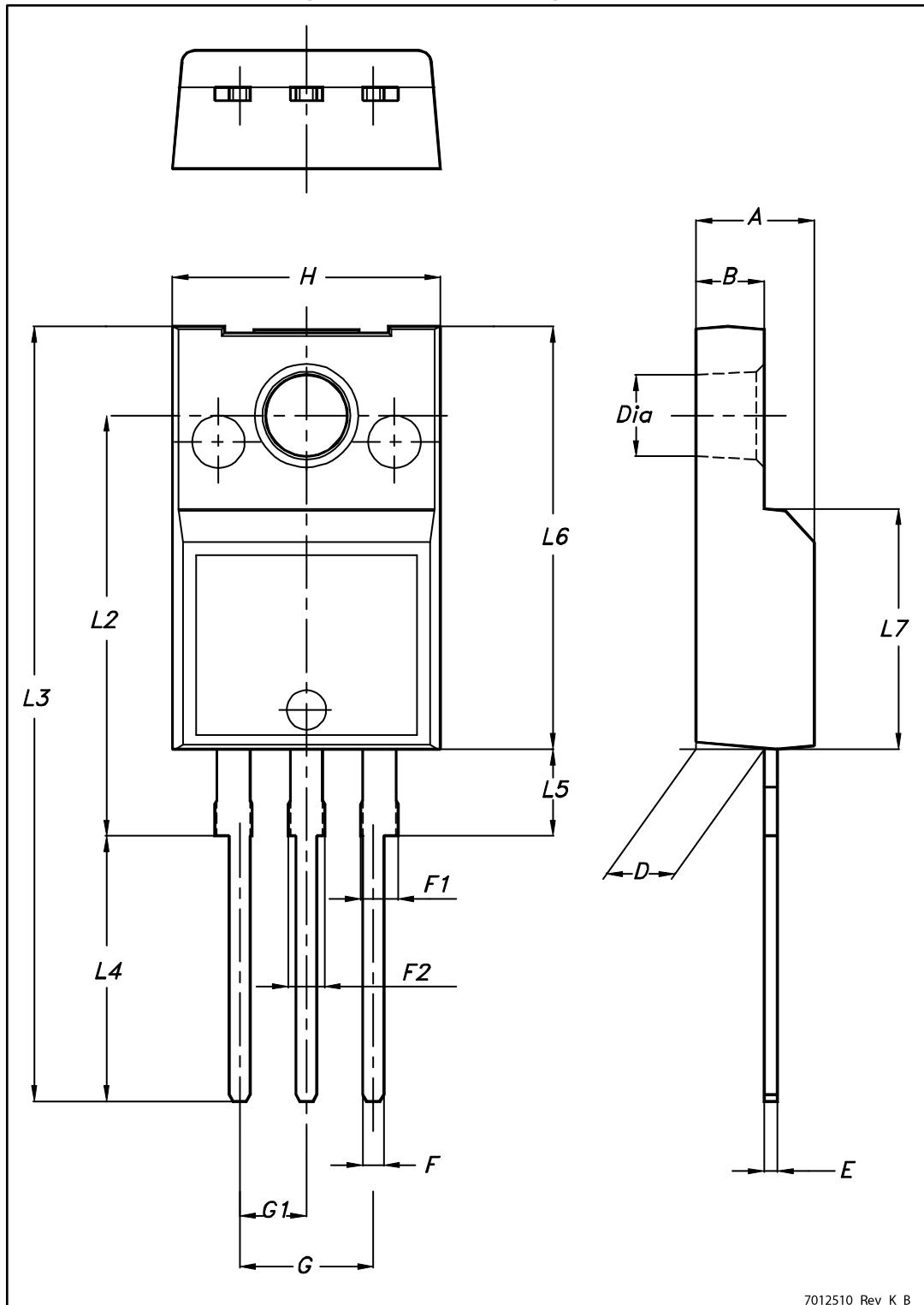
Table 11: TO-220FP package mechanical data

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

0015988_typeA_Rev_21
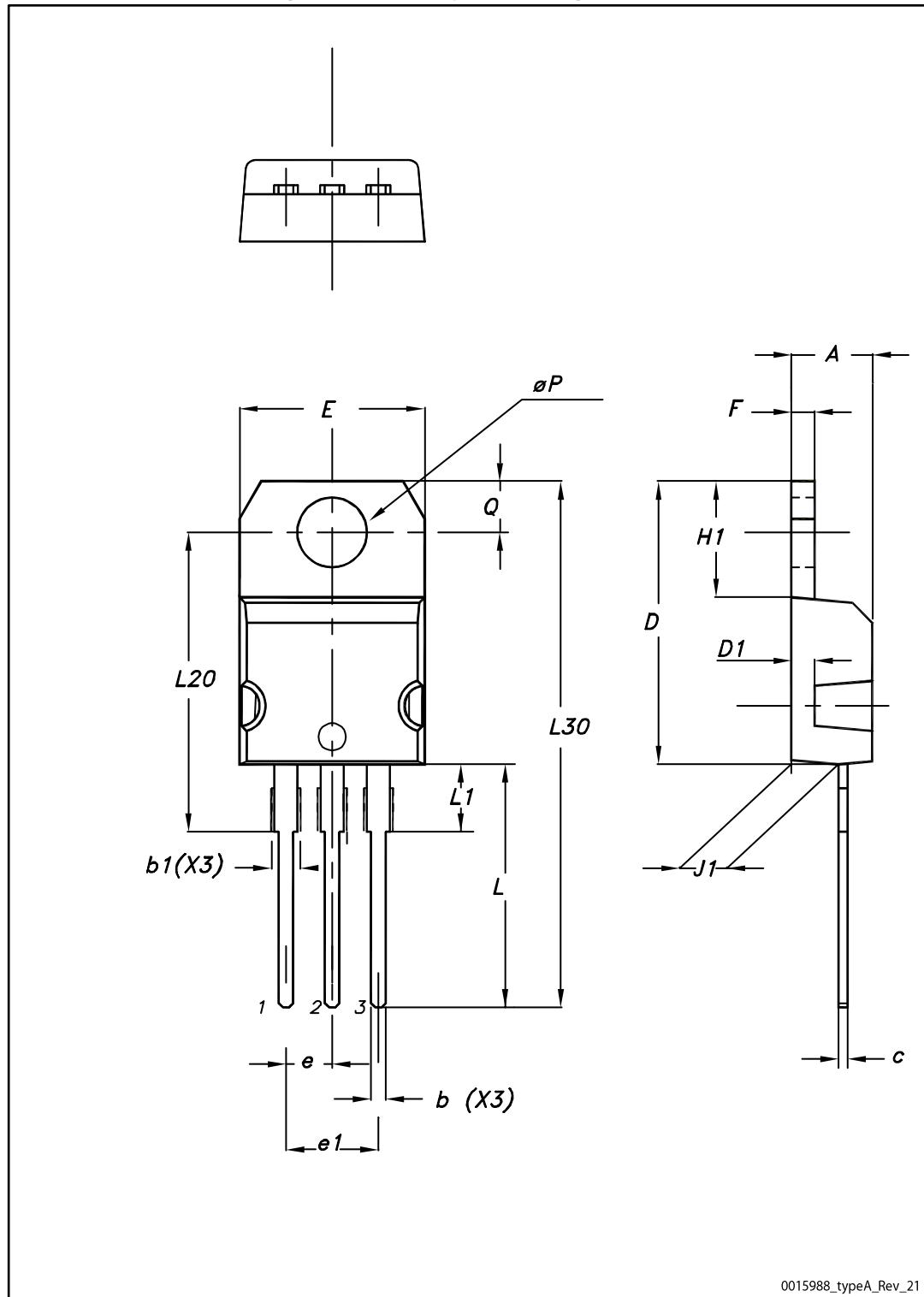
Table 12: TO-220 type A mechanical data

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
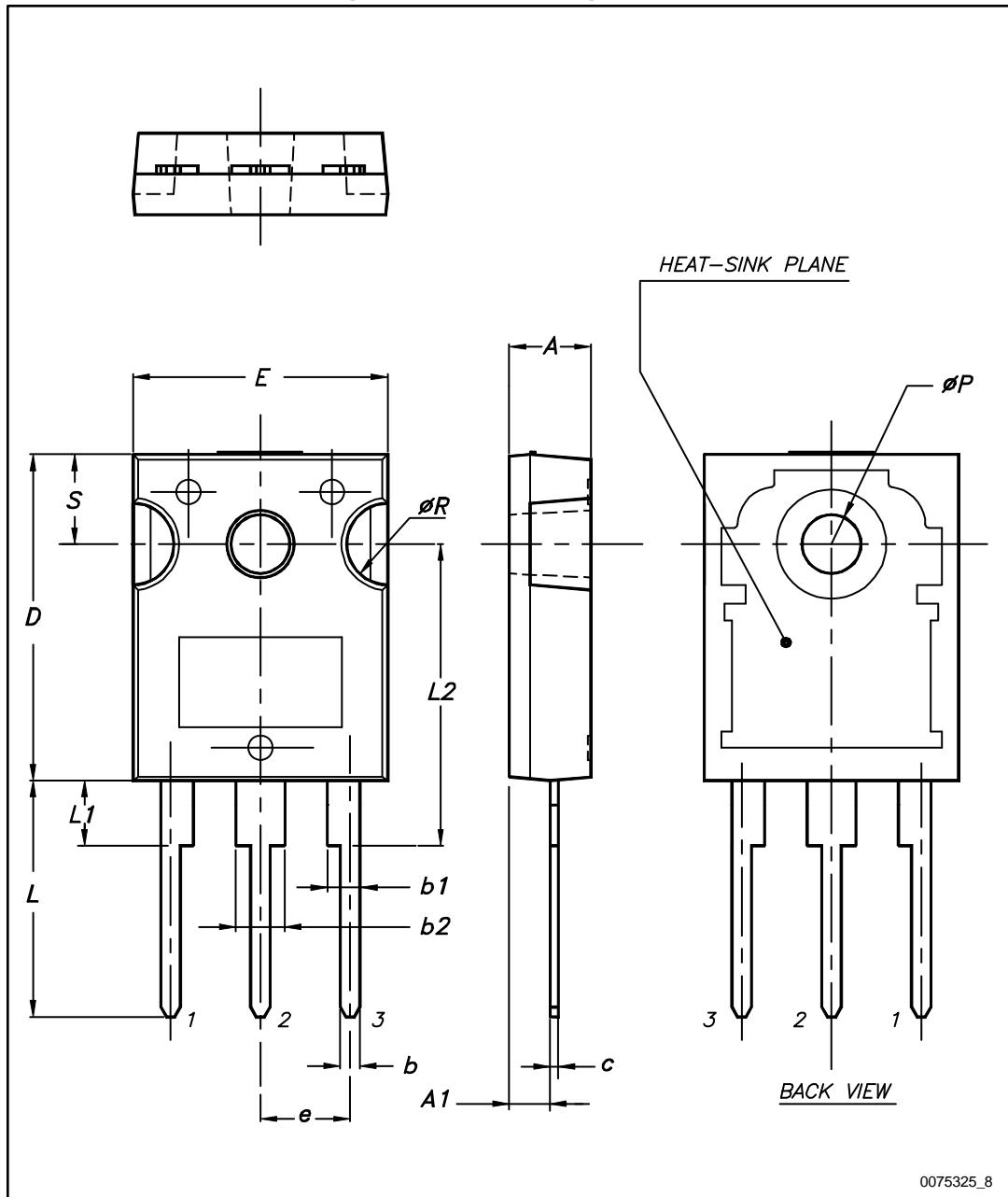
Table 13: TO-247 package mechanical data

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
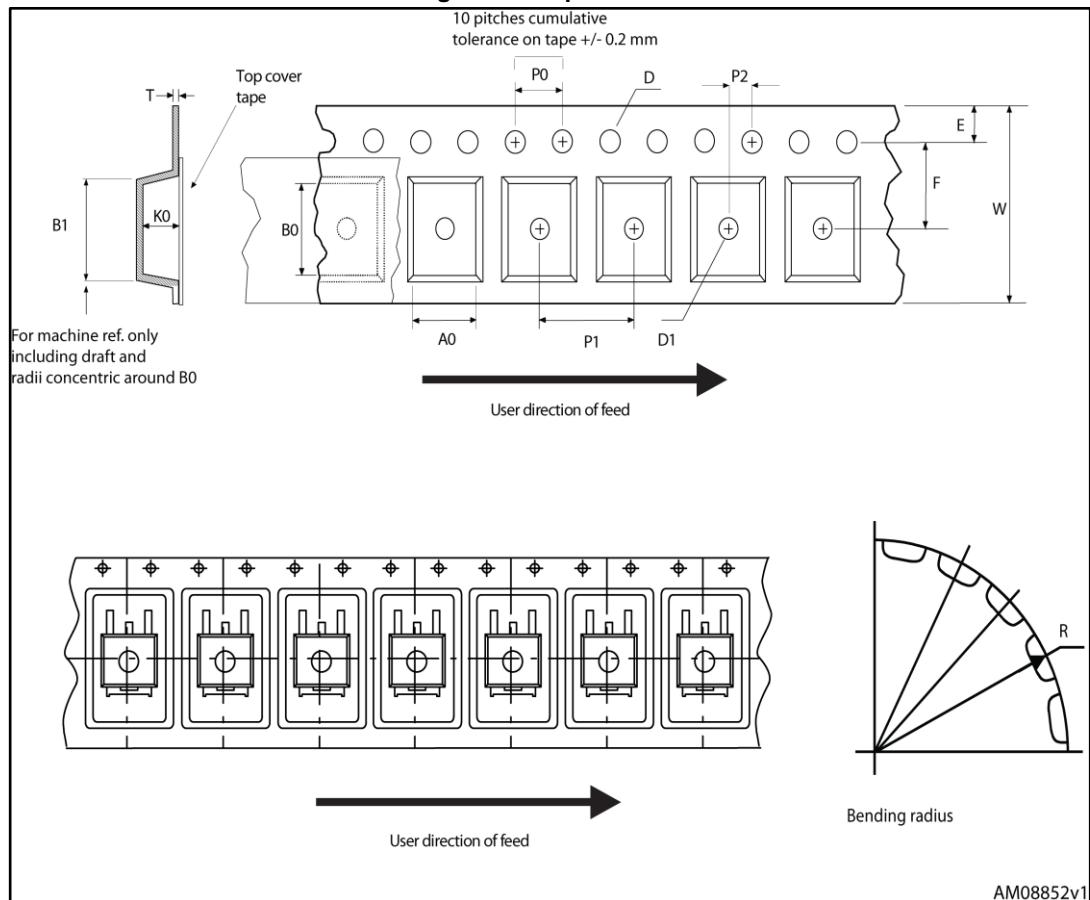
Figure 31: Reel outline

AM06038v1
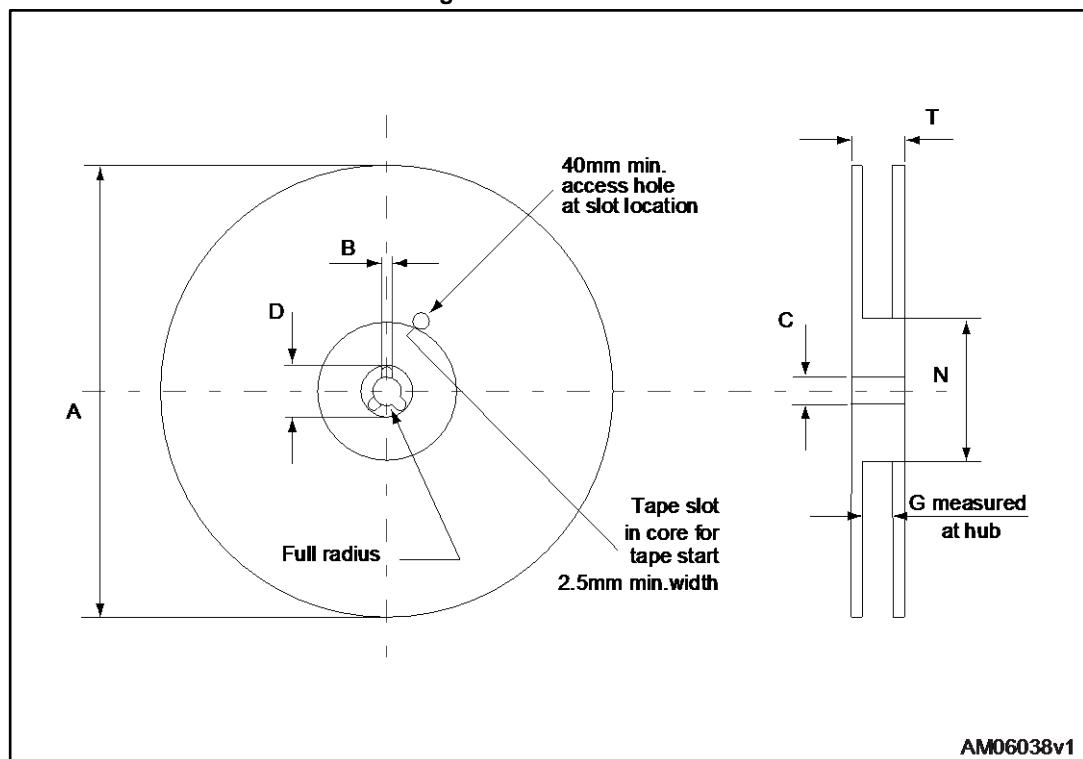
Table 14: D²PAK tape and reel mechanical data

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 *Table 2: Absolute maximum ratings*.
22-Dec-2011	3	Inserted device in D²PAK. Document status promoted from preliminary data to datasheet. Added: *Section 2.1: Electrical characteristics (curves)* Updated *Section 4: Package mechanical data.* Added *Section 5: Packaging mechanical data.* Minor text changes.
06-Jun-2012	4	*Figure 9: Transfer characteristics* has been updated.
16-Jan-2017	5	Updated title, features, description and schematic diagram in cover page. Minor text changes in *Section 1: "Electrical ratings"* and *Section 2: "Electrical characteristics"*. Updated *Section 2.1: "Electrical characteristics (curves)"* Updated package information section.

IMPORTANT NOTICE – PLEASE READ CAREFULLY

X-ON Electronics

Largest Supplier of Electrical and Electronic Components

Click to view similar products for MOSFET *category:*

Click to view products by STMicroelectronics *manufacturer:*

Other Similar products are found below :

614233C 648584F IRFD120 JANTX2N5237 FCA20N60_F109 FDZ595PZ 2SK2545(Q,T) 405094E 423220D TPCC8103,L1Q(CM MIC4420CM-TR VN1206L SBVS138LT1G 614234A 715780A NTNS3166NZT5G SSM6J414TU,LF(T 751625C BUK954R8-60E NTE6400 SQJ402EP-T1-GE3 2SK2614(TE16L1,Q) 2N7002KW-FAI DMN1017UCP3-7 EFC2J004NUZTDG ECH8691-TL-W FCAB21350L1 P85W28HP2F-7071 DMN1053UCP4-7 NTE221 NTE2384 NTE2903 NTE2941 NTE2945 NTE2946 NTE2960 NTE2967 NTE2969 NTE2976 NTE455 NTE6400A NTE2910 NTE2916 NTE2956 NTE2911 DMN2080UCB4-7 TK10A80W,S4X(S SSM6P69NU,LF DMP22D4UFO-7B DMN1006UCA6-7