

# STD3N80K5, STF3N80K5, STP3N80K5, STU3N80K5

N-channel 800 V, 2.8  $\Omega$  typ., 2.5 A MDmesh™ K5  
Power MOSFETs in DPAK, TO-220FP, TO-220 and IPAK

Datasheet - production data

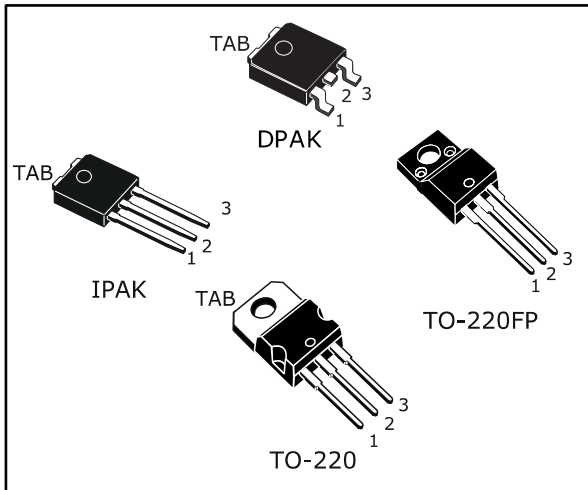
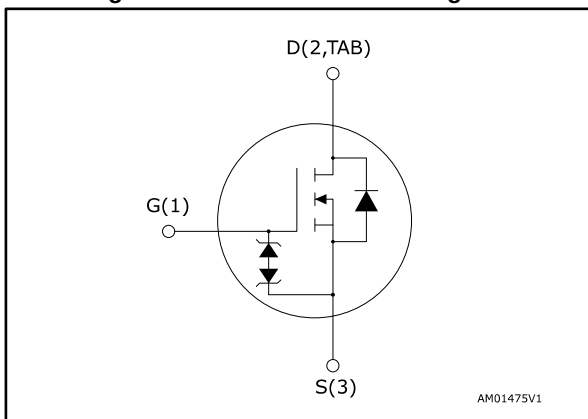


Figure 1: Internal schematic diagram



## Features

Order code	V <sub>DS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>	P <sub>TOT</sub>
STD3N80K5	800 V	3.5 $\Omega$	2.5 A	60 W
STF3N80K5				20 W
STP3N80K5				60 W
STU3N80K5				

- Industry's lowest R<sub>DS(on)</sub> 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
STD3N80K5	3N80K5	DPAK	Tape and reel
STF3N80K5		TO-220FP	Tube
STP3N80K5		TO-220	
STU3N80K5		IPAK	

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value				Unit
		DPAK	TO-220FP	TO-220	IPAK	
V <sub>GS</sub>	Gate-source voltage	±30				V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	2.5				A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	1.6				A
I <sub>D</sub> <sup>(1)</sup>	Drain current (pulsed)	10				A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	60	20	60	60	W
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat-sink (t = 1 s, T <sub>C</sub> = 25 °C)		2.5			kV
dv/dt <sup>(2)</sup>	Peak diode recovery voltage slope	4.5				V/ns
dv/dt <sup>(3)</sup>	MOSFET dv/dt ruggedness	50				
T <sub>j</sub>	Operating junction temperature range	-55 to 150				°C
T <sub>stg</sub>	Storage temperature range					

**Notes:**

- (1)Pulse width limited by safe operating area.
- (2)I<sub>SD</sub> ≤ 2.5 A, di/dt = 100 A/μs; V<sub>DS</sub> peak < V<sub>(BR)DSS</sub>.
- (3)V<sub>DS</sub> ≤ 640 V.

Table 3: Thermal data

Symbol	Parameter	Value				Unit
		DPAK	TO-220FP	TO-220	IPAK	
R <sub>thj-case</sub>	Thermal resistance junction-case	2.08	6.25	2.08		°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient		62.5	62.5	100	°C/W
R <sub>thj-pcb</sub> <sup>(1)</sup>	Thermal resistance junction-pcb	50				°C/W

**Notes:**

- (1)When mounted on FR-4 board of 1 inch<sup>2</sup>, 2 oz Cu.

Table 4: Avalanche characteristics

Symbol	Parameter	Value	Unit
I <sub>AR</sub>	Avalanche current, repetitive or not repetitive (pulse width limited by T <sub>jmax</sub> )	1	A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>j</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V)	65	mJ

## 2 Electrical characteristics

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

**Table 5: On/off-state**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$	800			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 800\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 800\text{ V}$ , $T_C = 125\text{ °C}^{(1)}$			50	$\mu\text{A}$
$I_{GSS}$	Gate body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 20\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DD} = V_{GS}$ , $I_D = 100\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$ , $I_D = 1\text{ A}$		2.8	3.5	$\Omega$

**Notes:**

<sup>(1)</sup>Defined by design, not subject to production test.

**Table 6: Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	130	-	pF
$C_{oss}$	Output capacitance		-	14	-	pF
$C_{rss}$	Reverse transfer capacitance		-	0.6	-	pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ to }640\text{ V}$	-	20	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related		-	9	-	pF
$R_g$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , $I_D = 0\text{ A}$	-	15.5	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 640\text{ V}$ , $I_D = 2.5\text{ A}$ $V_{GS} = 0\text{ to }10\text{ V}$ (see <a href="#">Figure 19: "Test circuit for gate charge behavior"</a> )	-	9.5	-	nC
$Q_{gs}$	Gate-source charge		-	1.5	-	nC
$Q_{gd}$	Gate-drain charge		-	7.5	-	nC

**Notes:**

<sup>(1)</sup> $C_{o(tr)}$  is a constant capacitance value that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

<sup>(2)</sup> $C_{o(er)}$  is a constant capacitance value that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

Table 7: Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 400\text{ V}$ , $I_D = 1.25\text{ A}$ , $R_G = 4.7\ \Omega$ $V_{GS} = 10\text{ V}$ (see <i>Figure 18: "Test circuit for resistive load switching times"</i> and <i>Figure 23: "Switching time waveform"</i> )	-	8.5	-	ns
$t_r$	Rise time		-	10.5	-	ns
$t_{d(off)}$	Turn-off delay time		-	20.5	-	ns
$t_f$	Fall time		-	25	-	ns

Table 8: Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		2.5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		10	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 2.5\text{ A}$ , $V_{GS} = 0\text{ V}$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 2.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ (see <i>Figure 20: "Test circuit for inductive load switching and diode recovery times"</i> )	-	265		ns
$Q_{rr}$	Reverse recovery charge		-	1.2		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	9.2		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 2.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ ( see <i>Figure 20: "Test circuit for inductive load switching and diode recovery times"</i> )	-	430		ns
$Q_{rr}$	Reverse recovery charge		-	1.9		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	8.8		A

**Notes:**

<sup>(1)</sup>Pulse width limited by safe operating area

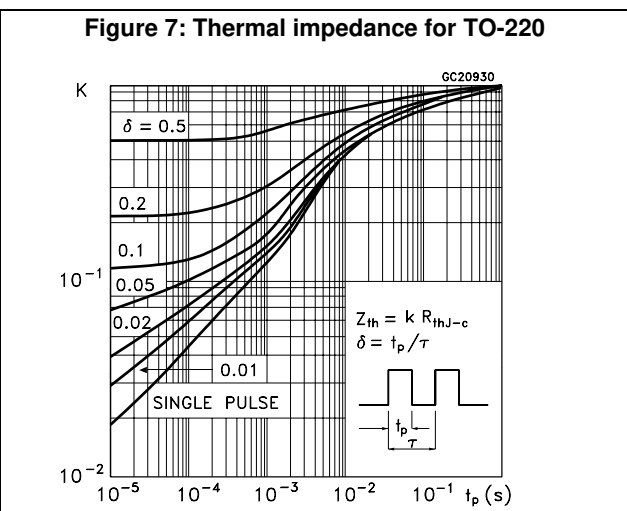
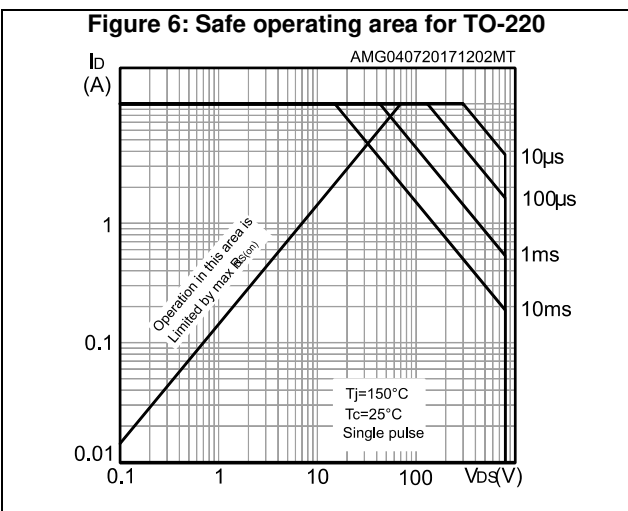
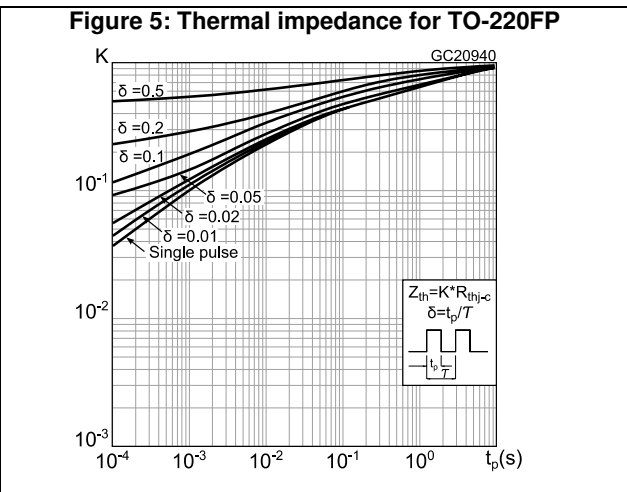
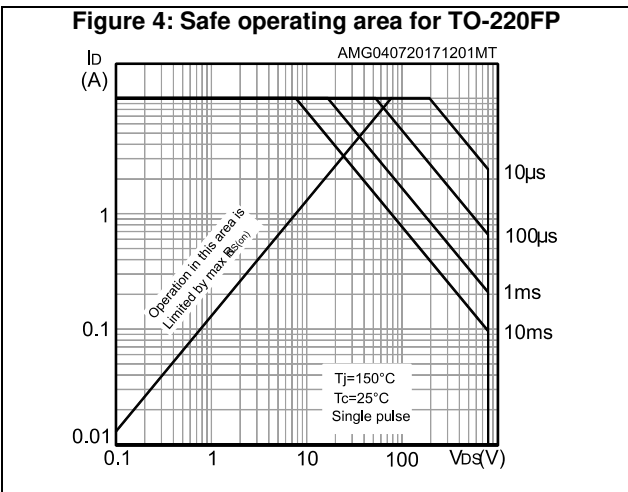
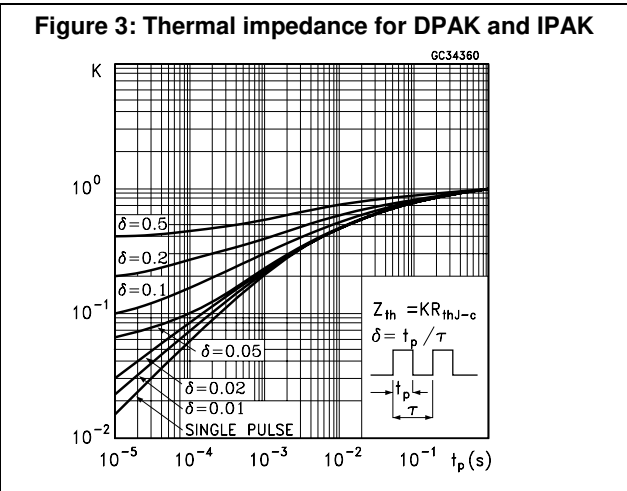
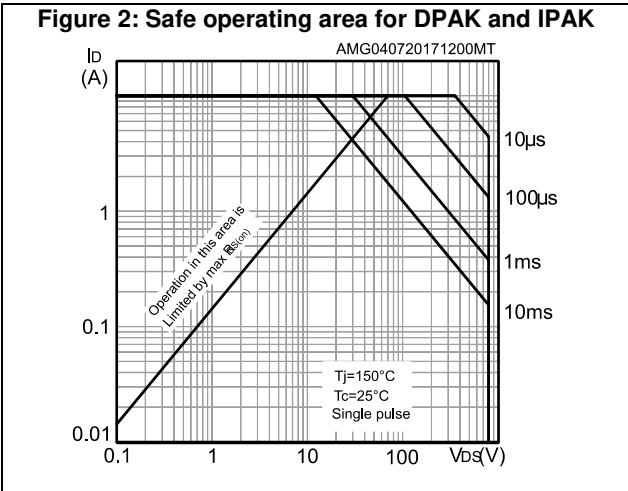
<sup>(2)</sup>Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

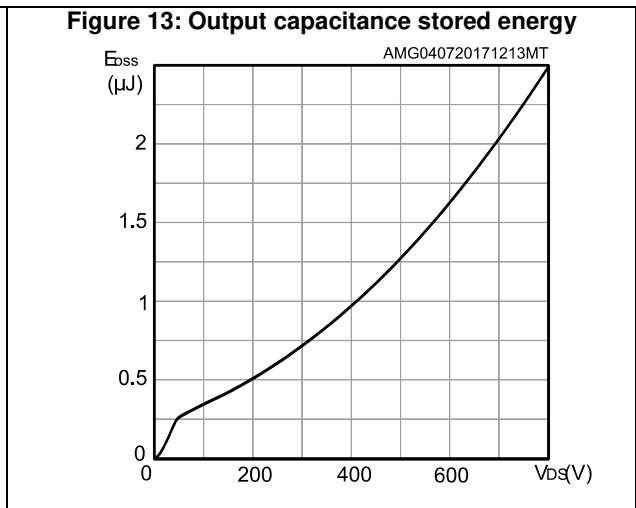
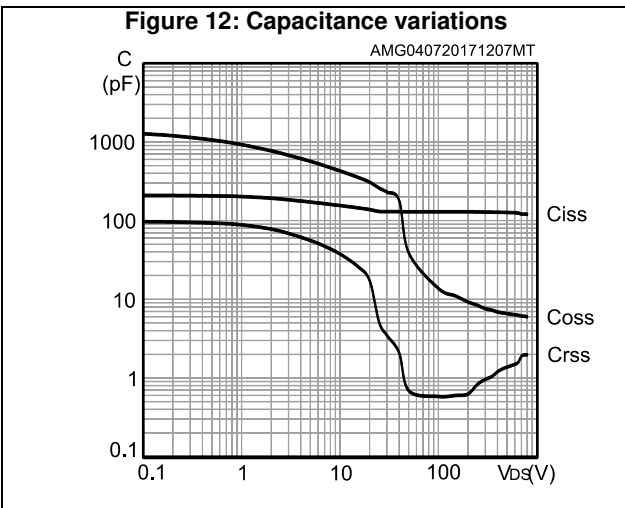
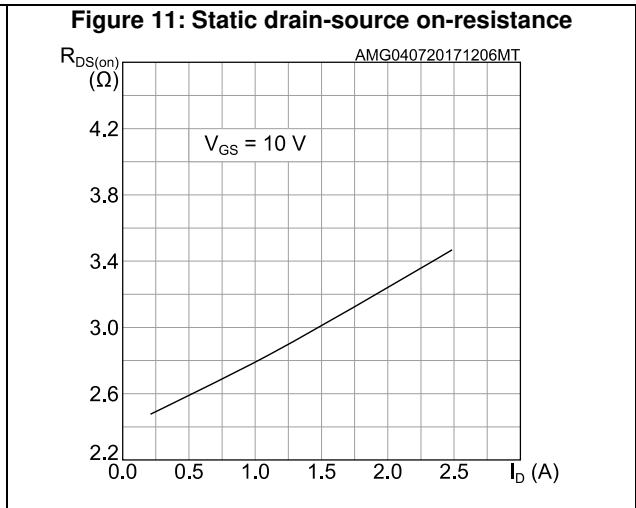
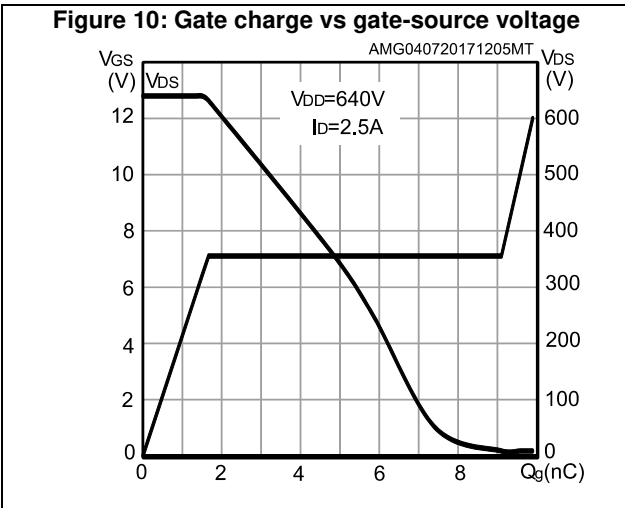
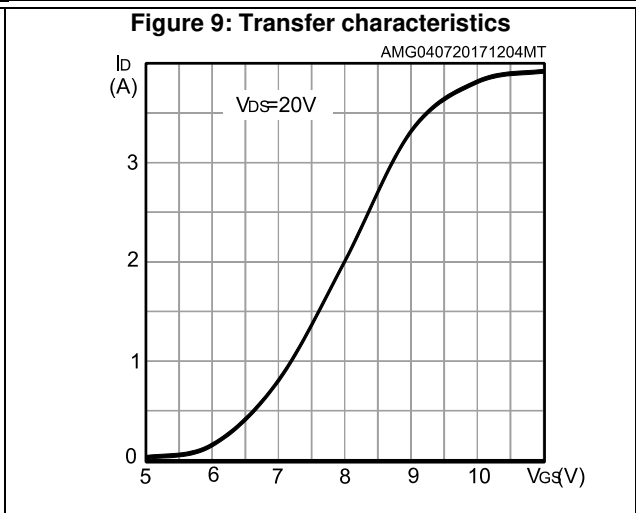
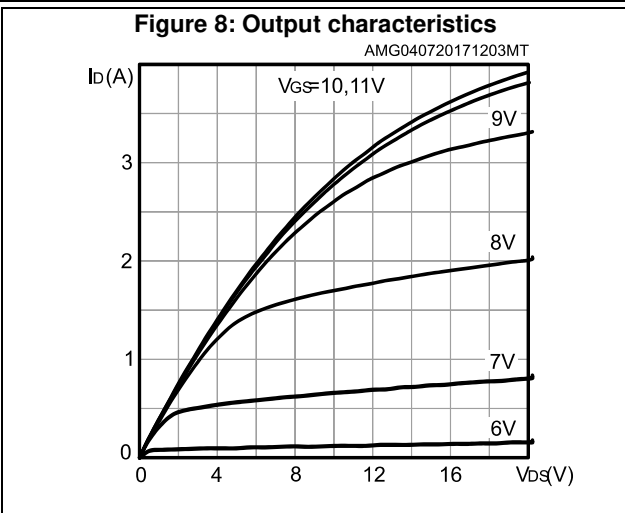
Table 9: Gate-source Zener diode

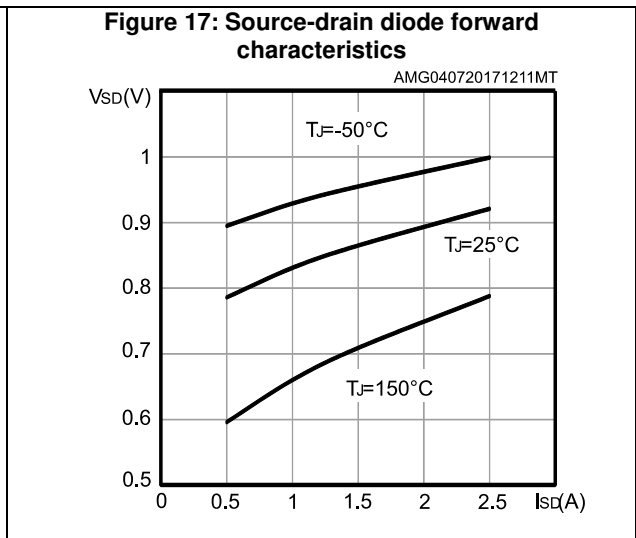
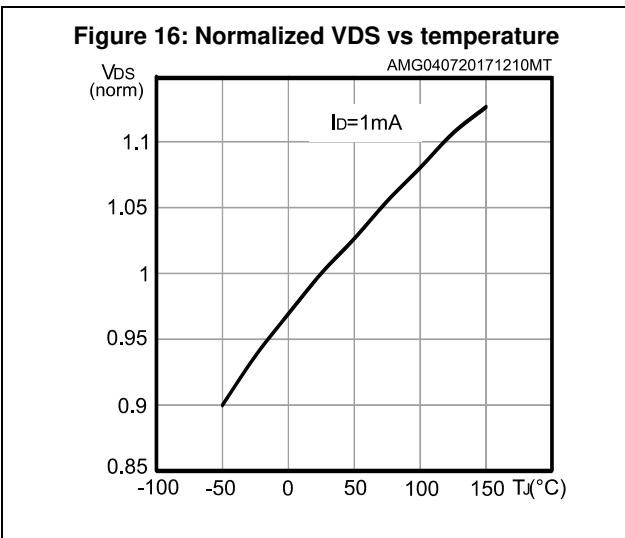
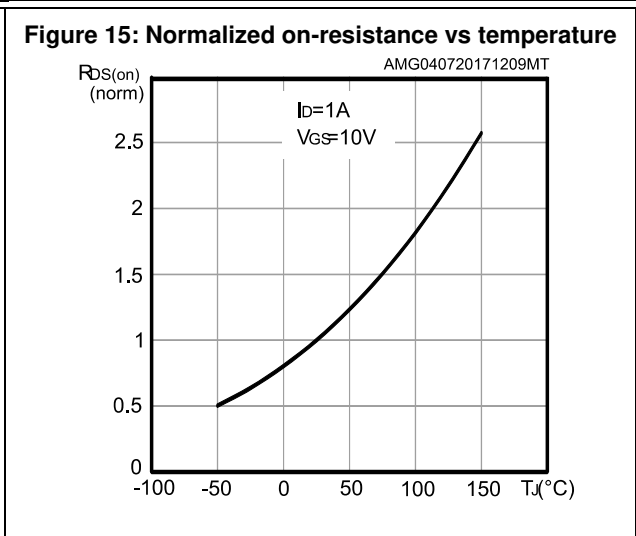
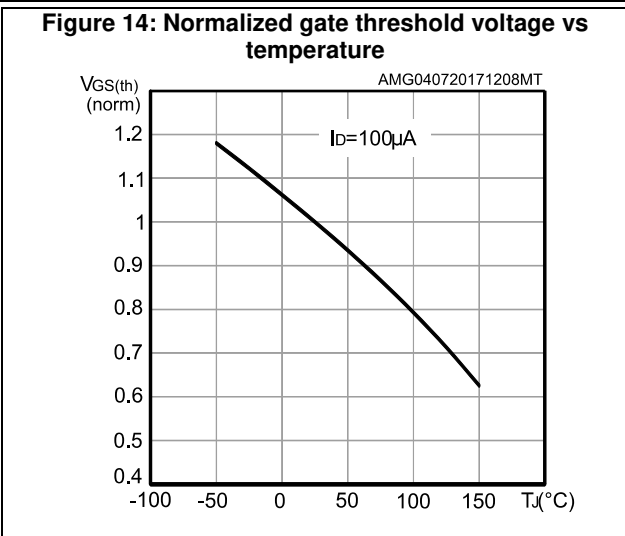
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)GSO}$	Gate-source breakdown voltage	$I_{GS} = \pm 1\text{ mA}$ , $I_D = 0\text{ A}$	$\pm 30$	-	-	V

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)



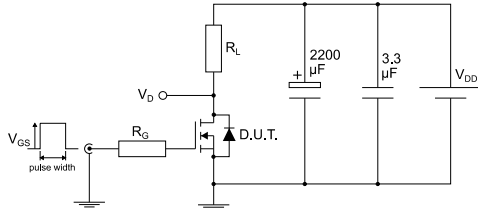






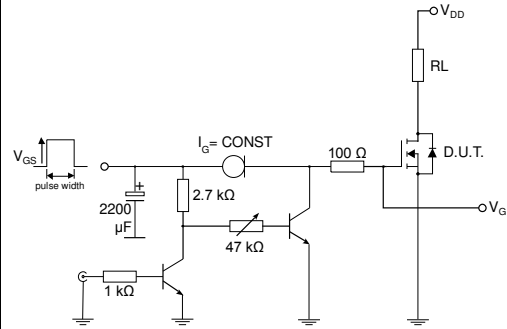
### 3 Test circuits

**Figure 18: Test circuit for resistive load switching times**



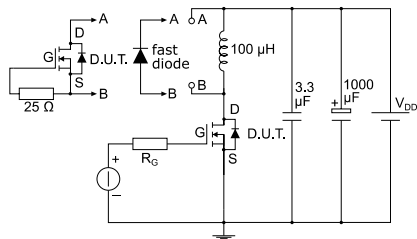
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**Figure 19: Test circuit for gate charge behavior**



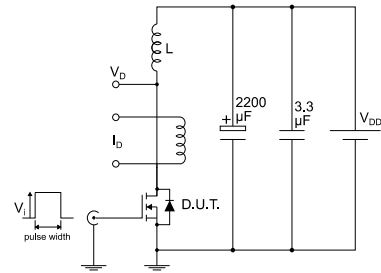
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**Figure 20: Test circuit for inductive load switching and diode recovery times**



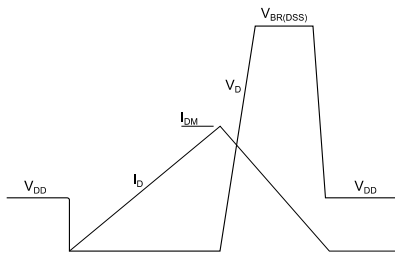
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**Figure 21: Unclamped inductive load test circuit**



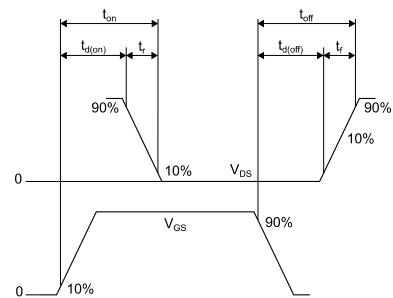
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**Figure 22: Unclamped inductive waveform**



AM01472v1

**Figure 23: 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](http://www.st.com). ECOPACK® is an ST trademark.

### 4.1 DPAK (TO-252) type A package information

Figure 24: DPAK (TO-252) type A package outline

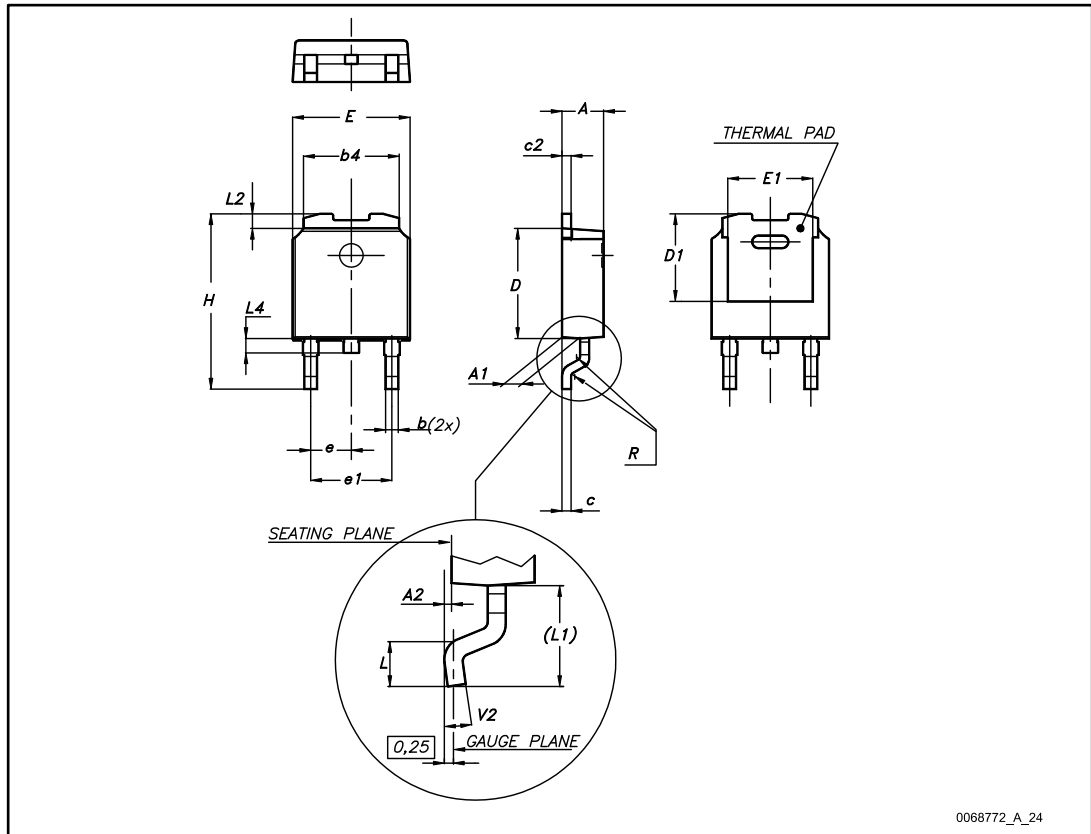


Table 10: DPAK (TO-252) type A mechanical data

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	4.95	5.10	5.25
E	6.40		6.60
E1	4.60	4.70	4.80
e	2.16	2.28	2.40
e1	4.40		4.60
H	9.35		10.10
L	1.00		1.50
(L1)	2.60	2.80	3.00
L2	0.65	0.80	0.95
L4	0.60		1.00
R		0.20	
V2	0°		8°



## 4.2 DPAK (TO-252) type E package information

Figure 26: DPAK (TO-252) type E package outline

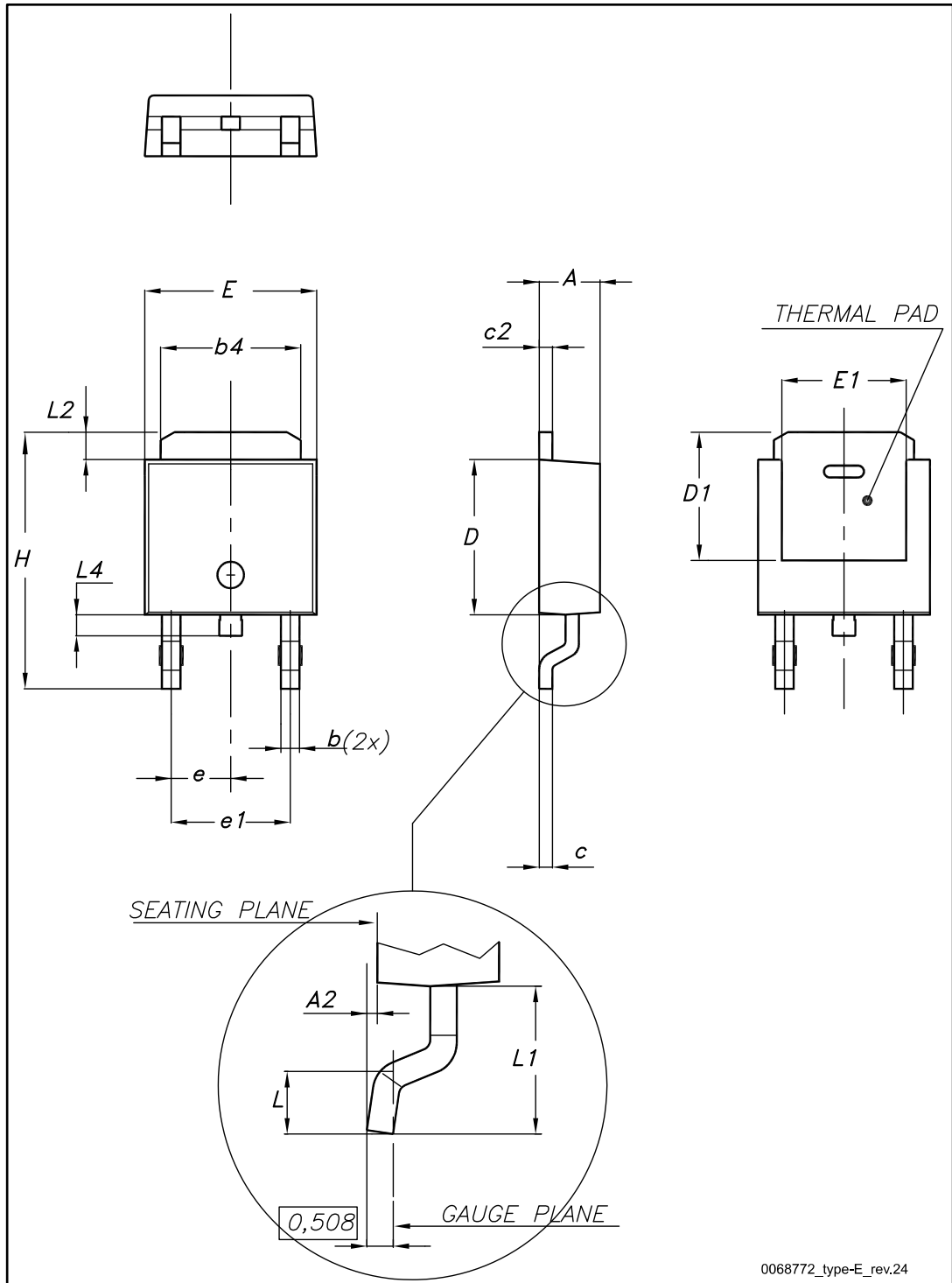
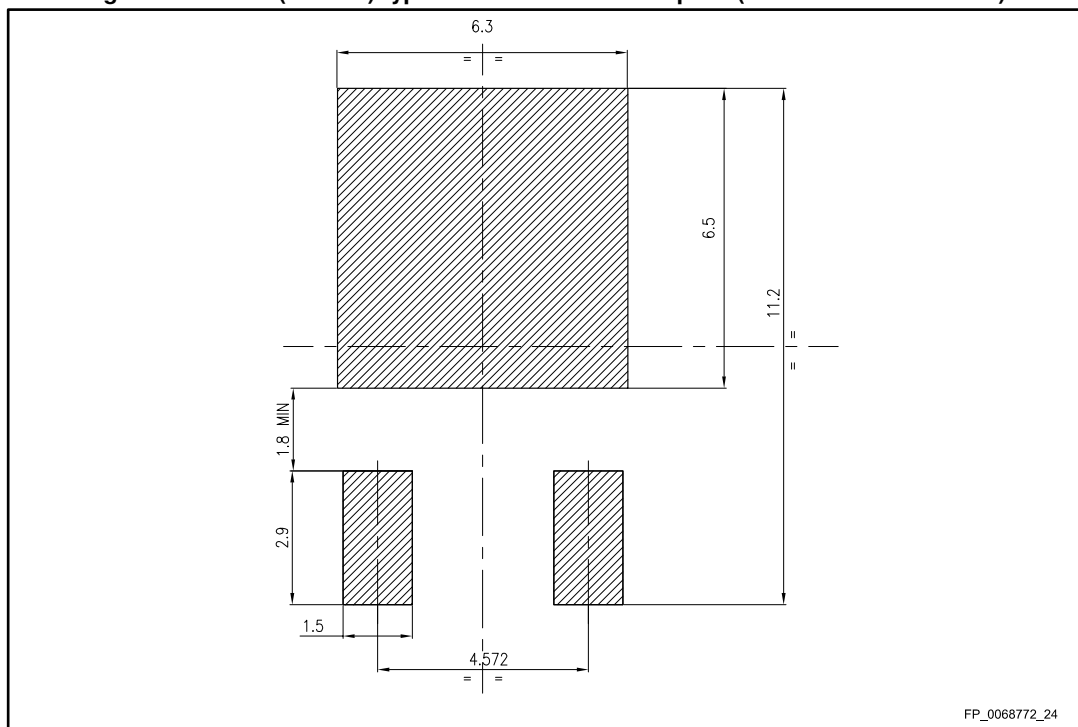


Table 11: DPAK (TO-252) type E mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.18		2.39
A2			0.13
b	0.65		0.884
b4	4.95		5.46
c	0.46		0.61
c2	0.46		0.60
D	5.97		6.22
D1	5.21		
E	6.35		6.73
E1	4.32		
e		2.286	
e1		4.572	
H	9.94		10.34
L	1.50		1.78
L1		2.74	
L2	0.89		1.27
L4			1.02

Figure 27: DPAK (TO-252) type E recommended footprint (dimensions are in mm)



### 4.3 DPAK (TO-252) packing information

Figure 28: DPAK (TO-252) tape outline

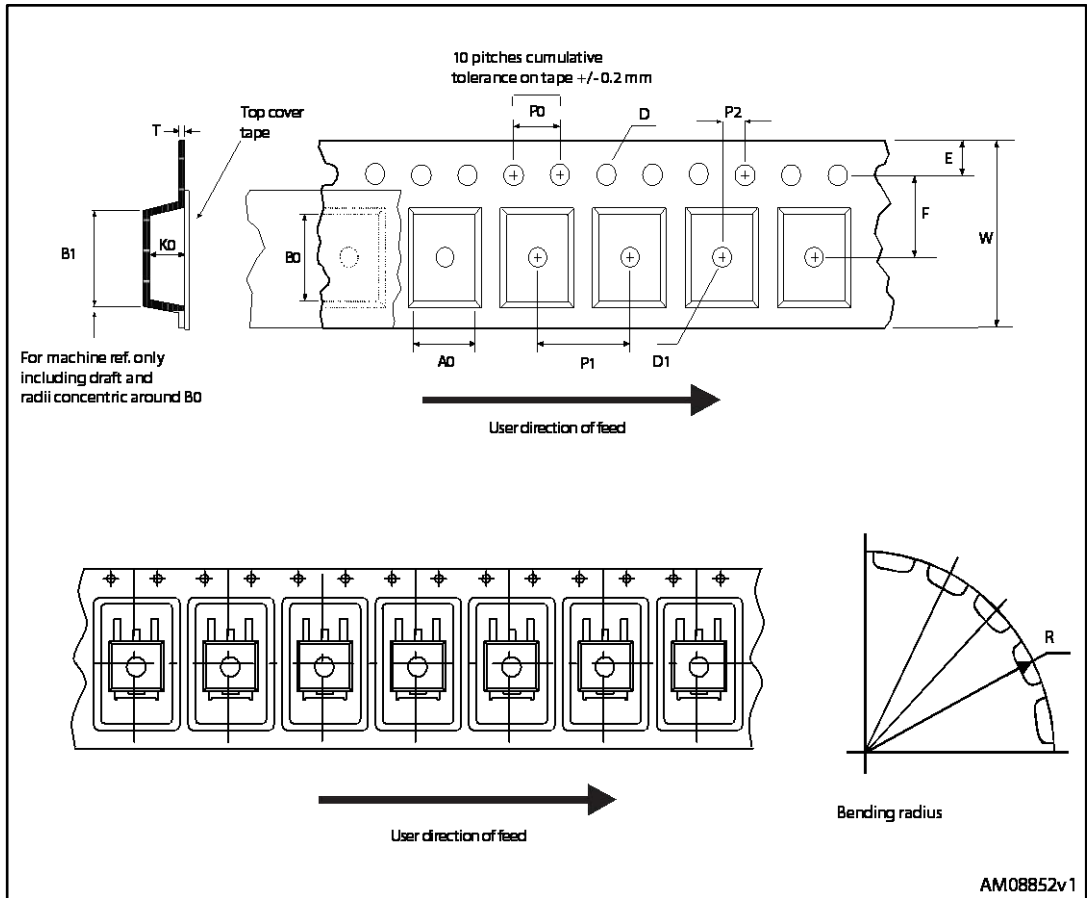
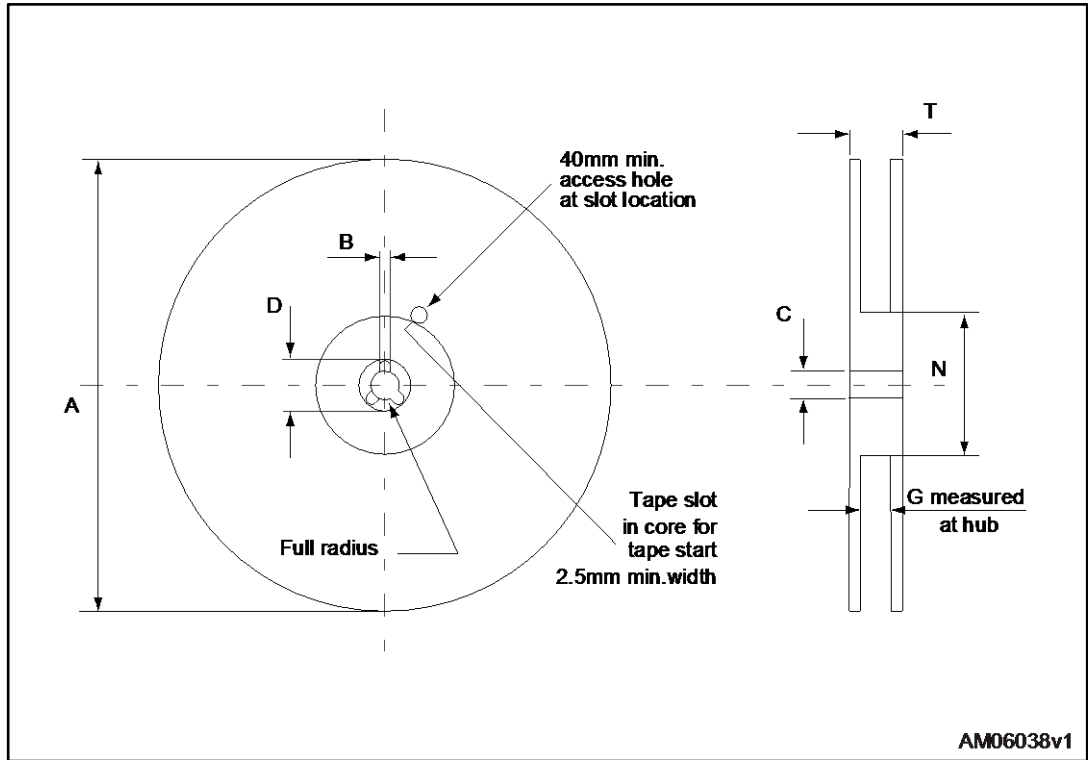


Figure 29: DPAK (TO-252) reel outline



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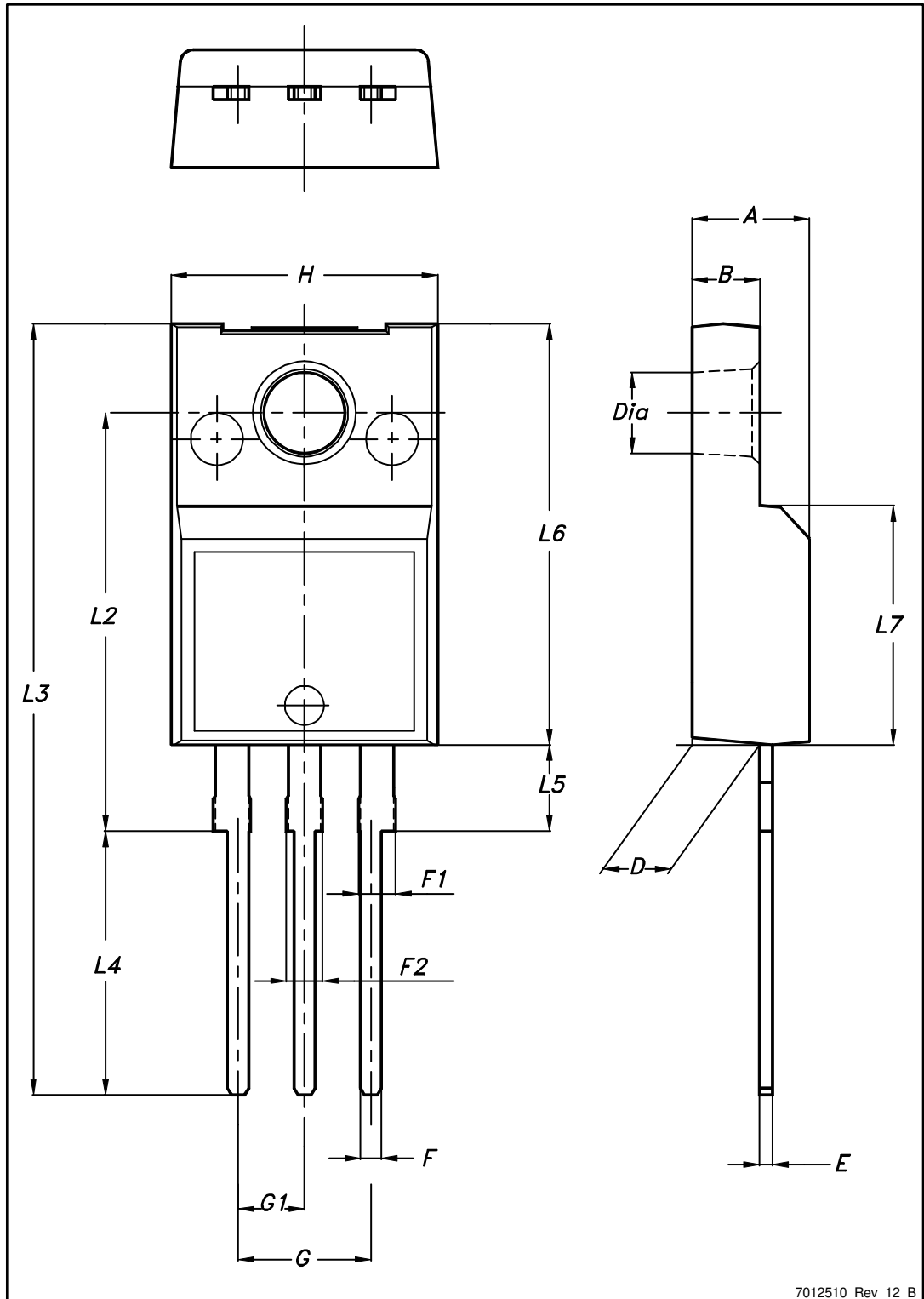
Table 12: DPAK (TO-252) tape and reel mechanical data

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			



### 4.4 TO-220FP package information

Figure 30: TO-220FP package outline



7012510\_Rev\_12\_B

Table 13: 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

### 4.5 TO-220 type A package information

Figure 31: TO-220 type A package outline

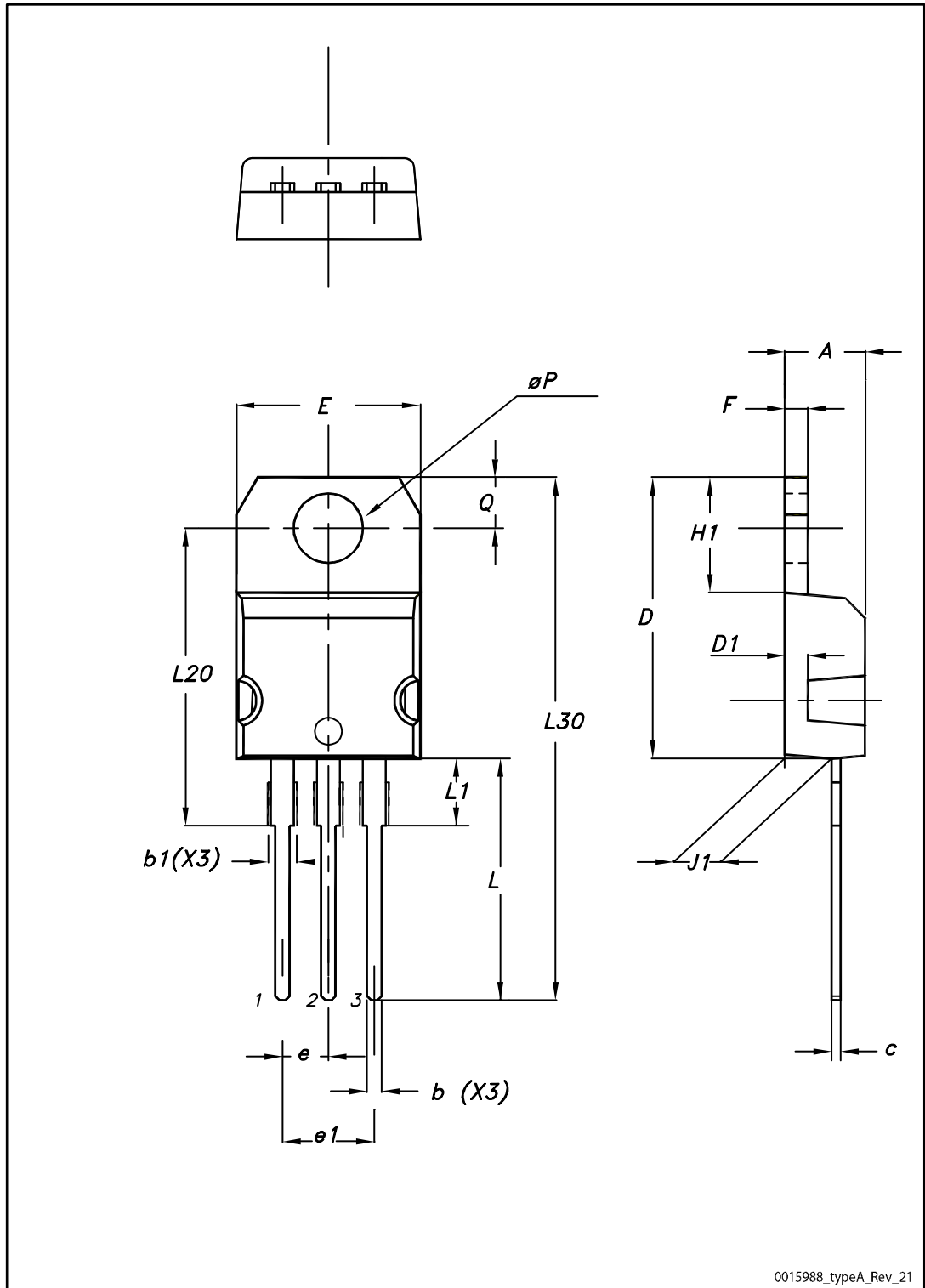


Table 14: TO-220 type A package mechanical data

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

### 4.6 IPAK (TO-251) type A package information

Figure 32: IPAK (TO-251) type A package outline

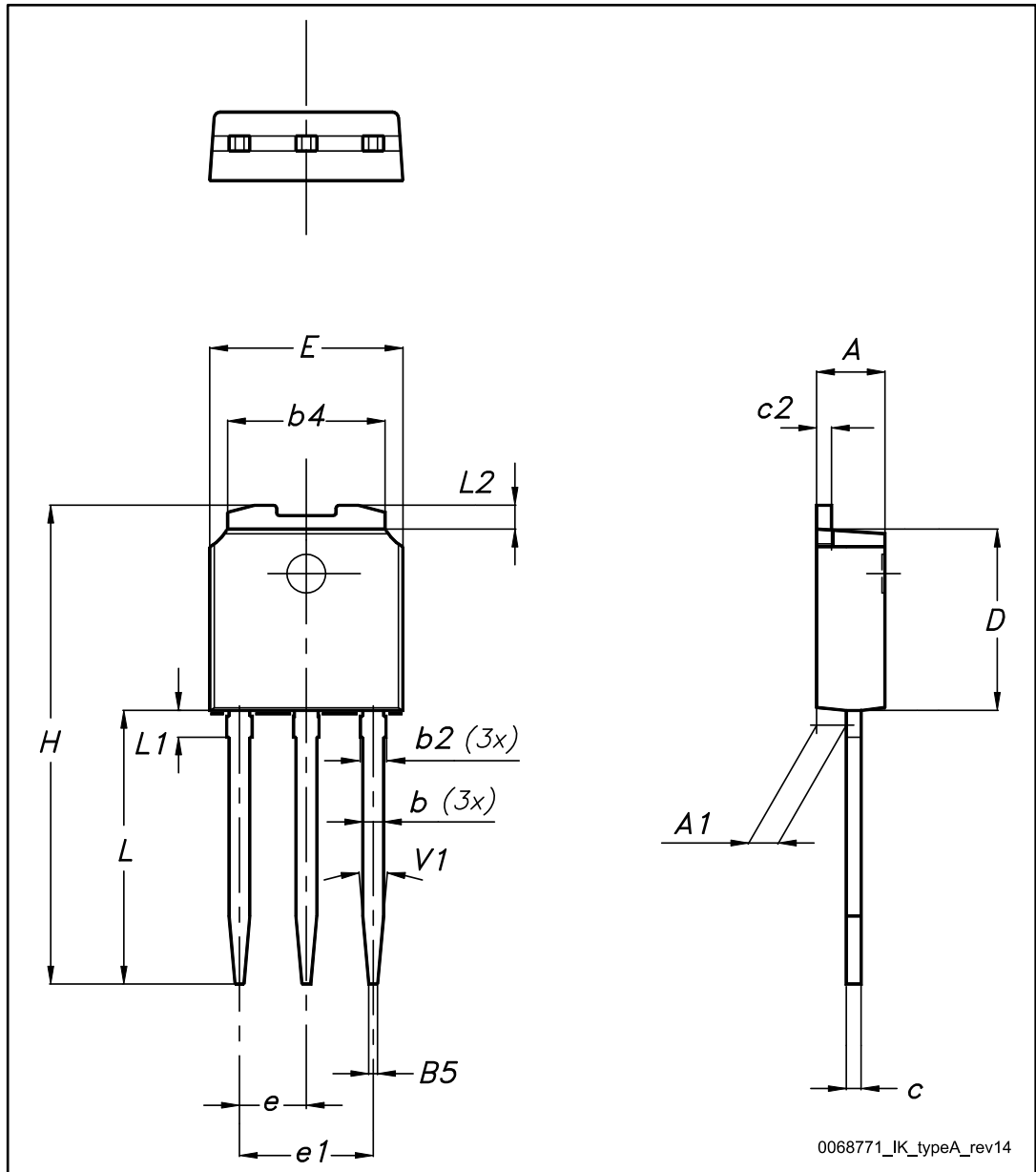


Table 15: IPAK (TO-251) type A package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
B5		0.30	
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
L1	0.80		1.20
L2		0.80	1.00
V1		10°	

## 5 Revision history

Table 16: Document revision history

Date	Revision	Changes
12-Jul-2013	1	First release.
15-Jan-2014	2	<ul style="list-style-type: none"> <li>– Modified: PTOT and EAS values in Table 2</li> <li>– Modified: Rthj-case values in Table 3</li> <li>– Modified: the entire typical values in Table 5 and 6</li> <li>– Modified: ISD and ISDM max values and typical values in Table 7</li> <li>– Updated: Table 24 and Table 9</li> <li>– Added: Section 2.1: Electrical characteristics (curves)</li> <li>– Minor text changes</li> </ul>
17-Jan-2014	3	<ul style="list-style-type: none"> <li>– Modified: Figure 8 and 9</li> <li>– Minor text changes</li> </ul>
17-Jul-2017	4	Updated <a href="#">Table 7: "Switching times"</a> and <a href="#">Section 4: "Package information"</a> . Minor text changes.

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