

N-channel 800 V, 0.37  $\Omega$  typ., 12 A MDmesh™ K5  
Power MOSFETs in D<sup>2</sup>PAK, TO-220FP, TO-220 and TO-247

Datasheet - production data

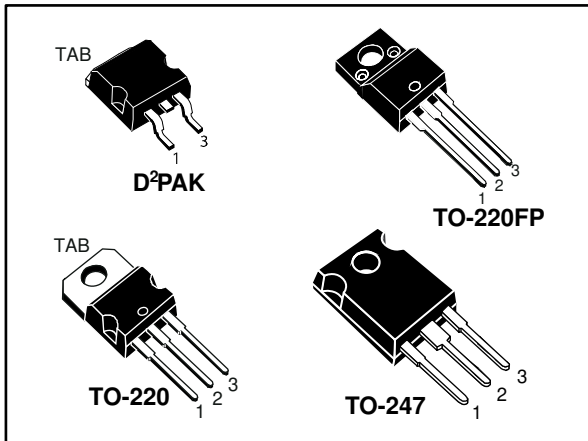
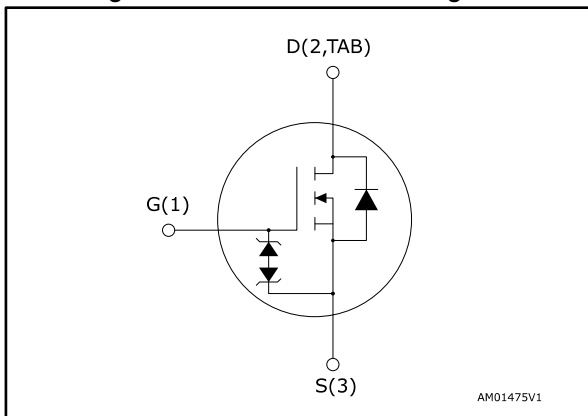


Figure 1: Internal schematic diagram



## Features

Order code	V <sub>DS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>	P <sub>TOT</sub>
STB13N80K5	800 V	0.45 $\Omega$	12 A	190 W
STF13N80K5				35 W
STP13N80K5				190 W
STW13N80K5				

- 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
STB13N80K5	13N80K5	D <sup>2</sup> PAK	Tape and reel
STF13N80K5		TO-220FP	Tube
STP13N80K5		TO-220	
STW13N80K5		TO-247	

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D <sup>2</sup> PAK, TO-220, TO-247	TO-220FP	
V <sub>GS</sub>	Gate-source voltage	±30		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	12	12 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	7.6	7.6 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	48	48 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	190	35	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)		2500	V
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	4.5		V/ns
dv/dt <sup>(4)</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:**

- <sup>(1)</sup>Limited by package.
- <sup>(2)</sup>Pulse width limited by safe operating area.
- <sup>(3)</sup>I<sub>SD</sub> ≤ 12 A, di/dt = 100 A/μs; V<sub>DS</sub> peak < V<sub>(BR)DSS</sub>.
- <sup>(4)</sup>V<sub>DS</sub> ≤ 640 V.

Table 3: Thermal data

Symbol	Parameter	Value				Unit
		D <sup>2</sup> PAK	TO-220	TO-220FP	TO-247	
R <sub>thj-case</sub>	Thermal resistance junction-case	0.66		3.57	0.66	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient		62.5		50	°C/W
R <sub>thj-pcb</sub> <sup>(1)</sup>	Thermal resistance junction-pcb	30				°C/W

**Notes:**

- <sup>(1)</sup>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> )	4	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)	148	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	$V_{GS} = 10\text{ V}$ , $I_D = 6\text{ A}$		0.37	0.45	$\Omega$

**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	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	870	-	pF
$C_{oss}$	Output capacitance		-	50	-	pF
$C_{rss}$	Reverse transfer capacitance		-	2	-	pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ to }640\text{ V}$	-	110	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related		-	43	-	pF
$R_g$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , $I_D = 0\text{ A}$	-	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 22: "Test circuit for gate charge behavior"</a> )	-	29	-	nC
$Q_{gs}$	Gate-source charge		-	7	-	nC
$Q_{gd}$	Gate-drain charge		-	18	-	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	$V_{DD} = 400\text{ V}$ , $I_D = 6\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 21</a> : "Test circuit for resistive load switching times" and <a href="#">Figure 26</a> : "Switching time waveform")	-	16	-	ns
$t_r$	Rise time		-	16	-	ns
$t_{d(off)}$	Turn-off delay time		-	42	-	ns
$t_f$	Fall time		-	16	-	ns

Table 8: Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		14	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		56	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 12\text{ A}$ , $V_{GS} = 0\text{ V}$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 12\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ (see <a href="#">Figure 23</a> : "Test circuit for inductive load switching and diode recovery times")	-	406		ns
$Q_{rr}$	Reverse recovery charge		-	5.7		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	28		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 12\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 23</a> : "Test circuit for inductive load switching and diode recovery times")	-	600		ns
$Q_{rr}$	Reverse recovery charge		-	7.9		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	26		A

**Notes:**

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

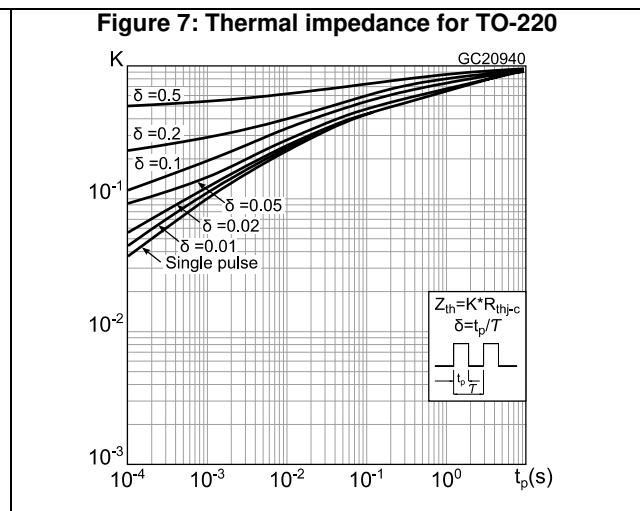
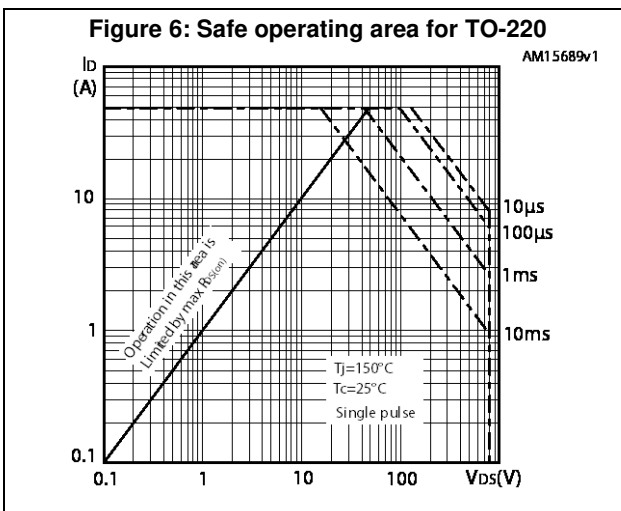
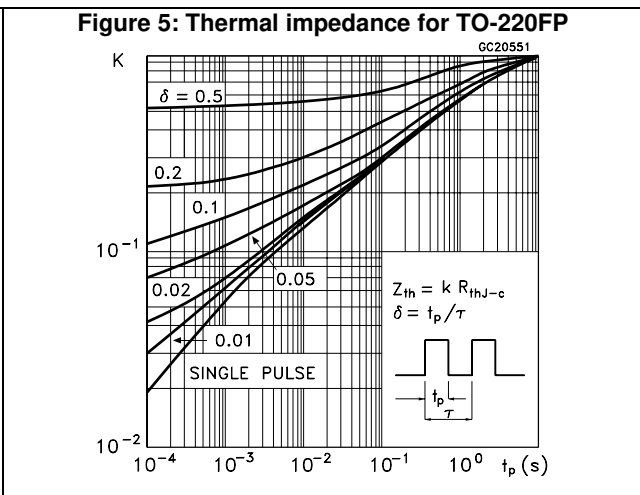
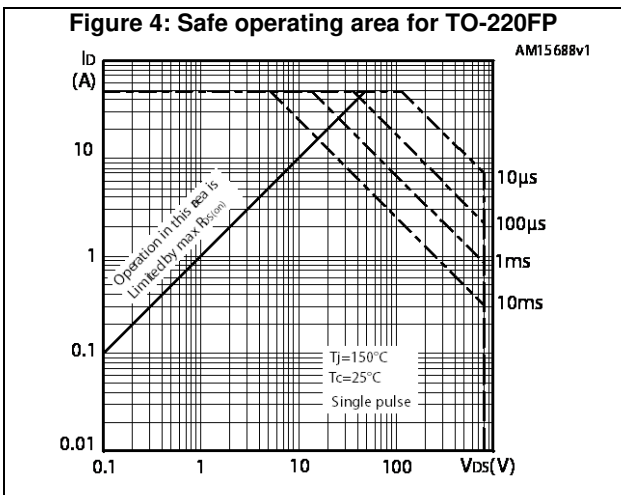
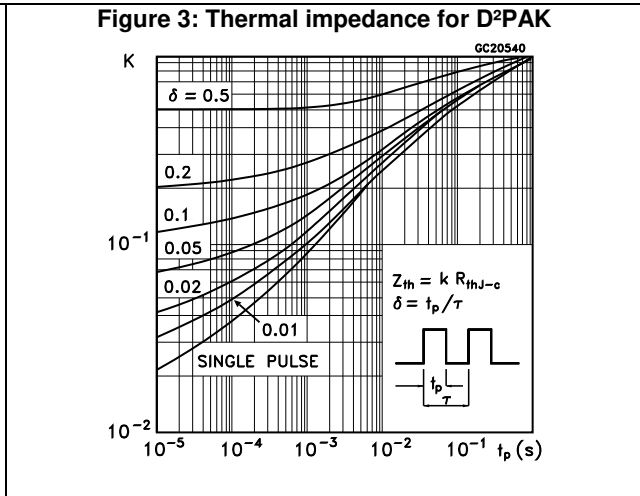
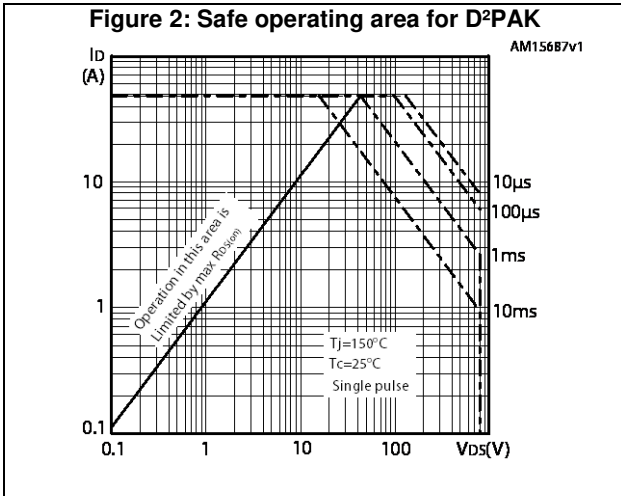
<sup>(2)</sup>Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

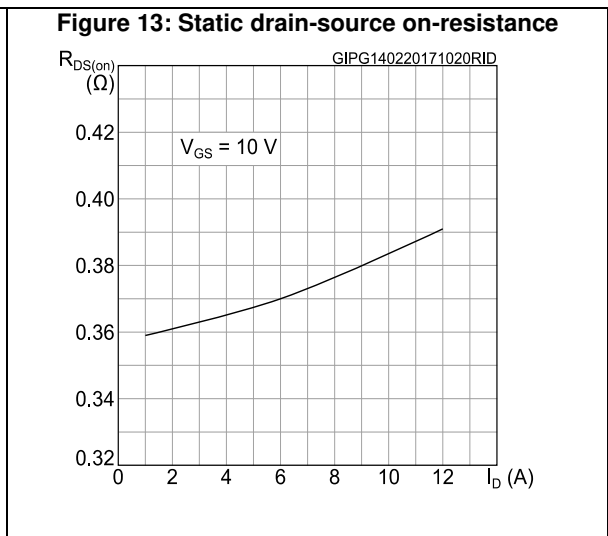
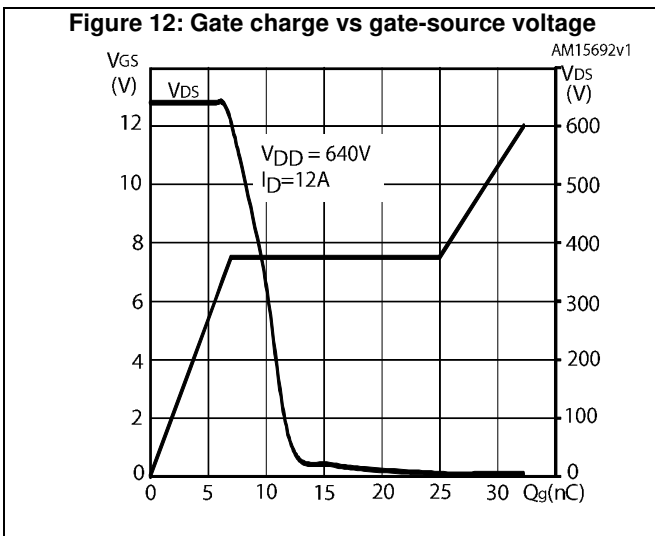
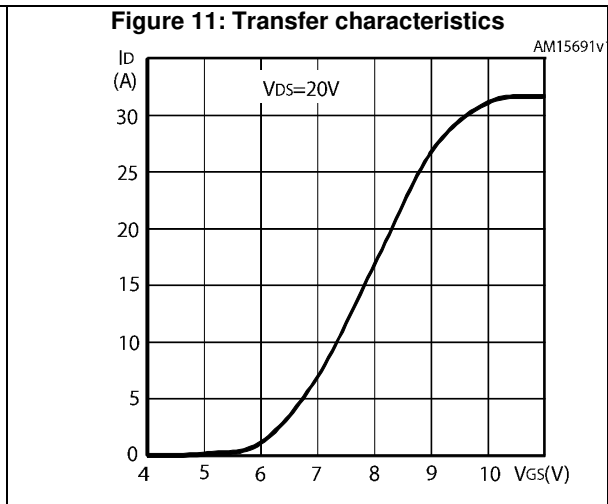
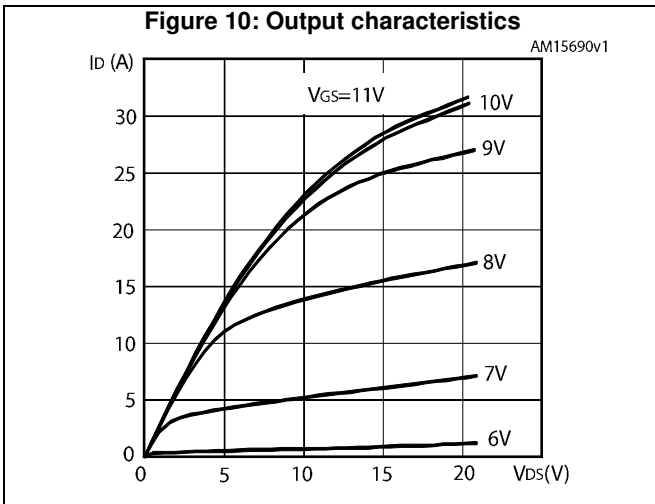
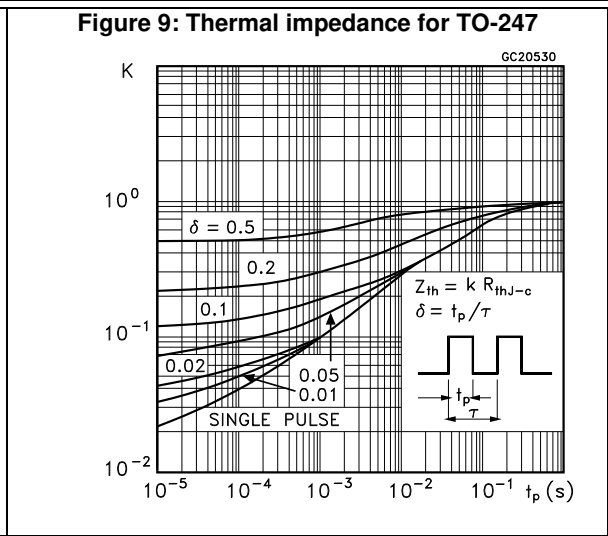
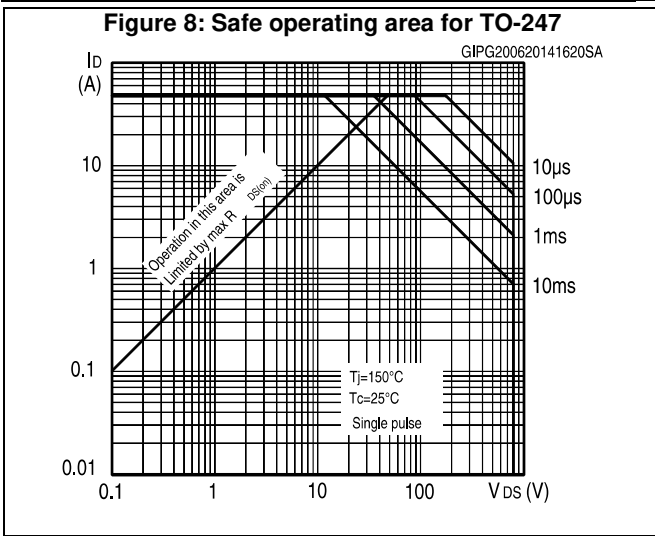
Table 9: Gate-source Zener diode

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)





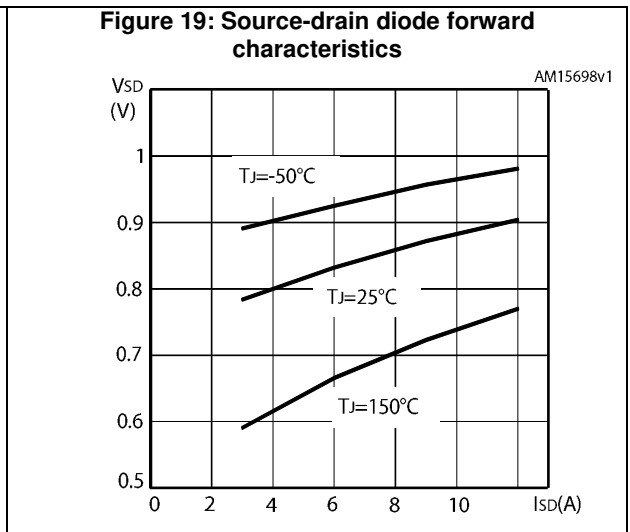
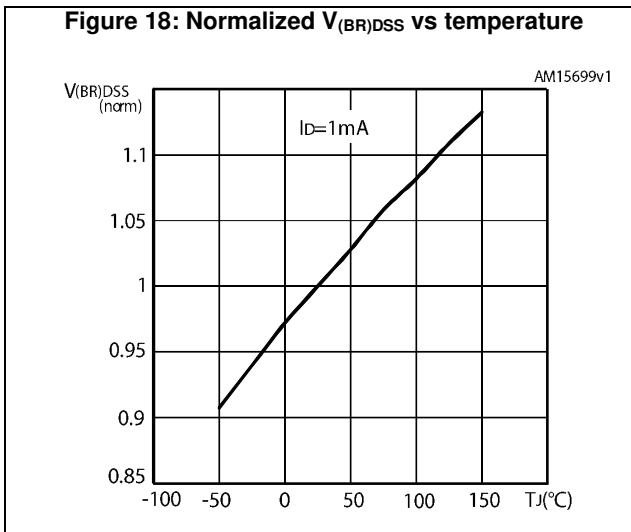
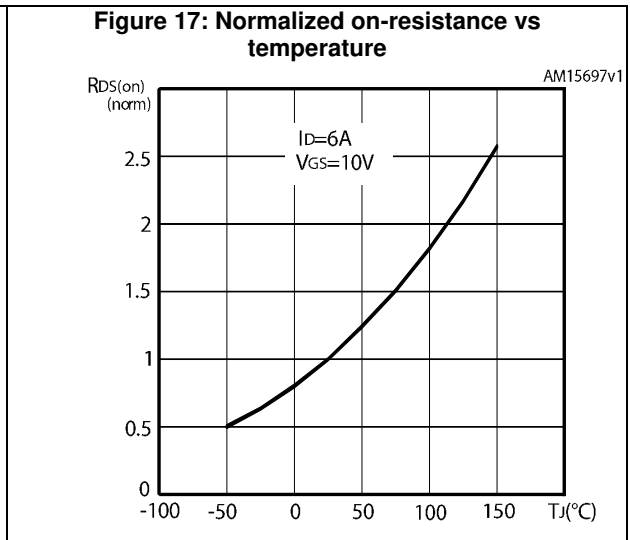
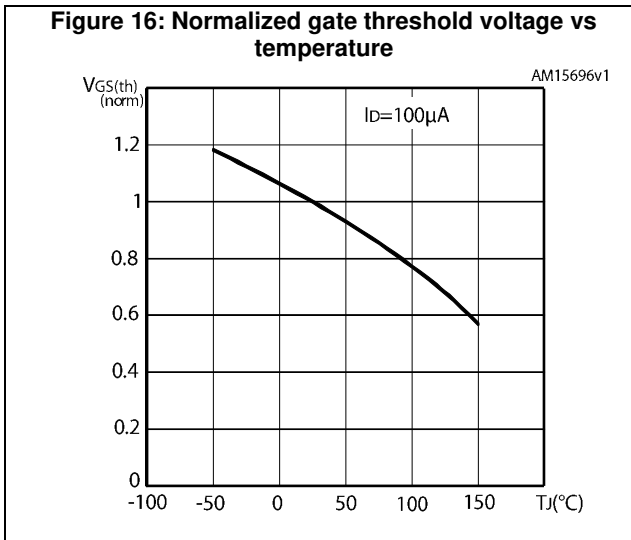
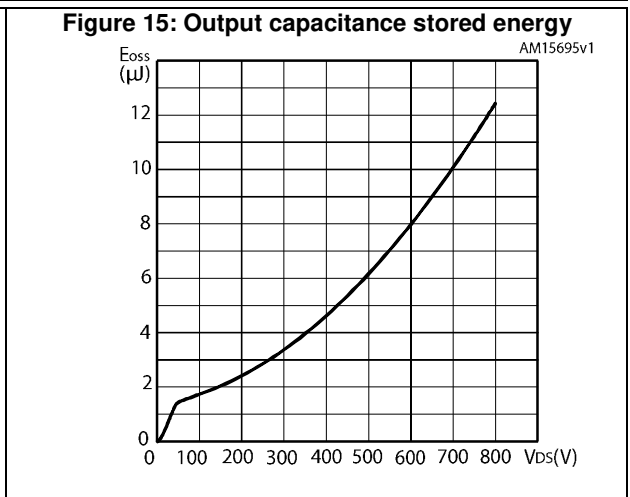
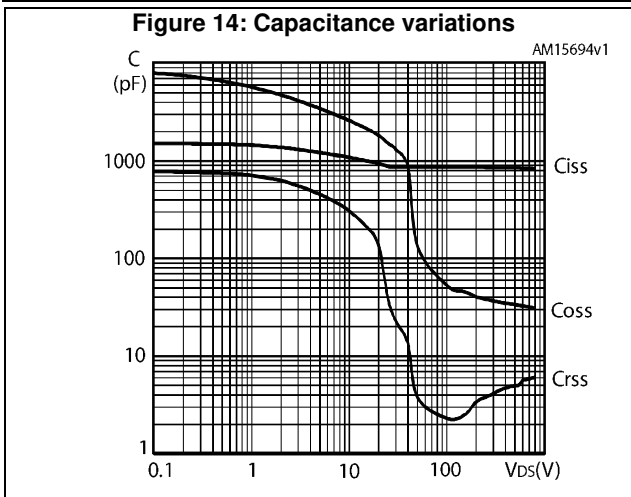
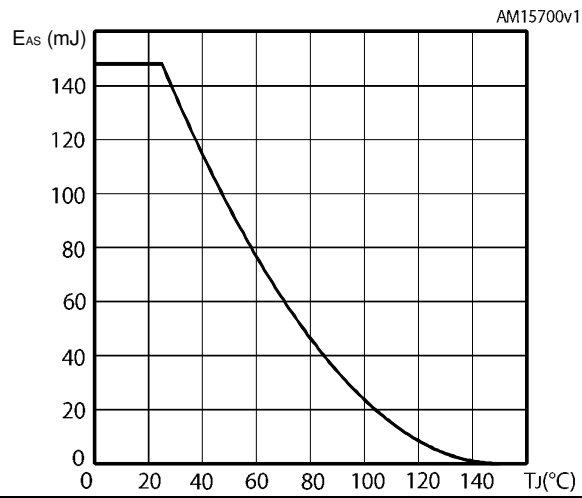


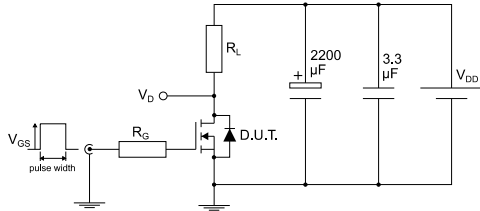


Figure 20: Maximum avalanche energy vs. starting  $T_j$



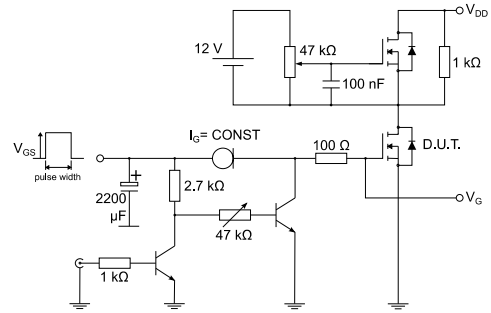
### 3 Test circuits

**Figure 21: Test circuit for resistive load switching times**



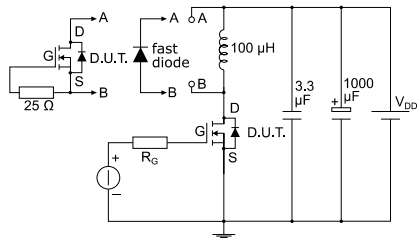
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**Figure 22: Test circuit for gate charge behavior**



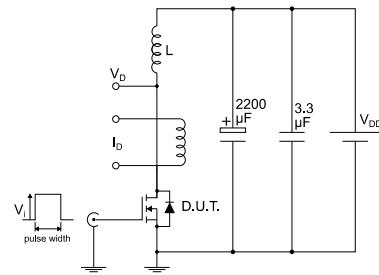
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**Figure 23: Test circuit for inductive load switching and diode recovery times**



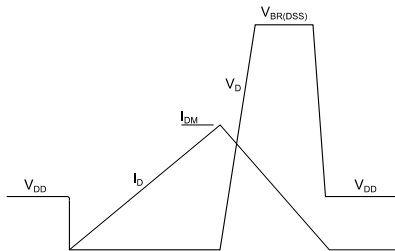
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**Figure 24: Unclamped inductive load test circuit**



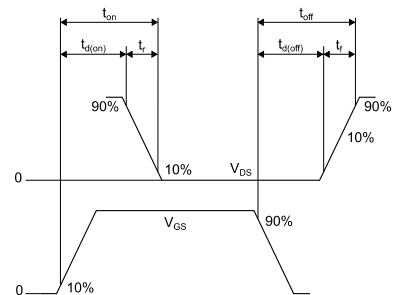
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**Figure 25: Unclamped inductive waveform**



AM01472v1

**Figure 26: 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 D<sup>2</sup>PAK (TO-263) type A package information

Figure 27: D<sup>2</sup>PAK (TO-263) type A package outline

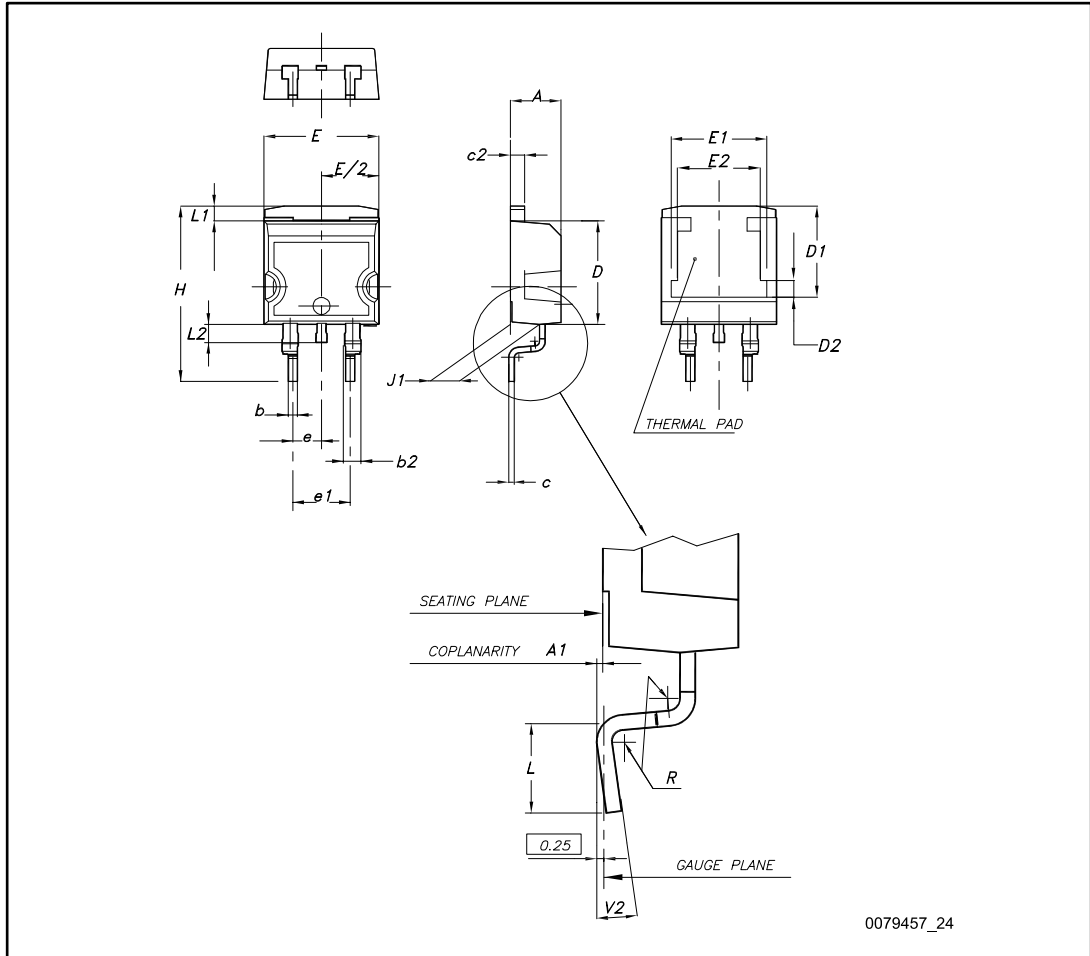
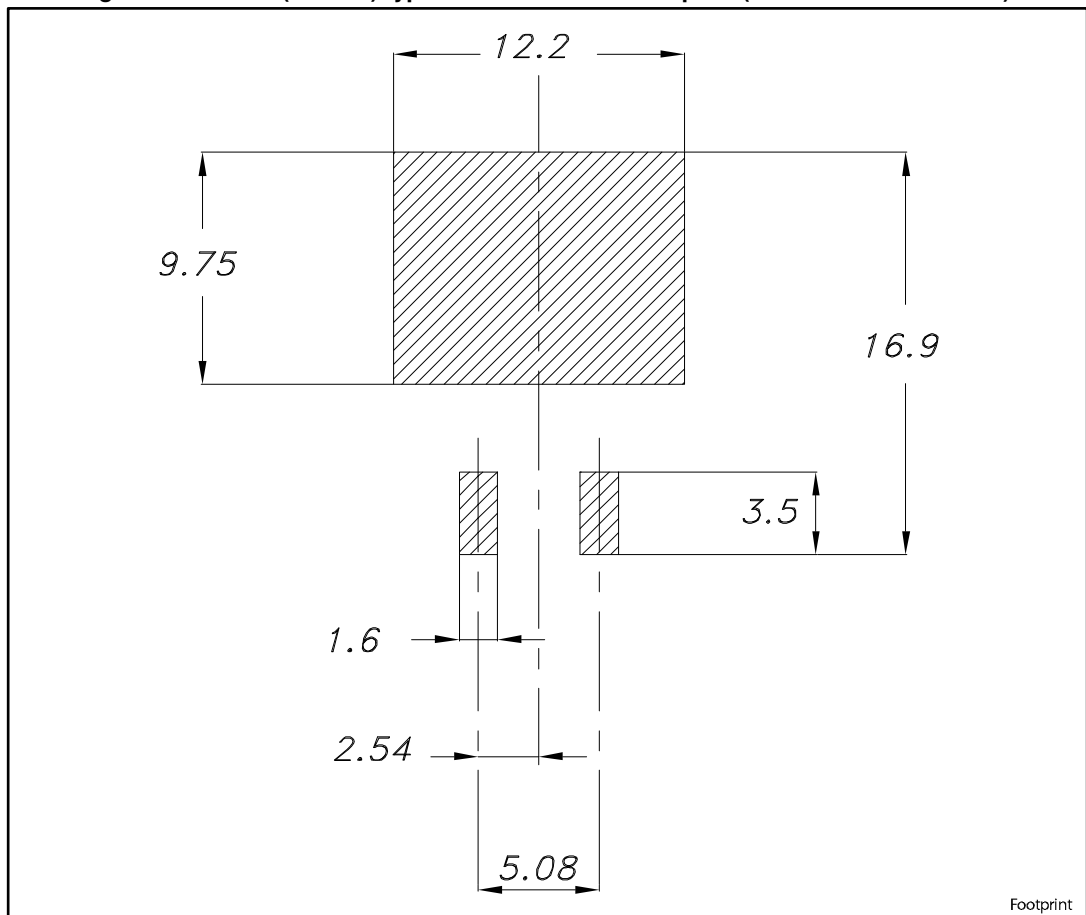


Table 10: D<sup>2</sup>PAK (TO-263) type A package mechanical data

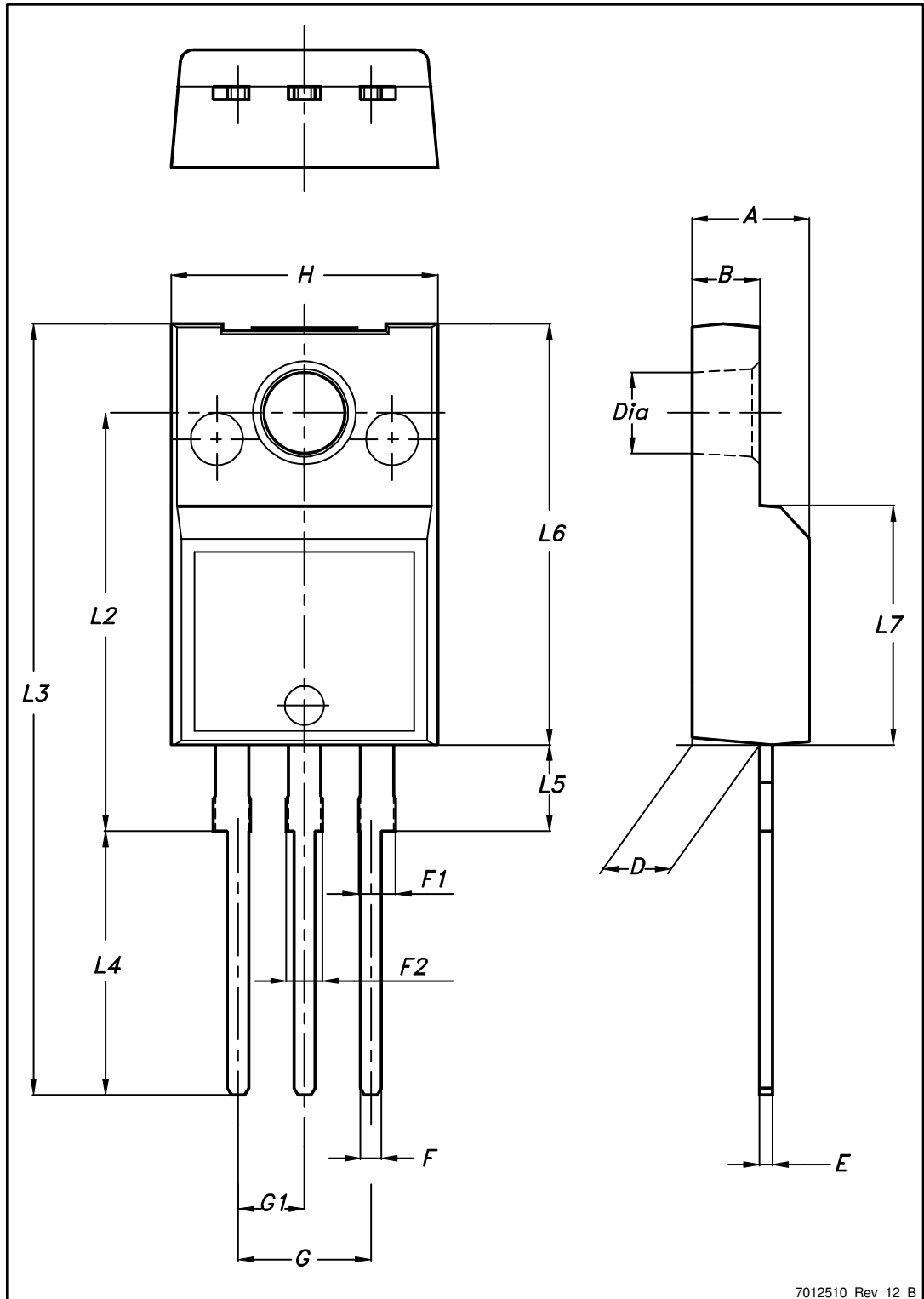
Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50	7.75	8.00
D2	1.10	1.30	1.50
E	10.00		10.40
E1	8.50	8.70	8.90
E2	6.85	7.05	7.25
e		2.54	
e1	4.88		5.28
H	15.00		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.40	
V2	0°		8°

Figure 28: D<sup>2</sup>PAK (TO-263) type A recommended footprint (dimensions are in mm)



### 4.2 TO-220FP package information

Figure 29: TO-220FP package outline



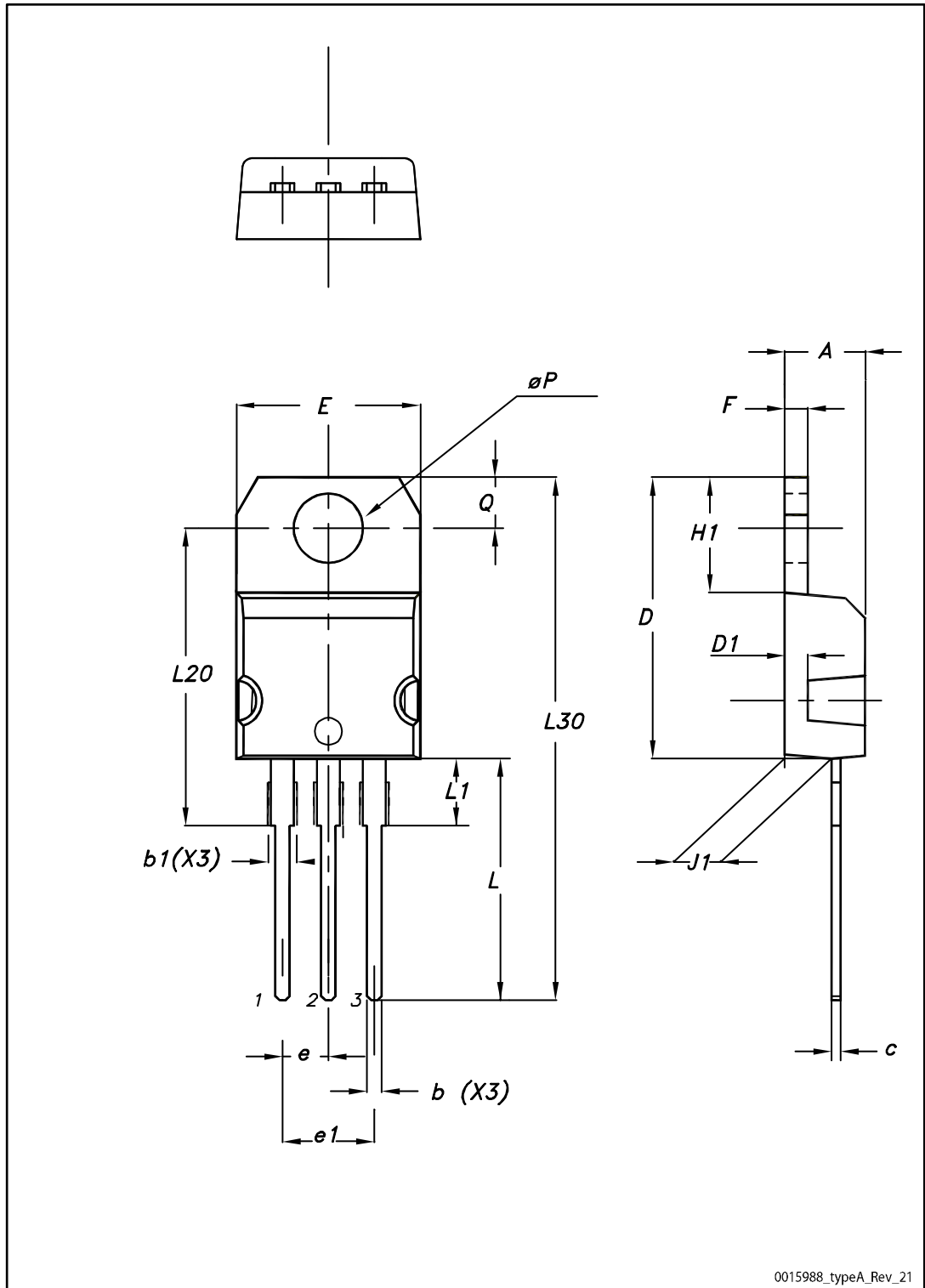
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Table 11: TO-220FP package mechanical data

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 packing information

Figure 30: TO-220 type A package outline



0015988\_typeA\_Rev\_21



Table 12: 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

### 4.4 TO-247 package information

Figure 31: TO-247 package outline

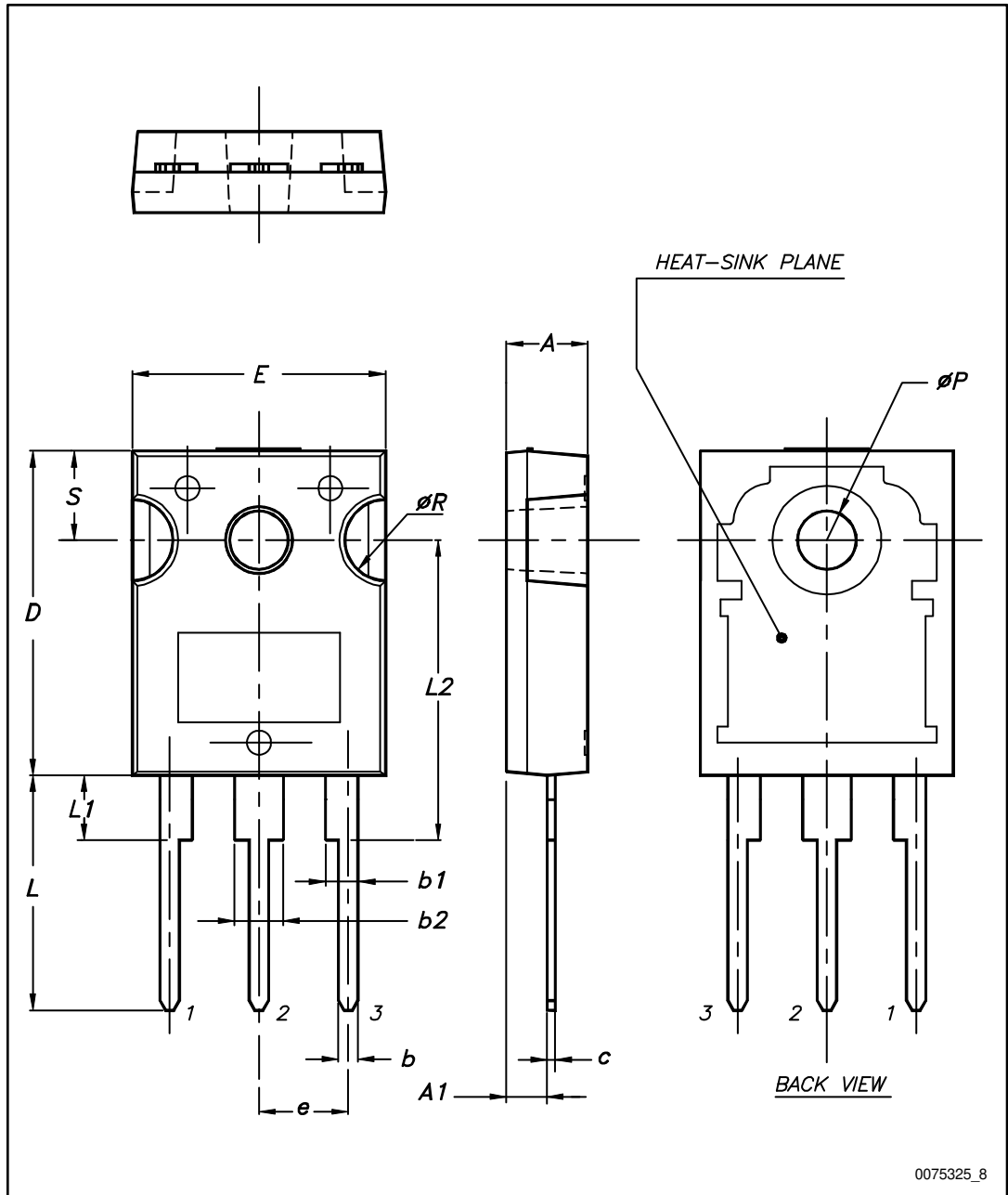


Table 13: TO-247 package mechanical data

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 D<sup>2</sup>PAK type A packing information

Figure 32: D<sup>2</sup>PAK type A tape outline

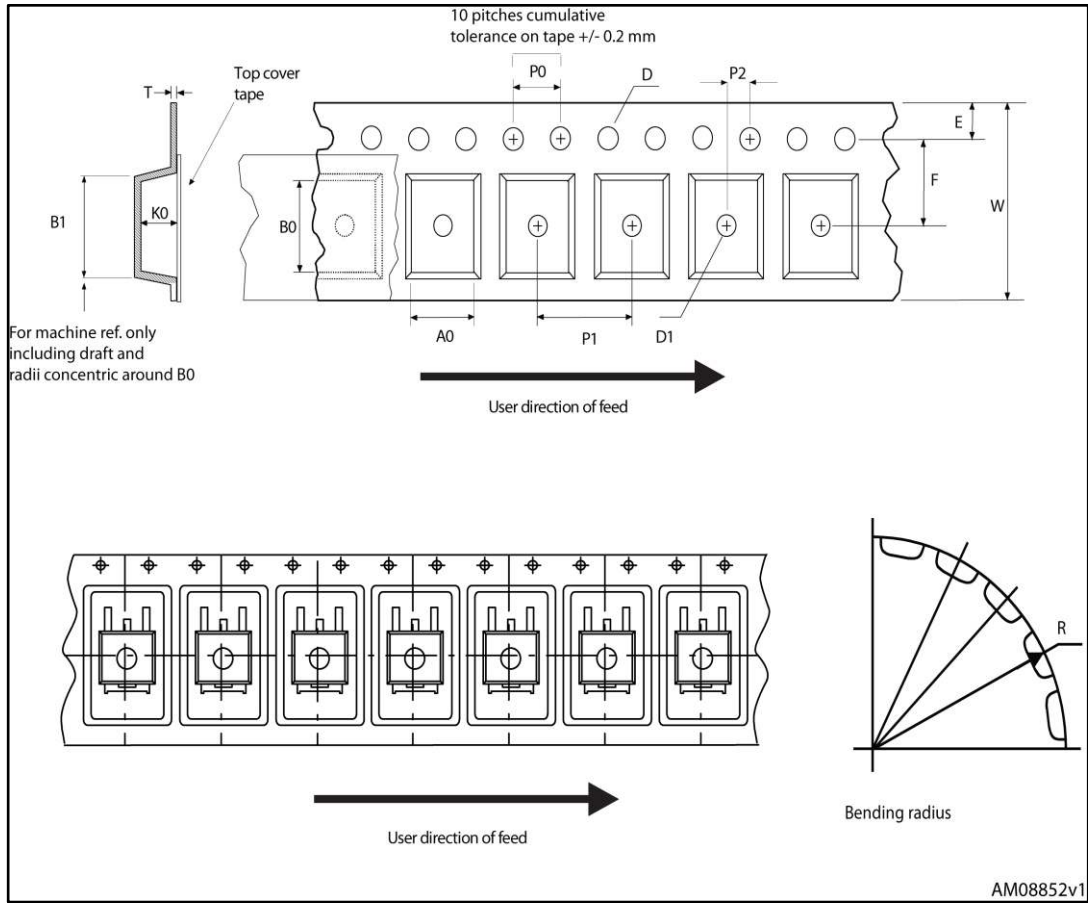
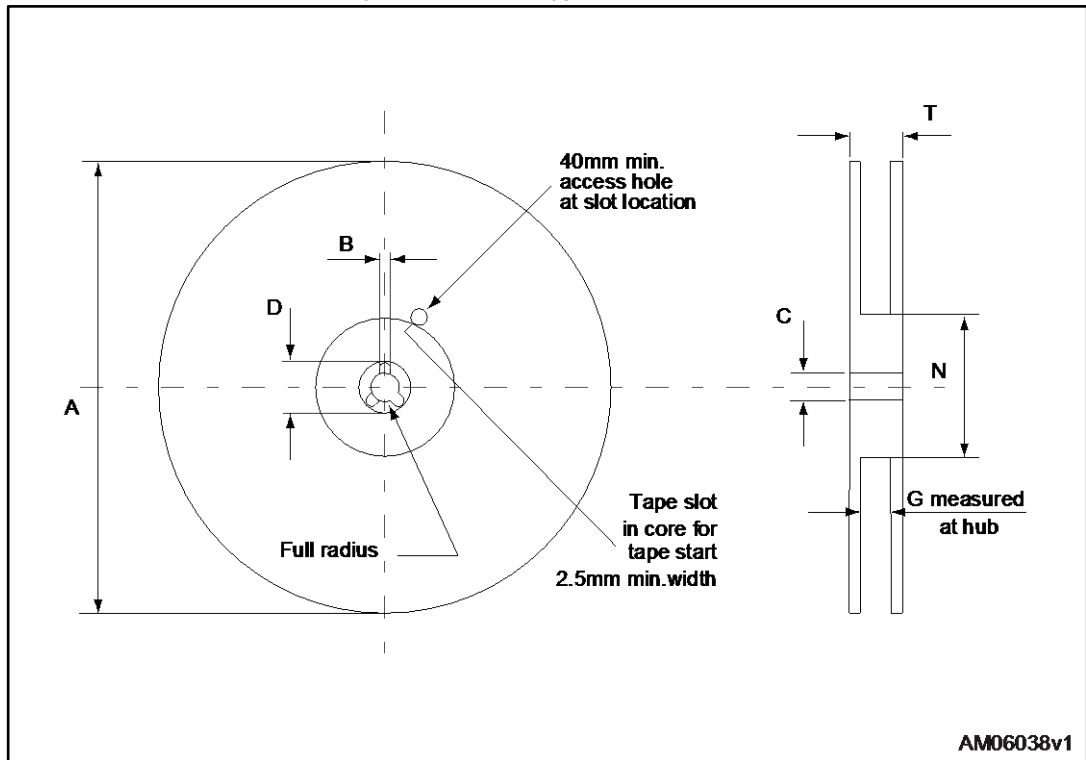


Figure 33: D<sup>2</sup>PAK type A reel outline



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Table 14: D<sup>2</sup>PAK type A 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
07-Mar-2013	1	First release.
27-Mar-2013	2	Updated Figure 1: Internal schematic diagram. Minor text changes. Document status promoted from preliminary data to production data.
15-Apr-2013	3	– Modified: E <sub>AS</sub> value, the entire typical values on <i>Table 5, 6 and 7</i> – Inserted: <i>Section 2.1: Electrical characteristics (curves)</i> – Minor text changes
25-Sep-2017	4	Added: TO-247 package. Updated title, features and description. Updated <i>Figure 13: "Static drain-source on-resistance"</i> . Updated <i>Table 2: "Absolute maximum ratings"</i> , <i>Table 5: "On/off-state"</i> , <i>Table 6: "Dynamic"</i> and <i>Table 8: "Source-drain diode"</i> . Added <i>Figure 8: "Safe operating area for TO-247"</i> and <i>Figure 9: "Thermal impedance for TO-247"</i> . Updated <i>Section 4.4: "TO-247 package information"</i> . Minor text changes.

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