

N-channel 600 V, 0.55 Ω typ., 7.5 A MDmesh™ M2 Power MOSFETs in D²PAK, DPAK, TO-220 and IPAK packages

Datasheet - production data

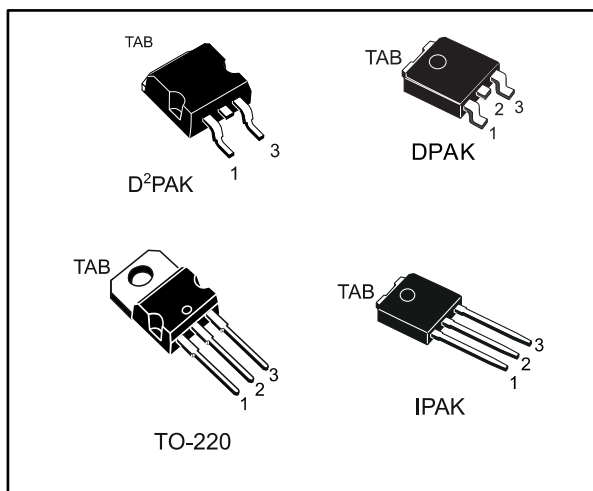
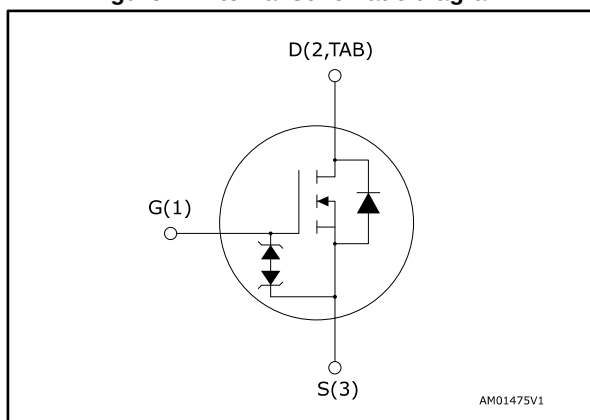


Figure 1: Internal schematic diagram



Features

Order code	V _{DS} @T _{Jmax.}	R _{DS(on)} max.	I _D
STB10N60M2	650 V	0.60 Ω	7.5 A
STD10N60M2			
STP10N60M2			
STU10N60M2			

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

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using MDmesh™ M2 technology. Thanks to their strip layout and improved vertical structure, these 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	Package	Packing
STB10N60M2	10N60M2	D ² PAK	Tape and reel
STD10N60M2		DPAK	
STP10N60M2		TO-220	Tube
STU10N60M2		IPAK	

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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 $T_{case} = 25\text{ }^{\circ}\text{C}$	7.5	A
	Drain current (continuous) at $T_{case} = 100\text{ }^{\circ}\text{C}$	4.9	
$I_{DM}^{(1)}$	Drain current (pulsed)	30	A
P_{TOT}	Total dissipation at $T_{case} = 25\text{ }^{\circ}\text{C}$	85	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15	V/ns
$dv/dt^{(3)}$	MOSFET dv/dt ruggedness	50	
T_{stg}	Storage temperature range	-55 to 150	$^{\circ}\text{C}$
T_j	Operating junction temperature range		

Notes:

(1) Pulse limited by safe operating area.

(2) $I_{SD} \leq 7.5\text{ A}$, $di/dt \leq 400\text{ A}/\mu\text{s}$; $V_{DS\text{ peak}} < V_{(BR)DSS}$, $V_{DD} = 400\text{ V}$ (3) $V_{DS} \leq 480\text{ V}$.

Table 3: Thermal data

Symbol	Parameter	Value				Unit
		D ² PAK	DPAK	TO-220	IPAK	
$R_{thj-case}$	Thermal resistance junction-case	1.47				$^{\circ}\text{C}/\text{W}$
$R_{thj-pcb}$	Thermal resistance junction-pcb ⁽¹⁾	30	50			
$R_{thj-amb}$	Thermal resistance junction-ambient			62.5	100	

Notes:(1) When mounted on 1 inch² FR-4, 2 Oz copper board.

Table 4: Avalanche characteristics

Symbol	Parameter	Value	Unit
$I_{AR}^{(1)}$	Avalanche current, repetitive or not repetitive	1.5	A
$E_{AS}^{(2)}$	Single pulse avalanche energy	110	mJ

Notes:(1) Pulse width limited by T_{jmax} .(2) Starting $T_j = 25\text{ }^{\circ}\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$.

2 Electrical characteristics

(T_{case} = 25 °C unless otherwise specified)

Table 5: Static

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V _{(BR)DSS}	Drain-source breakdown voltage	V _{GS} = 0 V, I _D = 1 mA	600			V
I _{DSS}	Zero gate voltage drain current	V _{GS} = 0 V, V _{DS} = 600 V			1	μA
		V _{GS} = 0 V, V _{DS} = 600 V, T _{case} = 125 °C ⁽¹⁾			100	
I _{GSS}	Gate-body leakage current	V _{DS} = 0 V, 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 = 3 A		0.55	0.60	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	-	400	-	pF
C _{oss}	Output capacitance		-	22	-	
C _{rss}	Reverse transfer capacitance		-	0.84	-	
C _{oss} eq. ⁽¹⁾	Equivalent output capacitance	V _{DS} = 0 to 480 V, V _{GS} = 0 V	-	83	-	pF
R _G	Intrinsic gate resistance	f = 1 MHz, I _D = 0 A	-	6.4	-	Ω
Q _g	Total gate charge	V _{DD} = 480 V, I _D = 7.5 A, V _{GS} = 0 to 10 V (see Figure 17: "Test circuit for gate charge behavior")	-	13.5	-	nC
Q _{gs}	Gate-source charge		-	2.1	-	
Q _{gd}	Gate-drain charge		-	7.2	-	

Notes:

⁽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 = 3.75 A R _G = 4.7 Ω, V _{GS} = 10 V (see Figure 16: "Test circuit for resistive load switching times" and Figure 21: "Switching time waveform")	-	8.8	-	ns
t _r	Rise time		-	8	-	
t _{d(off)}	Turn-off delay time		-	32.5	-	
t _f	Fall time		-	13.2	-	

Table 8: Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		7.5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		30	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0\text{ V}$, $I_{SD} = 7.5\text{ A}$	-		1.6	V
t_{rr}	Reverse recovery time	$I_{SD} = 7.5\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$ (see Figure 18 : "Test circuit for inductive load switching and diode recovery times")	-	270		ns
Q_{rr}	Reverse recovery charge		-	2		μC
I_{RRM}	Reverse recovery current		-	14.4		A
t_{rr}	Reverse recovery time	$I_{SD} = 7.5\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$ (see Figure 18 : "Test circuit for inductive load switching and diode recovery times")	-	376		ns
Q_{rr}	Reverse recovery charge		-	2.8		μC
I_{RRM}	Reverse recovery current		-	15		A

Notes:

(1) Pulse width is limited by safe operating area.

(2) Pulse test: pulse duration = 300 μs , duty cycle 1.5%.

2.1 Electrical characteristics (curves)

Figure 2: Safe operating area for DPAK and IPAK

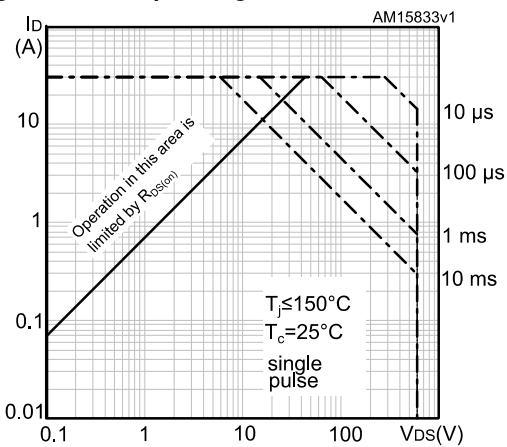


Figure 3: Thermal impedance for DPAK and IPAK

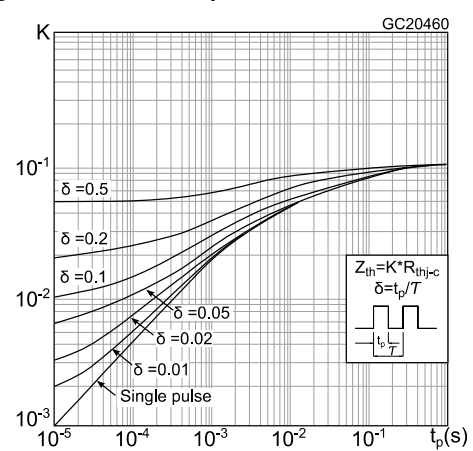
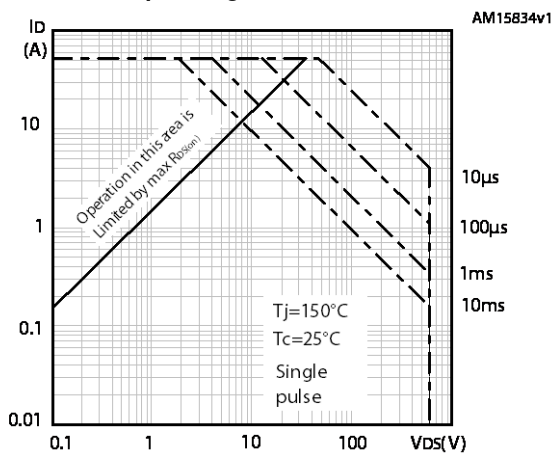
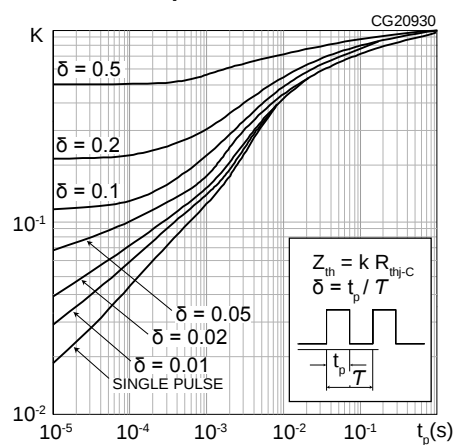
Figure 4: Safe operating area for D²PAK and TO-220Figure 5: Thermal impedance for D²PAK and TO-220

Figure 6: Output characteristics

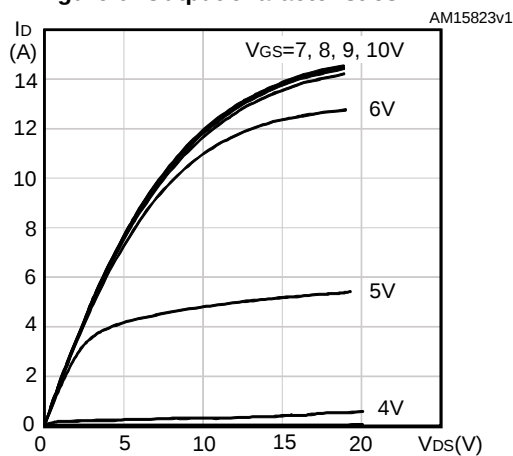


Figure 7: Transfer characteristics

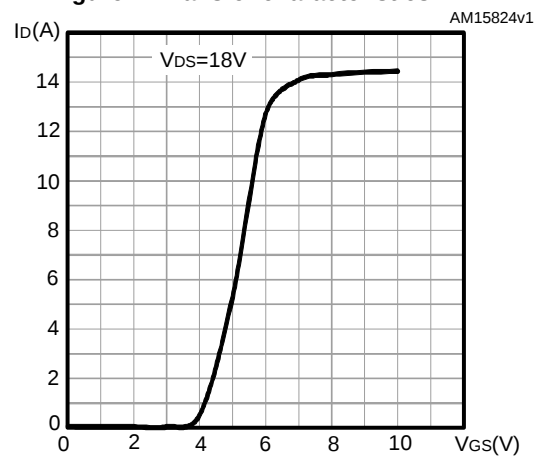


Figure 8: Gate charge vs gate-source voltage

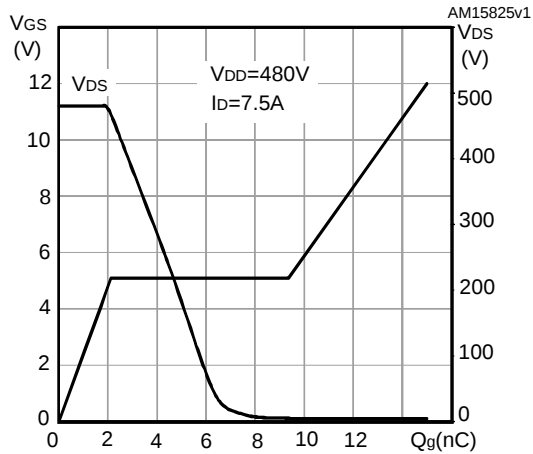


Figure 9: Static drain-source on-resistance

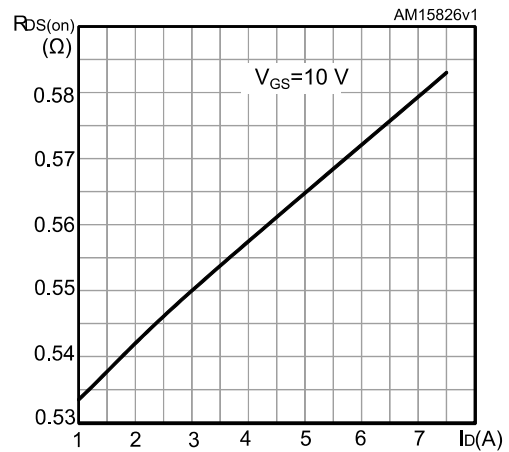


Figure 10: Capacitance variations

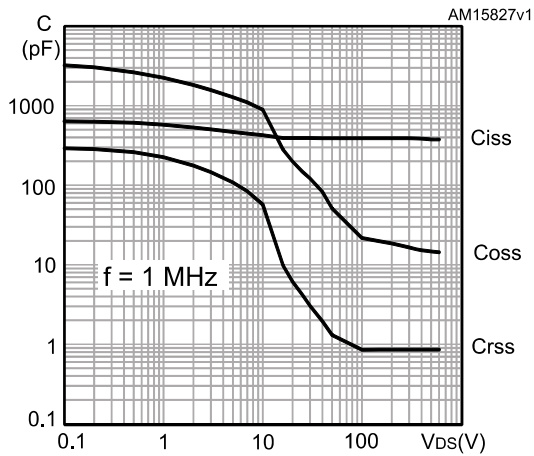


Figure 11: Normalized gate threshold voltage vs temperature

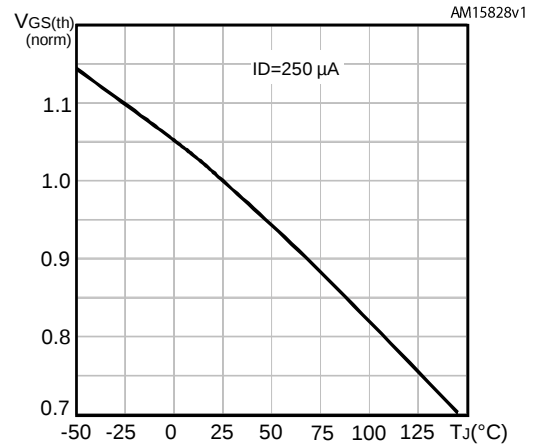


Figure 12: Normalized on-resistance vs temperature

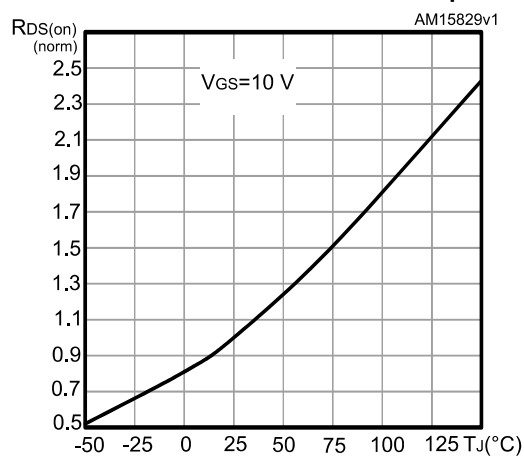


Figure 13: Normalized $V_{(BR)DSS}$ vs temperature

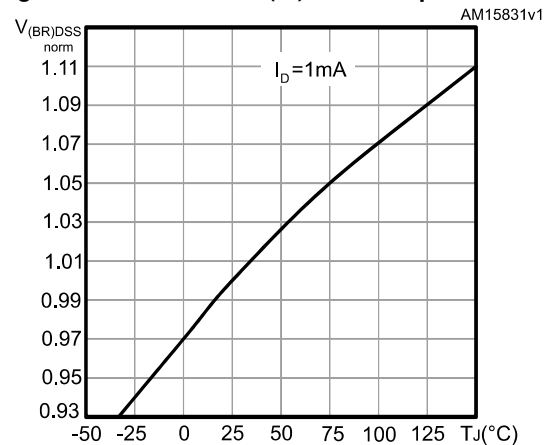


Figure 14: Source-drain diode forward characteristics

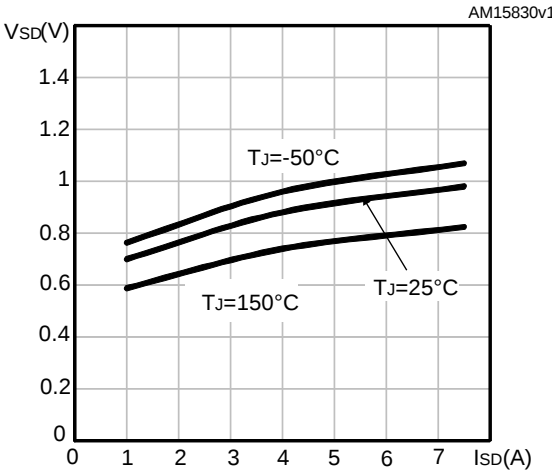
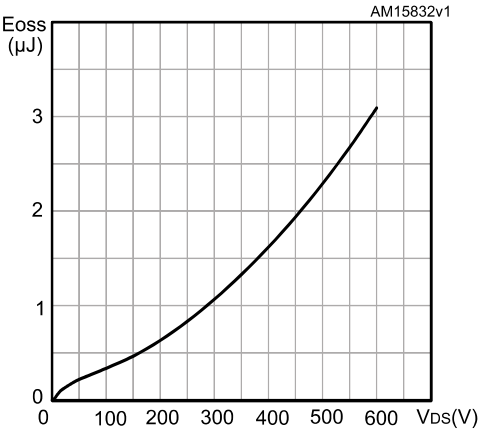
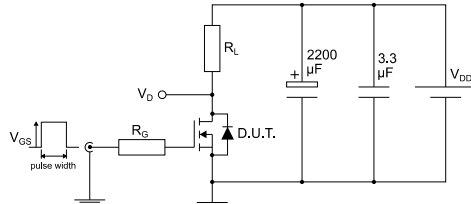


Figure 15: Output capacitance stored energy



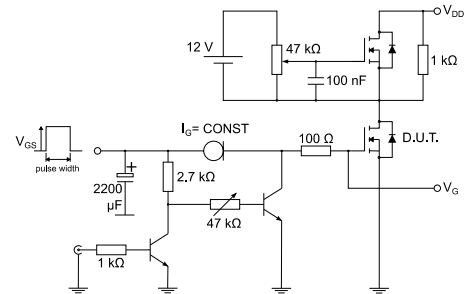
3 Test circuits

Figure 16: Test circuit for resistive load switching times



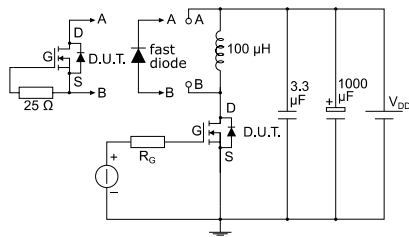
AM01468v1

Figure 17: Test circuit for gate charge behavior



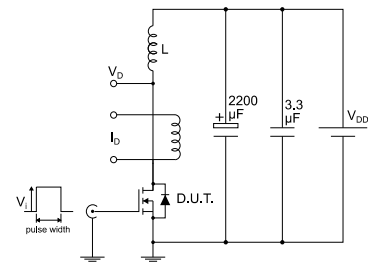
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Figure 18: Test circuit for inductive load switching and diode recovery times



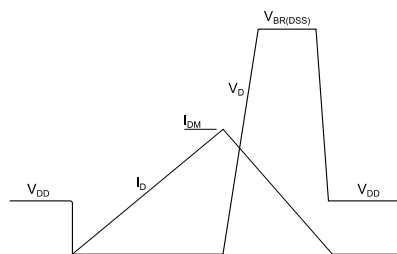
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Figure 19: Unclamped inductive load test circuit



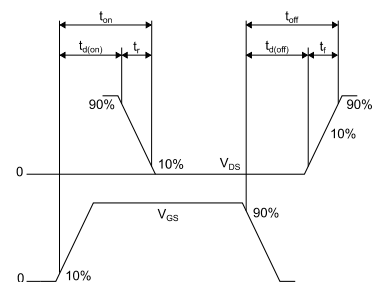
AM01471v1

Figure 20: Unclamped inductive waveform



AM01472v1

Figure 21: 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 (TO-263) type A package information

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

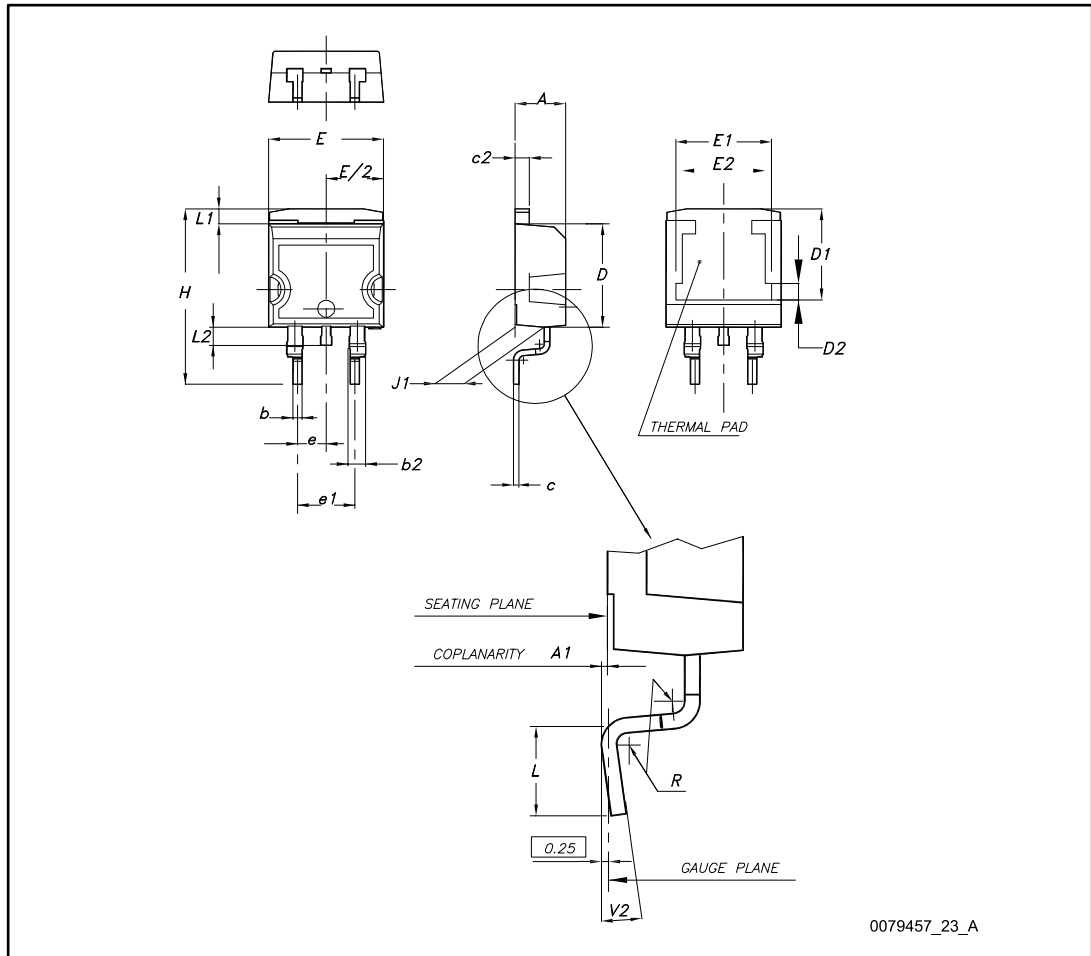
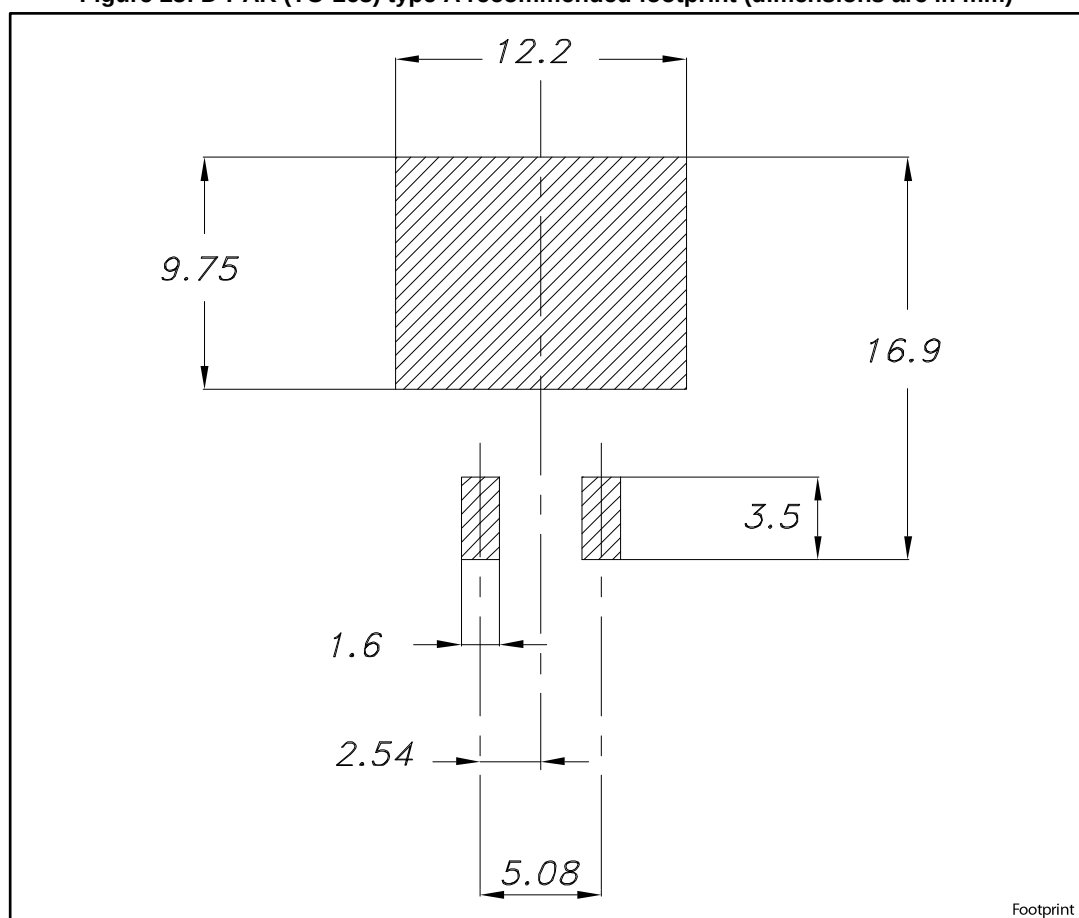


Table 9: D²PAK (TO-263) type A package mechanical data

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	10.00		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 23: D²PAK (TO-263) type A recommended footprint (dimensions are in mm)

4.2 DPAK (TO-252) type A package information

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

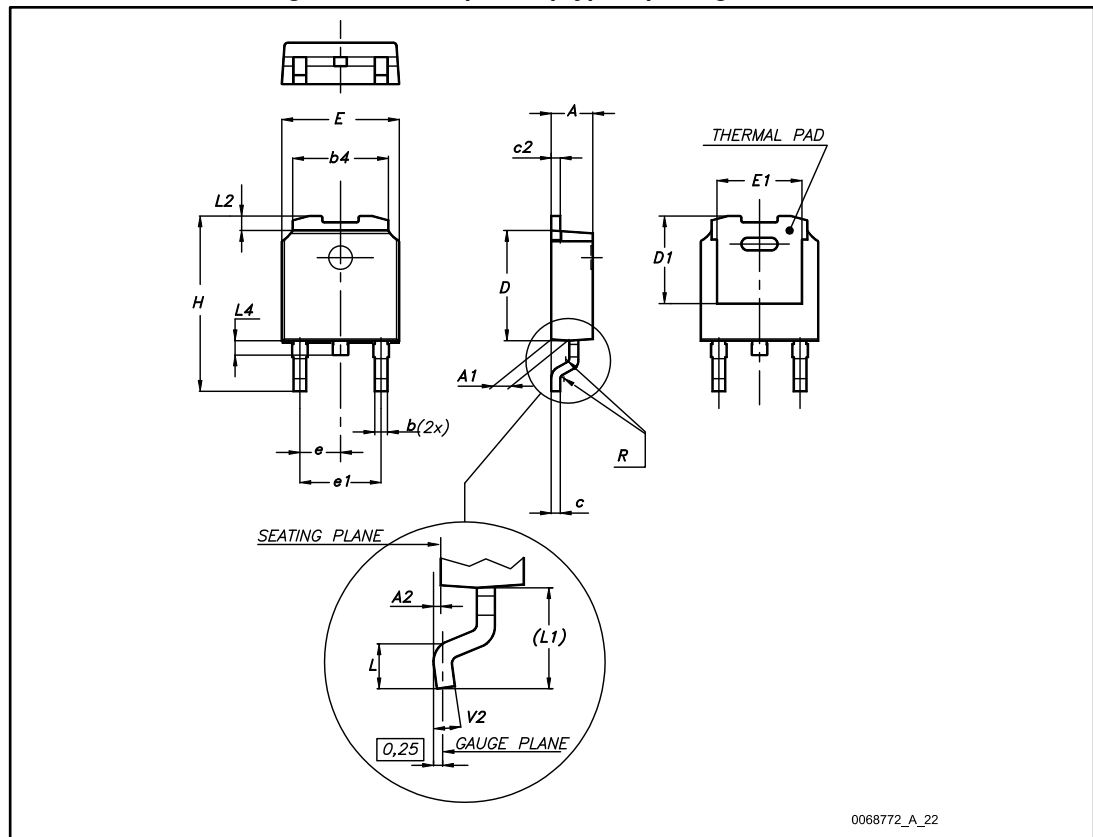


Table 10: DPAK (TO-252) type A mechanical data

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°

4.3 DPAK (TO-252) type C package information

Figure 25: DPAK (TO-252) type C package outline

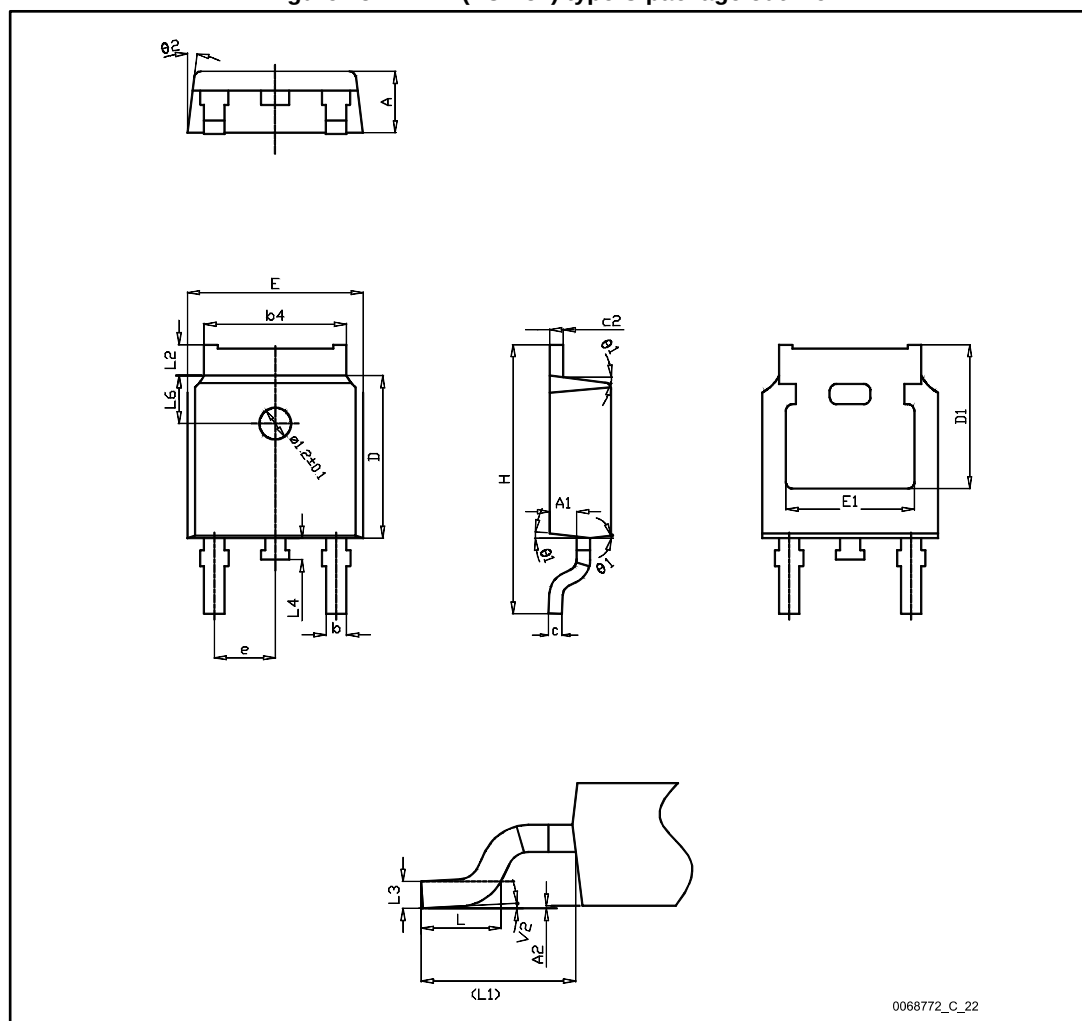
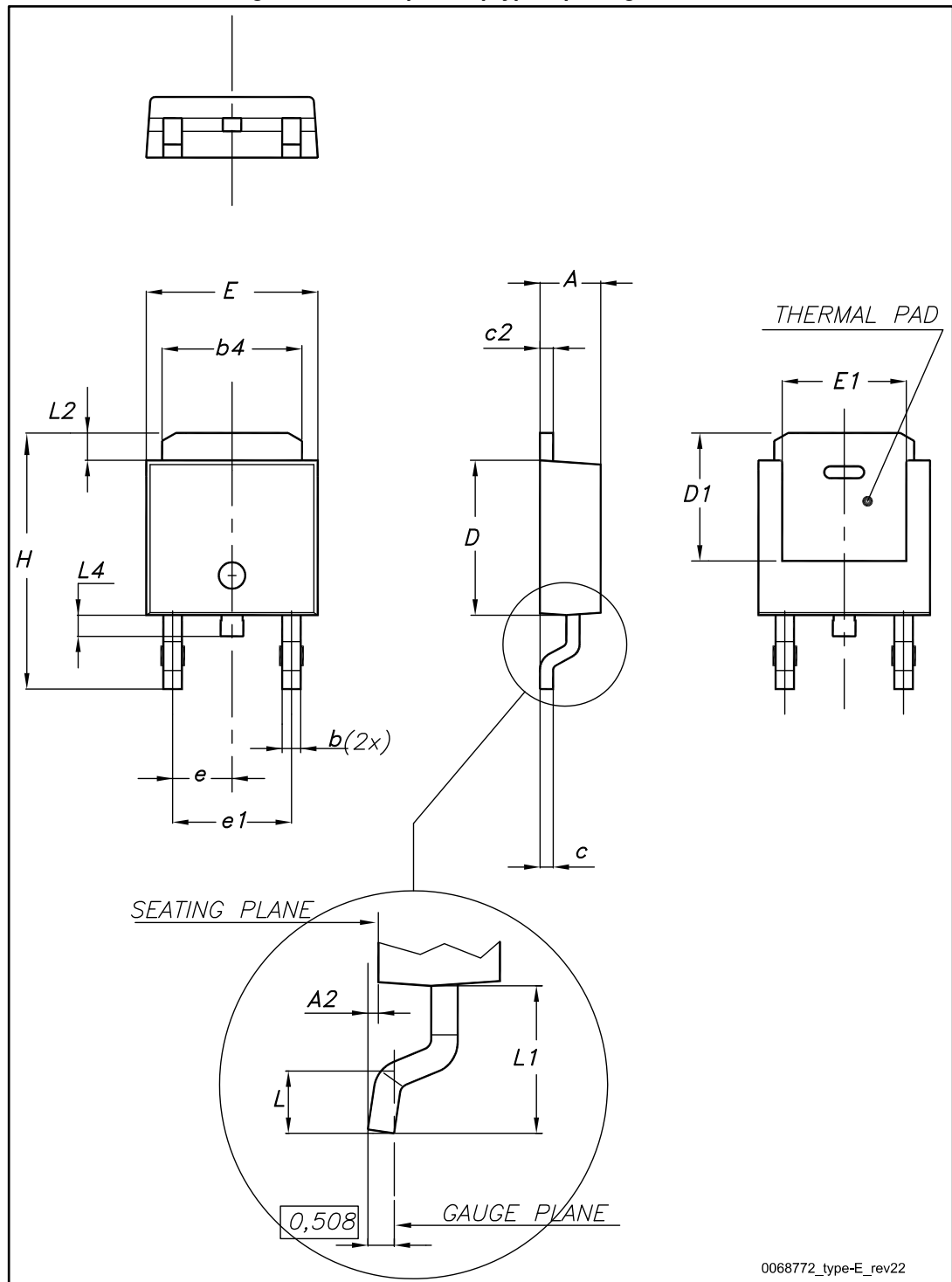


Table 11: DPAK (TO-252) type C mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20	2.30	2.38
A1	0.90	1.01	1.10
A2	0.00		0.10
b	0.72		0.85
b4	5.13	5.33	5.46
c	0.47		0.60
c2	0.47		0.60
D	6.00	6.10	6.20
D1	5.25		
E	6.50	6.60	6.70
E1	4.70		
e	2.186	2.286	2.386
H	9.80	10.10	10.40
L	1.40	1.50	1.70
L1	2.90 REF		
L2	0.90		1.25
L3	0.51 BSC		
L4	0.60	0.80	1.00
L6	1.80 BSC		
θ1	5°	7°	9°
θ2	5°	7°	9°
V2	0°		8°

4.4 DPAK (TO-252) type E package information

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

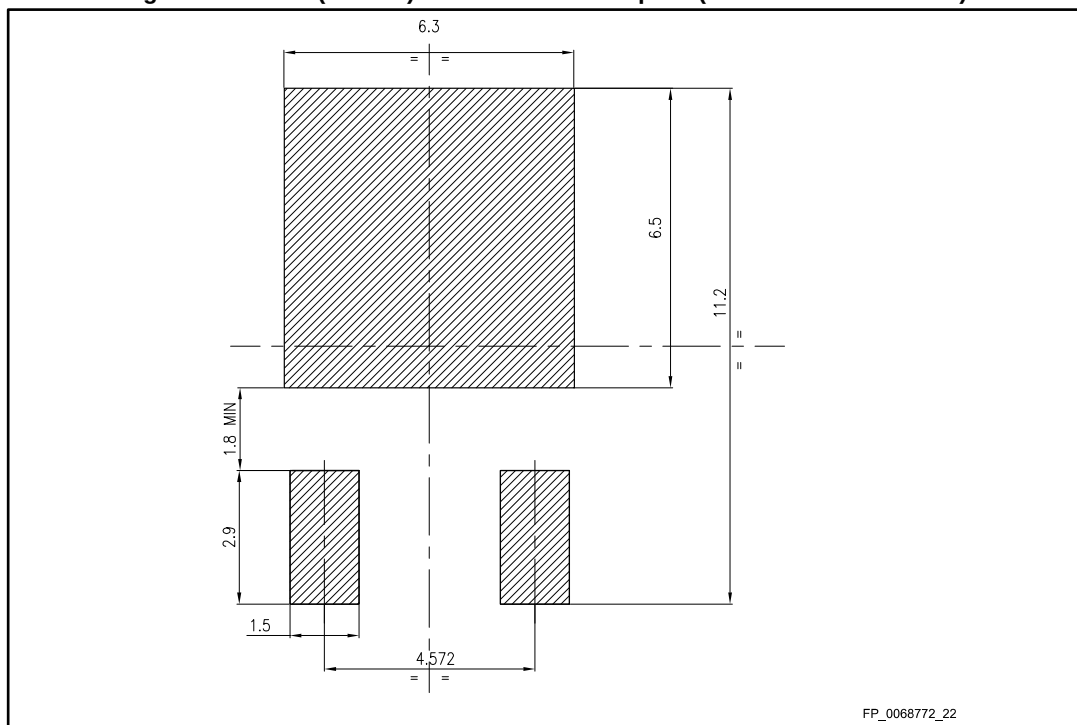


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Table 12: DPAK (TO-252) type E mechanical data

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) recommended footprint (dimensions are in mm)



4.5 TO-220 type A package information

Figure 28: TO-220 type A package outline

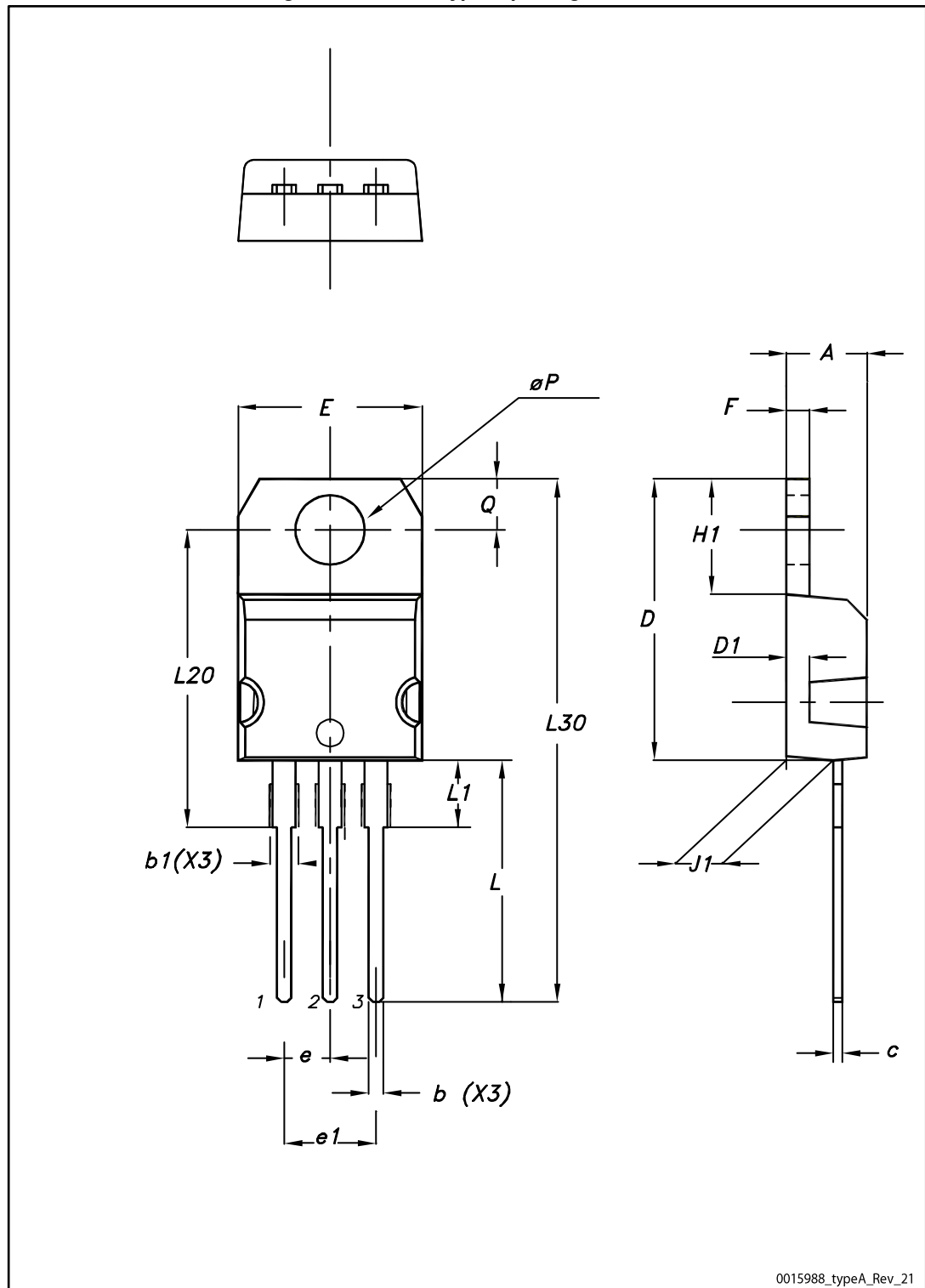


Table 13: TO-220 type A mechanical data

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

4.6 IPAK (TO-251) type A package information

Figure 29: IPAK (TO-251) type A package outline

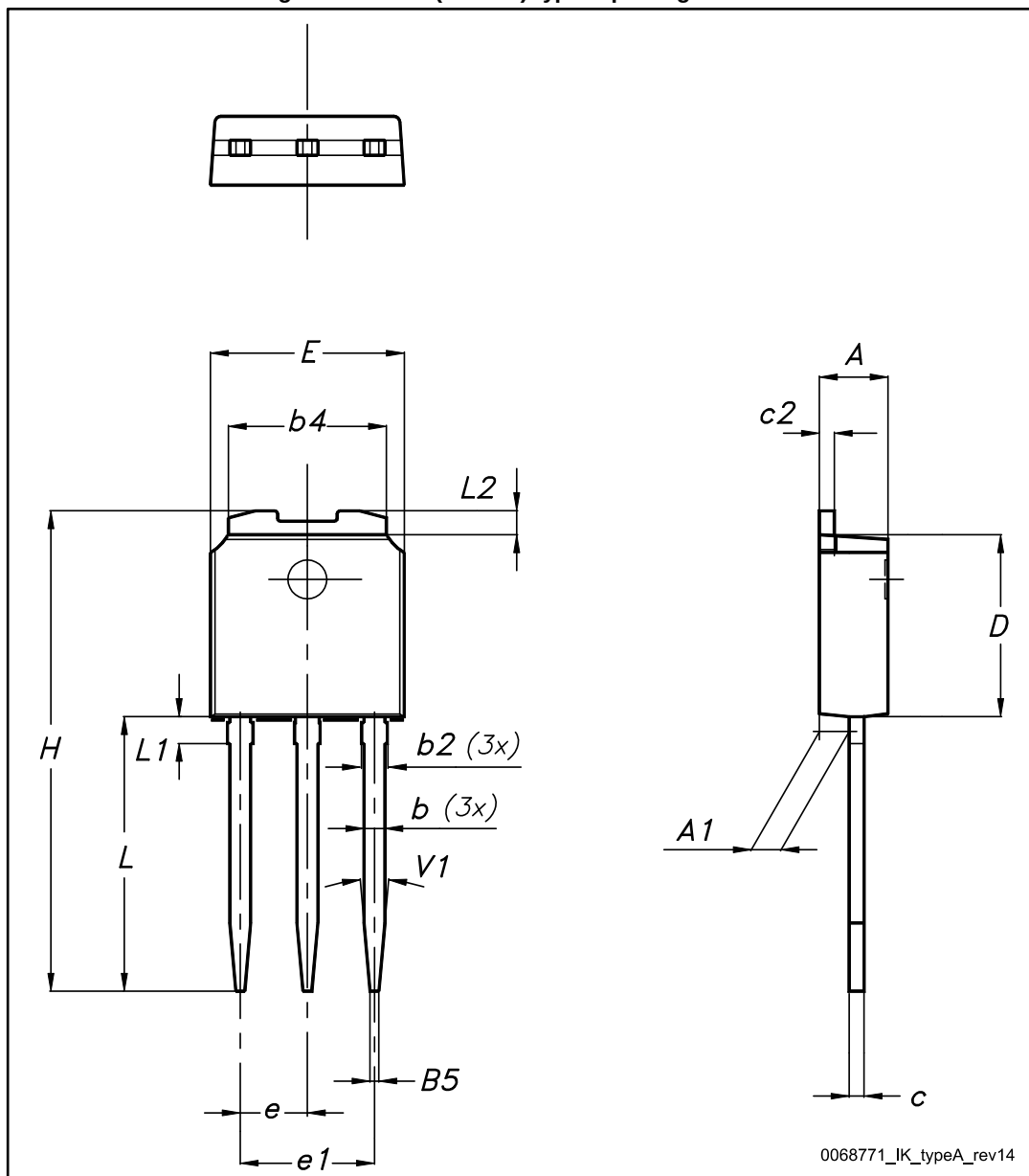


Table 14: IPAK (TO-251) type A package mechanical data

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°	

4.7 IPAK (TO-251) type C package information

Figure 30: IPAK (TO-251) type C package outline

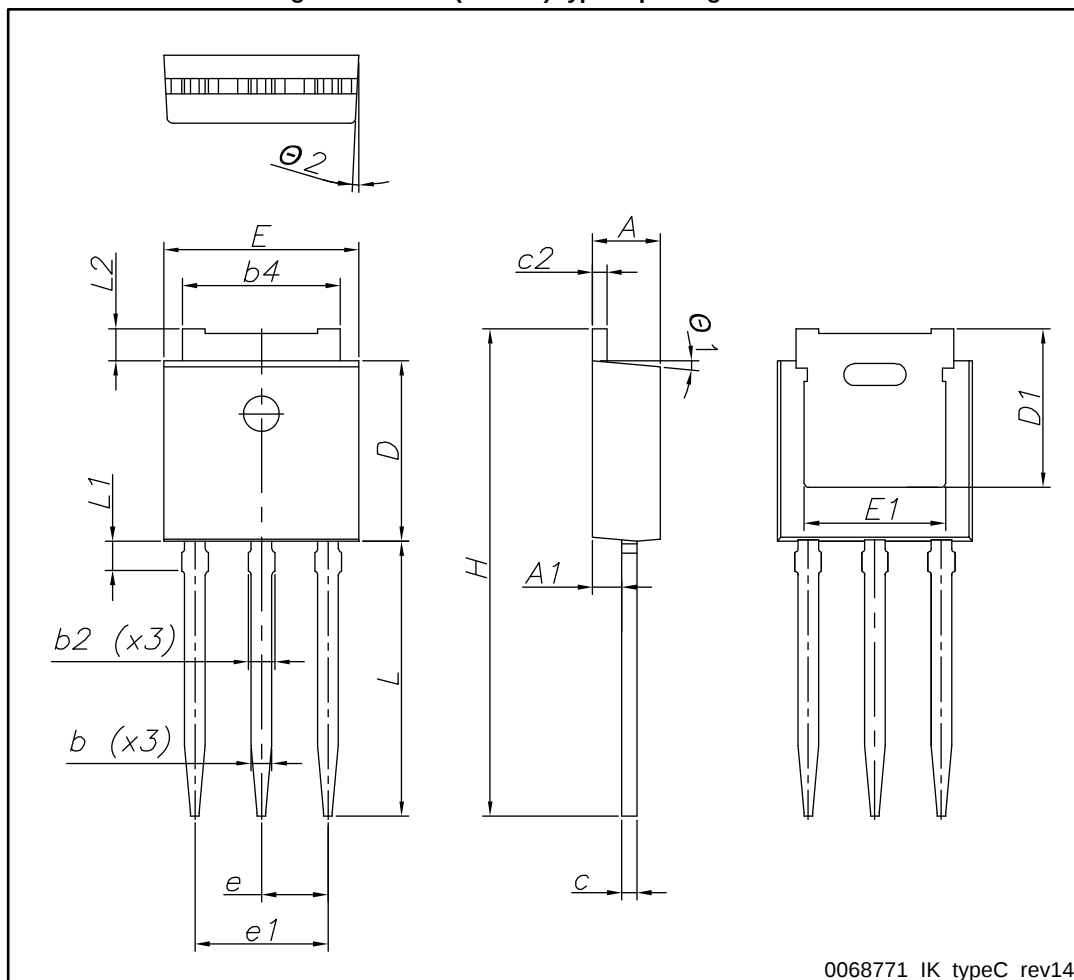


Table 15: IPAK (TO-251) type C package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20	2.30	2.35
A1	0.90	1.00	1.10
b	0.66		0.79
b2			0.90
b4	5.23	5.33	5.43
c	0.46		0.59
c2	0.46		0.59
D	6.00	6.10	6.20
D1	5.20	5.37	5.55
E	6.50	6.60	6.70
E1	4.60	4.78	4.95
e	2.20	2.25	2.30
e1	4.40	4.50	4.60
H	16.18	16.48	16.78
L	9.00	9.30	9.60
L1	0.80	1.00	1.20
L2	0.90	1.08	1.25
θ1	3°	5°	7°
θ2	1°	3°	5°

4.8 D²PAK and DPAK packing information

Figure 31: Tape outline

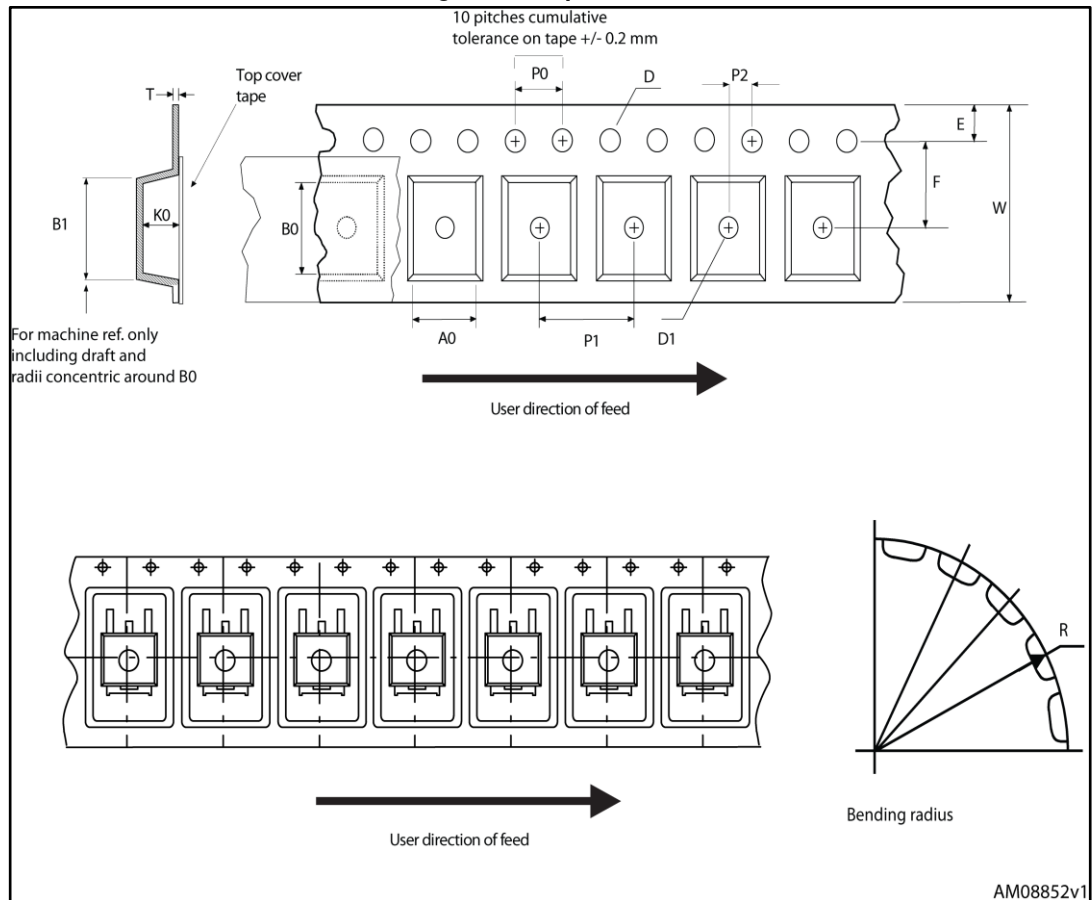
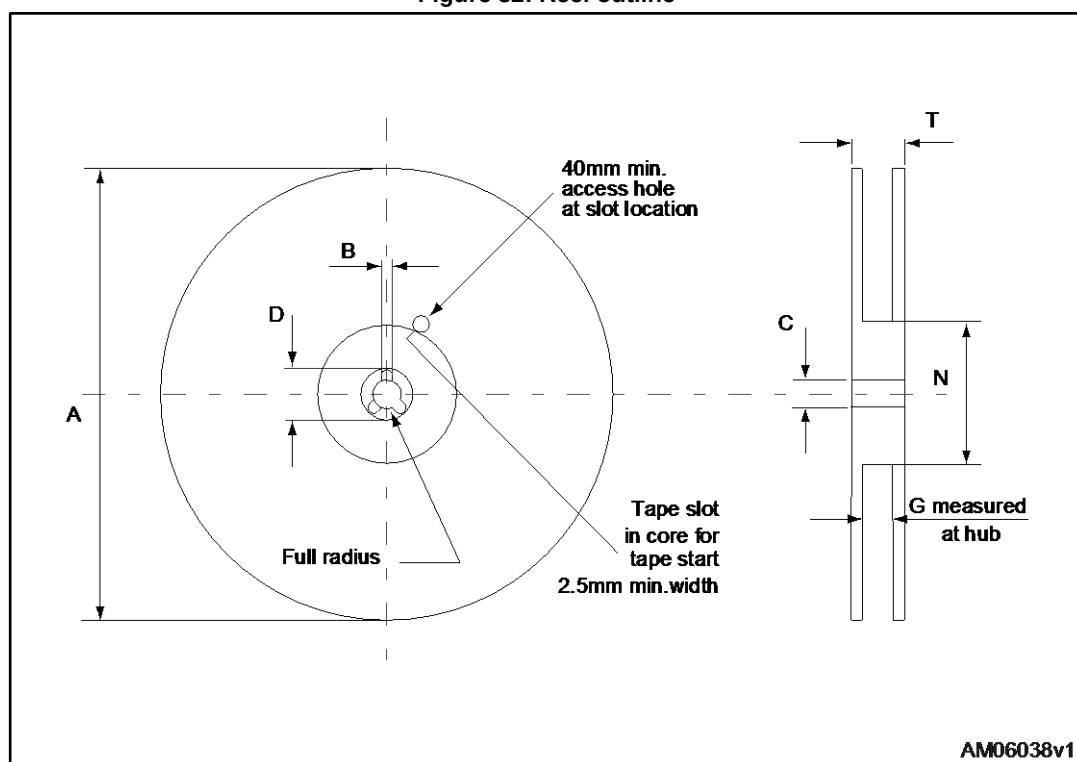


Figure 32: Reel outline

Table 16: 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			

Table 17: DPAK 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			

5 Revision history

Table 18: Document revision history

Date	Revision	Changes
29-May-2013	1	First release.
06-Dec-2013	2	– Added: D²PAK package – Modified: title and R_{DS(on)} values in cover page – Modified: R_{DS(on)} values in <i>Table 5</i> – Modified: R_G value in <i>Table 6</i> – Modified: <i>Figure 9</i> and I_D value in <i>Figure 12</i> – Added: <i>Table 9, 13, Figure 22 and 23</i> – Updated: <i>Table 10, 11, Figure 24, 25 and 26</i> – Minor text changes
13-Mar-2017	3	Updated the title and the description in cover page. Updated <i>Table 4: "Avalanche characteristics"</i>. Updated <i>Section 4.2: "DPAK (TO-252) type A package information"</i>. Added <i>Section 4.4: "DPAK (TO-252) type E package information"</i> and <i>Section 4.7: "IPAK (TO-251) type C package information"</i>. Minor text changes.

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