STD3NK80Z-1, STD3NK80ZT4, STF3NK80Z, STP3NK80Z

N-channel 800 V, 3.8 Ω typ., 2.5 A SuperMESH™ Power MOSFETs in IPAK, DPAK, TO-220FP, TO-220 packages

Datasheet - production data

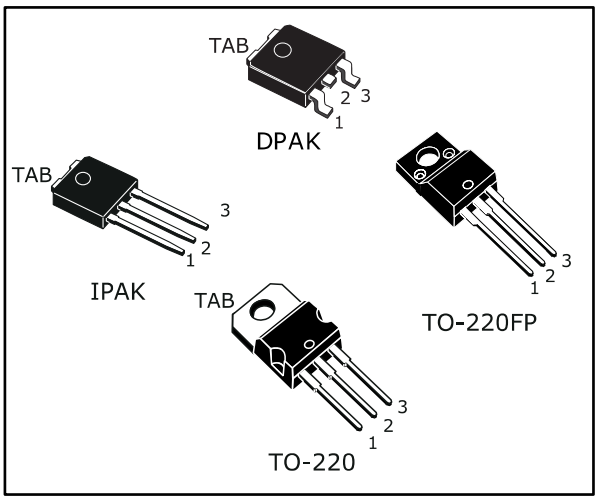
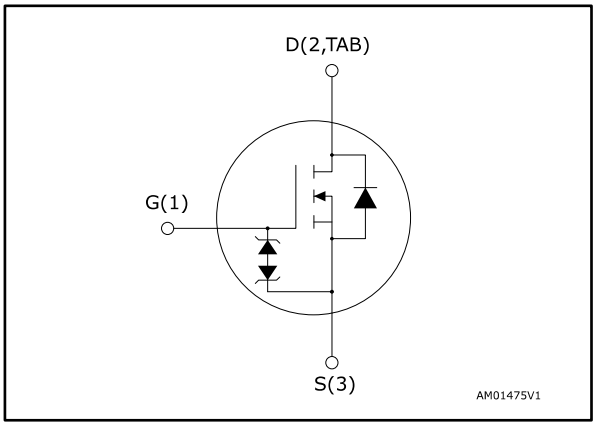


Figure 1: Internal schematic diagram



Features

Order code	V_{DS}	$R_{DS(on)}$ max.	I_D
STD3NK80Z-1	800 V	4.5 Ω	2.5 A
STD3NK80ZT4	800 V	4.5 Ω	2.5 A
STF3NK80Z	800 V	4.5 Ω	2.5 A
STP3NK80Z	800 V	4.5 Ω	2.5 A

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Zener-protected

Applications

- Switching applications

Description

These high voltage devices are Zener-protected N-channel Power MOSFETs developed using the SuperMESH™ technology by STMicroelectronics, an optimization of the well-established PowerMESH™. In addition to a significant reduction in on-resistance, these devices are designed to ensure a high level of dv/dt capability for the most demanding applications. Such series complements ST's full range of high voltage MOSFETs including the revolutionary MDmesh™ products.

Table 1: Device summary

Order code	Marking	Package	Packaging
STD3NK80Z-1	D3NK80Z	IPAK	Tube
STD3NK80ZT4	D3NK80Z	DPAK	Tape and reel
STF3NK80Z	F3NK80Z	TO-220FP	Tube
STP3NK80Z	P3NK80Z	TO-220	Tube

This is information on a product in full production.

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1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220, DPAK, IPAK	TO-220FP	
V_{DS}	Drain-source voltage	800		V
V_{GS}	Gate-source voltage	±30		V
I_D	Drain current (continuous) at T_C = 25 °C	2.5	2.5(1)	A
	Drain current (continuous) at T_C = 100 °C	1.57	1.57(1)	A
I_{DM}(2)	Drain current (pulsed)	10	10(1)	A
P_{TOT}	Total dissipation at T_C = 25 °C	70	25	W
ESD	Gate-source, human body model, R = 1.5 kΩ, C = 100 pF	2		kV
dv/dt(3)	Peak diode recovery voltage slope	4.5		V/ns
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s, T_C = 25 °C)		2.5	kV
T_{stg}	Storage temperature range	-55 to 150		°C
T_j	Operation junction temperature range			

Notes:

(1)This value is limited by package.

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

(3)$I_{SD} \leq 2.5$ A, di/dt ≤ 200 A/µs, $V_{DS(peak)} < V_{(BR)DSS}$, V_{DD} = 640 V

Table 3: Thermal data

Symbol	Parameter	Value				Unit
		TO-220	TO-220FP	DPAK	IPAK	
$R_{thj\text{-}case}$	Thermal resistance junction-case	1.78	5	1.78		°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient	62.5			100	°C/W
$R_{thj\text{-}pcb}$(1)	Thermal resistance junction-pcb			50		°C/W

Notes:

(1)When mounted on FR-4 board of 1 inch², 2 oz Cu.

Table 4: Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or non-repetitive (pulse width limited by $T_{J\ max}$)	2.5	A
E_{AS}	Single pulse avalanche energy (starting T_J =25 °C, $I_D = I_{AR}$, V_{DD}= 50 V)	170	mJ

2 Electrical characteristics

(T_C = 25 °C unless otherwise specified)

Table 5: On /off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	V_{GS} = 0 V, I_D = 1 mA	800			V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V, V_{DS} = 800 V			1	µA
		V_{GS} = 0 V, V_{DS} = 800 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 = 50 µA	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on- resistance	V_{GS} = 10 V, I_D = 1.25 A		3.8	4.5	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_{GS} = 0 V, V_{DS} = 25 V, f = 1 MHz	-	485	-	pF
C_{oss}	Output capacitance		-	57	-	pF
C_{rss}	Reverse transfer capacitance		-	11	-	pF
$C_{oss\ eq}$(1)	Equivalent output capacitance	V_{GS} = 0 V, V_{DS} = 0 to 640 V	-	22	-	pF
Q_g	Total gate charge	V_{DD} = 640 V, I_D = 2.5 A, V_{GS} = 0 to 10 V (see *Figure 17: "Test circuit for gate charge behavior"*)	-	19	-	nC
Q_{gs}	Gate-source charge		-	3.2	-	nC
Q_{gd}	Gate-drain charge		-	10.8	-	nC

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%

Table 7: Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 400 V, I_D = 1.25 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"*)	-	17	-	ns
t_r	Rise time		-	27	-	ns
$t_{d(off)}$	Turn-off delay time		-	36	-	ns
t_f	Fall time		-	40	-	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 A, V_{GS} = 0 V	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 2.5 A, di/dt = 100 A/µs V_{DD} = 50 V (see *Figure 18: "Test circuit for inductive load switching and diode recovery times"*)	-	384		ns
Q_{rr}	Reverse recovery charge		-	1.6		µC
I_{RRM}	Reverse recovery current		-	8.4		A
t_{rr}	Reverse recovery time	I_{SD} = 2.5 A, di/dt = 100 A/µs, V_{DD} = 50 V , T_J = 150 °C (see *Figure 18: "Test circuit for inductive load switching and diode recovery times"*)	-	474		ns
Q_{rr}	Reverse recovery charge		-	2.1		µC
I_{RRM}	Reverse recovery current		-	8.8		A

Notes:

(1)Pulsed: pulse duration = 300 µs, duty cycle 1.5%.

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

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 (open drain)	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 TO-220, DPAK, IPAK

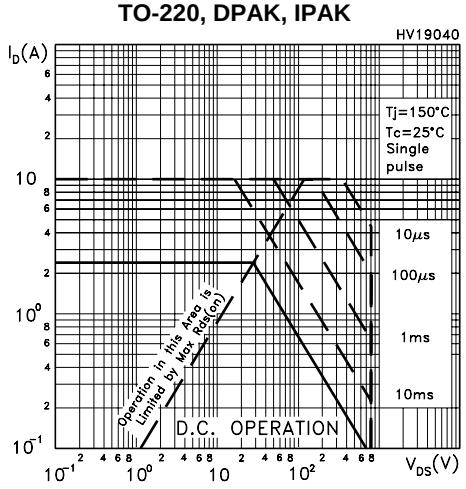


Figure 3: Thermal impedance for TO-220, DPAK, IPAK

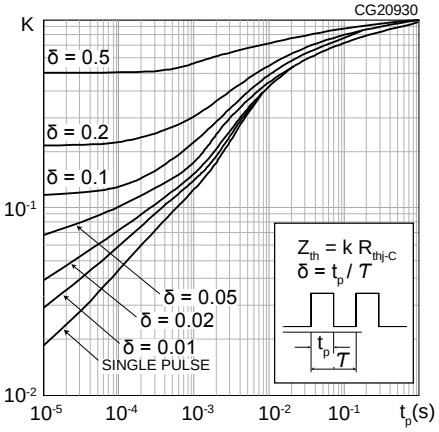


Figure 4: Safe operating area for TO-220FP

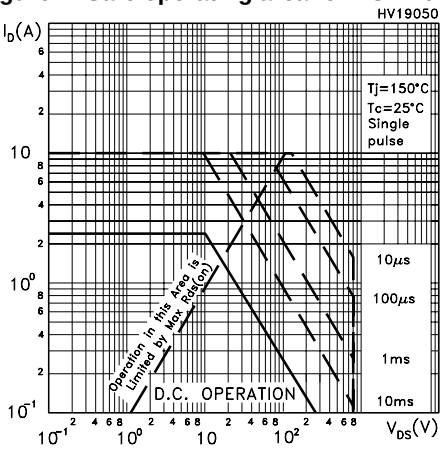


Figure 5: Thermal impedance for TO-220FP

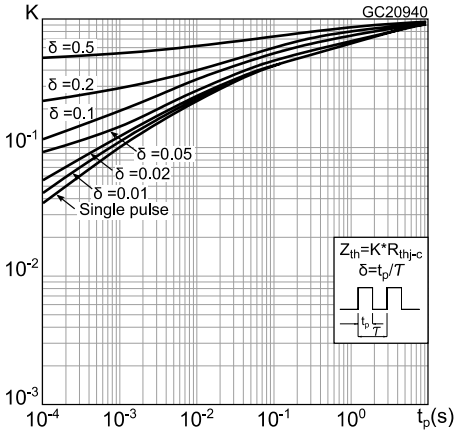


Figure 6: Output characteristics

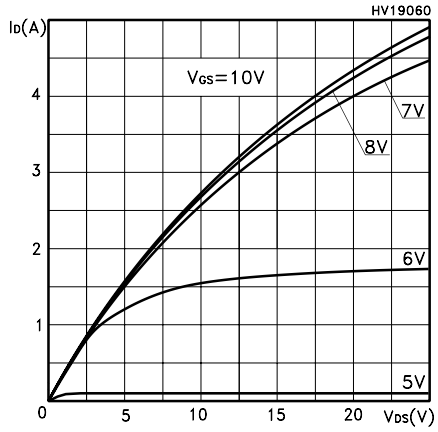


Figure 7: Transfer characteristics

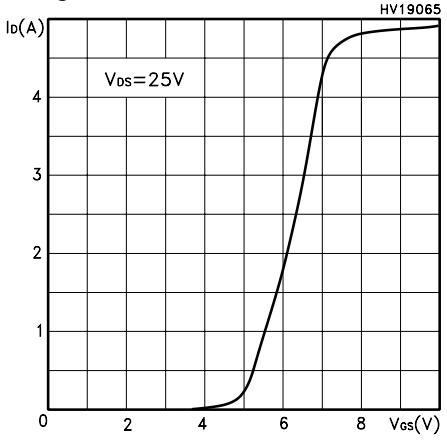


Figure 8: Static drain-source on-resistance

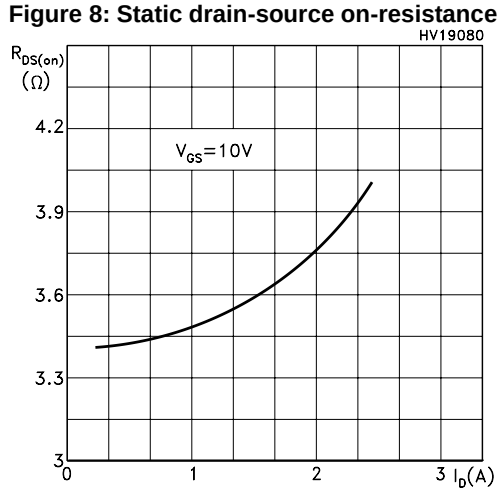


Figure 9: Gate charge vs. gate-source voltage

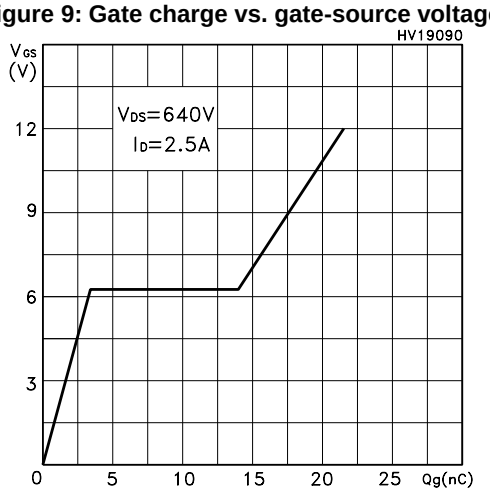


Figure 10: Capacitance variations

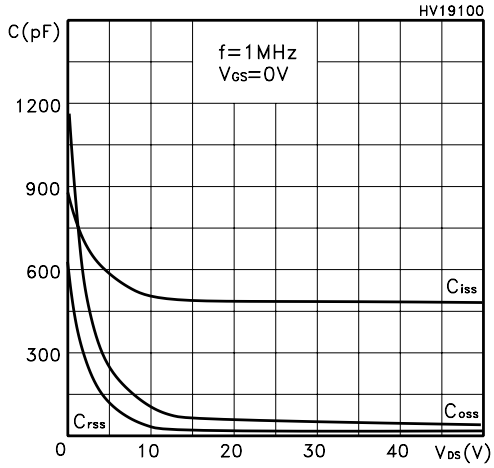


Figure 11: Normalized gate threshold voltage vs. temperature

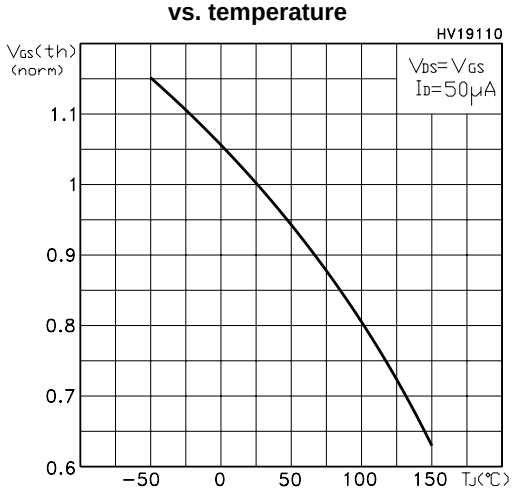


Figure 12: Normalized on-resistance vs. temperature

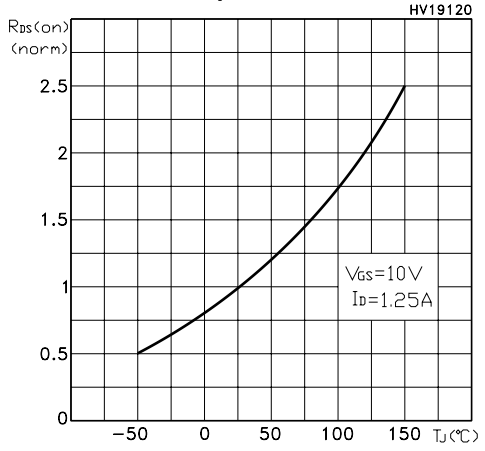


Figure 13: Source-drain diode forward characteristics

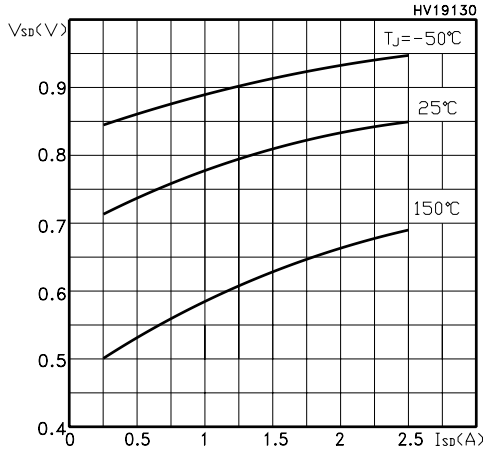


Figure 14: Normalized $V_{(BR)DSS}$ vs. temperature

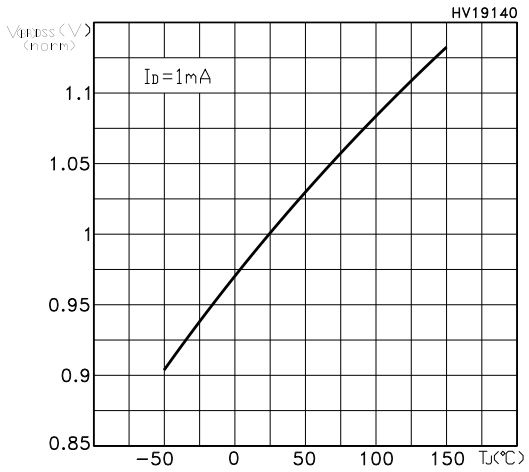
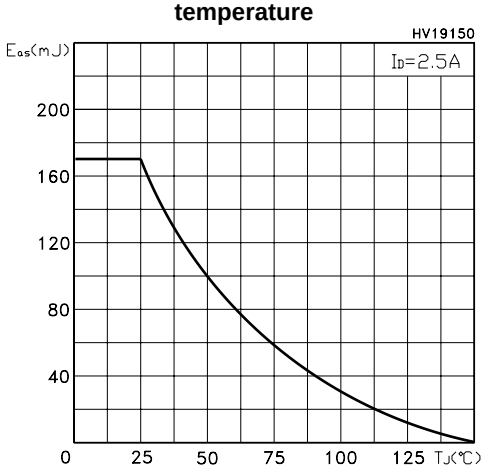


Figure 15: Maximum avalanche energy vs. temperature



3 Test circuits

Figure 16: Test circuit for resistive load switching times

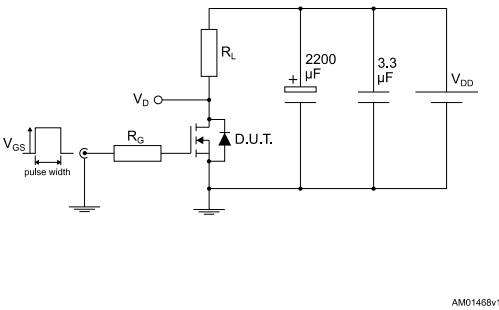


Figure 17: Test circuit for gate charge behavior

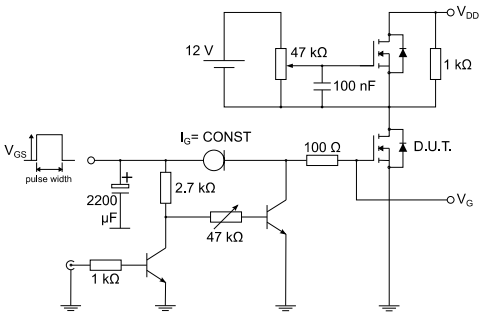


Figure 18: Test circuit for inductive load switching and diode recovery times

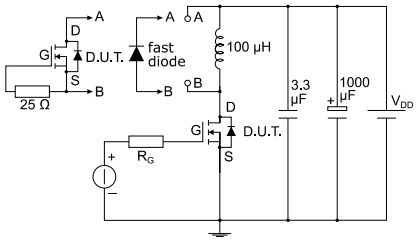


Figure 19: Unclamped inductive load test circuit

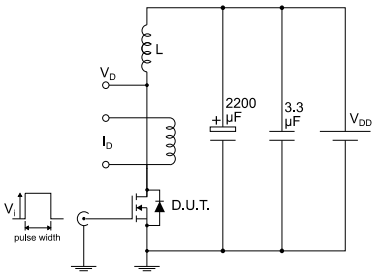


Figure 20: Unclamped inductive waveform

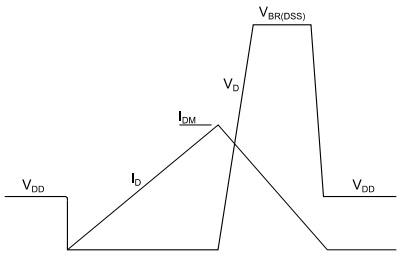
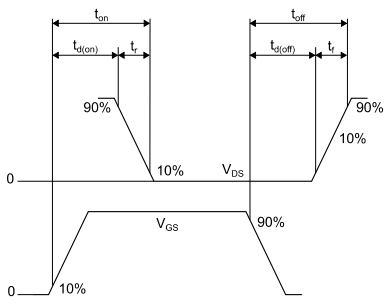


Figure 21: Switching time waveform



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 IPAK (TO-251) type A package information

Figure 22: IPAK (TO-251) type A package outline

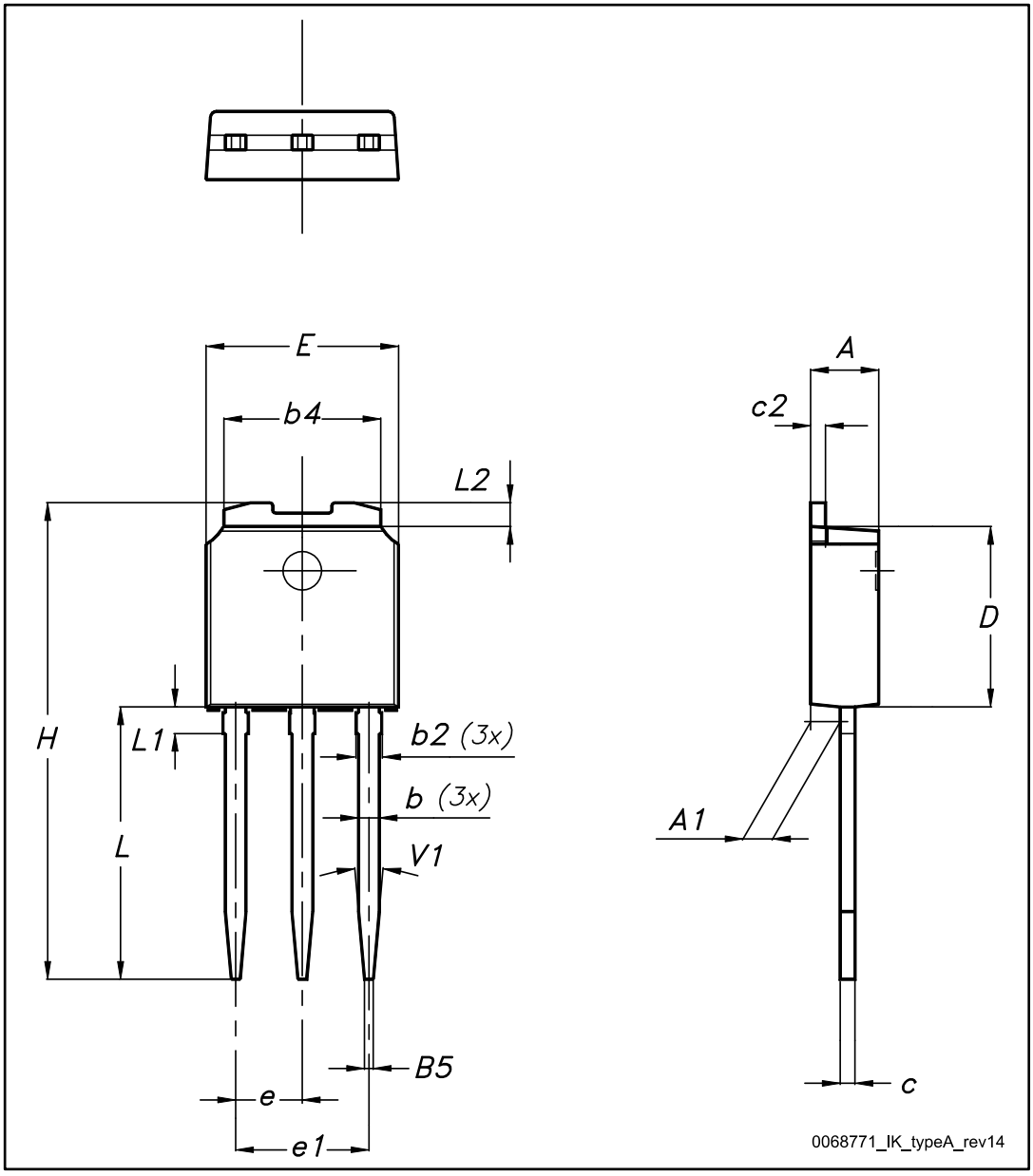


Table 10: IPAK (TO-251) type A package mechanical data

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°	

4.2 DPAK package information

4.2.1 DPAK (TO-252) type A package information

Figure 23: DPAK (TO-252) type A package outline

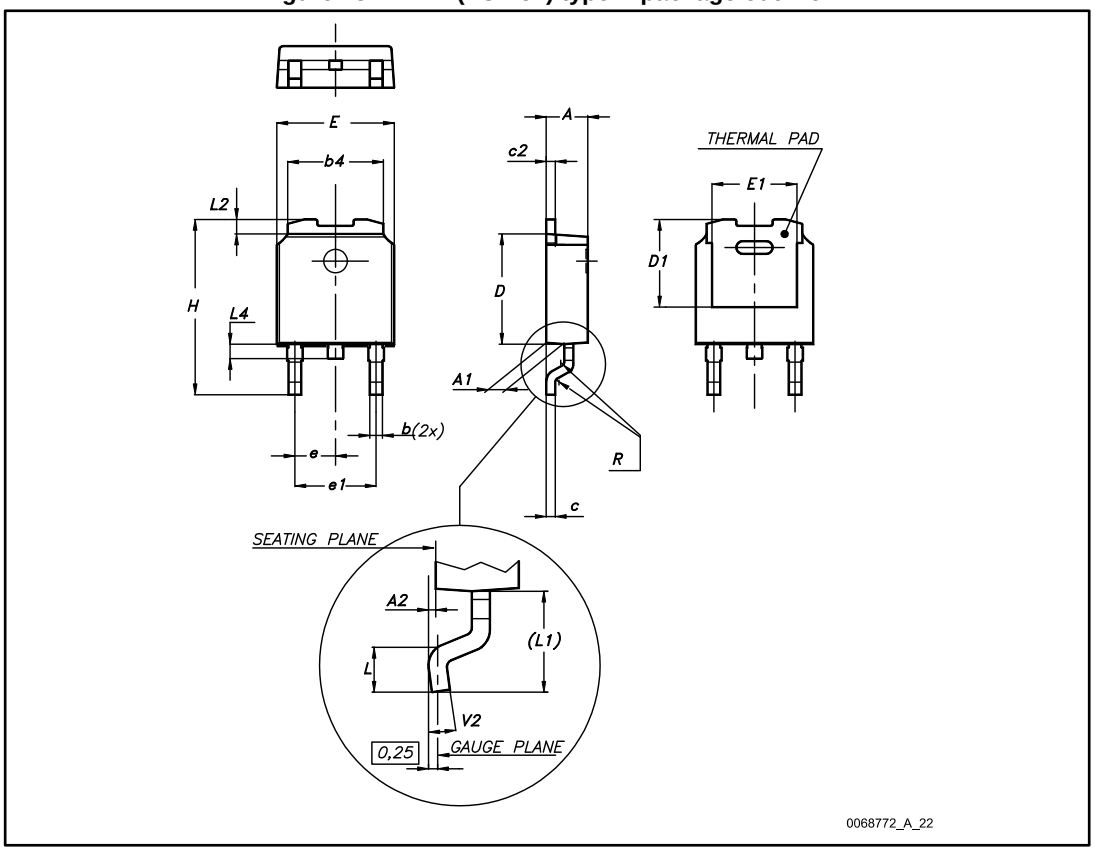
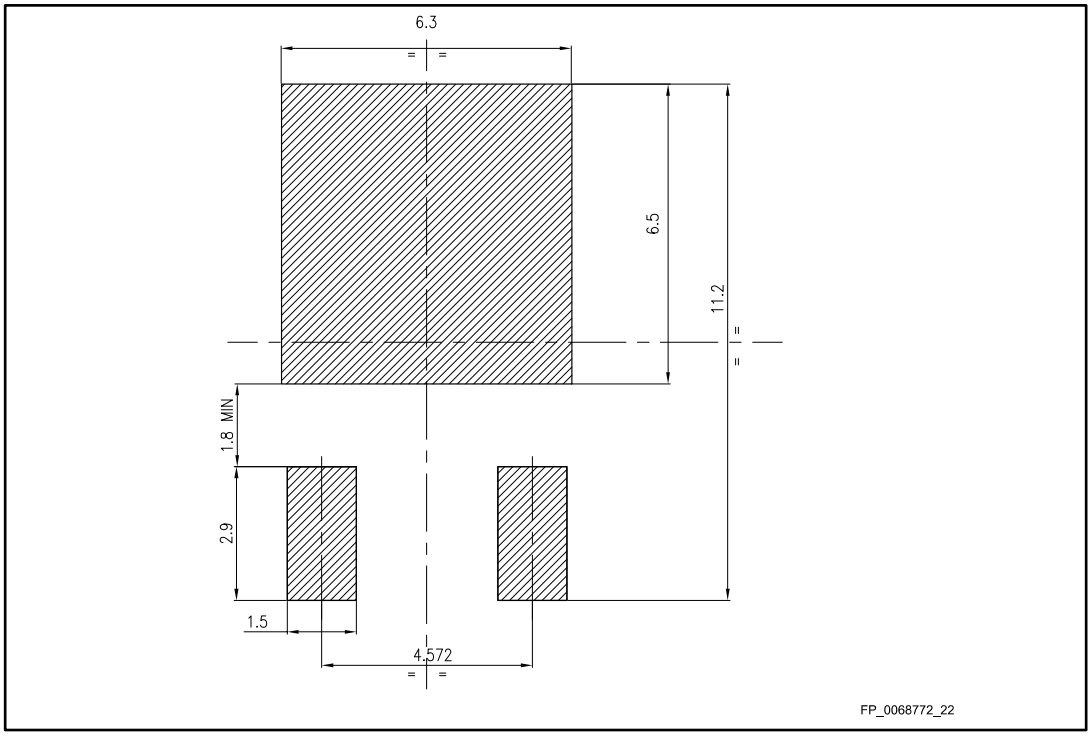


Table 11: DPAK (TO-252) type A mechanical data

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°

Figure 24: DPAK (TO-252) type A recommended footprint (dimensions are in mm)



4.2.2 DPAK (TO-252) type C2 package information

Figure 25: DPAK (TO-252) type C2 package outline

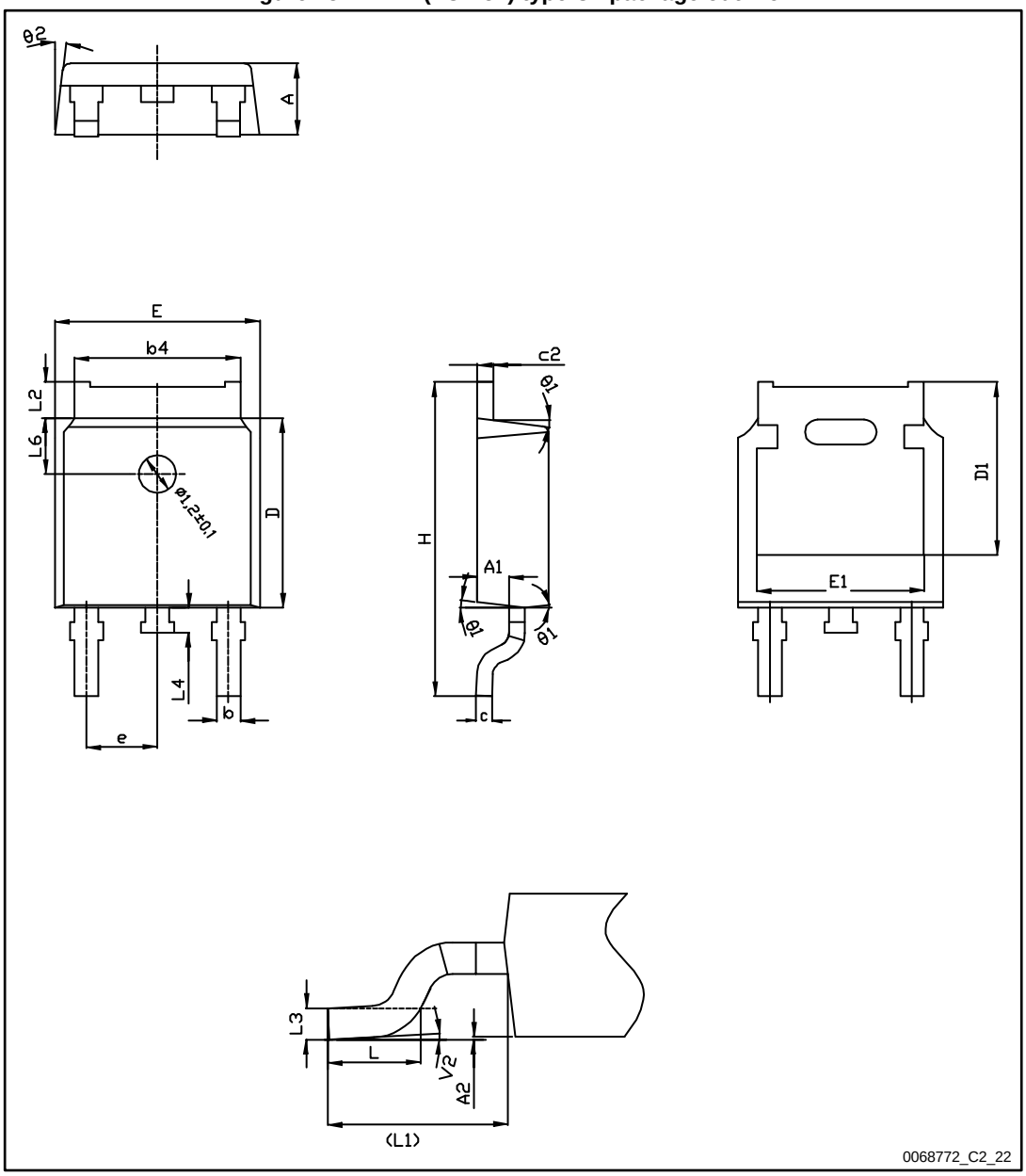
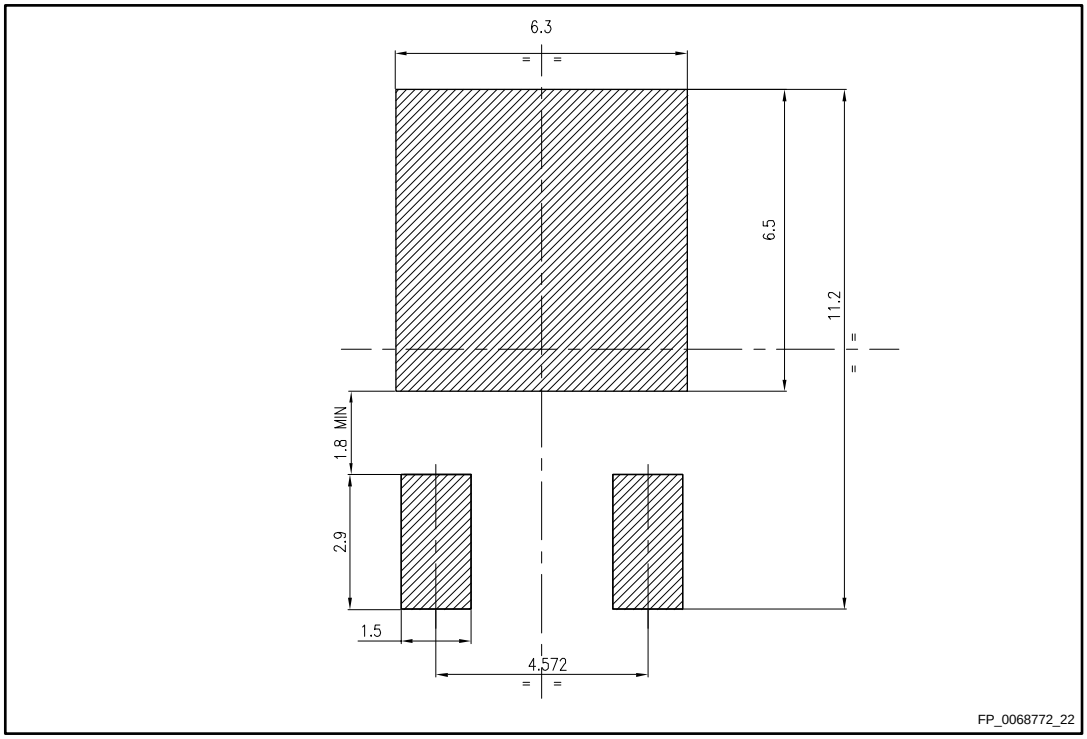


Table 12: DPAK (TO-252) type C2 mechanical data

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	5.10		5.60
E	6.50	6.60	6.70
E1	5.20		5.50
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°

Figure 26: DPAK (TO-252) type C2 recommended footprint (dimensions are in mm)



4.2.3 DPAK (TO-252) type E package information

Figure 27: DPAK (TO-252) type E package outline

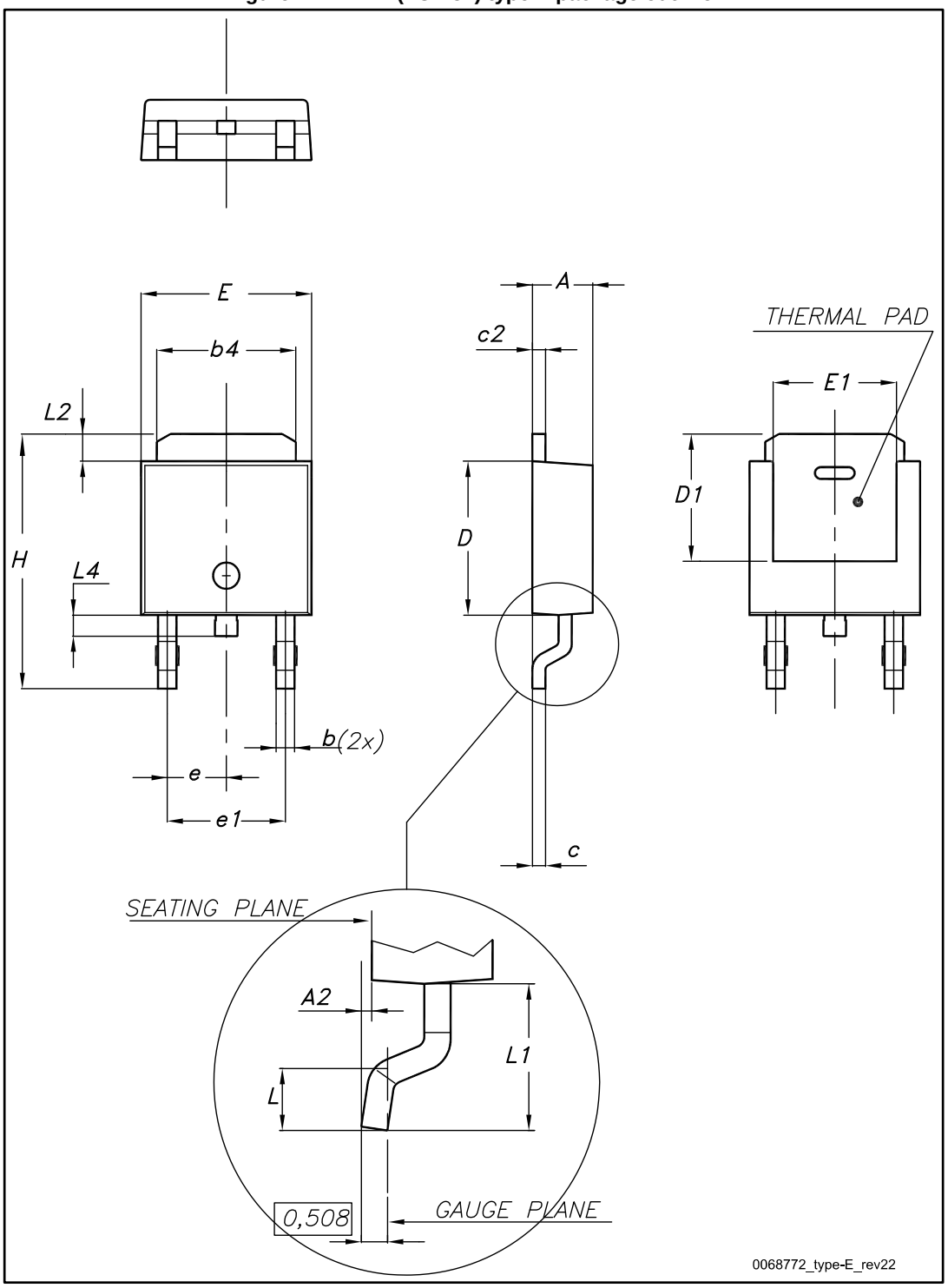
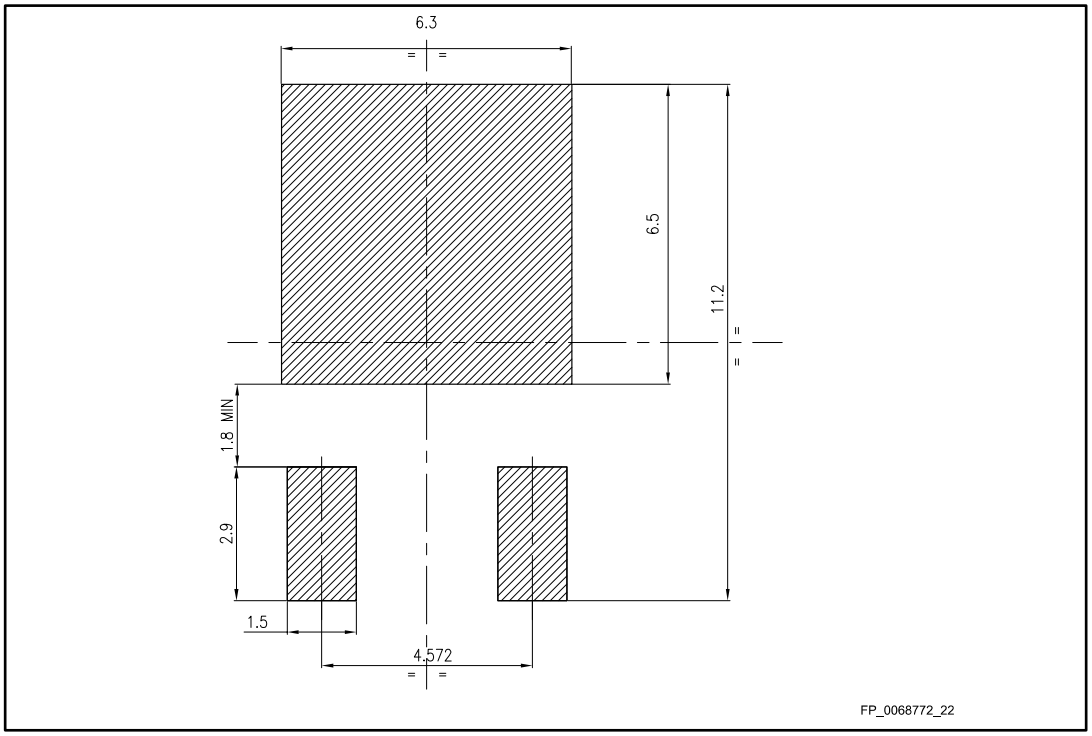


Table 13: DPAK (TO-252) type E mechanical data

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



4.2.4 DPAK (TO-252) packing information

Figure 29: DPAK (TO-252) tape outline

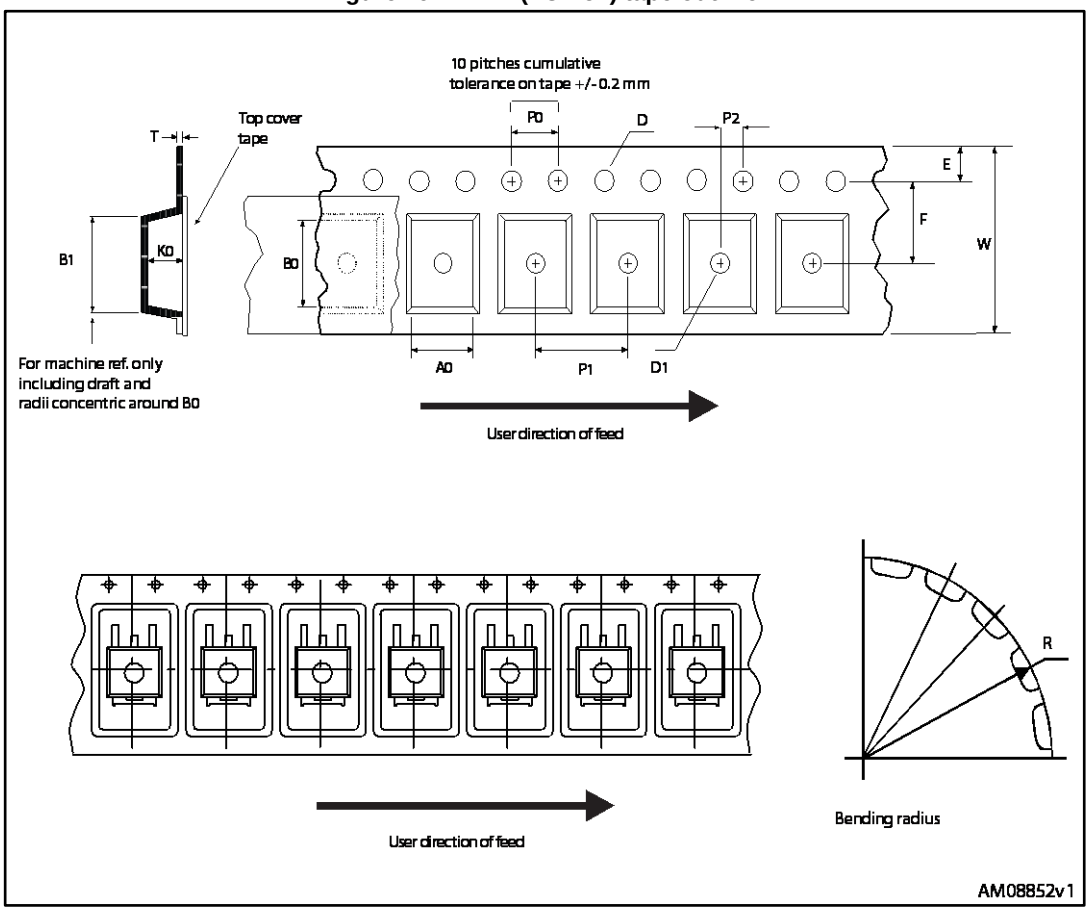


Figure 30: DPAK (TO-252) reel outline

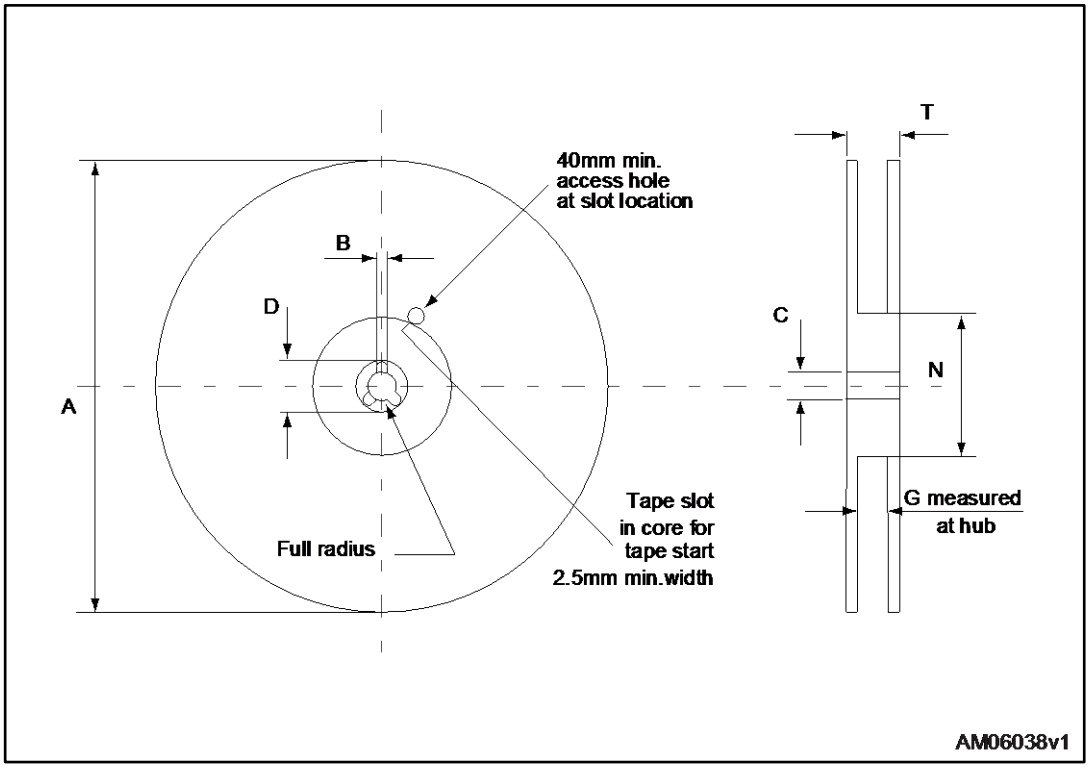


Table 14: DPAK (TO-252) tape and reel mechanical data

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			

4.3 TO-220FP package information

Figure 31: TO-220FP package outline

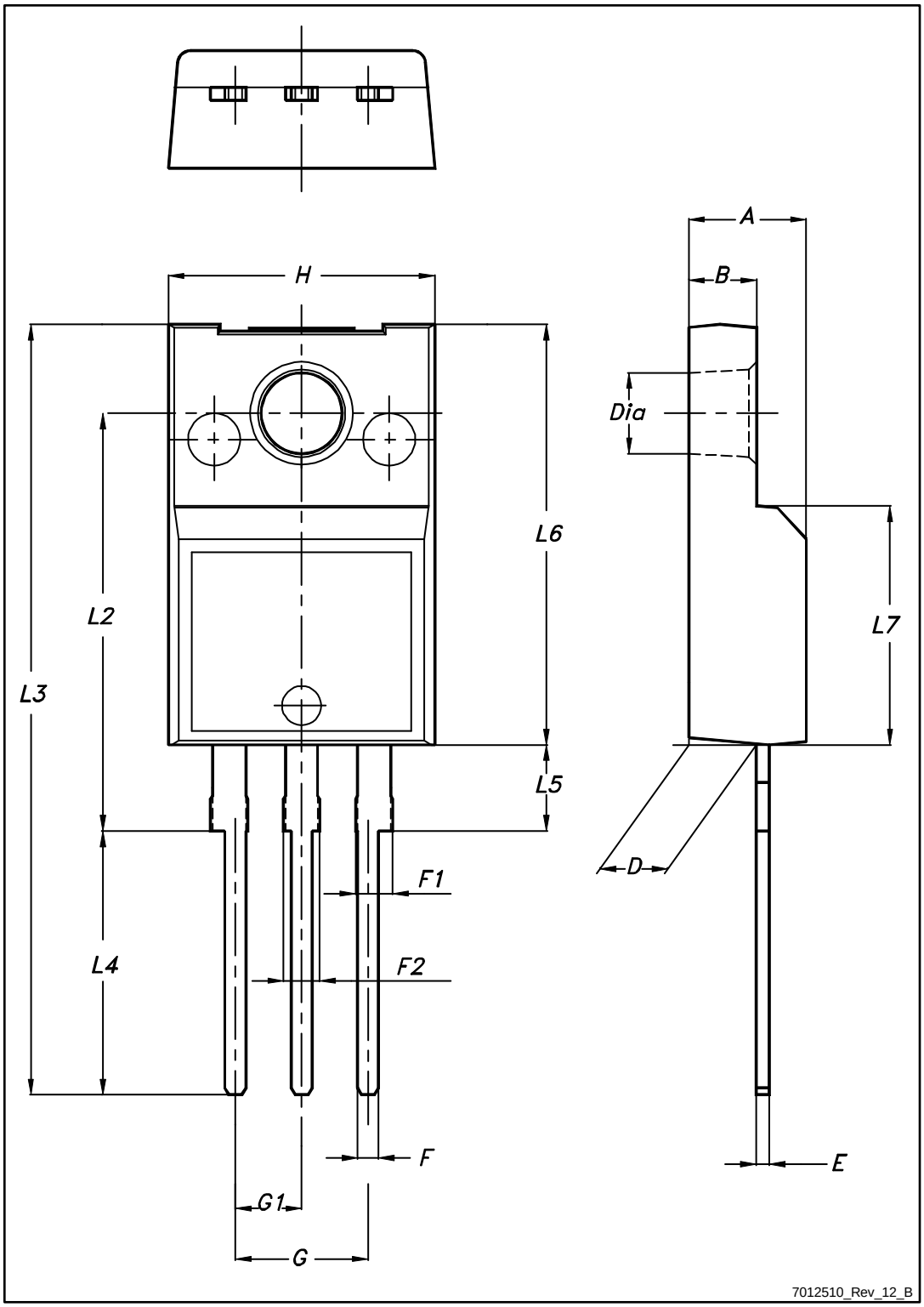


Table 15: TO-220FP package mechanical data

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

4.4 TO-220 package information

4.4.1 TO-220 type A package information

Figure 32: TO-220 type A package outline

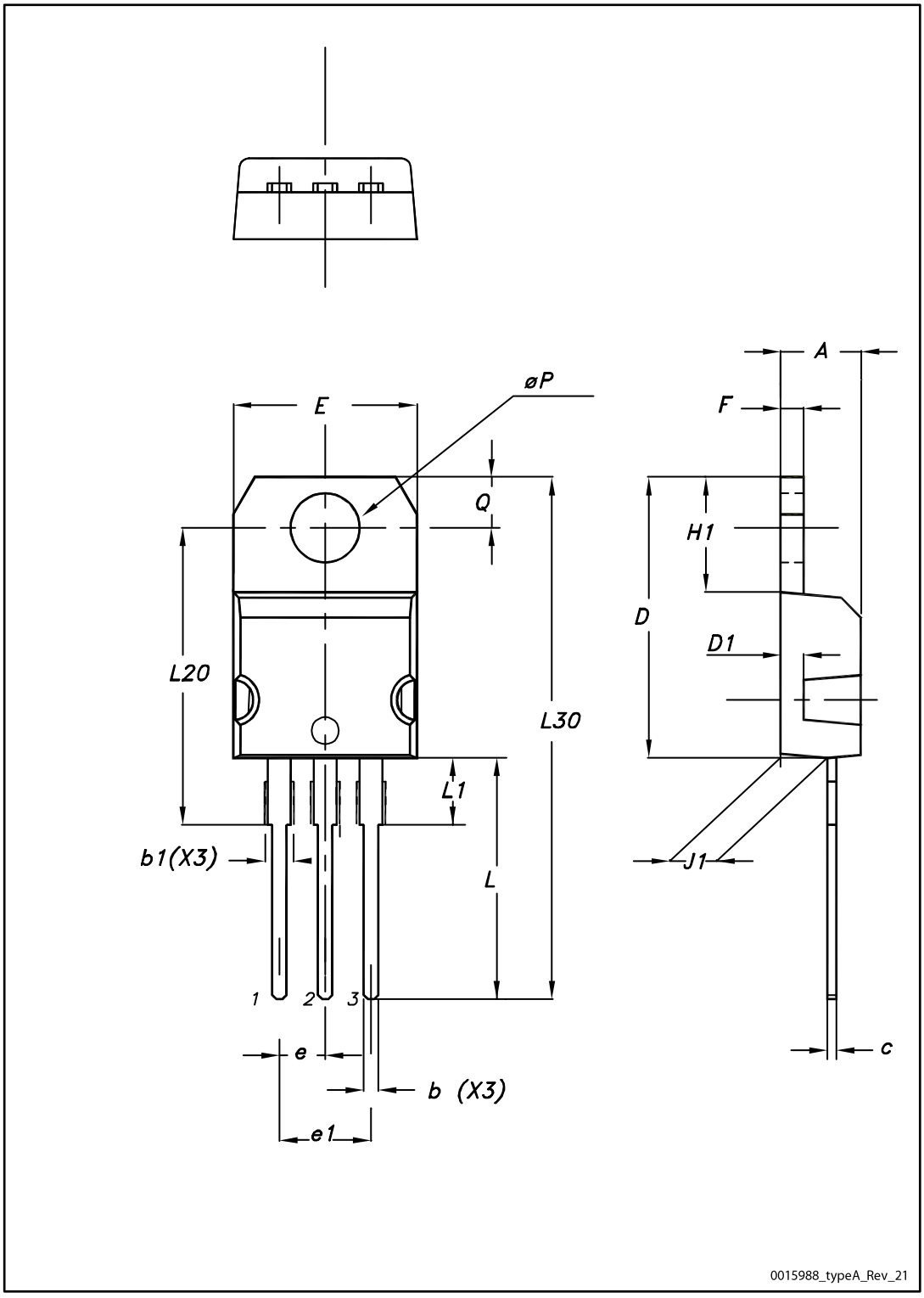


Table 16: TO-220 type A mechanical data

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

4.4.2 TO-220 type H package information

Figure 33: TO-220 type H package outline

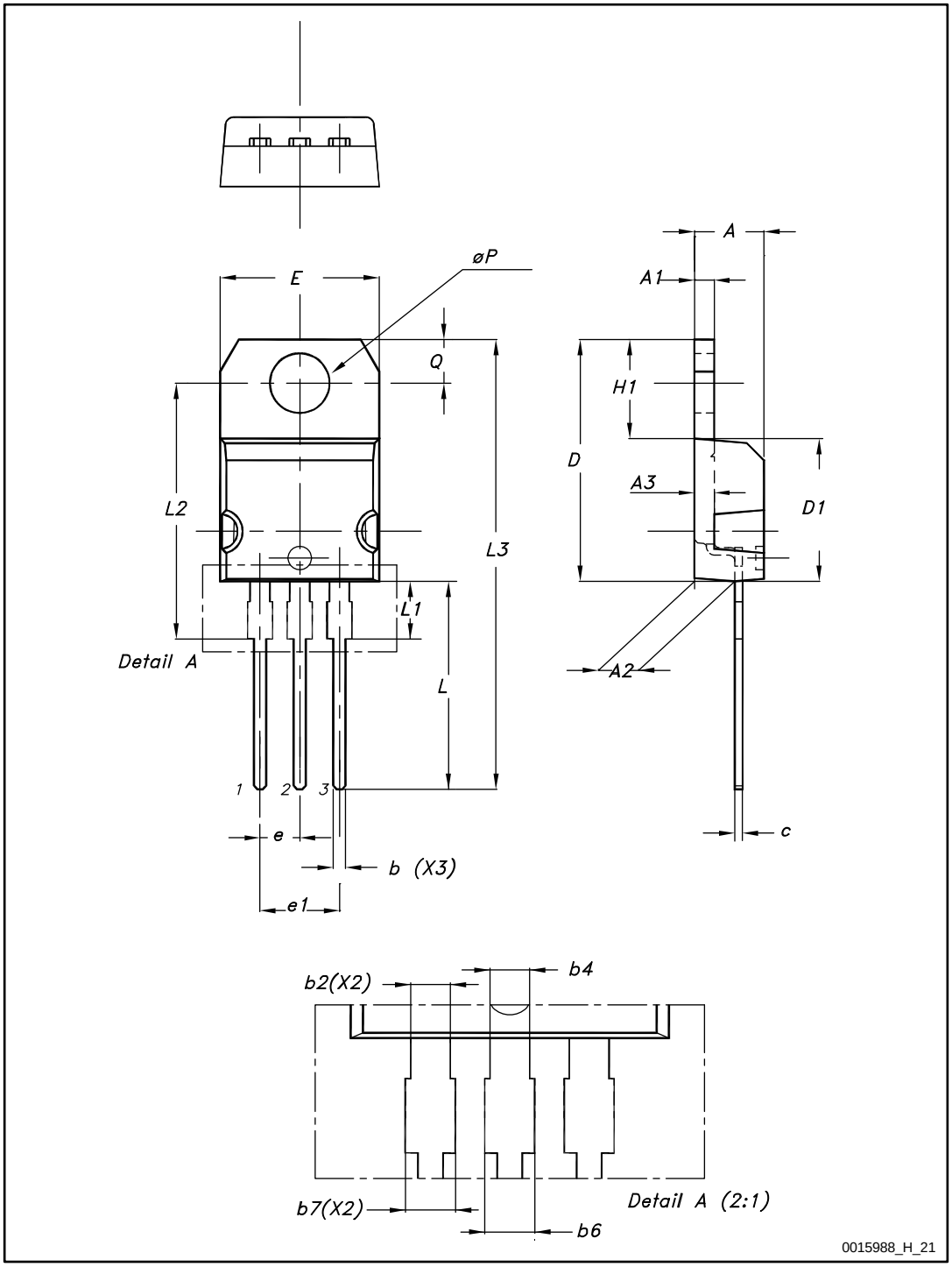


Table 17: TO-220 type H package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40	4.45	4.50
A1	1.22		1.32
A2	2.49	2.59	2.69
A3	1.17	1.27	1.37
b	0.78		0.87
b2	1.25		1.34
b4	1.20		1.29
b6			1.50
b7			1.45
c	0.49		0.56
D	15.40	15.50	15.60
D1	9.05	9.15	9.25
E	10.08	10.18	10.28
e	2.44	2.54	2.64
e1	4.98	5.08	5.18
H1	6.25	6.35	6.45
L	13.20	13.40	13.60
L1	3.50	3.70	3.90
L2	16.30	16.40	16.50
L3	28.70	28.90	29.10
ØP	3.75	3.80	3.85
Q	2.70	2.80	2.90

5 Revision history

Table 18: Document revision history

Date	Revision	Changes
09-Sep-2004	3	Complete document
10-Aug-2006	4	New template, no content change
26-Feb-2009	5	Updated mechanical data
07-Sep-2009	6	$V_{ESD(G-S)}$ value has been corrected
06-Apr-2017	7	Updated *Section 1: "Electrical ratings"*, *Section 2: "Electrical characteristics"* and *Section 4: "Package information"*. Minor text changes

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