1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		D^2PAK, TO-220	TO-220FP	DPAK, IPAK	
V_{DS}	Drain-source voltage	600			V
V_{GS}	Gate-source voltage	±30			V
I_D	Drain current (continuous) at T_C = 25 °C	2.4	2.4 (1)	2.4	A
I_D	Drain current (continuous) at T_C = 100 °C	1.51	1.51 (1)	1.51	A
I_{DM} (2)	Drain current (pulsed)	9.6	9.6 (1)	9.6	A
P_{TOT}	Total dissipation at T_C = 25 °C	45	20	45	W
ESD	Gate-source human body model (R = 1.5 kΩ, C = 100 pF)	2.1			kV
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat-sink (t = 1 s, T_C = 25 °C)		2.5		kV
dv/dt (3)	Peak diode recovery voltage slope	4.5			V/ns
T_j	Operating junction temperature range	-55 to 150			°C
T_{stg}	Storage temperature range				

1. *Limited by maximum junction temperature.*
2. *Pulse width limited by safe operating area.*
3. *I_{SD} ≤ 2.4 A, di/dt ≤ 200 A/µs, V_{DSpeak} ≤ $V_{(BR)DSS}$, V_{DD} = 80% $V_{(BR)DSS}$.*

Table 2. Thermal data

Symbol	Parameter	Value					Unit
		D^2PAK	TO-220	TO-220FP	DPAK	IPAK	
$R_{thj\text{-}case}$	Thermal resistance junction-case	2.78		6.25	2.78		°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient		62.5			100	°C/W
$R_{thj\text{-}pcb}$ (1)	Thermal resistance junction-pcb	35			50		°C/W

1. *When mounted on an 1-inch² FR-4, 2oz Cu board.*

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_j Max)	2.4	A
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, I_D = I_{AR}, V_{DD} = 50 V)	150	mJ

2 Electrical characteristics

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

Table 4. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	I_D = 1 mA, V_{GS} = 0 V	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_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 = 1.2 A		3.2	3.6	Ω

1. *Defined by design, not subject to production test.*

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{DS} = 25 V, f = 1 MHz, V_{GS} = 0 V	-	311	-	pF
C_{oss}	Output capacitance			43		
C_{rss}	Reverse transfer capacitance			8		
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{DS} = 0 to 480 V, V_{GS} = 0 V	-	26	-	pF
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 2.4 A, V_{GS} = 0 to 10 V (see Figure 16. Test circuit for gate charge behavior)	-	11.8	-	nC
Q_{gs}	Gate-source charge			2.6	-	
Q_{gd}	Gate-drain charge			6.4		

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 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 300 V, I_D = 1.5 A, R_G = 4.7 Ω, V_{GS} = 10 V (see Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform)	-	9	-	ns
t_r	Rise time			14		
$t_{d(off)}$	Turn-off delay time			19		
t_f	Fall time			14		

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		2.4	A
I_{SDM} (1)	Source-drain current (pulsed)				9.6	
V_{SD} (2)	Forward on voltage	I_{SD} = 2.4 A, V_{GS} = 0 V	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 2.4 A, di/dt = 100 A/µs	-	306		ns
Q_{rr}	Reverse recovery charge	V_{DD} = 48 V, T_j = 150°C (see Figure 17. Test circuit for inductive load switching and diode recovery times)		948		nC
I_{RRM}	Reverse recovery current			6.2		A

1. *Pulse width limited by safe operating area.*
2. *Pulsed: pulse duration = 300 µs, duty cycle 1.5%.*

Table 8. 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 1. Safe operating area

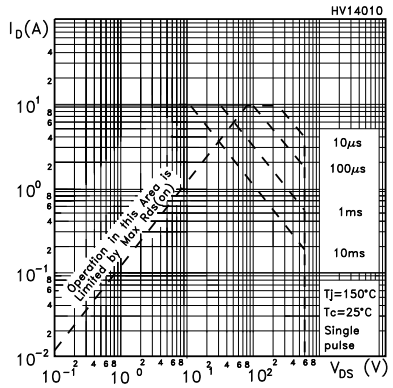


Figure 2. Thermal impedance

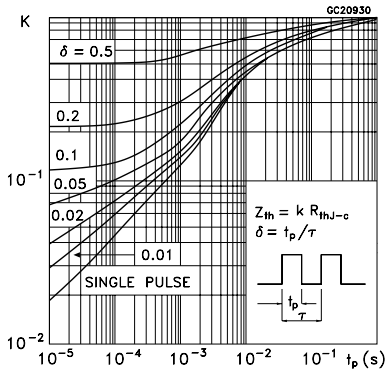


Figure 3. Safe operating area for TO-220FP

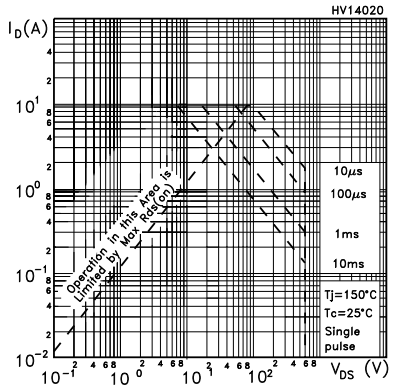


Figure 4. Thermal impedance for TO-220FP

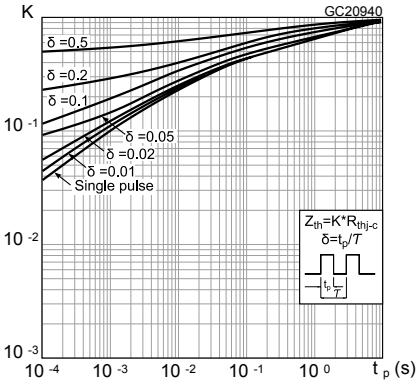


Figure 5. Output characterisics

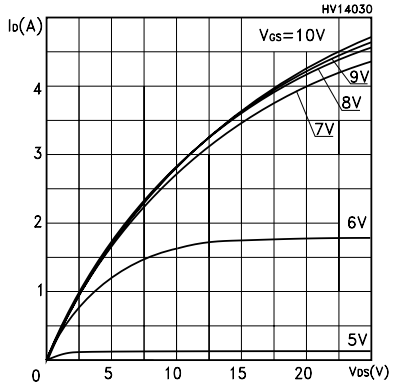


Figure 6. Transfer characteristics

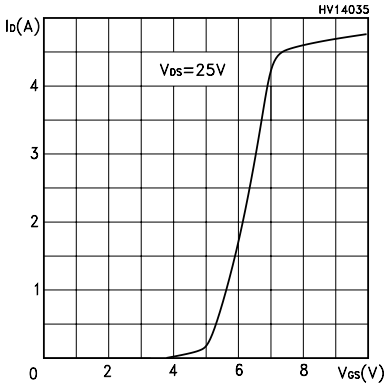


Figure 7. Static drain-source on resistance

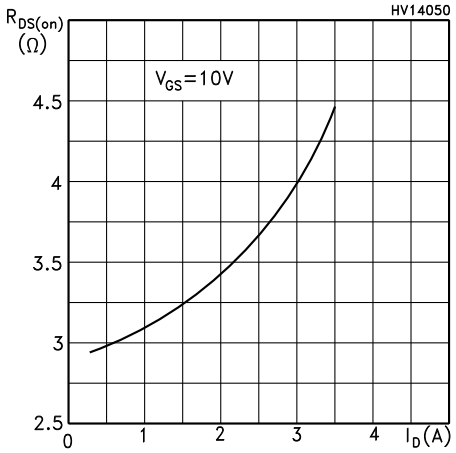


Figure 8. Gate charge vs gate-source voltage

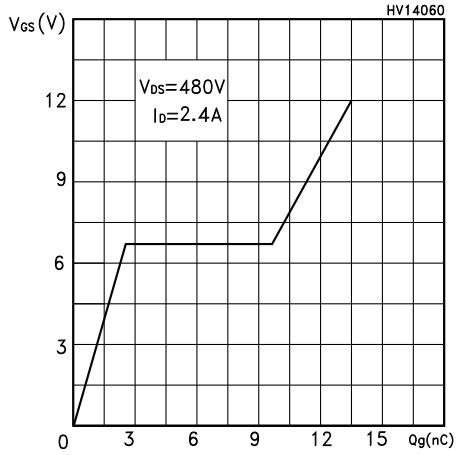


Figure 9. Capacitance variations

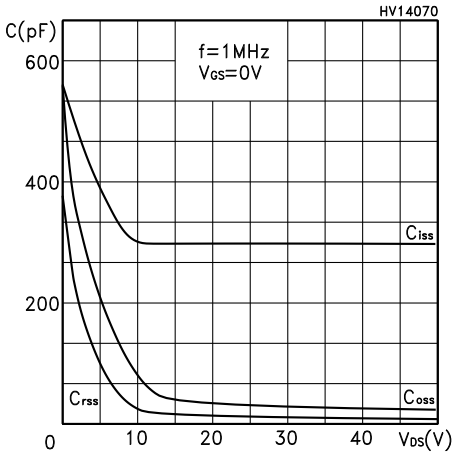


Figure 10. Normalized gate threshold voltage vs temperature

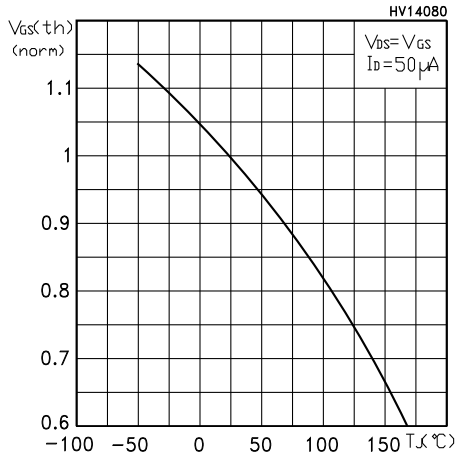


Figure 11. Normalized on resistance vs temperature

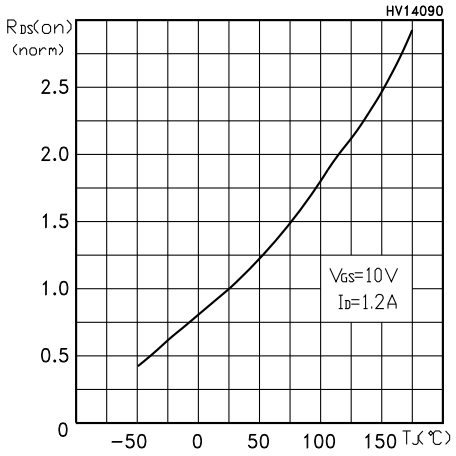


Figure 12. Source-drain diode forward characteristic

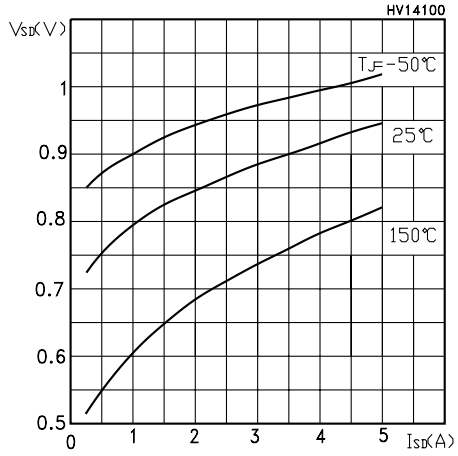


Figure 13. **Normalized $V_{(BR)DSS}$ vs temperature**

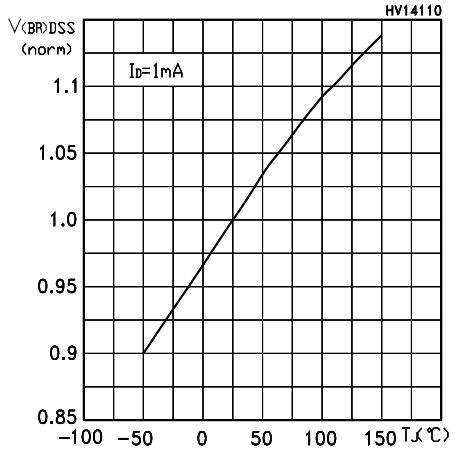
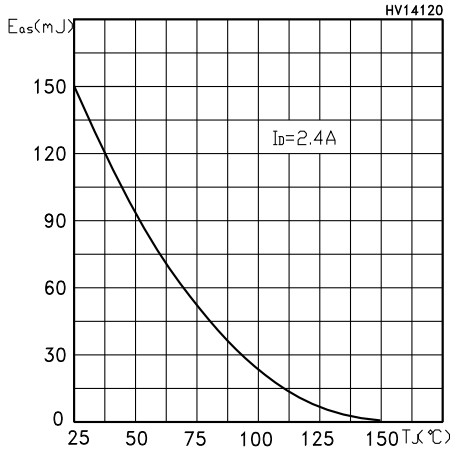


Figure 14. **Maximum avalanche energy vs temperature**



3 Test circuits

Figure 15. Test circuit for resistive load switching times

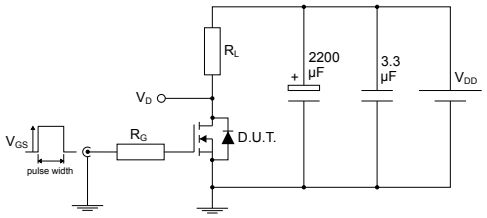


Figure 16. Test circuit for gate charge behavior

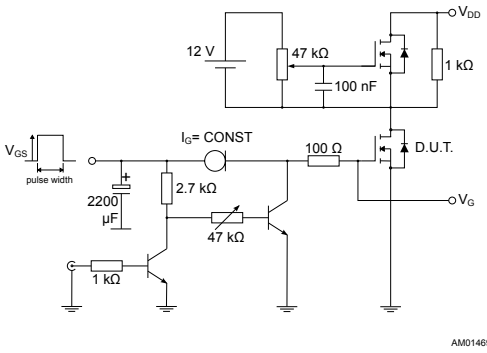


Figure 17. Test circuit for inductive load switching and diode recovery times

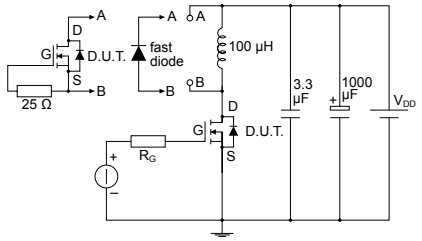


Figure 18. Unclamped inductive load test circuit

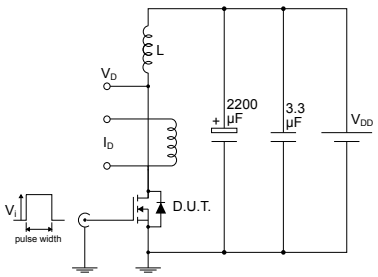


Figure 19. Unclamped inductive waveform

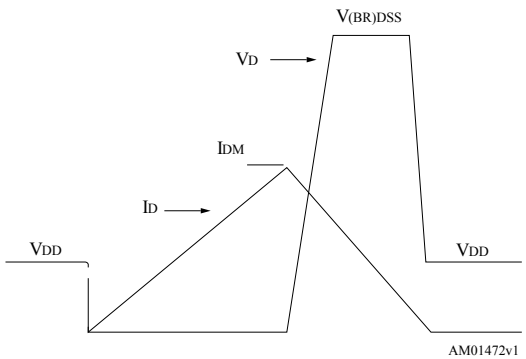
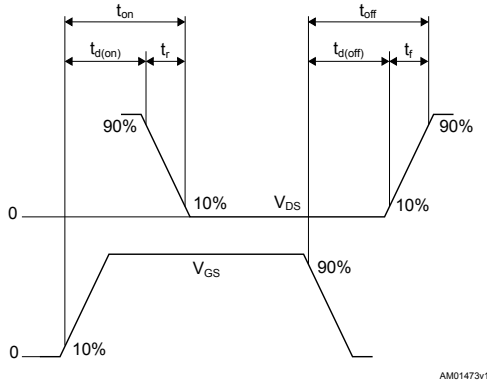


Figure 20. Switching time waveform



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 D²PAK (TO-263) type A package information

Figure 21. D²PAK (TO-263) type A package outline

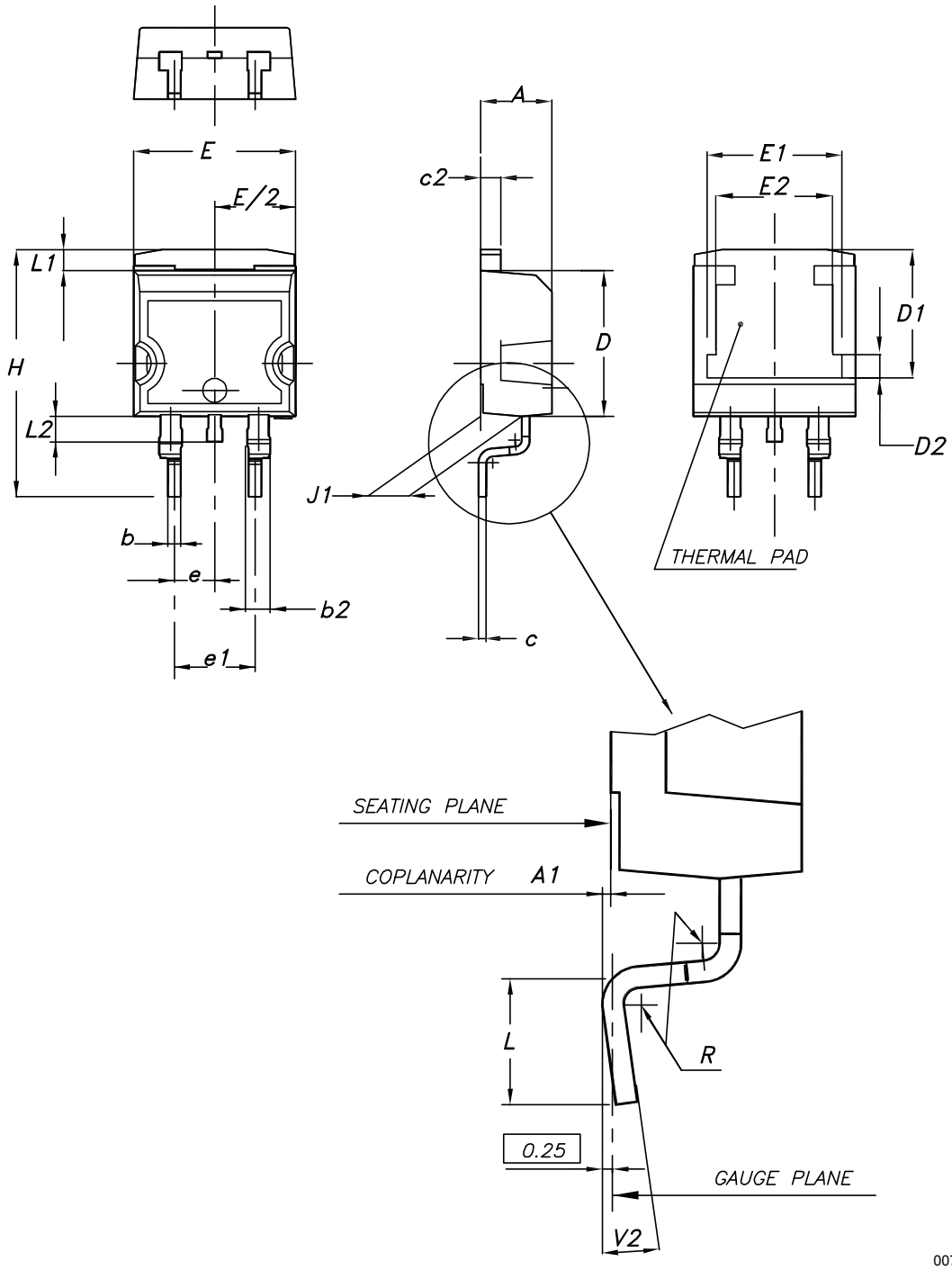
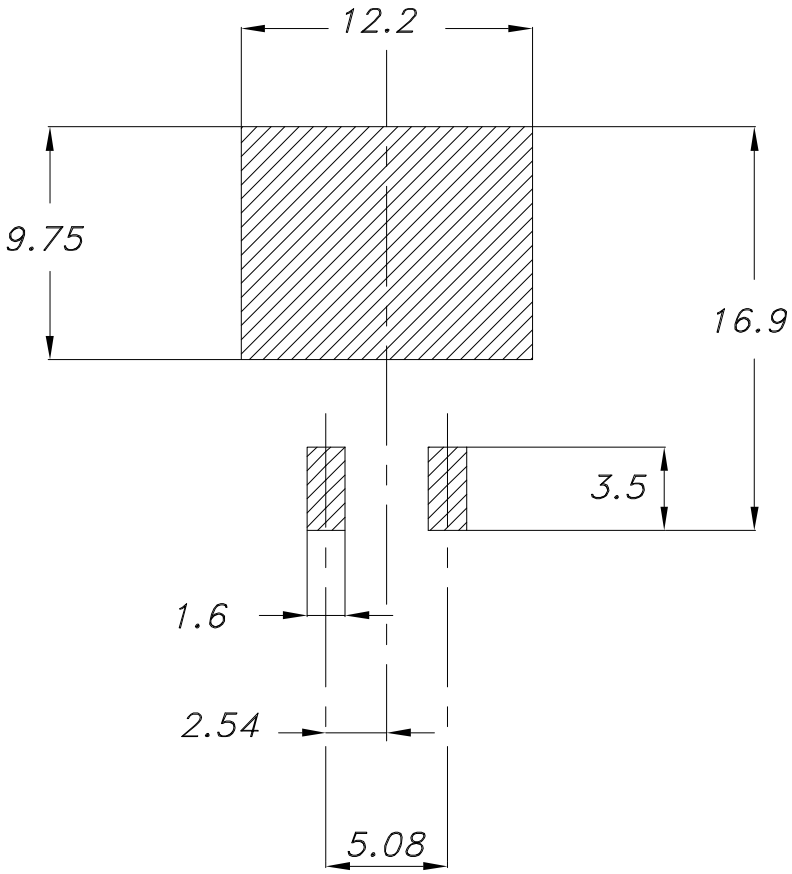


Table 9. D²PAK (TO-263) type A package mechanical data

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	8.30	8.50	8.70
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 22. **D²PAK (TO-263) recommended footprint (dimensions are in mm)**



Footprint

4.2 D²PAK packing information

Figure 23. D²PAK tape outline

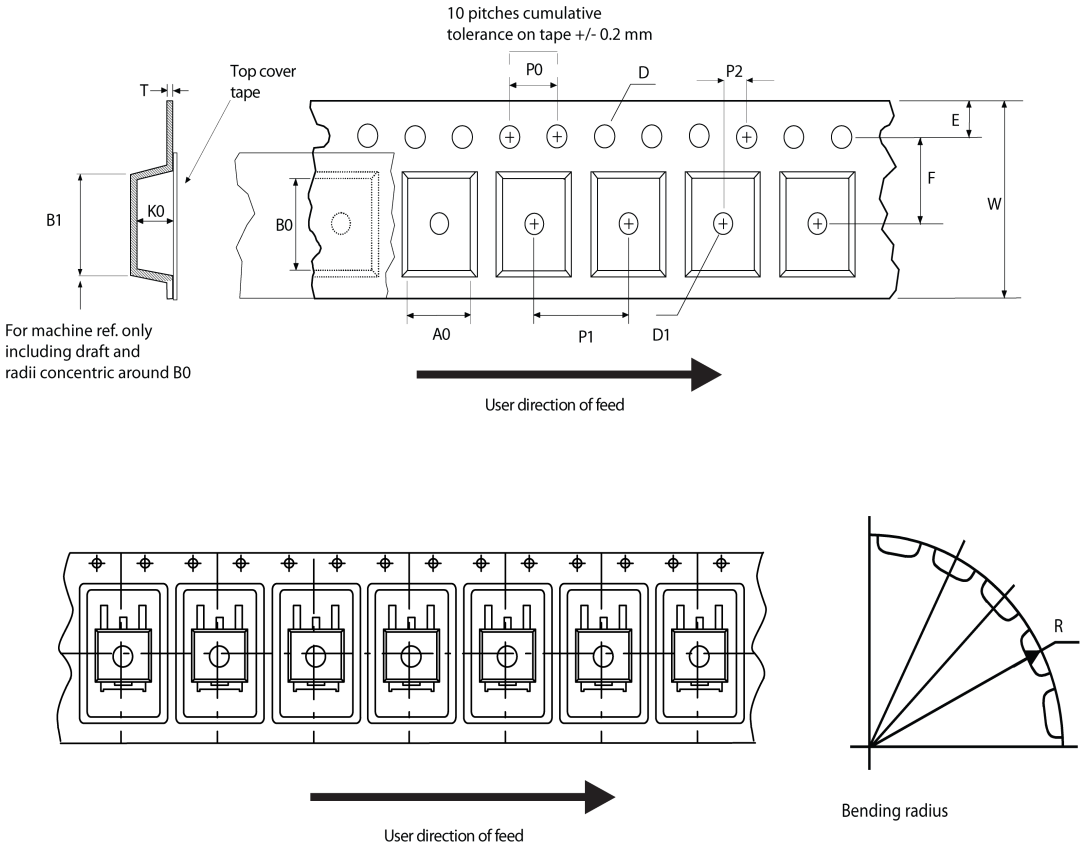


Figure 24. **D²PAK reel outline**

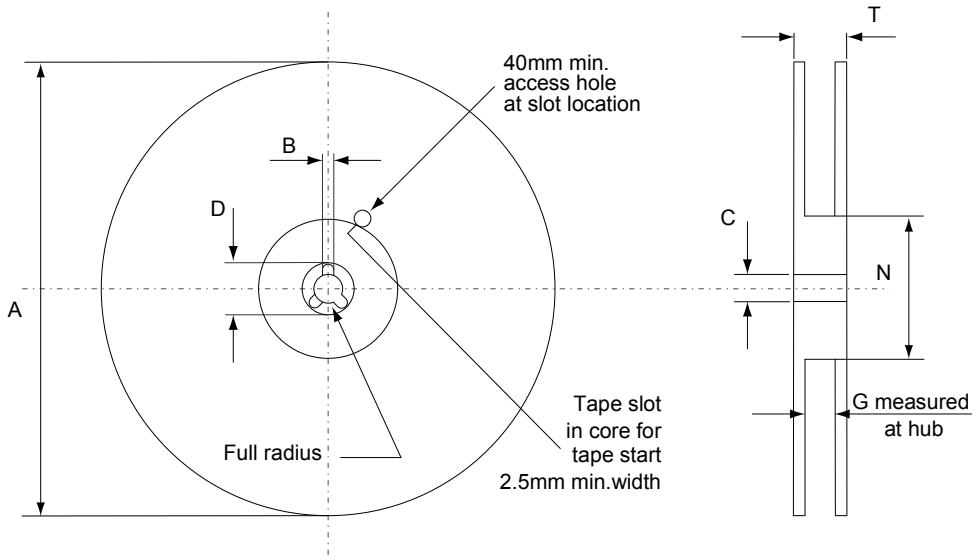


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Table 10. **D²PAK tape and reel mechanical data**

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			

4.3 IPAK (TO-251) type A package information

Figure 25. **IPAK (TO-251) type A package outline**

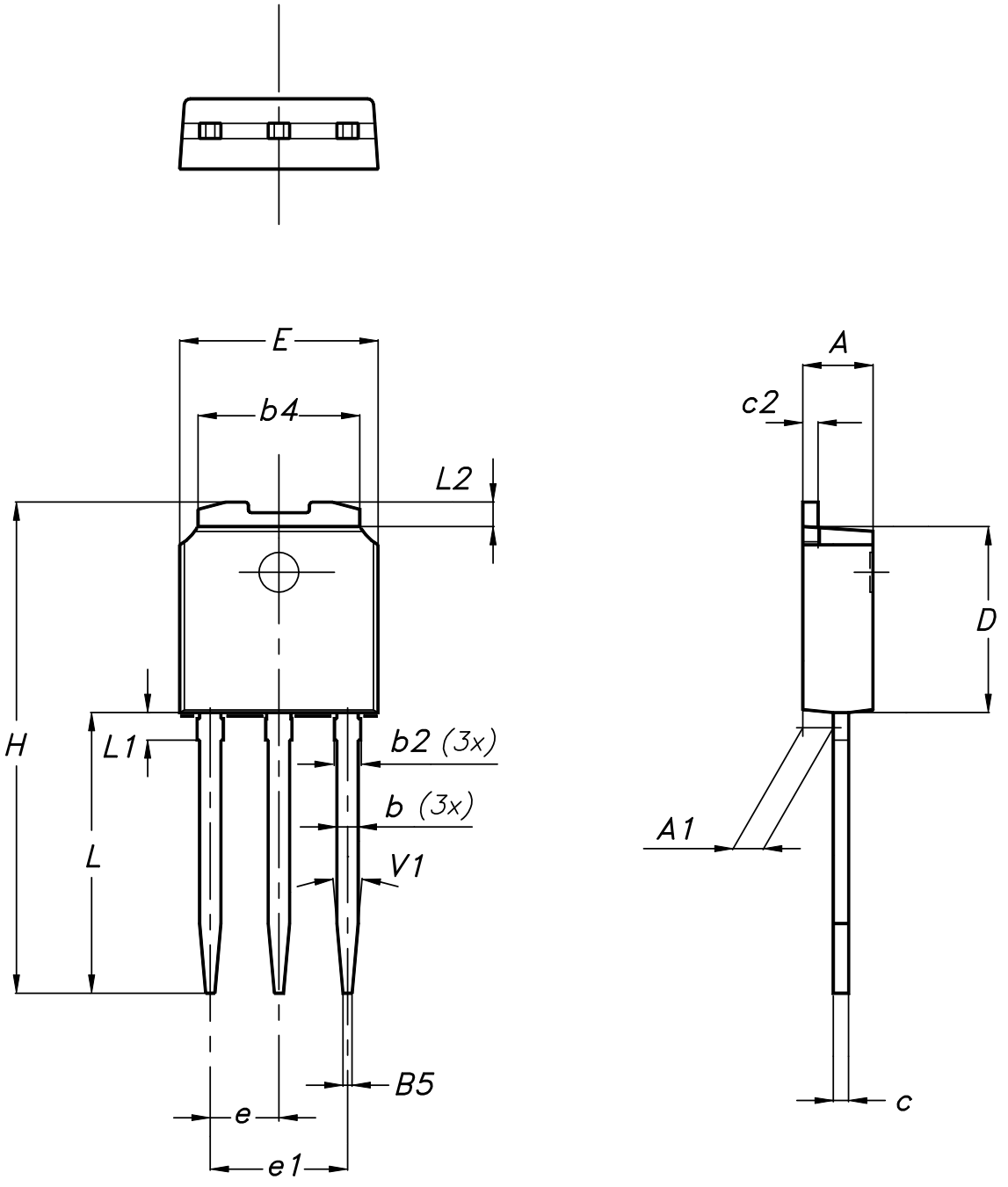

Table 11. **IPAK (TO-251) type A package mechanical data**

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°	

4.4 IPAK (TO-251) type C package information

Figure 26. **IPAK (TO-251) type C package outline**

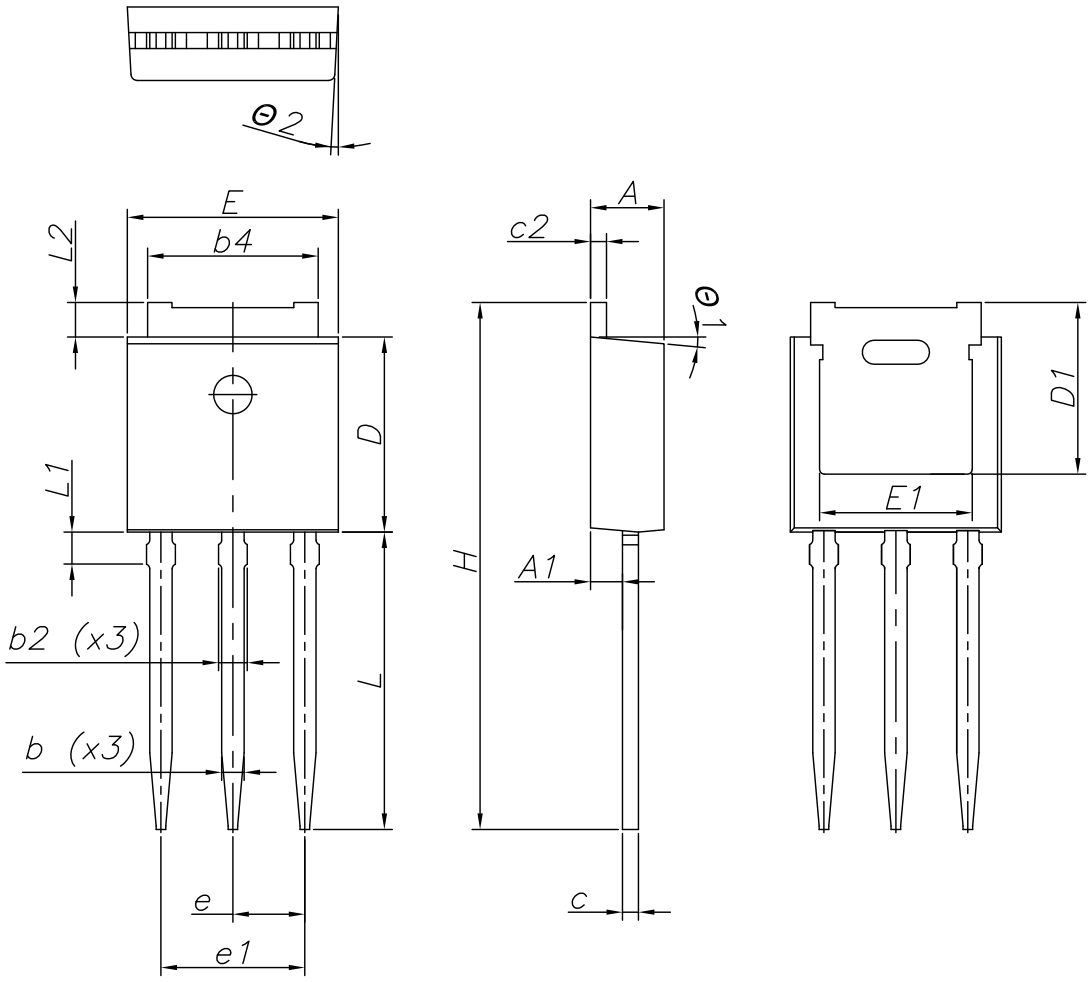

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Table 12. **IPAK (TO-251) type C package mechanical data**

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°

4.5 DPAK (TO-252) type A package information

Figure 27. **DPAK (TO-252) type A package outline**

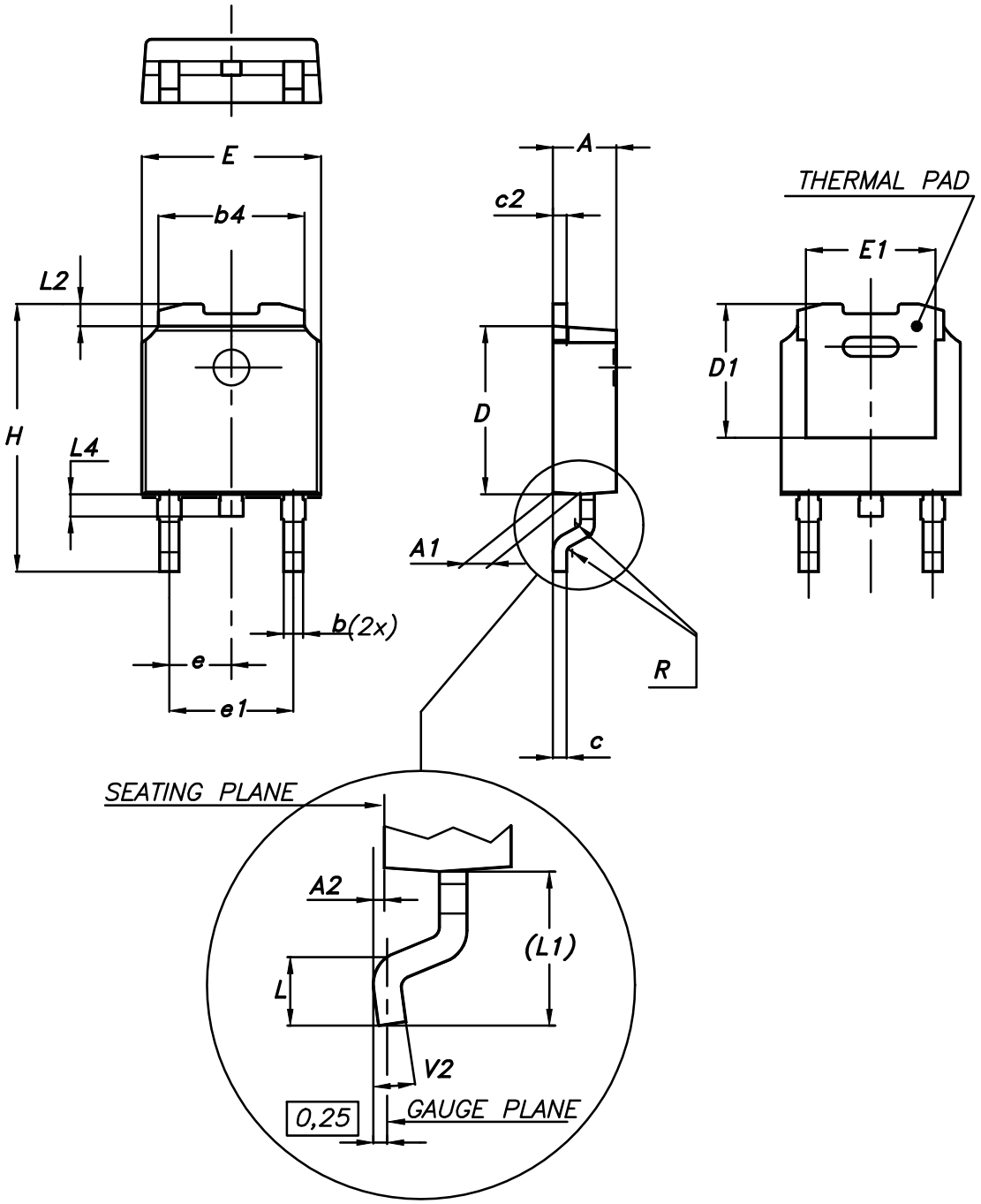

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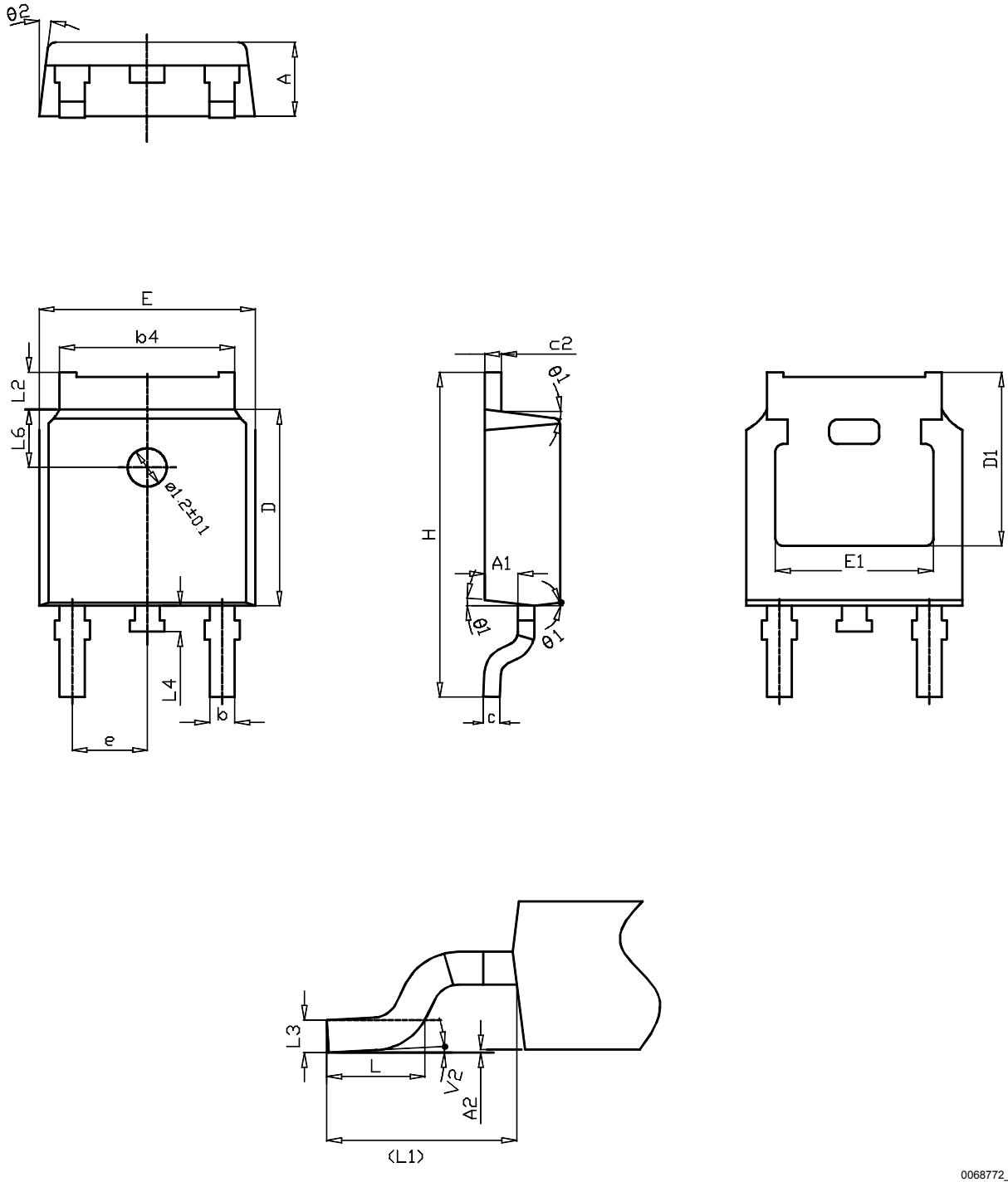
Table 13. **DPAK (TO-252) type A mechanical data**

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	2.159	2.286	2.413
e1	4.445	4.572	4.699
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°

4.6 DPAK (TO-252) type C package information

Figure 28. **DPAK (TO-252) type C package outline**



0068772_C_25

Table 14. 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°

4.7 DPAK (TO-252) type E package information

Figure 29. **DPAK (TO-252) type E package outline**

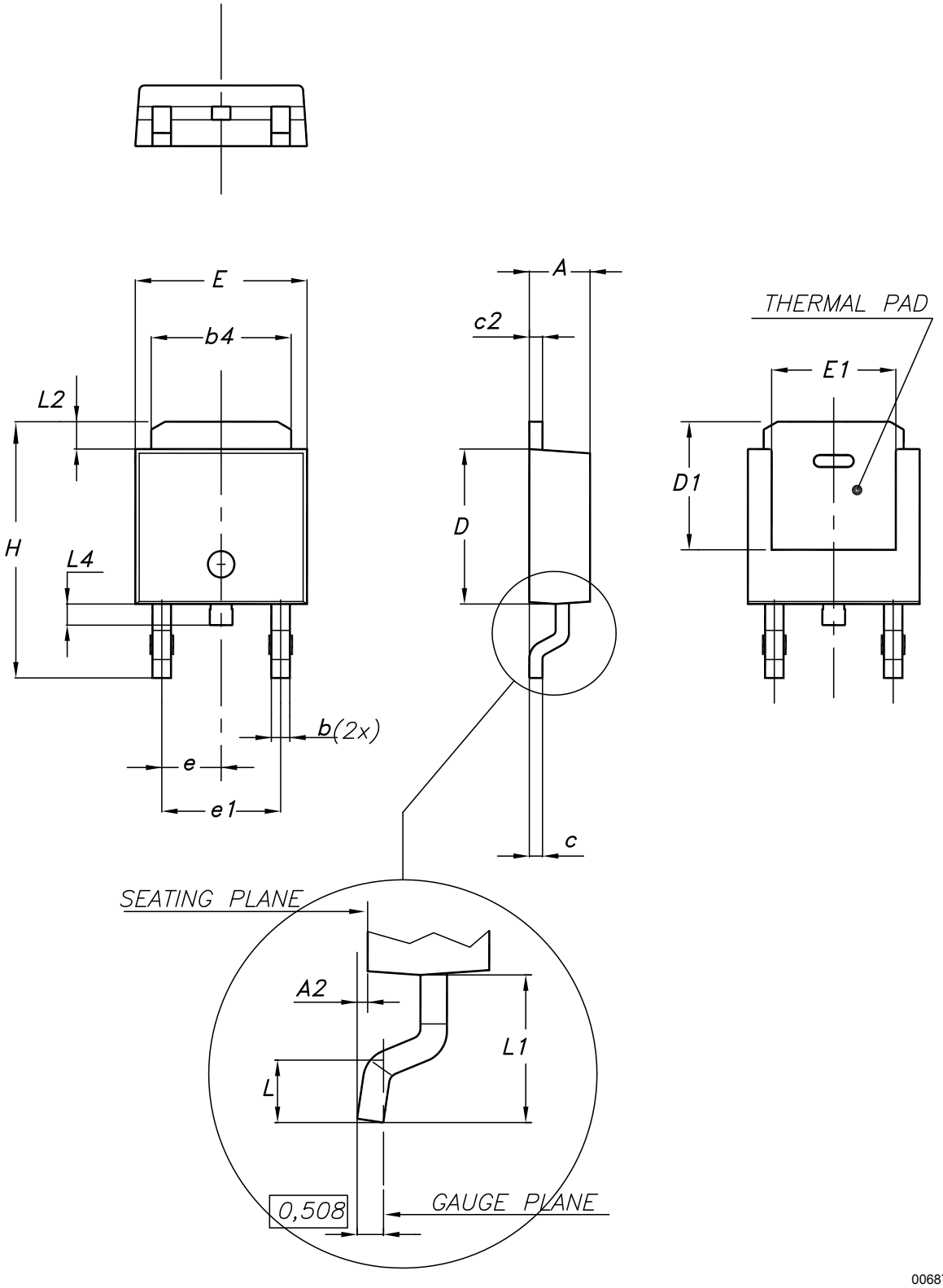


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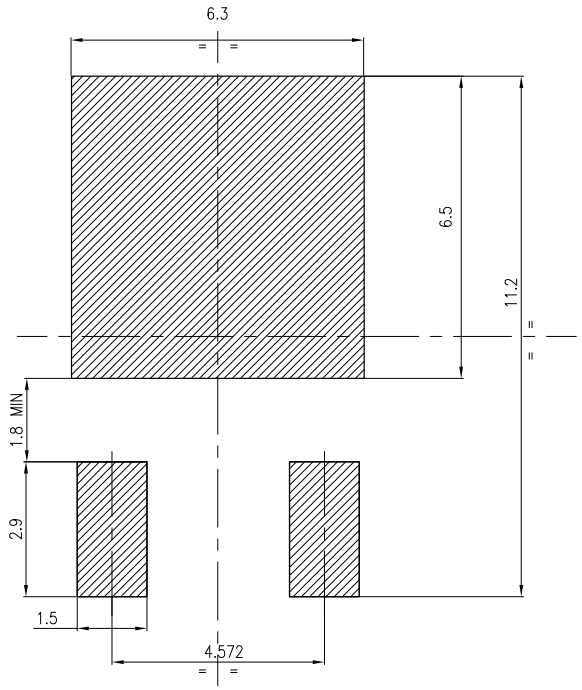
Table 15. DPAK (TO-252) type E mechanical data

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 30. DPAK (TO-252) recommended footprint (dimensions are in mm)



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4.8 DPAK (TO-252) packing information

Figure 31. **DPAK (TO-252) tape outline**

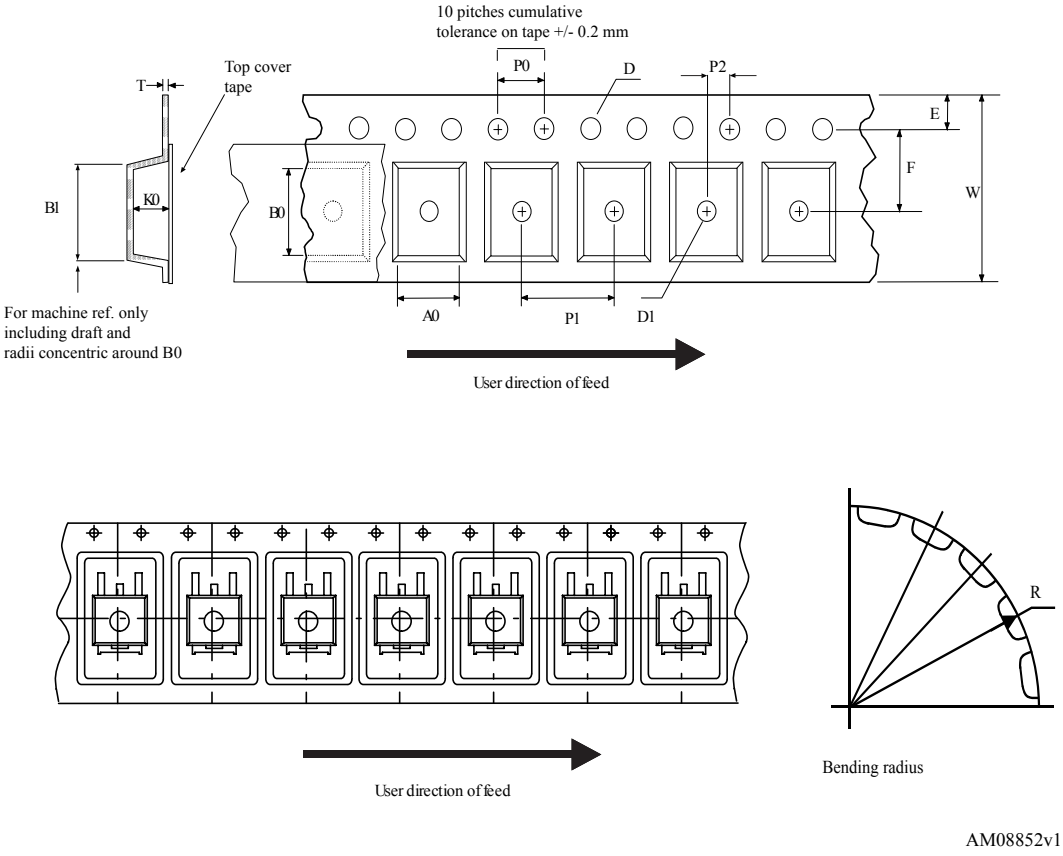

Figure 32. **DPAK (TO-252) reel outline**

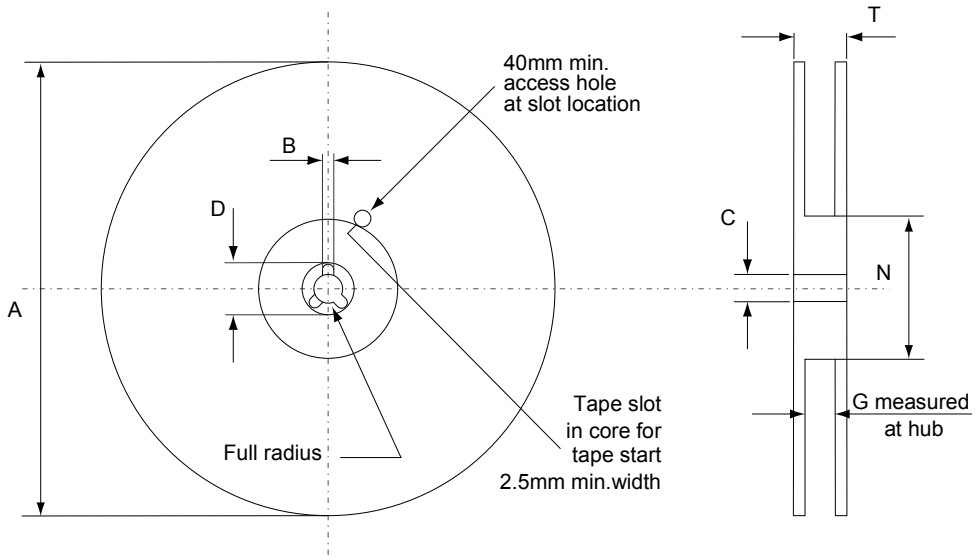

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Table 16. **DPAK (TO-252) tape and reel mechanical data**

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			

4.9 TO-220 type A package information

Figure 33. **TO-220 type A package outline**

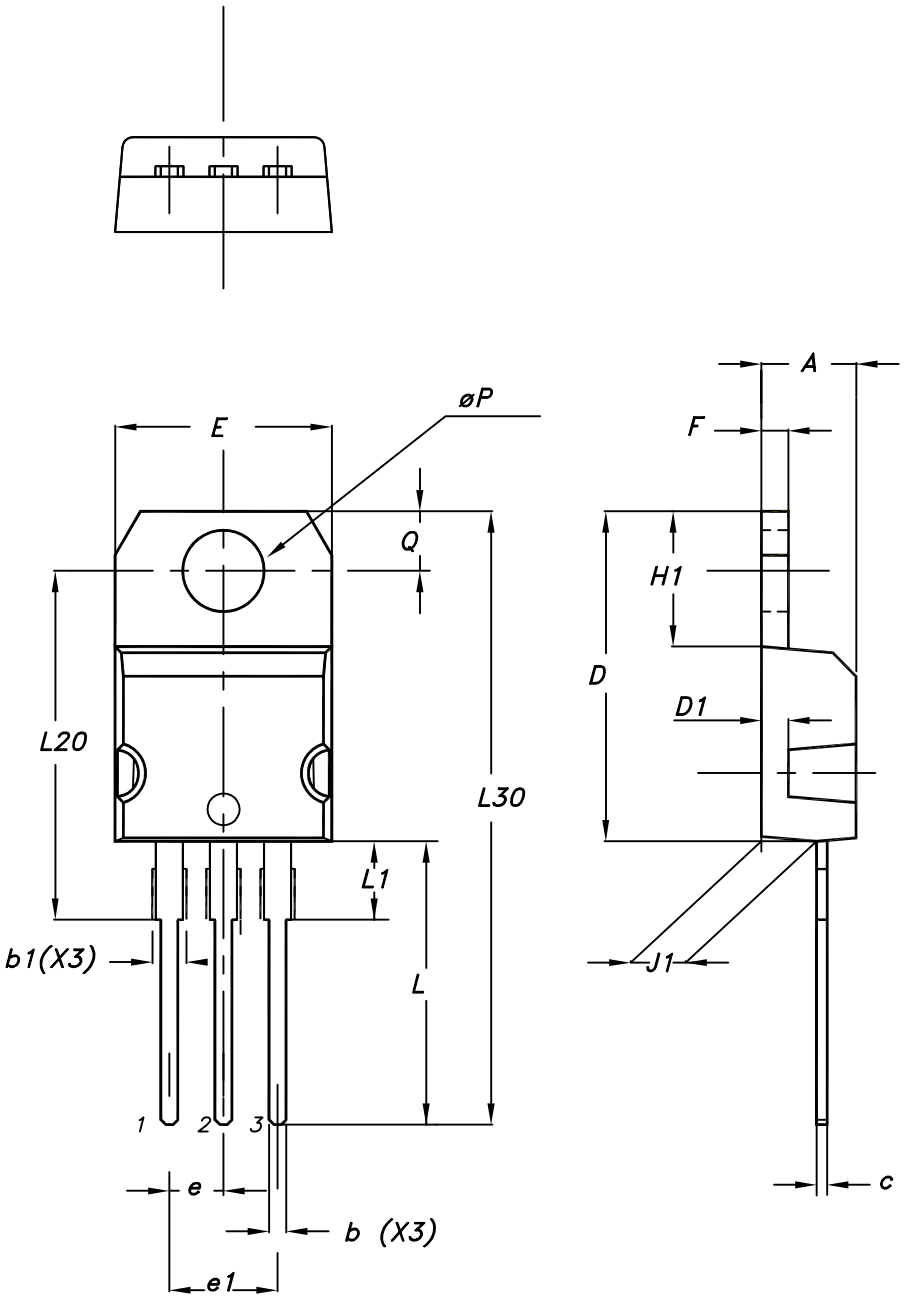

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Table 17. **TO-220 type A package mechanical data**

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

4.10 TO-220FP package information

Figure 34. **TO-220FP package outline**

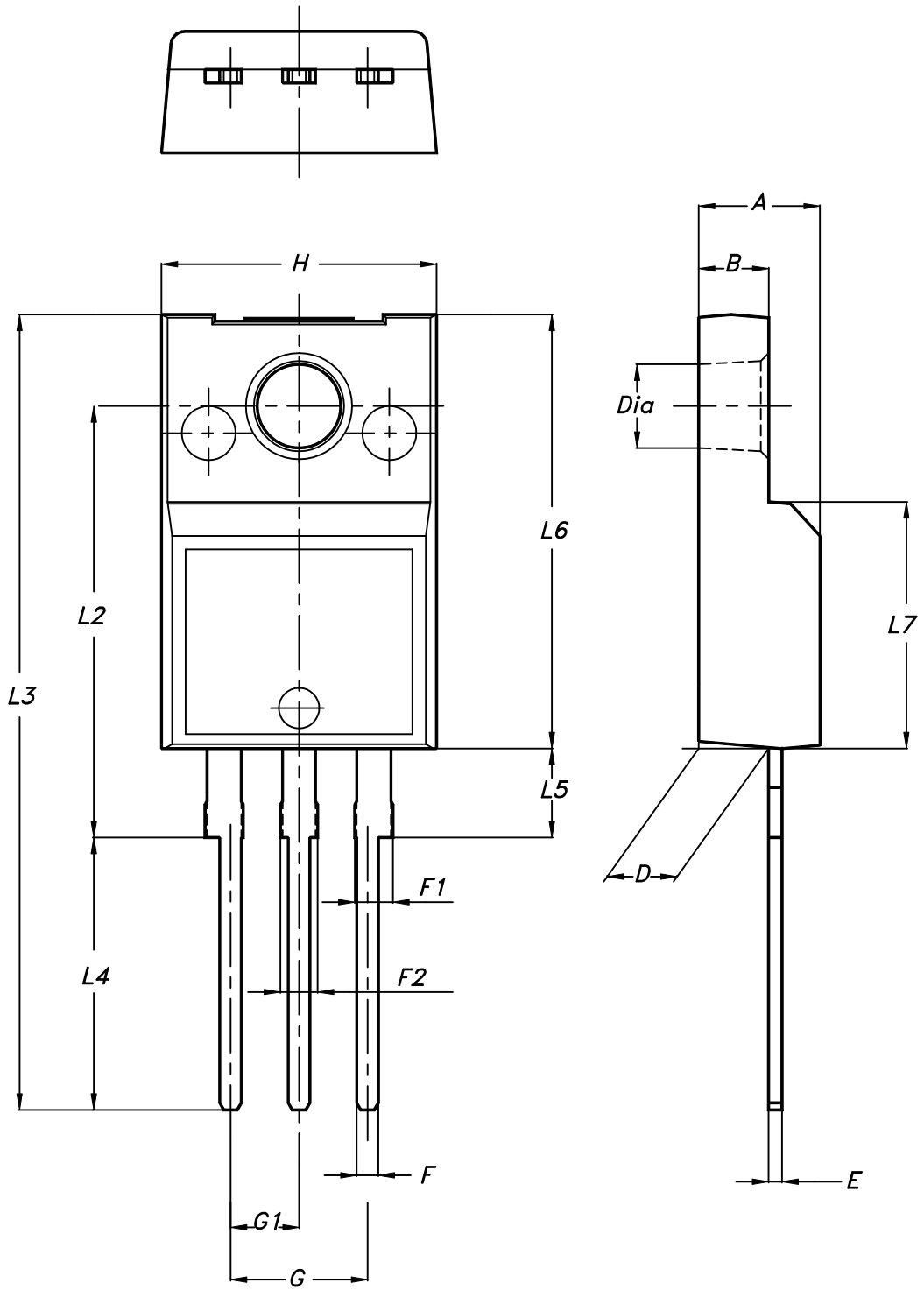

Table 18. **TO-220FP package mechanical data**

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

5 Ordering information

Table 19. **Order codes**

Order code	Marking	Package	Packing
STB3NK60ZT4	B3NK60Z	D^2PAK	Tape and reel
STD3NK60Z-1	D3NK60Z	IPAK	Tube
STD3NK60ZT4		DPAK	Tape and reel
STP3NK60Z	P3NK60Z	TO-220	Tube
STP3NK60ZFP	P3NK60ZFP	TO-220FP	Tube

Revision history

Table 20. **Document revision history**

Date	Version	Changes
07-Jul-2003	5	Updated document.
20-Aug-2018	6	Updated Section 1 Electrical ratings, Section 2 Electrical characteristics and Section 4 Package information. Minor text changes.

Contents