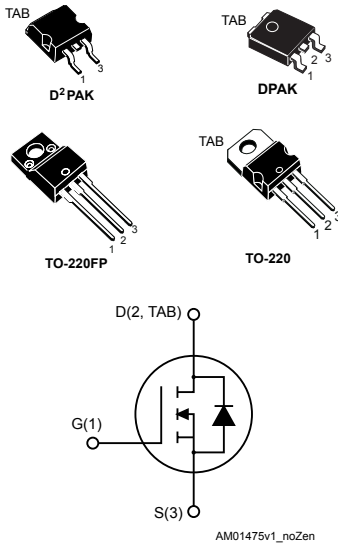




THE DATASHEET OF STF11N65M5



N-channel 650 V, 0.43 Ω typ., 9 A MDmesh™ M5 Power MOSFETs in a DPAK, D²PAK, TO-220FP and TO-220 packages



Features

Order code	V_{DS} @ $T_{jmax.}$	$R_{DS(on)max.}$	I_D
STB11N65M5	710 V	0.48 Ω	9 A
STD11N65M5			
STF11N65M5			
STP11N65M5			

- Extremely low $R_{DS(on)}$
- Low gate charge and input capacitance
- Excellent switching performance
- 100% avalanche tested

Applications

- Switching applications

Description

These devices are N-channel Power MOSFET based on the MDmesh™ M5 innovative vertical process technology combined with the well-known PowerMESH™ horizontal layout. The resulting products offer extremely low on-resistance, making them particularly suitable for applications requiring high power and superior efficiency.

Product status
STB11N65M5
STD11N65M5
STF11N65M5
STP11N65M5

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D ² PAK DPAK TO-220	TO-220FP	
V _{GS}	Gate-source voltage	±25		V
I _D	Drain current (continuous) at T _C = 25 °C	9	9 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100 °C	5.6	5.6 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	36	36 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25 °C	85	25	W
dv/dt ⁽³⁾	Peak diode recovery voltage slope	15		V/ns
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T _C = 25 °C)		2500	V
T _J	Operating junction temperature range	-55 to 150		°C
T _{stg}	Storage temperature range			

- Limited by maximum junction temperature.
- Pulse width limited by safe operating area.
- $I_{SD} \leq 9\text{ A}$, $di/dt \leq 400\text{ A}/\mu\text{s}$; $V_{DS\ peak} < V_{(BR)DSS}$, $V_{DD} = 400\text{ V}$.

Table 2. Thermal data

Symbol	Parameter	Value				Unit
		D ² PAK	DPAK	TO-220FP	TO-220	
R _{thj-case}	Thermal resistance junction-case	1.47		5.0	1.47	°C/W
R _{thj-amb}	Thermal resistance junction-ambient			62.5		°C/W
R _{thj-pcb} ⁽¹⁾	Thermal resistance junction-pcb	30	50			°C/W

- When mounted on 1 inch² FR-4, 2 Oz copper 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	A
E _{AS}	Single pulse avalanche energy (starting T _J = 25 °C, I _D = I _{AR} , V _{DD} = 50 V)	130	mJ

2 Electrical characteristics

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

Table 4. On/off states

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source Breakdown voltage	$I_D = 1\text{ mA}$, $V_{GS} = 0\text{ V}$	650			V
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$, $V_{DS} = 650\text{ V}$			1	μA
		$V_{GS} = 0\text{ V}$, $V_{DS} = 650\text{ V}$, $T_C = 125\text{ °C}^{(1)}$			100	μA
I_{GSS}	Gate body leakage current	$V_{DS} = 0\text{ V}$, $V_{GS} = \pm 25\text{ V}$			± 100	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}$, $I_D = 4.5\text{ A}$		0.43	0.48	Ω

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

Table 5. Dynamic

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$	-	644	-	μF
C_{oss}	Output capacitance			18		
C_{rss}	Reverse transfer capacitance			2.5		
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{DS} = 0\text{ to }520\text{ V}$, $V_{GS} = 0\text{ V}$	-	55	-	μF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related			17		
R_g	Gate input resistance	$f = 1\text{ MHz}$ open drain	-	5	-	Ω
Q_g	Total gate charge	$V_{DD} = 520\text{ V}$, $I_D = 4.5\text{ A}$, $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 20. Test circuit for gate charge behavior)	-	17	-	nC
Q_{gs}	Gate-source charge			4.6		
Q_{gd}	Gate-drain charge			8.5		

1. Time related 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} .

2. Energy related is defined as a constant equivalent capacitance giving the same stored energy as C_{oss} when V_{DS} increases from 0 to 80% V_{DSS} .

Table 6. Switching times

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$t_{d(v)}$	Voltage delay time	$V_{DD} = 400\text{ V}$, $I_D = 7.5\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$ (see Figure 21. Test circuit for inductive load switching and diode recovery times and Figure 24. Switching time waveform)	-	23	-	ns
$t_{r(v)}$	Voltage rise time			10		
$t_{c(off)}$	Crossing time			13		
$t_{f(i)}$	Fall time			13.5		

Table 7. Source drain diode

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current				9	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		36	
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 9\text{ A}$, $V_{GS} = 0\text{ V}$	-		1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 9\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$		232		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 100\text{ V}$ (see Figure 21. Test circuit for inductive load switching and diode recovery times)	-	2		μC
I_{RRM}	Reverse recovery current			17.5		A
t_{rr}	Reverse recovery time	$I_{SD} = 9\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$		328		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 100\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 21. Test circuit for inductive load switching and diode recovery times)	-	2.8		μC
I_{RRM}	Reverse recovery current			17		A

1. Pulse width limited by safe operating area.

2. Pulsed: pulse duration = 300 μs , duty cycle 1.5%.

2.1 Electrical characteristics curves

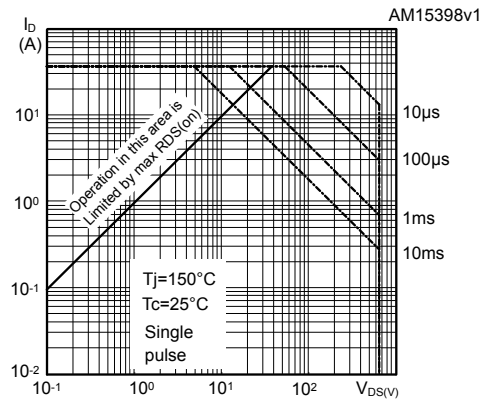
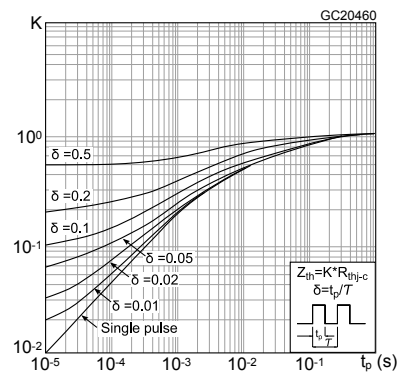
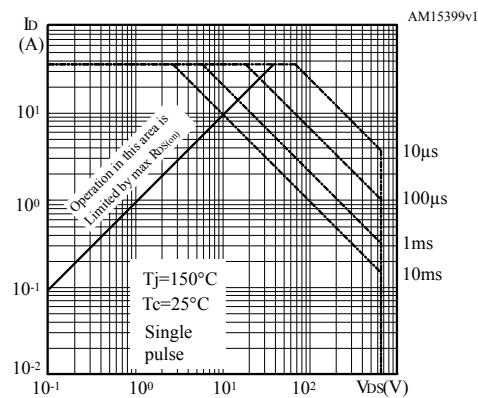
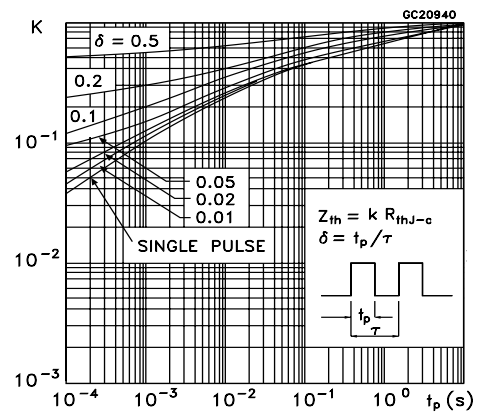
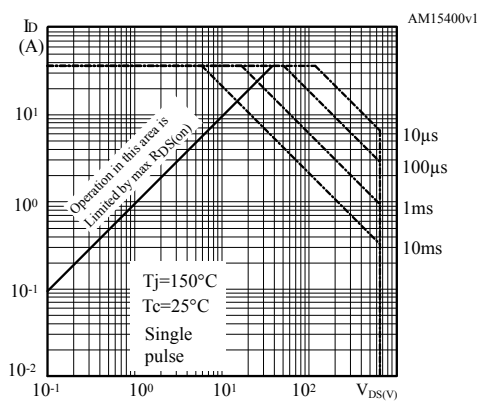
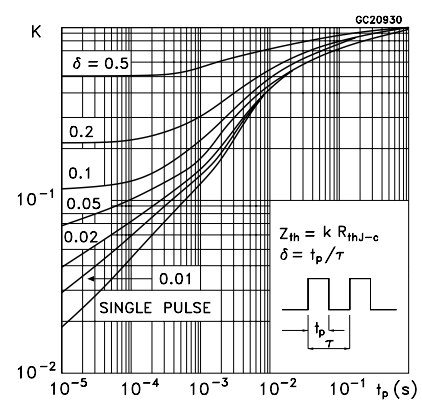
Figure 1. Safe operating area for DPAK

Figure 2. Thermal impedance DPAK

Figure 3. Safe operating area for TO-220FP

Figure 4. Thermal impedance for TO-220FP

Figure 5. Safe operating area for TO-220 and D²PAK

Figure 6. Thermal impedance for TO-220 and D²PAK


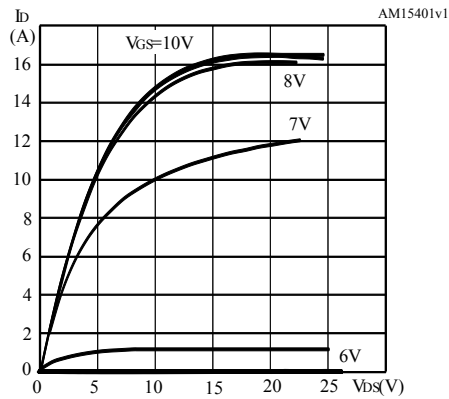
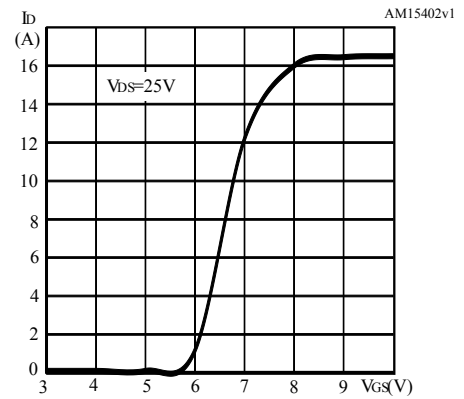
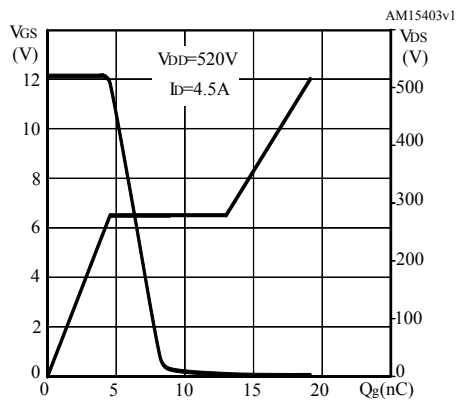
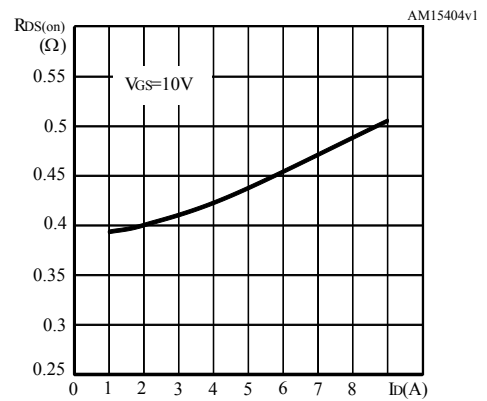
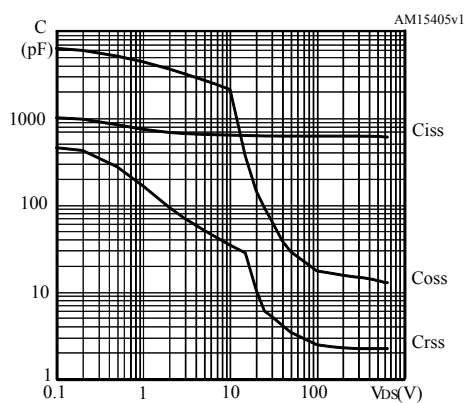
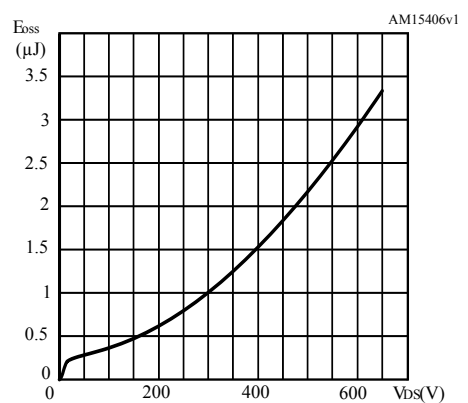
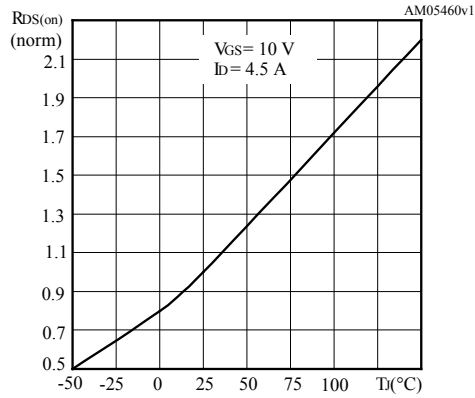
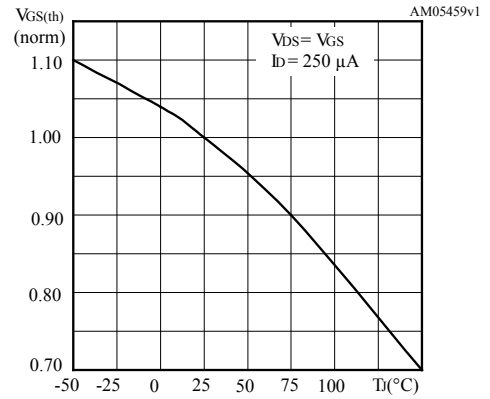
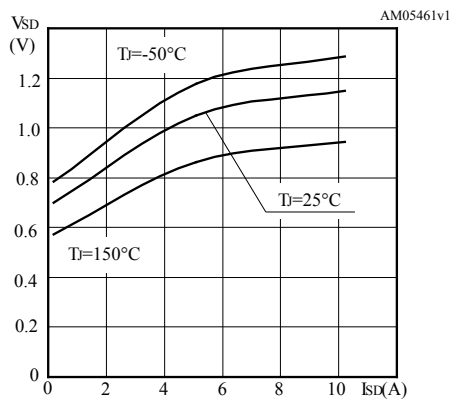
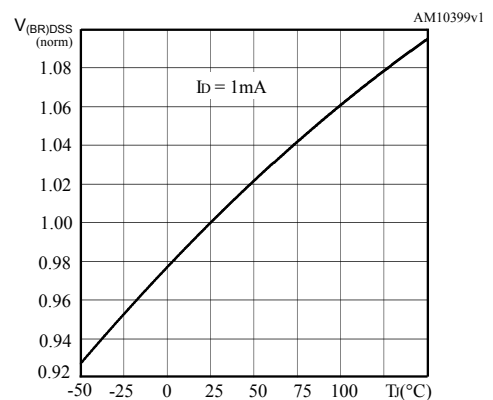
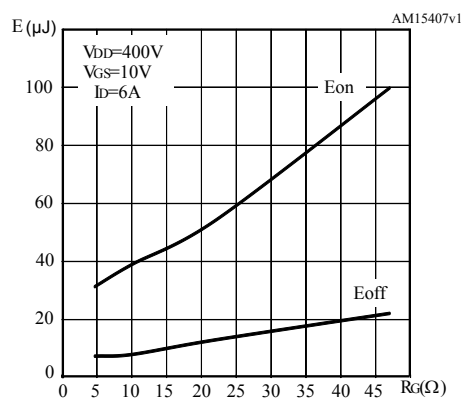
Figure 8. Output characteristics

Figure 9. Transfer characteristics

Figure 10. Gate charge vs gate-source voltage

Figure 11. Static drain-source on resistance

Figure 12. Capacitance variations

Figure 13. Output capacitance stored energy


Figure 14. Normalized on-resistance vs temperature

Figure 15. Normalized gate threshold voltage vs temperature

Figure 16. Drain-source diode forward characteristics

Figure 17. Normalized $V_{(BR)DSS}$ vs temperature

Figure 18. Switching energy vs gate resistance


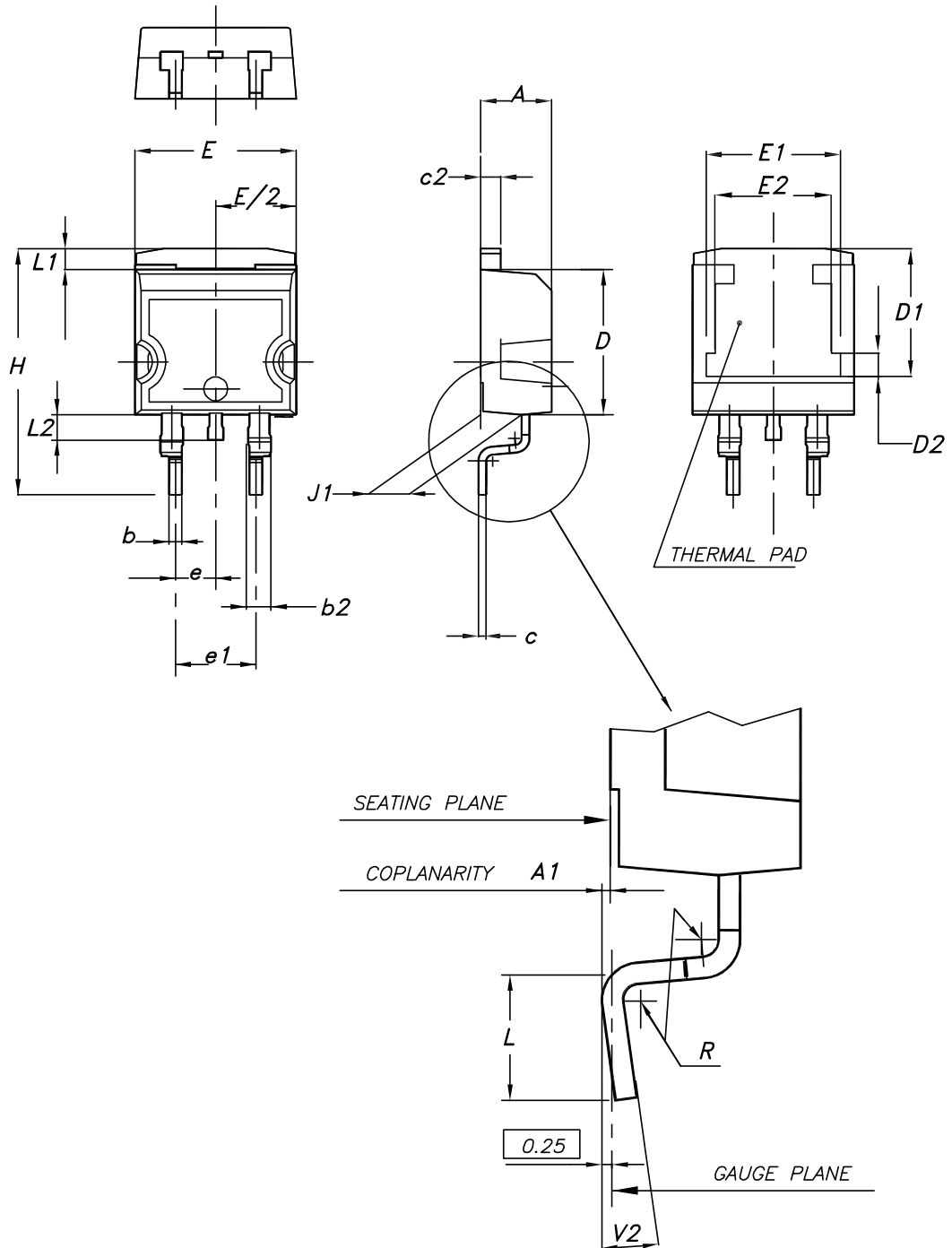


4 Package information

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 25. D²PAK (TO-263) type A package outline

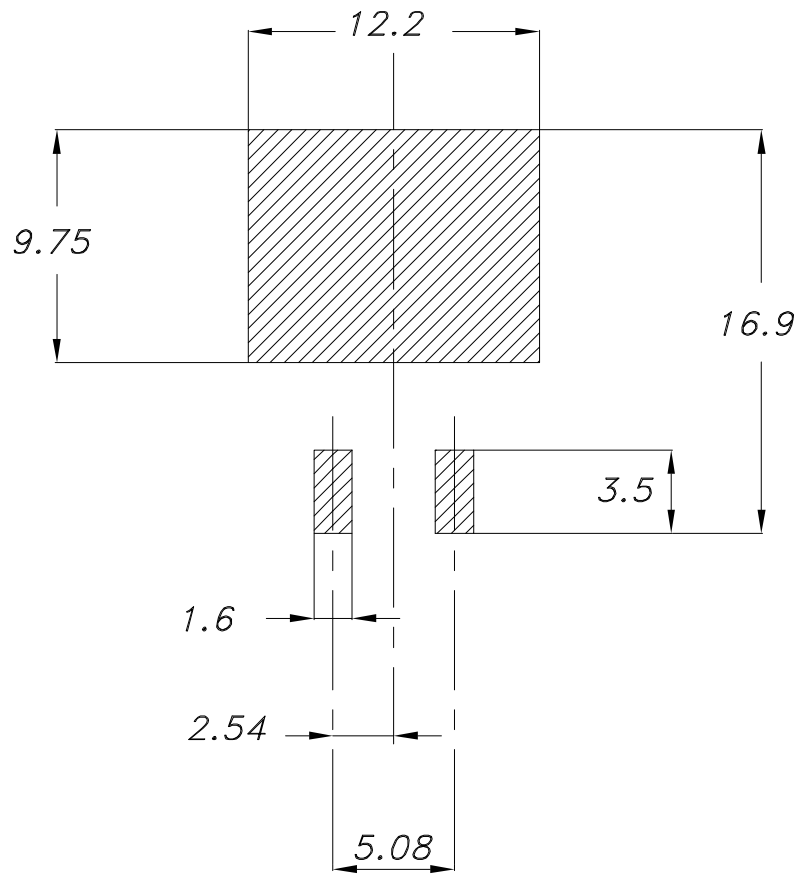


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Table 8. D²PAK (TO-263) type A package mechanical data

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°

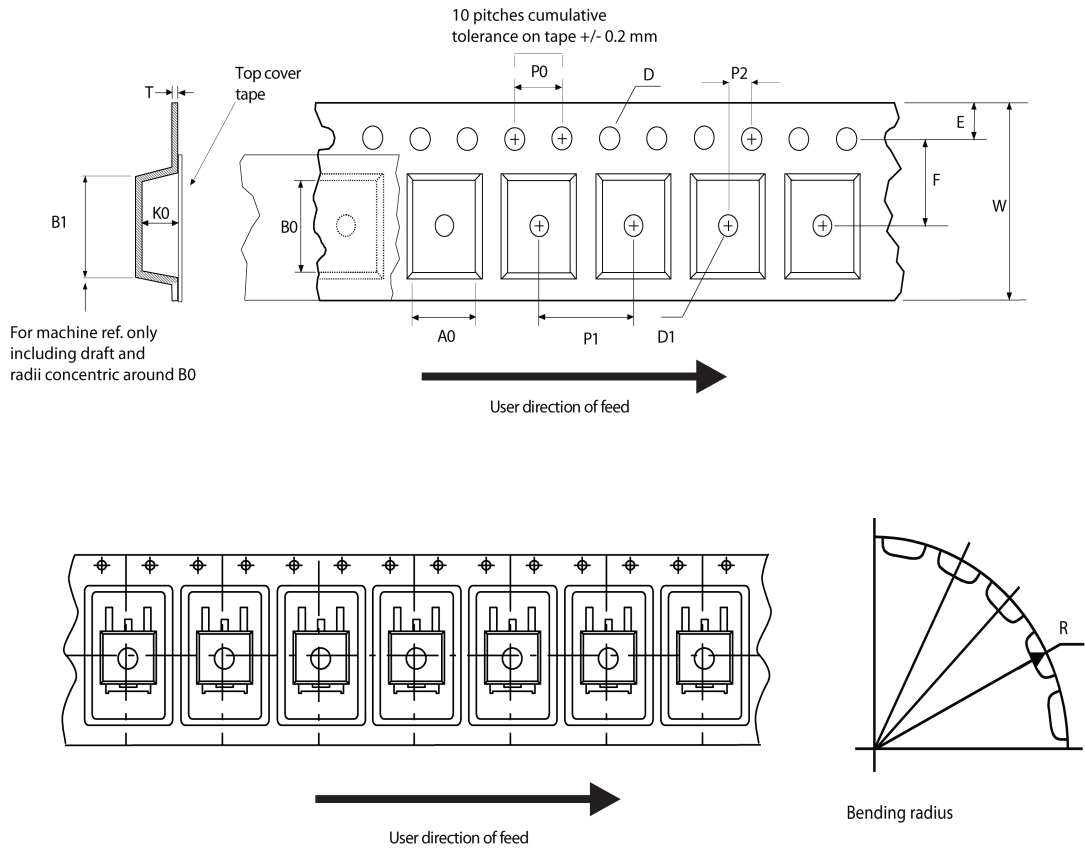
Figure 26. D²PAK (TO-263) recommended footprint (dimensions are in mm)



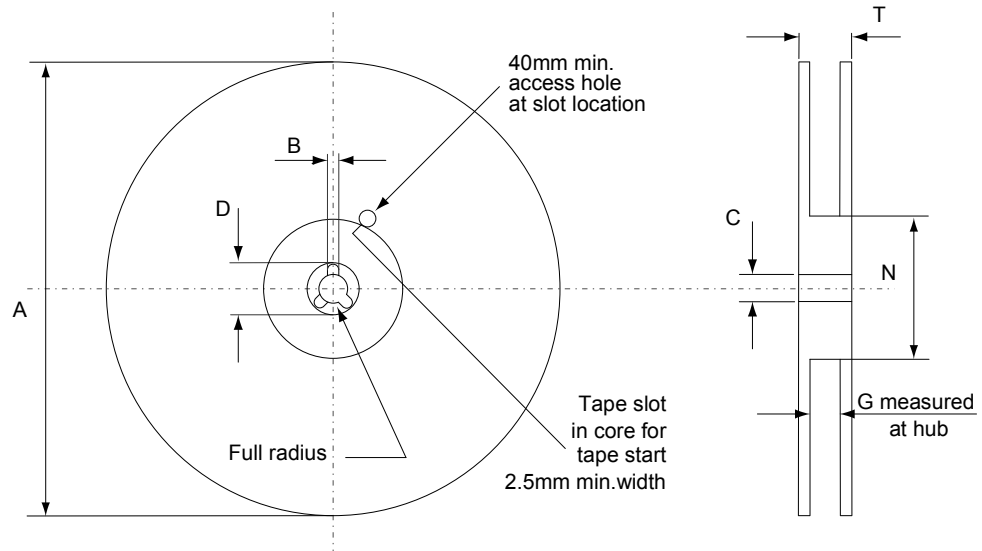
Footprint

4.2 D²PAK packing information

Figure 27. D²PAK tape outline



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Figure 28. D²PAK reel outline


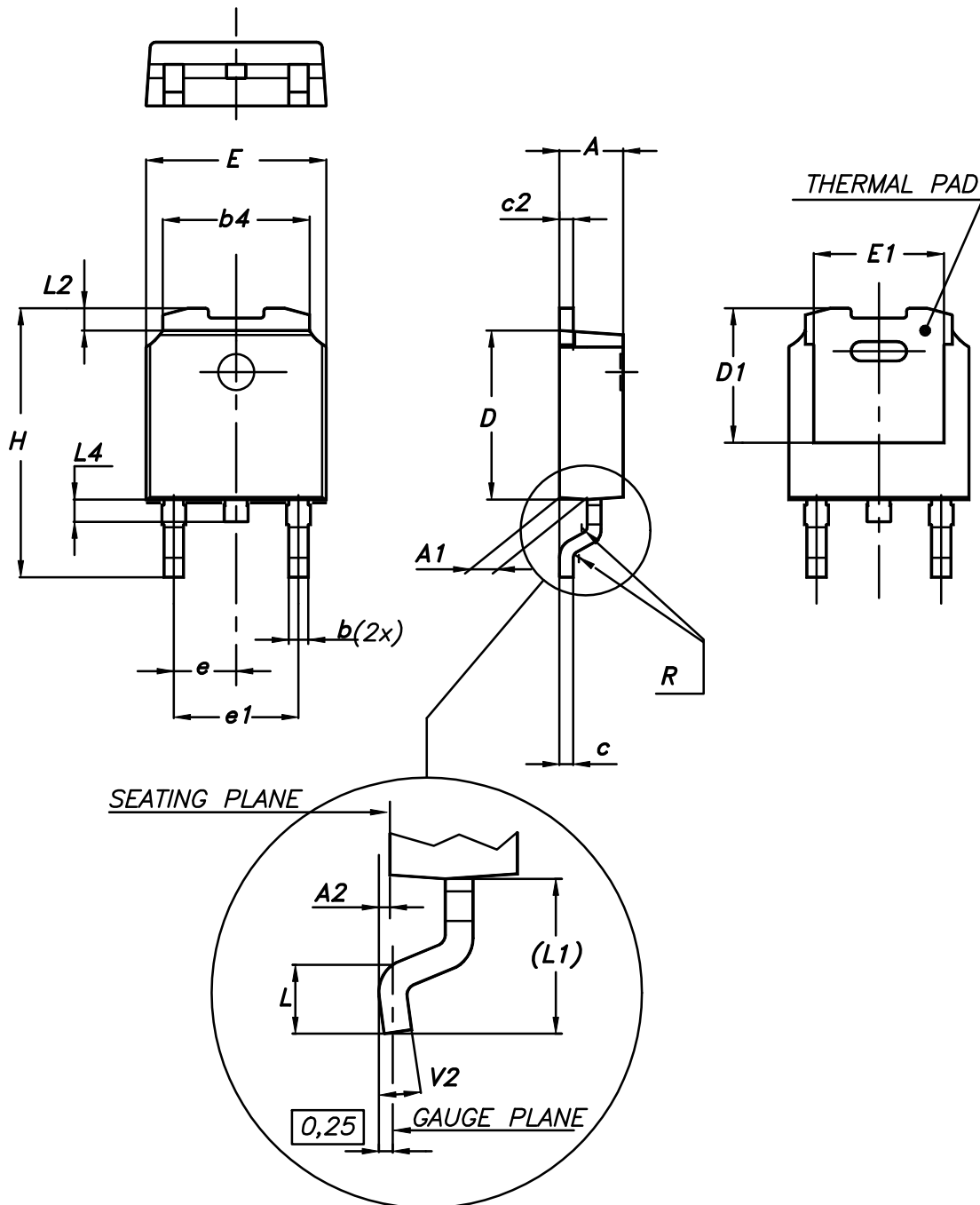
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Table 9. D²PAK tape and reel mechanical data

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	Base quantity Bulk quantity			
P1	11.9	12.1				1000
P2	1.9	2.1				1000
R	50					
T	0.25	0.35				
W	23.7	24.3				

4.3 DPAK (TO-252) type A package information

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



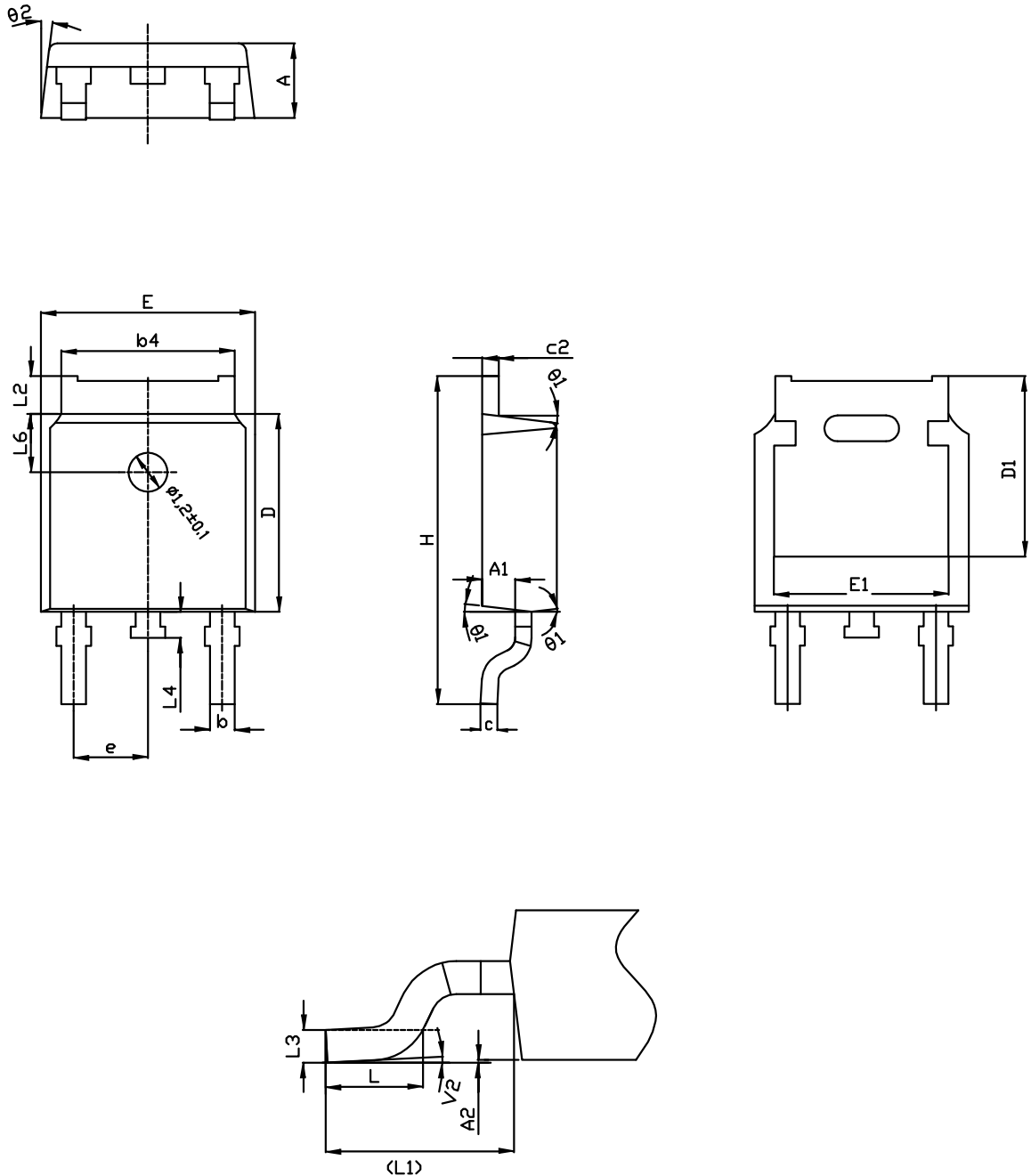
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Table 10. DPAK (TO-252) type A mechanical data

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	2.159	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°

4.4 DPAK (TO-252) type C2 package information

Figure 30. DPAK (TO-252) type C2 package outline



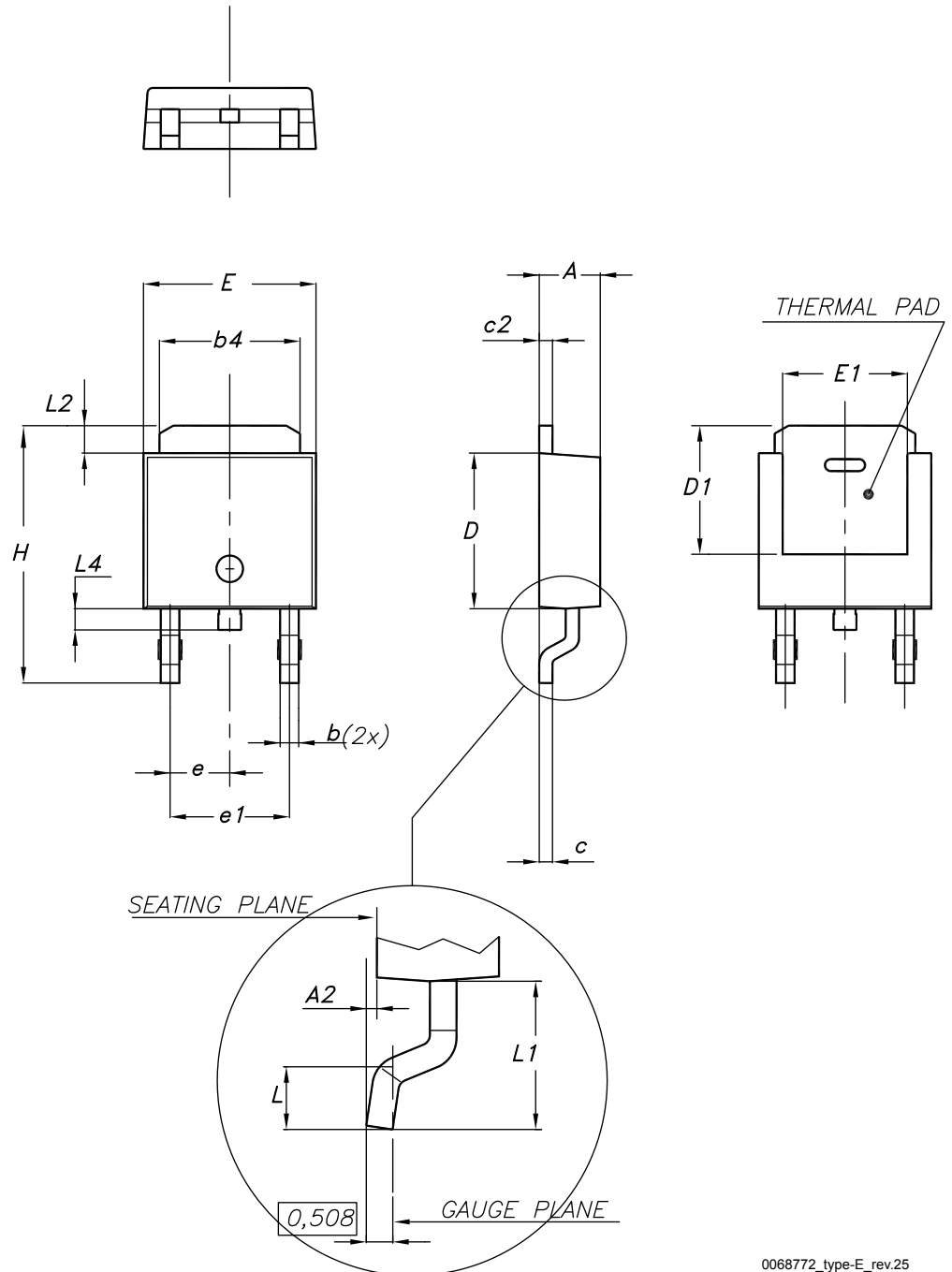
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Table 11. DPAK (TO-252) type C2 mechanical data

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°

4.5 DPAK (TO-252) type E package information

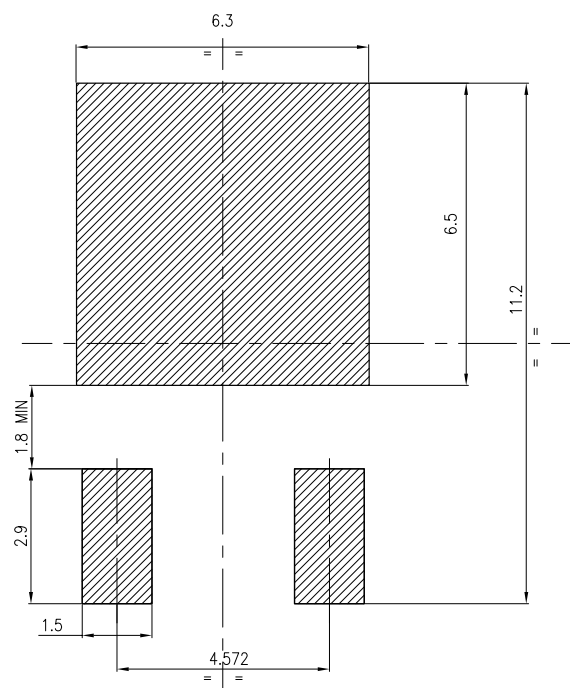
Figure 31. DPAK (TO-252) type E package outline



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

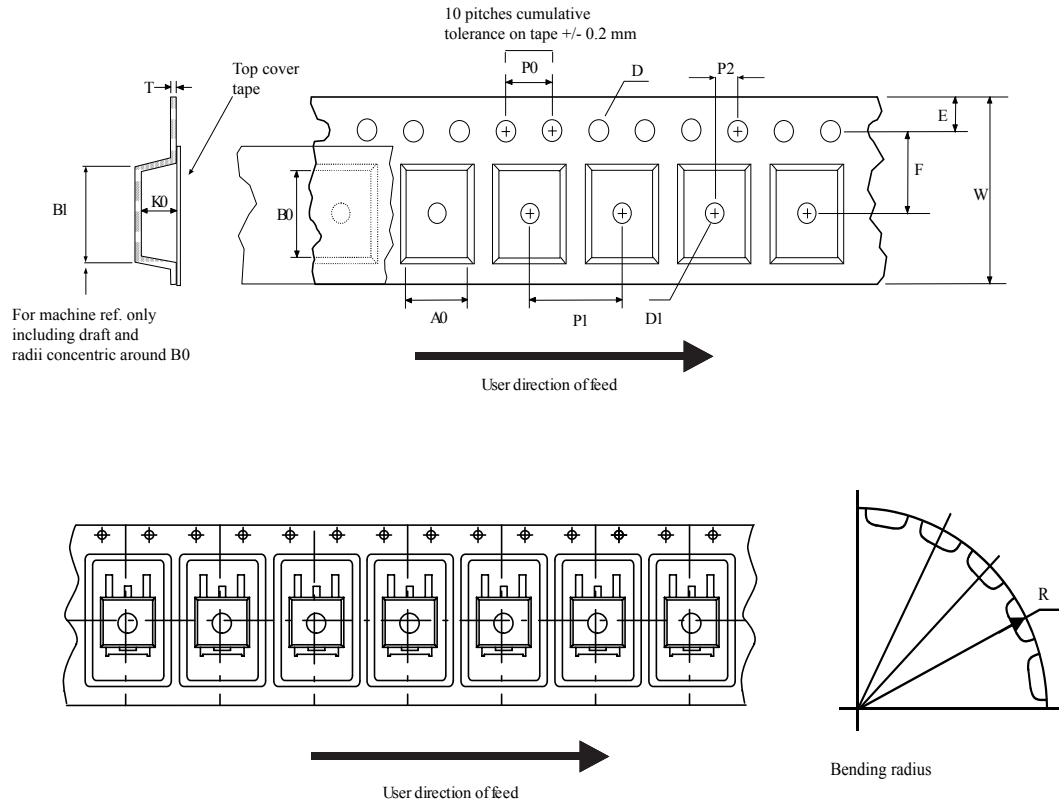
Dim.	mm		
	Min.	Typ.	Max.
A	2.18		2.39
A2			0.13
b	0.65		0.884
b4	4.95		5.46
c	0.46		0.61
c2	0.46		0.60
D	5.97		6.22
D1	5.21		
E	6.35		6.73
E1	4.32		
e		2.286	
e1		4.572	
H	9.94		10.34
L	1.50		1.78
L1		2.74	
L2	0.89		1.27
L4			1.02

Figure 32. DPAK (TO-252) recommended footprint (dimensions are in mm)


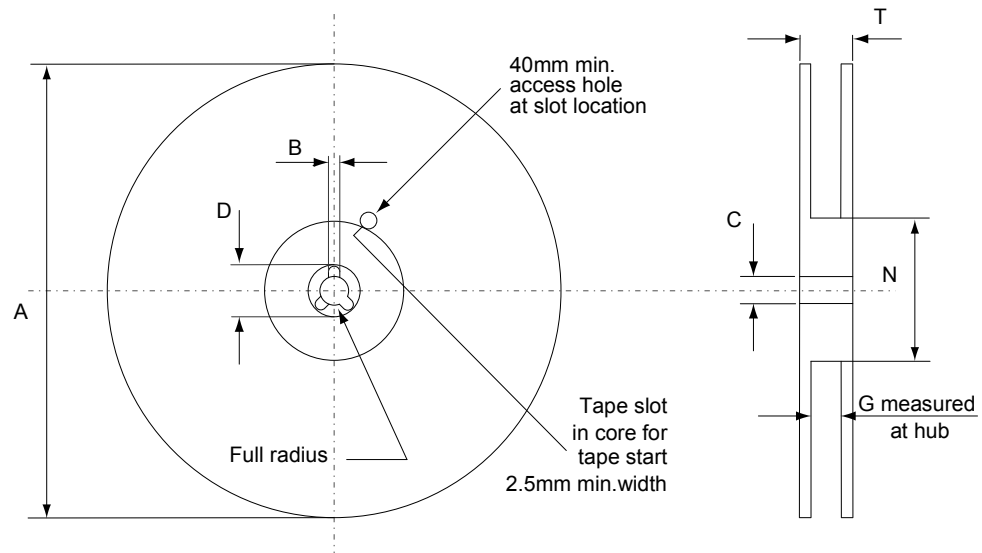
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4.6 DPAK (TO-252) packing information

Figure 33. DPAK (TO-252) tape outline



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Figure 34. DPAK (TO-252) reel outline


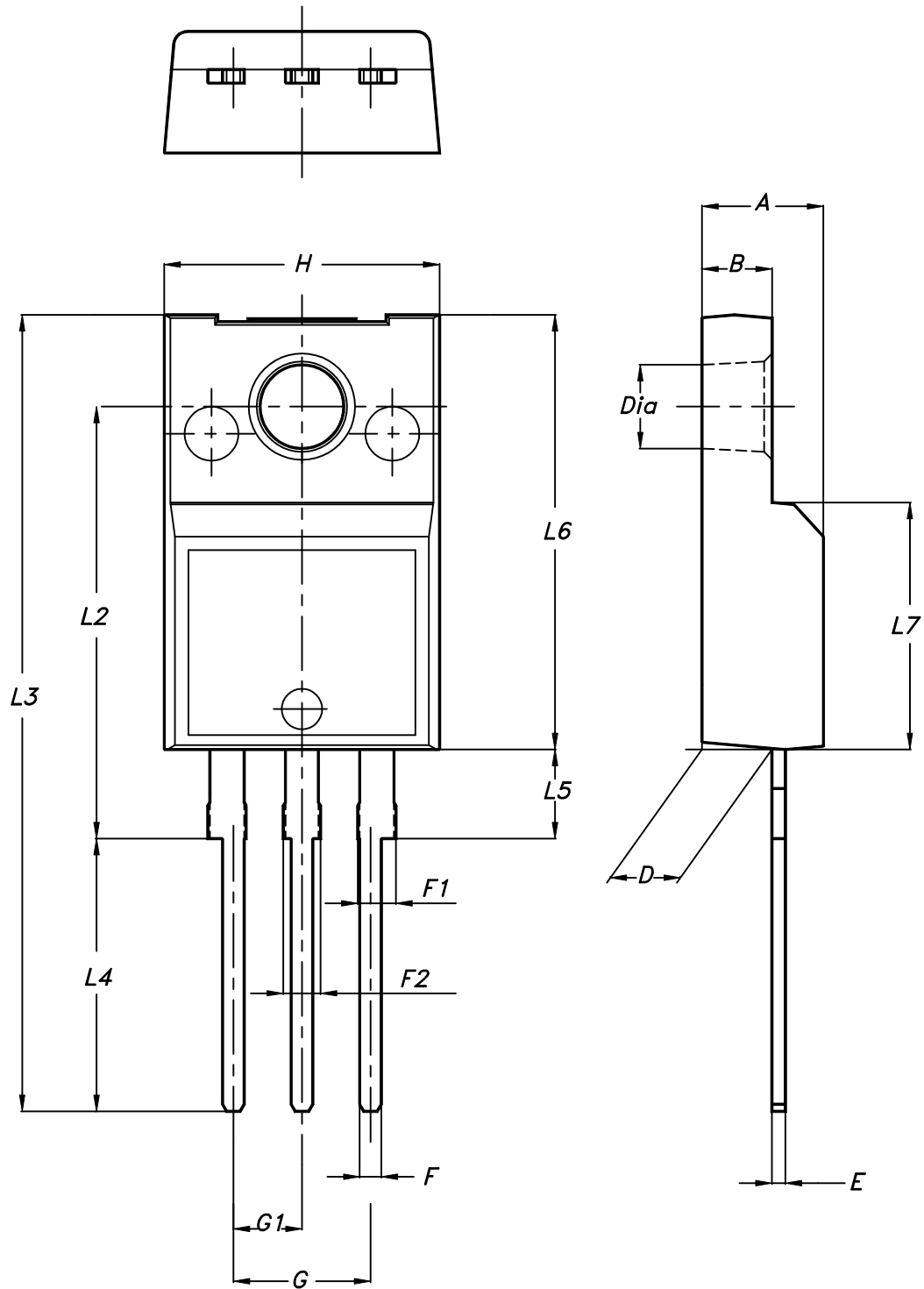
AM06038v1

Table 13. 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			

4.7 TO-220FP package information

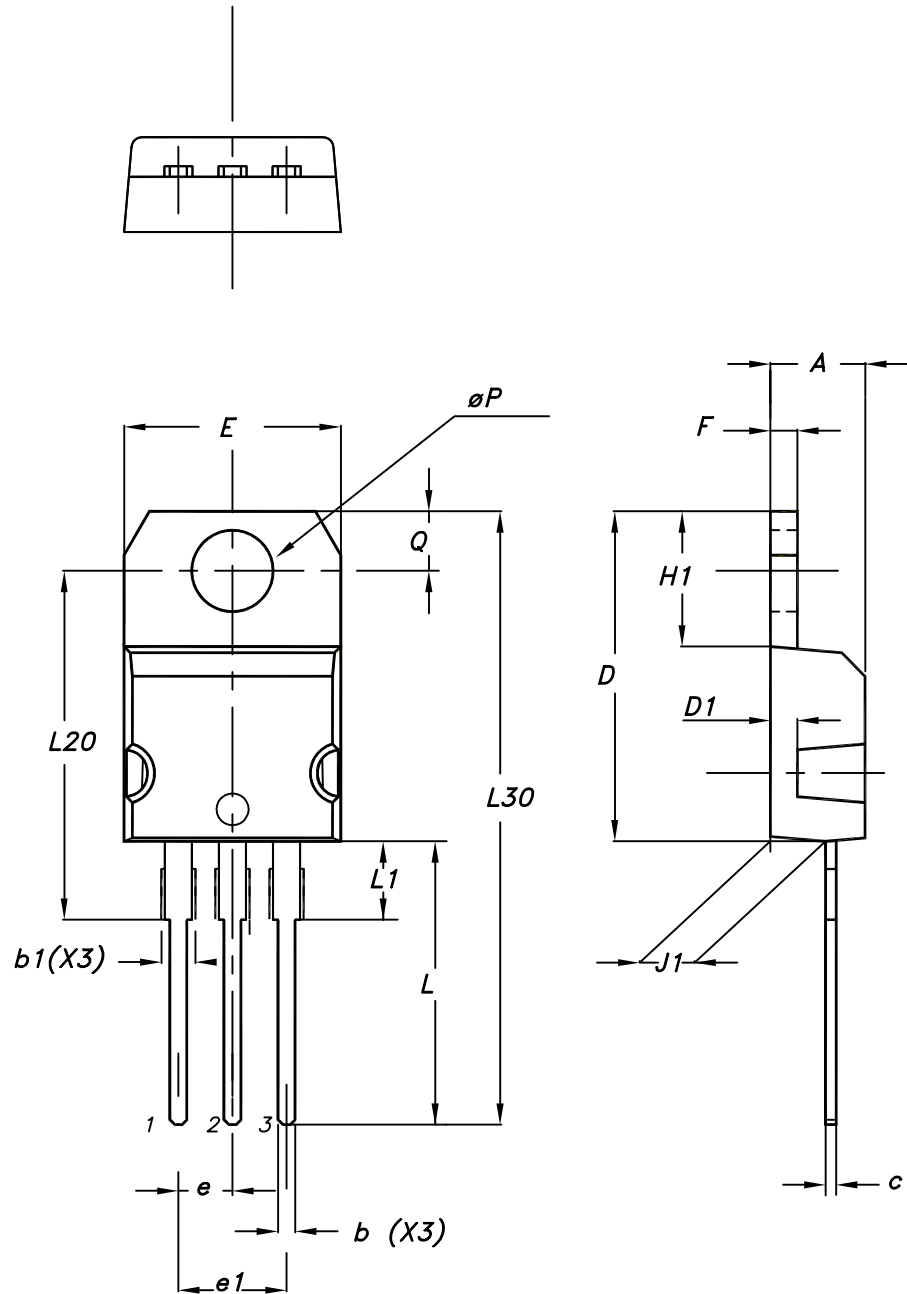
Figure 35. TO-220FP package outline



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Table 14. 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

4.8 TO-220 type A package information
Figure 36. TO-220 type A package outline


0015988_typeA_Rev_21

Table 15. 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

5 Ordering information

Table 16. Order codes

Order code	Marking	Package	Packing
STB11N65M5	11N65M5	D ² PAK	Tape and reel
STD11N65M5		DPAK	
STF11N65M5		TO-220FP	Tube
STP11N65M5		TO-220	

Revision history

Table 17. Document revision history

Date	Version	Changes
23-Feb-2012	1	First release.
03-Dec-2012	2	<ul style="list-style-type: none"> – Minor text changes in cover page – Added IPAK packages – Added <i>Section 2.1: Electrical characteristics (curves)</i> – Updated <i>Section 5: Packaging mechanical data</i> – Modified: <i>note 2</i> on <i>Table 2</i> – Updated: mechanical data for TO-220FP package
02-May-2018	3	<p>The part number STU11N65M5 has been moved to a separate datasheet.</p> <p>Removed maturity status indication from cover page. The document status is production data.</p> <p>Updated title and features in cover page, Section 1 Electrical ratings, Section 2 Electrical characteristics, Section 2.1 Electrical characteristics curves and Section 4 Package information.</p> <p>Minor text changes.</p>

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