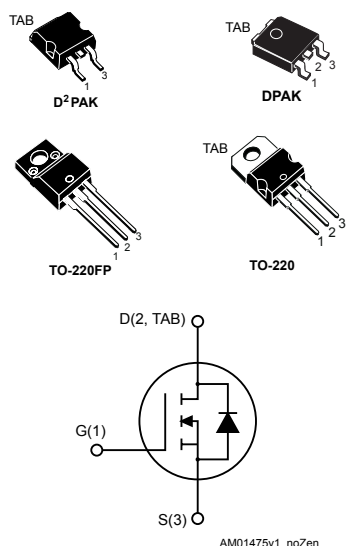


N-channel 650 V, 0.43 Ω typ., 9 A MDmesh™ M5 Power MOSFETs
in a DPAK, D²PAK, TO-220FP and TO-220 packages



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			

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

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

1. 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 °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 mA, V _{GS} = 0 V	650			V
I _{DSS}	Zero gate voltage drain current	V _{GS} = 0 V, V _{DS} = 650 V			1	μA
		V _{GS} = 0 V, V _{DS} = 650 V, T _C = 125 °C ⁽¹⁾			100	μA
I _{GSS}	Gate body leakage current	V _{DS} = 0 V, V _{GS} = ±25 V			±100	nA
V _{GS(th)}	Gate threshold voltage	V _{DS} = V _{GS} , I _D = 250 μA	3	4	5	V
R _{DS(on)}	Static drain-source on resistance	V _{GS} = 10 V, I _D = 4.5 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 V, f = 1 MHz, V _{GS} = 0 V	-	644	-	pF
C _{oss}	Output capacitance			18		
C _{rss}	Reverse transfer capacitance			2.5		
C _{o(tr)} ⁽¹⁾	Equivalent capacitance time related	V _{DS} = 0 to 520 V, V _{GS} = 0 V	-	55	-	pF
C _{o(er)} ⁽²⁾	Equivalent capacitance energy related		-	17	-	pF
R _g	Gate input resistance	f = 1 MHz open drain	-	5	-	Ω
Q _g	Total gate charge	V _{DD} = 520 V, I _D = 4.5 A,	-	17	-	nC
Q _{gs}	Gate-source charge	V _{GS} = 0 to 10 V		4.6		
Q _{gd}	Gate-drain charge	(see Figure 20. Test circuit for gate charge behavior)		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 V, I _D = 7.5 A, R _G = 4.7 Ω, V _{GS} = 10 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	$I_{SD} = 9\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$ (see Figure 21. Test circuit for inductive load switching and diode recovery times)	-	232		ns
Q_{rr}	Reverse recovery charge			2		μC
I_{RRM}	Reverse recovery current			17.5		A
t_{rr}	Reverse recovery time	$I_{SD} = 9\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 21. Test circuit for inductive load switching and diode recovery times)	-	328		ns
Q_{rr}	Reverse recovery charge			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

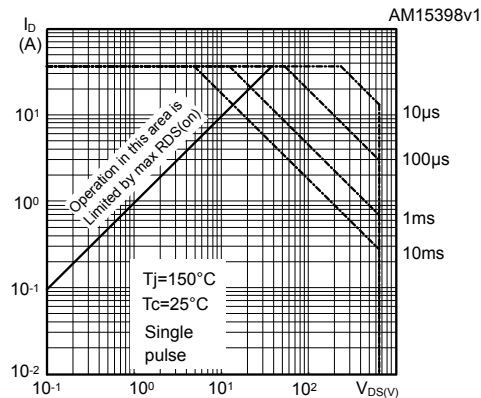
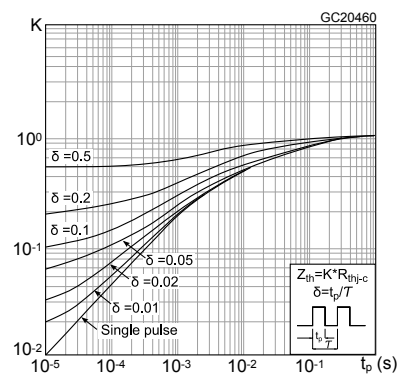
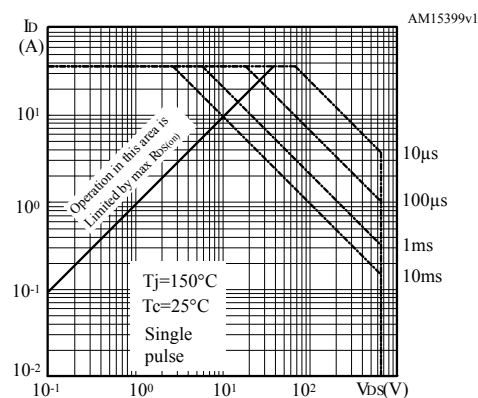
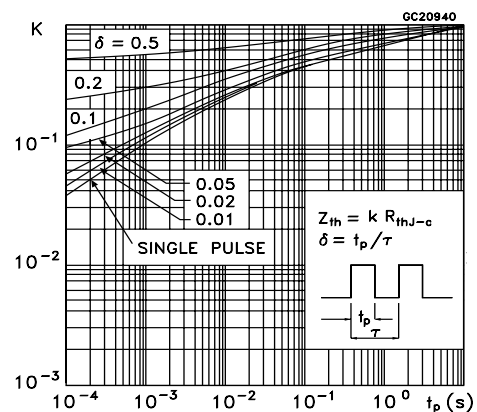
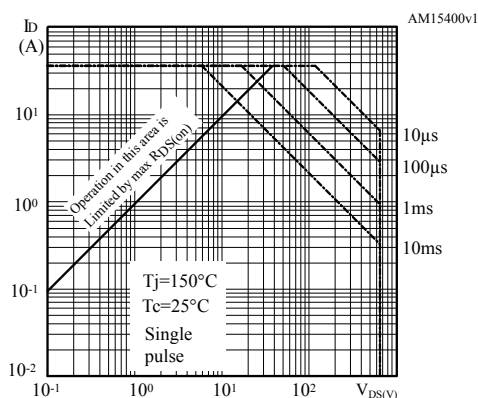
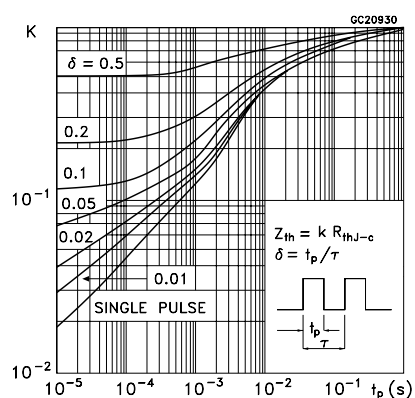
Figure 1. Safe operating area for DPAK

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


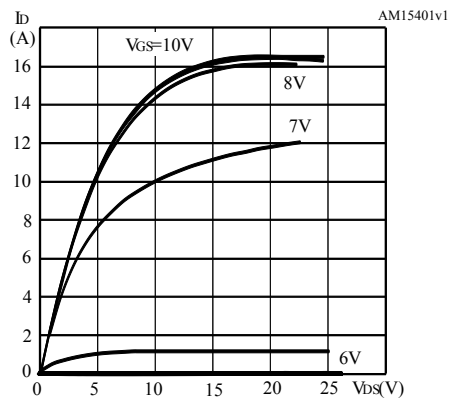
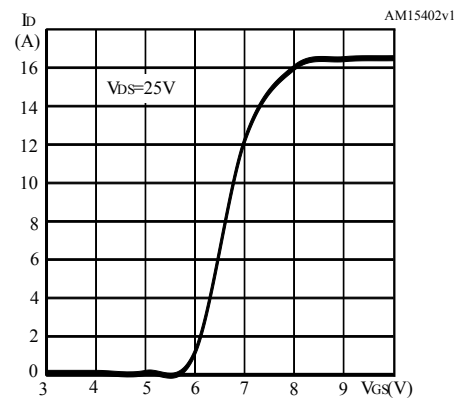
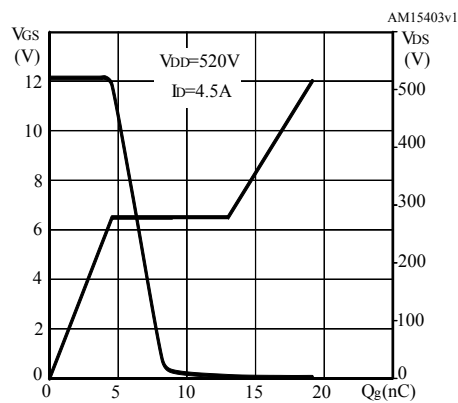
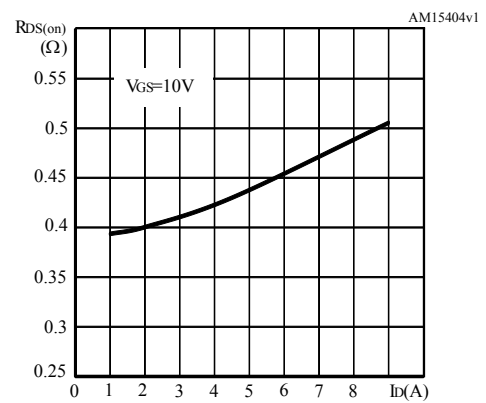
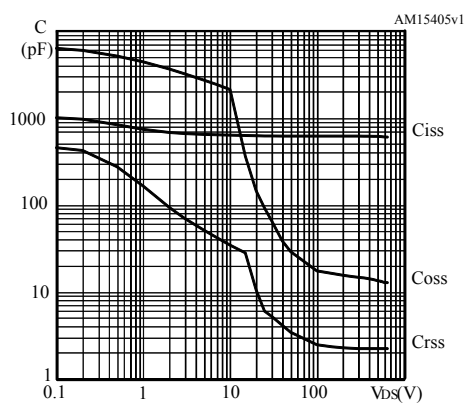
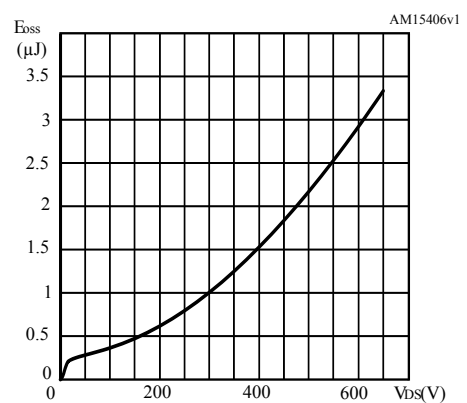
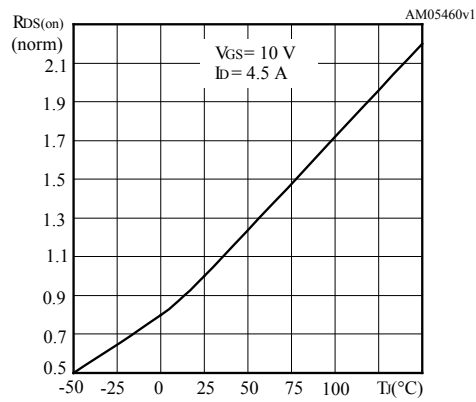
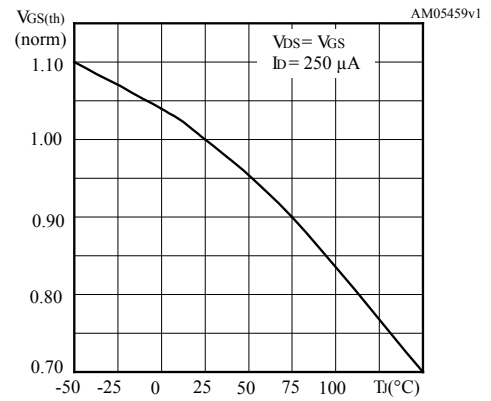
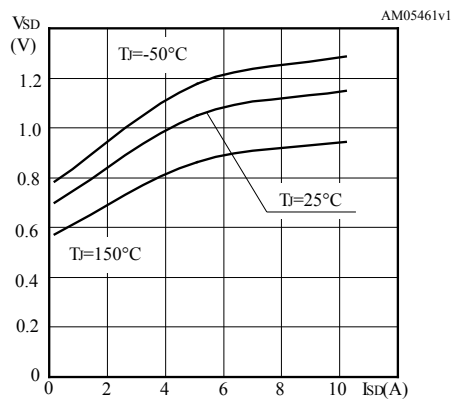
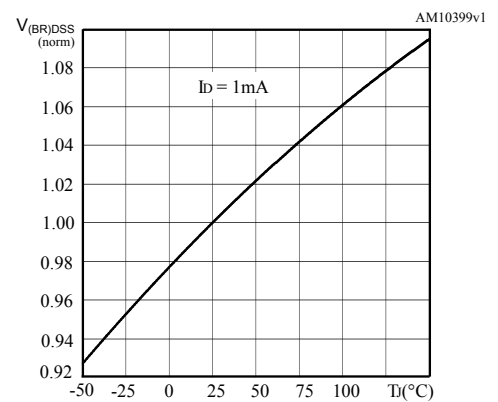
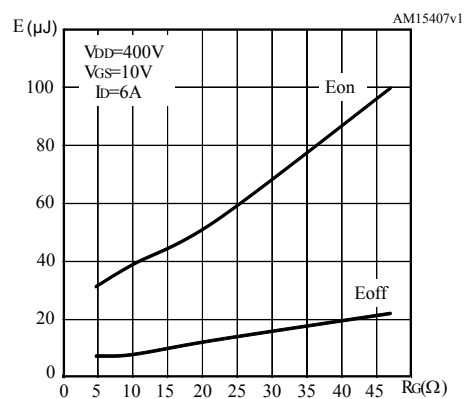
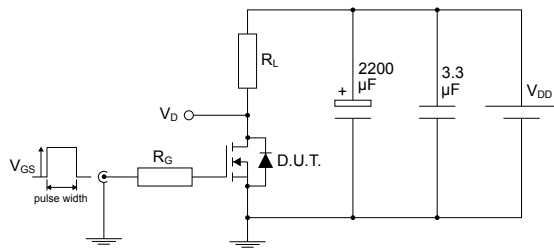
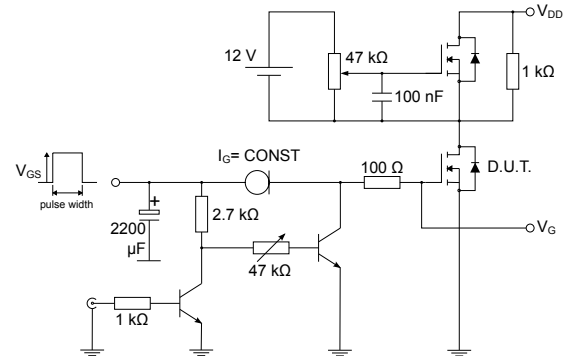
Figure 8. Output characteristics

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


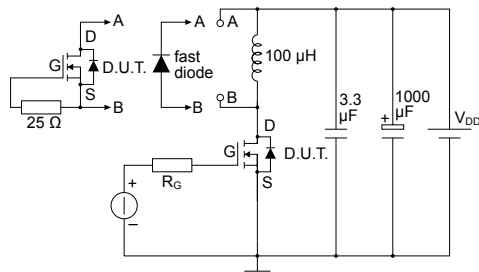
3 Test circuits

Figure 19. Test circuit for resistive load switching times


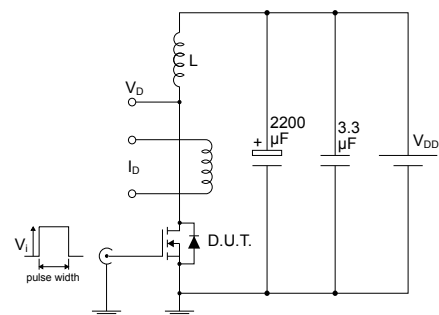
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Figure 20. Test circuit for gate charge behavior


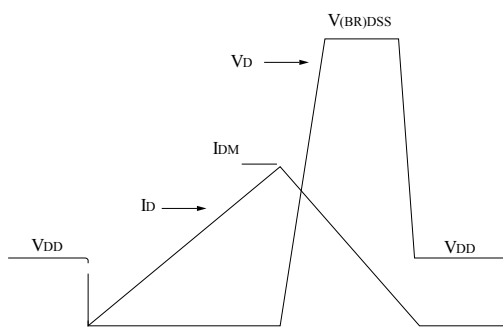
AM01469v1

Figure 21. Test circuit for inductive load switching and diode recovery times


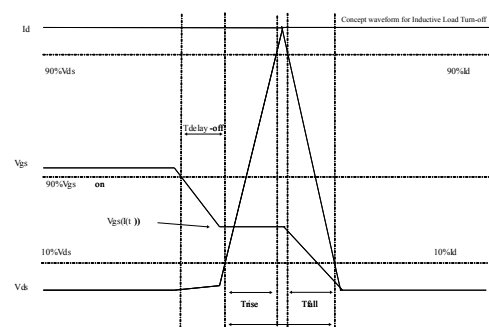
AM01470v1

Figure 22. Unclamped inductive load test circuit


AM01471v1

Figure 23. Unclamped inductive waveform


AM01472v1

Figure 24. Switching time waveform


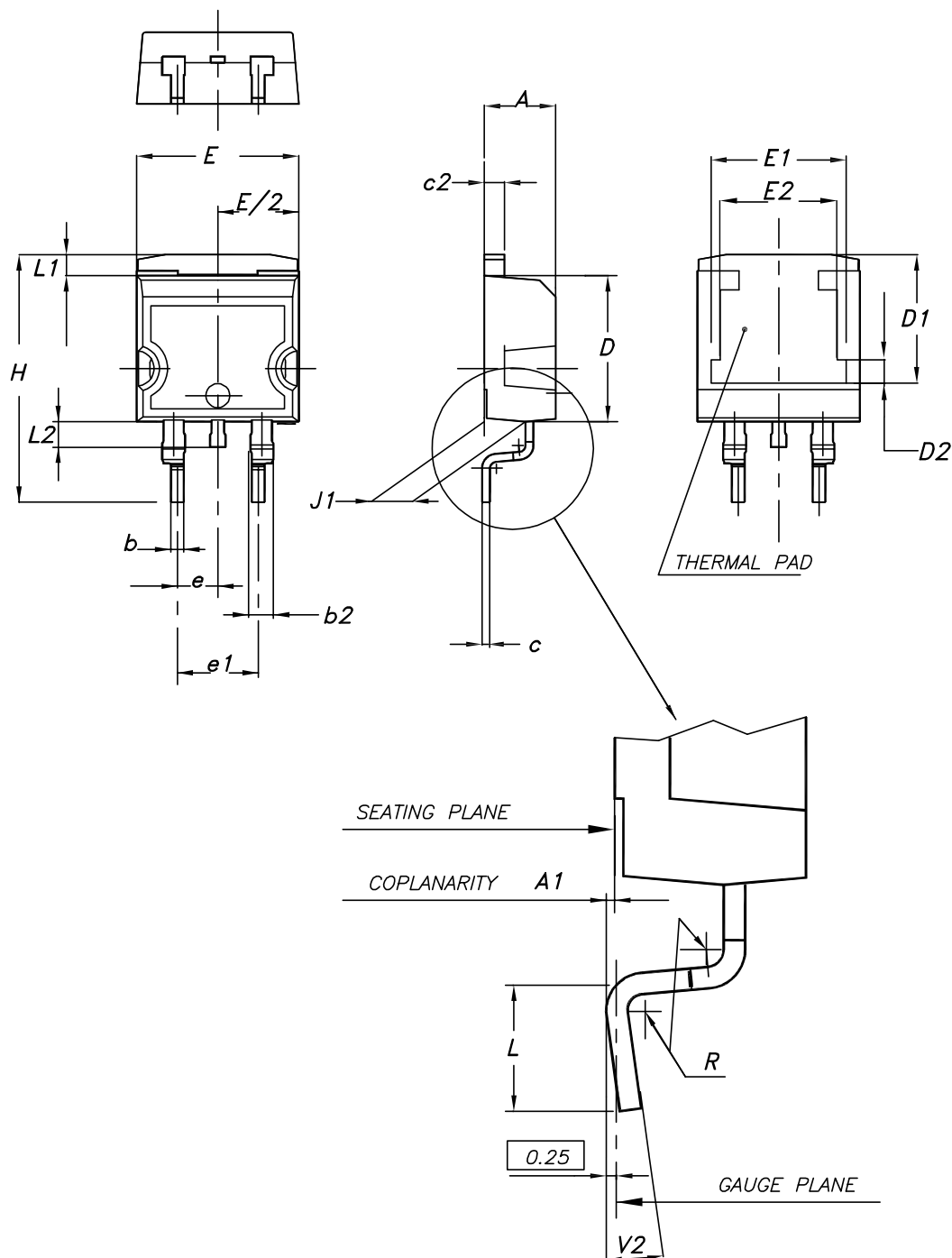
AM05540v2_for_M5

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

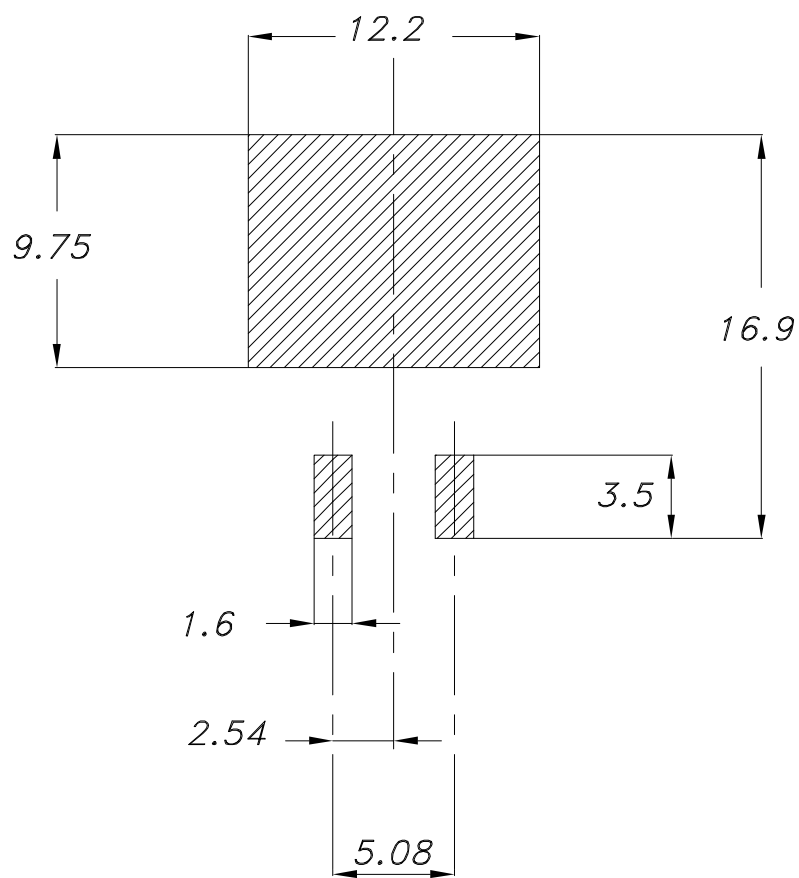


0079457_25

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°

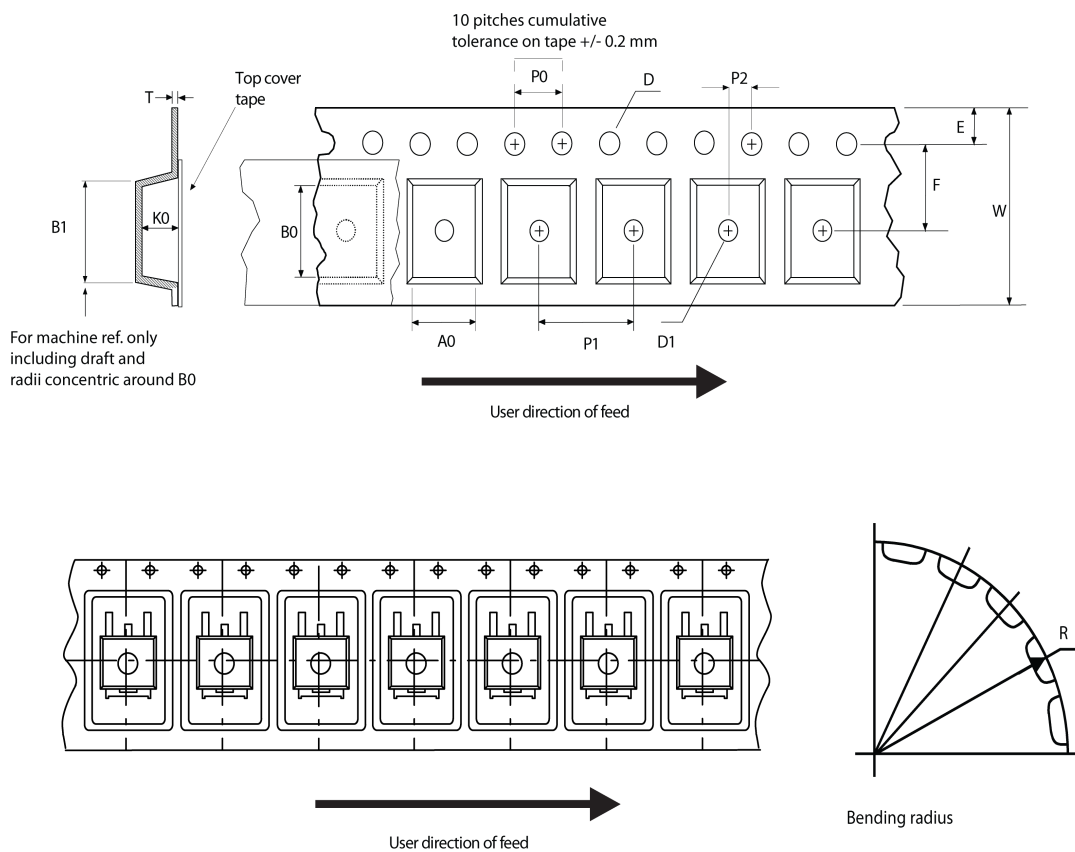
Figure 26. D²PAK (TO-263) recommended footprint (dimensions are in mm)



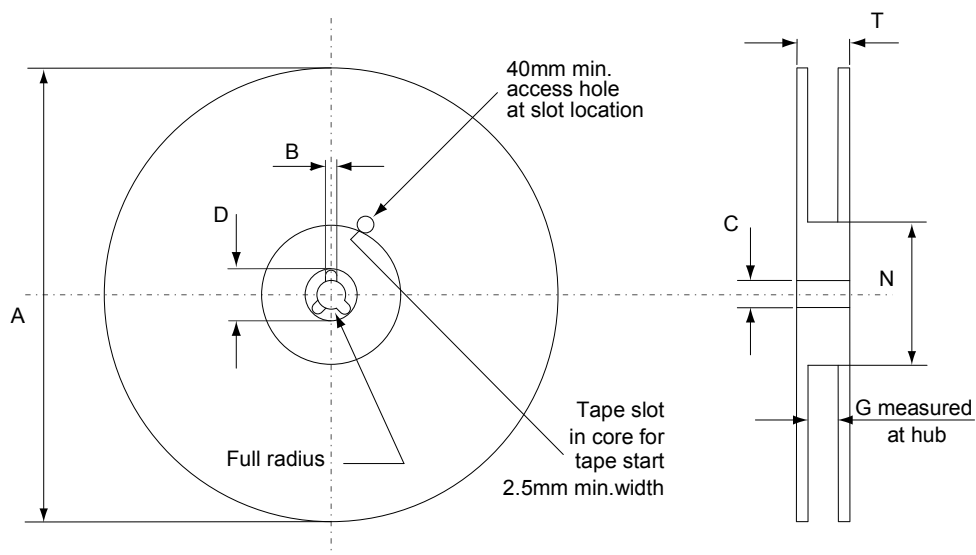
Footprint

4.2 D²PAK packing information

Figure 27. D²PAK tape outline



AM08852v1

Figure 28. D²PAK reel outline


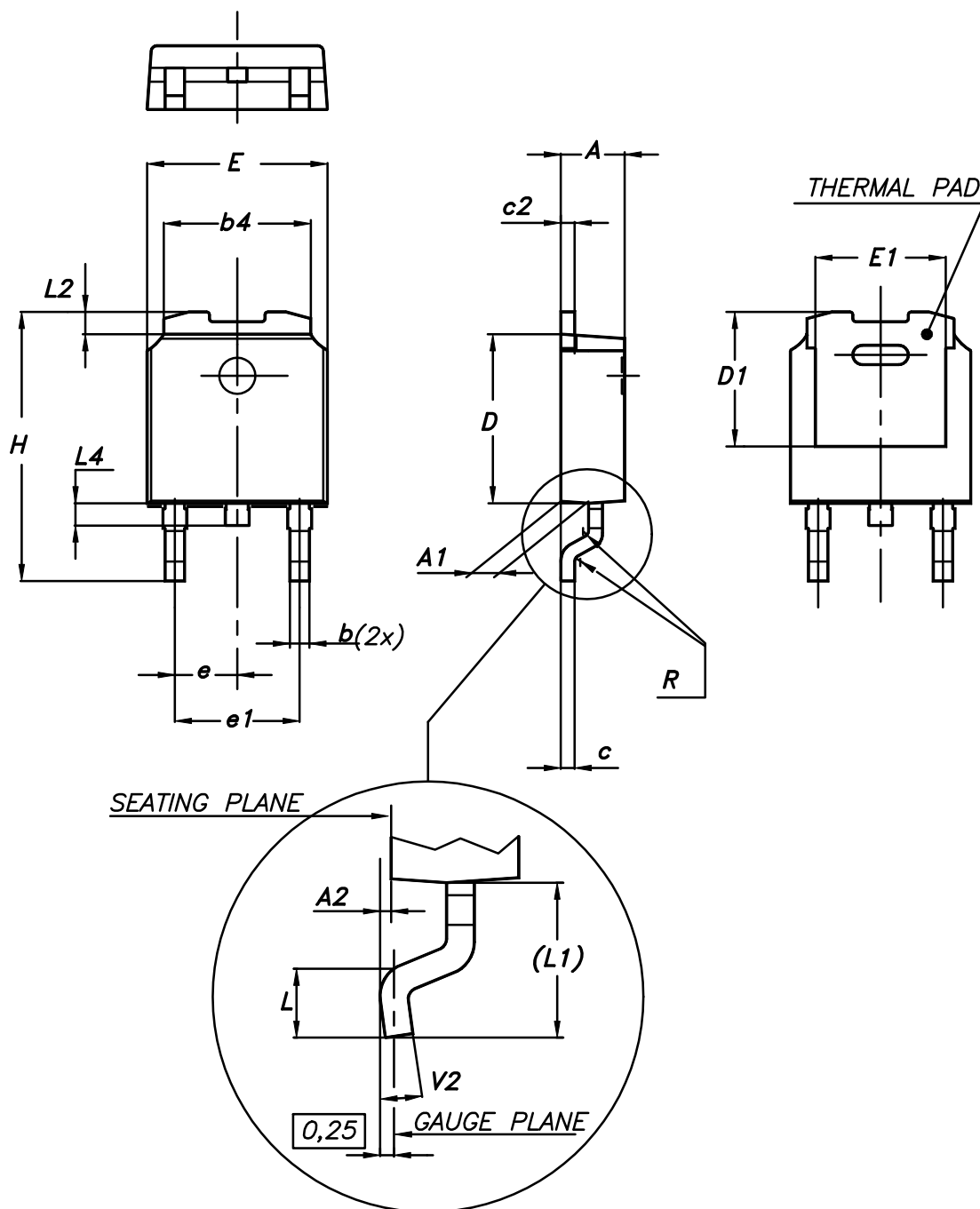
AM06038v1

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			
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 DPAK (TO-252) type A package information

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



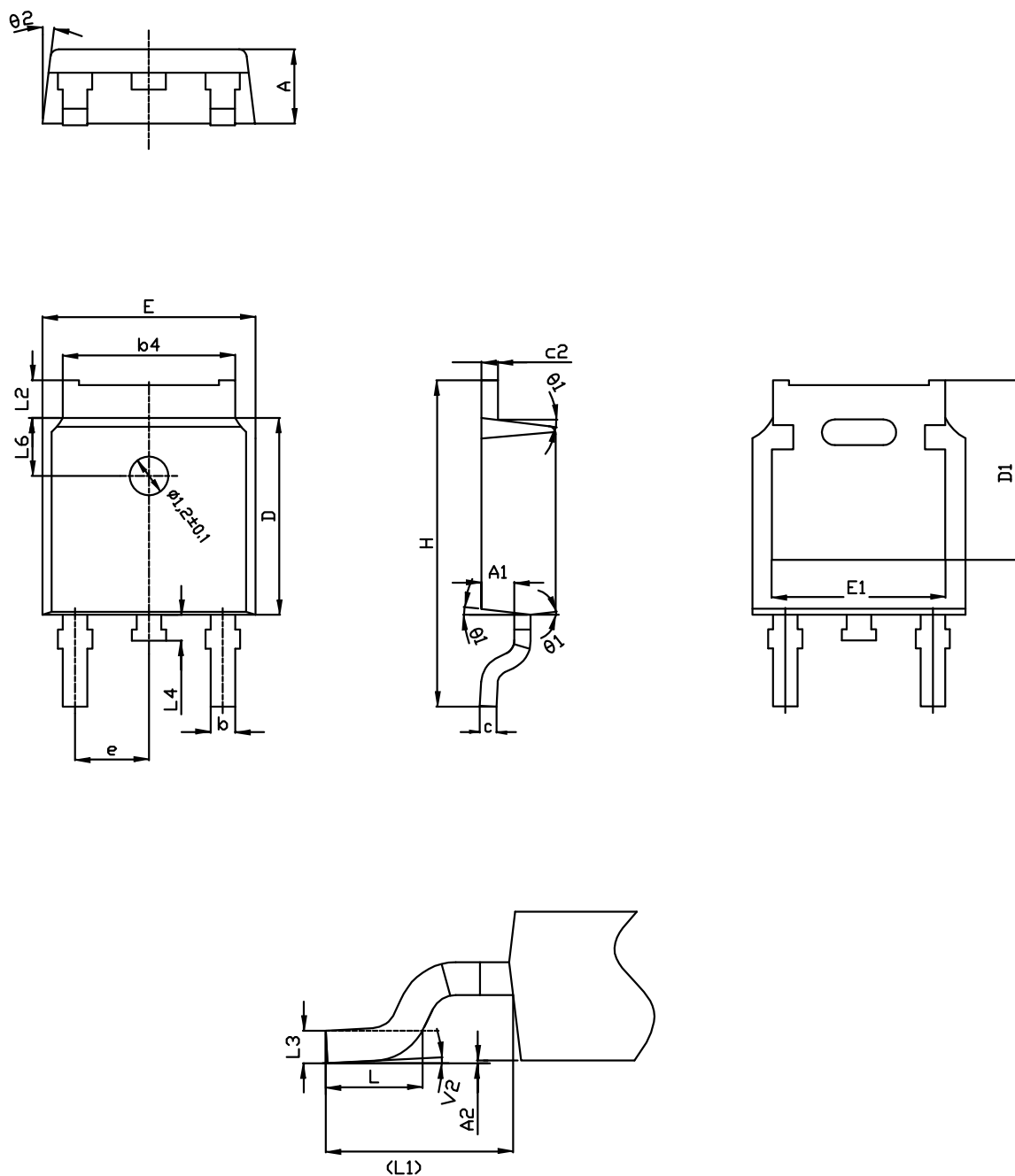
0068772_A_25

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



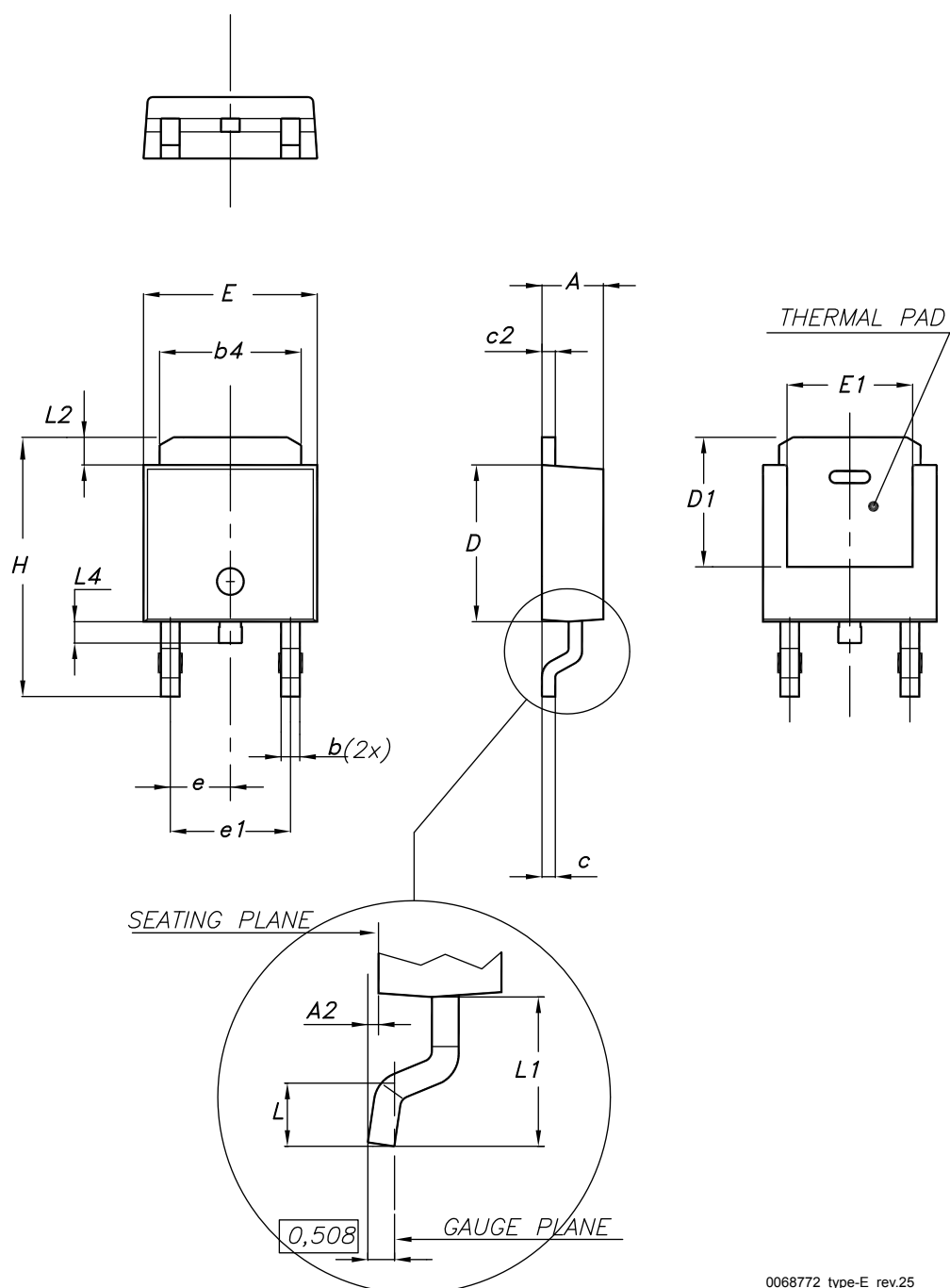
0068772_C2_25

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

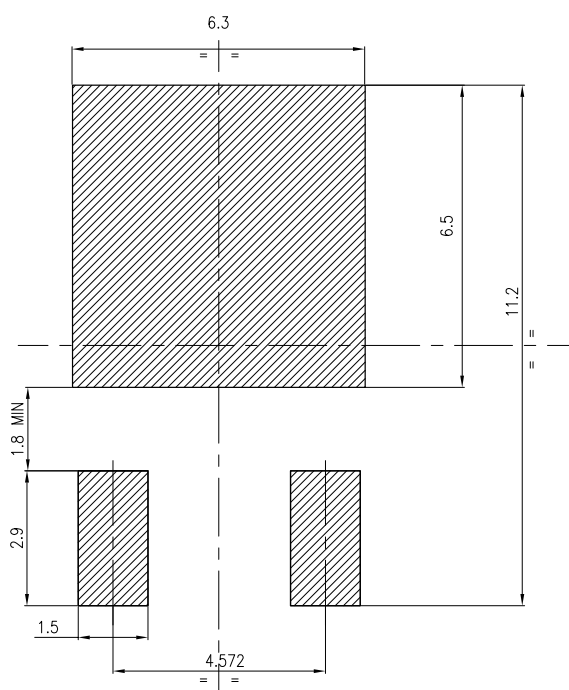
Figure 31. DPAK (TO-252) type E package outline



0068772_type-E_rev.25

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

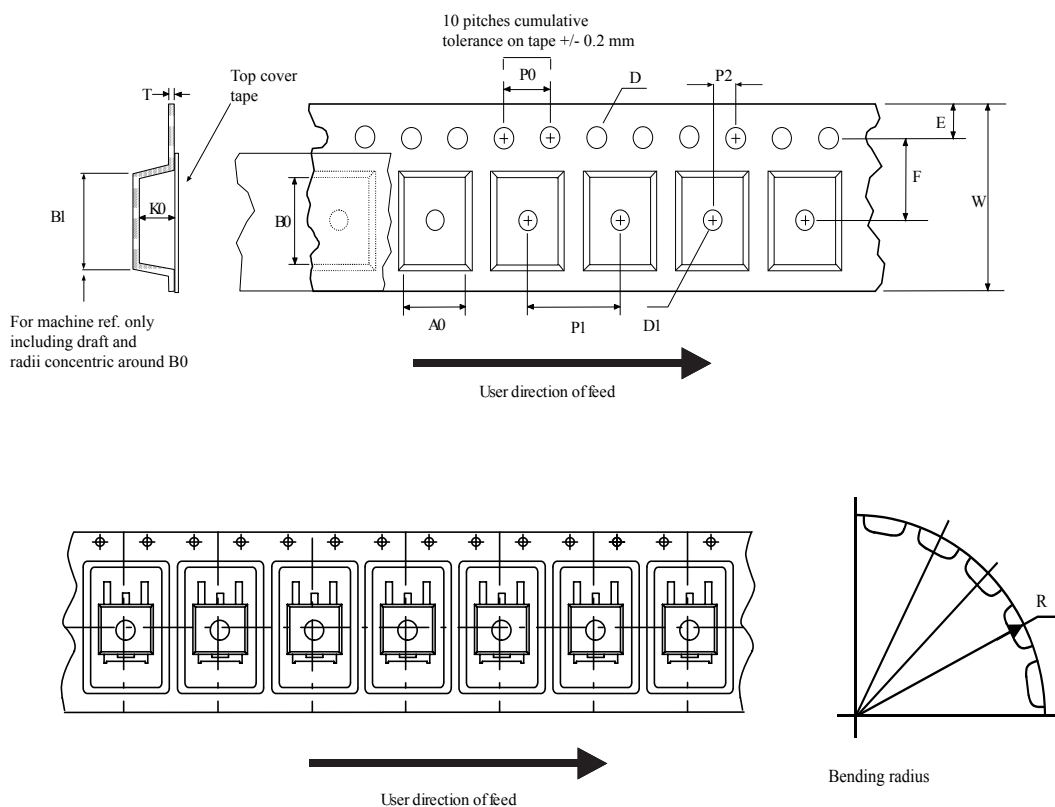
Dim.	mm		
	Min.	Typ.	Max.
A	2.18		2.39
A2			0.13
b	0.65		0.884
b4	4.95		5.46
c	0.46		0.61
c2	0.46		0.60
D	5.97		6.22
D1	5.21		
E	6.35		6.73
E1	4.32		
e		2.286	
e1		4.572	
H	9.94		10.34
L	1.50		1.78
L1		2.74	
L2	0.89		1.27
L4			1.02

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


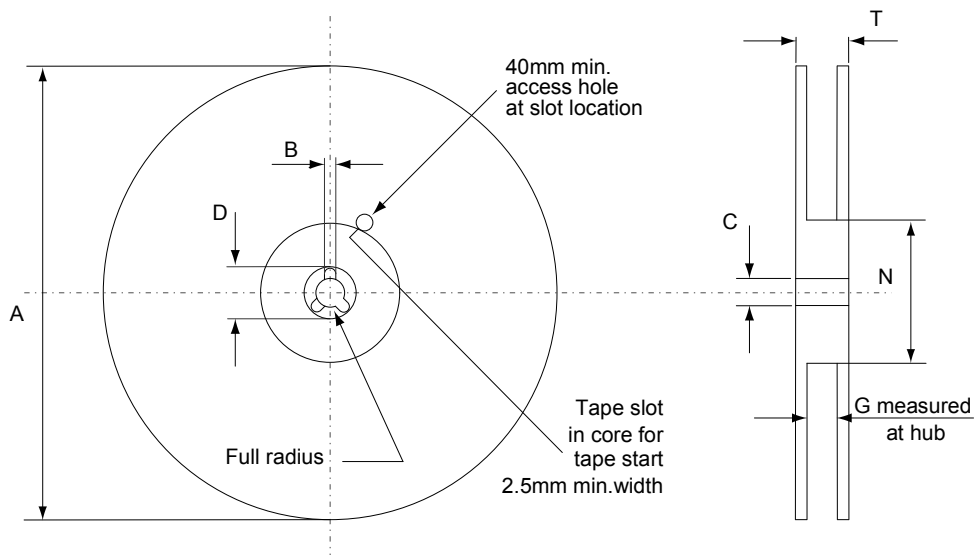
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4.6 DPAK (TO-252) packing information

Figure 33. DPAK (TO-252) tape outline



AM08852v1

Figure 34. DPAK (TO-252) reel outline


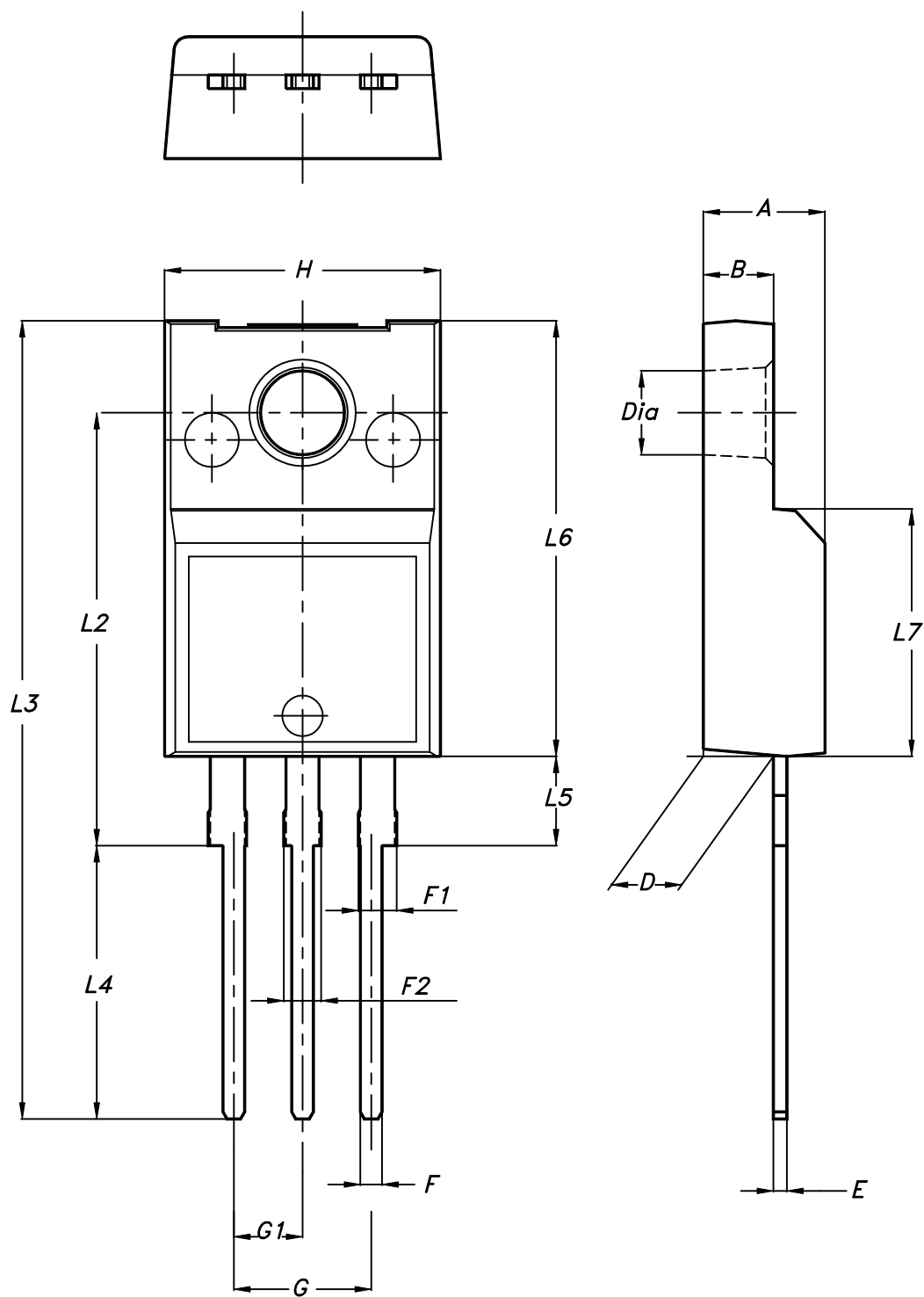
AM06038v1

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



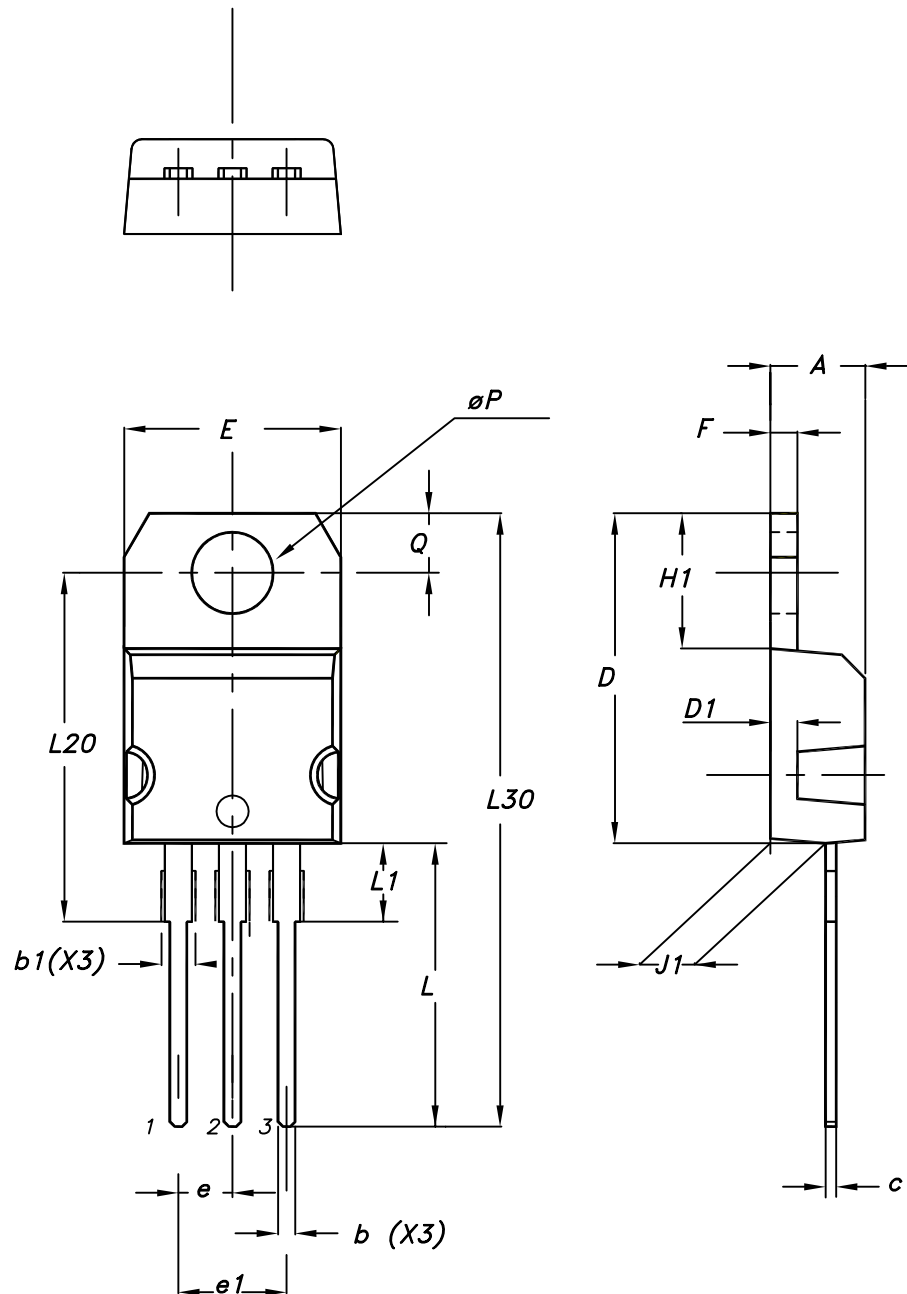
7012510_Rev_12_B

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	– 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	The part number STU11N65M5 has been moved to a separate datasheet. Removed maturity status indication from cover page. The document status is production data. 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. Minor text changes.

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