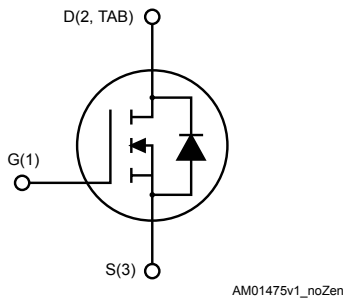
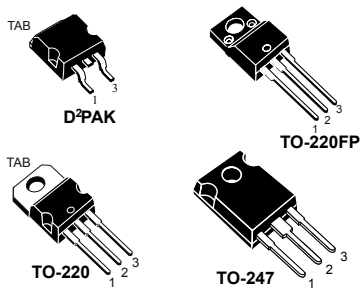


N-channel 650 V, 0.124 Ω , 22 A, MDmesh M5 Power MOSFETs in D²PAK, TO-220FP, TO-220 and TO-247 packages



Features

Order code	$V_{DS} @ T_{JMAX}$	$R_{DS(on)}$ max.	I_D	Package
STB31N65M5	710 V	0.148 Ω	22 A	D ² PAK
STF31N65M5				TO-220FP
STP31N65M5				TO-220
STW31N65M5				TO-247

- 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 MOSFETs 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 link

[STB31N65M5](#)

[STF31N65M5](#)

[STP31N65M5](#)

[STW31N65M5](#)

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D ² PAK, TO-220, TO-247	TO-220FP	
V _{GS}	Gate-source voltage	±25		V
I _D	Drain current (continuous) at T _C = 25 °C	22	22 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100 °C	13.9	13.9 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	88	88 ⁽¹⁾	A
P _{TOT}	Total power dissipation at T _C = 25 °C	150	30	W
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat-sink (t = 1 s, T _C = 25 °C)		2500	V
dv/dt ⁽³⁾	Peak diode recovery voltage slope	15		V/ns
dv/dt ⁽⁴⁾	MOSFET dv/dt ruggedness	50		
T _J	Operating junction temperature range	-55 to 150		°C
T _{stg}	Storage temperature range			

1. Limited by package.
2. Limited by maximum junction temperature.
3. $I_{SD} \leq 22$ A, $di/dt \leq 400$ A/ μ s; V_{DS} (peak) < $V_{(BR)DSS}$; $V_{DD} = 400$ V.
4. $V_{DS} \leq 480$ V.

Table 2. Thermal data

Symbol	Parameter	Value				Unit
		D ² PAK	TO-220	TO-220FP	TO-247	
R _{thj-case}	Thermal resistance junction-case	0.83		4.17	0.83	°C/W
R _{thj-amb}	Thermal resistance junction-ambient		62.5		50	°C/W
R _{thj-pcb} ⁽¹⁾	Thermal resistance junction-pcb	30				°C/W

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

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by T_{jmax})	5	A
E_{AS}	Single pulse avalanche energy (starting $T_j = 25\text{ °C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$)	410	mJ

2 Electrical characteristics

$T_C = 25\text{ }^\circ\text{C}$ unless otherwise specified

Table 4. On/off-state

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}, I_D = 1\text{ mA}$	650			V
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0\text{ V}, V_{DS} = 650\text{ V}$			1	μA
		$V_{GS} = 0\text{ V}, V_{DS} = 650\text{ V},$ $T_C = 125\text{ }^\circ\text{C}$ ⁽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	$V_{GS} = 10\text{ V}, I_D = 11\text{ A}$		0.124	0.148	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	$V_{DS} = 100\text{ V}, f = 1\text{ MHz},$ $V_{GS} = 0\text{ V}$	-	1865	-	pF
C_{oss}	Output capacitance		-	45	-	pF
C_{rss}	Reverse transfer capacitance		-	4.2	-	pF
$C_{o(tr)}$ ⁽¹⁾	Equivalent capacitance time related	$V_{GS} = 0\text{ V},$	-	146	-	pF
$C_{o(er)}$ ⁽²⁾	Equivalent capacitance energy related	$V_{DS} = 0\text{ to } 520\text{ V}$	-	43	-	pF
R_g	Intrinsic gate resistance	$f = 1\text{ MHz}$	-	2.8	-	Ω
Q_g	Total gate charge	$V_{DD} = 520\text{ V}, I_D = 11\text{ A}$	-	45	-	nC
Q_{gs}	Gate-source charge	$V_{GS} = 0\text{ to } 10\text{ V}$	-	11.5	-	nC
Q_{gd}	Gate-drain charge	(see Figure 18. Test circuit for gate charge behavior)	-	20	-	nC

- $C_{o(tr)}$ 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} .
- $C_{o(er)}$ 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 conditions	Min.	Typ.	Max.	Unit
$t_{d(v)}$	Voltage delay time	$V_{DD} = 400\text{ V}$, $I_D = 14\text{ A}$,	-	46	-	ns
$t_{r(v)}$	Voltage rise time	$R_G = 4.7\ \Omega$	-	8	-	ns
$t_{f(i)}$	Current fall time	$V_{GS} = 10\text{ V}$	-	8.5	-	ns
$t_{c(off)}$	Crossing time	(see Figure 19. Test circuit for inductive load switching and diode recovery times and Figure 22. Switching time waveform)	-	11	-	ns

Table 7. Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		22	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		88	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 22\text{ A}$, $V_{GS} = 0\text{ V}$	-		1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 22\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 100\text{ V}$ (see Figure 19. Test circuit for inductive load switching and diode recovery times)	-	336		ns
Q_{rr}	Reverse recovery charge		-	5		μC
I_{RRM}	Reverse recovery current		-	30		A
t_{rr}	Reverse recovery time	$I_{SD} = 22\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$,	-	406		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 100\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 19. Test circuit for inductive load switching and diode recovery times)	-	6		μC
I_{RRM}	Reverse recovery current		-	31		A

1. Pulse width limited by safe operating area

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

2.1 Electrical characteristics (curves)

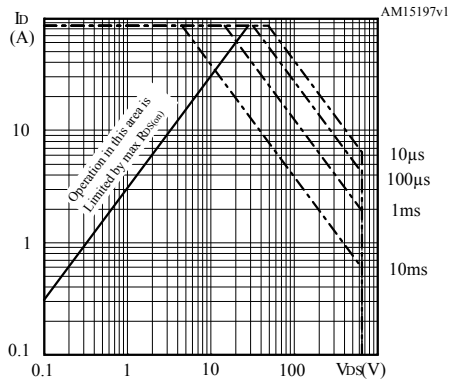
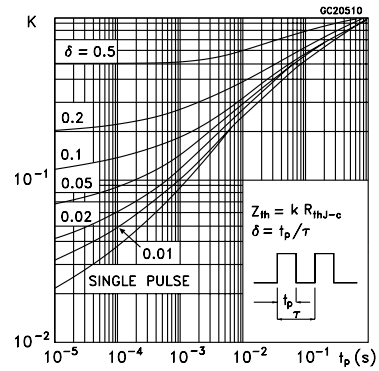
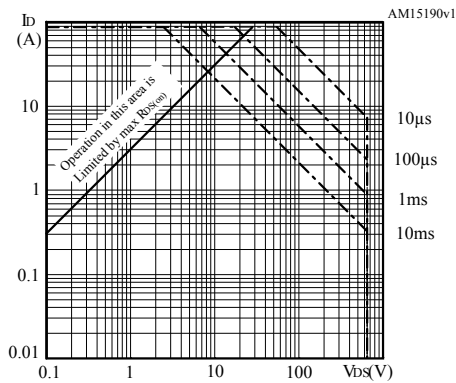
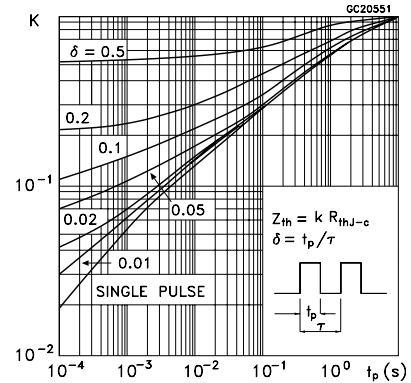
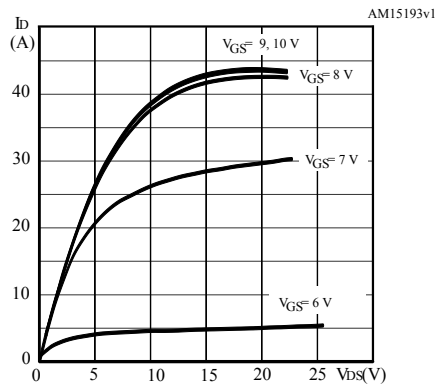
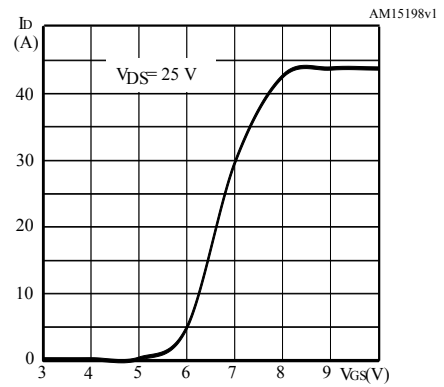
Figure 1. Safe operating area for D²PAK, TO-220 and TO-247

Figure 2. Thermal impedance for D²PAK, TO-220 and TO-247

Figure 3. Safe operating area for TO-220FP

Figure 4. Thermal impedance for TO-220FP

Figure 5. Output characteristics

Figure 6. Transfer characteristics


Figure 7. Gate charge vs gate-source voltage

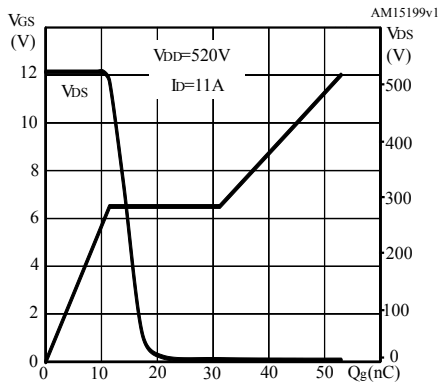


Figure 8. Static drain-source on-resistance

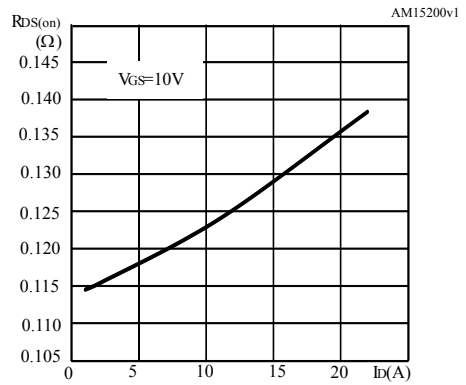


Figure 9. Capacitance variations

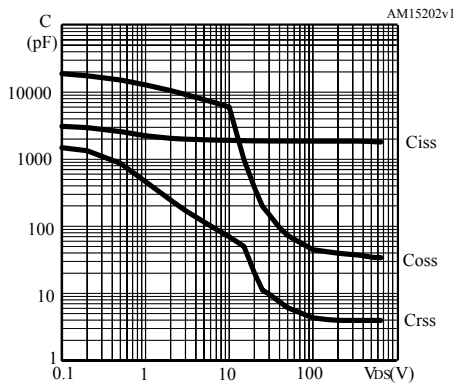


Figure 10. Output capacitance stored energy

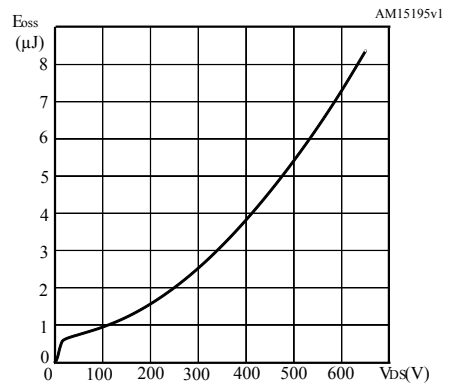


Figure 11. Normalized gate threshold voltage vs temperature

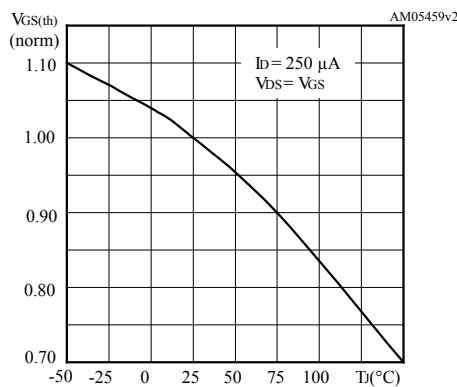


Figure 12. Normalized on-resistance vs temperature

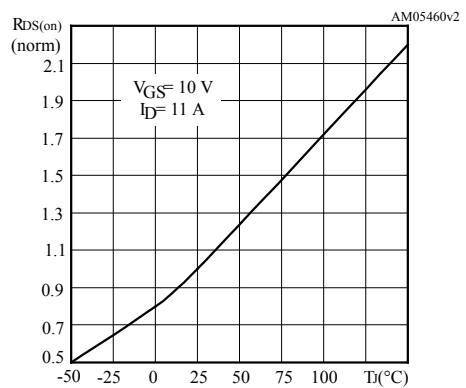
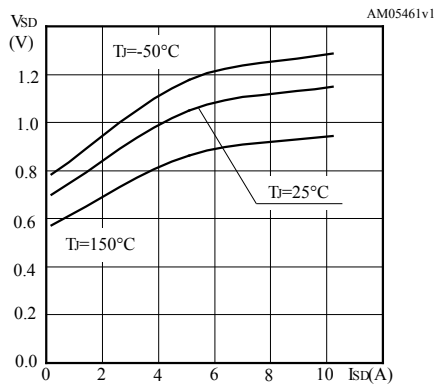
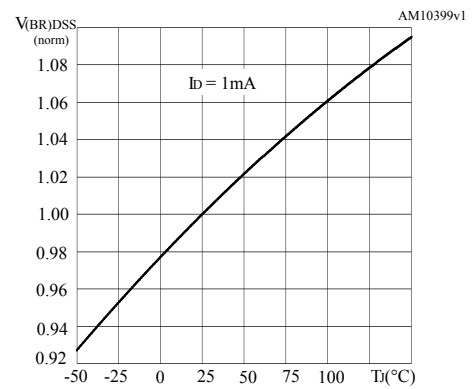
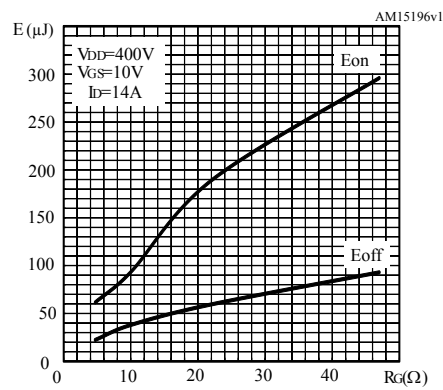
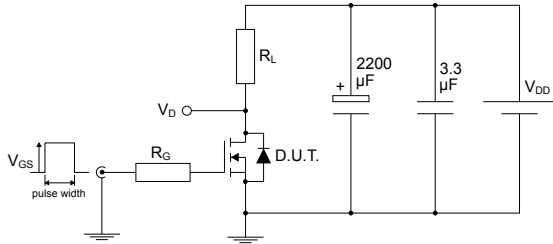


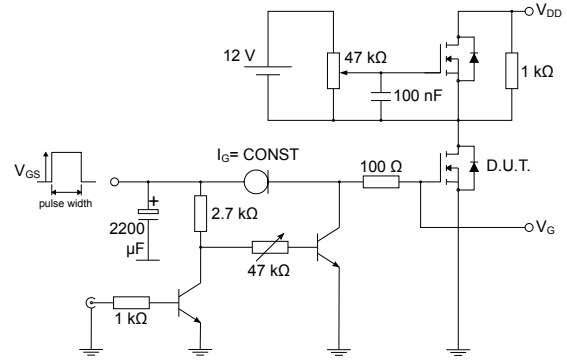
Figure 13. Source-drain diode forward characteristics

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

Figure 15. Switching energy vs gate resistance


Note: E_{on} including reverse recovery of a SiC diode.

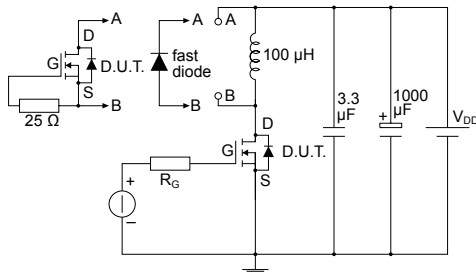
3 Test circuits

Figure 17. Test circuit for resistive load switching times


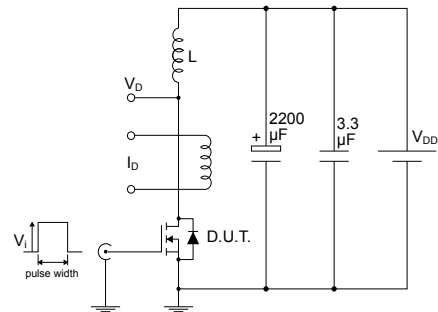
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Figure 18. Test circuit for gate charge behavior


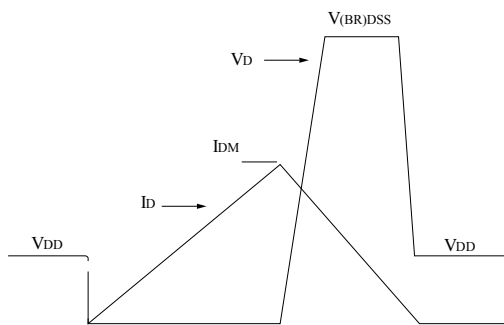
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Figure 19. Test circuit for inductive load switching and diode recovery times


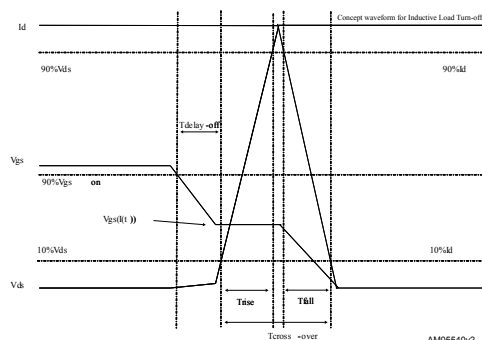
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Figure 20. Unclamped inductive load test circuit


AM01471v1

Figure 21. Unclamped inductive waveform


AM01472v1

Figure 22. Switching time waveform


AM05540v2

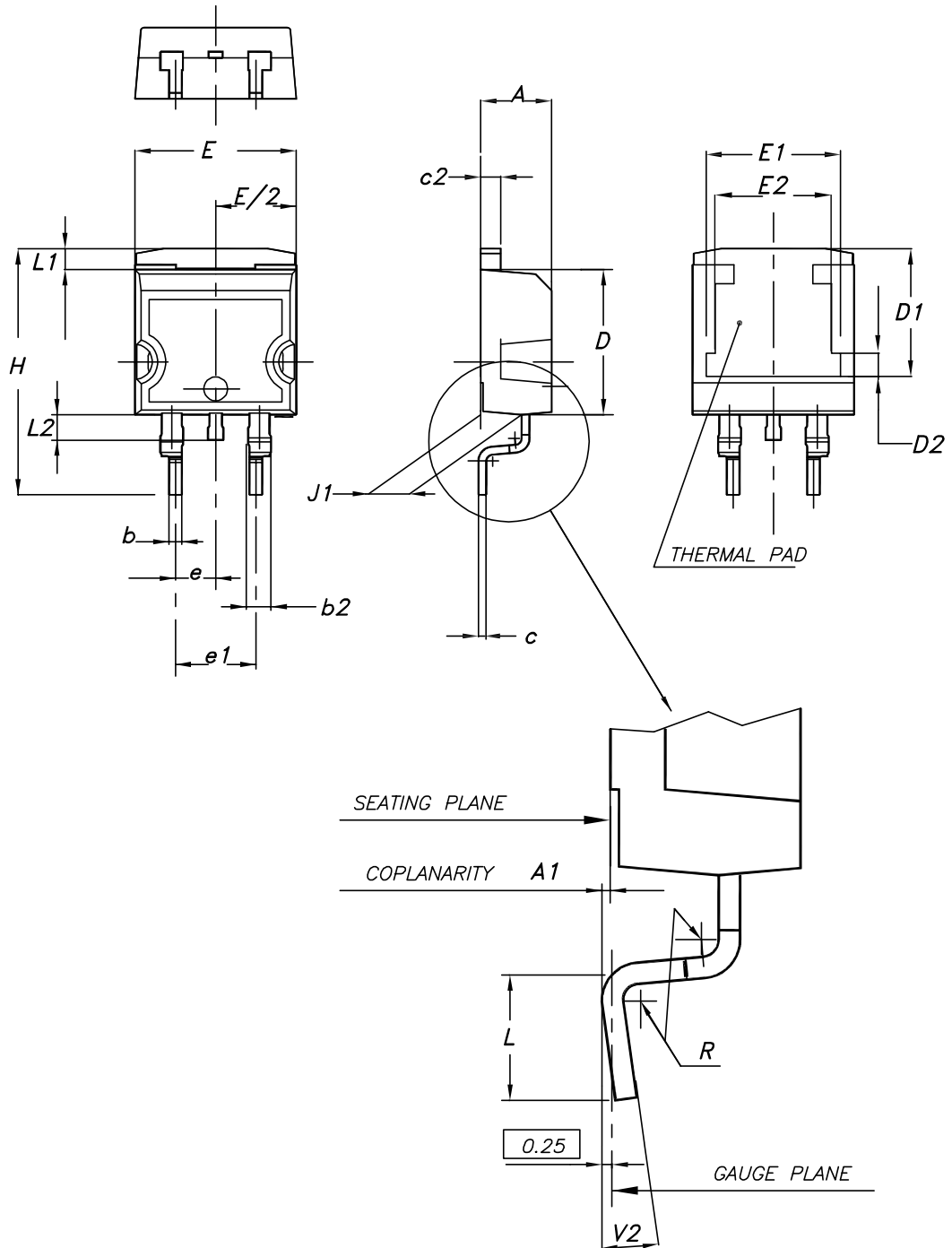


4 Package information

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) package information

Figure 23. D²PAK (TO-263) type A package outline

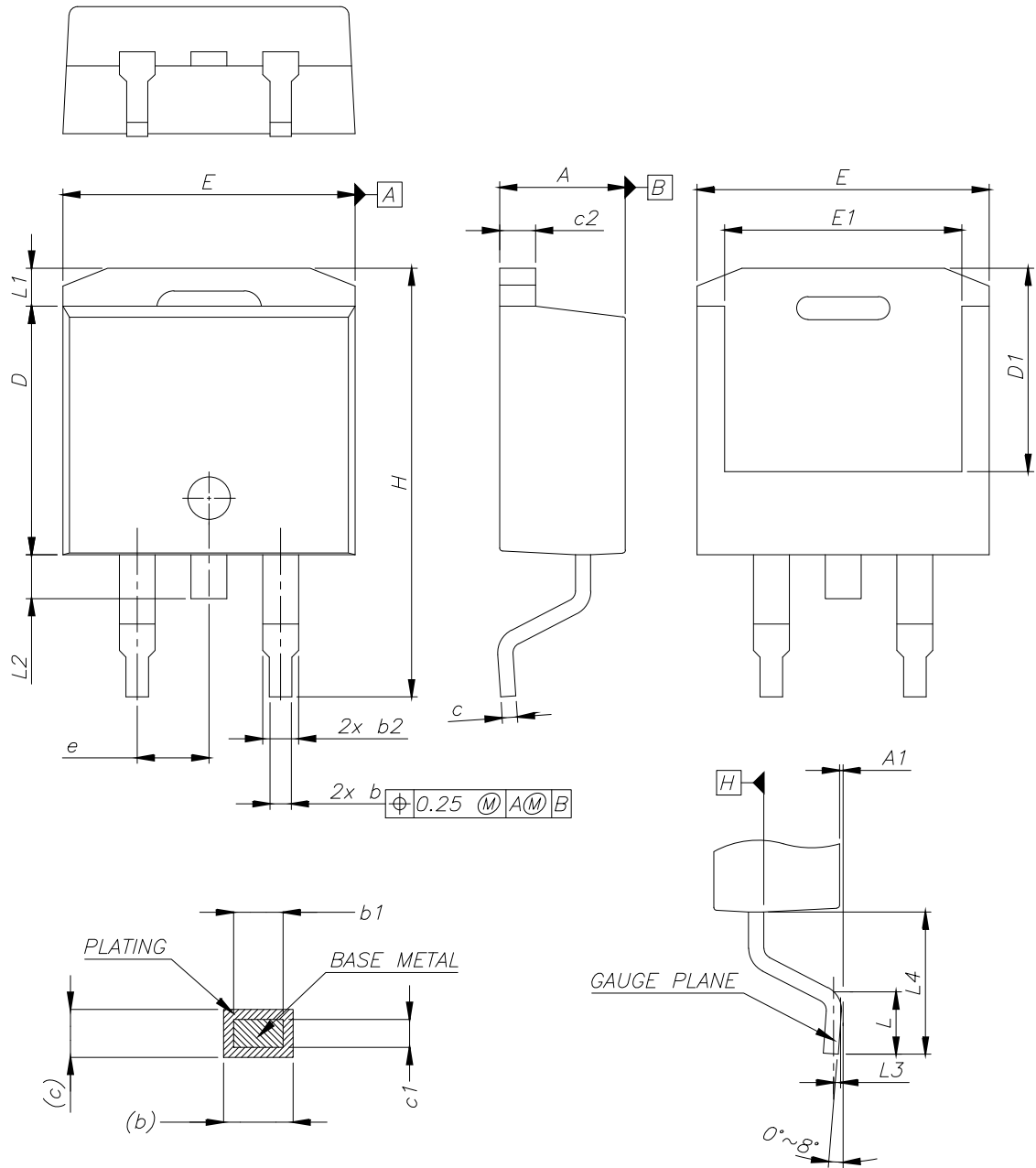


0079457_25

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 24. D²PAK (TO-263) type B package outline

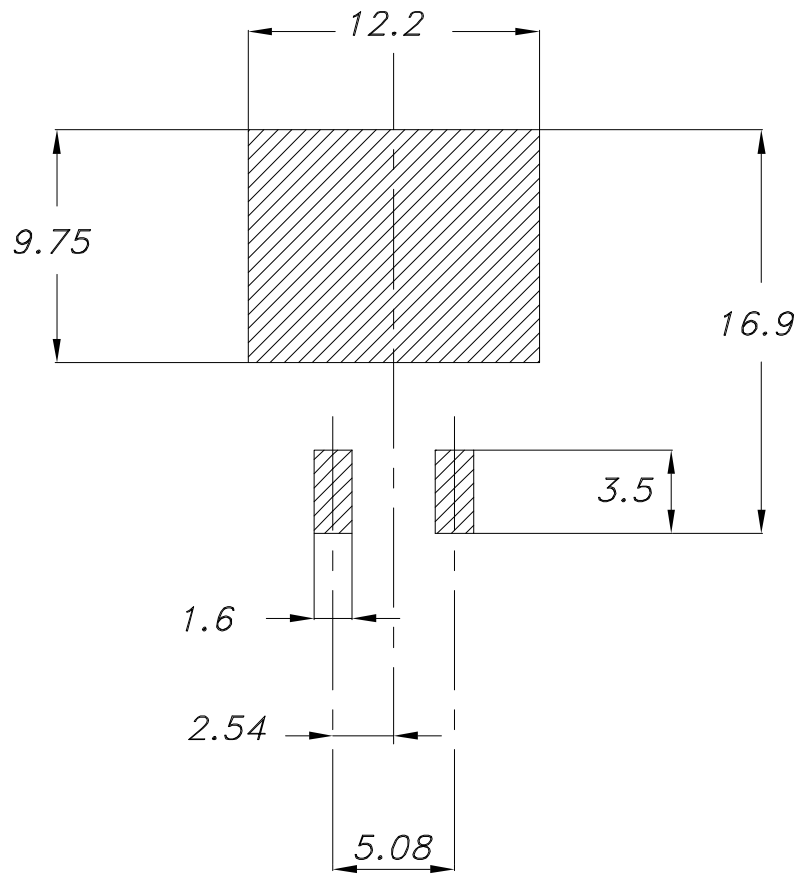


0079457_26_B

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

Dim.	mm		
	Min.	Typ.	Max.
A	4.36		4.56
A1	0		0.25
b	0.70		0.90
b1	0.51		0.89
b2	1.17		1.37
c	0.38		0.694
c1	0.38		0.534
c2	1.19		1.34
D	8.60		9.00
D1	6.90		7.50
E	10.15		10.55
E1	8.10		8.70
e	2.54 BSC		
H	15.00		15.60
L	1.90		2.50
L1			1.65
L2			1.78
L3		0.25	
L4	4.78		5.28

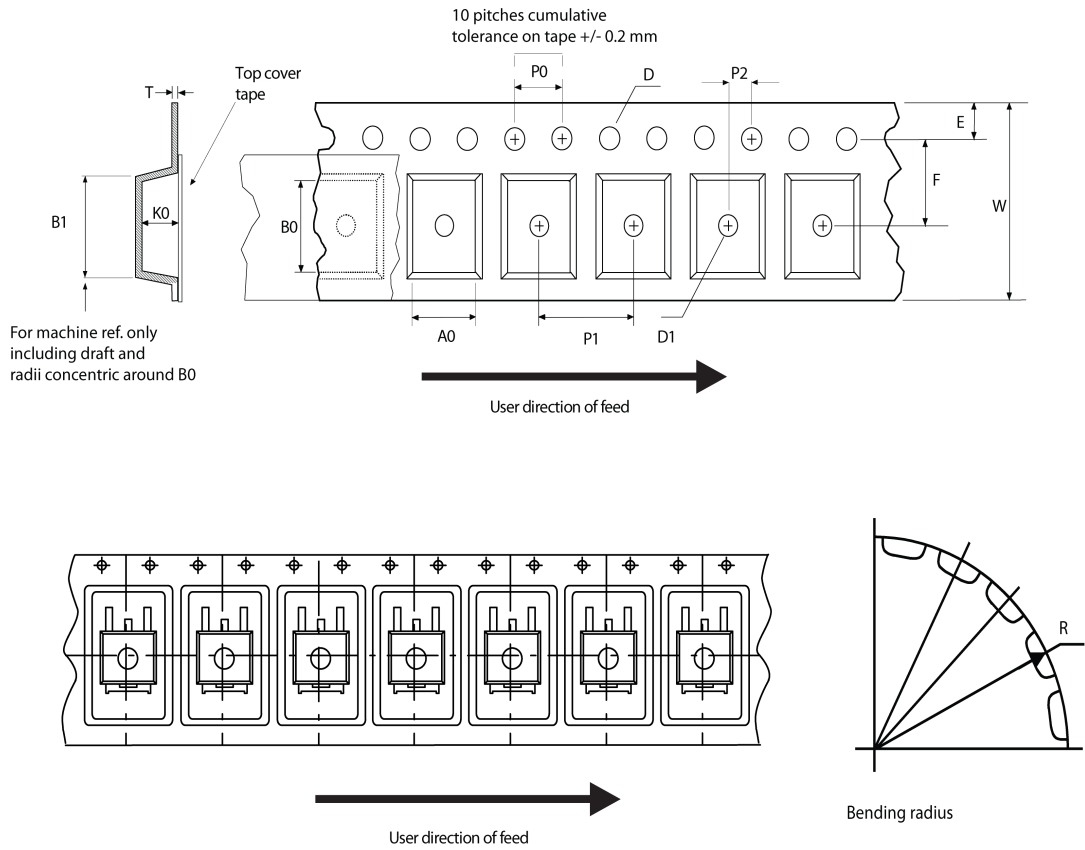
Figure 25. D²PAK (TO-263) recommended footprint (dimensions are in mm)



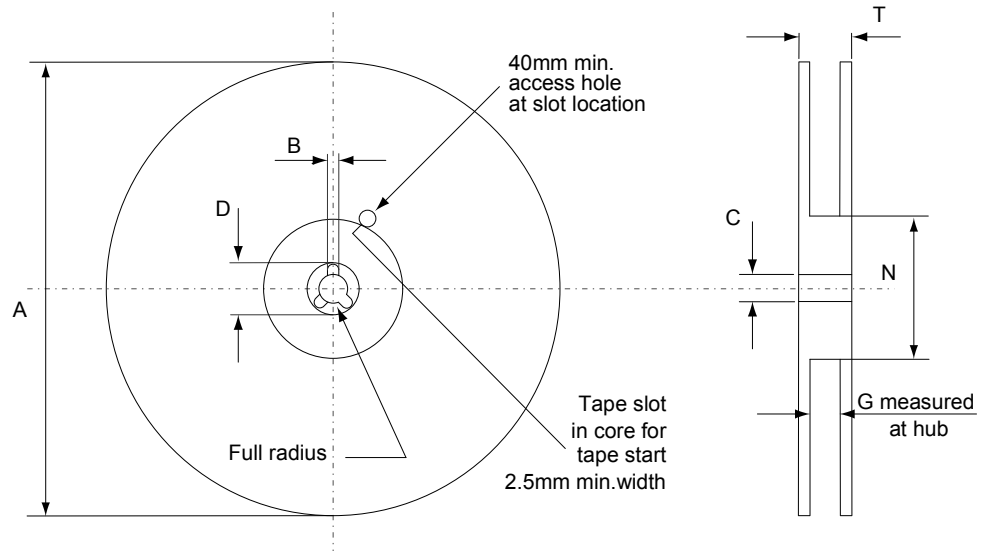
Footprint

4.2 D²PAK packing information

Figure 26. D²PAK tape outline



AM08852v1

Figure 27. D²PAK reel outline


AM06038v1

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	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 D²PAK type B packing information

Figure 28. D²PAK type B tape outline

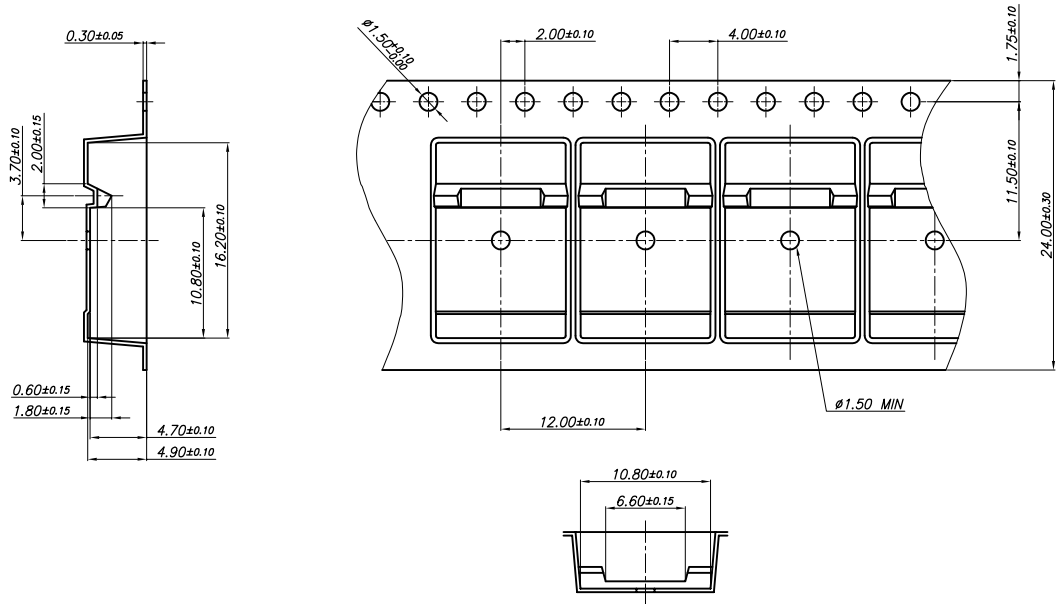
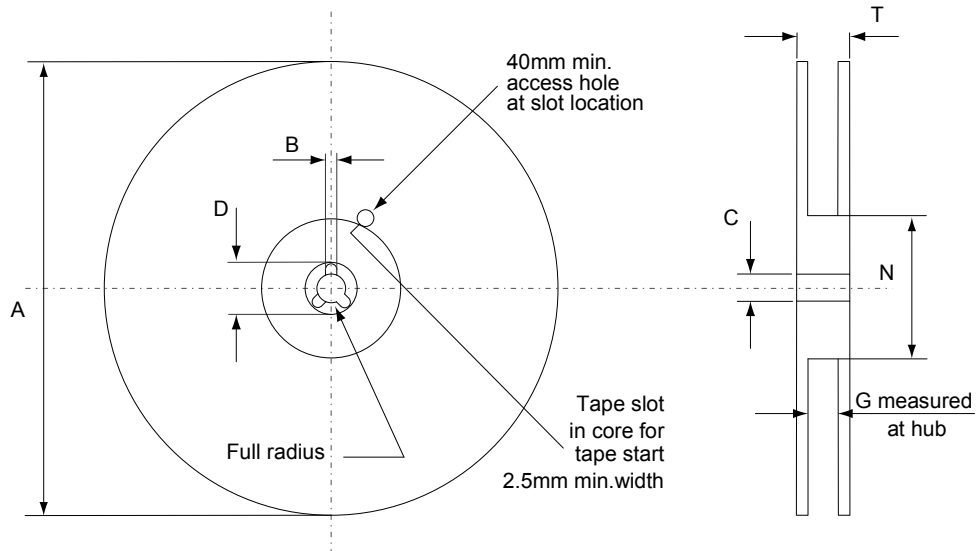


Figure 29. D²PAK type B reel outline



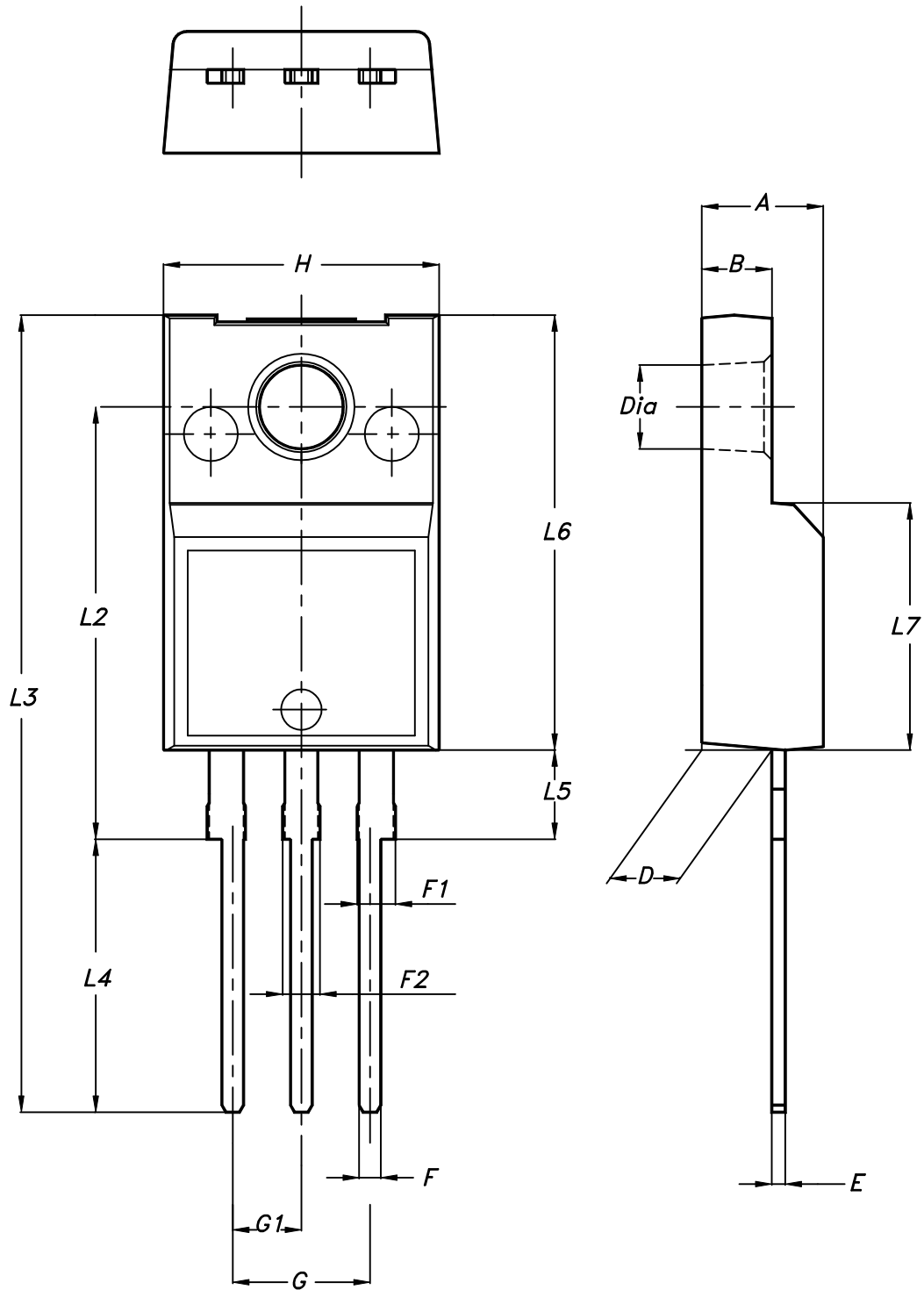
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Table 11. D²PAK type B reel mechanical data

Dim.	mm	
	Min.	Max.
A		330
B	1.5	
C	12.8	13.2
D	20.2	
G	24.4	26.4
N	100	
T		30.4

4.4 TO-220FP package information

Figure 30. TO-220FP package outline



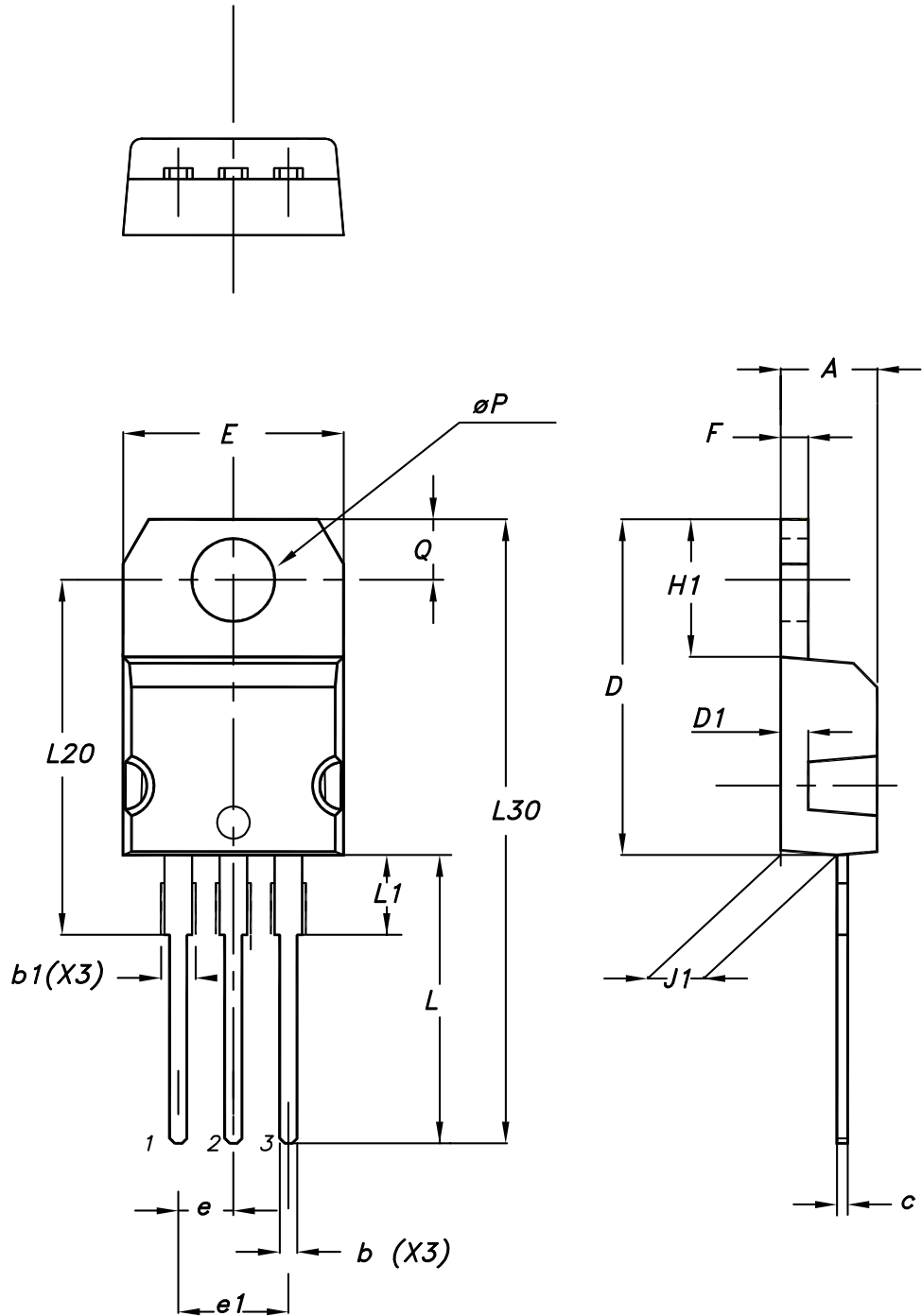
7012510_Rev_12_B

Table 12. 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

4.5 TO-220 type A package information

Figure 31. TO-220 type A package outline



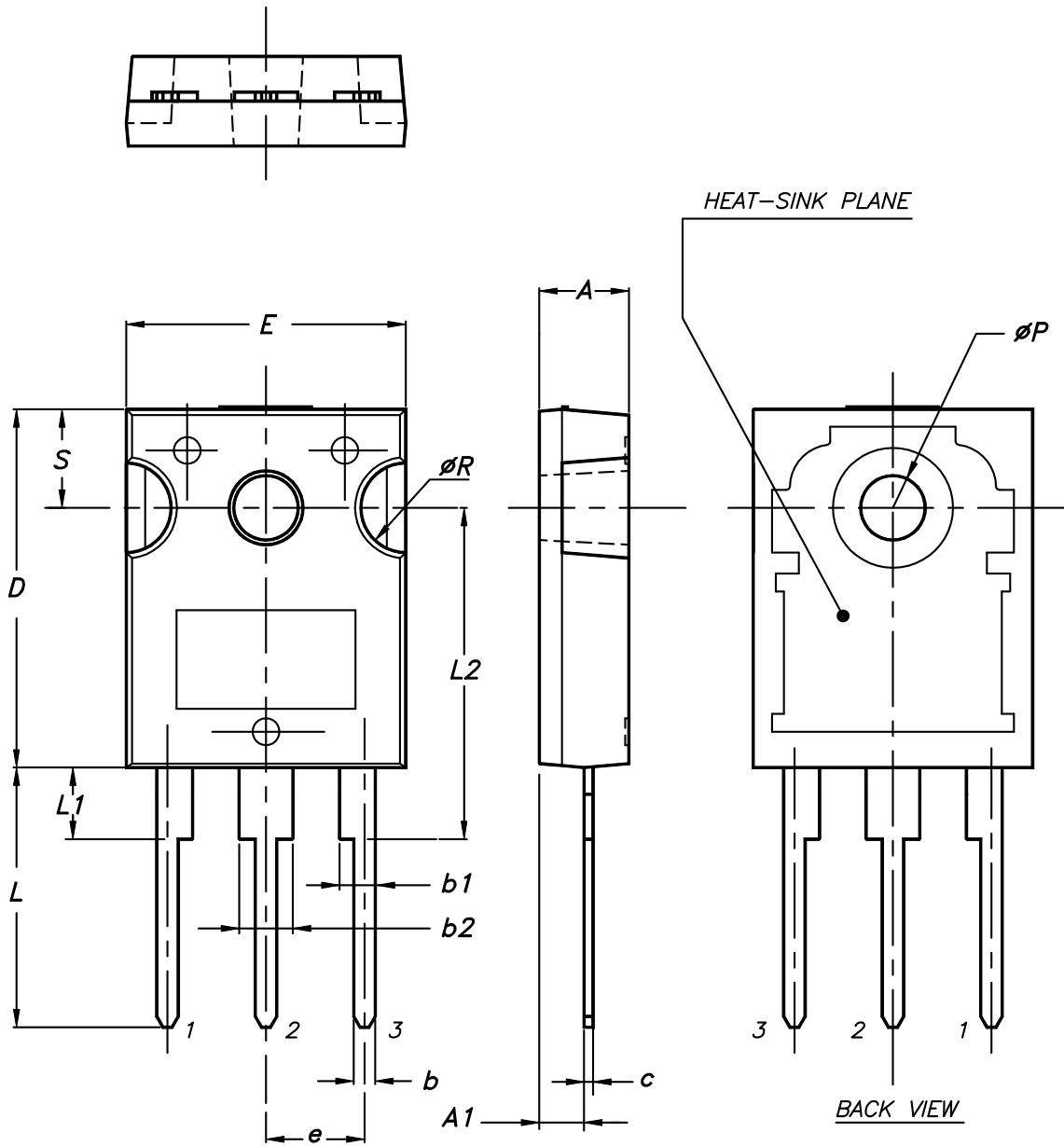
0015988_typeA_Rev_22

Table 13. 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

4.6 TO-247 package information

Figure 32. TO-247 package outline



0075325_9

Table 14. TO-247 package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

5 Ordering information

Table 15. Order codes

Order code	Marking	Package	Packing
STB31N65M5	31N65M5	D ² PAK	Tape e reel
STF31N65M5		TO-220FP	Tube
STP31N65M5		TO-220	
STW31N65M5		TO-247	

Revision history

Table 16. Document revision history

Date	Revision	Changes
23-Feb-2012	1	First release.
10-Sep-2012	2	<ul style="list-style-type: none"> – Modified <i>note 2</i> under the <i>Table 2</i>. – Updated typical values in <i>Table 4, 5 and 6</i>. – Added <i>Section 2.1</i>. – Minor text changes on the cover page.
05-Mar-2013	3	Added <i>dv/dt</i> value on <i>Table 2: Absolute maximum ratings</i> .
15-Apr-2019	4	<p>The part number STFI31N65M5 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 features and description in cover page.</p> <p>Updated Section 4 Package information.</p> <p>Added Section 5 Ordering information.</p> <p>Minor text changes.</p>

Contents

1	Electrical ratings	2
2	Electrical characteristics	4
2.1	Electrical characteristics (curves)	6
3	Test circuits	9
4	Package information	10
4.1	D ² PAK (TO-263) package information	10
4.2	D ² PAK packing information	15
4.3	D ² PAK type B packing information	18
4.4	TO-220FP package information	19
4.5	TO-220 type A package information	21
4.6	TO-247 package information	23
5	Ordering information	26
	Revision history	27



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