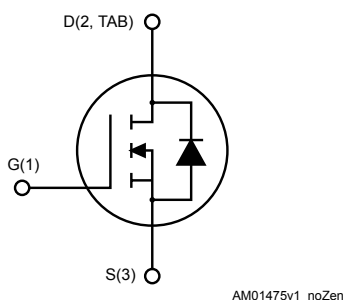
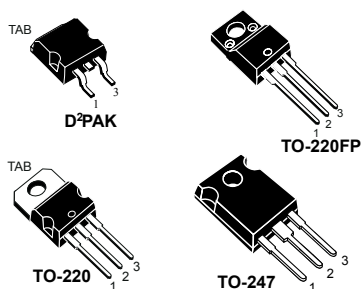


N-channel 650 V, 0.124 Ω , 22 A, MDmesh M5 Power MOSFETs in D²PAK, TO-220FP, TO-220 and TO-247 packages



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/μs; 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 $T_j = 25\text{ }^{\circ}\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$)	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	$V_{GS} = 0\text{ V}$, $V_{DS} = 0\text{ to }520\text{ V}$	-	146	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related		-	43	-	pF
R_g	Intrinsic gate resistance	$f = 1\text{ MHz}$	-	2.8	-	Ω
Q_g	Total gate charge	$V_{DD} = 520\text{ V}$, $I_D = 11\text{ A}$ $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 18. Test circuit for gate charge behavior)	-	45	-	nC
Q_{gs}	Gate-source charge		-	11.5	-	nC
Q_{gd}	Gate-drain charge		-	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	-	336		ns
Q_{rr}	Reverse recovery charge	Figure 19. Test circuit for inductive load switching and diode recovery times)	-	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	-	6		μC
I_{RRM}	Reverse recovery current	Figure 19. Test circuit for inductive load switching and diode recovery times)	-	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

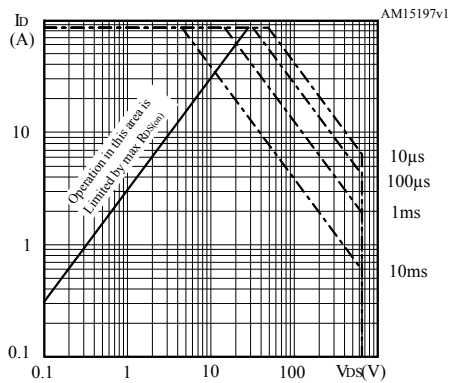


Figure 2. Thermal impedance for D²PAK, TO-220 and TO-247

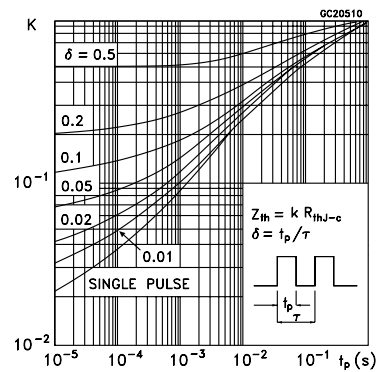


Figure 3. Safe operating area for TO-220FP

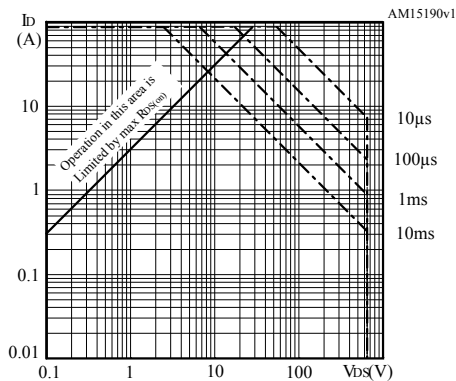


Figure 4. Thermal impedance for TO-220FP

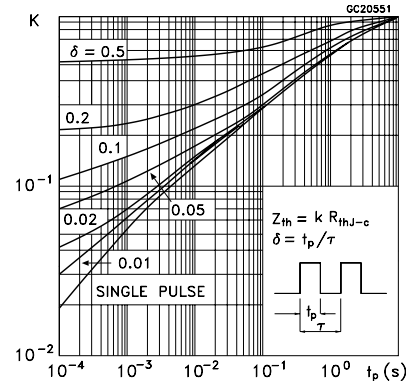


Figure 5. Output characteristics

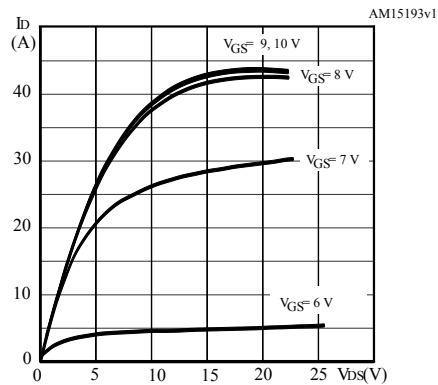


Figure 6. Transfer characteristics

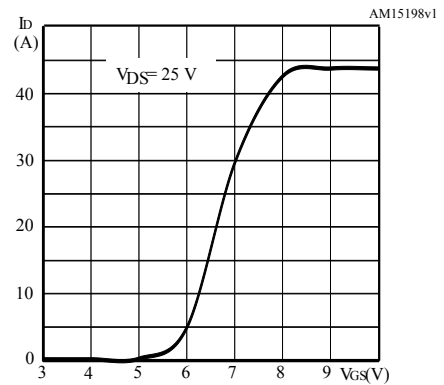


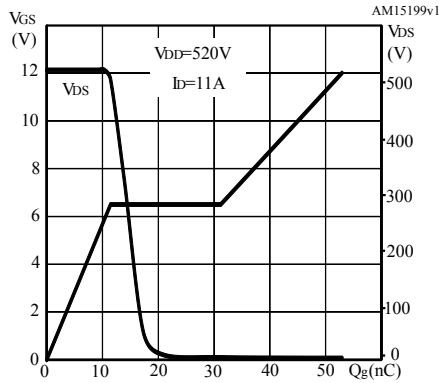
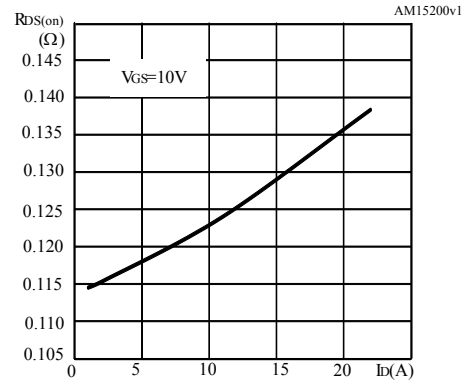
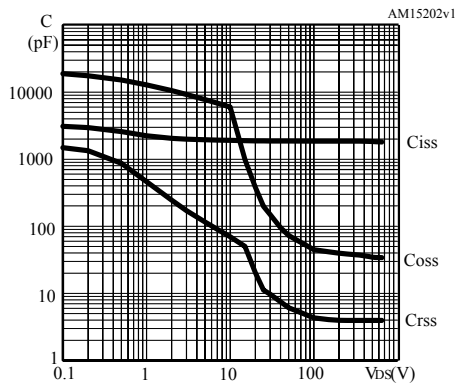
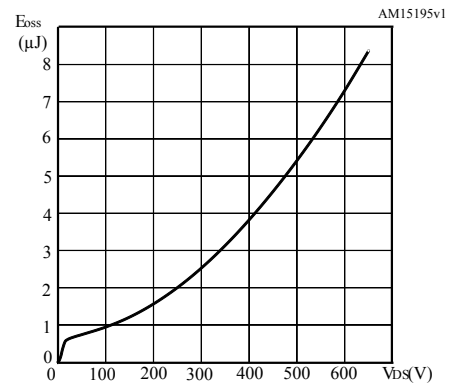
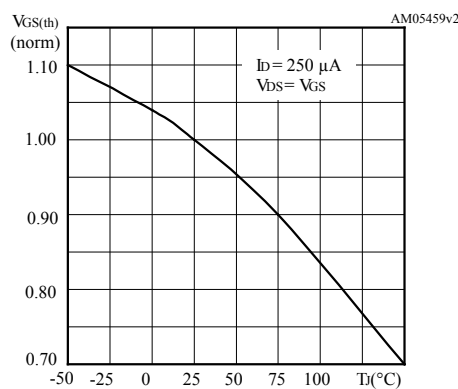
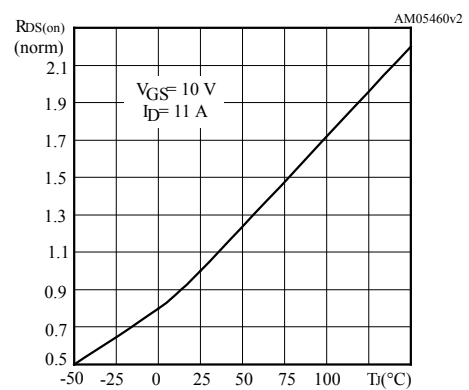
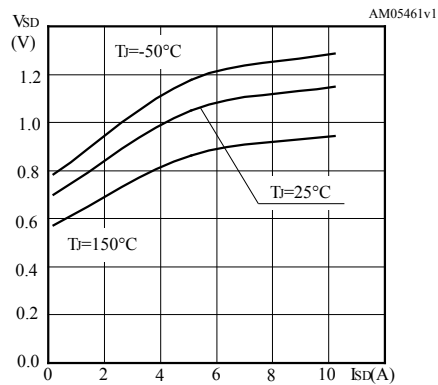
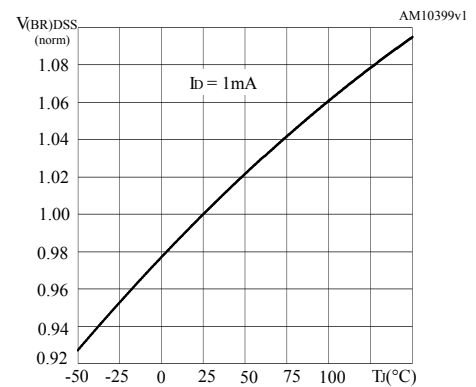
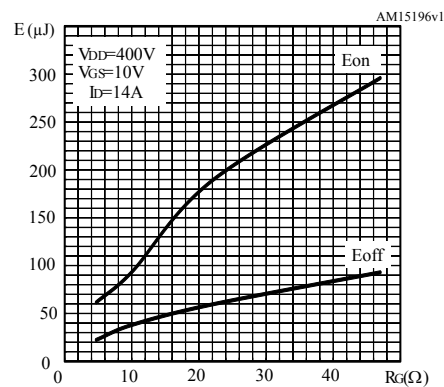
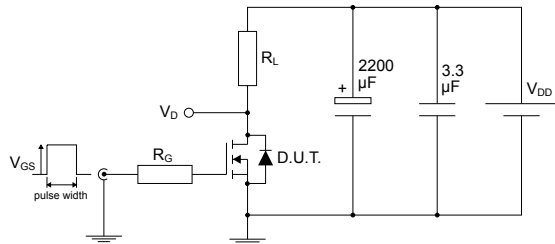
Figure 7. Gate charge vs gate-source voltage

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


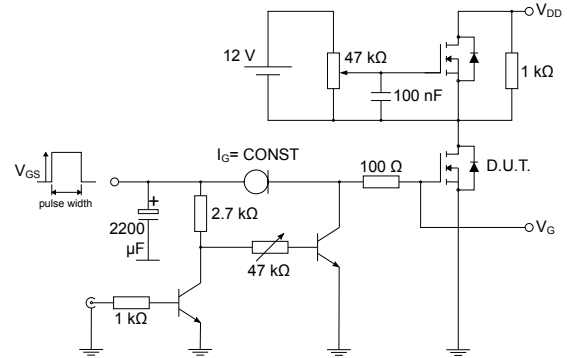
Figure 13. Source-drain diode forward characteristics

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.

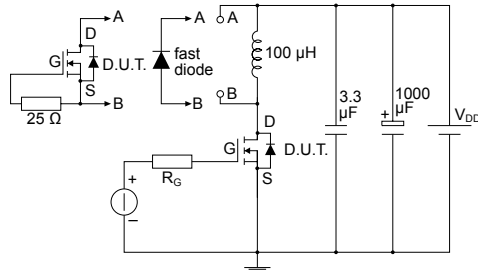
3 Test circuits

Figure 17. Test circuit for resistive load switching times


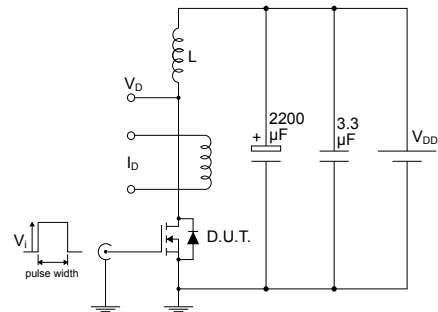
AM01468v1

Figure 18. Test circuit for gate charge behavior


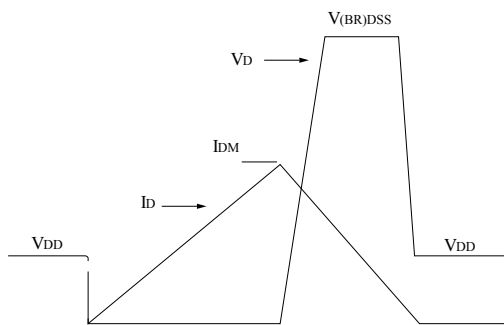
AM01469v1

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


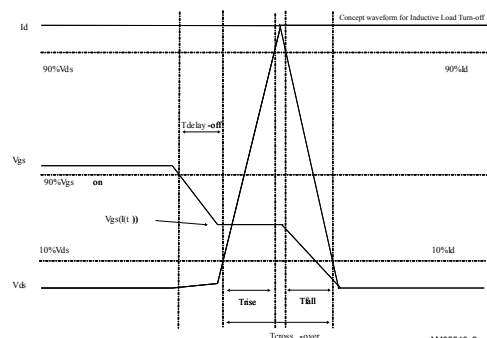
AM01470v1

Figure 20. Unclamped inductive load test circuit


AM01471v1

Figure 21. Unclamped inductive waveform


AM01472v1

Figure 22. Switching time waveform


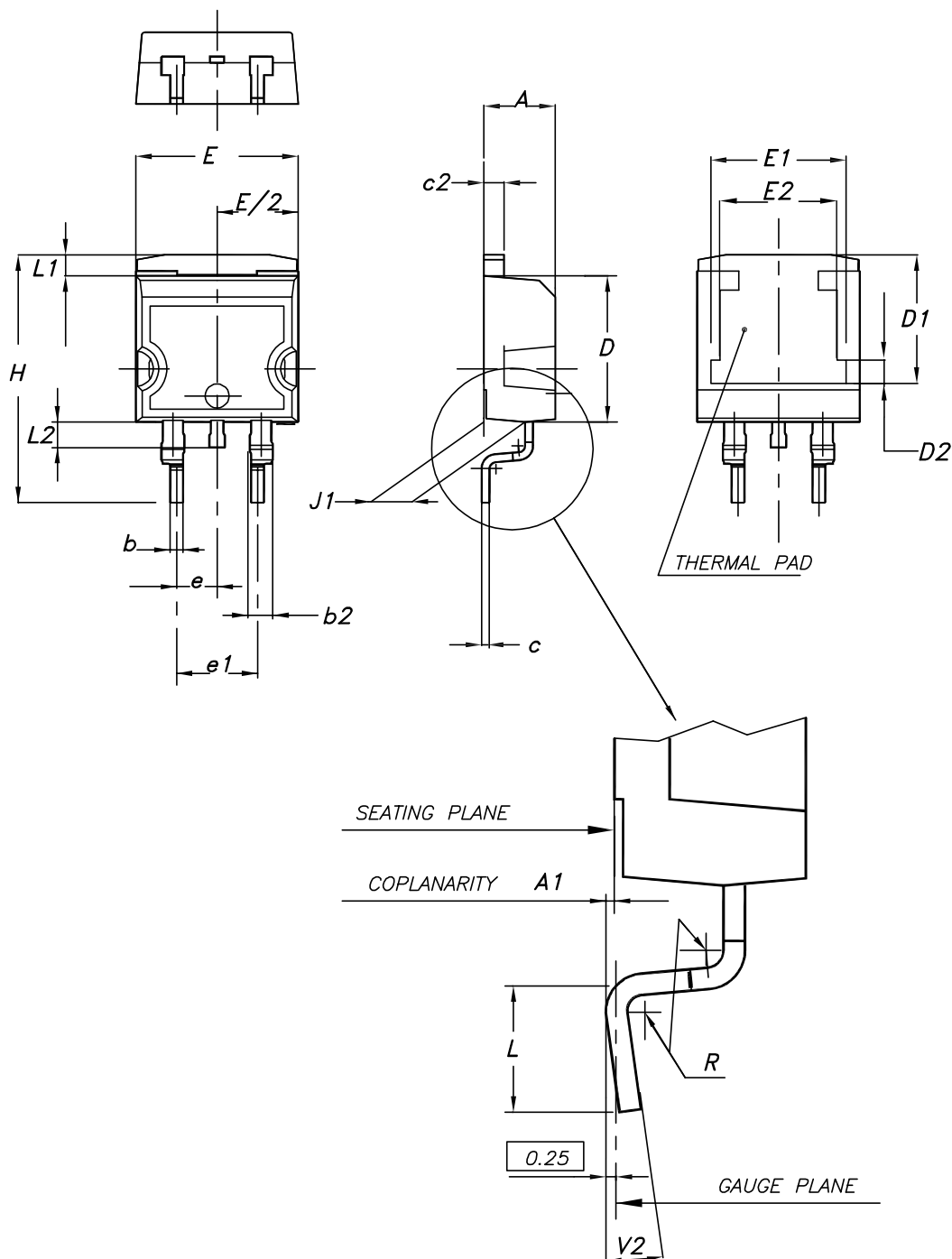
AM05540v2

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

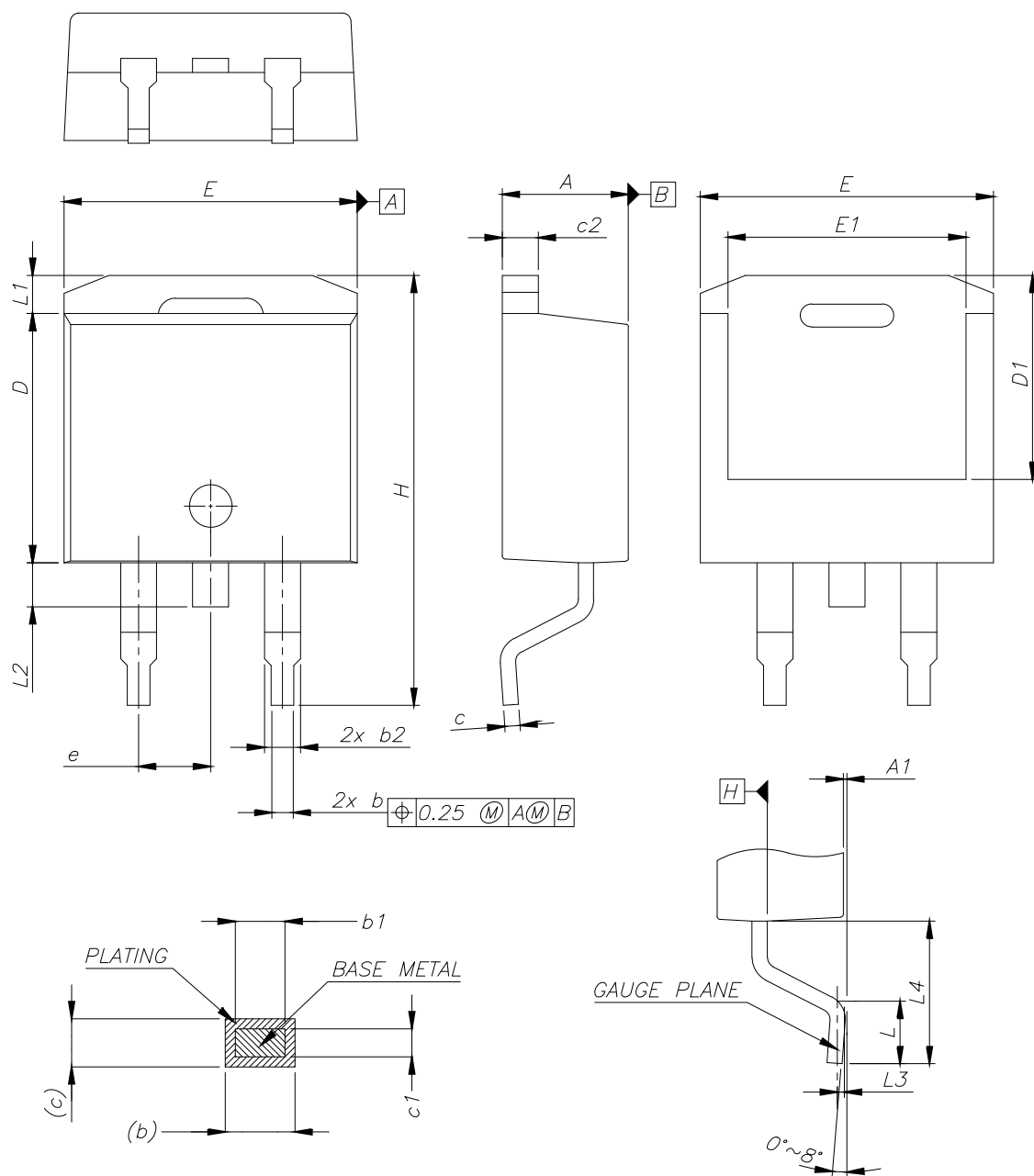
Figure 23. D²PAK (TO-263) type A package outline



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°

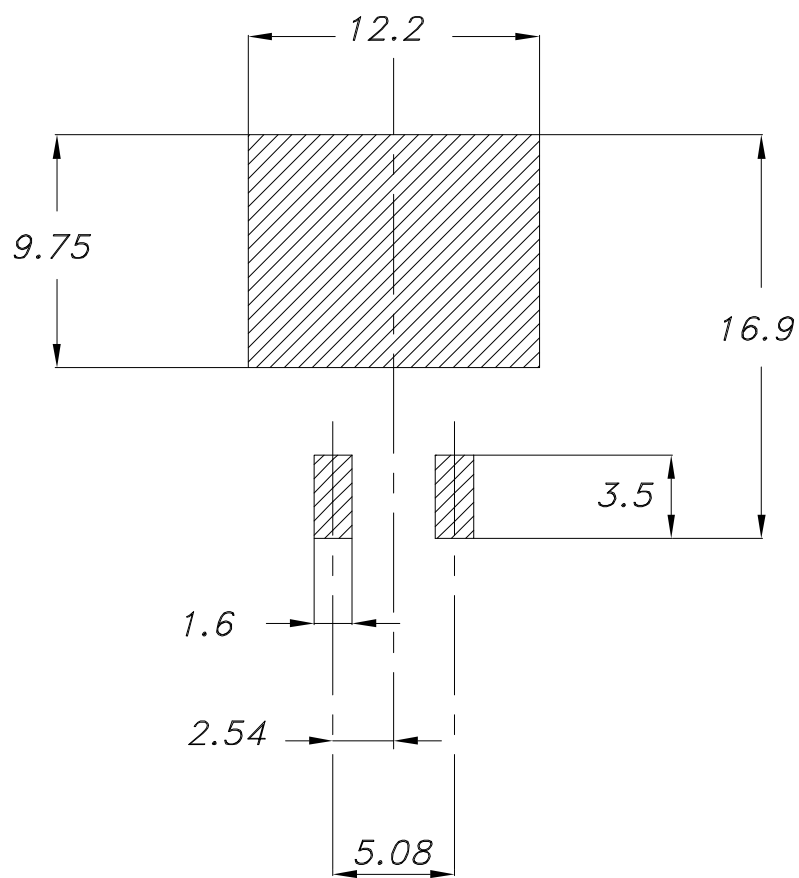
Figure 24. D²PAK (TO-263) type B package outline


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

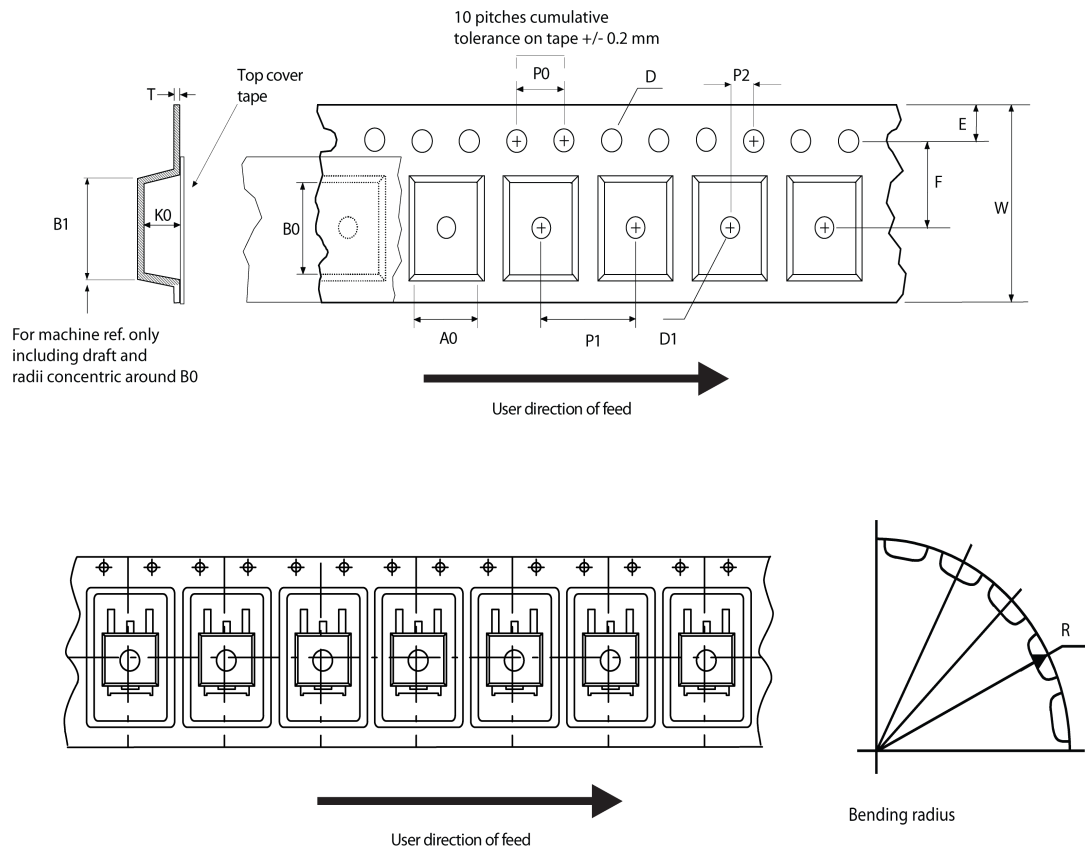
Figure 25. D²PAK (TO-263) recommended footprint (dimensions are in mm)



Footprint

4.2 D²PAK packing information

Figure 26. D²PAK tape outline



AM08852v1

Technical drawing of a tape reel showing front and side views with dimension labels A through T.

Front View (Left):

- A:** Overall diameter of the reel.
- B:** Width of the reel.
- C:** Diameter of the central hub.
- D:** Diameter of the tape slot.
- Full radius:** Dimension from the center to the outer edge of the tape.
- 40mm min. access hole at slot location:** Dimension from the center to the edge of the access hole.
- 2.5mm min. width:** Dimension of the tape slot.
- Tape slot in core for tape start:** Dimension from the center to the edge of the tape slot.

Side View (Right):

- T:** Thickness of the reel.
- N:** Thickness of the tape.
- G measured at hub:** Dimension from the center to the edge of the hub.

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 D²PAK type B packing information

Figure 28. D²PAK type B tape outline

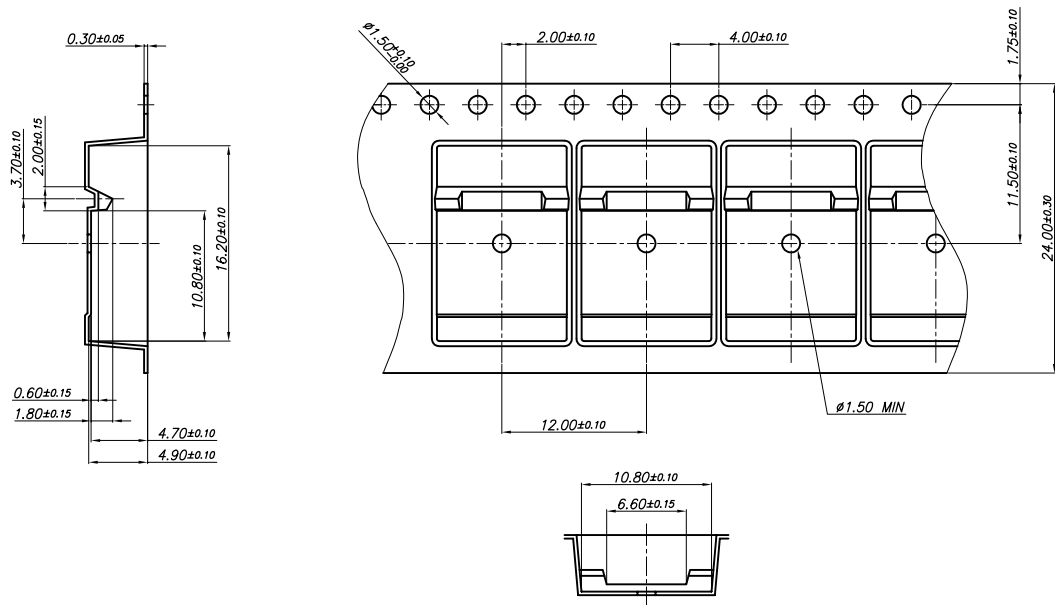
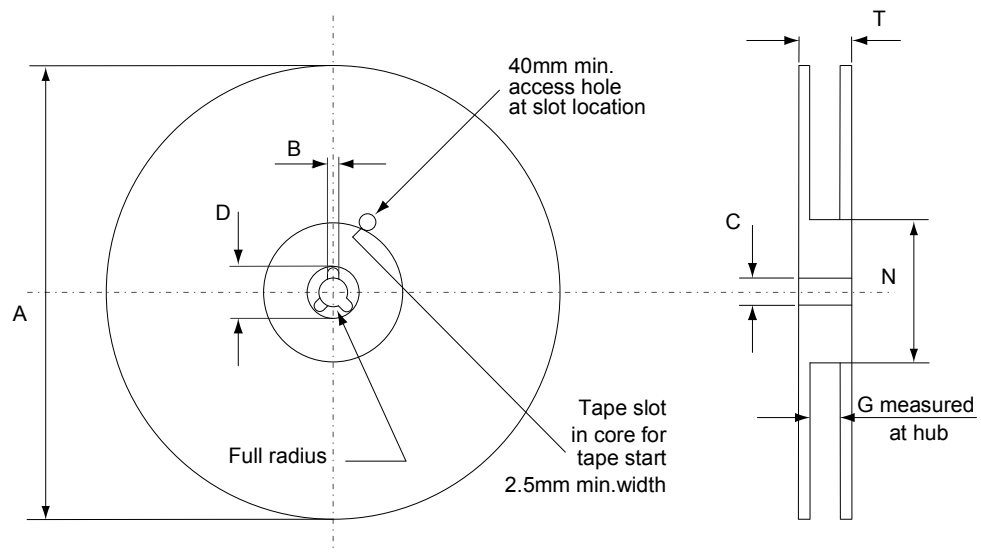


Figure 29. D²PAK type B reel outline



AM06038v1

Table 11. D²PAK type B reel mechanical data

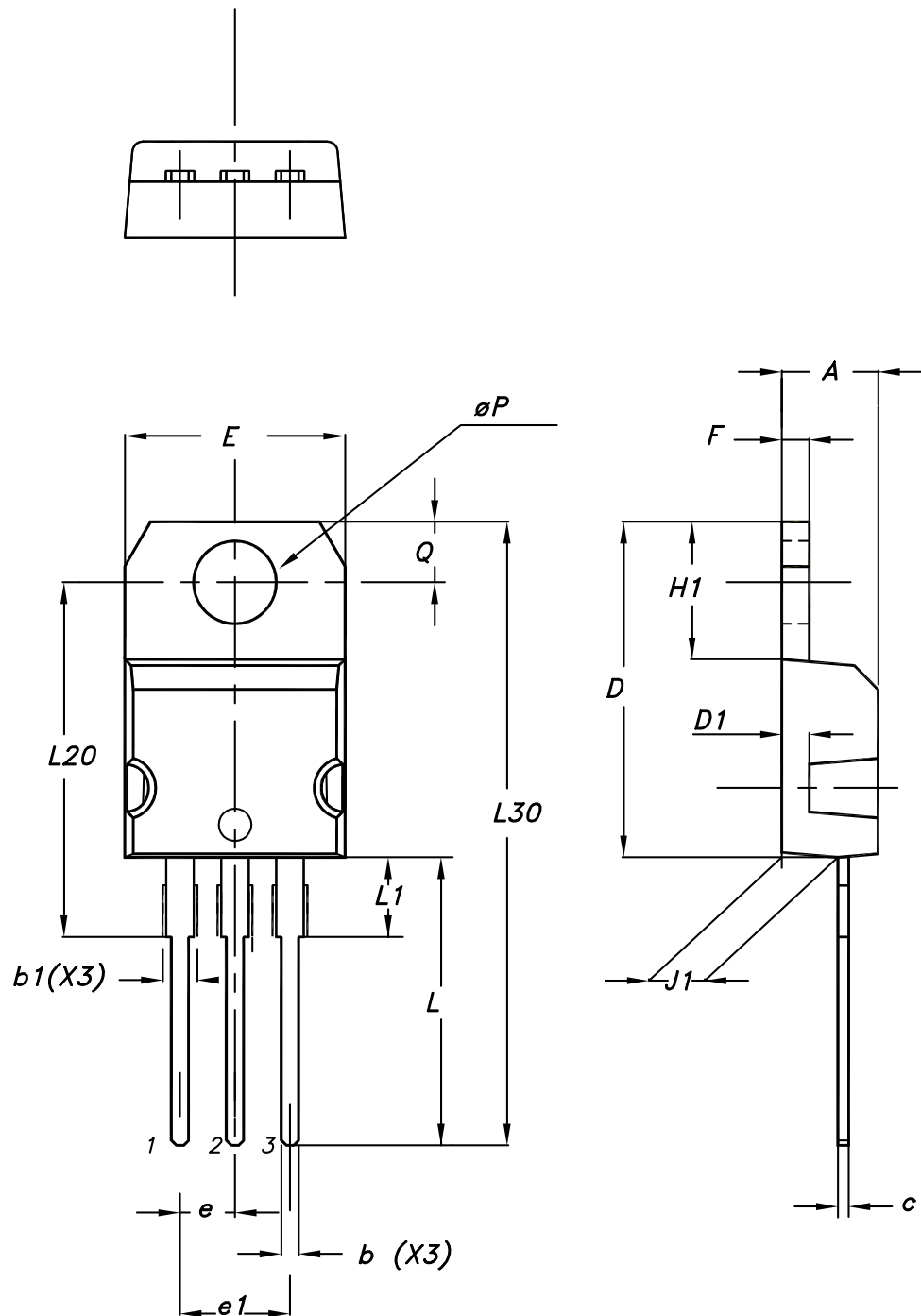
Dim.	mm	
	Min.	Max.
A		330
B	1.5	
C	12.8	13.2
D	20.2	
G	24.4	26.4
N	100	
T		30.4

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



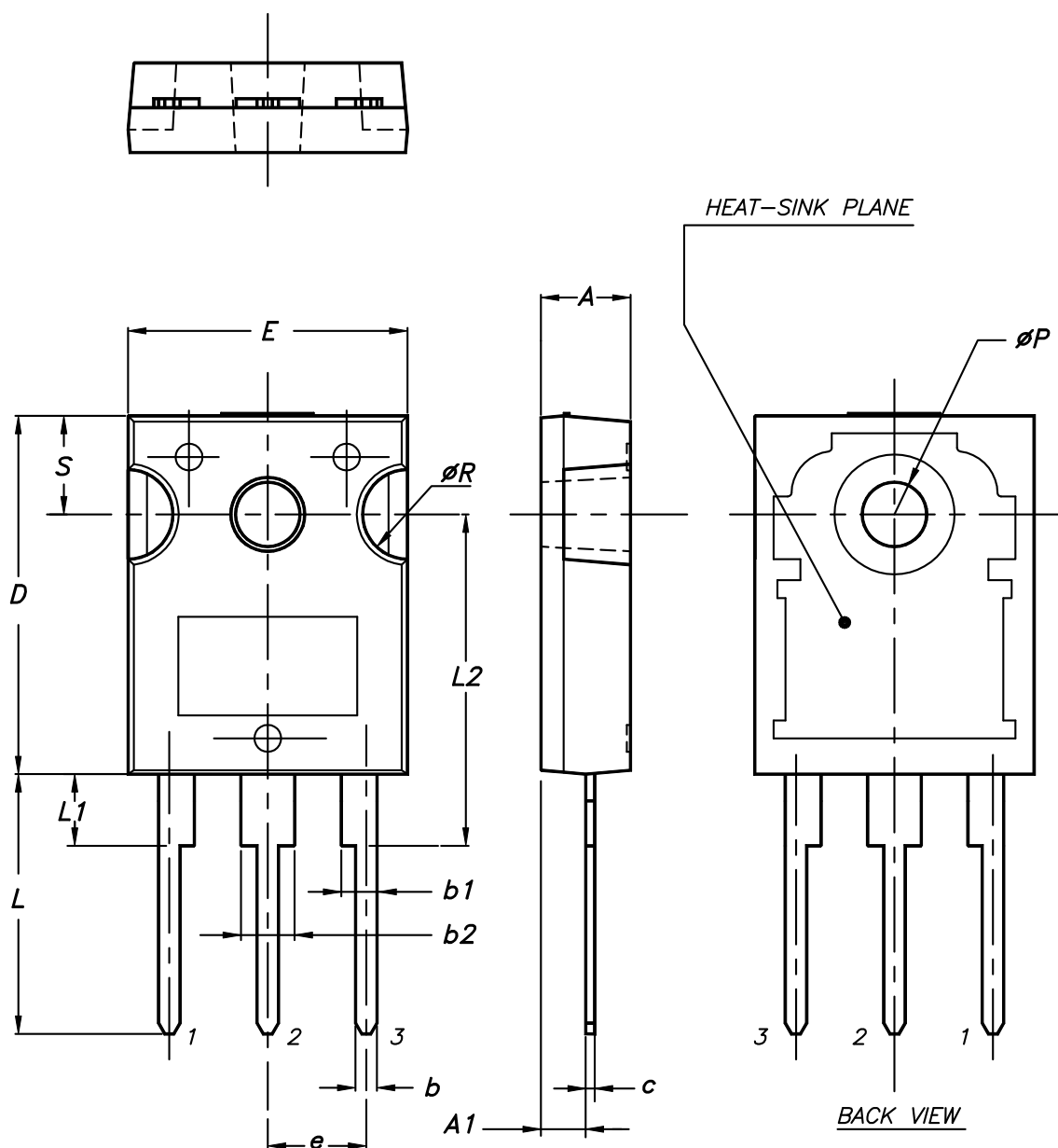
0015988_typeA_Rev_22

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	– Modified <i>note 2</i> under the <i>Table 2</i>. – Updated typical values in Table 4, 5 and 6. – Added <i>Section 2.1</i>. – Minor text changes on the cover page.
05-Mar-2013	3	Added dv/dt value on <i>Table 2: Absolute maximum ratings</i> .
15-Apr-2019	4	The part number STFI31N65M5 has been moved to a separate datasheet. Removed maturity status indication from cover page. The document status is production data. Updated features and description in cover page. Updated Section 4 Package information. Added Section 5 Ordering information. Minor text changes.

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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