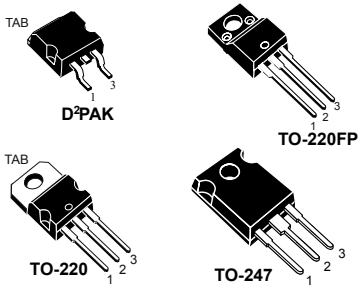
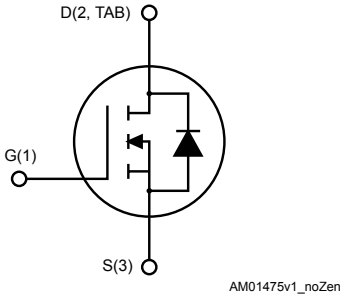
STB31N65M5, STF31N65M5
STP31N65M5, STW31N65M5

Datasheet

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	D²PAK
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.

STPOWER

Product status link
STB31N65M5
STF31N65M5
STP31N65M5
STW31N65M5

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D²PAK, 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} ≤ 22 A, di/dt ≤ 400 A/µs; V_{DS} (peak) < $V_{(BR)DSS}$, V_{DD} = 400 V.*
4. *V_{DS} ≤ 480 V.*

Table 2. Thermal data

Symbol	Parameter	Value				Unit
		D²PAK	TO-220	TO-220FP	TO-247	
$R_{thj\text{-}case}$	Thermal resistance junction-case	0.83		4.17	0.83	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient		62.5		50	°C/W
$R_{thj\text{-}pcb}$ (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 °C, I_D = I_{AR}, V_{DD} = 50 V)	410	mJ

2 Electrical characteristics

T_C = 25 °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 V, I_D = 1 mA	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 = 11 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 V, f = 1 MHz, V_{GS} = 0 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 V, V_{DS} = 0 to 520 V	-	146	-	pF
$C_{o(er)}$ (2)	Equivalent capacitance energy related		-	43	-	pF
R_g	Intrinsic gate resistance	f = 1 MHz	-	2.8	-	Ω
Q_g	Total gate charge	V_{DD} = 520 V, I_D = 11 A V_{GS}= 0 to 10 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

1. *$C_{o(tr)}$ 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}.*
2. *$C_{o(er)}$ 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 V, I_D = 14 A, R_G = 4.7 Ω V_{GS} = 10 V (see Figure 19. Test circuit for inductive load switching and diode recovery times and Figure 22. Switching time waveform)	-	46	-	ns
$t_{r(v)}$	Voltage rise time		-	8	-	ns
$t_{f(i)}$	Current fall time		-	8.5	-	ns
$t_{c(off)}$	Crossing time		-	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 A, V_{GS} = 0 V	-		1.5	V
t_{rr}	Reverse recovery time	I_{SD} = 22 A, di/dt = 100 A/µs, V_{DD} = 100 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 A, di/dt = 100 A/µs, V_{DD}= 100 V, T_j= 150 °C (see Figure 19. Test circuit for inductive load switching and diode recovery times)	-	406		ns
Q_{rr}	Reverse recovery charge		-	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

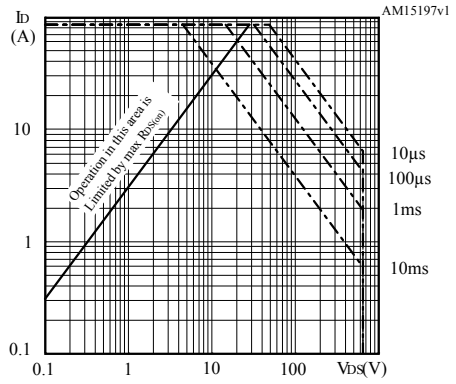


Figure 2. Thermal impedance for D²PAK, TO-220 and TO-247

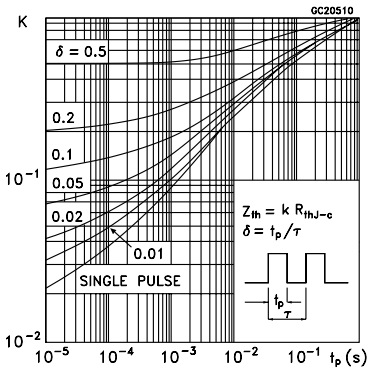


Figure 3. Safe operating area for TO-220FP

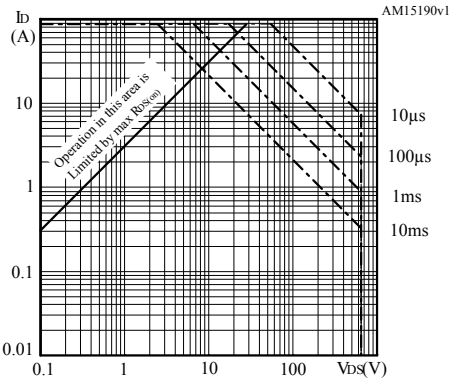


Figure 4. Thermal impedance for TO-220FP

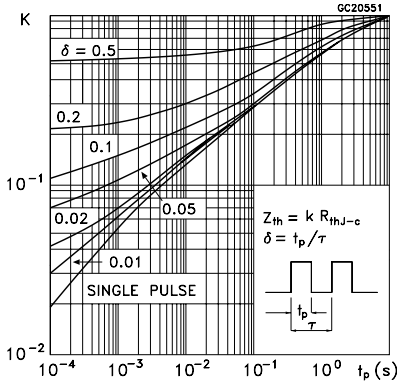


Figure 5. Output characteristics

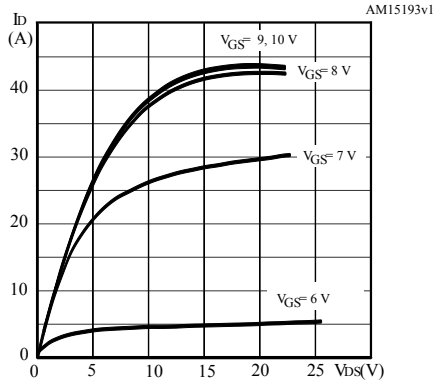


Figure 6. Transfer characteristics

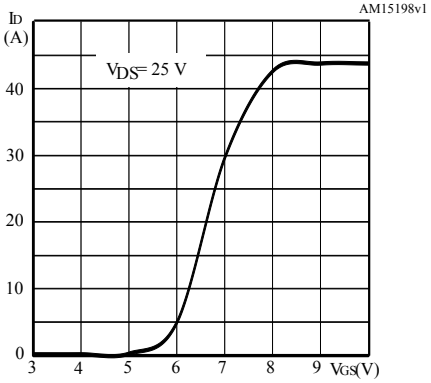


Figure 7. Gate charge vs gate-source voltage

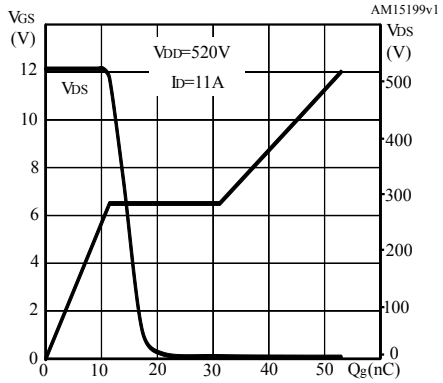


Figure 8. Static drain-source on-resistance

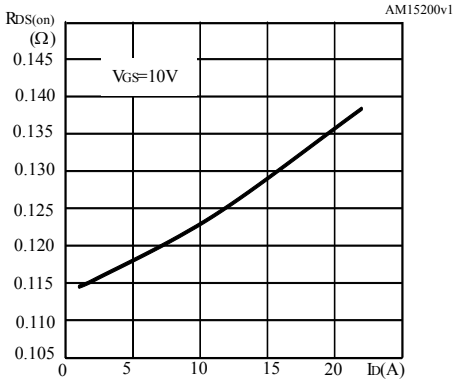


Figure 9. Capacitance variations

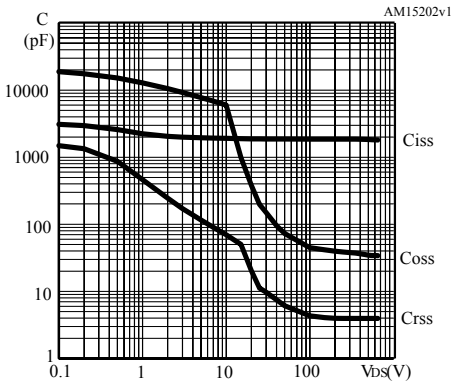


Figure 10. Output capacitance stored energy

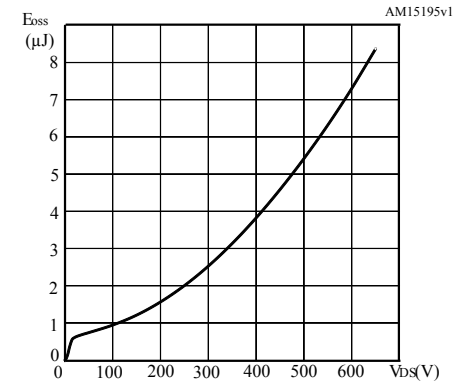


Figure 11. Normalized gate threshold voltage vs temperature

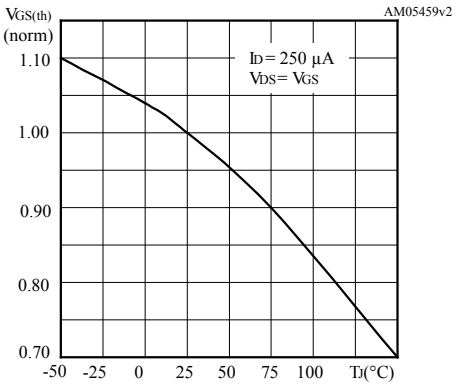


Figure 12. Normalized on-resistance vs temperature

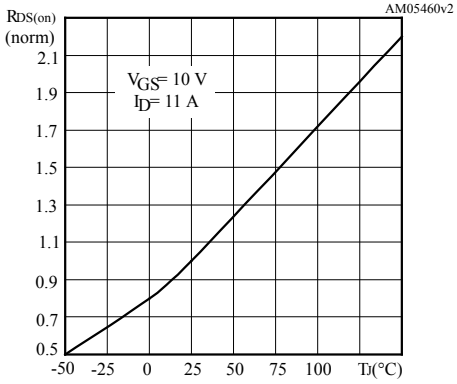


Figure 13. Source-drain diode forward characteristics

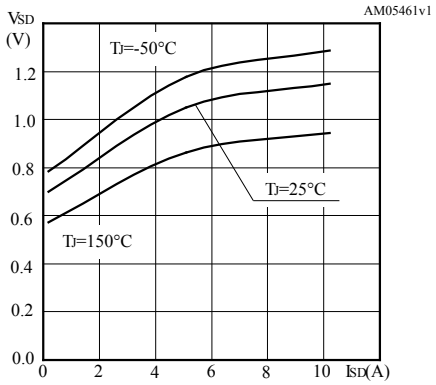


Figure 14. Normalized $V_{(BR)DSS}$ vs temperature

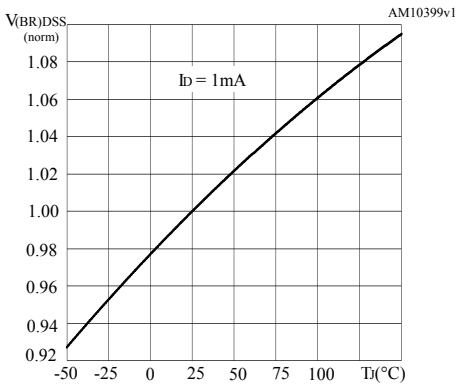
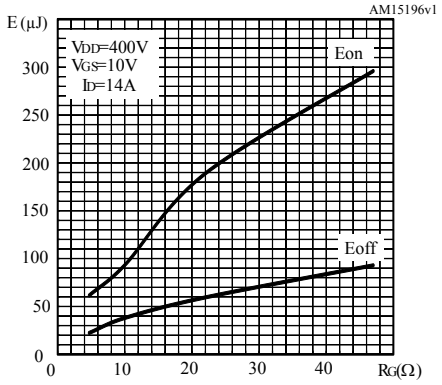


Figure 15. Switching energy vs gate resistance



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

3 Test circuits

Figure 17. Test circuit for resistive load switching times

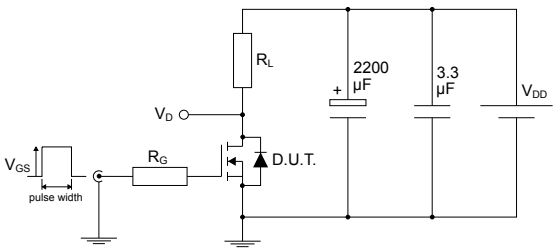


Figure 18. Test circuit for gate charge behavior

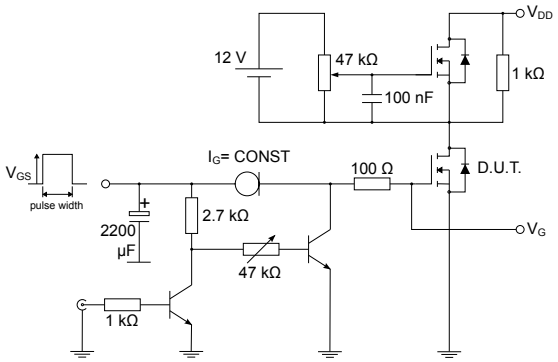


Figure 19. Test circuit for inductive load switching and diode recovery times

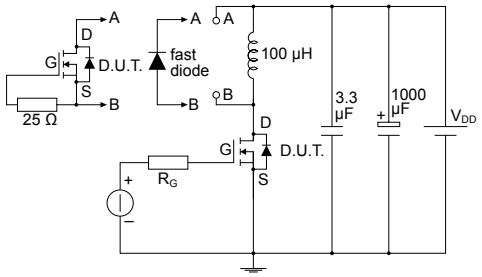


Figure 20. Unclamped inductive load test circuit

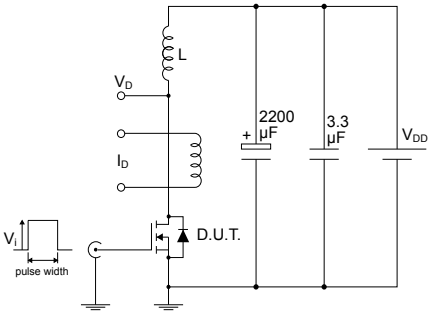


Figure 21. Unclamped inductive waveform

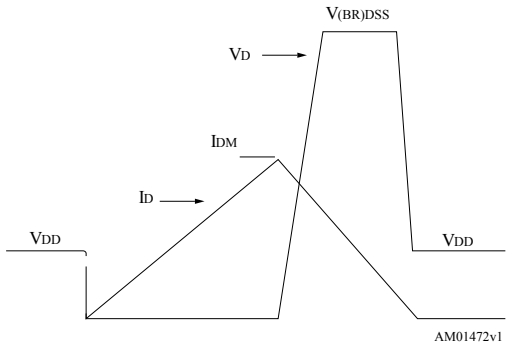
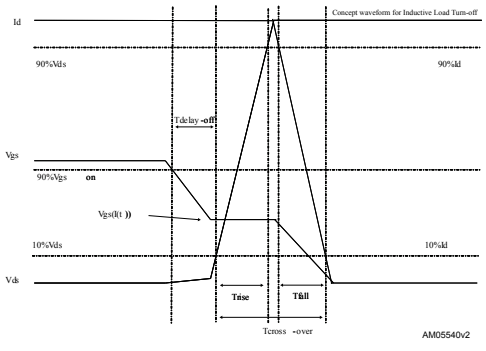


Figure 22. Switching time waveform



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) package information

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

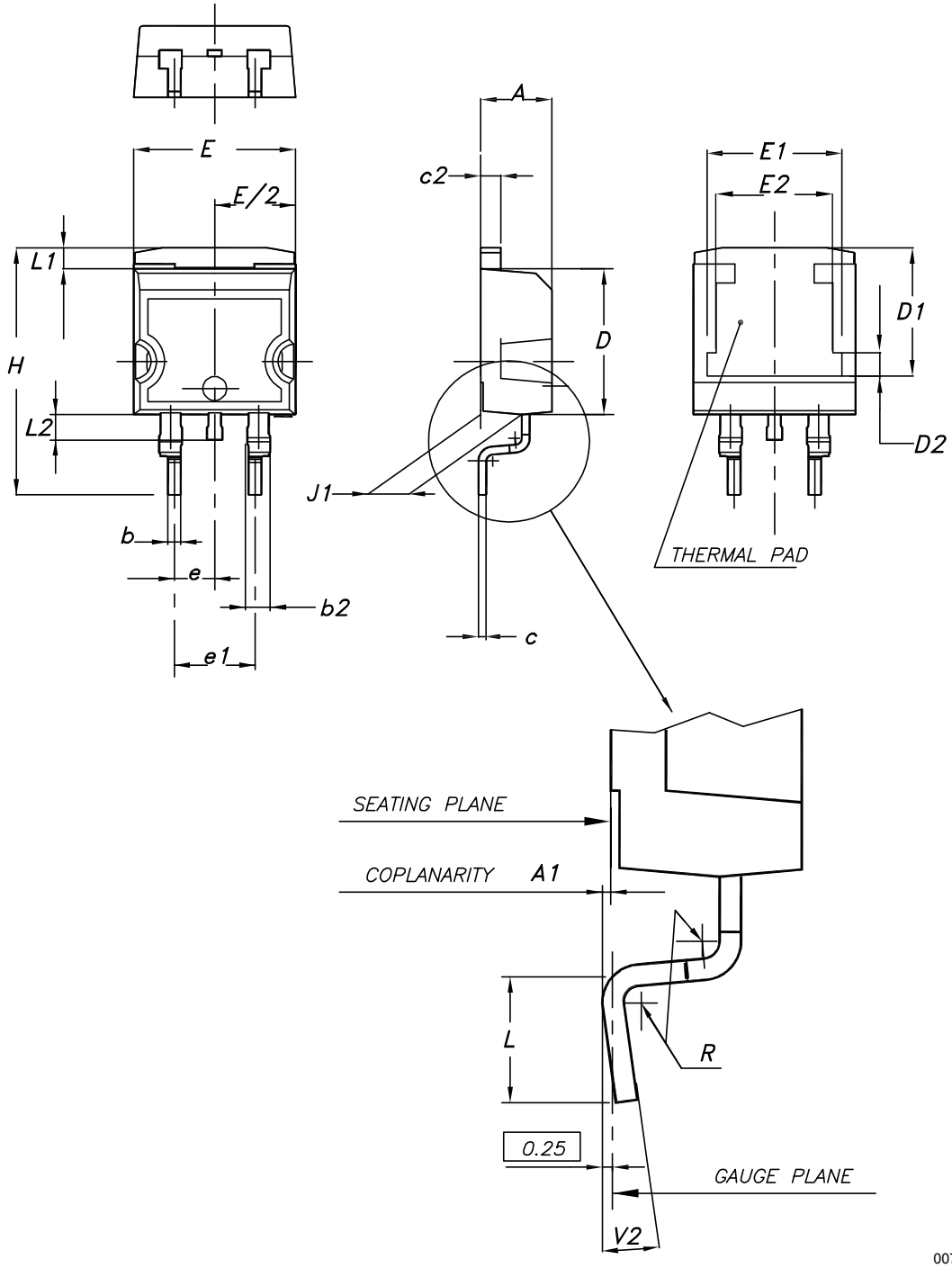


Table 8. D²PAK (TO-263) type A package mechanical data

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**

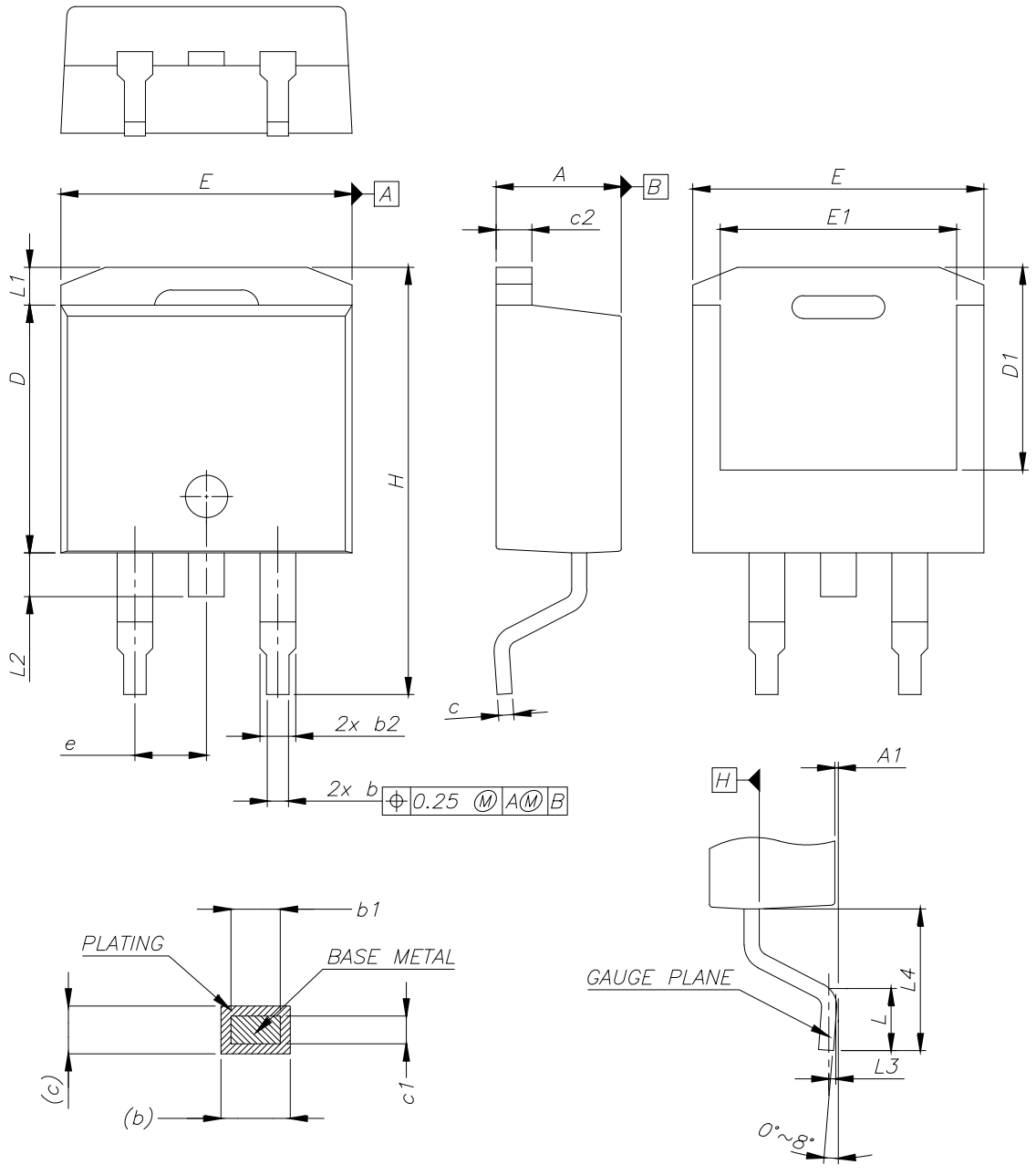


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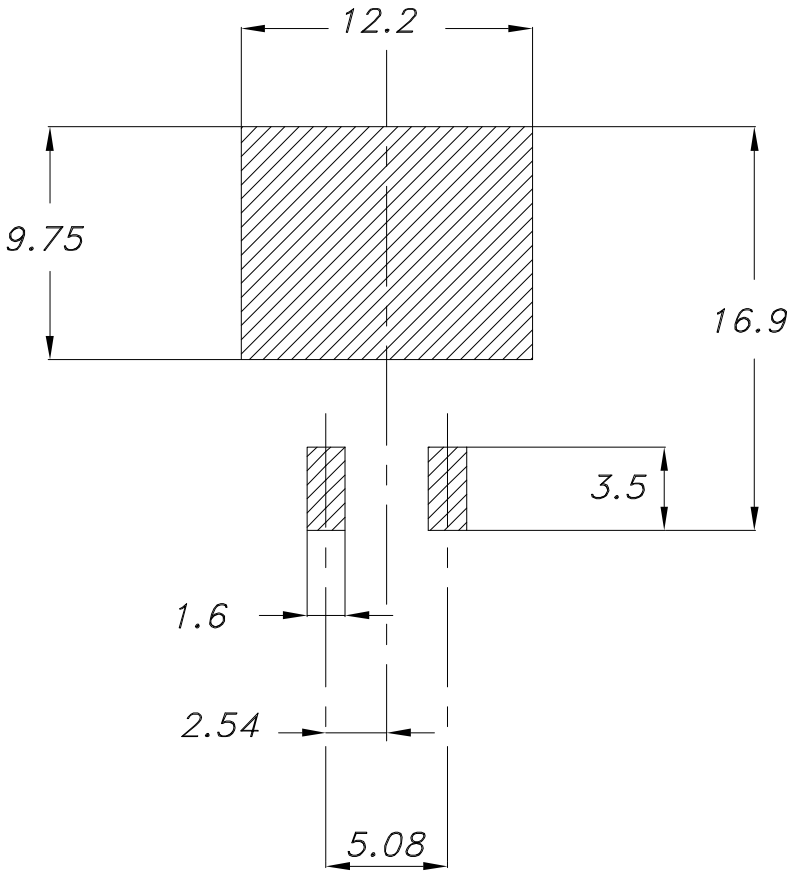
Table 9. **D²PAK (TO-263) type B mechanical data**

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

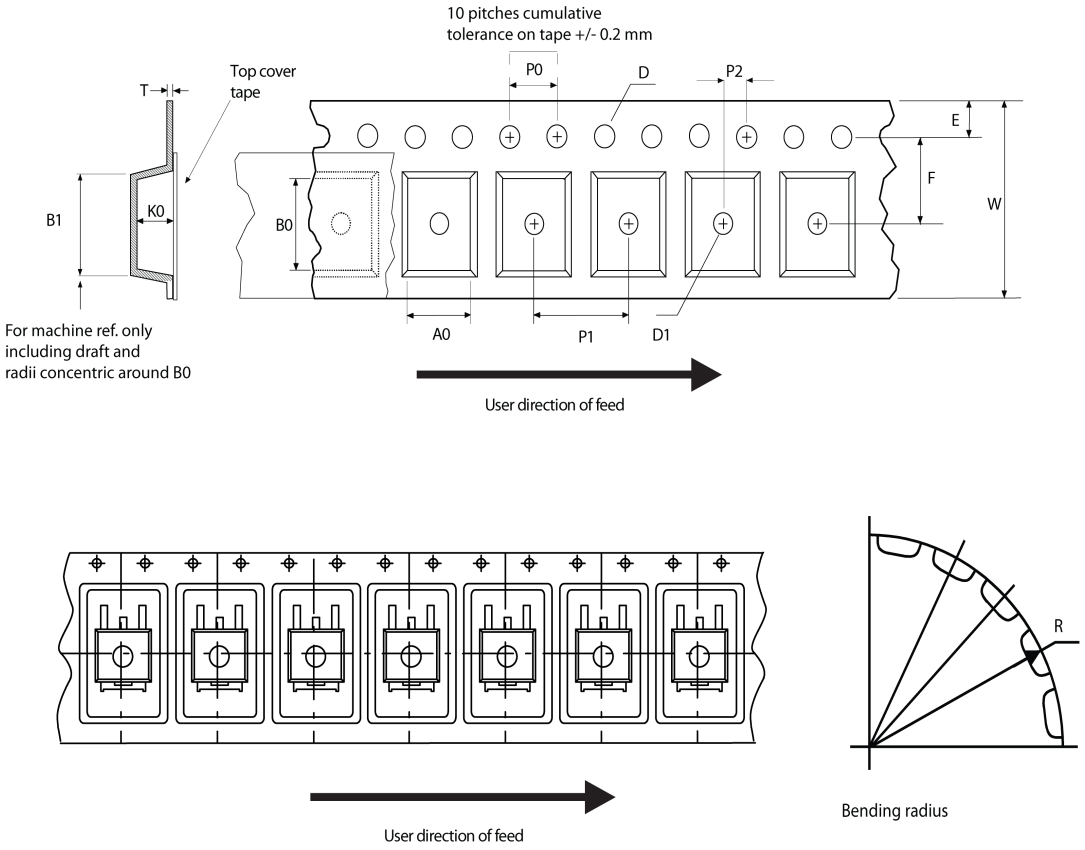


Figure 27. **D²PAK reel outline**

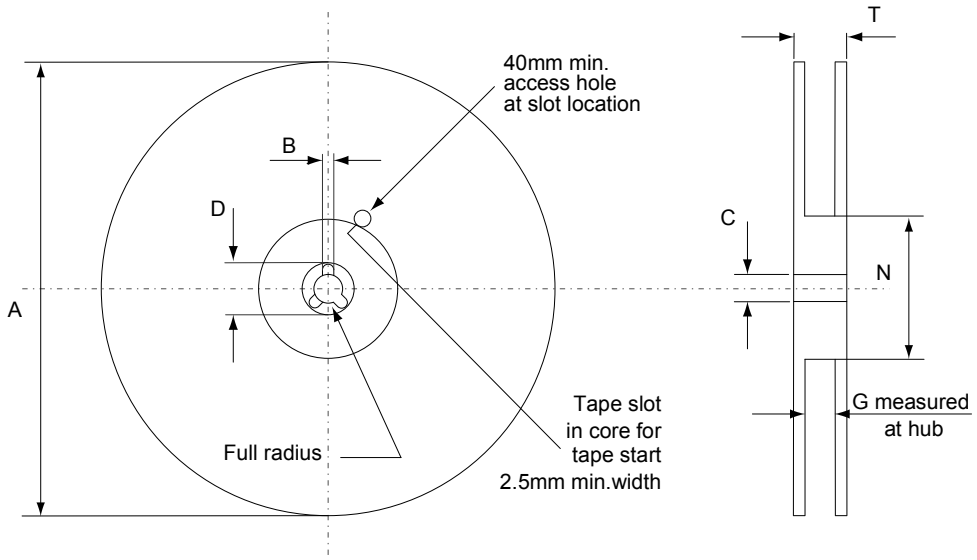


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Table 10. **D²PAK tape and reel mechanical data**

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 D²PAK type B packing information

Figure 28. **D²PAK type B tape outline**

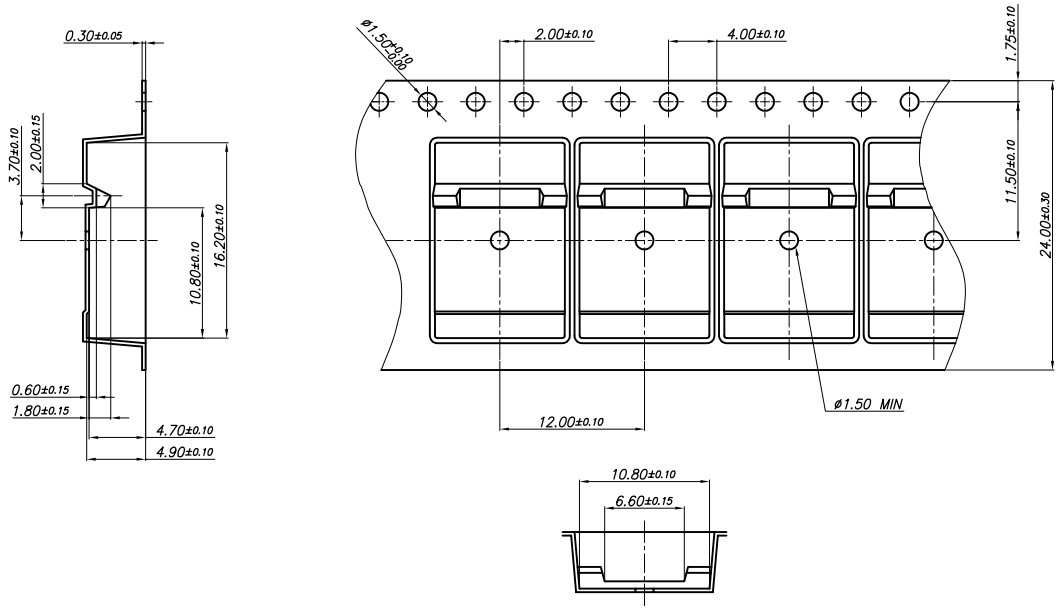

Figure 29. **D²PAK type B reel outline**

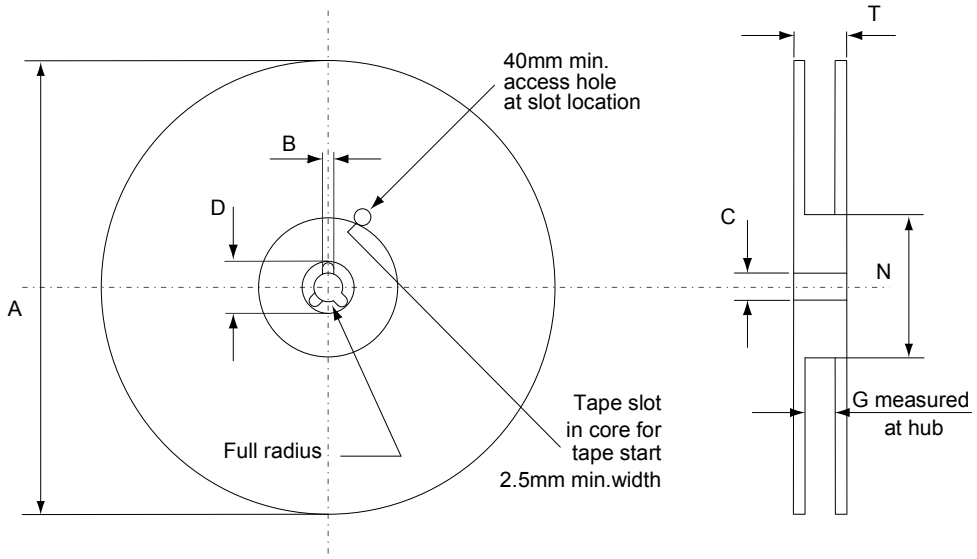

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Table 11. D²PAK type B reel mechanical data

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**

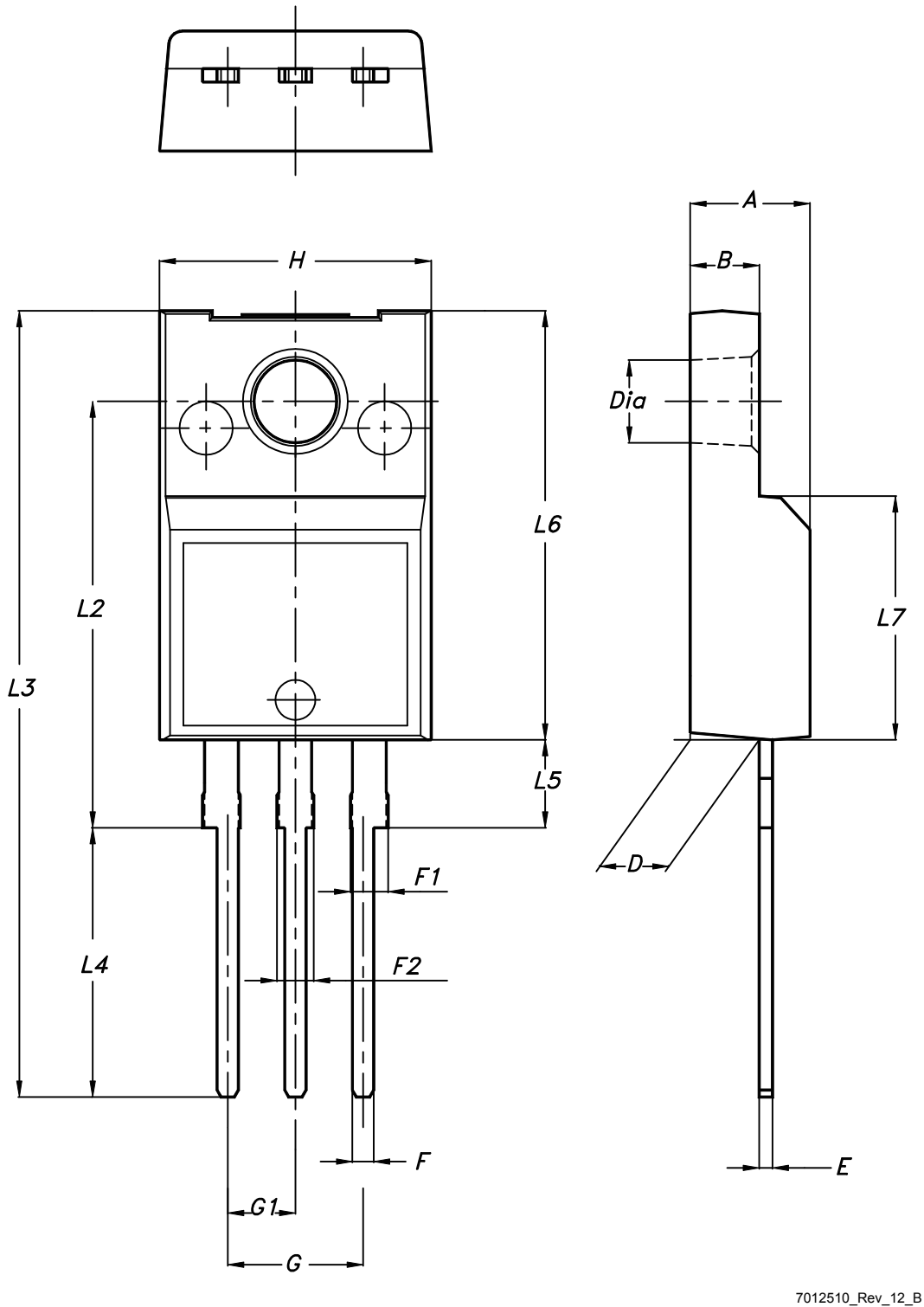

Table 12. **TO-220FP package mechanical data**

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**

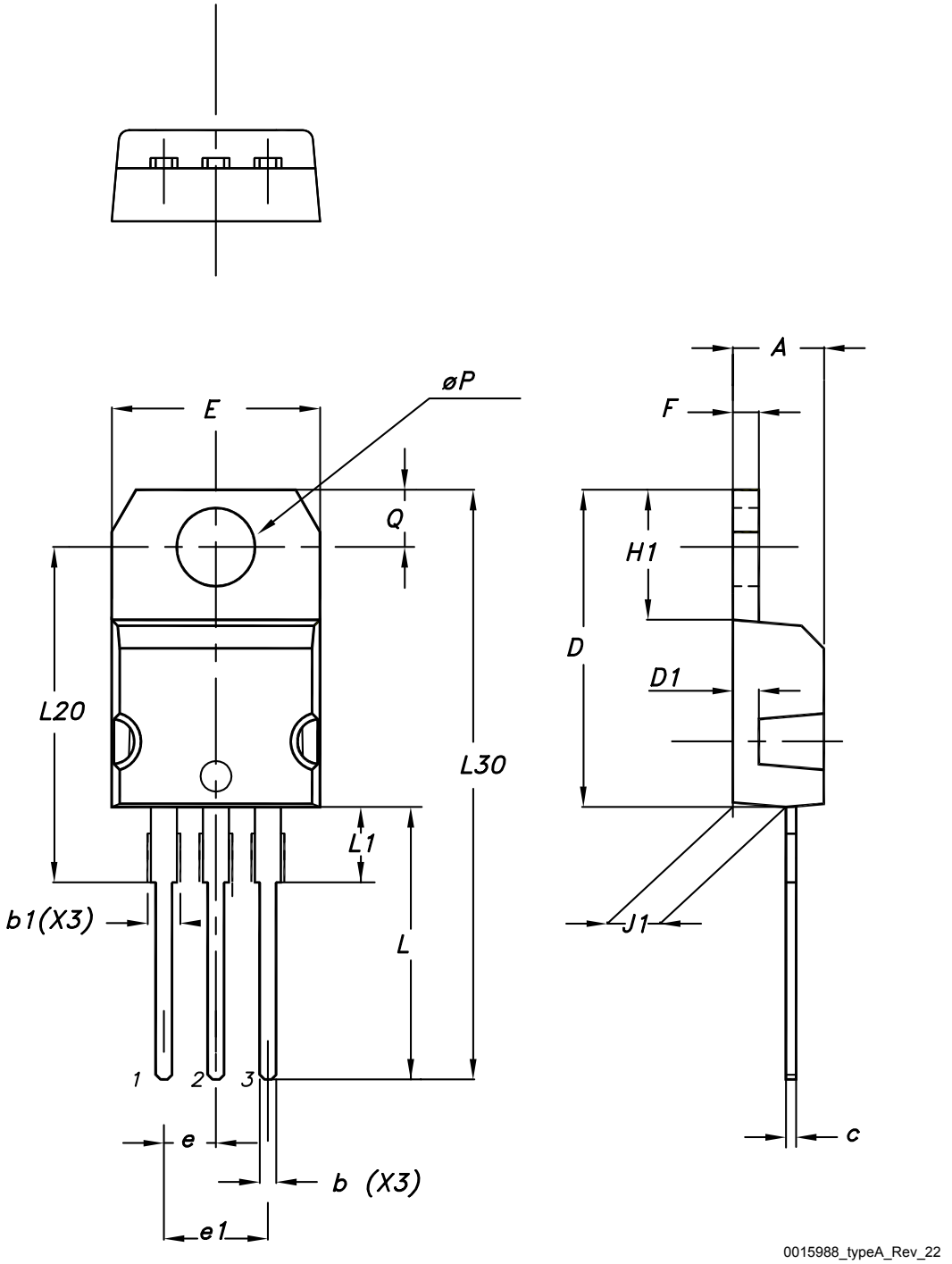

Table 13. **TO-220 type A package mechanical data**

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**

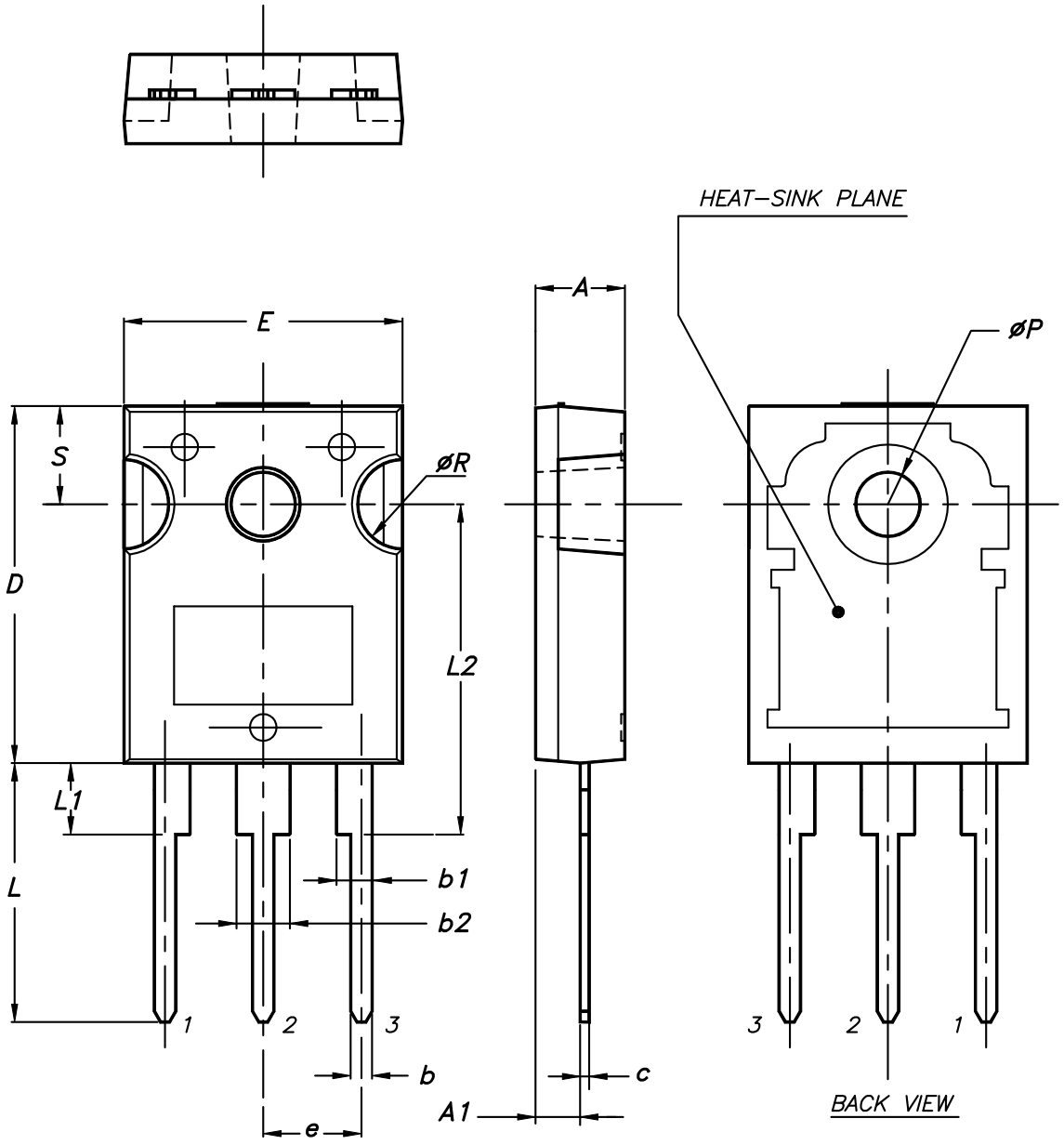

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Table 14. **TO-247 package mechanical data**

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^2PAK	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 *note 2* under the *Table 2*. – Updated typical values in Table 4, 5 and 6. – Added *Section 2.1*. – Minor text changes on the cover page.
05-Mar-2013	3	Added dv/dt value on *Table 2: Absolute maximum ratings*.
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.

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