

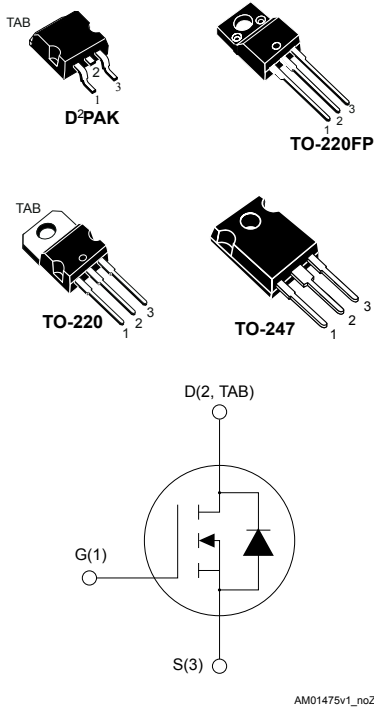


STB31N65M5, STF31N65M5 STP31N65M5, STW31N65M5

Datasheet

N-channel 650 V, 124 mΩ typ., 22 A, MDmesh M5 Power MOSFETs in D²PAK, TO-220FP, TO-220 and TO-247 packages

Features



Order code	$V_{DS} @ T_{JMAX}$	$R_{DS(on) \text{ max.}}$	I_D	Package
STB31N65M5	710 V	148 mΩ	22 A	D ² PAK
STF31N65M5				TO-220FP
STP31N65M5				TO-220
STW31N65M5				TO-247

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

Applications

- Switching applications

Description

This device is an N-channel Power MOSFET based on the MDmesh M5 innovative vertical process technology combined with the well-known PowerMESH horizontal layout. The resulting product offers extremely low on-resistance, making it 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)		2.5	kV
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 _{thJC}	Thermal resistance, junction-to-case	0.83		4.17	0.83	°C/W
R _{thJA}	Thermal resistance, junction-to-ambient	30 ⁽¹⁾	62.5		50	°C/W

1. When mounted on a standard 1 inch² area of FR-4 PCB with 2-oz copper.

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

$T_C = 25\text{ }^{\circ}\text{C}$ 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	$V_{GS} = 10\text{ V}$, $I_D = 11\text{ A}$		124	148	m Ω

1. Specified by design, not tested in production.

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	$f = 1\text{ MHz}$, $I_B = 0\text{ A}$	-	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 17. 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	$V_{DD} = 400\text{ V}$, $I_D = 14\text{ A}$, $R_G = 4.7\text{ }\Omega$ $V_{GS} = 10\text{ V}$	-	46	-	ns
$t_{r(v)}$	Voltage rise time		-	8	-	ns
$t_{f(i)}$	Current fall time		-	8.5	-	ns
$t_{c(off)}$	Crossing time	(see Figure 18. Test circuit for inductive load switching and diode recovery times and Figure 21. 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 18. 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	$I_{SD} = 22\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 100\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$ (see Figure 18. 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)

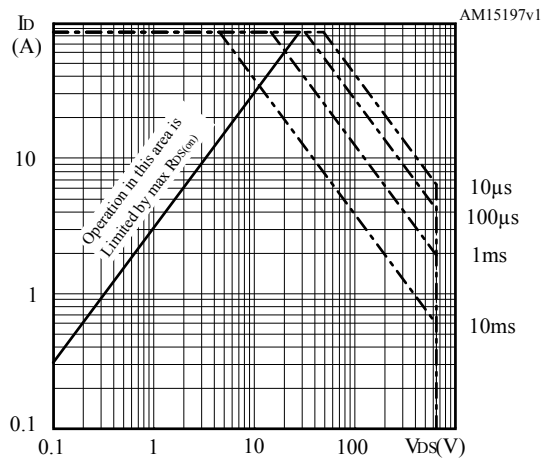
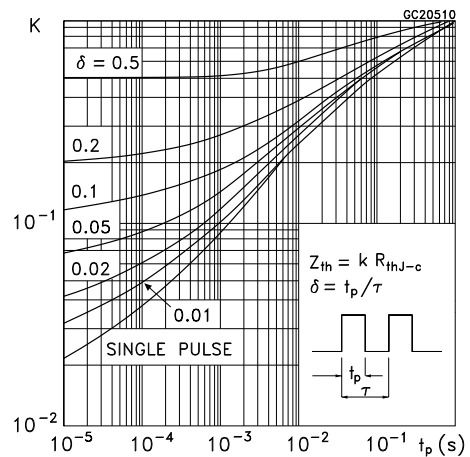
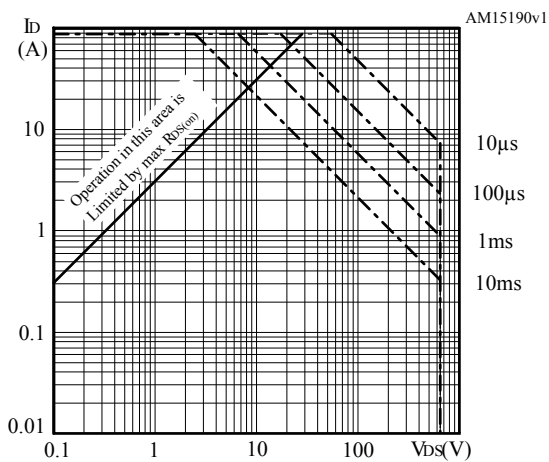
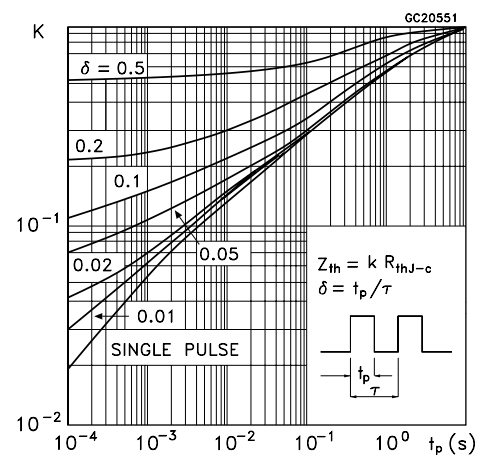
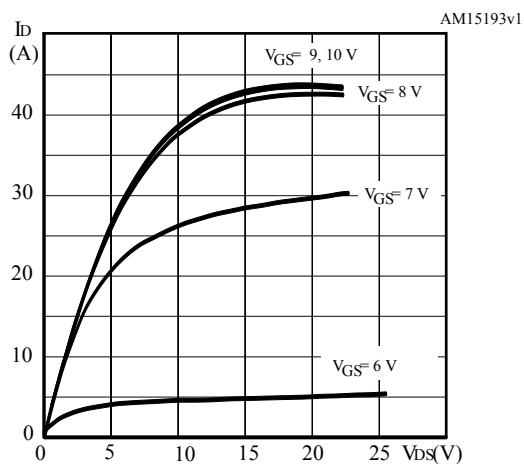
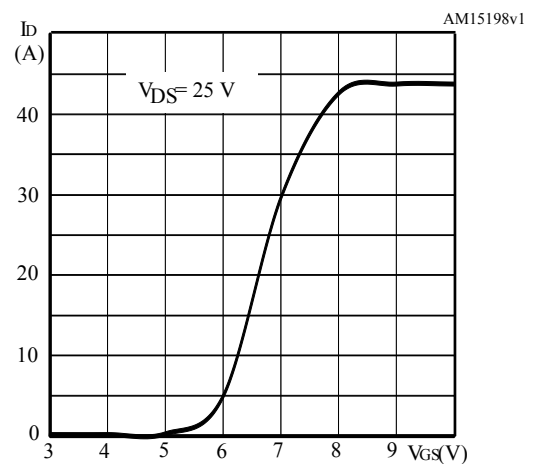
Figure 1. Safe operating area for D²PAK, TO-220 and TO-247

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


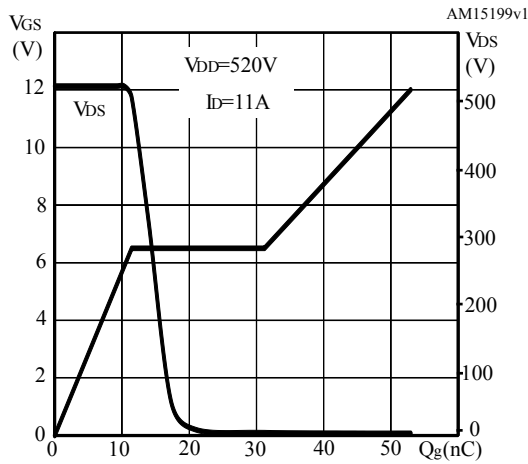
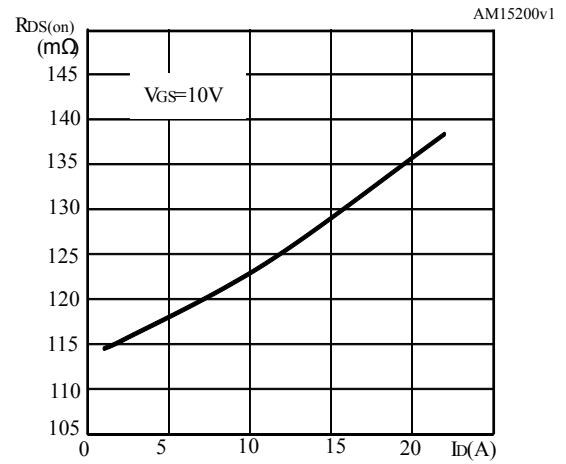
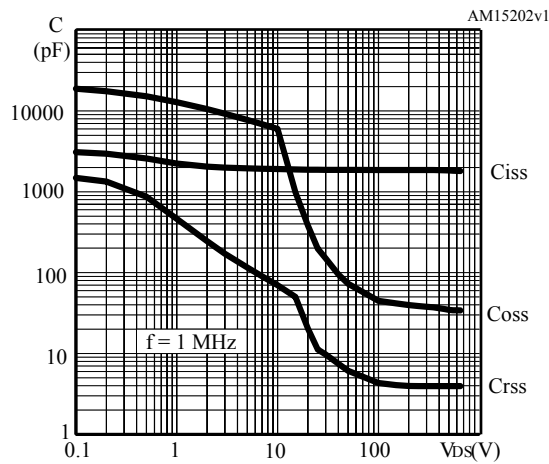
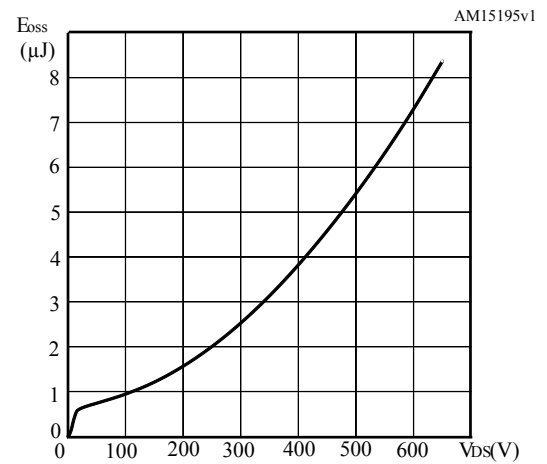
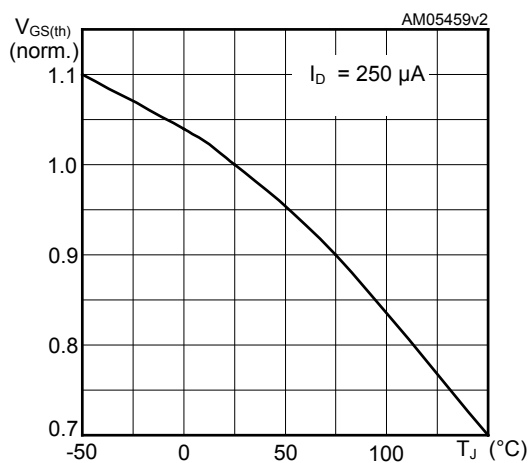
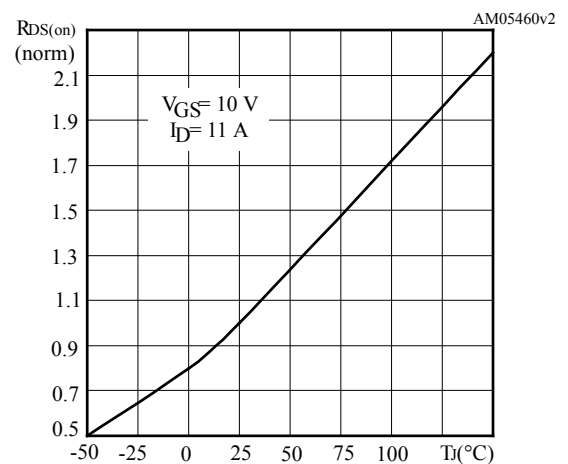
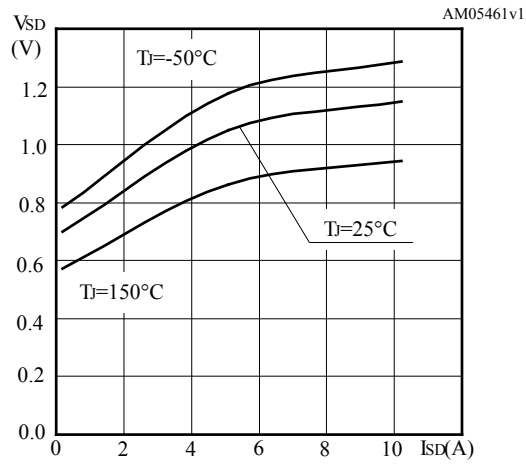
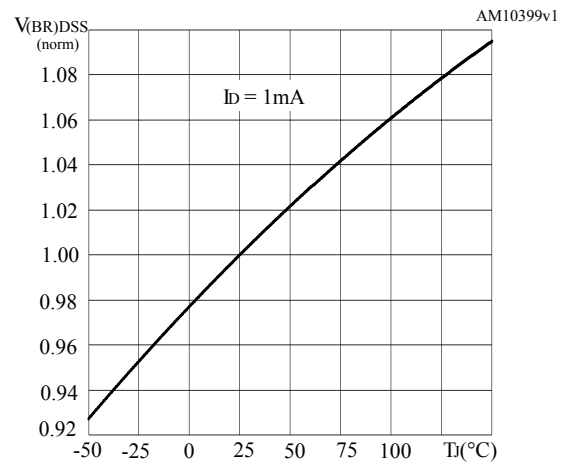
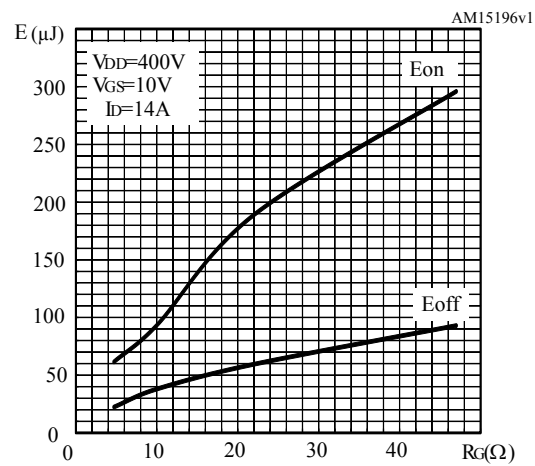
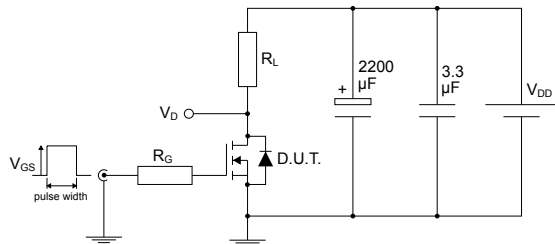
Figure 7. Gate charge vs gate-source voltage

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


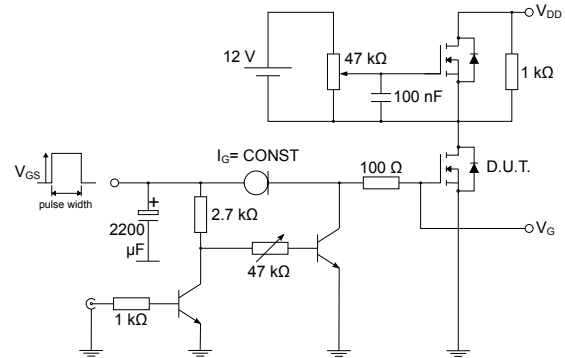
Figure 13. Source-drain diode forward characteristics

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.

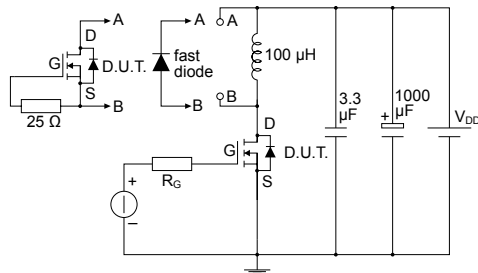
3 Test circuits

Figure 16. Test circuit for resistive load switching times


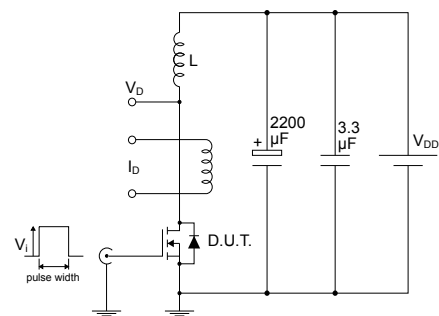
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Figure 17. Test circuit for gate charge behavior


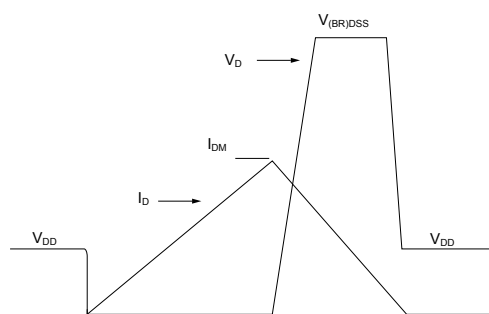
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Figure 18. Test circuit for inductive load switching and diode recovery times


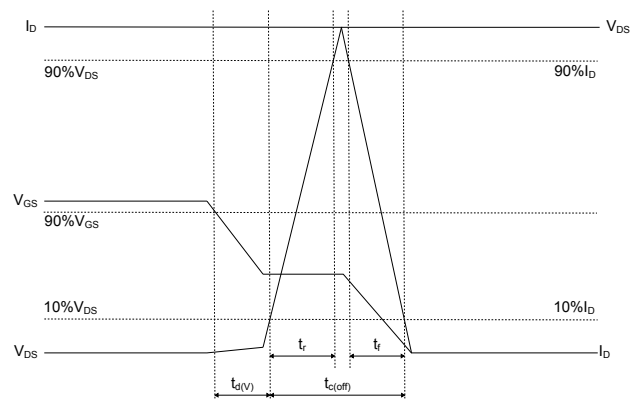
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Figure 19. Unclamped inductive load test circuit


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Figure 20. Unclamped inductive waveform


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Figure 21. Switching time waveform


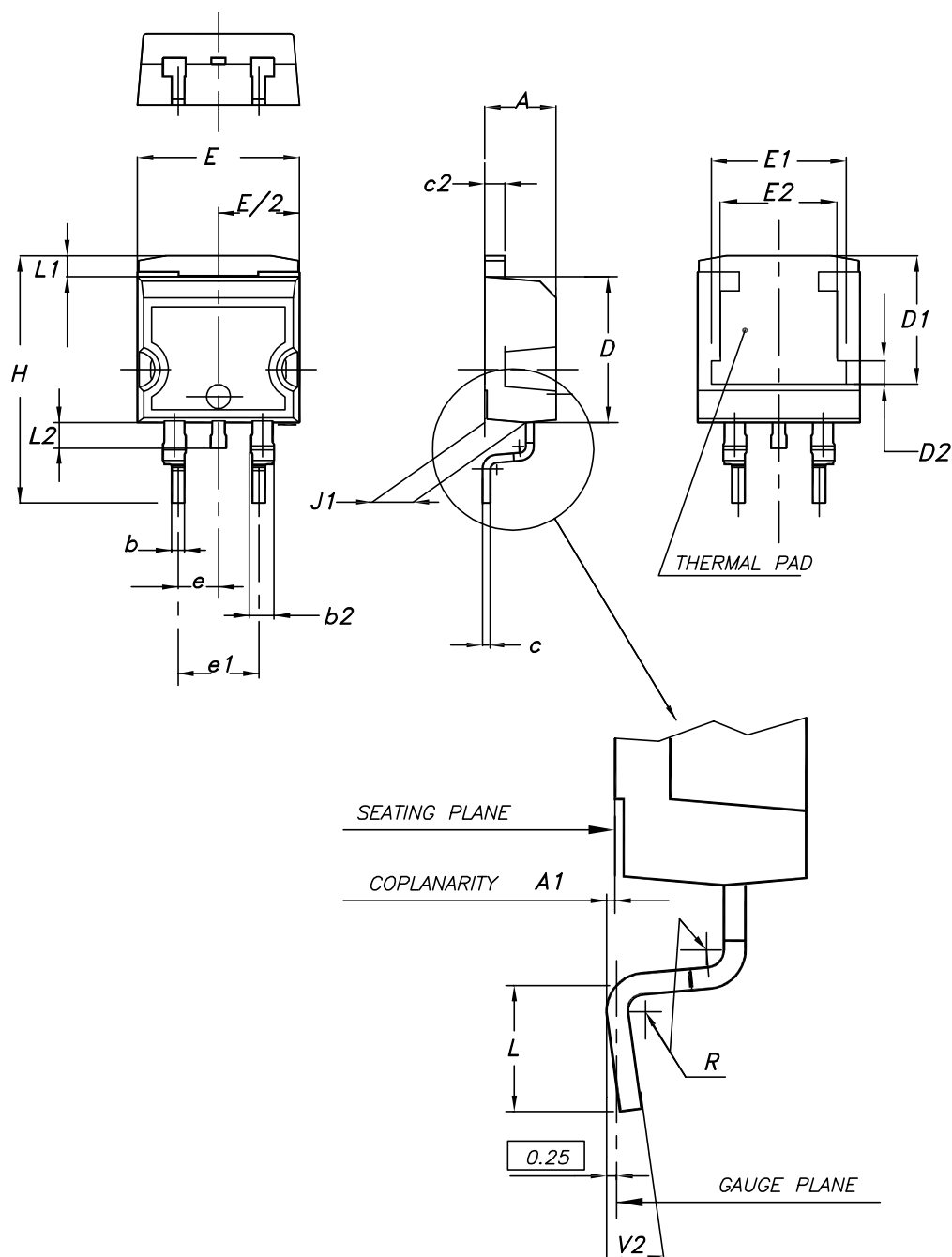
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4 Package information

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



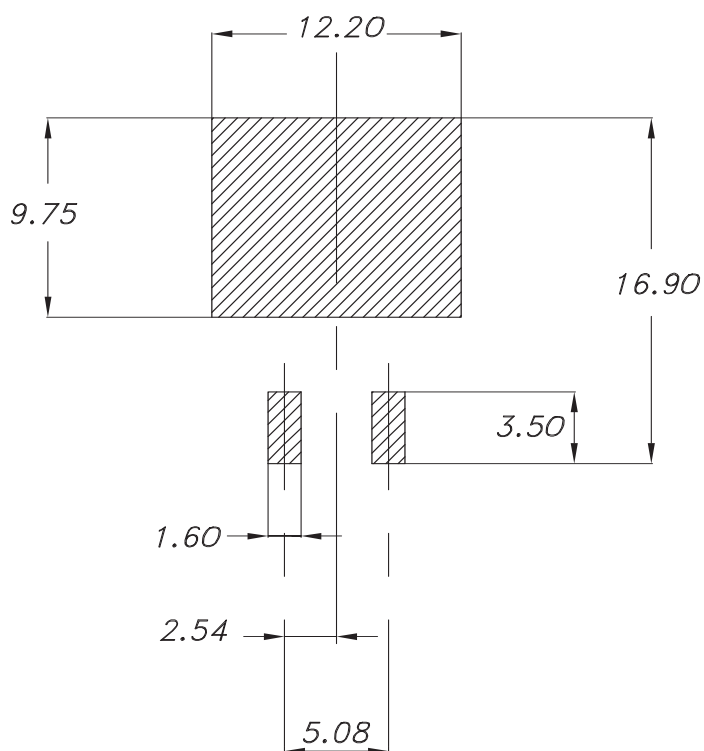
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Table 8. D²PAK (TO-263) type A package mechanical data

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°

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

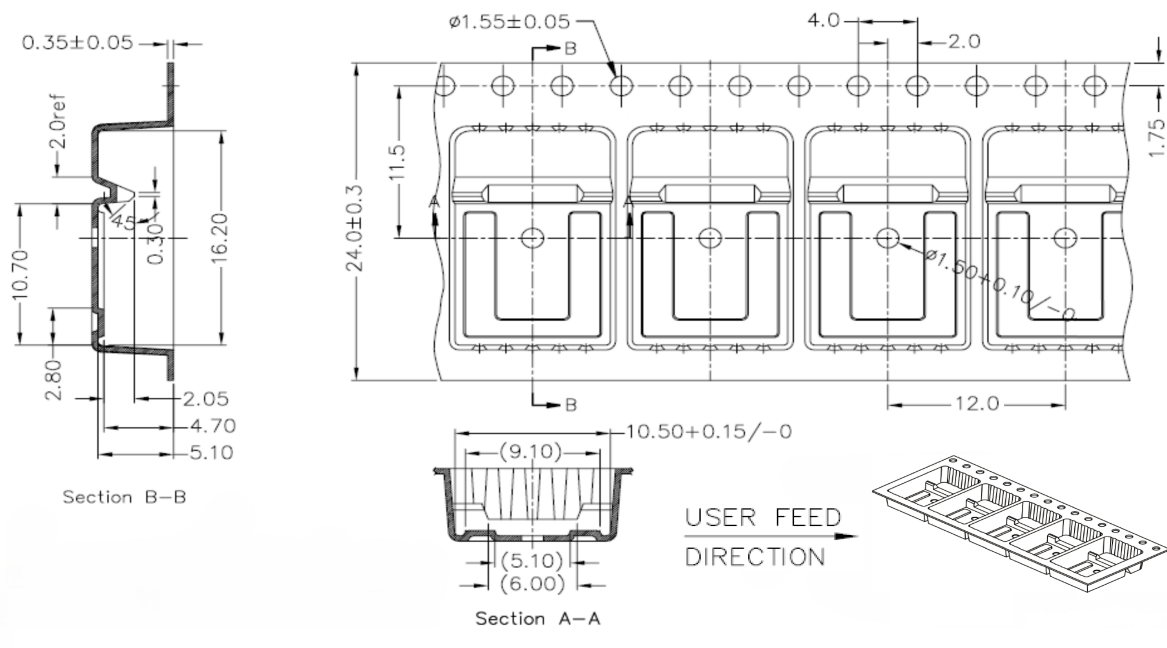
Dim.	mm		
	Min.	Typ.	Max.
A	4.36		4.56
A1	0.00		0.25
b	0.70		0.90
b1	0.51		0.89
b2	1.17		1.37
c	0.38		0.694
c1	0.38		0.534
c2	1.19		1.34
D	8.60		9.00
D1	6.90		7.50
E	10.15		10.55
E1	8.10		8.70
e	2.54 BSC		
H	15.00		15.60
L	1.90		2.50
L1			1.65
L2			1.78
L3		0.25	
L4	4.78		5.28

Figure 24. D²PAK (TO-263) recommended footprint (dimensions are in mm)


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4.3 D²PAK packing information

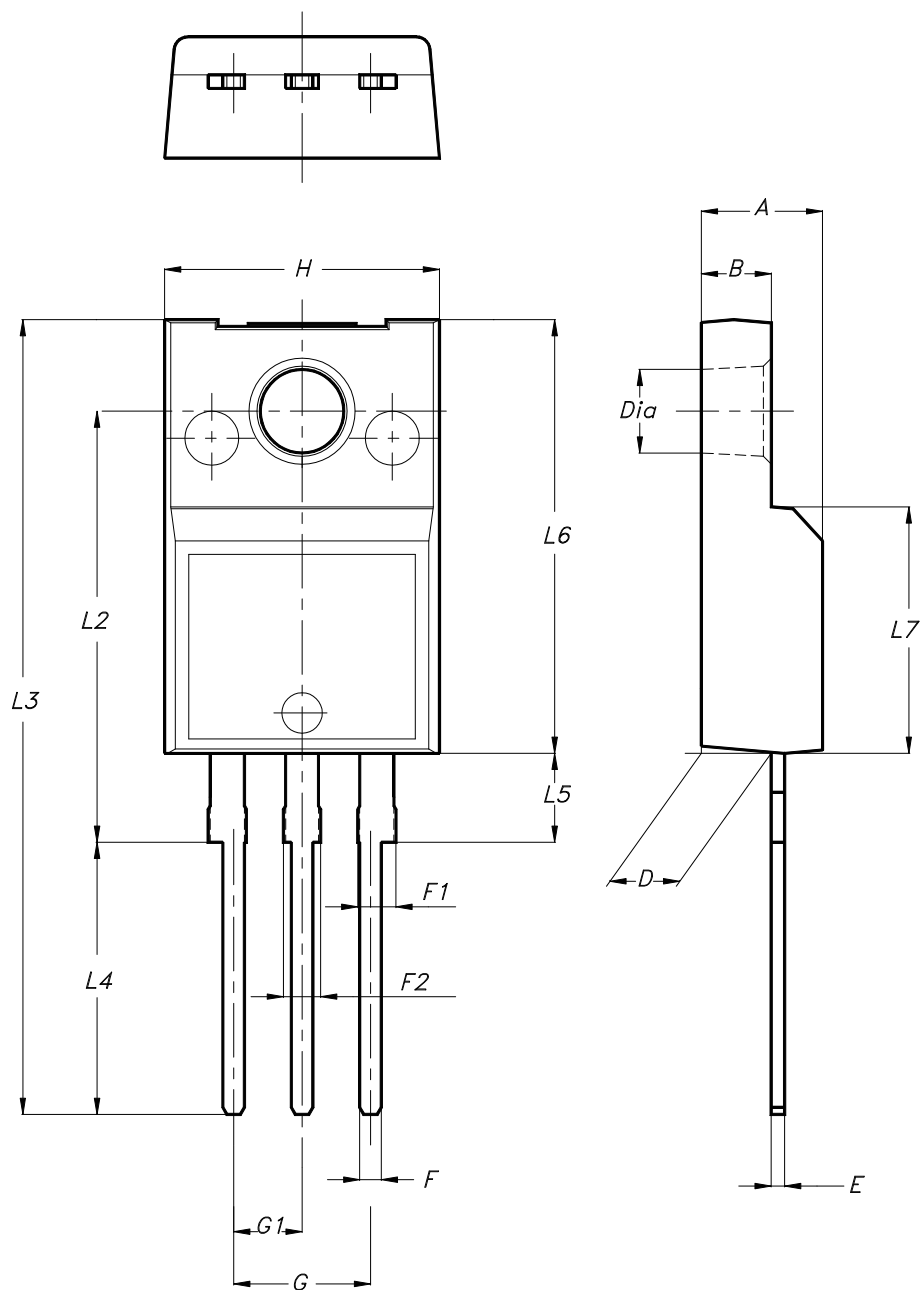
Figure 25. D²PAK tape drawing (dimensions are in mm)



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4.4 TO-220FP type B package information

Figure 26. TO-220FP type B package outline



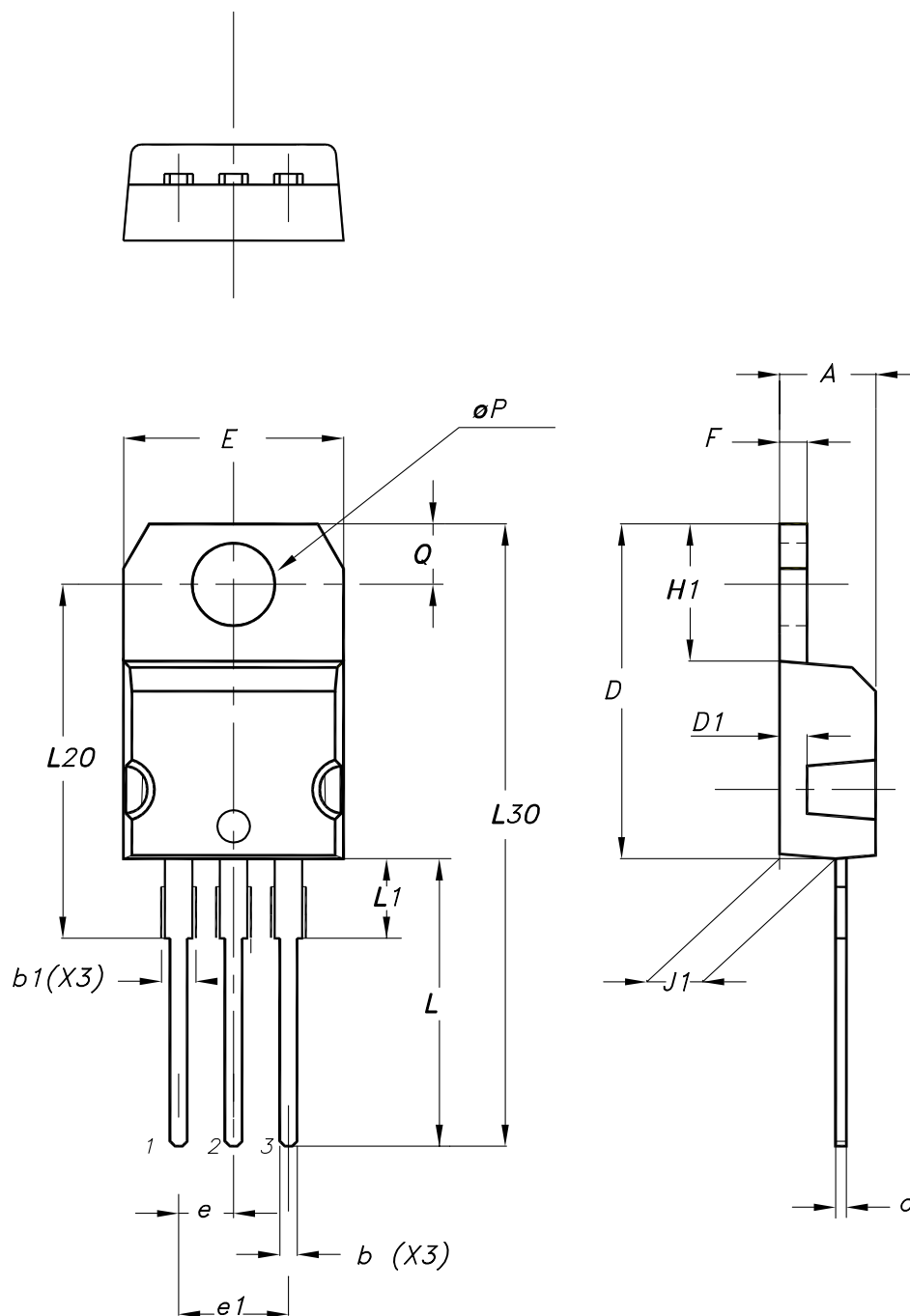
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Table 10. TO-220FP type B package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
B	2.50		2.70
D	2.50		2.75
E	0.45		0.70
F	0.75		1.00
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.20
G1	2.40		2.70
H	10.00		10.40
L2		16.00	
L3	28.60		30.60
L4	9.80		10.60
L5	2.90		3.60
L6	15.90		16.40
L7	9.00		9.30
Dia	3.00		3.20

4.5 TO-220 type A package information

Figure 27. TO-220 type A package outline



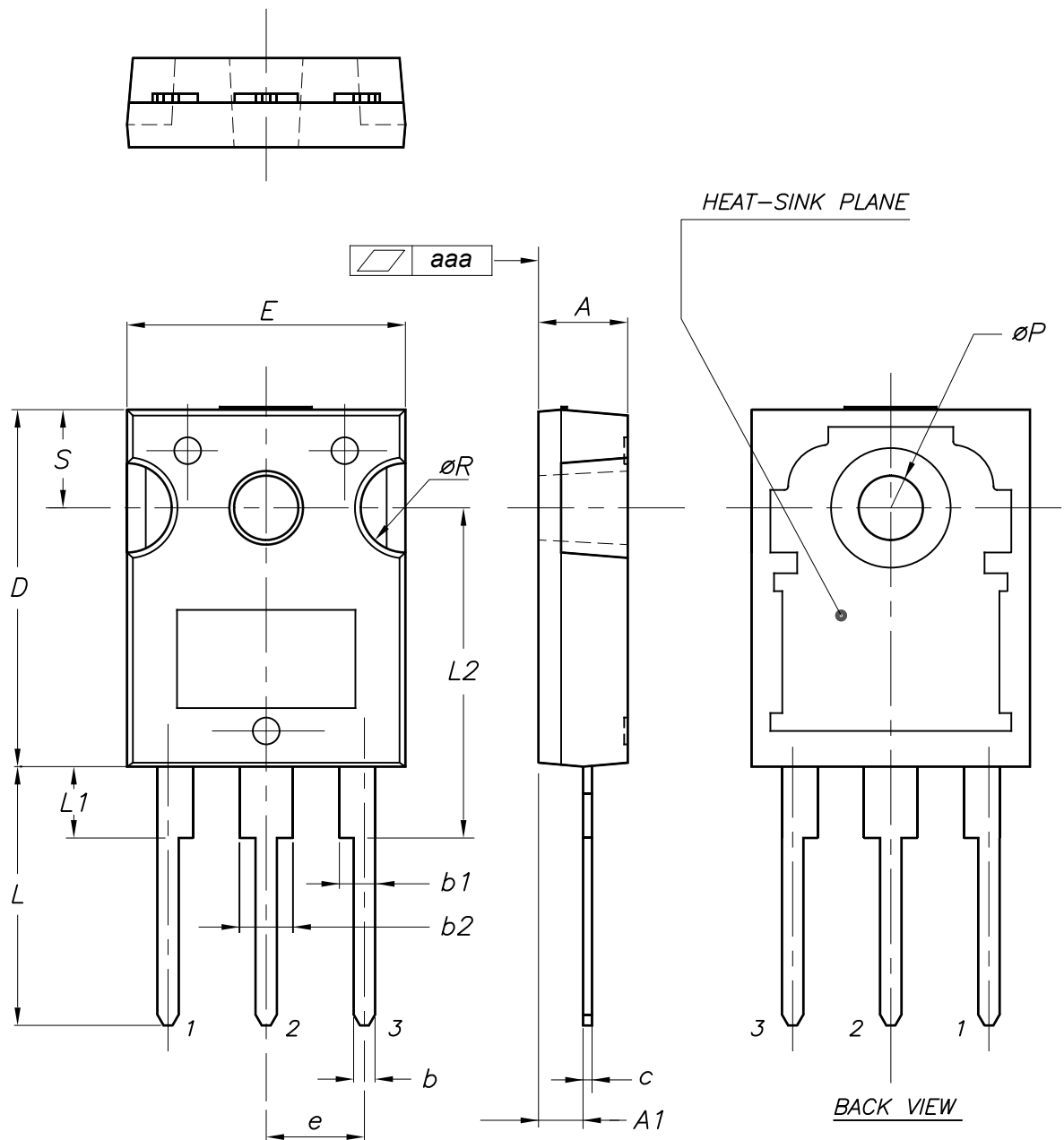
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Table 11. TO-220 type A package mechanical data

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
Slug flatness		0.03	0.10

4.6 TO-247 package information

Figure 28. TO-247 package outline



0075325_10

Table 12. 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
aaa		0.04	0.10



5 Ordering information

Table 13. 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 14. 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 <i>Section 4 Package information</i>. Added <i>Section 5 Ordering information</i>. Minor text changes.
21-Aug-2025	5	Updated Section 4: Package information. Minor text changes.

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