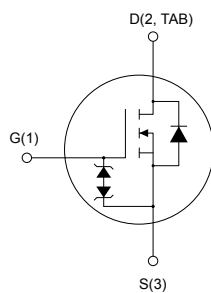
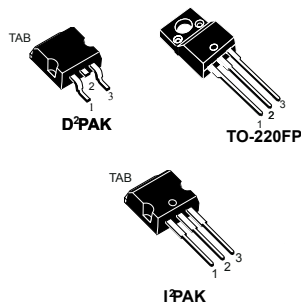




N-channel 650 V, 117 mΩ typ., 24 A MDmesh M2 Power MOSFET in a D²PAK, TO-220FP and I²PAK packages



AM01476v1_tab



Features

Order code	V _{DS}	R _{DS(on)} max.	I _D
STB33N65M2	650 V	140 mΩ	24 A
STF33N65M2			
STI33N65M2			

- Extremely low gate charge
- Excellent output capacitance (C_{oss}) profile
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using the MDmesh M2 technology. Thanks to their strip layout and improved vertical structure, these devices exhibit low on-resistance and optimized switching characteristics, rendering them suitable for the most demanding high-efficiency converters.

Product status links

[STB33N65M2](#)

[STF33N65M2](#)

[STI33N65M2](#)

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D ² PAK I ² PAK	TO-220FP	
V _{DS}	Drain-source voltage	650		V
V _{GS}	Gate-source voltage	±25		V
I _D	Drain current (continuous) at T _C = 25 °C	24		A
I _D	Drain current (continuous) at T _C = 100 °C	15		A
I _{DM} ⁽¹⁾	Drain current (pulsed)	96		A
P _{TOT}	Total power dissipation at T _C = 25 °C	190	34	W
dv/dt ⁽²⁾	Peak diode recovery voltage slope	15		V/ns
dv/dt ⁽³⁾	MOSFET dv/dt ruggedness	50		V/ns
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T _C = 25 °C)	-	2.5	kV
T _{stg}	Storage temperature range	-55 to 150		°C
T _J	Maximum operating junction temperature	150		°C

1. Pulse width limited by safe operating area.
2. $I_{SD} \leq 24$ A, $di/dt \leq 400$ A/ μ s, V_{DS} (peak) < V_{(BR)DSS}, V_{DD} = 400 V.
3. V_{DS} = 520 V.

Table 2. Thermal data

Symbol	Parameter	Value			Unit
		D ² PAK	I ² PAK	TO-220FP	
R _{thJC}	Thermal resistance, junction-to-case	0.66		3.68	°C/W
R _{thJA}	Thermal resistance, junction-to-ambient	30 ⁽¹⁾	62.5		°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 _J max.)	2.5	A
E _{AS}	Single pulse avalanche energy (starting T _J = 25 °C, I _D = I _{AR} , V _{DD} = 50 V)	780	mJ

2 Electrical characteristics

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

Table 4. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$, $V_{GS} = 0\text{ V}$	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	$V_{DS} = 0\text{ V}$, $V_{GS} = \pm 25\text{ V}$	-	-	± 10	μA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$	2	3	4	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$, $I_D = 12\text{ A}$	-	117	140	$\text{m}\Omega$

1. Specified by design, not tested in production.

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$	-	1790	-	pF
C_{oss}	Output capacitance		-	75	-	pF
C_{rss}	Reverse transfer capacitance		-	2	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent capacitance time related	$V_{DS} = 0\text{ to }520\text{ V}$, $V_{GS} = 0\text{ V}$	-	380	-	pF
Q_g	Total gate charge	$V_{DD} = 520\text{ V}$, $I_D = 24\text{ A}$, $V_{GS} = 0\text{ to }10\text{ V}$ (see the Figure 16. Test circuit for gate charge behavior)	-	41.5	-	nC
Q_{gs}	Gate-source charge		-	6.8	-	nC
Q_{gd}	Gate-drain charge		-	18	-	nC
R_g	Intrinsic gate resistance	$f = 1\text{ MHz}$, $I_D = 0\text{ A}$	-	5	-	Ω

1. $C_{oss\text{ eq.}}$ 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} .

Table 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 325\text{ V}$, $I_D = 12\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$	-	13.5	-	ns
t_r	Rise time		-	11.5	-	ns
$t_{d(off)}$	Turn-off delay time	(see the Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform)	-	72.5	-	ns
t_f	Fall time		-	9	-	ns

Table 7. Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-	-	24	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-	-	96	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 24\text{ A}$, $V_{GS} = 0\text{ V}$	-	-	1.6	V
t_{rr}	Reverse recovery time	$I_{SD} = 24\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$ (see the Figure 17. Test circuit for inductive load switching and diode recovery times)	-	426	-	ns
Q_{rr}	Reverse recovery charge		-	7	-	μC
I_{RRM}	Reverse recovery current		-	33.5	-	A
t_{rr}	Reverse recovery time	$I_{SD} = 24\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$, $T_J = 150\text{ }^{\circ}\text{C}$ (see the Figure 17. Test circuit for inductive load switching and diode recovery times)	-	544	-	ns
Q_{rr}	Reverse recovery charge		-	10	-	μC
I_{RRM}	Reverse recovery current		-	36.5	-	A

1. Pulse width limited by safe operating area.

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

2.1 Electrical characteristics (curves)

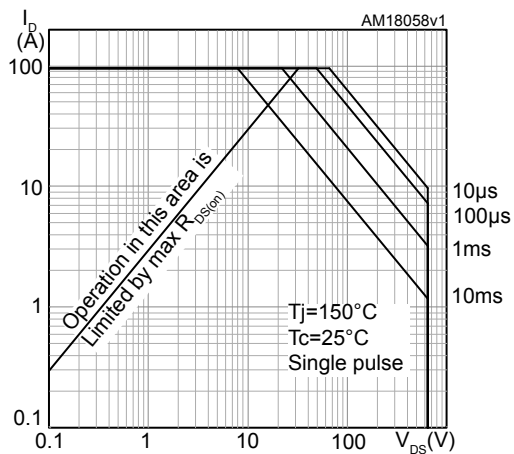
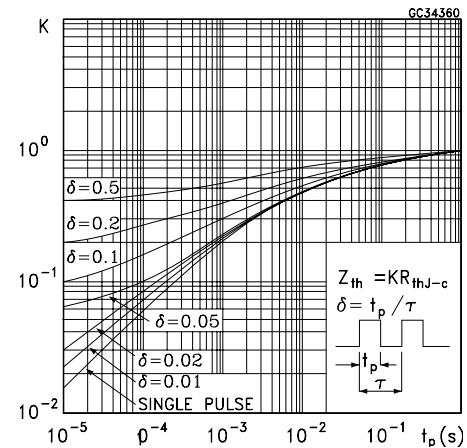
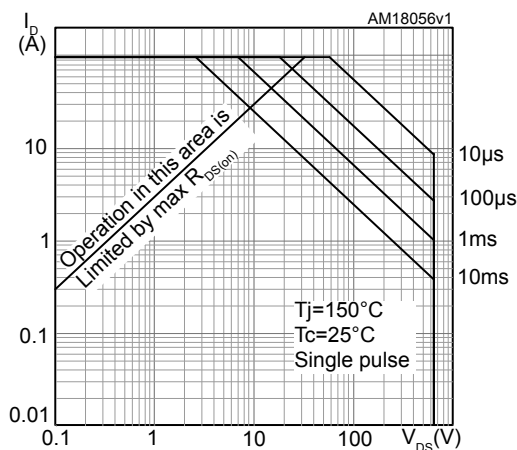
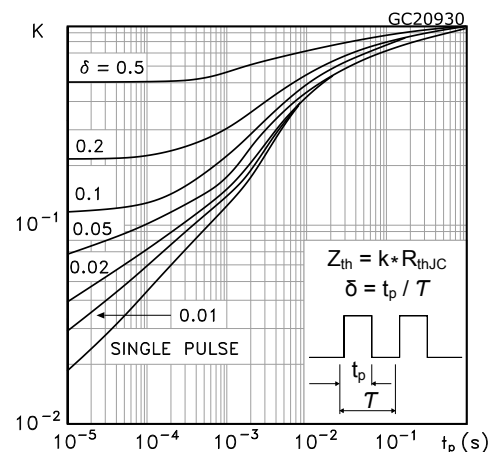
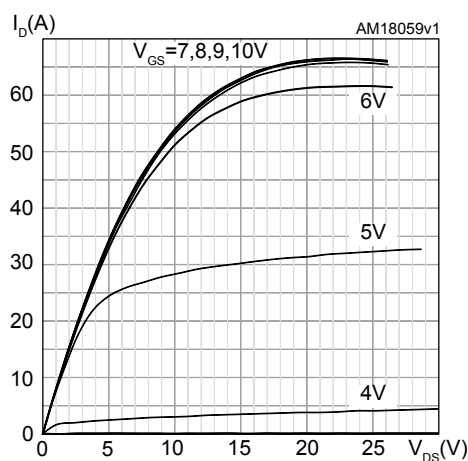
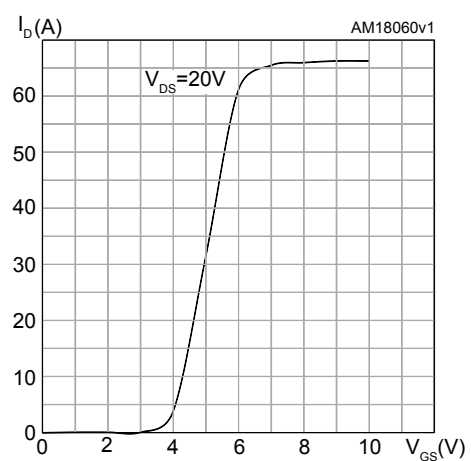
Figure 1. Safe operating area for D²PAK and I²PAK

Figure 2. Normalized transient thermal impedance for D²PAK and I²PAK

Figure 3. Safe operating area for TO-220FP

Figure 4. Normalized transient thermal impedance for TO-220FP

Figure 5. Typical output characteristics

Figure 6. Typical transfer characteristics


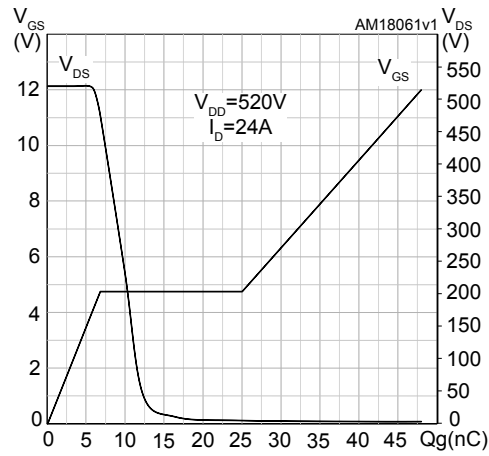
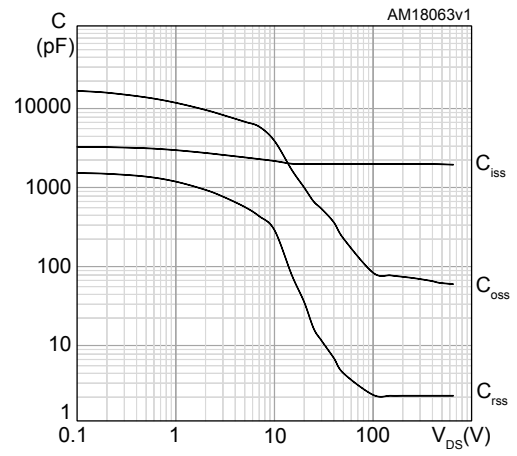
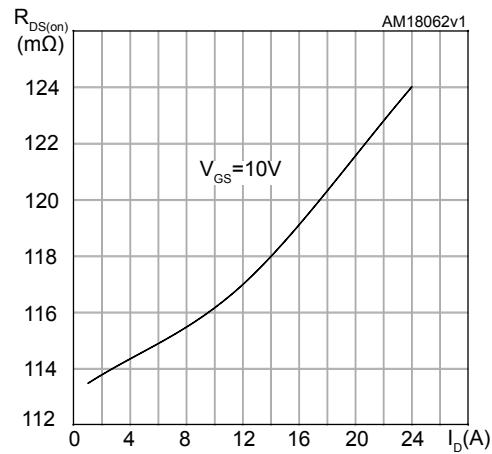
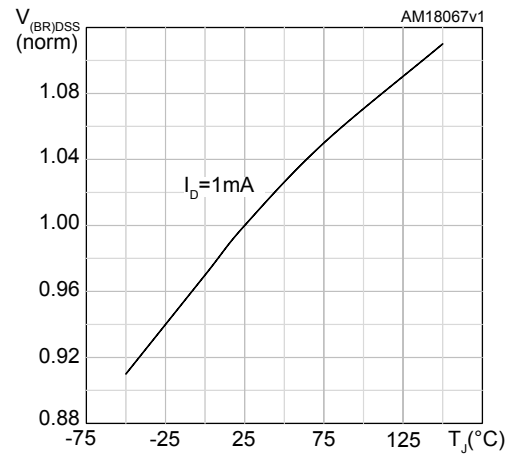
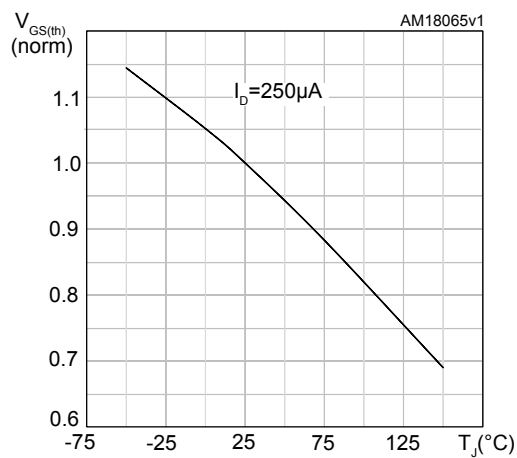
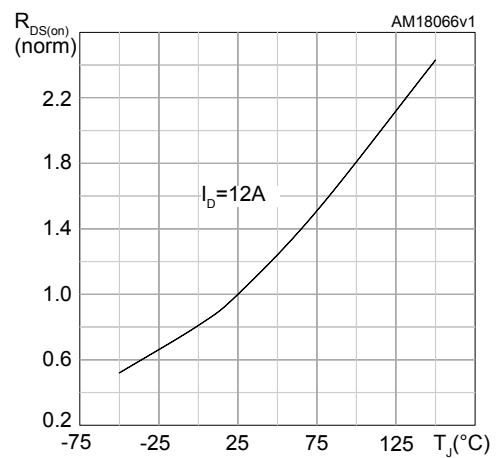
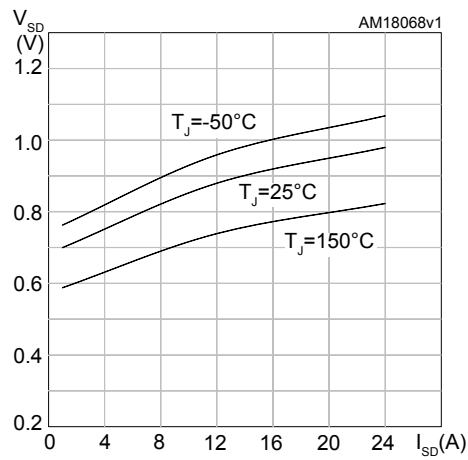
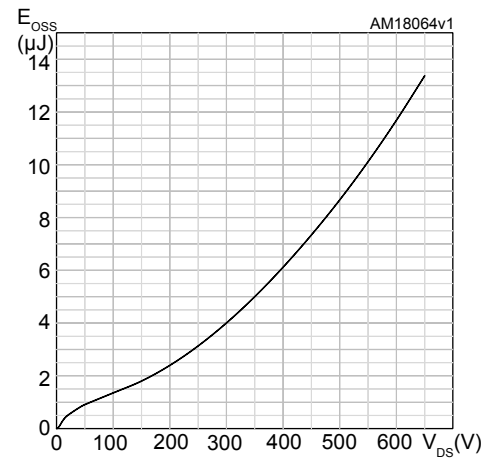
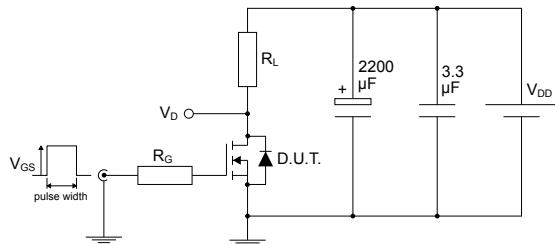
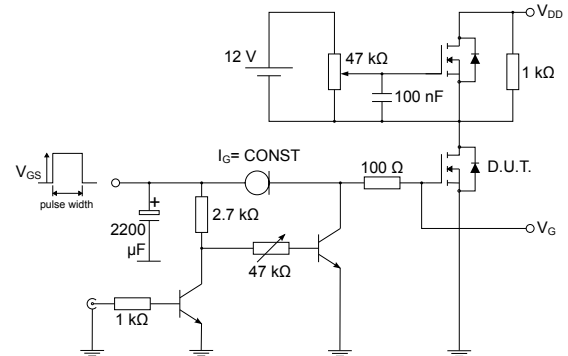
Figure 7. Typical gate charge characteristics

Figure 8. Typical capacitance characteristics

Figure 9. Typical drain-source on-resistance

Figure 10. Normalized breakdown voltage vs temperature

Figure 11. Normalized gate threshold vs temperature

Figure 12. Normalized on-resistance vs temperature


Figure 13. Typical reverse diode forward characteristics

Figure 14. Output capacitance stored energy


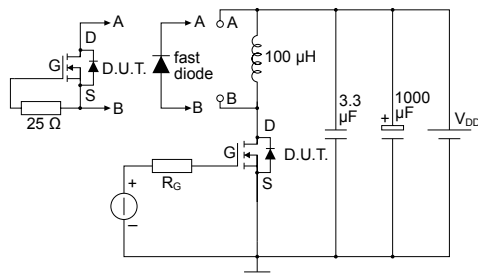
3 Test circuits

Figure 15. Test circuit for resistive load switching times


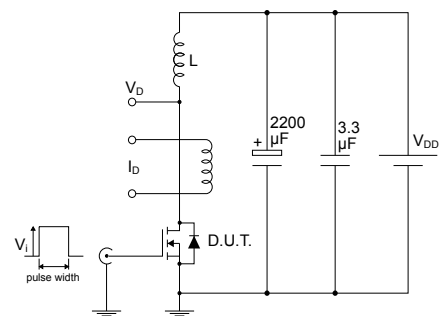
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Figure 16. Test circuit for gate charge behavior


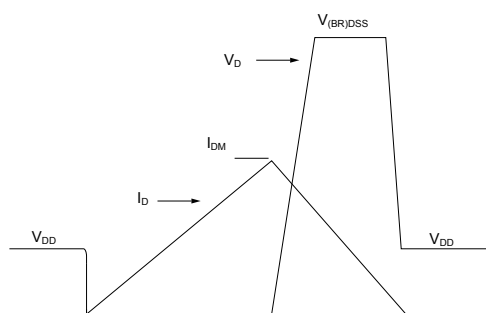
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Figure 17. Test circuit for inductive load switching and diode recovery times


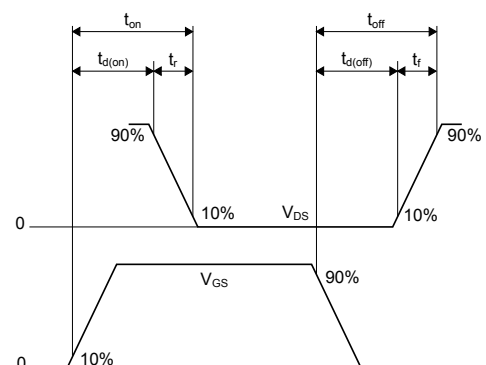
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Figure 18. Unclamped inductive load test circuit


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Figure 19. Unclamped inductive waveform


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Figure 20. Switching time waveform


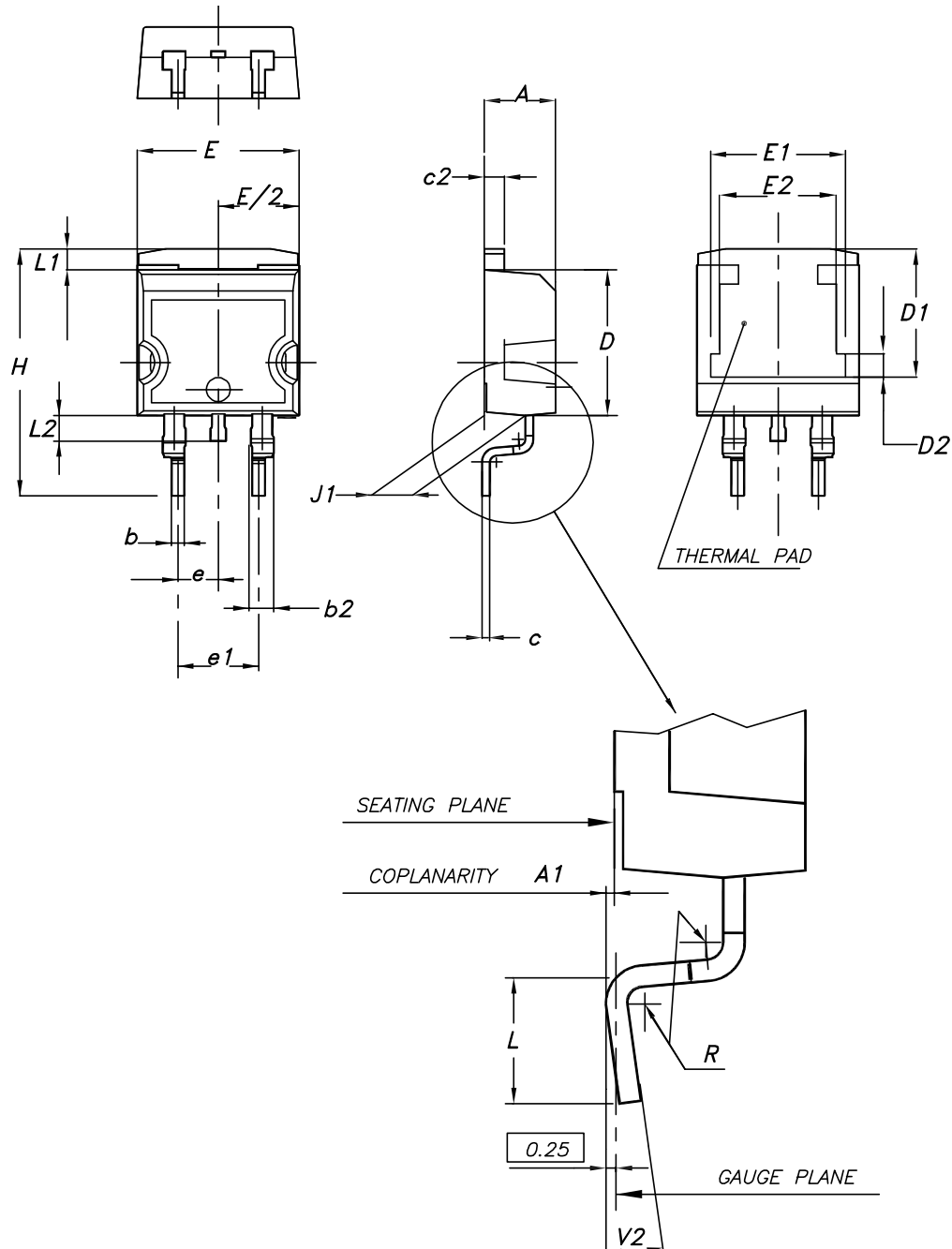
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4 Package information

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

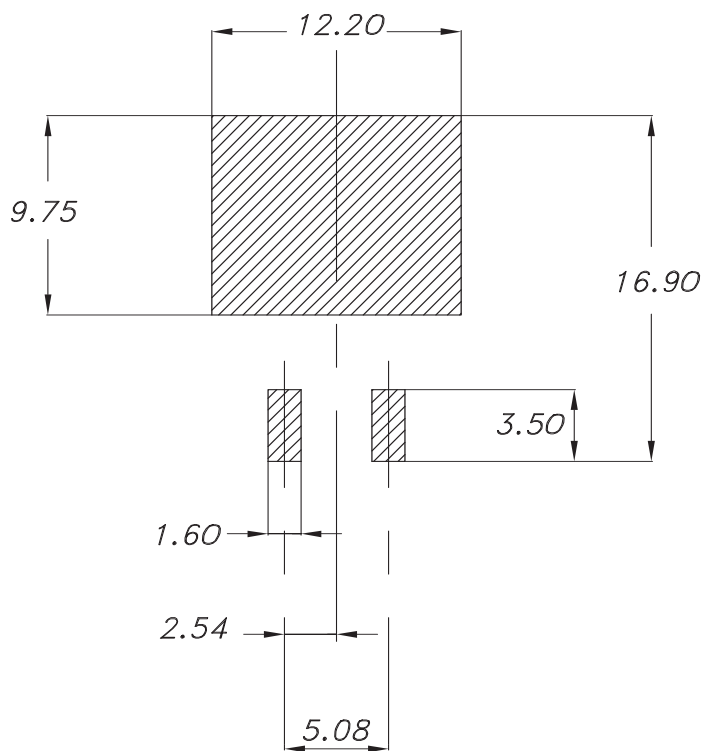


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Table 8. D²PAK (TO-263) type A package mechanical data

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°

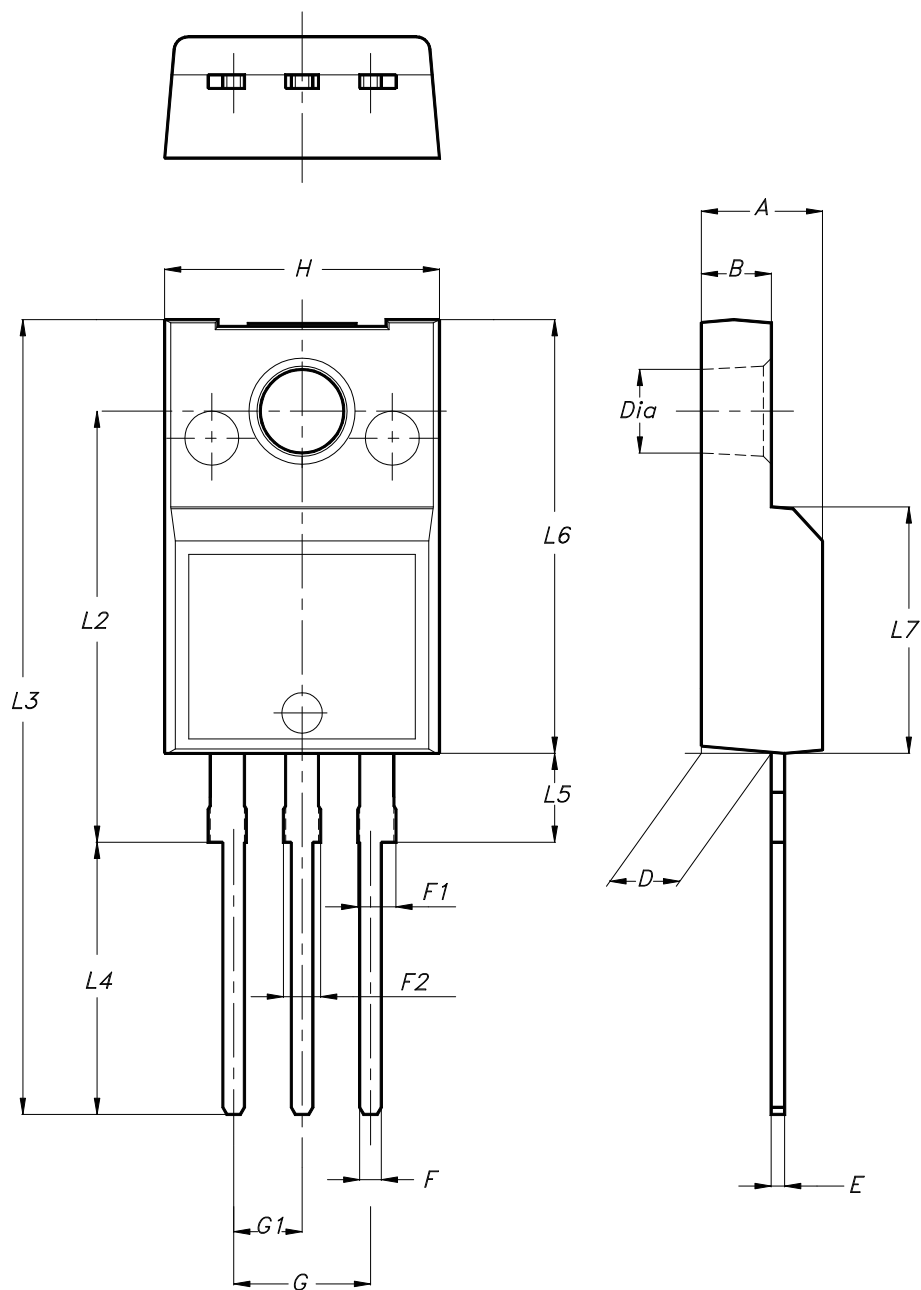
Figure 22. D²PAK (TO-263) recommended footprint (dimensions are in mm)



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4.2 TO-220FP type B package information

Figure 23. TO-220FP type B package outline



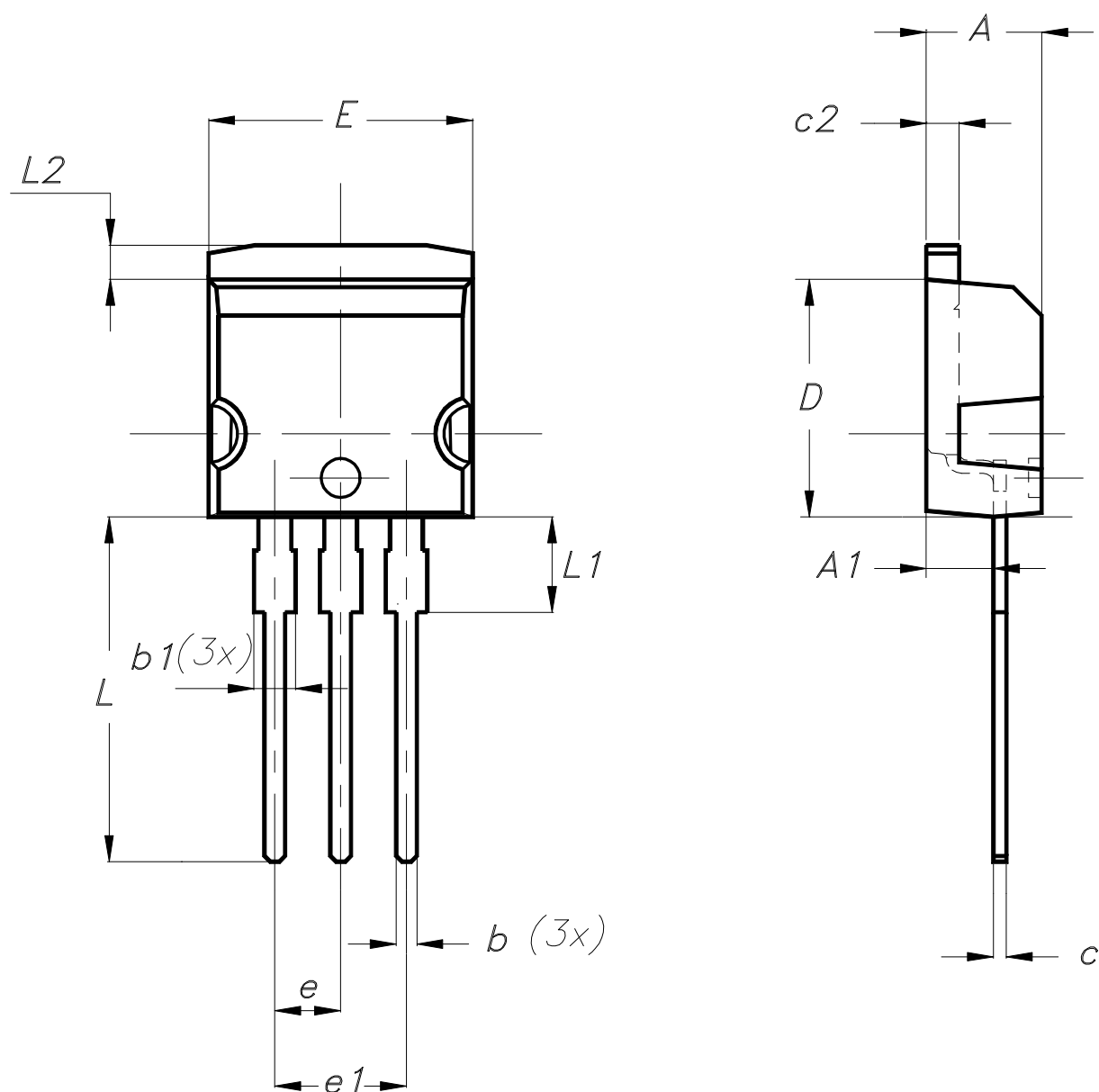
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Table 9. TO-220FP type B package mechanical data

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

4.3 I²PAK package information

Figure 24. I²PAK package outline



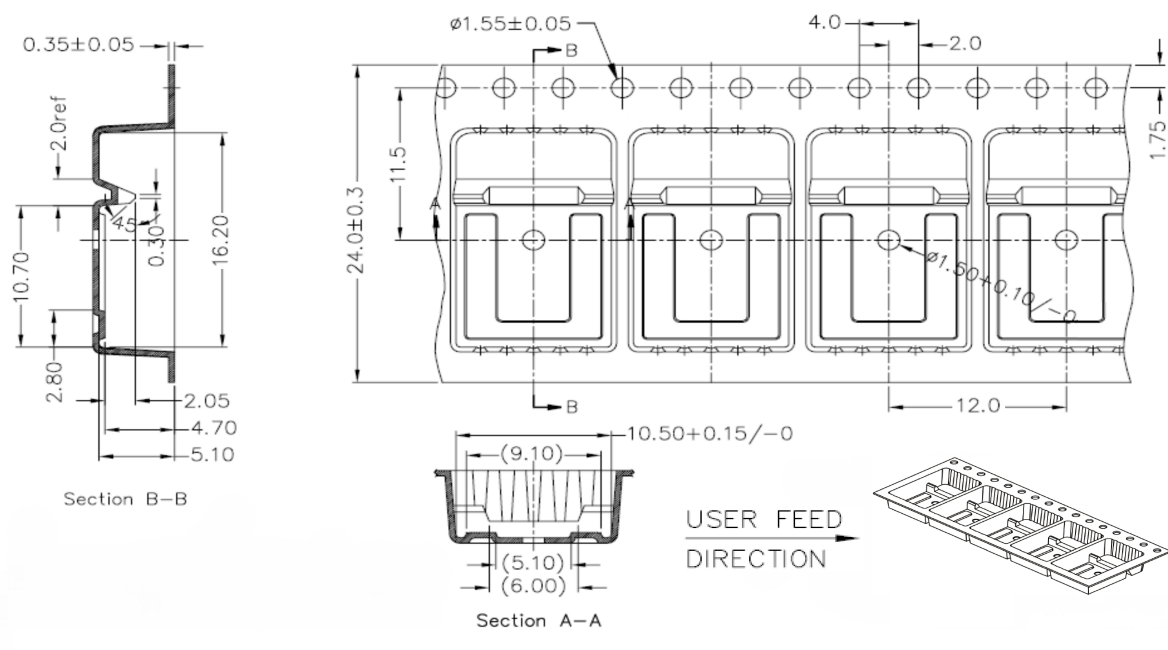
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Table 10. I²PAK package mechanical data

Dim.	mm	
	Min.	Max.
A	4.40	4.60
A1	2.40	2.72
b	0.61	0.88
b1	1.14	1.70
c	0.49	0.70
c2	1.23	1.32
D	8.95	9.35
e	2.40	2.70
e1	4.95	5.15
E	10.00	10.40
L	13.00	14.00
L1	3.50	3.93
L2	1.27	1.40

4.4 D²PAK packing information

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



DM01095771_2

5 Ordering information

Table 11. Order codes

Order codes	Marking	Package	Packing
STB33N65M2	33N65M2	D ² PAK	Tape and reel
STF33N65M2		TO-220FP	Tube
STI33N65M2		I ² PAK	

Revision history

Table 12. Document revision history

Date	Revision	Changes
10-Dec-2014	1	First release.
22-Aug-2025	2	Removed order code STP33N65M2. Updated Section 4: Package information . Minor text changes.

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