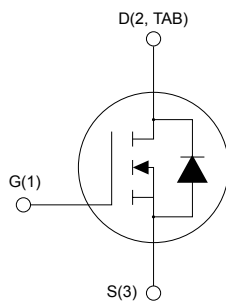
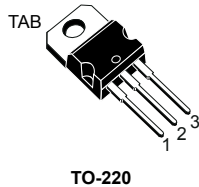


N-channel 650 V, 39 mΩ typ., 54 A MDmesh M9 Power MOSFET in a TO-220 package



AM01475v1_noZen


Product status link
[STP65N045M9](#)
Product summary

Order code	STP65N045M9
Marking	65N045M9
Package	TO-220
Packing	Tube

Features

Order code	V _{DS}	R _{DS(on)} max.	I _D
STP65N045M9	650 V	45 mΩ	54A

- Worldwide best FOM R_{DS(on)}*Q_g among silicon-based devices
- Higher V_{DSS} rating
- Higher dv/dt capability
- Excellent switching performance
- Easy to drive
- 100% avalanche tested

Applications

- High efficiency switching applications

Description

This N-channel Power MOSFET is based on the most innovative super-junction MDmesh M9 technology, suitable for medium/high voltage MOSFETs featuring very low R_{DS(on)} per area. The silicon based M9 technology benefits from a multi-drain manufacturing process which allows an enhanced device structure. The resulting product has one of the lower on-resistance and reduced gate charge values, among all silicon based fast switching super-junction Power MOSFETs, making it particularly suitable for applications that require superior power density and outstanding efficiency.

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{GS}	Gate-source voltage	± 30	V
$I_D^{(1)}$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	54	A
	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	34	
$I_{DM}^{(2)}$	Drain current (pulsed)	170	A
P_{TOT}	Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$	245	W
$dv/dt^{(3)}$	Peak diode recovery voltage slope	50	V/ns
$di/dt^{(3)}$	Peak diode recovery current slope	900	A/ μs
$dv/dt^{(4)}$	MOSFET dv/dt ruggedness	120	V/ns
T_{stg}	Storage temperature range	-55 to 150	$^\circ\text{C}$
T_J	Operating junction temperature range		$^\circ\text{C}$

1. Referred to TO-247 long leads package.
2. Pulse width is limited by safe operating area.
3. $I_{SD} \leq 28\text{ A}$, $V_{DS} (\text{peak}) < V_{(BR)DSS}$, $V_{DD} = 400\text{ V}$.
4. $V_{DS} (\text{peak}) < V_{(BR)DSS}$, $V_{DD} = 400\text{ V}$.

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance, junction-to-case	0.51	$^\circ\text{C/W}$
R_{thJA}	Thermal resistance, junction-to-ambient	62.5	$^\circ\text{C/W}$

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or non-repetitive (pulse width limited by T_J max.)	6	A
E_{AS}	Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$)	775	mJ

2 Electrical characteristics

$T_C = 25\text{ °C}$ unless otherwise specified.

Table 4. On-/off-states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$, $I_D = 1\text{ mA}$	650			V
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$, $V_{DS} = 650\text{ V}$			1	μA
		$V_{GS} = 0\text{ V}$, $V_{DS} = 650\text{ V}$, $T_C = 125\text{ °C}^{(1)}$			200	
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	$V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$	3.2	3.7	4.2	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$, $I_D = 28\text{ A}$		39	45	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	$V_{DS} = 400\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$	-	4610	-	pF
C_{oss}	Output capacitance		-	76	-	pF
$C_{oss\ eq.}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }400\text{ V}$, $V_{GS} = 0\text{ V}$	-	885	-	pF
R_G	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	1	-	Ω
Q_g	Total gate charge	$V_{DD} = 400\text{ V}$, $I_D = 28\text{ A}$, $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 14. Test circuit for gate charge behavior)	-	80	-	nC
Q_{gs}	Gate-source charge		-	26.5	-	nC
Q_{gd}	Gate-drain charge		-	23.5	-	nC

1. $C_{oss\ eq.}$ is a constant equivalent capacitance that provides the same charging time as C_{oss} while V_{DS} is rising from 0 V to the stated value.

Table 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 325\text{ V}$, $I_D = 28\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$	-	25	-	ns
t_r	Rise time		-	26	-	ns
$t_{d(off)}$	Turn-off delay time	(see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform)	-	77	-	ns
t_f	Fall time		-	4	-	ns

Table 7. Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}^{(1)}$	Source-drain current		-		54	A
$I_{SDM}^{(2)}$	Source-drain current (pulsed)		-		170	A
$V_{SD}^{(3)}$	Forward on voltage	$I_{SD} = 55 \text{ A}$, $V_{GS} = 0 \text{ V}$	-		1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 55 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$,	-	288		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 100 \text{ V}$	-	4		μC
I_{RRM}	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	26		A
t_{rr}	Reverse recovery time	$I_{SD} = 55 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$,	-	400		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 100 \text{ V}$, $T_J = 150 \text{ }^\circ\text{C}$	-	7.5		μC
I_{RRM}	Reverse recovery current	(see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	34		A

1. Referred to TO-247 long leads package.
2. Pulse width is limited by safe operating area.
3. Pulsed: pulse duration = 300 μs , duty cycle 1.5%.

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

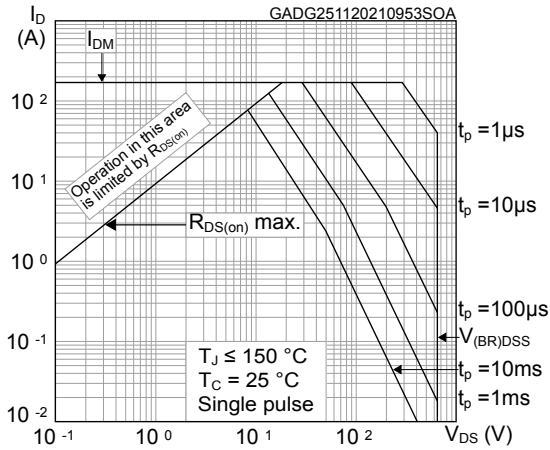


Figure 2. Maximum transient thermal impedance

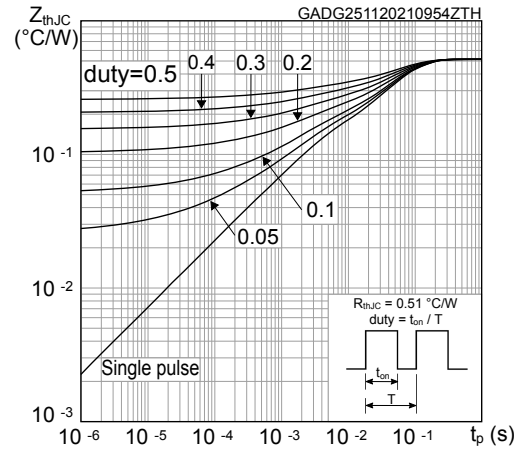


Figure 3. Typical output characteristics

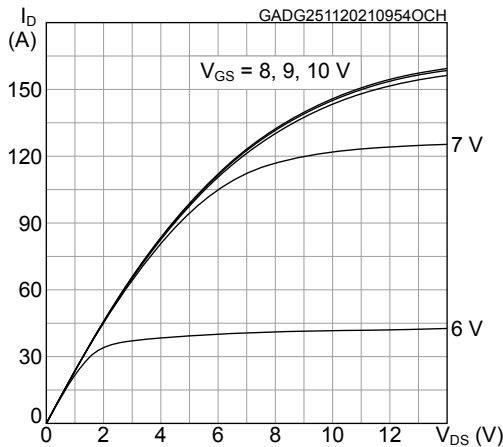


Figure 4. Typical transfer characteristics

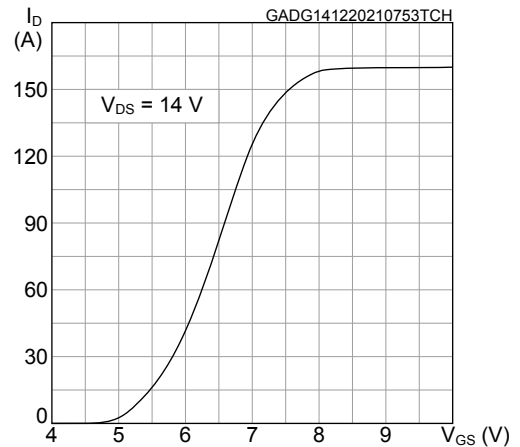


Figure 5. Typical gate charge characteristics

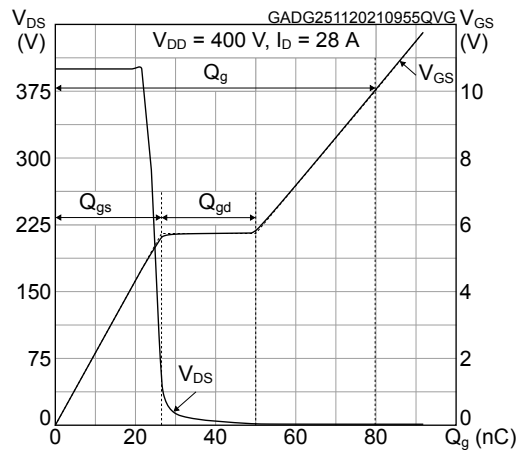


Figure 6. Typical drain-source on-resistance

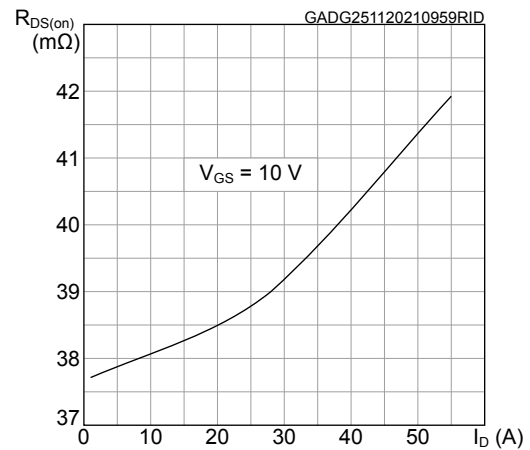


Figure 7. Typical capacitance characteristics

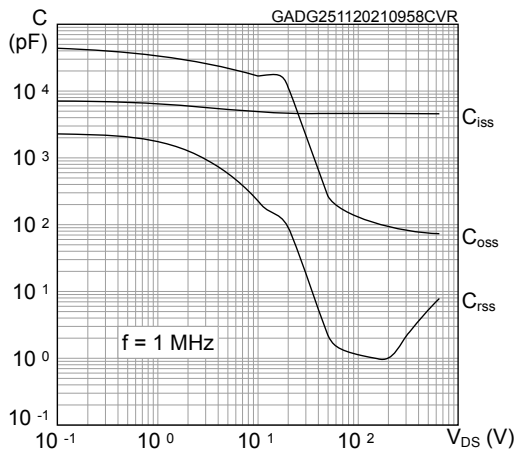


Figure 8. Typical output capacitance stored energy

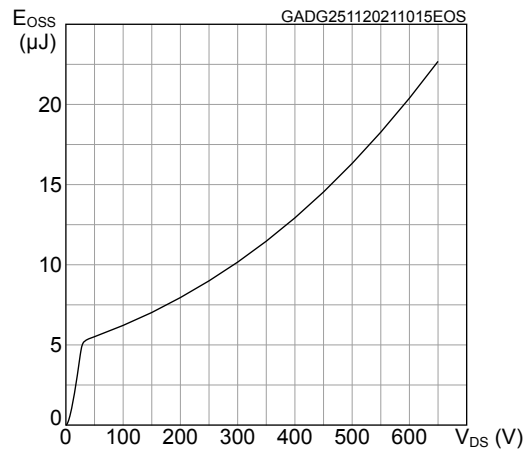


Figure 9. Normalized gate threshold vs temperature

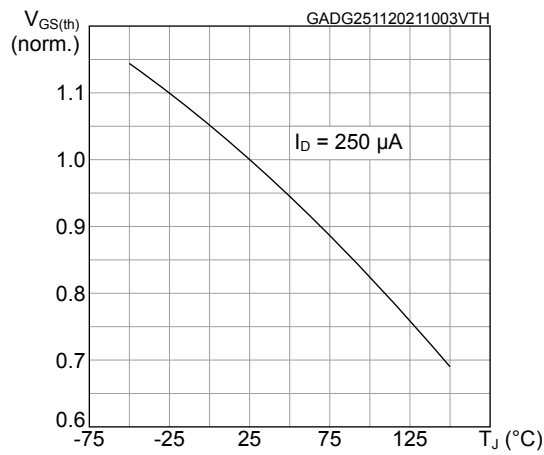


Figure 10. Normalized on-resistance vs temperature

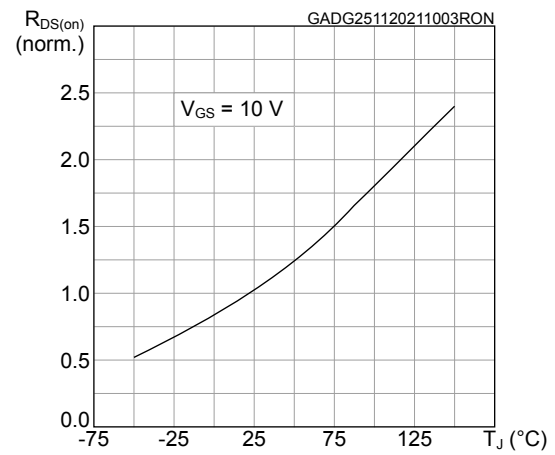


Figure 11. Normalized breakdown voltage vs temperature

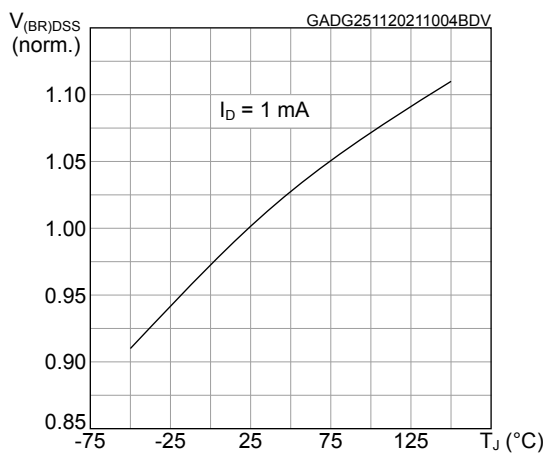
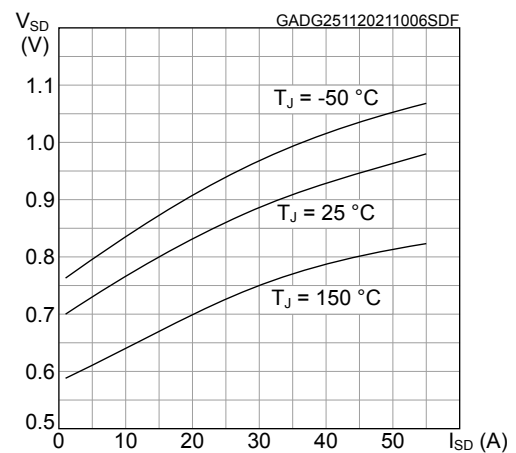
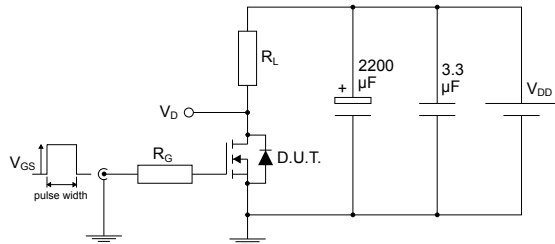


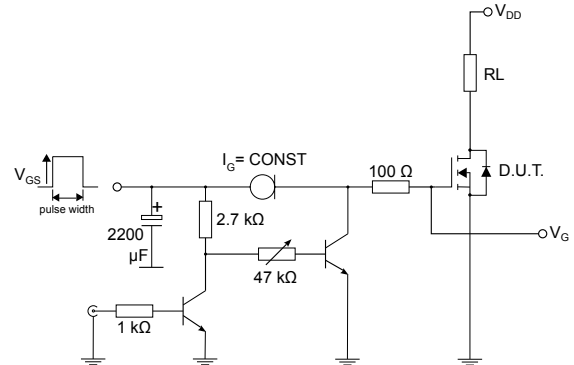
Figure 12. Typical reverse diode forward characteristics



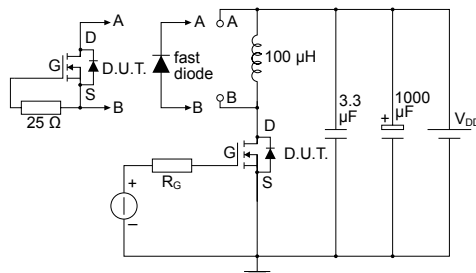
3 Test circuits

Figure 13. Test circuit for resistive load switching times


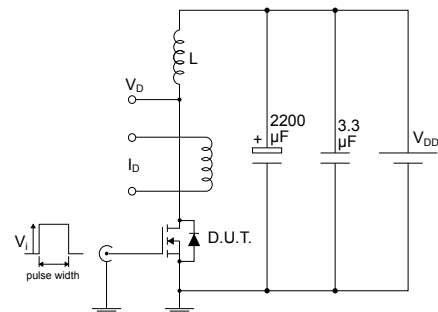
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Figure 14. Test circuit for gate charge behavior


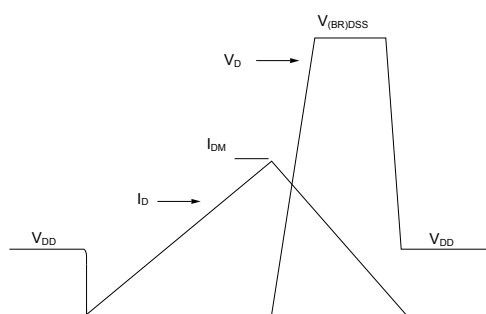
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Figure 15. Test circuit for inductive load switching and diode recovery times


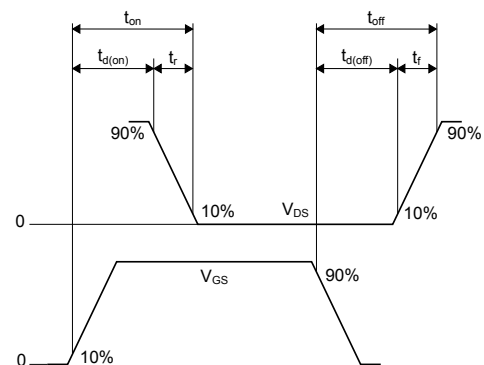
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Figure 16. Unclamped inductive load test circuit


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Figure 17. Unclamped inductive waveform


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Figure 18. Switching time waveform


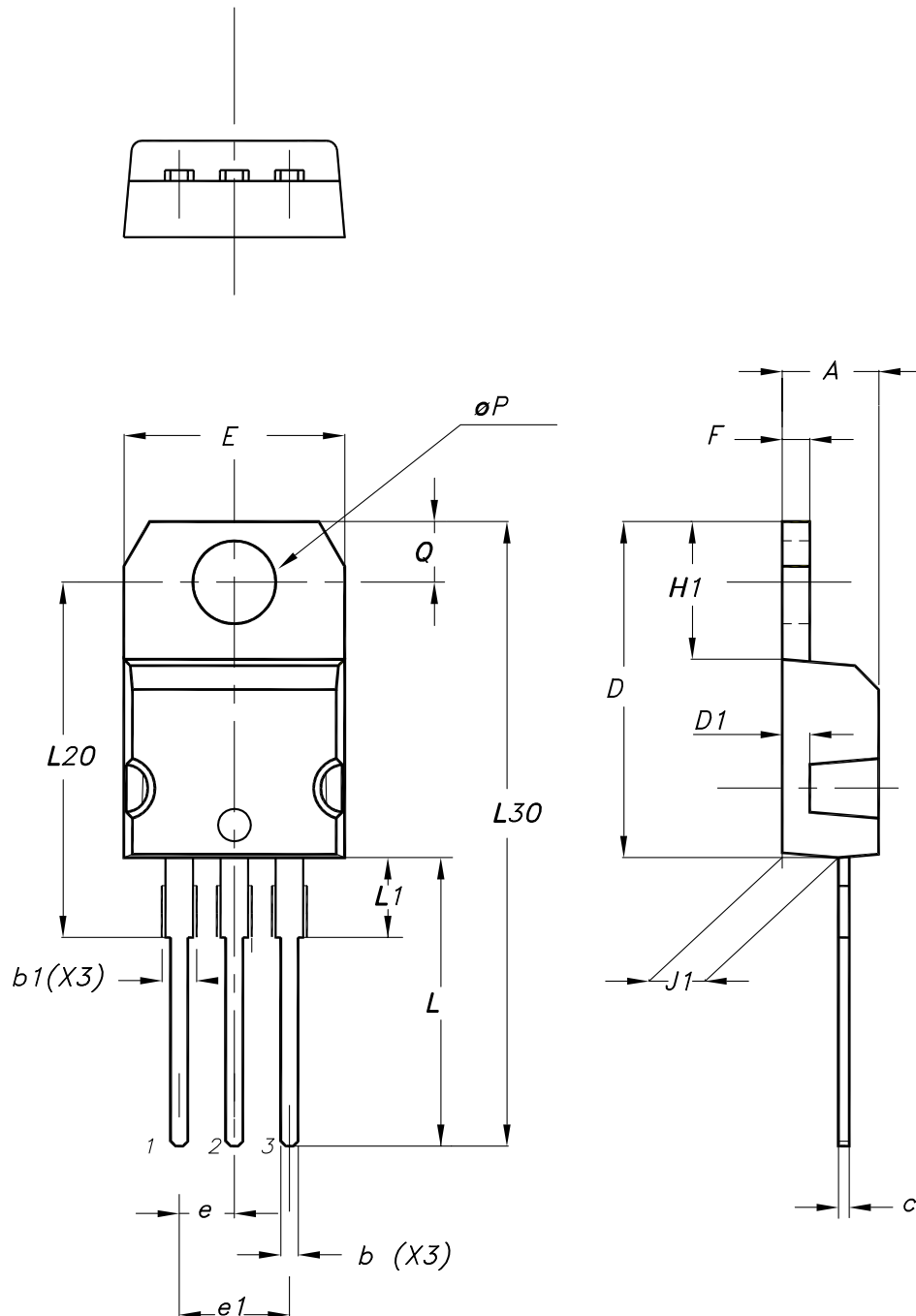
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4 Package information

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 TO-220 type A package information

Figure 19. TO-220 type A package outline



0015988_typeA_Rev_23

Table 8. 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

Revision history

Table 9. Document revision history

Date	Version	Changes
24-Feb-2021	1	First release.
16-Dec-2021	2	Updated title, <i>Features</i> and <i>Description</i> on cover page. Updated <i>Section 1 Electrical ratings</i> . Updated <i>Section 2 Electrical characteristics</i> . Added <i>Section 2.1 Electrical characteristics (curves)</i> . Updated <i>Section 3 Test circuits</i> .
16-Feb-2022	3	Updated <i>Table 1. Absolute maximum ratings</i> . Updated <i>Table 5. Dynamic</i> . Minor text changes.
25-May-2022	4	Updated <i>Features</i> on cover page.
04-Sep-2023	5	Updated title and <i>Features</i> on cover page. Updated <i>Table 1. Absolute maximum ratings</i> . Updated <i>Table 6. Switching times</i> . Updated <i>Table 7. Source-drain diode</i> . Updated <i>Section 3: Test circuits</i> .
19-Jul-2024	6	Updated <i>Figure 10. Normalized on-resistance vs temperature</i> and <i>Figure 11. Normalized breakdown voltage vs temperature</i> . Minor text changes.

Contents

1	Electrical ratings	2
2	Electrical characteristics	3
2.1	Electrical characteristics (curves)	5
3	Test circuits	7
4	Package information	8
4.1	TO-220 type A package information	8
	Revision history	10

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