

Automotive-grade N-channel 400 V, 0.063 Ω typ., 38 A MDmesh™ DM2 Power MOSFET in a TO-220 package

Datasheet - production data

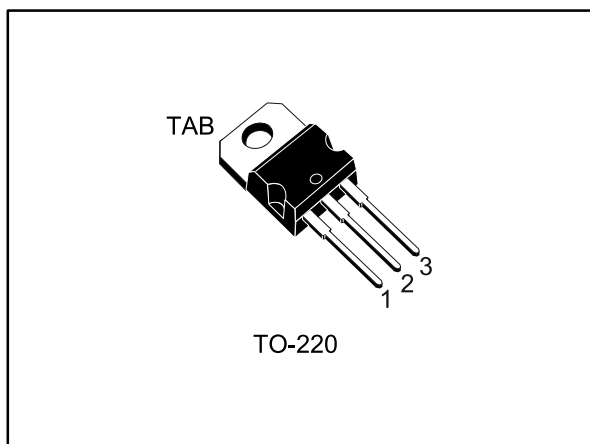
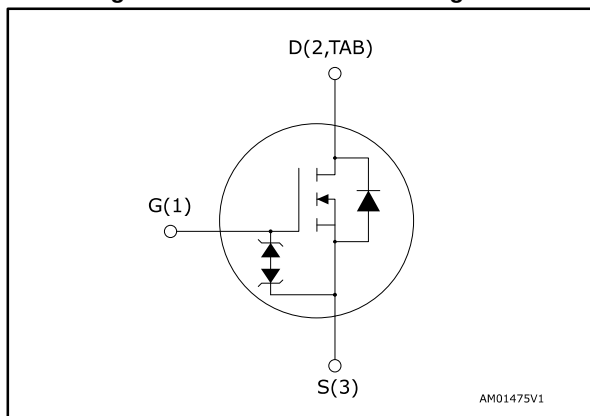


Figure 1: Internal schematic diagram



Features

Order code	V_{DS}	$R_{DS(on)}$ max.	I_D	P_{TOT}
STP45N40DM2AG	400 V	0.072 Ω	38 A	250 W

- Designed for automotive applications and AEC-Q101 qualified
- Fast-recovery body diode
- Extremely low gate charge and input capacitance
- Low on-resistance
- 100% avalanche tested
- Extremely high dv/dt ruggedness
- Zener-protected

Applications

- Switching applications

Description

This high voltage N-channel Power MOSFET is part of the MDmesh™ DM2 fast recovery diode series. It offers very low recovery charge (Q_{rr}) and time (t_{rr}) combined with low $R_{DS(on)}$, rendering it suitable for the most demanding high efficiency converters and ideal for bridge topologies and ZVS phase-shift converters.

Table 1: Device summary

Order code	Marking	Package	Packing
STP45N40DM2AG	45N40DM2	TO-220	Tube

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1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{GS}	Gate-source voltage	± 25	V
I_D	Drain current (continuous) at $T_{case} = 25\text{ }^{\circ}\text{C}$	38	A
	Drain current (continuous) at $T_{case} = 100\text{ }^{\circ}\text{C}$	24	
$I_{DM}^{(1)}$	Drain current (pulsed)	152	A
P_{TOT}	Total dissipation at $T_{case} = 25\text{ }^{\circ}\text{C}$	250	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	50	V/ns
$dv/dt^{(3)}$	MOSFET dv/dt ruggedness	50	
T_{stg}	Storage temperature range	-55 to 150	$^{\circ}\text{C}$
T_j	Operating junction temperature range		

Notes:

(1) Pulse width is limited by safe operating area.

(2) $I_{SD} \leq 38\text{ A}$, $di/dt=800\text{ A}/\mu\text{s}$; $V_{DS}\text{ peak} < V_{(BR)DSS}$, $V_{DD} = 80\% V_{(BR)DSS}$.

(3) $V_{DS} \leq 320\text{ V}$

Table 3: Thermal data

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case	0.5	$^{\circ}\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient	62.5	

Table 4: Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive	7	A
$E_{AS}^{(1)}$	Single pulse avalanche energy	1100	mJ

Notes:

(1) starting $T_j = 25\text{ }^{\circ}\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$.

2 Electrical characteristics

(T_{case} = 25 °C unless otherwise specified)

Table 5: Static

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V _{(BR)DSS}	Drain-source breakdown voltage	V _{GS} = 0 V, I _D = 1 mA	400			V
I _{DSS}	Zero gate voltage drain current	V _{GS} = 0 V, V _{DS} = 400 V			10	μA
		V _{GS} = 0 V, V _{DS} = 400 V, T _{case} = 125 °C ⁽¹⁾			100	
I _{GSS}	Gate-body leakage current	V _{DS} = 0 V, V _{GS} = ±25 V			±5	μA
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 = 19 A		0.063	0.072	Ω

Notes:

⁽¹⁾Defined by design, not subject to production test.

Table 6: Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C _{iss}	Input capacitance	V _{DS} = 100 V, f = 1 MHz, V _{GS} = 0 V	-	2600	-	pF
C _{oss}	Output capacitance		-	180	-	
C _{rss}	Reverse transfer capacitance		-	3.5	-	
C _{oss eq.} ⁽¹⁾	Equivalent output capacitance	V _{DS} = 0 to 320 V, V _{GS} = 0 V	-	300	-	pF
R _G	Intrinsic gate resistance	f = 1 MHz, I _D = 0 A	-	4	-	Ω
Q _g	Total gate charge	V _{DD} = 320 V, I _D = 38 A, V _{GS} = 10 V (see Figure 15: "Test circuit for gate charge behavior")	-	56	-	nC
Q _{gs}	Gate-source charge		-	13	-	
Q _{gd}	Gate-drain charge		-	28	-	

Notes:

⁽¹⁾ C_{oss 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 7: Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t _{d(on)}	Turn-on delay time	V _{DD} = 200 V, I _D = 19 A R _G = 4.7 Ω, V _{GS} = 10 V (see Figure 14: "Test circuit for resistive load switching times")	-	20	-	ns
t _r	Rise time		-	6.7	-	
t _{d(off)}	Turn-off delay time		-	68	-	
t _f	Fall time		-	9.8	-	

Table 8: Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		38	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		152	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0\text{ V}$, $I_{SD} = 38\text{ A}$	-		1.6	V
t_{rr}	Reverse recovery time	$I_{SD} = 38\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$ (see Figure 16 : "Test circuit for inductive load switching and diode recovery times")	-	95		ns
Q_{rr}	Reverse recovery charge		-	0.4		μC
I_{RRM}	Reverse recovery current		-	8.5		A
t_{rr}	Reverse recovery time	$I_{SD} = 38\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 16 : "Test circuit for inductive load switching and diode recovery times")	-	185		ns
Q_{rr}	Reverse recovery charge		-	1.62		μC
I_{RRM}	Reverse recovery current		-	17.5		A

Notes:

⁽¹⁾ Pulse width is limited by safe operating area.

⁽²⁾ Pulse test: pulse duration = 300 μs , duty cycle 1.5%.

Table 9: Gate-source Zener diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)GSO}$	Gate-source breakdown voltage	$I_{GS} = \pm 250\text{ }\mu\text{A}$, $I_D = 0\text{ A}$	± 30	-	-	V

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

2.1 Electrical characteristics (curves)

Figure 2: Safe operating area

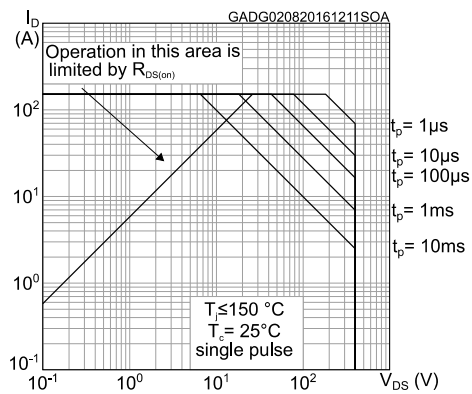


Figure 3: Thermal impedance

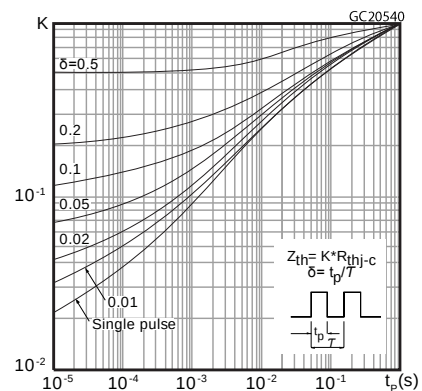


Figure 4: Output characteristics

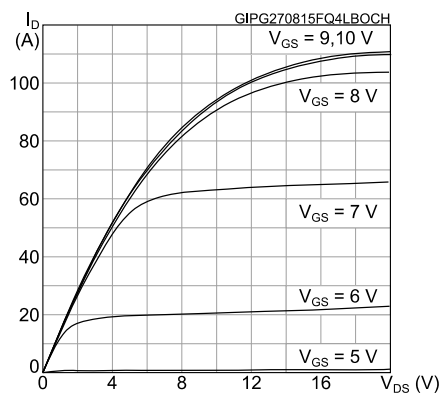


Figure 5: Transfer characteristics

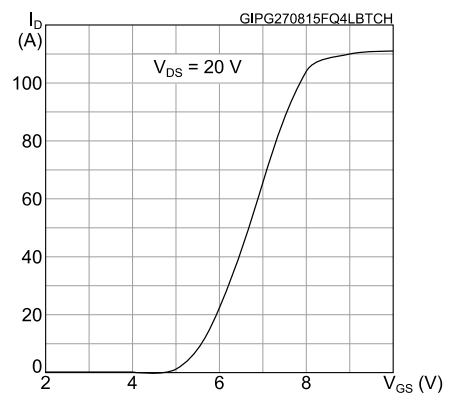


Figure 6: Gate charge vs gate-source voltage

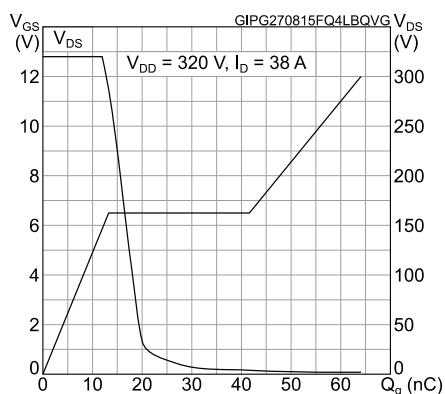


Figure 7: Static drain-source on-resistance

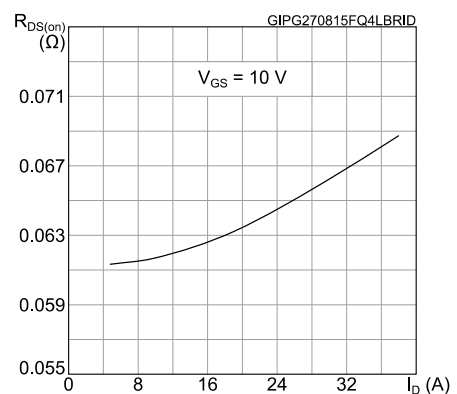


Figure 8: Capacitance variations

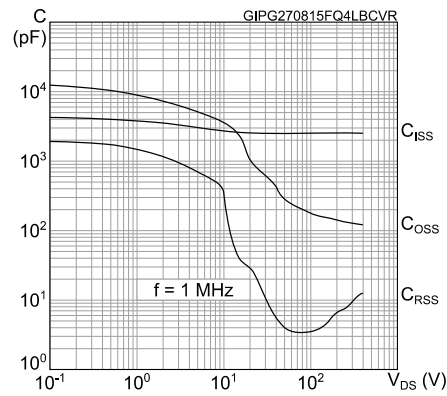


Figure 9: Normalized gate threshold voltage vs temperature

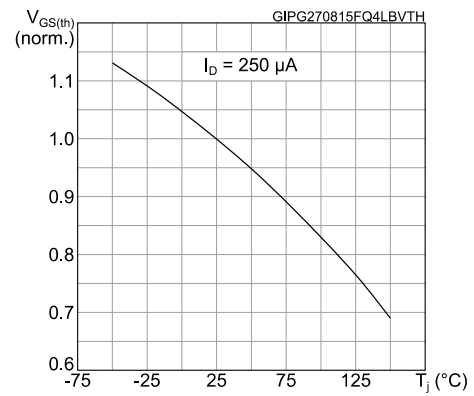


Figure 10: Normalized on-resistance vs temperature

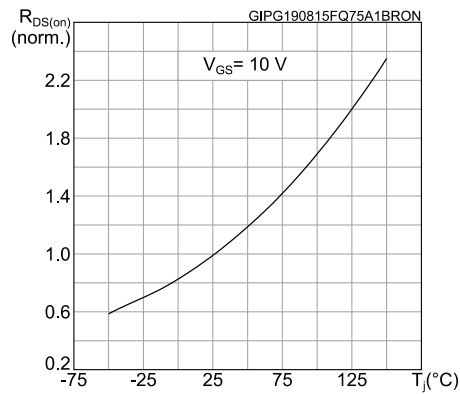


Figure 11: Normalized V(BR)DSS vs temperature

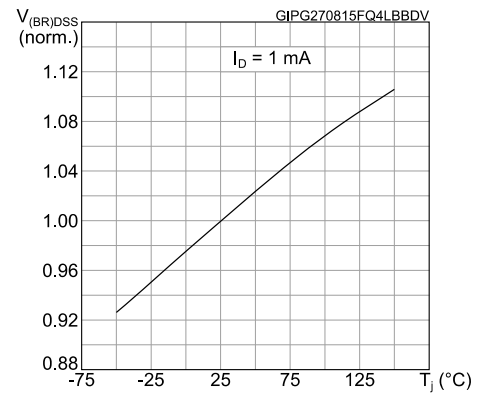


Figure 12: Output capacitance stored energy

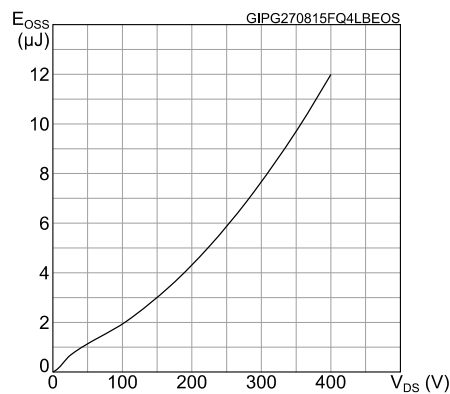
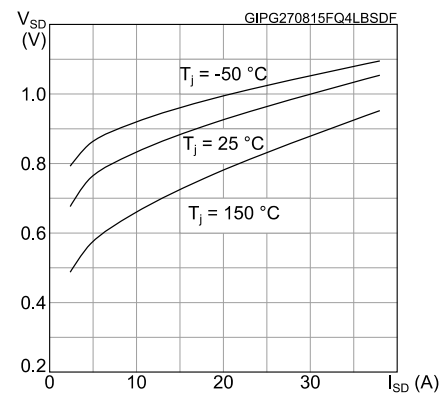
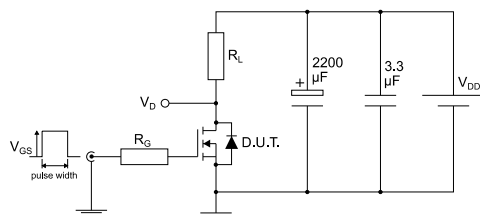


Figure 13: Source- drain diode forward characteristics



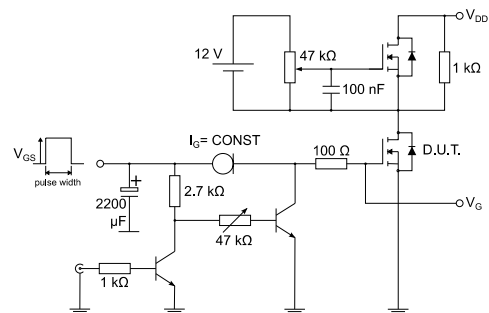
3 Test circuits

Figure 14: Test circuit for resistive load switching times



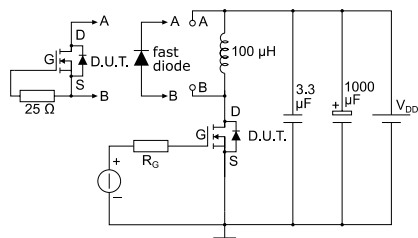
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Figure 15: Test circuit for gate charge behavior



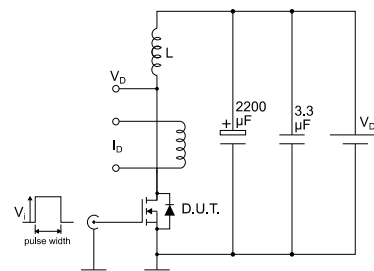
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Figure 16: Test circuit for inductive load switching and diode recovery times



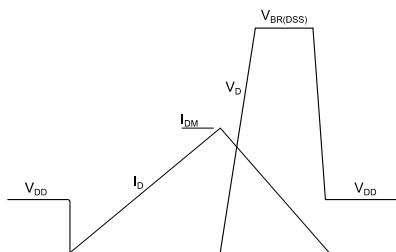
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Figure 17: Unclamped inductive load test circuit



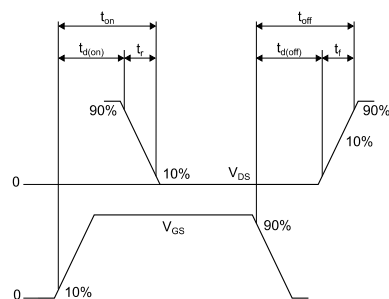
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Figure 18: Unclamped inductive waveform



AM01472v1

Figure 19: Switching time waveform



AM01473v1

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 20: TO-220 type A package outline

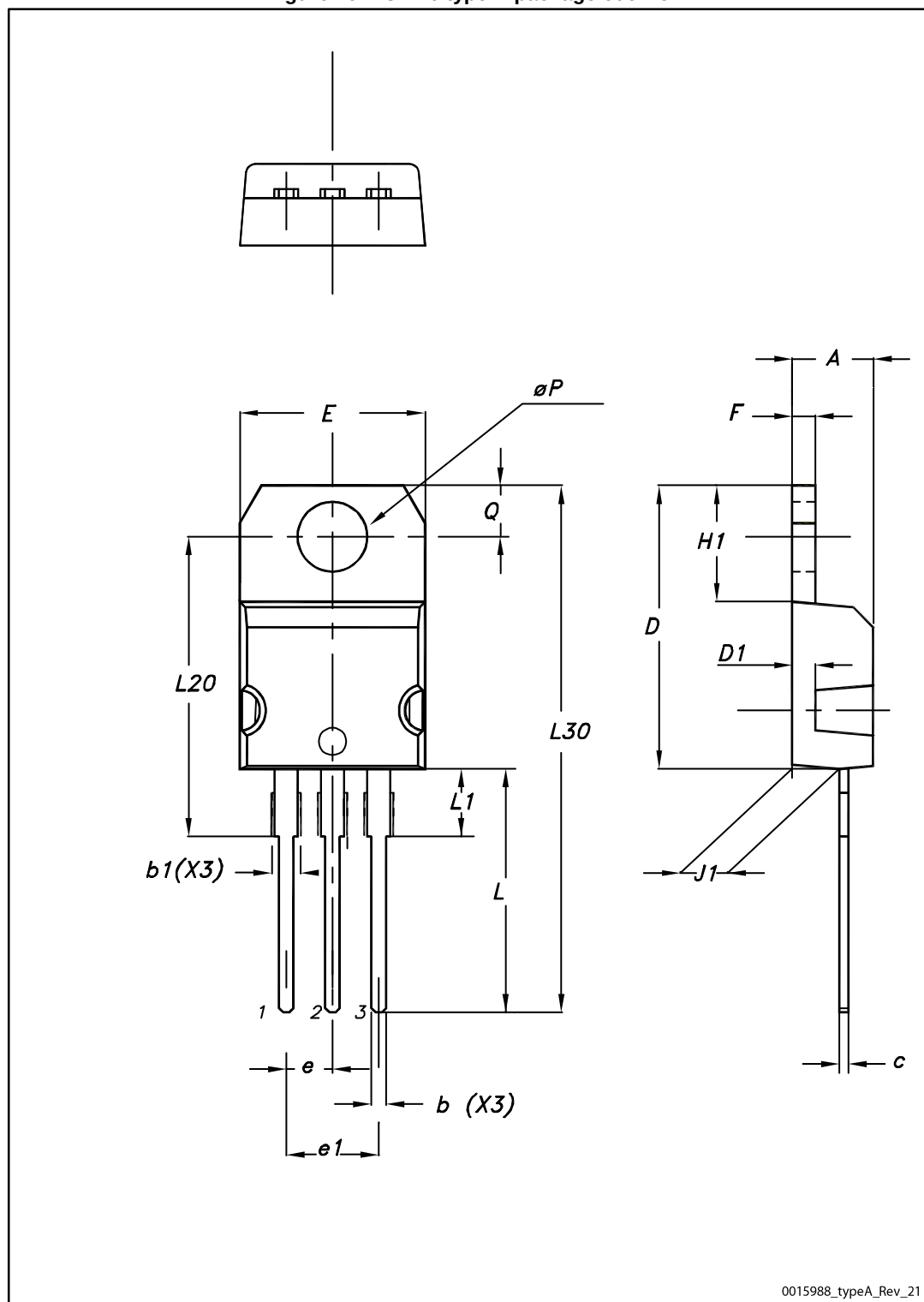


Table 10: TO-220 type A mechanical data

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

5 Revision history

Table 11: Document revision history

Date	Revision	Changes
06-Jul-2015	1	First release.
03-Sep-2015	2	Datasheet promoted from preliminary data to production data Modified: I_D , I_{DM} , dv/dt values in table 2 Added: note 2 and 3 in table2 Modified: the entire values in table 4 Modified: $R_{DS(on)}$ typical value in table 5 Modified: the entire typical values in table 6 and 7 Modified: the entire typical values and I_{SD} , I_{SDM} in table 8 Added: Electrical characteristics (curves) section Minor text changes
02-Aug-2016	3	Modified title in cover page. Updated Section 1: "Electrical ratings" , Table 5: "Static" , Table 8: "Source-drain diode" and Figure 2: "Safe operating area" . Minor text changes.

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