

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

Datasheet - production data

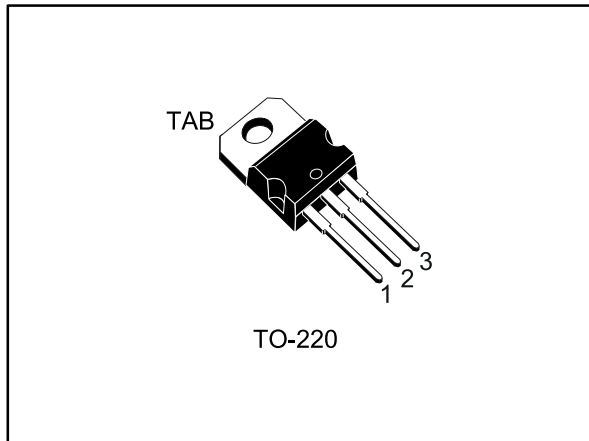
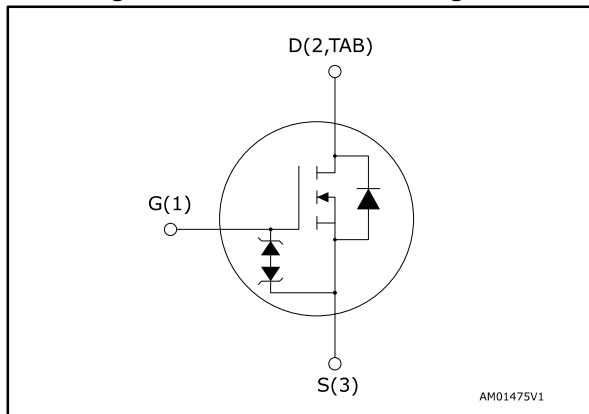


Figure 1: Internal schematic diagram



### Features

Order code	V <sub>DS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>	P <sub>TOT</sub>
STP45N40DM2AG	400 V	0.072 $\Omega$	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	$\pm 25$	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

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

**Table 5: Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(\text{BR})\text{DSS}}$	Drain-source breakdown voltage	$V_{\text{GS}} = 0\text{ V}$ , $I_{\text{D}} = 1\text{ mA}$	400			V
$I_{\text{DSS}}$	Zero gate voltage drain current	$V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 400\text{ V}$			10	$\mu\text{A}$
		$V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 400\text{ V}$ , $T_{\text{case}} = 125\text{ °C}^{(1)}$			100	
$I_{\text{GSS}}$	Gate-body leakage current	$V_{\text{DS}} = 0\text{ V}$ , $V_{\text{GS}} = \pm 25\text{ V}$			$\pm 5$	$\mu\text{A}$
$V_{\text{GS(th)}}$	Gate threshold voltage	$V_{\text{DS}} = V_{\text{GS}}$ , $I_{\text{D}} = 250\text{ }\mu\text{A}$	3	4	5	V
$R_{\text{DS(on)}}$	Static drain-source on-resistance	$V_{\text{GS}} = 10\text{ V}$ , $I_{\text{D}} = 19\text{ A}$		0.063	0.072	$\Omega$

**Notes:**

<sup>(1)</sup> Defined by design, not subject to production test.

**Table 6: Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{\text{iss}}$	Input capacitance	$V_{\text{DS}} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{\text{GS}} = 0\text{ V}$	-	2600	-	$\text{pF}$
$C_{\text{oss}}$	Output capacitance		-	180	-	
$C_{\text{riss}}$	Reverse transfer capacitance		-	3.5	-	
$C_{\text{oss eq.}}^{(1)}$	Equivalent output capacitance	$V_{\text{DS}} = 0\text{ to }320\text{ V}$ , $V_{\text{GS}} = 0\text{ V}$	-	300	-	$\text{pF}$
$R_{\text{G}}$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , $I_{\text{D}} = 0\text{ A}$	-	4	-	$\Omega$
$Q_{\text{g}}$	Total gate charge	$V_{\text{DD}} = 320\text{ V}$ , $I_{\text{D}} = 38\text{ A}$ , $V_{\text{GS}} = 10\text{ V}$ (see <a href="#">Figure 15: "Test circuit for gate charge behavior"</a> )	-	56	-	$\text{nC}$
$Q_{\text{gs}}$	Gate-source charge		-	13	-	
$Q_{\text{gd}}$	Gate-drain charge		-	28	-	

**Notes:**

<sup>(1)</sup>  $C_{\text{oss eq.}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{\text{oss}}$  when  $V_{\text{DS}}$  increases from 0 to 80%  $V_{\text{DSS}}$ .

**Table 7: Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{\text{d(on)}}$	Turn-on delay time	$V_{\text{DD}} = 200\text{ V}$ , $I_{\text{D}} = 19\text{ A}$ $R_{\text{G}} = 4.7\text{ }\Omega$ , $V_{\text{GS}} = 10\text{ V}$ (see <a href="#">Figure 14: "Test circuit for resistive load switching times"</a> )	-	20	-	$\text{ns}$
$t_{\text{r}}$	Rise time		-	6.7	-	
$t_{\text{d(off)}}$	Turn-off delay time		-	68	-	
$t_{\text{f}}$	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 <a href="#">Figure 16</a> : "Test circuit for inductive load switching and diode recovery times")	-	95		ns
$Q_{rr}$	Reverse recovery charge		-	0.4		$\mu\text{C}$
$I_{RRM}$	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 <a href="#">Figure 16</a> : "Test circuit for inductive load switching and diode recovery times")	-	185		ns
$Q_{rr}$	Reverse recovery charge		-	1.62		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	17.5		A

**Notes:**

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

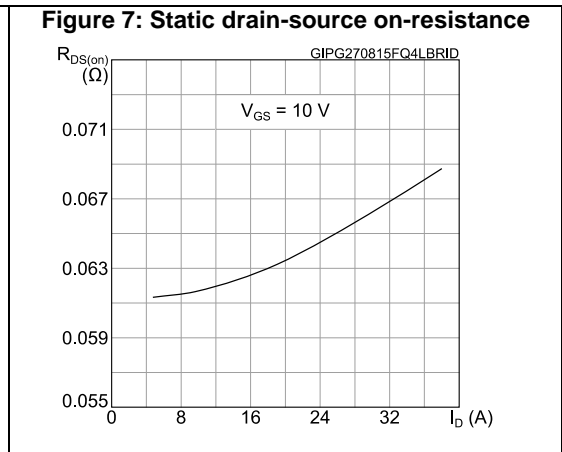
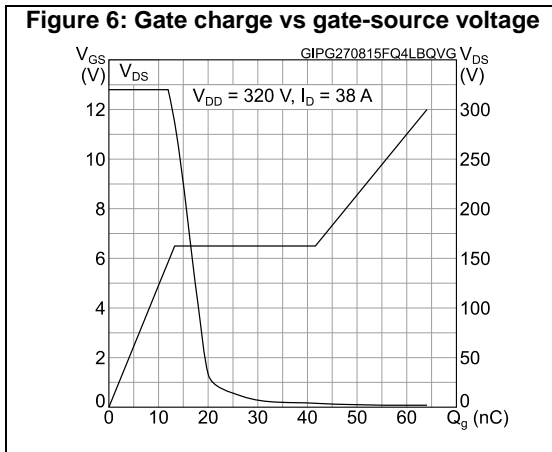
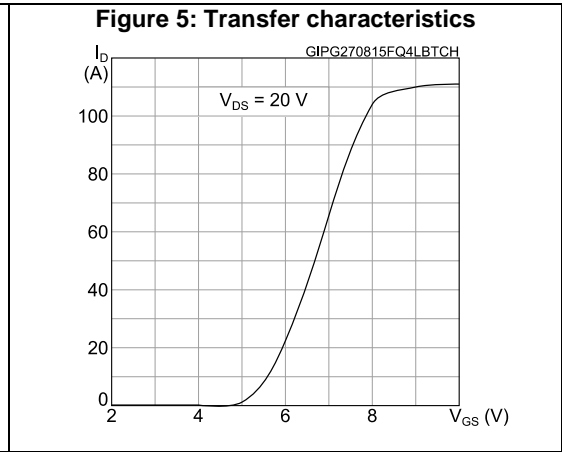
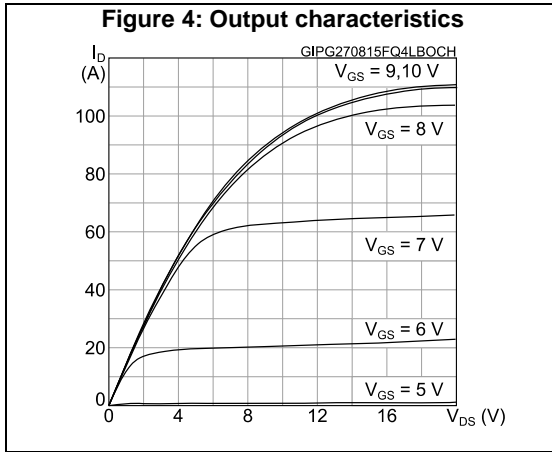
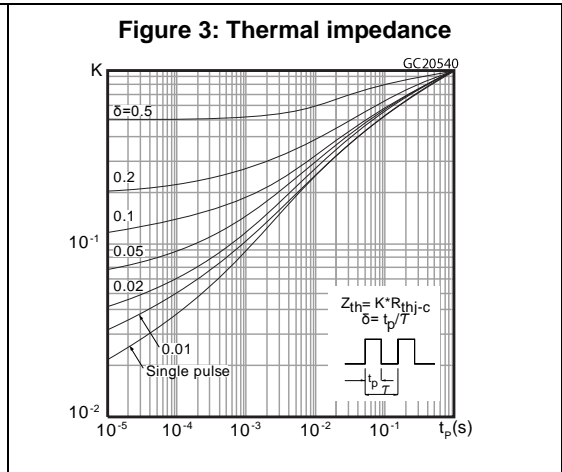
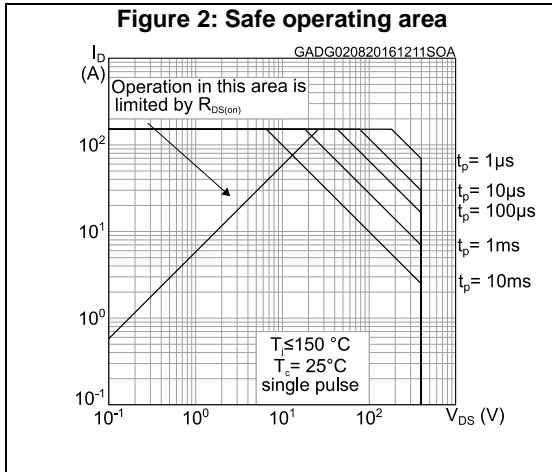
(2) Pulse test: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

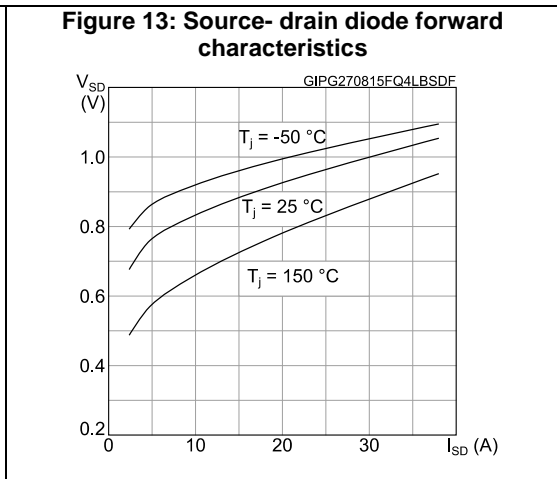
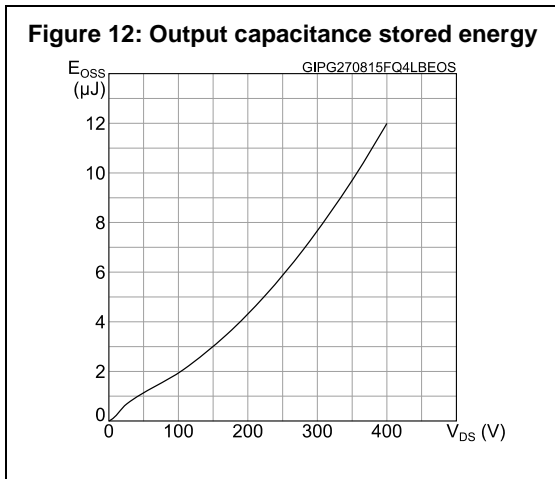
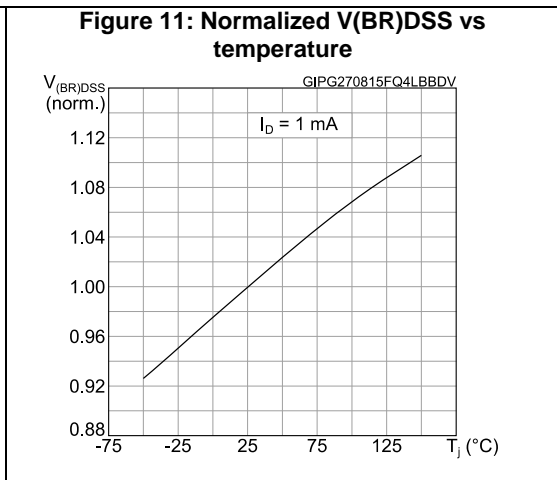
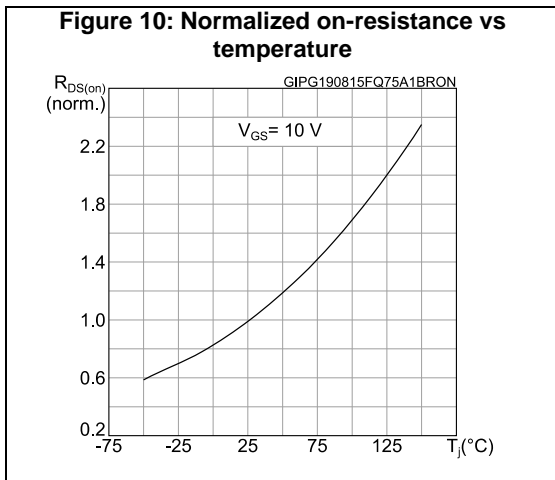
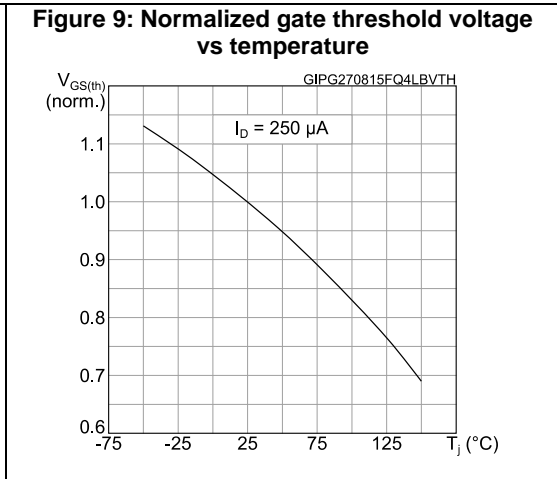
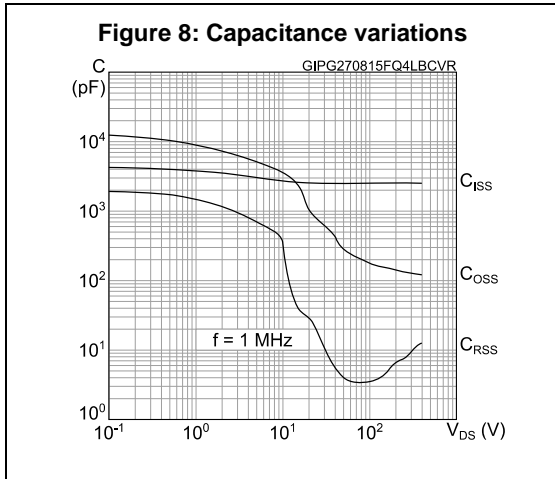
Table 9: Gate-source Zener diode

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





### 3 Test circuits

**Figure 14: Test circuit for resistive load switching times**



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**Figure 15: Test circuit for gate charge behavior**



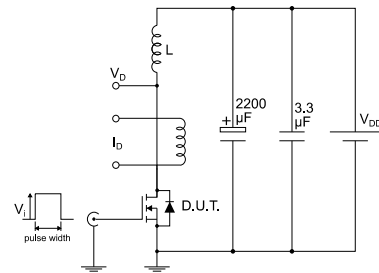
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**Figure 16: Test circuit for inductive load switching and diode recovery times**



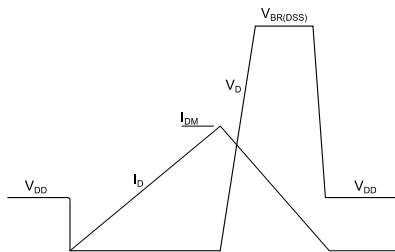
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**Figure 17: Unclamped inductive load test circuit**



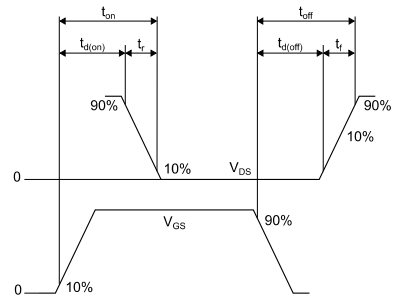
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**Figure 18: Unclamped inductive waveform**



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**Figure 19: Switching time waveform**



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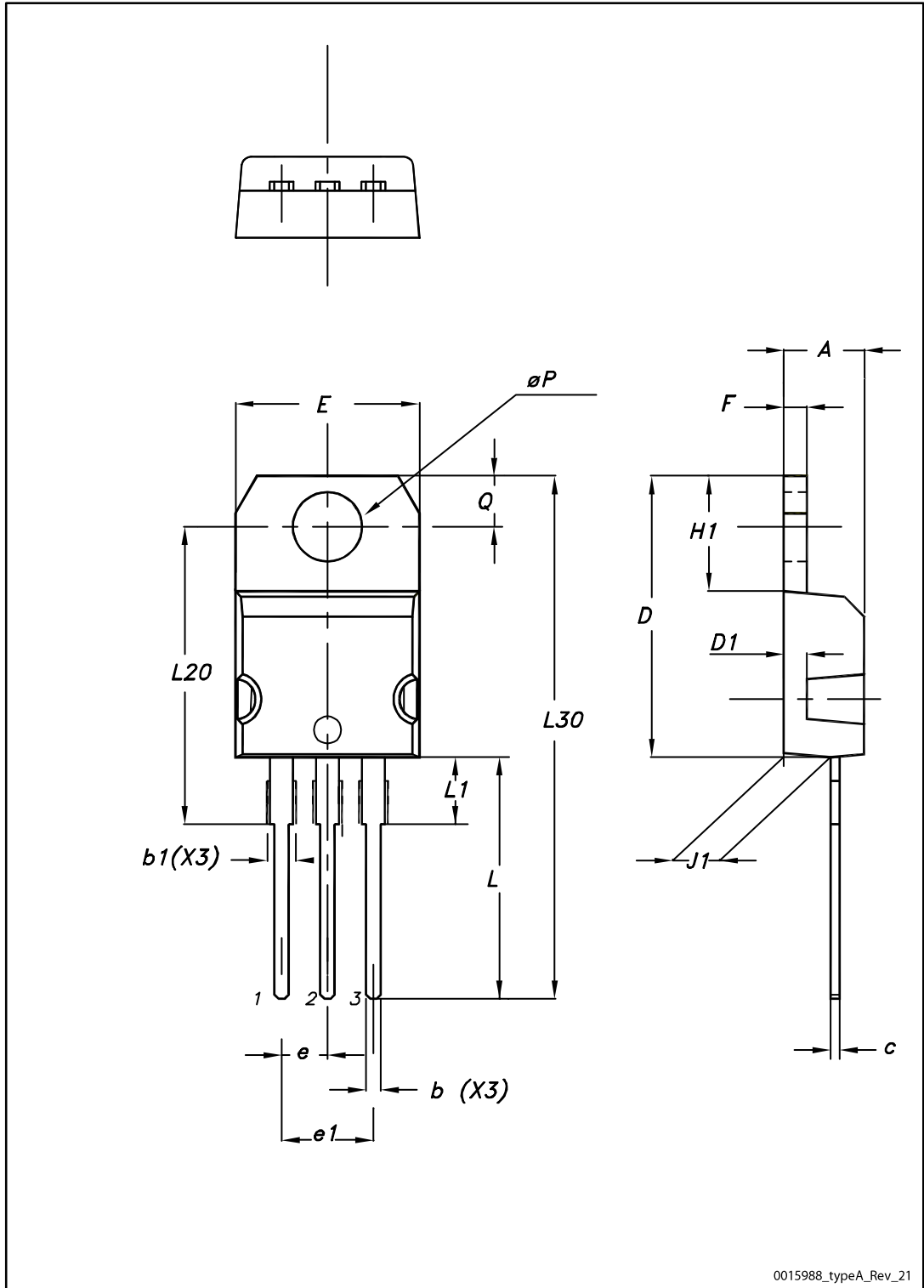


## 4 Package information

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](http://www.st.com). ECOPACK® is an ST trademark.

### 4.1 TO-220 type A package information

Figure 20: TO-220 type A package outline



0015988\_typeA\_Rev\_21

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 <a href="#">Section 1: "Electrical ratings"</a> , <a href="#">Table 5: "Static"</a> , <a href="#">Table 8: "Source-drain diode"</a> and <a href="#">Figure 2: "Safe operating area"</a> . Minor text changes.

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