STP45N40DM2AG

Automotive N-channel 400 V, 0.058 Ω typ., 38 A MDmesh™ DM2 Power MOSFET in a TO-220 package

Datasheet - production data

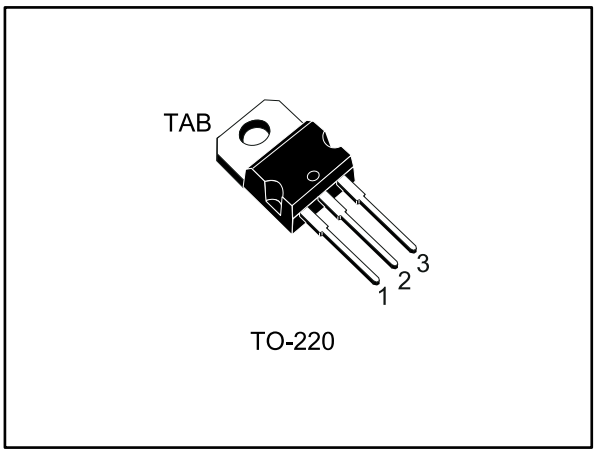
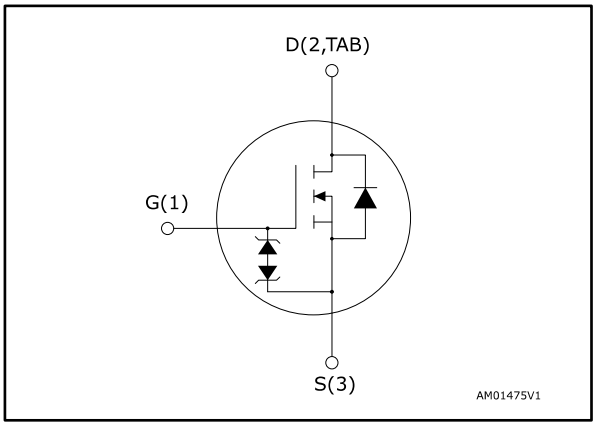


Figure 1: Internal schematic diagram



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

Contents

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 °C	38	A
	Drain current (continuous) at T_{case} = 100 °C	24	
I_{DM} (1)	Drain current (pulsed)	152	A
P_{TOT}	Total dissipation at T_{case} = 25 °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	-55 to 150	°C
T_j	Operating junction temperature		

Notes:

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

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

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

Table 3: Thermal data

Symbol	Parameter	Value	Unit
$R_{thj\text{-}case}$	Thermal resistance junction-case	0.50	°C/W
$R_{thj\text{-}amb}$	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 °C, $I_D = I_{AR}$, V_{DD} = 50 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			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

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 V, I_{SD} = 38 A	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 39 A, di/dt = 100 A/µs, V_{DD} = 60 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} = 39 A, di/dt = 100 A/µs, V_{DD} = 60 V, T_j = 150 °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} = ±250 µA, I_D = 0 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.

2.2 Electrical characteristics (curves)

Figure 2: Safe operating area

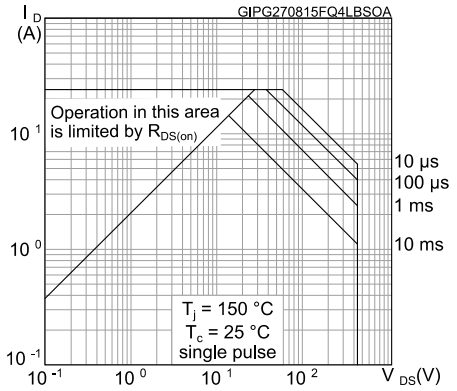


Figure 3: Thermal impedance

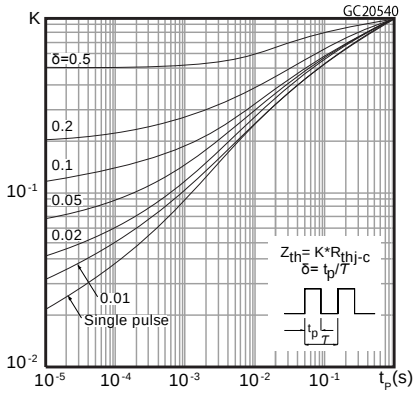


Figure 4: Output characteristics

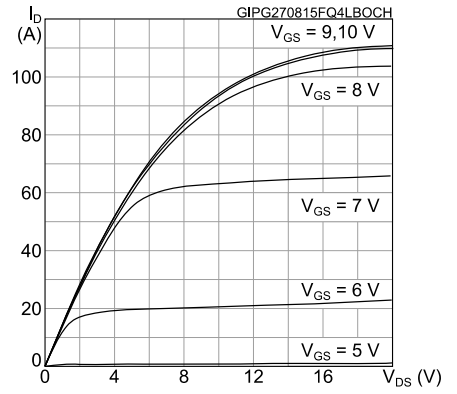


Figure 5: Transfer characteristics

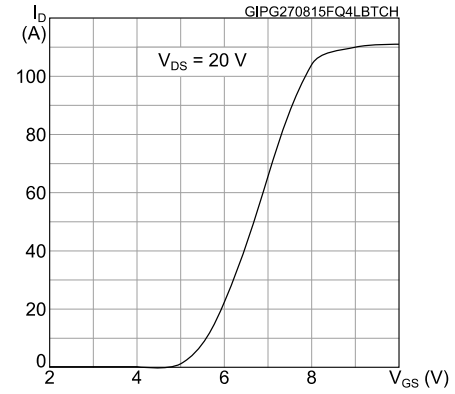


Figure 6: Gate charge vs gate-source voltage

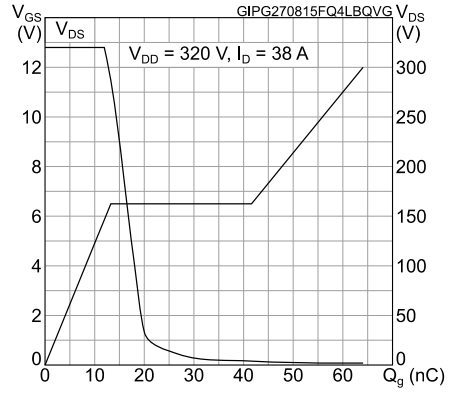


Figure 7: Static drain-source on-resistance

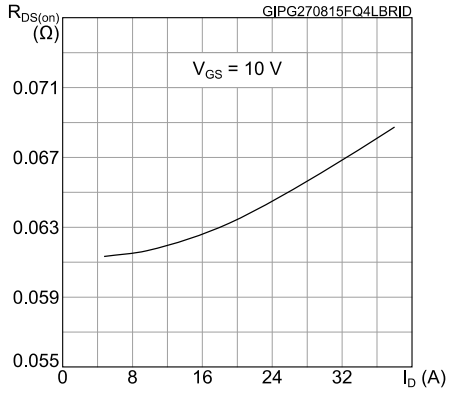


Figure 8: Capacitance variations

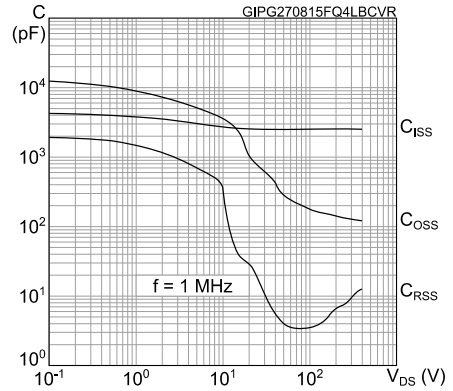


Figure 9: Normalized gate threshold voltage vs temperature

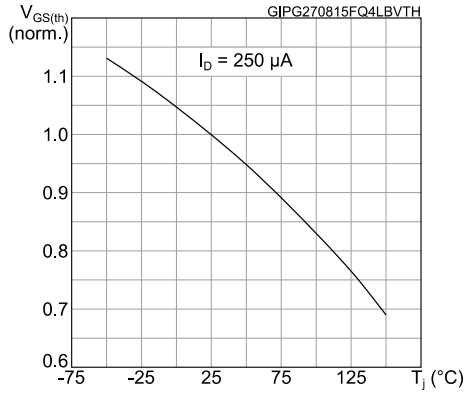


Figure 10: Normalized on-resistance vs temperature

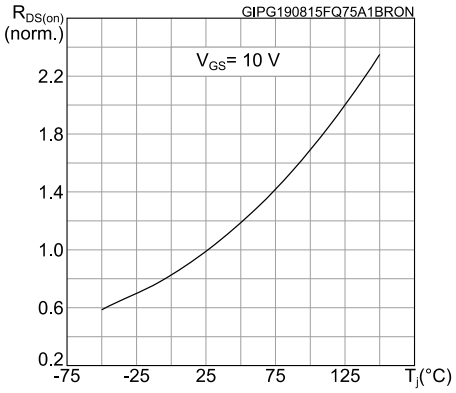


Figure 11: Normalized V(BR)DSS vs temperature

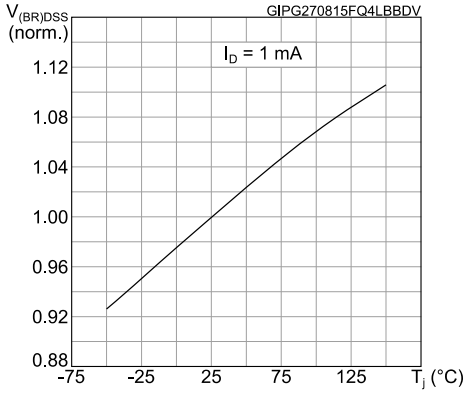


Figure 12: Output capacitance stored energy

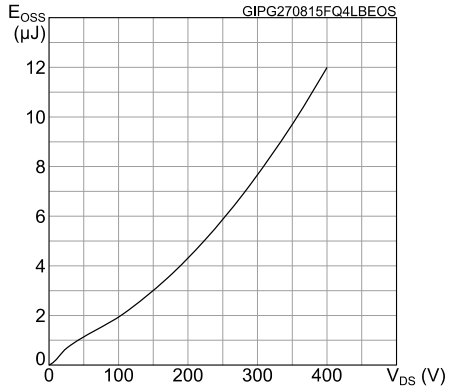
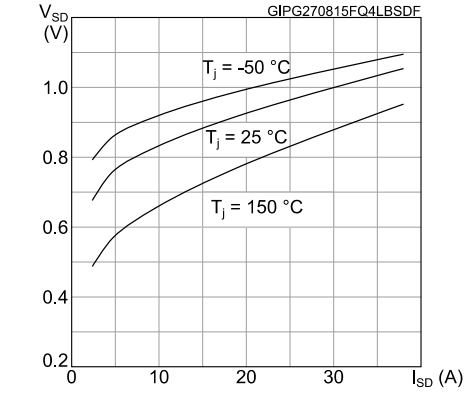


Figure 13: Source- drain diode forward characteristics



3 Test circuits

Figure 14: Test circuit for resistive load switching times

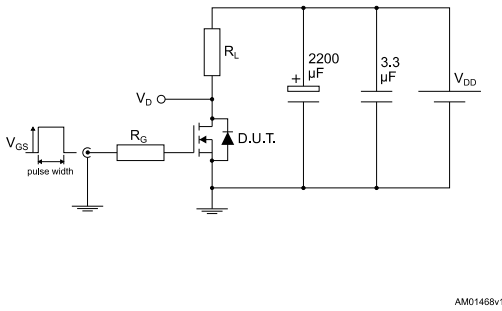


Figure 15: Test circuit for gate charge behavior

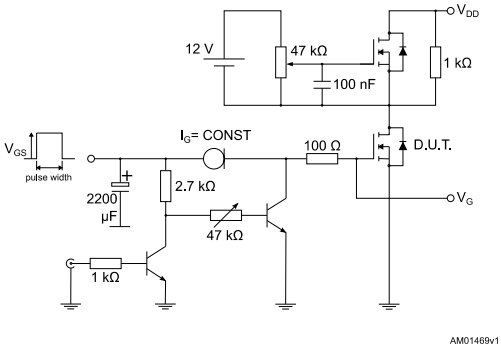


Figure 16: Test circuit for inductive load switching and diode recovery times

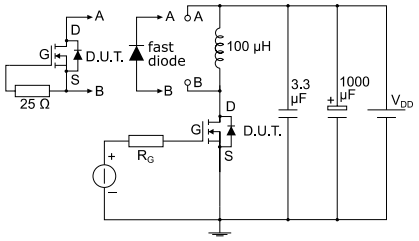


Figure 17: Unclamped inductive load test circuit

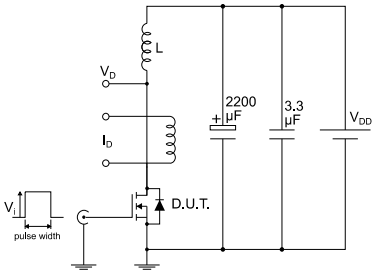


Figure 18: Unclamped inductive waveform

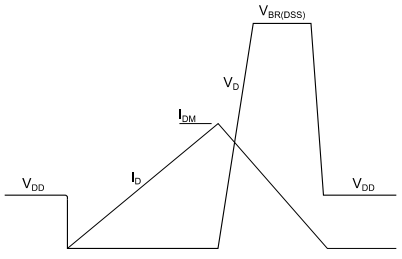
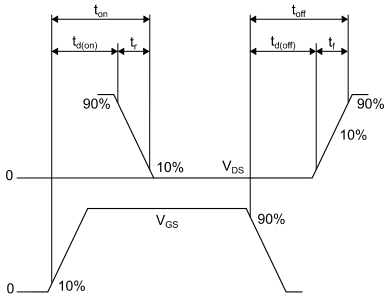


Figure 19: Switching time waveform



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

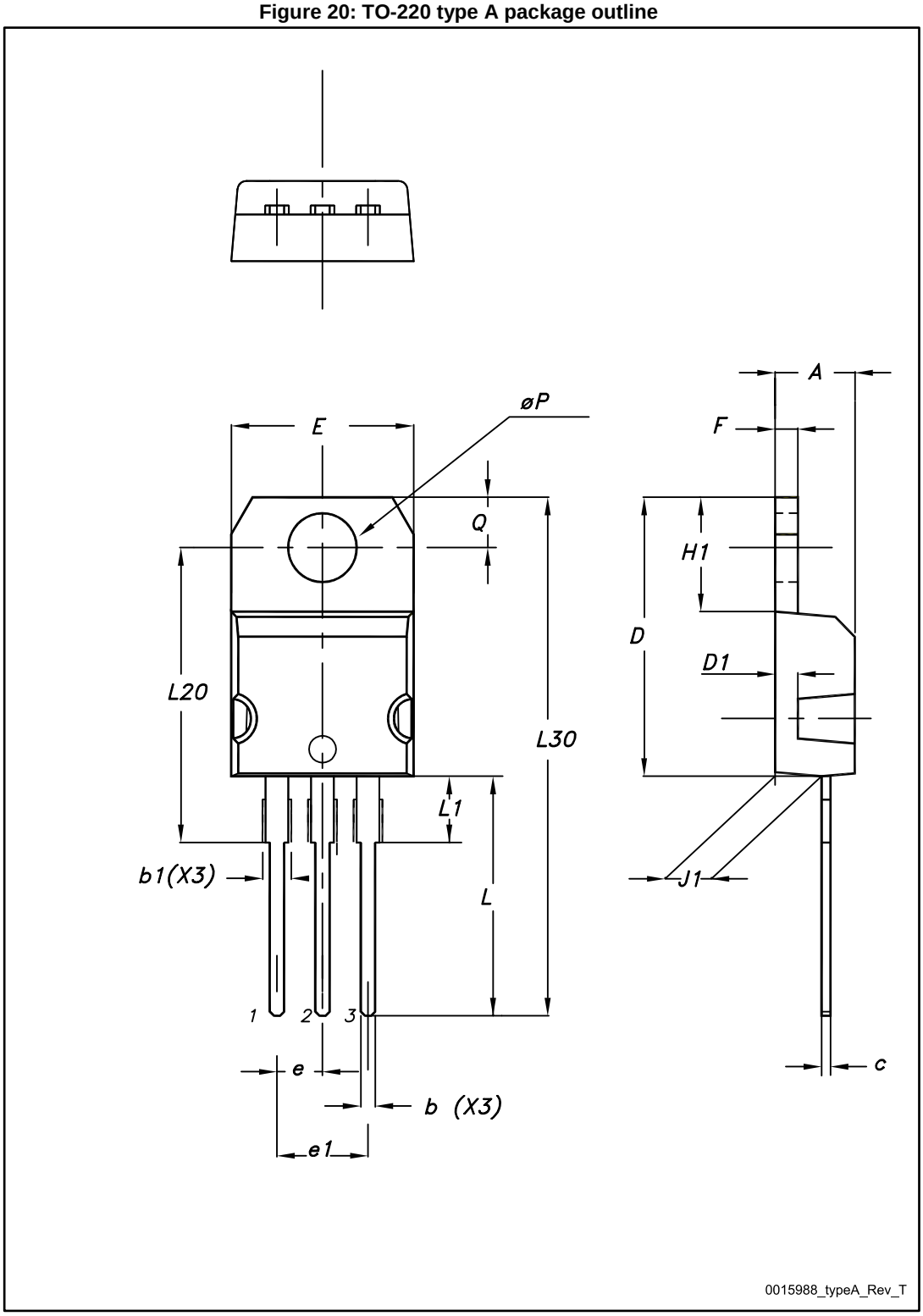


Table 10: TO-220 type A mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		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		14
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

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