

N-channel 600 V, 0.28 Ω typ., 12 A MDmesh™ M2 Power MOSFET in TO-220 and IPAK packages

Datasheet - production data

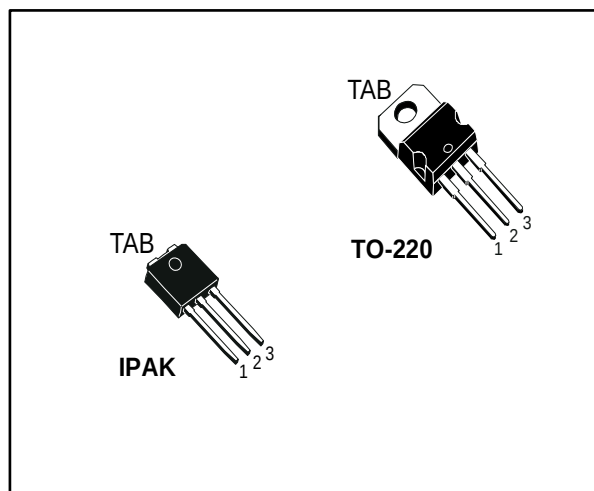
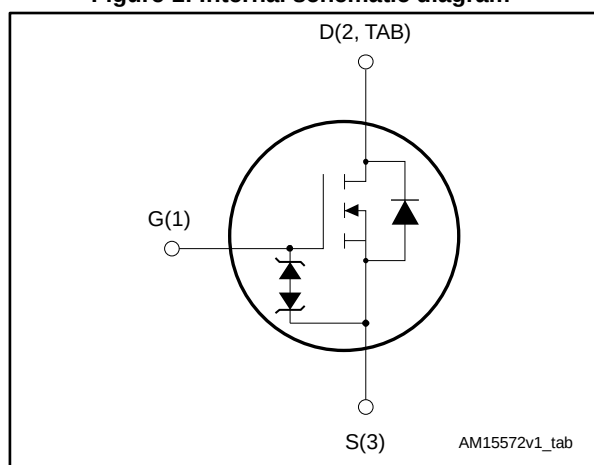


Figure 1: Internal schematic diagram



Features

Order code	V _{DS}	R _{DS(on)} max.	I _D
STP16N60M2	600 V	0.32 Ω	12 A
STU16N60M2			

- 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 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.

Table 1: Device summary

Order code	Marking	Package	Packaging
STP16N60M2	16N60M2	TO-220	Tube
STU16N60M2		IPAK	

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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 $T_C = 25\text{ }^{\circ}\text{C}$	12	A
I_D	Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$	7.6	A
$I_{DM}^{(1)}$	Drain current (pulsed)	48	A
P_{TOT}	Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	110	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15	V/ns
$dv/dt^{(3)}$	MOSFET dv/dt ruggedness	50	V/ns
T_{stg}	Storage temperature	- 55 to 150	$^{\circ}\text{C}$
T_j	Max. operating junction temperature	150	$^{\circ}\text{C}$

Notes:

⁽¹⁾ Pulse width limited by safe operating area.

⁽²⁾ $I_{SD} \leq 12\text{ A}$, $di/dt \leq 400\text{ A}/\mu\text{s}$; $V_{DS\text{ peak}} < V_{(BR)DSS}$, $V_{DD} = 80\% V_{(BR)DSS}$.

⁽³⁾ $V_{DS} \leq 480\text{ V}$

Table 3: Thermal data

Symbol	Parameter	Value		Unit
		TO-220	IPAK	
$R_{thj-case}$	Thermal resistance junction-case max.	1.14		$^{\circ}\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max.	62.5	100	$^{\circ}\text{C}/\text{W}$

Table 4: Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by T_{jmax})	2.9	A
E_{AS}	Single pulse avalanche energy (starting $T_j = 25\text{ }^{\circ}\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$)	130	mJ

2 Electrical characteristics

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

Table 5: Static

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$, $I_D = 1\text{ mA}$	600			V
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$, $V_{DS} = 600\text{ V}$			1	μA
		$V_{GS} = 0\text{ V}$, $V_{DS} = 600\text{ V}$, $T_C = 125\text{ }^{\circ}\text{C}$			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	$V_{GS} = 10\text{ V}$, $I_D = 6\text{ A}$		0.28	0.32	Ω

Table 6: Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$	-	700	-	pF
C_{oss}	Output capacitance		-	38	-	pF
C_{rss}	Reverse transfer capacitance		-	1.2	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ V}$ to 480 V , $V_{GS} = 0\text{ V}$	-	140	-	pF
R_G	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	5.3	-	Ω
Q_g	Total gate charge	$V_{DD} = 480\text{ V}$, $I_D = 12\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 17: "Gate charge test circuit")	-	19	-	nC
Q_{gs}	Gate-source charge		-	3.3	-	nC
Q_{gd}	Gate-drain charge		-	9.5	-	nC

Notes:

⁽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 7: Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$, $I_D = 6\text{ A}$ $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$ (see Figure 16: "Switching times test circuit for resistive load" and Figure 21: "Switching time waveform")	-	10.5	-	ns
t_r	Rise time		-	9.5	-	ns
$t_{d(off)}$	Turn-off-delay time		-	58	-	ns
t_f	Fall time		-	18.5	-	ns

Table 8: Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		12	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		48	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0\text{ V}$, $I_{SD} = 12\text{ A}$	-		1.6	V
t_{rr}	Reverse recovery time	$I_{SD} = 12\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$ (see Figure 18 : "Test circuit for inductive load switching and diode recovery times")	-	316		ns
Q_{rr}	Reverse recovery charge		-	3.25		μC
I_{RRM}	Reverse recovery current		-	20.5		A
t_{rr}	Reverse recovery time	$I_{SD} = 12\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 60\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 18 : "Test circuit for inductive load switching and diode recovery times")	-	454		ns
Q_{rr}	Reverse recovery charge		-	4.8		μC
I_{RRM}	Reverse recovery current		-	21		A

Notes:

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

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

2.1 Electrical characteristics (curves)

Figure 2: TO-220 safe operating area

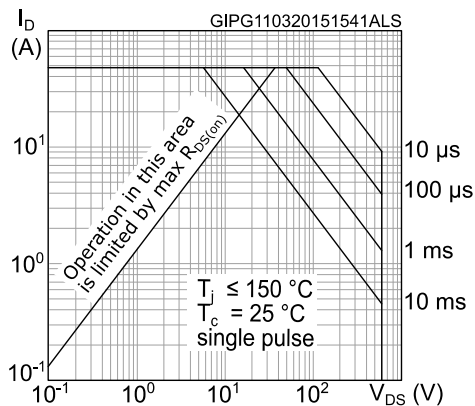


Figure 3: TO-220 thermal impedance

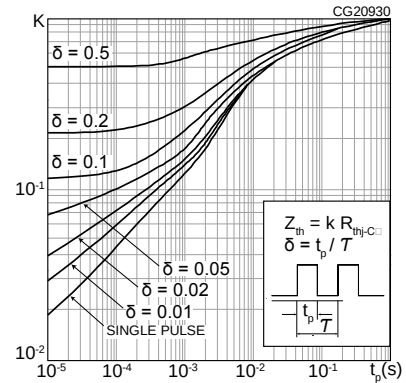


Figure 4: IPAK safe operating area

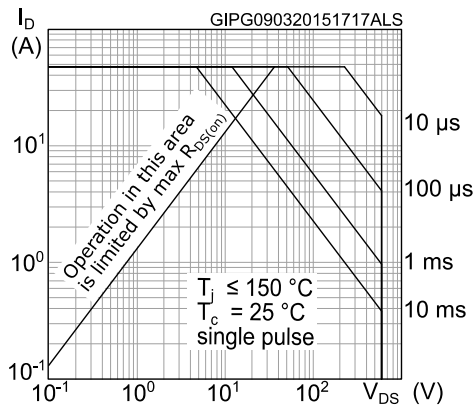


Figure 5: IPAK thermal impedance

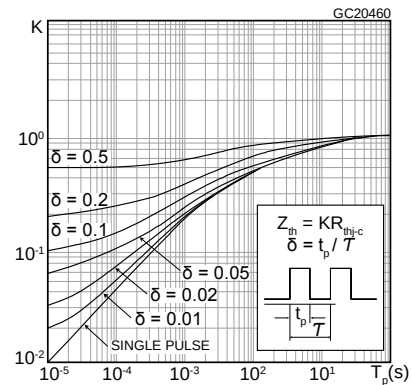


Figure 6: Output characteristics

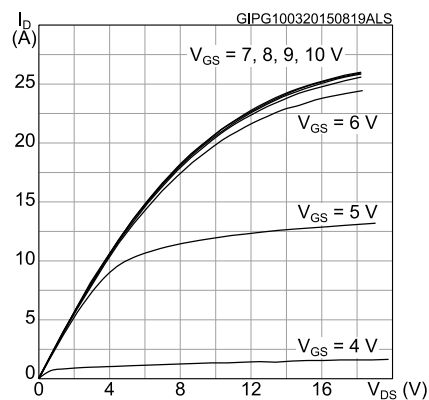


Figure 7: Transfer characteristics

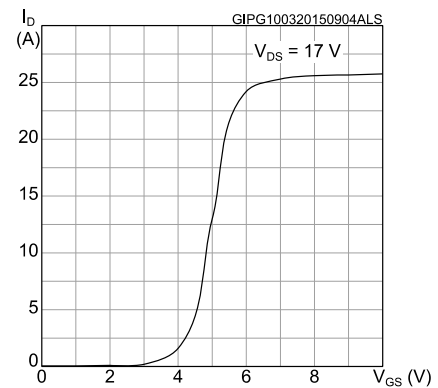


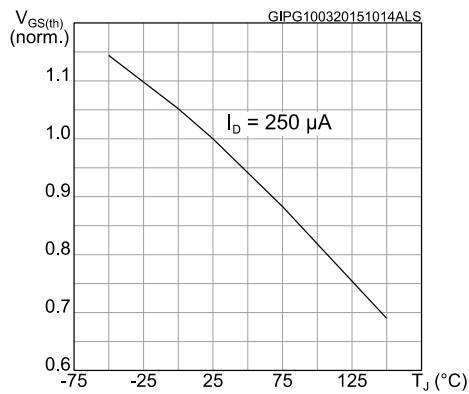
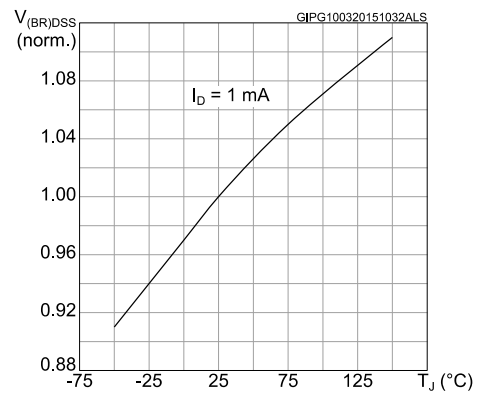
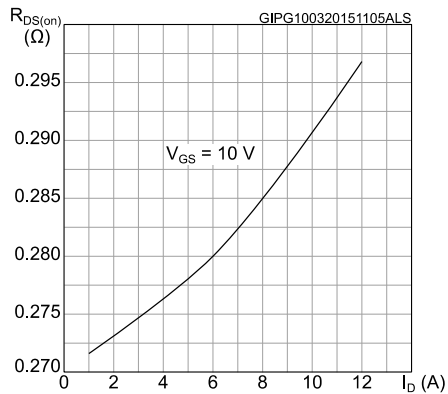
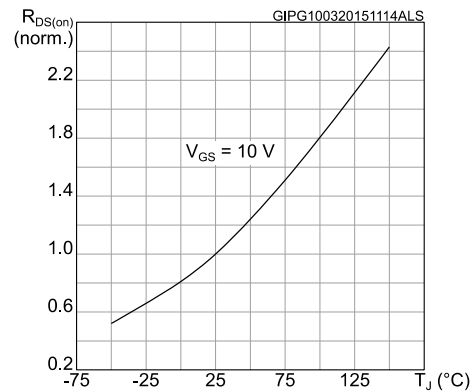
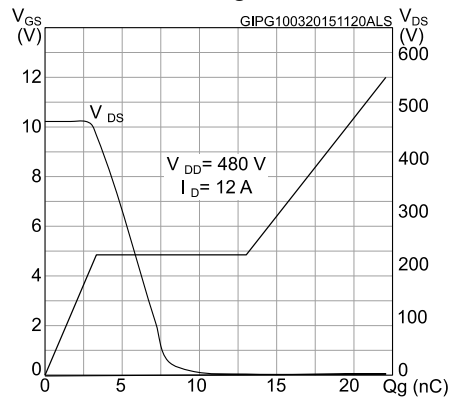
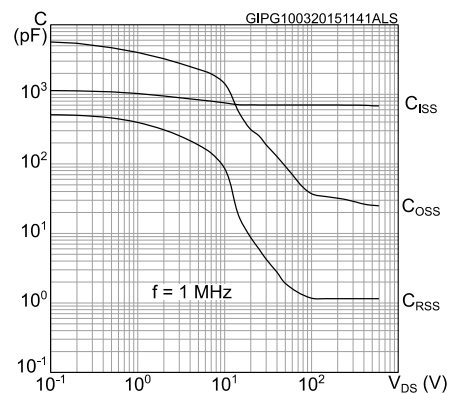
Figure 8: Normalized gate threshold voltage vs. temperature**Figure 9: Normalized $V_{(BR)DSS}$ vs. temperature****Figure 10: Static drain-source on-resistance****Figure 11: Normalized on-resistance vs. temperature****Figure 12: Gate charge vs. gate-source voltage****Figure 13: Capacitance variations**

Figure 14: Output capacitance stored energy

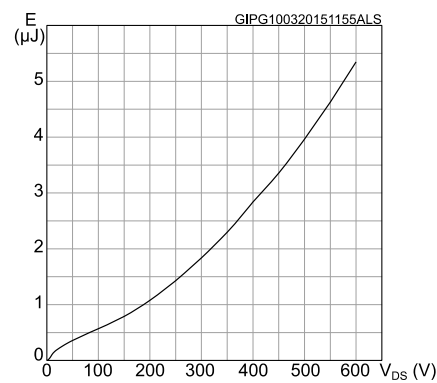
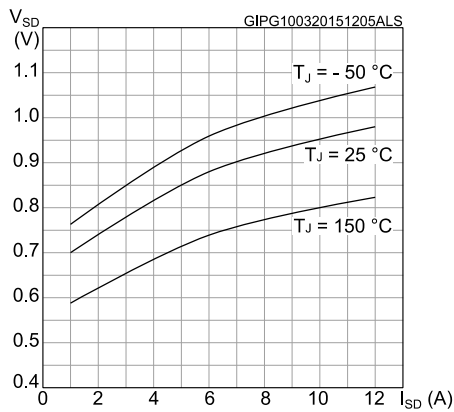


Figure 15: Source- drain diode forward characteristics



3 Test circuits

Figure 16: Switching times test circuit for resistive load

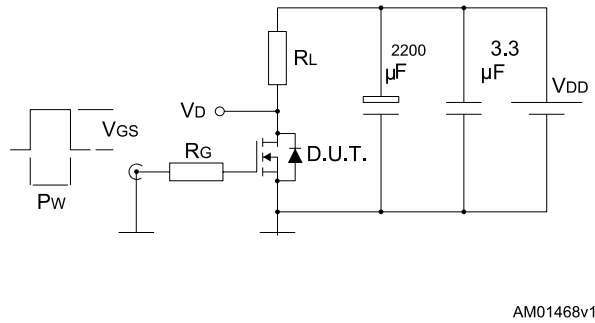


Figure 17: Gate charge test circuit

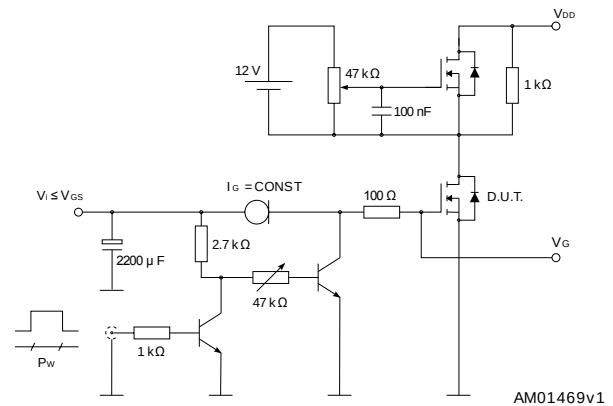


Figure 18: Test circuit for inductive load switching and diode recovery times

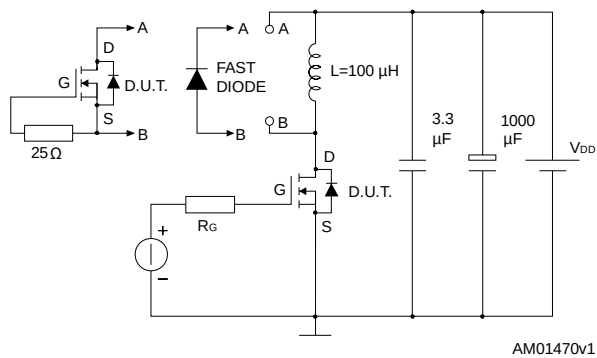


Figure 19: Unclamped inductive load test circuit

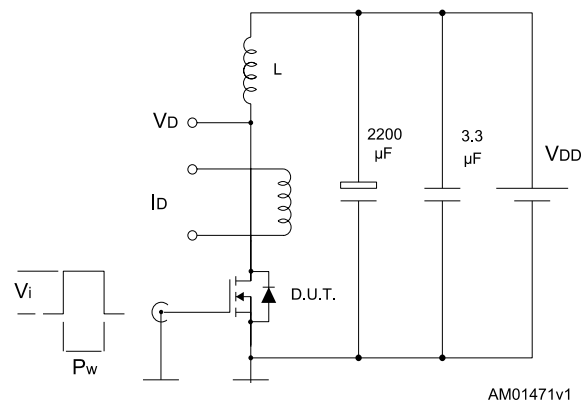


Figure 20: Unclamped inductive waveform

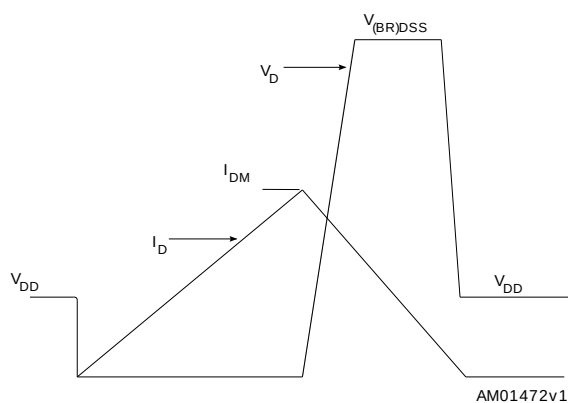
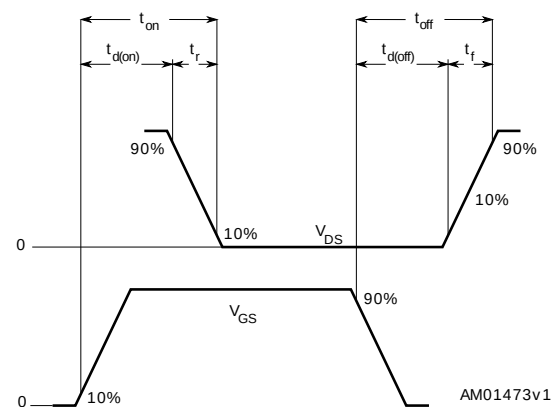


Figure 21: Switching time waveform



4 Package mechanical data

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 22: TO-220 type A package outline

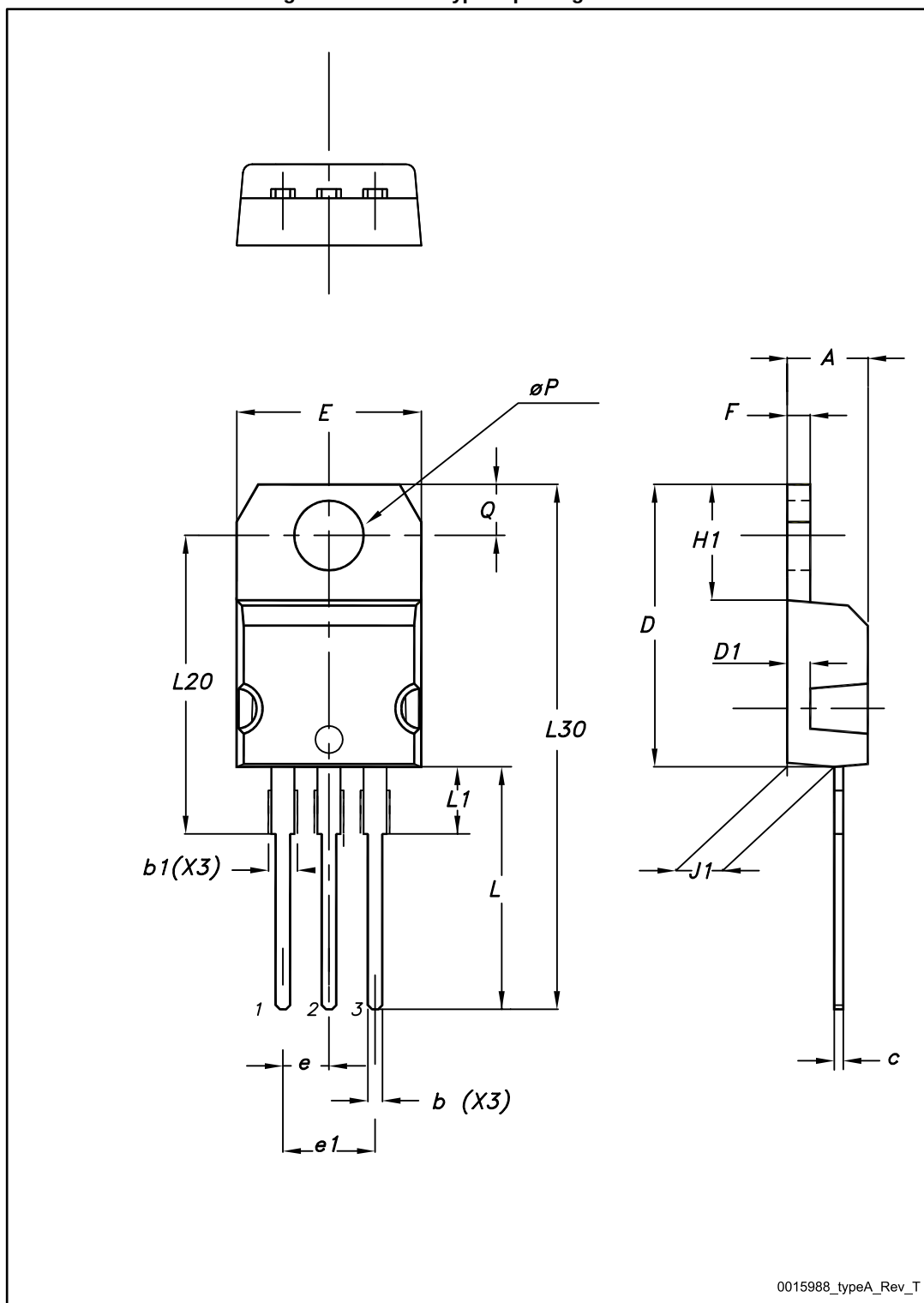


Table 9: TO-220 type A mechanical data

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

4.2 IPAK (TO-251) Type A package information

Figure 23: IPAK (TO-251) type A drawing

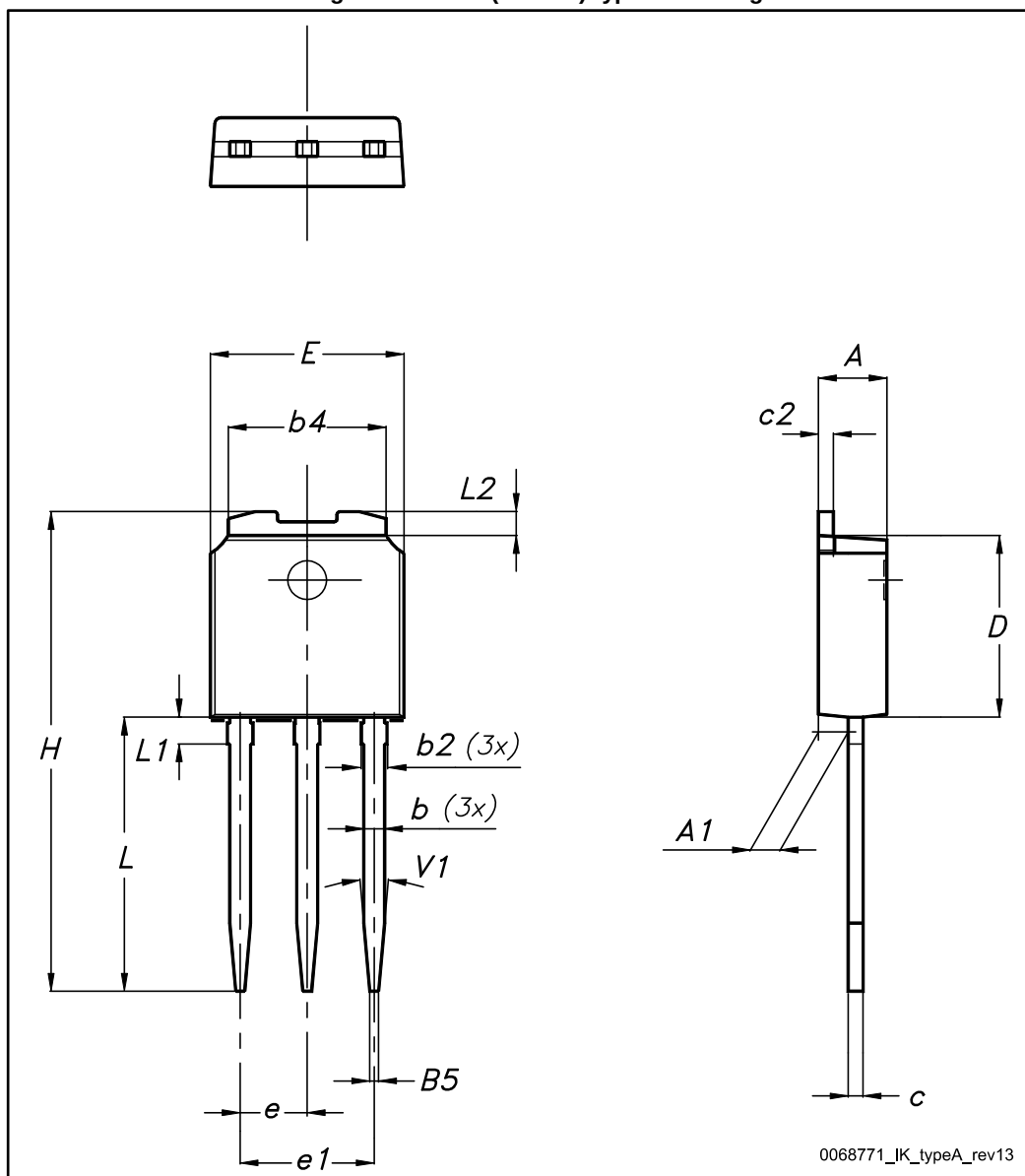


Table 10: IPAK (TO-251) type A mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
B5		0.30	
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
L1	0.80		1.20
L2		0.80	1.00
V1		10°	

5 Revision history

Table 11: Document revision history

Date	Revision	Changes
11-Mar-2015	1	Initial release.

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