

## N-channel 650 V, 0.98 $\Omega$ typ., 5 A MDmesh™ M2 Power MOSFETs in TO-220 and IPAK packages

Datasheet - preliminary data

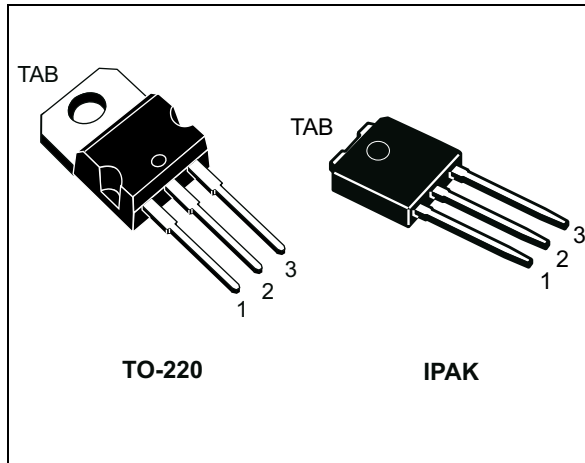
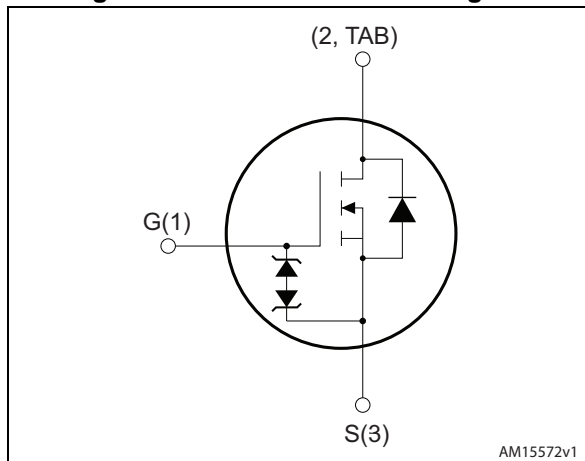


Figure 1. Internal schematic diagram



### Features

Order code	$V_{DS}$	$R_{DS(on)max}$	$I_D$
STP7N65M2	650 V	1.15 $\Omega$	5 A
STU7N65M2	650 V	1.15 $\Omega$	5 A

- 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 MOSFET developed using the MDmesh™ M2 technology. Thanks to the strip layout associated to an improved vertical structure, the device exhibits both low on-resistance and optimized switching characteristics. It is therefore suitable for the most demanding high efficiency converters.

Table 1. Device summary

Order code	Marking	Package	Packaging
STP7N65M2	7N65M2	TO-220	Tube
STU7N65M2	7N65M2	IPAK	Tube

# Contents

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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 $T_C = 25\text{ }^\circ\text{C}$	5	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	3.2	A
$I_{DM}^{(1)}$	Drain current (pulsed)	20	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	60	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15	V/ns
$dv/dt^{(3)}$	MOSFET $dv/dt$ ruggedness	50	
$T_{stg}$	Storage temperature	- 55 to 150	$^\circ\text{C}$
$T_j$	Max. operating junction temperature		

1. Pulse width limited by safe operating area
2.  $I_{SD} \leq 5\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD}=400\text{ V}$
3.  $V_{DS} \leq 520\text{ V}$

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		TO-220	IPAK	
$R_{thj-case}$	Thermal resistance junction-case max	2.08		$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	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 $T_{jmax}$ )	1	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j=25\text{ }^\circ\text{C}$ , $I_D=I_{AR}$ ; $V_{DD}=50\text{ V}$ )	103	mJ

## 2 Electrical characteristics

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

**Table 5. On /off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0, I_D = 1\text{ mA}$	650			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0, V_{DS} = 650\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0, V_{DS} = 650\text{ V}, T_C = 125\text{ °C}$			100	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0, V_{GS} = \pm 25\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	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	$V_{GS} = 10\text{ V}, I_D = 2.5\text{ A}$		0.98	1.15	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$	-	270	-	pF
$C_{oss}$	Output capacitance		-	14.5	-	pF
$C_{riss}$	Reverse transfer capacitance		-	0.8	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }520\text{ V}, V_{GS} = 0$	-	108	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz open drain}$	-	7	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 520\text{ V}, I_D = 5\text{ A}, V_{GS} = 10\text{ V}$ (see <a href="#">Figure 17</a> )	-	9	-	nC
$Q_{gs}$	Gate-source charge		-	2.3	-	nC
$Q_{gd}$	Gate-drain charge		-	4.3	-	nC

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	$V_{DD} = 325\text{ V}, I_D = 2.5\text{ A}, R_G = 4.7\text{ }\Omega, V_{GS} = 10\text{ V}$ (see <a href="#">Figure 16</a> and <a href="#">21</a> )	-	8	-	ns
$t_r$	Rise time		-	20	-	ns
$t_{d(off)}$	Turn-off delay time		-	30	-	ns
$t_f$	Fall time		-	20	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		20	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 5 \text{ A}$ , $V_{GS} = 0$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 5 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ (see <a href="#">Figure 21</a> )	-	275		ns
$Q_{rr}$	Reverse recovery charge		-	1.62		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	11.8		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 5 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ , $T_j = 150 \text{ }^\circ\text{C}$ (see <a href="#">Figure 21</a> )	-	430		ns
$Q_{rr}$	Reverse recovery charge		-	2.54		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	11.9		A

1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220

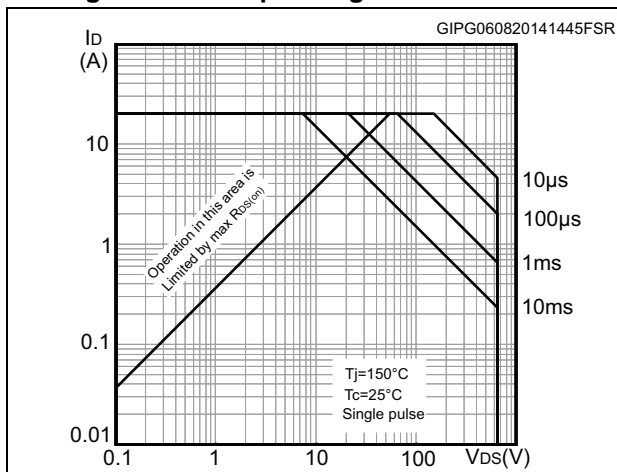


Figure 3. Thermal impedance for TO-220

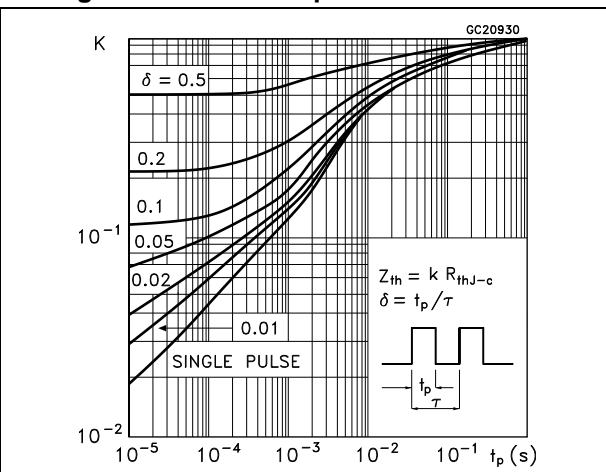


Figure 4. Safe operating area for IPAK

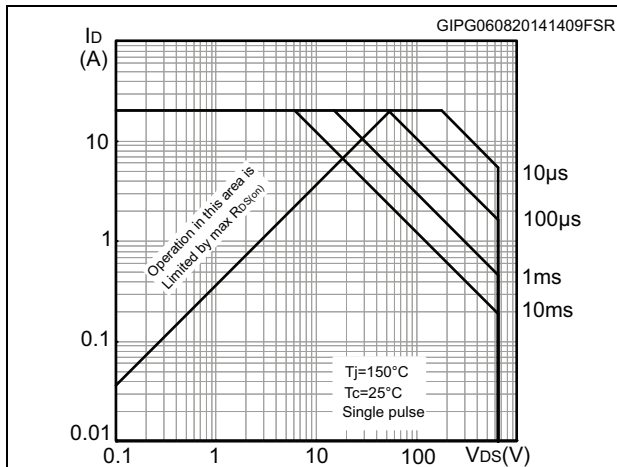


Figure 5. Thermal impedance for IPAK

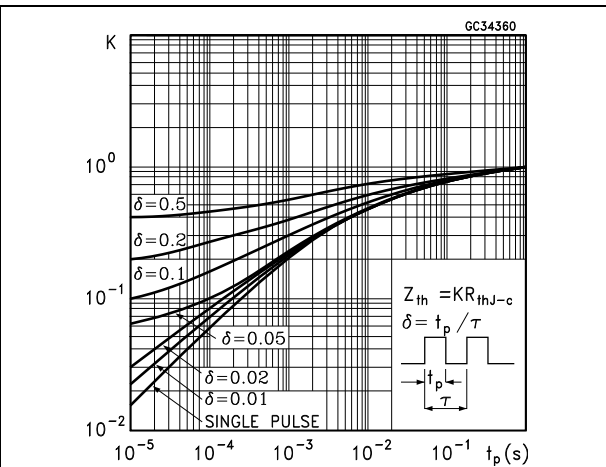


Figure 6. Output characteristics

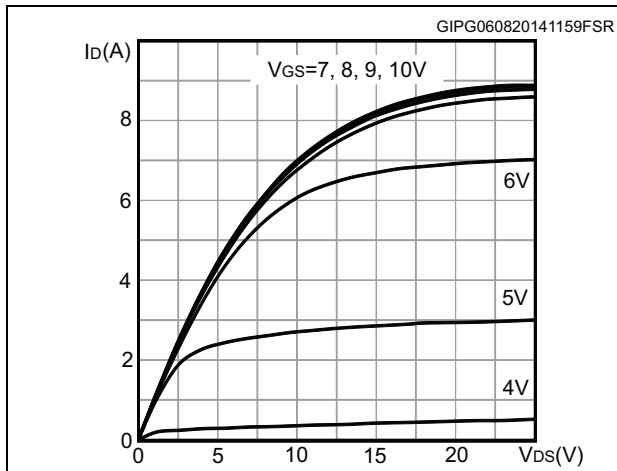


Figure 7. Transfer characteristics

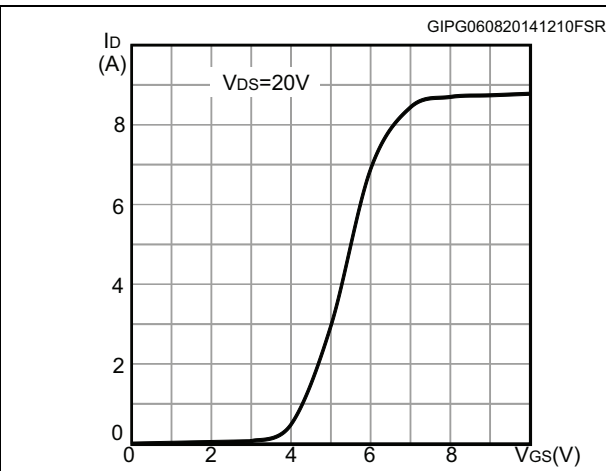


Figure 8. Gate charge vs gate-source voltage

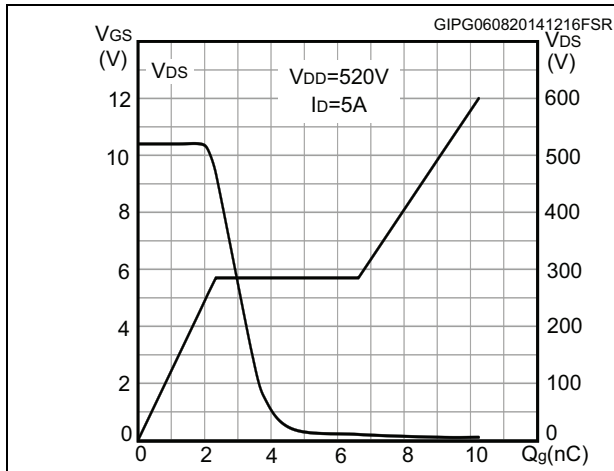


Figure 9. Static drain-source on-resistance

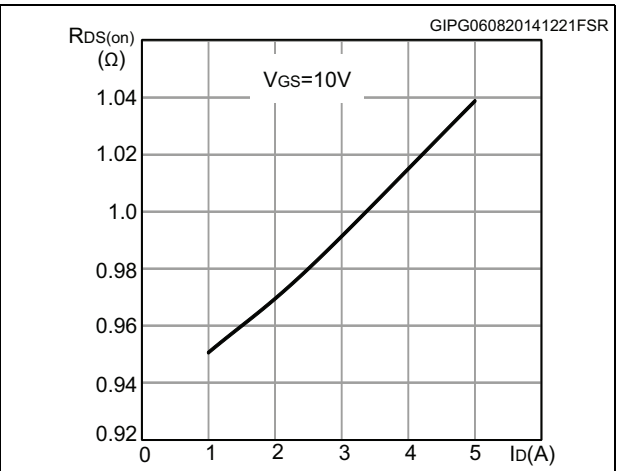


Figure 10. Capacitance variations

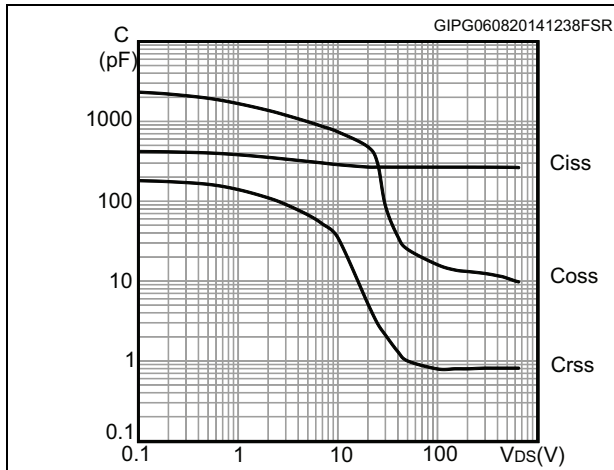


Figure 11. Output capacitance stored energy

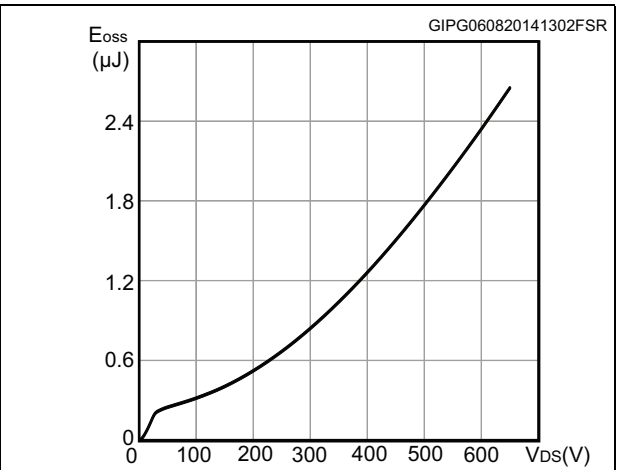


Figure 12. Normalized gate threshold voltage vs temperature

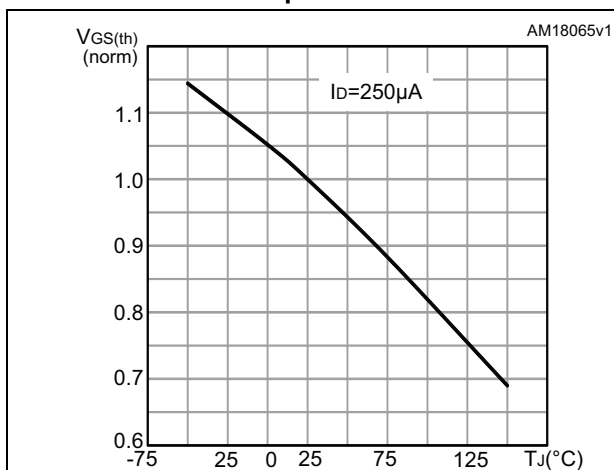


Figure 13. Normalized on-resistance vs temperature

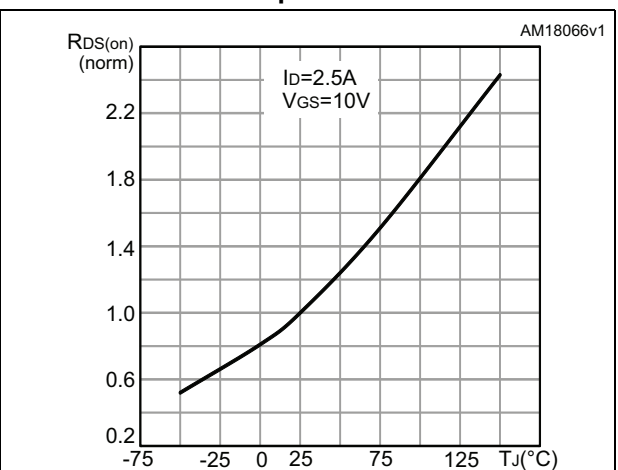


Figure 14. Source-drain diode forward characteristics

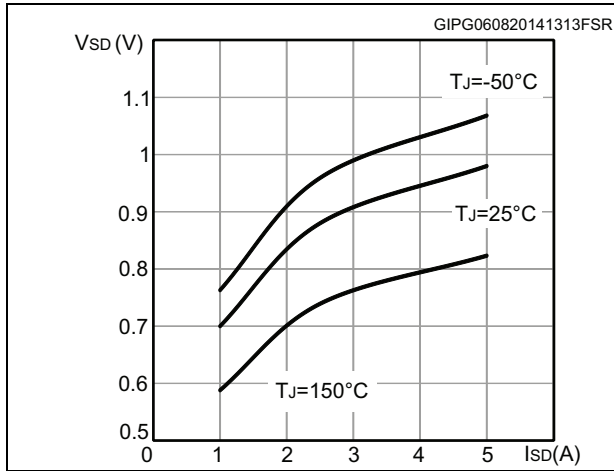
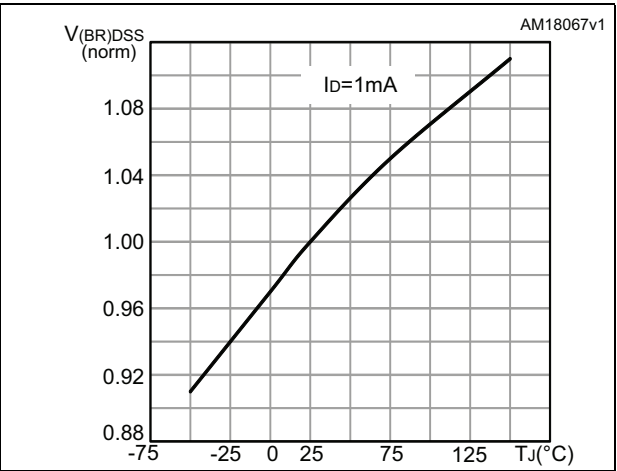


Figure 15. Normalized V<sub>(BR)DSS</sub> vs temperature





### 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

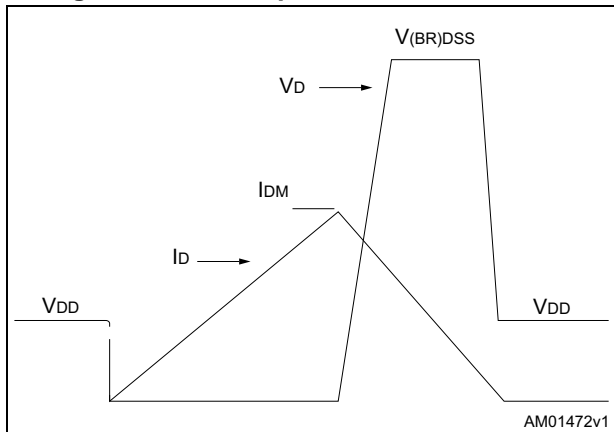


Figure 21. Switching time waveform

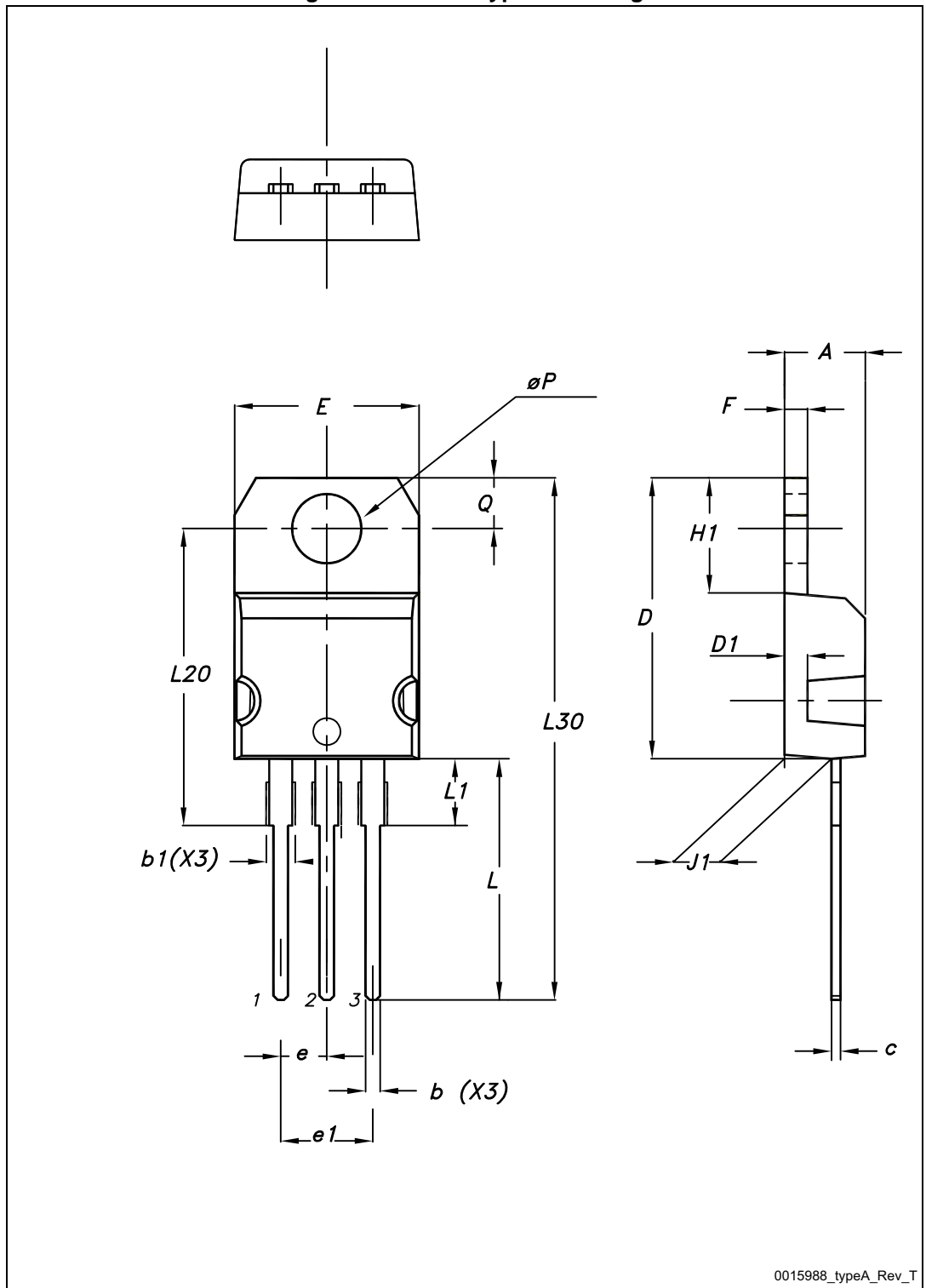


## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

### 4.1 TO-220, STP7N65M2

Figure 22. TO-220 type A drawing



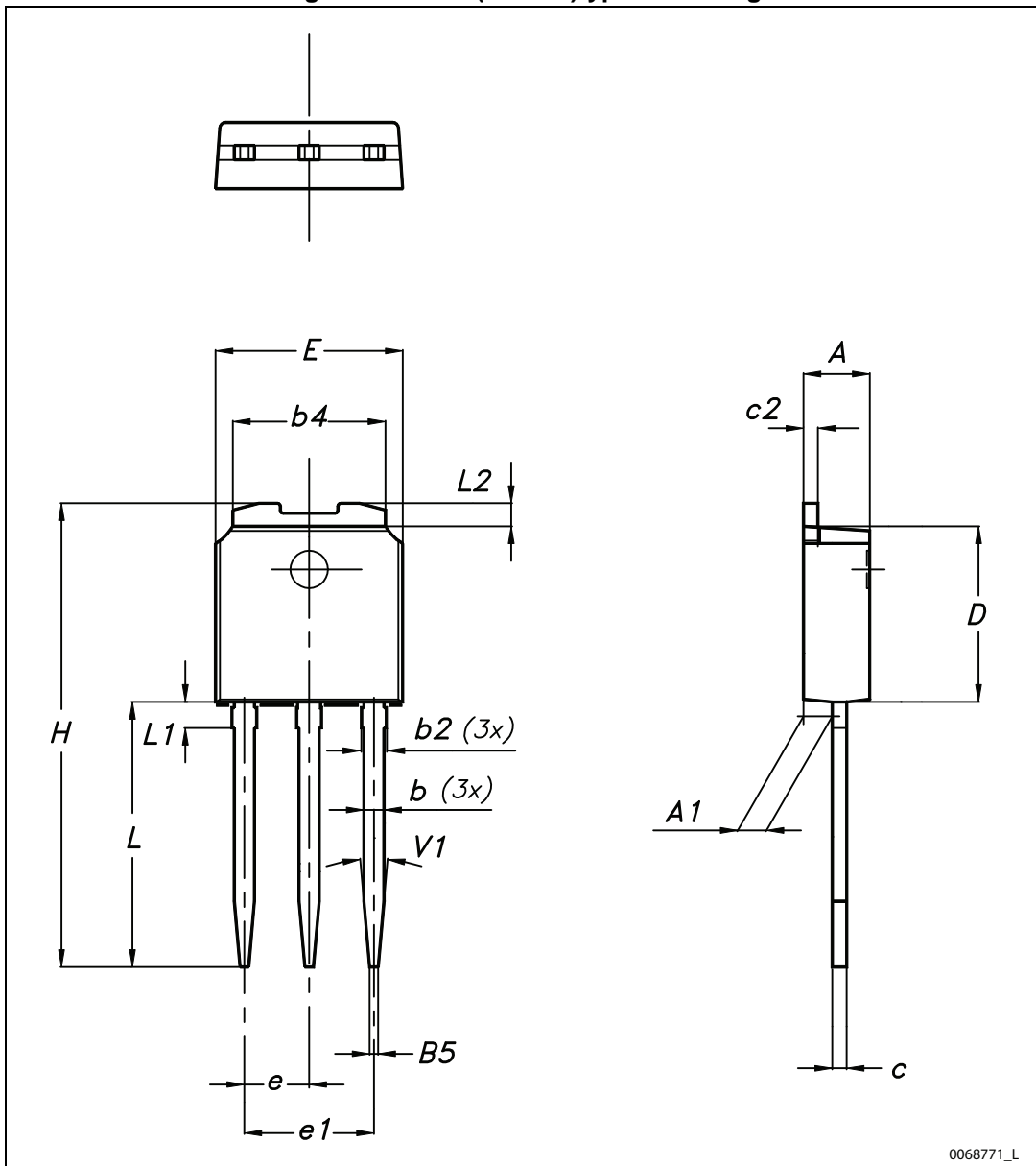
0015988\_typeA\_Rev\_T

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, STU7N65M2

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

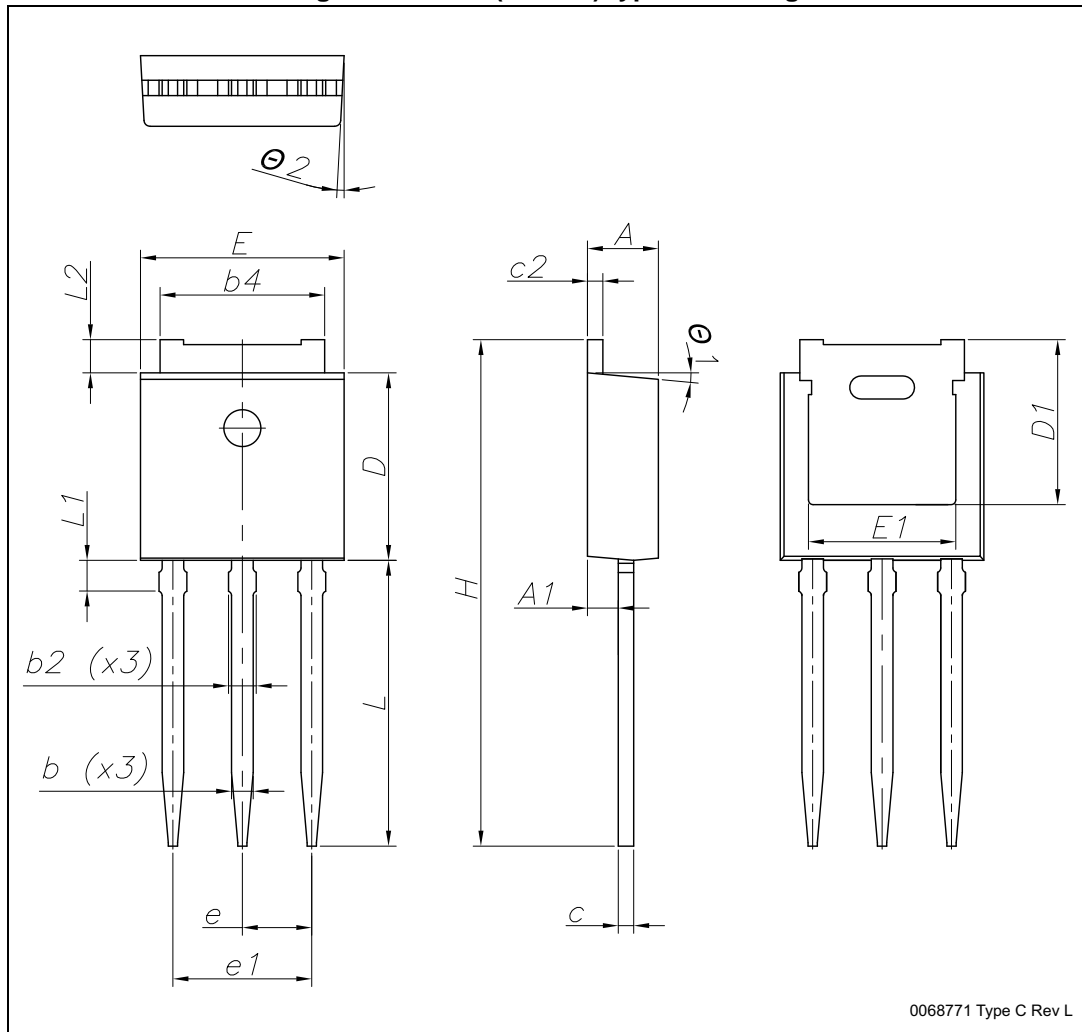


0068771\_L

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		5.43
B5		0.30	
c	0.45		0.60
c2	0.46		0.60
D	6.00		6.20
E	6.40		6.70
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.60
L1	0.80		1.20
L2		0.80	1.25
V1		10°	

Figure 24. IPAK (TO-251) type C drawing



0068771 Type C Rev L

Table 11. IPAK (TO-251) type C mechanical data

Dim.	mm		
	min.	typ.	max.
A	2.20	2.30	2.35
A1	0.90	1.00	1.10
b	0.66		0.79
b2			0.90
b4	5.23	5.33	5.43
c	0.46		0.59
c2	0.46		0.59
D	6.00	6.10	6.20
D1	5.20	5.37	5.55
E	6.50	6.60	6.70
E1	4.60	4.78	4.95
e	2.20	2.25	2.30
e1	4.40	4.50	4.60
H	16.18	16.48	16.78
L	9.00	9.30	9.60
L1	0.80	1.00	1.20
L2	0.90	1.08	1.25
$\theta 1$	3°	5°	7°
$\theta 2$	1°	3°	5°



## 5 Revision history

Table 12. Document revision history

Date	Revision	Changes
07-Aug-2014	1	First release.
09-Oct-2014	2	Added <i>Figure 4: Safe operating area for IPAK</i> and <i>Figure 5: Thermal impedance for IPAK</i> . Updated <i>Section 4: Package mechanical data</i> . Minor text changes.

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