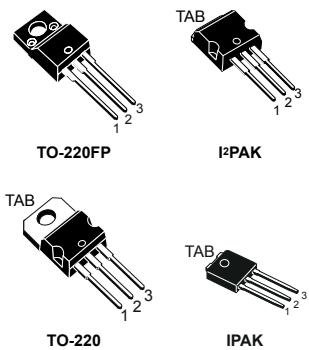


N-channel 600 V, 280 mΩ typ., 11 A MDmesh II Power MOSFETs  
in a TO-220FP, I<sup>2</sup>PAK, TO-220 and IPAK packages



## Features

Order codes	V <sub>DS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>
STF13NM60N	600 V	360 mΩ	11 A
STI13NM60N			
STP13NM60N			
STU13NM60N			

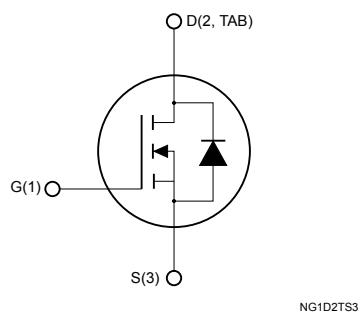
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

## Applications

- Switching applications

## Description

These devices are N-channel Power MOSFETs developed using the second generation of MDmesh technology. These revolutionary Power MOSFETs associate a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. They are therefore suitable for the most demanding high-efficiency converters.



Product status link
<a href="#">STF13NM60N</a>
<a href="#">STI13NM60N</a>
<a href="#">STP13NM60N</a>
<a href="#">STU13NM60N</a>

## 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220FP	I <sup>2</sup> PAK, TO-220, IPAK	
V <sub>DS</sub>	Drain-source voltage		600	V
V <sub>GS</sub>	Gate-source voltage		±25	V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	11 <sup>(1)</sup>	11	A
	Drain current (continuous) at T <sub>C</sub> = 100 °C	6.9 <sup>(1)</sup>	6.9	
I <sub>DM</sub> <sup>(2)</sup>	Drain current pulsed	44 <sup>(1)</sup>	44	A
P-TOT	Total power dissipation at T <sub>C</sub> = 25 °C	25	90	W
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope		15	V/ns
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s, T <sub>C</sub> = 25 °C)	2.5		kV
T <sub>J</sub>	Operating junction temperature range	-55 to 150		
T <sub>stg</sub>	Storage temperature range	°C		

1. Limited by maximum junction temperature.
2. Pulse width limited by safe operating area.
3. I<sub>SD</sub> ≤ 11 A, di/dt ≤ 400 A/μs, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>.

**Table 2. Thermal data**

Symbol	Parameter	Value			Unit
		TO-220FP	I <sup>2</sup> PAK, TO-220	IPAK	
R <sub>thj-case</sub>	Thermal resistance junction-case	5	1.39		°C/W
R <sub>thj-a</sub>	Thermal resistance junction-ambient		62.5	100	°C/W

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
I <sub>AS</sub>	Avalanche current, repetitive or not repetitive (pulse width limited by T <sub>J</sub> max)	3.5	A
E <sub>AS</sub>	Single-pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> = I <sub>AS</sub> , V <sub>DD</sub> = 50 V)	200	mJ

## 2

## Electrical characteristics

(T<sub>C</sub> = 25 °C unless otherwise specified)**Table 4. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-source breakdown voltage	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 1 mA	600			V
I <sub>DSS</sub>	Zero gate voltage drain current	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 600 V			1	μA
		V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 600 V, T <sub>C</sub> = 125 °C <sup>(1)</sup>			100	
I <sub>GSS</sub>	Gate-body leakage current	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±25 V			±100	nA
V <sub>GS(th)</sub>	Gate threshold voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA	2	3	4	V
R <sub>D(on)</sub>	Static drain-source on-resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 5.5 A		280	360	mΩ

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

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C <sub>iss</sub>	Input capacitance	V <sub>DS</sub> = 50 V, f = 1 MHz, V <sub>GS</sub> = 0 V	-	790	-	pF
C <sub>oss</sub>	Output capacitance		-	60	-	pF
C <sub>rss</sub>	Reverse transfer capacitance		-	3.6	-	pF
C <sub>oss eq.</sub> <sup>(1)</sup>	Equivalent output capacitance	V <sub>DS</sub> = 0 to 480 V, V <sub>GS</sub> = 0 V	-	135	-	pF
Q <sub>g</sub>	Total gate charge	V <sub>DD</sub> = 480 V, I <sub>D</sub> = 11 A, V <sub>GS</sub> = 0 to 10 V (see Figure 17. Test circuit for gate charge behavior)	-	27	-	nC
Q <sub>gs</sub>	Gate-source charge		-	4	-	nC
Q <sub>gd</sub>	Gate-drain charge		-	14	-	nC
R <sub>g</sub>	Gate input resistance	f = 1 MHz, open drain	-	4.7	-	Ω

1. C<sub>oss eq.</sub> is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DSS</sub>.**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t <sub>d(on)</sub>	Turn-on delay time	V <sub>DD</sub> = 300 V, I <sub>D</sub> = 5.5 A, R <sub>G</sub> = 4.7 Ω, V <sub>GS</sub> = 10 V (see Figure 16. Test circuit for resistive load switching times and Figure 21. Switching time waveform)	-	3	-	ns
t <sub>r</sub>	Rise time		-	8	-	ns
t <sub>d(off)</sub>	Turn-off delay time		-	30	-	ns
t <sub>f</sub>	Fall time		-	10	-	ns

**Table 7. Source-drain diode**

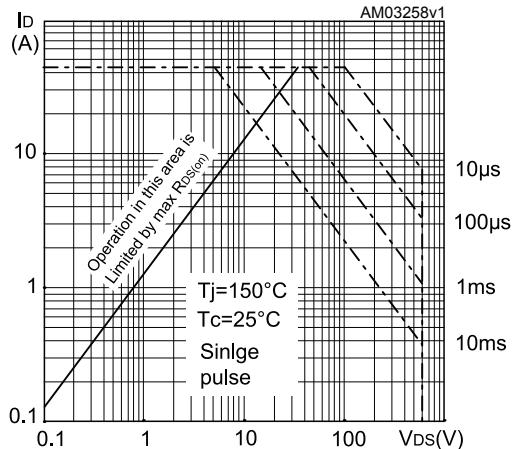
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		11	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		44	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0 \text{ V}$ , $I_{SD} = 11 \text{ A}$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 11 \text{ A}$ , $dI/dt = 100 \text{ A}/\mu\text{s}$ ,	-	230		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100 \text{ V}$	-	2		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 18. Test circuit for inductive load switching and diode recovery times)	-	18		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 11 \text{ A}$ , $dI/dt = 100 \text{ A}/\mu\text{s}$ ,	-	290		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 100 \text{ V}$ , $T_J = 150 \text{ }^\circ\text{C}$	-	2.5		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 18. Test circuit for inductive load switching and diode recovery times)	-	17		A

1. Pulse width is limited by safe operating area.

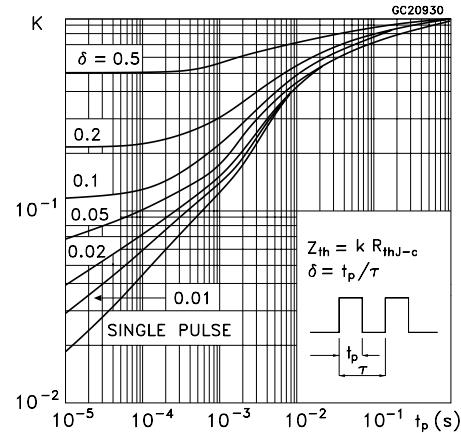
2. Pulse test: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

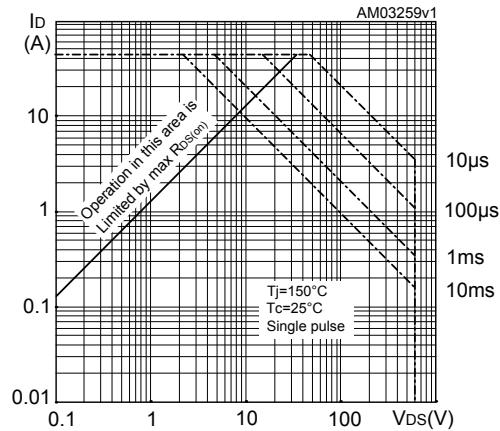
**Figure 1.** Safe operating area for I<sup>2</sup>PAK and TO-220



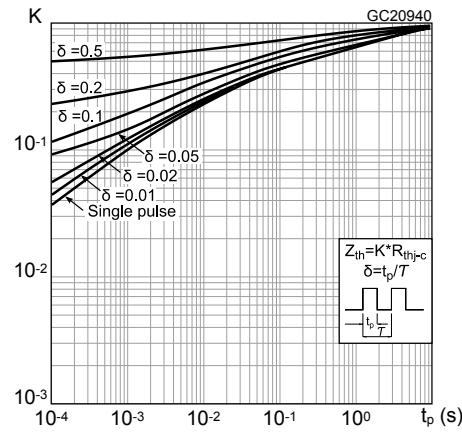
**Figure 2.** Thermal impedance for I<sup>2</sup>PAK and TO-220



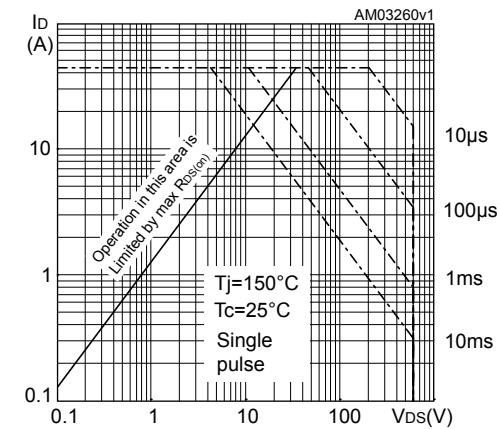
**Figure 3.** Safe operating area for TO-220FP



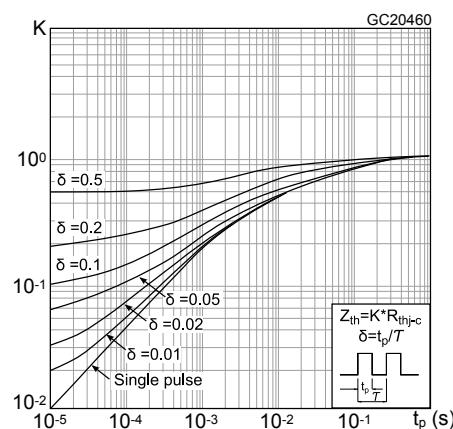
**Figure 4.** Thermal impedance for TO-220FP

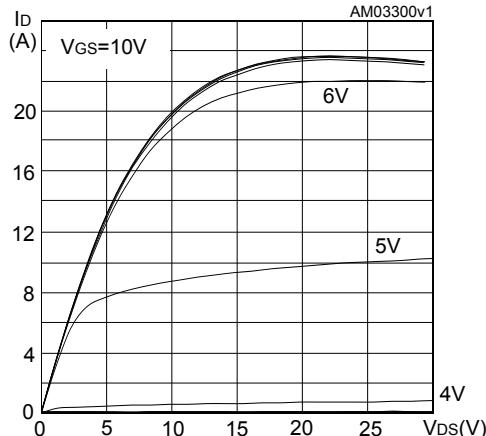
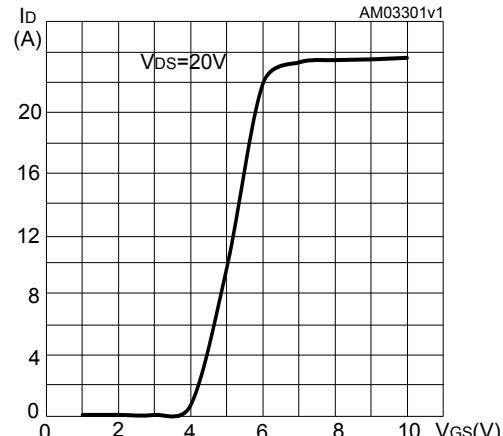
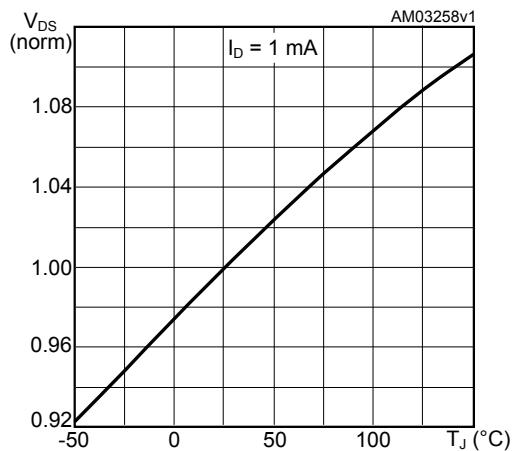
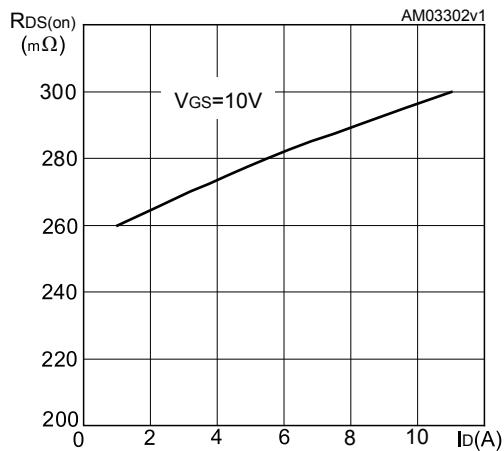
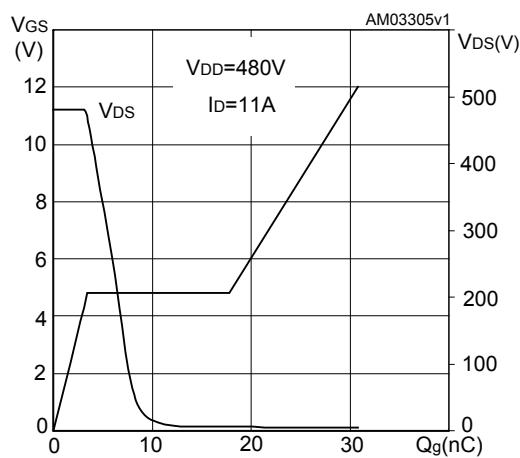
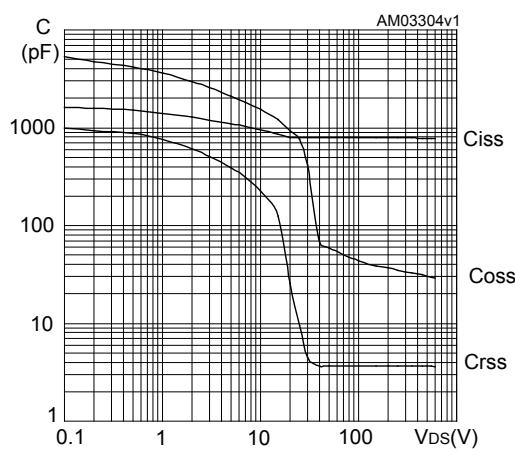


**Figure 5.** Safe operating area for IPAK

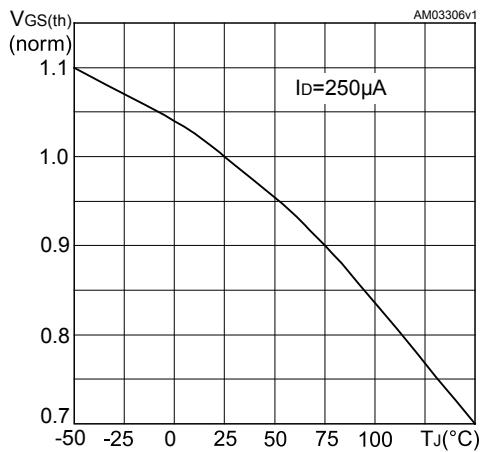


**Figure 6.** Thermal impedance for IPAK

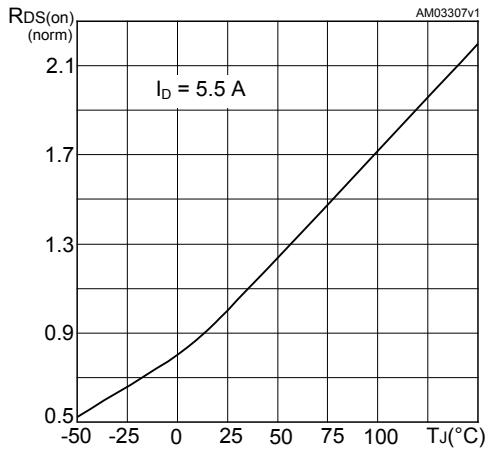


**Figure 7. Output characteristics**

**Figure 8. Transfer characteristics**

**Figure 9. Normalized  $V_{DS}$  vs temperature**

**Figure 10. Static drain-source on-resistance**

**Figure 11. Gate charge vs gate-source voltage**

**Figure 12. Capacitance variations**


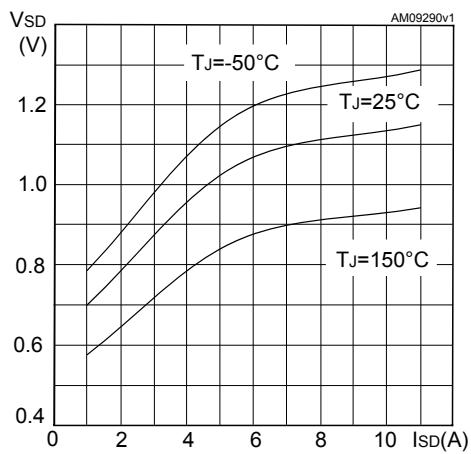
**Figure 13. Normalized gate threshold voltage vs temperature**



**Figure 14. Normalized on resistance vs temperature**

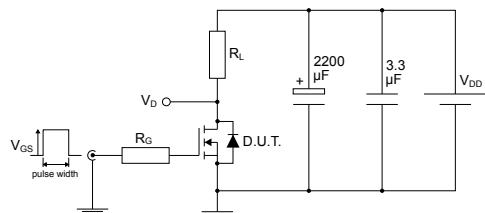


**Figure 15. Source-drain diode forward characteristics**



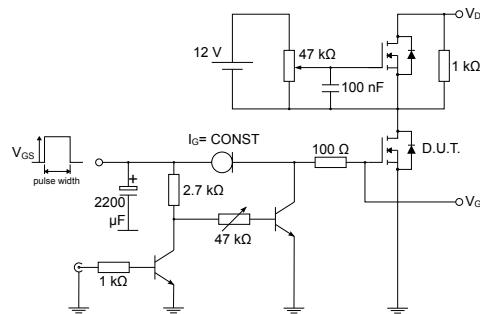
### 3 Test circuits

**Figure 16. Test circuit for resistive load switching times**



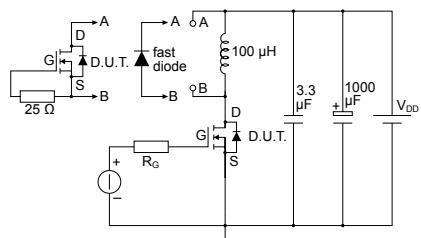
AM01468v1

**Figure 17. Test circuit for gate charge behavior**



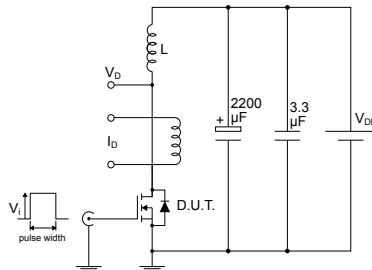
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**Figure 18. Test circuit for inductive load switching and diode recovery times**



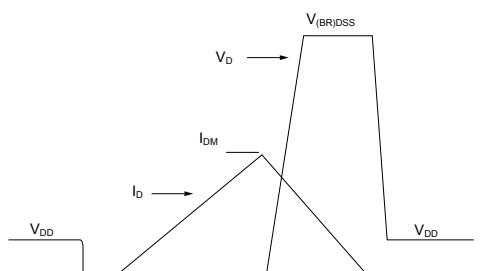
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**Figure 19. Unclamped inductive load test circuit**



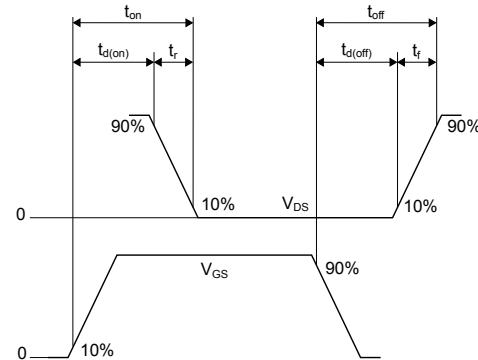
AM01471v1

**Figure 20. Unclamped inductive waveform**



AM01472v1

**Figure 21. Switching time waveform**



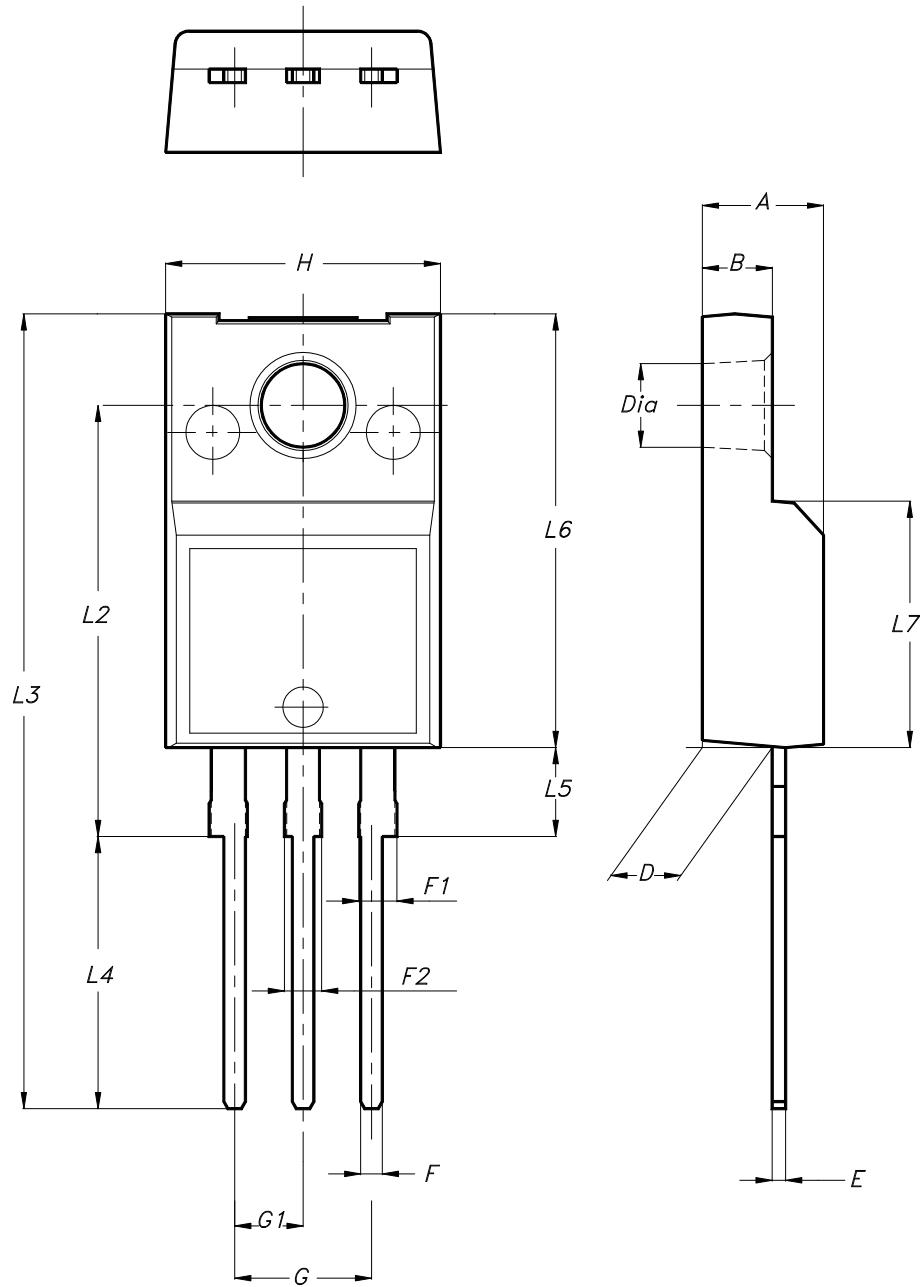
AM01473v1

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

### 4.1 TO-220FP package information

Figure 22. TO-220FP package outline



7012510\_Rev\_13\_B

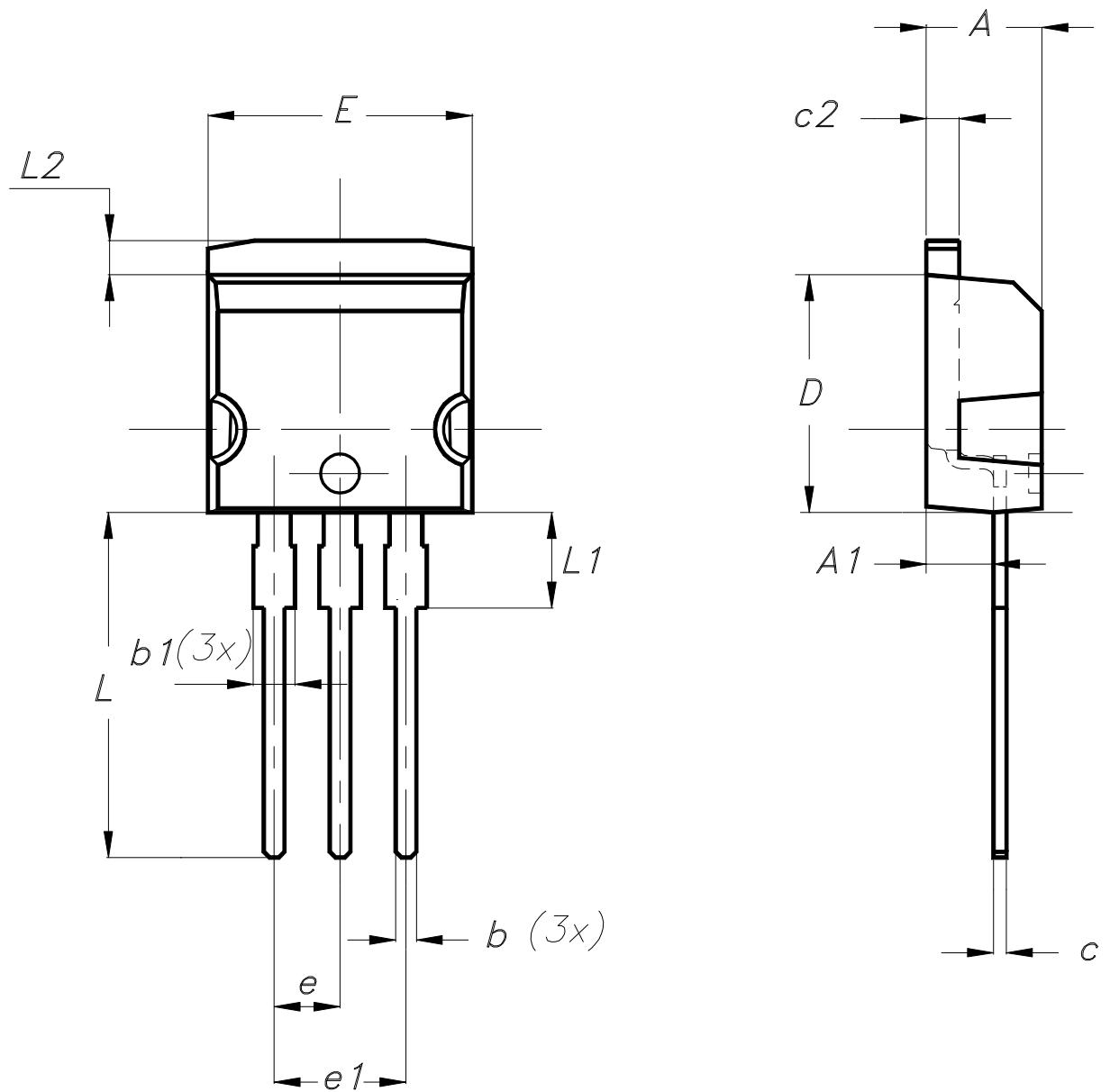


Table 8. TO-220FP package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
B	2.50		2.70
D	2.50		2.75
E	0.45		0.70
F	0.75		1.00
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.20
G1	2.40		2.70
H	10.00		10.40
L2		16.00	
L3	28.60		30.60
L4	9.80		10.60
L5	2.90		3.60
L6	15.90		16.40
L7	9.00		9.30
Dia	3.00		3.20

## 4.2 I<sup>2</sup>PAK package information

Figure 23. I<sup>2</sup>PAK package outline



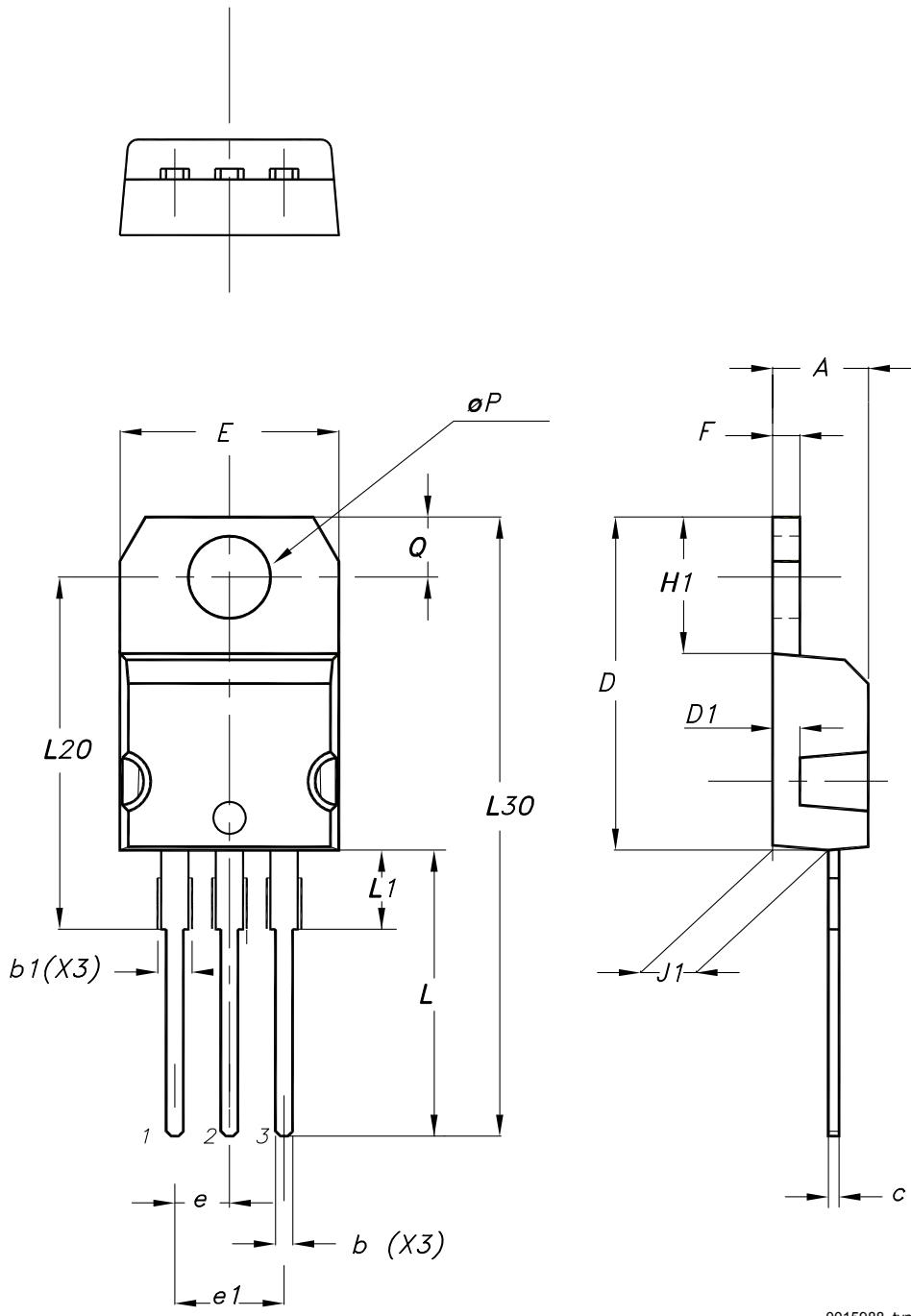
0004982\_Rev\_9

**Table 9.** I<sup>2</sup>PAK package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40	-	4.60
A1	2.40	-	2.72
b	0.61	-	0.88
b1	1.14	-	1.70
c	0.49	-	0.70
c2	1.23	-	1.32
D	8.95	-	9.35
e	2.40	-	2.70
e1	4.95	-	5.15
E	10.00	-	10.40
L	13.00	-	14.00
L1	3.50	-	3.93
L2	1.27	-	1.40

#### 4.3 TO-220 type A package information

Figure 24. TO-220 type A package outline



0015988\_typeA\_Rev\_23

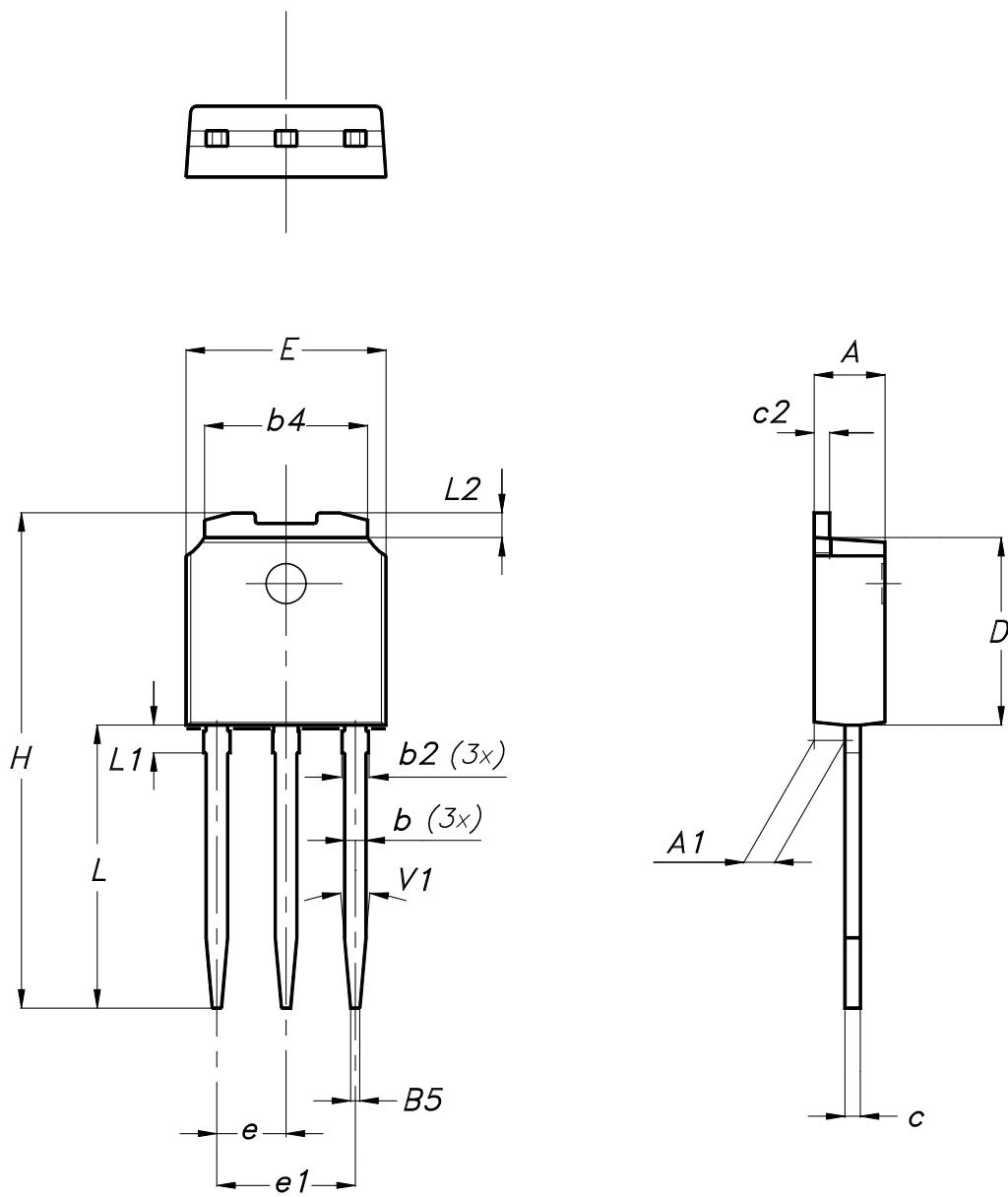


Table 10. TO-220 type A package mechanical data

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
Slug flatness		0.03	0.10

#### 4.4 IPAK (TO-251) type A package information

**Figure 25. IPAK (TO-251) type A package outline**



0068771\_IK\_typeA\_rev15

**Table 11. IPAK (TO-251) type A package 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 Ordering information

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**Table 12. Order codes**

Order codes	Marking	Package	Packing
STF13NM60N	13NM60N	TO-220FP	Tube
STI13NM60N		I <sup>2</sup> PAK	
STP13NM60N		TO-220	
STU13NM60N		IPAK	

## Revision history

**Table 13. Document revision history**

Date	Revision	Changes
29-Feb-2009	1	First release
13-Jan-2010	2	<ul style="list-style-type: none"><li>– Added new package, mechanical data: TO-247</li><li>– Added new package, mechanical data: D<sup>2</sup>PAK</li></ul>
08-Nov-2010	3	<ul style="list-style-type: none"><li>– Modified <i>Figure 4</i></li><li>– Added new package, mechanical data: I<sup>2</sup>PAK</li></ul>
18-Jan-2012	4	<ul style="list-style-type: none"><li>– Added new package, mechanical data: IPAK</li><li>– Minor text changes</li></ul>
14-Nov-2012	5	<p>The part numbers STB13NM60N and STD13NM60N have been moved to a separate datasheet.</p> <p><i>Section 4: Package mechanical data</i> has been updated.</p>
26-Oct-2020	6	<p>The part number STW13NM60N have been moved to a separate datasheet and the document has been updated accordingly.</p> <p>Updated cover page.</p> <p>Updated <a href="#">Section 1 Electrical ratings</a>.</p> <p>Updated <a href="#">Table 4. Static</a> and <a href="#">Table 7. Source-drain diode</a>.</p> <p>Updated <a href="#">Section 4 Package information</a>.</p> <p>Added <a href="#">Section 5 Ordering information</a>.</p> <p>Minor text changes.</p>

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