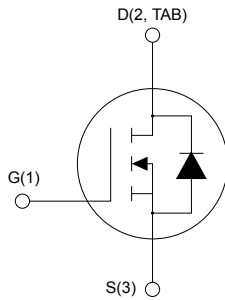
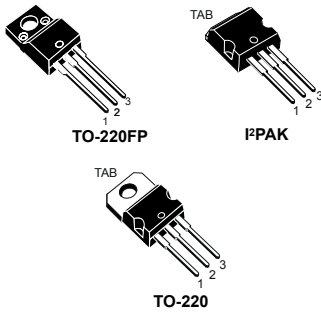




N-channel 600 V, 168 mΩ typ., 17 A MDmesh II Power MOSFET in a TO-220FP, I<sup>2</sup>PAK and TO-220 packages



AM01475v1\_noZen



## Features

Order code	V <sub>DS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>
STF24NM60N	600 V	190 mΩ	17 A
STI24NM60N			
STP24NM60N			

- 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 links

[STF24NM60N](#)

[STI24NM60N](#)

[STP24NM60N](#)

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		I <sup>2</sup> PAK TO-220	TO-220FP	
V <sub>DS</sub>	Drain-source voltage	600		V
V <sub>GS</sub>	Gate-source voltage	±30		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	17		A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	11		A
I <sub>DM</sub> <sup>(1)</sup>	Drain current (pulsed)	68		A
P <sub>TOT</sub>	Total power dissipation at T <sub>C</sub> = 25 °C	125	30	W
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
dv/dt <sup>(2)</sup>	Peak diode recovery voltage slope	15		V/ns
T <sub>stg</sub>	Storage temperature range	-55 to 150		°C
T <sub>J</sub>	Operating junction temperature range			°C

1. Pulse width limited by safe operating area.

2. I<sub>SD</sub> ≤ 17 A, di/dt ≤ 400 A/μs, V<sub>DS</sub> (peak) ≤ V<sub>(BR)DSS</sub>, V<sub>DD</sub> = 480 V.

**Table 2. Thermal data**

Symbol	Parameter	Value			Unit
		I <sup>2</sup> PAK	TO-220	TO-220FP	
R <sub>thJC</sub>	Thermal resistance, junction-to-case	1		4.17	°C/W
R <sub>thJA</sub>	Thermal resistance, junction-to-ambient	62.5			°C/W

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
I <sub>AR</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> max.)	6	A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V)	300	mJ

## 2 Electrical characteristics

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

**Table 4. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$ , $V_{GS} = 0\text{ V}$	600	-	-	V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$	-	-	1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ }^\circ\text{C}^{(1)}$	-	-	100	
$I_{GSS}$	Gate body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 25\text{ V}$	-	-	$\pm 100$	nA
$V_{GS(th)}$	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	$V_{GS} = 10\text{ V}$ , $I_D = 8\text{ A}$	-	168	190	m $\Omega$

1. Specified by design, not tested in production.

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	1330	-	pF
$C_{oss}$	Output capacitance		-	80	-	pF
$C_{rSS}$	Reverse transfer capacitance		-	3.2	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent capacitance time related	$V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$	-	182	-	pF
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 17\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$ (see the Figure 16. Test circuit for gate charge behavior)	-	44	-	nC
$Q_{gs}$	Gate-source charge		-	7	-	nC
$Q_{gd}$	Gate-drain charge		-	24	-	nC
$R_g$	Intrinsic gate resistance		$f = 1\text{ MHz}$ open drain	-	5	-

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%  $V_{DSS}$ .

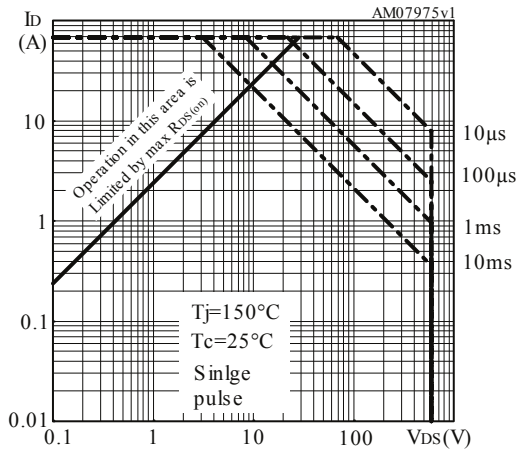
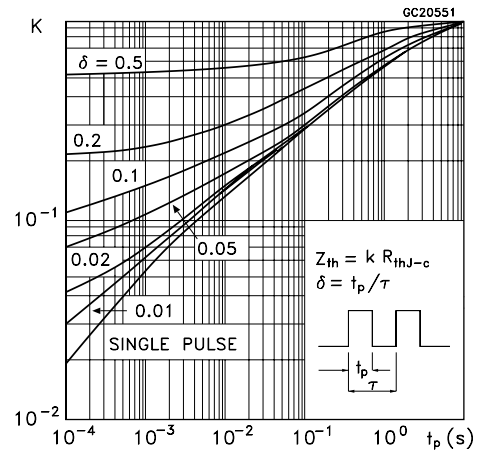
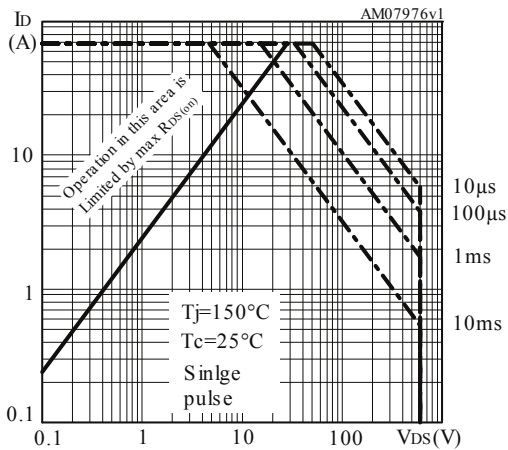
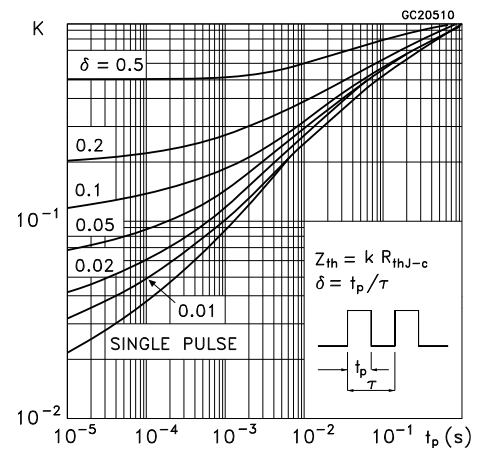
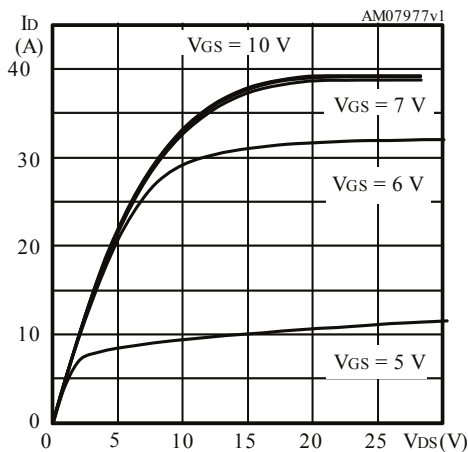
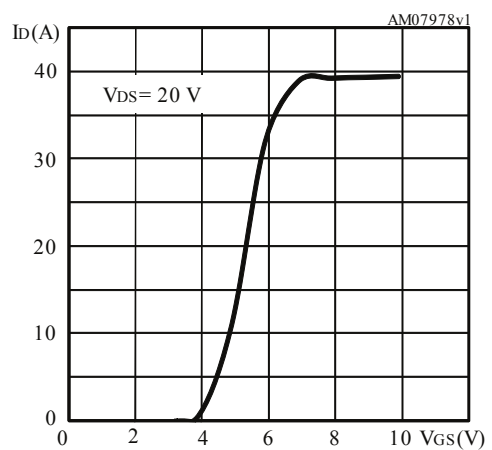
**Table 6. Switching times**

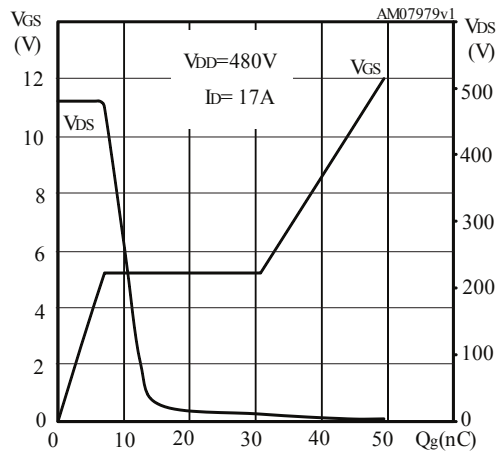
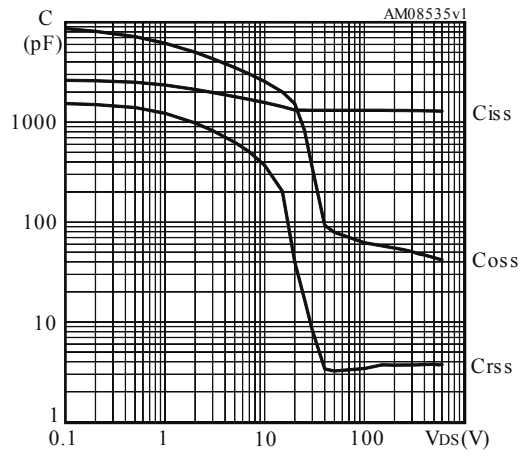
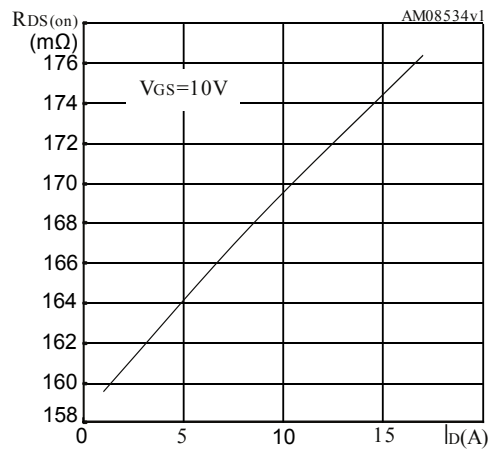
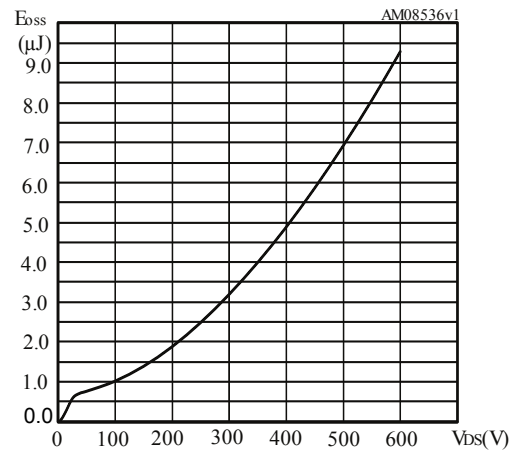
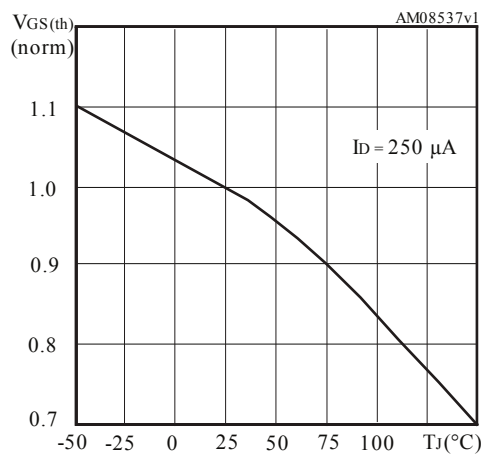
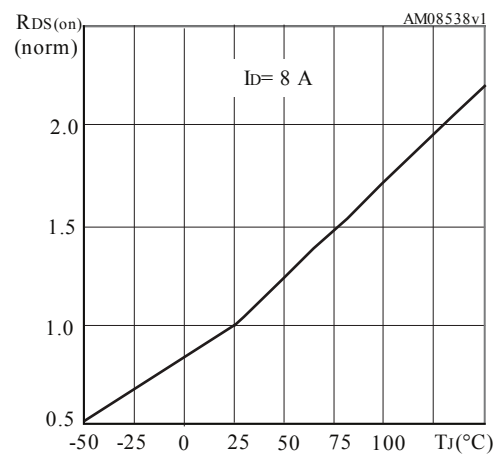
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 8.5\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$	-	11.5	-	ns
$t_r$	Rise time		-	16.5	-	ns
$t_{d(off)}$	Turn-off delay time	(see the Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform)	-	73	-	ns
$t_f$	Fall time		-	37	-	ns

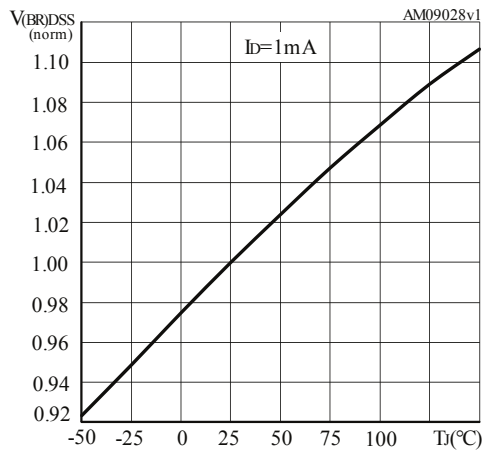
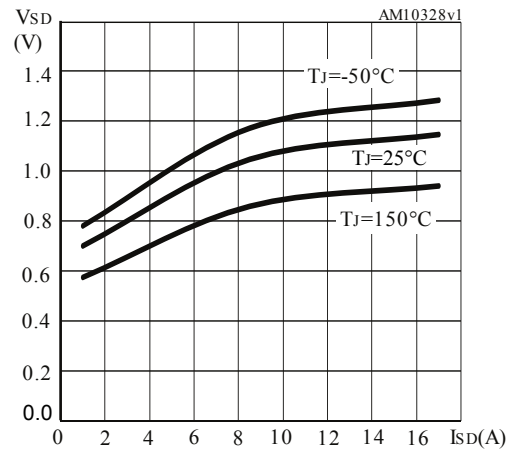
**Table 7. Source-drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-	-	17	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-	-	68	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 17\text{ A}$ , $V_{GS} = 0\text{ V}$	-	-	1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 17\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ (see the Figure 17. Test circuit for inductive load switching and diode recovery times)	-	340	-	ns
$Q_{rr}$	Reverse recovery charge		-	4.6	-	$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	27	-	A
$t_{rr}$	Reverse recovery time	$I_{SD} = 17\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$ (see the Figure 17. Test circuit for inductive load switching and diode recovery times)	-	404	-	ns
$Q_{rr}$	Reverse recovery charge		-	5.7	-	$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	28	-	A

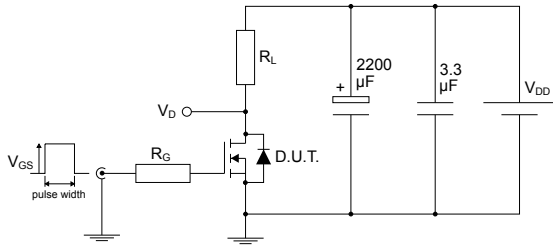
1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

**2.1 Electrical characteristics (curves)**
**Figure 1. Safe operating area for TO-220FP**

**Figure 2. Normalized transient thermal impedance for TO-220FP**

**Figure 3. Safe operating area for I<sup>2</sup>PAK and TO-220**

**Figure 4. Normalized transient thermal impedance for I<sup>2</sup>PAK and TO-220**

**Figure 5. Typical output characteristics**

**Figure 6. Typical transfer characteristics**


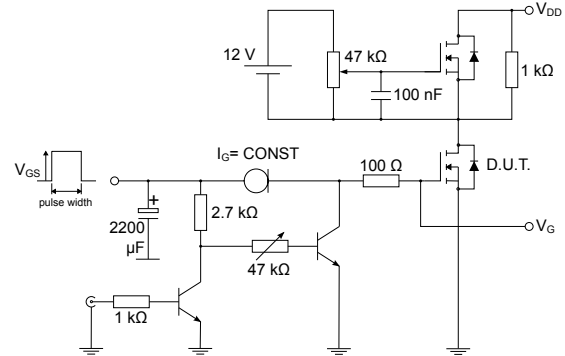
**Figure 7. Typical gate charge characteristics**

**Figure 8. Typical capacitance characteristics**

**Figure 9. Typical drain-source on-resistance**

**Figure 10. Typical output capacitance stored energy**

**Figure 11. Normalized gate threshold vs temperature**

**Figure 12. Normalized on-resistance vs temperature**


**Figure 13. Normalized breakdown voltage vs temperature**

**Figure 14. Typical reverse diode forward characteristics**


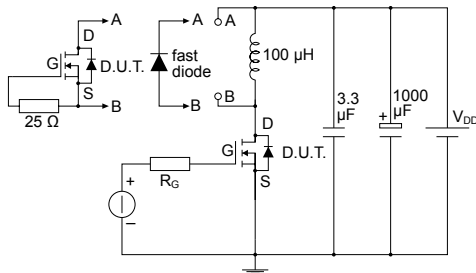
### 3 Test circuits

**Figure 15. Test circuit for resistive load switching times**


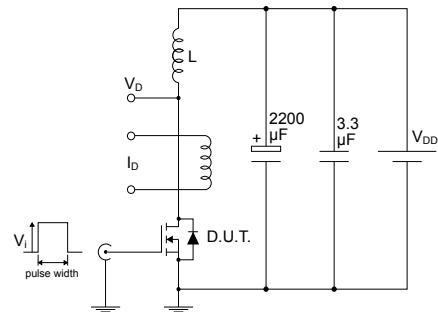
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**Figure 16. Test circuit for gate charge behavior**


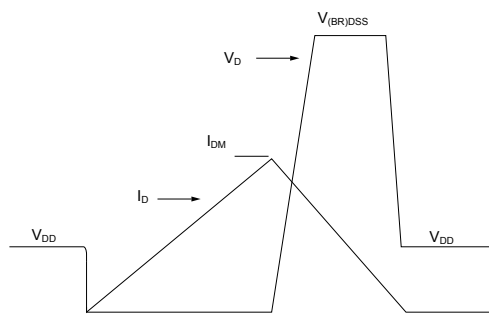
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**Figure 17. Test circuit for inductive load switching and diode recovery times**


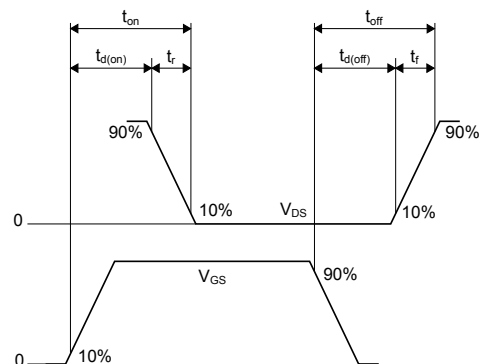
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**Figure 18. Unclamped inductive load test circuit**


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**Figure 19. Unclamped inductive waveform**


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**Figure 20. Switching time waveform**


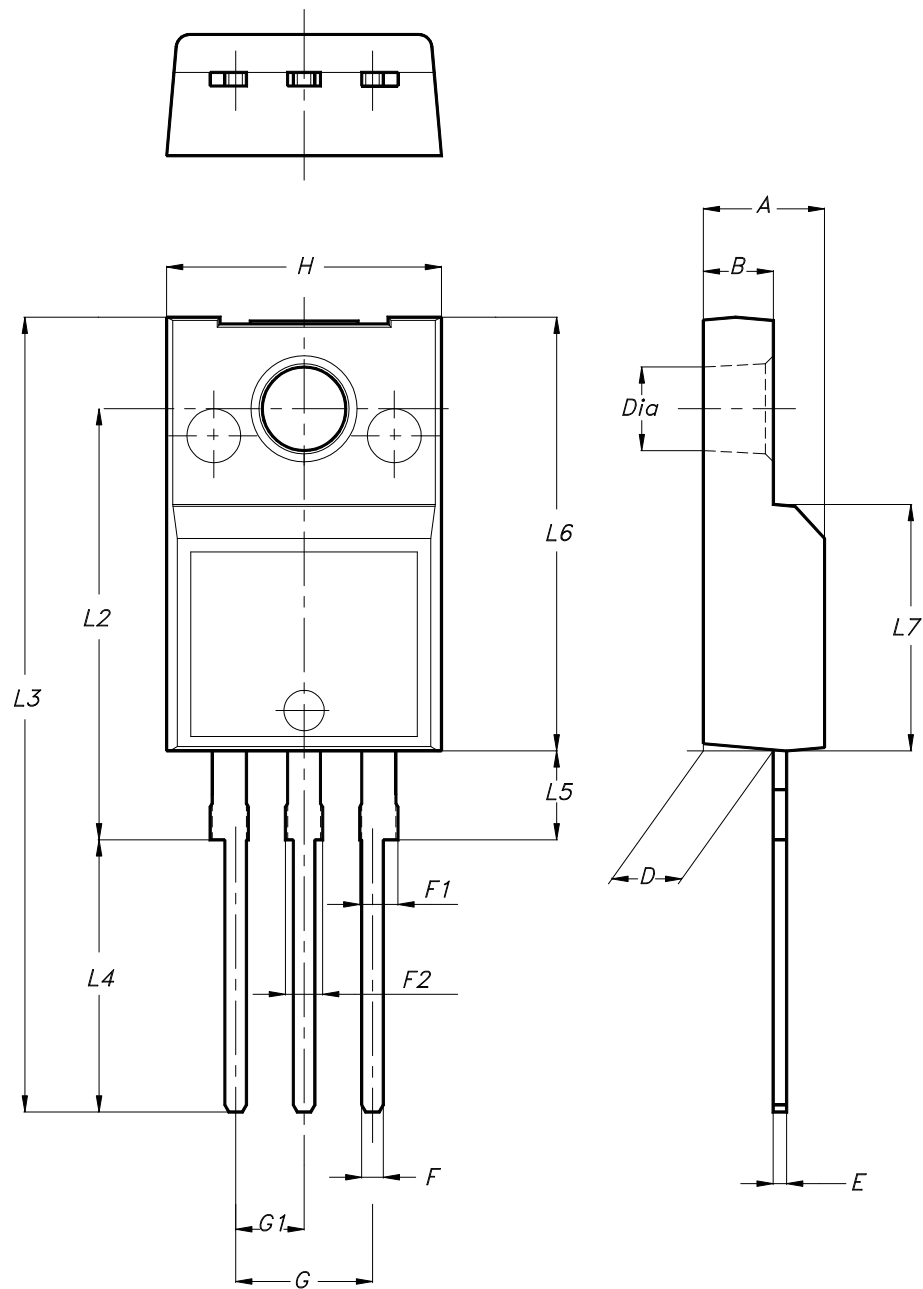
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## 4 Package information

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 type B package information

Figure 21. TO-220FP type B package outline



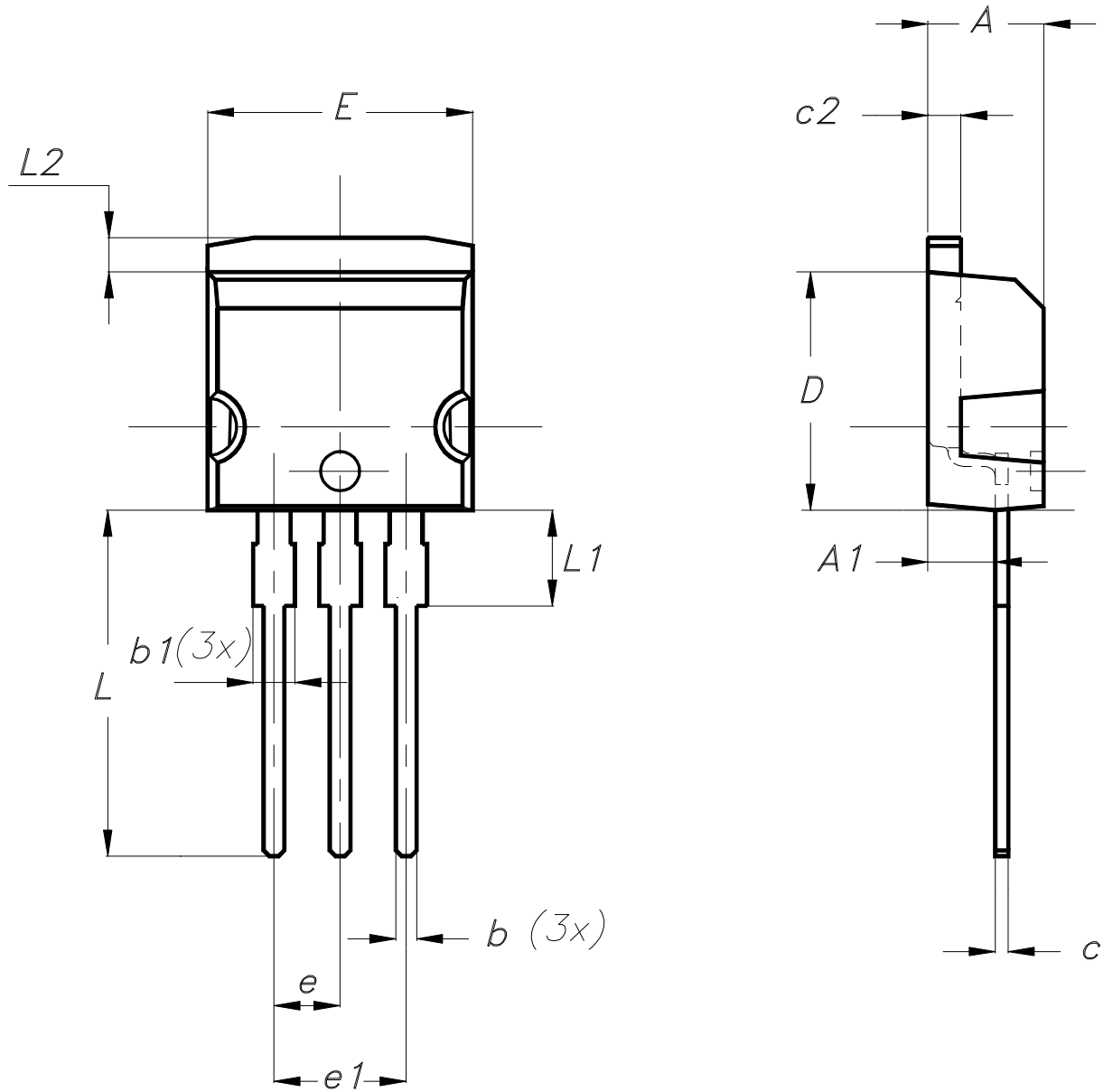
7012510\_B\_rev.14

**Table 8. TO-220FP type B 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 22. I<sup>2</sup>PAK package outline



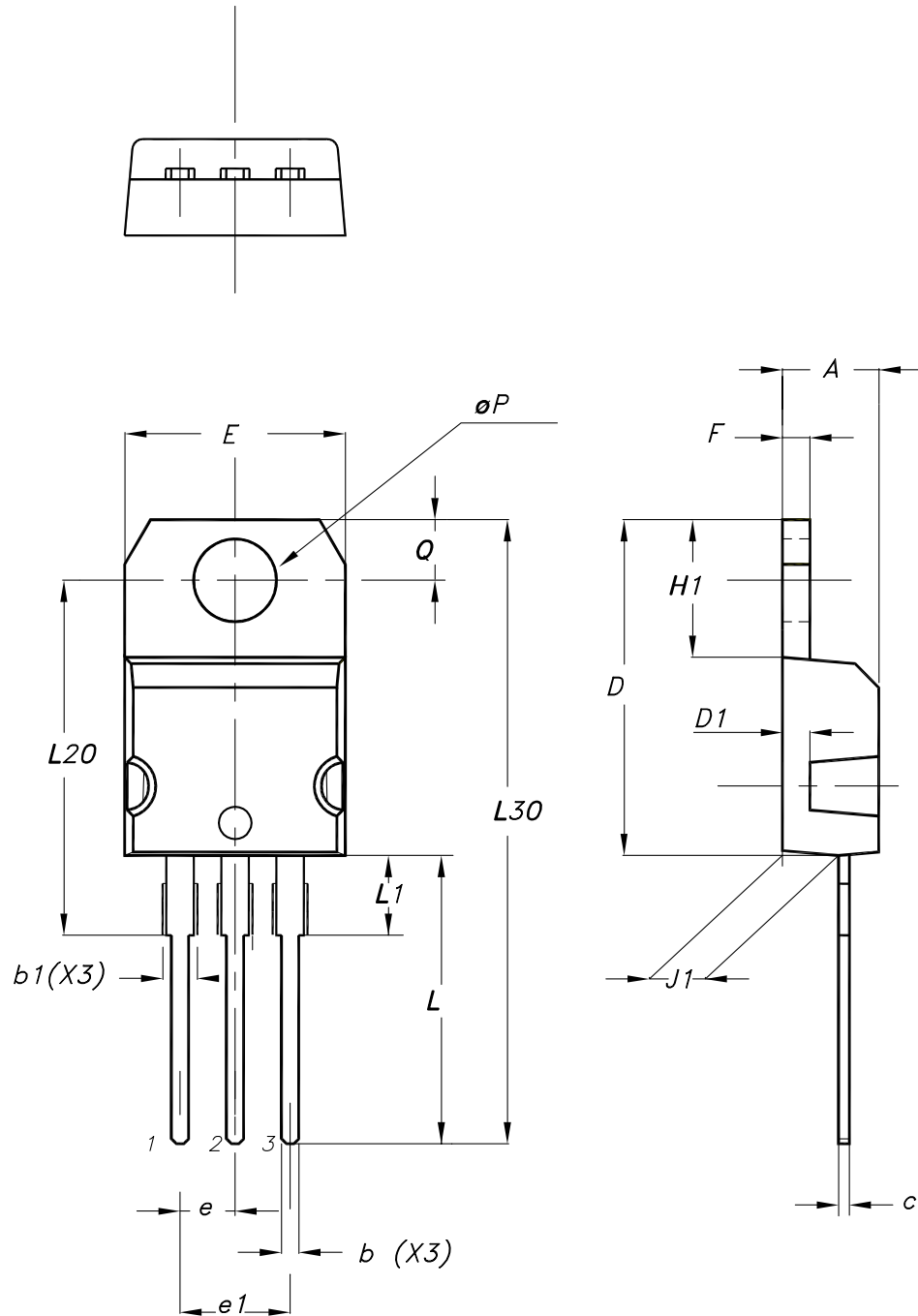
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**Table 9. I<sup>2</sup>PAK package mechanical data**

Dim.	mm	
	Min.	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 23. TO-220 type A package outline



0015988\_typeA\_Rev\_24

**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



## 5 Ordering information

Table 11. Order codes

Order codes	Marking	Package	Packing
STF24NM60N	24NM60N	TO-220FP	Tube
STI24NM60N		I <sup>2</sup> PAK	
STP24NM60N		TO-220	

## Revision history

**Table 12. Document revision history**

Date	Revision	Changes
05-Jan-2011	1	First release.
01-Jul-2011	2	Corrected $R_{thj-amb}$ value (see <i>Table 3: Thermal data</i> ). Added new package and mechanical data: TO-247.
22-Aug-2011	3	Inserted device in I <sup>2</sup> PAK. Updated <i>Table 1: Device summary</i> , <i>Table 2: Absolute maximum ratings</i> and <i>Table 3: Thermal data</i> . Inserted new mechanical data in <i>Section 4: Package mechanical data</i> .
24-Jul-2014	4	Modified: the entire typical values in <i>Table 6</i> . Modified: <i>Figure 12</i> . Updated: <i>Section 4: Package mechanical data</i> . Minor text changes.
13-Jan-2026	5	Removed order code STW24NM60N. Updated <i>Section 4: Package information</i> . Minor text changes.



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