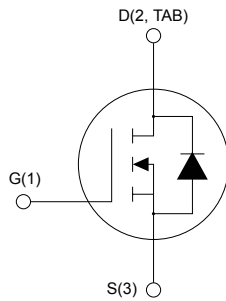
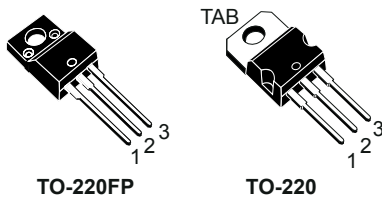


## N-channel 600 V, 200 mΩ typ., 16 A MDmesh II Power MOSFET in a TO-220FP and TO-220 packages



AM01475v1\_noZen



### Features

Order code	$V_{DS}$	$R_{DS(on)}$ max.	$I_D$
STF22NM60N	600 V	220 mΩ	16 A
STP22NM60N			

- 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

[STF22NM60N](#)

[STP22NM60N](#)

#### Product summary

Order code	STF22NM60N
Marking	22NM60N
Package	TO-220FP
Packing	Tube
Order code	STP22NM60N
Marking	22NM60N
Package	TO-220
Packing	Tube

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220FP	TO-220	
$V_{DS}$	Drain-source voltage	600		V
$V_{GS}$	Gate-source voltage	±30		V
$I_D$	Drain current (continuous) at $T_C = 25\text{ °C}$	16		A
$I_D$	Drain current (continuous) at $T_C = 100\text{ °C}$	10		A
$I_{DM}^{(1)}$	Drain current (pulsed)	64		A
$P_{TOT}$	Total power dissipation at $T_C = 25\text{ °C}$	30	125	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15		V/ns
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; $T_C = 25\text{ °C}$ )	2.5	-	kV
$T_{stg}$	Storage temperature range	-55 to 150		°C
$T_J$	Operating junction temperature range			°C

1. Pulse width limited by safe operating area.

2.  $I_{SD} \leq 16\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DS(peak)} \leq V_{(BR)DSS}$ ,  $V_{DD} = 480\text{ V}$ .

**Table 2. Thermal data**

Symbol	Parameter	Value		Unit
		TO-220FP	TO-220	
$R_{thJC}$	Thermal resistance, junction-to-case	4.17	1	°C/W
$R_{thJA}$	Thermal resistance, junction-to-ambient	62.5		°C/W

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_J$ max.)	6	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J = 25\text{ °C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	300	mJ

## 2 Electrical characteristics

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

**Table 4. On/off states**

Symbol	Parameter	Test condition	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	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ °C}^{(1)}$	-	-	100	$\mu\text{A}$
$I_{GSS}$	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	$V_{GS} = 10\text{ V}$ , $I_D = 8\text{ A}$	-	200	220	m $\Omega$

1. Specified by design, not tested in production.

**Table 5. Dynamic**

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 50\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	1330	-	$\mu\text{F}$
$C_{oss}$	Output capacitance			84		
$C_{rSS}$	Reverse transfer capacitance			4.6		
$C_{oss\ eq.}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0$ to $480\text{ V}$ , $V_{GS} = 0\text{ V}$	-	181	-	$\mu\text{F}$
$R_g$	Gate input resistance	$f = 1\text{ MHz}$ , $I_D = 0\text{ A}$	-	4.7	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 16\text{ A}$ , $V_{GS} = 0$ to $10\text{ V}$ (see the Figure 15. Test circuit for gate charge behavior)	-	44	-	nC
$Q_{gs}$	Gate-source charge			6		
$Q_{gd}$	Gate-drain charge			25		

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 6. Switching times**

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 8\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see the Figure 14. Test circuit for resistive load switching times and Figure 19. Switching time waveform)	-	11	-	ns
$t_r$	Rise time			18		
$t_{d(off)}$	Turn-off delay time			74		
$t_f$	Fall time			38		

**Table 7. Source drain diode**

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-	-	16	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-	-	64	
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 16\text{ A}$ , $V_{GS} = 0\text{ V}$	-	-	1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 16\text{ A}$ , $di/dt = 100\text{ V}$ , $V_{DD} = 60\text{ V}$ (see the Figure 16. Test circuit for inductive load switching and diode recovery times)	-	296	-	ns
$Q_{rr}$	Reverse recovery charge		4	-	$\mu\text{C}$	
$I_{RRM}$	Reverse recovery current		26.8	A		
$t_{rr}$	Reverse recovery time	$I_{SD} = 16\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ (see the Figure 16. Test circuit for inductive load switching and diode recovery times)	-	350	-	ns
$Q_{rr}$	Reverse recovery charge		4.7	$\mu\text{C}$		
$I_{RRM}$	Reverse recovery current		27	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

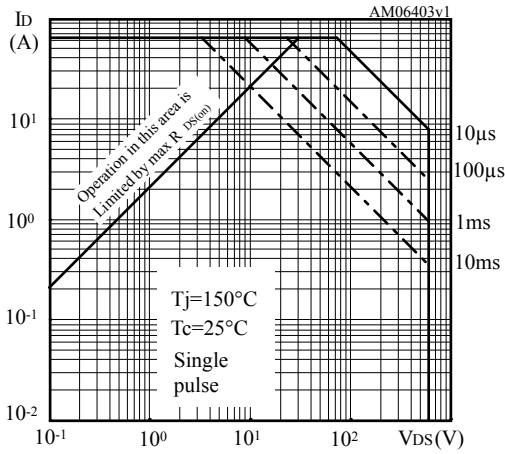


Figure 2. Normalized transient thermal impedance for TO-220FP

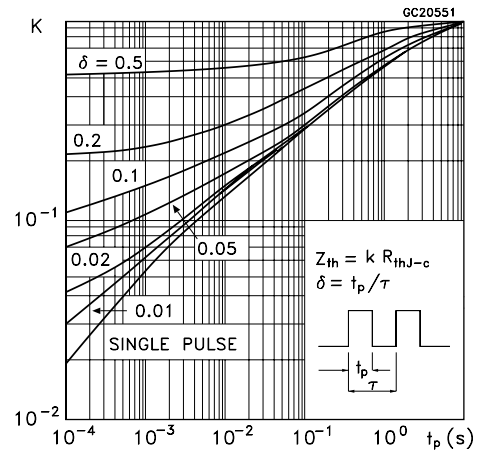


Figure 3. Safe operating area for TO-220

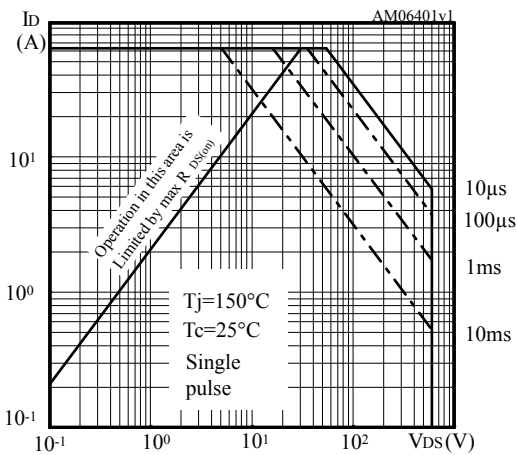


Figure 4. Normalized transient thermal impedance for TO-220

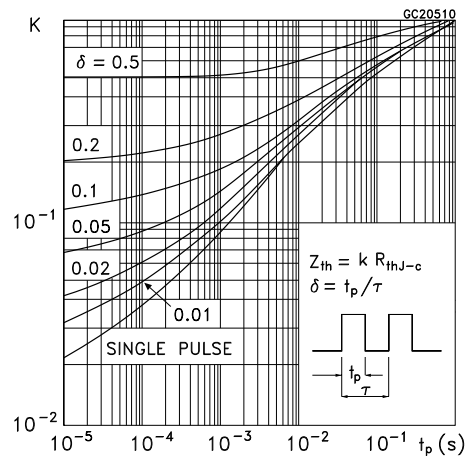


Figure 5. Typical output characteristics

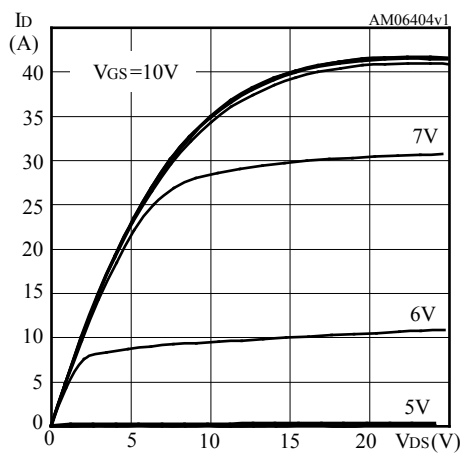
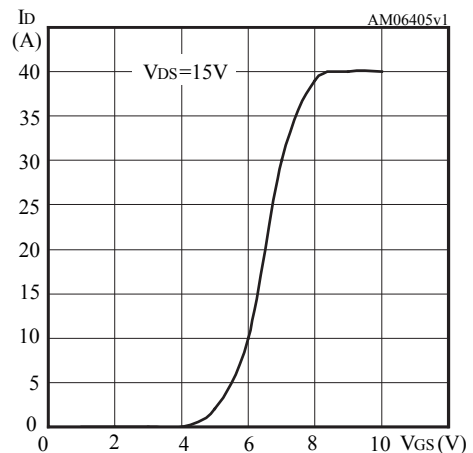


Figure 6. Typical transfer characteristics



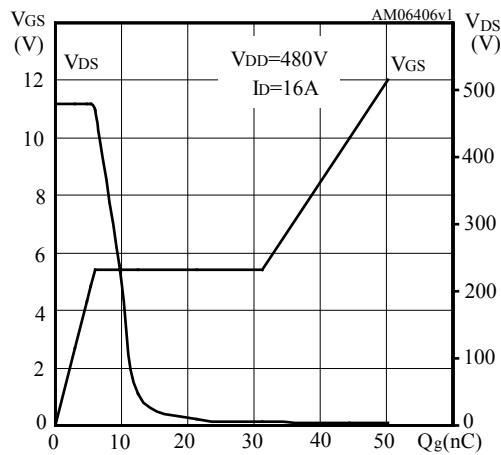
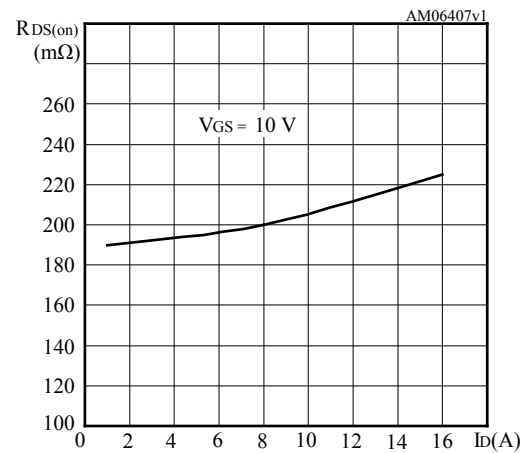
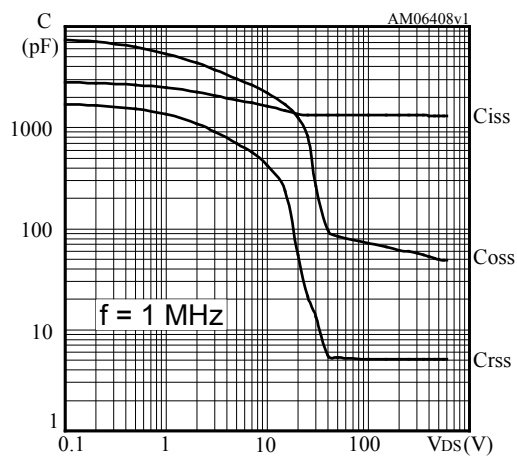
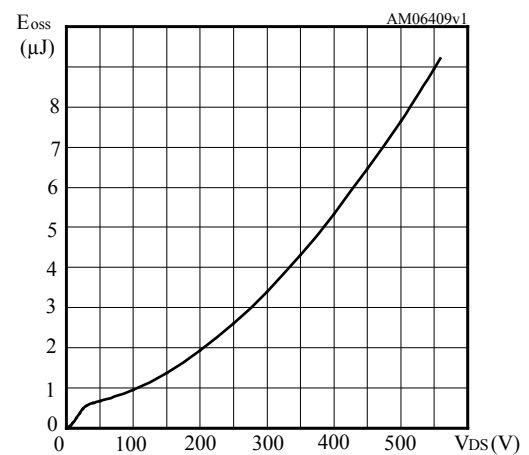
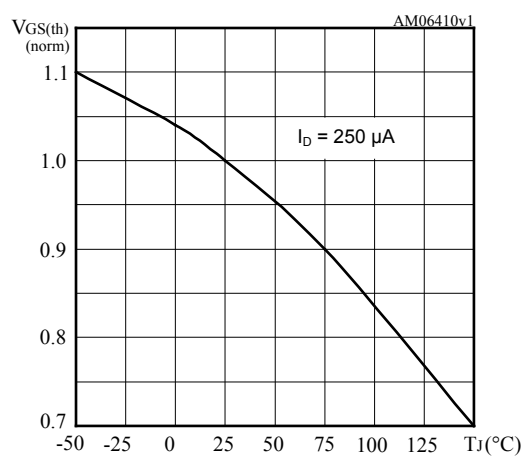
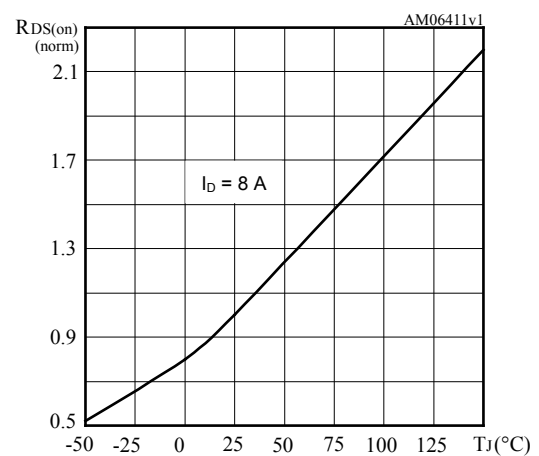
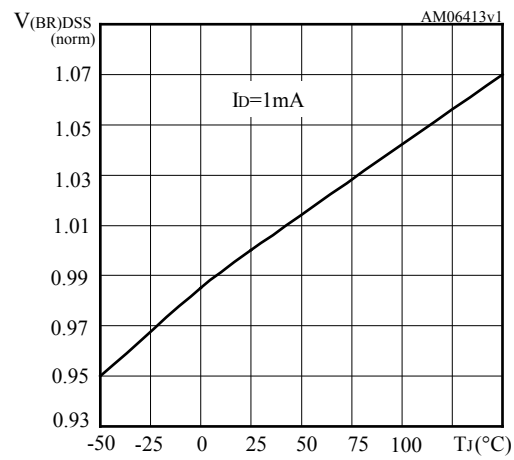
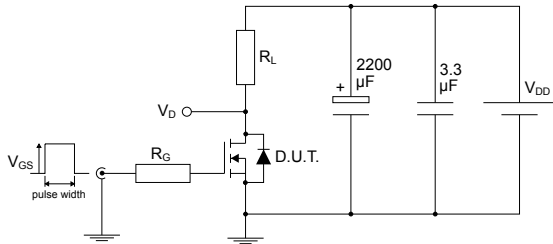
**Figure 7. Typical gate charge characteristics**

**Figure 8. Typical drain-source on-resistance**

**Figure 9. Typical capacitance characteristics**

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

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

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


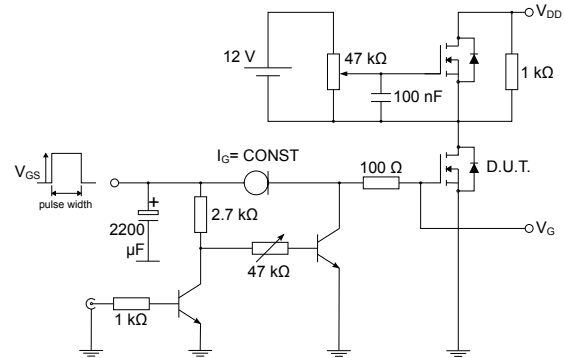
Figure 13. Normalized breakdown voltage vs temperature



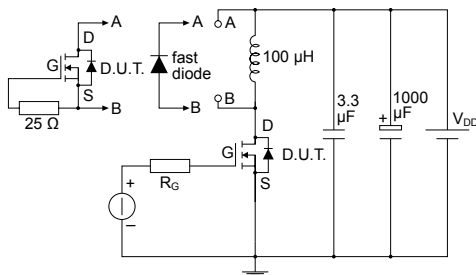
### 3 Test circuits

**Figure 14. Test circuit for resistive load switching times**


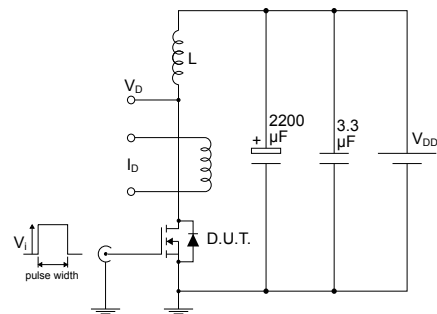
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**Figure 15. Test circuit for gate charge behavior**


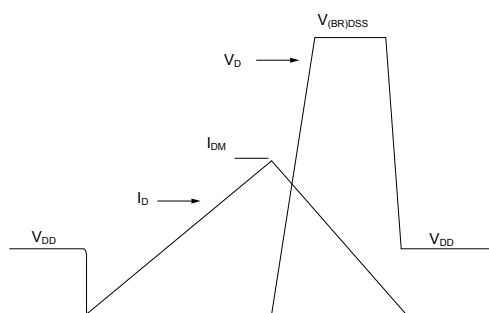
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**Figure 16. Test circuit for inductive load switching and diode recovery times**


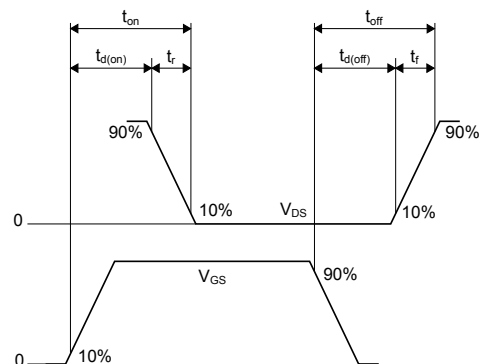
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**Figure 17. Unclamped inductive load test circuit**


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**Figure 18. Unclamped inductive waveform**


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**Figure 19. Switching time waveform**


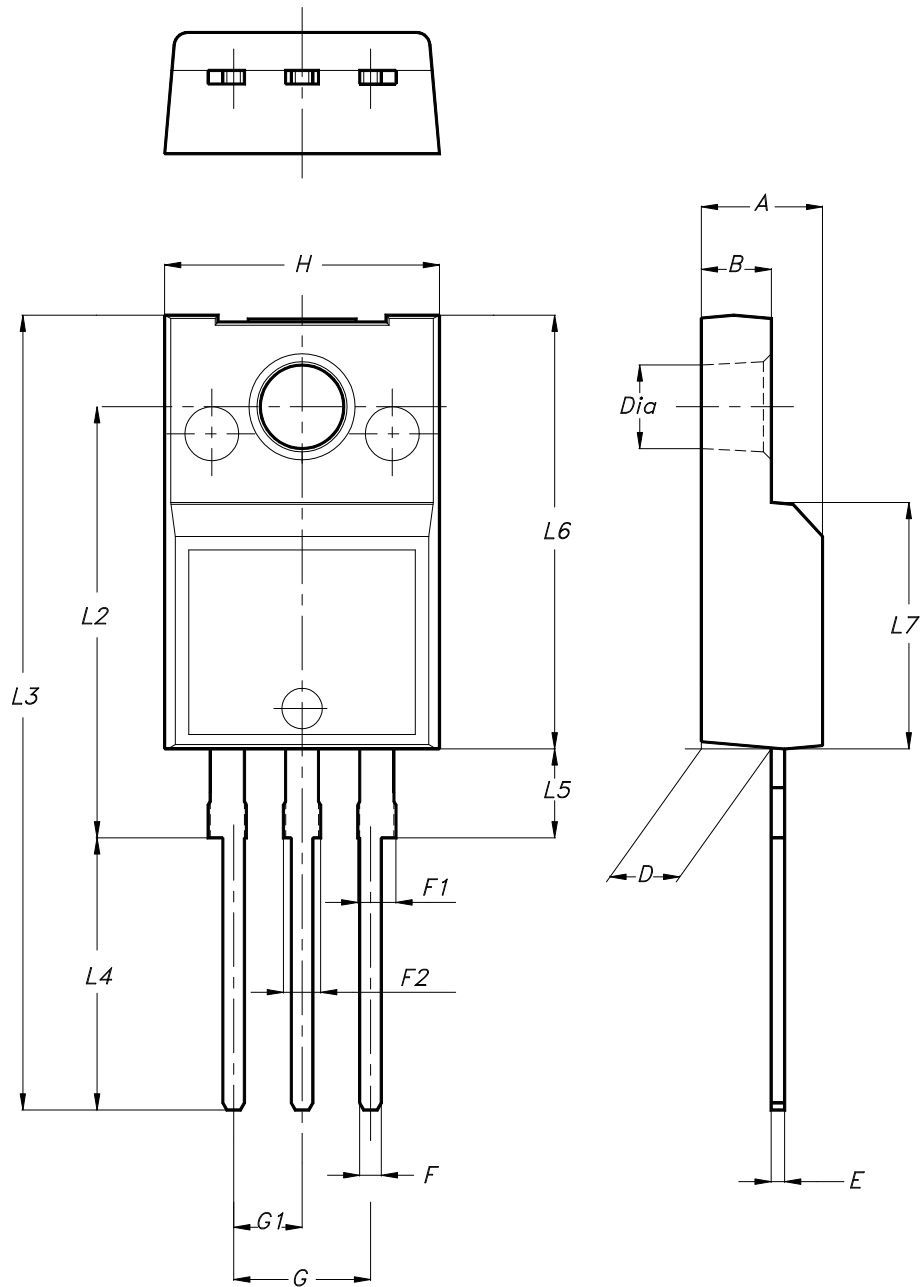
AM01473v1

## 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 20. 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



**Table 9. 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

## Revision history

**Table 10. Document revision history**

Date	Version	Changes
02-Jul-2009	1	First release.
18-Feb-2010	2	Document status promoted from preliminary data to datasheet.
27-Aug-2010	3	New package, mechanical data has been inserted: I <sup>2</sup> PAK.
05-Nov-2011	4	Some value changed in <i>Table 5: On/off states</i> .
02-May-2018	5	<p>The part numbers STI22NM60N and STW22NM60N have been moved to a separate datasheet.</p> <p>Removed maturity status indication from cover page. The document status is production data</p> <p>Updated title and features in cover page.</p> <p>Updated <i>Section 1 Electrical ratings</i>, <i>Section 2 Electrical characteristics</i>, <i>Section 2.1 Electrical characteristics curves</i> and <i>Section 4 Package</i>.</p> <p>Minor text changes.</p>
04-Feb-2026	6	<p>Removed order code STB22NM60N.</p> <p>Updated <i>Section 4: Package information</i>.</p> <p>Minor text changes.</p>

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