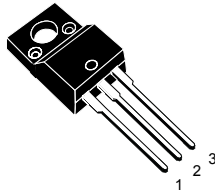
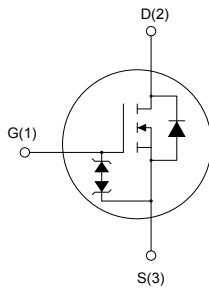


## N-channel 600 V, 0.340 $\Omega$ typ., 11 A MDmesh™ M2 EP Power MOSFET in a TO-220FP package



TO-220FP



AM01476v1

### Features

Order code	$V_{DS@T_{Jmax}}$	$R_{DS(on)max.}$	$I_D$
STF15N60M2-EP	650 V	0.378 $\Omega$	11 A

- Extremely low gate charge
- Excellent output capacitance ( $C_{OSS}$ ) profile
- Very low turn-off switching losses
- 100% avalanche tested
- Zener-protected

### Applications

- Switching applications
- Tailored for very high frequency converters ( $f > 150$  kHz)

### Description

This device is an N-channel Power MOSFET developed using MDmesh™ M2 enhanced performance (EP) technology. Thanks to its strip layout and an improved vertical structure, the device exhibits low on-resistance, optimized switching characteristics with very low turn-off switching losses, rendering it suitable for the most demanding very high frequency converters.

#### Product status

STF15N60M2-EP

#### Product summary

<b>Order code</b>	STF15N60M2-EP
<b>Marking</b>	15N60M2EP
<b>Package</b>	TO-220FP
<b>Packing</b>	Tube

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate-source voltage	$\pm 25$	V
$I_D^{(1)}$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	11	A
$I_D^{(1)}$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	7	A
$I_{DM}^{(2)}$	Drain current (pulsed)	44	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	25	W
$dv/dt^{(3)}$	Peak diode recovery voltage slope	15	V/ns
$dv/dt^{(4)}$	MOSFET $dv/dt$ ruggedness	50	V/ns
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t = 1\text{ s}, T_C = 25\text{ }^\circ\text{C}$ )	2500	V
$T_{stg}$	Storage temperature range	-55 to 150	$^\circ\text{C}$
$T_j$	Operating junction temperature range		

- Limited by maximum junction temperature.
- Pulse width limited by safe operating area.
- $I_{SD} \leq 11\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DS\ peak} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$ .
- $V_{DS} \leq 480\text{ V}$

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case	5	$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient	62.5	$^\circ\text{C}/\text{W}$

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$ )	2.8	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	125	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	$V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$	600			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ }^\circ\text{C}^{(1)}$			100	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 25\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	3.25	4	4.75	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$ , $I_D = 5.5\text{ A}$		0.340	0.378	$\Omega$

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

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	590	-	pF
$C_{oss}$	Output capacitance		-	30	-	pF
$C_{riss}$	Reverse transfer capacitance		-	1.1	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0$ to $480\text{ V}$ , $V_{GS} = 0\text{ V}$	-	148	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , $I_D = 0\text{ A}$	-	7	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 11\text{ A}$ ,	-	17	-	nC
$Q_{gs}$	Gate-source charge	$V_{GS} = 0$ to $10\text{ V}$	-	3.1	-	nC
$Q_{gd}$	Gate-drain charge	(see Figure 15. Test circuit for gate charge behavior)	-	7.3	-	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 6. Switching energy**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{(off)}$	Turn-off energy (from 90% $V_{GS}$ to 0% $I_D$ )	$V_{DD} = 400\text{ V}$ , $I_D = 1.5\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$	-	4.7	-	$\mu\text{J}$
		$V_{DD} = 400\text{ V}$ , $I_D = 3.5\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$	-	5.2	-	$\mu\text{J}$

**Table 7. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 5.5\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see Figure 14. Test circuit for resistive load switching times and Figure 19. Switching time waveform)	-	11	-	ns
$t_r$	Rise time		-	10	-	ns
$t_{d(off)}$	Turn-off delay time		-	40	-	ns
$t_f$	Fall time		-	15	-	ns

**Table 8. 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	$V_{GS} = 0\text{ V}$ , $I_{SD} = 11\text{ A}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$	-	280		ns
$Q_{rr}$	Reverse recovery charge		-	2.7		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see Figure 16. Test circuit for inductive load switching and diode recovery times)	-	19.5		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 11\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$	-	400		ns
$Q_{rr}$	Reverse recovery charge		-	3.8		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		(see Figure 16. Test circuit for inductive load switching and diode recovery times)	-	19	

1. Pulse width is 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

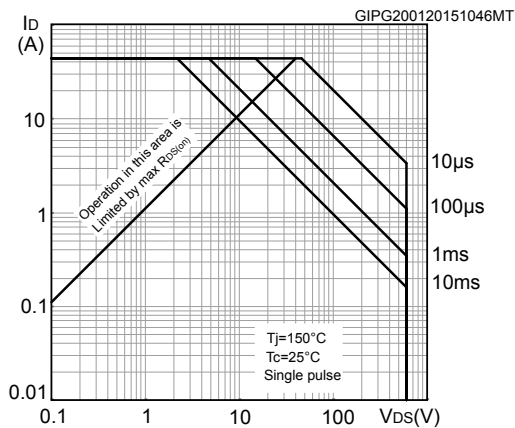


Figure 2. Thermal impedance

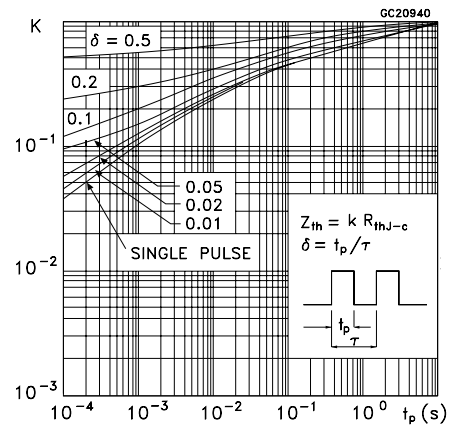


Figure 3. Output characteristics

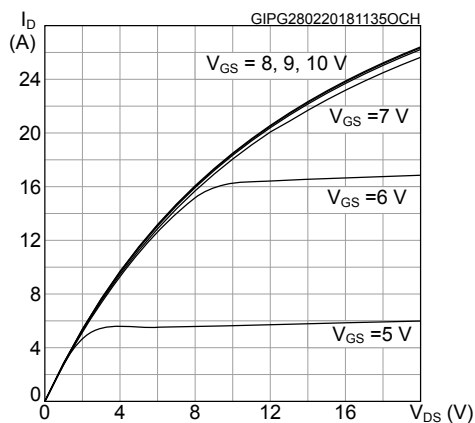


Figure 4. Transfer characteristics

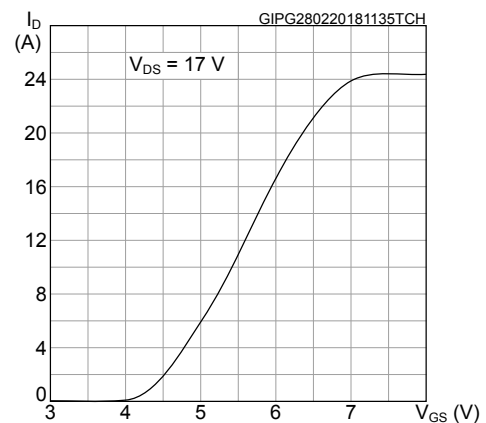


Figure 5. Normalized gate threshold voltage vs temperature

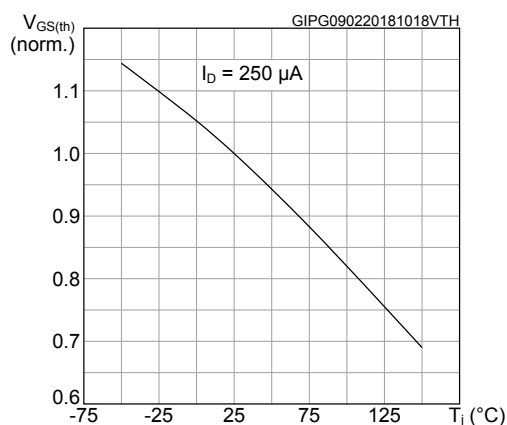


Figure 6. Normalized  $V_{(BR)DSS}$  vs temperature

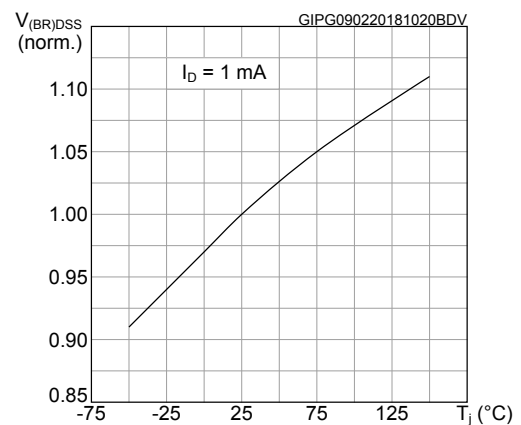


Figure 7. Static drain-source on-resistance

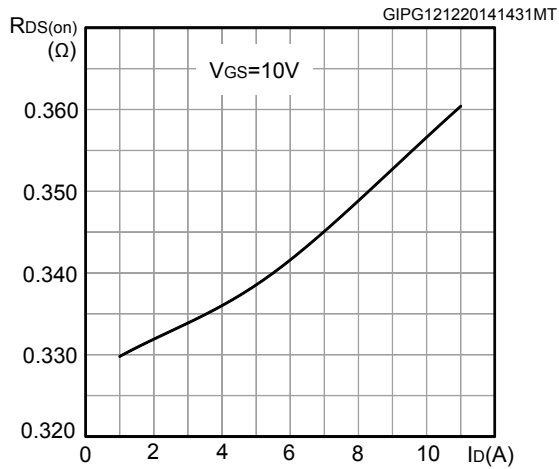


Figure 8. Normalized on-resistance vs temperature

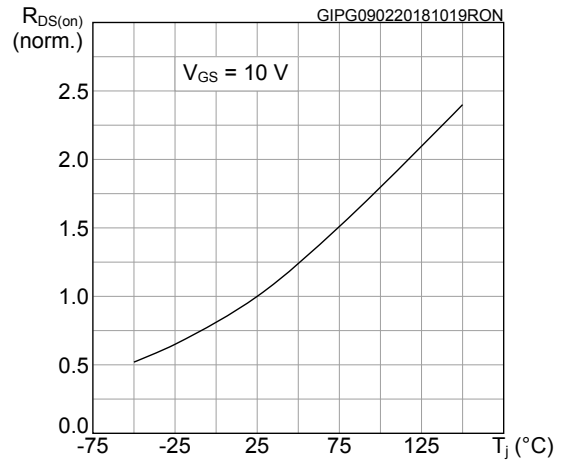


Figure 9. Gate charge vs gate-source voltage

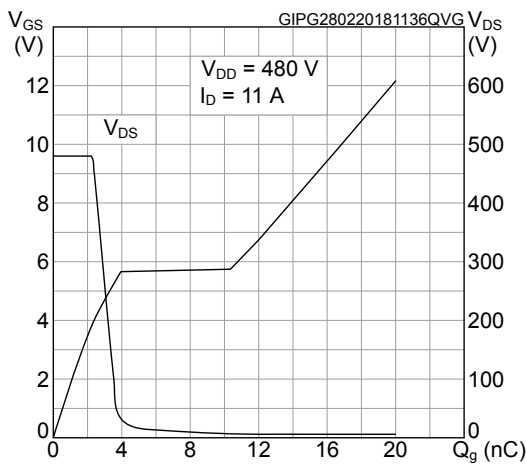


Figure 10. Capacitance variations

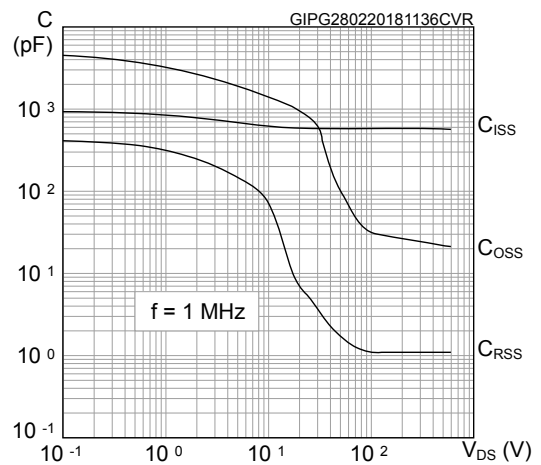


Figure 11. Turn-off switching energy vs drain current

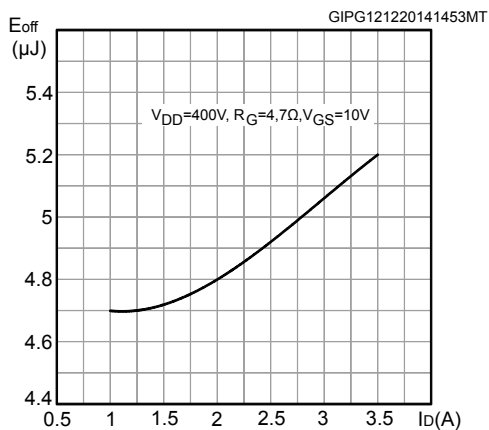
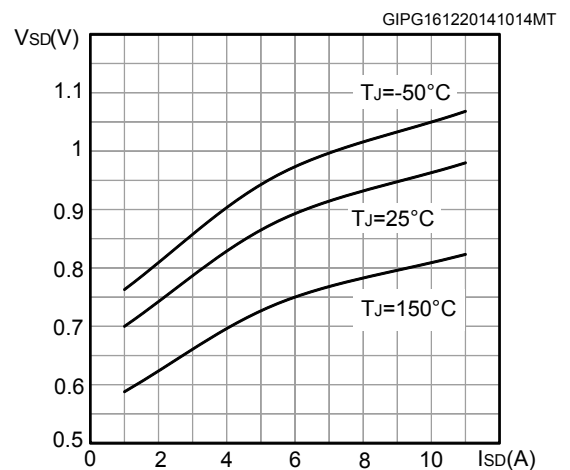
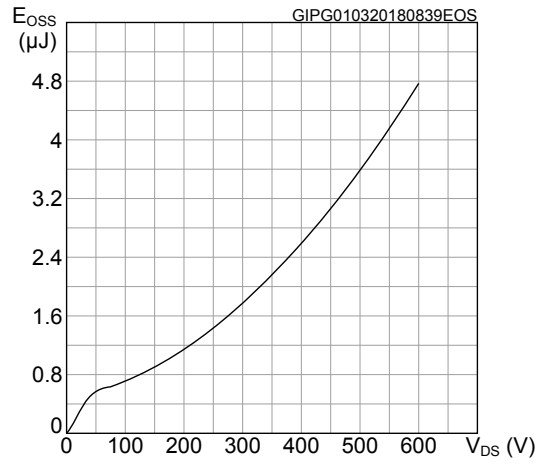


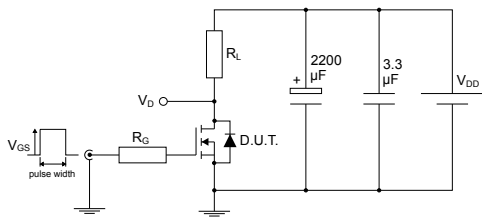
Figure 12. Source-drain diode forward characteristic



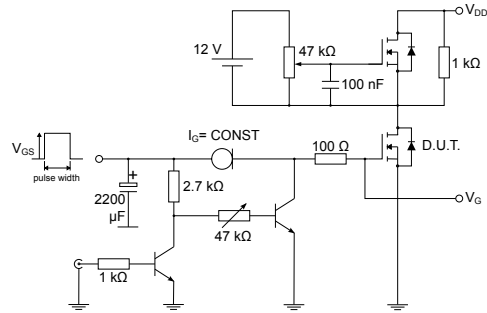
**Figure 13. Output capacitance stored energy**



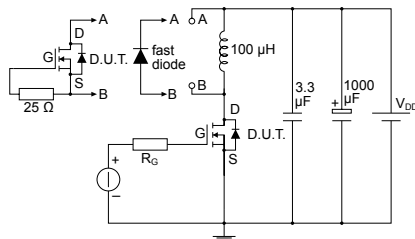
### 3 Test circuits

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


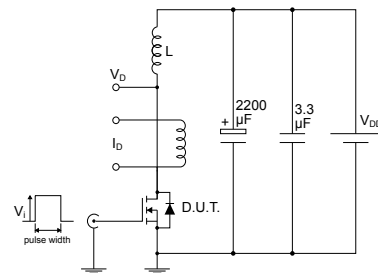
AM01468v1

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


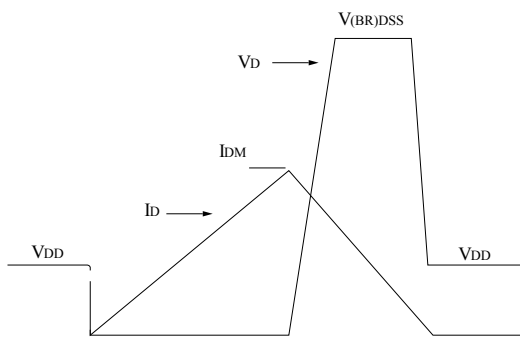
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**Figure 16. Test circuit for inductive load switching and diode recovery times**


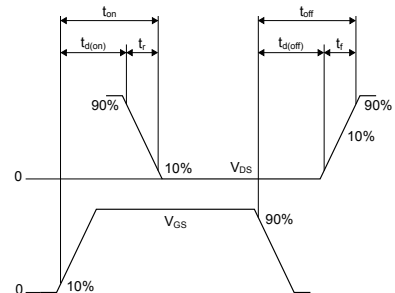
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**Figure 17. Unclamped inductive load test circuit**


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**Figure 18. Unclamped inductive waveform**


AM01472v1

**Figure 19. Switching time waveform**


AM01473v1



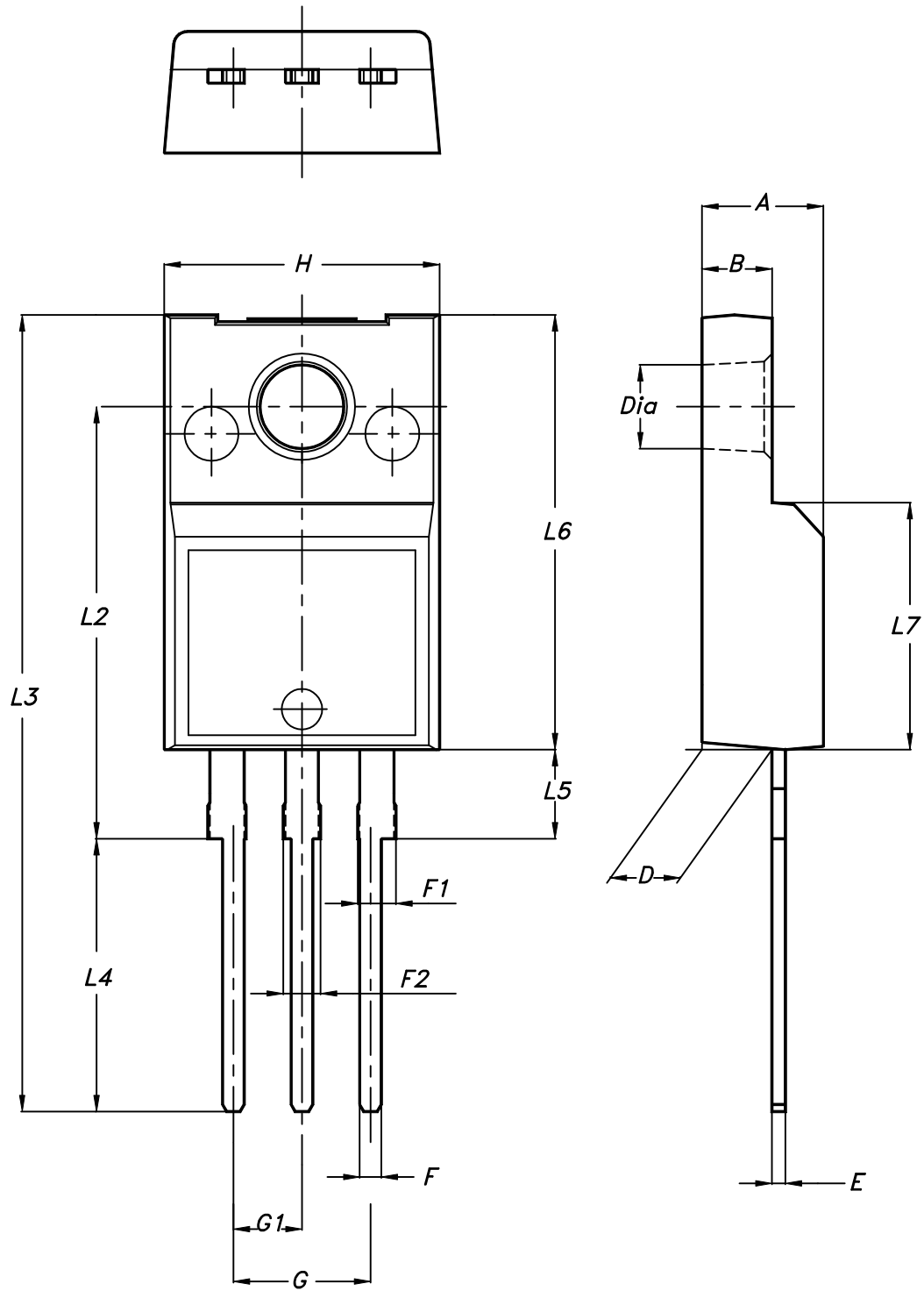
## 4 Package mechanical data

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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 20. TO-220FP package outline



7012510\_Rev\_12\_B

**Table 9. TO-220FP package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

## Revision history

**Table 10. Document revision history**

Date	Revision	Changes
26-Jan-2015	1	First release.
08-Mar-2018	2	<p>The part number STF15N60M2-EP has been moved to a separate datasheet and document updated accordingly.</p> <p>Removed maturity status indication from cover page. The document status is production data.</p> <p>Updated <i>Section 2.1 Electrical characteristics (curves)</i>.</p> <p>Minor text changes.</p>
05-Jun-2018	3	<p>Updated <a href="#">Table 1. Absolute maximum ratings</a>, <a href="#">Table 5. Dynamic</a>, <a href="#">Table 6. Switching energy</a> and <a href="#">Table 8. Source drain diode</a>.</p> <p>Updated <a href="#">Figure 1. Safe operating area</a>, <a href="#">Figure 2. Thermal impedance</a> and <a href="#">Figure 11. Turn-off switching energy vs drain current</a>.</p> <p>Minor text changes</p>

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