

## N-channel 600 V, 0.078 $\Omega$ typ., 34 A MDmesh™ M2 Power MOSFET in a TO-220FP wide creepage package

Datasheet - preliminary data

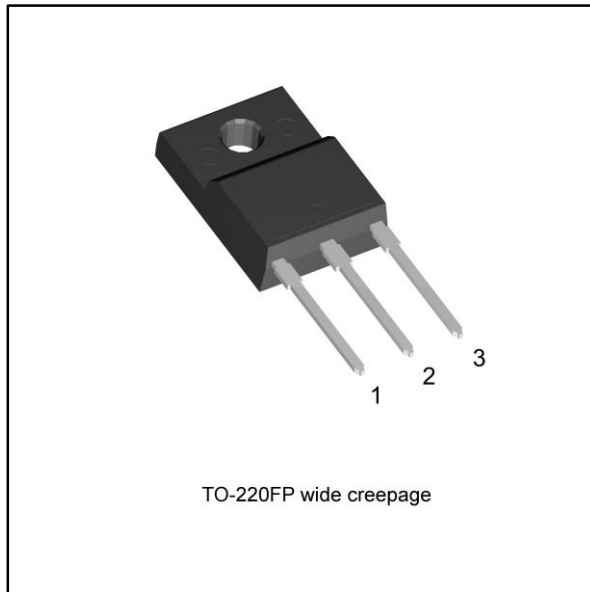
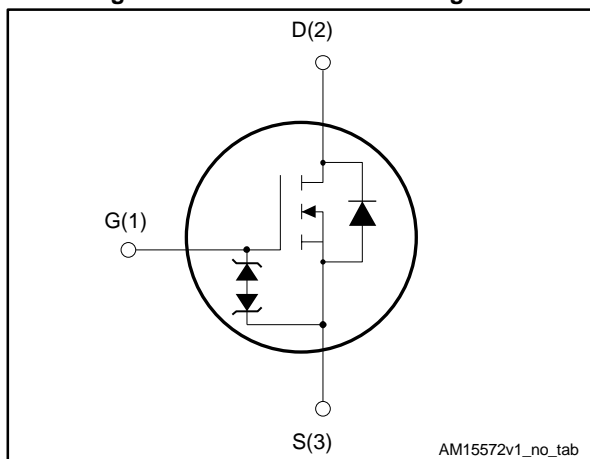


Figure 1: Internal schematic diagram



### Features

Order codes	V <sub>DS</sub> @ T <sub>Jmax</sub>	R <sub>DS(on)</sub> max	I <sub>D</sub>
STFH40N60M2	650 V	0.088 $\Omega$	34 A

- Extremely low gate charge
- Excellent output capacitance (C<sub>oss</sub>) profile
- 100% avalanche tested
- Zener-protected
- Wide creepage distance of 4.25 mm between the pins

### Applications

- Switching applications
- LLC converters, resonant converters

### Description

This device is an N-channel Power MOSFET developed using MDmesh™ M2 technology. Thanks to its strip layout and an improved vertical structure, the device exhibits low on-resistance and optimized switching characteristics, rendering it suitable for the most demanding high efficiency converters.

The TO-220FP wide creepage package provides increased surface insulation for Power MOSFETs to prevent failure due to arcing, which can occur in polluted environments.

Table 1: Device summary

Order codes	Marking	Package	Packaging
STFH40N60M2	40N60M2	TO-220FP wide creepage	Tube

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# 1 Electrical ratings

**Table 2: Absolute maximum ratings**

Symbol	Parameter	Value	Unit
V <sub>GS</sub>	Gate-source voltage	± 25	V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	34 <sup>(1)</sup>	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	22 <sup>(1)</sup>	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	136 <sup>(1)</sup>	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	40	W
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	15	V/ns
dv/dt <sup>(4)</sup>	MOSFET dv/dt ruggedness	50	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)	2500	V
T <sub>stg</sub>	Storage temperature range	- 55 to 150	°C
T <sub>j</sub>	Operating junction temperature range		

**Notes:**

<sup>(1)</sup>Limited by maximum junction temperature.

<sup>(2)</sup>Pulse width limited by safe operating area.

<sup>(3)</sup>I<sub>SD</sub> ≤ 13 A, di/dt ≤ 400 A/μs; V<sub>DSpeak</sub> < V<sub>(BR)DSS</sub>, V<sub>DD</sub> = 400 V

<sup>(4)</sup>V<sub>DS</sub> ≤ 480 V

**Table 3: Thermal data**

Symbol	Parameter	Value	Unit
R <sub>thj-case</sub>	Thermal resistance junction-case max	3.13	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max	62.5	°C/W

**Table 4: Avalanche characteristics**

Symbol	Parameter	Value	Unit
I <sub>AR</sub>	Avalanche current, repetitive or not repetitive (pulse width limited by T <sub>jmax</sub> )	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)	500	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	$V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$	600			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ °C}^{(1)}$			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	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	2	3	4	V
$R_{DS(on)}$	Static drain-source on- resistance	$V_{GS} = 10\text{ V}$ , $I_D = 17\text{ A}$		0.078	0.088	$\Omega$

**Notes:**

<sup>(1)</sup>Defined by design, not subject to production test.

**Table 6: Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	2500	-	pF
$C_{oss}$	Output capacitance		-	117	-	pF
$C_{riss}$	Reverse transfer capacitance		-	2.4	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }480\text{ V}$ , $V_{GS} = 0\text{ V}$	-	342	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , $I_D = 0\text{ A}$	-	4.4	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 34\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 15: "Test circuit for gate charge behavior"</a> )	-	57	-	nC
$Q_{gs}$	Gate-source charge		-	10	-	nC
$Q_{gd}$	Gate-drain charge		-	25.5	-	nC

**Notes:**

<sup>(1)</sup> $C_{oss\text{ eq.}}$  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	$V_{DD} = 300\text{ V}$ , $I_D = 34\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 14: "Test circuit for resistive load switching times"</a> and <a href="#">Figure 19: "Switching time waveform"</a> )	-	20.5	-	ns
$t_r$	Rise time		-	13.5	-	ns
$t_{d(off)}$	Turn-off delay time		-	96.5	-	ns
$t_f$	Fall time		-	11	-	ns

Table 8: Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}^{(1)}$	Source-drain current		-		34	A
$I_{SDM}^{(2)}$	Source-drain current (pulsed)		-		136	A
$V_{SD}^{(3)}$	Forward on voltage	$I_{SD} = 34 \text{ A}$ , $V_{GS} = 0 \text{ V}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 34 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ (see <i>Figure 16: "Test circuit for inductive load switching and diode recovery times"</i> )	-	440		ns
$Q_{rr}$	Reverse recovery charge		-	8.2		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	37		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 34 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ , $T_j = 150 \text{ }^\circ\text{C}$ (see <i>Figure 16: "Test circuit for inductive load switching and diode recovery times"</i> )	-	568		ns
$Q_{rr}$	Reverse recovery charge		-	11.5		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	40.5		A

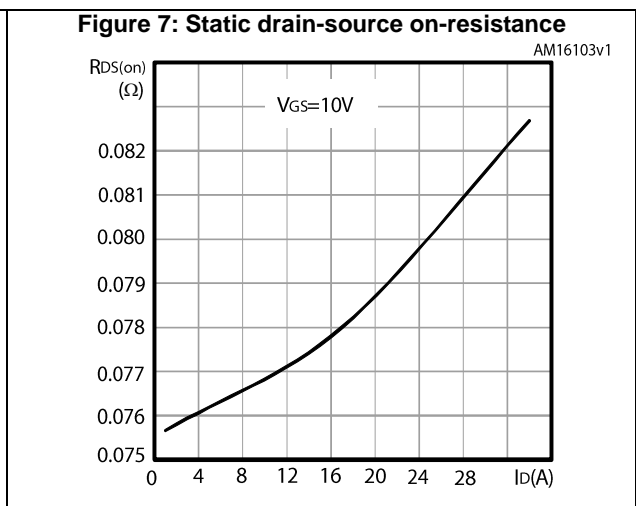
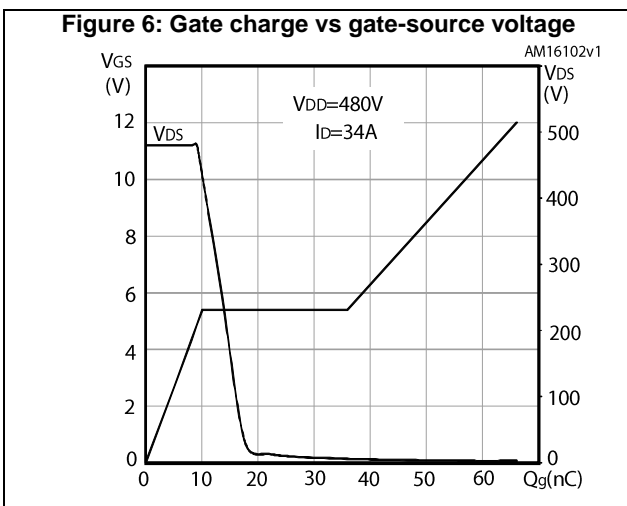
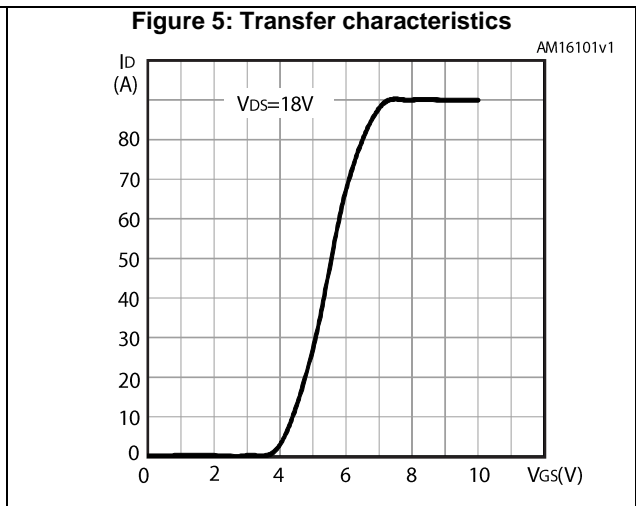
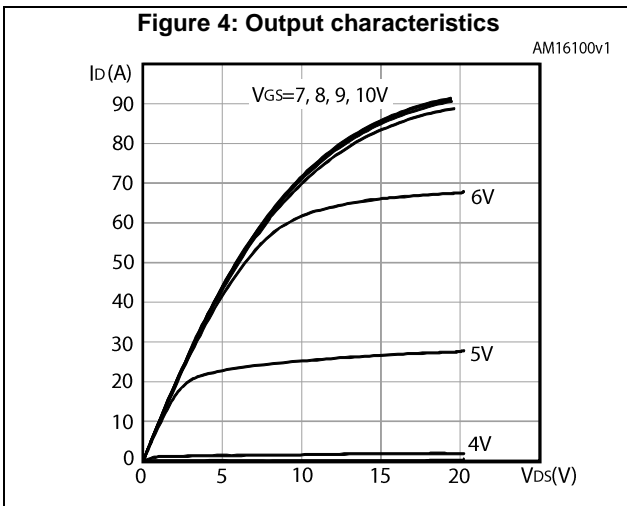
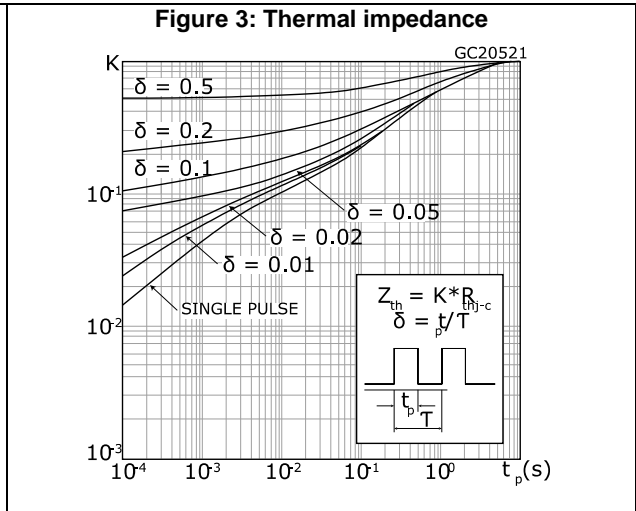
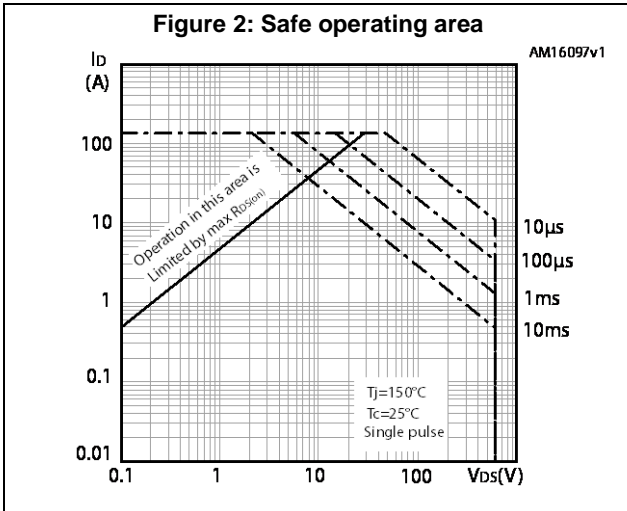
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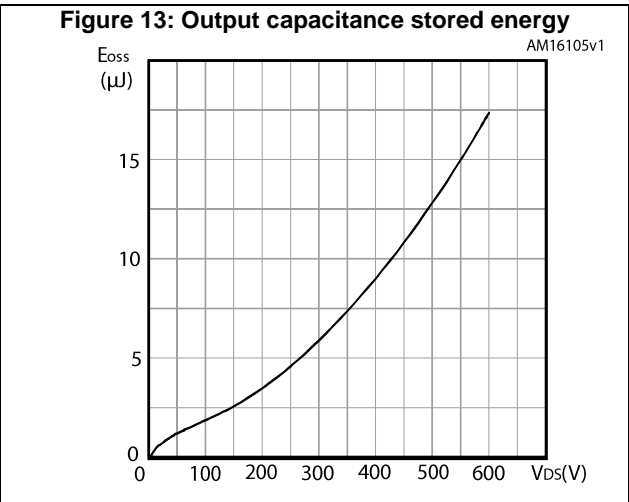
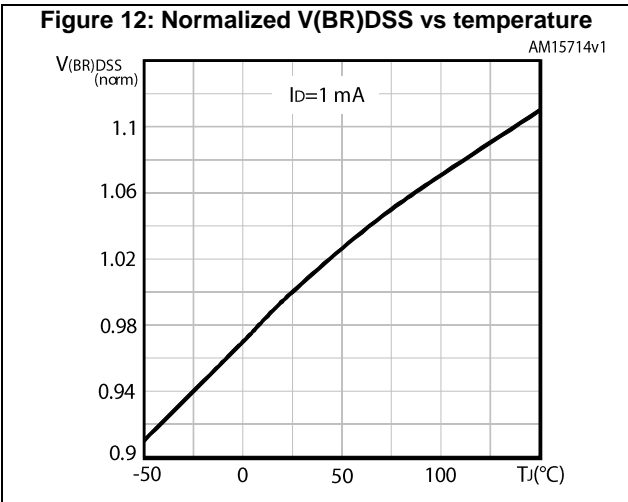
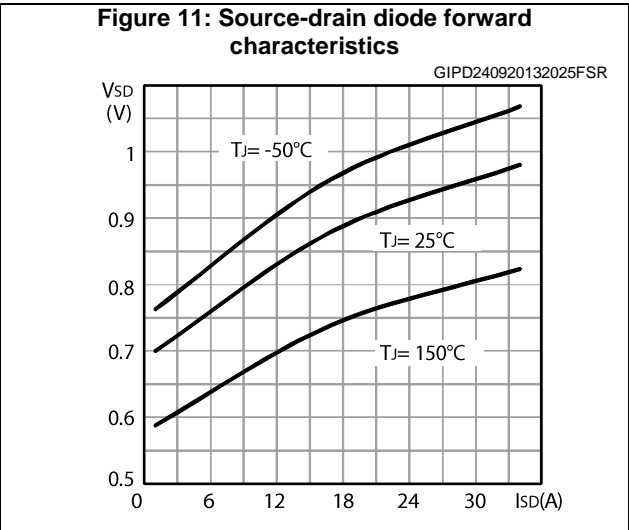
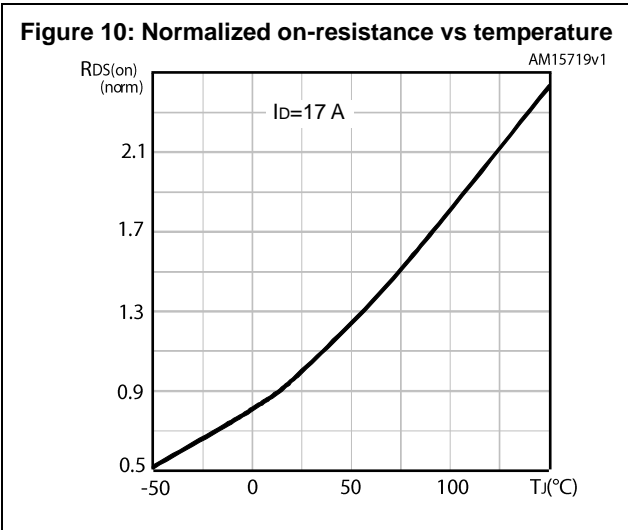
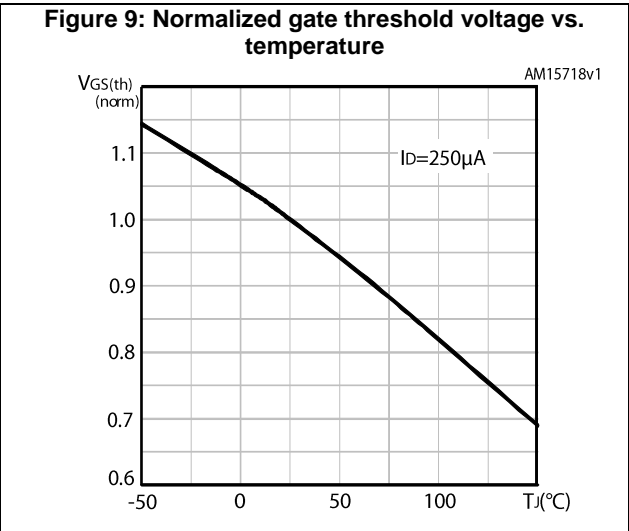
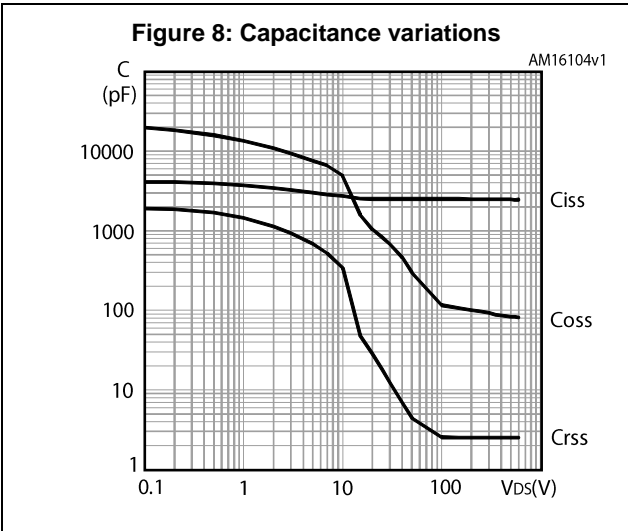
(1)The value is rated according to  $R_{thj-case}$  and limited by package.

(2)Pulse width limited by safe operating area.

(3)Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

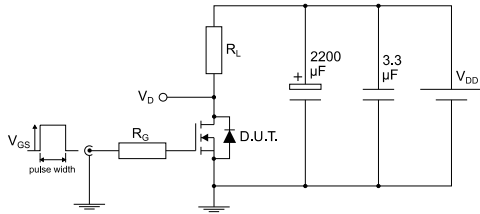
## 2.1 Electrical characteristics (curves)





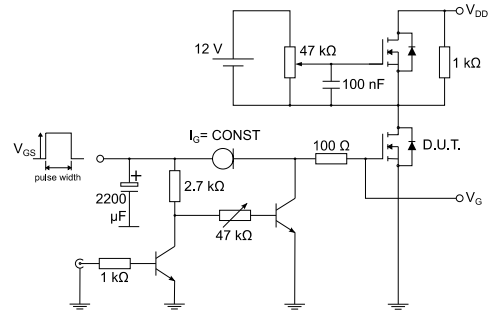
### 3 Test circuits

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



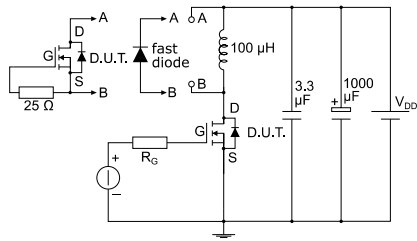
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**Figure 15: Test circuit for gate charge behavior**



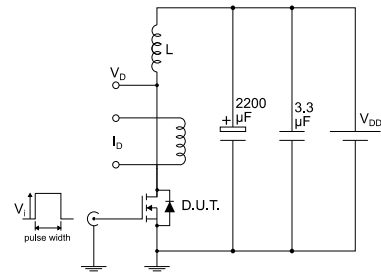
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**Figure 16: Test circuit for inductive load switching and diode recovery times**



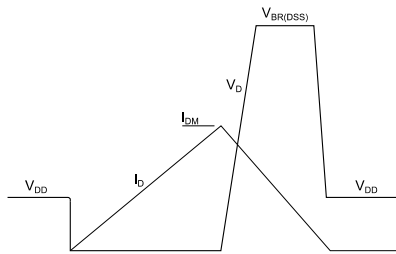
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**Figure 17: Unclamped inductive load test circuit**



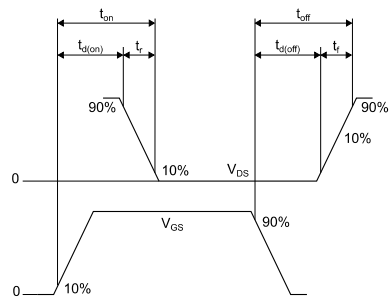
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**Figure 18: Unclamped inductive waveform**



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**Figure 19: Switching time waveform**



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## 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 wide creepage package information

Figure 20: TO-220FP wide creepage package outline

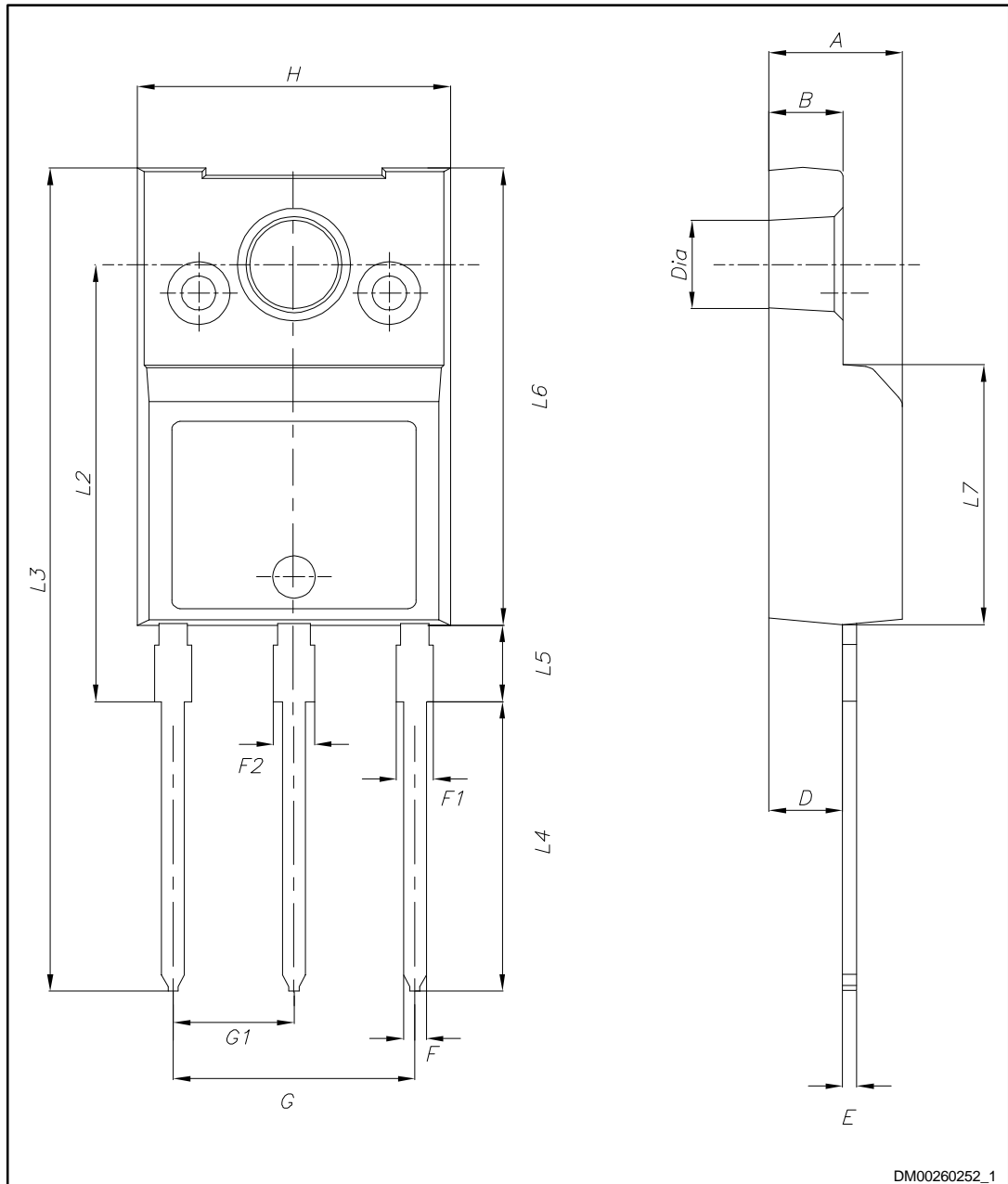


Table 9: TO-220FP wide creepage package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.60	4.70	4.80
B	2.50	2.60	2.70
D	2.49	2.59	2.69
E	0.46		0.59
F	0.76		0.89
F1	0.96		1.25
F2	1.11		1.40
G	8.40	8.50	8.60
G1	4.15	4.25	4.35
H	10.90	11.00	11.10
L2	15.25	15.40	15.55
L3	28.70	29.00	29.30
L4	10.00	10.20	10.40
L5	2.55	2.70	2.85
L6	16.00	16.10	16.20
L7	9.05	9.15	9.25
Dia	3.00	3.10	3.20

## 5 Revision history

Table 10: Document revision history

Date	Revision	Changes
08-Jun-2016	1	First release.

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