

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

Datasheet - preliminary data

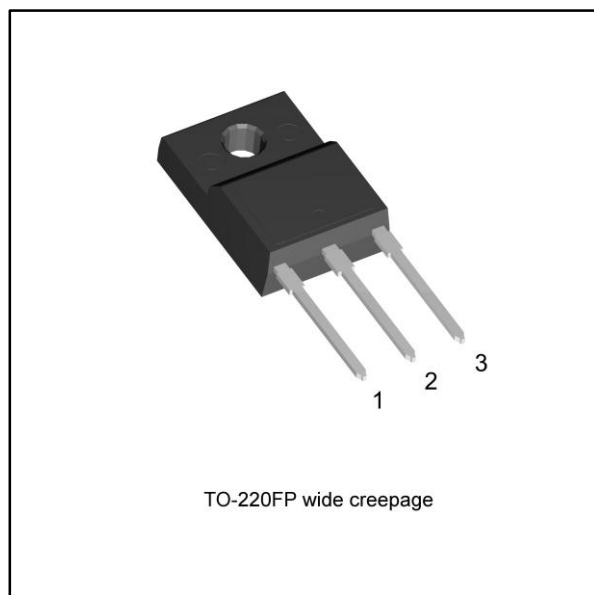
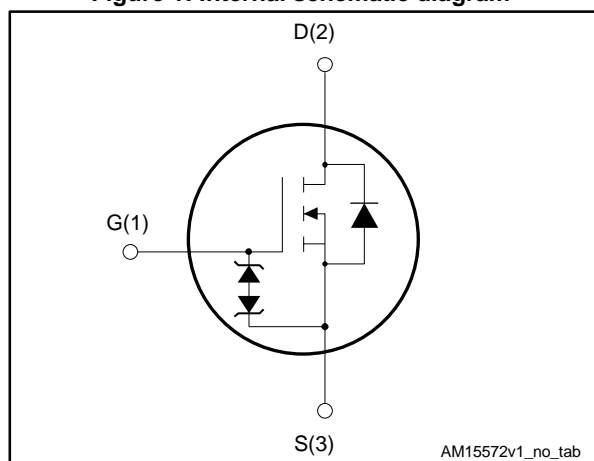


Figure 1: Internal schematic diagram



### 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
$V_{GS}$	Gate-source voltage	$\pm 25$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$	34 <sup>(1)</sup>	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$	22 <sup>(1)</sup>	A
$I_{DM}$ <sup>(2)</sup>	Drain current (pulsed)	136 <sup>(1)</sup>	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	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
$V_{ISO}$	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		

**Notes:**

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

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

<sup>(3)</sup> $I_{SD} \leq 13\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DSpeak} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$

<sup>(4)</sup> $V_{DS} \leq 480\text{ V}$

Table 3: Thermal data

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max	3.13	$^{\circ}\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	62.5	$^{\circ}\text{C}/\text{W}$

Table 4: Avalanche characteristics

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$ )	6	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j=25\text{ }^{\circ}\text{C}$ , $I_D = I_{AR}$ ; $V_{DD}=50\text{ V}$ )	500	mJ

## 2 Electrical characteristics

(T<sub>C</sub> = 25 °C unless otherwise specified)

**Table 5: On /off states**

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	μA
I <sub>GSS</sub>	Gate-body leakage current	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±25 V			±10	μA
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>DS(on)</sub>	Static drain-source on- resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 17 A		0.078	0.088	Ω

**Notes:**

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

**Table 6: Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C <sub>iss</sub>	Input capacitance	V <sub>DS</sub> = 100 V, f = 1 MHz, V <sub>GS</sub> = 0 V	-	2500	-	pF
C <sub>oss</sub>	Output capacitance		-	117	-	pF
C <sub>rss</sub>	Reverse transfer capacitance		-	2.4	-	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	-	342	-	pF
R <sub>G</sub>	Intrinsic gate resistance	f = 1 MHz, I <sub>D</sub> = 0 A	-	4.4	-	Ω
Q <sub>g</sub>	Total gate charge	V <sub>DD</sub> = 480 V, I <sub>D</sub> = 34 A, V <sub>GS</sub> = 10 V (see <a href="#">Figure 15: "Test circuit for gate charge behavior"</a> )	-	57	-	nC
Q <sub>gs</sub>	Gate-source charge		-	10	-	nC
Q <sub>gd</sub>	Gate-drain charge		-	25.5	-	nC

**Notes:**

<sup>(1)</sup>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 7: 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> = 34 A, R <sub>G</sub> = 4.7 Ω, V <sub>GS</sub> = 10 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 <sub>r</sub>	Rise time		-	13.5	-	ns
t <sub>d(off)</sub>	Turn-off delay time		-	96.5	-	ns
t <sub>f</sub>	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 <a href="#">Figure 16: "Test circuit for inductive load switching and diode recovery times"</a> )	-	440		ns
$Q_{rr}$	Reverse recovery charge		-	8.2		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	37		A
$t_{rr}$	Reverse recovery time		-	568		ns
$Q_{rr}$	Reverse recovery charge	$I_{SD} = 34\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 16: "Test circuit for inductive load switching and diode recovery times"</a> )	-	11.5		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	40.5		A

**Notes:**

<sup>(1)</sup>The value is rated according to  $R_{thj\text{-case}}$  and limited by package.

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

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

## 2.1 Electrical characteristics (curves)

Figure 2: Safe operating area

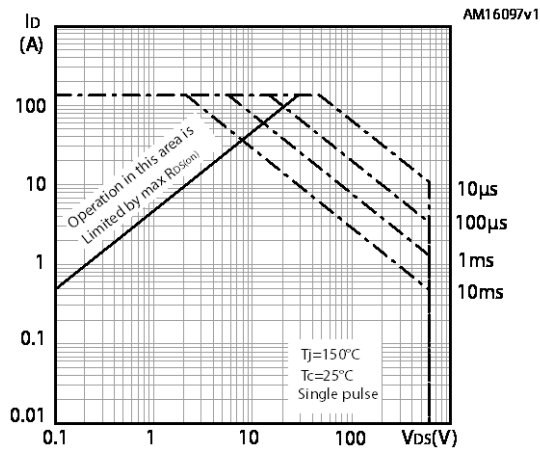


Figure 3: Thermal impedance

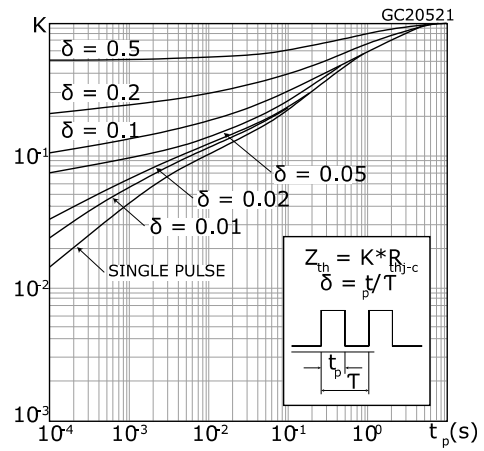


Figure 4: Output characteristics

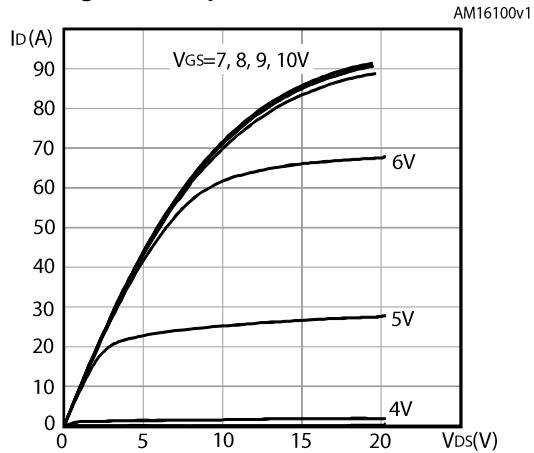


Figure 5: Transfer characteristics

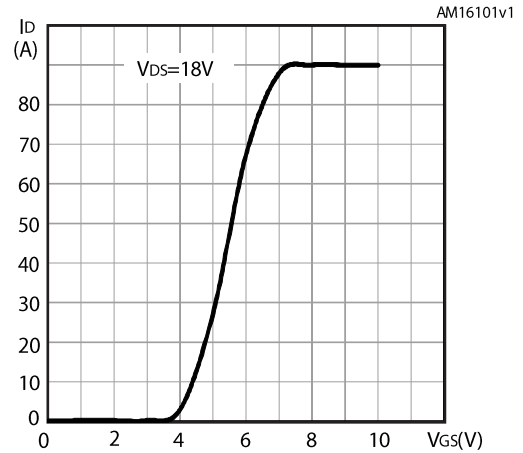


Figure 6: Gate charge vs gate-source voltage

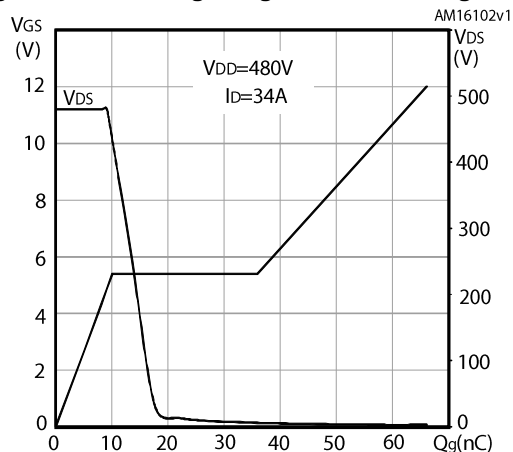


Figure 7: Static drain-source on-resistance

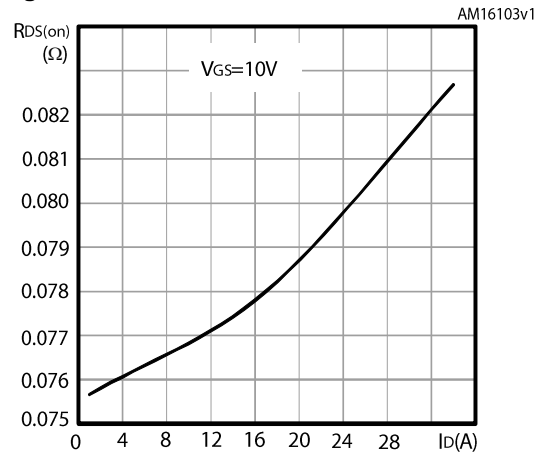


Figure 8: Capacitance variations

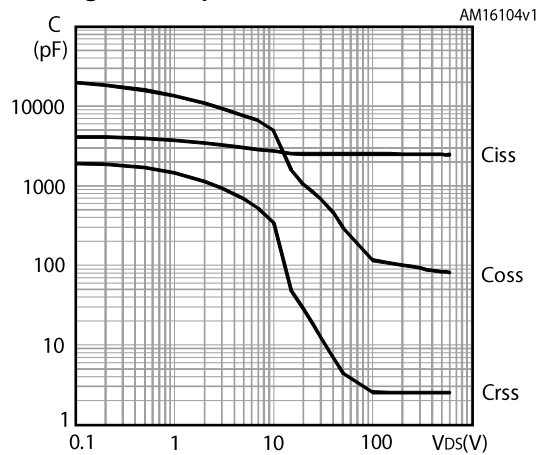


Figure 9: Normalized gate threshold voltage vs. temperature

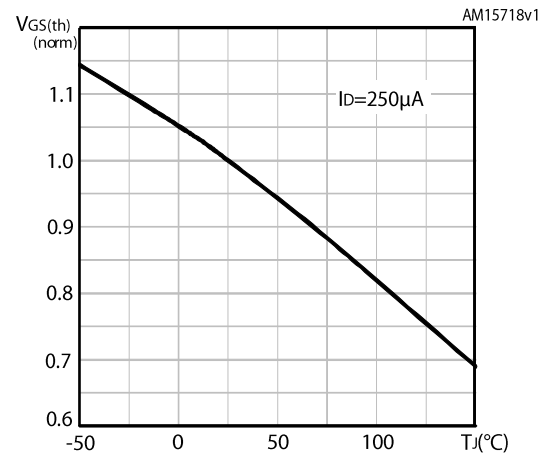


Figure 10: Normalized on-resistance vs temperature

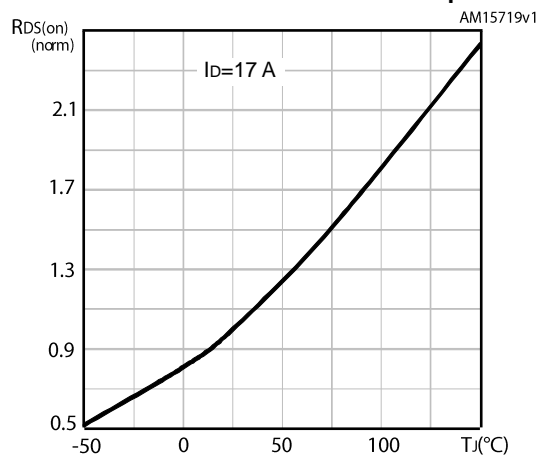


Figure 11: Source-drain diode forward characteristics

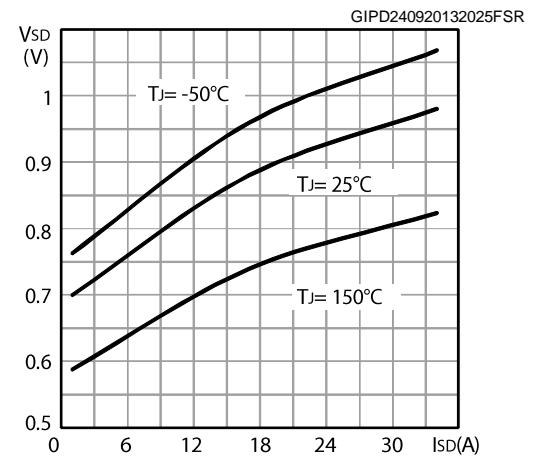
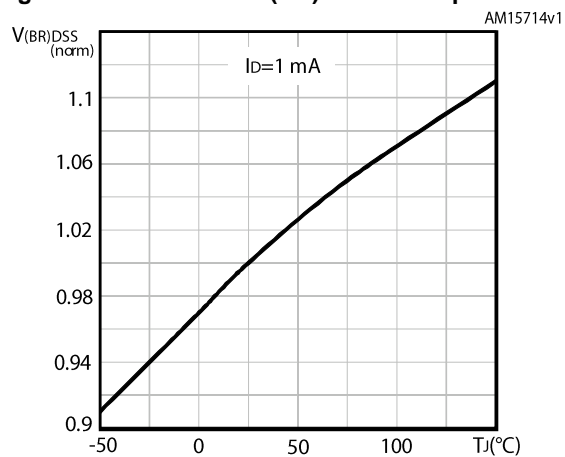
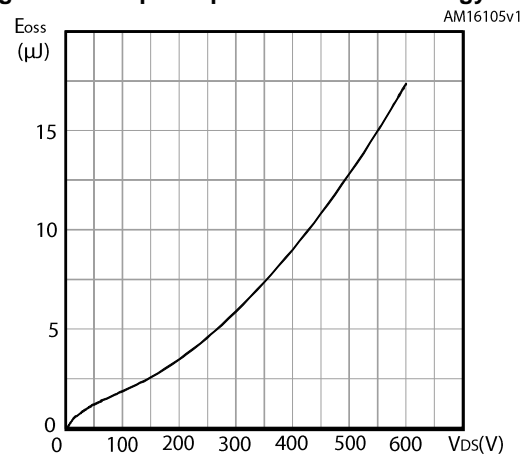
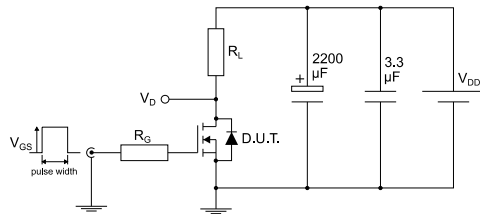
Figure 12: Normalized  $V(BR)_{DSS}$  vs temperature

Figure 13: Output capacitance stored energy



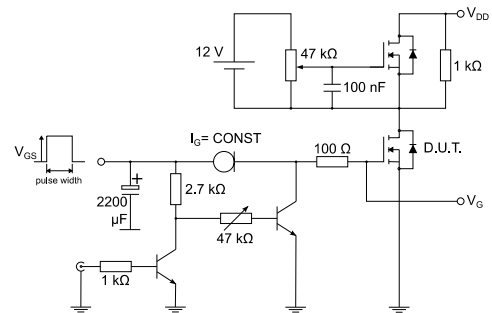
### 3 Test circuits

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



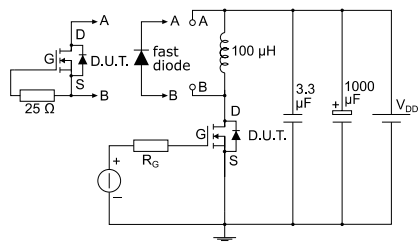
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**Figure 15: Test circuit for gate charge behavior**



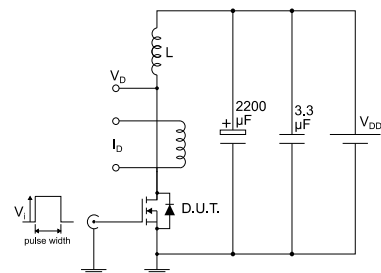
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**Figure 16: Test circuit for inductive load switching and diode recovery times**



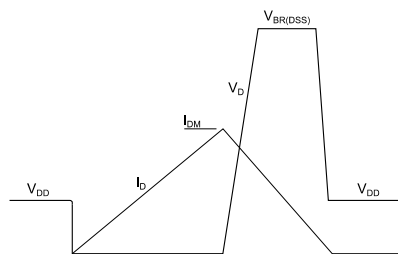
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**Figure 17: Unclamped inductive load test circuit**



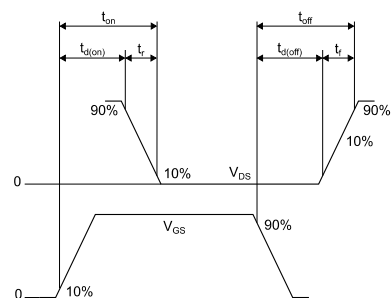
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**Figure 18: Unclamped inductive waveform**



AM01472v1

**Figure 19: 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 wide creepage package information

Figure 20: TO-220FP wide creepage package outline

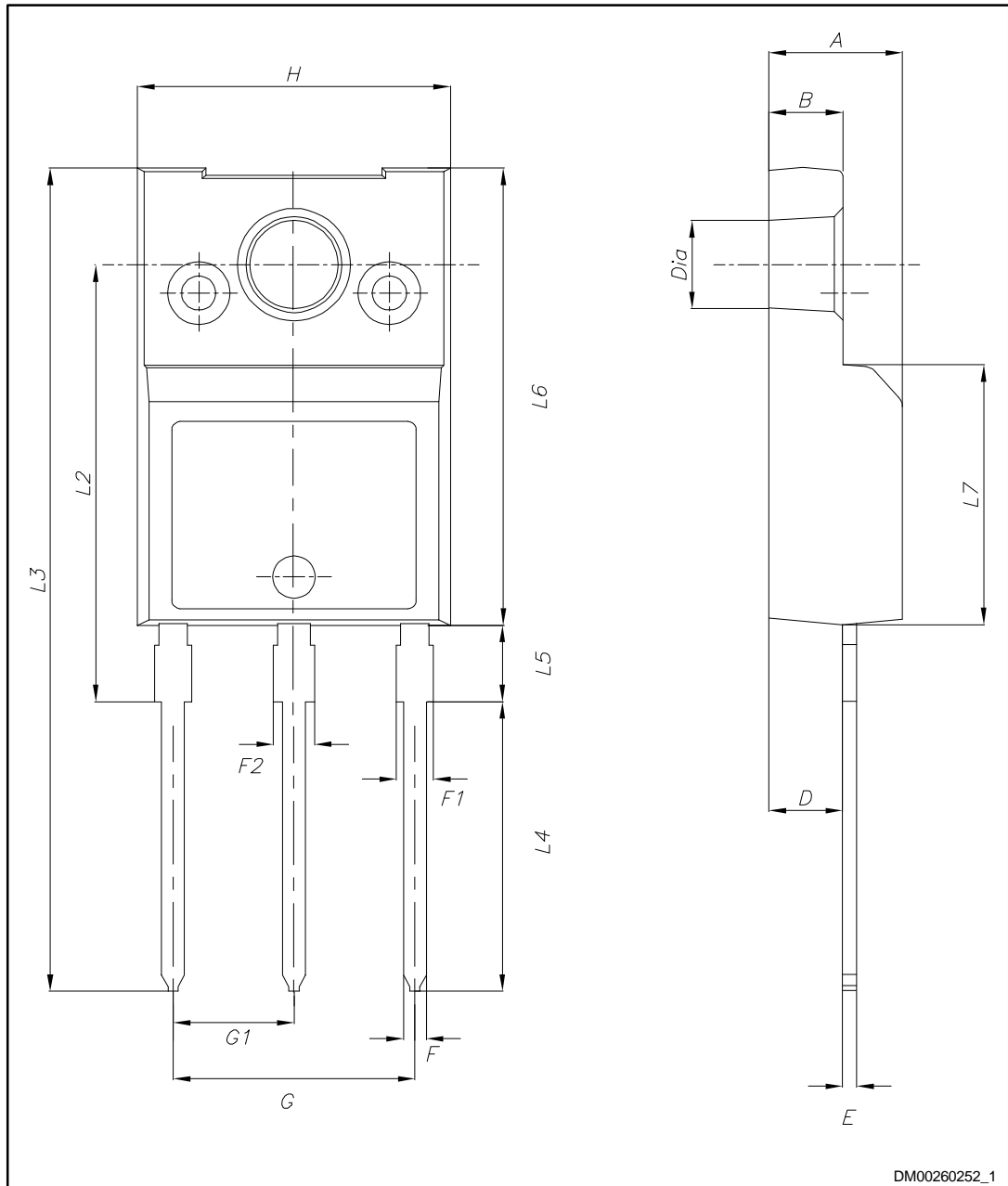


Table 9: TO-220FP wide creepage package mechanical data

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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