

N-channel 600 V, 0.078  $\Omega$  typ., 34 A MDmesh M2  
Power MOSFETs in TO-220FP, I<sup>2</sup>PAKFP and TO-3PF packages

Datasheet – production data

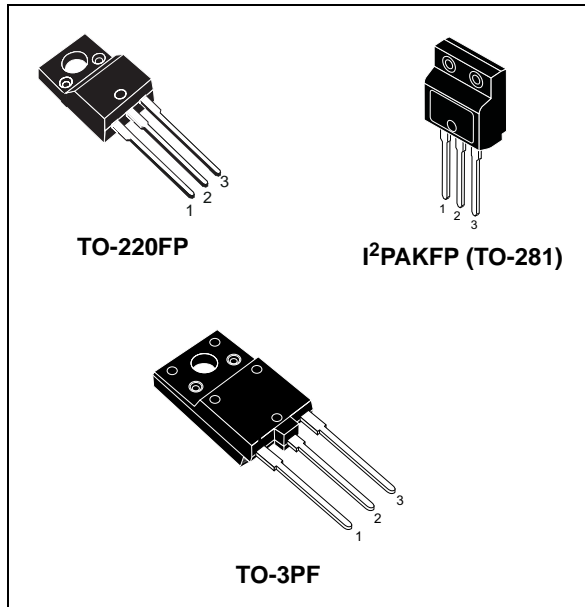
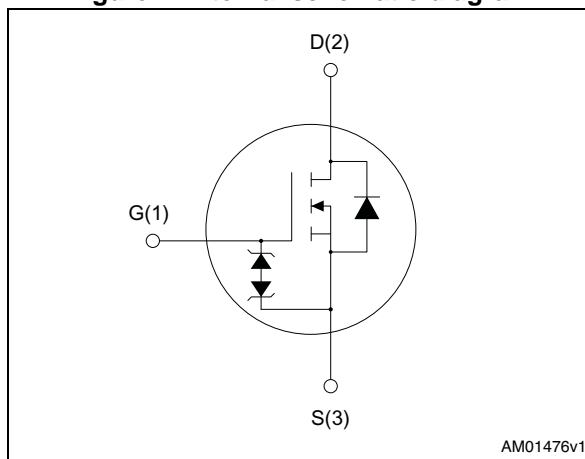


Figure 1. Internal schematic diagram



## Features

Order codes	$V_{DS} @ T_{Jmax}$	$R_{DS(on) max}$	$I_D$
STF40N60M2	650 V	0.088 $\Omega$	34 A
STFI40N60M2			
STFW40N60M2			

- Extremely low gate charge
- Excellent output capacitance ( $C_{oss}$ ) profile
- 100% avalanche tested
- Zener-protected

## Applications

- Switching applications
- LLC converters, resonant converters

## Description

These devices are N-channel Power MOSFETs developed using MDmesh™ M2 technology. Thanks to their strip layout and improved vertical structure, the devices exhibit low on-resistance and optimized switching characteristics, rendering them suitable for the most demanding high efficiency converters.

Table 1. Device summary

Order code	Marking	Packages	Packing
STF40N60M2	40N60M2	TO-220FP	Tube
STFI40N60M2		I <sup>2</sup> PAKFP (TO-281)	
STFW40N60M2		TO-3PF	

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220FP, I <sup>2</sup> PAKFP	TO-3PF	
V <sub>GS</sub>	Gate-source voltage	± 25		V
I <sub>D</sub> <sup>(1)</sup>	Drain current (continuous) at T <sub>C</sub> = 25 °C	34		A
I <sub>D</sub> <sup>(1)</sup>	Drain current (continuous) at T <sub>C</sub> = 100 °C	22		A
I <sub>DM</sub> <sup>(1),(2)</sup>	Drain current (pulsed)	136		A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	40	63	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	3500	V
T <sub>stg</sub>	Storage temperature range	- 55 to 150		°C
T <sub>j</sub>	Operating junction temperature range			°C

- Limited by maximum junction temperature
- Pulse width limited by safe operating area.
- I<sub>SD</sub> ≤ 34 A, di/dt ≤ 400 A/μs; V<sub>DS peak</sub> < V<sub>(BR)DSS</sub>; V<sub>DD</sub>=400 V.
- V<sub>DS</sub> ≤ 480 V

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		TO-220FP, I <sup>2</sup> PAKFP	TO-3PF	
R <sub>thj-case</sub>	Thermal resistance junction-case	3.13	2.00	°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient	62.5	50	°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	$V_{GS} = 0, I_D = 1\text{ mA}$	600			V
$I_{DSS}$	Zero gate voltage drain current ( )	$V_{GS} = 0, V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0, V_{DS} = 600\text{ V}, T_C = 125\text{ °C}^{(1)}$			100	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0, V_{GS} = \pm 25\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	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	$\Omega$

1. Defined by design, not subject to production test

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0, V_{DS} = 100\text{ V}, f = 1\text{ MHz}$	-	2500	-	pF
$C_{oss}$	Output capacitance		-	117	-	pF
$C_{rss}$	Reverse transfer capacitance		-	2.4	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0\text{ to }480\text{ V}$	-	342	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}, I_D = 0$	-	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 17: Gate charge test circuit</a> )	-	57	-	nC
$Q_{gs}$	Gate-source charge		-	10	-	nC
$Q_{gd}$	Gate-drain charge		-	25.5	-	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 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 34\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 16: Switching times test circuit for resistive load</a> and <a href="#">Figure 21: Switching time waveform</a> )	-	20.5	-	ns
$t_r$	Rise time		-	13.5	-	ns
$t_{d(off)}$	Turn-off-delay time		-	96	-	ns
$t_f$	Fall time		-	11	-	ns

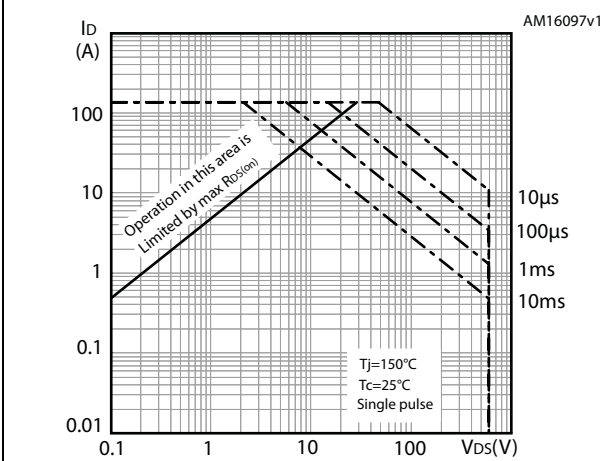
Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-	34		A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-	136		A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 34\text{ A}$ , $V_{GS} = 0$	-		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 18: 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	$I_{SD} = 34\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 18: Test circuit for inductive load switching and diode recovery times</a> )	-	37		A
$t_{rr}$	Reverse recovery time		-	568		ns
$Q_{rr}$	Reverse recovery charge		-	11.5		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	40.5		A

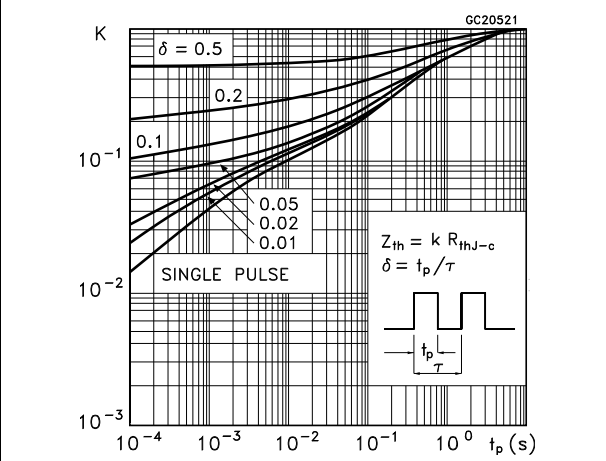
1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

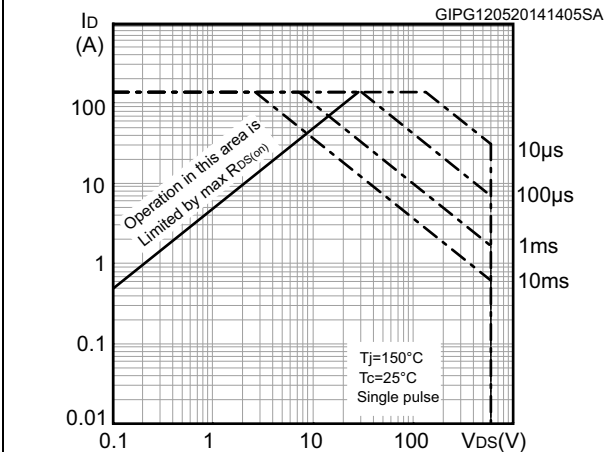
**Figure 2. Safe operating area for TO-220FP and I<sup>2</sup>PAKFP**



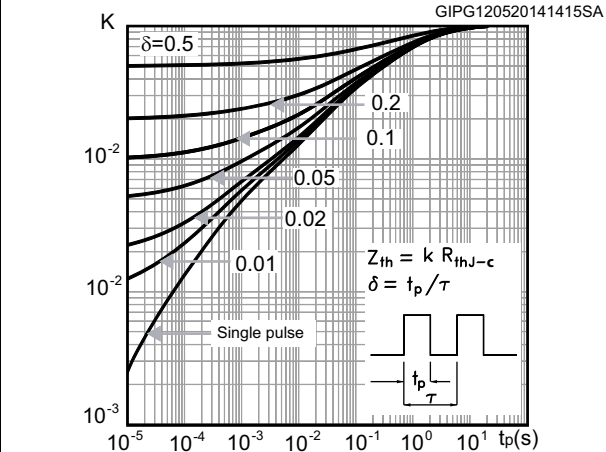
**Figure 3. Thermal impedance for TO-220FP and I<sup>2</sup>PAKFP**



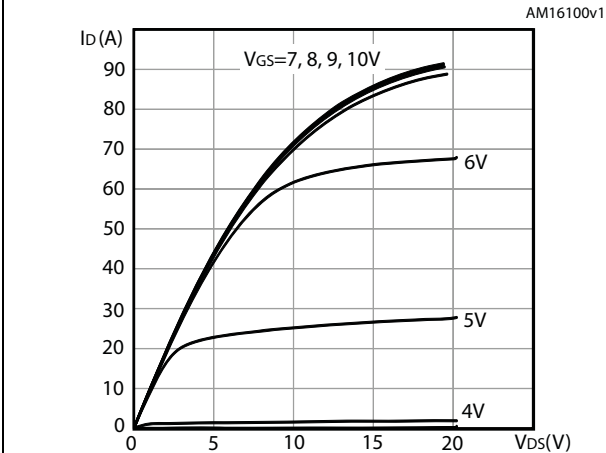
**Figure 4. Safe operating area for TO-3PF**



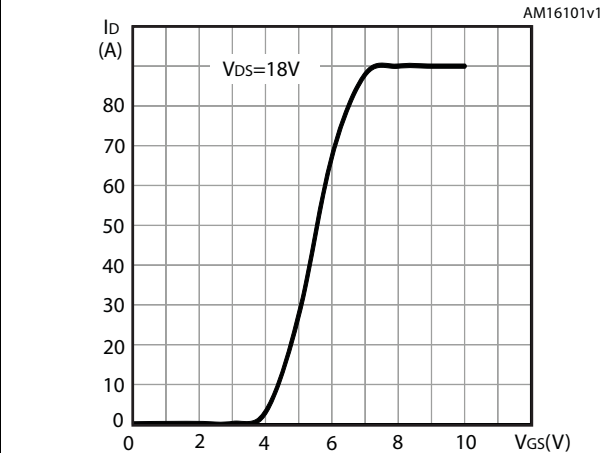
**Figure 5. Thermal impedance for TO-3PF**



**Figure 6. Output characteristics**



**Figure 7. Transfer characteristics**



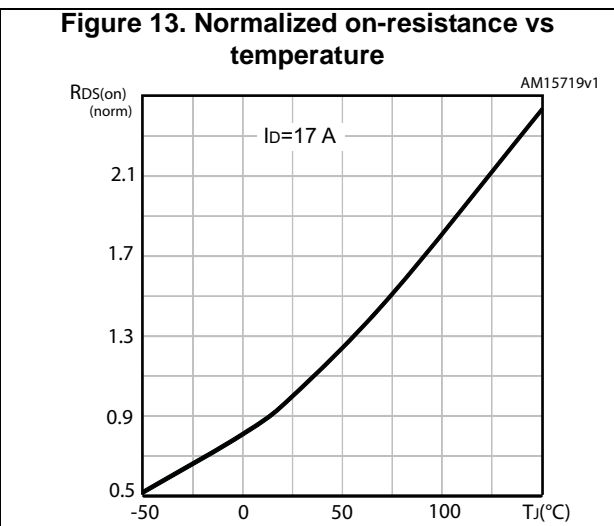
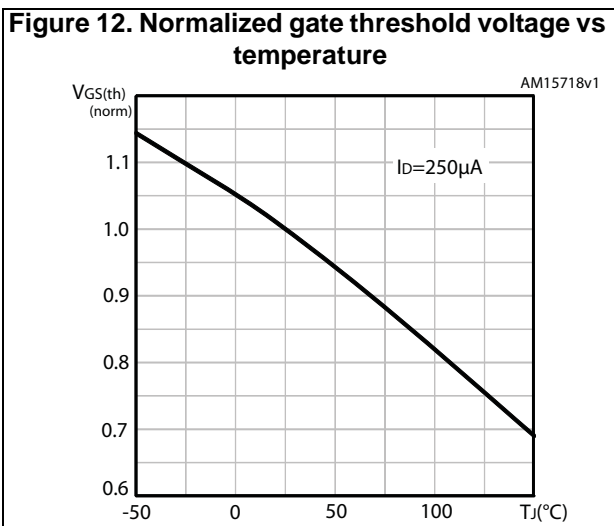
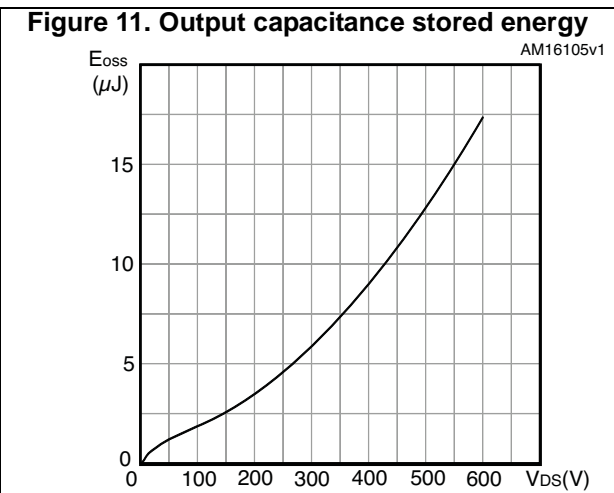
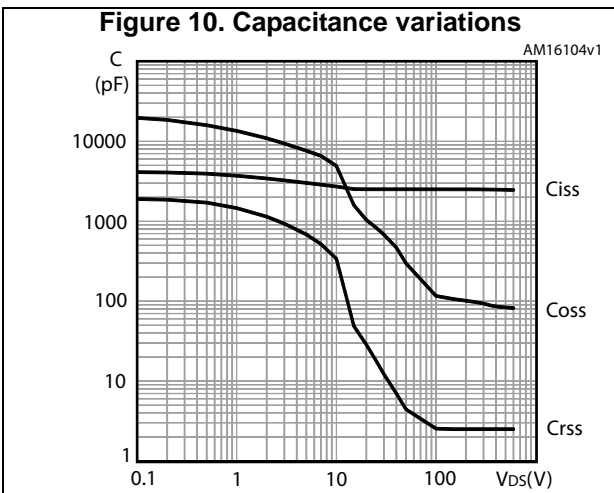
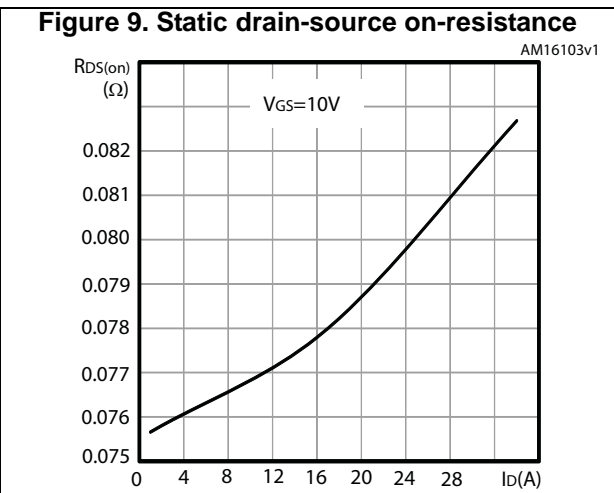
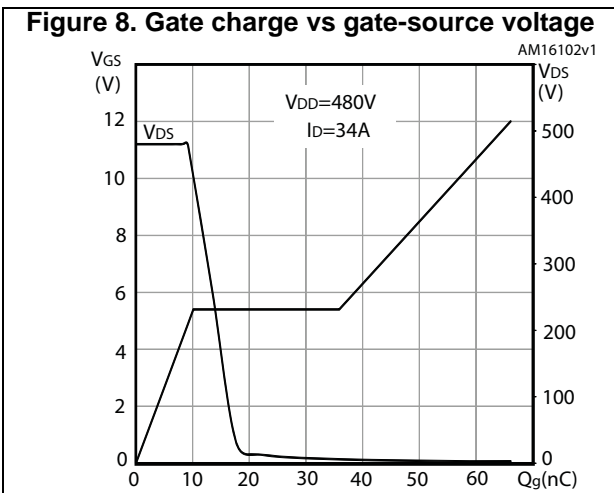


Figure 14. Normalized  $V_{(BR)DSS}$  vs temperature

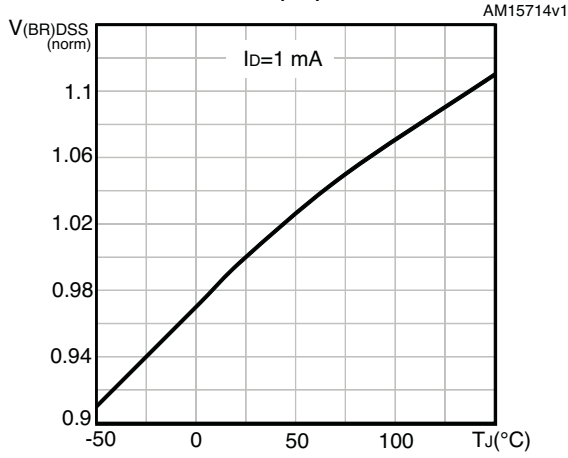
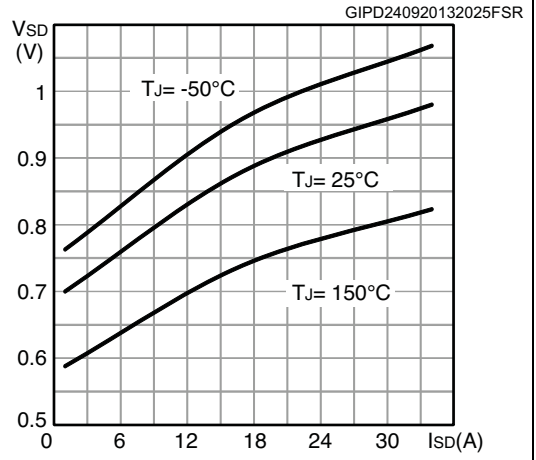
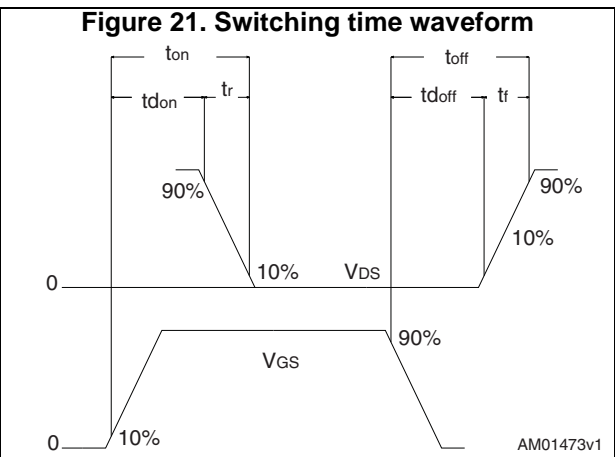
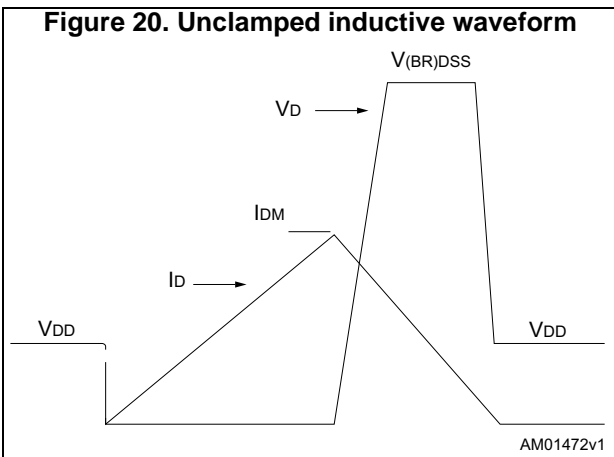
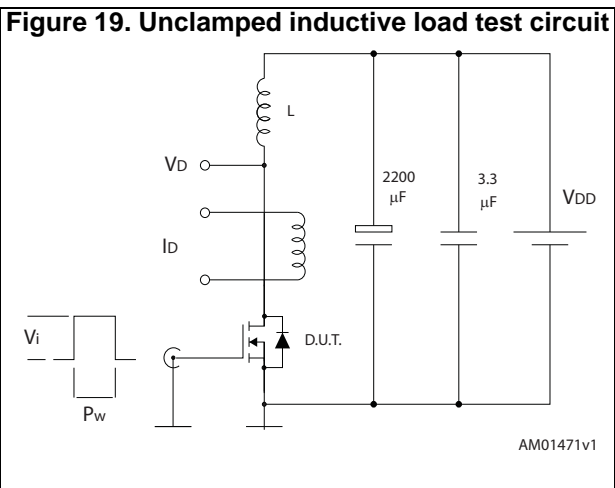
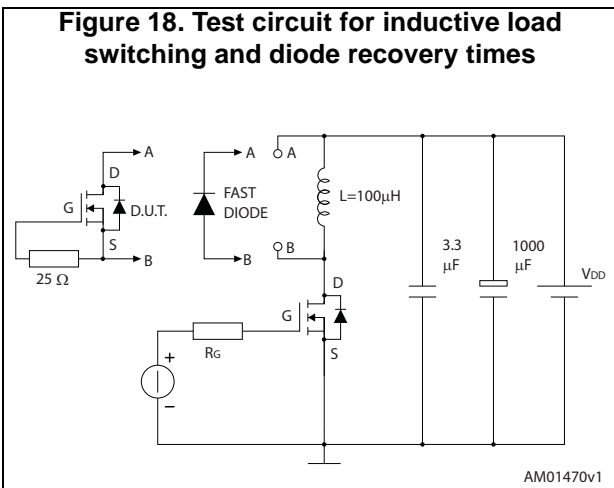
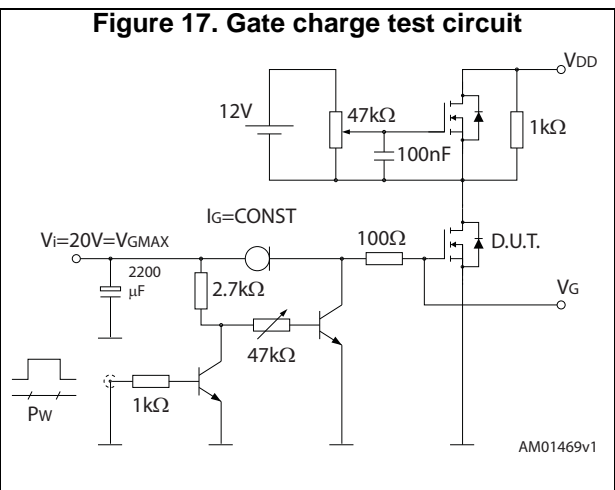
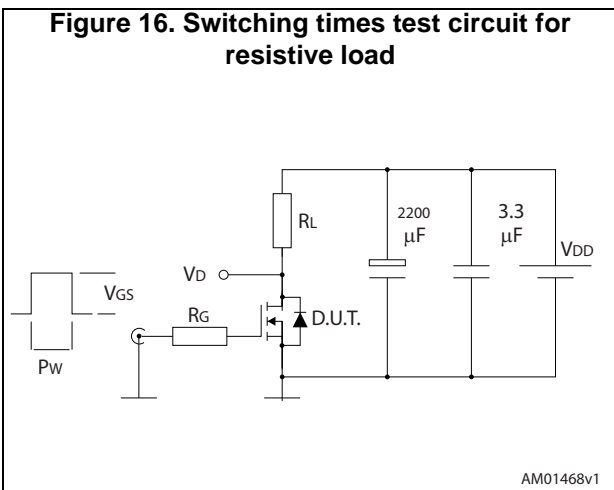


Figure 15. Source-drain diode forward vs temperature





### 3 Test circuits

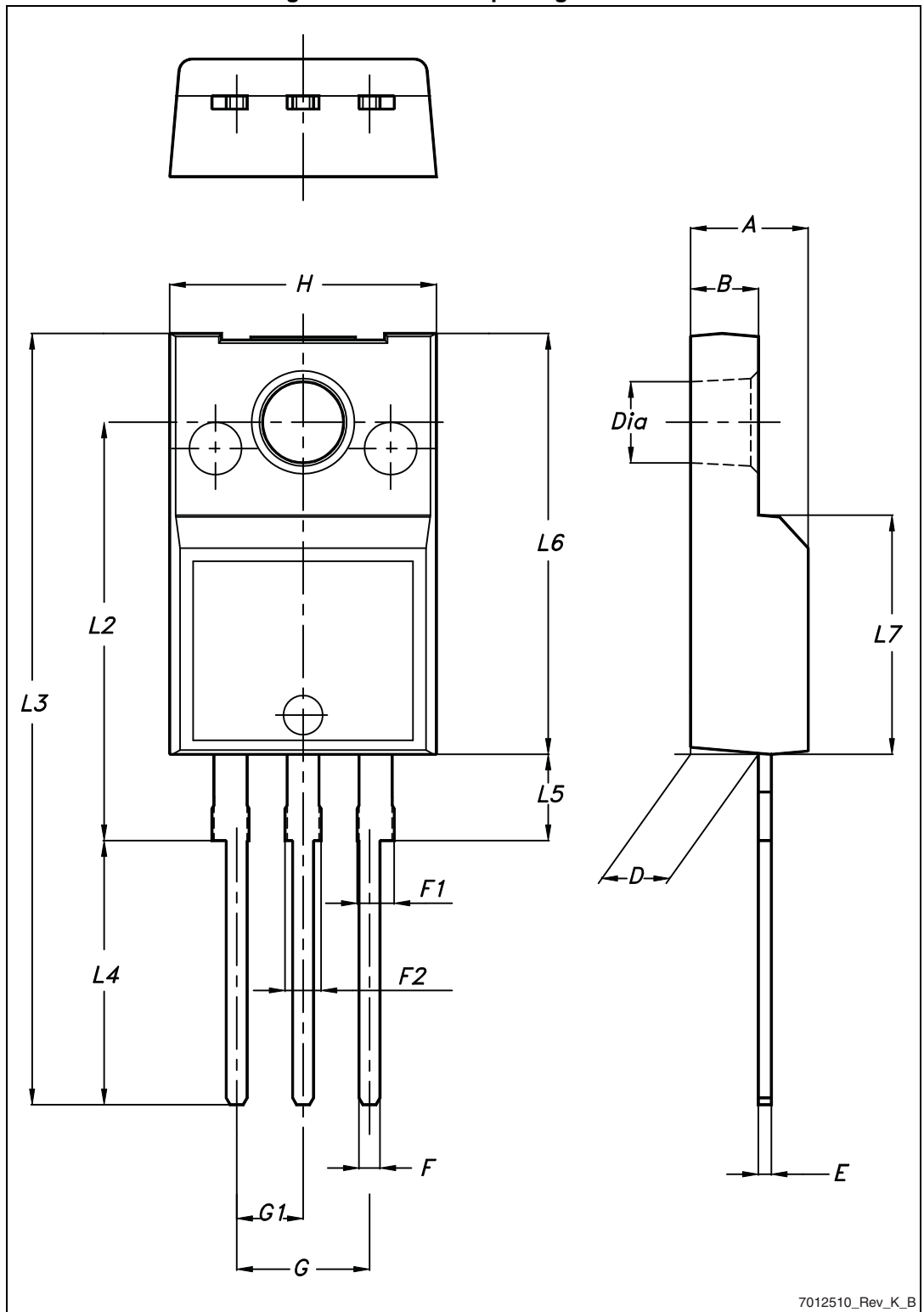


## 4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

### 4.1 TO-220FP, package outline

Figure 22. TO-220FP package outline



7012510\_Rev\_K\_B

Table 9. TO-220FP 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

### 4.2 I<sup>2</sup>PAKFP (TO-281) package information

Figure 23. I<sup>2</sup>PAK(TO-281) package outline

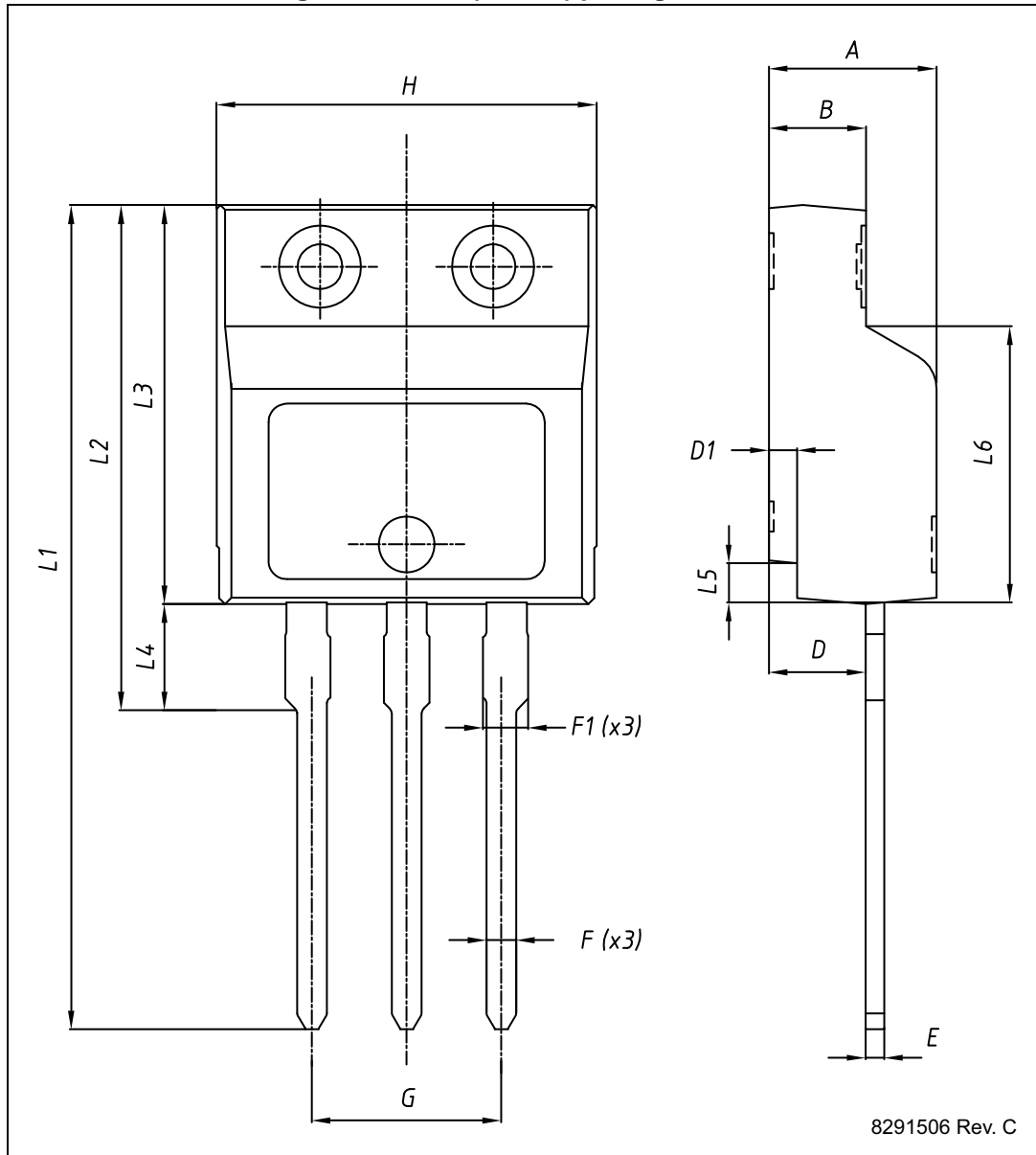


Table 10. I<sup>2</sup>PAKFP (TO-281) package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40	-	4.60
B	2.50		2.70
D	2.50		2.75
D1	0.65		0.85
E	0.45		0.70
F	0.75		1.00
F1			1.20
G	4.95		5.20
H	10.00		10.40
L1	21.00		23.00
L2	13.20		14.10
L3	10.55		10.85
L4	2.70		3.20
L5	0.85		1.25
L6	7.50	7.60	7.70

### 4.3 TO-3PF, package information

Figure 24. TO-3PF package outline

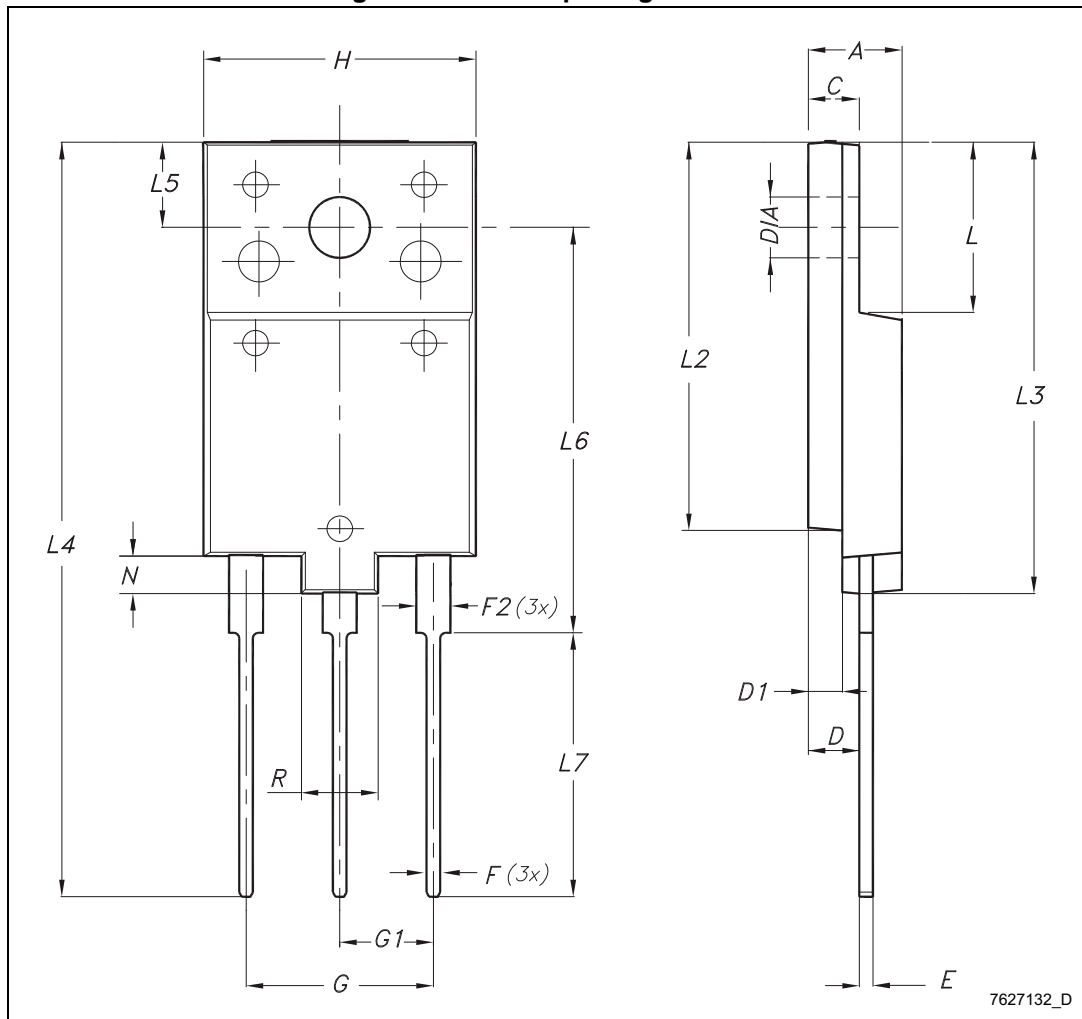


Table 11. TO-3PF package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	5.30		5.70
C	2.80		3.20
D	3.10		3.50
D1	1.80		2.20
E	0.80		1.10
F	0.65		0.95
F2	1.80		2.20
G	10.30		11.50
G1		5.45	
H	15.30		15.70
L	9.80	10	10.20
L2	22.80		23.20
L3	26.30		26.70
L4	43.20		44.40
L5	4.30		4.70
L6	24.30		24.70
L7	14.60		15
N	1.80		2.20
R	3.80		4.20
Dia	3.40		3.80



## 5 Revision history

**Table 12. Document revision history**

Date	Revision	Changes
15-May-2014	1	First release. Part numbers STF40N60M2 and STFI40N60M2 previously included in datasheet DocID024932.
28-Sep-2016	2	Updated title in cover page. Updated <a href="#">Table 2: Absolute maximum ratings</a> , <a href="#">Table 5: On /off states</a> , <a href="#">Table 6: Dynamic</a> and <a href="#">Table 8: Source drain diode</a> . Minor text changes.

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