

N-channel 600 V, 0.078 Ω typ., 34 A MDmesh M2
Power MOSFETs in TO-220FP, I²PAKFP and TO-3PF packages

Datasheet – production data

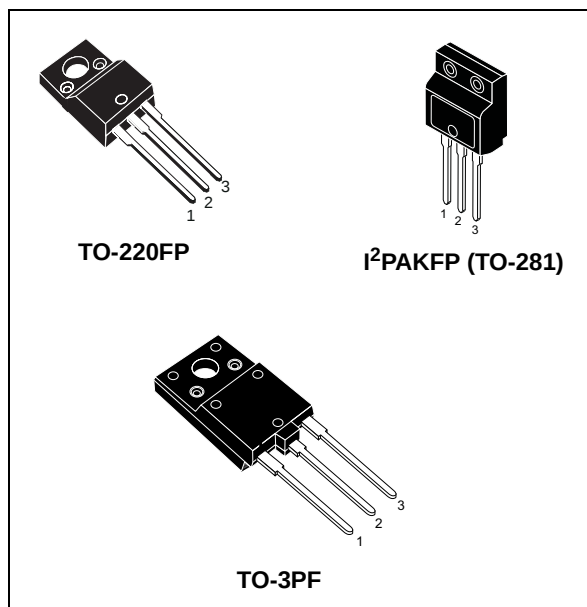
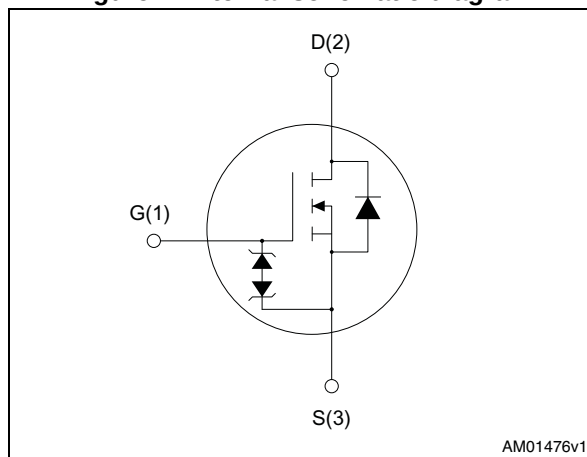


Figure 1. Internal schematic diagram



Features

Order codes	$V_{DS} @ T_{Jmax}$	$R_{DS(on)}$ max	I_D
STF40N60M2	650 V	0.088 Ω	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 ² 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 ² PAKFP	TO-3PF	
V _{GS}	Gate-source voltage	± 25		V
I _D ⁽¹⁾	Drain current (continuous) at T _C = 25 °C	34		A
I _D ⁽¹⁾	Drain current (continuous) at T _C = 100 °C	22		A
I _{DM} ^{(1),(2)}	Drain current (pulsed)	136		A
P _{TOT}	Total dissipation at T _C = 25 °C	40	63	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 s; T _C =25 °C)	2500	3500	V
T _{stg}	Storage temperature range	- 55 to 150		°C
T _j	Operating junction temperature range			°C

1. Limited by maximum junction temperature
2. Pulse width limited by safe operating area.
3. I_{SD} ≤ 34 A, di/dt ≤ 400 A/μs; V_{DS peak} < V_{(BR)DSS}; V_{DD}=400 V.
4. V_{DS} ≤ 480 V

Table 3. Thermal data

Symbol	Parameter	Value		Unit
		TO-220FP, I ² PAKFP	TO-3PF	
R _{thj-case}	Thermal resistance junction-case	3.13	2.00	°C/W
R _{thj-amb}	Thermal resistance junction-ambient	62.5	50	°C/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°C, I _D = I _{AR} ; V _{DD} =50 V)	500	mJ

2 Electrical characteristics

($T_C = 25\text{ }^{\circ}\text{C}$ 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	μA
		$V_{GS} = 0, V_{DS} = 600\text{ V}, T_C = 125\text{ }^{\circ}\text{C}^{(1)}$			100	μA
I_{GSS}	Gate-body leakage current	$V_{DS} = 0, V_{GS} = \pm 25\text{ V}$			± 10	μA
$V_{GS(th)}$	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	Ω

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	-	Ω
Q_g	Total gate charge	$V_{DD} = 480\text{ V}, I_D = 34\text{ A}, V_{GS} = 10\text{ V}$ (see Figure 17: Gate charge test circuit)	-	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 Figure 16: Switching times test circuit for resistive load and Figure 21: Switching time waveform)	-	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 Figure 18: Test circuit for inductive load switching and diode recovery times)	-	440		ns
Q_{rr}	Reverse recovery charge		-	8.2		μC
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 Figure 18: Test circuit for inductive load switching and diode recovery times)	-	568		ns
Q_{rr}	Reverse recovery charge		-	11.5		μC
I_{RRM}	Reverse recovery current		-	40.5		A

1. Pulse width limited by safe operating area.

2. Pulsed: pulse duration = 300 μs , duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220FP and I²PAKFP

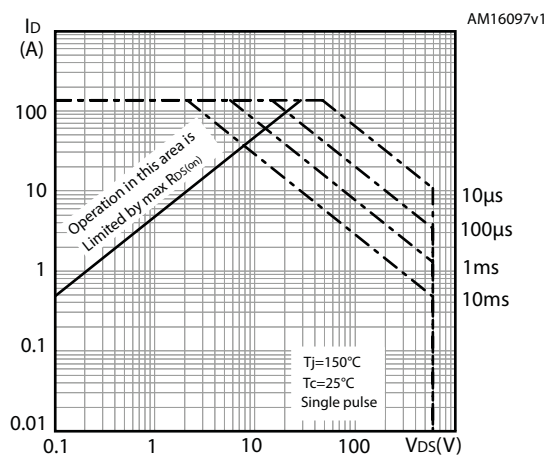


Figure 3. Thermal impedance for TO-220FP and I²PAKFP

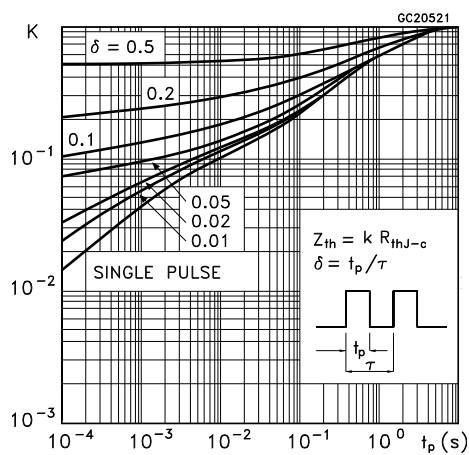


Figure 4. Safe operating area for TO-3PF

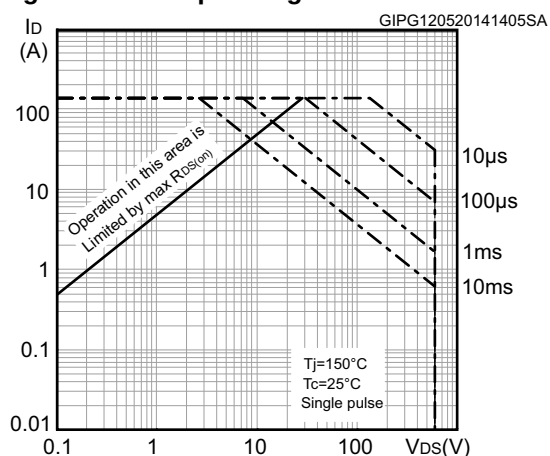


Figure 5. Thermal impedance for TO-3PF

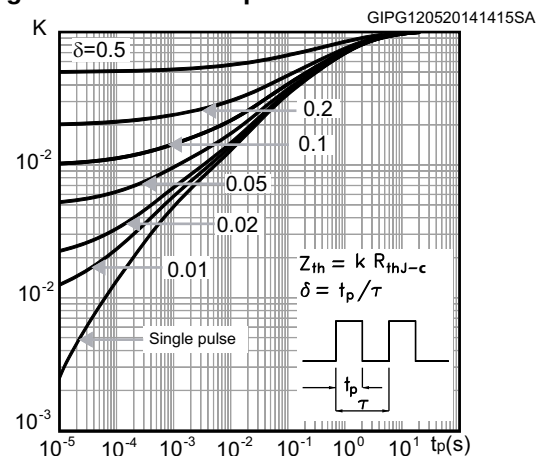


Figure 6. Output characteristics

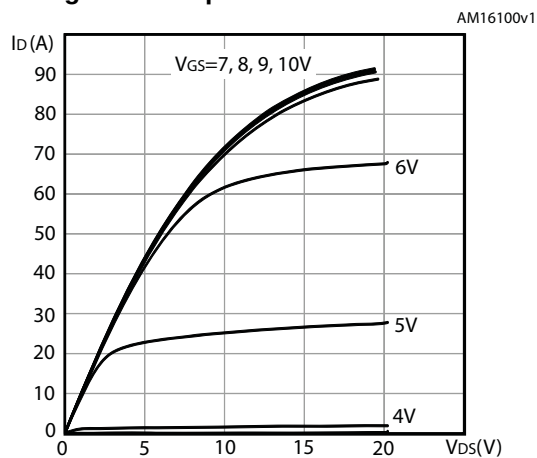


Figure 7. Transfer characteristics

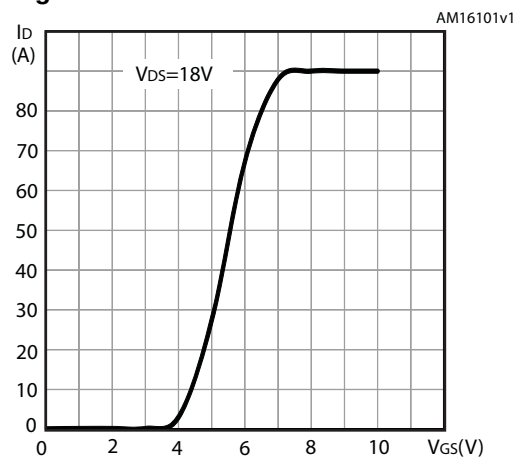


Figure 8. Gate charge vs gate-source voltage

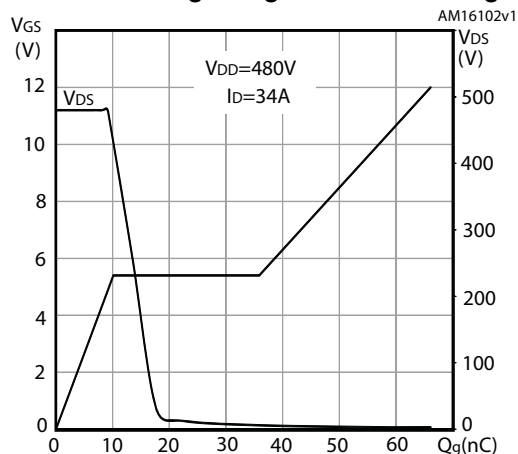


Figure 9. Static drain-source on-resistance

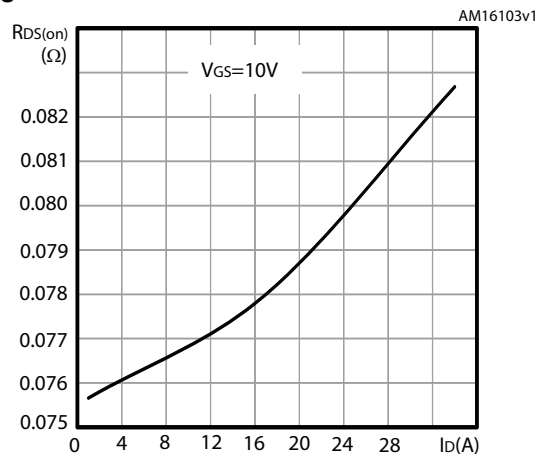


Figure 10. Capacitance variations

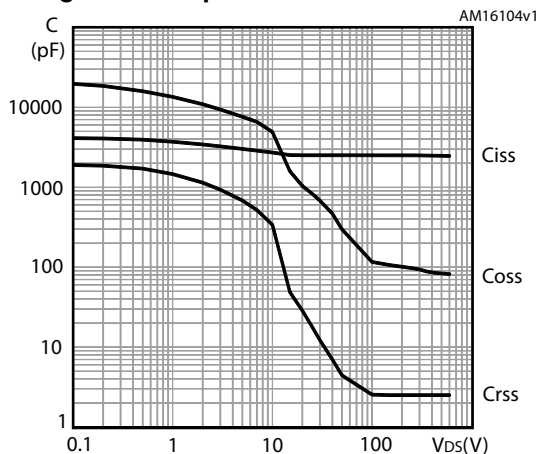


Figure 11. Output capacitance stored energy

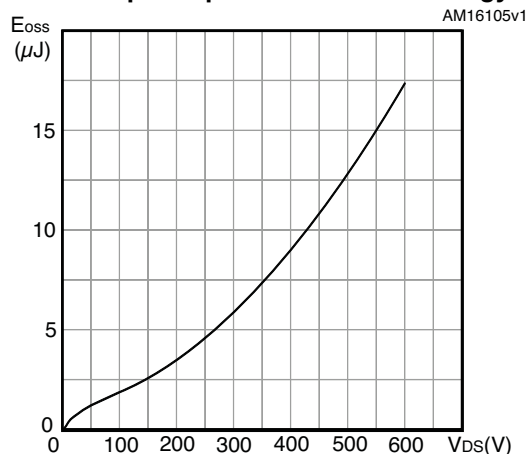


Figure 12. Normalized gate threshold voltage vs temperature

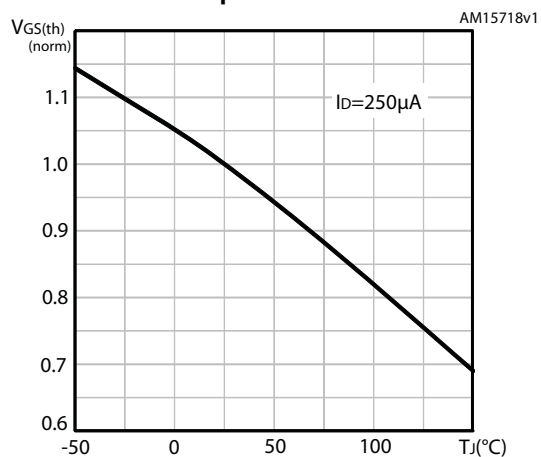


Figure 13. Normalized on-resistance vs temperature

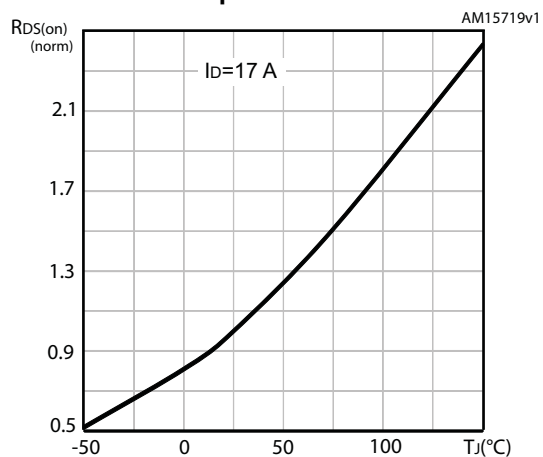


Figure 14. Normalized $V_{(BR)DSS}$ vs temperature

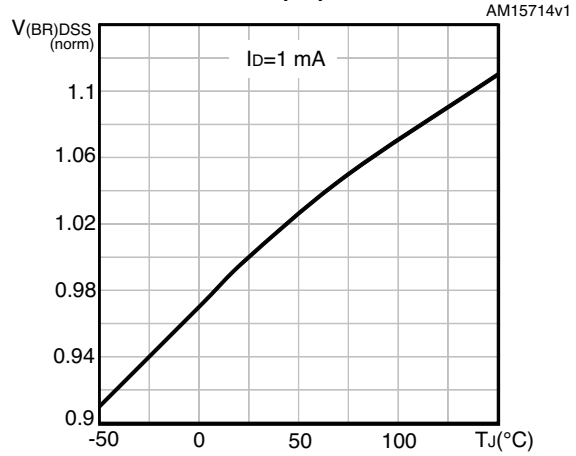
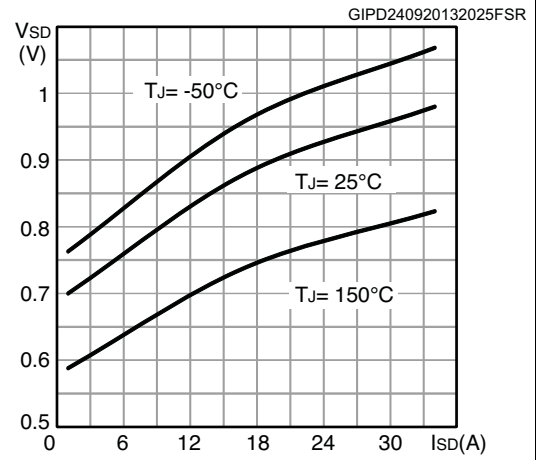
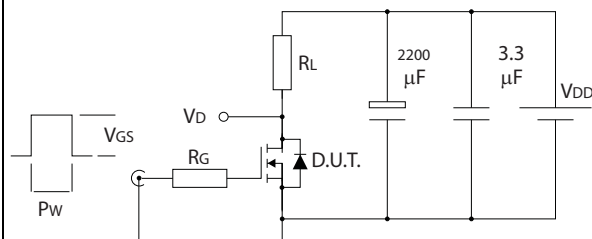


Figure 15. Source-drain diode forward vs temperature



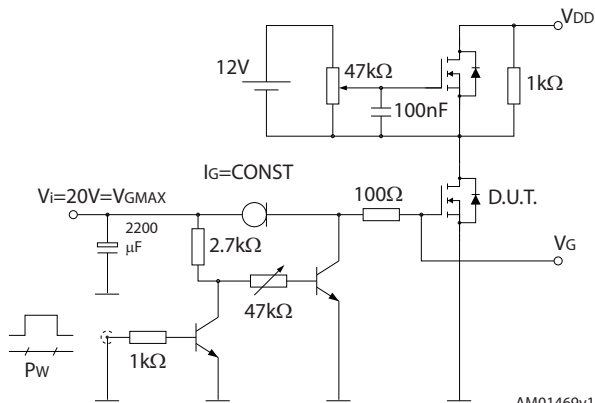
3 Test circuits

Figure 16. Switching times test circuit for resistive load



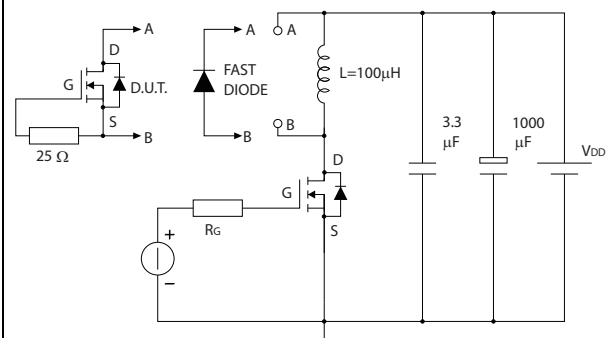
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Figure 17. Gate charge test circuit



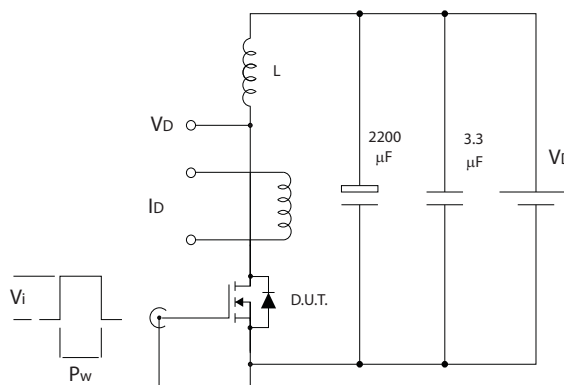
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Figure 18. Test circuit for inductive load switching and diode recovery times



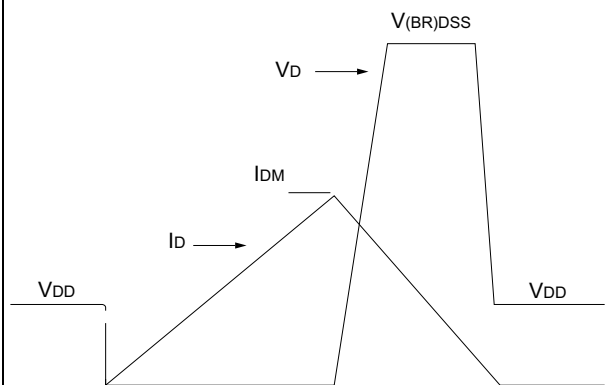
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Figure 19. Unclamped inductive load test circuit



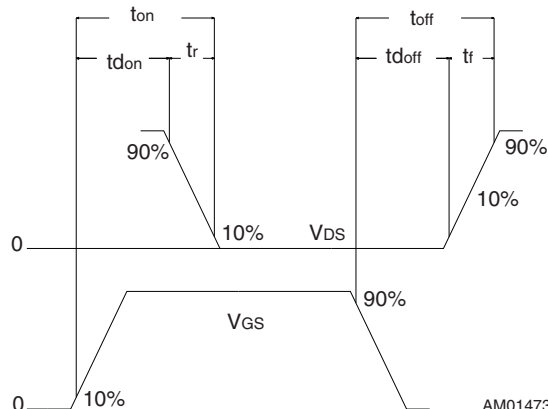
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Figure 20. Unclamped inductive waveform



AM01472v1

Figure 21. Switching time waveform



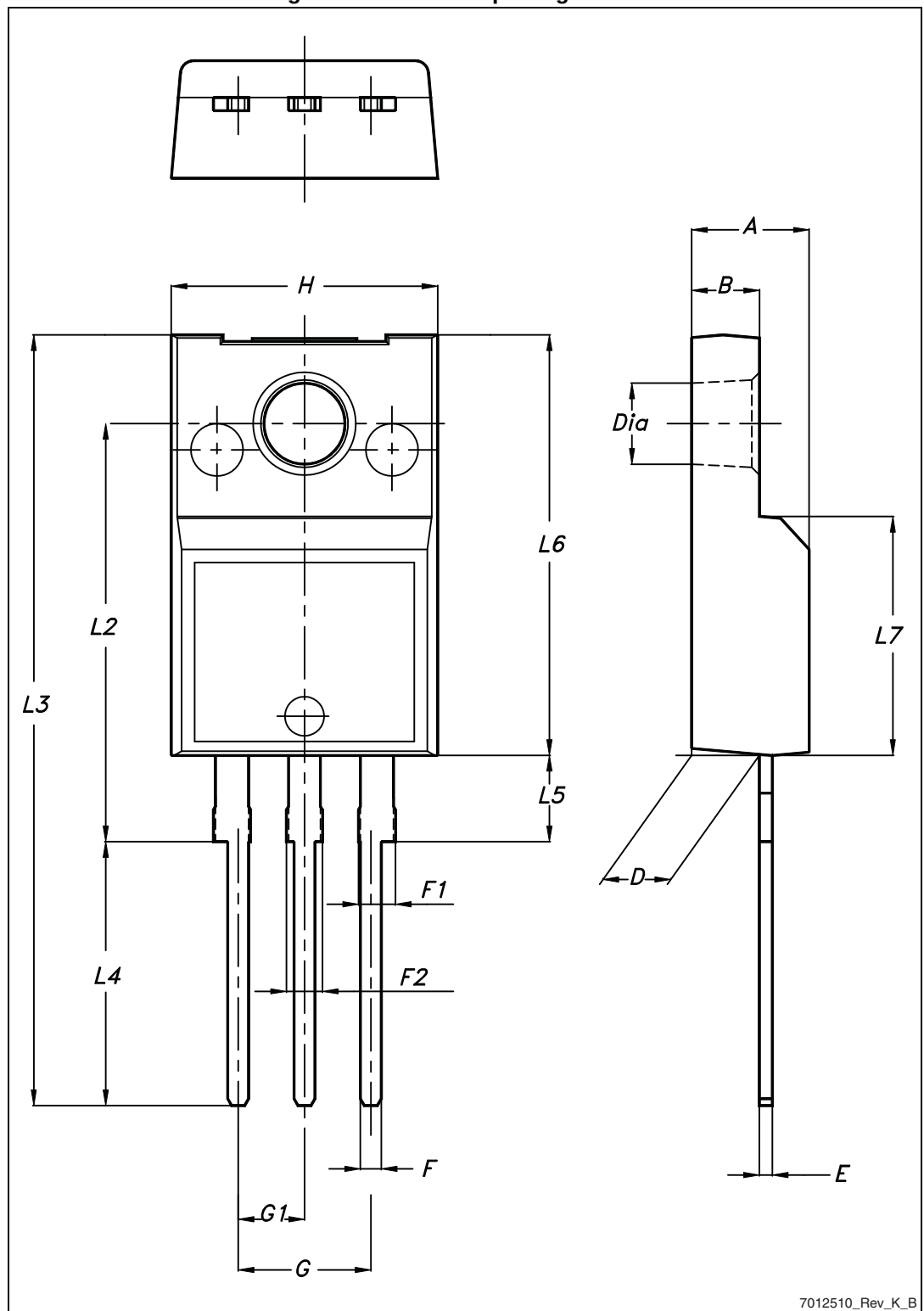
AM01473v1

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. ECOPACK[®] 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 I²PAKFP (TO-281) package information

Figure 23. I²PAK(TO-281) package outline

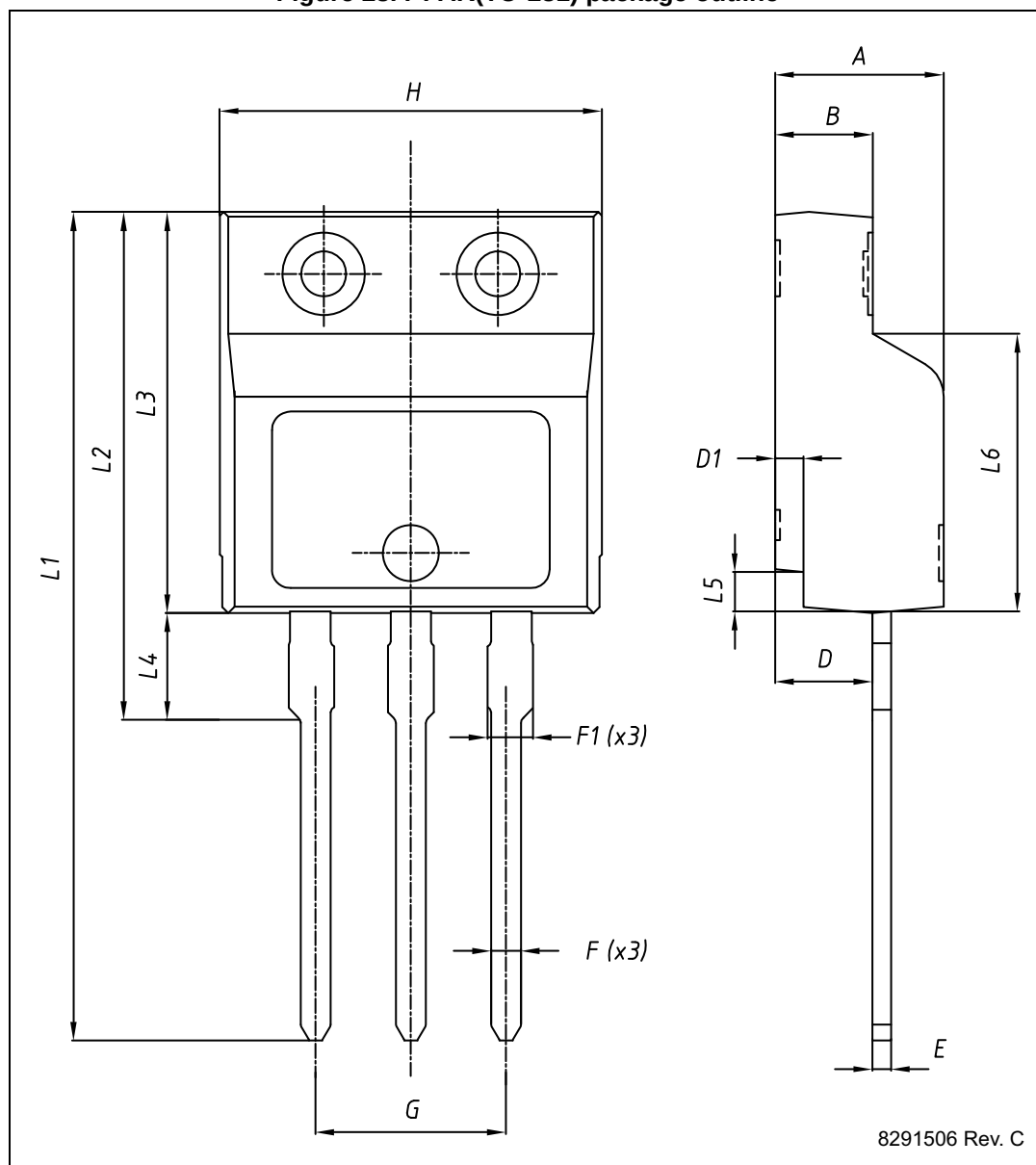


Table 10. I²PAKFP (TO-281) package mechanical data

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

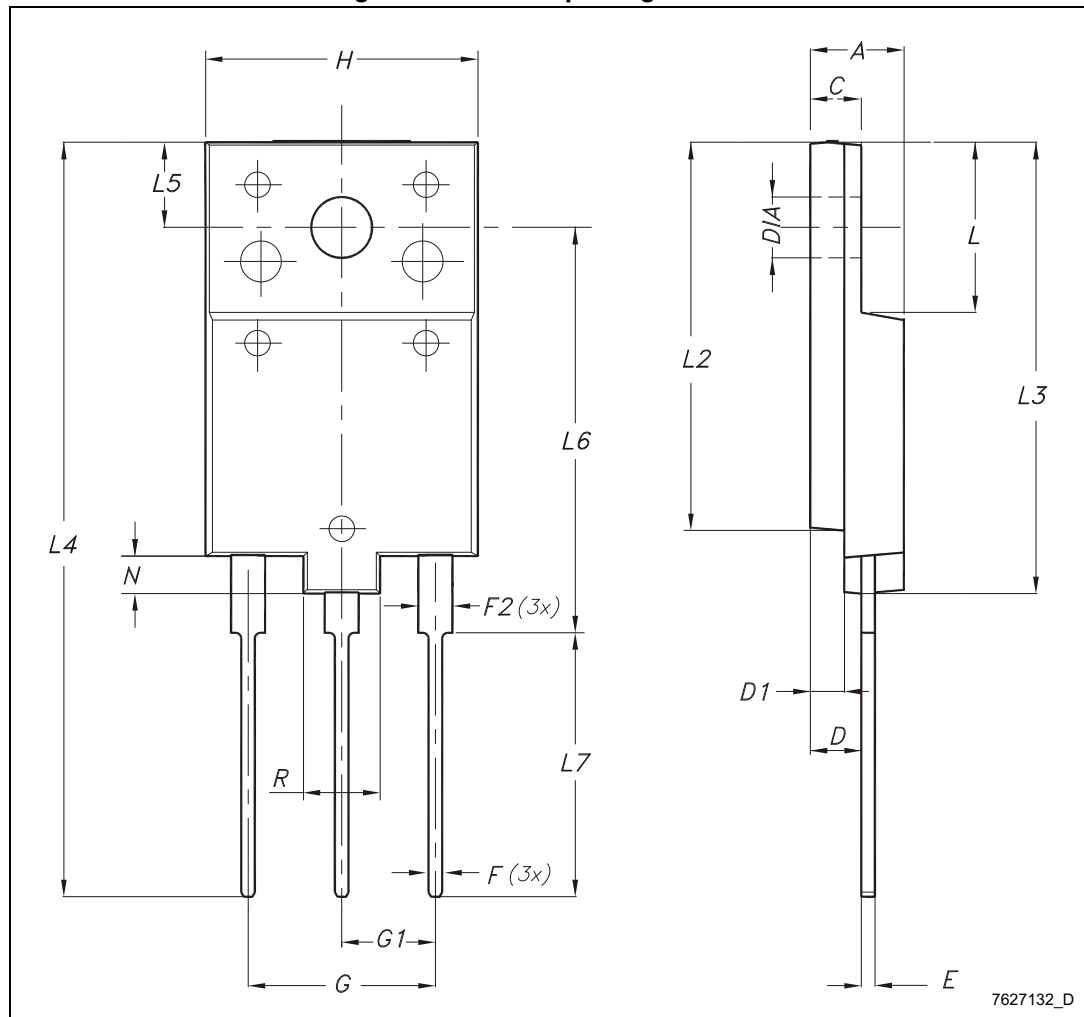


Table 11. TO-3PF package mechanical data

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 Table 2: Absolute maximum ratings , Table 5: On /off states , Table 6: Dynamic and Table 8: Source drain diode . Minor text changes.

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