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STF20N65M5, STFI20N65M5, STFW20N65M5

N-channel 650 V, 0.160 Ω typ., 18 A MDmesh M5 Power MOSFETs in TO-220FP, I²PAKFP and TO-3PF packages

Datasheet - production data

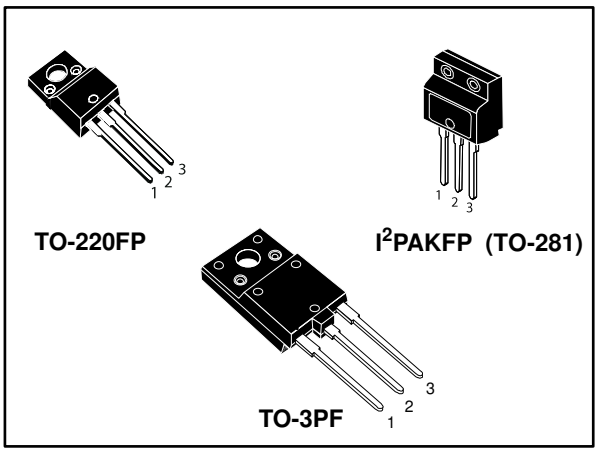
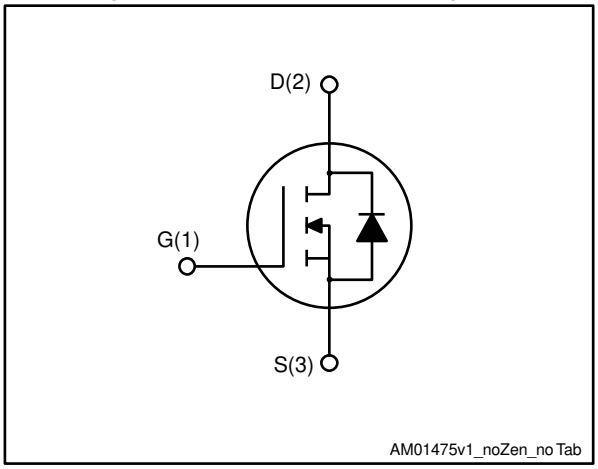


Figure 1: Internal schematic diagram



Features

Order code	V_{DS} @ T_{Jmax}	$R_{DS(on)}$ max	I_D
STF20N65M5	710 V	0.190 Ω	18 A
STFI20N65M5			
STFW20N65M5			

- Extremely low $R_{DS(on)}$
- Low gate charge and input capacitance
- Excellent switching performance
- 100% avalanche tested

Applications

- Switching applications

Description

These devices are N-channel Power MOSFET based on the MDmesh™ M5 innovative vertical process technology combined with the well-known PowerMESH™ horizontal layout. The resulting products offer extremely low on-resistance, making them particularly suitable for applications requiring high power and superior efficiency.

Table 1: Device summary

Order code	Marking	Package	Packaging
STF20N65M5	20N65M5	TO-220FP	Tube
STFI20N65M5		I²PAKFP (TO-281)	
STFW20N65M5		TO-3FP	

Contents

1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220FP, I²PAKFP	TO-3PF	
V_{GS}	Gate- source voltage	±25		V
I_D	Drain current (continuous) at T_C = 25 °C	18 (1)		A
I_D	Drain current (continuous) at T_C = 100 °C	11.3 (1)		A
I_{DM} (2)	Drain current (pulsed)	36 (1)		A
P_{TOT}	Total dissipation at T_C = 25 °C	30	48	W
dv/dt (3)	Peak diode recovery voltage slope	15		V/ns
V_{ISO} (4)	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			

Notes:

(1)Limited by maximum junction temperature.

(2)Pulse width limited by safe operating area

(3)$I_{SD} \leq 18$ A, di/dt = 400 A/µs, $V_{DS(peak)} < V_{(BR)DSS}$, V_{DD} = 400 V

(4)$V_{DS} \leq 520$ V

Table 3: Thermal data

Symbol	Parameter	Value		Unit
		TO-220FP, I²PAKFP	TO-3PF	
$R_{thj\text{-}case}$	Thermal resistance junction-case	4.17	2.6	°C/W
$R_{thj\text{-}amb}$	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})	4	°C/W
E_{AS}	Single pulse avalanche energy (starting T_J = 25 °C, $I_D = I_{AR}$, V_{DD} = 50 V)	270	mJ

2 Electrical characteristics

(T_C = 25 °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 mA	650			V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0, V_{DS} = 650 V			1	µA
		V_{GS} = 0, V_{DS} = 650 V, T_C=125 °C (1)			100	µA
I_{GSS}	Gate-body leakage current	V_{DS} = 0, V_{GS} = ± 25 V			±100	nA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 9 A		0.160	0.190	Ω

Notes:

(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 V, f = 1 MHz	-	1434	-	pF
C_{oss}	Output capacitance		-	38	-	pF
C_{rss}	Reverse transfer capacitance		-	3.7	-	pF
$C_{o(tr)}$(1)	Equivalent capacitance time related	V_{GS} = 0, V_{DS} = 0 to 520 V	-	118	-	pF
$C_{o(er)}$(2)	Equivalent capacitance energy related		-	35	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz, I_D=0 A	-	3.5	-	Ω
Q_g	Total gate charge	V_{DD} = 520 V, I_D = 9 A, V_{GS} = 0 to 10 V (see *Figure 18: "Test circuit for gate charge behavior"*)	-	36	-	nC
Q_{gs}	Gate-source charge		-	7.5	-	nC
Q_{gd}	Gate-drain charge		-	18	-	nC

Notes:

(1)$C_{o(tr)}$ is a constant capacitance value that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.

(2)$C_{o(er)}$ is a constant capacitance value that gives the same stored energy as Coss while V_{DS} is rising from 0 to 80% V_{DSS}.

Table 7: Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(V)}$	Voltage delay time	V_{DD} = 400 V, I_D = 12 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 19: "Test circuit for inductive load switching and diode recovery times"* and *Figure 22: "Switching time waveform"*)	-	43	-	ns
$t_{r(V)}$	Voltage rise time		-	7.5	-	ns
$t_{f(i)}$	Current fall time		-	7.5	-	ns
$t_{c(off)}$	Crossing time		-	11.5	-	ns

Table 8: Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		18	A
I_{SDM}(1)	Source-drain current (pulsed)		-		36	A
V_{SD}(2)	Forward on voltage	I_{SD} = 18 A, V_{GS} = 0	-		1.5	V
t_{rr}	Reverse recovery time	I_{SD} = 18 A, di/dt = 100 A/µs V_{DD} = 100 V (see *Figure 19: "Test circuit for inductive load switching and diode recovery times"*)	-	288		ns
Q_{rr}	Reverse recovery charge		-	4		µC
I_{RRM}	Reverse recovery current		-	27		A
t_{rr}	Reverse recovery time	I_{SD} = 18 A, di/dt = 100 A/µs V_{DD} = 100 V, T_j = 150 °C (see *Figure 19: "Test circuit for inductive load switching and diode recovery times"*)	-	342		ns
Q_{rr}	Reverse recovery charge		-	4.7		µC
I_{RRM}	Reverse recovery current		-	28		A

Notes:

(1)Pulse width limited by safe operating area

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

2.1 Electrical characteristics (curve)

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

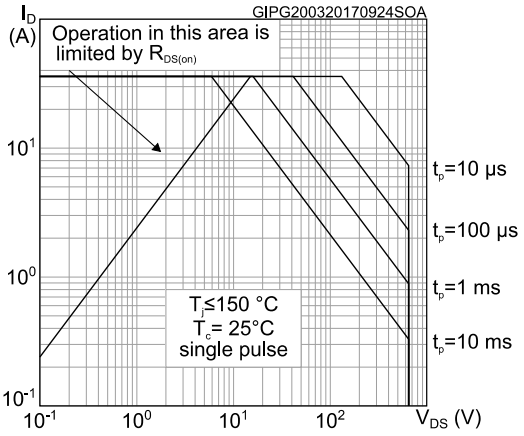


Figure 3: Thermal impedance for for TO-220FP and I²PAKFP

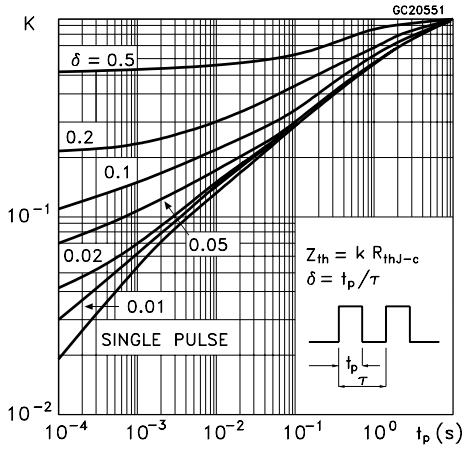


Figure 4: Safe operating area for TO-3PF

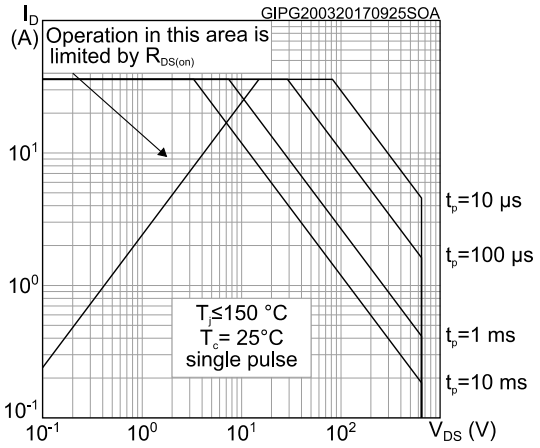


Figure 5: Thermal impedance for TO-3PF

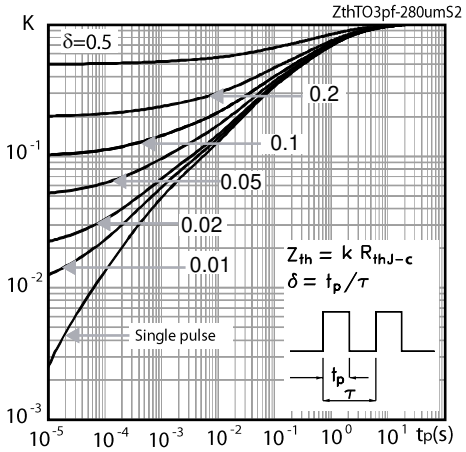


Figure 6: Output characteristics

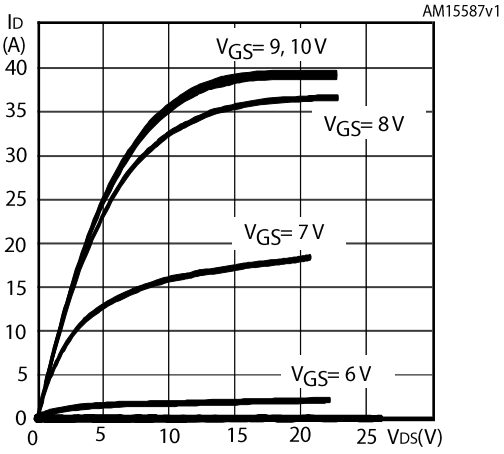


Figure 7: Tranfer characteristics

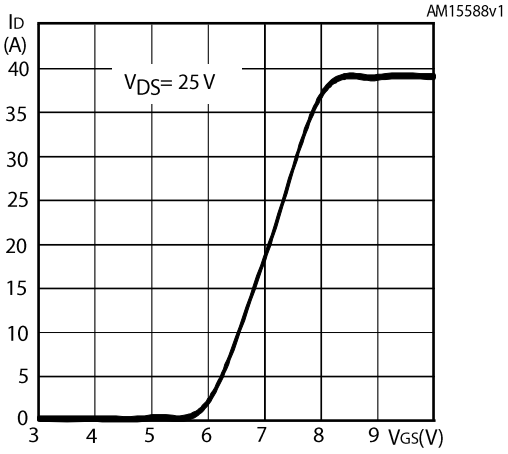


Figure 8: Gate charge vs gate-source voltage

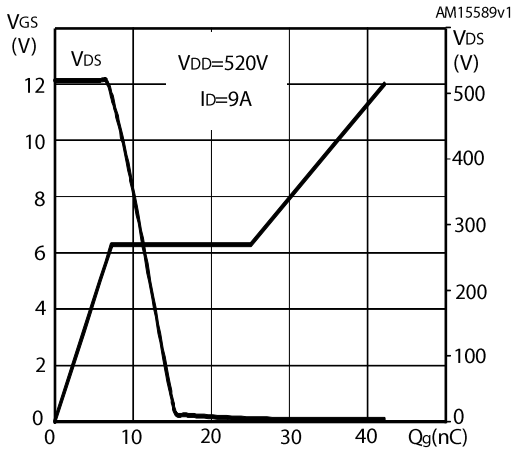


Figure 9: Static drain-source on-resistance

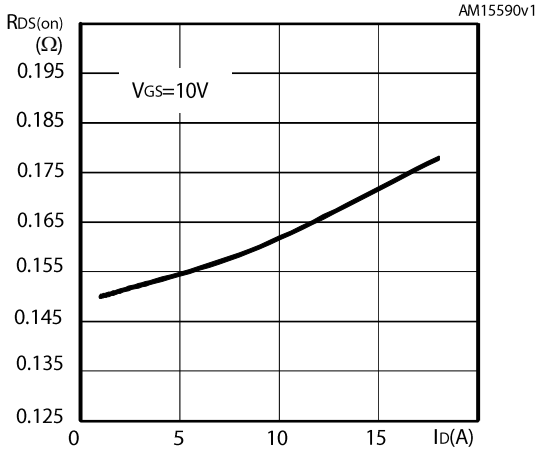


Figure 10: Capacitance variations

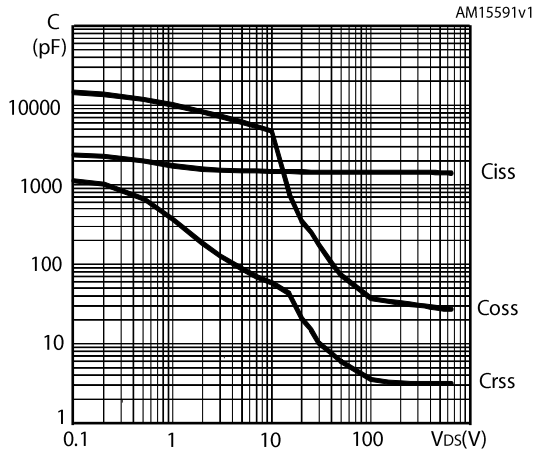


Figure 11: Output capacitance stored energy

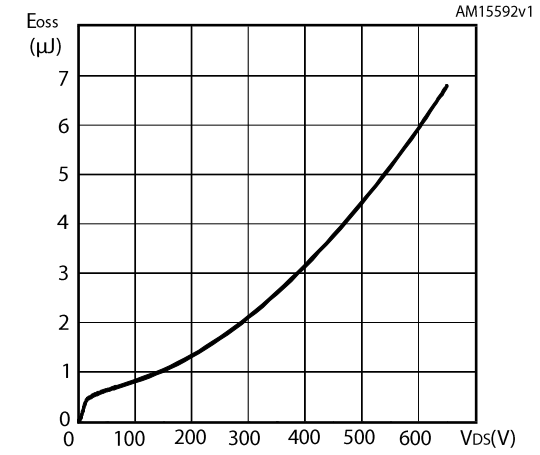


Figure 12: Normalized gate threshold voltage vs temperature

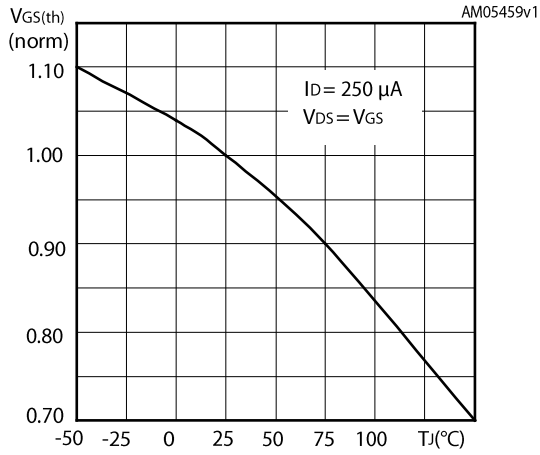


Figure 13: Normalized on-resistance vs temperature

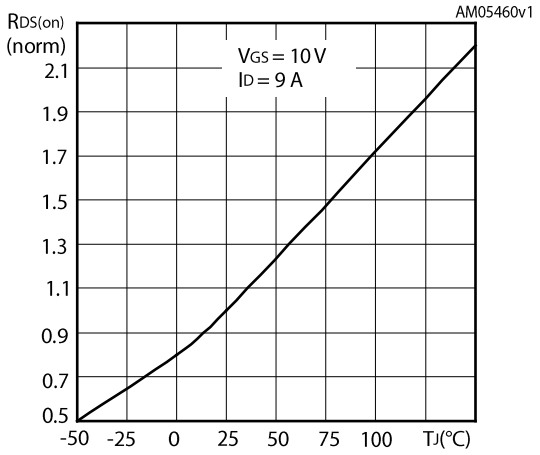


Figure 14: Source-drain diode forward characteristics

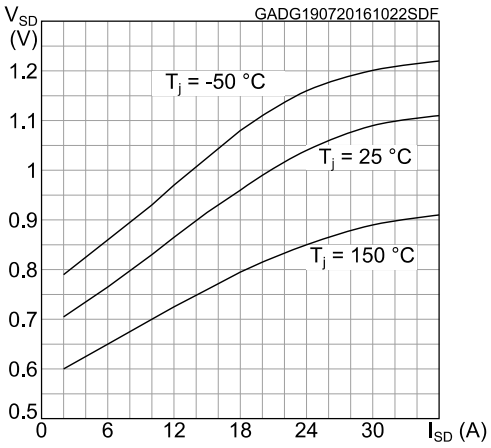


Figure 15: Normalized $V_{(BR)DSS}$ vs temperature

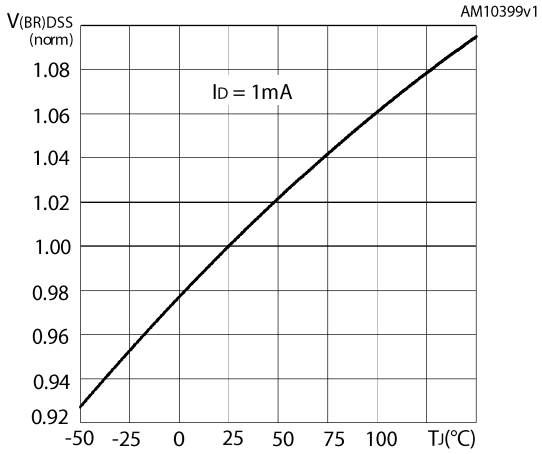
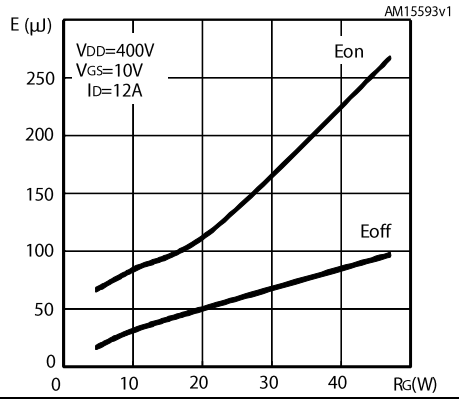


Figure 16: Switching energy vs gate resistance



E_{on} including reverse recovery of a SiC diode.

3 Test circuits

Figure 17: Test circuit for resistive load switching times

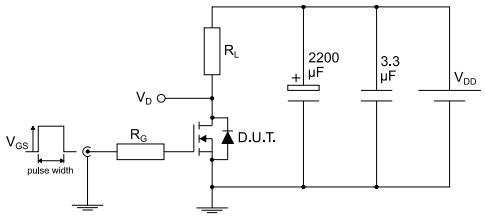


Figure 18: Test circuit for gate charge behavior

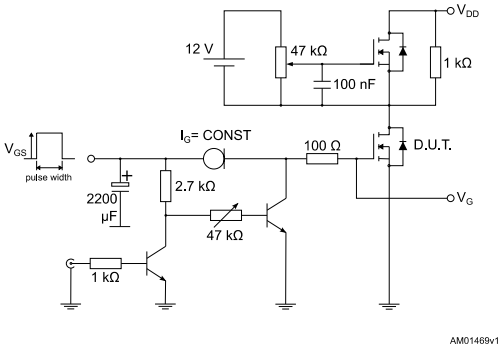


Figure 19: Test circuit for inductive load switching and diode recovery times

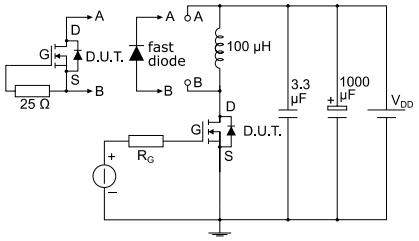


Figure 20: Unclamped inductive load test circuit

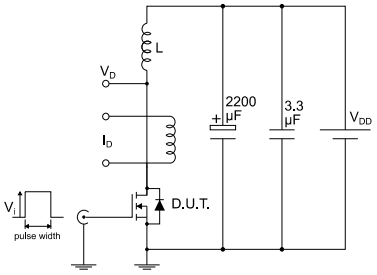


Figure 21: Unclamped inductive waveform

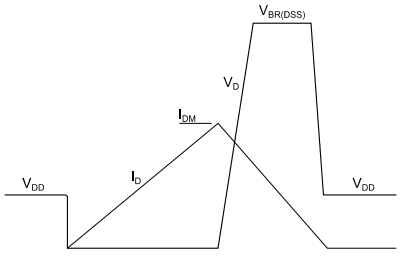
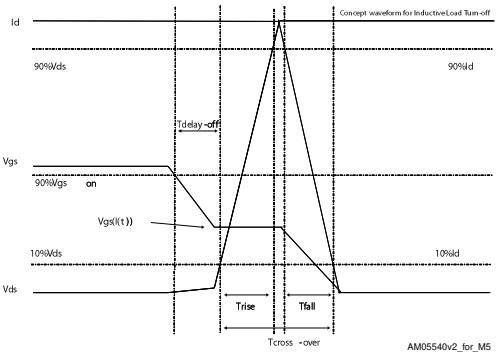


Figure 22: Switching time waveform



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 information

Figure 23: TO-220FP package outline

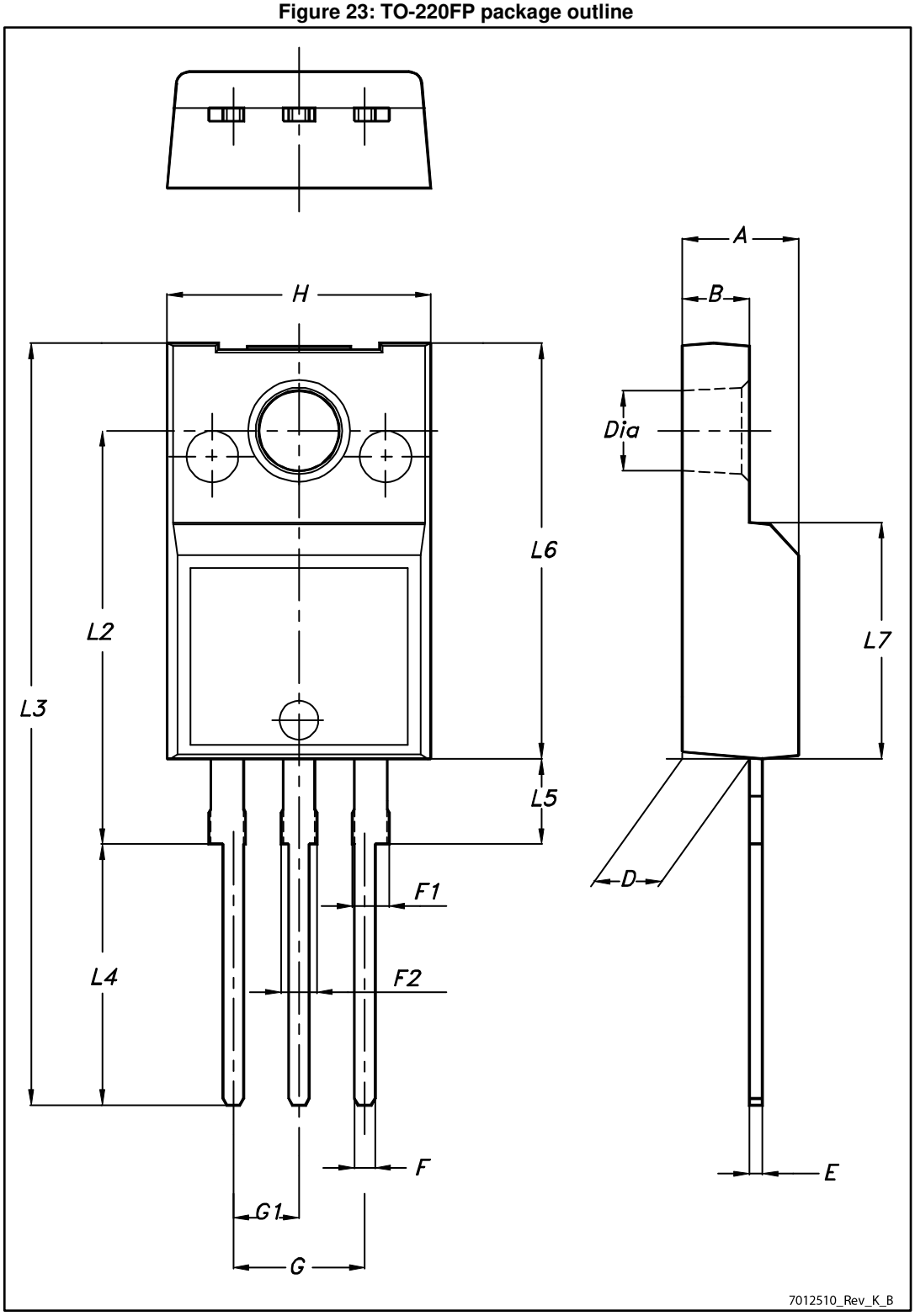


Table 9: TO-220FP package mechanical data

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

4.2 I²PAKFP (TO-281) package information

Figure 24: I²PAKFP (TO-281) package outline

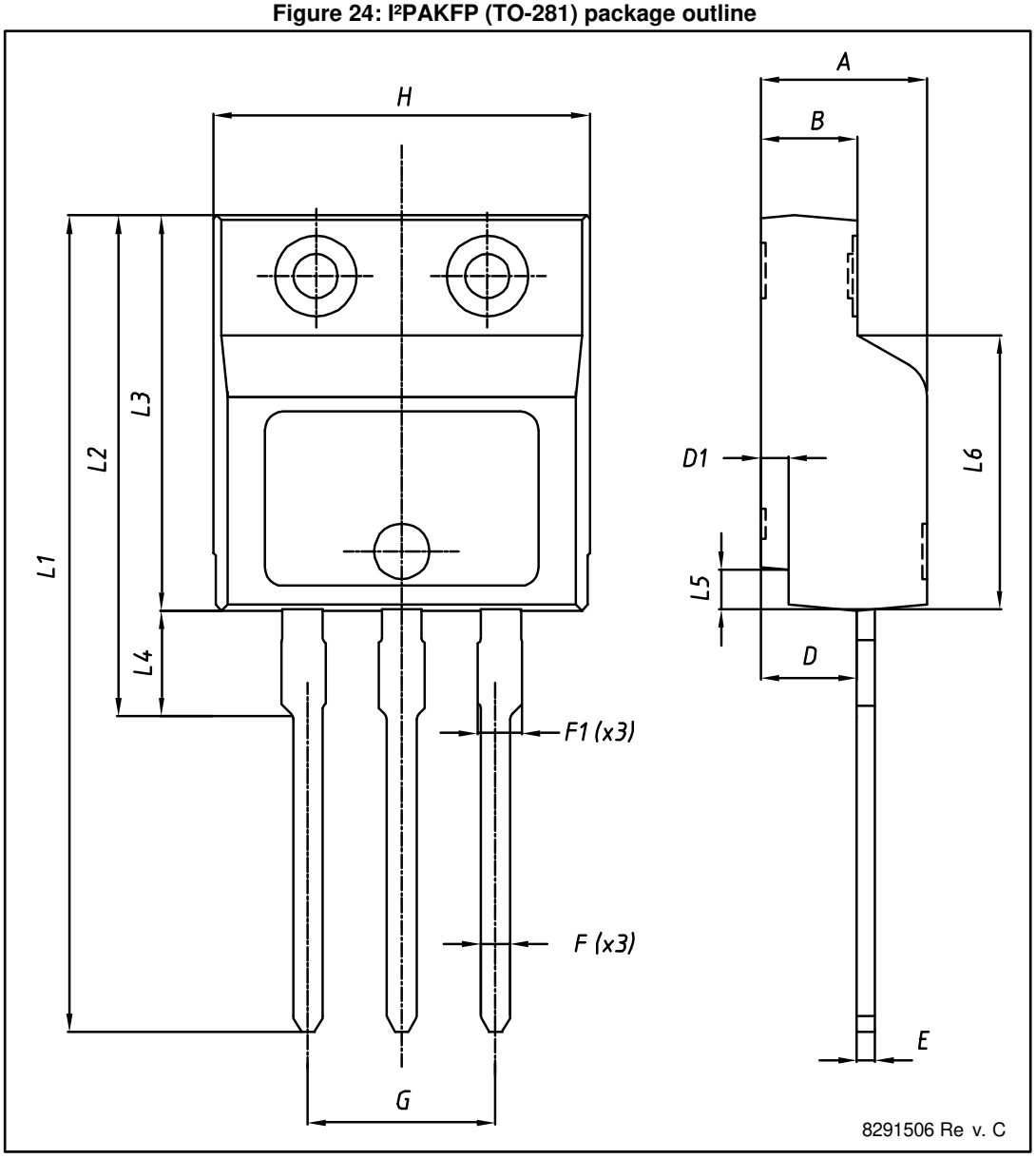


Table 10: I²PAKFP (TO-281) mechanical data

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 25: TO-3PF package outline

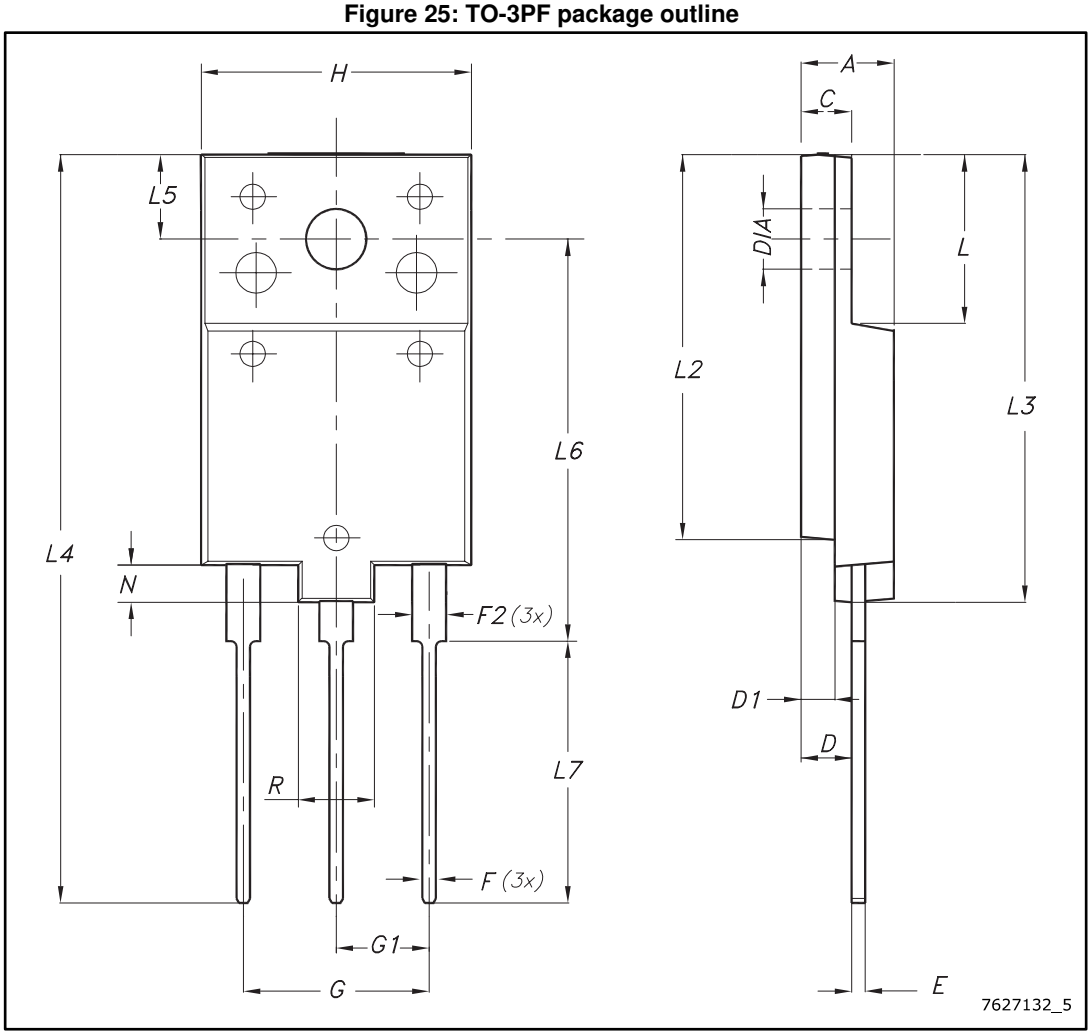


Table 11: TO-3PF mechanical data

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
01-Feb-2013	1	First release. Part numbers previously included in datasheet DM00049308
21-Jul-2016	2	Added device in TO-3PF. Modified: *Table 2: "Absolute maximum ratings", Table 5: "On /off states".* Modified: *Figure 2: "Safe operating area for TO-220FP* and *I²PAKFP", Figure 4: "Safe operating area for TO-3PF", Figure 5: "Thermal impedance for TO-3PF".* Minor text changes
22-Mar-2017	3	Modified *Table 2: "Absolute maximum ratings"*, *Table 8: "Source drain diode"*. Modified *Figure 2: "Safe operating area for TO-220FP and I²PAKFP"*, *Figure 4: "Safe operating area for TO-3PF"*, *Figure 12: "Normalized gate threshold voltage vs temperature "*, *Figure 13: "Normalized on-resistance vs temperature"* and *Figure 14: "Source-drain diode forward characteristics "*. Minor text changes.

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