

## N-channel 650 V, 0.073 $\Omega$ typ., 30 A MDmesh™ V Power MOSFETs in TO-220FP and TO-3PF packages

Datasheet - production data

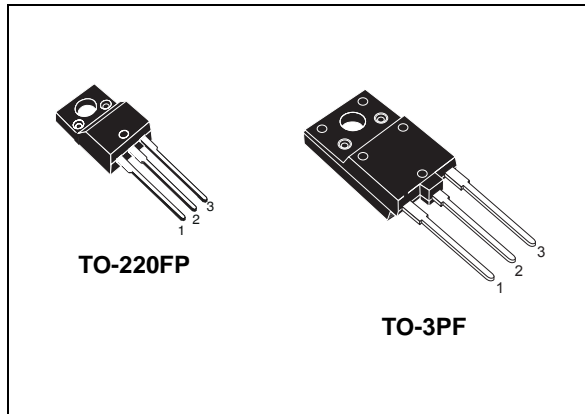
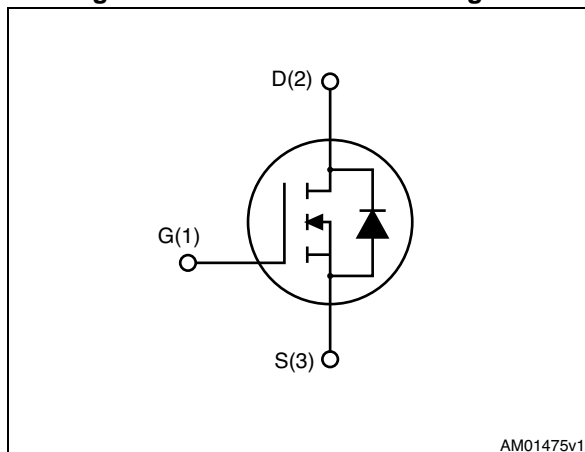


Figure 1. Internal schematic diagram



### Features

Order codes	$V_{DS}@T_{Jmax}$	$R_{DS(on)} \max$	$I_D$
STF38N65M5	710 V	0.095 $\Omega$	30 A
STFW38N65M5			

- Higher  $V_{DSS}$  rating and high dv/dt capability
- Excellent switching performance
- 100% avalanche tested

### Applications

- Switching applications

### Description

These devices are N-channel MDmesh™ V Power MOSFETs based on an innovative proprietary vertical process technology, which is combined with STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product has extremely low on-resistance, which is unmatched among silicon-based Power MOSFETs, making it especially suitable for applications which require superior power density and outstanding efficiency.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STF38N65M5	38N65M5	TO-220FP	Tube
STFW38N65M5		TO-3PF	

# Contents

- 1      Electrical ratings ..... 3**
- 2      Electrical characteristics ..... 4**
  - 2.1    Electrical characteristics (curves) ..... 6
- 3      Test circuits ..... 9**
- 4      Package mechanical data ..... 10**
  - 4.1    TO-220FP, STF38N65M5 .....11
  - 4.2    TO-3PF, STFW38N65M5 ..... 13
- 5      Revision history ..... 15**

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220FP	TO-3PF	
$V_{GS}$	Gate-source voltage	± 25		V
$I_D^{(1)}$	Drain current (continuous) at $T_C = 25\text{ °C}$	30		A
$I_D^{(1)}$	Drain current (continuous) at $T_C = 100\text{ °C}$	19		A
$I_{DM}^{(1), (2)}$	Drain current (pulsed)	120		A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	35	57	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 ( $t = 1\text{ s}$ ; $T_C = 25\text{ °C}$ )	2500	3500	V
$T_{stg}$	Storage temperature	-55 to 150		°C
$T_j$	Max. operating junction temperature	150		°C

1. Limited by maximum junction temperature
2. Pulse width limited by safe operating area.
3.  $I_{SD} \leq 30\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{Peak} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$
4.  $V_{DS} \leq 520\text{ V}$

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		TO-220FP	TO-3PF	
$R_{thj-case}$	Thermal resistance junction-case max	3.6	2.2	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient max	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 $T_{jmax}$ )	8	A
$E_{AS}$	Single pulse avalanche energy (starting $t_j = 25\text{ °C}$ , $I_d = I_{AR}$ ; $V_{dd} = 50\text{ V}$ )	660	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	$I_D = 1\text{ mA}$ , $V_{GS} = 0$	650			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 650\text{ V}$			1	$\mu\text{A}$
		$V_{DS} = 650\text{ V}$ , $T_C = 125\text{ °C}$			100	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 25\text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$ , $I_D = 15\text{ A}$		0.073	0.095	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	3000	-	pF
$C_{oss}$	Output capacitance		-	74	-	pF
$C_{riss}$	Reverse transfer capacitance		-	5.8	-	pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{DS} = 0\text{ to }520\text{ V}$ , $V_{GS} = 0$	-	244	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related		-	70	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	2.4	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 520\text{ V}$ , $I_D = 15\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 18</a> )	-	71	-	nC
$Q_{gs}$	Gate-source charge		-	18	-	nC
$Q_{gd}$	Gate-drain charge		-	30	-	nC

1. Time related is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$
2. Energy related is defined as a constant equivalent capacitance giving the same stored energy 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
$t_{d(v)}$	Voltage delay time	$V_{DD} = 400\text{ V}$ , $I_D = 20\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 19</a> and <a href="#">Figure 22</a> )	-	66	-	ns
$t_{r(v)}$	Voltage rise time		-	9	-	ns
$t_{f(i)}$	Current fall time		-	9	-	ns
$t_{c(off)}$	Crossing time		-	13	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		30	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		120	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 30\text{ A}$ , $V_{GS} = 0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 30\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$ (see <a href="#">Figure 22</a> )	-	382		ns
$Q_{rr}$	Reverse recovery charge		-	6.6		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	35		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 30\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 100\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 22</a> )	-	522		ns
$Q_{rr}$	Reverse recovery charge		-	10.3		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	40		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

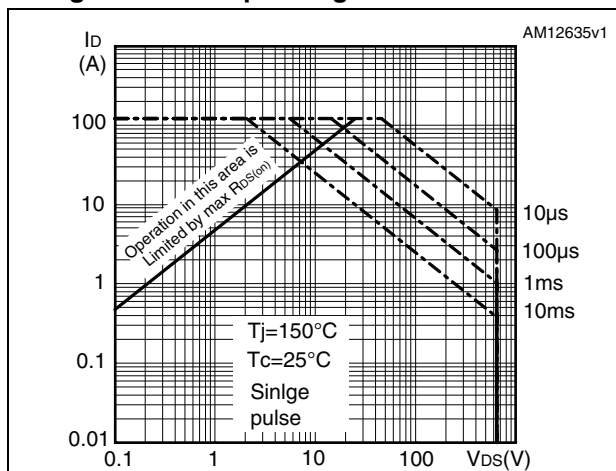


Figure 3. Thermal impedance for TO-220FP

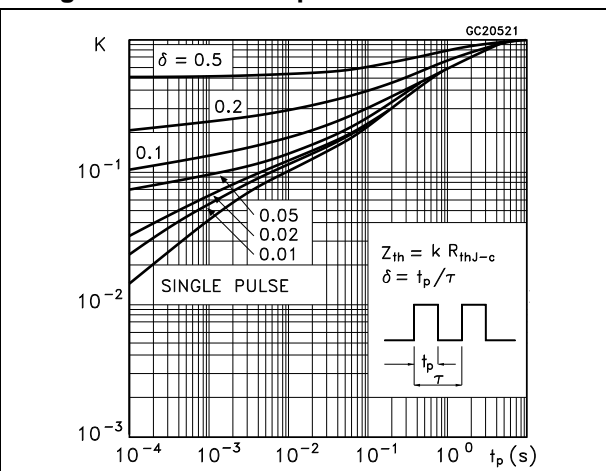


Figure 4. Safe operating area for TO-3PF

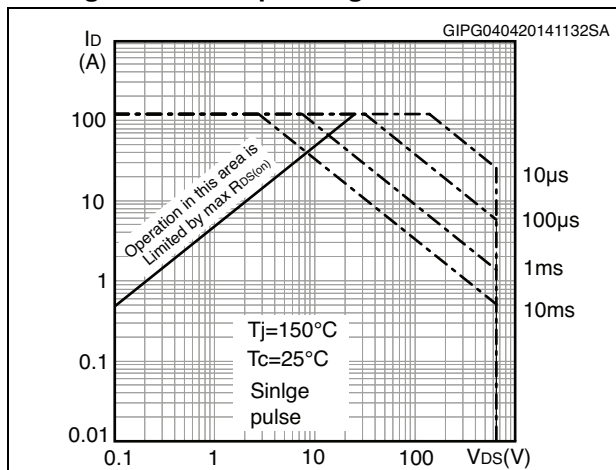


Figure 5. Thermal impedance for TO-3PF

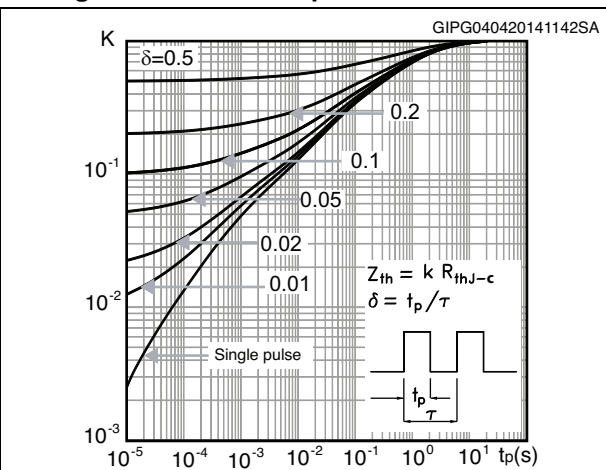


Figure 6. Output characteristics

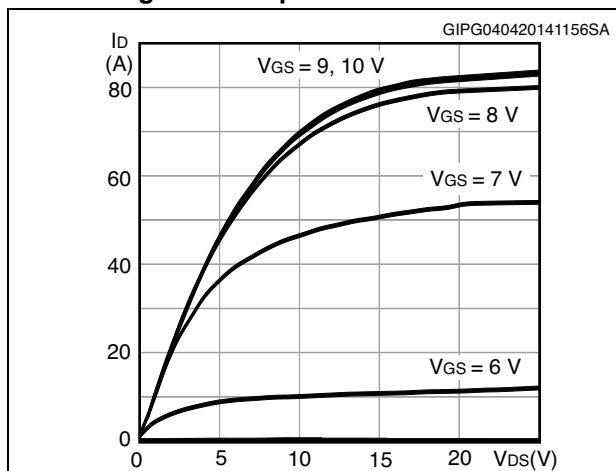


Figure 7. Transfer characteristics

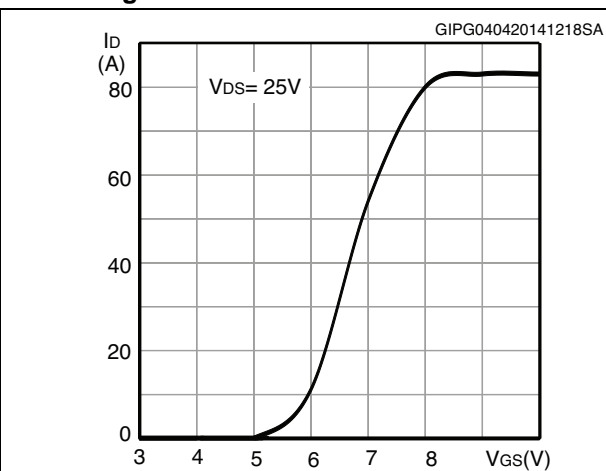


Figure 8. Gate charge vs gate-source voltage

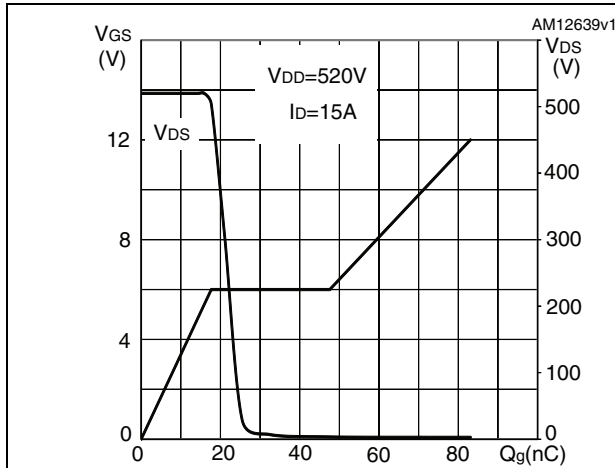


Figure 9. Static drain-source on-resistance

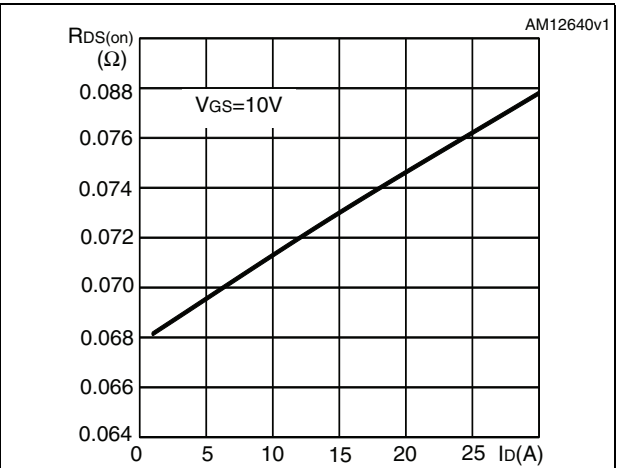


Figure 10. Capacitance variations

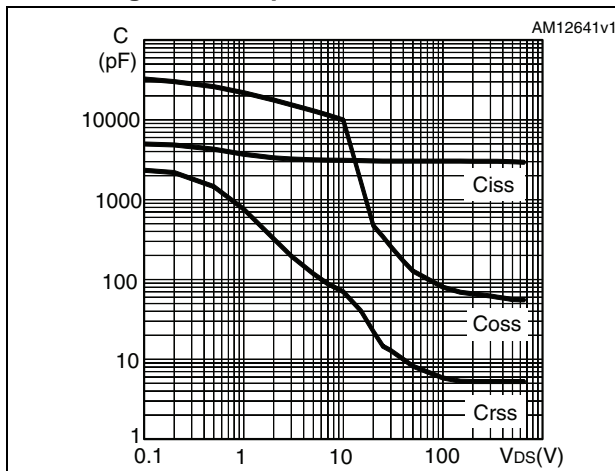


Figure 11. Output capacitance stored energy

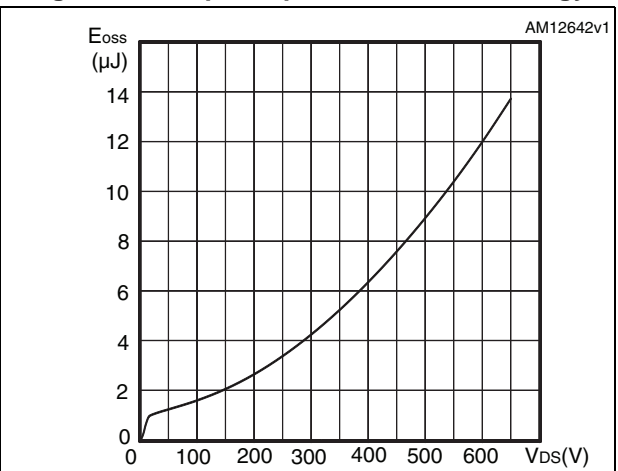


Figure 12. Normalized gate threshold voltage vs temperature

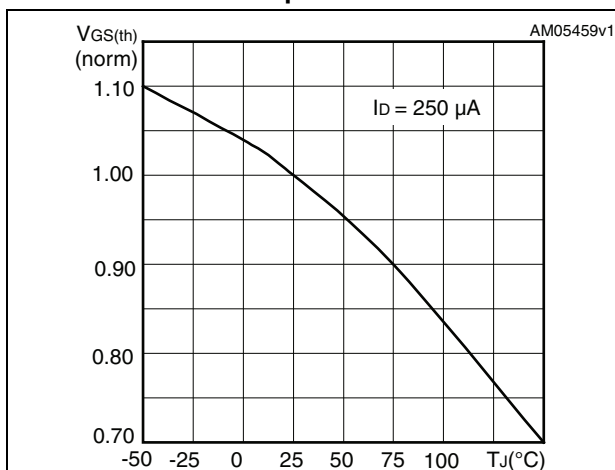


Figure 13. Normalized on-resistance vs temperature

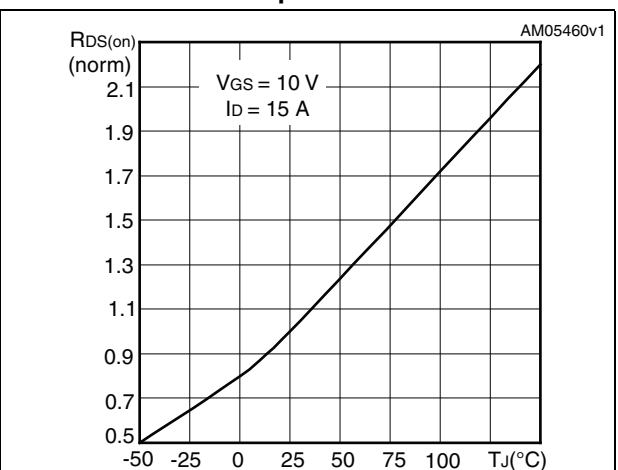


Figure 14. Source-drain diode forward characteristics

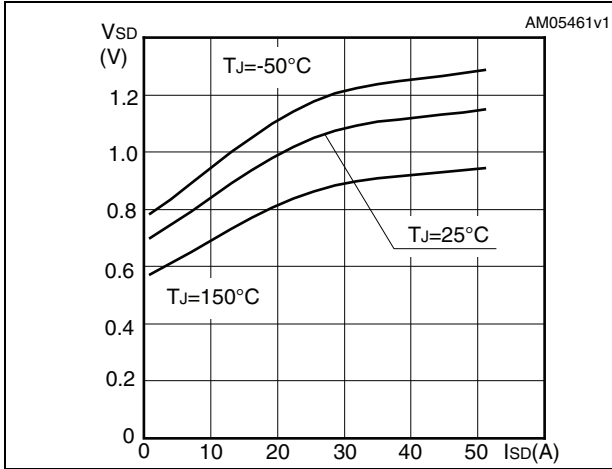


Figure 15. Normalized  $V_{(BR)DSS}$  vs temperature

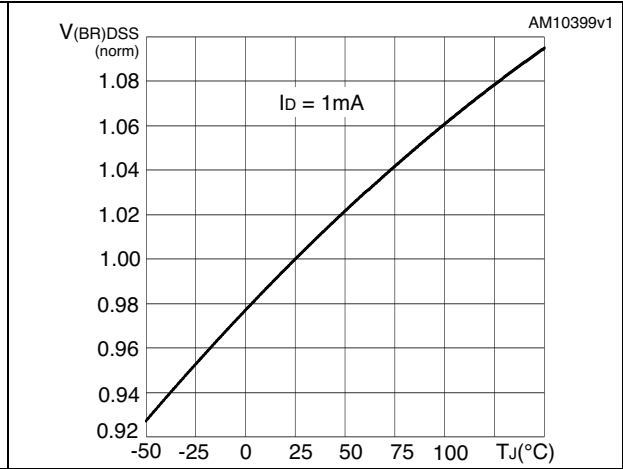
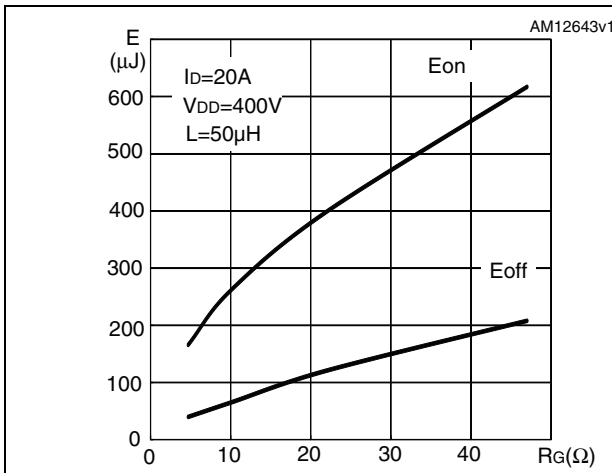


Figure 16. Switching losses vs gate resistance (1)

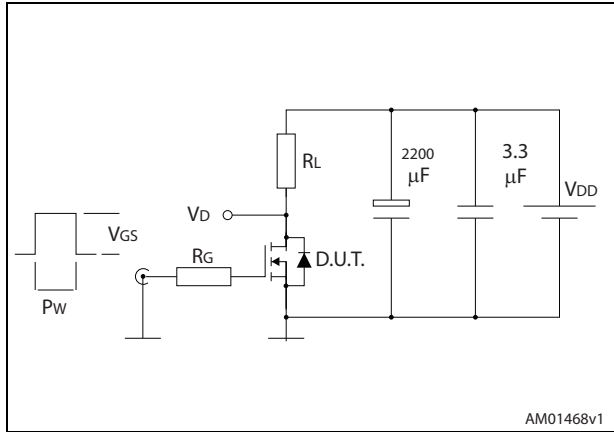


1. Eon including reverse recovery of a SiC diode.



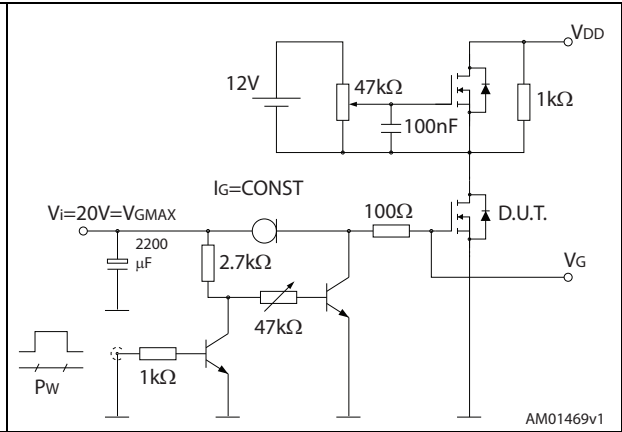
### 3 Test circuits

Figure 17. Switching times test circuit for resistive load



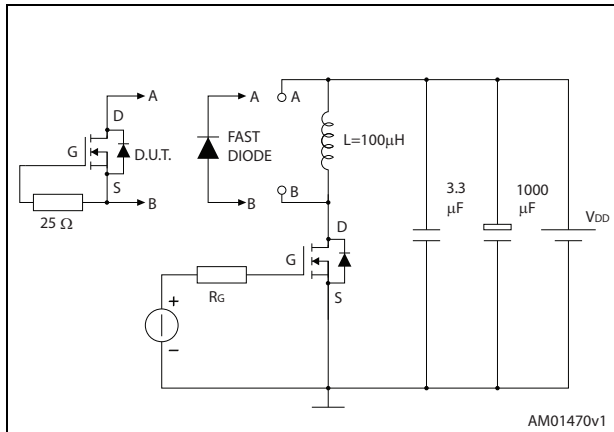
AM01468v1

Figure 18. Gate charge test circuit



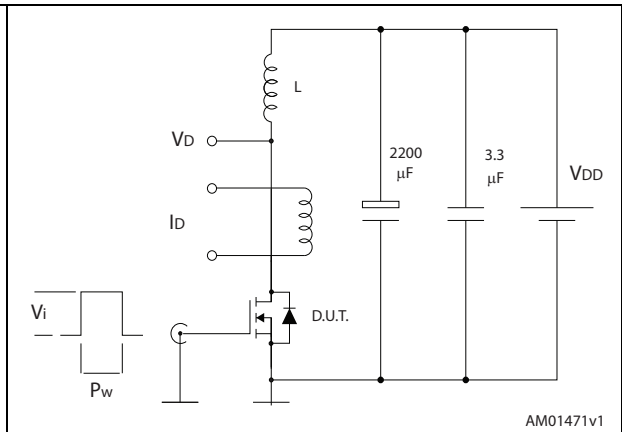
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Figure 19. Test circuit for inductive load switching and diode recovery times



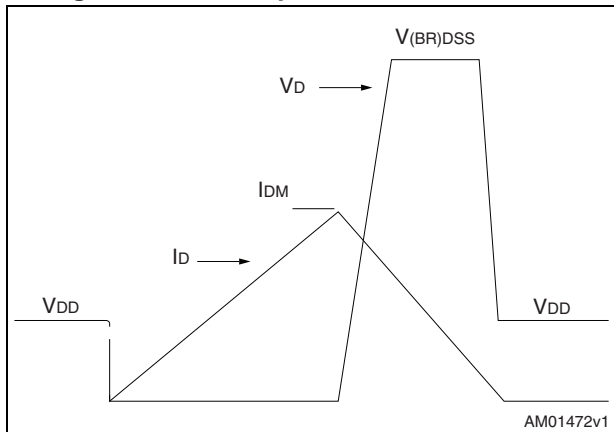
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Figure 20. Unclamped inductive load test circuit



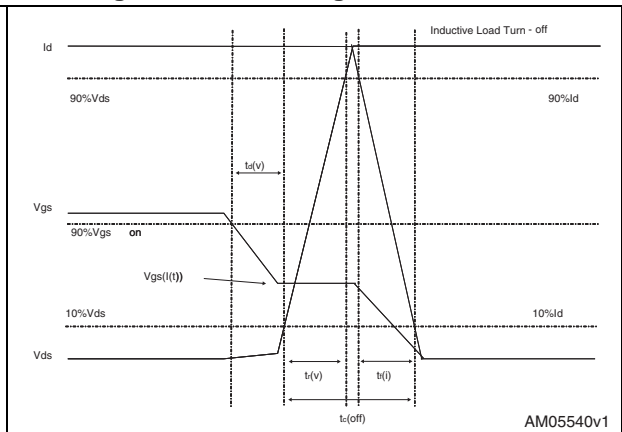
AM01471v1

Figure 21. Unclamped inductive waveform



AM01472v1

Figure 22. Switching time waveform



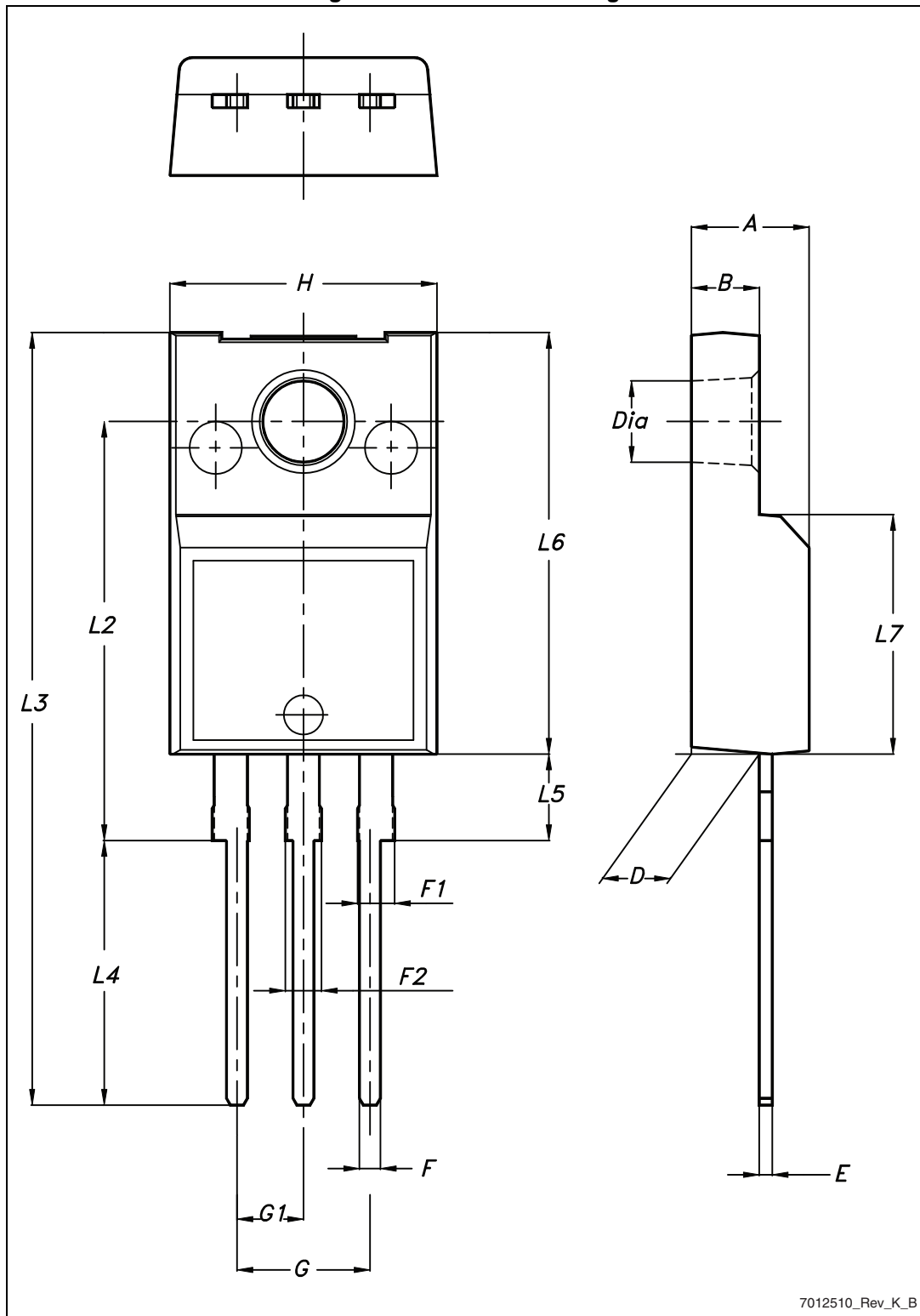
AM05540v1

## 4 Package mechanical data

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, STF38N65M5

Figure 23. TO-220FP drawing



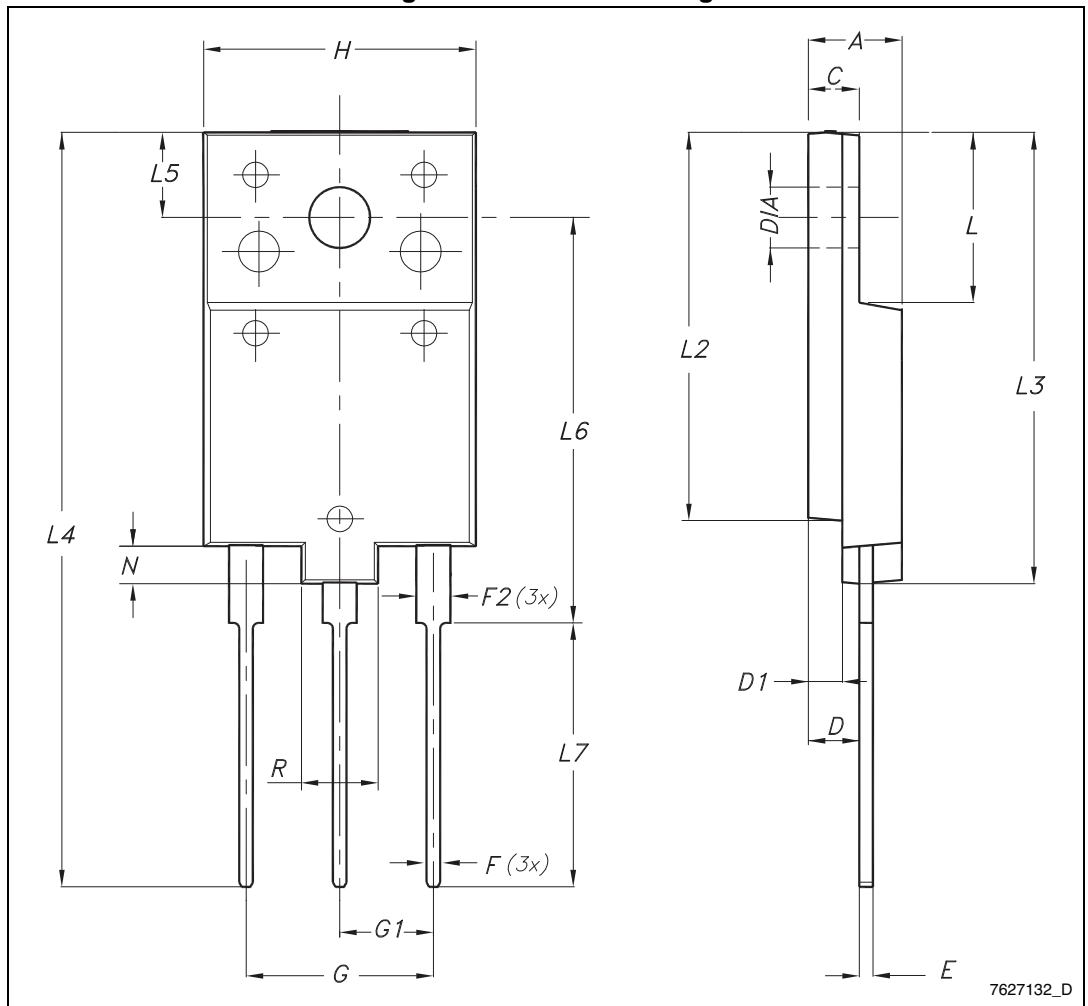
7012510\_Rev\_K\_B

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 TO-3PF, STFW38N65M5

Figure 24. TO-3PF drawing



7627132\_D

Table 10. 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 11. Document revision history**

Date	Revision	Changes
14-Apr-2014	1	First release. Part numbers previously included in datasheet DocID022851

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