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N-channel 650 V, 0.09  $\Omega$  typ., 28 A MDmesh™ V Power MOSFETs  
in TO-220FP, I<sup>2</sup>PAKFP, I<sup>2</sup>PAK packages

Datasheet - production data

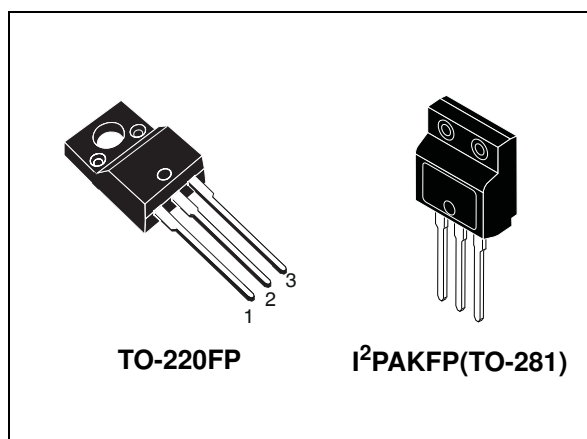
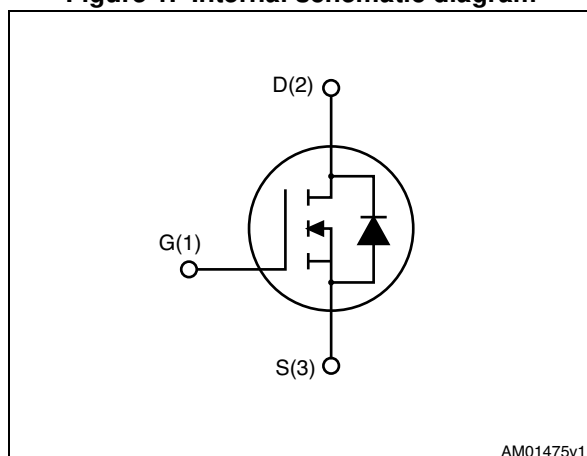


Figure 1. Internal schematic diagram



## Features

Order codes	V <sub>DS</sub> @ T <sub>Jmax</sub>	R <sub>DS(on)</sub> max	I <sub>D</sub>
STF34N65M5	710 V	0.11 $\Omega$	28 A
STFI34N65M5			

- Worldwide best R<sub>DS(on)</sub> \* area
- Higher V<sub>DSS</sub> 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	Packages	Packaging
STF34N65M5	34N65M5	TO-220FP	Tube
STFI34N65M5		I <sup>2</sup> PAKFP (TO-281)	

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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 $T_C = 25\text{ }^{\circ}\text{C}$	28 <sup>(1)</sup>	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$	17.7 <sup>(1)</sup>	A
$I_{DM}$ <sup>(1)</sup>	Drain current (pulsed)	112 <sup>(1)</sup>	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	35	W
$dv/dt$ <sup>(2)</sup>	Peak diode recovery voltage slope	15	V/ns
$dv/dt$ <sup>(3)</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	- 55 to 150	$^{\circ}\text{C}$
$T_j$	Max. operating junction temperature	150	$^{\circ}\text{C}$

1. Limited by maximum junction temperature.

2.  $I_{SD} \leq 28\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD}=400\text{ V}$ .

3.  $V_{DS} \leq 480\text{ V}$

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max	3.57	$^{\circ}\text{C}/\text{W}$
$R_{thj-amb}$	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 $T_{jmax}$ )	7	A
$E_{AS}$	Single pulse avalanche energy (starting $t_j=25^{\circ}\text{C}$ , $I_d = I_{AR}$ ; $V_{dd}=50$ )	510	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 ( $V_{GS} = 0$ )	$V_{DS} = 650\text{ V}$ $V_{DS} = 650\text{ V}$ , $T_C = 125\text{ °C}$			1 100	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	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	$V_{GS} = 10\text{ V}$ , $I_D = 14\text{ A}$		0.09	0.11	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	2700	-	pF
$C_{oss}$	Output capacitance		-	75	-	pF
$C_{rss}$	Reverse transfer capacitance		-	6.3	-	pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{DS} = 0\text{ to }520\text{ V}$ , $V_{GS} = 0$	-	220	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related		-	63	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	1.95	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 520\text{ V}$ , $I_D = 14\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 16</a> )	-	62.5	-	nC
$Q_{gs}$	Gate-source charge		-	17	-	nC
$Q_{gd}$	Gate-drain charge		-	28	-	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	$V_{DD} = 400$ V, $I_D = 18$ A, $R_G = 4.7$ $\Omega$ , $V_{GS} = 10$ V (see <a href="#">Figure 17</a> and <a href="#">Figure 20</a> )	-	59	-	ns
$t_r$ (v)	Voltage rise time		-	8.7	-	ns
$t_f$ (i)	Current fall time		-	7.5	-	ns
$t_c$ (off)	Crossing time		-	12	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		28	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		112	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 28$ A, $V_{GS} = 0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 28$ A, $di/dt = 100$ A/ $\mu$ s $V_{DD} = 100$ V (see <a href="#">Figure 20</a> )	-	350		ns
$Q_{rr}$	Reverse recovery charge		-	5.6		$\mu$ C
$I_{RRM}$	Reverse recovery current		-	32		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 28$ A, $di/dt = 100$ A/ $\mu$ s $V_{DD} = 100$ V, $T_j = 150$ °C (see <a href="#">Figure 20</a> )	-	422		ns
$Q_{rr}$	Reverse recovery charge		-	7.4		$\mu$ C
$I_{RRM}$	Reverse recovery current		-	35		A

1. Pulse width limited by safe operating area.

2. Pulsed: pulse duration = 300  $\mu$ s, duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

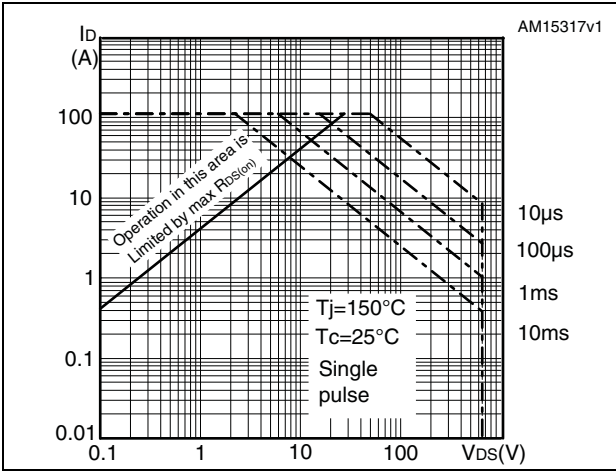


Figure 3. Thermal impedance

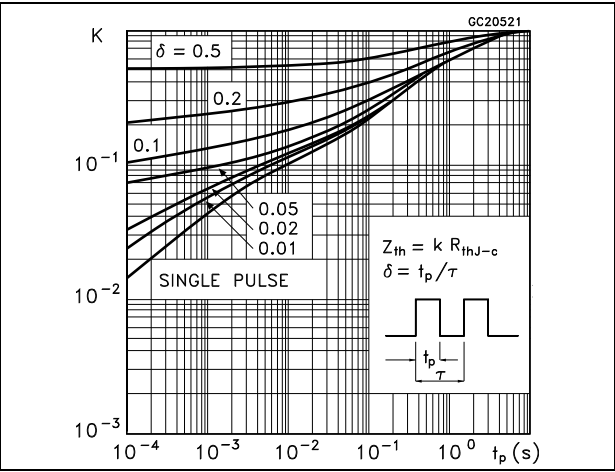


Figure 4. Output characteristics

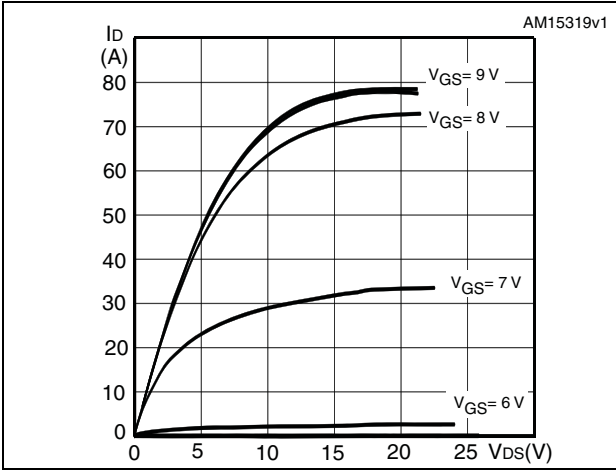


Figure 5. Transfer characteristics

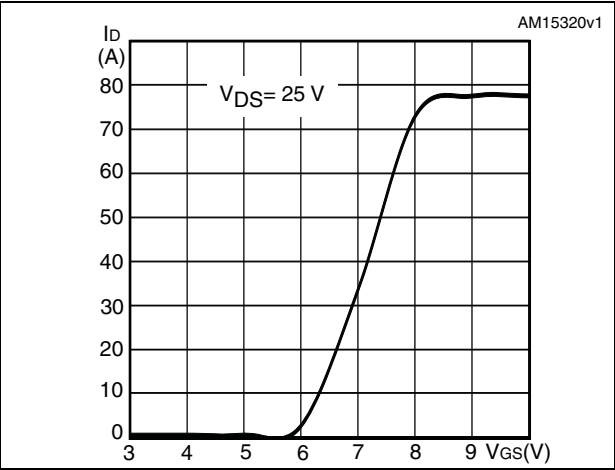


Figure 6. Gate charge vs gate-source voltage

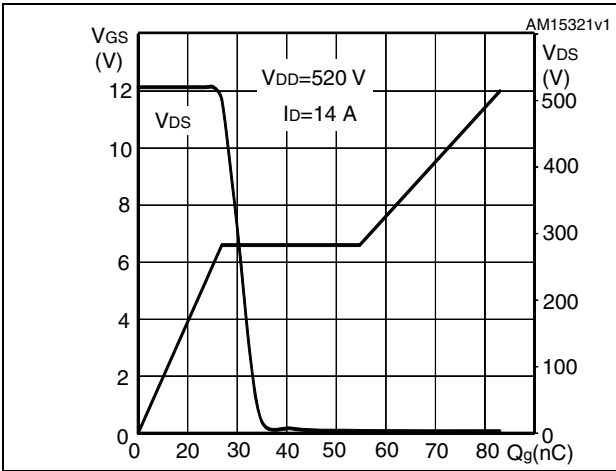


Figure 7. Static drain-source on-resistance

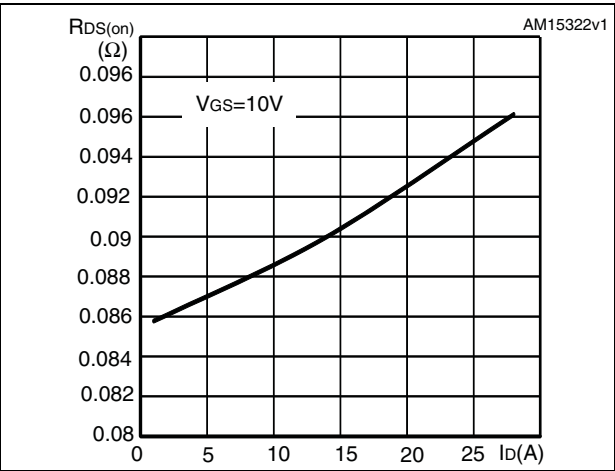


Figure 8. Capacitance variations

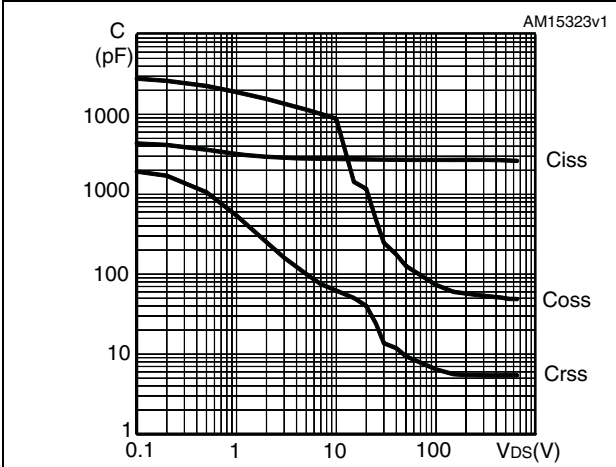


Figure 9. Output capacitance stored energy

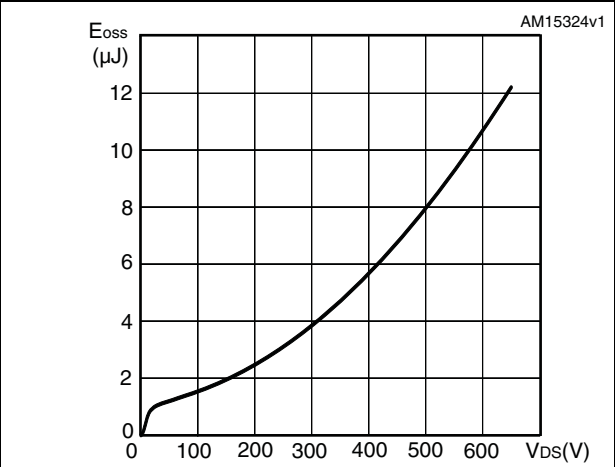


Figure 10. Normalized gate threshold voltage vs temperature

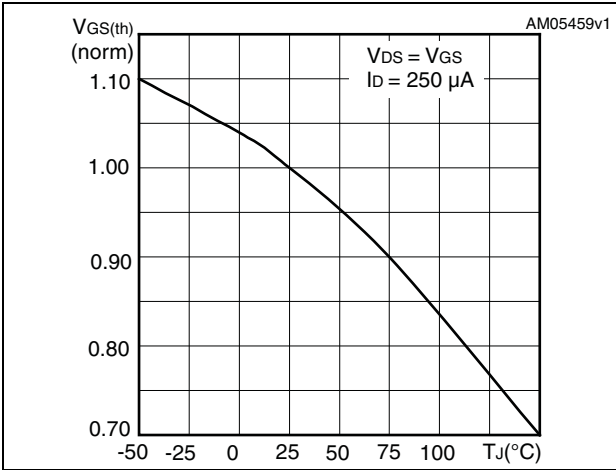


Figure 11. Normalized on-resistance vs temperature

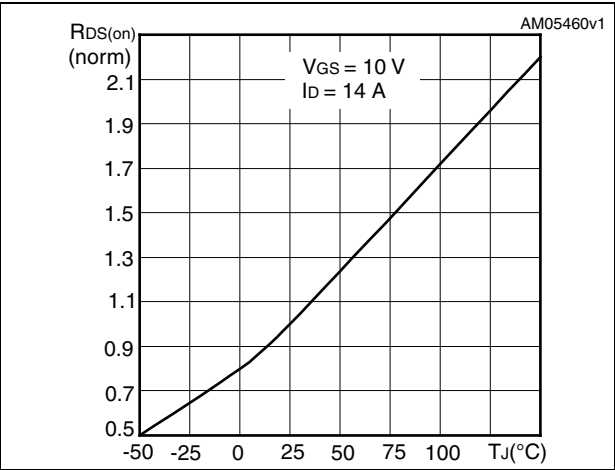


Figure 12. Source-drain diode forward characteristics

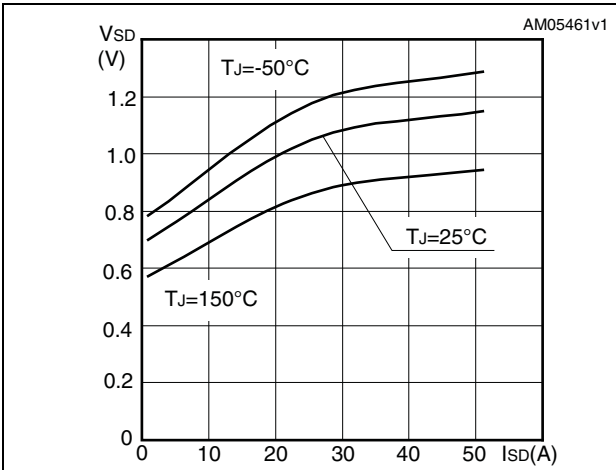


Figure 13. Normalized  $V_{DS}$  vs temperature

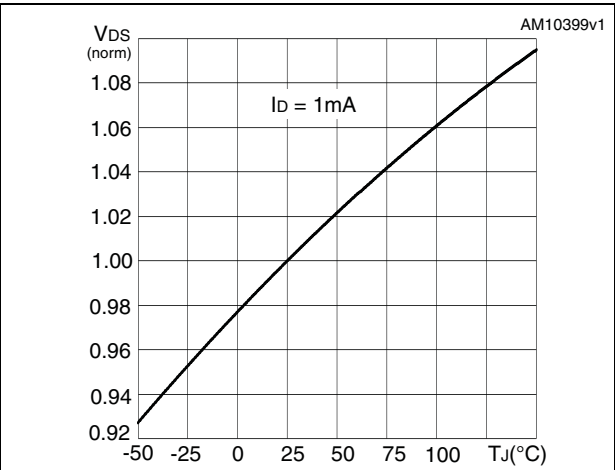
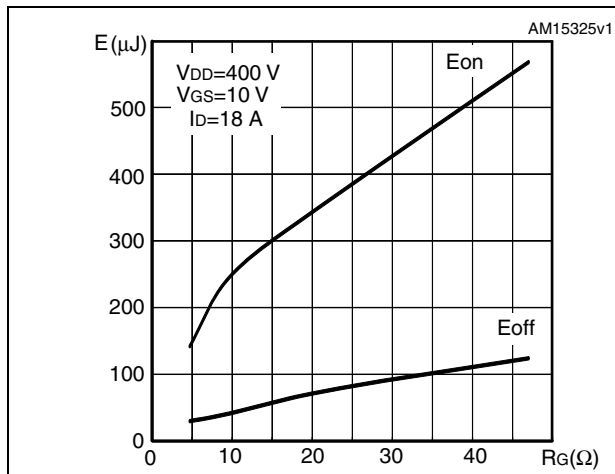




Figure 14. Switching losses vs gate resistance  
(1)



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

### 3 Test circuits

Figure 15. Switching times test circuit for resistive load

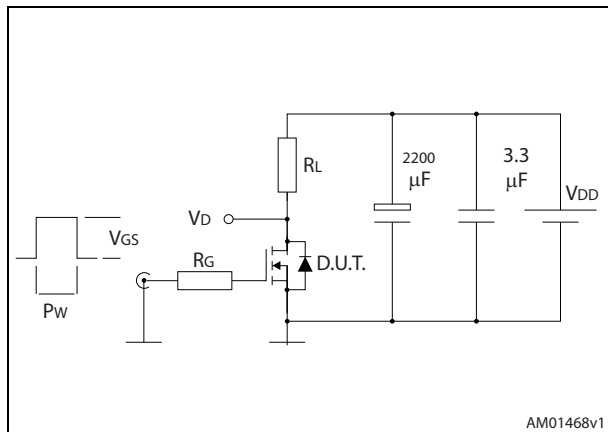


Figure 16. Gate charge test circuit

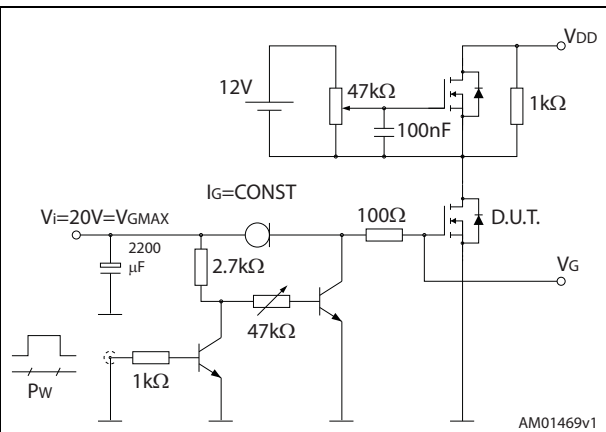


Figure 17. Test circuit for inductive load switching and diode recovery times

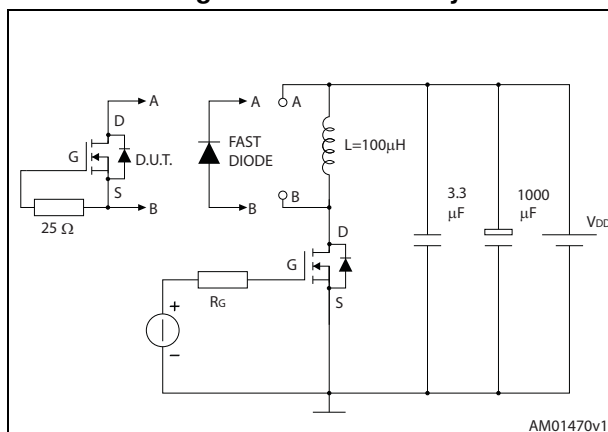


Figure 18. Unclamped inductive load test circuit

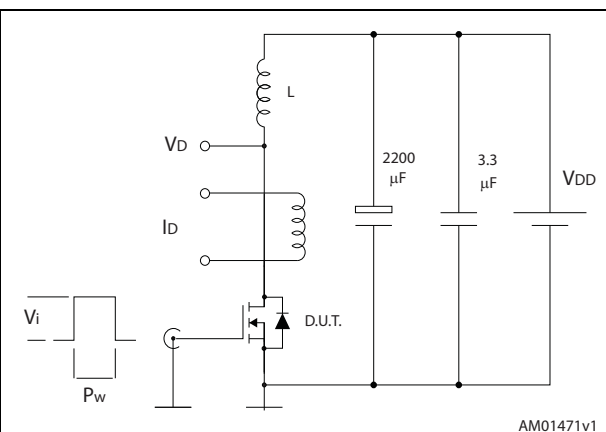


Figure 19. Unclamped inductive waveform

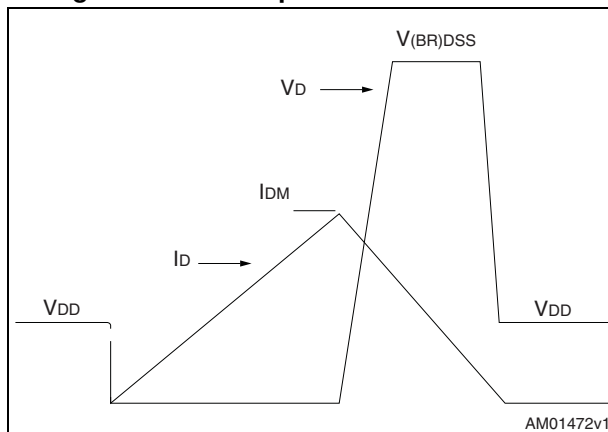
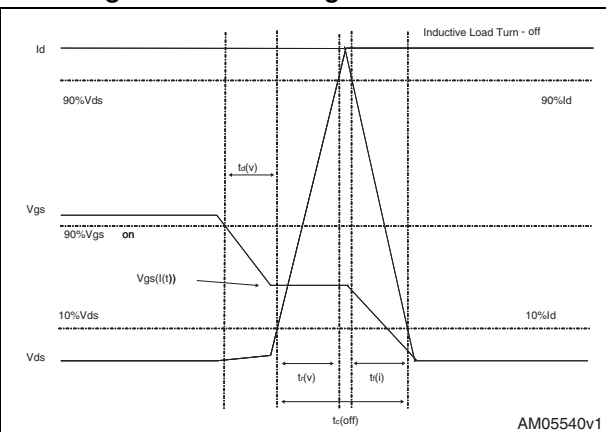


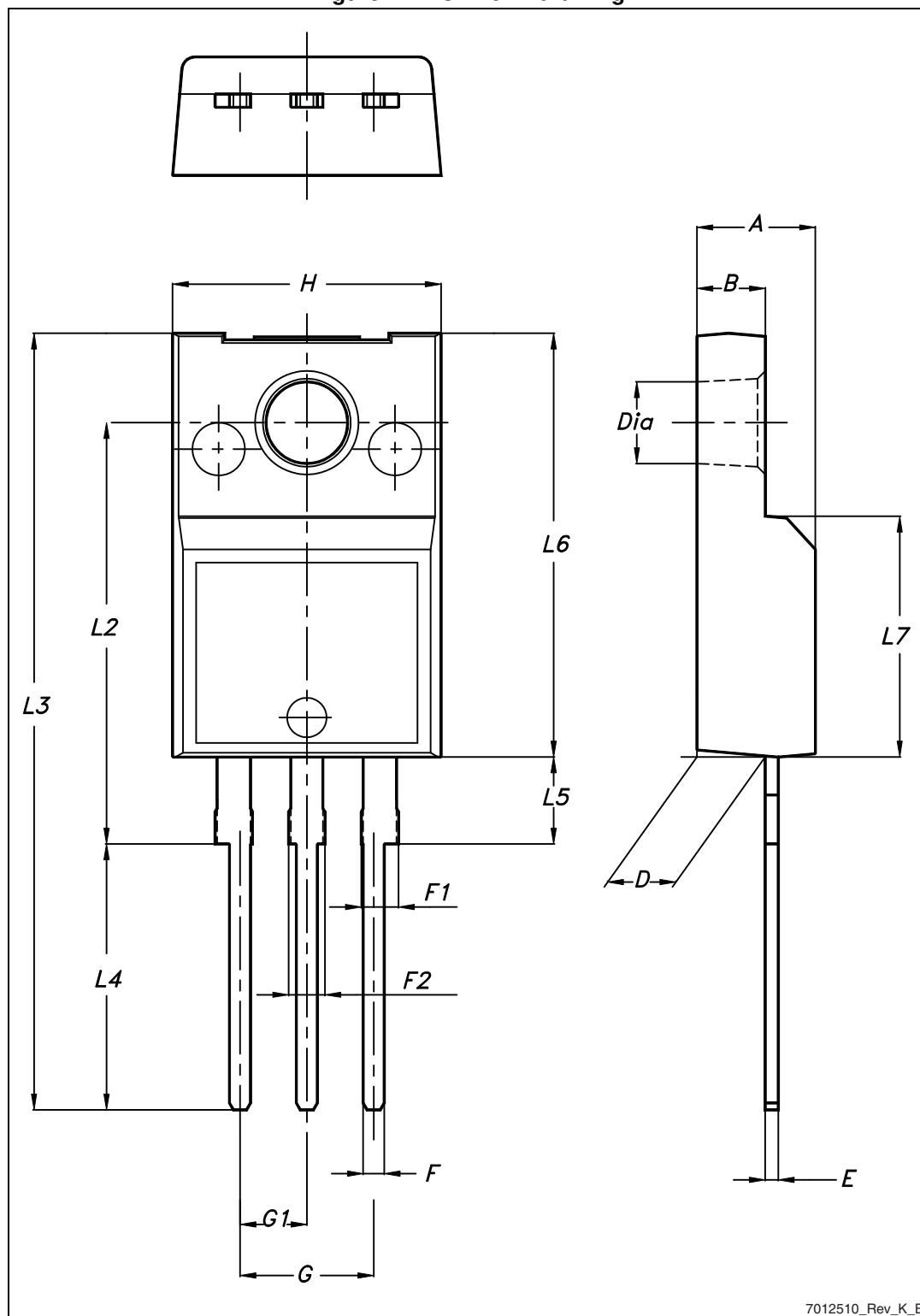
Figure 20. Switching time waveform



## 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.

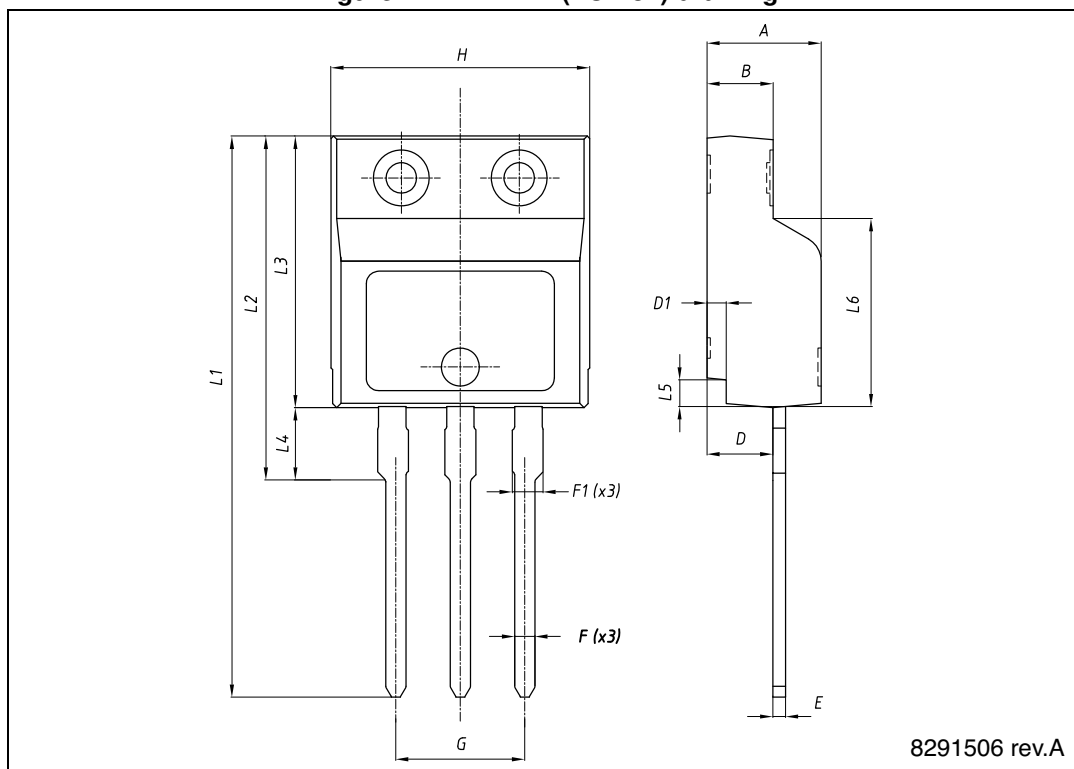
Figure 21. TO-220FP drawing



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

Figure 22. I<sup>2</sup>PAKFP (TO-281) drawingTable 10. I<sup>2</sup>PAKFP (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	7.30		7.50



## 5 Revision history

**Table 11. Document revision history**

Date	Revision	Changes
14-Jan-2014	1	First release. Part numbers previously included in datasheet DocID022853

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