



# THE DATASHEET OF STF11N65K3





# STF11N65K3

N-channel 650 V, 0.765  $\Omega$ , 11 A, TO-220FP  
SuperMESH3™ Power MOSFET

## Features

Type	V <sub>DSS</sub>	R <sub>DS(on)</sub> max	I <sub>D</sub>	P <sub>tot</sub>
STF11N65K3	650 V	< 0.85 $\Omega$	11 A	35 W

- 100% avalanche tested
- Extremely high dv/dt capability
- Gate charge minimized
- Very low intrinsic capacitances
- Improved diode reverse recovery characteristics
- Zener-protected

## Applications

- Switching applications

## Description

This device is an N-channel Zener-protected SuperMESH3™ Power MOSFET developed using STMicroelectronics' SuperMESH™ technology, achieved through optimization of ST's well established strip-based PowerMESH™ layout. In addition to a significant reduction in on-resistance, this device is designed to ensure a high level of dv/dt capability for the most demanding applications.

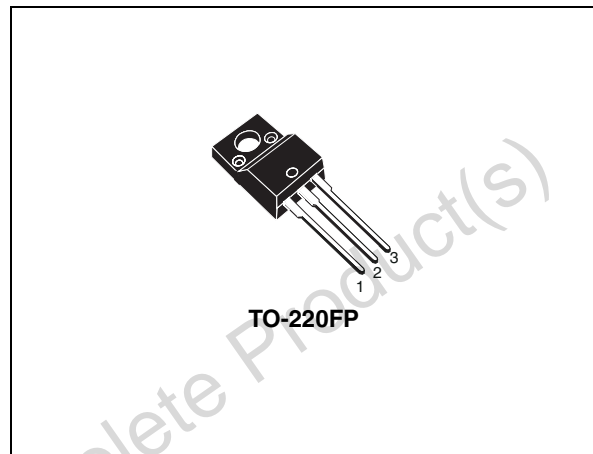


Figure 1. Internal schematic diagram

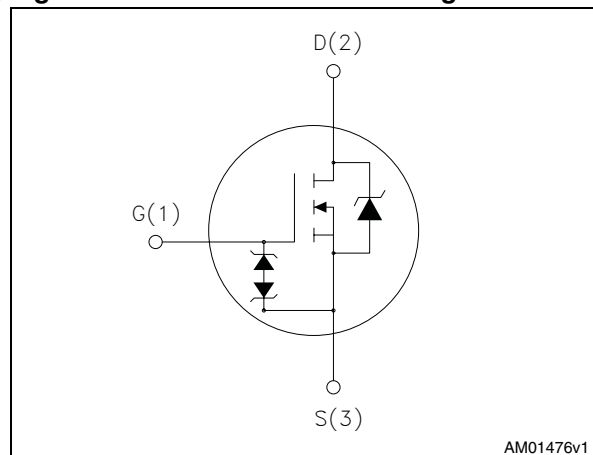


Table 1. Device summary

Order codes	Marking	Package	Packaging
STF11N65K3	11N65K3	TO-220FP	Tube

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DSS}$	Drain source voltage ( $V_{GS}=0$ )	650	V
$V_{GS}$	Gate-source voltage	$\pm 30$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	11	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	6.3	A
$I_{DM}^{(1)}$	Drain current (pulsed)	40	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	35	W
$I_{AR}$	Max current during repetitive or single pulse avalanche (pulse width limited by $T_{JMAX}$ )	7.2	A
$E_{AS}$	Single pulse avalanche energy <sup>(2)</sup>	212	mJ
	Derating factor	0.28	W/ $^\circ\text{C}$
$dv/dt$ <sup>(3)</sup>	Peak diode recovery voltage slope	12	V/ns
$V_{ESD(G-S)}$	G-S ESD (HBM $C=100\text{ pF}$ , $R=1.5\text{ k}\Omega$ )	2500	V
$V_{ISO}$	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
$T_j$ $T_{stg}$	Operating junction temperature Storage temperature	-55 to 150	$^\circ\text{C}$

1. Pulse width limited by safe operating area.
2. Starting  $T_j = 25\text{ }^\circ\text{C}$ ,  $I_D = I_{AR}$ ,  $V_{DD} = 50\text{ V}$
3.  $I_{SD} \leq 11\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$ ,  $V_{DS\text{ peak}} < V_{(BR)DSS}$

**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	$^\circ\text{C}/\text{W}$
$T_l$	Maximum lead temperature for soldering purpose	300	$^\circ\text{C}$

## 2 Electrical characteristics

(T<sub>case</sub> = 25 °C unless otherwise specified).

**Table 4. On /off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-source breakdown voltage (V <sub>GS</sub> = 0)	I <sub>D</sub> = 1 mA	650			V
I <sub>DSS</sub>	Zero gate voltage drain current (V <sub>GS</sub> = 0)	V <sub>DS</sub> = 650 V V <sub>DS</sub> = 650 V, T <sub>C</sub> = 125 °C			1 50	μA μA
I <sub>GSS</sub>	Gate-body leakage current (V <sub>DS</sub> = 0)	V <sub>GS</sub> = ± 20 V			10	μA
V <sub>GS(th)</sub>	Gate threshold voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 100 μA	3		4.5	V
R <sub>DS(on)</sub>	Static drain-source on resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 3.6 A		0.765	0.85	Ω

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C <sub>iss</sub>	Input capacitance	V <sub>DS</sub> = 50 V, f = 1 MHz, V <sub>GS</sub> = 0	-	1180	-	pF
C <sub>oss</sub>	Output capacitance			125		pF
C <sub>rss</sub>	Reverse transfer capacitance			14		pF
C <sub>oss eq.</sub>	Equivalent output capacitance	V <sub>DS</sub> = 0 to 520 V, V <sub>GS</sub> = 0	-	77	-	pF
R <sub>G</sub>	Intrinsic gate resistance	f = 1 MHz open drain	-	3	-	Ω
Q <sub>g</sub>	Total gate charge	V <sub>DD</sub> = 520 V, I <sub>D</sub> = 7.2 A,	-	42	-	nC
Q <sub>gs</sub>	Gate-source charge	V <sub>GS</sub> = 10 V		7.4		nC
Q <sub>gd</sub>	Gate-drain charge	(see <a href="#">Figure 16</a> )		23		nC

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
t <sub>d(on)</sub>	Turn-on delay time	V <sub>DD</sub> = 310 V, I <sub>D</sub> = 3.5 A, R <sub>G</sub> = 4.7 Ω, V <sub>GS</sub> = 10 V (see <a href="#">Figure 15</a> )	-	14.5	-	ns
t <sub>r</sub>	Rise time			14		ns
t <sub>d(off)</sub>	Turn-off-delay time			44		ns
t <sub>f</sub>	Fall time			35		ns

**Table 7. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		7.2	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		28.8	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 7 \text{ A}, V_{GS} = 0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 7 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ (see <a href="#">Figure 20</a> )	-	320		ns
$Q_{rr}$	Reverse recovery charge			2		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			13		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 7 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}, T_j = 150 \text{ }^\circ\text{C}$ (see <a href="#">Figure 20</a> )	-	410		ns
$Q_{rr}$	Reverse recovery charge			2.9		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			14		A

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

**Table 8. Gate-source Zener diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$BV_{GSO}$	Gate-source breakdown voltage	$I_{gs} = \pm 1 \text{ mA}$ (open drain)	30	-	-	V

The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

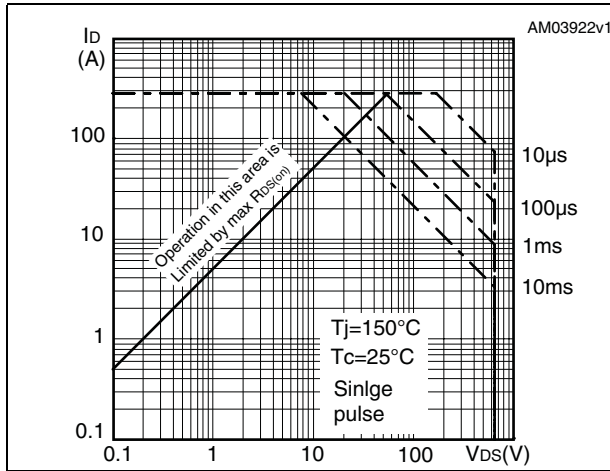


Figure 3. Thermal impedance

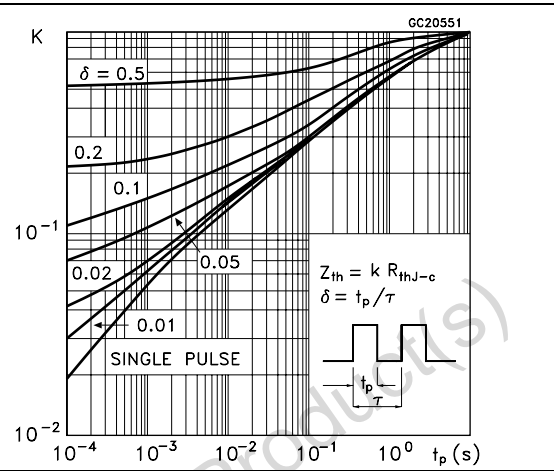


Figure 4. Output characteristics

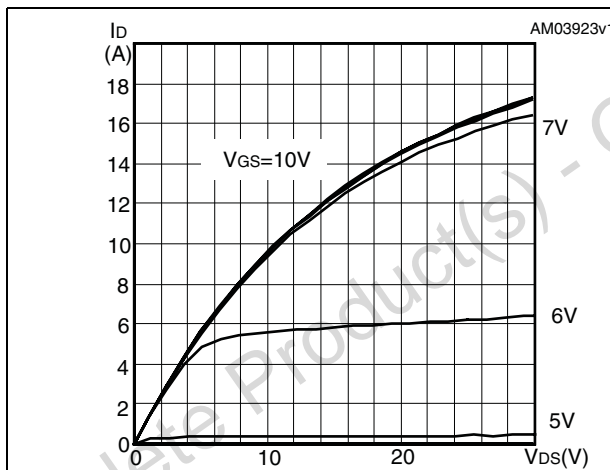


Figure 5. Transfer characteristics

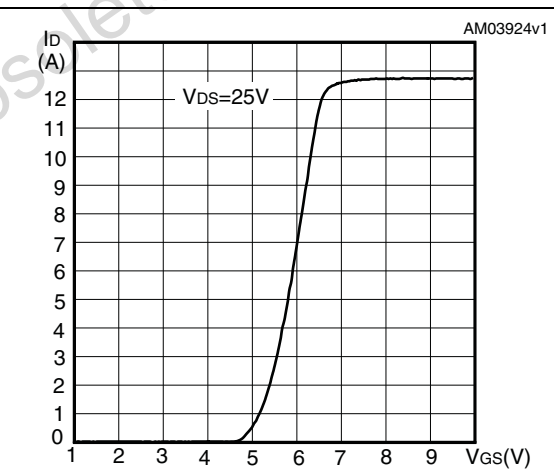


Figure 6. Normalized  $BV_{DSS}$  vs temperature

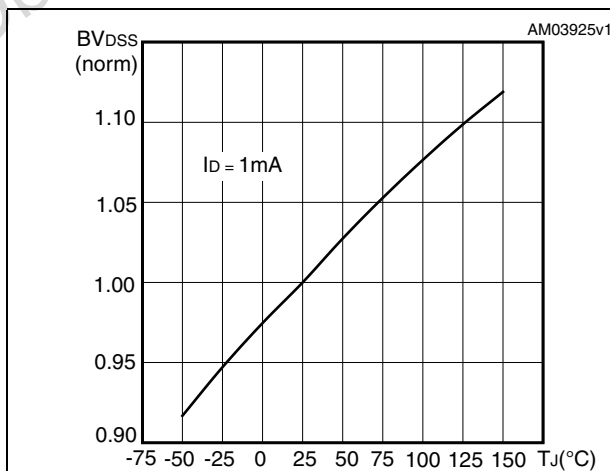


Figure 7. Static drain-source on resistance

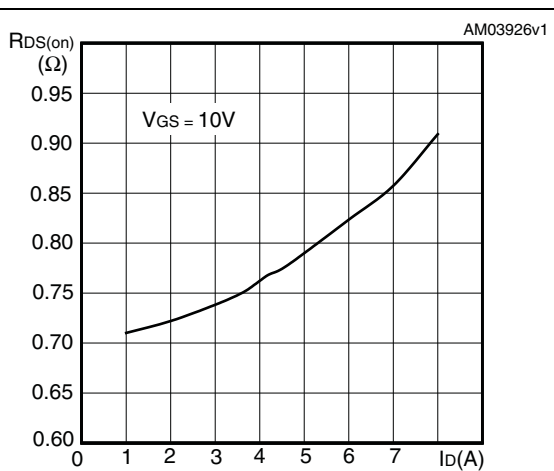


Figure 8. Output capacitance stored energy      Figure 9. Capacitance variations

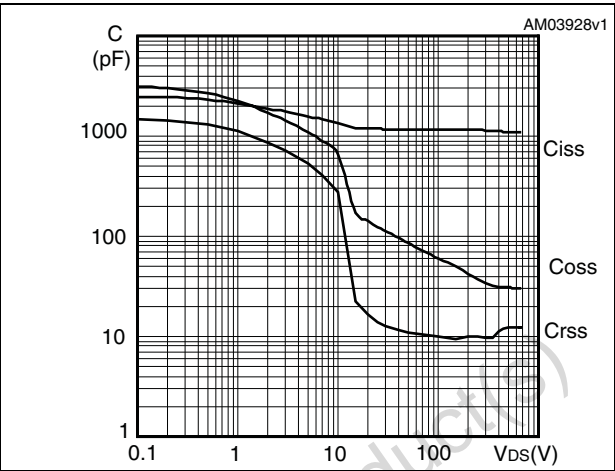
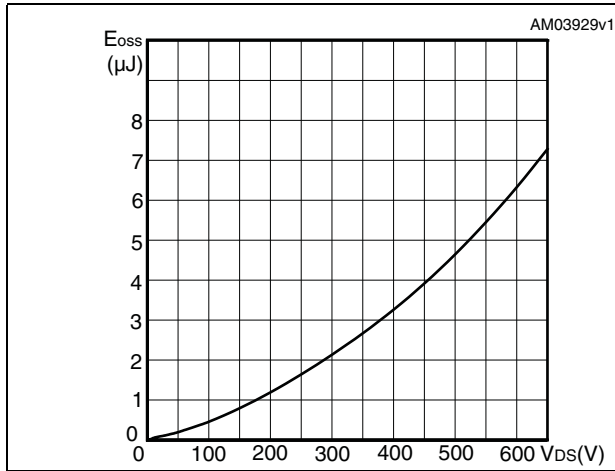


Figure 10. Gate charge vs gate-source voltage

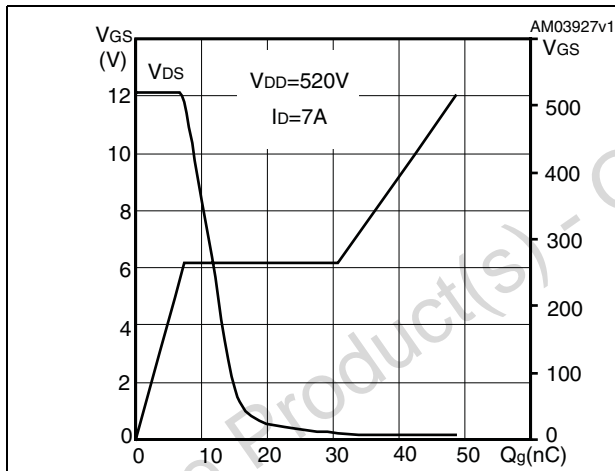


Figure 11. Normalized on resistance vs temperature

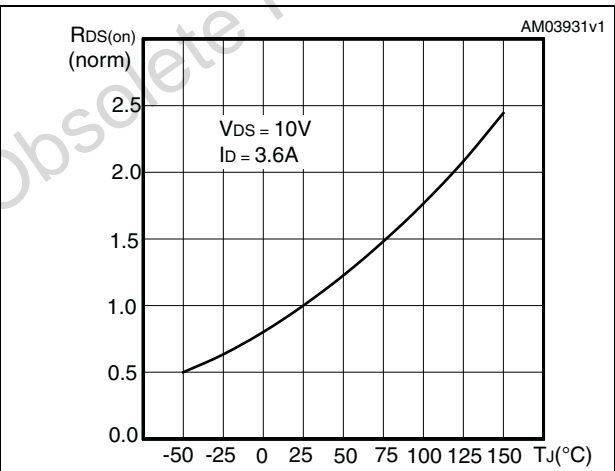


Figure 12. Normalized gate threshold voltage vs temperature

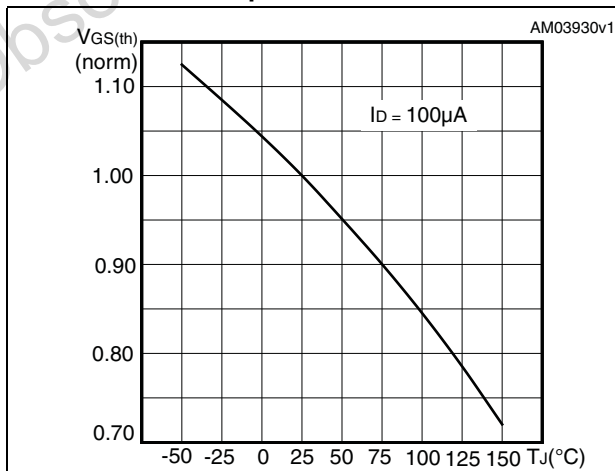


Figure 13. Maximum avalanche energy vs temperature

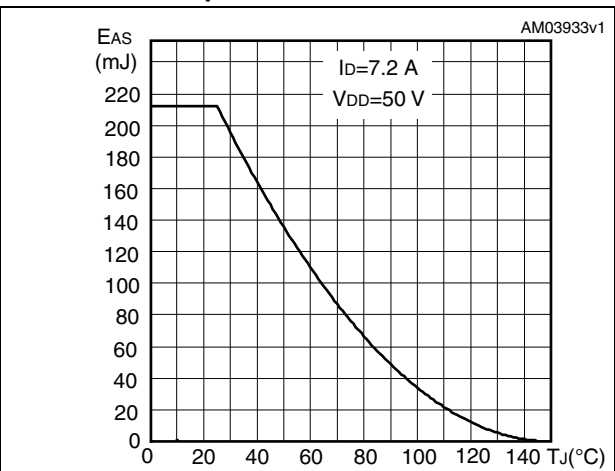
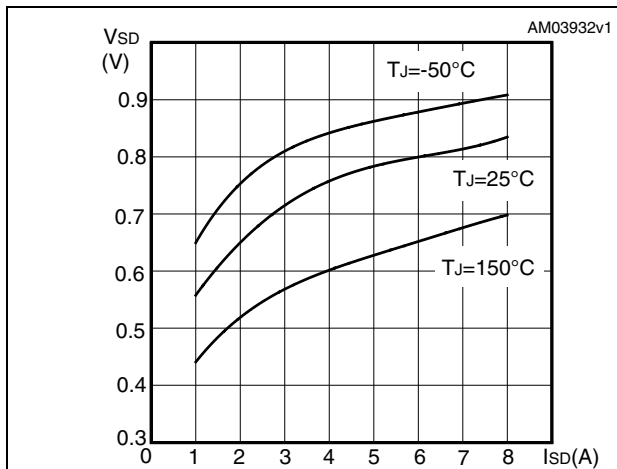


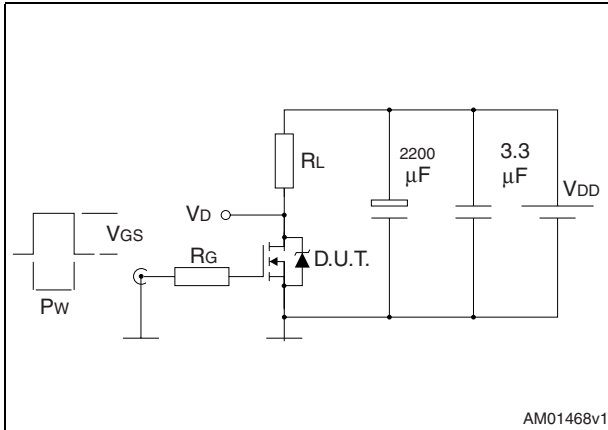
Figure 14. Source-drain diode forward characteristics



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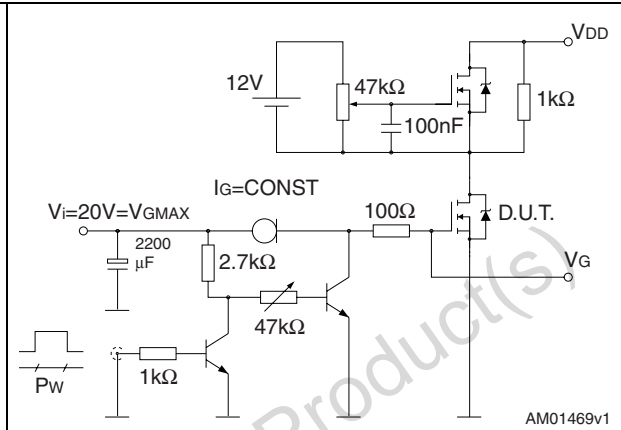
### 3 Test circuits

**Figure 15. Switching times test circuit for resistive load**



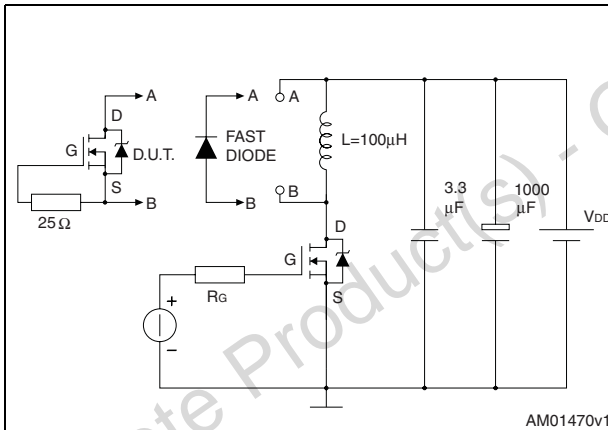
AM01468v1

**Figure 16. Gate charge test circuit**



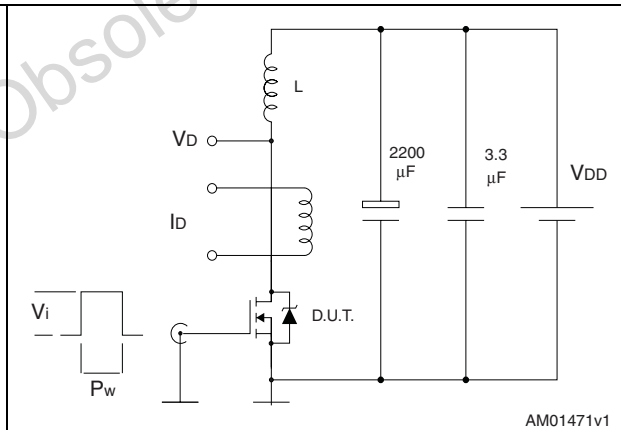
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**Figure 17. Test circuit for inductive load switching and diode recovery times**



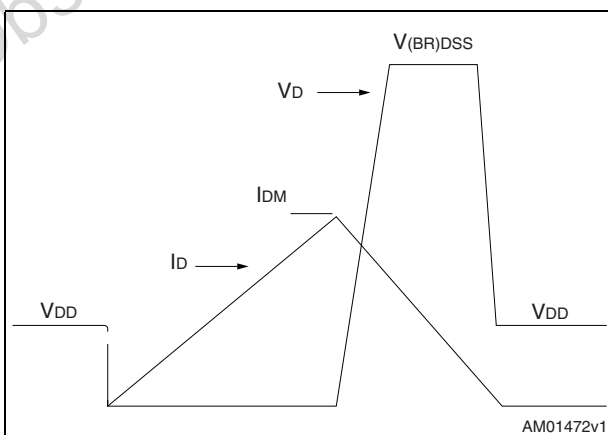
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**Figure 18. Unclamped inductive load test circuit**



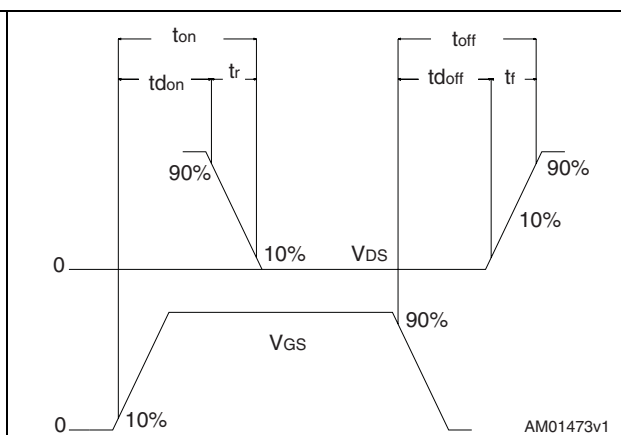
AM01471v1

**Figure 19. Unclamped inductive waveform**



AM01472v1

**Figure 20. Switching time waveform**



AM01473v1

## 4 Package mechanical data

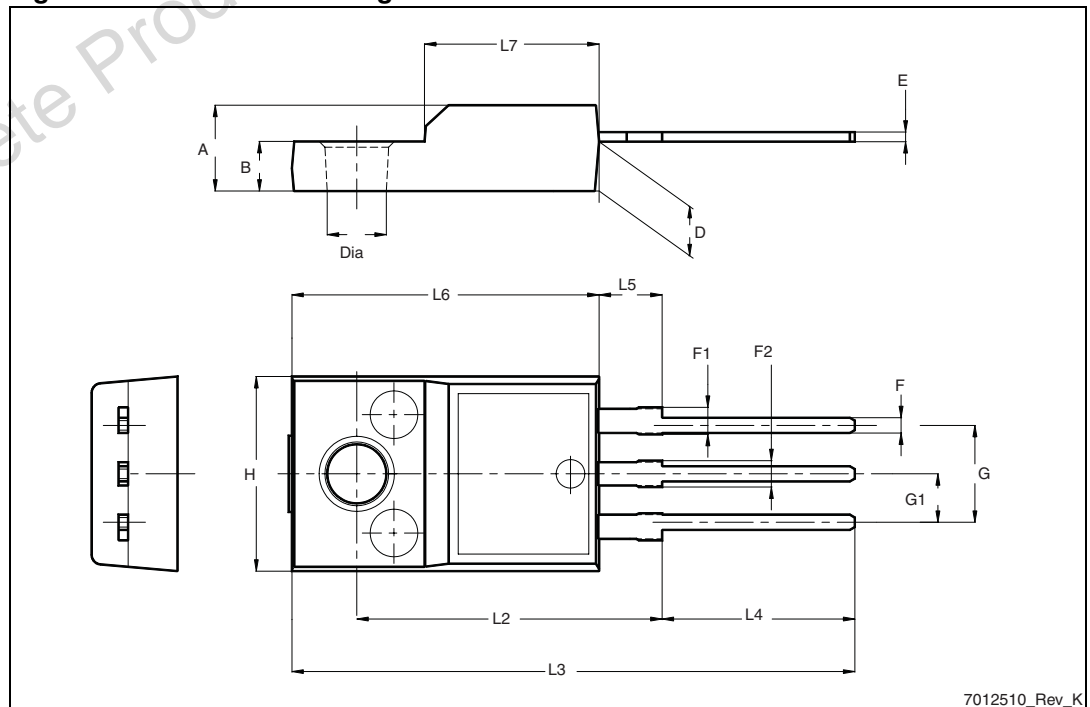
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Table 9. TO-220FP mechanical data

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 21. TO-220FP drawing



## 5 Revision history

Table 10. Document revision history

Date	Revision	Changes
10-Sep-2010	1	First release
03-Oct-2011	2	Updated <i>Figure 6: Normalized <math>BV_{DSS}</math> vs temperature</i> , <i>Figure 7: Static drain-source on resistance</i> , <i>Figure 10: Gate charge vs gate-source voltage</i> , <i>Figure 11: Normalized on resistance vs temperature</i> , <i>Figure 12: Normalized gate threshold voltage vs temperature</i> . Minor text changes.

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