STF6N65K3, STFI6N65K3, STU6N65K3

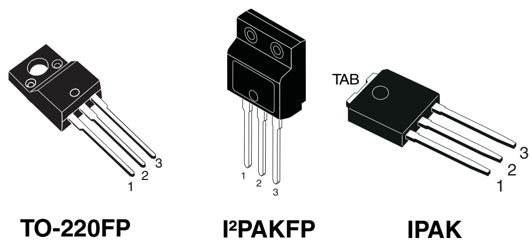
N-channel 650 V, 1.1 Ω typ., 5.4 A SuperMESH3™ Power MOSFET in TO-220FP, I²PAKFP, IPAK

Datasheet — production data

Features

Order codes	V_{DSS}	$R_{DS(on)}$ max.	I_D	Ptot
STF6N65K3	650 V	< 1.3 Ω	5.4 A	30 W
STFI6N65K3				
STU6N65K3				110 W

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



Applications

- Switching applications

Description

These SuperMESH3™ Power MOSFETs are the result of improvements applied to STMicroelectronics' SuperMESH™ technology, combined with a new optimized vertical structure. These devices boast an extremely low on-resistance, superior dynamic performance and high avalanche capability, rendering them suitable for the most demanding applications.

Figure 1. Internal schematic diagram

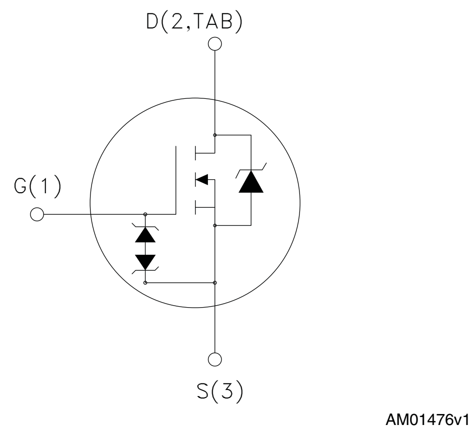


Table 1. Device summary

Order codes	Marking	Package	Packaging
STF6N65K3	6N65K3	TO-220FP	Tube
STFI6N65K3		I²PAKFP	
STU6N65K3		IPAK	

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		TO-220FP	I²PAKFP	IPAK	
V_{DS}	Drain-source voltage	650			V
V_{GS}	Gate- source voltage	± 30			V
I_D	Drain current (continuous) at T_C = 25 °C	5.4 (1)		5.4	A
I_D	Drain current (continuous) at T_C = 100 °C	3(1)		3	A
I_{DM} (2)	Drain current (pulsed)	21.6 (1)		21.6	A
P_{TOT}	Total dissipation at T_C = 25 °C	30		110	W
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_j max)	5.4			A
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, I_D = I_{AR}, V_{DD} = 50 V)	100			mJ
ESD	Gate-source human body model (C = 100 pF, R = 1.5 kΩ)	2.5			kV
dv/dt (3)	Peak diode recovery voltage slope	12			V/ns
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; Tc = 25 °C)	2500			V
T_{stg}	Storage temperature	-55 to 150			°C
T_j	Max. operating junction temperature	150			°C

1. Limited by package
2. Pulse width limited by safe operating area
3. I_{SD} ≤ 5.4 A, di/dt ≤ 400 A/µs, V_{DD} = 80% $V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		TO-220FP	I²PAKFP	IPAK	
$R_{thj-case}$	Thermal resistance junction-case max	4.17		1.14	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient max	62.5		100	°C/W

2 Electrical characteristics

(T_C = 25 °C unless otherwise specified)

Table 4. On /off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	I_D = 1 mA, V_{GS} = 0	650			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = 650 V V_{DS} = 650 V, T_C=125 °C			0.8 50	µA µA
I_{GSS}	Gate-body leakage current (V_{DS} = 0)	V_{GS} = ± 20 V			± 9	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 50 µA	3	3.75	4.5	V
$R_{DS(on}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 2.7 A		1.1	1.3	Ω

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{DS} = 50 V, f = 1 MHz, V_{GS} = 0	-	880 65 12	-	pF pF pF
$C_{o(tr)}$ (1)	Eq. capacitance time related	V_{GS} = 0, V_{DS} = 0 to 520 V	-	43	-	pF
$C_{o(er)}$ (2)	Eq. capacitance energy related		-	27	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz open drain	-	3.5	-	Ω
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD} = 500 V, I_D = 5.4 A, V_{GS} = 10 V (see *Figure 18*)	-	33 4 21	-	nC nC nC

1. $C_{oss\ eq.}$ 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. $C_{oss\ eq.}$ 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 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ t_r $t_{d(off)}$ t_f	Turn-on delay time Rise time Turn-off-delay time Fall time	V_{DD} = 325 V, I_D = 2.7 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 17*)	-	14 10 44 24	-	ns ns ns ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM} (1)	Source-drain current Source-drain current (pulsed)		-		5.4 21.6	A A
V_{SD} (2)	Forward on voltage	I_{SD} = 5.4 A, V_{GS} = 0	-		1.5	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 5.4 A, di/dt = 100 A/µs V_{DD} = 60 V (see *Figure 22*)	-	285 5100 14		ns nC A
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 5.4 A, di/dt = 100 A/µs V_{DD} = 60 V, T_j = 150 °C (see *Figure 22*)	-	330 2500 15.5		ns nC A

1. Pulse width limited by safe operating area
2. Pulsed: Pulse duration = 300 µs, duty cycle 1.5%

Table 8. Gate-source Zener diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)GSO}$	Gate-source breakdown voltage	Igs=± 1 mA, I_D=0 (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 for TO-220FP and I²PAKFP

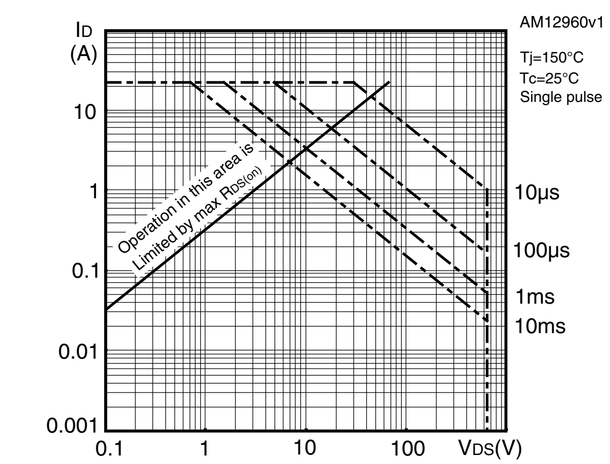


Figure 3. Thermal impedance for TO-220FP and I²PAKFP

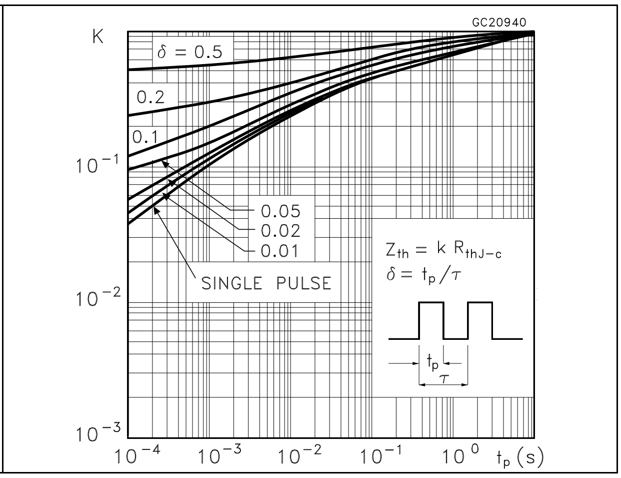


Figure 4. Safe operating area for IPAK

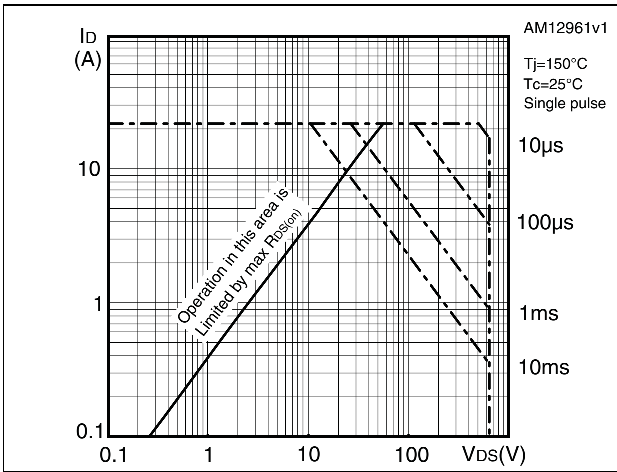


Figure 5. Thermal impedance for IPAK

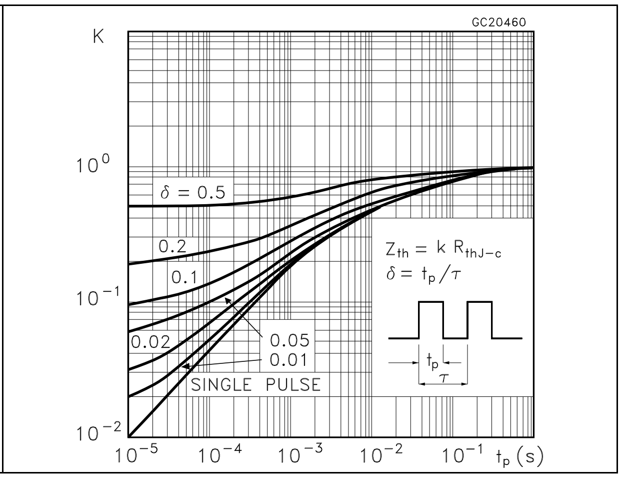


Figure 6. Output characteristics

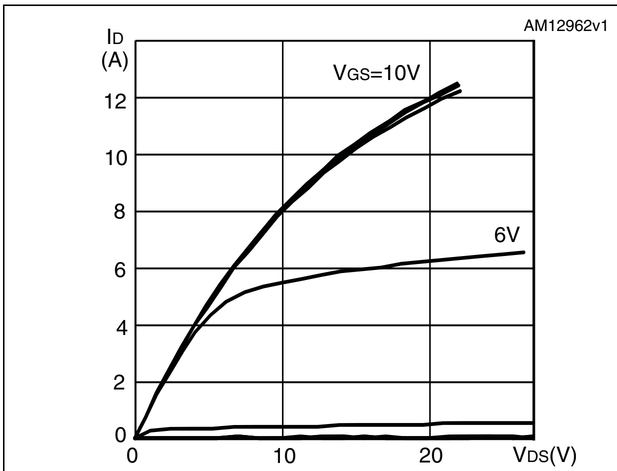


Figure 7. Transfer characteristics

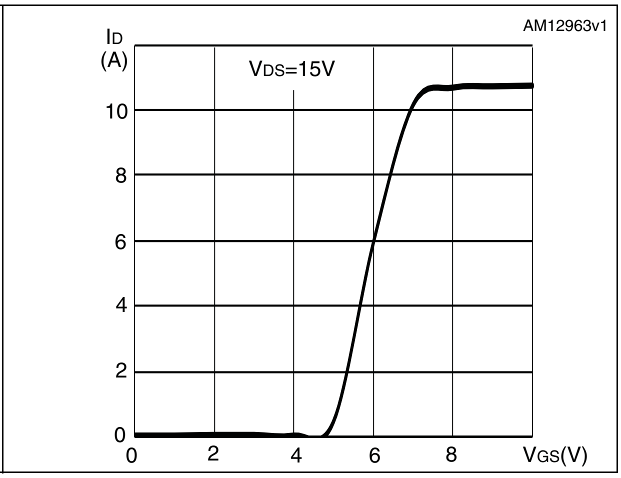


Figure 8. Gate charge vs gate-source voltage

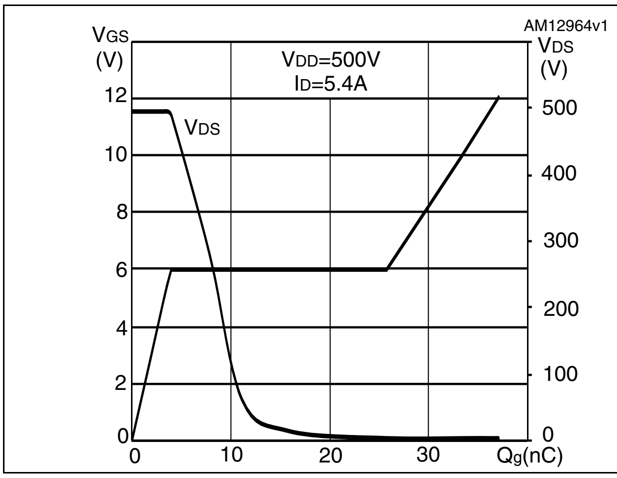


Figure 9. Static drain-source on-resistance

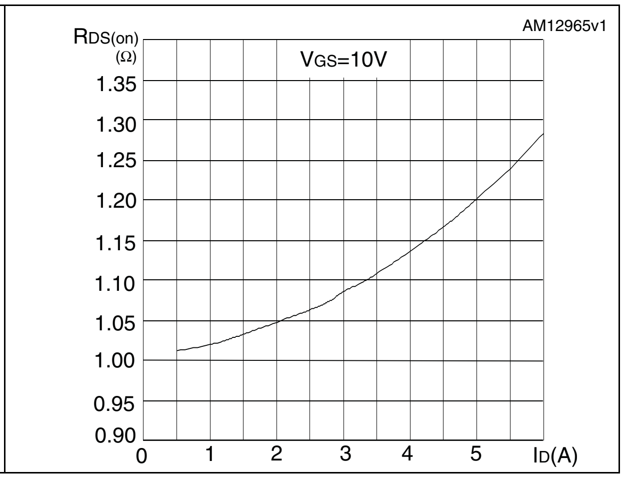


Figure 10. Capacitance variations

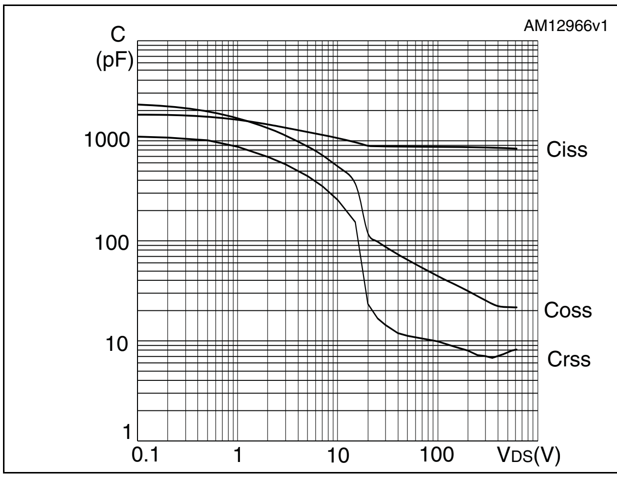


Figure 11. Output capacitance stored energy

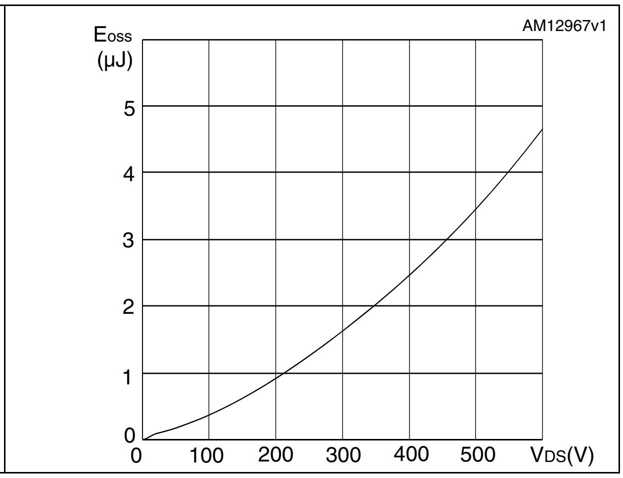


Figure 12. Normalized gate threshold voltage vs temperature

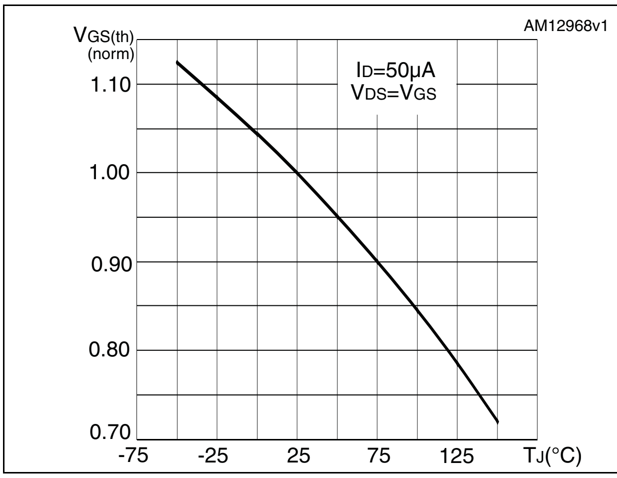


Figure 13. Normalized on-resistance vs temperature

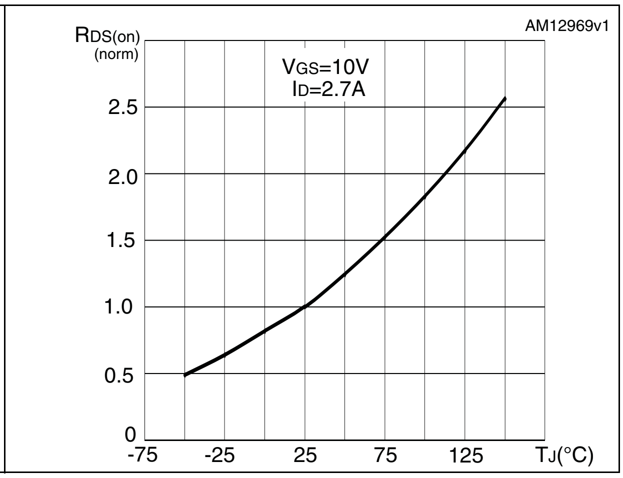


Figure 14. Normalized BV_{DSS} vs temperature

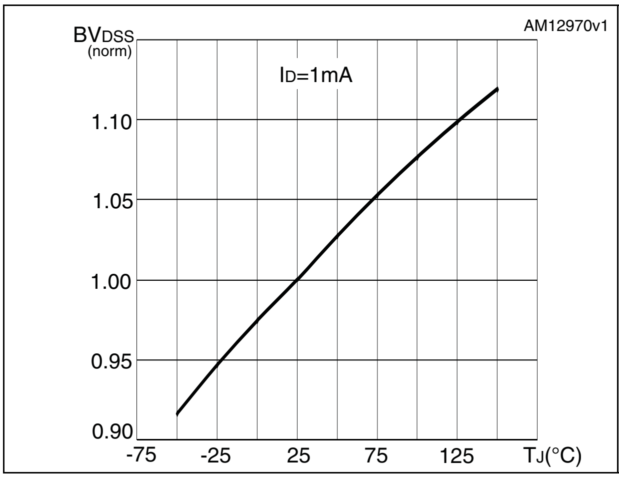


Figure 15. Source-drain diode forward characteristics

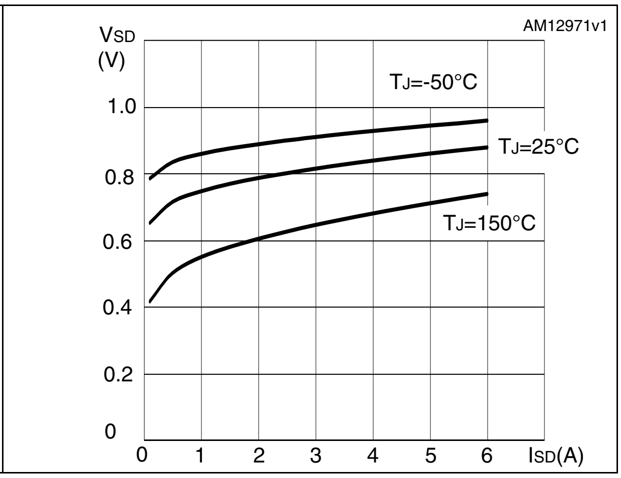
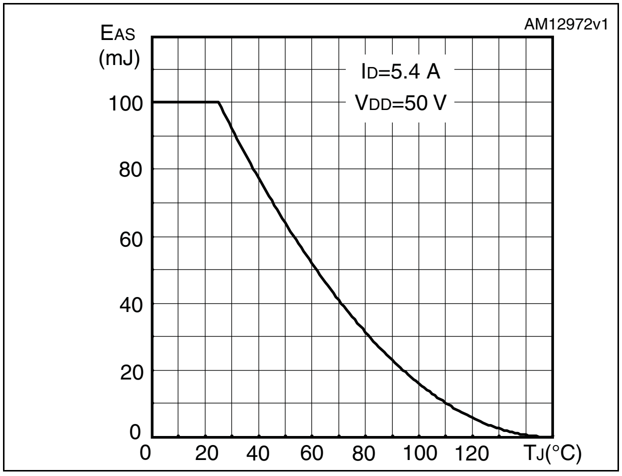


Figure 16. Maximum avalanche energy vs temperature



3 Test circuits

Figure 17. Switching times test circuit for resistive load

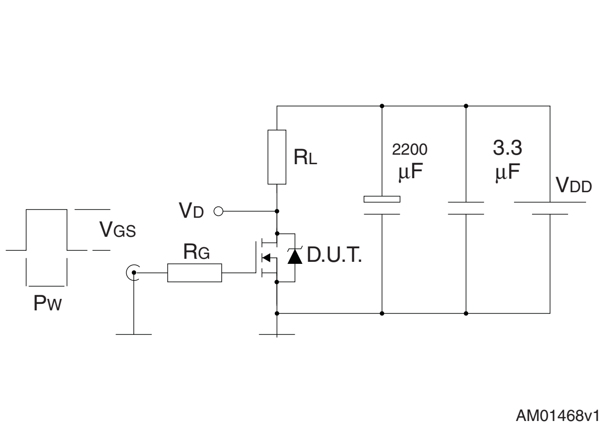


Figure 18. Gate charge test circuit

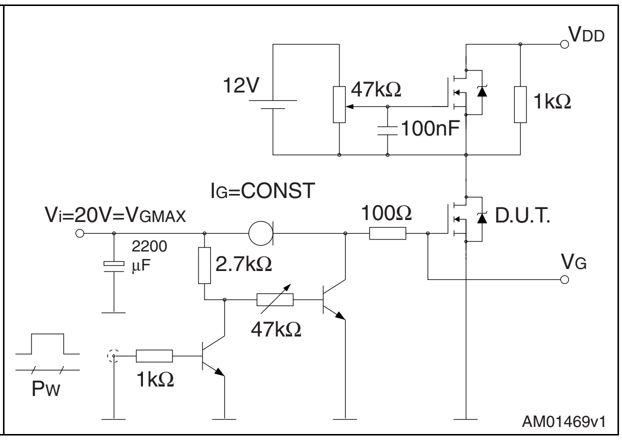


Figure 19. Test circuit for inductive load switching and diode recovery times

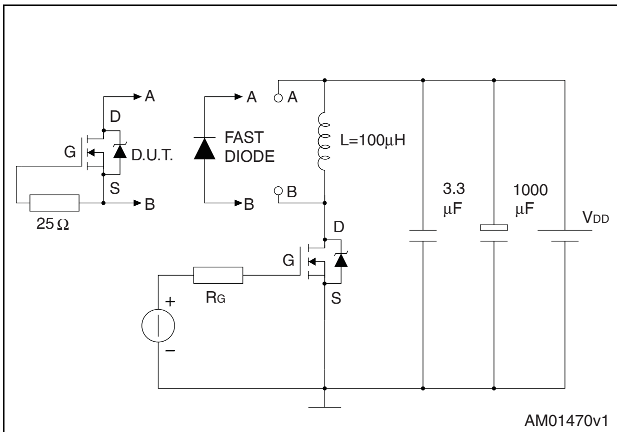


Figure 20. Unclamped inductive load test circuit

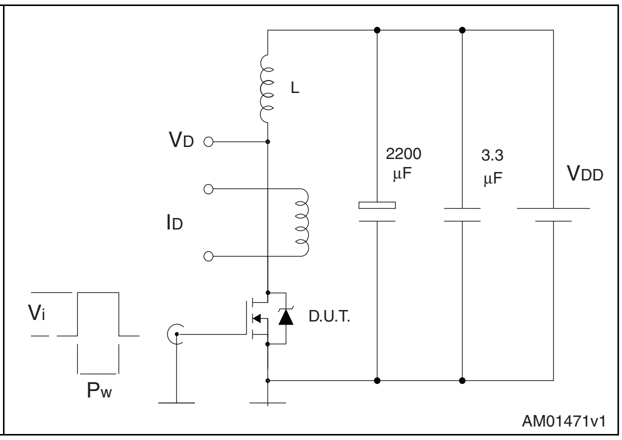


Figure 21. Unclamped inductive waveform

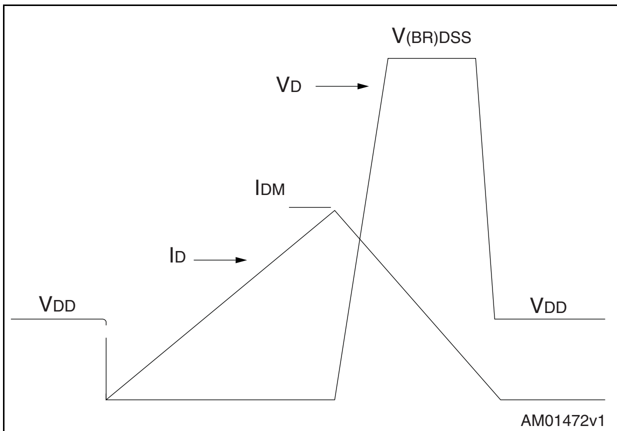
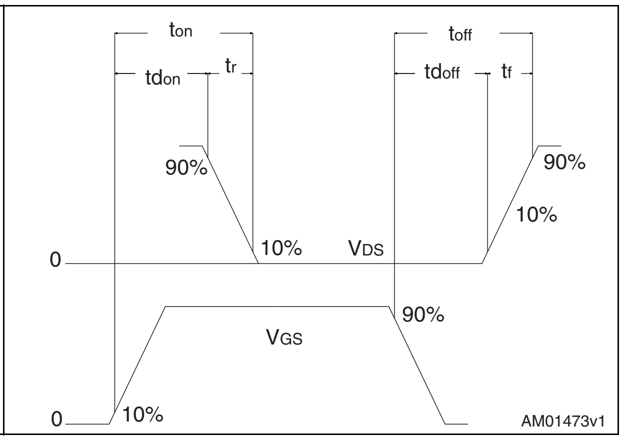


Figure 22. Switching time waveform



4 Package mechanical data

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.

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 23. TO-220FP drawing

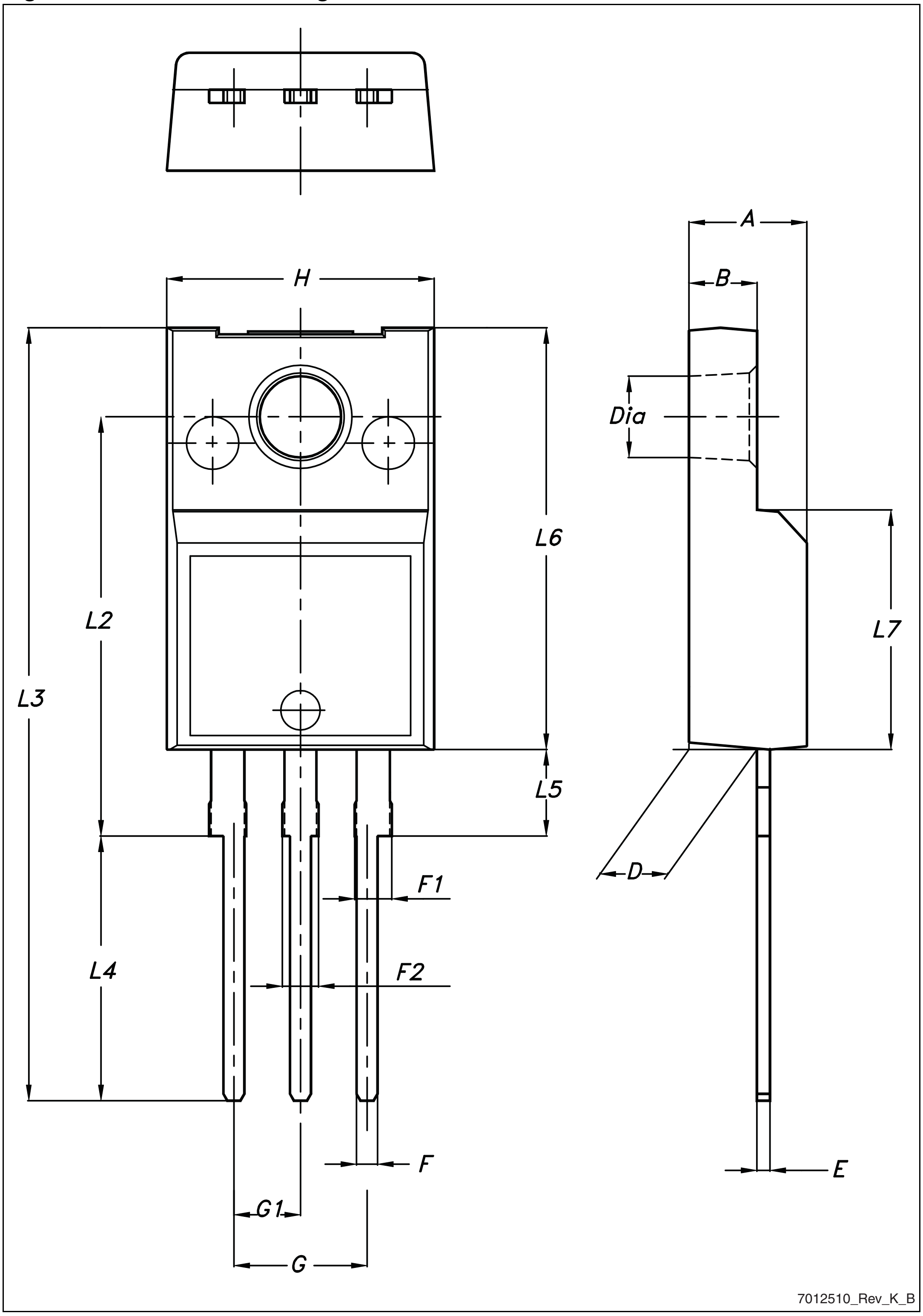


Table 10. I^2PAKFP (TO-281) mechanical data

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

Figure 24. I^2PAKFP (TO-281) drawing

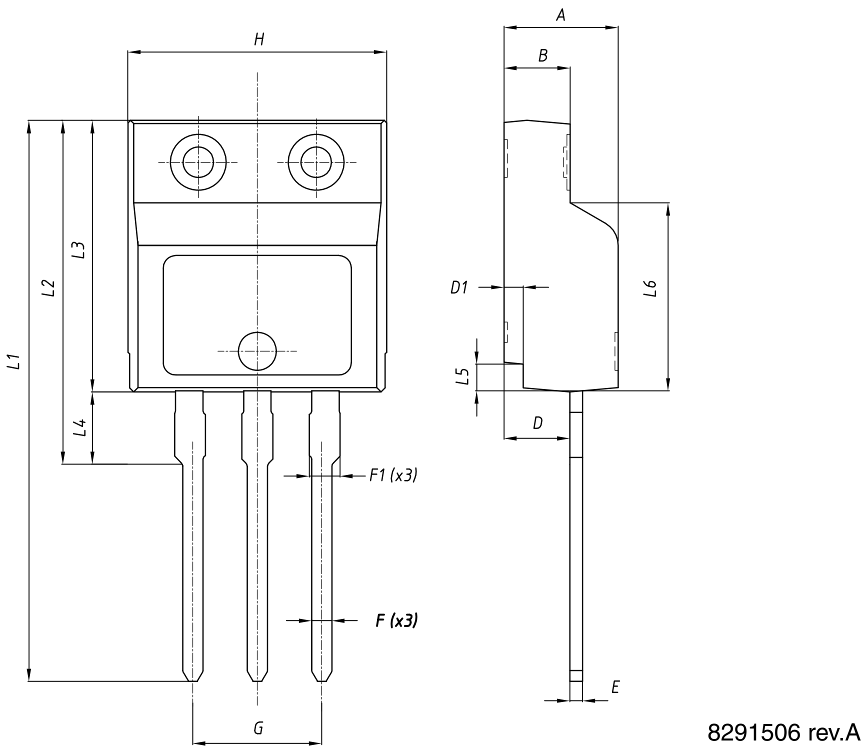
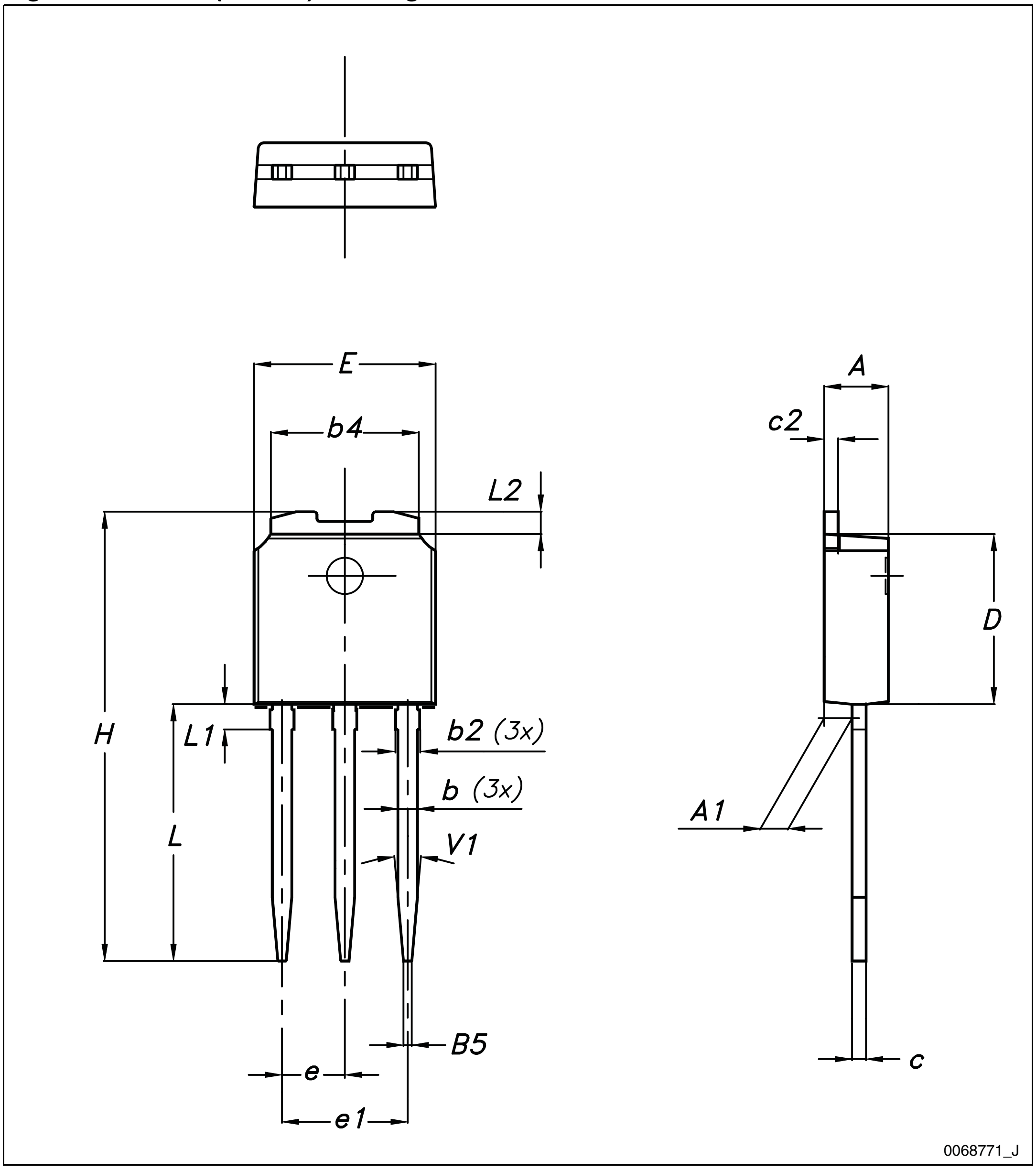


Table 11. IPAK (TO-251) mechanical data

DIM.	mm.		
	min.	typ	max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
B5		0.3	
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
L1	0.80		1.20
L2		0.80	1.00
V1		10 ^{o}	

Figure 25. IPAK (TO-251) drawing



5 Revision history

Table 12. Document revision history

Date	Revision	Changes
05-Apr-2011	1	First release
07-Nov-2012	2	Added new part numbers: STFI6N65K3 in I^2PAKFP package and STU6N65K3 in IPAK packages. *Section 2.1: Electrical characteristics (curves)* has been updated. Minor text changes.