

## N-channel 1200 V, 0.62 $\Omega$ typ., 12 A MDmesh™ K5 Power MOSFETs in TO-220FP and TO-3PF packages

Datasheet - production data

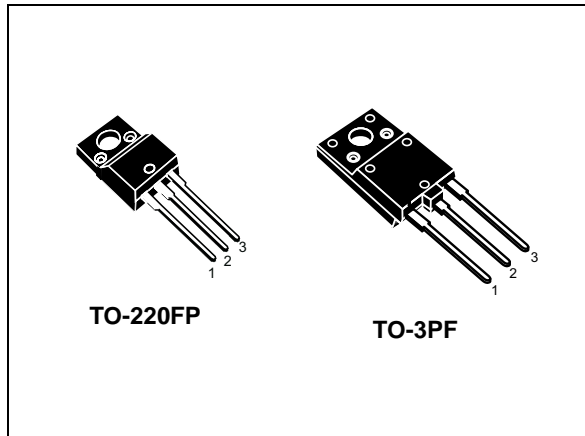
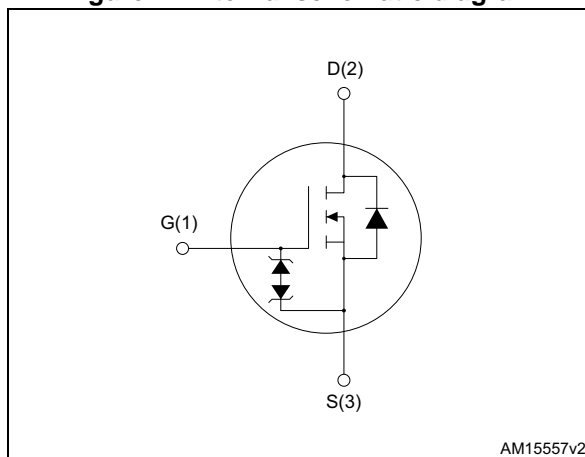


Figure 1. Internal schematic diagram



### Features

Order code	$V_{DS}$	$R_{DS(on)}$ max.	$I_D$	$P_{TOT}$
STF12N120K5	1200 V	0.69 $\Omega$	12 A	40 W
STFW12N120K5				63 W

- Industry's lowest  $R_{DS(on)}$  x area
- Industry's best figure of merit (FoM)
- Ultra low gate charge
- 100% avalanche tested
- Zener-protected

### Applications

- Switching applications

### Description

These very high voltage N-channel Power MOSFETs are designed using MDmesh™ K5 technology based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance and ultra-low gate charge for applications requiring superior power density and high efficiency.

Table 1. Device summary

Order code	Marking	Packages	Packing
STF12N120K5	12N120K5	TO-220FP	Tube
STFW12N120K5		TO-3PF	

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-220FP	TO-3PF	
$V_{GS}$	Gate-source voltage	$\pm 30$		V
$I_D$	Drain current at $T_C = 25\text{ °C}$	12		A
$I_D$	Drain current at $T_C = 100\text{ °C}$	7.6		A
$I_{DM}^{(1)}$	Drain current (pulsed)	48		A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	40	63	W
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t = 1\text{ s}$ , $T_C = 25\text{ °C}$ )	2500	3500	V
$I_{AR}^{(2)}$	Max current during repetitive or single pulse avalanche	4		A
$E_{AS}^{(3)}$	Single pulse avalanche energy	215		mJ
$dv/dt^{(4)}$	Peak diode recovery voltage slope	4.5		V/ns
$dv/dt^{(5)}$	MOSFET $dv/dt$ ruggedness	50		V/ns
$T_j$ $T_{stg}$	Operating junction temperature Storage temperature	- 55 to 150		°C

1. Pulse width limited by safe operating area.
2. Pulse width limited by  $T_{Jmax}$ .
3. Starting  $T_j = 25\text{ °C}$ ,  $I_D = I_{AS}$ ,  $V_{DD} = 50\text{ V}$
4.  $I_{SD} \leq 12\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ ,  $V_{Peak} \leq V_{(BR)DSS}$
5.  $V_{DS} \leq 960\text{ V}$

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		TO-220FP	TO-3PF	
$R_{thj-case}$	Thermal resistance junction-case max	3.1	1.98	°C/W
$R_{thj-amb}$	Thermal resistance junction-amb max	62.5	50	°C/W

## 2 Electrical characteristics

( $T_{CASE} = 25\text{ °C}$  unless otherwise specified)

**Table 4. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage, ( $V_{GS} = 0$ )	$I_D = 1\text{ mA}$	1200			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 1200\text{ V}$			1	$\mu\text{A}$
		$V_{DS} = 1200\text{ V}$ , $T_C = 125\text{ °C}$			50	$\mu\text{A}$
$I_{GSS}$	Gate body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 100\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}$ , $I_D = 6\text{ A}$		0.62	0.69	$\Omega$

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	1370	-	pF
$C_{oss}$	Output capacitance		-	110	-	pF
$C_{rss}$	Reverse transfer capacitance		-	0.6	-	pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance, time-related	$V_{GS} = 0$ , $V_{DS} = 0\text{ to }960\text{ V}$	-	128	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance, energy-related		-	42	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , $I_D = 0$	-	3.5	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 960\text{ V}$ , $I_D = 6\text{ A}$ $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 18</a> )	-	44.2	-	nC
$Q_{gs}$	Gate-source charge		-	7.3	-	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 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 600\text{ V}$ , $I_D = 6\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 20</a> )	-	23	-	ns
$t_r$	Rise time		-	11	-	ns
$t_{d(off)}$	Turn-off delay time		-	68.5	-	ns
$t_f$	Fall time		-	18.5	-	ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		12	A
$I_{SDM}$	Source-drain current (pulsed)		-		48	A
$V_{SD}^{(1)}$	Forward on voltage	$I_{SD} = 12\text{ A}$ , $V_{GS} = 0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 12\text{ A}$ , $V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ , (see <a href="#">Figure 19</a> )	-	630		ns
$Q_{rr}$	Reverse recovery charge		-	12.6		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	40		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 12\text{ A}$ , $V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$ , $T_j = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 19</a> )	-	892		ns
$Q_{rr}$	Reverse recovery charge		-	15.6		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	35		A

1. 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
$V_{(BR)GSO}$	Gate-source breakdown voltage	$I_{GS} = \pm 1\text{ mA}$ , $I_D = 0$	30	-		V

The built-in back-to-back Zener diodes have been specifically designed to enhance the ESD capability of the device. The Zener voltage is appropriate for efficient and cost-effective intervention to protect the device integrity. These integrated Zener diodes thus eliminate the need for external components.

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220FP

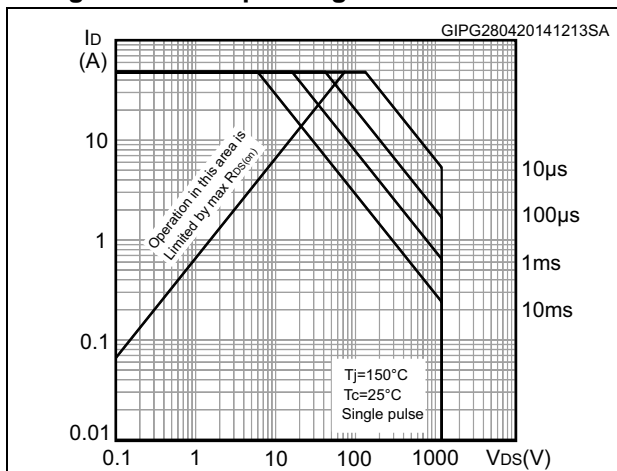


Figure 3. Thermal impedance for TO-220FP

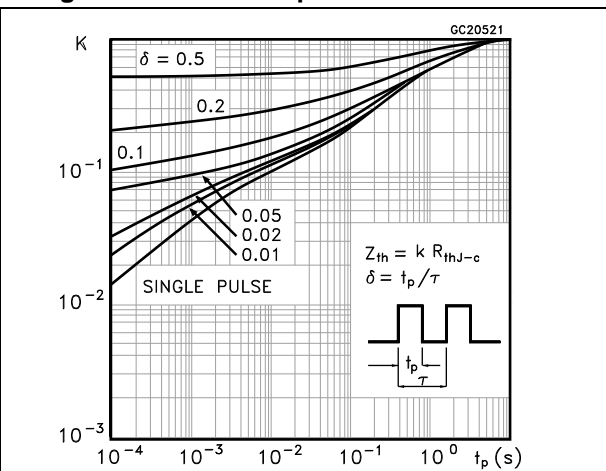


Figure 4. Safe operating area for TO-3PF

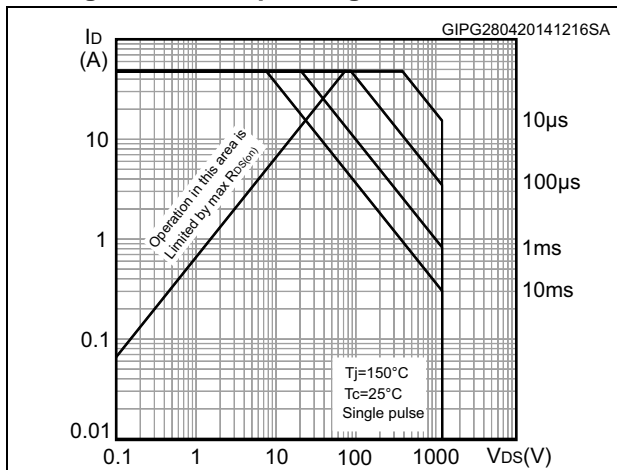


Figure 5. Thermal impedance for TO-3PF

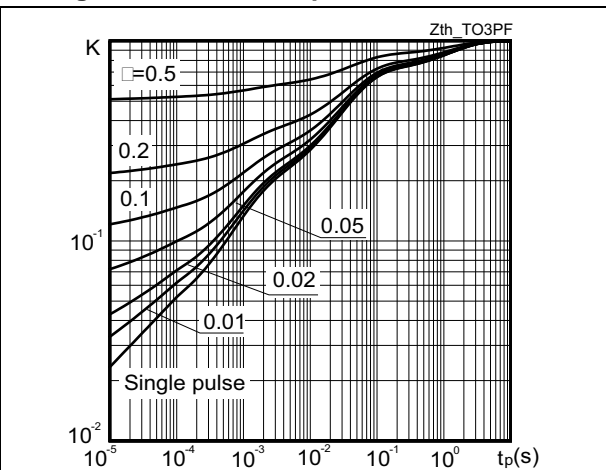


Figure 6. Output characteristics

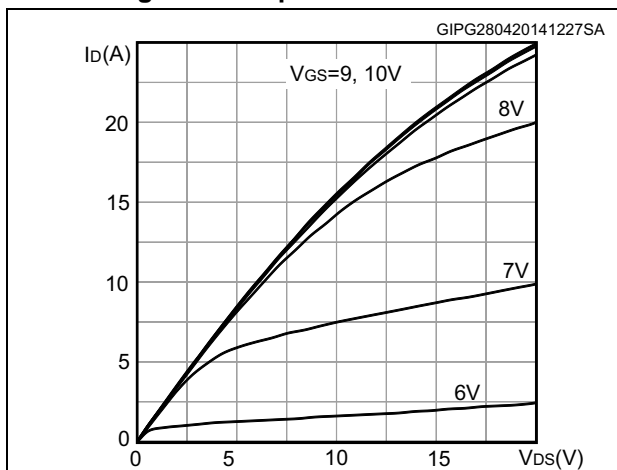


Figure 7. Transfer characteristics

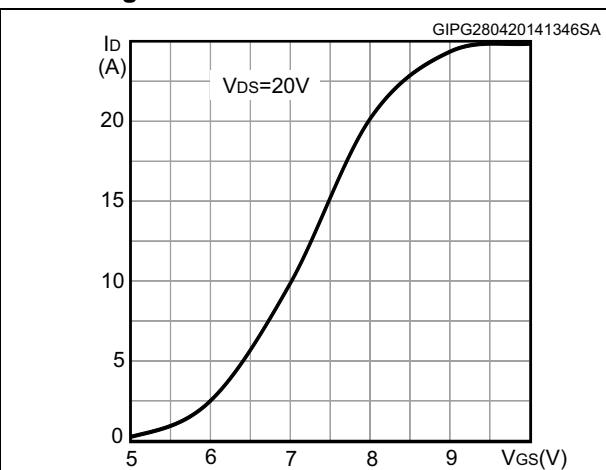


Figure 8. Gate charge vs gate-source voltage

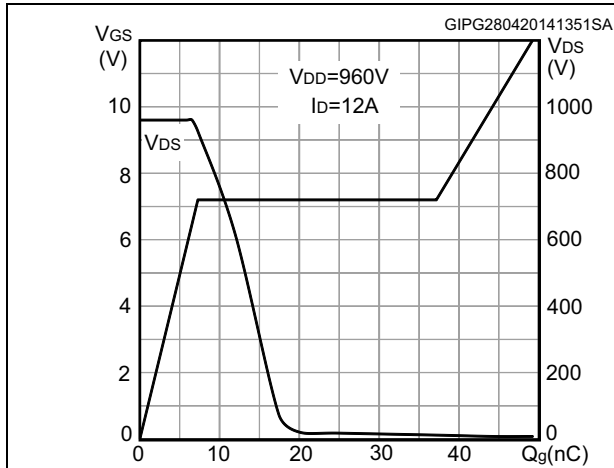


Figure 9. Static drain-source on-resistance

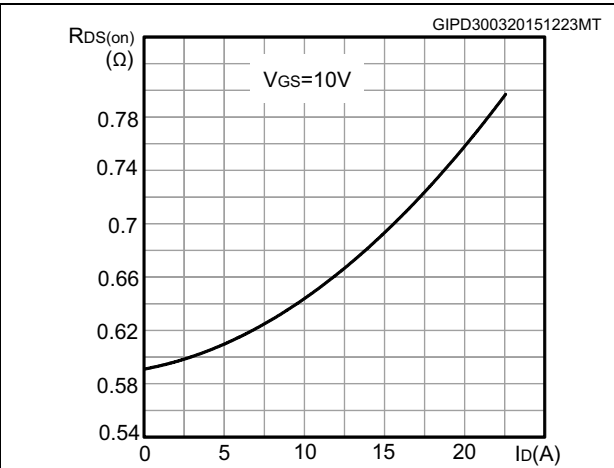


Figure 10. Capacitance variations

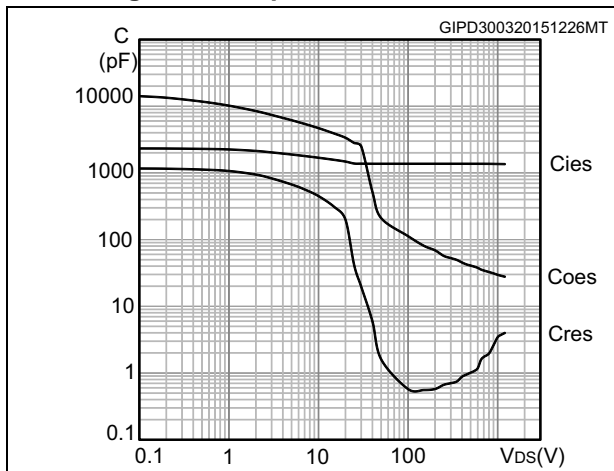


Figure 11. Output capacitance stored energy

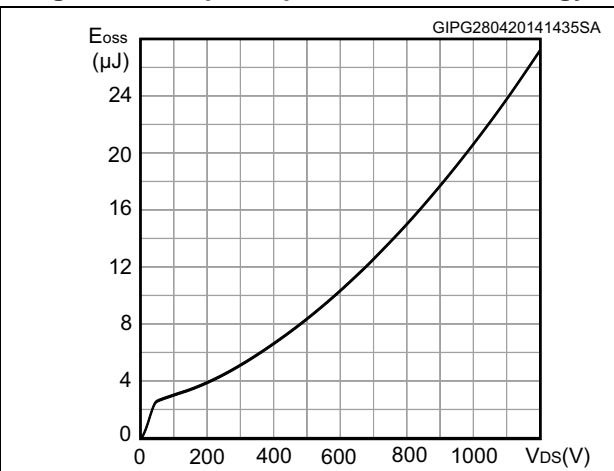


Figure 12. Normalized gate threshold voltage vs temperature

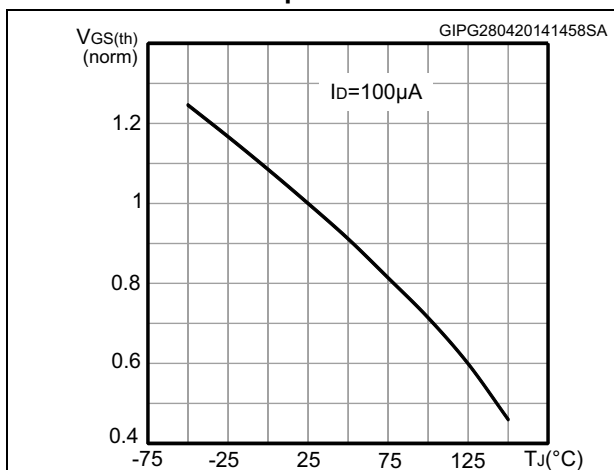


Figure 13. Normalized on-resistance vs temperature

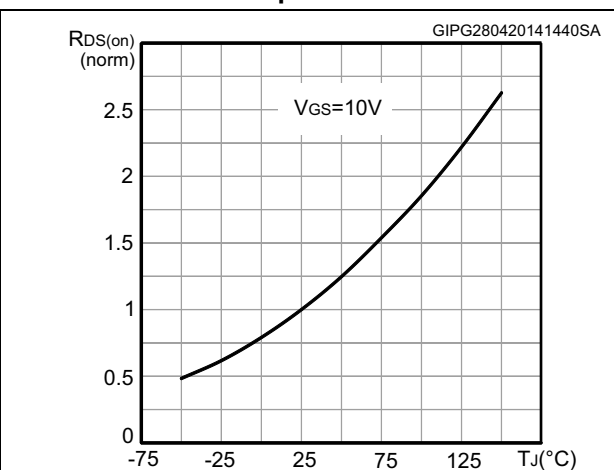


Figure 14. Normalized  $V_{(BR)DSS}$  vs temperature

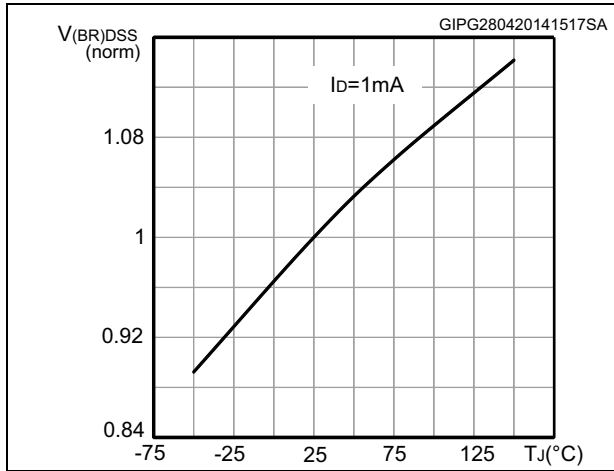


Figure 15. Source-drain diode forward characteristics

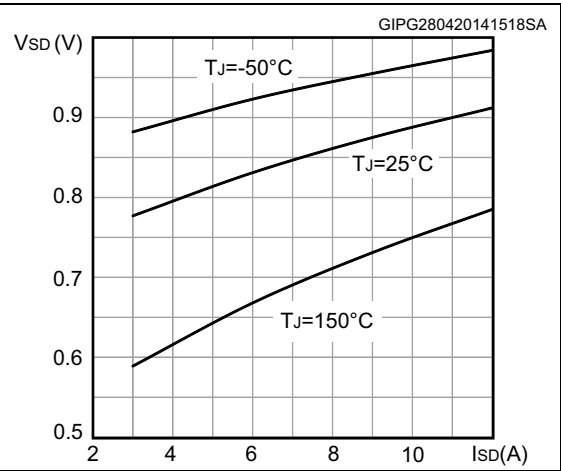
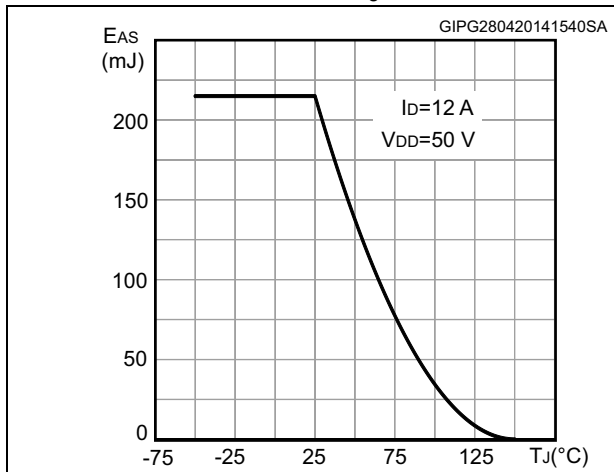


Figure 16. Maximum avalanche energy vs starting  $T_J$





### 3 Test circuits

Figure 17. Switching time test circuit for resistive load

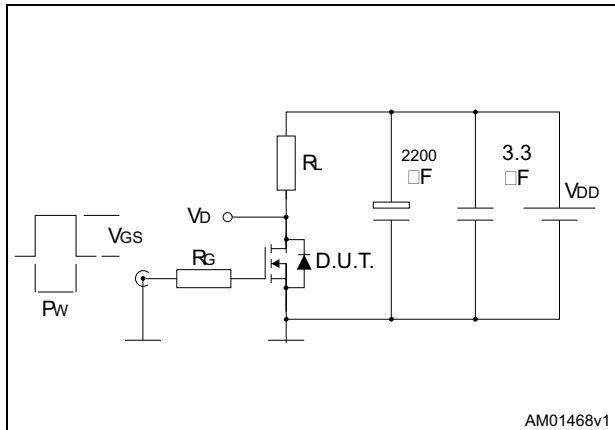


Figure 18. Gate charge test circuit

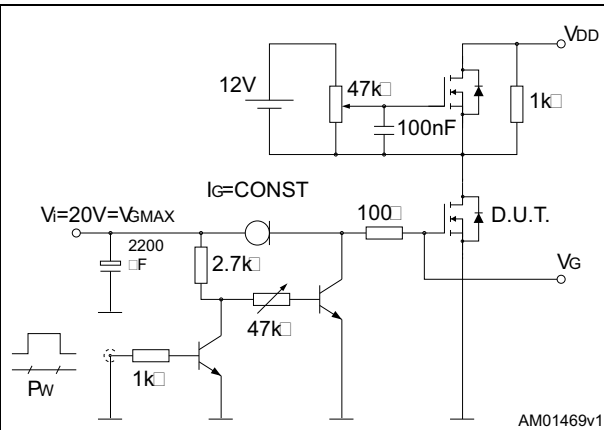


Figure 19. Test circuit for inductive load switching and diode recovery times

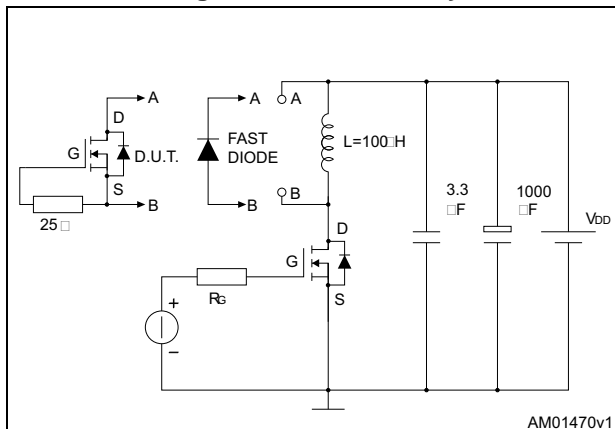


Figure 20. Unclamped inductive load test circuit

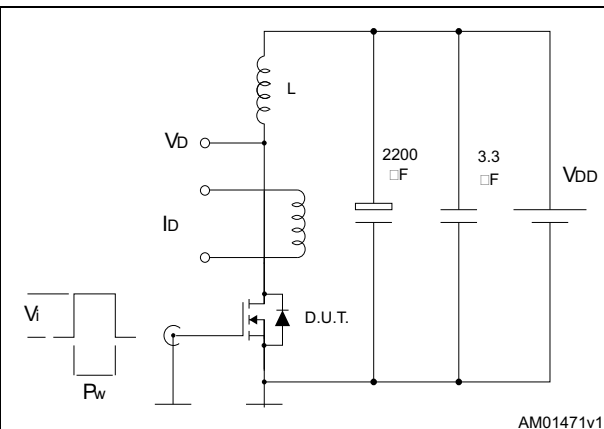


Figure 21. Unclamped inductive waveform

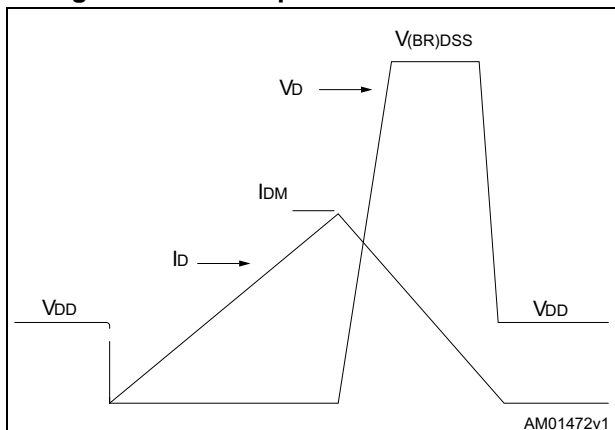
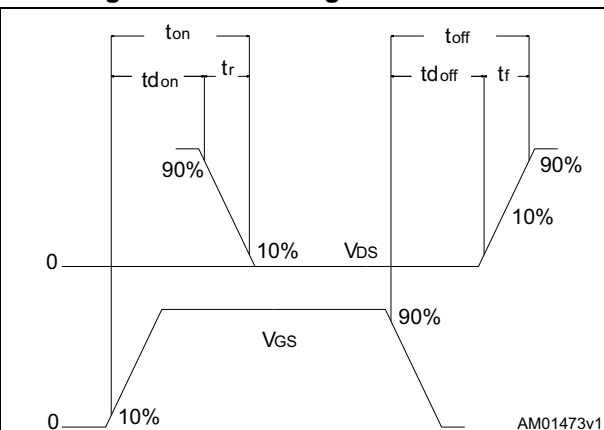


Figure 22. Switching time waveform

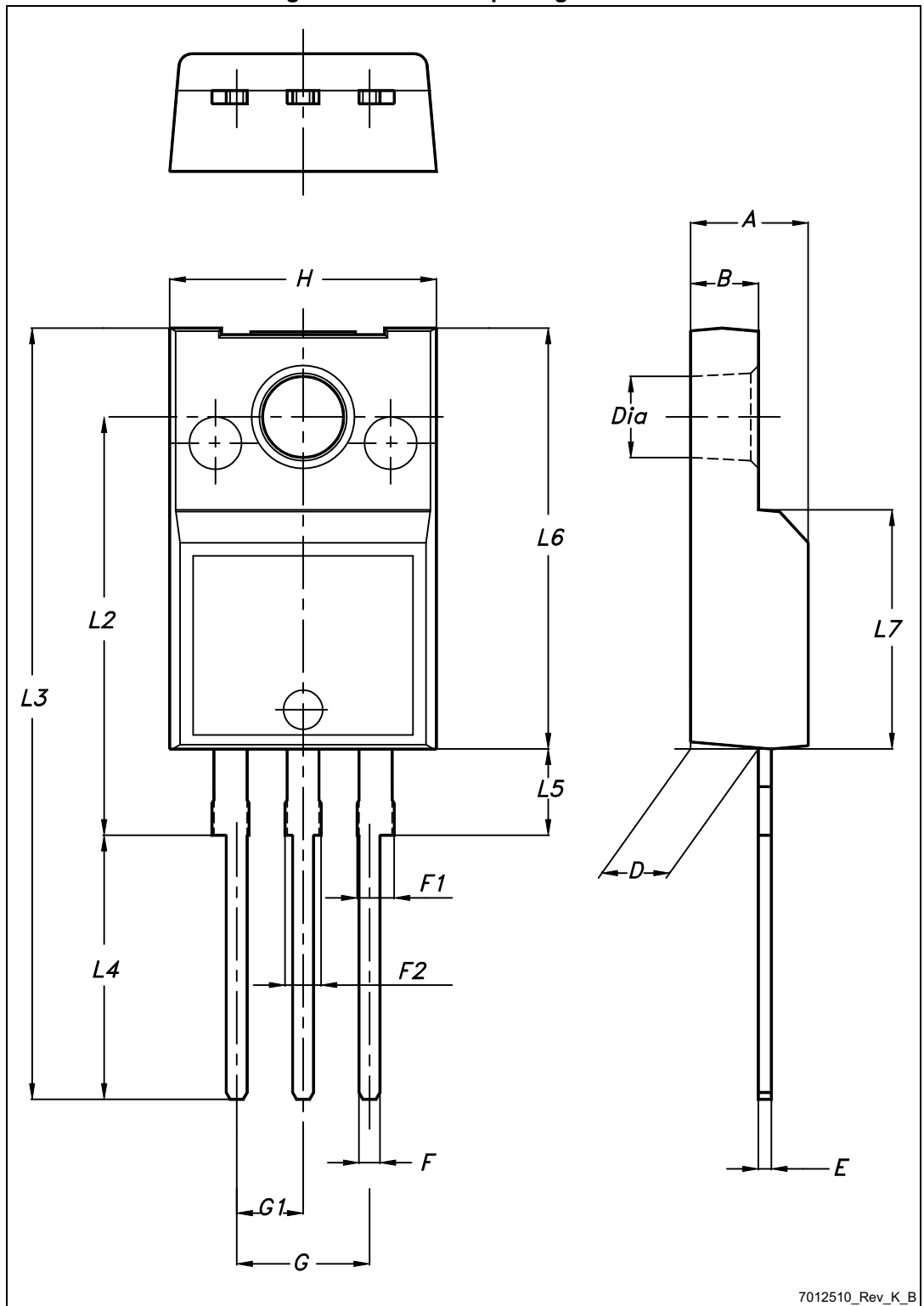


## 4 Package information

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, package outline

Figure 23. TO-220FP package outline



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
Ø	3		3.2

### 4.2 TO-3PF, package outline

Figure 24. TO-3PF package outline

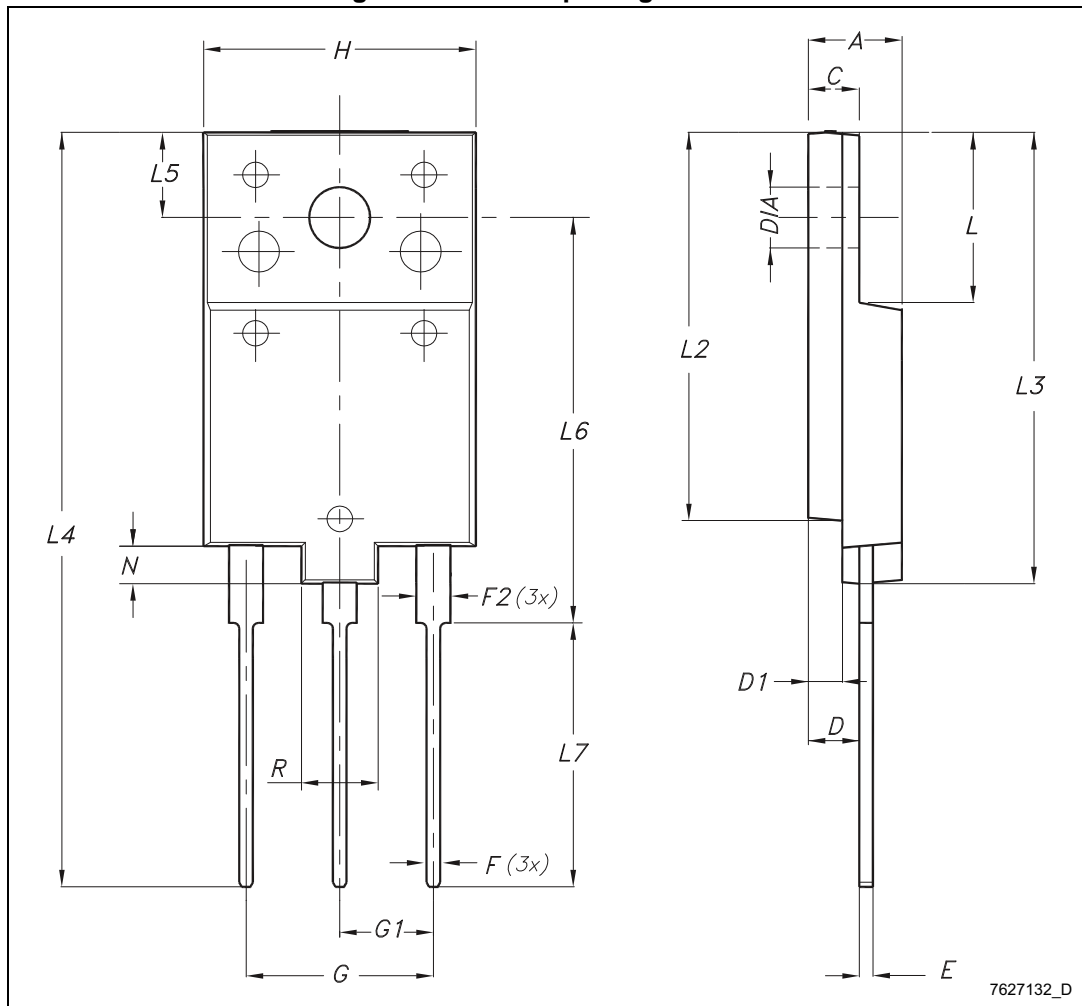


Table 10. TO-3PF mechanical data

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
∅	3.40		3.80

## 5 Revision history

**Table 11. Document revision history**

Date	Revision	Changes
22-May-2014	1	First release. Part number (STFW12N120K5) previously included in datasheet DocID022133
11-May-2015	2	Updated title, features and description. Updated <a href="#">Table 4.: On/off states</a> and <a href="#">Table 5.: Dynamic</a> . Updated <a href="#">Figure 9.: Static drain-source on-resistance</a> and <a href="#">Figure 10.: Capacitance variations</a> Minor text changes.

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