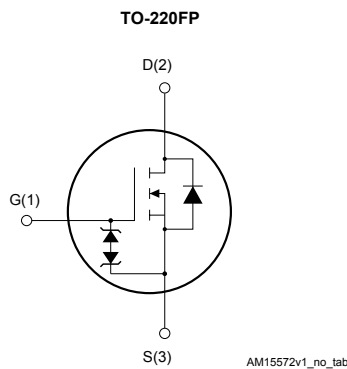
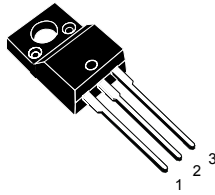


## N-channel 900 V, 0.21 $\Omega$ typ., 20 A MDmesh™ K5 Power MOSFET in a TO-220FP package



### Product status link

[STF20N90K5](#)

### Product summary

<b>Order code</b>	STF20N90K5
<b>Marking</b>	20N90K5
<b>Package</b>	TO-220FP
<b>Packing</b>	Tube

### Features

Order code	$V_{DS}$	$R_{DS(on)}$ max.	$I_D$
STF20N90K5	900 V	0.25 $\Omega$	20 A

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

### Applications

- Switching applications

### Description

This very high voltage N-channel Power MOSFET is 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.

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate-source voltage	±30	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ °C}$	20	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ °C}$	13	A
$I_D^{(1)}$	Drain current (pulsed)	80	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	40	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	V
$dv/dt^{(2)}$	Peak diode recovery voltage slope	4.5	V/ns
$dv/dt^{(3)}$	MOSFET $dv/dt$ ruggedness	50	
$T_J$	Operating junction temperature range	-55 to 150	°C
$T_{stg}$	Storage temperature range		

1. Pulse width limited by safe operating area.
2.  $I_{SD} \leq 20\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} \leq V_{(BR)DSS}$ ,  $V_{DD} = 450\text{ V}$ .
3.  $V_{DS} \leq 720\text{ V}$ .

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj\text{-case}}$	Thermal resistance junction-case	3.1	°C/W
$R_{thj\text{-amb}}$	Thermal resistance junction-ambient	62.5	°C/W

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$ )	6.5	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j = 25\text{ °C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	500	mJ

## 2 Electrical characteristics

$T_C = 25\text{ °C}$  unless otherwise specified

**Table 4. On/off-state**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$	900			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 900\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 900\text{ V}$ $T_C = 125\text{ °C}$ <sup>(1)</sup>			50	$\mu\text{A}$
$I_{GSS}$	Gate body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 20\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DD} = V_{GS}$ , $I_D = 100\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$ , $I_D = 10\text{ A}$		0.21	0.25	$\Omega$

1. Defined by design, not subject to production test.

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	1500	-	pF
$C_{oss}$	Output capacitance		-	120	-	pF
$C_{riss}$	Reverse transfer capacitance		-	1	-	pF
$C_{o(er)}$ <sup>(1)</sup>	Equivalent capacitance energy related	$V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ to }720\text{ V}$	-	78	-	pF
$C_{o(tr)}$ <sup>(2)</sup>	Equivalent capacitance time related		-	220	-	pF
$R_g$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , $I_D = 0\text{ A}$	-	3.7	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 720\text{ V}$ , $I_D = 20\text{ A}$	-	40	-	nC
$Q_{gs}$	Gate-source charge	$V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 14. Test circuit for gate charge behavior)	-	14	-	nC
$Q_{gd}$	Gate-drain charge		-	17	-	nC

1.  $C_{o(er)}$  is a constant capacitance value that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

2.  $C_{o(tr)}$  is a constant capacitance value that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising 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	$V_{DD} = 450\text{ V}$ , $I_D = 10\text{ A}$ , $R_G = 4.7\text{ }\Omega$	-	20.2	-	ns
$t_r$	Rise time		-	13.5	-	ns
$t_{d(off)}$	Turn-off delay time	$V_{GS} = 10\text{ V}$ (see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform)	-	64.7	-	ns
$t_f$	Fall time		-	16	-	ns

**Table 7. Source-drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		20	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		80	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 20\text{ A}$ , $V_{GS} = 0\text{ V}$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 20\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,	-	517		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60\text{ V}$ (see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	11.4		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	44		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 20\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ ,	-	674		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60\text{ V}$ ,	-	14		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	$T_j = 150\text{ }^\circ\text{C}$ (see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	41.6		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
$V_{(BR)GSO}$	Gate-source breakdown voltage	$I_{GS} = \pm 1\text{ mA}$ , $I_D = 0\text{ A}$	30	-	-	V

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

## 2.1 Electrical characteristics (curves)

Figure 1. Safe operating area

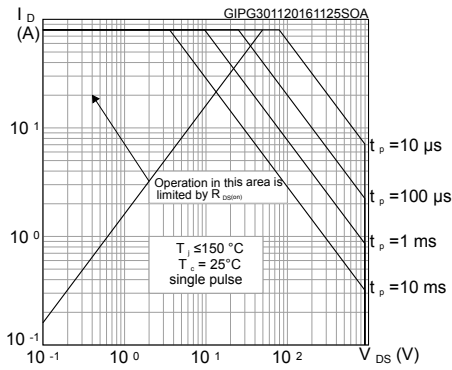


Figure 2. Thermal impedance

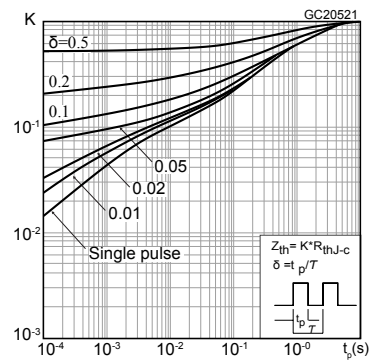


Figure 3. Output characteristics

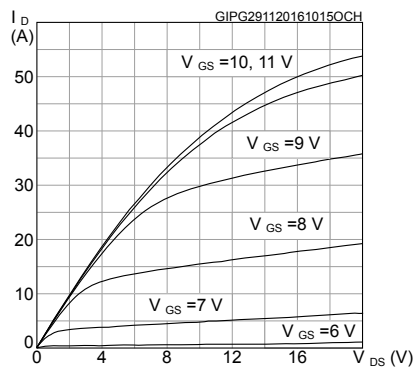


Figure 4. Transfer characteristics

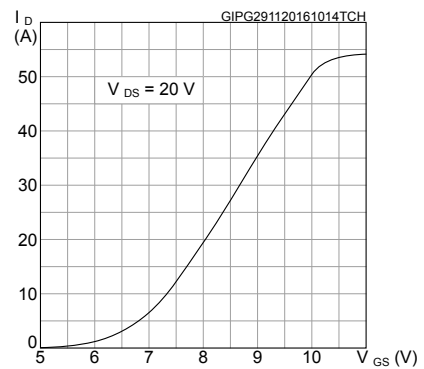


Figure 5. Normalized  $V_{(BR)DSS}$  vs temperature

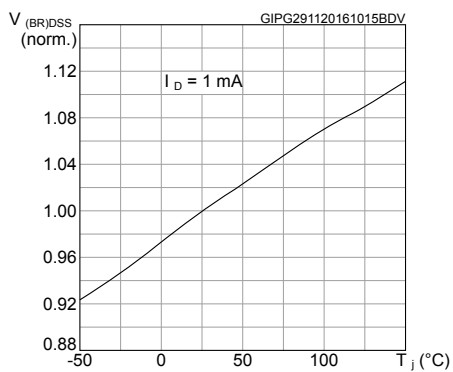
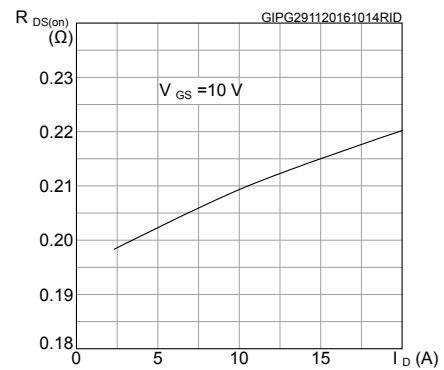
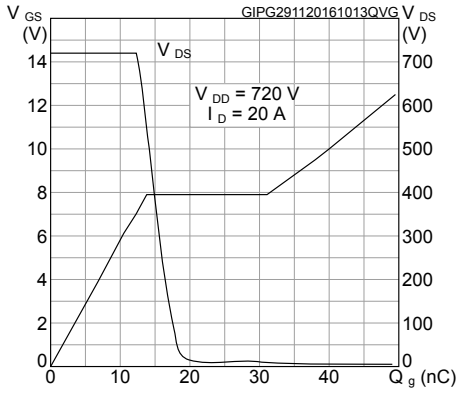


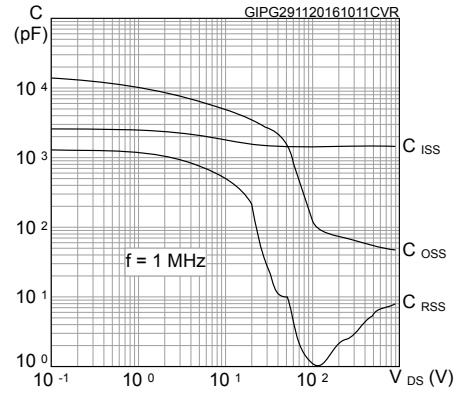
Figure 6. Static drain-source on-resistance



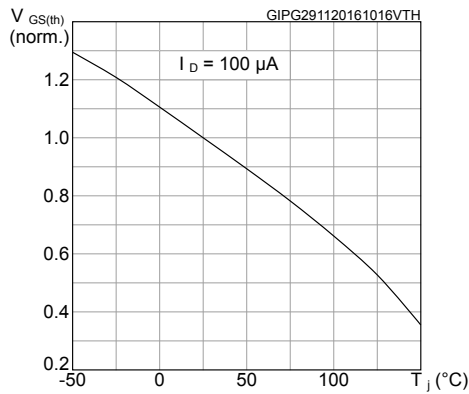
**Figure 7. Gate charge vs gate-source voltage**



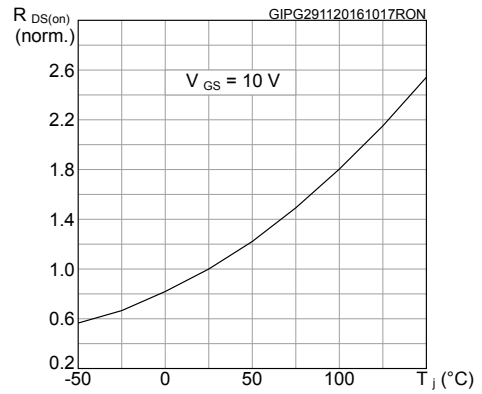
**Figure 8. Capacitance variation**



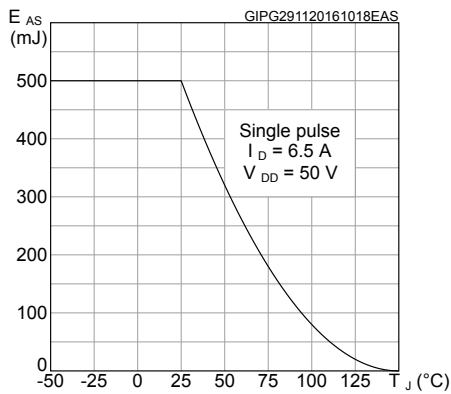
**Figure 9. Normalized gate threshold voltage vs temperature**



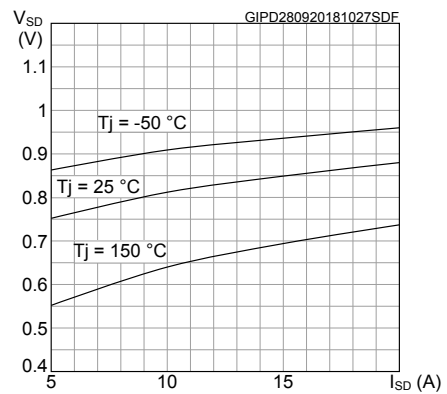
**Figure 10. Normalized on-resistance vs temperature**



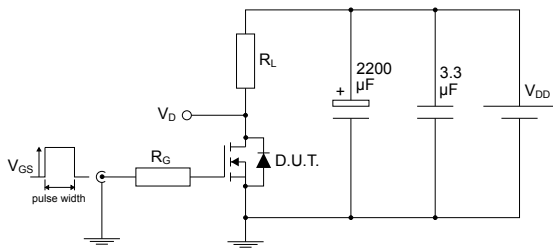
**Figure 11. Maximum avalanche energy vs. starting T<sub>j</sub>**



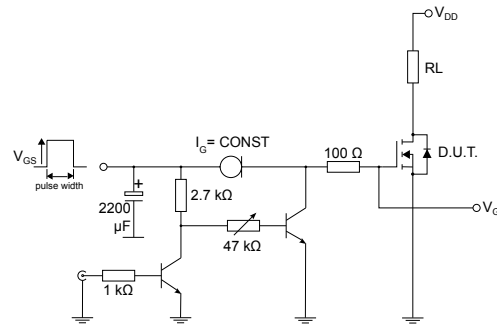
**Figure 12. Source-drain diode forward characteristics**



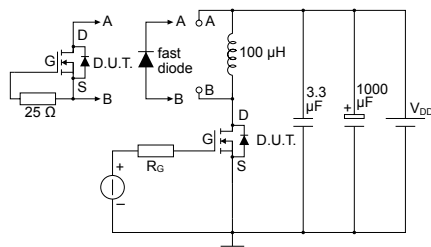
### 3 Test circuits

**Figure 13. Test circuit for resistive load switching times**


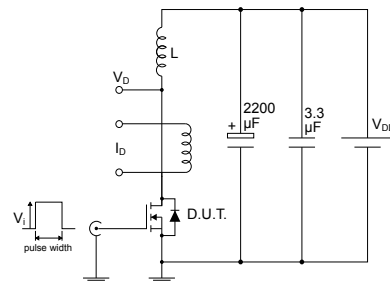
AM01468v1

**Figure 14. Test circuit for gate charge behavior**


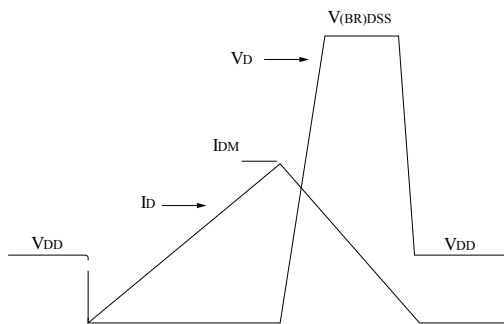
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**Figure 15. Test circuit for inductive load switching and diode recovery times**


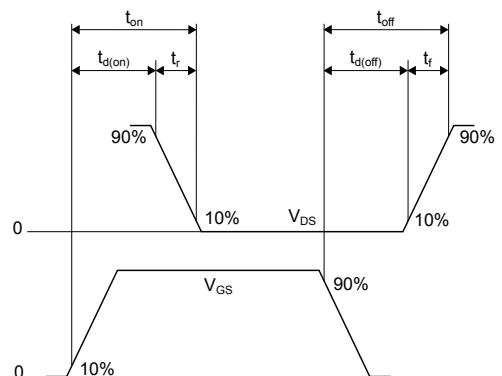
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**Figure 16. Unclamped inductive load test circuit**


AM01471v1

**Figure 17. Unclamped inductive waveform**


AM01472v1

**Figure 18. Switching time waveform**


AM01473v1

## 4 Package information

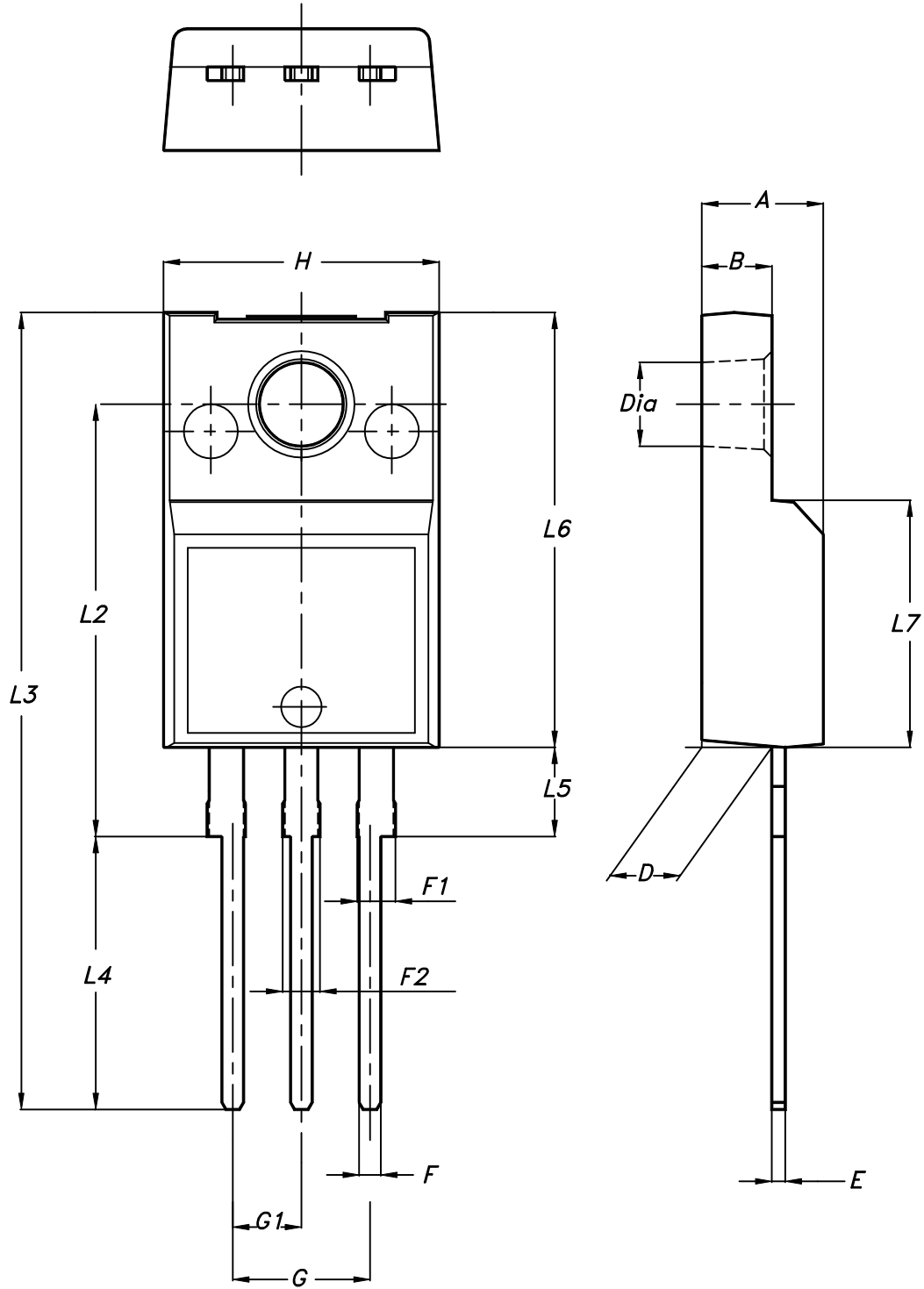
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In order to meet environmental requirements, ST offers these devices in different grades of **ECOPACK®** packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.



### 4.1 TO-220FP package information

Figure 19. TO-220FP package outline



7012510\_Rev\_12\_B

**Table 9. TO-220FP package 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

## Revision history

**Table 10. Document revision history**

Date	Revision	Changes
11-May-2016	1	First release.
01-Dec-2016	2	Modified title and $R_{DS(on)}$ in features table Modified <i>Table 4: "Avalanche characteristics"</i> , <i>Table 5: "On/off-state"</i> , <i>Table 6: "Dynamic"</i> , <i>Table 7: "Switching times"</i> and <i>Table 8: "Sourcedrain diode"</i> Added <i>Section 2.1: "Electrical characteristics (curves)"</i> Modified <i>Section 3: "Test circuits"</i> Datasheet promoted from preliminary data to production data Minor text changes
21-Jan-2017	3	Modified $R_{DS(on)}$ max. value on cover page Minor text changes
05-Oct-2018	4	Removed maturity status indication from cover page. Added <a href="#">Figure 12. Source-drain diode forward characteristics</a> . Minor text changes

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