



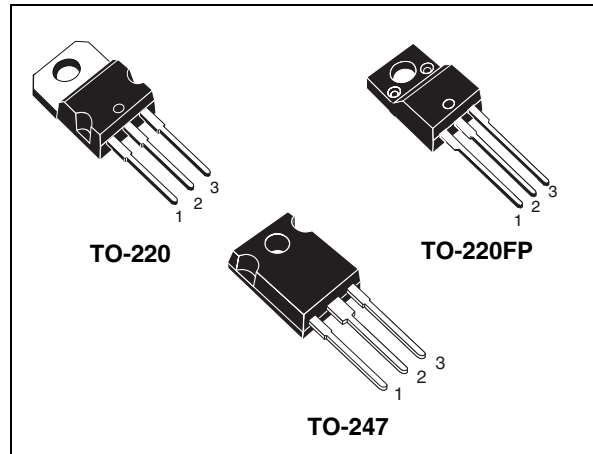
STF21N90K5 STP21N90K5, STW21N90K5

N-channel 900 V, 0.25 Ω , 17 A TO-220, TO-220FP, TO-247
Zener-protected SuperMESH5™ Power MOSFET

Features

Type	V _{DSS}	R _{DS(on)} max	I _D	P _W
STF21N90K5	900 V	< 0.299 Ω	17 A	40 W
STP21N90K5				210 W
STW21N90K5				

- TO-220 worldwide best R_{DS(on)}
- Worldwide best FOM (figure of merit)
- Ultra low gate charge
- 100% avalanche tested
- Zener-protected



Application

Switching applications

Description

These devices are N-channel SuperMESH5™, a revolutionary avalanche-rugged very high voltage Power MOSFET technology based on an innovative proprietary vertical structure. The result is a drastic reduction in on-resistance and ultra low gate charge for applications which require superior power density and high efficiency.

Figure 1. Internal schematic diagram

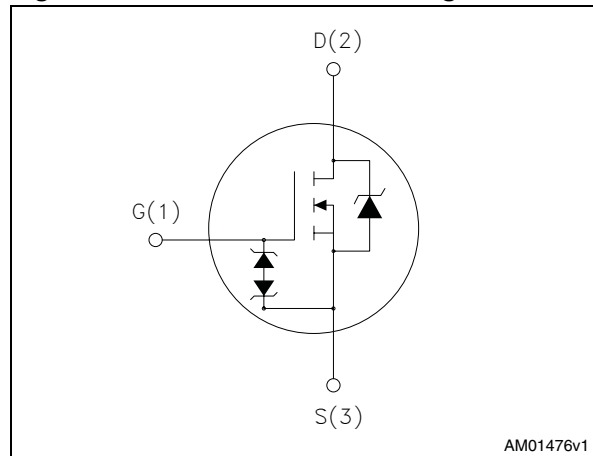


Table 1. Device summary

Order codes	Marking	Package	Packaging
STF21N90K5	21N90K5	TO-220FP	Tube
STP21N90K5		TO-220	
STW21N90K5		TO-247	

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220, TO-247	TO-220FP	
V_{GS}	Gate- source voltage	± 30		V
I_D	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	17	17 ⁽¹⁾	A
I_D	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	11	11 ⁽¹⁾	A
$I_{DM}^{(2)}$	Drain current (pulsed)	68	68 ⁽¹⁾	A
P_{TOT}	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	210	40	W
I_{AR}	Max current during repetitive or single pulse avalanche (pulse width limited by T_{jmax})	8		A
E_{AS}	Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$, $I_D = I_{AS}$, $V_{DD} = 50\text{ V}$)	170		mJ
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
$dv/dt^{(3)}$	Peak diode recovery voltage slope	4.5		V/ns
T_j T_{stg}	Operating junction temperature Storage temperature	-55 to 150		$^\circ\text{C}$

- Limited by package.
- Pulse width limited by safe operating area.
- $I_{SD} \leq 20\text{ A}$, $di/dt \leq 100\text{ A}/\mu\text{s}$, $V_{Peak} \leq V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		TO-220	TO-247	TO-220FP	
$R_{thj-case}$	Thermal resistance junction-case max	0.60		3.13	$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-amb max	62.5	50	62.5	$^\circ\text{C}/\text{W}$
T_l	Maximum lead temperature for soldering purpose	300			$^\circ\text{C}$

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	$I_D = 1\text{ mA}, V_{GS} = 0$	900			V
I_{DSS}	Zero gate voltage drain current ($V_{GS} = 0$)	$V_{DS} = \text{max rating},$ $V_{DS} = \text{Max rating}, T_c = 125\text{ °C}$			1 50	μA μA
I_{GSS}	Gate body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 20\text{ V}$			± 10	μA
$V_{GS(th)}$	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	$V_{GS} = 10\text{ V}, I_D = 9\text{ A}$		0.25	0.299	Ω

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit		
C_{iss}	Input capacitance			1645		pF		
C_{oss}	Output capacitance	$V_{DS} = 100\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$	-	112	-	pF		
C_{rss}	Reverse transfer capacitance						2	pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{GS} = 0, V_{DS} = 0\text{ to }720\text{ V}$	-	133	-	pF		
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related						16	pF
R_G	Intrinsic gate resistance	$f = 1\text{ MHz open drain}$	-	4	-	Ω		
Q_g	Total gate charge	$V_{DD} = 450\text{ V}, I_D = 10\text{ A}$ $V_{GS} = 10\text{ V}$ (see Figure 20)	-	43	-	nC		
Q_{gs}	Gate-source charge						12	nC
Q_{gd}	Gate-drain charge						25	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	$V_{DD} = 450\text{ V}$, $I_D = 10\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 22)		17		ns	
t_r	Rise time		-	27	-	ns	
$t_{d(off)}$	Turn-off delay time				52		ns
t_f	Fall time				40		ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		17	A
I_{SDM}	Source-drain current (pulsed)				68	A
$V_{SD}^{(1)}$	Forward on voltage	$I_{SD} = 17\text{ A}$, $V_{GS} = 0$	-		1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 20\text{ A}$, $V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$, (see Figure 21)	-	548		ns
Q_{rr}	Reverse recovery charge				12	μC
I_{RRM}	Reverse recovery current				46	A
t_{rr}	Reverse recovery time	$I_{SD} = 20\text{ A}$, $V_{DD} = 60\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$, $T_J = 150\text{ }^\circ\text{C}$ (see Figure 21)	-	660		ns
Q_{rr}	Reverse recovery charge				15	μC
I_{RRM}	Reverse recovery current				45	A

1. Pulsed: pulse duration = 300 μs , 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 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-220

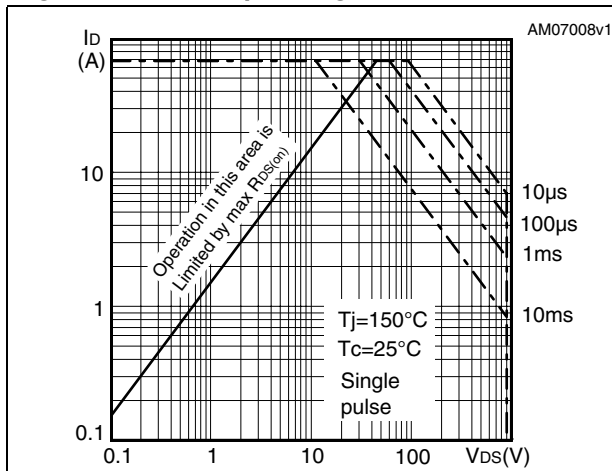


Figure 3. Thermal impedance for TO-220

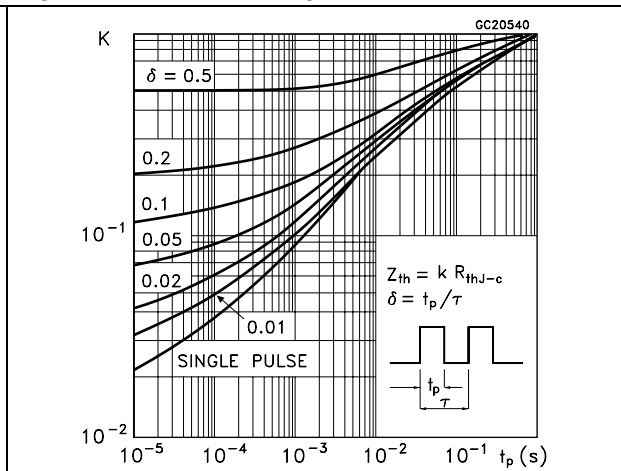


Figure 4. Safe operating area for TO-220FP

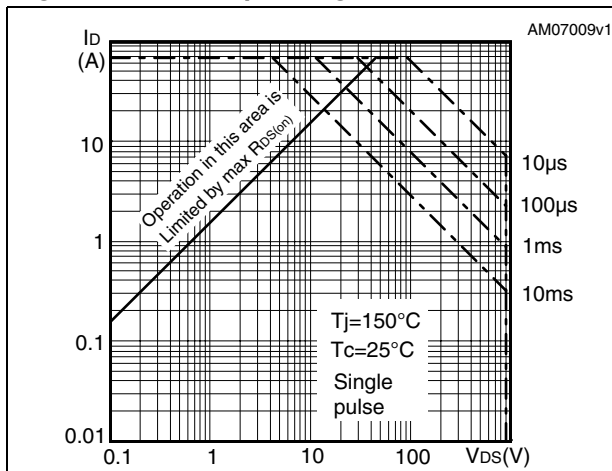


Figure 5. Thermal impedance for TO-220FP

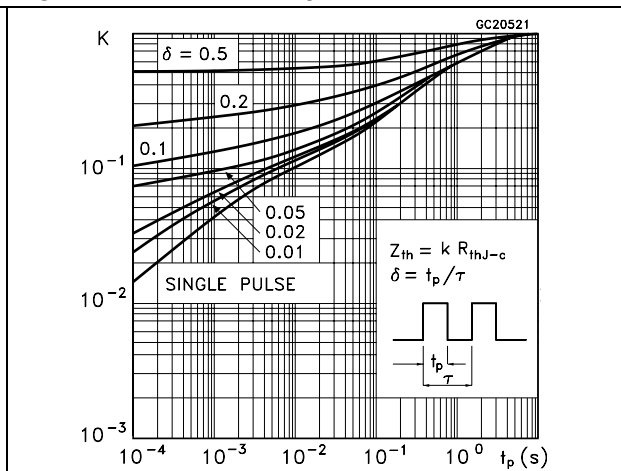


Figure 6. Safe operating area for TO-247

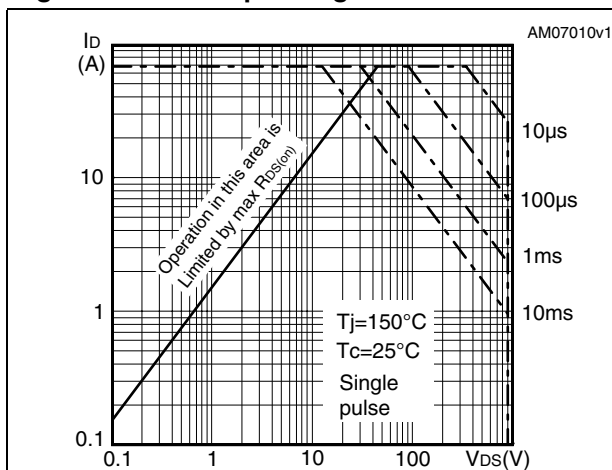


Figure 7. Thermal impedance for TO-247

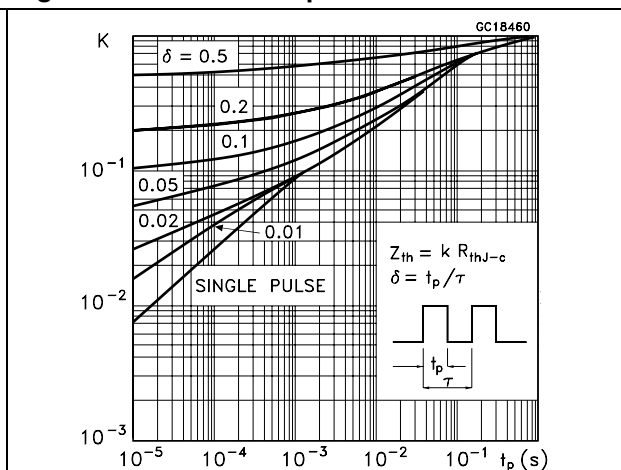


Figure 8. Output characteristics

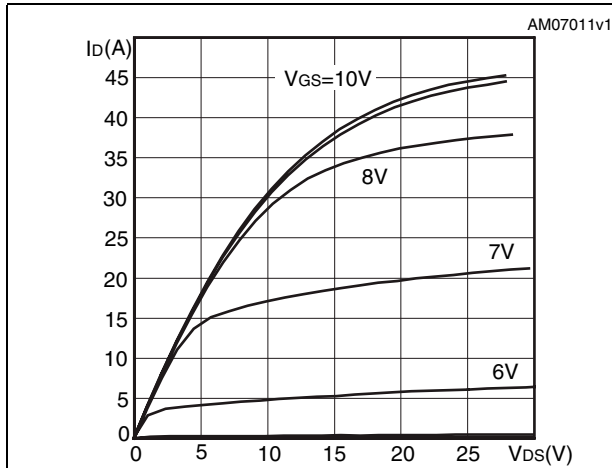


Figure 9. Transfer characteristics

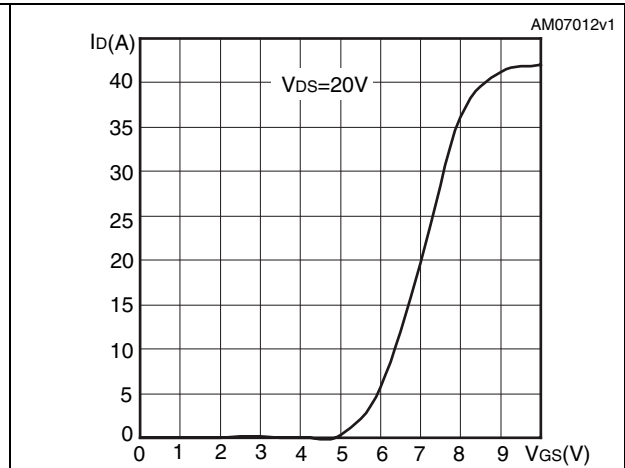


Figure 10. Gate charge vs gate-source voltage Figure 11. Static drain-source on resistance

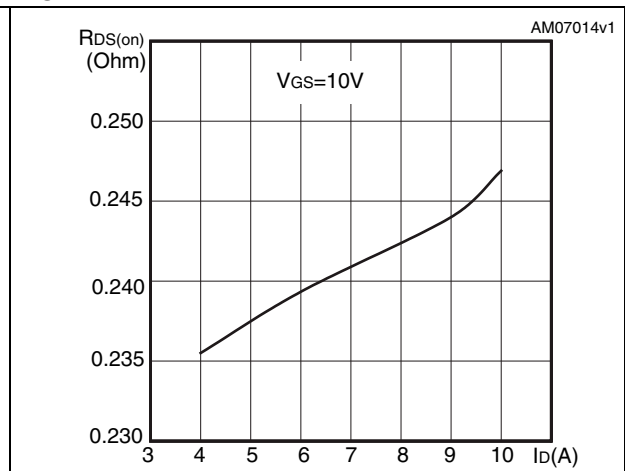
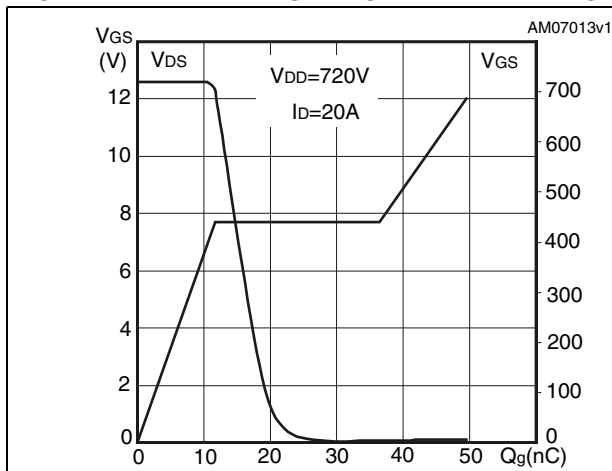


Figure 12. Capacitance variations

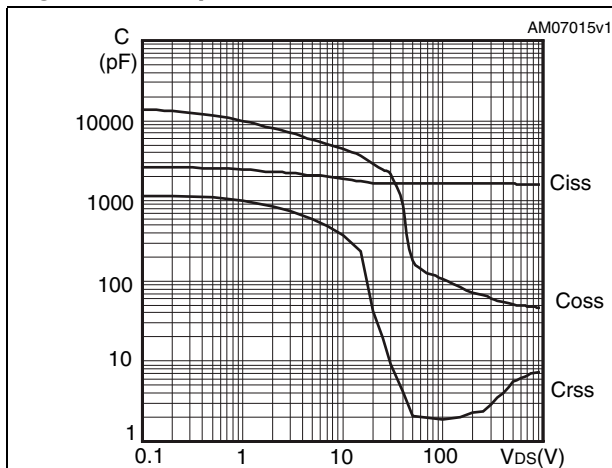


Figure 13. Output capacitance stored energy

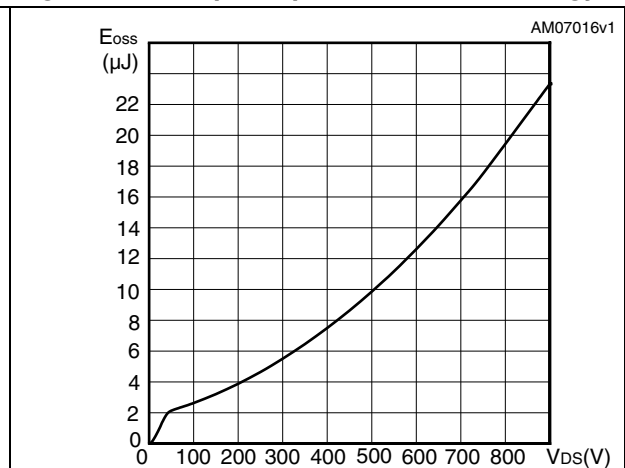


Figure 14. Normalized gate threshold voltage vs temperature

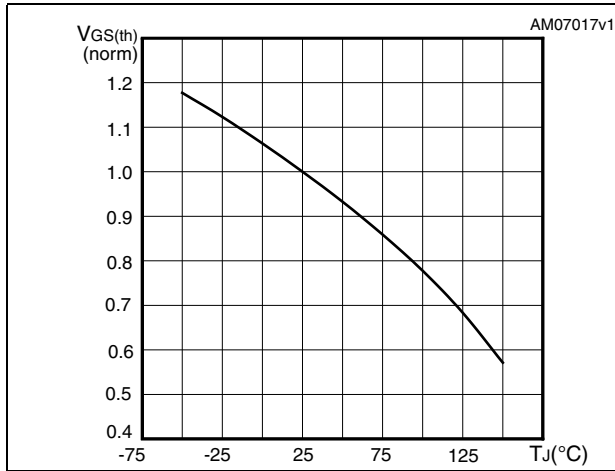


Figure 15. Normalized on resistance vs temperature

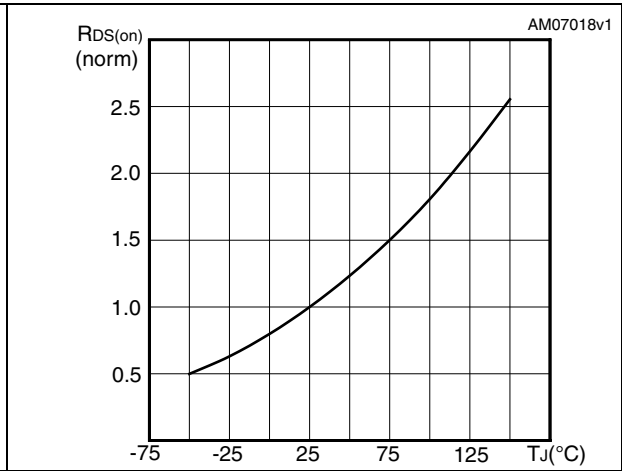


Figure 16. Source-drain diode forward characteristics

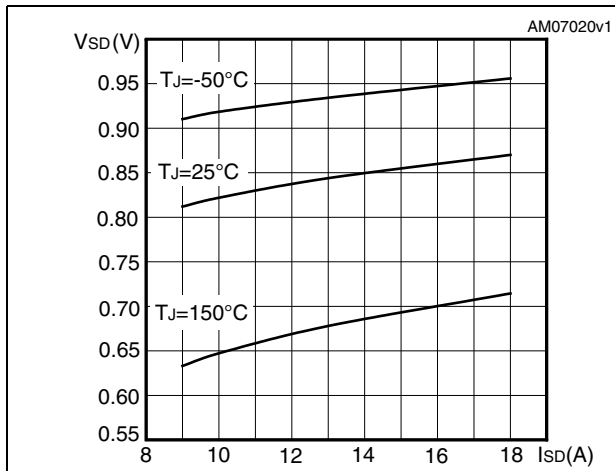


Figure 17. Normalized B_{VDSS} vs temperature

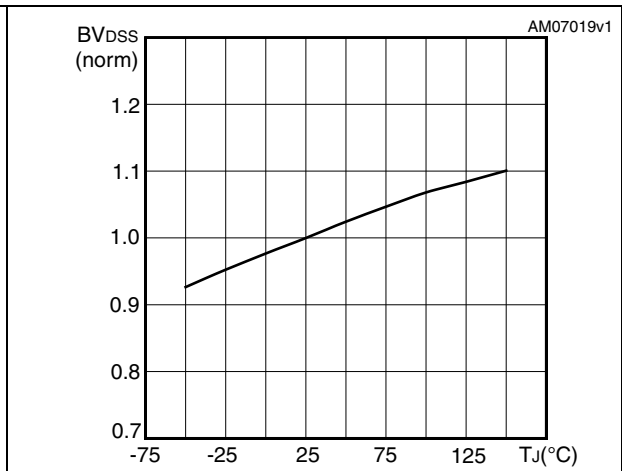
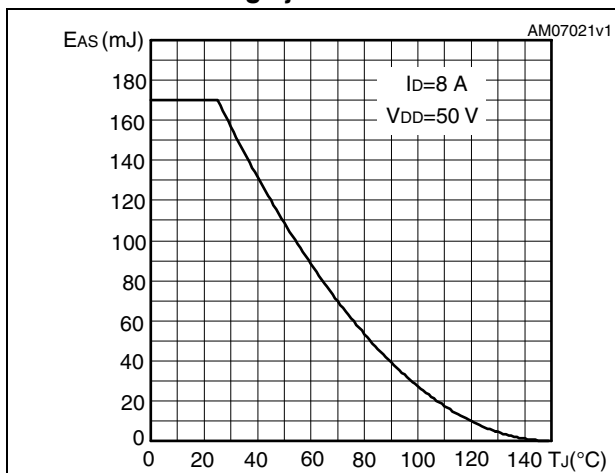
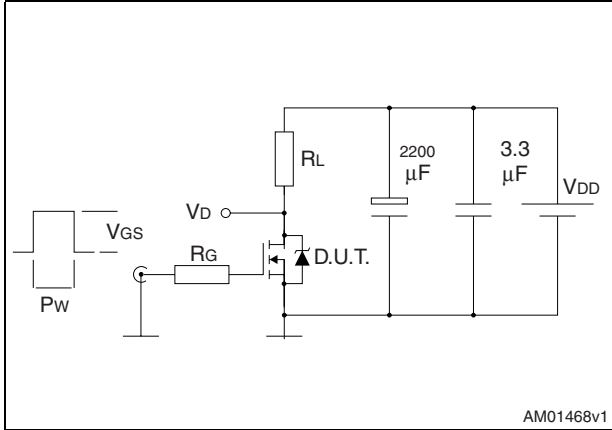


Figure 18. Maximum avalanche energy vs starting T_j



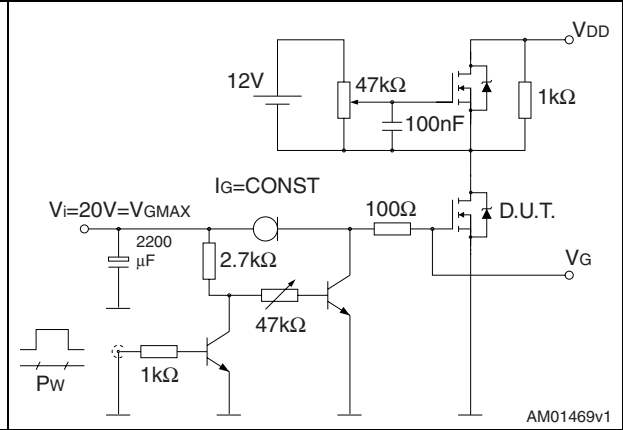
3 Test circuits

Figure 19. Switching times test circuit for resistive load



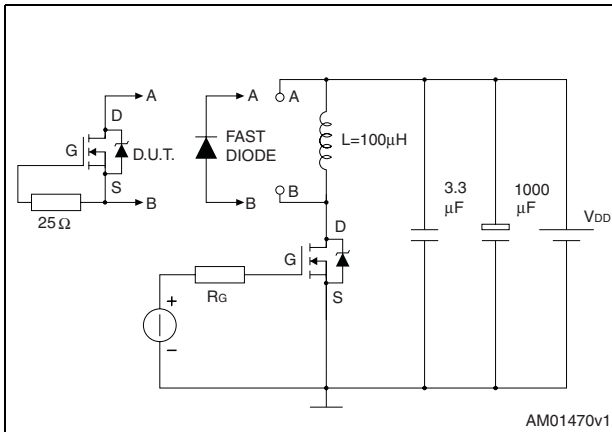
AM01468v1

Figure 20. Gate charge test circuit



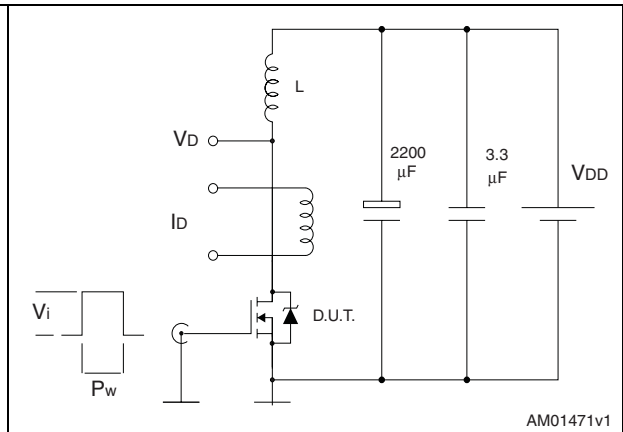
AM01469v1

Figure 21. Test circuit for inductive load switching and diode recovery times



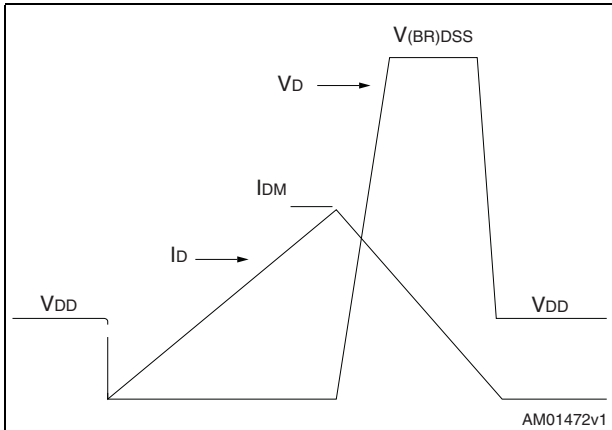
AM01470v1

Figure 22. Unclamped inductive load test circuit



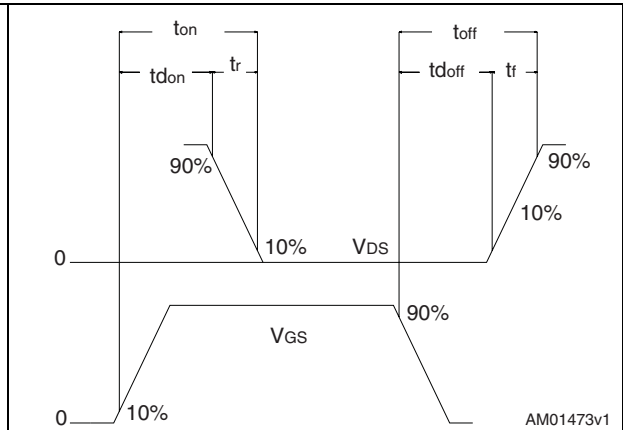
AM01471v1

Figure 23. Unclamped inductive waveform



AM01472v1

Figure 24. Switching time waveform



AM01473v1

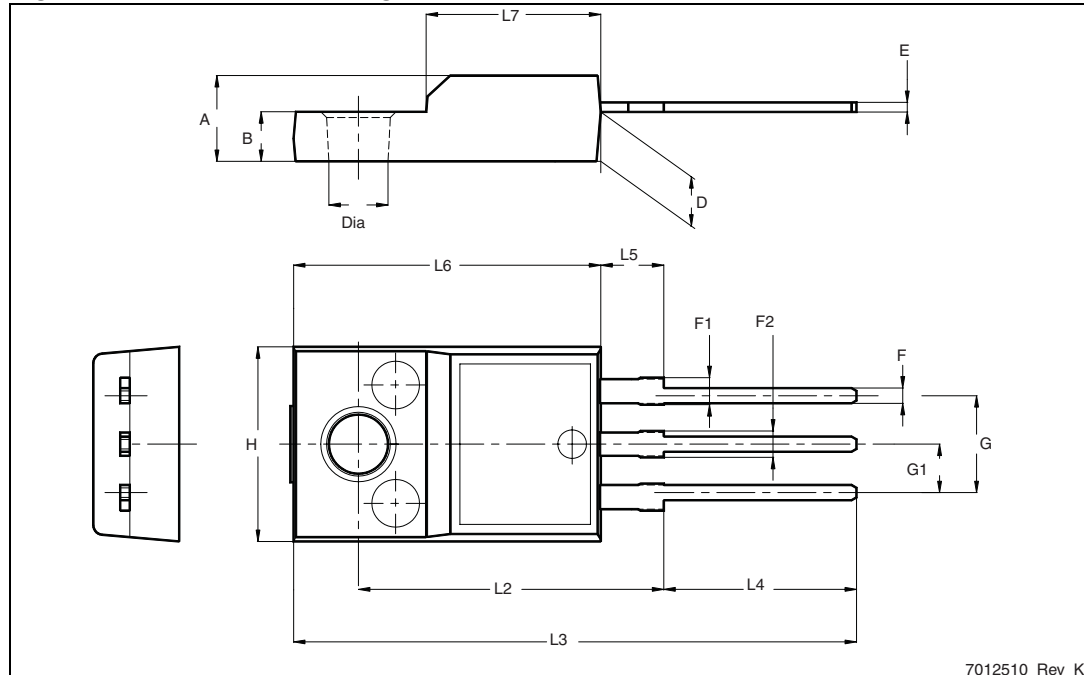
4 Package mechanical data

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

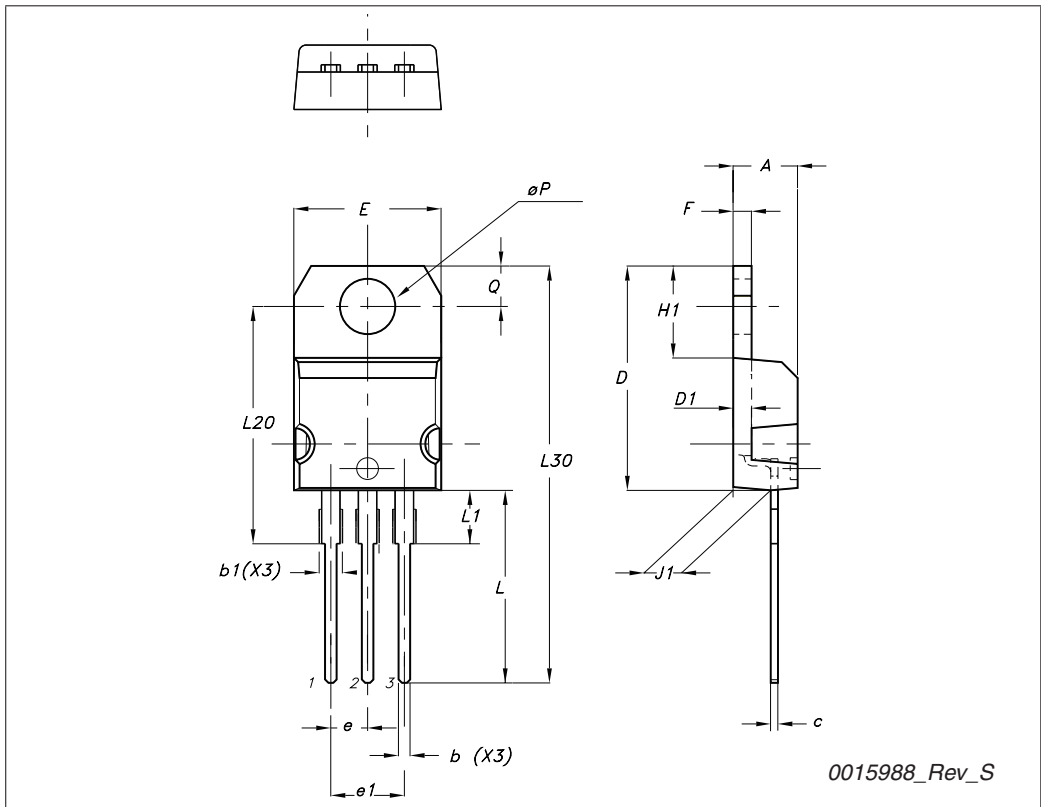
Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 25. TO-220FP drawing



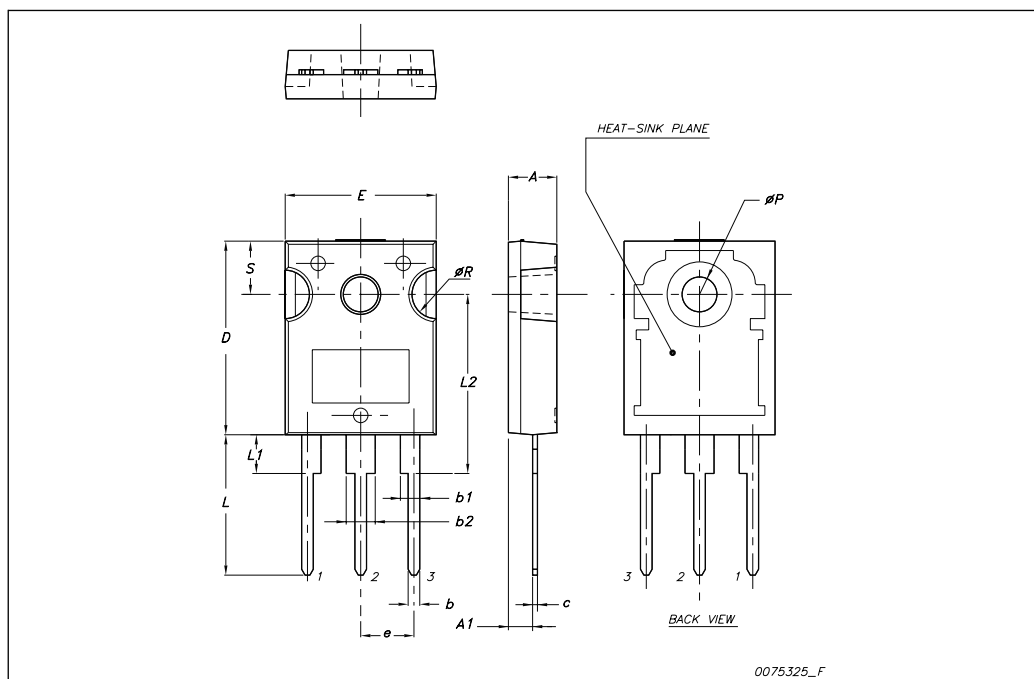
TO-220 type A mechanical data

Dim	mm		
	Min	Typ	Max
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
∅P	3.75		3.85
Q	2.65		2.95



TO-247 mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e		5.45	
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
øP	3.55		3.65
øR	4.50		5.50
S		5.50	



5 Revision history

Table 10. Document revision history

Date	Revision	Changes
05-Nov-2009	1	First release.
18-Nov-2009	2	Updated description on cover page
12-Jan-2010	3	Corrected V_{GS} value in Table 2: Absolute maximum ratings
14-Jul-2010	4	Document status promoted from preliminary data to datasheet

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