

N-channel 950 V, 0.41 Ω typ., 12 A SuperMESH™ 5 Power MOSFETs in TO-220FP, TO-220 and TO-247 packages

Datasheet - production data

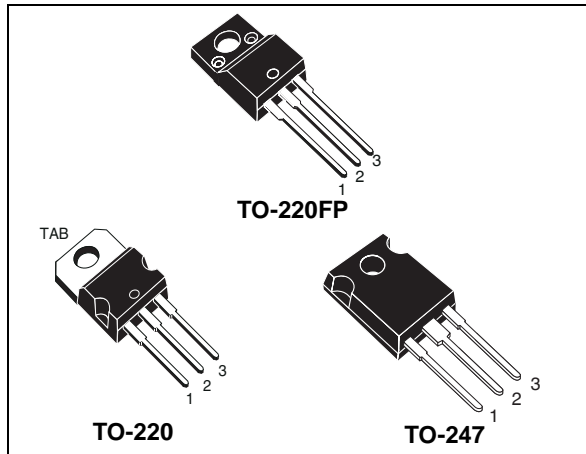
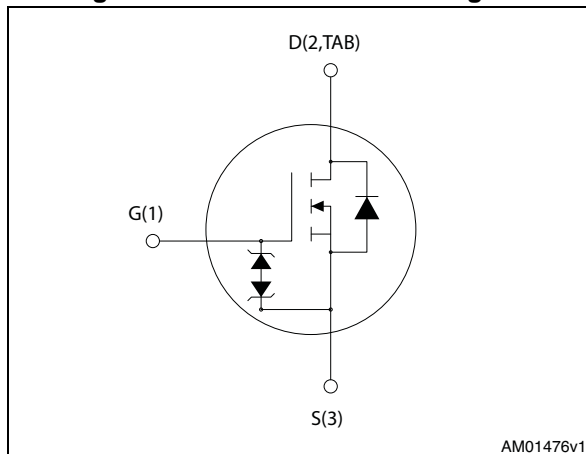


Figure 1. Internal schematic diagram



AM01476v1

Features

Order codes	V_{DS}	$R_{DS(on)max}$	I_D	P_{TOT}
STF15N95K5	950 V	0.5 Ω	12 A	30 W
STP15N95K5				170 W
STW15N95K5				170 W

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

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using SuperMESH™ 5 technology. This revolutionary, avalanche-rugged, high voltage Power MOSFET technology is 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.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STF15N95K5	15N95K5	TO-220FP	Tube
STP15N95K5	15N95K5	TO-220	
STW15N95K5	15N95K5	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 $T_C = 25\text{ °C}$	12	12 ⁽¹⁾	A
I_D	Drain current (continuous) at $T_C = 100\text{ °C}$	7.6	7.6 ⁽¹⁾	A
$I_{DM}^{(2)}$	Drain current (pulsed)	48	48 ⁽¹⁾	A
P_{TOT}	Total dissipation at $T_C = 25\text{ °C}$	170	30	W
I_{AR}	Max current during repetitive or single pulse avalanche (pulse width limited by T_{jmax})	4		A
E_{AS}	Single pulse avalanche energy (starting $T_J = 25\text{ °C}$, $I_D = I_{AS}$, $V_{DD} = 50\text{ V}$)	124		mJ
ESD	Gate-source human body model (R= 1,5 kΩ, C = 100 pF)	2		kV
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; $T_C = 25\text{ °C}$)	2500		V
dv/dt ⁽³⁾	Peak diode recovery voltage slope	4.5		V/ns
dv/dt ⁽⁴⁾	MOSFET dv/dt ruggedness	50		V/ns
T_J T_{stg}	Operating junction temperature Storage temperature	-55 to 150		°C

- Limited by maximum junction temperature.
- Pulse width limited by safe operating area.
- $I_{SD} \leq 12$, $di/dt \leq 100\text{ A}/\mu\text{s}$, $V_{DS(peak)} \leq V_{(BR)DSS}$
- $V_{DS} \leq 760\text{ V}$

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		TO-220	TO-247	TO-220FP	
$R_{thj-case}$	Thermal resistance junction-case max	0.74		4.2	°C/W
$R_{thj-amb}$	Thermal resistance junction-amb max	62.5	50	62.5	°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	$I_D = 1\text{ mA}$, $V_{GS} = 0$	950			V
I_{DSS}	Zero gate voltage drain current ($V_{GS} = 0$)	$V_{DS} = 950\text{ V}$,			1	μA
		$V_{DS} = 950\text{ V}$, $T_c = 125\text{ °C}$			50	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	$V_{GS} = 10\text{ V}$, $I_D = 6\text{ A}$		0.41	0.50	Ω

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$	-	855	-	pF
C_{oss}	Output capacitance		-	65		pF
C_{rss}	Reverse transfer capacitance		-	1		pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{GS} = 0$, $V_{DS} = 0\text{ to }760\text{ V}$	-	104	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related		-	38	-	pF
R_G	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	6	-	Ω
Q_g	Total gate charge	$V_{DD} = 760\text{ V}$, $I_D = 12\text{ A}$ $V_{GS} = 10\text{ V}$ (see Figure 20)	-	30	-	nC
Q_{gs}	Gate-source charge		-	5	-	nC
Q_{gd}	Gate-drain charge		-	22	-	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
$t_{d(v)}$	Voltage delay time	$V_{DD} = 475 \text{ V}$, $I_D = 6 \text{ A}$, $R_G = 4.7 \text{ } \Omega$, $V_{GS} = 10 \text{ V}$ (see Figure 22)	-	23	-	ns
$t_{r(v)}$	Voltage rise time		-	20	-	ns
$t_{f(i)}$	Current fall time		-	62	-	ns
$t_{c(off)}$	Crossing time		-	11	-	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 Figure 21)	-	444		ns
Q_{rr}	Reverse recovery charge		-	7		μC
I_{RRM}	Reverse recovery current		-	32		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 Figure 21)	-	630		ns
Q_{rr}	Reverse recovery charge		-	9.2		μC
I_{RRM}	Reverse recovery current		-	29		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 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

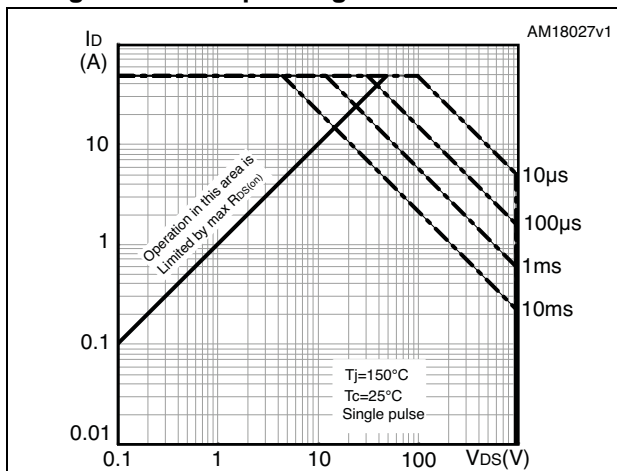


Figure 3. Thermal impedance for TO-220FP

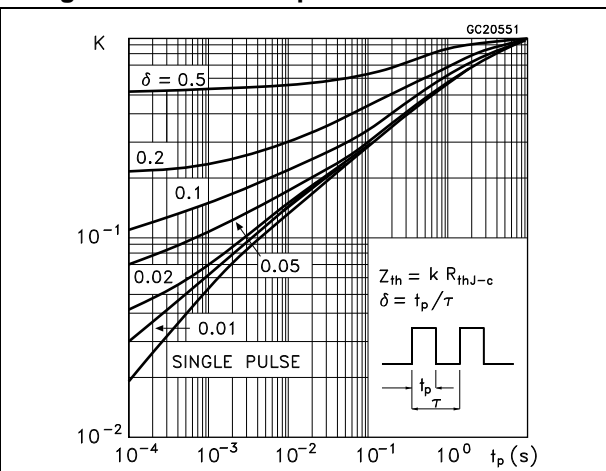


Figure 4. Safe operating area for TO-220

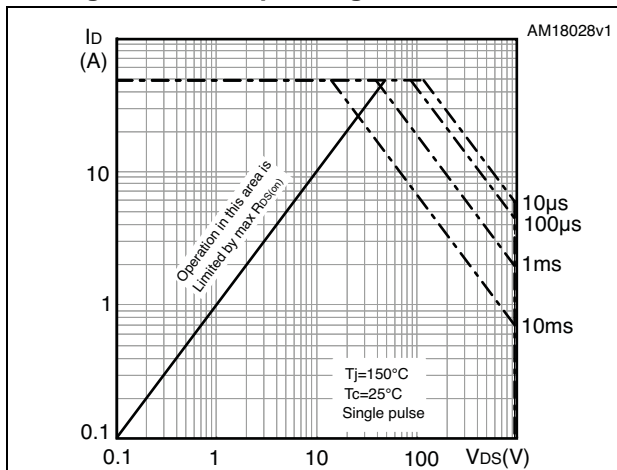


Figure 5. Thermal impedance for TO-220

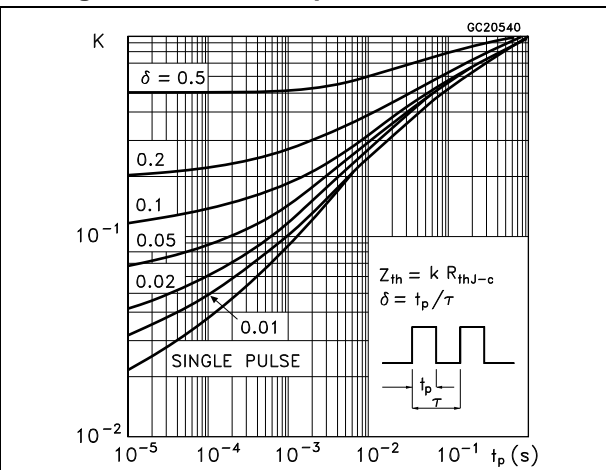


Figure 6. Safe operating area for TO-247

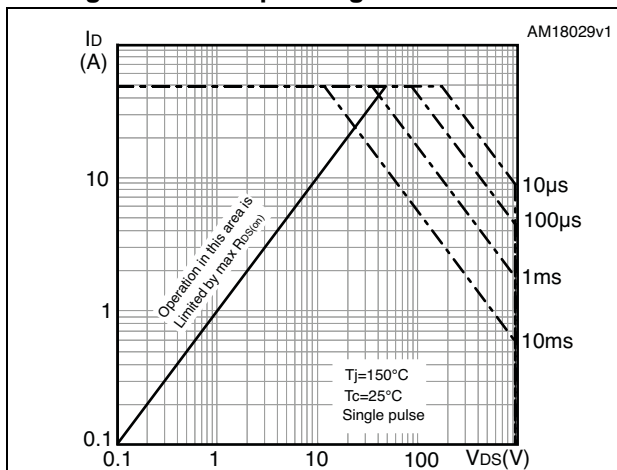


Figure 7. Thermal impedance for TO-247

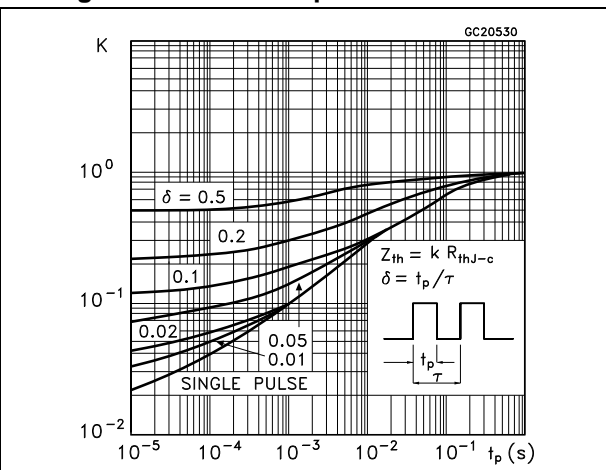


Figure 8. Output characteristics

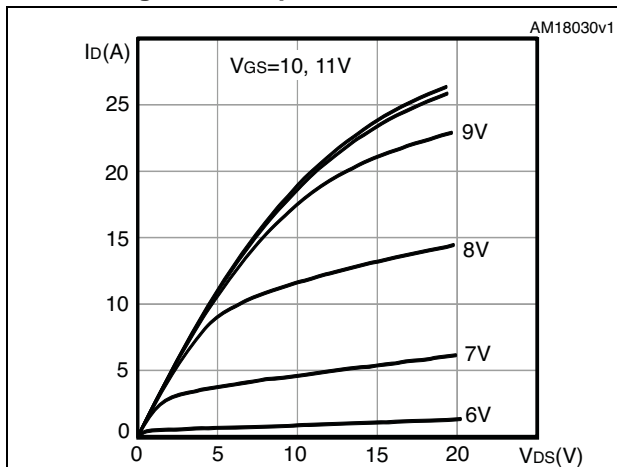


Figure 9. Transfer characteristics

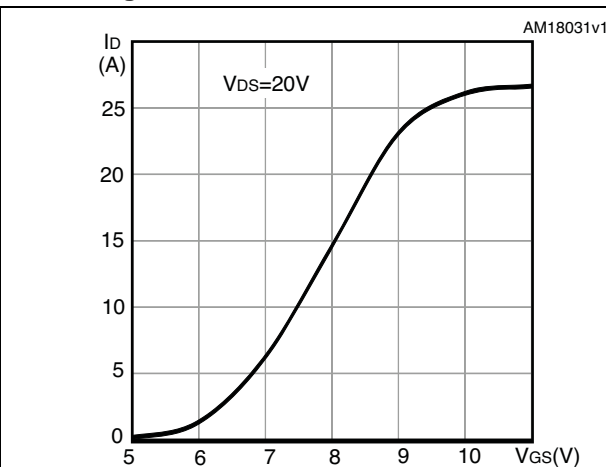


Figure 10. Gate charge vs gate-source voltage

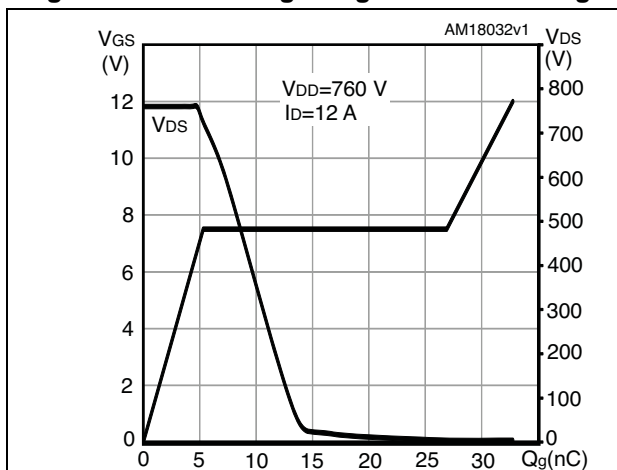


Figure 11. Static drain-source on-resistance

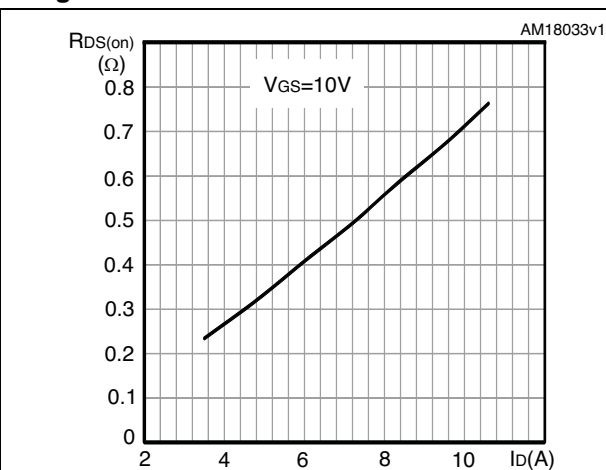


Figure 12. Capacitance variations

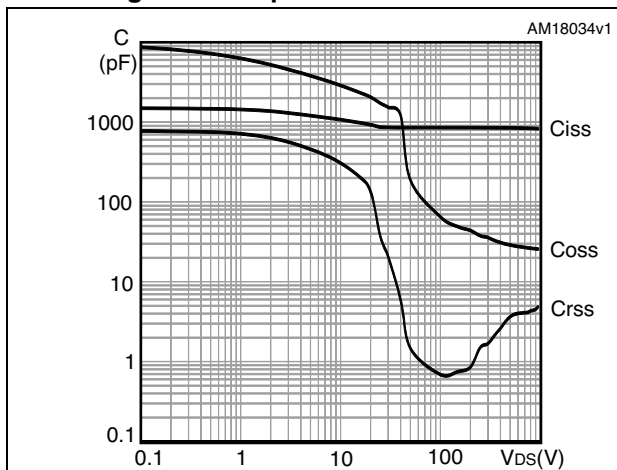


Figure 13. Output capacitance stored energy

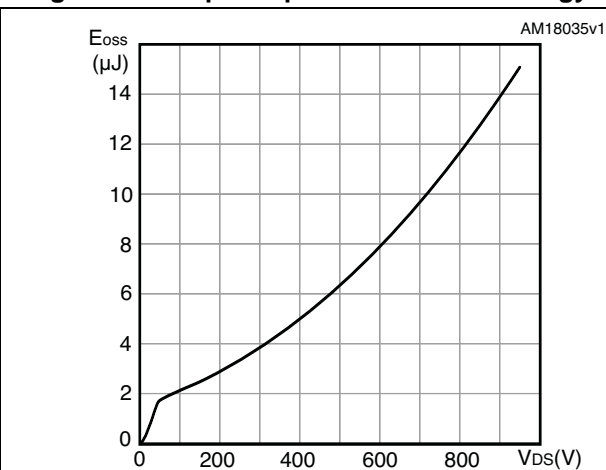


Figure 14. Normalized gate threshold voltage vs temperature

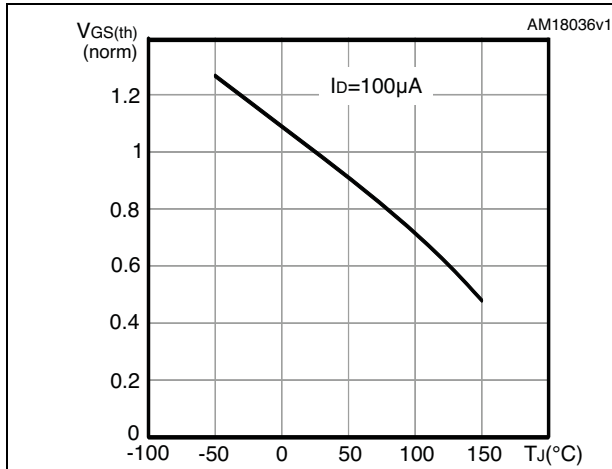


Figure 15. Normalized on-resistance vs temperature

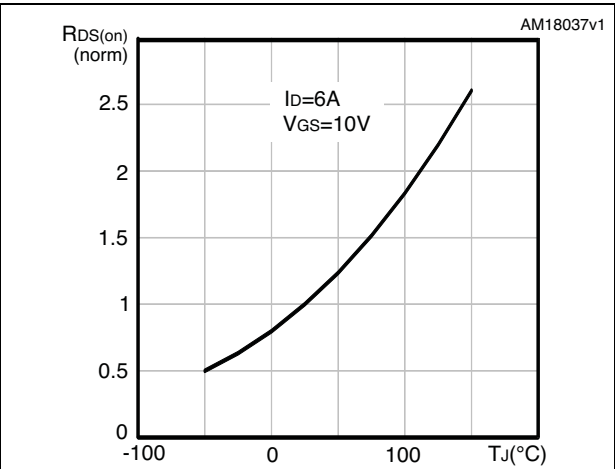


Figure 16. Normalized V_{DS} vs temperature

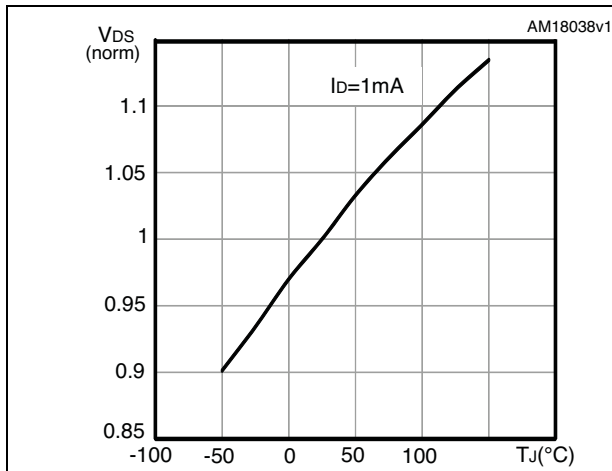


Figure 17. Source-drain diode forward characteristics

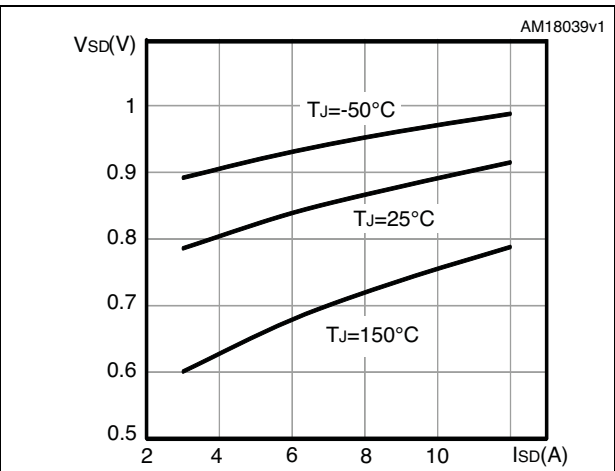
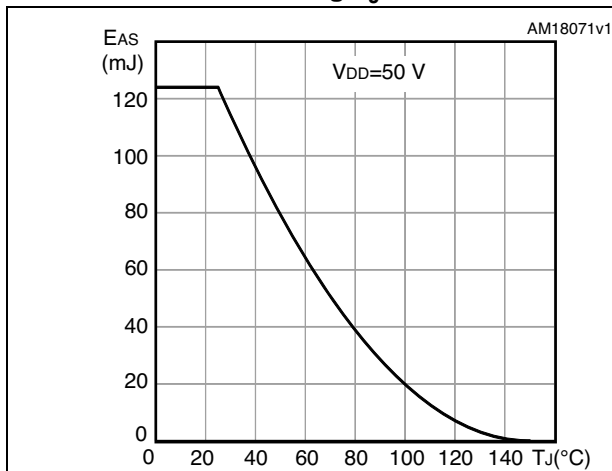


Figure 18. Maximum avalanche energy vs starting T_J



3 Test circuits

Figure 19. Switching times test circuit for resistive load



Figure 20. Gate charge test circuit

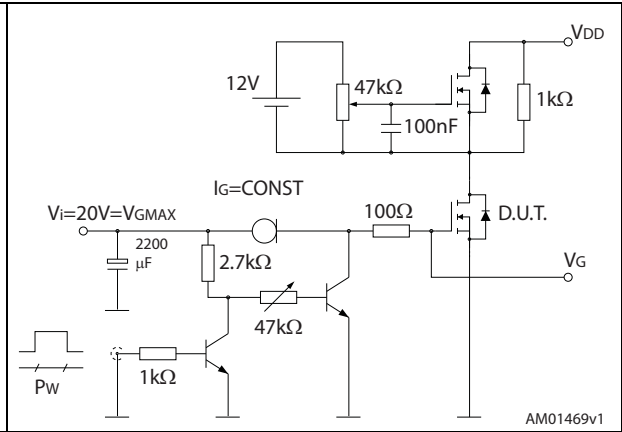


Figure 21. Test circuit for inductive load switching and diode recovery times



Figure 22. Unclamped inductive load test circuit

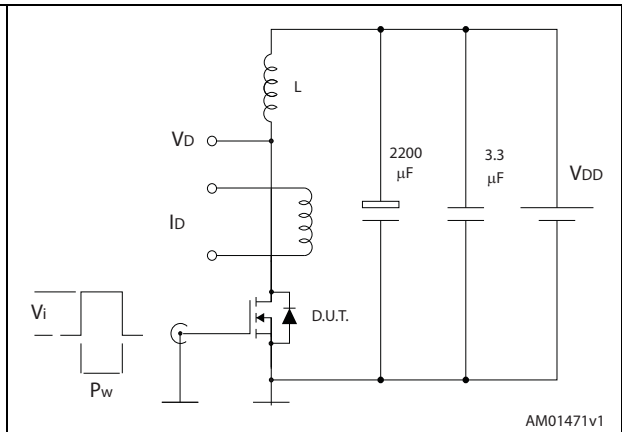


Figure 23. Unclamped inductive waveform



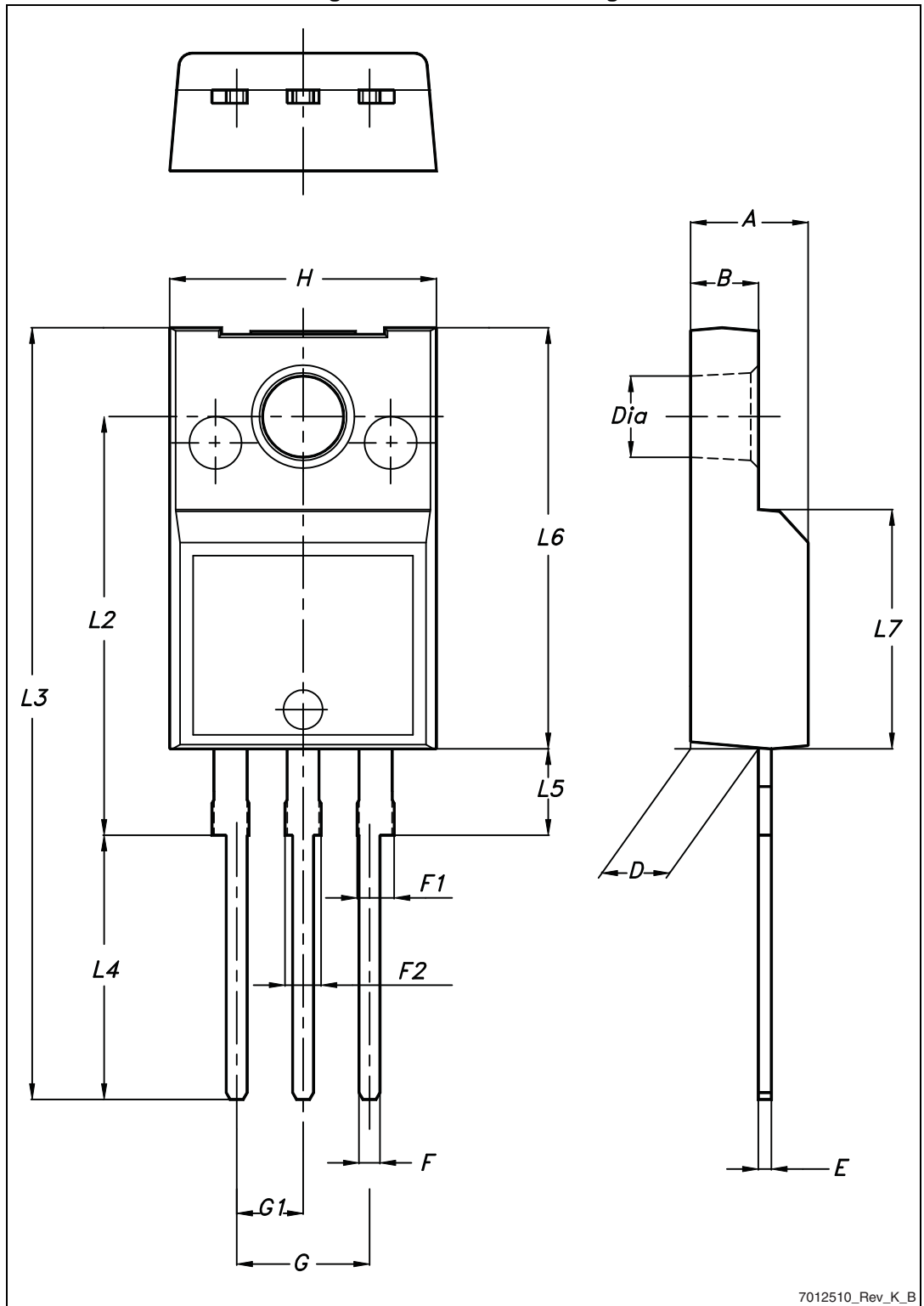
Figure 24. Switching time waveform



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.

Figure 25. TO-220FP drawing



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
Dia	3		3.2

Figure 26. TO-220 type A drawing

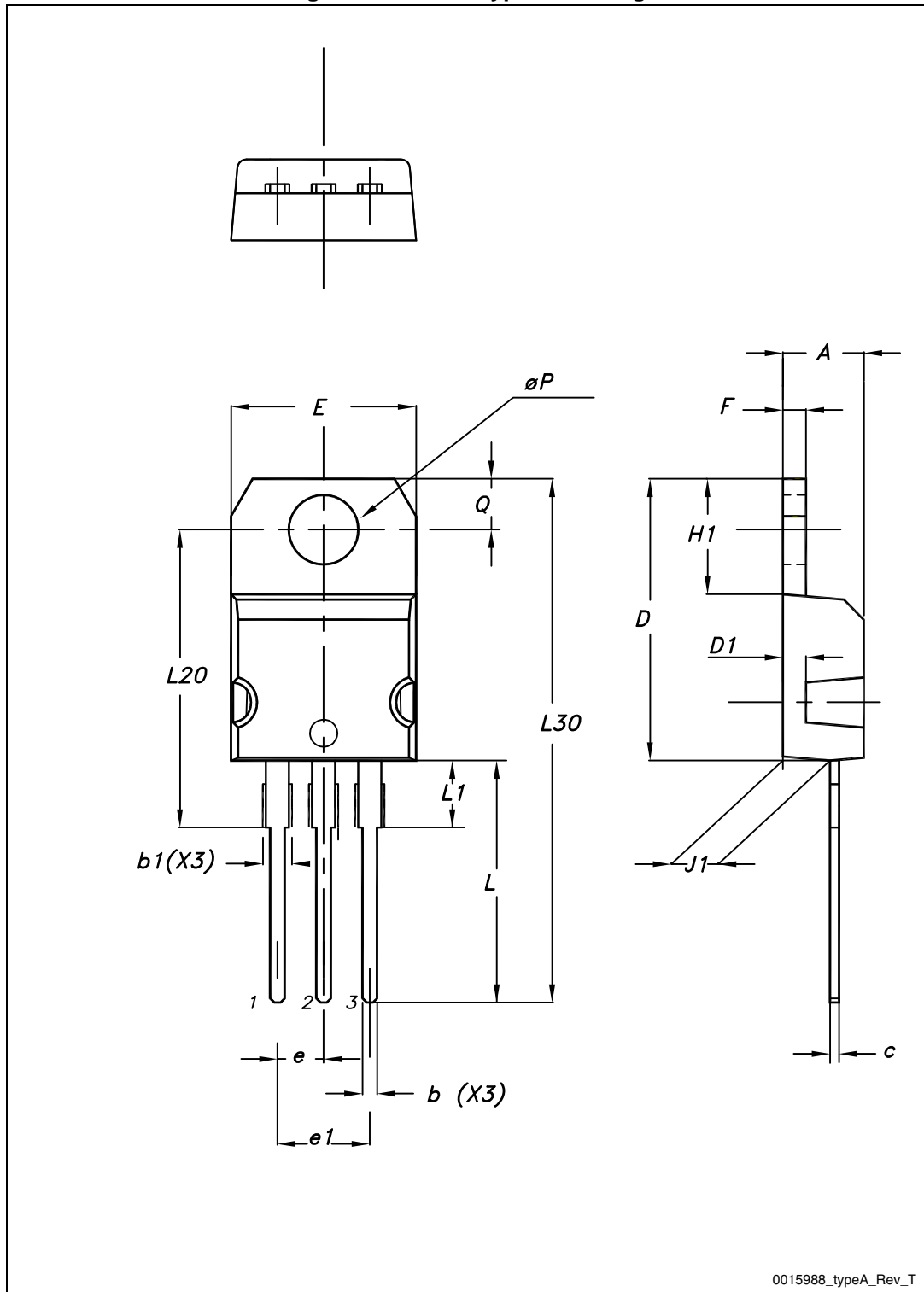
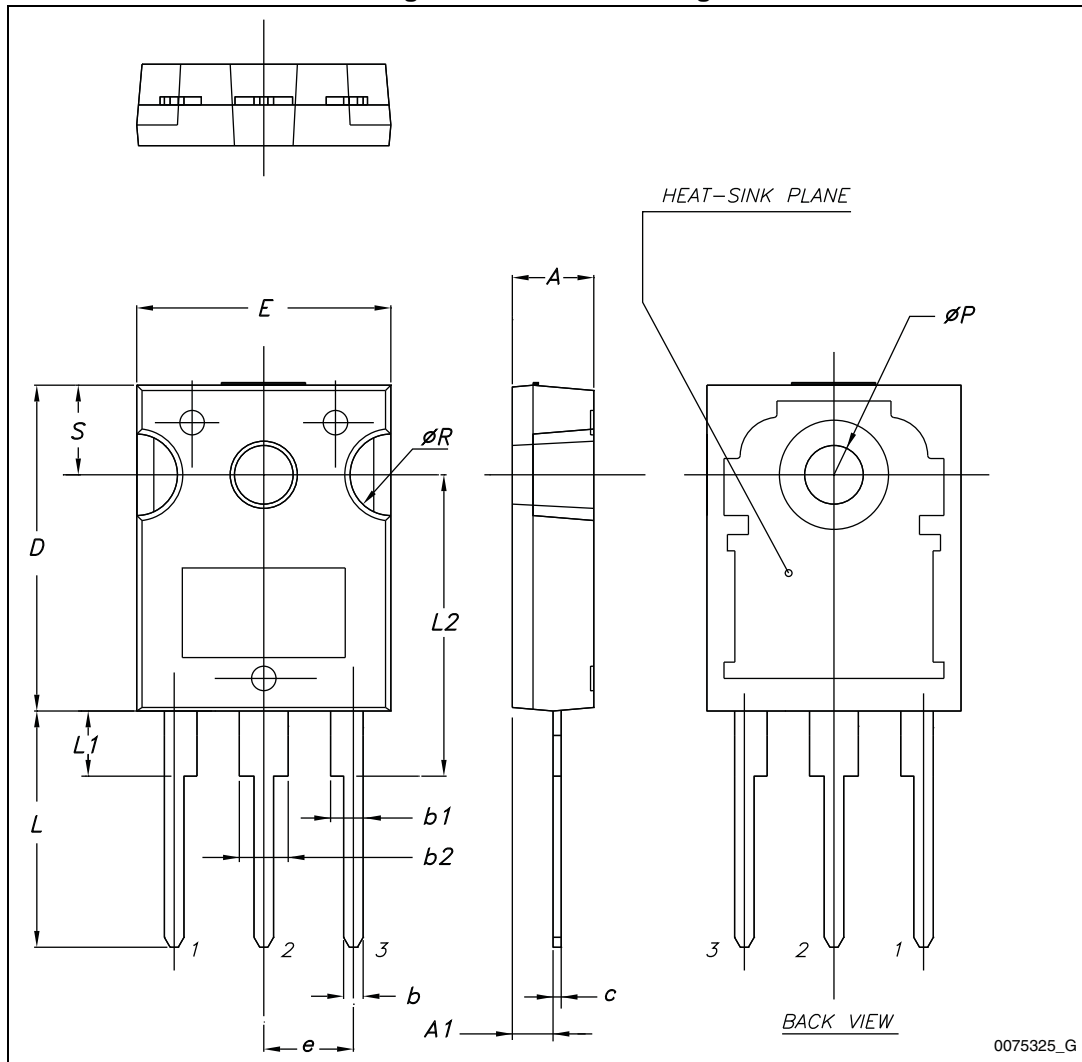


Table 10. TO-220 type A mechanical data

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	
ØP	3.75		3.85
Q	2.65		2.95

Figure 27. TO-247 drawing



0075325_G

Table 11. 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

Table 11. TO-247 mechanical data (continued)

Dim.	mm.		
	Min.	Typ.	Max.
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

5 Revision history

Table 12. Document revision history

Date	Revision	Changes
20-Sep-2013	1	First release.
07-Feb-2014	2	<ul style="list-style-type: none">– Modified: I_{AR} and E_{AS} values in Table 2– Added: note 4 in Table 2– Modified: $R_{thj-case}$ values in Table 3– Modified: typical values in Table 5, 6 and 7– Added: Section 2.1: Electrical characteristics (curves)– Updated: Figure 19, 20, 21 and 22– Minor text changes

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