STF16NK60Z
STP16NK60Z, STW16NK60Z

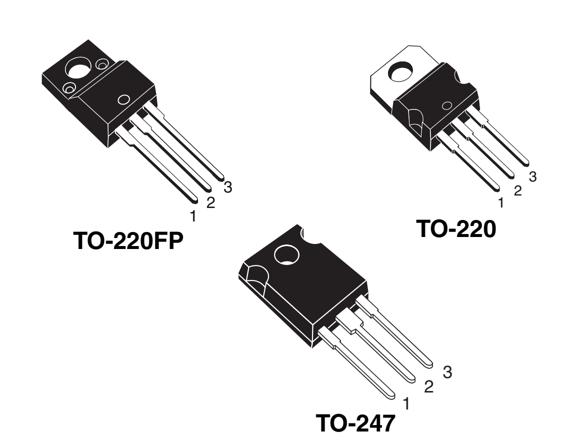
N-channel 600 V, 038 Ω, 14 A, TO-220, TO-220FP, TO-247 Zener-protected SuperMESH™ Power MOSFET

Features

Type	V_{DSS}	$R_{DS(on)}$ max	I_D	Pw
STF16NK60Z	600 V	< 0.42 Ω	14 A[(1)]	40 W
STP16NK60Z	600 V	< 0.42 Ω	14 A	190 W
STW16NK60Z	600 V	< 0.42 Ω	14 A	190 W

1. Limited by package.

- 100% avalanche tested
- Extremely high dv/dt capability
- Gate charge minimized
- Very low intrinsic capacitances
- Very good manufacturing repeatability



Application

- Switching applications

Description

The new SuperMESH™ series of Power MOSFETS is the result of further design improvements on ST's well-established strip-based PowerMESH™ layout. In addition to significantly lower on-resistance, the device offers superior dv/dt capability to ensure optimal performance even in the most demanding applications. The SuperMESH™ devices further complement an already broad range of innovative high voltage MOSFETs, which includes the revolutionary MDmesh™ products.

Figure 1. Internal schematic diagram

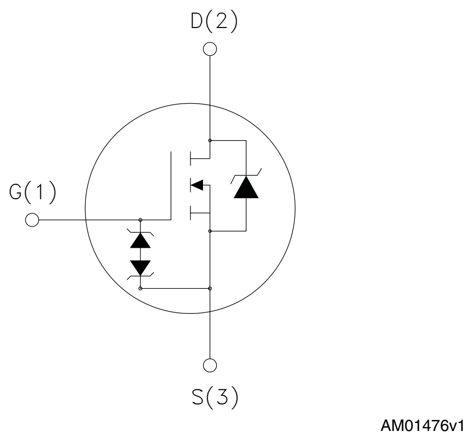


Table 1. Device summary

Order codes	Marking	Package	Packaging
STF16NK60Z	F16NK60Z	TO-220FP	Tube
STP16NK60Z	P16NK60Z	TO-220	
STW16NK60Z	W16NK60Z	TO-247	

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220 / TO-247	TO-220FP	
V_{DS}	Drain-source voltage (V_{GS} = 0)	600		V
V_{GS}	Gate- source voltage	± 30		V
I_D	Drain current (continuous) at T_C = 25 °C	14	14 (1)	A
I_D	Drain current (continuous) at T_C = 100 °C	8.8	8.8 (1)	A
I_{DM} (2)	Drain current (pulsed)	56	56(1)	A
P_{TOT}	Total dissipation at T_C = 25 °C	190	40	W
	Derating factor	1.51		W/°C
$V_{ESD(G-S)}$	Gate source ESD(HBM-C = 100 pF, R = 1.5 kΩ)	6000		V
dv/dt (3)	Peak diode recovery voltage slope	4.5		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. $I_{SD} \leq$ 14 A, di/dt $\leq$ 200 A/µs, V_{DD} = 80% $V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameter	TO-220	TO-247	TO-220FP	Unit
$R_{thj-case}$	Thermal resistance junction-case max	0.66		3.1	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient max	62.5	50	62.5	°C/W
T_l	Maximum lead temperature for soldering purpose	300			°C

Table 4. Avalanche characteristics

Symbol	Parameter	Max value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_j max)	14	A
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, I_D = I_{AR}, V_{DD} = 50 V)	360	mJ

2 Electrical characteristics

(T_C = 25 °C unless otherwise specified)

Table 5. 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	620			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = Max rating V_{DS} = Max rating, T_C=125 °C			1 50	µA µA
I_{GSS}	Gate-body leakage current (V_{DS} = 0)	V_{GS} = ± 20 V			± 10	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 = 7 A		0.38	0.42	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{DS} = 25 V, f = 1 MHz, V_{GS} = 0	-	2650 285 62	-	pF pF pF
$C_{OSS\ eq}$ (1)	Equivalent output capacitance	V_{GS} = 0, V_{DS} = 0 to 480 V	-	158	-	pF
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD} = 480 V, I_D = 14 A, V_{GS} = 10 V (see *Figure 19*)	-	86 17 46	-	nC nC nC

1. $C_{oss\ eq.}$ 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}

Table 7. 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} = 480 V, I_D = 14 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 18*)	-	30 25 70 15	-	ns ns ns ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM} (1)	Source-drain current Source-drain current (pulsed)		-		14 56	A A
V_{SD} (2)	Forward on voltage	I_{SD} = 14 A, V_{GS} = 0	-		1.6	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 14 A, di/dt = 100 A/µs V_{DD} = 100 V (see *Figure 23*)	-	490 5.4 22		ns nC A
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 14 A, di/dt = 100 A/µs V_{DD} = 100 V, T_j = 150 °C (see *Figure 23*)	-	585 7 24		ns nC A

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

Table 9. Gate-source Zener diode

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
BV_{GSO}	Gate-source breakdown voltage	Igs=± 1 mA (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-220

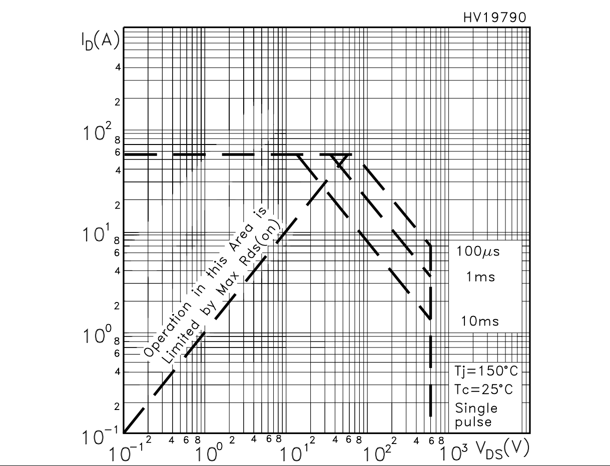


Figure 3. Thermal impedance for TO-220

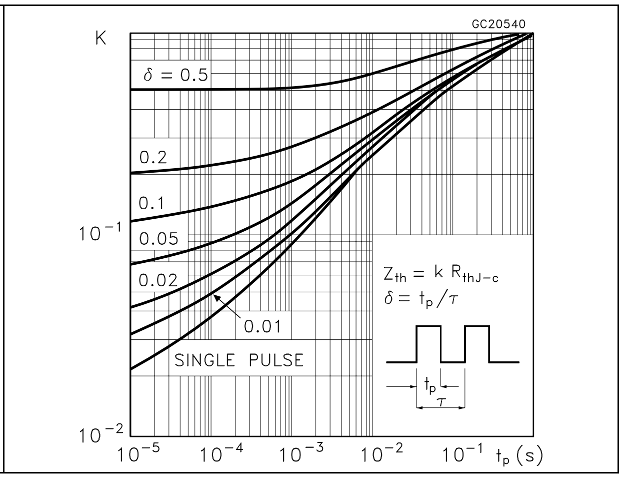


Figure 4. Safe operating area for TO-220FP

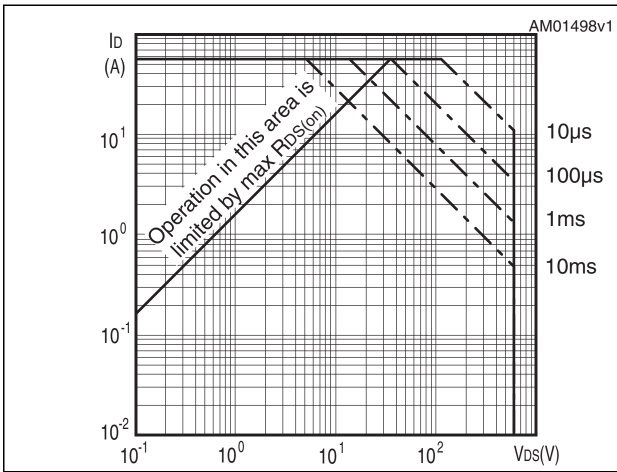


Figure 5. Thermal impedance for TO-220FP

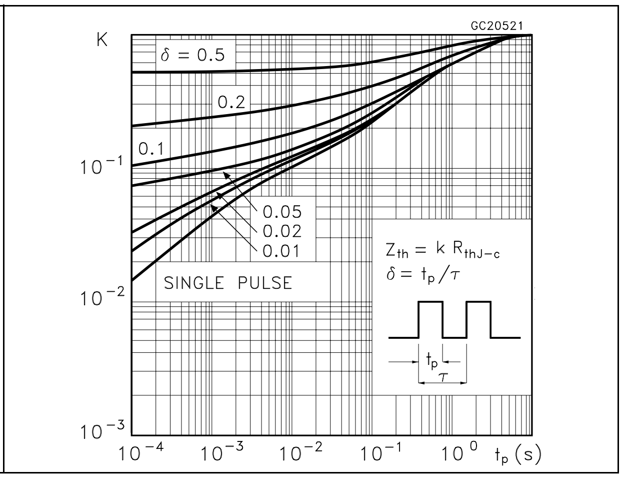


Figure 6. Safe operating area for TO-247

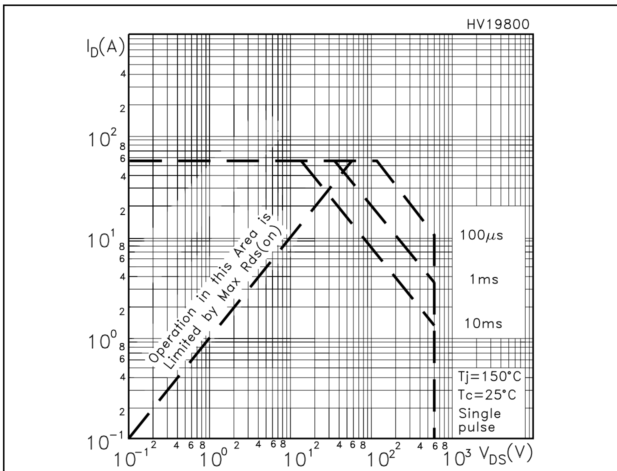


Figure 7. Thermal impedance for TO-247

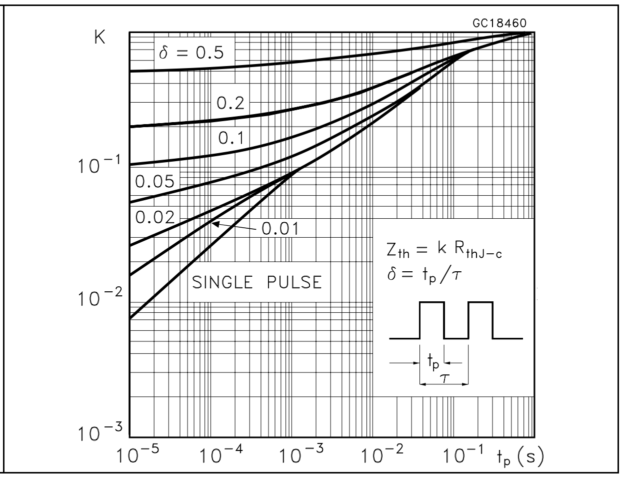


Figure 8. Output characteristics

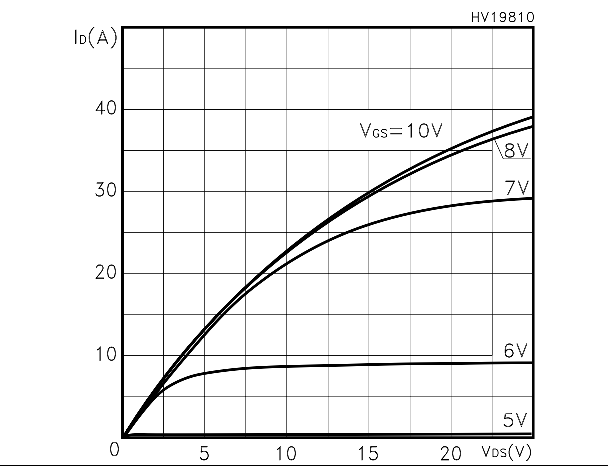


Figure 9. Transfer characteristics

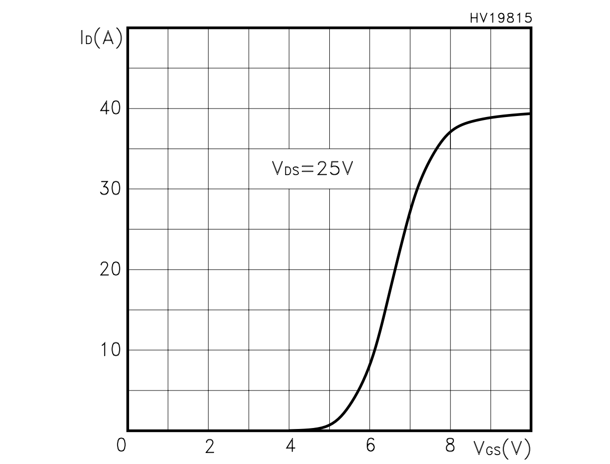


Figure 10. Normalized BV_{DSS} vs temperature

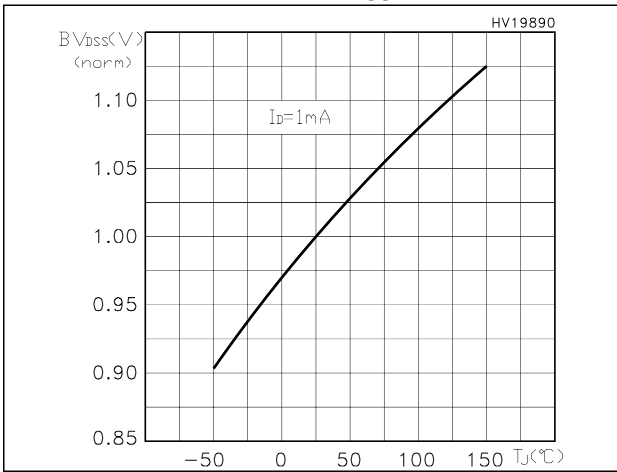


Figure 11. Static drain-source on resistance

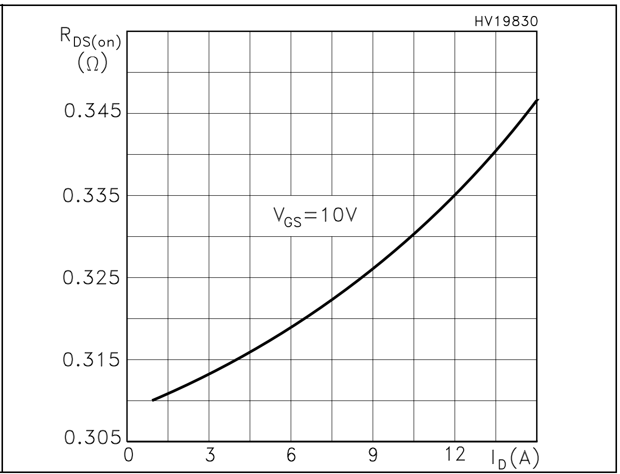


Figure 12. Gate charge vs gate-source voltage

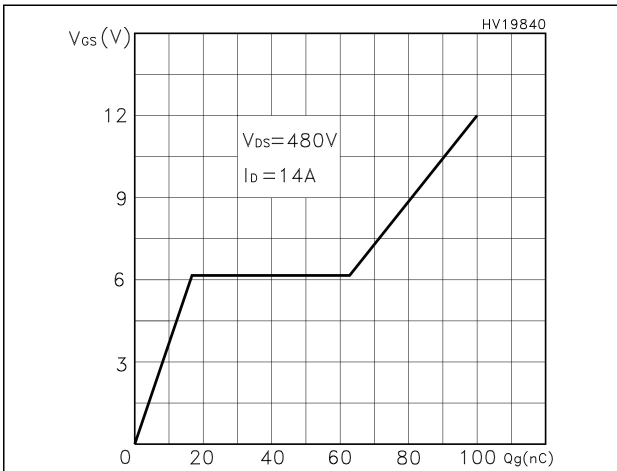


Figure 13. Capacitance variations

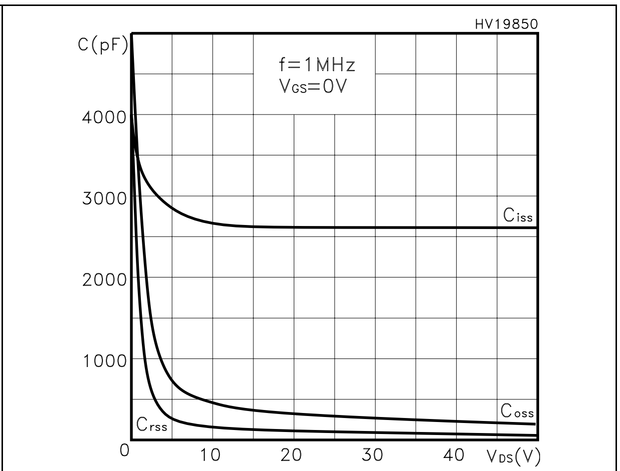


Figure 14. Normalized gate threshold voltage vs temperature

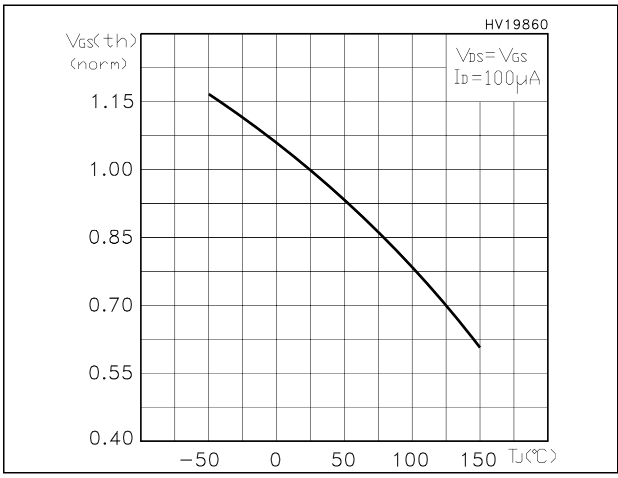


Figure 15. Normalized on resistance vs temperature

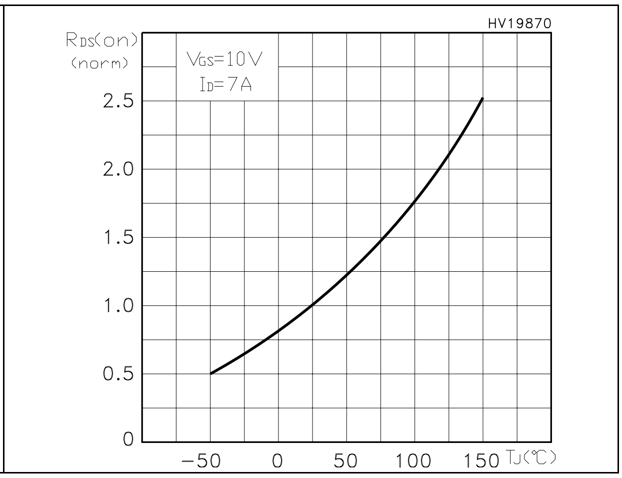


Figure 16. Source-drain diode forward characteristics

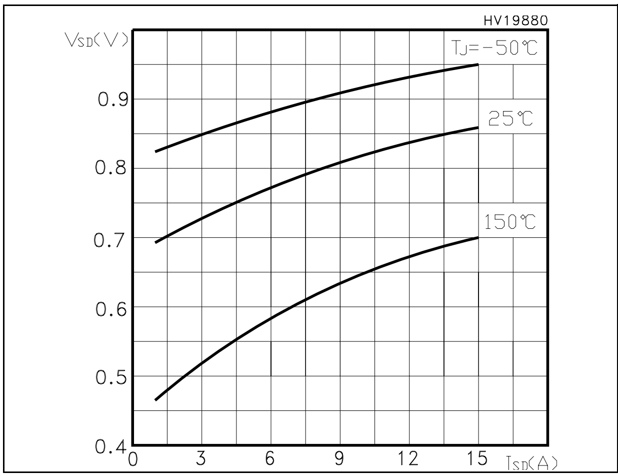
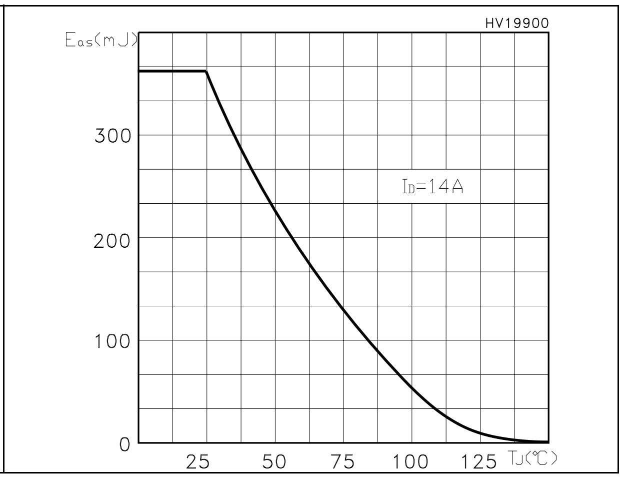


Figure 17. Maximum avalanche energy vs temperature



3 Test circuits

Figure 18. Switching times test circuit for resistive load

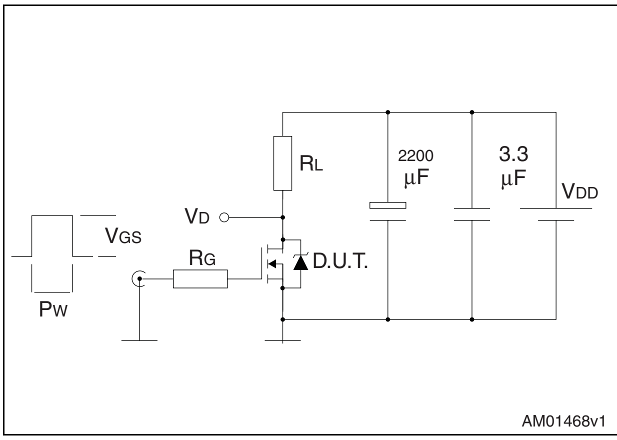


Figure 19. Gate charge test circuit

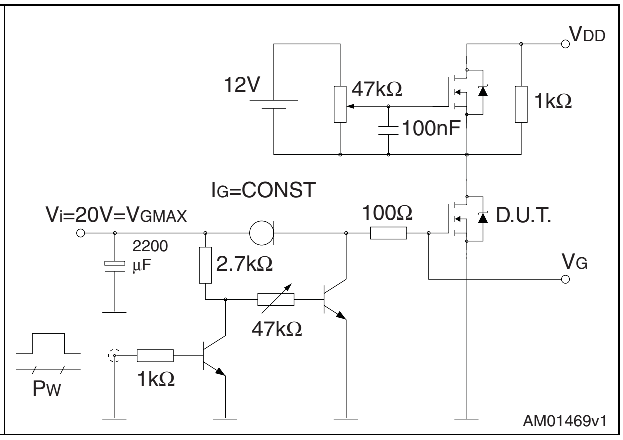


Figure 20. Test circuit for inductive load switching and diode recovery times

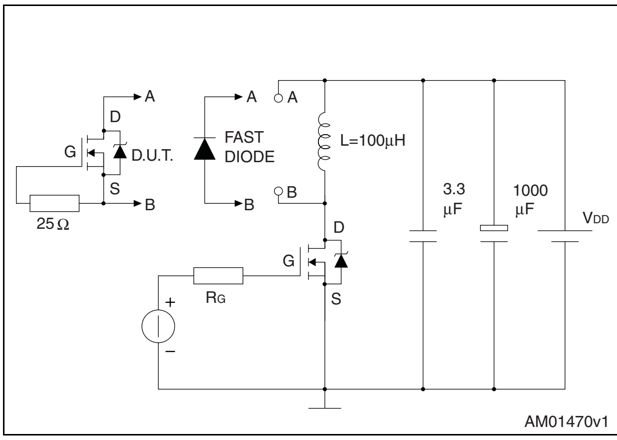


Figure 21. Unclamped inductive load test circuit

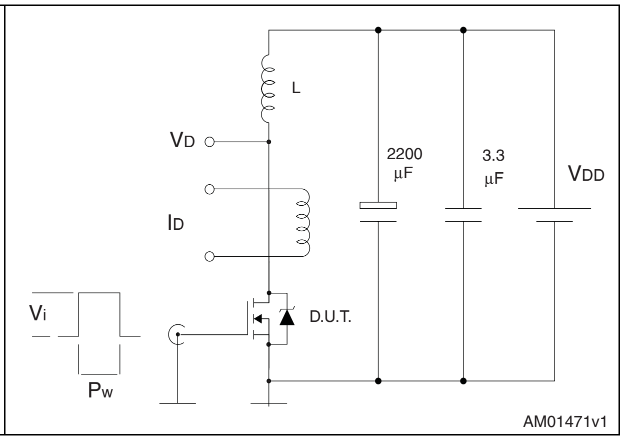


Figure 22. Unclamped inductive waveform

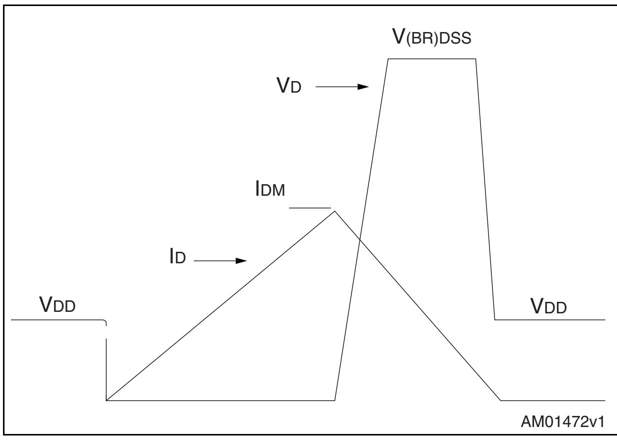
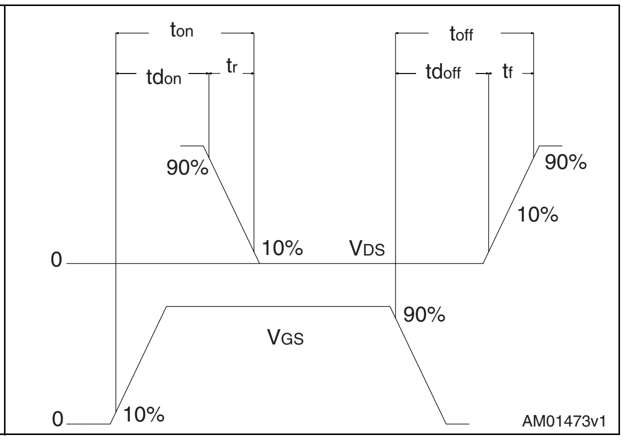


Figure 23. Switching time waveform



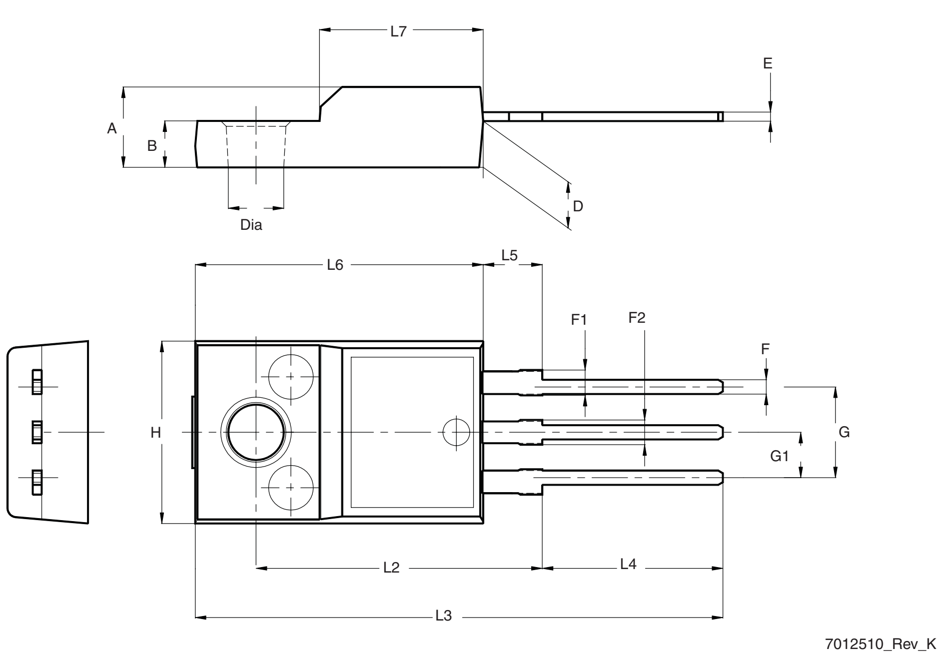
4 Package mechanical data

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 10. TO-220FP mechanical data

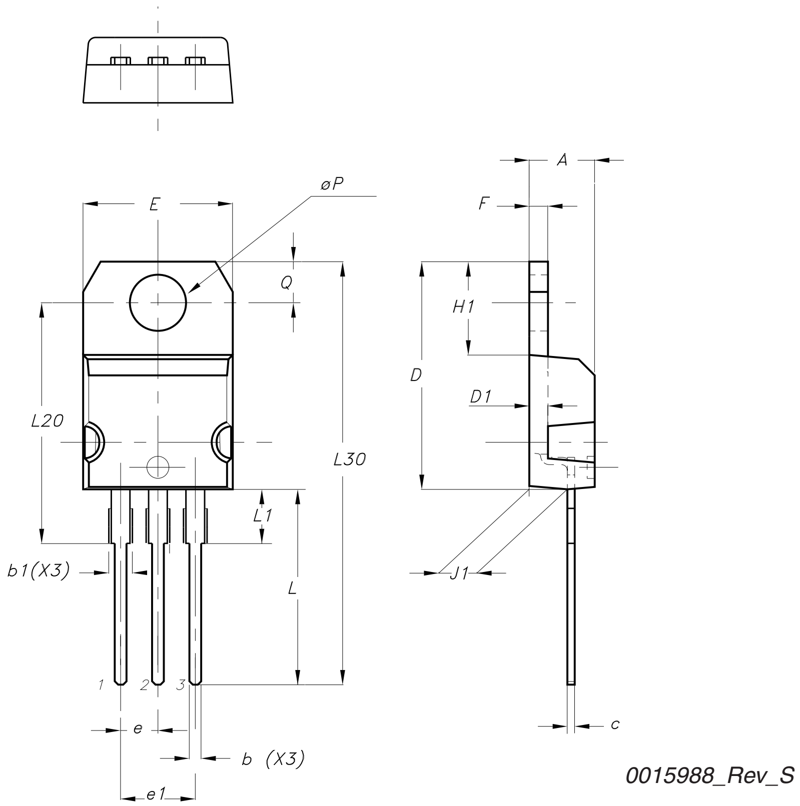
Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 24. TO-220FP drawing



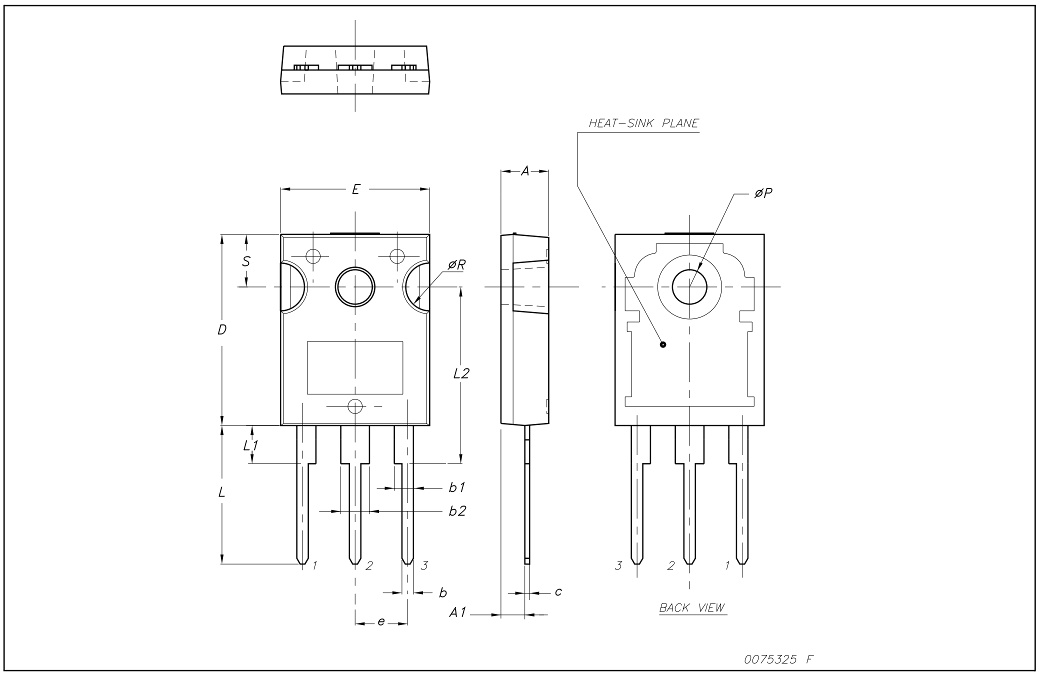
TO-220 type A mechanical data

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 11. Document revision history

Date	Revision	Changes
11-Sep-2006	3	
07-Jun-2007	4	Added statement for ECOPACK®.
04-Dec-2009	5	Updated packages mechanical data.