

N-channel 600 V, 0.45 Ω typ., 13.5 A SuperMESH™
Power MOSFETs in I²PAK, TO-220 and TO-247 packages

Datasheet - obsolete product

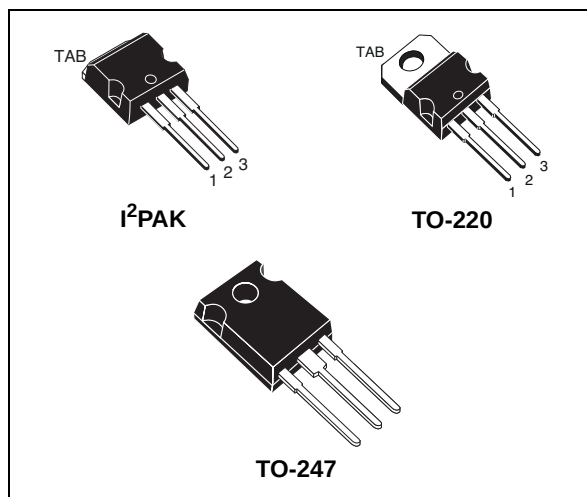
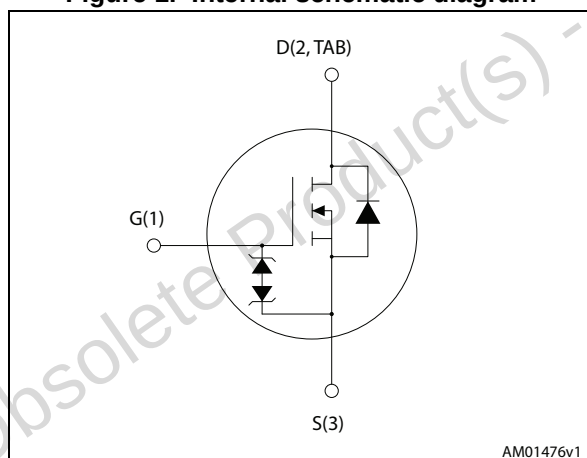


Figure 1. Internal schematic diagram



Features

Order codes	V _{DS}	R _{DS(on)} max.	I _D	P _{TOT}
STB14NK60Z-1	600 V	0.5 Ω	13.5 A	160 W
STP14NK60Z				
STW14NK60Z				

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

Applications

- Switching applications

Description

These devices are N-channel Zener-protected Power MOSFETs developed using STMicroelectronics' SuperMESH™ technology, achieved through optimization of ST's well established strip-based PowerMESH™ layout. In addition to a significant reduction in on-resistance, this device is designed to ensure a high level of dv/dt capability for the most demanding applications.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STB14NK60Z-1	B14NK60Z	I ² PAK	Tube
STP14NK60Z	P14NK60Z	TO-220	
STW14NK60Z	W14NK60Z	TO-247	

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{DS}	Drain-source voltage	600	V
V_{DGR}	Drain-gate voltage ($R_{GS} = 20\text{ k}\Omega$)	600	V
V_{GS}	Gate-source voltage	± 30	V
I_D	Drain current (continuous) at $T_C = 25^\circ\text{C}$	13.5	A
I_D	Drain current (continuous) at $T_C = 100^\circ\text{C}$	8.5	A
$I_{DM}^{(1)}$	Drain current (pulsed)	54	A
P_{TOT}	Total dissipation at $T_C = 25^\circ\text{C}$	160	W
	Derating factor	1.28	W/ $^\circ\text{C}$
ESD	Gate-source human body model ($R = 1.5\text{ k}\Omega$, $C = 100\text{ pF}$)	4	kV
$dv/dt^{(2)}$	Peak diode recovery voltage slope	4.5	V/ns
T_J T_{stg}	Operating junction temperature Storage temperature	-55 to 150	$^\circ\text{C}$

1. Pulse width limited by safe operating area

2. $I_{SD} \leq 13.5\text{ A}$, $di/dt \leq 200\text{ A}/\mu\text{s}$, $V_{DD} \leq V_{(BR)DSS}$, $T_J \leq T_{JMAX}$.

Table 3. Thermal data

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max	0.78	$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	62.5	$^\circ\text{C}/\text{W}$

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AS}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_{Jmax})	12	A
E_{AS}	Single pulse avalanche energy (starting $T_J = 25^\circ\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$)	300	mJ

2 Electrical characteristics

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

Table 5. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1 \text{ mA}$, $V_{GS} = 0$	600			V
I_{DSS}	Zero gate voltage drain current ($V_{GS} = 0$)	$V_{DS} = 600 \text{ V}$			1	μA
		$V_{DS} = 600 \text{ V}$, $T_C = 125^{\circ}\text{C}$			50	μA
I_{GSS}	Gate body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 30 \text{ V}$			± 10	μA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 100 \mu\text{A}$	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10 \text{ V}$, $I_D = 6 \text{ A}$		0.45	0.5	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 25 \text{ V}$, $f = 1 \text{ MHz}$, $V_{GS} = 0$	-	2220	-	pF
C_{oss}	Output capacitance		-	240	-	pF
C_{rss}	Reverse transfer capacitance		-	57	-	pF
$C_{oss \text{ eq}}^{(1)}$	Equivalent output capacitance	$V_{GS} = 0$, $V_{DS} = 0 \text{ V to } 480 \text{ V}$	-	122	-	pF
Q_g	Total gate charge	$V_{DD} = 480 \text{ V}$, $I_D = 12 \text{ A}$ $V_{GS} = 10 \text{ V}$	-	75	-	nC
Q_{gs}	Gate-source charge		-	13.2	-	nC
Q_{gd}	Gate-drain charge		-	38.6	-	nC

1. $C_{oss \text{ eq}}$ 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
$t_{d(on)}$	Turn-on delay time	$V_{DD}=300\text{ V}$, $I_D=6\text{ A}$, $R_G=4.7\ \Omega$, $V_{GS}=10\text{ V}$ (see Figure 17)	-	26	-	ns
t_r	Rise time		-	18	-	ns
$t_{d(off)}$	Turn-off delay time		-	62	-	ns
t_f	Fall time		-	13	-	ns
$t_{r(Voff)}$	Off-voltage rise time	$V_{DD}=480\text{ V}$, $I_D=12\text{ A}$, $R_G=4.7\ \Omega$, $V_{GS}=10\text{ V}$ (see Figure 19)	-	12	-	ns
t_f	Fall time		-	9.5	-	ns
t_c	Cross-over time		-	22	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
I_{SD}	Source-drain current		-		12	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		48	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD}=12\text{ A}$, $V_{GS}=0$	-		1.6	V
t_{rr}	Reverse recovery time	$I_{SD}=12\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD}=50\text{ V}$	-	490		ns
Q_{rr}	Reverse recovery charge		-	4.7		μC
I_{RRM}	Reverse recovery current		-	19.3		A
t_{rr}	Reverse recovery time	$I_{SD}=12\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD}=50\text{ V}$, $T_j=150\text{ }^\circ\text{C}$	-	664		ns
Q_{rr}	Reverse recovery charge		-	6.8		μC
I_{RRM}	Reverse recovery current		-	20.5		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
$V_{(BR)GSO}$	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 the device's ESD capability. 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 I²PAK and TO-220

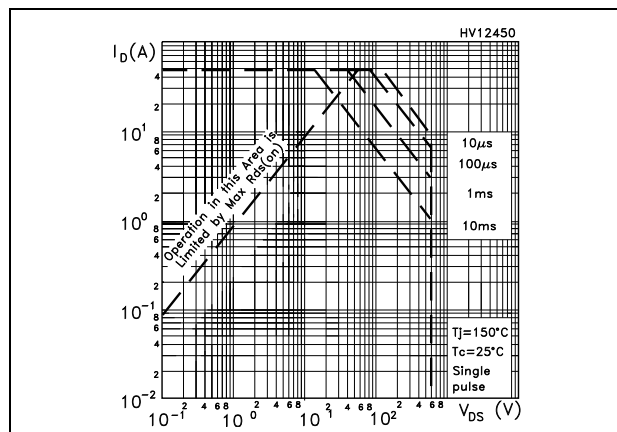


Figure 3. Thermal impedance for I²PAK and TO-220

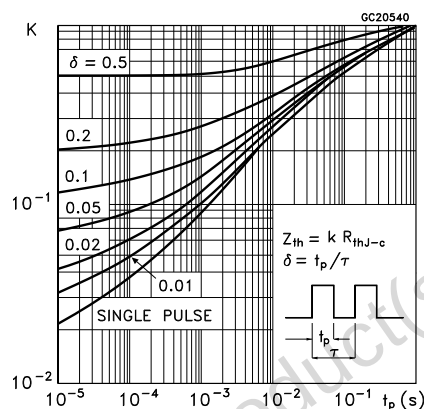


Figure 4. Safe operating area for TO-247

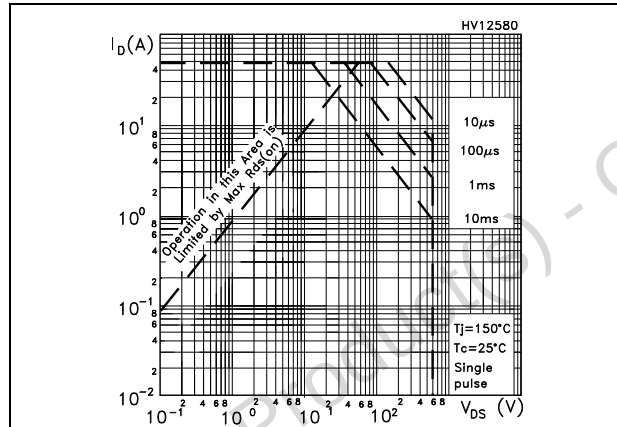


Figure 5. Thermal impedance for TO-247

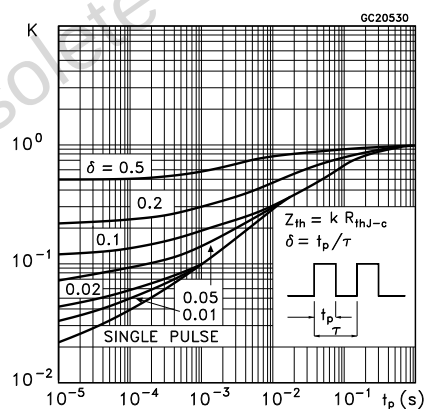


Figure 6. Output characteristics

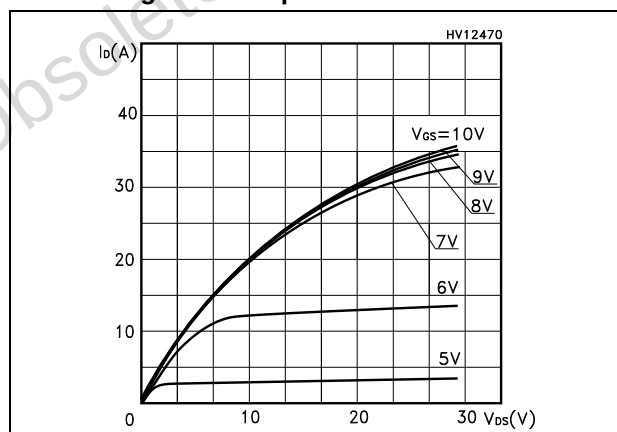


Figure 7. Transfer characteristics

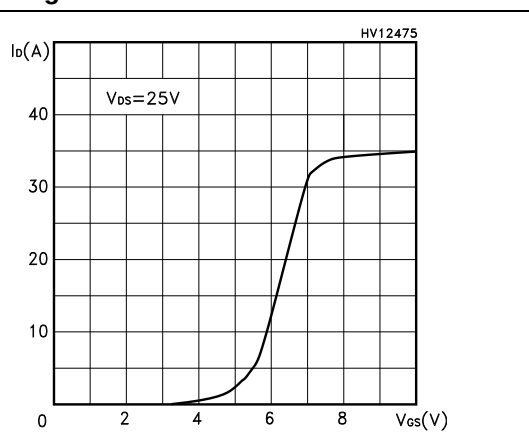


Figure 8. Transconductance

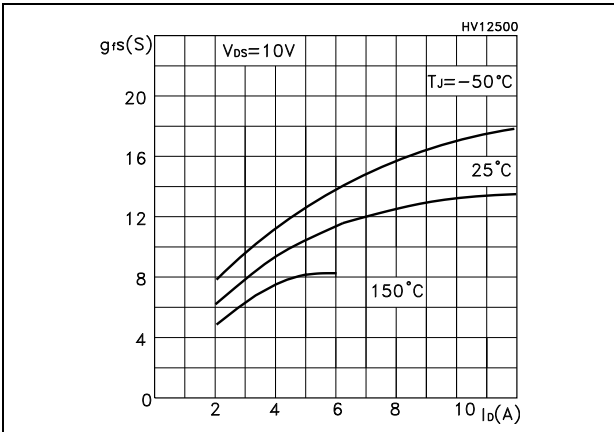


Figure 9. Static drain-source on-resistance

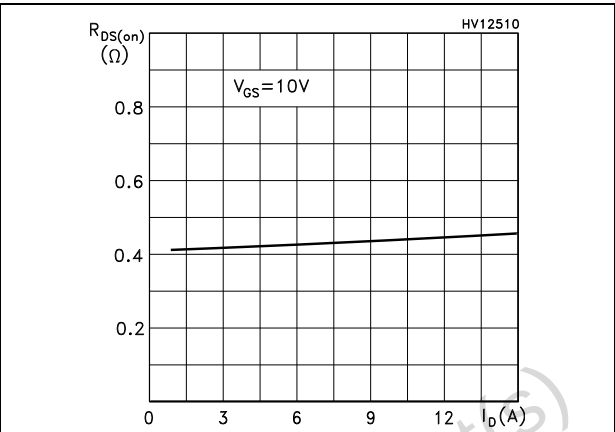


Figure 10. Gate charge vs gate-source voltage

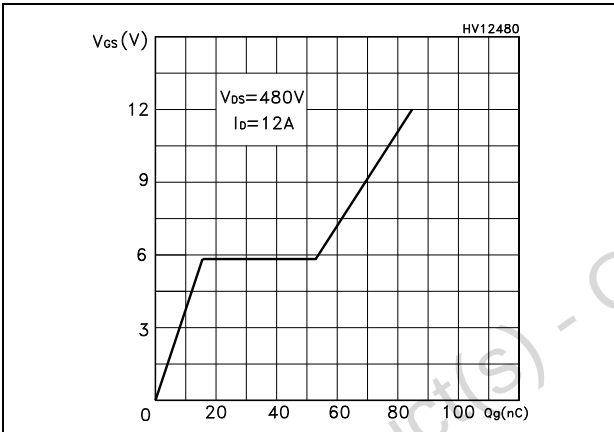


Figure 11. Capacitance variations

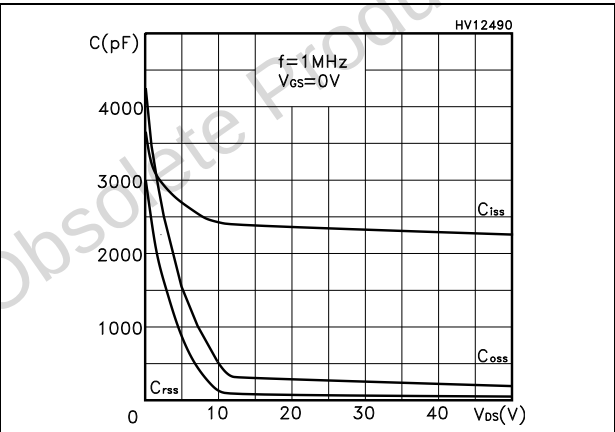


Figure 12. Normalized gate threshold voltage vs temperature

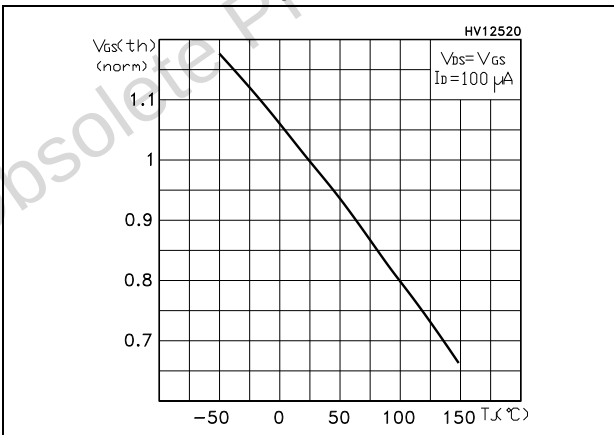


Figure 13. Normalized on-resistance vs temperature

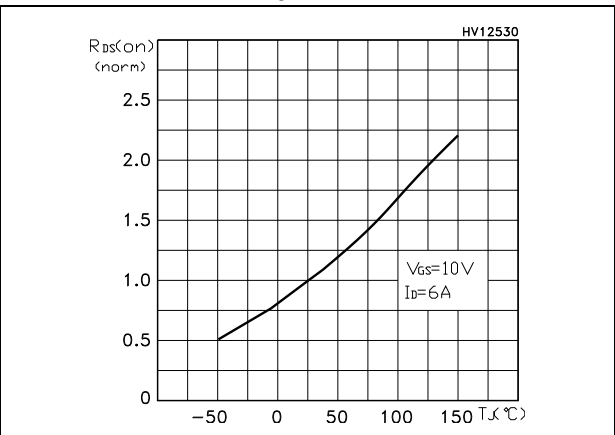


Figure 14. Source-drain diode forward characteristics

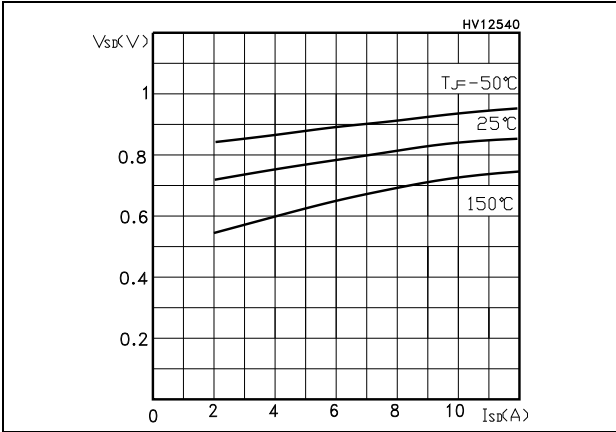


Figure 15. Normalized $V_{(BR)DSS}$ vs temperature

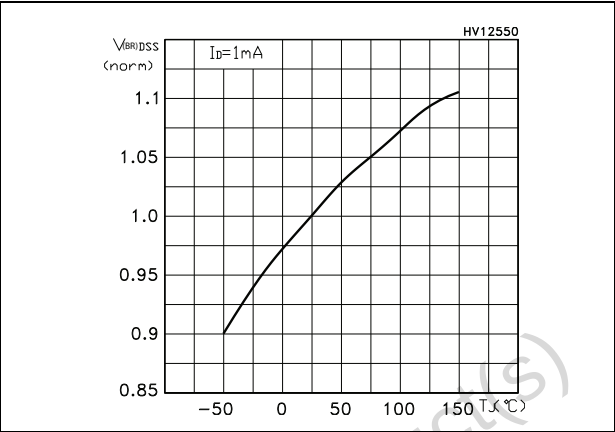
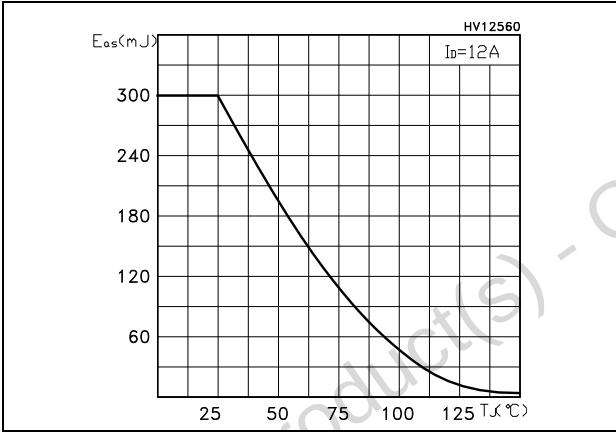


Figure 16. Maximum avalanche energy vs temperature



3 Test circuits

Figure 17. Switching times test circuit for resistive load

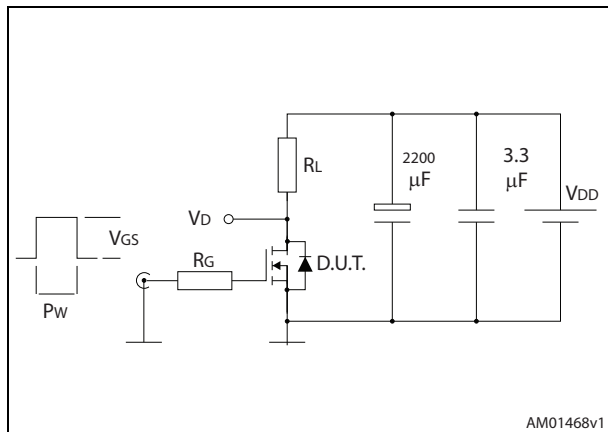


Figure 18. Gate charge test circuit

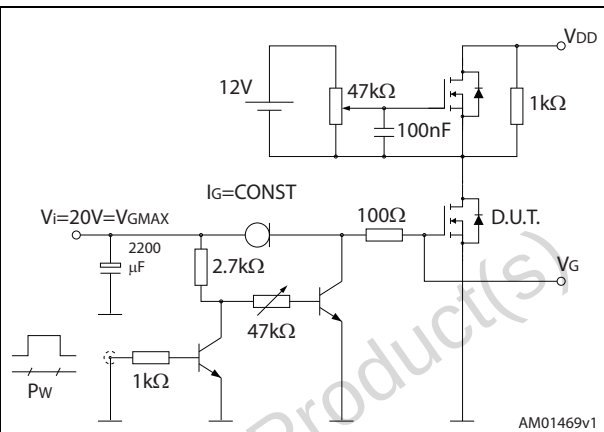


Figure 19. Test circuit for inductive load switching and diode recovery times

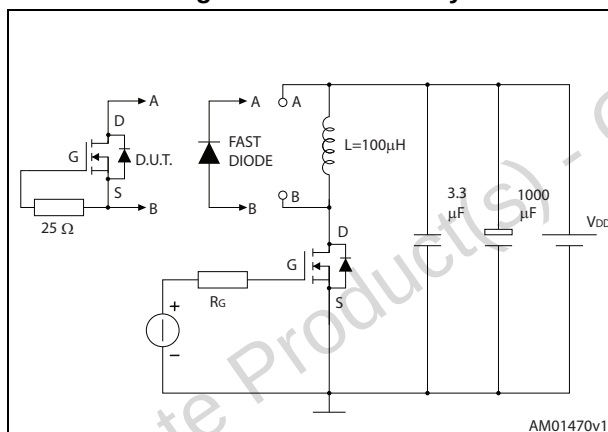


Figure 20. Unclamped inductive load test circuit

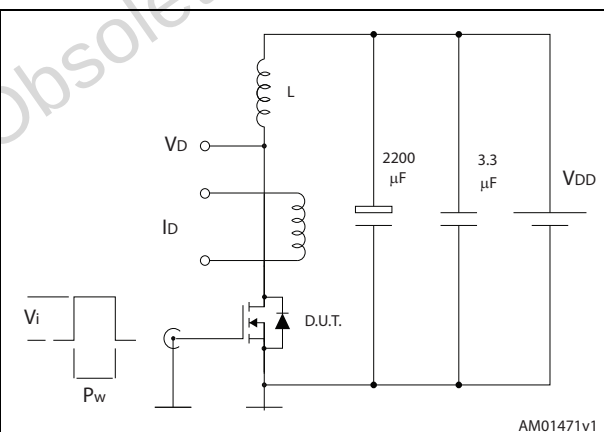


Figure 21. Unclamped inductive waveform

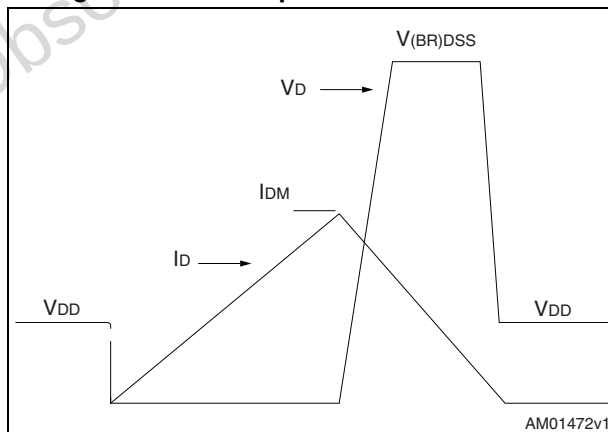
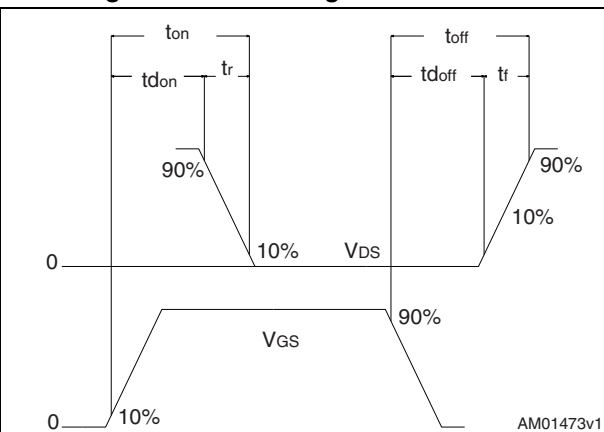


Figure 22. Switching time waveform



4 Package mechanical data

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Obsolete Product(s) - Obsolete Product(s)

4.1 I²PAK, STB14NK60Z

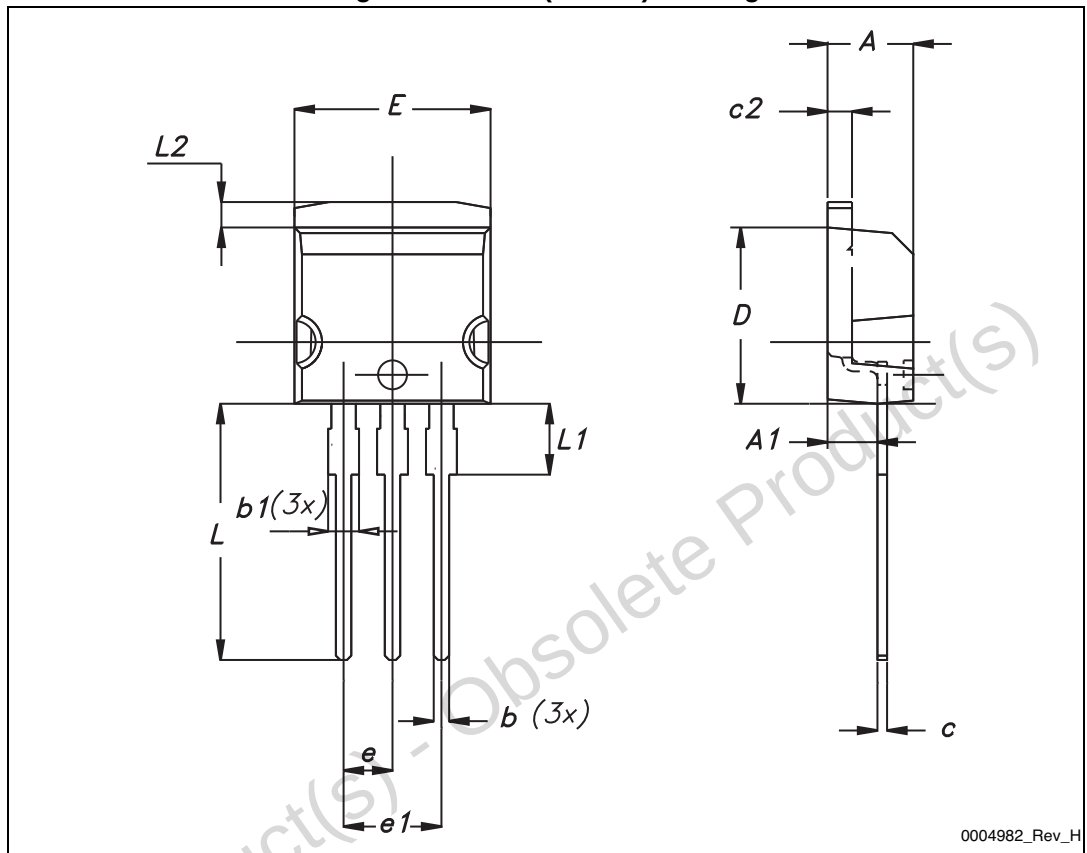
Figure 23. I²PAK (TO-262) drawing

Table 10. I²PAK (TO-262) mechanical data

DIM.	mm.		
	min.	typ	max.
A	4.40		4.60
A1	2.40		2.72
b	0.61		0.88
b1	1.14		1.70
c	0.49		0.70
c2	1.23		1.32
D	8.95		9.35
e	2.40		2.70
e1	4.95		5.15
E	10		10.40
L	13		14
L1	3.50		3.93
L2	1.27		1.40

4.2 TO-220, STP14NK60Z

Figure 24. TO-220 type A drawing

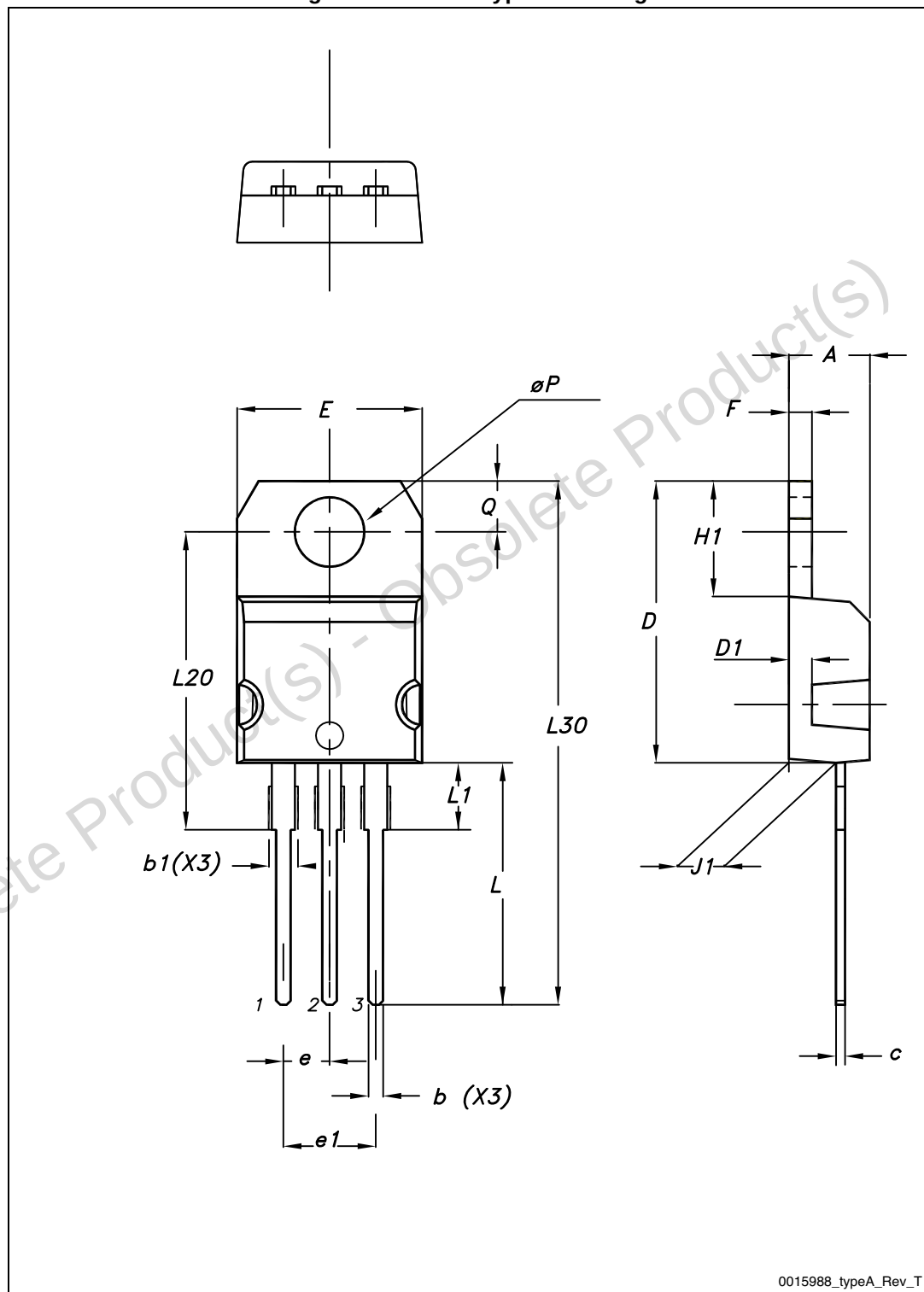


Table 11. TO-220 type A mechanical data

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

4.3 TO-247, STW14NK60Z

Figure 25. TO-247 drawing

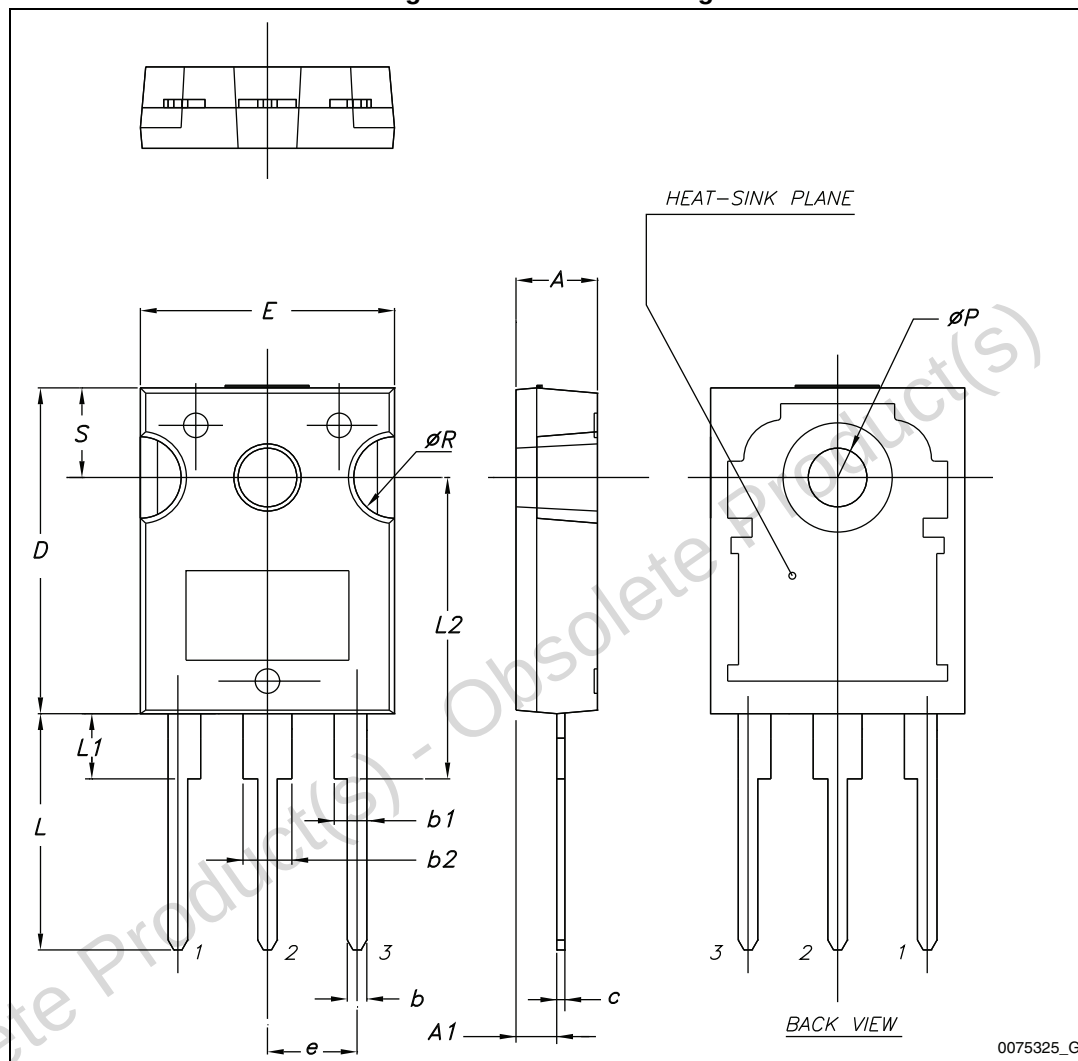


Table 12. TO-247 mechanical data

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	5.30	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 13. Document revision history

Date	Revision	Changes
30-Aug-2004	3	Preliminary version
17-Aug-2005	4	Complete version with curves
08-Sep-2005	5	Inserted ecopack indication
14-Oct-2005	6	New package inserted: TO-247
26-Jul-2006	7	New template, no content change
06-May-2014	8	– Updated: Figure 17, 18, 19 and 20 – Updated: Section 4: Package mechanical data – Minor text changes – The part number STP14NK60ZFP has been moved to a separate datasheet

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