



# STW9NK95Z

N-channel 950 V - 1.15  $\Omega$  - 7 A - TO-247  
Zener-protected SuperMESH™ Power MOSFET

## Features

Type	V <sub>DSS</sub>	R <sub>DS(on) Max</sub>	I <sub>D</sub>	P <sub>w</sub>
STW9NK95Z	950 V	< 1.38 $\Omega$	7 A	160 W

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized

## Application

- Switching applications

## Description

The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications.

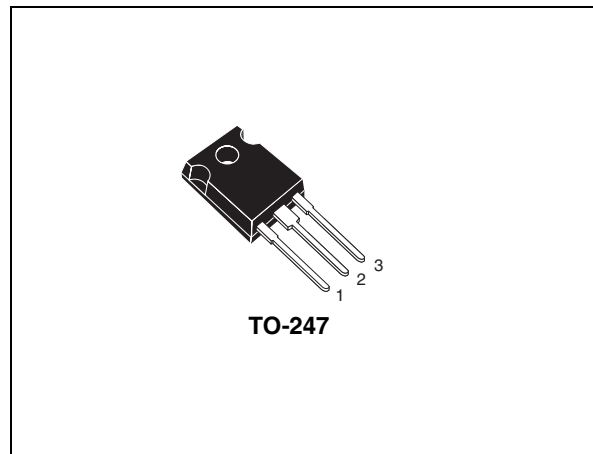


Figure 1. Internal schematic diagram

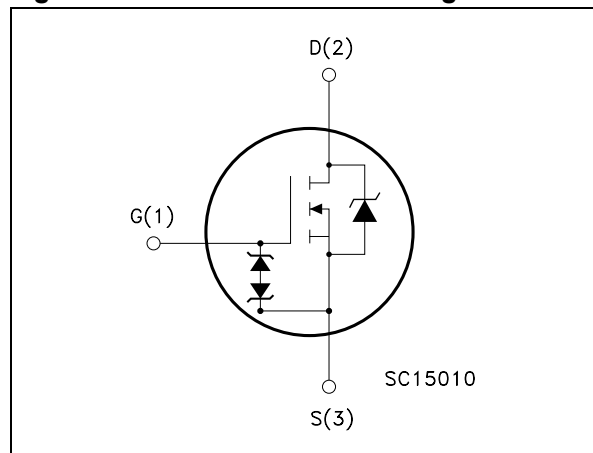


Table 1. Device summary

Order code	Marking	Package	Packaging
STW9NK95Z	9NK95Z	TO-247	Tube

# Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{DS}$	Drain-source voltage ( $V_{GS} = 0$ )	950	V
$V_{GS}$	Gate-source voltage	$\pm 30$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	7	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	4.41	A
$I_{DM}^{(1)}$	Drain current (pulsed)	28	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	160	W
	Derating Factor	1.28	W/ $^\circ\text{C}$
$V_{esd}(G-S)$	G-S ESD (HBM $C=100\text{ pF}$ , $R=1.5\text{ k}\Omega$ )	4000	V
$dv/dt^{(2)}$	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.  $I_{SD} \leq 7\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq 80\% V_{(BR)DSS}$

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max	0.78	$^\circ\text{C}/\text{W}$
$R_{thj-a}$	Thermal resistance junction-ambient max	50	$^\circ\text{C}/\text{W}$
$T_l$	Maximum lead temperature for soldering purpose	300	$^\circ\text{C}$

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AS}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_J$ Max)	7	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J=25\text{ }^\circ\text{C}$ , $I_D=I_{AS}$ , $V_{DD}=50\text{ V}$ ) (see Figure 17) and (see Figure 18)	300	mJ

## 2 Electrical characteristics

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

**Table 5. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1 \text{ mA}, V_{GS} = 0$	950			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = \text{max rating},$ $V_{DS} = \text{max rating} @ 125^{\circ}C$			1 50	$\mu A$ $\mu A$
$I_{GSS}$	Gate body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20 \text{ V}, V_{DS} = 0$			$\pm 10$	$\mu A$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 100 \mu A$	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10 \text{ V}, I_D = 3.6 \text{ A}$		1.15	1.38	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15 \text{ V}, I_D = 3.6 \text{ A}$		5.7		S
$C_{iss}$	Input capacitance	$V_{DS} = 25 \text{ V}, f = 1 \text{ MHz},$ $V_{GS} = 0$		2256		pF
$C_{oss}$	Output capacitance			189		pF
$C_{rss}$	Reverse transfer capacitance			30		pF
$C_{oss \text{ eq}}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0 \text{ to } 760 \text{ V}$		37		pF
$R_G$	Intrinsic gate resistance	$f = 1 \text{ MHz}, \text{ open drain}$		1.6		$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 760 \text{ V}, I_D = 7.2 \text{ A}$ $V_{GS} = 10 \text{ V}$ <i>(see Figure 15)</i>		56		nC
$Q_{gs}$	Gate-source charge			10		nC
$Q_{gd}$	Gate-drain charge			30		nC

1. Pulsed: pulse duration=300 $\mu s$ , duty cycle 1.5%

2.  $C_{oss \text{ eq}}$  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
$t_{d(on)}$ $t_r$	Turn-on delay time Rise Time	$V_{DD}= 475\text{ V}$ , $I_D= 3.6\text{ A}$ , $R_G= 4.7\ \Omega$ , $V_{GS}= 10\text{ V}$ <i>(see Figure 14)</i> <i>(see Figure 19)</i>		22 15		ns ns
$t_{d(off)}$ $t_f$	Turn-off delay time Fall time	$V_{DD}= 475\text{ V}$ , $I_D= 3.6\text{ A}$ , $R_G= 4.7\ \Omega$ , $V_{GS}= 10\text{ V}$ <i>(see Figure 14)</i> <i>(see Figure 19)</i>		51 22		ns ns

**Table 8. Gate-source Zener diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$BV_{GSO}^{(1)}$	Gate-source breakdown voltage	$I_{GS}=\pm 1\text{ mA}$ (open drain)	30			V

1. 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.

**Table 9. Source drain diode**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$I_{SD}$	Source-drain current				7	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				28	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD}= 7.2\text{ A}$ , $V_{GS}=0$			1.6	V
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_{SD}= 7.2\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD}= 60\text{ V}$ , $T_j = 25^\circ\text{C}$ <i>(see Figure 16)</i>		660 5.9 18		ns $\mu\text{C}$ A
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_{SD}= 7.2\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD}= 60\text{ V}$ , $T_j = 150^\circ\text{C}$ <i>(see Figure 16)</i>		800 7.4 18.6		ns $\mu\text{C}$ A

1. Pulse width limited by safe operating area  
2. Pulsed: pulse duration=300 $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

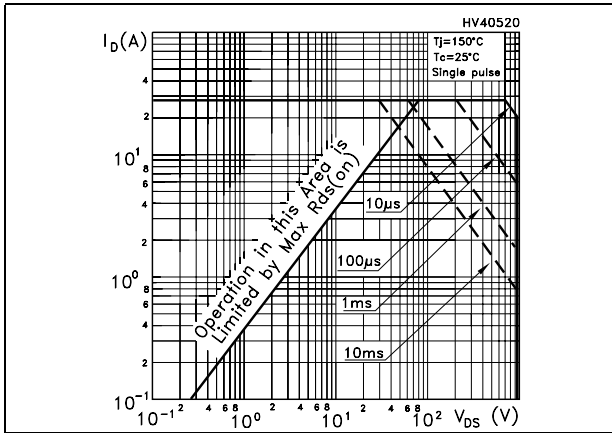


Figure 3. Thermal impedance

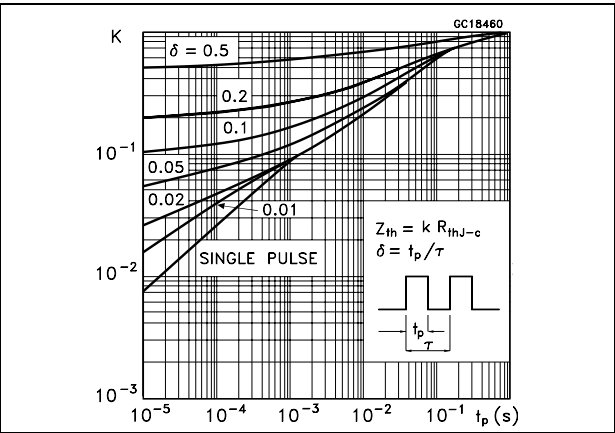


Figure 4. Output characteristics

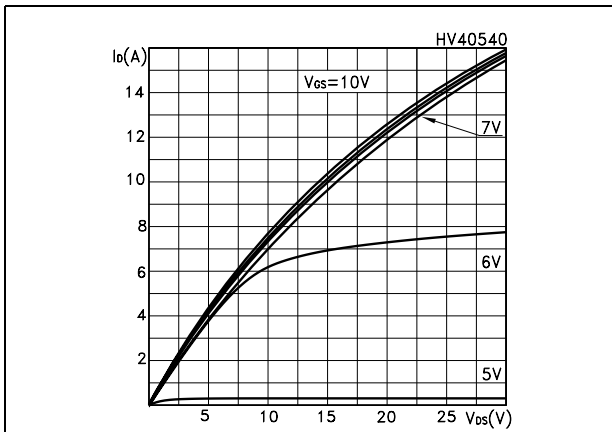


Figure 5. Transfer characteristics

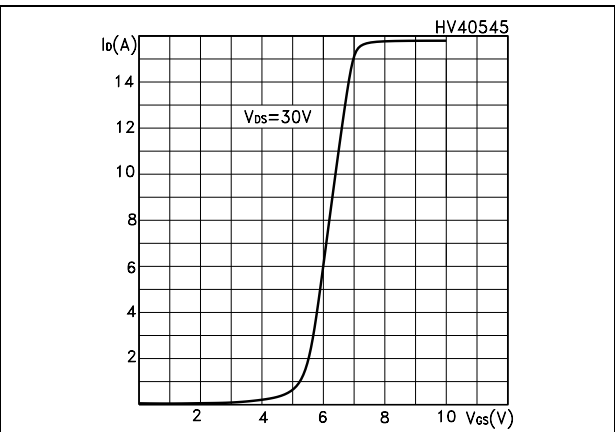


Figure 6. Normalized  $B_{V_{DS}}$  vs temperature

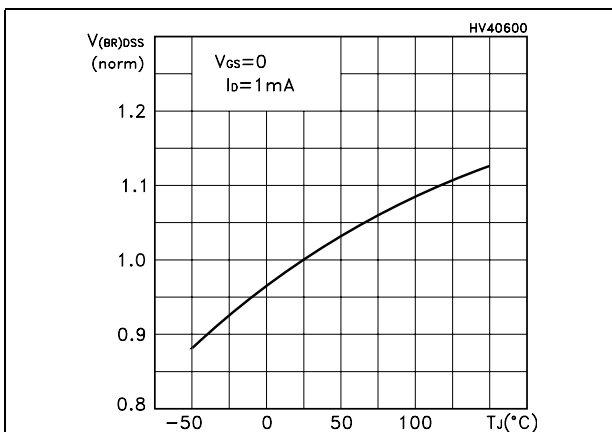


Figure 7. Static drain-source on resistance

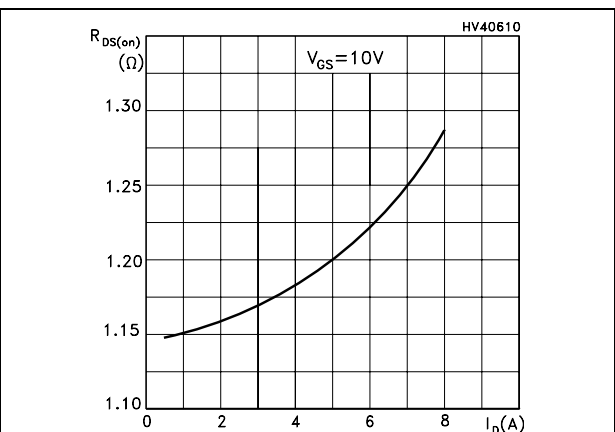


Figure 8. Gate charge vs gate-source voltage Figure 9. Capacitance variations

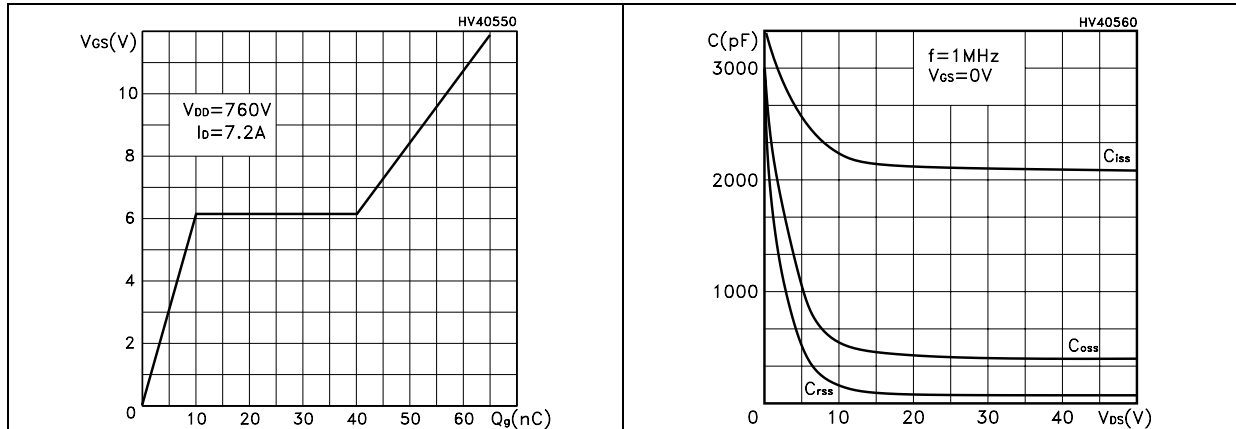


Figure 10. Normalized gate threshold voltage vs temperature Figure 11. Normalized on resistance vs temperature

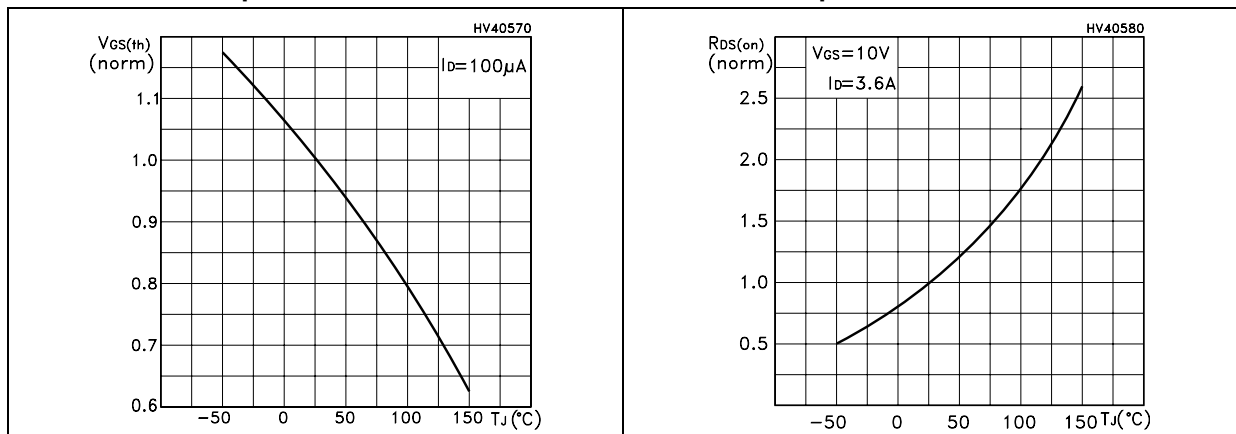
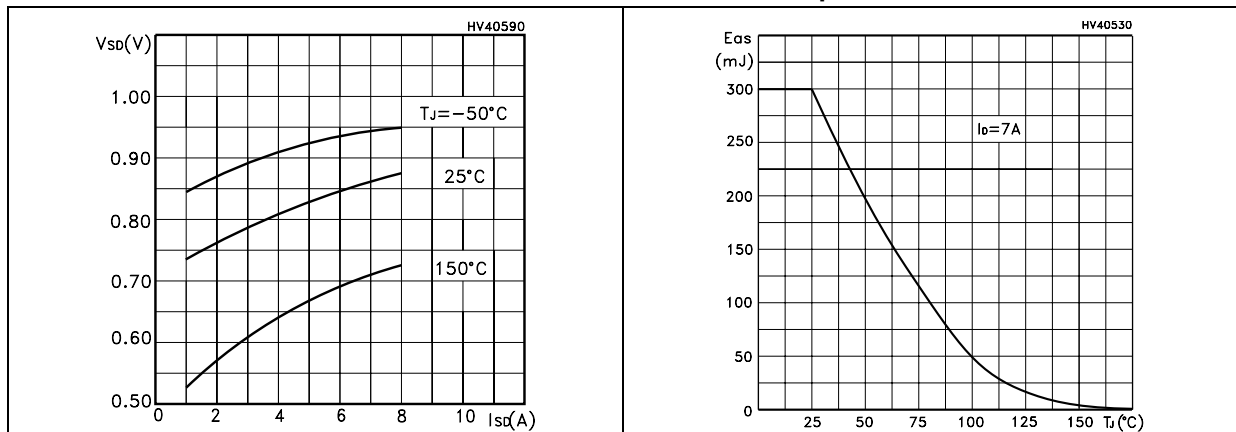


Figure 12. Source-drain diode forward characteristics Figure 13. Maximum avalanche energy vs temperature



### 3 Test circuits

Figure 14. Switching times test circuit for resistive load

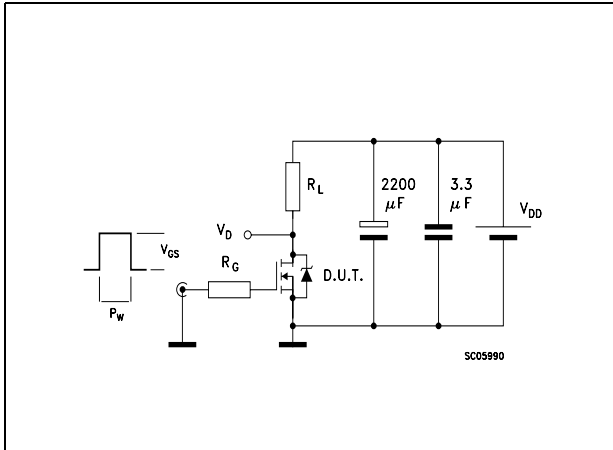


Figure 15. Gate charge test circuit

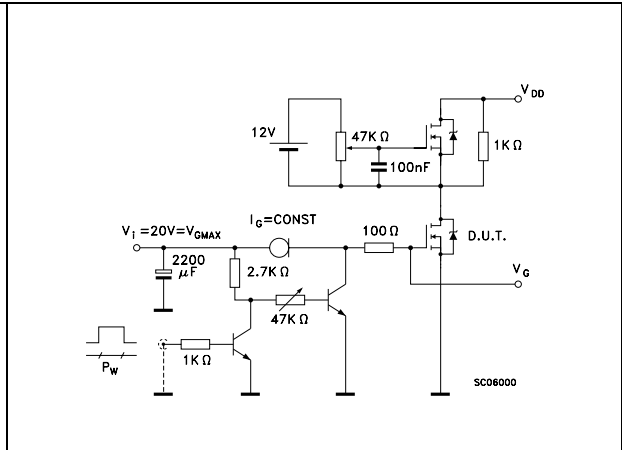


Figure 16. Test circuit for inductive load switching and diode recovery times

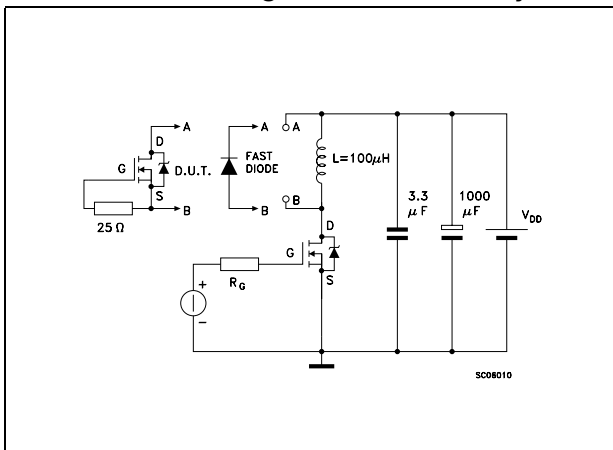


Figure 17. Unclamped Inductive load test circuit

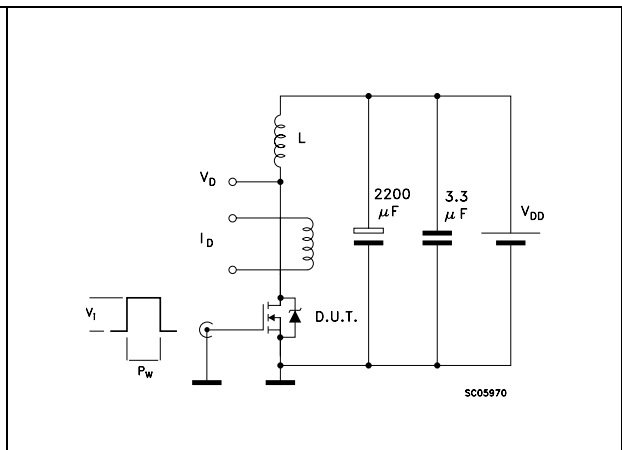


Figure 18. Unclamped inductive waveform

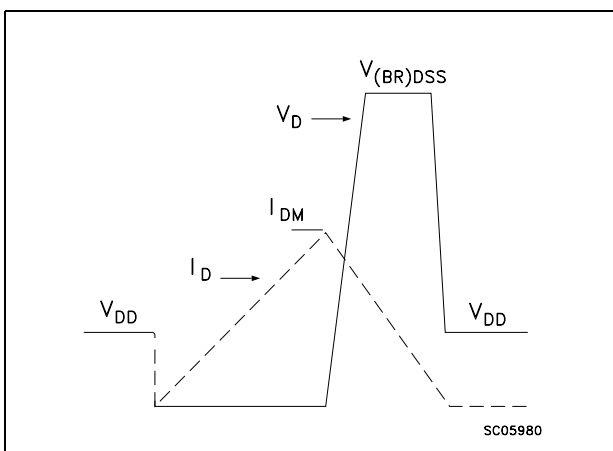
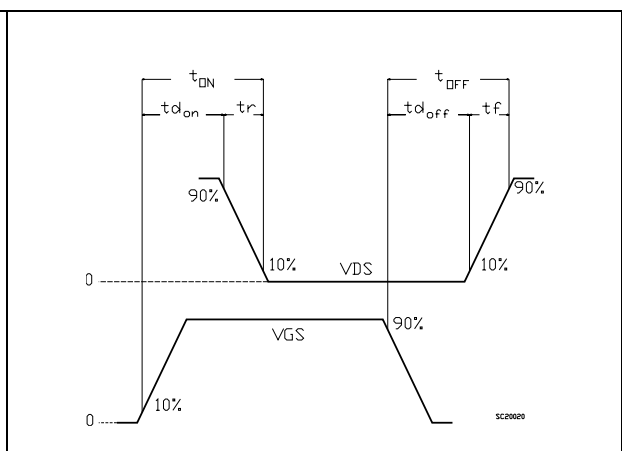


Figure 19. Switching time waveform



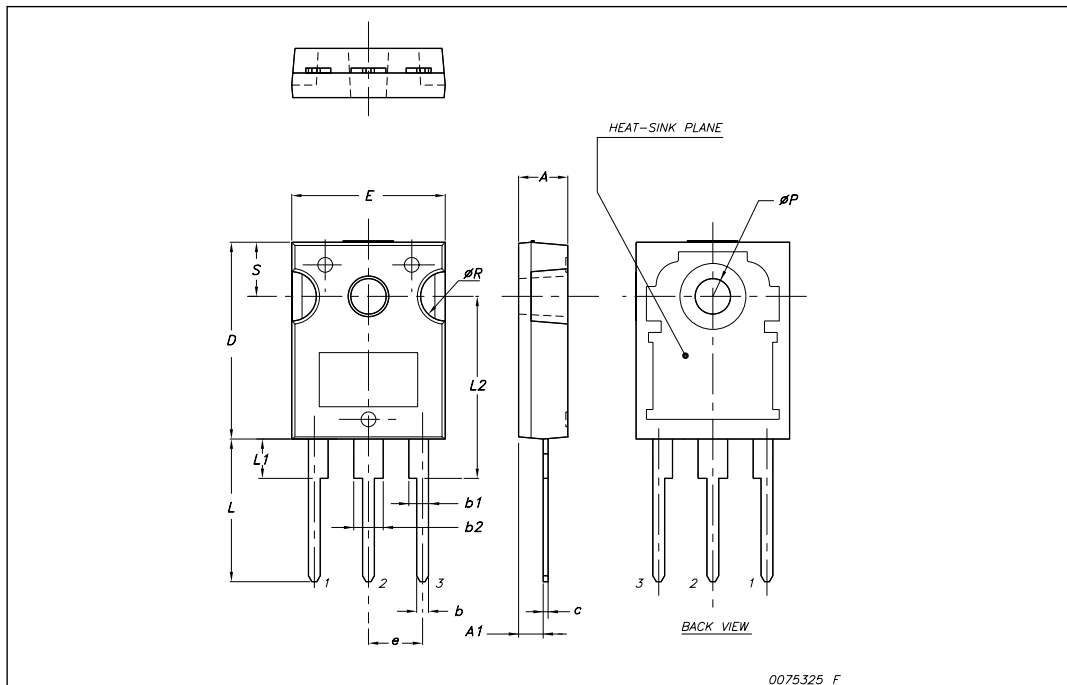


## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com)

**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
11-Oct-2006	1	Initial release
03-Jul-2008	2	Updated <a href="#">Figure 6</a> , <a href="#">Figure 7</a> , <a href="#">Figure 9</a>

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