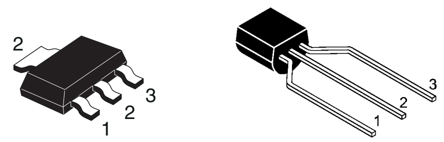
STN1NK60Z
STQ1NK60ZR-AP

N-channel 600 V, 13 Ω, 0.8 A TO-92, SOT-223 Zener-protected SuperMESH™ Power MOSFET

Features

Order codes	V_{DSS}	$R_{DS(on)}$	I_D	Pw
STQ1NK60ZR-AP	600 V	< 15 Ω	0.3 A	3 W
STN1NK60Z				3.3 W

- 100% avalanche tested
- Extremely high dv/dt capability
- Gate charge minimized
- ESD improved capability
- New high voltage benchmark



SOT-223 TO-92 (Ammopak)

Application

Switching applications

Description

This device is a N-channel SuperMESH™ that is obtained through an optimization of STMicroelectronics' well-established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly lower, it also ensures very good dv/dt capability for the most demanding applications. This series complement STs' full range of high voltage Power MOSFETs.

Figure 1. Internal schematic diagram

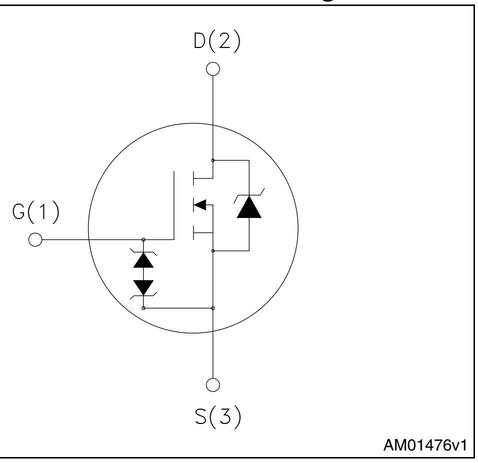


Table 1. Device summary

Order codes	Marking	Package	Packaging
STQ1NK60ZR-AP	1NK60ZR	TO-92	Ammopak
STN1NK60Z	1NK60Z	SOT-223	Tape and reel

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-92	SOT-223	
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	0.3	0.3	A
I_D	Drain current (continuous) at T_C=100 °C	0.189		A
I_{DM}(1)	Drain current (pulsed)	1.2		A
P_{TOT}	Total dissipation at T_C = 25 °C	3	3.3	W
	Derating factor	0.25	0.26	W/°C
$V_{ESD(G-D)}$	Gate source ESD (HBM-C=100 pF, R=1.5 kΩ)	800		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		°C

1. Pulse width limited by safe operating area
2. I_{SD} ≤ 0.3 A, di/dt ≤ 200 A/µs, V_{DD} = 80%$V_{(BR)DSS}$

Table 3. Thermal resistance

Symbol	Parameter	Value		Unit
		TO-92	SOT-223	
R_{thj-a}	Thermal resistance junction-ambient max	120	38(1)	°C/W
$R_{thj-lead}$	Thermal resistance junction-lead max	40		°C/W
T_l	Maximum lead temperature for soldering purpose	260		°C

1. When mounted on 1 inch² FR-4 board, 2 Oz Cu, t < 30 s.

Table 4. Avalanche data

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by Tj Max)	0.8	A
E_{AS}	Single pulse avalanche energy (starting T_J = 25 °C, I_D = I_{AR}, V_{DD} = 50 V)	60	mJ

2 Electrical characteristics

(T_{CASE} = 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	600			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} =max rating, V_{DS} =max rating @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 = 0.4 A		13	15	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{fs} (1)	Forward transconductance	V_{DS} =15 V, I_D = 0.4 A		0.5		S
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{DS} = 25 V, f=1 MHz, V_{GS} = 0		94 17.6 2.8		pF pF pF
$C_{oss\ eq}$ (2).	Equivalent output capacitance	V_{GS}= 0, V_{DS} = 0 to 480 V		11		pF
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD}=480 V, I_D = 0.8 A V_{GS} =10 V *(see Figure 19)*		4.9 1 2.7	6.9	nC nC nC

1. Pulsed: pulse duration=300µs, duty cycle 1.5%
2. $C_{oss\ eq.}$ 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} = 300 V, I_D = 0.4 A, R_G = 4.7 Ω, V_{GS} = 10 V *(see Figure 18)*		5.5 5 13 28		ns ns ns ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
I_{SD}	Source-drain current				0.8	A
I_{SDM}(1)	Source-drain current (pulsed)				2.4	A
V_{SD}(2)	Forward on voltage	I_{SD} = 0.8 A, V_{GS}=0			1.6	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 0.8 A, di/dt = 100 A/µs, V_{DD} = 20 V		135 216 3.2		ns nC A
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 0.8 A, di/dt = 100 A/µs, V_{DD} = 20V, Tj = 150 °C		140 224 3.2		ns nC A

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

Table 9. Gate-source Zener diode

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

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-92

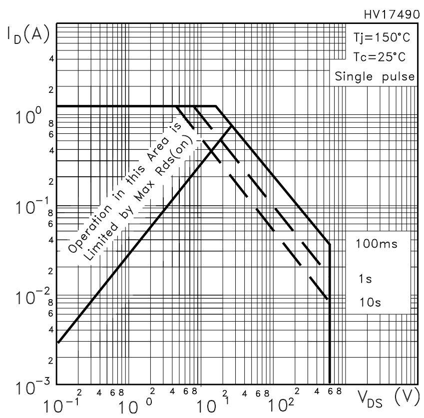


Figure 3. Thermal impedance for TO-92

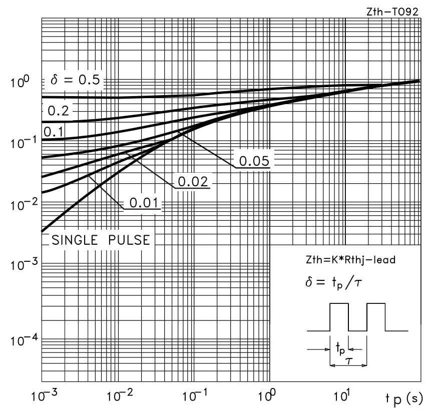


Figure 4. Safe operating area for SOT-223

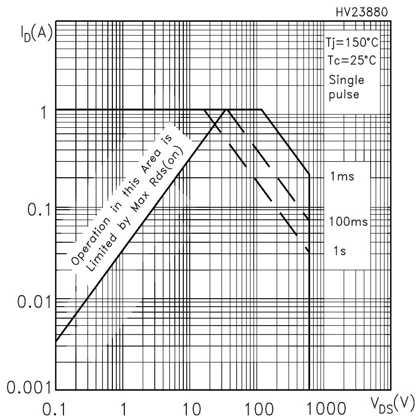


Figure 5. Thermal impedance for SOT-223

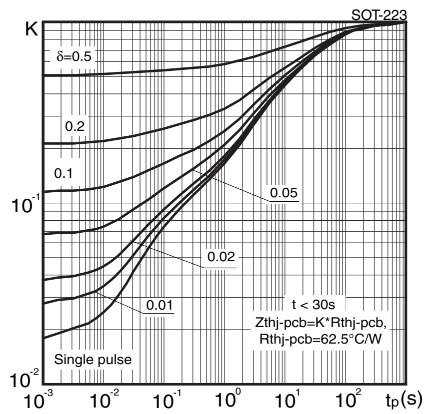


Figure 6. Output characteristics

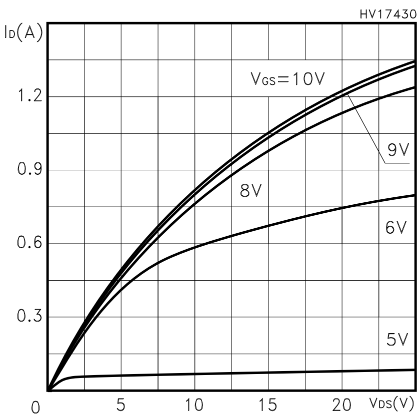


Figure 7. Transfer characteristics

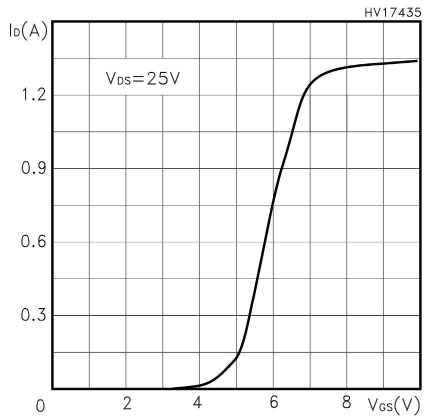


Figure 8. Transconductance

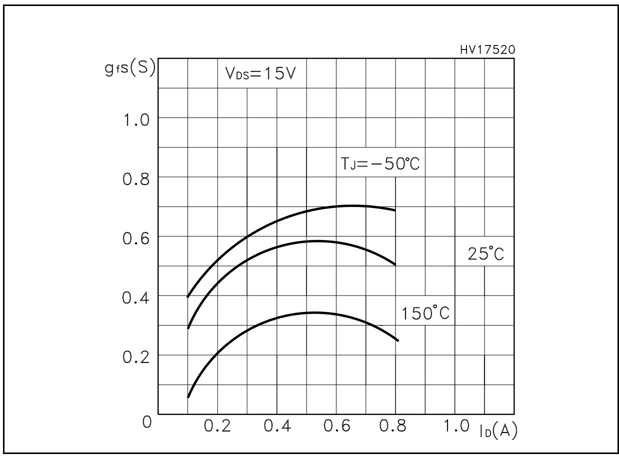


Figure 9. Static drain-source on resistance

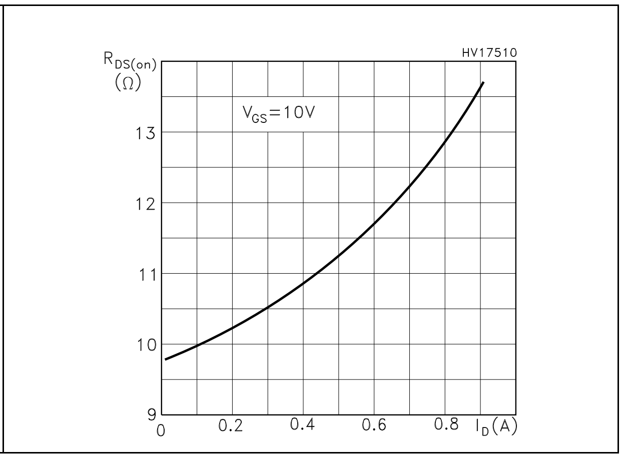


Figure 10. Gate charge vs gate-source voltage

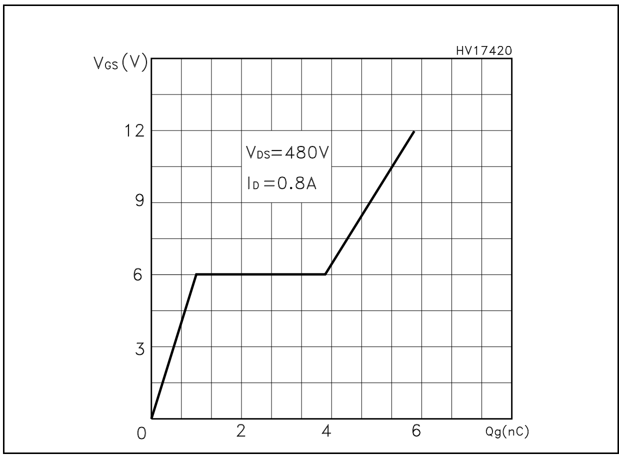


Figure 11. Capacitance variations

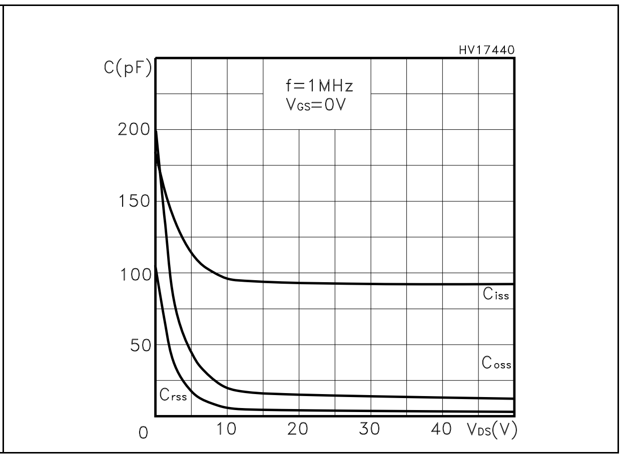


Figure 12. Normalized gate threshold voltage vs temperature

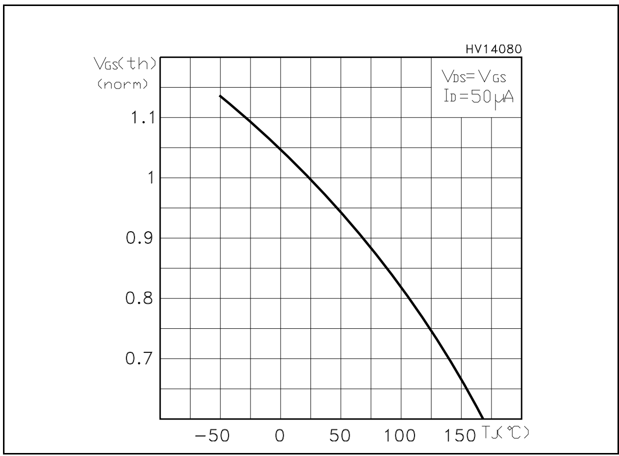


Figure 13. Normalized on resistance vs temperature

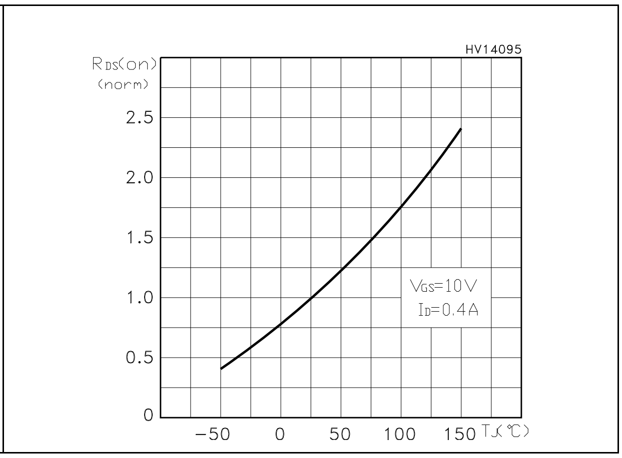


Figure 14. Source-drain diode forward characteristics

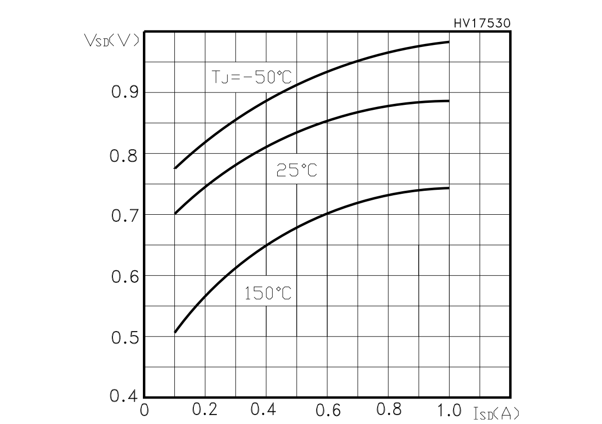


Figure 15. Normalized B_{VDSS} vs temperature

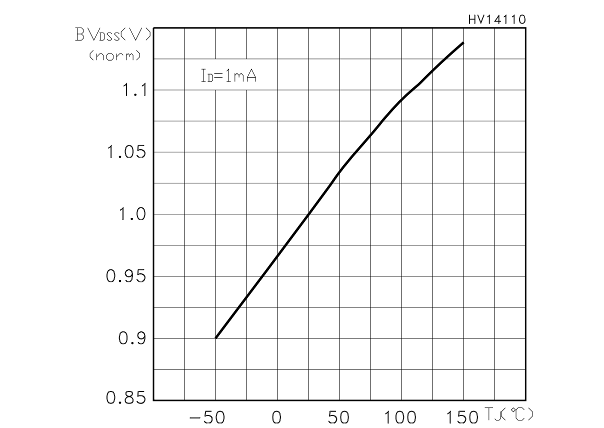


Figure 16. Maximum avalanche energy vs temperature

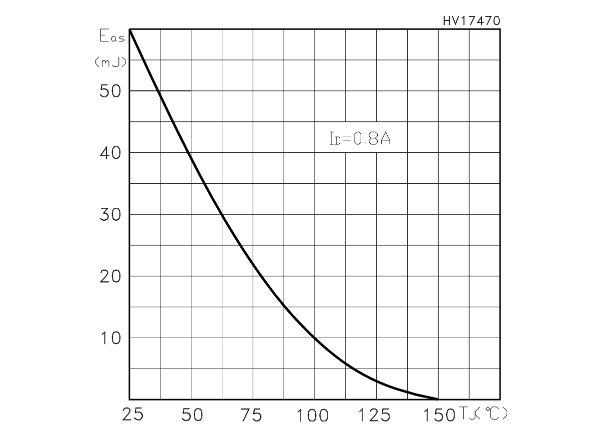
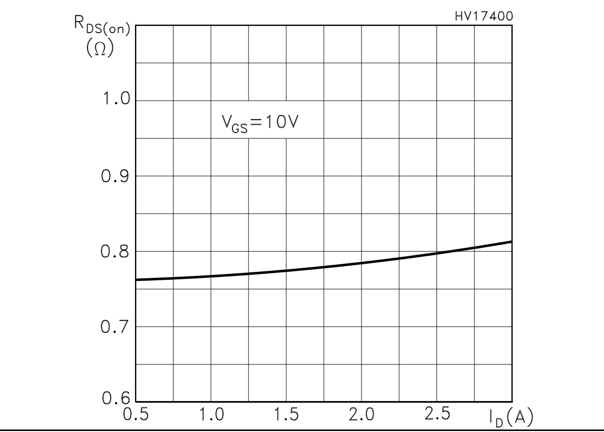


Figure 17. Max Id Current vs Tc



3 Test circuit

Figure 18. Switching times test circuit for resistive load

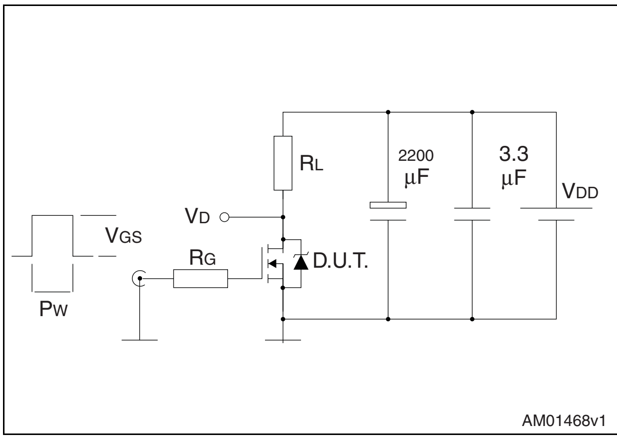


Figure 19. Gate charge test circuit

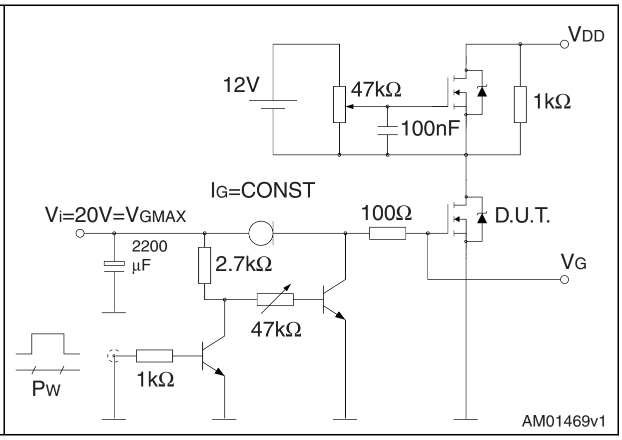


Figure 20. Test circuit for inductive load switching and diode recovery times

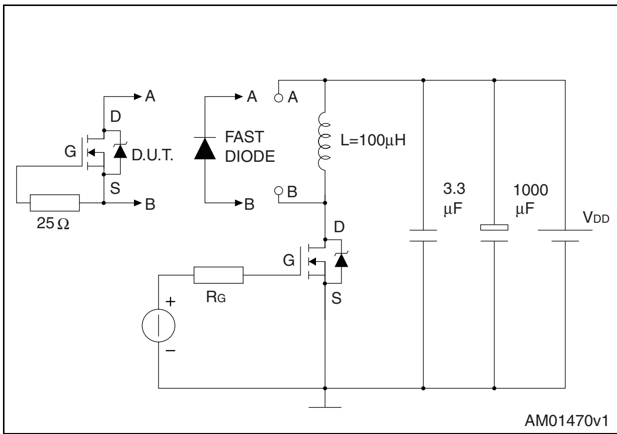


Figure 21. Unclamped inductive load test circuit

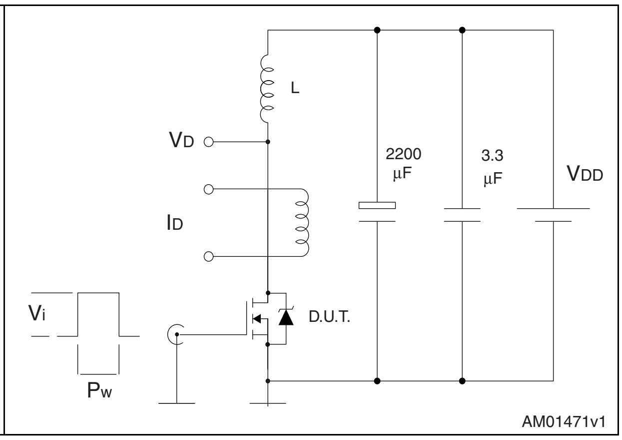


Figure 22. Unclamped inductive waveform

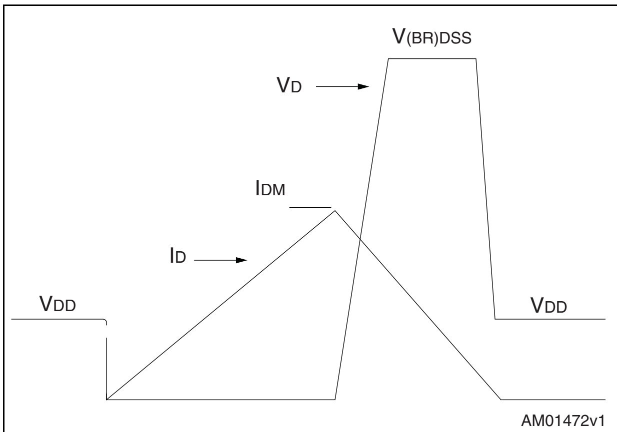
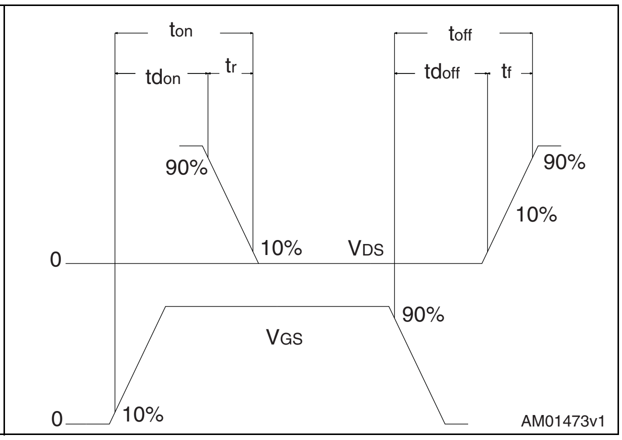


Figure 23. Switching time waveform



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. SOT-223 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
a	2.27	2.3	2.33
b	4.57	4.6	4.63
c	0.2	0.4	0.6
d	0.63	0.65	0.67
e1	1.5	1.6	1.7
e4			0.32
f	2.9	3	3.1
g	0.67	0.7	0.73
l1	6.7	7	7.3
l2	3.5	3.5	3.7
L	6.3	6.5	6.7

Figure 24. SOT-223 mechanical data drawing

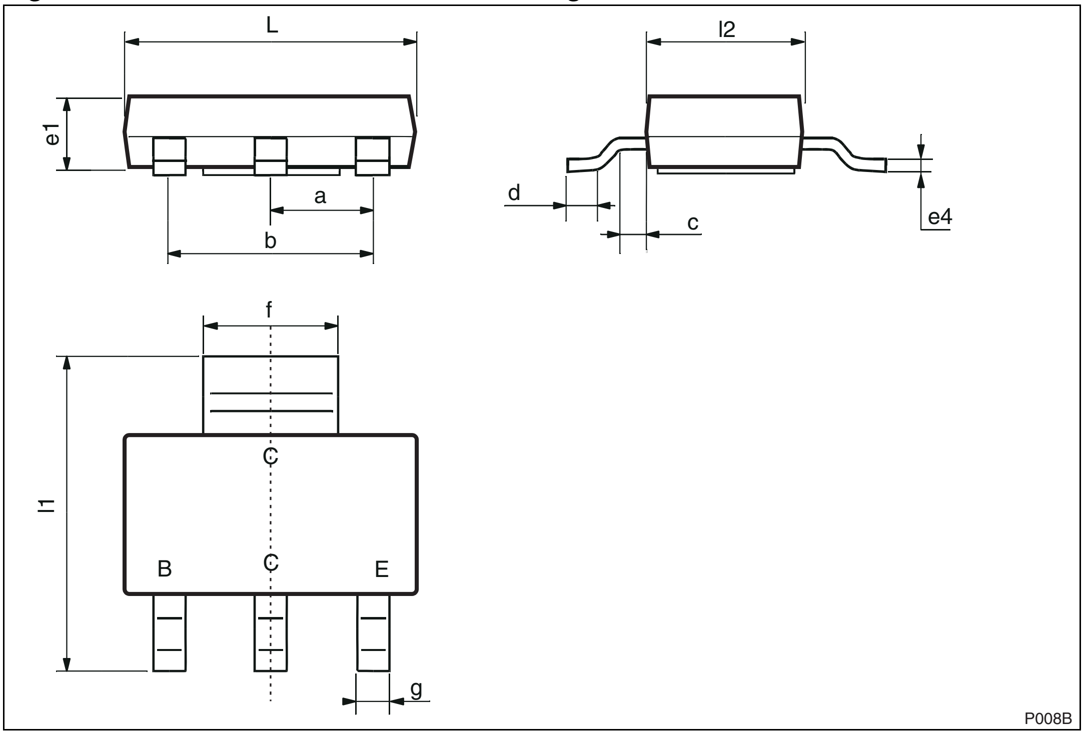


Table 11. TO-92 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.32		4.95
b	0.36		0.51
D	4.45		4.95
E	3.30		3.94
e	2.41		2.67
e1	1.14		1.40
L	12.70		15.49
R	2.16		2.41
S1	0.92		1.52
W	0.41		0.56
V		5°	

Figure 25. TO-92 mechanical data drawing

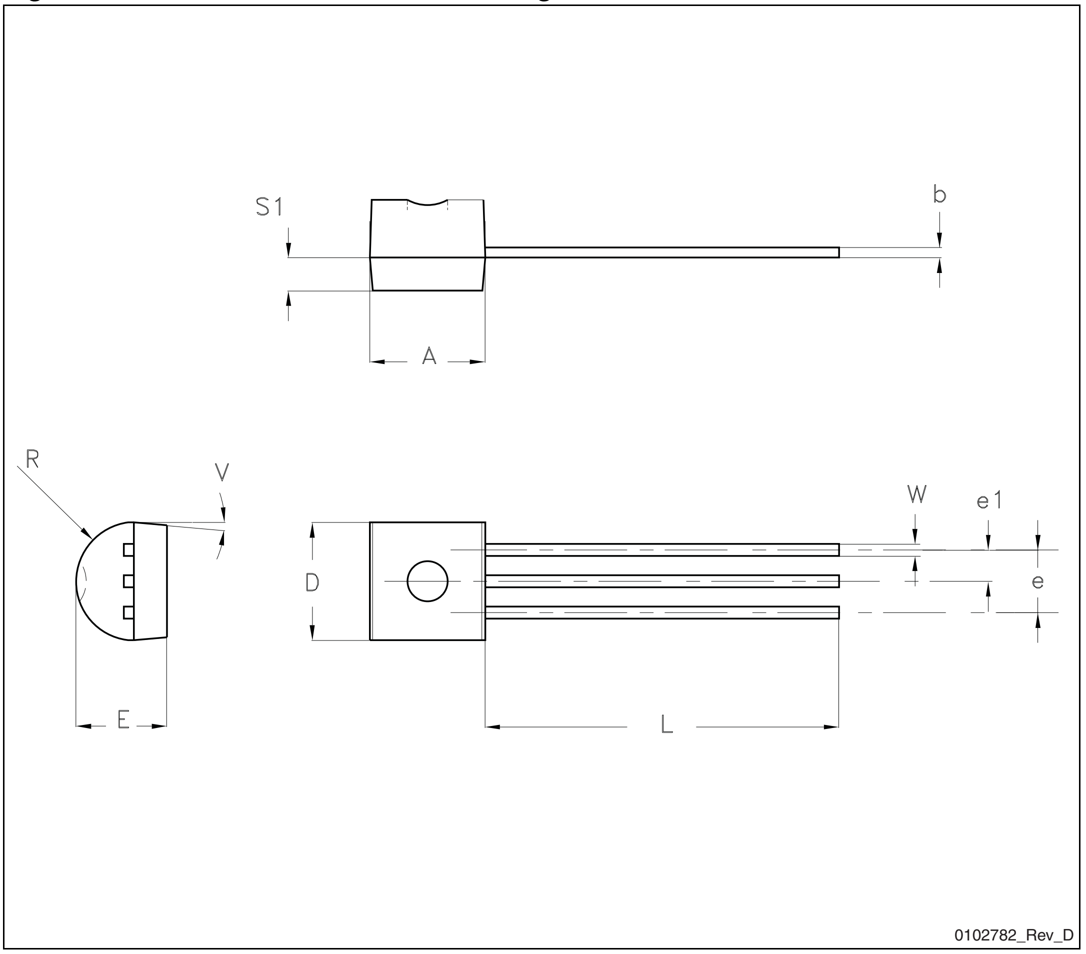
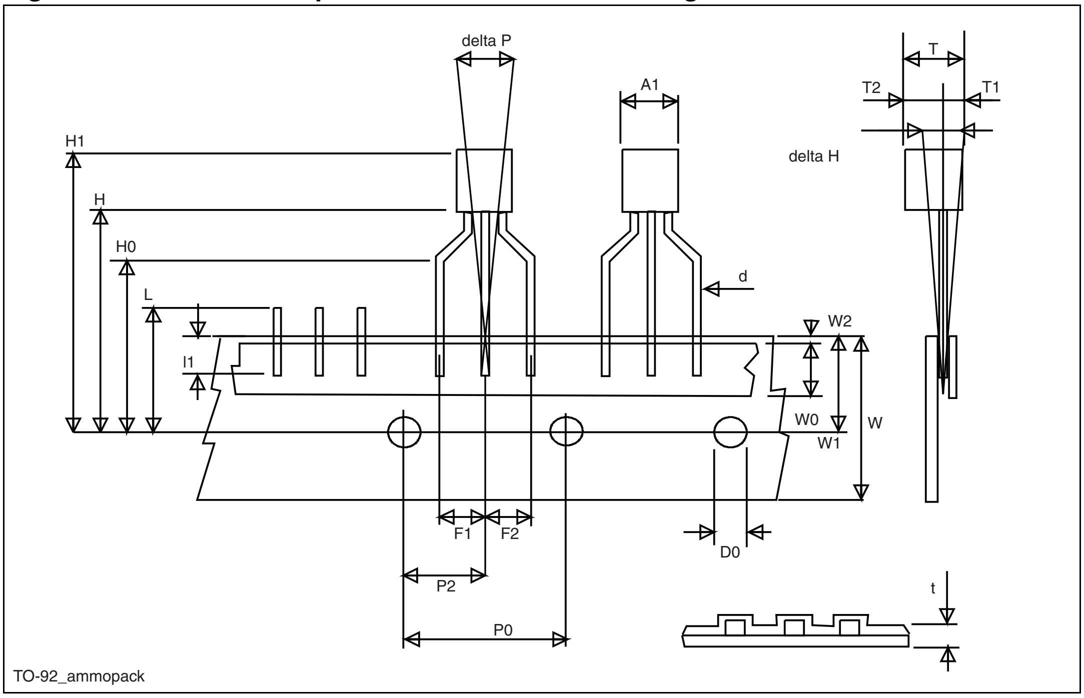


Table 12. TO-92 ammopack mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A1	4.45		4.95
T	3.30		3.94
T1			1.6
T2			2.3
d	0.41		0.56
P0	12.5	12.7	12.9
P2	5.65	6.35	7.05
F1, F2	2.44	2.54	2.94
delta H	-2		2
W	17.5	18	19
W0	5.7	6	6.3
W1	8.5	9	925
W2			0.5
H	18.5		20.5
H0	15.5	16	16.5
H1			25
D0	3.8	4	4.2
t			0.9
L			11
I1	3		
delta P	-1		1

Figure 26. TO-92 ammopack mechanical data drawing



5 Revision history

Table 13. Revision history

Date	Revision	Changes
19-Mar-2003	3	First electronic version
15-May-2003	4	Removed DPAK
09-Jun-2003	5	Final datasheet
17-Nov-2004	6	Inserted SOT-223
15-Feb-2005	7	Modified *Figure 2.*
07-Sep-2005	8	Inserted ecopack indication
22-Feb-2006	9	The document has been reformatted
01-Jun-2007	10	Order code table on first page has been updated
19-Jul-2007	11	*Table 1: Device summary* has been updated
05-Jan-2011	12	Corrected *Figure 4: Safe operating area for SOT-223* and *Figure 5: Thermal impedance for SOT-223*