



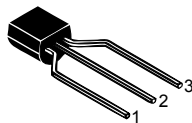
**THE DATASHEET OF  
STQ1H NK60R-AP**



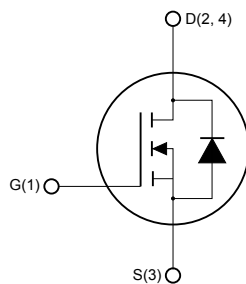
## N-channel 600 V, 7.3 $\Omega$ typ., 0.4 A SuperMESH™ Power MOSFETs in a SOT-223 and TO-92 packages



SOT-223



TO-92 (Ammopack)



Int\_schem\_nTnZ\_SOT\_223

### Features

Order code	$V_{DS}$	$R_{DS(on)}$ max.	$I_D$	Package
STN1HNK60	600 V	8.5 $\Omega$	0.4 A	SOT-223
STQ1HNK60R-AP				TO-92

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

### Applications

- Switching applications

### Description

These high-voltage devices are Zener-protected N-channel Power MOSFETs developed using the SuperMESH™ technology by STMicroelectronics, an optimization of the well-established PowerMESH™. In addition to a significant reduction in on-resistance, these devices are designed to ensure a high level of dv/dt capability for the most demanding applications.

#### Product status

STN1HNK60

STQ1HNK60R-AP

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		SOT-223	TO-92	
$V_{DS}$	Drain-source voltage	600		V
$V_{DGR}$	Drain-gate voltage ( $R_{GS} = 20\text{ k}\Omega$ )	600		V
$V_{GS}$	Gate- source voltage	$\pm 30$		V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	0.4		A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	0.25		A
$I_{DM}^{(1)}$	Drain current (pulsed)	1.6		A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	3.3	3	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	3		V/ns
$T_j$	Operating junction temperature range	-55 to 150		$^\circ\text{C}$
$T_{stg}$	Storage temperature range			

1. Pulse width limited by safe operating area.
2.  $I_{SD} \leq 0.4\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ .

**Table 2. Thermal data**

Symbol	Parameter	Value		Unit
		SOT-223	TO-92	
$R_{thj-amb}$	Thermal resistance junction-ambient		120	$^\circ\text{C}/\text{W}$
$R_{thj-lead}$	Thermal resistance junction-lead		40	$^\circ\text{C}/\text{W}$
$R_{thj-pcb}^{(1)}$	Thermal resistance junction-pcb	37.87		$^\circ\text{C}/\text{W}$

1. When mounted on FR-4 board of  $1\text{ in}^2$ , 2 oz Cu,  $t < 10\text{ s}$ .

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j\text{ Max}$ )	0.4	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	25	mJ

## 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	$I_D = 1\text{ mA}$ , $V_{GS} = 0\text{ V}$	600			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 600\text{ V}$ , $T_C = 125\text{ °C}$ <sup>(1)</sup>			50	$\mu\text{A}$
$I_{GSS}$	Gate body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 30\text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	2.25	3	3.7	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}$ , $I_D = 0.5\text{ A}$		7.3	8.5	$\Omega$

1. Defined by design, not subject to production test.

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0\text{ V}$	-	156		$\mu\text{F}$
$C_{oss}$	Output capacitance			23.5		
$C_{rss}$	Reverse transfer capacitance			3.8		
$Q_g$	Total gate charge	$V_{DD} = 480\text{ V}$ , $I_D = 1\text{ A}$ , $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 16. Test circuit for gate charge behavior)	-	7	10	nC
$Q_{gs}$	Gate-source charge			1.1		
$Q_{gd}$	Gate-drain charge			3.7		

**Table 6. Switching times**

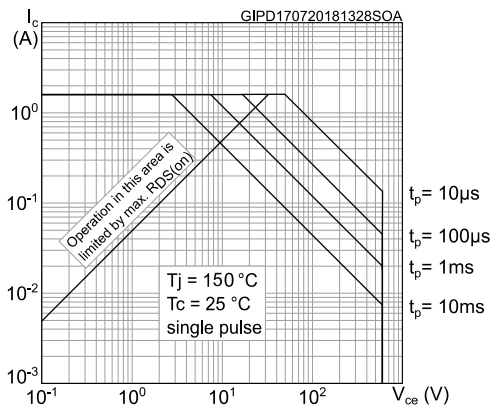
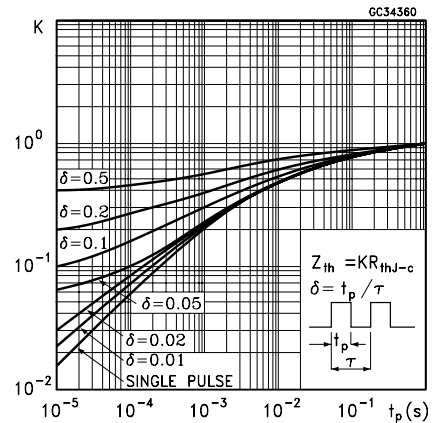
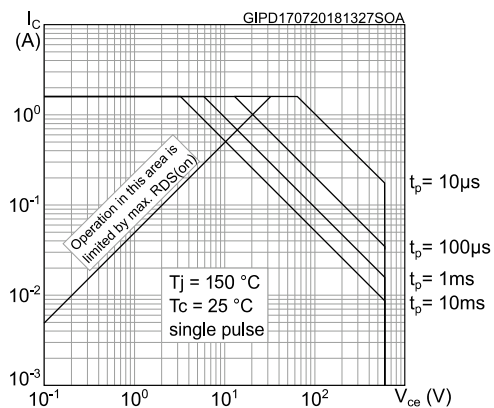
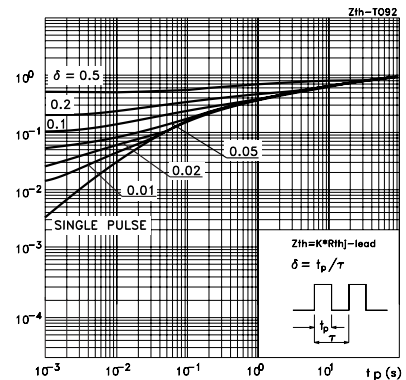
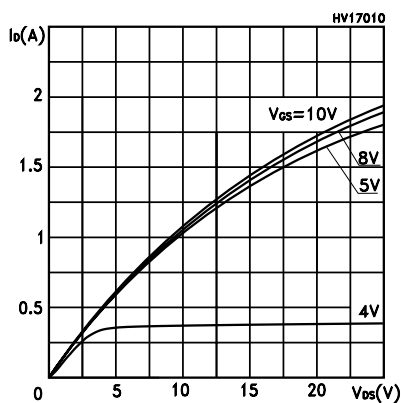
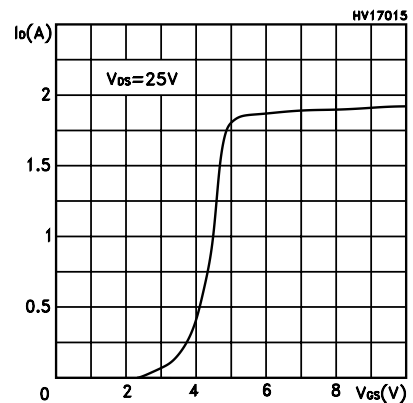
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$ , $I_D = 0.5\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ (see Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform)	-	6.5	-	ns
$t_r$	Rise time			5		
$t_{d(off)}$	Turn-off delay time			19		
$t_f$	Fall time			25		

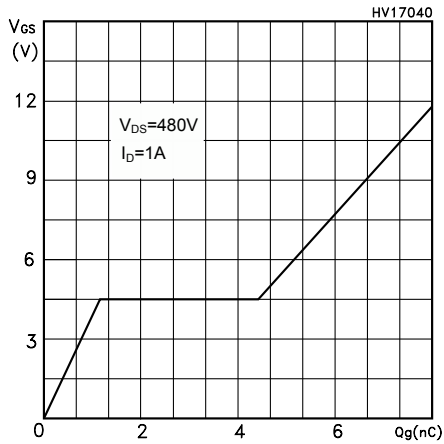
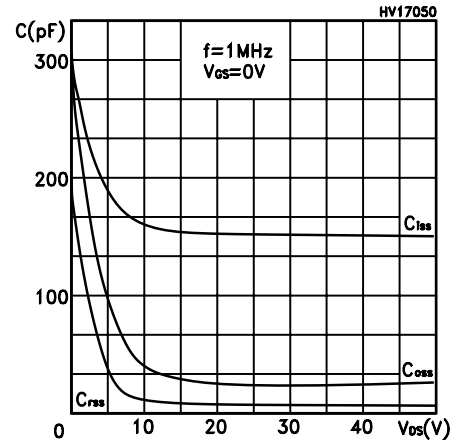
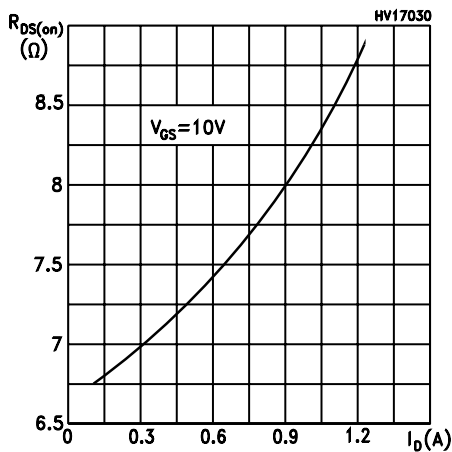
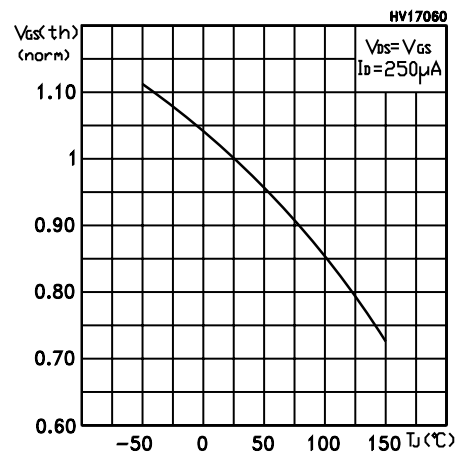
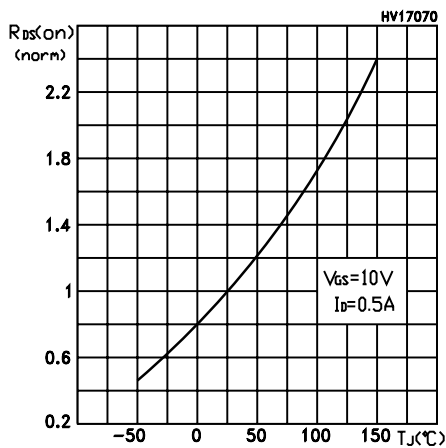
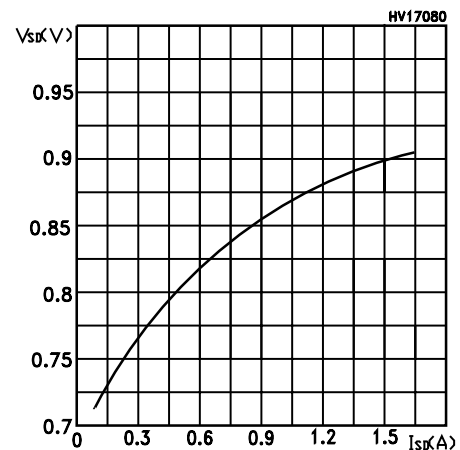
**Table 7. Source drain diode**

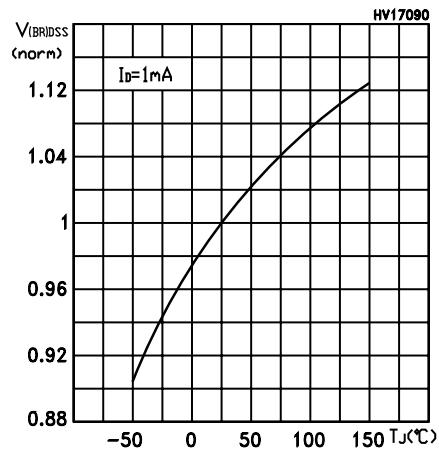
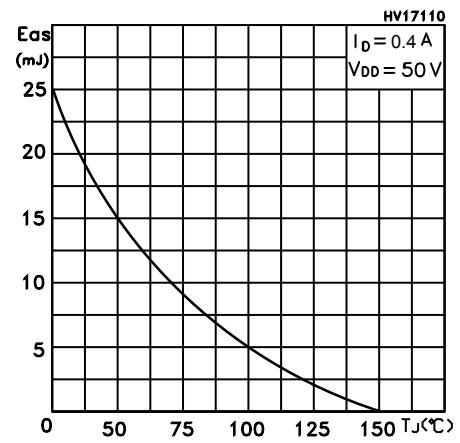
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current				0.4	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		1.6	
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 0.4 \text{ A}$ , $V_{GS} = 0 \text{ V}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 1.0 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$		140		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 25 \text{ V}$ (see <a href="#">Figure 17. Test circuit for inductive load switching and diode recovery times</a> )	-	240		nC
$I_{RRM}$	Reverse recovery current			3.3		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 1.0 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$		229		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 25 \text{ V}$ , $T_J = 150 \text{ }^\circ\text{C}$ (see <a href="#">Figure 17. Test circuit for inductive load switching and diode recovery times</a> )	-	377		nC
$I_{RRM}$	Reverse recovery current			3.3		A

1. Pulse width limited by safe operating area.

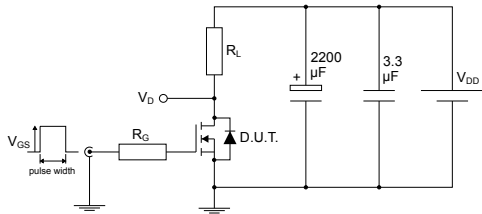
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

**2.1 Electrical characteristics curves**
**Figure 1. Safe operating area for SOT-223**

**Figure 2. Thermal impedance for SOT-223**

**Figure 3. Safe operating area for TO-92**

**Figure 4. Thermal impedance for TO-92**

**Figure 5. Output characteristics**

**Figure 6. Transfer characteristics**


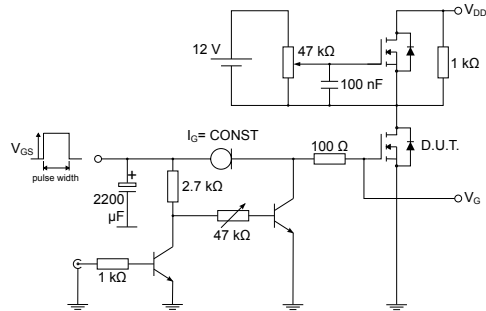
**Figure 7. Gate charge vs gate-source voltage**

**Figure 8. Capacitance variations**

**Figure 9. Static drain-source on-resistance**

**Figure 10. Normalized gate threshold voltage vs temperature**

**Figure 11. Normalized on-resistance vs temperature**

**Figure 12. Source-drain forward characteristics**


**Figure 13. Normalized  $V_{(BR)DSS}$  vs Temperature**

**Figure 14. Maximum avalanche energy vs temperature**


### 3 Test circuits

**Figure 15. Test circuit for resistive load switching times**


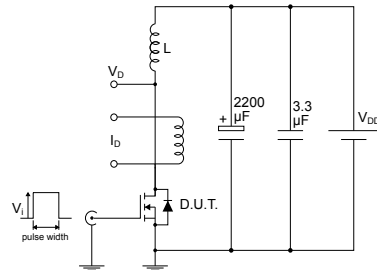
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**Figure 16. Test circuit for gate charge behavior**


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**Figure 17. Test circuit for inductive load switching and diode recovery times**

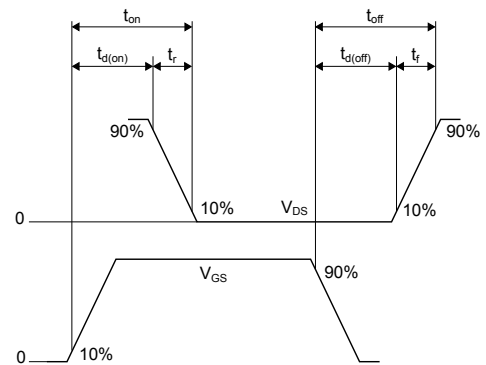

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**Figure 18. Unclamped inductive load test circuit**


AM01471v1

**Figure 19. Unclamped inductive waveform**


AM01472v1

**Figure 20. Switching time waveform**


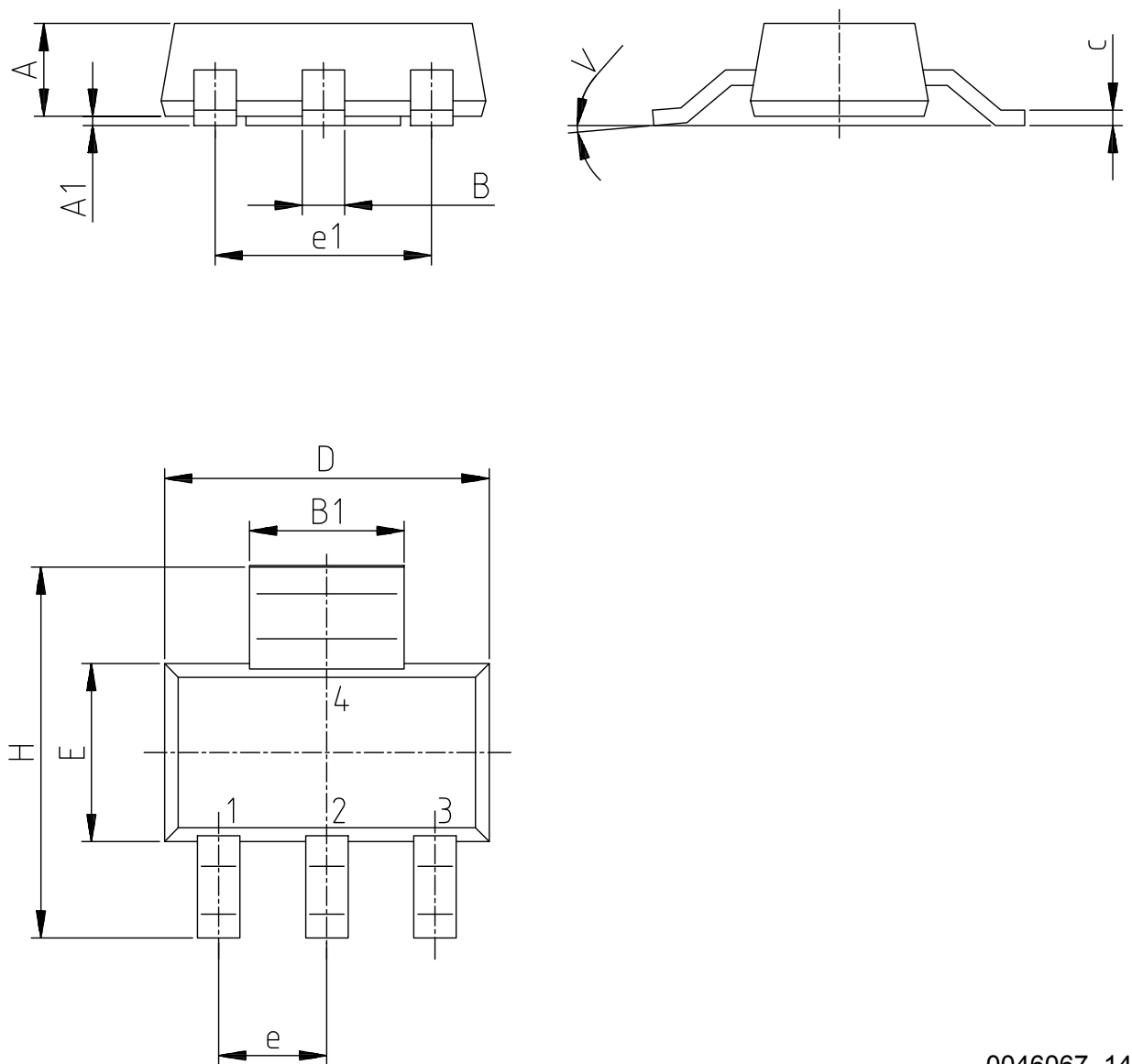
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## 4 Package information

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](http://www.st.com). ECOPACK® is an ST trademark.

### 4.1 SOT-223 package information

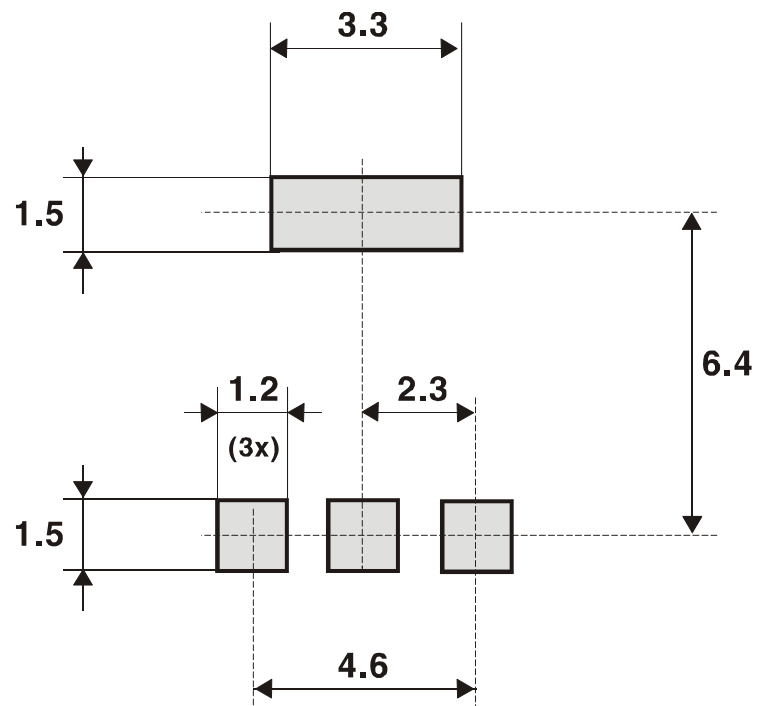
Figure 21. SOT-223 package outline



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**Table 8. SOT-223 package mechanical data**

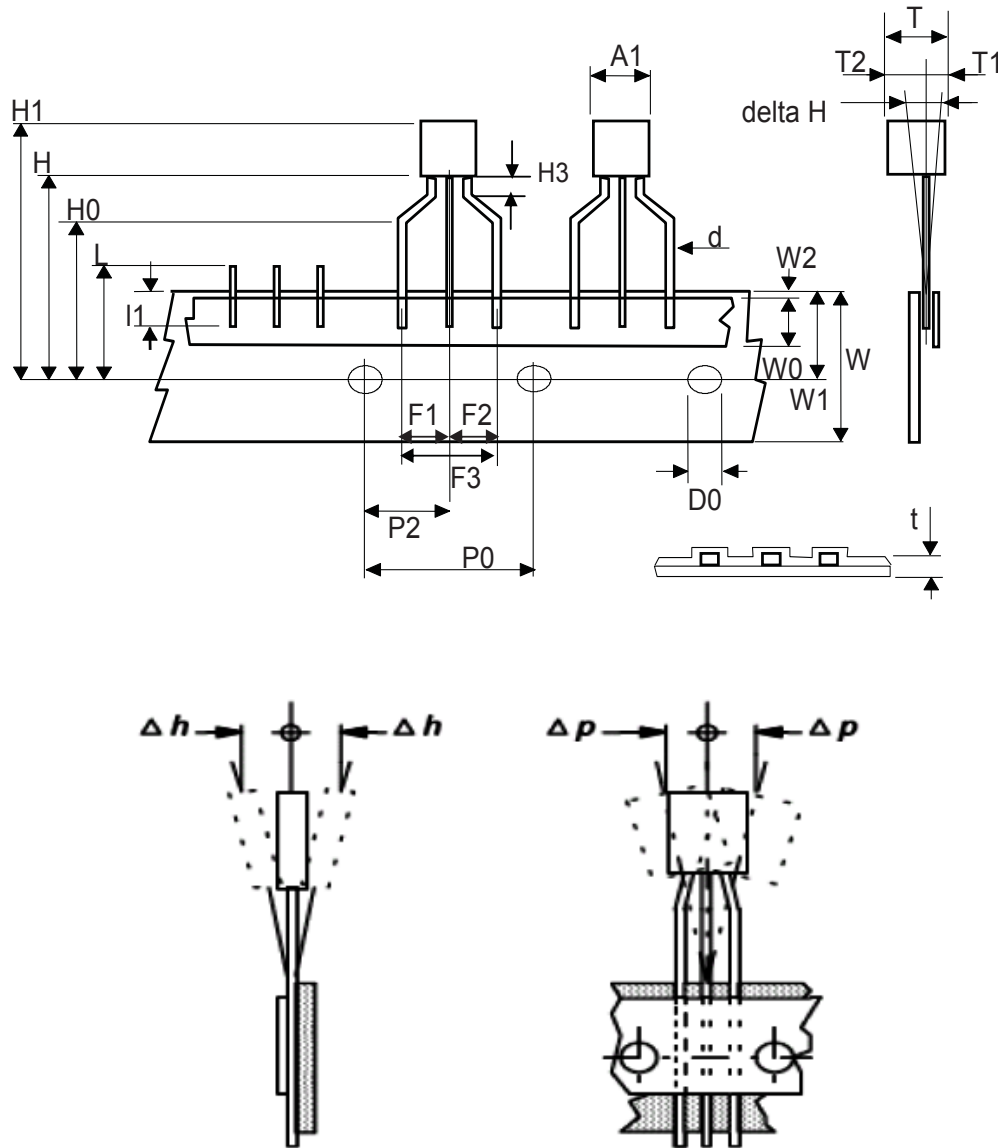
Dim.	mm		
	Min.	Typ.	Max.
A			1.8
A1	0.02		0.1
B	0.6	0.7	0.85
B1	2.9	3	3.15
c	0.24	0.26	0.35
D	6.3	6.5	6.7
e		2.3	
e1		4.6	
E	3.3	3.5	3.7
H	6.7	7.0	7.3
V			10°

**Figure 22. SOT-223 recommended footprint (dimensions are in mm)**


0046067

## 4.2 TO-92 Ammopack package information

Figure 23. TO-92 Ammopack package outline



0050910\_Rev\_22

**Table 9. TO-92 Ammopack mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A1			4.80
T			3.80
T1			1.60
T2			2.30
d	0.45	0.47	0.48
P0	12.50	12.70	12.90
P2	5.65	6.35	7.05
F1, F2	2.40	2.50	2.94
F3	4.98	5.08	5.48
delta H	-2.00		2.00
W	17.50	18.00	19.00
W0	5.50	6.00	6.50
W1	8.50	9.00	9.25
W2			0.50
H		18.50	21.00
H0	15.50	16.00	18.20
H1		25.00	27.00
H3	0.50	1.00	2.00
D0	3.80	4.00	4.20
t			0.90
L			11.00
l1	3.00		
delta P	-1.00		1.00

## 5 Ordering information

**Table 10. Order codes**

Order code	Marking	Package	Packing
STN1HNK60	N1HNK60	SOT-223	Tape and reel
STQ1HNK60R-AP	1HNK60R	TO-92	Ammopak

## Revision history

**Table 11. Document revision history**

Date	Version	Changes
20-Aug-2018	1	Initial release.

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