

## Precision low noise dual operational amplifier

Datasheet – production data

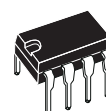
### Features

- Large output voltage swing: +14.3 V/-14.6 V
- Low input offset voltage 850  $\mu\text{V}$  max.
- Low voltage noise: 4.5 nV/ $\sqrt{\text{Hz}}$
- High gain bandwidth product: 15 MHz
- High slew rate: 7 V/ $\mu\text{s}$
- Low distortion: 0.002%
- ESD internal protection 2 kV
- Excellent frequency stability

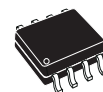
### Description

The TS522 device is a monolithic dual operational amplifier mainly dedicated to audio applications. The TS522 device offers a very low input offset voltage as well as low voltage noise (4.5 nV/ $\sqrt{\text{Hz}}$ ) and high dynamic performances (15 MHz gain bandwidth product, 7 V/ $\mu\text{s}$  slew rate).

The output stage allows a large output voltage swing and symmetrical source and sink currents.

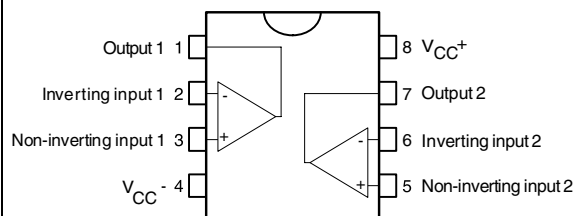


**N**  
**DIP8**  
(plastic package)



**D**  
**SO8**  
(plastic micropackage)

#### Pin connections top view



# 1 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply voltage	±18 to 36	V
V <sub>id</sub>	Differential input voltage <sup>(1)</sup>	±30	V
V <sub>i</sub>	Input voltage <sup>(1)</sup>	±15	V
	Output short-circuit duration <sup>(2)</sup>	Infinite	
T <sub>j</sub>	Maximum junction temperature	+ 150	°C
T <sub>stg</sub>	Storage temperature range	-65 to +150	°C
R <sub>thja</sub>	Thermal resistance junction-to-ambient <sup>(3), (4)</sup>		°C/W
	SO-8 DIP8	125 85	
R <sub>thjc</sub>	Thermal resistance junction-to-case <sup>(3), (4)</sup>		°C/W
	SO-8 DIP8	40 41	
ESD	HBM: human body model <sup>(5)</sup>	2	kV
	MM: machine model <sup>(6)</sup>	200	V
	CDM: charged device model <sup>(7)</sup>	1.5	kV

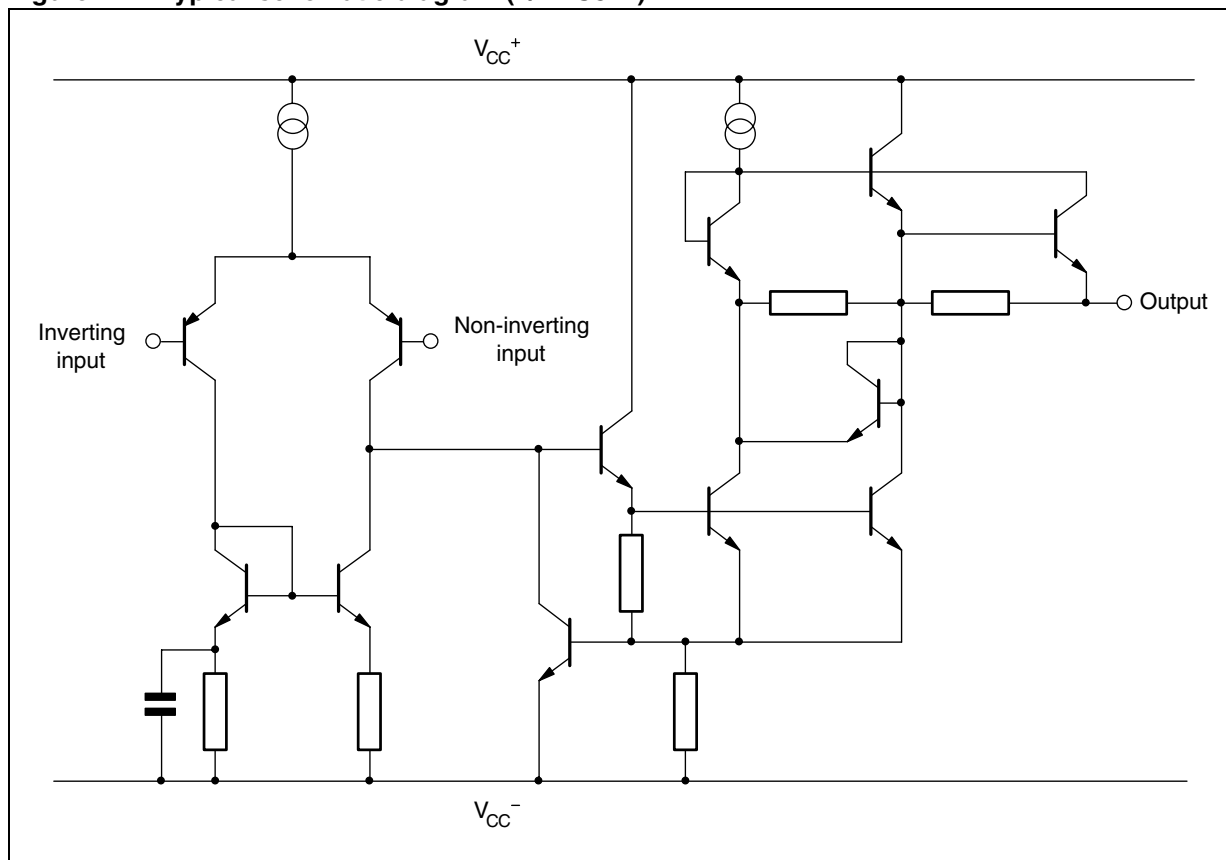
1. Either or both input voltages must not exceed the magnitude of V<sub>CC</sub><sup>+</sup> or V<sub>CC</sub><sup>-</sup>.
2. Power dissipation must be considered to ensure maximum junction temperature (T<sub>j</sub>) is not exceeded.
3. Short-circuits can cause excessive heating and destructive dissipation.
4. R<sub>th</sub> are typical values.
5. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
6. Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of connected pin combinations while the other pins are floating.
7. Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to ground through only one pin. This is done for all pins.

**Table 2. Operating conditions**

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply voltage	±2.5 to ±15	V
T <sub>oper</sub>	Operating free air temperature range	-40 to 125	°C

## 2 Schematic diagram

Figure 1. Typical schematic diagram (1/2 TS522)



### 3 Electrical characteristics

**Table 3. Electrical characteristics at  $V_{CC+} = 15\text{ V}$ ,  $V_{CC-} = -15\text{ V}$ ,  $T_{amb} = 25\text{ °C}$  (unless otherwise specified)**

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input offset voltage ( $V_o = 0\text{ V}$ , $V_{ic} = 0\text{ V}$ ) $T_{amb} = +25\text{ °C}$ $T_{min} \leq T_{amb} \leq T_{max}$			0.85 1.7	mV
$\Delta V_{io}$	Input offset voltage drift $V_{ic} = 0\text{ V}$ , $V_o = 0\text{ V}$ , $T_{min} \leq T_{amb} \leq T_{max}$		2		$\mu\text{V}/\text{°C}$
$I_{io}$	Input offset current ( $V_{ic} = 0\text{ V}$ , $V_o = 0\text{ V}$ ) $T_{amb} = +25\text{ °C}$ $T_{min} \leq T_{amb} \leq T_{max}$		10	150 175	nA
$I_{ib}$	Input bias current ( $V_{ic} = 0\text{ V}$ , $V_o = 0\text{ V}$ ) $T_{amb} = +25\text{ °C}$ $T_{min} \leq T_{amb} \leq T_{max}$		250	750 800	nA
$V_{icm}$	Common mode input voltage range ( $\Delta V_{io} = 5\text{ mV}$ , $V_o = 0\text{ V}$ )	$\pm 13$	$\pm 14$		V
$A_{vd}$	Large signal voltage gain ( $R_L = 2\text{ k}\Omega$ , $V_o = \pm 10\text{ V}$ ) $T_{amb} = +25\text{ °C}$ $T_{min} \leq T_{amb} \leq T_{max}$	90 85	100		dB
$\pm V_{opp}$	Output voltage swing ( $V_{id} = \pm 1\text{ V}$ ) $R_L = 600\ \Omega$ $R_L = 600\ \Omega$  $R_L = 2.0\text{ k}\Omega$ $R_L = 2.0\text{ k}\Omega$  $R_L = 10\text{ k}\Omega$ $R_L = 10\text{ k}\Omega$		12.2 -12.7  14 -14.2  14.3 -14.6		V
CMR	Common mode rejection ratio ( $V_{ic} = \pm 13\text{ V}$ )	80	100		dB
SVR	Supply voltage rejection ratio $V_{CC+}/V_{CC-} = +15\text{ V}/-15\text{ V}$ to $+5\text{ V}/-5\text{ V}$	80	105		dB
$I_o$	Output short-circuit current ( $V_{id} = \pm 1\text{ V}$ , output to ground) Source Sink	15 20	29 37		mA
$I_{CC}$	Supply current ( $V_o = 0\text{ V}$ , all amplifiers) $T_{amb} = +25\text{ °C}$ $T_{min} \leq T_{amb} \leq T_{max}$		4	5 5.5	mA
SR	Slew rate ( $V_i = -10\text{ V}$ to $+10\text{ V}$ , $R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $A_v = +1$ )	5	7		$\text{V}/\mu\text{s}$
GBP	Gain bandwidth product ( $f = 100\text{ kHz}$ , $R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ )	10	15		MHz
B	Unity gain bandwidth (open loop)		9		MHz

**Table 3. Electrical characteristics at  $V_{CC+} = 15\text{ V}$ ,  $V_{CC-} = -15\text{ V}$ ,  $T_{amb} = 25\text{ °C}$   
(unless otherwise specified) (continued)**

Symbol	Parameter	Min.	Typ.	Max.	Unit
$A_m$	Gain margin ( $R_L = 2\text{ k}\Omega$ ) $C_L = 0\text{ pF}$ $C_L = 100\text{ pF}$		-11 -6		dB
$\varnothing_m$	Phase margin $C_L = 0\text{ pF}$ $C_L = 100\text{ pF}$		55 30		Degrees
$e_n$	Equivalent input noise voltage ( $R_s = 100\ \Omega$ , $f = 1\text{ kHz}$ )		4.5		$\frac{nV}{\sqrt{Hz}}$
$i_n$	Equivalent input noise current ( $f = 1\text{ kHz}$ )		0.5		$\frac{\mu A}{\sqrt{Hz}}$
THD	Total harmonic distortion $R_L = 2\text{ k}\Omega$ , $f = 20\text{ Hz to } 20\text{ kHz}$ , $V_o = 3\ V_{rms}$ , $A_v = +1$		0.002		%
$V_{o1}/V_{o2}$	Channel separation ( $f = 20\text{ Hz to } 20\text{ kHz}$ )		120		dB
FPB	Full power bandwidth ( $V_o = 27\ V_{pp}$ , $R_L = 2\text{ k}\Omega$ , $THD \leq 1\%$ )		120		kHz
$Z_o$	Output impedance ( $V_o = 0\text{ V}$ , $f = 9\text{ MHz}$ )		37		$\Omega$
$R_i$	Input resistance ( $V_{ic} = 0\text{ V}$ )		175		k $\Omega$
$C_i$	Input capacitance ( $V_{ic} = 0\text{ V}$ )		12		pF

Figure 2. Total supply current vs. supply voltage

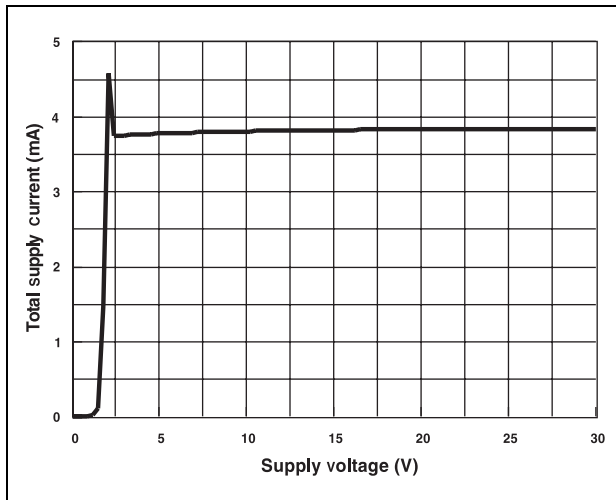


Figure 3. Output short-circuit current vs. output voltage

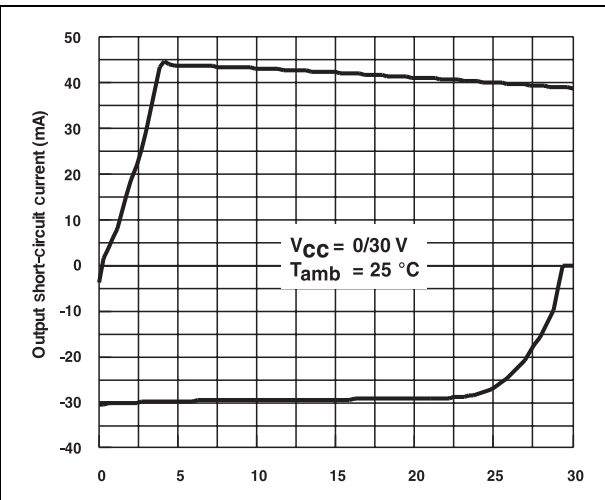


Figure 4. Output voltage vs. supply voltage ( $V_{id} = \pm 1\text{ V}$ ,  $R_L = 600\ \Omega$ )

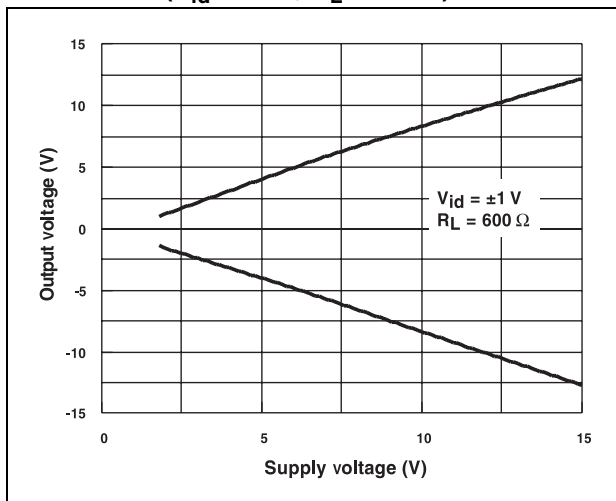


Figure 5. Output voltage vs. supply voltage ( $V_{id} = \pm 1\text{ V}$ ,  $R_L = 2\text{ k}\Omega$ )

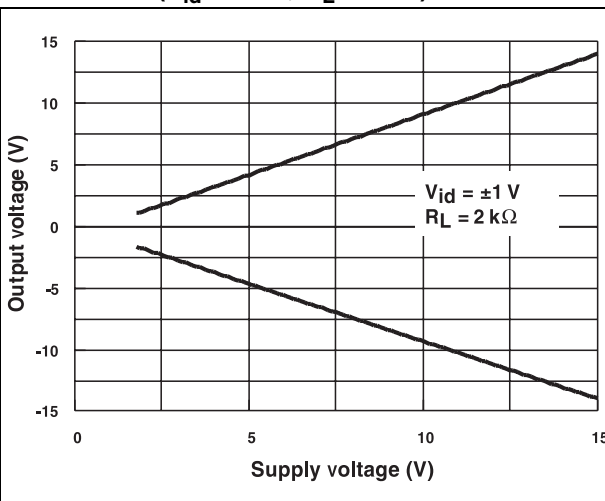


Figure 6. Equivalent input noise voltage vs. frequency

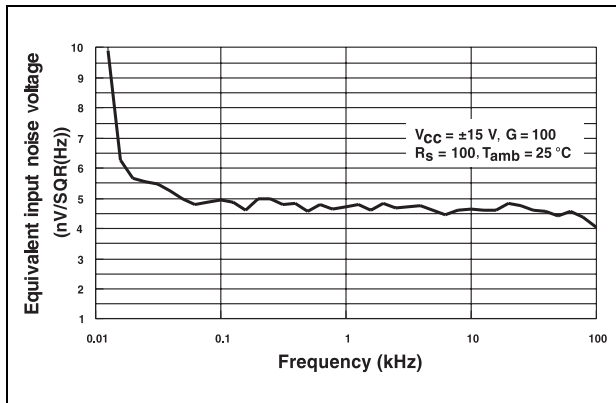


Figure 7. THD + noise vs. frequency

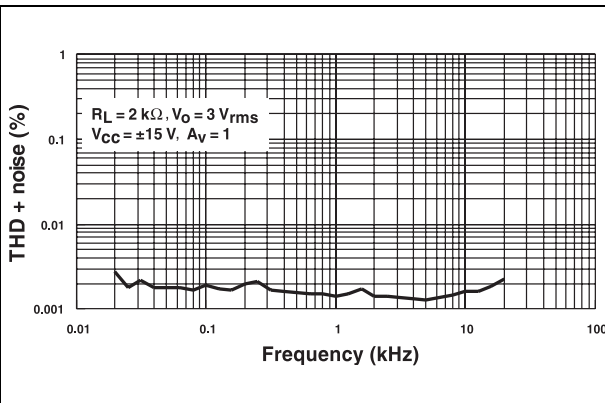


Figure 8. Voltage gain and phase vs. frequency

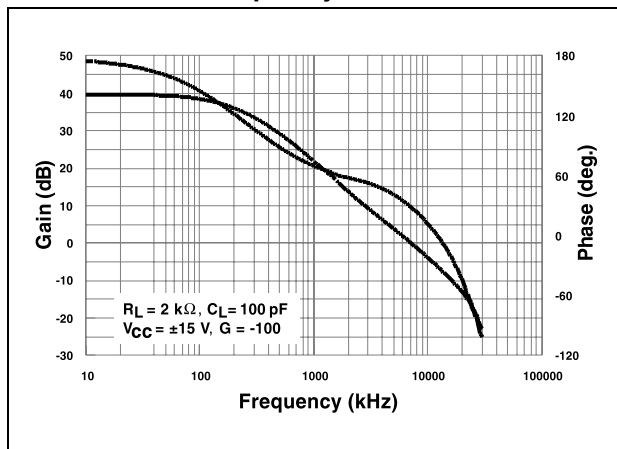
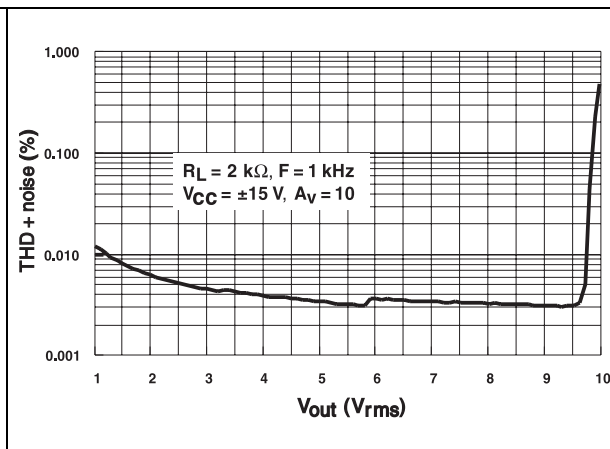


Figure 9. THD + noise vs.  $V_{out}$



## 4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> 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.



Figure 10. DIP8 package outline

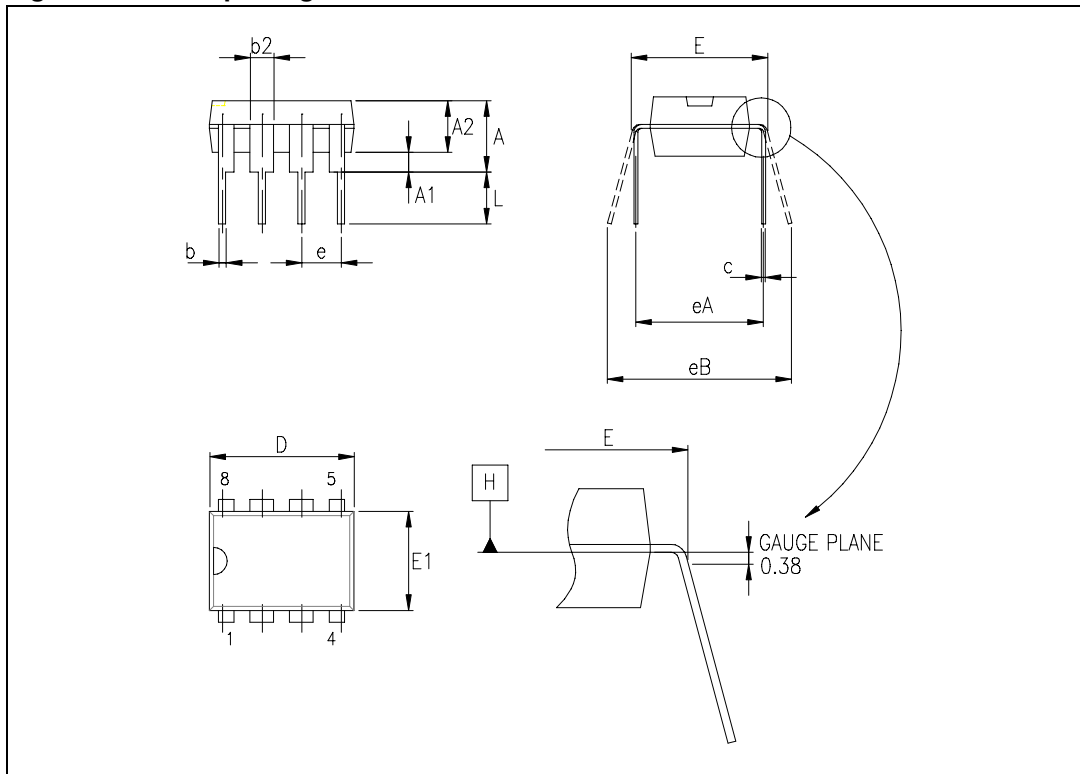


Table 4. DIP8 package mechanical data

Symbol	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0.260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

Figure 11. SO-8 package outline

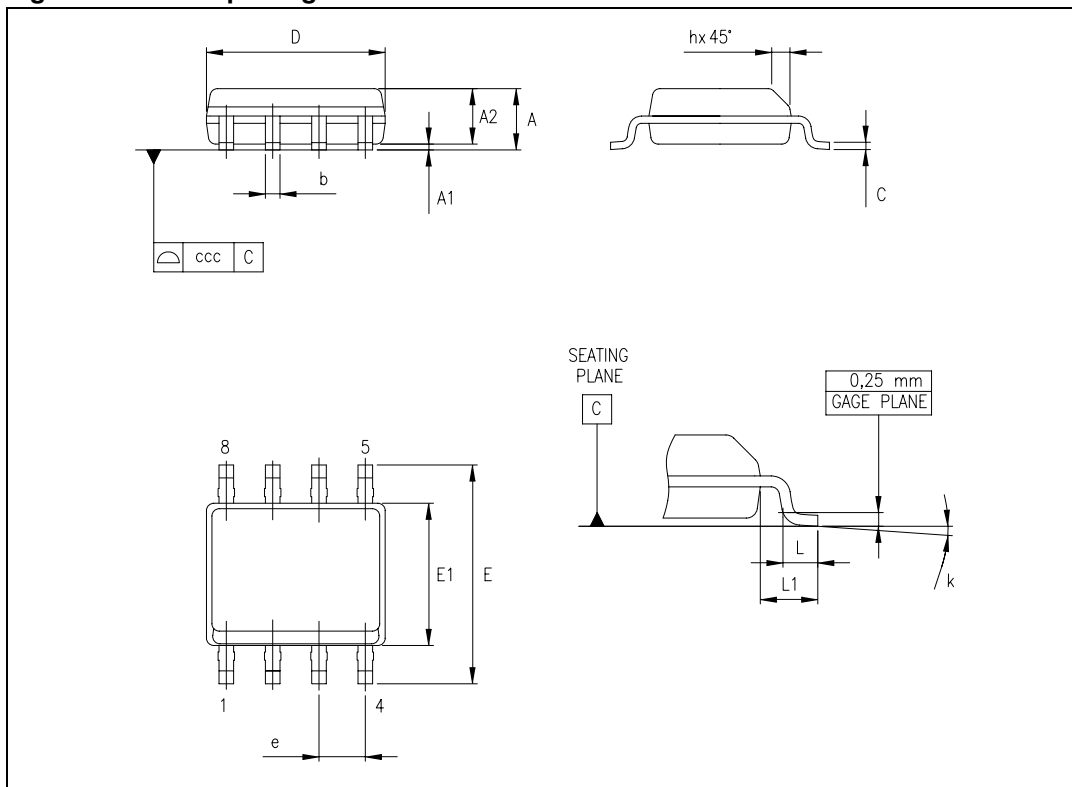


Table 5. SO-8 package mechanical data

Symbol	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.004		0.010
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
L1		1.04			0.040	
k	1°		8°	1°		8°
ccc			0.10			0.004

## 5 Ordering information

**Table 6. Order codes**

Order code	Temperature range	Package	Packing	Marking
TS522ID/DT	-40 to +125 °C	SO-8	Tube/tape and reel	522I
TS522IN	-40 to +125 °C	DIP8	Tube	TS522IN
TS522IYDT <sup>(1)</sup>	-40 to +125 °C	SO-8 (automotive grade)	Tube/tape and reel	522IY

1. Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q 002 or equivalent.

## 6 Revision history

**Table 7. Document revision history**

Date	Revision	Changes
01-Nov-2001	1	Initial release.
14-Oct-2008	2	Document reformatted. Added automotive grade order codes in <a href="#">Table 6: Order codes</a> . Removed macromodel.
12-Sep-2012	3	Updated <a href="#">Features</a> (removed "Macromodel"). Removed TS522IYD order code from <a href="#">Table 6</a> . Updated ECOPACK text in <a href="#">Section 4</a> . Minor corrections throughout document.

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