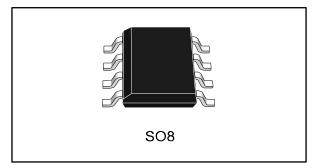


TSV912H

High temperature, rail-to-rail input/output, 8 MHz operational amplifier

Datasheet - production data



Features

- Rail-to-rail input and output
- Wide bandwidth
- Low power consumption: 820 µA typ
- Unity gain stability
- High output current: 35 mA
- Operating range from 2.5 to 5.5 V
- Low input bias current, 1 pA typ
- ESD internal protection ≥ 5 kV
- Latch-up immunity

Applications

• Automotive products

Description

The TSV912H operational amplifier offers low voltage operation and rail-to-rail input and output.

The device features an excellent speed/power consumption ratio, offering an 8 MHz gainbandwidth product while consuming only 1.1 mA maximum at 5 V. It is unity gain stable and features an ultra-low input bias current.

The TSV912H is a high temperature version of the TSV912, and can operate from -40 °C to 150 °C with unique characteristics. Its main target applications are automotive, but the device is also ideal for sensor interfaces, battery-supplied and portable applications, as well as active filtering.

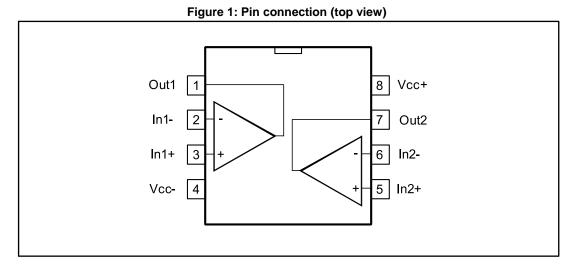
This is information on a product in full production.

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1 Package pin connections





Absolute maximum ratings and operating conditions 2

Table 1: Absolute maximum ratings							
Symbol	Parameter	Value	Unit				
Vcc	Supply voltage, $(V_{CC}^+) - (V_{CC}^-)^{(1)}$	6					
V_{id}	Differential input voltage ⁽²⁾	±V _{CC}	V				
V _{in}	Input voltage ⁽³⁾	$(V_{CC}) - 0.2 \text{ to } (V_{CC}) + 0.2$					
l _{in}	Input current ⁽⁴⁾	10	mA				
T _{stg}	Storage temperature	-65 to 150					
Tj	Maximum junction temperature	160	- °C				
R _{thja}	Thermal resistance junction to ambient ⁽⁵⁾⁽⁶⁾	125	°C M/				
R _{thjc}	Thermal resistance junction to case ⁽⁵⁾⁽⁶⁾	40	°C/W				
	HBM: human body model ⁽⁷⁾	5	kV				
ESD	MM: machine model ⁽⁸⁾	400					
	CDM: charged device model ⁽⁹⁾	1500	V				
	Latch-up immunity	200	mA				

Notes:

⁽¹⁾All voltage values, except the differential voltage, are with respect to the network ground terminal.

⁽²⁾Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.

 $^{(3)}V_{CC}$ - V_{in} must not exceed 6 V.

⁽⁴⁾Input current must be limited by a resistor in series with the inputs.

⁽⁵⁾R_{th} are typical values.

⁽⁶⁾Short-circuits can cause excessive heating and destructive dissipation.

 $^{(7)}$ Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 k Ω resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.

⁽⁸⁾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.

⁽⁹⁾Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This is done for all pins.

Symbol	Parameter	Value	Unit				
Vcc	Supply voltage (V _{cc} ⁺) - (V _{cc} ⁻)	2.5 to 5.5	V				
V _{icm}	Common mode input voltage range	$(V_{CC}) - 0.1$ to $(V_{CC}) + 0.1$	v				
T _{oper}	Operating free-air temperature range	-40 to 150	°C				

Table 2: Operating conditions



Table 3: Electrical characteristics at VCC+ = 2.5 V with VCC- = 0 V, Vicm = VCC/2,RL connected to VCC/2, T = 25 °C (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
DC perfo	rmance					
		T = 25 °C		0.1	4.5	
Vio	Input offset voltage	T _{min} < T < T _{max}			7.5	mV
		-40 °C < T < 125 °C		2		
DV _{io} /DT	Input offset voltage drift	125 °C < T < 150 °C		20		µV/°C
	la suit affa at annua at	$V_{out} = V_{CC}/2$, T = 25 °C		1	10 ⁽¹⁾	pА
l _{io}	Input offset current	$V_{out} = V_{CC}/2$, $T_{min} < T < T_{max}$			5	nA
	land him and	$V_{out} = V_{CC}/2$, T = 25 °C		1	10 ⁽¹⁾	pА
l _{ib}	Input bias current	$V_{out} = V_{CC}/2, T_{min} < T < T_{max}$			5	nA
CMD	Common mode rejection	0 V to 2.5 V, $V_{out} = 1.25$ V, T = 25 °C	58	75		
CMR	ratio 20 log (ΔV _{ic} /ΔV _{io})	0 V to 2.5 V, V _{out} = 1.25 V, T _{min} < T < T _{max}	53			чD
•	I = 25 °C	89		dB		
A _{vd}			70			
	High-level output voltage	R _L = 10 kΩ, T = 25 °C		15	40	
V _{cc} -		R_L = 10 kΩ, T_{min} < T < T_{max}			60	
V _{OH}		R _L = 600 Ω, T = 25 °C		45	150	
		R_L = 600 Ω , T_{min} < T < T_{max}			250	
		R _L = 10 kΩ, T = 25 °C		15	40	mV
V		R_L = 10 kΩ, T_{min} < T < T_{max}			60	
V _{OL}	Low-level output voltage	R _L = 600 Ω, T = 25 °C		45	150	
		$R_L = 600 \ \Omega, \ T_{min} < T < T_{max}$			250	
		$V_{out} = 2.5 V, T = 25 °C$	18	32		
l _{out}	lsink	V_{out} = 2.5 V, T_{min} < T < T_{max}	14			
lout	1	V _{out} = 0 V, T = 25 °C	18	35		mA
	Isource	$V_{out} = 0 V, T_{min} < T < T_{max}$	14			ША
امم	Supply current	No load, $V_{out} = V_{CC}/2$, T = 25 °C		0.78	1.1	
I _{CC}	(per operator)	No load, $V_{out} = V_{CC}/2$, $T_{min} < T < T_{max}$			1.1	
AC perfo	rmance					
	Cain handwidth product	$\label{eq:RL} \begin{array}{l} R_{L} = 2 \ k\Omega, \ C_{L} = 100 \ pF, \ f = 100 \ kHz, \\ T = 25 \ ^{\circ}C \end{array}$		8		
GBP	Gain bandwidth product	$\label{eq:RL} \begin{aligned} R_L &= 2 \; k\Omega, C_L = 100 \; pF, f = 100 \; kHz, \\ T_{min} &< T < T_{max} \end{aligned}$		4		MHz
Fu	Unity gain frequency	$R_{L} = 2 k\Omega, C_{L} = 100 pF$		7.2		



TSV912H

Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
φm	Phase margin	$R_{L} = 2 k\Omega, C_{L} = 100 pF$		45		Degrees
Gm	Gain margin	$R_{L} = 2 R\Omega, G_{L} = 100 \text{ pr}$		8		dB
CD		R_L = 2 kΩ, C_L = 100 pF, A_v = 1, T = 25 °C		4.5		
SR	Slew rate	$\label{eq:RL} \left[\begin{array}{l} R_L = 2 \ k\Omega, \ C_L = 100 \ pF, \ A_v = 1, \\ T_{min} < T < T_{max} \end{array} \right]$		3.5		V/µs
en	Equivalent input noise voltage	f = 10 kHz		21		nV/√Hz
THD+en	Total harmonic distortion			0.001		%

Notes:

⁽¹⁾Guaranteed by design.





Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
DC perfo	rmance					
		T = 25 °C		0.1	4.5	
V _{io}	Input offset voltage	T _{min} < T < T _{max}			7.5	mV
		-40 °C < T < 125 °C		2		
DV_{io}	Input offset voltage drift	125 °C < T < 150 °C		20		µV/°C
		$V_{out} = V_{CC}/2$, T = 25 °C		1	10 (1)	pА
l _{io}	Input offset current	$V_{out} = V_{CC}/2, T_{min} < T < T_{max}$			5	nA
	lanut biog gumant	$V_{out} = V_{CC}/2$, T = 25 °C		1	10 (1)	pА
l _{ib}	Input bias current	$V_{out} = V_{CC}/2, T_{min} < T < T_{max}$			5	nA
CMR	Common mode rejection	0 V to 3.3 V, $V_{out} = 1.65$ V, T = 25 °C	60	78		
CIVIR	ratio 20 log ($\Delta V_{ic}/\Delta V_{io}$)	0 V to 3.3 V, V _{out} = 1.65 V, T _{min} < T < T _{max}	55			dD
•		$\label{eq:RL} \begin{array}{l} R_{L} = 10 \; k\Omega, \; V_{out} = 0.5 \; V \; \text{to} \; 2.8 \; V, \\ T = 25 \; ^{\circ}C \end{array}$	80	90		- dB
A _{vd}	Large signal voltage gain	$\label{eq:RL} \begin{array}{l} R_{L} = 10 \; k\Omega, V_{out} = 0.5 \; V \; \text{to} \; 2.8 \; V, \\ T_{min} < T < T_{max} \end{array}$	70			
	High-level output voltage	R _L = 10 kΩ, T = 25 °C		15	40	
V _{CC} -		R_L = 10 kΩ, T_{min} < T < T_{max}			60	
V _{OH}		R _L = 600 Ω, T = 25 °C		45	150	- mV
		$R_L = 600 \ \Omega, \ T_{min} < T < T_{max}$			250	
	Low-level output voltage	R _L = 10 kΩ, T = 25 °C		15	40	IIIV
V _{OL}		R_L = 10 k Ω , T_{min} < T < T_{max}			60	
VOL	Low-level output voltage	R _L = 600 Ω, T = 25 °C		45	150	
		$R_L = 600 \ \Omega, \ T_{min} < T < T_{max}$			250	
	l _{sink}	V _{out} = 3.3 V, T = 25 °C	18	32		
l _{out}	ISINK	$V_{out} = 3.3 V$, $T_{min} < T < T_{max}$	14			
out	I _{source}	V _{out} = 0 V, T = 25 °C	18	35		mA
	source	$V_{out} = 0 V, T_{min} < T < T_{max}$	14			
Icc	Supply current	No load, $V_{out} = V_{CC}/2$, T = 25 °C		0.8	1.1	
100	(per operator)	No load, $V_{out} = V_{CC}/2$, $T_{min} < T < T_{max}$			1.1	
AC perfo	rmance				_	-
GBP	Gain handwidth product	$\label{eq:RL} \begin{array}{l} R_{L} \texttt{=} 2 \ k\Omega, \ C_{L} \texttt{=} 100 \ pF, \ f \texttt{=} 100 \ kHz, \\ T \texttt{=} 25 \ ^{\circ}C \end{array}$		8		
	Gain bandwidth product	$\label{eq:RL} \begin{array}{l} R_{L} = 2 \; k\Omega, \; C_{L} = 100 \; pF, \; f = 100 \; kHz, \\ T_{min} < T < T_{max} \end{array}$		4.2		MHz
F_{u}	Unity gain frequency			7.2		
φm	Phase margin	R_L = 2 k Ω , C_L = 100 pF		45		Degree
Gm	Gain margin			8		dB

Table 4: Electrical characteristics at VCC+ = 3.3 V with VCC- = 0 V, Vicm = VCC/2, RL connected to VCC/2, T = 25 °C (unless otherwise specified)



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Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
SR		$\label{eq:RL} \begin{array}{l} R_L = 2 \; k\Omega, \; C_L = 100 \; pF, \; A_v = 1, \\ T = 25 \; ^\circC \end{array}$		4.5		
	Slew rate	$\label{eq:RL} \begin{array}{l} R_{L} = 2 \; k\Omega, \; C_{L} = 100 \; pF, \; A_{v} = 1, \\ T_{min} < T < T_{max} \end{array}$		3.5		V/µs
en	Equivalent input noise voltage	f = 10 kHz		21		nV/√Hz
THD+e _n	Total harmonic distortion			0.0007		%

Notes:

⁽¹⁾Guaranteed by design.



Symbol	Parameter	to VCC/2, full temperature range (unle Conditions	Min.	Тур.	Max.	Unit
DC perfo				- 76-		
DC perio		T = 25 °C		0.1	4.5	
Vio	Input offset voltage	T = 25 C $T_{min} < T < T_{max}$		0.1	4.5 7.5	mV
		-40 °C < T < 125 °C		2	7.5	
DV_{io}	Input offset voltage drift	125 °C < T < 150 °C		20		μV/°C
		$V_{out} = V_{CC}/2, T = 25 \text{ °C}$		1	10 (1)	pА
l _{io}	Input offset current	$V_{out} = V_{CC}/2, T = 25$ C $V_{out} = V_{CC}/2, T_{min} < T < T_{max}$			5	nA
		$V_{out} = V_{CC}/2$, $T = 25 \text{ °C}$		1	10 (1)	pA
l _{ib}	Input bias current	$V_{out} = V_{CC}/2, T_{min} < T < T_{max}$		•	5	nA
	Common mode rejection	$\begin{array}{c} 0 \text{ V to 5 V, } V_{\text{out}} = 2.5 \text{ V,} \\ T = 25 \text{ °C} \end{array}$	62	82		
CMR	ratio 20 log ($\Delta V_{ic}/\Delta V_{ic}$)	0 V to 5 V, V _{out} = 2.5 V, T _{min} < T < T _{max}	58			
SVR	Supply voltage rejection	V_{CC} = 2.5 to 5 V, T = 25 °C	70	86		٩D
SVR	ratio 20 log ($\Delta V_{CC}/\Delta V_{io}$)	V_{CC} = 2.5 to 5 V, T_{min} < T < T_{max}	65			dB
٨	Large signal voltage gain	$\label{eq:RL} \begin{array}{l} R_{L} = 10 \; k\Omega, \; V_{out} = 0.5 \; V \; to \; 4.5 \; V, \\ T = 25 \; ^{\circ}C \end{array}$	80	91		
A _{vd}		$\label{eq:RL} \begin{array}{l} R_{L} = 10 \; k\Omega, V_{out} = 0.5 \; V \; to \; 4.5 \; V, \\ T_{min} < T < T_{max} \end{array}$	70			
	High-level output voltage	R _L = 10 kΩ, T = 25 °C		15	40	
V _{CC} -		R_L = 10 kΩ, T_{min} < T < T_{max}			60	
V _{OH}		R_L = 600 Ω , T = 25 °C		45	150	
		$R_L = 600 \ \Omega, \ T_{min} < T < T_{max}$			250	mV
		R _L = 10 kΩ, T = 25 °C		15	40	mv
V _{OL}	Low-level output voltage	$R_L = 10 \text{ k}\Omega, T_{min} < T < T_{max}$			60	
VOL	Low-level output voltage	R_L = 600 Ω , T = 25 °C		45	150	
		R_L = 600 Ω , $T_{min} < T < T_{max}$			250	
		V _{out} = 5 V, T = 25 °C	18	32		
1	l _{sink}	$V_{out} = 5 V, T_{min} < T < T_{max}$	14			
l _{out}		$V_{out} = 0 V, T = 25 °C$	18	35		mA
	Isource	$V_{out} = 0 V, T_{min} < T < T_{max}$	14			ШA
	Supply current	No load, V_{out} = 2.5 V, T = 25 °C		0.82	1.1	
I _{CC}	(per operator)	No load, V_{out} = 2.5 V, T_{min} < T < T_{max}			1.1	
AC perfo	rmance					
GBP	Gain bandwidth product	R_L = 2 k Ω , C_L = 100 pF, f = 100 kHz, T = 25 °C		8		
GDP	Gain bandwidth product	$\label{eq:RL} \begin{array}{l} R_{L} = 2 \; k\Omega, \; C_{L} = 100 \; pF, \; f = 100 \; kHz, \\ T_{min} < T < T_{max} \end{array}$		4.5		MHz
Fu	Unity gain frequency	$R_{L} = 2 k\Omega, C_{L} = 100 pF$		7.5		

Table 5: Electrical characteristics at VCC+ = 5 V with VCC- = 0 V, Vicm = VCC/2, RL connected to VCC/2, full temperature range (unless otherwise specified)



TSV912H

Symbol	Parameter	Conditions		Тур.	Max.	Unit	
φm	Phase margin	$B = 2k_0 C = 100 pE$		45		Degrees	
Gm	Gain margin	R _L = 2 kΩ, C _L = 100 pF		8		dB	
CD		R_L = 2 kΩ, C_L = 100 pF, A_v = 1, T = 25 °C		4.5			
SR	Slew rate	$\label{eq:RL} \left[\begin{array}{l} R_L = 2 \; k\Omega, \; C_L = 100 \; pF, \; A_v = 1, \\ T_{min} < T < T_{max} \end{array} \right]$		3.5		V/µs	
<u>^</u>	Equivalent input noise	f = 1 kHz		27		nV/√Hz	
en	voltage	f = 10 kHz		21		nv/√Hz	
THD+en	Total harmonic distortion			0.0004		%	

Notes:

⁽¹⁾Guaranteed by design.





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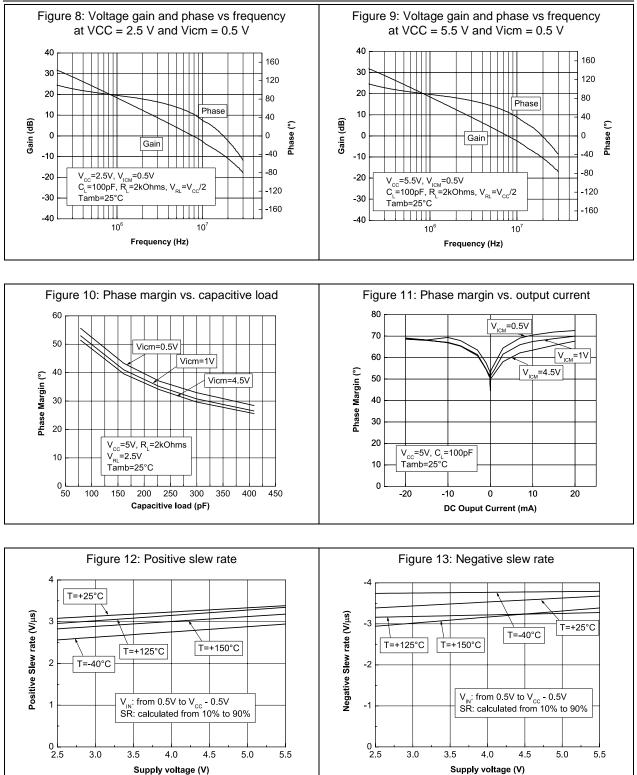
Electrical characteristic curves 4 Figure 2: Input offset voltage distribution at T = 25 °C Figure 3: Input offset voltage distribution at T = 150 °C 400 140 V_{cc}=5V V_{ICM}=2.5V V_{cc}= 5V V_{ICM}= 2.5V Tamb= +150°C 120 Tamb=25°C 300 100 Quantity of parts 000 001 Quantity of pieces 80 60 40 100 20 0 0 -2.0 -1.5 -1.0 -0.5 0.0 0.5 1.0 1.5 2.0 -4 3 -3 -2 -1 0 1 2 Input offset Voltage (mV) Input offset voltage (mV) Figure 4: Supply current vs. input common-mode Figure 5: Supply current vs. input common-mode voltage at VCC = 2.5 V voltage at VCC = 5 V 1.0 1.0 T = +25°C T=+25°C Supply current per operator (mA) Supply current per operator (mA) 0.8 0.8 T = +125°C T = - 40°C 0.6 0.6 T = +150°C T=+125°C T= - 40°C T=+150°C 0.4 0.4 $V_{cc} = +5V$ 0.2 V., = 2.5V 0.2 0.0 0.0 0.0 2 3 0.5 1.0 1.5 2.0 2.5 0 4 5 1 Input Common mode voltage (V) Input common mode voltage (V) Figure 7: Output current vs. output voltage Figure 6: Output current vs. output voltage at VCC = 2.5 V at VCC = 5 V 40 40 T=-40°C Sink Sink T=-40°C 30 30 T=+150°C T=+150°C Output current (mA) Output current (mA) 20 $V_{cc} = 5V$ $V_{cc} = 2.5V$ 20 T=+125°C T=+125°C 10 10 T=+25°C T=+25°C 0 0 T=+125°C T=+150°C T=+150°C -10 -10 T=+25°C T=+25°C T=+125°C -20 -20 T=-40°C -30 -30 Source T=-40°C Source -40 -40 0.5 1.5 2.0 2.5 3.0 3.5 4.0 4.5 0.0 1.0 5.0 0.5 1.5 2.0 0.0 1.0 2.5 Output voltage (V) Output voltage (V)

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Electrical characteristic curves

TSV912H



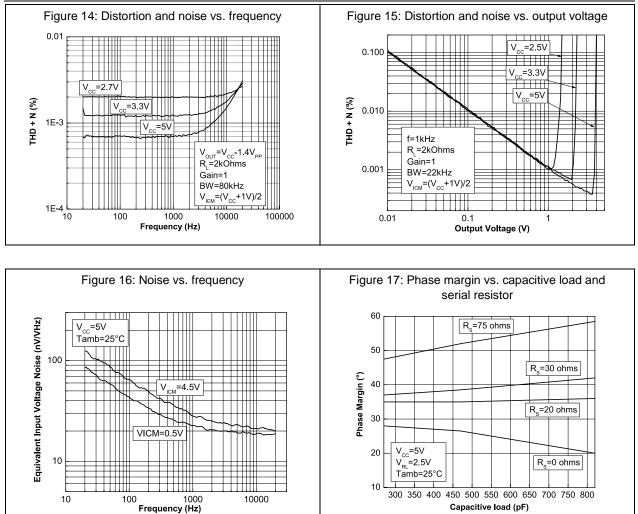
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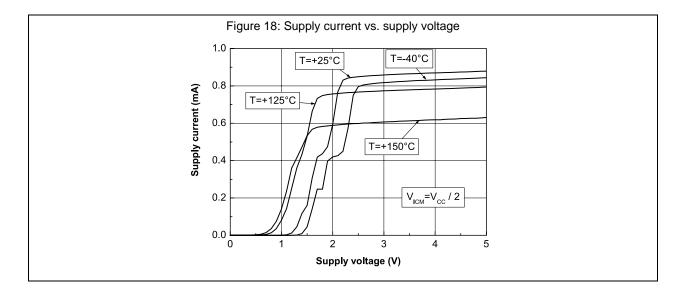
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TSV912H

Electrical characteristic curves





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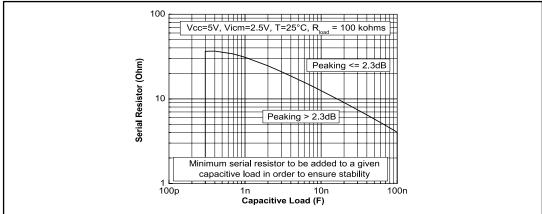
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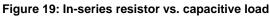
5 Application information

5.1 Driving resistive and capacitive loads

These products are low-voltage, low-power operational amplifiers optimized to drive rather large resistive loads above 2 k Ω .

In *follower* configuration, these operational amplifiers can drive capacitive loads up to 100 pF with no oscillations. When driving larger capacitive loads, adding a small in-series resistor at the output can improve the stability of the devices (see *Figure 19: "In-series resistor vs. capacitive load"* for recommended in-series resistor values). Once the in-series resistor value has been selected, the stability of the circuit should be tested on the bench and simulated with the simulation model.





5.2 PCB layouts

For correct operation, it is advised to add 10 nF decoupling capacitors as close as possible to the power supply pins.



6 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*. ECOPACK[®] is an ST trademark.



6.1 SO8 package information

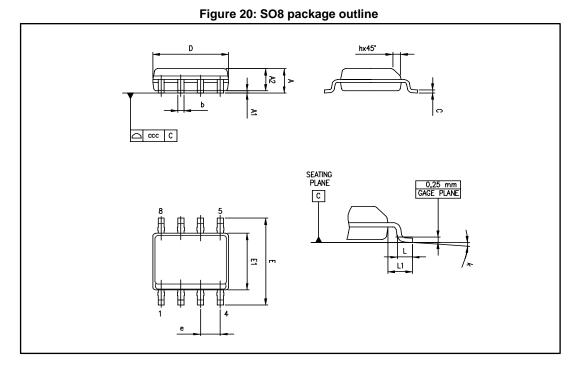


Table 6: SO8 mechanical data

			Dir	nensions			
Ref.		Millimeters			Inches		
	Min.	Тур.	Max.	Min.	Тур.	Max	
Α			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	
С	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	
е		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	



7 Ordering information

Table 7: Order codes								
Order code	Temperature range	Package	Packing	Marking				
TSV912HYDT ⁽¹⁾	-40 °C to 150 °C	SO8 ⁽²⁾ (automotive grade level)	Tape and reel	V912HY				

Notes:

 $^{(1)}$ Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent.

⁽²⁾SO8 package is moisture sensitivity level 1 as per Jedec J-STD-020-C.



8 Revision history

Table 8: Document revision history

Date	Revision	Changes
08-Jul-2010	1	Initial release.
22-Feb-2016	2	Removed TSV912AH part number Updated layout <i>Table 3, Table 4,</i> and <i>Table 5</i> : removed all references to TSV912AH <i>Table 6</i> : updated min (mm) value for k parameter <i>Table 7: "Order codes"</i> : removed order code TSV912AHYDT



TSV912H

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