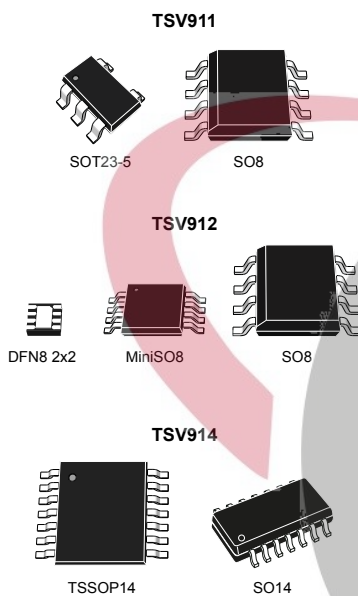


## Single, dual, and quad rail-to-rail input/output 8 MHz operational amplifiers



## Features

- Rail-to-rail input and output
- Wide bandwidth
- Low power consumption: 820  $\mu$ A typ.
- Unity gain stability
- High output current: 35 mA
- Operating from 2.5 V to 5.5 V
- Low input bias current, 1 pA typ.
- Low input offset voltage: 1.5 mV max. (A grade)
- ESD internal protection  $\geq$  5 kV
- Latch-up immunity

## Applications

- Battery-powered applications
- Portable devices
- Signal conditioning
- Active filtering
- Medical instrumentation
- Automotive applications

## Product status link

[TSV911](#), [TSV911A](#), [TSV912](#), [TSV912A](#),  
[TSV914](#), [TSV914A](#)

## Related products

See [TSV991](#),  
[TSV992](#), [TSV994](#)  
 and [TSV991A](#),  
[TSV992A](#),  
[TSV994A](#)

for higher speed

## Description

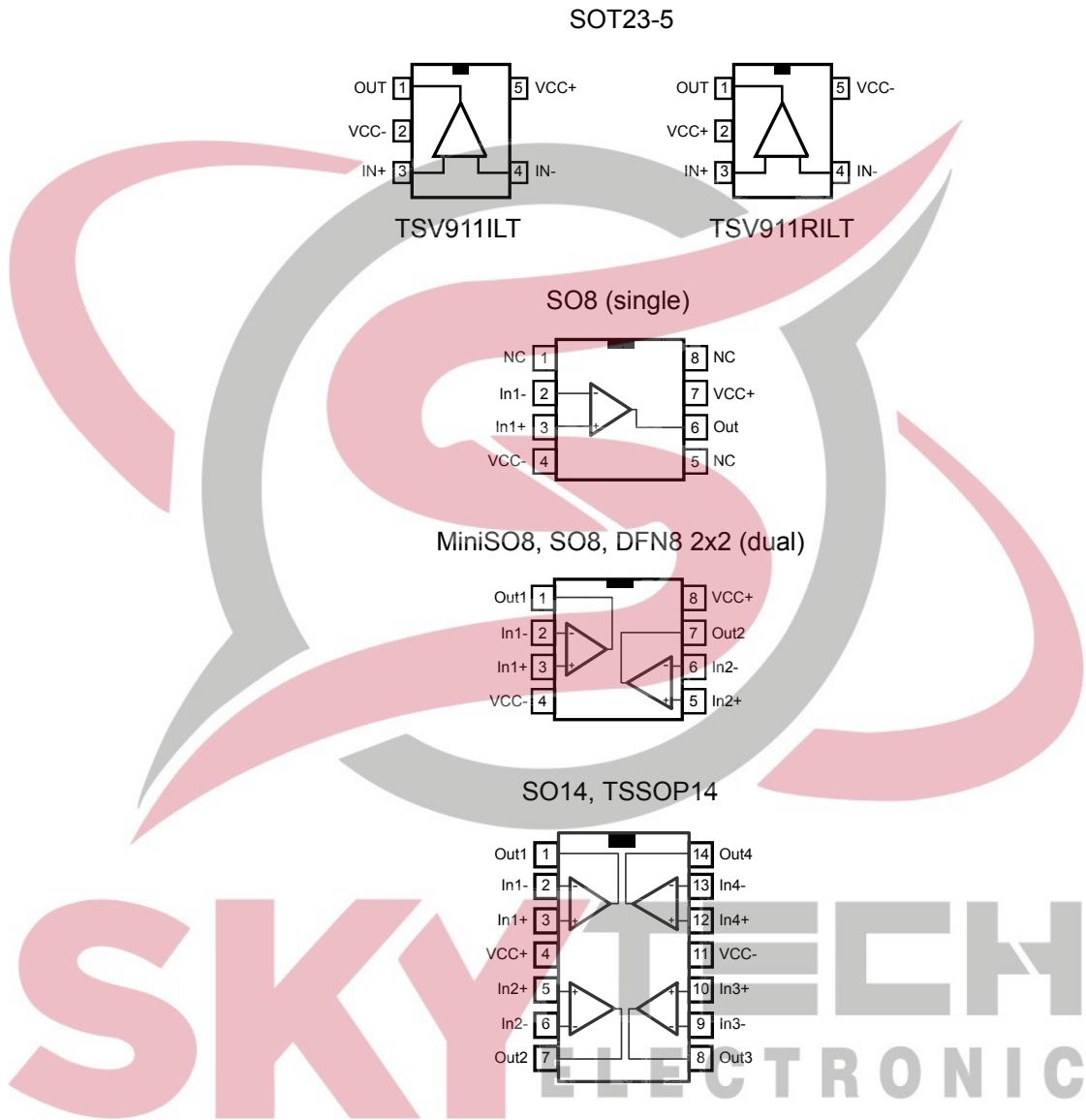
The TSV91x and TSV91xA operational amplifiers (op amps) offer low voltage operation and rail-to-rail input and output, as well as an excellent speed/power consumption ratio, providing an 8 MHz gain-bandwidth product while consuming only 1.1 mA maximum at 5 V. The op amps are unity gain stable and feature an ultra-low input bias current.

The devices are ideal for sensor interfaces, battery-supplied and portable applications, as well as active filtering.

SKYTECH ELECTRONIC

# 1 Package pin connections

Figure 1. Pin connections for each package (top view)



1. The exposed pad of the DFN8 2x2 package is not internally connected and can be set to  $V_{CC}^-$  or left floating.

## 2 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings (AMR)**

Symbol	Parameter	Value	Unit	
$V_{CC}$	Supply voltage <sup>(1)</sup>	6		
$V_{id}$	Differential input voltage <sup>(2)</sup>	$\pm V_{CC}$	V	
$V_{in}$	Input voltage <sup>(3)</sup>	$(V_{CC-}) - 0.2$ to $(V_{CC+}) + 0.2$		
$I_{in}$	Input current <sup>(4)</sup>	10	mA	
$T_{stg}$	Storage temperature	-65 to 150	°C	
$T_j$	Maximum junction temperature	150		
$R_{thja}$	Thermal resistance junction to ambient <sup>(5) (6)</sup>	SOT23-5	250	°C/W
		DFN8 2x2	57	
		SO8	125	
		MiniSO8	190	
		SO14	103	
$R_{thjc}$	Thermal resistance junction to case <sup>(5) (6)</sup>	SOT23-5	81	
		SO8	40	
		MiniSO8	39	
		SO14	31	
		TSSOP14	32	
ESD	HBM: human body model <sup>(7)</sup>	5	kV	
	MM: machine model <sup>(8)</sup>	400		
ESD	CDM: charged device model <sup>(9)</sup>	SOT23-5, SO8, MiniSO8	1500	V
		TSSOP14	750	
		SO14	500	
	Latch-up immunity	200	mA	

1. All voltage values, except the differential voltage, are with respect to 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. Short-circuits can cause excessive heating and destructive dissipation.
6.  $R_{th}$  are typical values
7. Human body model: 100 pF discharged through a 1.5 kΩ resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
8. Machine model: 200 pF charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω), done for all couples of pin combinations with other pins floating
9. Charged device model: all pins plus packages are charged together to the specified voltage and then discharged directly to the ground.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply voltage	-40 °C < T <sub>op</sub> < 125 °C	2.5 to 5.5
		0 °C < T <sub>op</sub> < 125 °C	2.3 to 5.5
V <sub>icm</sub>	Common mode input voltage range	(V <sub>CC-</sub> ) - 0.1 to (V <sub>CC+</sub> ) + 0.1	V
T <sub>op</sub>	Operating free air temperature range	-40 to 125	°C



### 3 Electrical characteristics

**Table 3. Electrical characteristics at  $V_{CC+} = 2.5\text{ V}$ ,  $V_{CC-} = 0\text{ V}$ ,  $V_{icm} = V_{CC}/2$ , with  $R_L$  connected to  $V_{CC}/2$ ,  $T = 25\text{ }^\circ\text{C}$  (unless otherwise specified)**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>DC performance</b>						
$V_{io}$	Offset voltage, TSV91x	$T_{op} = 25\text{ }^\circ\text{C}$		0.1	4.5	mV
		$T_{min} < T_{op} < T_{max}$			7.5	
$V_{io}$	Offset voltage, TSV91xA	$T_{op} = 25\text{ }^\circ\text{C}$			1.5	mV
		$T_{min} < T_{op} < T_{max}$			3	
$\Delta V_{io}/\Delta T$	Input offset voltage drift			5		$\mu\text{V}/^\circ\text{C}$
$I_{io}$	Input offset current <sup>(1)</sup>	$T_{op} = 25\text{ }^\circ\text{C}$		1	10	pA
		$T_{min} < T_{op} < T_{max}$			100	
$I_{ib}$	Input bias current <sup>(1)</sup>	$T_{op} = 25\text{ }^\circ\text{C}$		1	10	pA
		$T_{min} < T_{op} < T_{max}$			100	
CMR	Common mode rejection ratio, 20 log ( $\Delta V_{ic}/\Delta V_{io}$ )	$0\text{ V to } 2.5\text{ V}$ , $V_{out} = 1.25\text{ V}$ , $T_{op} = 25\text{ }^\circ\text{C}$	58	75		dB
		$T_{min} < T_{op} < T_{max}$	53			
$A_{vd}$	Large signal voltage gain	$R_L = 10\text{ k}\Omega$ , $V_{out} = 0.5\text{ V to } 2\text{ V}$ , $T_{op} = 25\text{ }^\circ\text{C}$	80	89		dB
		$T_{min} < T_{op} < T_{max}$	75			
$V_{CC} - V_{OH}$	High-level output voltage	$R_L = 10\text{ k}\Omega$		15	40	mV
		$T_{min} < T_{op} < T_{max}$			40	
		$R_L = 600\text{ }\Omega$		45	150	
		$T_{min} < T_{op} < T_{max}$			150	
$V_{OL}$	Low-level output voltage	$R_L = 10\text{ k}\Omega$		15	40	mV
		$T_{min} < T_{op} < T_{max}$			40	
		$R_L = 600\text{ }\Omega$		45	150	
		$T_{min} < T_{op} < T_{max}$			150	
$I_{out}$	$I_{sink}$	$V_o = 2.5\text{ V}$ , $T_{op} = 25\text{ }^\circ\text{C}$	18	32		mA
		$T_{min} < T_{op} < T_{max}$	16			
	$I_{source}$	$V_o = 0\text{ V}$ , $T_{op} = 25\text{ }^\circ\text{C}$	18	35		
		$T_{min} < T_{op} < T_{max}$	16			
$I_{CC}$	Supply current (per channel)	No load, $V_{out} = V_{CC}/2$		0.78	1.1	
		$T_{min} < T_{op} < T_{max}$			1.1	
<b>AC performance</b>						
GBP	Gain bandwidth product	$R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $f = 100\text{ kHz}$ , $T_{op} = 25\text{ }^\circ\text{C}$		8		MHz
$F_u$	Unity gain frequency	$R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $T_{op} = 25\text{ }^\circ\text{C}$		7.2		
$\phi_m$	Phase margin	$R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $T_{op} = 25\text{ }^\circ\text{C}$		45		Degrees

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
$G_m$	Gain margin	$R_L = 2\text{ k}\Omega, C_L = 100\text{ pF}, T_{op} = 25\text{ }^\circ\text{C}$		8		dB
SR	Slew rate	$R_L = 2\text{ k}\Omega, C_L = 100\text{ pF}, A_v = 1, T_{op} = 25\text{ }^\circ\text{C}$		4.5		V/ $\mu\text{s}$
$e_n$	Equivalent input noise voltage	$f = 10\text{ kHz}, T_{op} = 25\text{ }^\circ\text{C}$		21		nV/ $\sqrt{\text{Hz}}$
THD+ $e_n$	Total harmonic distortion	$G = 1, f = 1\text{ kHz}, R_L = 2\text{ k}\Omega, BW = 22\text{ kHz}, T_{op} = 25\text{ }^\circ\text{C}, V_{icm} = (V_{CC} + 1)/2, V_{out} = 1.1\text{ V}_{pp}$		0.001		%

1. Guaranteed by design



**Table 4. Electrical characteristics at  $V_{CC+} = 3.3\text{ V}$ ,  $V_{CC-} = 0\text{ V}$ ,  $V_{icm} = V_{CC}/2$ , with  $R_L$  connected to  $V_{CC}/2$ ,  $T = 25\text{ °C}$  (unless otherwise specified)**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>DC performance</b>						
$V_{io}$	Offset voltage, TSV91x	$T_{op} = 25\text{ °C}$		0.1	4.5	mV
		$T_{min} < T_{op} < T_{max}$			7.5	
$V_{io}$	Offset voltage, TSV91xA	$T_{op} = 25\text{ °C}$			1.5	mV
		$T_{min} < T_{op} < T_{max}$			3	
$\Delta V_{io}/\Delta T$	Input offset voltage drift	$T_{op} = 25\text{ °C}$		5		$\mu\text{V}/\text{°C}$
$I_{io}$	Input offset current <sup>(1)</sup>	$T_{op} = 25\text{ °C}$		1	10	pA
		$T_{min} < T_{op} < T_{max}$			100	
$I_{ib}$	Input bias current <sup>(1)</sup>	$T_{op} = 25\text{ °C}$		1	10	pA
		$T_{min} < T_{op} < T_{max}$			100	
CMR	Common mode rejection ratio, $20 \log (\Delta V_{ic}/\Delta V_{io})$	$0\text{ V to } 3.3\text{ V}$ , $V_{out} = 1.65\text{ V}$ , $T_{op} = 25\text{ °C}$	60	78		dB
		$T_{min} < T_{op} < T_{max}$	55			
$A_{vd}$	Large signal voltage gain	$R_L = 10\text{ k}\Omega$ , $V_{out} = 0.5\text{ V to } 2.8\text{ V}$ , $T_{op} = 25\text{ °C}$	80	89		dB
		$T_{min} < T_{op} < T_{max}$	75			
$V_{CC} - V_{OH}$	High-level output voltage	$R_L = 10\text{ k}\Omega$		15	40	mV
		$T_{min} < T_{op} < T_{max}$			40	
		$R_L = 600\ \Omega$		45	150	
		$T_{min} < T_{op} < T_{max}$			150	
$V_{OL}$	Low-level output voltage	$R_L = 10\text{ k}\Omega$		15	40	mV
		$T_{min} < T_{op} < T_{max}$			40	
		$R_L = 600\ \Omega$		45	150	
		$T_{min} < T_{op} < T_{max}$			150	
$I_{out}$	$I_{sink}$	$V_o = 3.3\text{ V}$ , $T_{op} = 25\text{ °C}$	18	32		mA
		$T_{min} < T_{op} < T_{max}$	16			
	$I_{source}$	$V_o = 0\text{ V}$ , $T_{op} = 25\text{ °C}$	18	35		
		$T_{min} < T_{op} < T_{max}$	16			
$I_{CC}$	Supply current (per channel)	No load, $V_{out} = V_{CC}/2$		0.8	1.1	
		$T_{min} < T_{op} < T_{max}$			1.1	
<b>AC performance</b>						
GBP	Gain bandwidth product	$R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $f = 100\text{ kHz}$ , $T_{op} = 25\text{ °C}$		8		MHz
$F_u$	Unity gain frequency	$R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $T_{op} = 25\text{ °C}$		7.2		
$\phi_m$	Phase margin	$R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $T_{op} = 25\text{ °C}$		45		Degrees
$G_m$	Gain margin	$R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $T_{op} = 25\text{ °C}$		8		dB

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
SR	Slew rate	$R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $A_V = 1$ , $T_{op} = 25\text{ }^\circ\text{C}$		4.5		V/ $\mu\text{s}$
$e_n$	Equivalent input noise voltage	$f = 10\text{ kHz}$ , $T_{op} = 25\text{ }^\circ\text{C}$		21		nV/ $\sqrt{\text{Hz}}$
THD+ $e_n$	Total harmonic distortion	$G = 1$ , $f = 1\text{ kHz}$ , $R_L = 2\text{ k}\Omega$ , $BW = 22\text{ kHz}$ , $T_{op} = 25\text{ }^\circ\text{C}$ , $V_{icm} = (V_{CC} + 1)/2$ , $V_{out} = 1.9\text{ V}_{pp}$		0.0007		%

1. Guaranteed by design





**Table 5. Electrical characteristics at  $V_{CC+} = 5\text{ V}$ ,  $V_{CC-} = 0\text{ V}$ ,  $V_{icm} = V_{CC}/2$ , with  $R_L$  connected to  $V_{CC}/2$ ,  $T = 25\text{ °C}$  (unless otherwise specified)**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>DC performance</b>						
$V_{io}$	Offset voltage, TSV91x	$T_{op} = 25\text{ °C}$		0.1	4.5	mV
		$T_{min} < T_{op} < T_{max}$			7.5	
	Offset voltage, TSV91xA	$T_{op} = 25\text{ °C}$			1.5	
		$T_{min} < T_{op} < T_{max}$			3	
$\Delta V_{io}/\Delta T$	Input offset voltage drift			5		$\mu\text{V}/\text{°C}$
$I_{io}$	Input offset current <sup>(1)</sup>	$T_{op} = 25\text{ °C}$		1	10	pA
		$T_{min} < T_{op} < T_{max}$			100	
$I_{ib}$	Input bias current <sup>(1)</sup>	$T_{op} = 25\text{ °C}$		1	10	pA
		$T_{min} < T_{op} < T_{max}$			100	
CMR	Common mode rejection ratio, $20 \log (\Delta V_{io}/\Delta V_{io})$	$0\text{ V to }5\text{ V}$ , $V_{out} = 2.5\text{ V}$ , $T_{op} = 25\text{ °C}$	62	82		dB
		$T_{min} < T_{op} < T_{max}$	58			
SVR	Supply voltage rejection ratio, $20 \log (\Delta V_{CC}/\Delta V_{io})$	$V_{CC} = 2.5\text{ to }5\text{ V}$	70	86		dB
$A_{vd}$	Large signal voltage gain	$R_L = 10\text{ k}\Omega$ , $V_{out} = 0.5\text{ V to }4.5\text{ V}$ , $T_{op} = 25\text{ °C}$	80	91		
		$T_{min} < T_{op} < T_{max}$	75			
$V_{CC} - V_{OH}$	High-level output voltage	$R_L = 10\text{ k}\Omega$		15	40	mV
		$T_{min} < T_{op} < T_{max}$			40	
		$R_L = 600\ \Omega$		45	150	
		$T_{min} < T_{op} < T_{max}$			150	
$V_{OL}$	Low-level output voltage	$R_L = 10\text{ k}\Omega$		15	40	mV
		$T_{min} < T_{op} < T_{max}$			40	
		$R_L = 600\ \Omega$		45	150	
		$T_{min} < T_{op} < T_{max}$			150	
$I_{out}$	$I_{sink}$	$V_o = 5\text{ V}$ , $T_{op} = 25\text{ °C}$	18	32		mA
		$T_{min} < T_{op} < T_{max}$	16			
	$I_{source}$	$V_o = 0\text{ V}$ , $T_{op} = 25\text{ °C}$	18	35		
		$T_{min} < T_{op} < T_{max}$	16			
$I_{CC}$	Supply current (per channel)	No load, $V_{out} = 2.5\text{ V}$		0.78	1.1	
		$T_{min} < T_{op} < T_{max}$			1.1	
<b>AC performance</b>						
GBP	Gain bandwidth product	$R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $f = 100\text{ kHz}$ , $T_{op} = 25\text{ °C}$		8		MHz
$F_u$	Unity gain frequency	$R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $T_{op} = 25\text{ °C}$		7.5		
$\phi_m$	Phase margin	$R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $T_{op} = 25\text{ °C}$		45		Degrees
$G_m$	Gain margin	$R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $T_{op} = 25\text{ °C}$		8		dB

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
SR	Slew rate	$R_L = 2\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $A_v = 1$ , $T_{op} = 25\text{ }^\circ\text{C}$		4.5		V/ $\mu\text{s}$
$e_n$	Equivalent input noise voltage	$f = 1\text{ kHz}$ , $T_{op} = 25\text{ }^\circ\text{C}$		27		nV/ $\sqrt{\text{Hz}}$
		$f = 10\text{ kHz}$ , $T_{op} = 25\text{ }^\circ\text{C}$		21		
THD+ $e_n$	Total harmonic distortion	$G = 1$ , $f = 1\text{ kHz}$ , $R_L = 2\text{ k}\Omega$ , $\text{BW} = 22\text{ kHz}$ , $T_{op} = 25\text{ }^\circ\text{C}$ , $V_{icm} = (V_{CC} + 1)/2$ , $V_{out} = 3.6\text{ V}_{pp}$		0.0004		%

1. Guaranteed by design



## 4 Electrical characteristic curves

Figure 2. Input offset voltage distribution at T = 25 °C

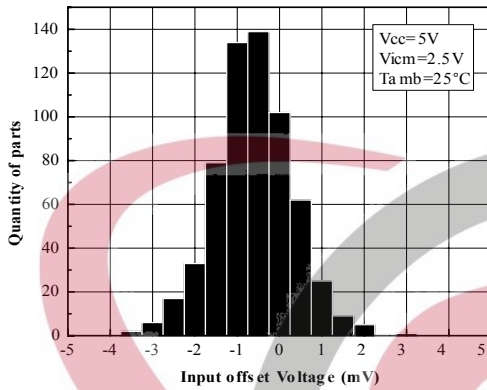


Figure 3. Input offset voltage distribution at T = 125 °C

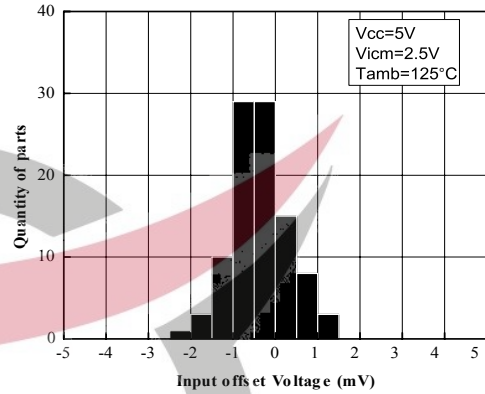


Figure 4. Supply current vs. input common-mode voltage at V<sub>CC</sub> = 2.5 V

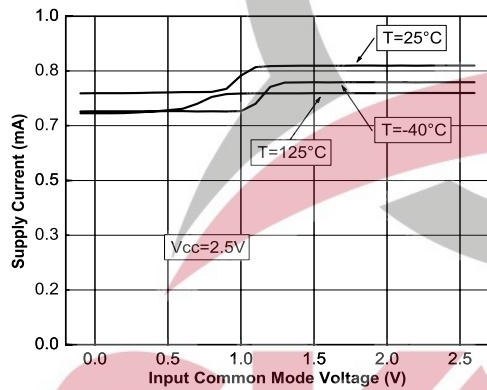


Figure 5. Supply current vs. input common-mode voltage at V<sub>CC</sub> = 5 V

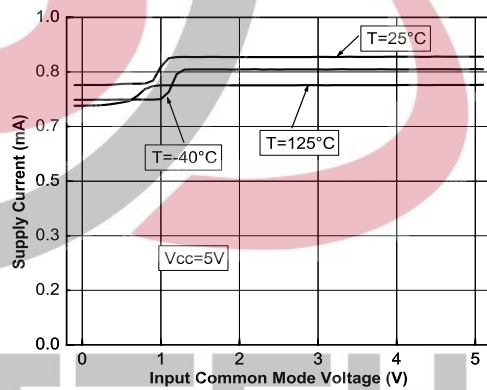


Figure 6. Output current vs. output voltage at V<sub>CC</sub> = 2.5 V

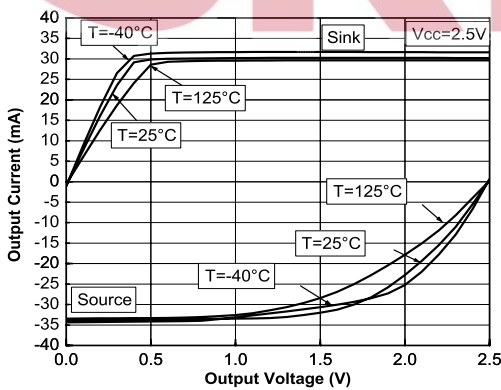


Figure 7. Output current vs. output voltage at V<sub>CC</sub> = 5 V

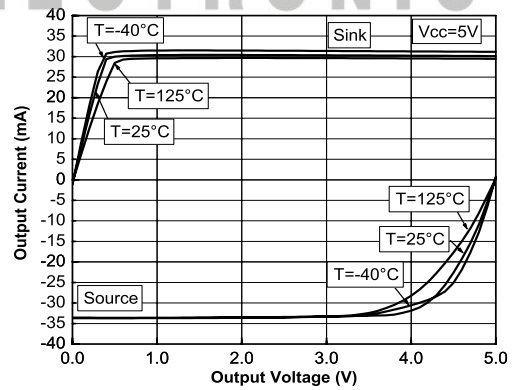


Figure 8. Voltage gain and phase vs. frequency at  $V_{CC} = 2.5\text{ V}$  and  $V_{icm} = 0.5\text{ V}$

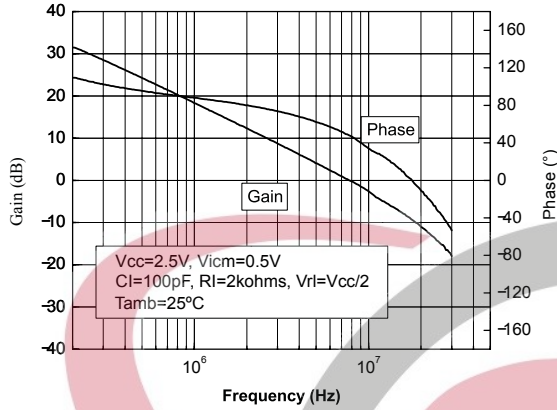


Figure 9. Voltage gain and phase vs. frequency at  $V_{CC} = 5.5\text{ V}$  and  $V_{icm} = 0.5\text{ V}$

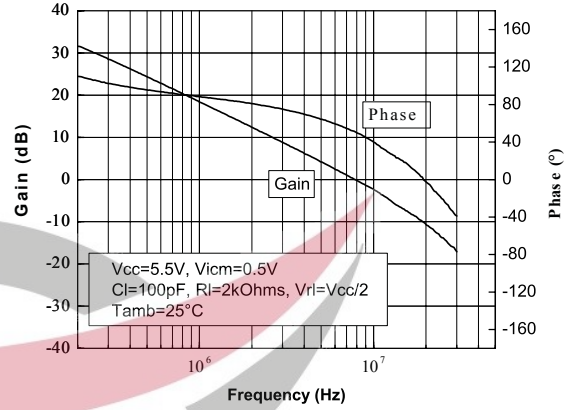


Figure 10. Phase margin vs. capacitive load

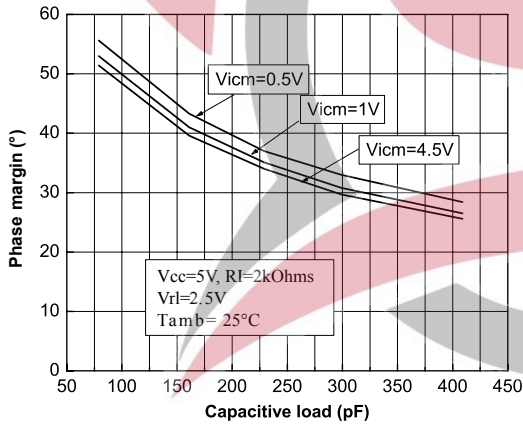


Figure 11. Phase margin vs. output current

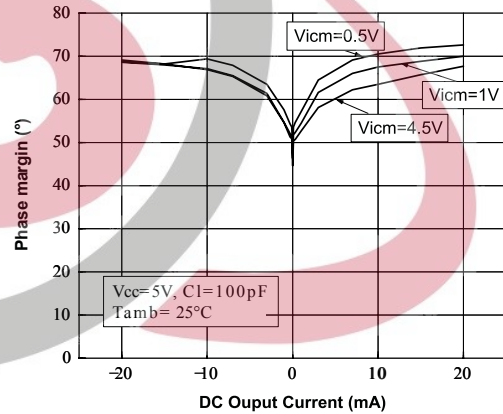


Figure 12. Positive slew rate

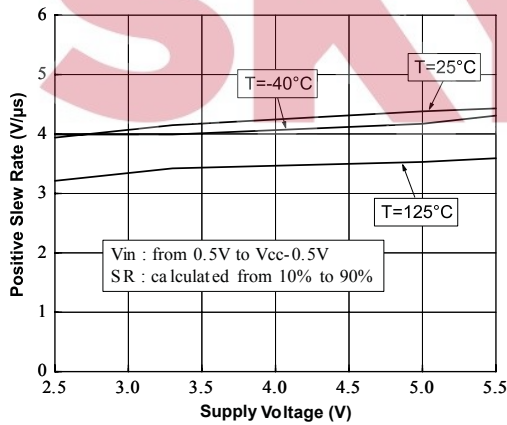


Figure 13. Negative slew rate

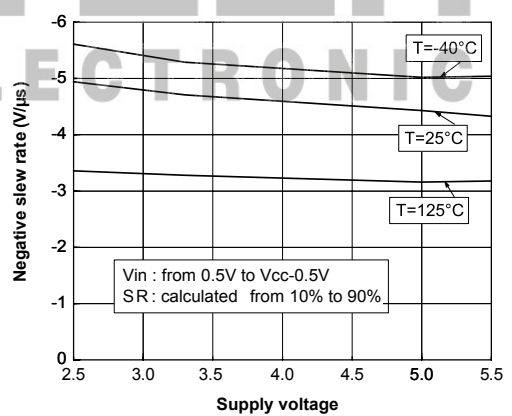


Figure 14. Distortion + noise vs. frequency

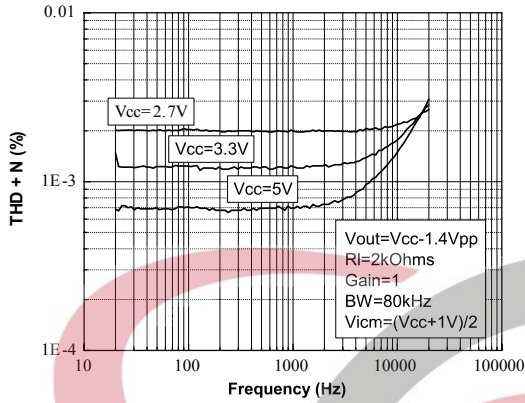


Figure 15. Distortion + noise vs. output voltage

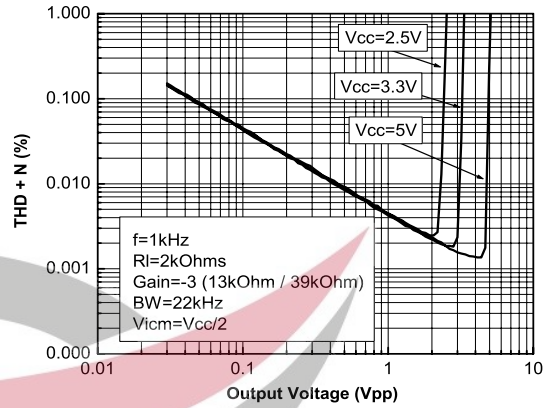


Figure 16. Noise vs. frequency

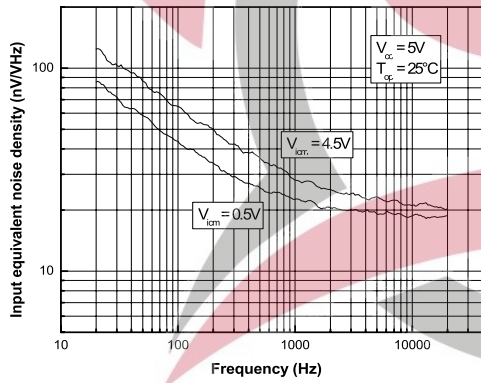


Figure 17. Phase margin vs. capacitive load and serial resistor

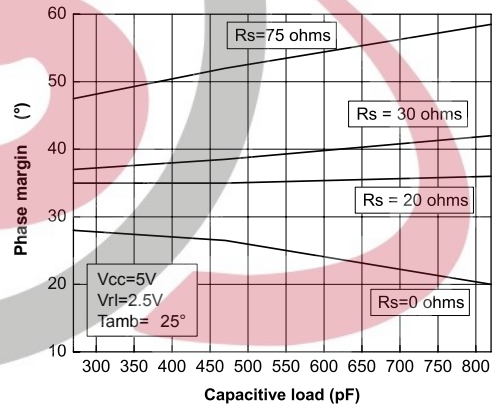
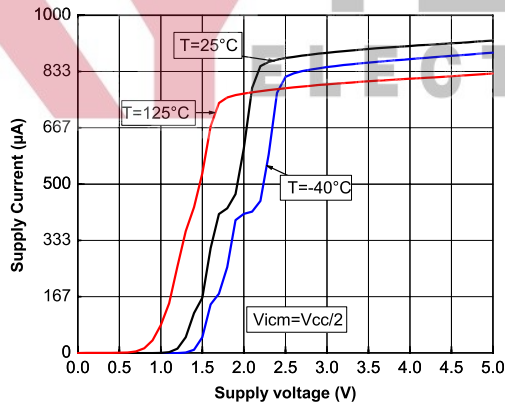


Figure 18. Supply current vs. supply voltage



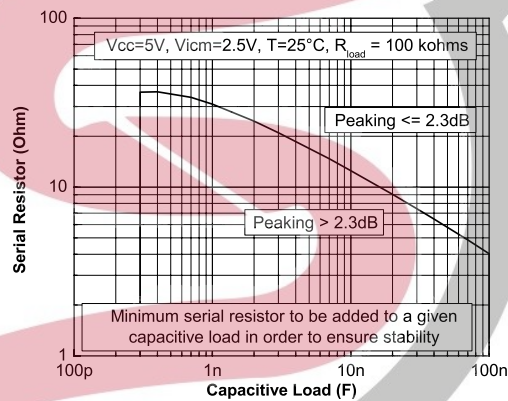
## 5 Application information

### 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 $\Omega$ .

In a *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 device (figure below shows the recommended in-series resistor values). Once the in-series resistor value has been selected, the stability of the circuit should be tested on bench and simulated with the simulation model.

Figure 19. In-series resistor vs. capacitive load



### 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.

### 5.3 Macromodel

An accurate macromodel of the TSV91x is available on STMicroelectronics' web site at: [www.st.com](http://www.st.com). This model is a trade-off between accuracy and complexity (that is, time simulation) of the TSV91x operational amplifiers. It emulates the nominal performances of a typical device within the specified operating conditions mentioned in the datasheet. It helps to validate a design approach and to select the right operational amplifier, *but it does not* replace on-board measurements.

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

### 6.1 SOT23-5 package information

Figure 20. SOT23-5 package outline

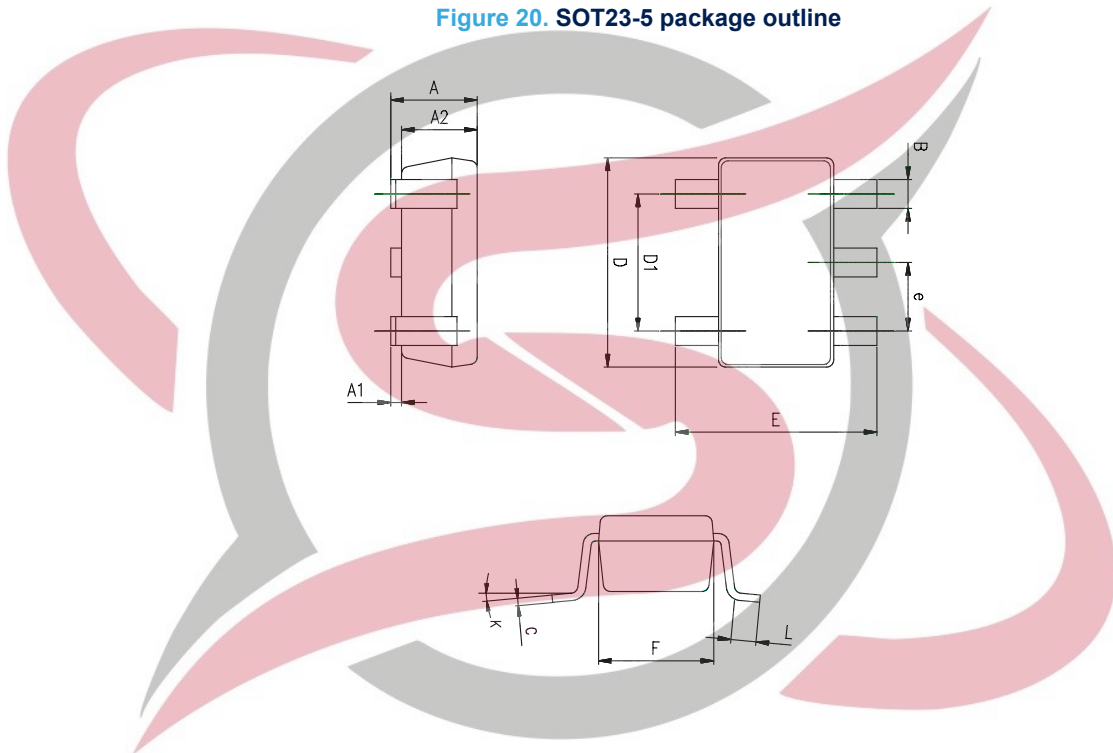


Table 6. SOT23-5 mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90	1.20	1.45	0.035	0.047	0.057
A1			0.15			0.006
A2	0.90	1.05	1.30	0.035	0.041	0.051
B	0.35	0.40	0.50	0.014	0.016	0.020
C	0.09	0.15	0.20	0.004	0.006	0.008
D	2.80	2.90	3.00	0.110	0.114	0.118
D1		1.90			0.075	
e		0.95			0.037	
E	2.60	2.80	3.00	0.102	0.110	0.118
F	1.50	1.60	1.75	0.059	0.063	0.069
L	0.10	0.35	0.60	0.004	0.014	0.024
K	0 degrees		10 degrees	0 degrees		10 degrees

## 6.2 DFN8 2 x 2 package information

Figure 21. DFN8 2 x 2 package outline

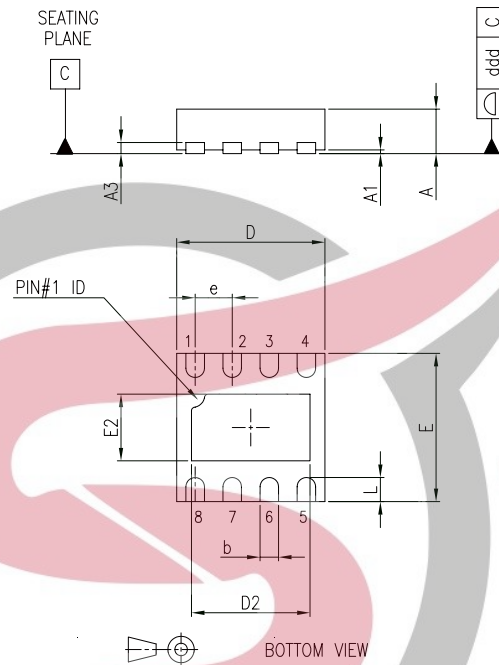
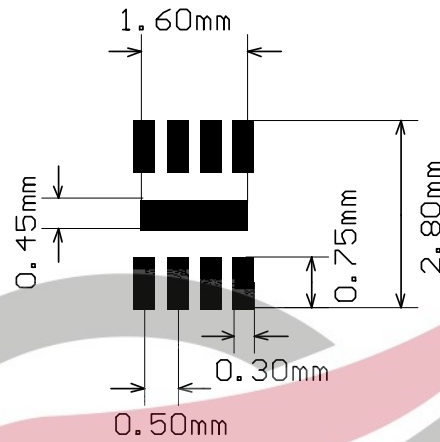


Table 7. DFN8 2 x 2 mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.51	0.55	0.60	0.020	0.022	0.024
A1			0.05			0.002
A3		0.15			0.006	
b	0.18	0.25	0.30	0.007	0.010	0.012
D	1.85	2.00	2.15	0.073	0.079	0.085
D2	1.45	1.60	1.70	0.057	0.063	0.067
E	1.85	2.00	2.15	0.073	0.079	0.085
E2	0.75	0.90	1.00	0.030	0.035	0.039
e		0.50			0.020	
L			0.425			0.017
ddd			0.08			0.003



Figure 22. DFN8 2 x 2 recommended footprint



Note: The exposed pad of the DFN8 2x2 package is not internally connected. It can be set to  $V_{CC^-}$  or left floating.

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### 6.3 MiniSO8 package information

Figure 23. MiniSO8 package outline

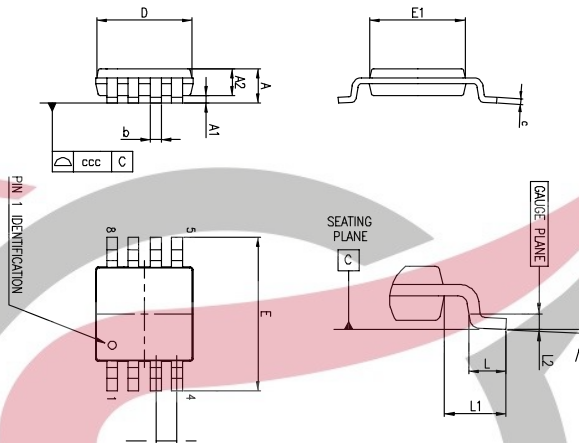


Table 8. MiniSO8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.1			0.043
A1	0		0.15	0		0.0006
A2	0.75	0.85	0.95	0.030	0.033	0.037
b	0.22		0.40	0.009		0.016
c	0.08		0.23	0.003		0.009
D	2.80	3.00	3.20	0.11	0.118	0.126
E	4.65	4.90	5.15	0.183	0.193	0.203
E1	2.80	3.00	3.10	0.11	0.118	0.122
e		0.65			0.026	
L	0.40	0.60	0.80	0.016	0.024	0.031
L1		0.95			0.037	
L2		0.25			0.010	
k	0°		8°	0°		8°
ccc			0.10			0.004

## 6.4 SO8 package information

Figure 24. SO8 package outline

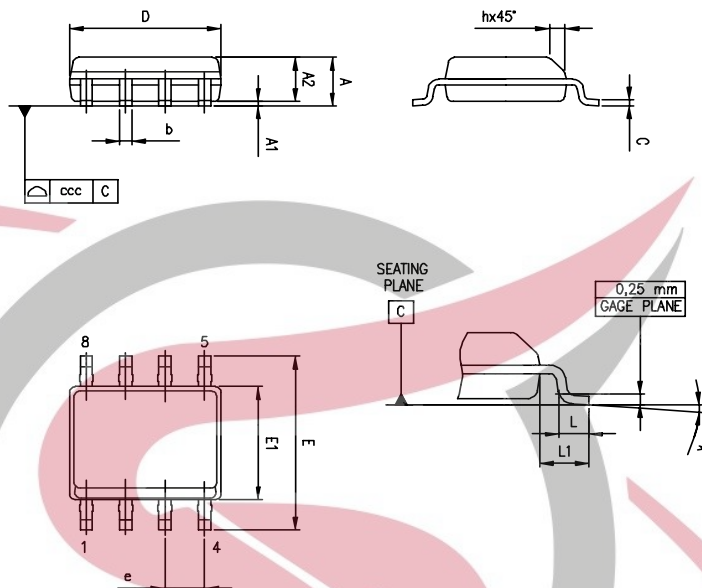


Table 9. SO8 package mechanical data

Ref.	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	0°		8°	0°		8°
ccc			0.10			0.004

## 6.5 TSSOP14 package information

Figure 25. TSSOP14 package outline

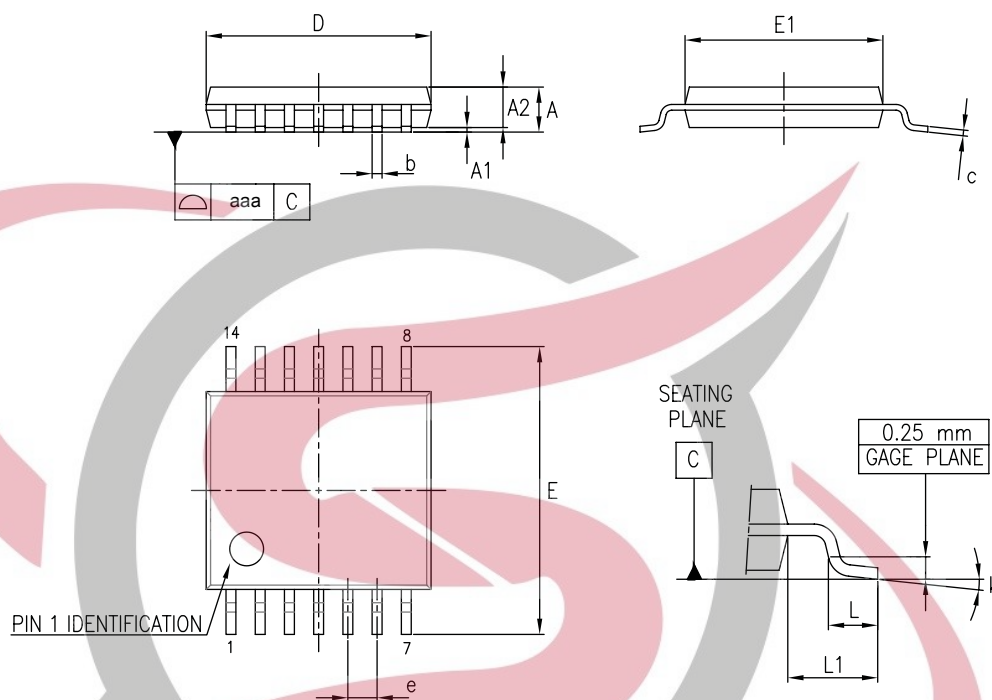


Table 10. TSSOP14 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.0089
D	4.90	5.00	5.10	0.193	0.197	0.201
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.176
e		0.65			0.0256	
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1.00			0.039	
k	0°		8°	0°		8°
aaa			0.10			0.004

## 6.6 SO14 package information

Figure 26. SO14 package outline

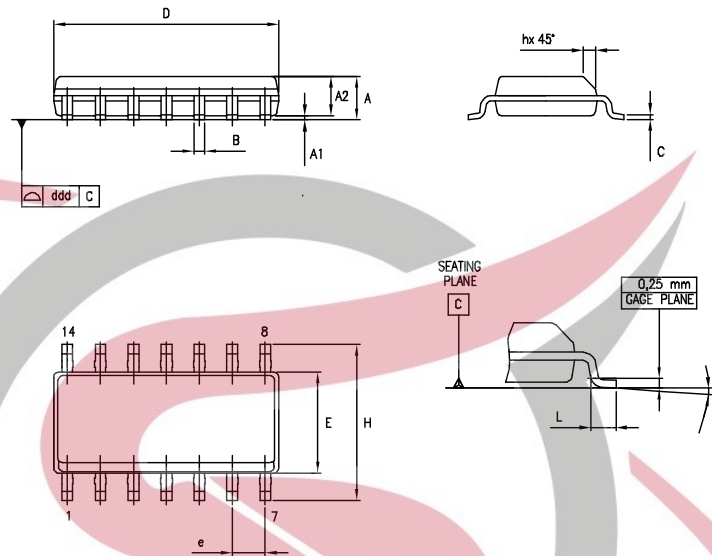


Table 11. SO14 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.35		1.75	0.05		0.068
A1	0.10		0.25	0.004		0.009
A2	1.10		1.65	0.04		0.06
B	0.33		0.51	0.01		0.02
C	0.19		0.25	0.007		0.009
D	8.55		8.75	0.33		0.34
E	3.80		4.0	0.15		0.15
e		1.27			0.05	
H	5.80		6.20	0.22		0.24
h	0.25		0.50	0.009		0.02
L	0.40		1.27	0.015		0.05
k	8° (max.)					
ddd			0.10			0.004

## 7 Ordering information

Table 12. Order codes

Order code	Temperature range	Package	Packing	Marking	
TSV911IDT	-40 °C to 125 °C	SO8	Tape and reel	V911I	
TSV911AIDT				V911AI	
TSV911ILT		SOT23-5		K127	
TSV911AILT				K128	
TSV911RILT		MiniSO8		K125	
TSV912IST				K125	
TSV912AIST		SO8		K126	
TSV912IDT				V912I	
TSV912AIDT		V912AI			
TSV912IQ2T		DFN8 2x2		K1Q	
TSV914IPT		TSSOP14		V914I	
TSV914AIPT				V914AI	
TSV914IDT		SO14		V914I	
TSV914AIDT				V914AI	
TSV911IYLT <sup>(1)</sup>		SOT23-5, automotive grade		K147	
TSV911AIYLT <sup>(1)</sup>				K148	
TSV911IYDT <sup>(1)</sup>		SO-8, automotive grade		V911IY	
TSV911AIYDT <sup>(1)</sup>				V911AIY	
TSV912IYDT <sup>(1)</sup>				V912IY	
TSV912AIYDT <sup>(1)</sup>				V912AIY	
TSV912IYST <sup>(1)</sup>				K147	
TSV912AIYST <sup>(1)</sup>				K148	
TSV914IYDT <sup>(1)</sup>				SO14, automotive grade	V914IY
TSV914AIYDT <sup>(1)</sup>					V914AIY
TSV914IYPT <sup>(1)</sup>		TSSOP14, automotive grade		V914IY	
TSV914AIYPT <sup>(1)</sup>				V914AIY	

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent.

## Revision history

**Table 13. Document revision history**

Date	Revision	Changes
28-Aug-2006	1	First release.
07-Jun-2007	2	<p>Modified ESD CDM parameter for SO-14 package in Table 2: Absolute maximum ratings.</p> <p>Noise parameters updated in Section 2: Electrical characteristics.</p> <p>Added limits in temperature in Section 2: Electrical characteristics.</p> <p>Added automotive grade level description in Table 13: Order codes.</p> <p>Added footnote about SO-14 package in Table 13: Order codes.</p> <p>Added Figure 16: Phase margin vs. capacitive load and serial resistor.</p>
11-Feb-2008	3	<p>Updated footnotes for ESD parameters in Table 2: Absolute maximum ratings.</p> <p>Corrected MiniSO-8 package information in Table 9: MiniSO-8 package mechanical data.</p> <p>Added missing markings for order codes TSV911AILT and TSV912AILT in Table 13: Order codes.</p>
22-Jun-2009	4	<p>Added input current information in Table 2: Absolute maximum ratings.</p> <p>Changed Figure 7 and Figure 8.</p> <p>Added Chapter 3: Application information.</p> <p>Updated package information in Chapter 4.</p> <p>Added automotive order codes: TSV911IYLT, TSV911AIYLT, TSV912IYST, TSV912AIYST, TSV914IYPT and TSV914AIYPT in Table 13: Order codes.</p>
17-Sep-2009	5	<p>Added A versions of devices in title on cover page.</p> <p>Modified ESD value for machine model in Table 2: Absolute maximum ratings.</p> <p>Added Figure 17: Supply current vs. supply voltage on page 10.</p>
18-Mar-2010	6	<p>Added TSV911RILT in Table 13: Order codes, housed in a SOT23-5 package with a new pinout.</p>
24-Jun-2010	7	<p>Added pin connections for TSV911ILT and TSV91RILT on cover page.</p> <p>Added Table 1: Device summary on cover page.</p> <p>Modified supply voltage value in Table 3.</p> <p>Corrected typical value of <math>DV_{IO}</math> in Table 4, Table 5 and Table 6.</p> <p>Added TSV911RILT, TSV911IYDT and TSV911AIYDT order codes in Table 13.</p> <p>Modified Note 2 under Table 13.</p>

Date	Revision	Changes
06-Mar-2012	8	Added DFN8 2x2 package and ordering information for TSV912 device to Chapter 4 and Chapter 5.
27-Nov-2015	9	Updated layout Section 2: replaced $DV_{iO}/DT$ by $\Delta V_{iO}/\Delta T$ . Section 5.2: updated name of package and title of drawings and table; added note about exposed pad. Table 13: "Order codes": removed obsolete order codes (TSV911ID, TSV911AID, TSV912ID, TSV912AID, TSV914ID, TSV914AID).
29-Aug-2016	10	Added silhouettes of packages to cover page Placed pinout diagrams in Section 2: "Package pin connections" Added Related products Description: added footnote 1 Section 7.2: "DFN8 2 x 2 package information": modified note about the exposed pad. Section 8: "Ordering information": removed note regarding "moisture sensitivity level 1"
10-Oct-2019	11	Updated <a href="#">Table 12. Order codes</a> .
20-Nov-2019	12	Updated cover page.





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