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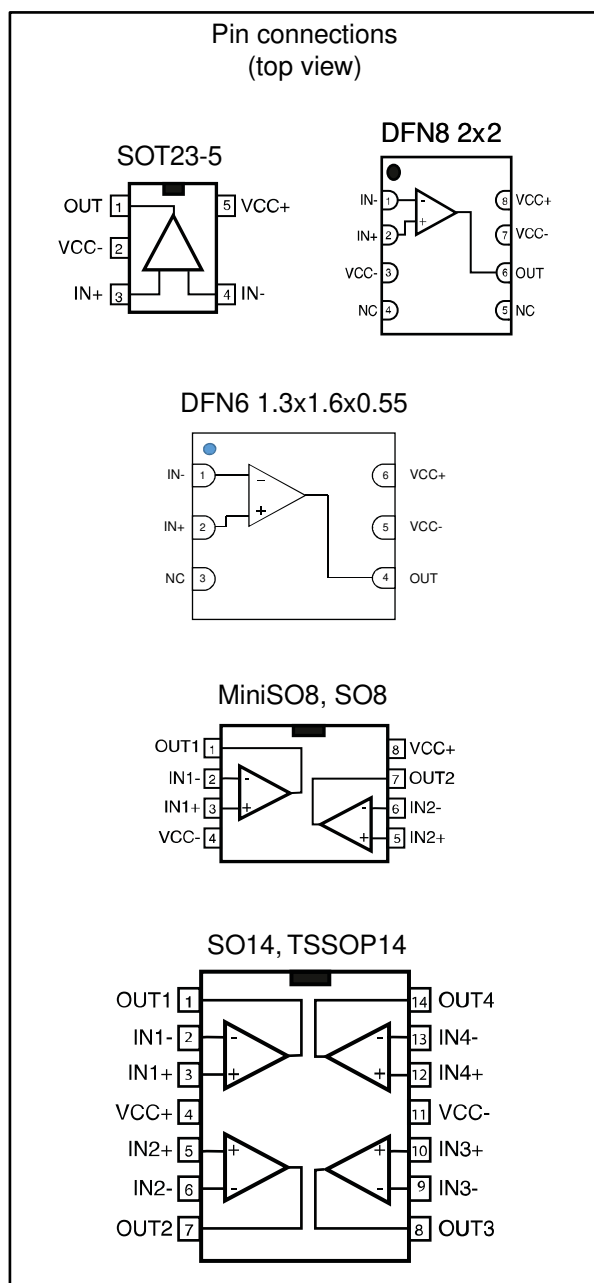
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Rail-to-rail input/output 20 MHz GBP operational amplifiers

Datasheet - production data



Features

- Low input offset voltage: 1.5 mV max (A grade)
- Rail-to-rail input and output
- Wide bandwidth 20 MHz
- Stable for gain ≥ 4 or ≤ -3
- Low power consumption: 820 μ A typ
- High output current: 35 mA
- Operating from 2.5 V to 5.5 V
- Low input bias current, 1 pA typ
- ESD internal protection ≥ 5 kV

Related products

- See TSV911, TSV912, and TSV914 for unity-gain stable amplifiers

Applications

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

Description

The TSV99x and TSV99xA family of single, dual, and quad operational amplifiers offers low voltage operation and rail-to-rail input and output. These devices feature an excellent speed/power consumption ratio, offering a 20 MHz gain-bandwidth, stable for gains above 4 (100 pF capacitive load), while consuming only 1.1 mA maximum at 5 V. They also feature an ultra-low input bias current. These characteristics make the TSV99x family ideal for sensor interfaces, battery-supplied and portable applications, as well as active filtering. These characteristics make the TSV99x, TSV99xA family ideal for sensor interfaces, battery-supplied and portable applications, as well as active filtering.

Contents

1	Absolute maximum ratings and operating conditions	3
2	Electrical characteristics	5
3	Electrical characteristic curves	11
4	Application information	14
	4.1 Driving resistive and capacitive loads	14
	4.2 PCB layouts	14
	4.3 Macromodel	14
5	Package information	15
	5.1 SOT23-5 package information	16
	5.2 DFN8 2 x 2 package information.....	17
	5.3 DFN6 1.3 x 1.6 x 0.55 package information	19
	5.4 MiniSO8 package information	21
	5.5 SO8 package information.....	22
	5.6 SO14 package information.....	23
	5.7 TSSOP14 package information.....	24
6	Ordering information.....	25
7	Revision history	26

1 Absolute maximum ratings and operating conditions

Table 1: Absolute maximum ratings (AMR)

Symbol	Parameter	Value	Unit	
V_{CC}	Supply voltage ⁽¹⁾	6	V	
V_{id}	Differential input voltage ⁽²⁾	$\pm V_{CC}$		
V_{in}	Input voltage ⁽³⁾	$(V_{CC-}) - 0.2$ to $(V_{CC+}) + 0.2$		
I_{in}	Input current ⁽⁴⁾	10	mA	
T_{stg}	Storage temperature	-65 to 150	°C	
T_j	Maximum junction temperature	150		
R_{thja}	Thermal resistance junction to ambient ⁽⁵⁾⁽⁶⁾	DFN8 2x2	57	°C/W
		DFN6 1.3x1.6x0.55	230	
		SOT23-5	250	
		SO8	125	
		MiniSO8	190	
		SO14	103	
		TSSOP14	100	
R_{thjc}	Thermal resistance junction to case	SOT23-5	81	°C/W
		SO8	40	
		MiniSO8	39	
		SO14	31	
		TSSOP14	32	
ESD	HBM: human body model ⁽⁷⁾		5	kV
	MM: machine model ⁽⁸⁾		400	V
	CDM: charged device model ⁽⁹⁾	SOT23-5, SO8, MiniSO8, DFN8 2x2	1500	
		DFN6 1.3x1.6x0.55	TBD	
		TSSOP14	750	
SO14		500		
	Latch-up immunity		200	mA

Notes:

- ⁽¹⁾Value is with respect to the V_{CC-} pin
- ⁽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 _{CC}	Supply voltage	2.5 to 5.5	V
V _{icm}	Common mode input voltage range	(V _{CC-}) - 0.1 to (V _{CC+}) + 0.1	
T _{op}	Operating free air temperature range	-40 to 125	°C

2 Electrical characteristics



In the electrical characteristic tables below, all parameter limits at temperatures other than 25 °C are guaranteed by correlation.

Table 3: Electrical characteristics at VCC+ = 2.5 V, VCC- = 0 V, Vicm = VCC/2, with RL connected to VCC/2, full temperature range (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V _{io}	Offset voltage, TSV99x	T _{op} = 25 °C		0.1	4.5	mV
		T _{min} < T _{op} < T _{max}			7.5	
	Offset voltage, TSV99xA	T _{op} = 25 °C			1.5	
		T _{min} < T _{op} < T _{max}			3	
ΔV _{io} /ΔT	Input offset voltage drift			2		μV/°C
I _{io}	Input offset current, V _{out} = V _{CC} /2 ⁽¹⁾	T _{op} = 25 °C		1	10	pA
		T _{min} < T _{op} < T _{max}			100	
I _{ib}	Input bias current, V _{out} = V _{CC} /2 ⁽¹⁾	T _{op} = 25 °C		1	10	
		T _{min} < T _{op} < T _{max}			100	
CMR	Common mode rejection ratio, 20 log (ΔV _{io} /ΔV _{io})	0 V to 2.5 V, V _{out} = 1.25 V, T _{op} = 25 °C	58	75		dB
		T _{min} < T _{op} < T _{max}	53			
A _{vd}	Large signal voltage gain	R _L = 10 kΩ, V _{out} = 0.5 V to 2 V, T _{op} = 25 °C	80	89		
		T _{min} < T _{op} < T _{max}	75			
V _{CC} - V _{OH}	High-level output voltage	R _L = 10 kΩ, T _{min} < T _{op} < T _{max}		15	40	mV
		R _L = 600 Ω, T _{min} < T _{op} < T _{max}		45	150	
V _{OL}	Low-level output voltage	R _L = 10 kΩ, T _{min} < T _{op} < T _{max}		15	40	
		R _L = 600 Ω, T _{min} < T _{op} < T _{max}		45	150	
I _{out}	I _{sink}	V _o = 2.5 V, T _{op} = 25 °C	18	32		mA
		T _{min} < T _{op} < T _{max}	16			
	I _{source}	V _o = 0 V, T _{op} = 25 °C	18	35		
		T _{min} < T _{op} < T _{max}	16			
I _{CC}	Supply current (per channel)	No load, V _{out} = V _{CC} /2, T _{min} < T _{op} < T _{max}		0.78	1.1	
AC performance						
GBP	Gain bandwidth product	R _L = 2 kΩ, C _L = 100 pF, f = 100 kHz, T _{op} = 25 °C		20		MHz
Gain	Minimum gain for stability	Phase margin = 45 °, R _f = 10 kΩ, R _L = 2 kΩ, C _L = 100 pF, T _{op} = 25 °C, positive gain configuration		4		V/V

Electrical characteristics

TSV991, TSV992, TSV994 TSV991A, TSV992A,
TSV994A

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Gain	Minimum gain for stability	Phase margin = 45 °, $R_f = 10\text{ k}\Omega$, $R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $T_{op} = 25\text{ }^\circ\text{C}$, negative gain configuration		-3		V/V
SR	Slew rate	$R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $T_{op} = 25\text{ }^\circ\text{C}$		10		V/ μs
e_n	Equivalent input noise voltage	$f = 10\text{ kHz}$, $T_{op} = 25\text{ }^\circ\text{C}$		21		nV/ $\sqrt{\text{Hz}}$
THD+N	Total harmonic distortion	$G = -3$, $f = 1\text{ kHz}$, $R_L = 2\text{ k}\Omega$, $Bw = 22\text{ kHz}$, $V_{icm} = V_{CC}/2$, $V_{out} = 2\text{ V}_{pp}$, $T_{op} = 25\text{ }^\circ\text{C}$		0.0025		%

Notes:

⁽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 $V_{CC}/2$, full temperature range (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Offset voltage, TSV99x	$T_{op} = 25\text{ }^{\circ}\text{C}$		0.1	4.5	mV
		$T_{min} < T_{op} < T_{max}$			7.5	
	Offset voltage, TSV99xA	$T_{op} = 25\text{ }^{\circ}\text{C}$			1.5	
		$T_{min} < T_{op} < T_{max}$			3	
$\Delta V_{io}/\Delta T$	Input offset voltage drift			2		$\mu\text{V}/^{\circ}\text{C}$
I_{io}	Input offset current, $V_{out} = V_{CC}/2$ ⁽¹⁾	$T_{op} = 25\text{ }^{\circ}\text{C}$		1	10	pA
		$T_{min} < T_{op} < T_{max}$			100	
I_{ib}	Input bias current, $V_{out} = V_{CC}/2$ ⁽¹⁾	$T_{op} = 25\text{ }^{\circ}\text{C}$		1	10	
		$T_{min} < T_{op} < T_{max}$			100	
CMR	Common mode rejection ratio, $20 \log (\Delta V_{ic}/\Delta V_{io})$	$0\text{ V to } 3.3\text{ V}$, $V_{out} = 1.65\text{ V}$, $T_{op} = 25\text{ }^{\circ}\text{C}$	60	78		dB
		$T_{min} < T_{op} < T_{max}$	55			
A_{vd}	Large signal voltage gain	$R_L = 10\text{ k}\Omega$, $V_{out} = 0.5\text{ V to } 2.8\text{ V}$, $T_{op} = 25\text{ }^{\circ}\text{C}$	80	89		
		$T_{min} < T_{op} < T_{max}$	75			
$V_{CC} - V_{OH}$	High-level output voltage	$R_L = 10\text{ k}\Omega$, $T_{min} < T_{op} < T_{max}$		15	40	mV
		$R_L = 600\text{ }\Omega$, $T_{min} < T_{op} < T_{max}$		45	150	
V_{OL}	Low-level output voltage	$R_L = 10\text{ k}\Omega$, $T_{min} < T_{op} < T_{max}$		15	40	
		$R_L = 600\text{ }\Omega$, $T_{min} < T_{op} < T_{max}$		45	150	
I_{out}	I_{sink}	$V_o = 3.3\text{ V}$, $T_{op} = 25\text{ }^{\circ}\text{C}$	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, $V_{out} = V_{CC}/2$, $T_{min} < T_{op} < T_{max}$		0.8	1.1	
AC performance						
GBP	Gain bandwidth product	$R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $f = 100\text{ kHz}$, $T_{op} = 25\text{ }^{\circ}\text{C}$		20		MHz
Gain	Minimum gain for stability	Phase margin = 45° , $R_f = 10\text{ k}\Omega$, $R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $T_{op} = 25\text{ }^{\circ}\text{C}$, positive gain configuration		4		V/V
		Phase margin = 45° , $R_f = 10\text{ k}\Omega$, $R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $T_{op} = 25\text{ }^{\circ}\text{C}$, negative gain configuration		-3		
SR	Slew rate	$R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $f = 100\text{ kHz}$, $T_{op} = 25\text{ }^{\circ}\text{C}$		10		V/ μs

Electrical characteristics

TSV991, TSV992, TSV994 TSV991A, TSV992A,
TSV994A

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
e_n	Equivalent input noise voltage	$f = 10 \text{ kHz}, T_{op} = 25 \text{ }^\circ\text{C}$		21		nV/ $\sqrt{\text{Hz}}$
THD+N	Total harmonic distortion	$G = -3, f = 1 \text{ kHz}, R_L = 2 \text{ k}\Omega,$ $Bw = 22 \text{ kHz}, V_{icm} = V_{CC}/2,$ $V_{out} = 2.8 V_{pp}, T_{op} = 25 \text{ }^\circ\text{C}$		0.0018		%

Notes:

⁽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 $V_{CC}/2$, full temperature range (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Offset voltage, TSV99x	$T_{op} = 25\text{ }^{\circ}\text{C}$		0.1	4.5	mV
		$T_{min} < T_{op} < T_{max}$			7.5	
	Offset voltage, TSV99xA	$T_{op} = 25\text{ }^{\circ}\text{C}$			1.5	
		$T_{min} < T_{op} < T_{max}$			3	
$\Delta V_{io}/\Delta T$	Input offset voltage drift			2		$\mu\text{V}/^{\circ}\text{C}$
I_{io}	Input offset current, $V_{out} = V_{CC}/2$ ⁽¹⁾	$T_{op} = 25\text{ }^{\circ}\text{C}$		1	10	pA
		$T_{min} < T_{op} < T_{max}$			100	
I_{ib}	Input bias current, $V_{out} = V_{CC}/2$ ⁽¹⁾	$T_{op} = 25\text{ }^{\circ}\text{C}$		1	10	
		$T_{min} < T_{op} < T_{max}$			100	
CMR	Common mode rejection ratio, $20\log(\Delta V_{ic}/\Delta V_{io})$	0 V to 5 V, $V_{out} = 2.5\text{ V}$, $T_{op} = 25\text{ }^{\circ}\text{C}$	62	82		dB
		$T_{min} < T_{op} < T_{max}$	57			
SVR	Supply voltage rejection ratio, $20\log(\Delta V_{cc}/\Delta V_{io})$	$V_{CC} = 2.5\text{ V to } 5\text{ V}$	70	86		
A_{vd}	Large signal voltage gain	$R_L = 10\text{ k}\Omega$, $V_{out} = 0.5\text{ V to } 4.5\text{ V}$, $T_{op} = 25\text{ }^{\circ}\text{C}$	80	91		
		$T_{min} < T_{op} < T_{max}$	75			
$V_{CC} - V_{OH}$	High-level output voltage	$R_L = 10\text{ k}\Omega$, $T_{min} < T_{op} < T_{max}$		15	40	mV
		$R_L = 600\text{ }\Omega$, $T_{min} < T_{op} < T_{max}$		45	150	
V_{OL}	Low-level output voltage	$R_L = 10\text{ k}\Omega$, $T_{min} < T_{op} < T_{max}$		15	40	
		$R_L = 600\text{ }\Omega$, $T_{min} < T_{op} < T_{max}$		45	150	
I_{out}	I_{sink}	$V_o = 5\text{ V}$, $T_{op} = 25\text{ }^{\circ}\text{C}$	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, $V_{out} = 2.5\text{ V}$, $T_{min} < T_{op} < T_{max}$		0.82	1.1	
AC performance						
GBP	Gain bandwidth product	$R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $f = 100\text{ kHz}$, $T_{op} = 25\text{ }^{\circ}\text{C}$		20		MHz
Gain	Minimum gain for stability	Phase margin = 45° , $R_f = 10\text{ k}\Omega$, $R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $T_{op} = 25\text{ }^{\circ}\text{C}$, positive gain configuration		4		V/V
		Phase margin = 45° , $R_f = 10\text{ k}\Omega$, $R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $T_{op} = 25\text{ }^{\circ}\text{C}$, negative gain configuration		-3		

Electrical characteristics

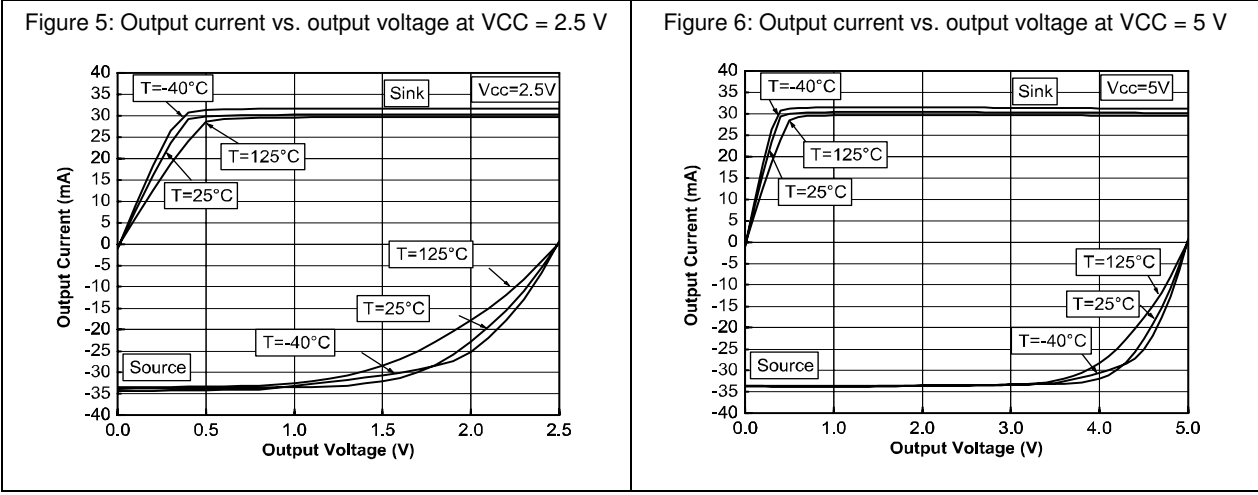
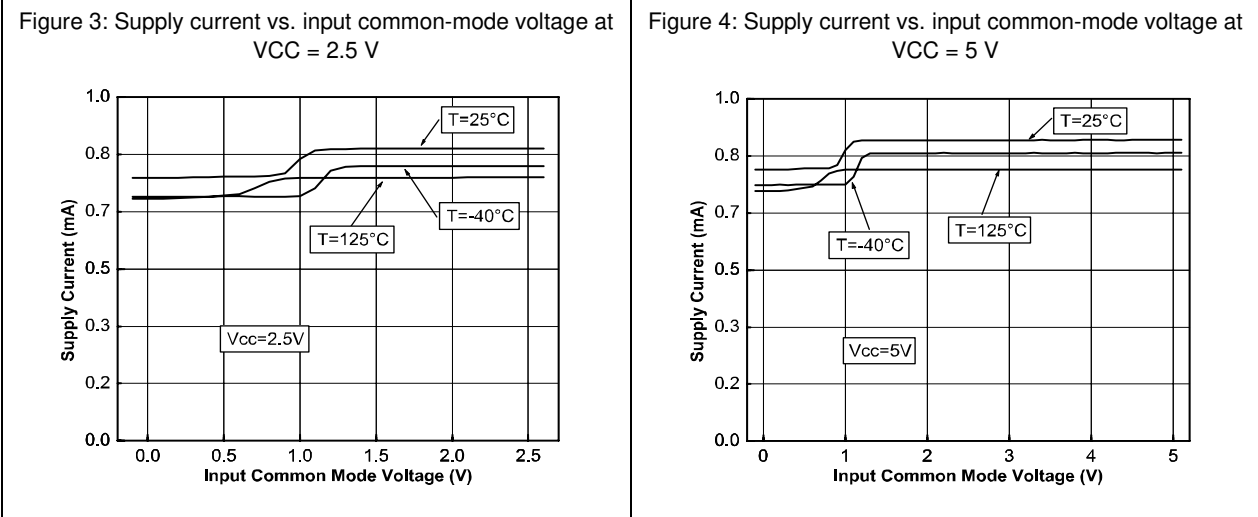
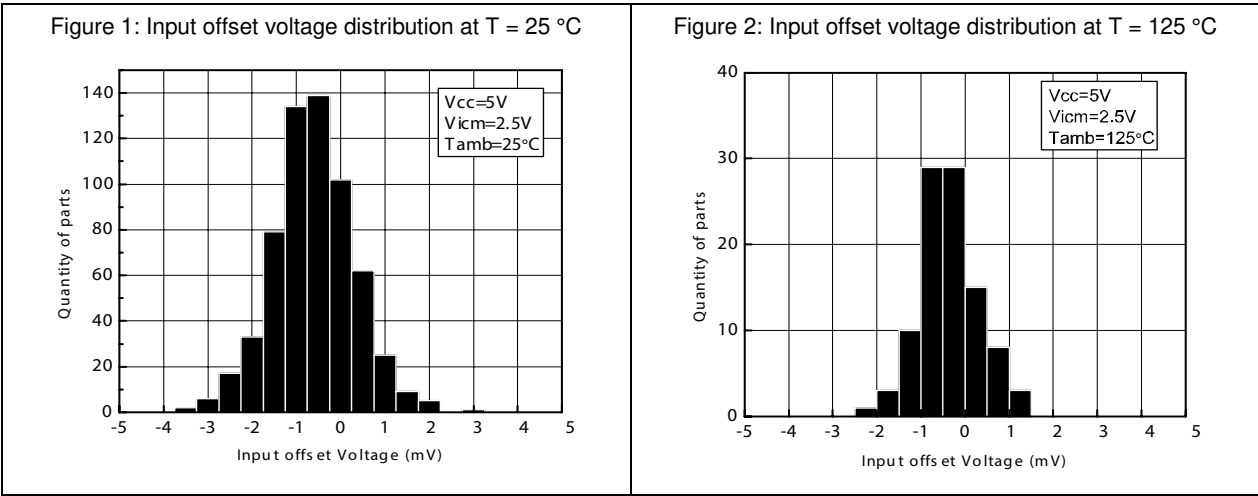
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TSV994A

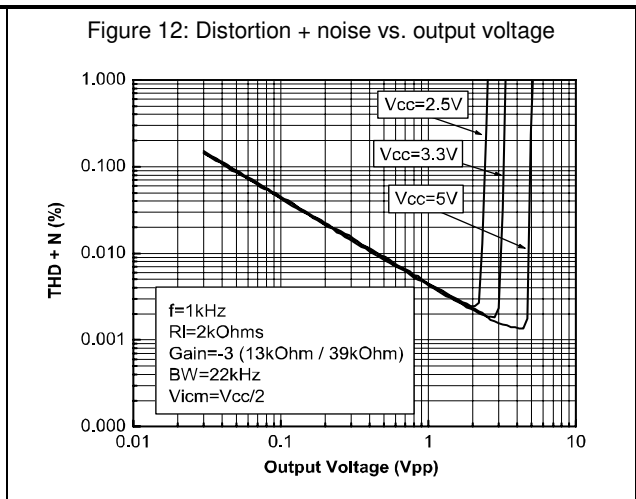
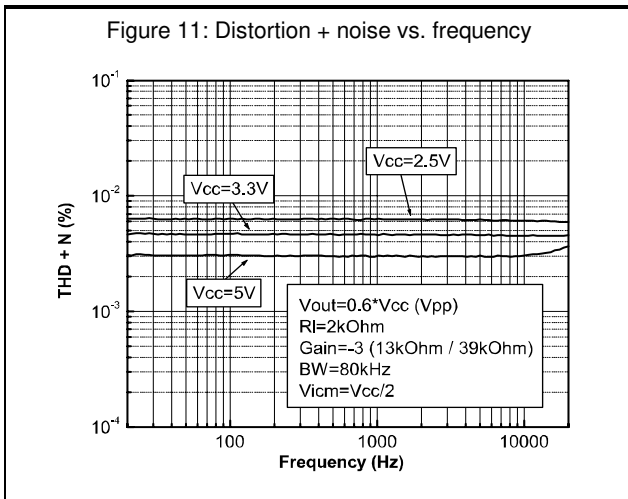
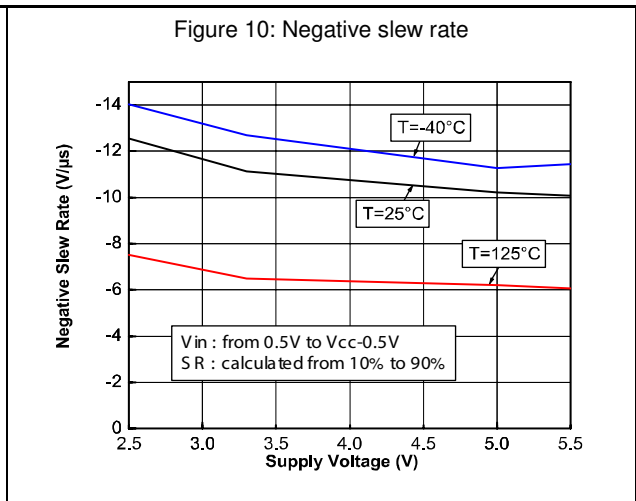
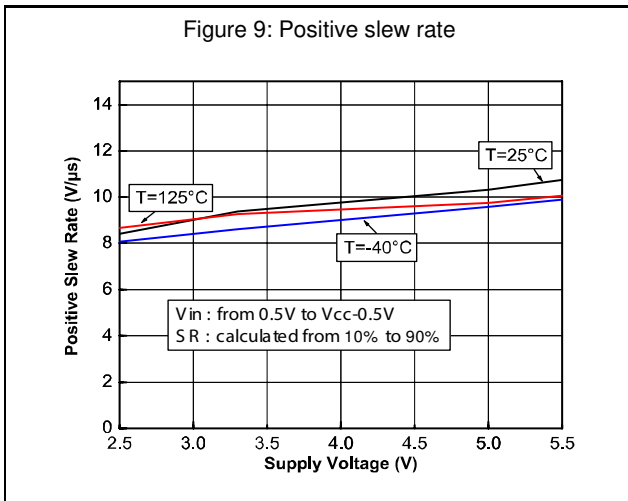
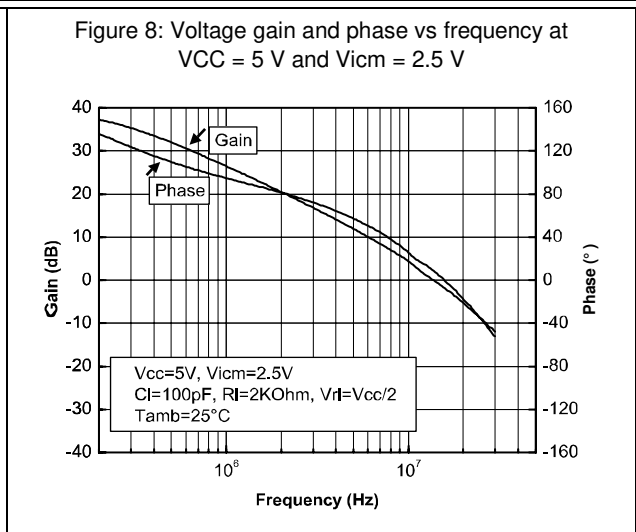
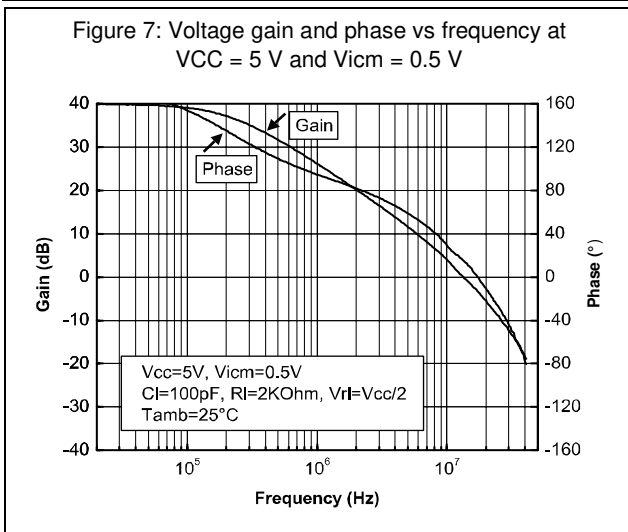
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
SR	Slew rate	$R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $f = 100\text{ kHz}$, $T_{op} = 25\text{ }^\circ\text{C}$		10		V/ μs
e_n	Equivalent input noise voltage	$f = 10\text{ kHz}$, $T_{op} = 25\text{ }^\circ\text{C}$		21		nV/ $\sqrt{\text{Hz}}$
THD+N	Total harmonic distortion	$G = -3$, $f = 1\text{ kHz}$, $R_L = 2\text{ k}\Omega$, $Bw = 22\text{ kHz}$, $V_{icm} = V_{CC}/2$, $V_{out} = 4.4\text{ V}_{pp}$, $T_{op} = 25\text{ }^\circ\text{C}$		0.0014		%

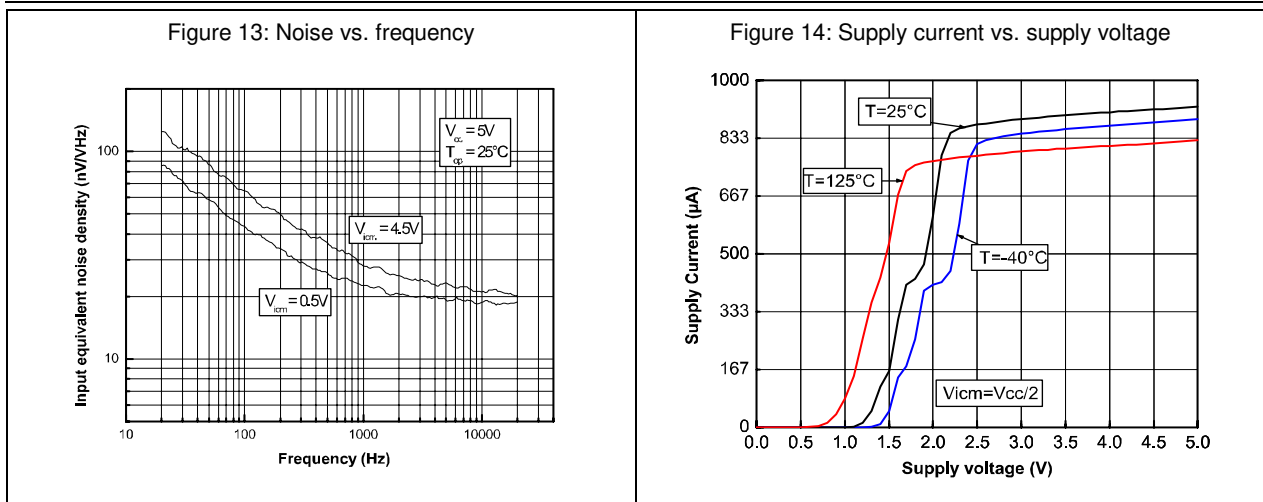
Notes:

⁽¹⁾Guaranteed by design

3 Electrical characteristic curves







4 Application information

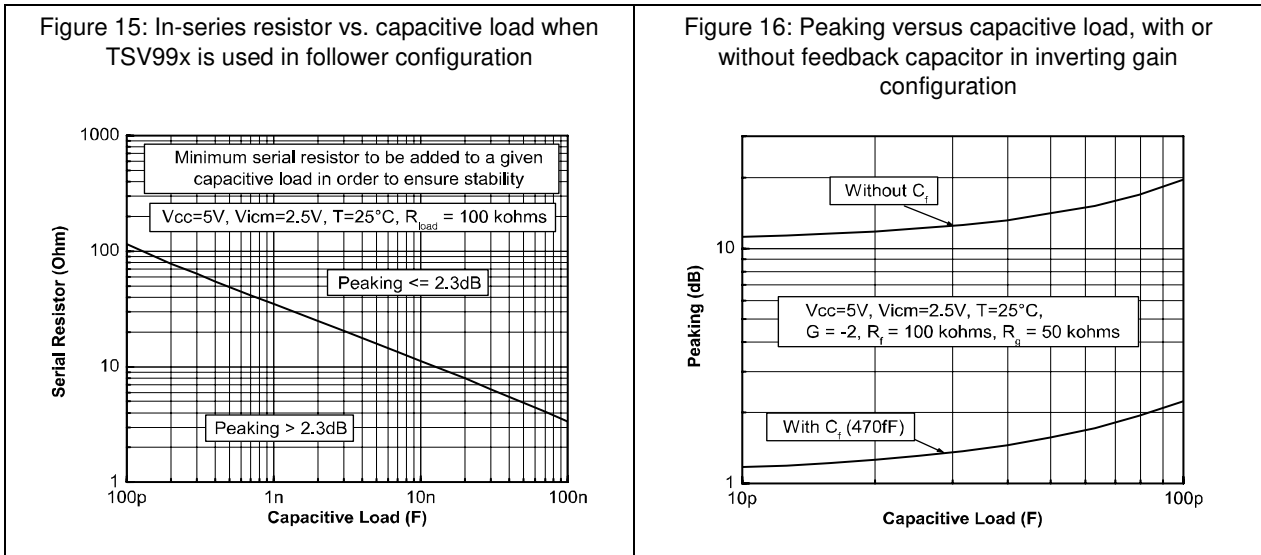
4.1 Driving resistive and capacitive loads

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

TSV99x products are not unity gain stable. To ensure proper stability they must be used in a gain configuration, with a minimum gain of -3 or 4.

However, they can be used in a “*follower*” configuration by adding a small, in-series resistor at the output, which drastically improves the stability of the device (*Figure 15* 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 the bench and simulated with the simulation model.

Another way to improve stability and reduce peaking is to add a capacitor in parallel with the feedback resistor. As shown in *Figure 16*, the feedback capacitor drastically reduces the peaking versus capacitive load (inverting gain configuration, gain = -2).



4.2 PCB layouts

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

4.3 Macromodel

An accurate macromodel of the TSV99x is available on STMicroelectronics’ web site at www.st.com. This model is a trade-off between accuracy and complexity (that is, time simulation) of the TSV99x 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, *however, it does not replace on-board measurements*

5 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.

5.1 SOT23-5 package information

Figure 17: SOT23-5 package outline

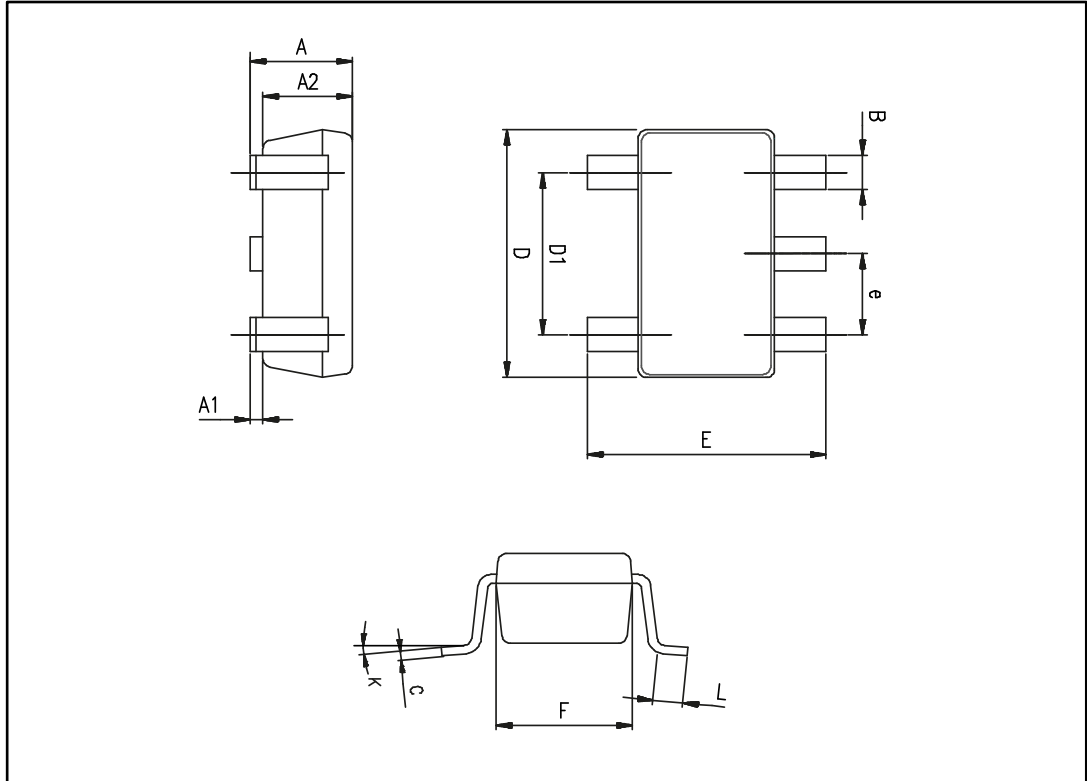


Table 6: SOT23-5 mechanical data

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

5.2 DFN8 2 x 2 package information

Figure 18: DFN8 2 x 2 package outline

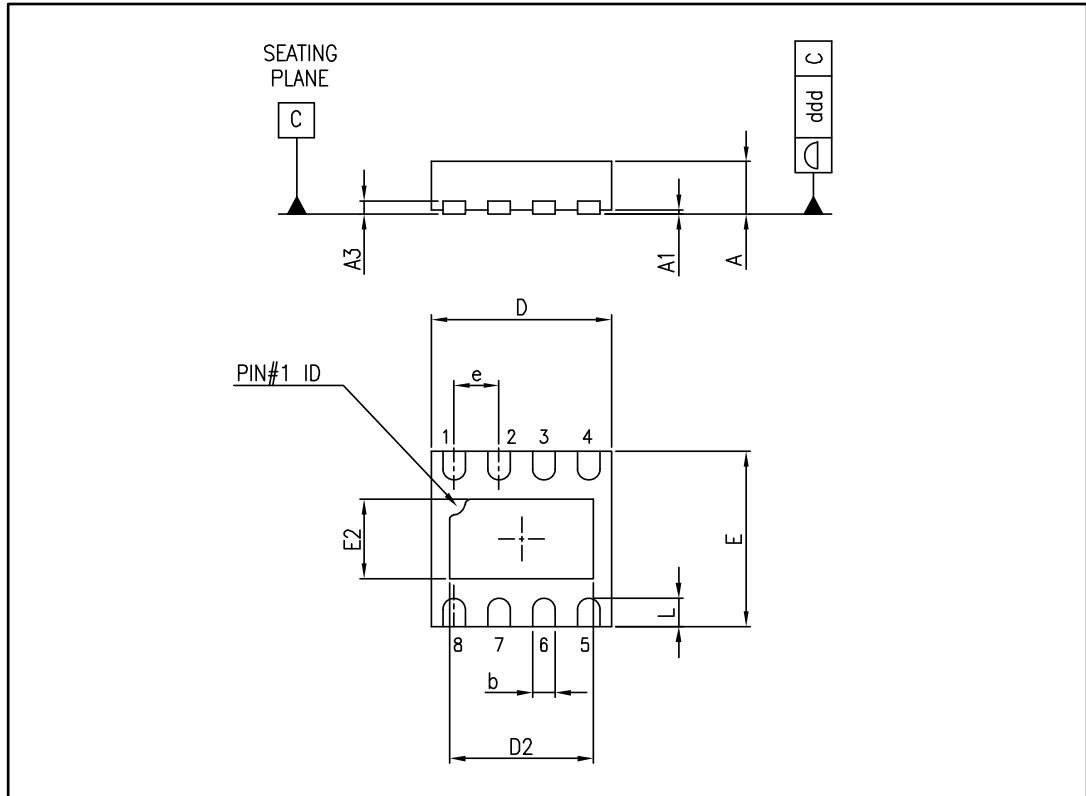
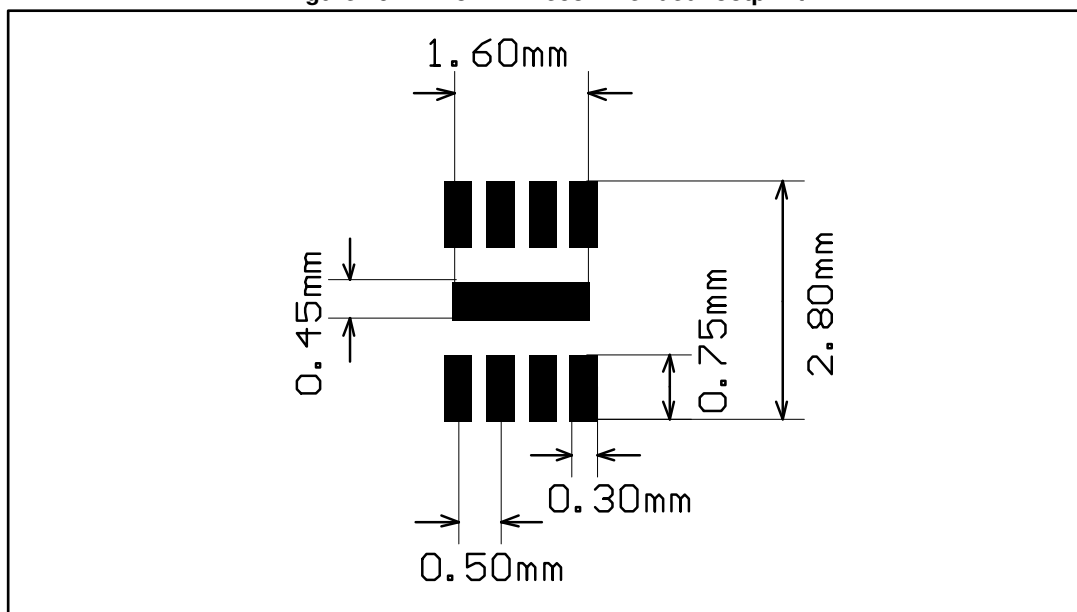


Table 7: DFN8 2 x 2 mechanical data

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 19: DFN8 2 x 2 recommended footprint



The exposed pad of the DFN8 2x2 package is not internally connected. It can be set to ground.

5.3 DFN6 1.3 x 1.6 x 0.55 package information

Figure 20: DFN6 1.3 x 1.6 x 0.55 package outline

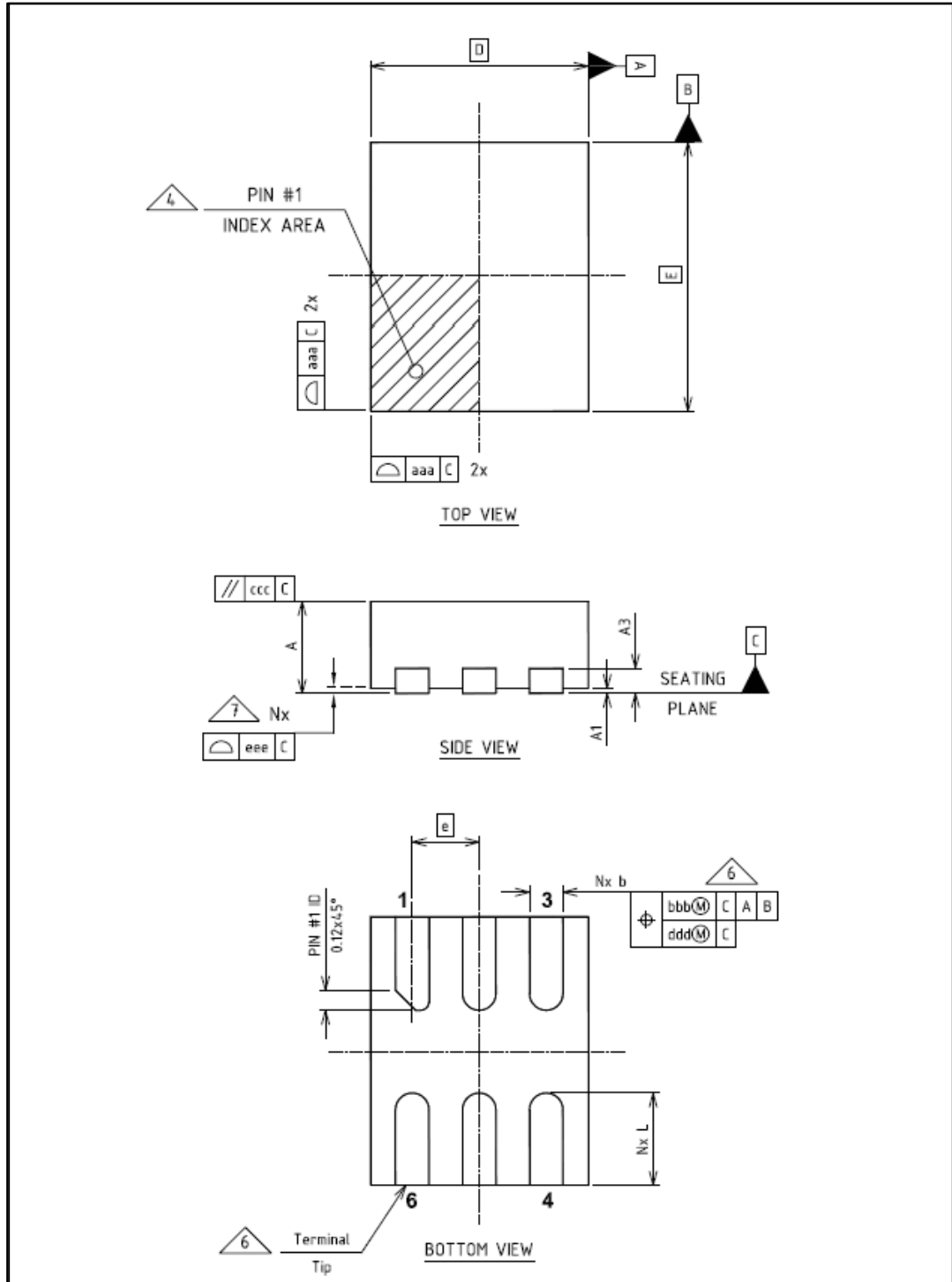
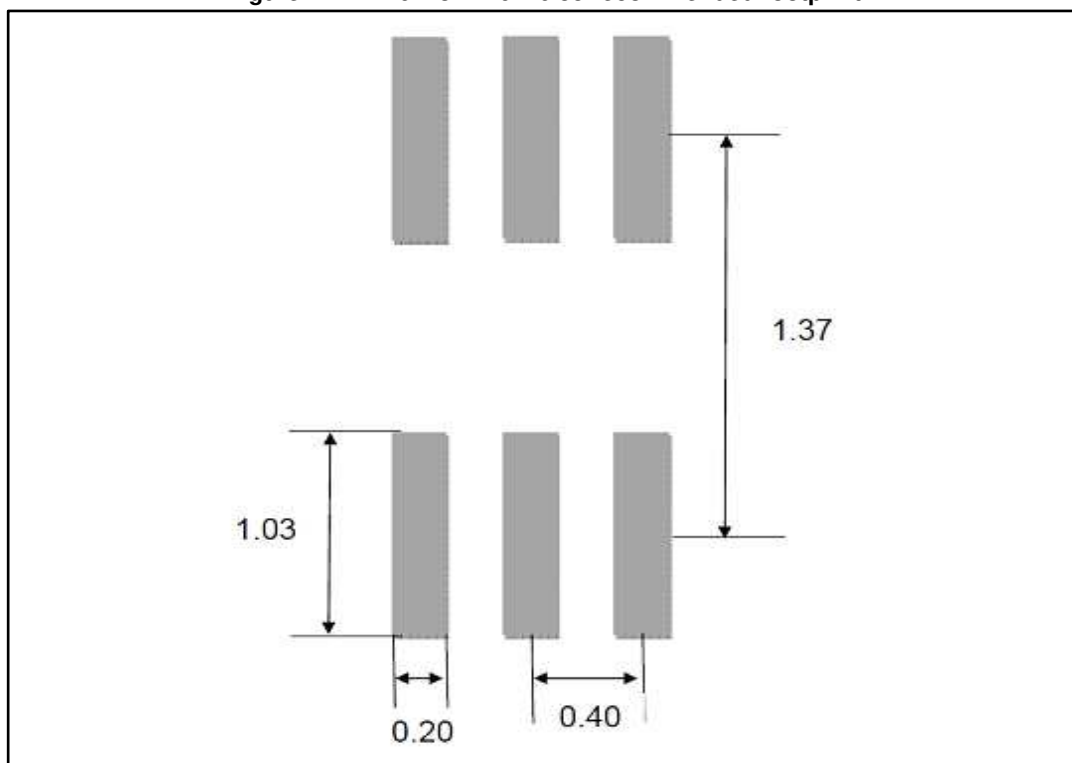


Table 8: DFN6 1.3 x 1.6 x 0.55 mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.50	0.55	0.60	0.020	0.022	0.024
A1	0.00	0.02	0.05	0.000	0.001	0.002
A3		0.15			0.006	
B	0.15	0.20	0.25	0.006	0.008	0.010
D		1.30			0.051	
E		1.60			0.063	
e		0.40			0.016	
L	0.453	0.553	0.653	0.018	0.022	0.026
N		6			0.236	
aaa		0.05			0.002	
bbb		0.07			0.003	
ccc		0.10			0.004	
ddd		0.05			0.002	
eee		0.08			0.003	

Figure 21: DFN6 1.3 x 1.6 x 0.55 recommended footprint



5.4 MiniSO8 package information

Figure 22: MiniSO8 package outline

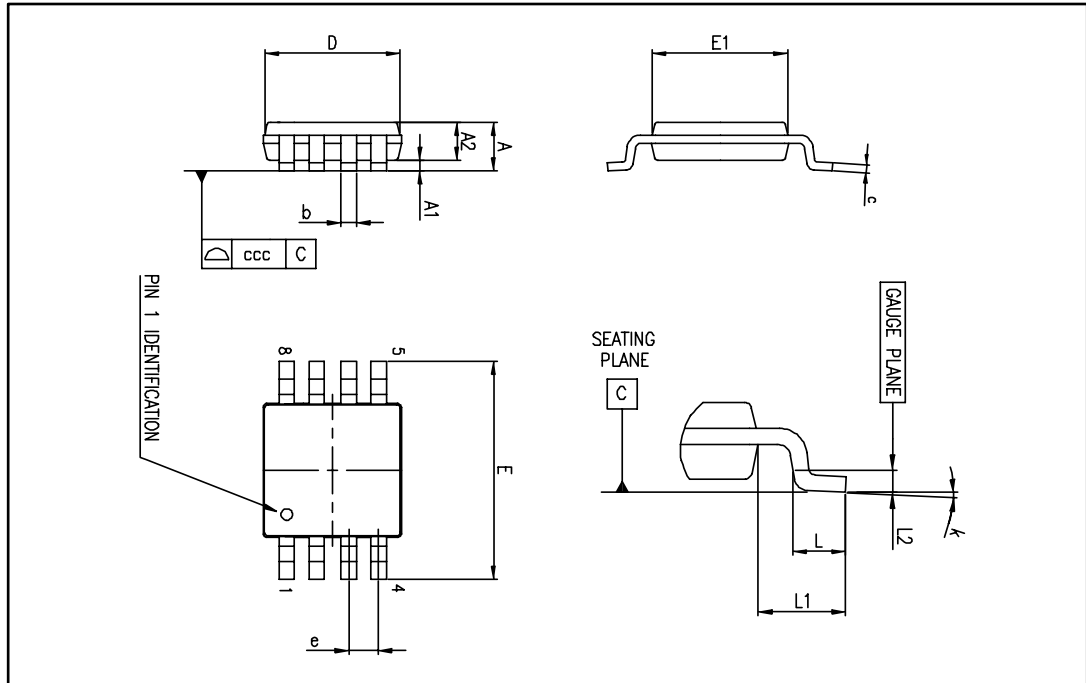


Table 9: MiniSO8 mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.1			0.043
A1	0		0.15	0		0.006
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

5.5 SO8 package information

Figure 23: SO8 package outline

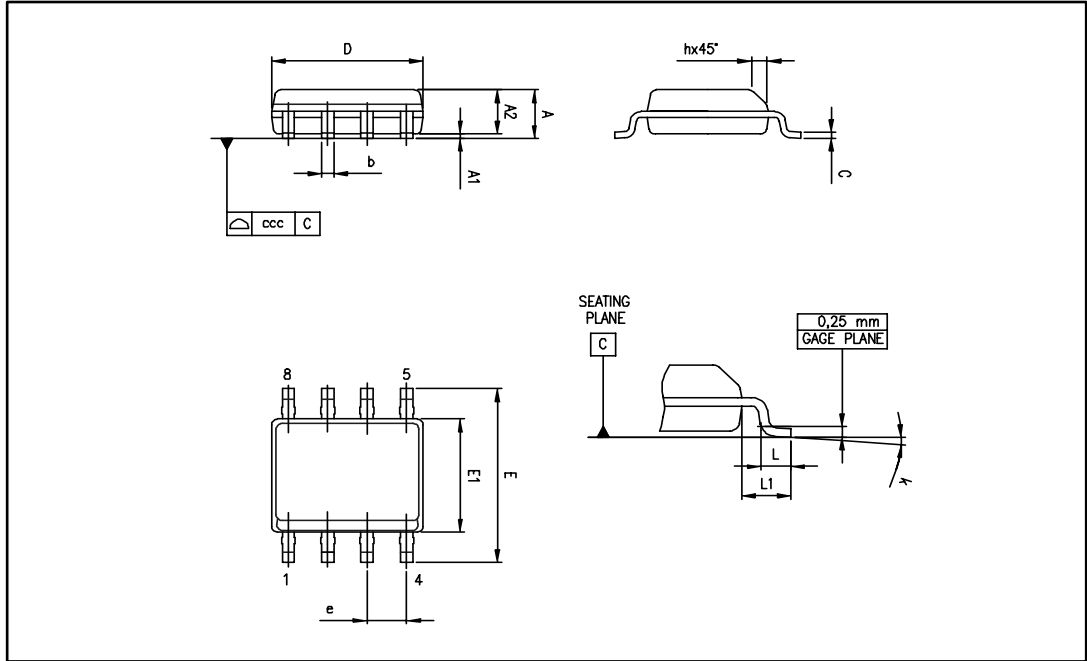


Table 10: SO8 mechanical data

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	1°		8°	1°		8°
ccc			0.10			0.004

5.6 SO14 package information

Figure 24: SO14 package outline

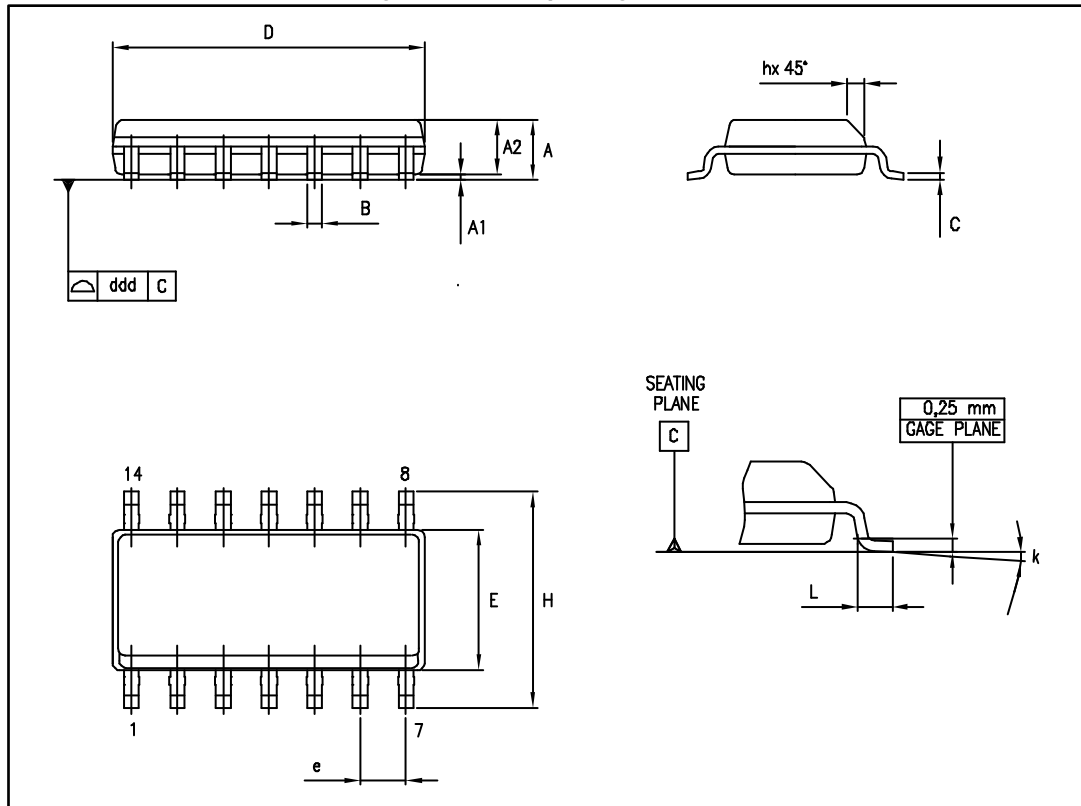


Table 11: SO14 mechanical data

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

5.7 TSSOP14 package information

Figure 25: TSSOP14 package outline

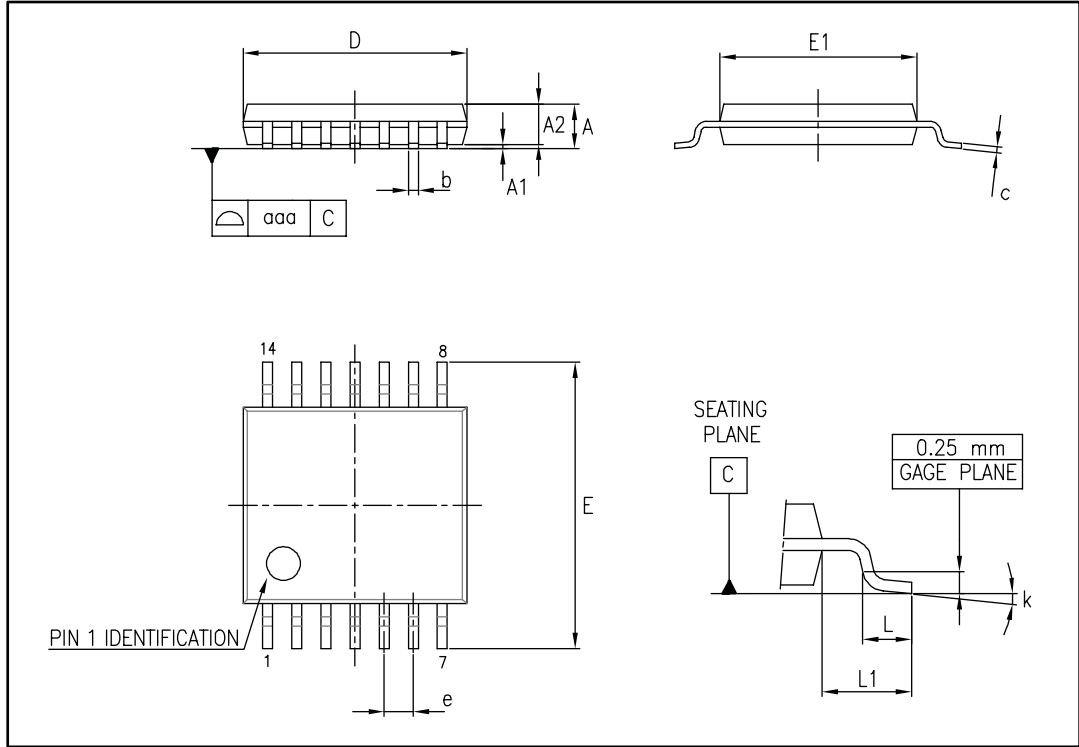


Table 12: TSSOP14 mechanical data

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 Ordering information

Table 13: Order codes

Order code	Temperature range	Package	Packing	Marking
TSV991ILT	-40 °C to 125 °C	SOT23-5	Tape and reel	K130
TSV991AILT				K129
TSV991IQ2T		DFN8 2x2		K1F
TSV991AIQ2T				K1E
TSV991AIQ1T		DFN6 1.3x1.6x0.55		K5
TSV992IST		MiniSO8		K132
TSV992AIST				K135
TSV992IDT		SO8		V992I
TSV992AIDT				V992AI
TSV994IPT		TSSOP14		V994I
TSV994AIPT				V994AI
TSV994IDT		SO14		V994I
TSV994AIDT				V994AI
TSV991IYLT ⁽¹⁾	-40 °C to 125 °C automotive grade	SOT23-5	K149	
TSV991AIYLT ⁽¹⁾			K150	
TSV992IYDT ⁽¹⁾		SO8	V992IY	
TSV992AIYDT ⁽¹⁾			V992AY	
TSV992IYST ⁽¹⁾		MiniSO8	K149	
TSV992AIYST ⁽¹⁾			K150	
TSV994IYDT ⁽¹⁾		SO14	V994IY	
TSV994AIYDT ⁽¹⁾			V994AY	
TSV994IYPT ⁽¹⁾		TSSOP14	V994IY	
TSV994AIYPT ⁽¹⁾			V994AY	

Notes:

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



In the table above, all packages except the SO14 are "moisture sensitivity level 1" as per Jedec J-STD-020-C. SO14 is Jedec level 3.