TSV911-TSV912-TSV914

Rail-to-rail input/output 8MHz operational amplifiers

Features

- Rail-to-rail input and output
- Wide bandwidth
- Low power consumption: 1.1mA max.
- Unity gain stability
- High output current: 35mA
- Operating from 2.5V to 5.5V
- Low input bias current
- ESD Internal protection≥ 5kV
- Latch-up immunity

Description

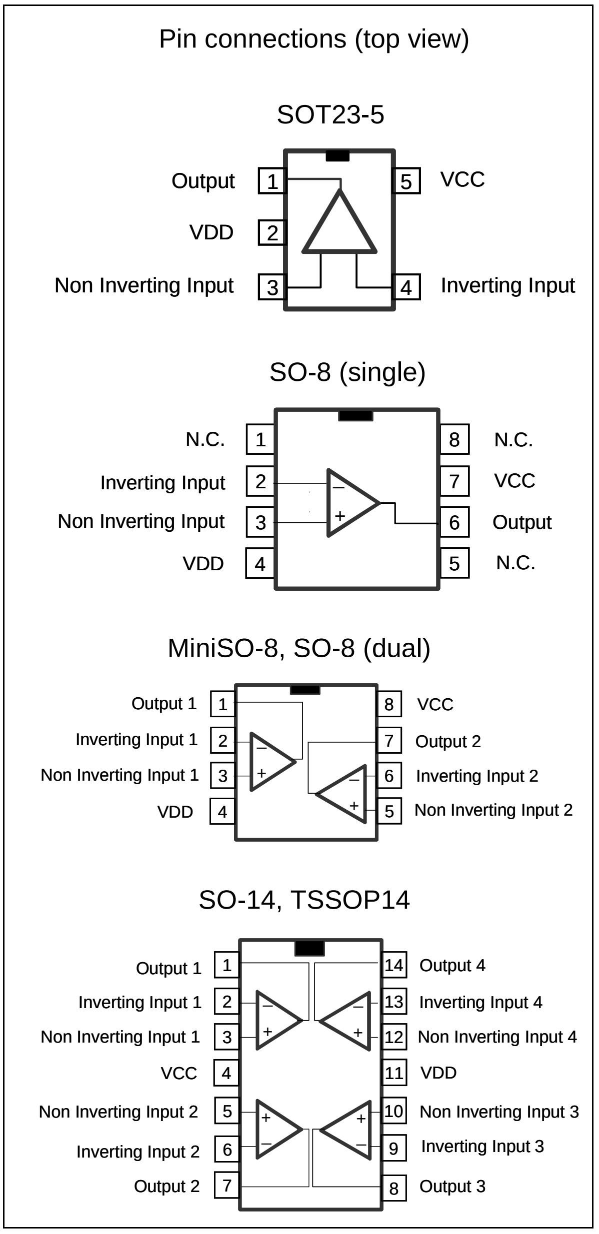
The TSV911/2/4 family of single, dual & quad operational amplifiers offers low voltage operation and rail-to-rail input and output.

This family features an excellent speed/power consumption ratio, offering an 8MHz gain-bandwidth product while consuming only 1.1mA max at 5V supply voltage. These op-amps are unity gain stable for capacitive loads up to 200pF. They also feature an ultra-low input bias current.

These characteristics make the TSV911/2/4 family ideal for sensor interfaces, battery-supplied and portable applications, as well as active filtering.

Applications

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



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2 Absolute maximum ratings & 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
V_{in}	Input voltage (3)	V_{DD}-0.2 to V_{CC}+0.2	V
T_{stg}	Storage temperature	-65 to +150	°C
R_{thja}	Thermal resistance junction to ambient(4) (5)	-	°C/W
	SOT23-5	250	
	SO-8	125	
	MiniSO-8	190	
	SO-14	103	
	TSSOP14	100	
R_{thjc}	Thermal resistance junction to case	-	°C/W
	SOT23-5	81	
	SO-8	40	
	MiniSO8	39	
	SO14	31	
	TSSOP14	32	
T_j	Maximum junction temperature	150	°C
ESD	HBM: human body model(6)	5	kV
	MM: machine model(7)	300	V
	CDM: charged device model(8)	1.5	kV
	Latch-up immunity	200	mA

1. All voltage values, except 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. Vcc-Vin must not exceed 6V.
4. Short-circuits can cause excessive heating and destructive dissipation.
5. Rth are typical values.
6. Human body model: 100pF discharged through a 1.5kΩ resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
7. Machine model: a 200pF cap is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5Ω), done for all couples of pin combinations with other pins floating.
8. Charge device model: all pins plus package 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_{DD} -0.1 to V_{CC} +0.1	V
T_{oper}	Operating free air temperature range	-40 to +125	°C

3 Electrical characteristics

Table 3. Electrical characteristics at V_{CC} = +2.5V

V_{DD} = 0V, V_{icm} = V_{CC}/2, T_{amb} = 25°C, R_L connected to V_{cc}/2 (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Offset voltage TSV91x		-	0.1	4.5	mV
		$T_{min.} < T_{op} < T_{max.}$	-	-	7.5	
	TSV91xA		-	-	1.5	
		$T_{min.} < T_{op} < T_{max.}$	-	-	3	
DV_{io}/DT	Input offset voltage drift		-	2	-	µV/°C
I_{io}	Input offset current ($V_{out} = V_{cc}/2$)		-	1	10(1)	pA
I_{ib}	Input bias current ($V_{out} = V_{cc}/2$)		-	1	10(1)	pA
CMR	Common Mode rejection ratio 20 log ($\Delta V_{ic}/\Delta V_{io}$)	0V to 2.5V, V_{out} = 1.25V	58	75	-	dB
A_{vd}	Large signal voltage gain	R_L= 10kΩ, Vout= 0.5V to 2V	80	89	-	dB
Vcc-V_{OH}	High level output voltage	R_L = 10kΩ R_L = 600Ω		15 45	40 150	mV
V_{OL}	Low level output voltage	R_L = 10kΩ R_L = 600Ω	-	15 45	40 150	mV
I_{out}	Isink	V_o = 2.5V	18	32	-	mA
		$T_{min.} < T_{amb} < T_{max.}$	16	-	-	
	Isource	V_o = 0V	18	35	-	
		$T_{min.} < T_{amb} < T_{max.}$	16	-	-	
I_{CC}	Supply current (per operator)	No load, $V_{out}=V_{cc}/2$	-	0.78	1.1	mA
		$T_{min.} < T_{op} < T_{max.}$	-	-	1.1	
AC performance						
GBP	Gain bandwidth product	R_L = 2kΩ, C_L = 100pF, f = 100kHz	-	8	-	MHz
F_u	Unity gain frequency	R_L = 2kΩ, C_L = 100pF,		7.2		MHz
ϕm	Phase margin	R_L = 2kΩ, C_L = 100pF	-	45	-	Degrees
G_m	Gain margin	R_L = 2kΩ, C_L = 100pF	-	8	-	dB
SR	Slew rate	R_L = 2kΩ, C_L = 100pF, Av=1	-	4.5	-	V/µs

Table 3. Electrical characteristics at V_{CC} = +2.5V

V_{DD} = 0V, V_{icm} = V_{CC}/2, T_{amb} = 25°C, R_L connected to V_{cc}/2 (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
e_n	Equivalent input noise voltage	f=10kHz	-	27	-	$\frac{nV}{\sqrt{Hz}}$
THD+e_n	Total harmonic distortion	G=1, f=1kHz, Rl=2kΩ, BW=22kHz, Vicm=(Vcc+1)/2, Vout=1.1Vpp	-	0.001	-	%

1. Guaranteed by design.

Table 4. Electrical characteristics at V_{CC} = +3.3V

V_{DD} = 0V, V_{icm} = V_{CC}/2, T_{amb} = 25°C, R_L connected to V_{cc}/2 (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Offset voltage TSV91x		-	0.1	4.5	mV
		$T_{min.} < T_{op} < T_{max.}$	-	-	7.5	
	TSV91xA		-	-	1.5	
		$T_{min.} < T_{op} < T_{max.}$	-	-	3	
DV_{io}	Input offset voltage drift		-	2	-	µV/°C
I_{io}	Input offset current		-	1	10(1)	pA
I_{ib}	Input bias current		-	1	10(1)	pA
CMR	Common mode rejection ratio 20 log ($\Delta V_{ic}/\Delta V_{io}$)	0V to 3.3V, V_{out} = 1.65V	60	78	-	dB
A_{vd}	Large signal voltage gain	R_L=10kΩ, Vout= 0.5V to 2.8V	80	90	-	dB
Vcc-V_{OH}	High level output voltage	R_L = 10kΩ R_L = 600Ω		15 45	40 150	mV
V_{OL}	Low level output voltage	R_L = 10kΩ R_L = 600Ω	-	15 45	40 150	mV
I_{out}	Isink	V_o = 3.3V	18	32	-	mA
		$T_{min.} < T_{amb} < T_{max.}$	16	-	-	
	Isource	V_o = 0V	18	35	-	
		$T_{min.} < T_{amb} < T_{max.}$	16	-	-	
I_{CC}	Supply current (per operator)	No load, V_{out}=V_{cc}/2	-	0.8	1.1	mA
		$T_{min.} < T_{op} < T_{max.}$	-	-	1.1	
AC performance						
GBP	Gain bandwidth product	R_L = 2kΩ, C_L = 100pF, f = 100kHz	-	8	-	MHz
F_u	Unity gain frequency	R_L = 2kΩ, C_L=100pF	-	7.2	-	MHz

Table 4. Electrical characteristics at V_{CC} = +3.3V

V_{DD} = 0V, V_{icm} = V_{CC}/2, T_{amb} = 25°C, R_L connected to V_{cc}/2 (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
ϕm	Phase margin	R_L = 2kΩ, C_L = 100pF, f = 100kHz	-	45	-	Degrees
G_m	Gain margin	R_L = 2kΩ, C_L = 100pF, f = 100kHz	-	8	-	dB
SR	Slew rate	R_L = 2kΩ, C_L = 100pF, f = 100kHz, Av=1	-	4.5	-	V/μs
e_n	Equivalent input noise voltage	f=10kHz	-	27	-	$\frac{nV}{\sqrt{Hz}}$
THD+e_n	Total harmonic distortion	G=1, f=1kHz, Rl=2kΩ, BW=22kHz, Vicm=(Vcc+1)/2, Vout=1.9Vpp	-	0.0007	-	%

1. Guaranteed by design.

Table 5. Electrical characteristics at V_{CC} = +5V

V_{DD} = 0V, V_{icm} = V_{CC}/2, T_{amb} = 25°C, R_L connected to V_{cc}/2 (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Offset voltage TSV91x		-	0.1	4.5	mV
		$T_{min.} < T_{op} < T_{max.}$	-	-	7.5	
	TSV91xA		-	-	1.5	
		$T_{min.} < T_{op} < T_{max.}$	-	-	3	
DV_{io}	Input offset voltage drift		-	2	-	μV/°C
I_{io}	Input offset current		-	1	10(1)	pA
I_{ib}	Input bias current		-	1	10(1)	pA
CMR	Common mode rejection ratio 20 log ($\Delta V_{ic}/\Delta V_{io}$)	0V to 5V, V_{out} = 2.5V	62	82	-	dB
SVR	Supply voltage rejection ratio 20 log ($\Delta V_{cc}/\Delta V_{io}$)	Vcc = 2.5 to 5V	70	86	-	dB
A_{vd}	Large signal voltage gain	R_L=10kΩ, Vout= 0.5V to 4.5V	80	91	-	dB
Vcc-V_{OH}	High level output voltage	R_L = 10kΩ R_L = 600Ω		15 45	40 150	mV
V_{OL}	Low level output voltage	R_L = 10kΩ R_L = 600Ω	-	15 45	40 150	mV
I_{out}	Isink	V_o = 5V	18	32	-	mA
		$T_{min.} < T_{amb} < T_{max.}$	16	-	-	
	Isource	V_o = 0V	18	35	-	
		$T_{min.} < T_{amb} < T_{max.}$	16	-	-	

Table 5. Electrical characteristics at V_{CC} = +5V

V_{DD} = 0V, V_{icm} = $V_{CC}/2$, T_{amb} = 25°C, R_L connected to $V_{cc}/2$ (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
I_{CC}	Supply current (per operator)	No load, V_{out}=2.5V	-	0.82	1.1	mA
		$T_{min.} < T_{op} < T_{max.}$	-	-	1.1	
AC performance						
GBP	Gain bandwidth product	R_L = 2kΩ, C_L = 100pF, f = 100kHz	-	8	-	MHz
F_u	Unity gain frequency	R_L = 2kΩ, C_L=100pF	-	7.5	-	MHz
ϕm	Phase margin	R_L = 2kΩ, C_L=100pF	-	45	-	Degrees
G_m	Gain margin	R_L = 2kΩ, C_L=100pF	-	8	-	dB
SR	Slew rate	R_L = 2kΩ, C_L = 100pF, A_V = 1	-	4.5	-	V/μs
e_n	Equivalent input noise voltage	f=10kHz	-	27	-	$\frac{nV}{\sqrt{Hz}}$
THD+e_n	Total harmonic distortion	G=1, f=1kHz, Rl=2kΩ, BW=22kHz, Vicm=(Vcc+1)/2, Vout=3.6Vpp	-	0.0004	-	%

1. Guaranteed by design.

Figure 1. Input offset voltage distribution at T=25°C

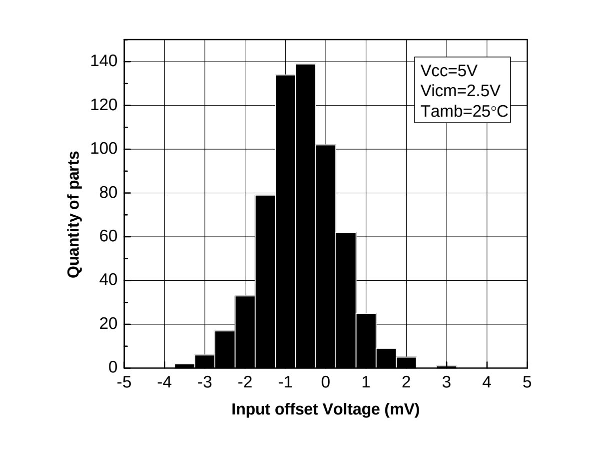


Figure 2. Input offset voltage distribution at T=125°C

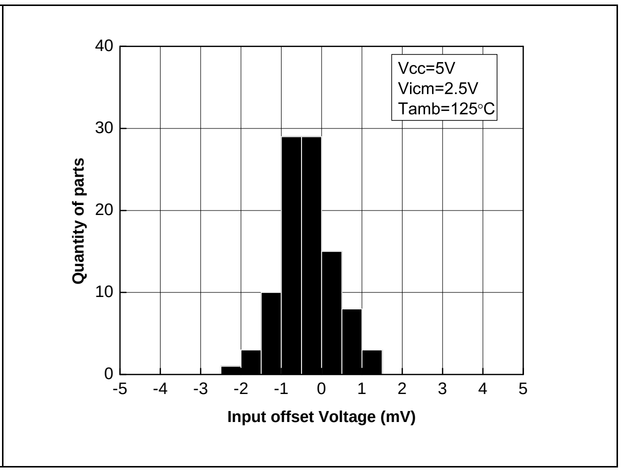


Figure 3. Supply current vs. input common mode voltage at Vcc=2.5V

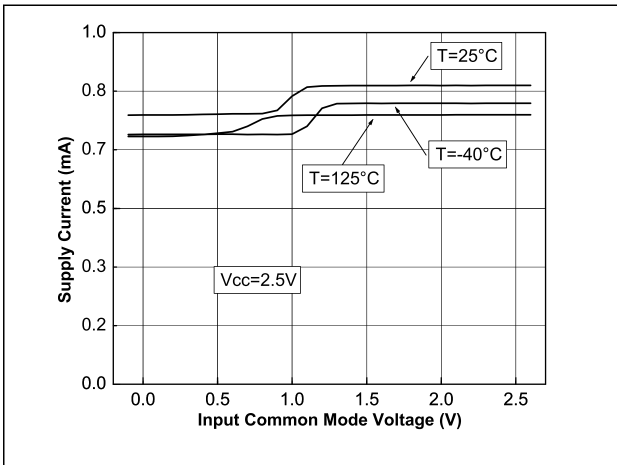


Figure 4. Supply current vs. input common mode voltage at Vcc=5V

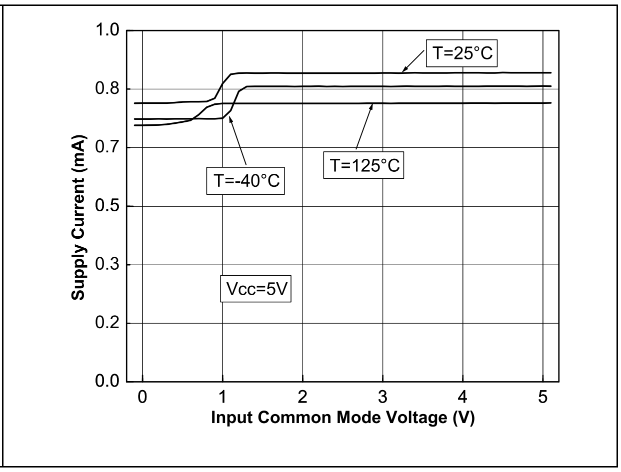


Figure 5. Output current vs. output voltage at Vcc=2.5V

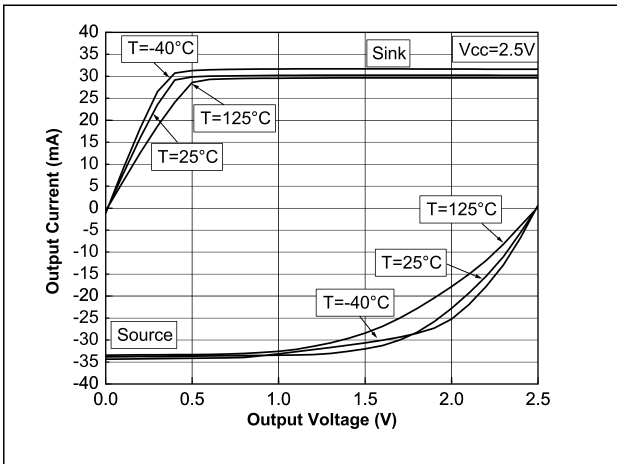


Figure 6. Output current vs. output voltage at Vcc=5V

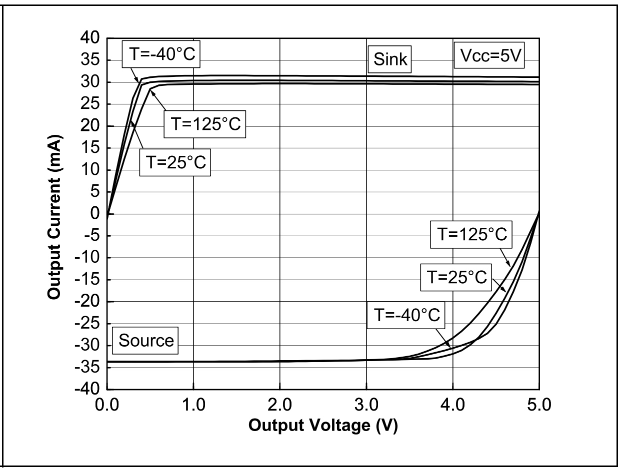


Figure 7. Voltage gain and phase vs frequency at Vcc=2.5V and Vicm=0.5V

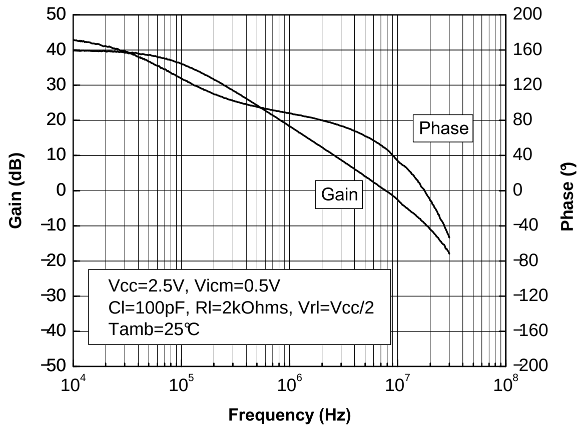


Figure 8. Voltage gain and phase vs frequency at Vcc=5.5V and Vicm=0.5V

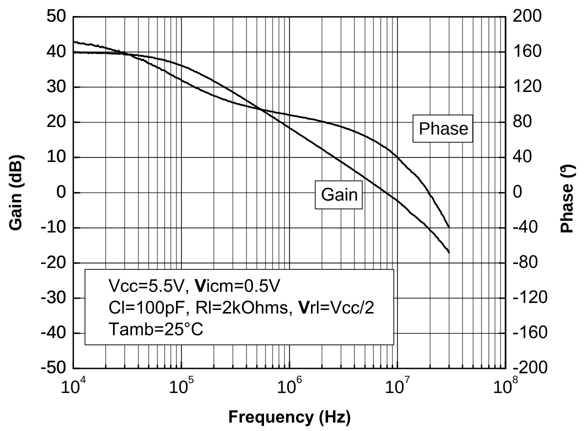


Figure 9. Phase margin vs.capacitive load

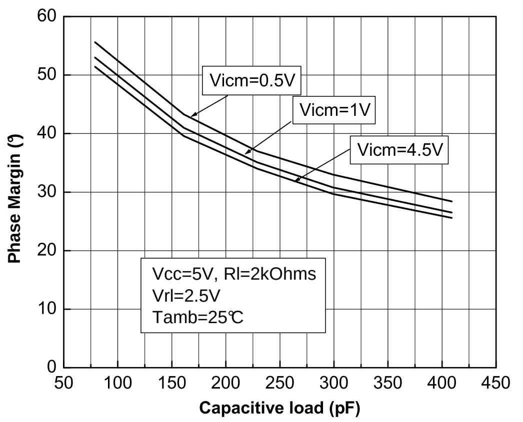


Figure 10. Phase margin vs.output current

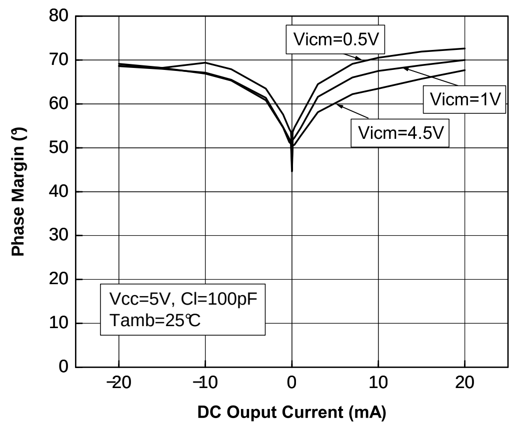


Figure 11. Positive slew rate

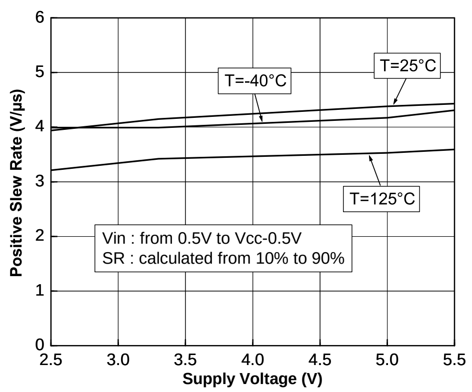


Figure 12. Negative slew rate

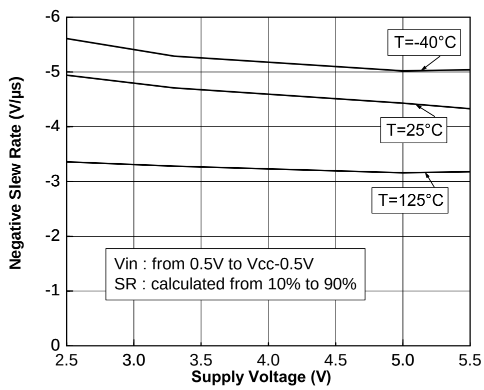


Figure 13. Distorsion + noise vs. frequency

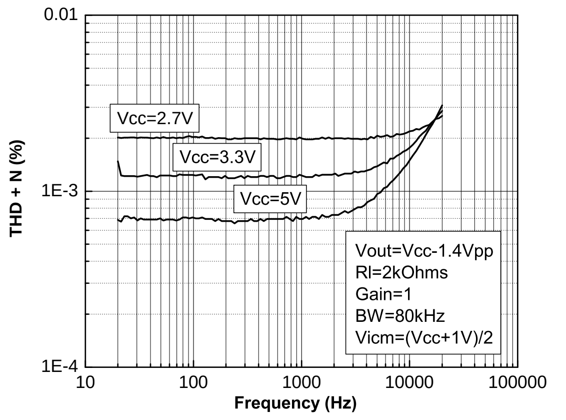


Figure 14. Distorsion + noise vs. output voltage

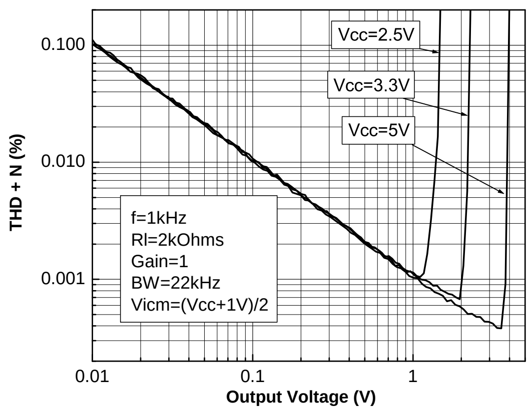
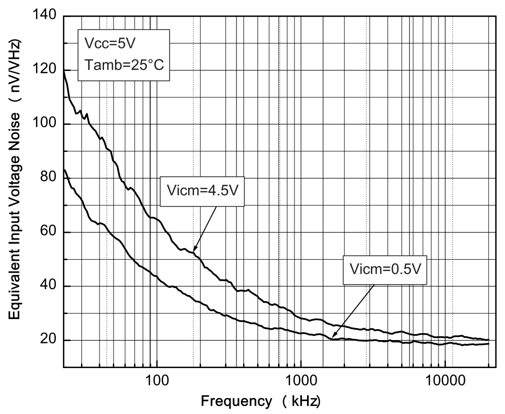


Figure 15. Noise vs. frequency



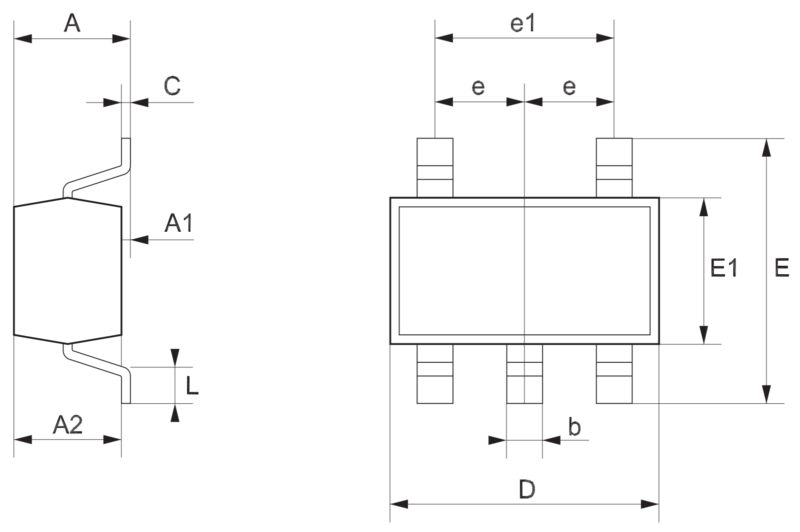
4 Package mechanical data

In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an STMicroelectronics trademark. ECOPACK specifications are available at: www.st.com.

4.1 SOT23-5 package

SOT23-5L MECHANICAL DATA

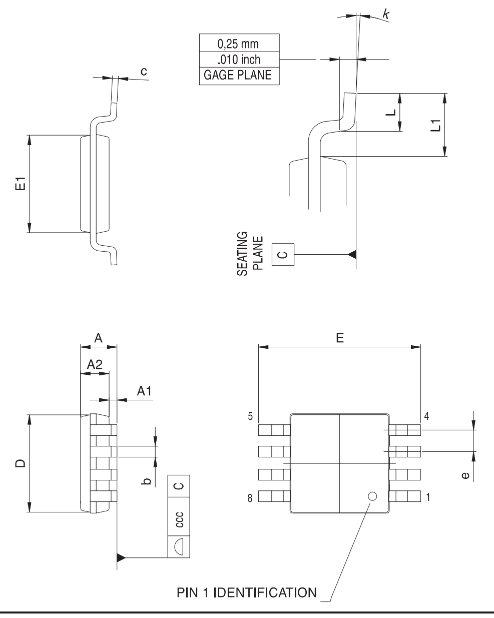
DIM.	mm.			mils		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	0.90		1.45	35.4		57.1
A1	0.00		0.15	0.0		5.9
A2	0.90		1.30	35.4		51.2
b	0.35		0.50	13.7		19.7
C	0.09		0.20	3.5		7.8
D	2.80		3.00	110.2		118.1
E	2.60		3.00	102.3		118.1
E1	1.50		1.75	59.0		68.8
e		0 .95			37.4	
e1		1.9			74.8	
L	0.35		0.55	13.7		21.6



4.2 MiniSO-8 package

miniSO-8 MECHANICAL DATA

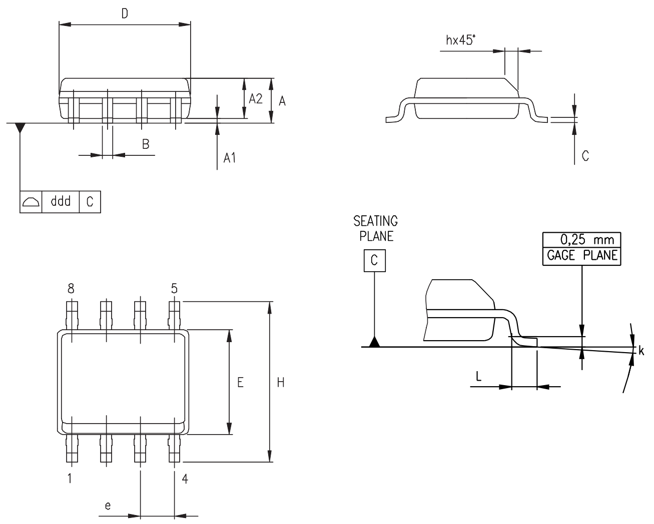
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.1			0.043
A1	0.05	0.10	0.15	0.002	0.004	0.006
A2	0.78	0.86	0.94	0.031	0.031	0.037
b	0.25	0.33	0.40	0.010	0.13	0.013
c	0.13	0.18	0.23	0.005	0.007	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	4.75	4.90	5.05	0.187	0.193	0.199
E1	2.90	3.00	3.10	.0114	0.118	0.122
e		0.65			0.026	
K	0°		6°	0°		6°
L	0.40	0.55	0.70	0.016	0.022	0.028
L1			0.10			0.004



4.3 SO-8 package

SO-8 MECHANICAL DATA

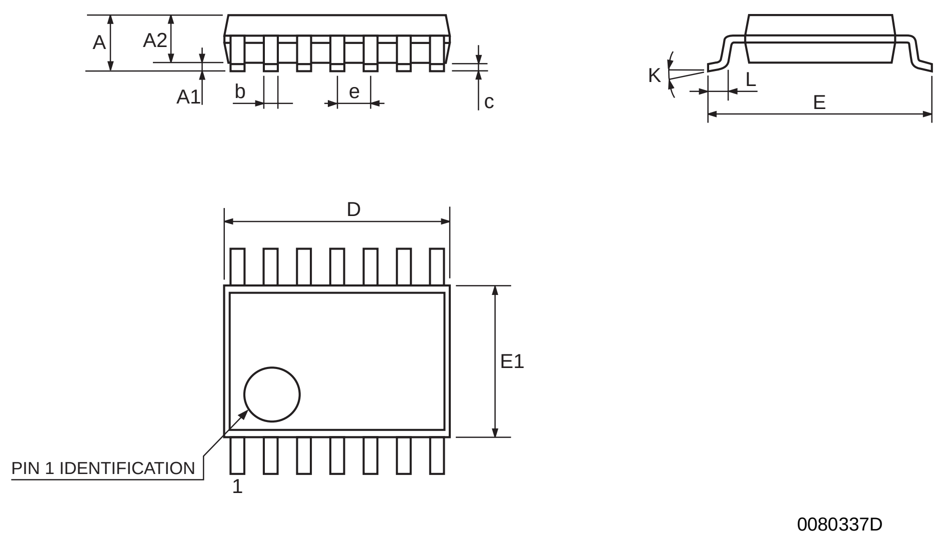
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.04		0.010
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.010
D	4.80		5.00	0.189		0.197
E	3.80		4.00	0.150		0.157
e		1.27			0.050	
H	5.80		6.20	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	8° (max.)					
ddd			0.1			0.04



0016023/C

4.4 TSSOP14 package

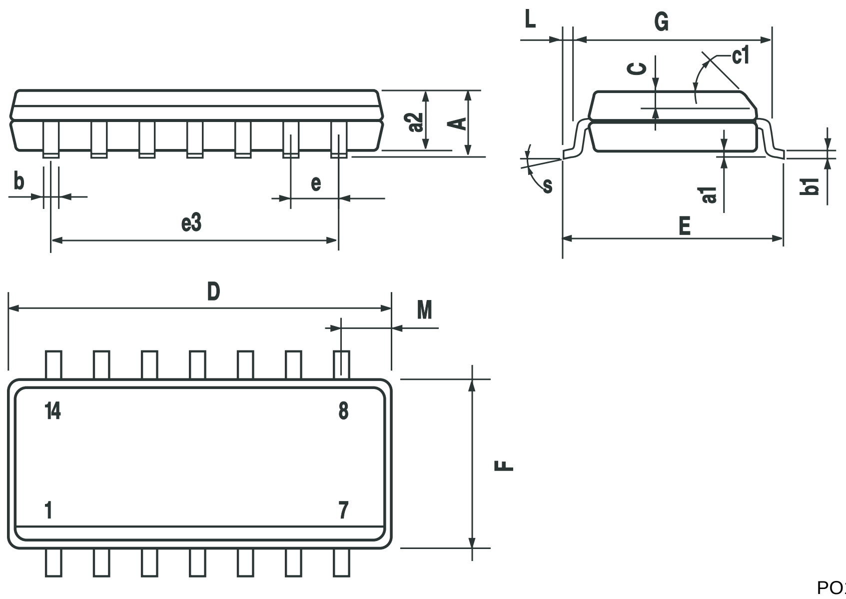
TSSOP14 MECHANICAL DATA						
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.2			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.8	1	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.0089
D	4.9	5	5.1	0.193	0.197	0.201
E	6.2	6.4	6.6	0.244	0.252	0.260
E1	4.3	4.4	4.48	0.169	0.173	0.176
e		0.65 BSC			0.0256 BSC	
K	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030



4.5 SO-14 package

SO-14 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.003		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.149		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.019		0.050
M			0.68			0.026
S	8° (max.)					



PO13G

5 Revision history

Table 6. Document revision history

Date	Revision	Changes
28-Aug-2006	1	First release.