



TSV611, TSV612

Rail-to-rail input/output 11 μA , 120 kHz CMOS operational amplifiers

Preliminary data

Features

- Rail-to-rail input and output
- Low power consumption: 11 μA typ at 5 V
- Low supply voltage: 1.5 to 5.5 V
- Gain bandwidth product: 120 kHz typ
- Unity gain stable
- Low input offset voltage: 1 mV max (A version)
- Low input bias current: 1 pA typ
- Temperature range: -40 to +85° C

Applications

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

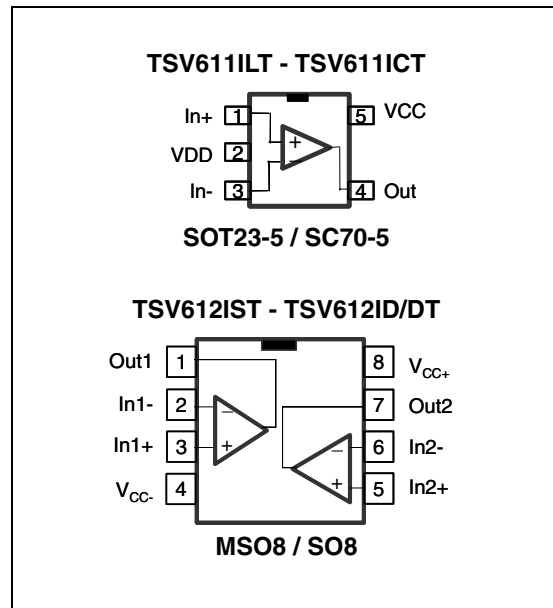
Description

The TSV61x family of single and dual operational amplifiers offers low voltage, low power operation and rail-to-rail input and output.

The devices also feature an ultra-low input bias current as well as a low input offset voltage.

The TSV61x have a gain bandwidth product of 120 kHz while consuming only 11 μA at 5 V.

These features make the TSV61x family ideal for sensor interfaces, battery-supplied and portable applications, as well as active filtering.



1 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

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⁾	$V_{CC} - 0.2$ 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
	SC70-5	205	
	SOT23-5	250	
	MiniSO-8	250	
	SO-8	125	
T_j	Maximum junction temperature	150	°C
ESD	HBM: human body model ⁽⁶⁾	4	kV
	MM: machine model ⁽⁷⁾	300	V
	CDM: charged device model ⁽⁸⁾	1.5	kV
	Latch-up immunity	200	mA

- All voltage values, except differential voltage are with respect to network ground terminal.
- Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
- V_{CC} - V_{in} must not exceed 6 V.
- Short-circuits can cause excessive heating and destructive dissipation.
- R_{th} are typical values.
- Human body model: 100 pF discharged through a 1.5 k Ω resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
- Machine model: a 200 pF cap is 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.
- Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to ground.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	1.5 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 +85	°C

2 Electrical characteristics

**Table 3. Electrical characteristics at $V_{CC+} = +1.8$ V
with $V_{CC-} = 0$ V, $V_{icm} = V_{CC}/2$, $T_{amb} = 25^{\circ}$ C, and R_L connected to $V_{CC}/2$
(unless otherwise specified)**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Offset voltage	TSV61x			5	mV
		TSV61xA			1	
		$T_{min.} < T_{op} < T_{max.}$ TSV61x			6	
		$T_{min.} < T_{op} < T_{max.}$ TSV61xA			2	
DV_{io}	Input offset voltage drift			2		$\mu V/^{\circ}C$
I_{io}	Input offset current ($V_{out} = V_{CC}/2$)			1	10	pA
		$T_{min.} < T_{op} < T_{max.}$		1	100	pA
I_{ib}	Input bias current ($V_{out} = V_{CC}/2$)			1	10	pA
		$T_{min.} < T_{op} < T_{max.}$		1	100	pA
CMR	Common mode rejection ratio $20 \log(\Delta V_{ic}/\Delta V_{io})$	0 V to 1.8 V, $V_{out} = 0.9$ V	55			dB
		$T_{min.} < T_{op} < T_{max.}$				dB
A_{vd}	Large signal voltage gain	$R_L = 10$ k Ω , $V_{out} = 0.5$ V to 1.3 V	tbd	87		dB
		$T_{min.} < T_{op} < T_{max.}$	tbd			dB
V_{OH}	High level output voltage	$R_L = 10$ k Ω $T_{min.} < T_{op} < T_{max.}$	35 50	3		mV
V_{OL}	Low level output voltage	$R_L = 10$ k Ω $T_{min.} < T_{op} < T_{max.}$		3	35 50	mV
I_{out}	Isink	$V_o = 1.8$ V $T_{min.} < T_{op} < T_{max.}$	5 5	10		mA
	Isource	$V_o = 0$ V $T_{min.} < T_{op} < T_{max.}$	5 5	10		
I_{CC}	Supply current (per operator)	No load, $V_{out} = V_{CC}/2$		8	12	μA
		$T_{min.} < T_{op} < T_{max.}$			12	μA
AC performance						
GBP	Gain bandwidth product	$R_L = 10$ k Ω , $C_L = 20$ pF, $f = 100$ kHz, $A_v = 1$		105		kHz
F_u	Unity gain frequency	$R_L = 10$ k Ω , $C_L = 20$ pF, $A_v = 1$		100		kHz
ϕ_m	Phase margin	$R_L = 10$ k Ω , $C_L = 20$ pF, $A_v = 1$		45		Degrees
G_m	Gain margin	$R_L = 10$ k Ω , $C_L = 20$ pF, $A_v = 1$		tbd		dB

**Table 3. Electrical characteristics at $V_{CC+} = +1.8\text{ V}$
with $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, $T_{amb} = 25^\circ\text{ C}$, and R_L connected to $V_{CC}/2$
(unless otherwise specified) (continued)**

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
SR	Slew rate	$R_L = 10\text{ k}\Omega$, $C_L = 20\text{ pF}$ $A_v = 1$, TSV61x		0.03		V/ μs
e_n	Equivalent input noise voltage	$f = 1\text{ kHz}$		156		$\frac{\text{nV}}{\sqrt{\text{Hz}}}$
THD+ e_n	Total harmonic distortion	tbd		tbd		%

Table 4. $V_{CC+} = +3.3\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, $T_{amb} = 25^\circ\text{ C}$,
 R_L connected to $V_{CC}/2$ (unless otherwise specified)

Symbol	Parameter		Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Offset voltage	TSV61x			5	mV
		TSV61xA			1	
		$T_{min} < T_{op} < T_{max}$ TSV61x			6	
		$T_{min} < T_{op} < T_{max}$ TSV61xA			2	
DV_{io}	Input offset voltage drift			2		$\mu\text{V}/^\circ\text{C}$
I_{io}	Input offset current			1	10	pA
		$T_{min.} < T_{op} < T_{max.}$		1	100	pA
I_{ib}	Input bias current			1	10	pA
		$T_{min.} < T_{op} < T_{max.}$		1	100	pA
CMR	Common mode rejection ratio $20 \log (\Delta V_{ic}/\Delta V_{io})$	0 V to 3.3 V, $V_{out} = 1.75\text{ V}$	60			dB
A_{vd}	Large signal voltage gain	$R_L = 10\text{ k}\Omega$, $V_{out} = 0.5\text{ V}$ to 2.8 V	tbd	93		dB
V_{OH}	High level output voltage	$R_L = 10\text{ k}\Omega$ $T_{min.} < T_{op} < T_{max.}$	35 50	3		mV
V_{OL}	Low level output voltage	$R_L = 10\text{ k}\Omega$ $T_{min.} < T_{op} < T_{max.}$		3	35 50	mV
I_{out}	Isink	$V_o = 5\text{ V}$ $T_{min.} < T_{op} < T_{max.}$	15	20		mA
	Isource	$V_o = 0\text{ V}$ $T_{min.} < T_{op} < T_{max.}$	15	20		
I_{CC}	Supply current (per operator)	No load, $V_{out} = 2.5\text{ V}$		10	14	μA
		$T_{min.} < T_{op} < T_{max.}$			14	μA
AC performance						
GBP	Gain bandwidth product	$R_L = 10\text{ k}\Omega$, $C_L = 20\text{ pF}$, $f = 100\text{ kHz}$, $A_v = 1$		110		kHz
F_u	Unity gain frequency	$R_L = 10\text{ k}\Omega$, $C_L = 20\text{ pF}$, $A_v = 1$		100		kHz
ϕ_m	Phase margin	$R_L = 10\text{ k}\Omega$, $C_L = 20\text{ pF}$, $A_v = 1$		tbd		Degrees
G_m	Gain margin	$R_L = 10\text{ k}\Omega$, $C_L = 20\text{ pF}$, $A_v = 1$		tbd		dB
SR	Slew rate	$R_L = 10\text{ k}\Omega$, $C_L = 20\text{ pF}$, $A_v = 1$		0.032		$\text{V}/\mu\text{s}$

Table 4. $V_{CC+} = +3.3\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, $T_{amb} = 25^\circ\text{ C}$,
 R_L connected to $V_{CC}/2$ (unless otherwise specified) (continued)

Symbol	Parameter		Min.	Typ.	Max.	Unit
e_n	Equivalent input noise voltage	$f = 1\text{ kHz}$		156		$\frac{\text{nV}}{\sqrt{\text{Hz}}}$
THD	Total harmonic distortion	tbd		tbd		%

Table 5. $V_{CC+} = +5\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, $T_{amb} = 25^\circ\text{ C}$, R_L connected to $V_{CC}/2$ (unless otherwise specified)

Symbol	Parameter		Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Offset voltage	TSV61x			5	mV
		TSV61xA			1	
		$T_{min} < T_{op} < T_{max}$ TSV61x			6	
		$T_{min} < T_{op} < T_{max}$ TSV61xA			2	
DV_{io}	Input offset voltage drift			2		$\mu\text{V}/^\circ\text{C}$
I_{io}	Input offset current			1	10	pA
		$T_{min.} < T_{op} < T_{max.}$		1	100	pA
I_{ib}	Input bias current			1	10	pA
		$T_{min.} < T_{op} < T_{max.}$		1	100	pA
CMR	Common mode rejection ratio $20 \log (\Delta V_{ic}/\Delta V_{io})$	0 V to 5 V, $V_{out} = 2.5\text{ V}$	60			dB
SVR	Supply voltage rejection ratio $20 \log (\Delta V_{cc}/\Delta V_{io})$	$V_{cc} = 1.8\text{ to }5\text{ V}$	75	96		dB
A_{vd}	Large signal voltage gain	$R_L = 10\text{ k}\Omega$, $V_{out} = 0.5\text{ V to }4.5\text{ V}$	tbd	96		dB
V_{OH}	High level output voltage	$R_L = 10\text{ k}\Omega$ $T_{min.} < T_{op} < T_{max.}$	35 50	3		mV
V_{OL}	Low level output voltage	$R_L = 10\text{ k}\Omega$ $T_{min.} < T_{op} < T_{max.}$		3	35 50	mV
I_{out}	Isink	$V_o = 5\text{ V}$	tbd	20		mA
	Isource	$V_o = 0\text{ V}$	tbd	20		
I_{CC}	Supply current (per operator)	No load, $V_{out} = 2.5\text{ V}$		11	14	μA
		$T_{min.} < T_{op} < T_{max.}$			tbd	μA
AC performance						
GBP	Gain bandwidth product	$R_L = 10\text{ k}\Omega$, $C_L = 20\text{ pF}$, $f = 100\text{ kHz}$, $A_v = 1$		120		kHz
F_u	Unity gain frequency	$R_L = 10\text{ k}\Omega$, $C_L = 20\text{ pF}$, $A_v = 1$		109		kHz
ϕ_m	Phase margin	$R_L = 10\text{ k}\Omega$, $C_L = 20\text{ pF}$, $A_v = 1$		53		Degrees
G_m	Gain margin	$R_L = 10\text{ k}\Omega$, $C_L = 20\text{ pF}$, $A_v = 1$		14		dB
SR	Slew rate	$R_L = 10\text{ k}\Omega$, $C_L = 20\text{ pF}$, $A_v = 1$		0.034		V/ μs

Table 5. $V_{CC+} = +5\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, $T_{amb} = 25^\circ\text{ C}$, R_L connected to $V_{CC}/2$
(unless otherwise specified) (continued)

Symbol	Parameter		Min.	Typ.	Max.	Unit
e_n	Equivalent input noise voltage	$f = 1\text{ kHz}$		156		$\frac{\text{nV}}{\sqrt{\text{Hz}}}$
THD	Total harmonic distortion	$f_{in} = 1\text{ kHz}$, $A_v = 1$, $V_{out} = 2\text{ V}_{pp}$		0.1		%

3 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.

3.1 SOT23-5 package information

Figure 1. SOT23-5L package mechanical drawing

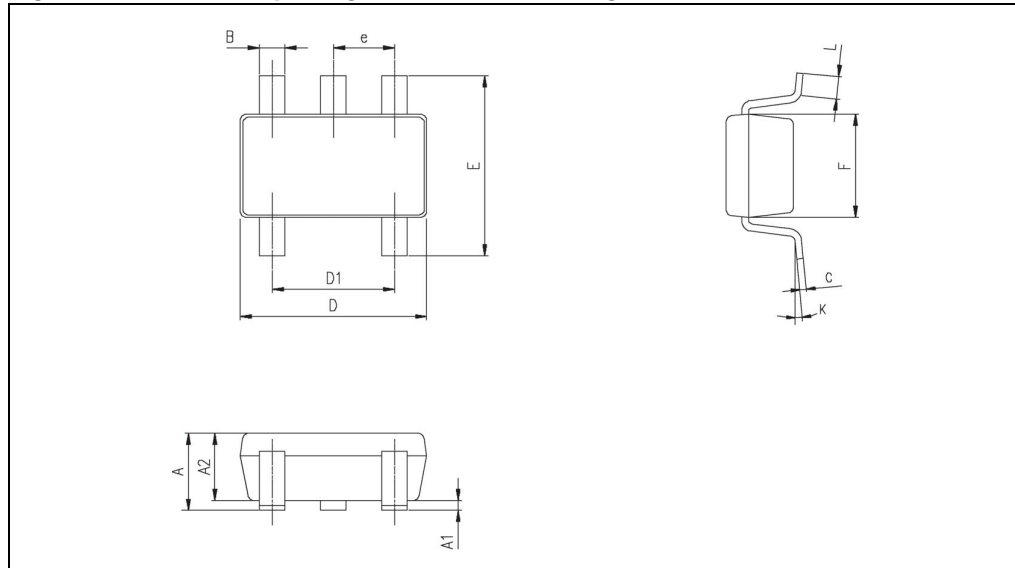


Table 6. SOT23-5L package mechanical data

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	0.013	0.015	0.019
C	0.09	0.15	0.20	0.003	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	0.013	0.023
K	0 degrees		10 degrees			

3.2 SC70-5 (or SOT323-5) package information

Figure 2. SC70-5 (or SOT323-5) package mechanical drawing

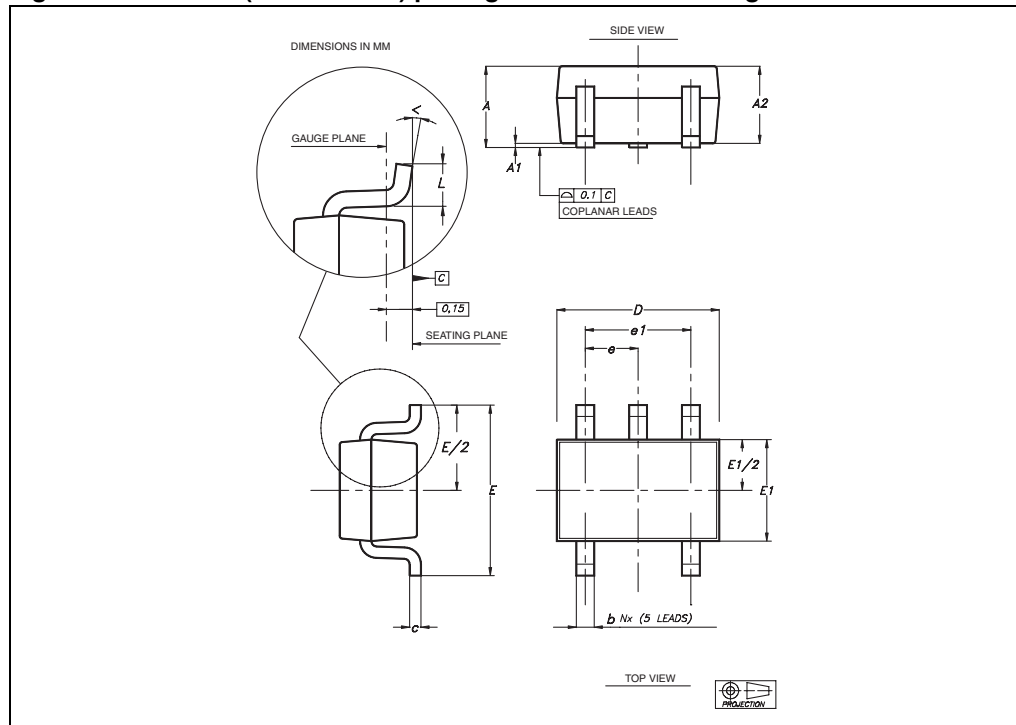


Table 7. SC70-5 (or SOT323-5) package mechanical data

Ref	Dimensions					
	Millimeters			Inches		
	Min	Typ	Max	Min	Typ	Max
A	0.80		1.10	0.315		0.043
A1			0.10			0.004
A2	0.80	0.90	1.00	0.315	0.035	0.039
b	0.15		0.30	0.006		0.012
c	0.10		0.22	0.004		0.009
D	1.80	2.00	2.20	0.071	0.079	0.087
E	1.80	2.10	2.40	0.071	0.083	0.094
E1	1.15	1.25	1.35	0.045	0.049	0.053
e		0.65			0.025	
e1		1.30			0.051	
L	0.26	0.36	0.46	0.010	0.014	0.018
<	0°		8°			

3.3 SO-8 package information

Figure 3. SO-8 package mechanical drawing

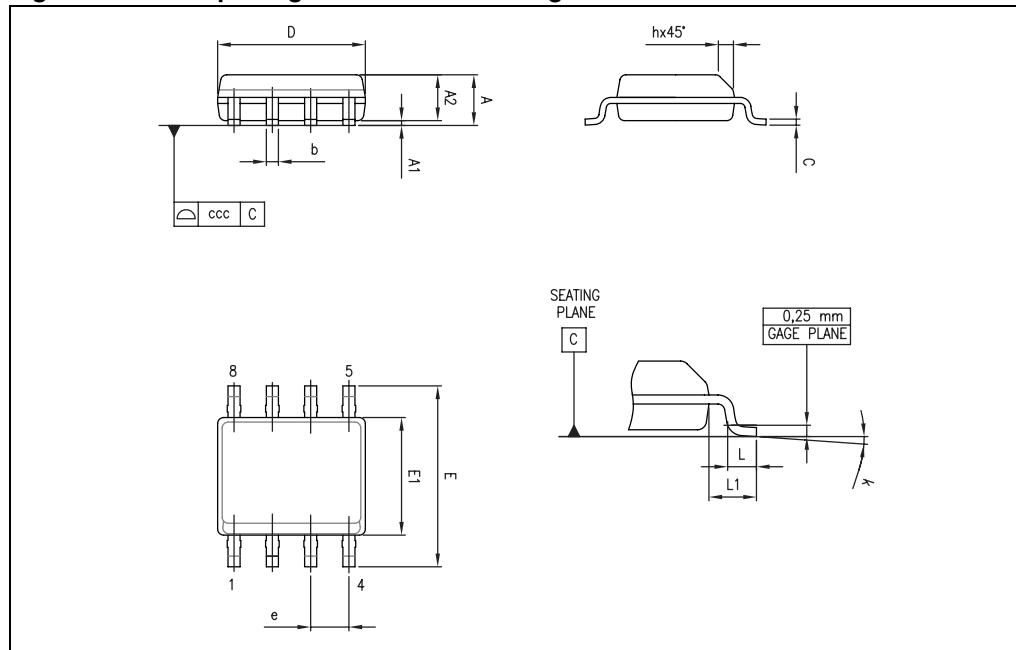


Table 8. SO-8 package mechanical data

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	1°		8°	1°		8°
ccc			0.10			0.004

3.4 MiniSO-8 package information

Figure 4. MiniSO-8 package mechanical drawing

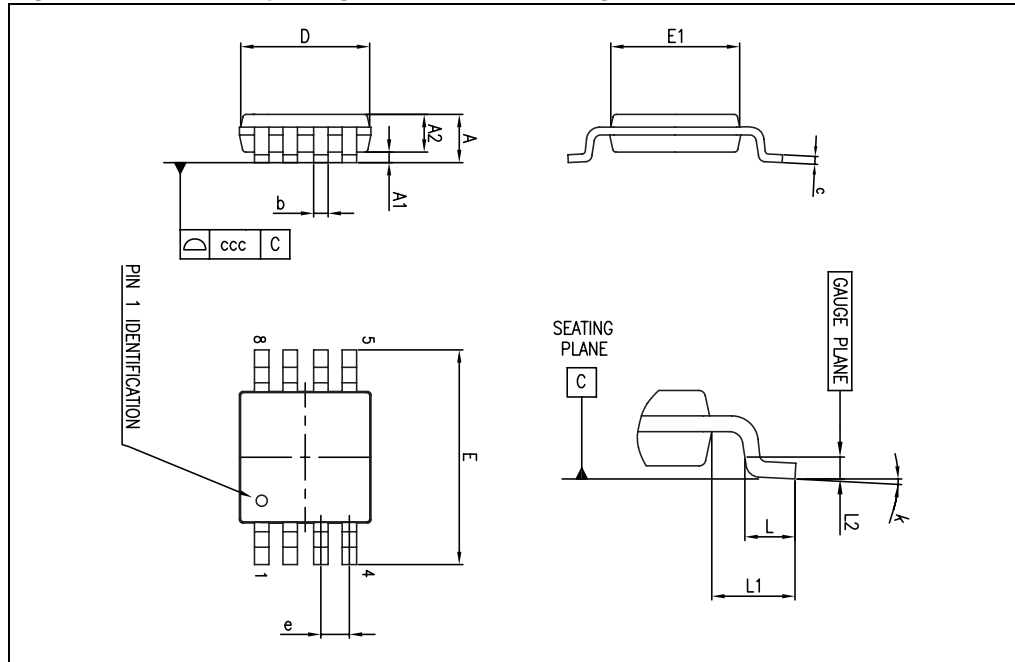


Table 9. MiniSO-8 package mechanical data

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

4 Ordering information

Table 10. Order codes

Order code	Temperature range	Package	Packing	Marking
TSV611ILT	-40° C to 85° C	SOT23-5	Tape & reel	K12
TSV611AILT				K11
TSV611ICT		SC70-5		K12
TSV611AICT				K11
TSV612ID/DT		SO-8	Tube & Tape & reel	V612I
TSV612AID/DT				V612AI
TSV612IST		MSO-8	Tape & reel	K113
TSV612AIST				K115

5 Revision history

Table 11. Document revision history

Date	Revision	Changes
28-May-2009	1	Initial release.

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