TSV611, TSV612

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

Preliminary data

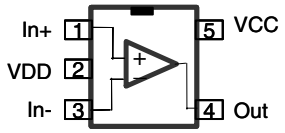
Features

- 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

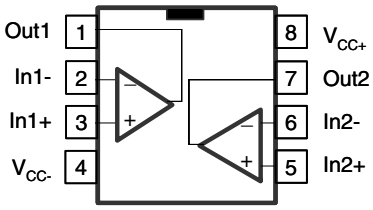
- Battery-powered applications
- Portable devices
- Signal conditioning
- Active filtering
- Medical instrumentation

TSV611ILT - TSV611ICT



SOT23-5 / SC70-5

TSV612IST - TSV612ID/DT



MSO8 / SO8

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

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 6 V.
4. Short-circuits can cause excessive heating and destructive dissipation.
5. Rth are typical values.
6. 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.
7. 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.
8. 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° 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 TSV61xA			5 1	mV
		$T_{min.} < T_{op} < T_{max.}$ TSV61x $T_{min.} < T_{op} < T_{max}$TSV61xA			6 2	
DV_{io}	Input offset voltage drift			2		µV/°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 kΩ, Vout = 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 kΩ $T_{min.} < T_{op} < T_{max.}$	35 50	3		mV
V_{OL}	Low level output voltage	R_L = 10 kΩ $T_{min.} < T_{op} < T_{max.}$		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 kΩ, C_L = 20 pF, f = 100 kHz, Av = 1		105		kHz
F_u	Unity gain frequency	R_L = 10 kΩ, C_L = 20 pF, Av = 1		100		kHz
ϕm	Phase margin	R_L = 10 kΩ, C_L = 20 pF, Av = 1		45		Degrees
G_m	Gain margin	R_L = 10 kΩ, C_L = 20 pF, Av = 1		tbd		dB

Table 3. Electrical characteristics at V_{CC+} = +1.8 V with V_{CC-} = 0 V, V_{icm} = V_{CC}/2, T_{amb} = 25° 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 kΩ, C_L = 20 pF Av = 1, TSV61x		0.03		V/µs
e_n	Equivalent input noise voltage	f = 1 kHz		156		$\frac{nV}{\sqrt{Hz}}$
THD+e_n	Total harmonic distortion	tbd		tbd		%

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

Symbol	Parameter		Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Offset voltage	TSV61x TSV61xA			5 1	mV
		$T_{min}<T_{op}<T_{max}$ TSV61x $T_{min}<T_{op}<T_{max}$TSV61xA			6 2	
DV_{io}	Input offset voltage drift			2		µV/°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 V	60			dB
A_{vd}	Large signal voltage gain	R_L = 10 kΩ, Vout = 0.5 V to 2.8 V	tbd	93		dB
V_{OH}	High level output voltage	R_L = 10 kΩ $T_{min.} < T_{op} < T_{max.}$	35 50	3		mV
V_{OL}	Low level output voltage	R_L = 10 kΩ $T_{min.} < T_{op} < T_{max.}$		3	35 50	mV
I_{out}	Isink	V_o = 5 V $T_{min.} < T_{op} < T_{max.}$	15	20		mA
	Isource	V_o = 0 V $T_{min.} < T_{op} < T_{max.}$	15	20		
I_{CC}	Supply current (per operator)	No load, V_{out} = 2.5 V		10	14	µA
		$T_{min.} < T_{op} < T_{max.}$			14	µA
AC performance						
GBP	Gain bandwidth product	R_L = 10 kΩ, C_L = 20 pF, f = 100 kHz, Av = 1		110		kHz
F_u	Unity gain frequency	R_L = 10 kΩ, C_L = 20 pF, Av = 1		100		kHz
ϕm	Phase margin	R_L = 10 kΩ, C_L = 20 pF, Av = 1		tbd		Degrees
G_m	Gain margin	R_L = 10 kΩ, C_L = 20 pF, Av = 1		tbd		dB
SR	Slew rate	R_L = 10 kΩ, C_L = 20 pF, A_V = 1		0.032		V/µs

Table 4. V_{CC+} = +3.3 V, V_{CC-} = 0 V, V_{icm} = V_{CC}/2, T_{amb} = 25° 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 kHz		156		$\frac{nV}{\sqrt{Hz}}$
THD	Total harmonic distortion	tbd		tbd		%

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

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

Table 5. V_{CC+} = +5 V, V_{CC-} = 0 V, V_{icm} = V_{CC}/2, T_{amb} = 25° 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 kHz		156		$\frac{nV}{\sqrt{Hz}}$
THD	Total harmonic distortion	fin = 1 kHz, Av = 1, Vout = 2 Vpp		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

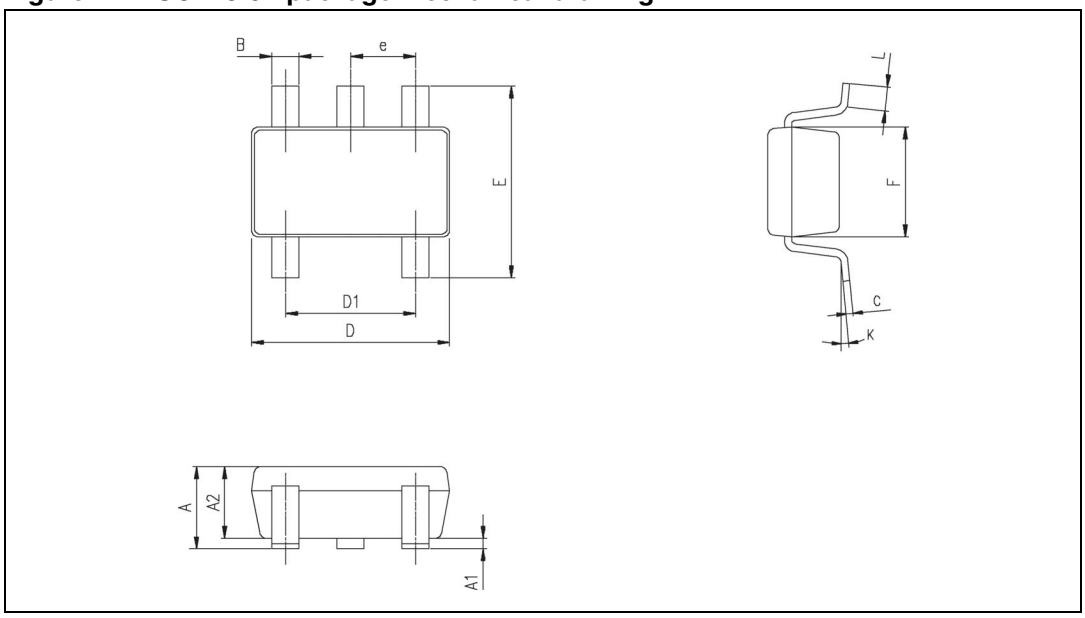


Table 6. SOT23-5L package mechanical data

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

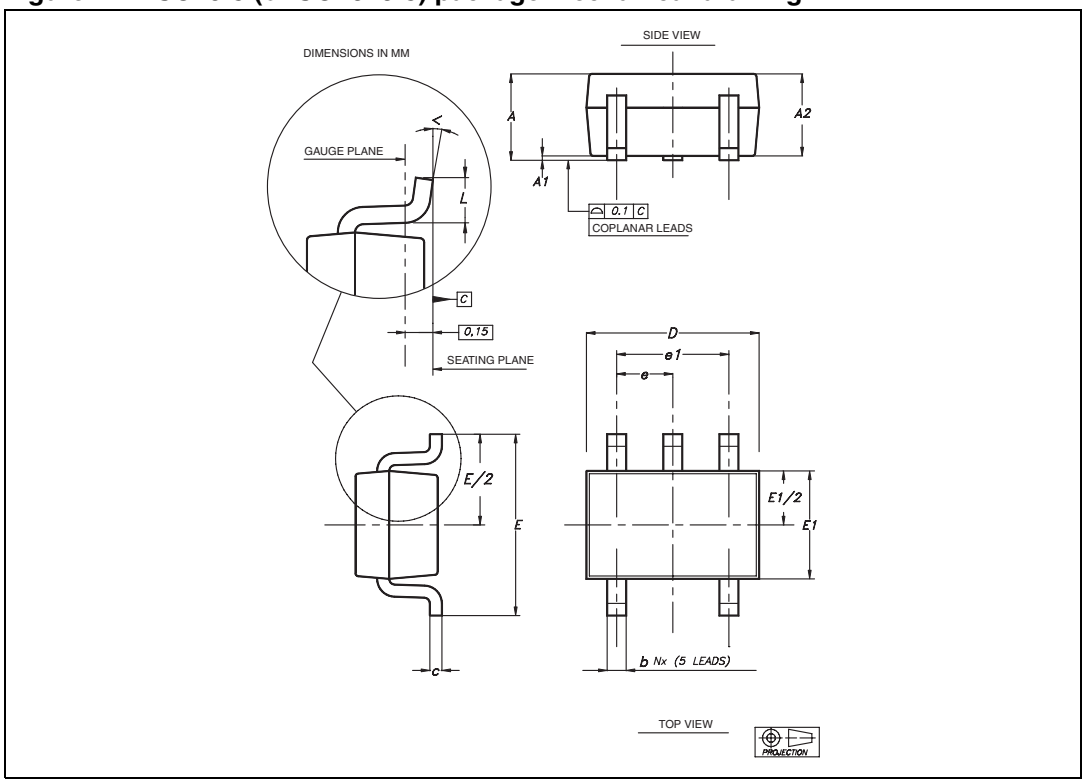


Table 7. SC70-5 (or SOT323-5) package mechanical data

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

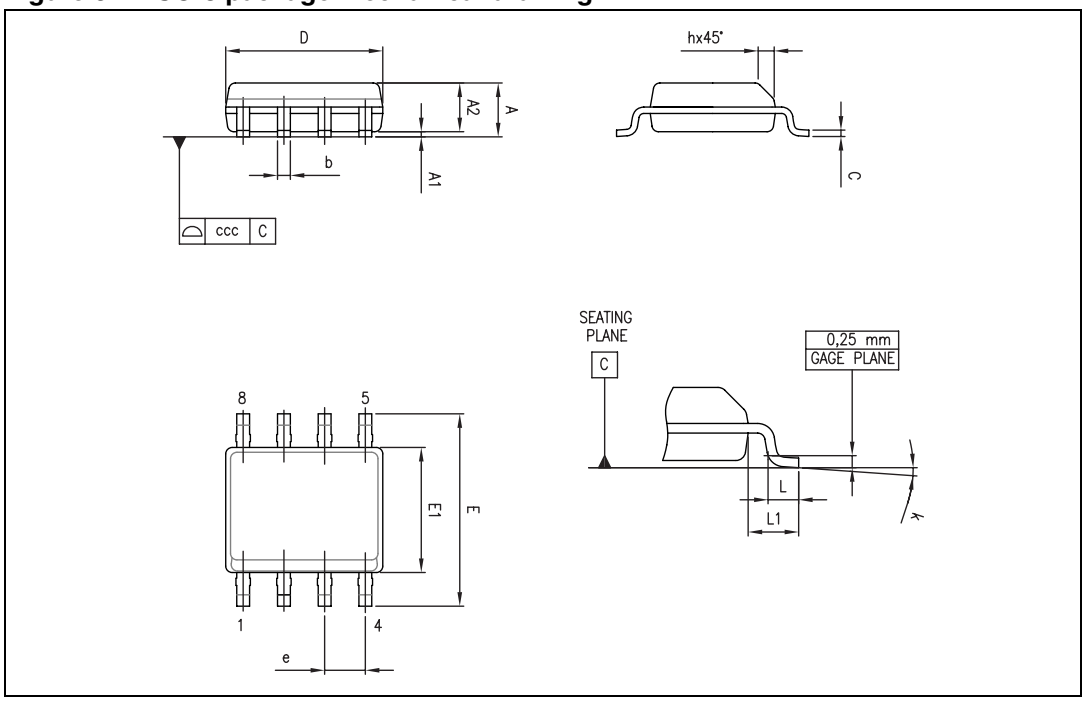


Table 8. SO-8 package mechanical data

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

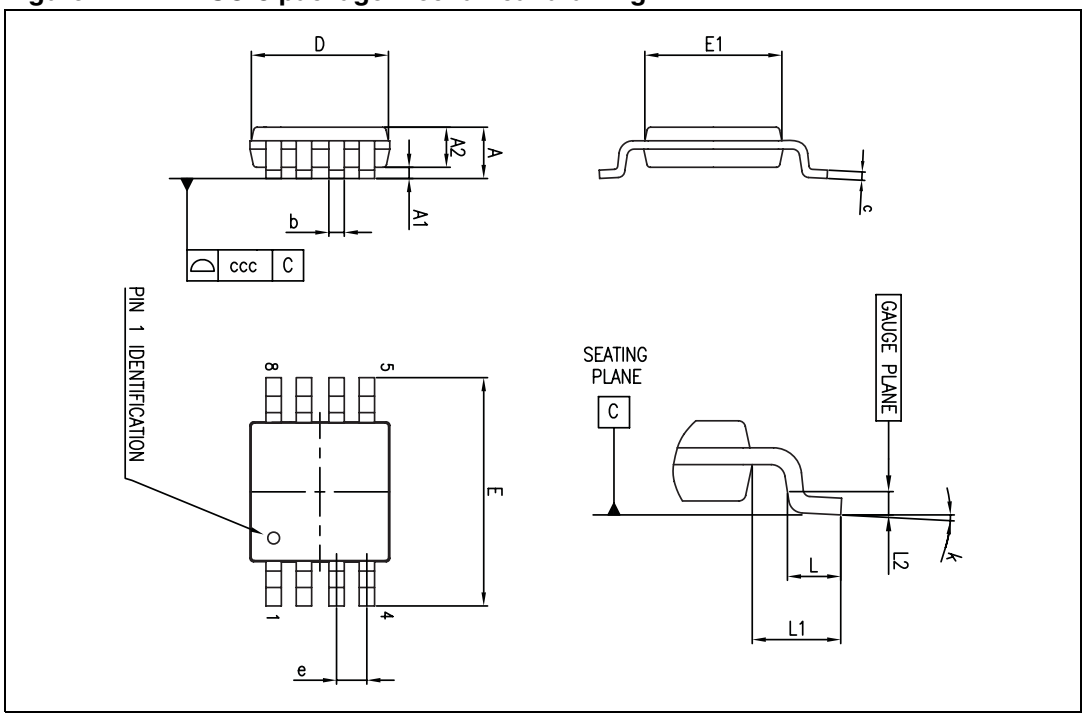


Table 9. MiniSO-8 package mechanical data

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.