

Low-power, 1 MHz, rail-to-rail, 5 V cost-effective Op Amp



Features

- Gain bandwidth product 1 MHz, unity gain stable
- Rail-to-rail input and output
- Wide supply voltage range: 1.8 V to 5.5 V
- Input offset voltage: 4.5 mV
- Low input bias current: 1 pA typ.
- Extended temperature range: -40 °C to +125 °C

Applications

- Cost-sensitive applications
- Battery-powered products

Description

The TSL6001, TSL6002 and the TSL6004 are single, dual and quad 1 MHz-bandwidth unity-gain-stable amplifiers. The rail-to-rail input stage and the wide supply range from 1.8 V to 5.5 V make the TSL600x ideal for low voltage signal conditioning.

Product status link	
SC70-5	TSL6001
SOT23-5	
MiniSO8	TSL6002
SO8	
TSSOP14	TSL6004
Related products	
For higher bandwidth	TSL6201
For more power savings	TSL6801

1 Pin description

1.1 TSL6001 single operational amplifier

Figure 1. SC70-5 and SOT23-5 pin connections (top view)

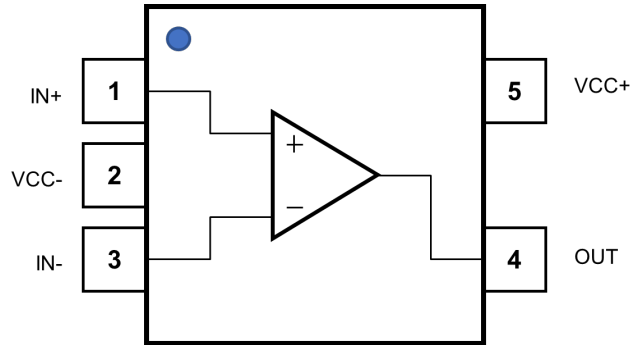


Table 1. SC70-5 and SOT23-5 pin description

Pin	Pin name	Description
1	IN+	Non-inverting input channel
2	VCC-	Negative supply voltage
3	IN-	Inverting input channel
4	OUT	Output channel
5	VCC+	Positive supply voltage

1.2 TSL6002 dual operational amplifier

Figure 2. MiniSO8 and SO8 pin connection (top view)

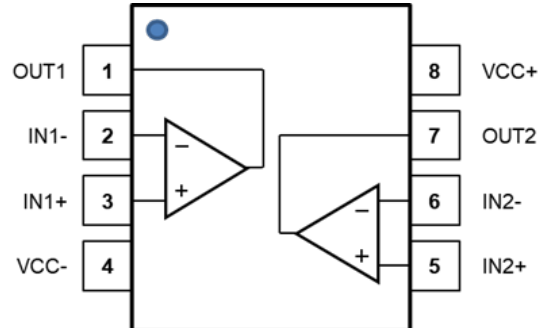


Table 2. MiniSO8 and SO8 pin description

Pin	Pin name	Description
1	OUT1	Output channel 1
2	IN1-	Inverting input channel 1
3	IN1+	Non-inverting input channel 1
4	VCC-	Negative supply voltage
5	IN2+	Non-inverting input channel 2
6	IN2-	Inverting input channel 2
7	OUT2	Output channel 2
8	VCC+	Positive supply voltage

1.3 Quad operational amplifier

Figure 3. TSSOP-14 pin connections (top view)

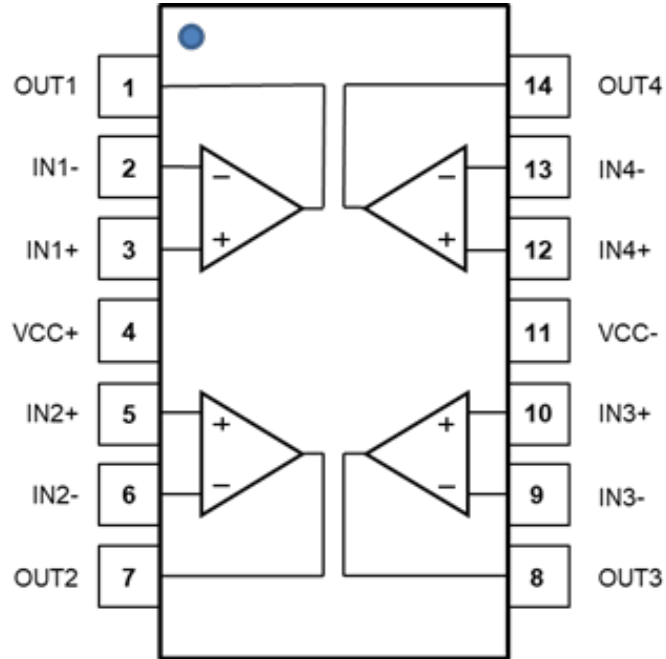


Table 3. TSSOP-14 pin description

Pin	Pin name	Description
1	OUT1	Output channel 1
2	IN1-	Inverting input channel 1
3	IN1+	Non-inverting input channel 1
4	VCC+	Positive supply voltage
5	IN2+	Non-inverting input channel 2
6	IN2-	Inverting input channel 2
7	OUT2	Output channel 2
8	OUT3	Output channel 3
9	IN3-	Inverting input channel 3
10	IN3+	Non-inverting input channel 3
11	VCC-	Negative supply voltage
12	IN4+	Non-inverting input channel 4
13	IN4-	Inverting input channel 4
14	OUT4	Output channel 4

2 Absolute maximum ratings

Table 4. Absolute maximum ratings

Symbol	Parameter ⁽¹⁾	Value	Unit
V _{CC}	Supply voltage	6	V
V _{id}	Input voltage differential (V _{IN+} - V _{IN-})	±V _{CC}	V
V _{in} ⁽²⁾	Input voltage	(V _{CC-}) - 0.2 to (V _{CC+}) + 0.2	V
I _{in}	Input current	±10	mA
T _{stg}	Storage temperature	-65 to +150	°C
R _{th-ja} ⁽³⁾	Thermal resistance junction-to-ambient		°C/W
	SC70-5	205	
	SOT23-5	250	
	MiniSO8	190	
	SO8	125	
	TSSOP-14	100	
T _j	Maximum junction temperature	150	°C
ESD	HBM: human body model ⁽⁴⁾	2	kV
	CDM: charged device model ⁽⁵⁾	1.5	kV

1. All voltage values are with respect to the VCC- pin, unless otherwise specified.
2. The maximum input voltage value may be extended to the condition that the input current is limited to ±10 mA.
3. R_{th-ja} is a typical value.
4. Human body model: HBM test according to the standard ESDA/JEDEC JS-001-2017.
5. Charged device model: the test CDM is done in according to the standard ESDA/JEDEC JS-002-2018.

Table 5. Operating conditions

Symbol	Parameter	Value
V _{CC}	Supply voltage	1.8 to 5.5 V
V _{icm}	Common mode input voltage range (CMR)	V _{CC-} - 0.1 V to V _{CC+} + 0.1 V
T _{oper}	Operating free air temperature range	-40 °C to +125 °C

3 Electrical characteristics

Table 6. Electrical characteristics at $V_{CC} = 1.8\text{ V}$ to 5.5 V , $V_{ICM} = V_{OUT} = V_{CC} / 2$, $T = 25\text{ °C}$ and OUT connected to $V_{CC} / 2$ through $R_L = 10\text{ k}\Omega$ (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Input offset voltage			± 0.75	± 4.5	mV
DV_{io}/DT	Input offset voltage temperature drift	$-40\text{ °C} \leq T \leq 125\text{ °C}$		2		$\mu\text{V}/\text{°C}$
I_{ib}	Input bias current			1		μA
I_{io}	Input offset current			1		μA
A_{VD}	Open loop gain	$V_{CC} - 500\text{ mV} \leq V_{OUT} \leq V_{CC} + 500\text{ mV}$	85	95		dB
CMR	Common-mode rejection ratio $20 \cdot \log(\Delta V_{io} / \Delta V_{icm})$	$V_{CC} - \leq V_{icm} \leq V_{CC} +$	53	74		dB
SVR	Supply voltage rejection ratio $20 \cdot \log(DV_{io} / DV_{CC})$	$1.8\text{ V} \leq V_{CC} \leq 5.5\text{ V}$		86		dB
V_{OH}	High level output voltage drop ($V_{OH} = V_{CC+} - V_{OUT}$)				35	mV
V_{OL}	Low level output voltage drop ($V_{OL} = V_{OUT}$)				35	mV
I_{OUT}	Short-circuit	$V_{CC} = 1.8\text{ V}$		± 10		mA
		$V_{CC} = 5\text{ V}$		± 30		
I_{CC}	Supply current (by operational amplifier)	No load		75	100	μA
AC performance						
GBP	Gain bandwidth product			1		MHz
SR	Slew rate	$A_V = 1\text{ V/V}$, 10% to 90%		0.4		$\text{V}/\mu\text{s}$
Φ_m	Phase margin	$C_L = 60\text{ pF}$		50		Degrees
en	Input voltage noise density	$f = 10\text{ kHz}$		45		$\text{nV}/\sqrt{\text{Hz}}$

4 Typical performance characteristics

Figure 4. Supply current vs. supply voltage at $V_{ICM} = V_{CC}/2$

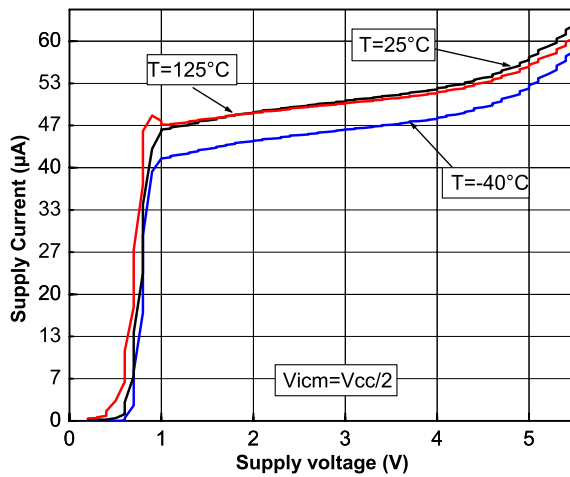


Figure 5. Output current vs. output voltage at $V_{CC} = 5V$

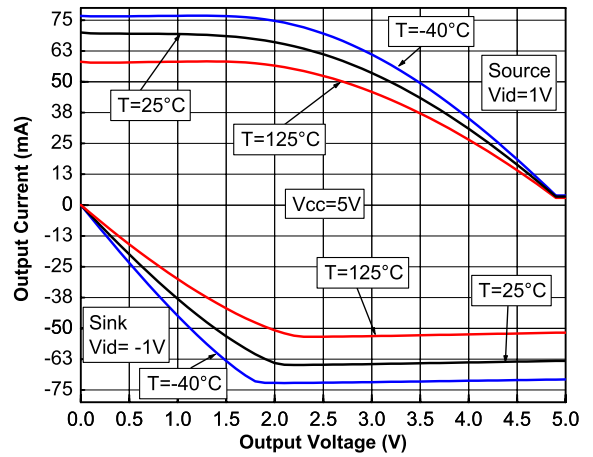


Figure 6. Input offset voltage vs. input common mode at $V_{CC} = 5V$

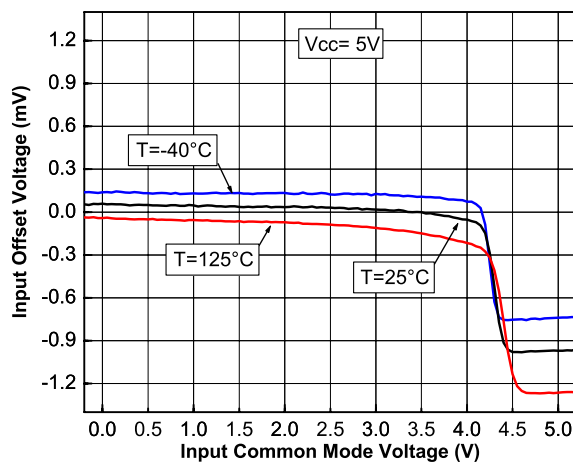


Figure 7. Positive slew rate at $V_{CC} = 5V$

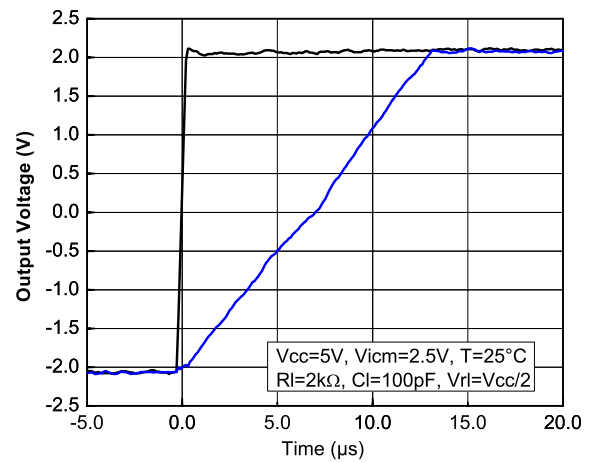


Figure 8. Negative slew rate at $V_{CC} = 5\text{ V}$

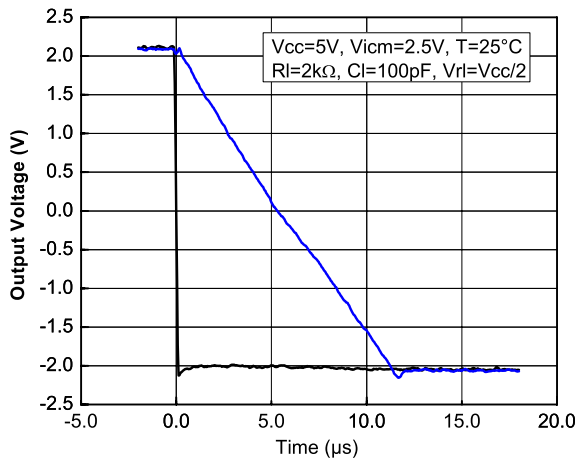


Figure 9. Bode diagram at $V_{CC} = 5\text{ V}$

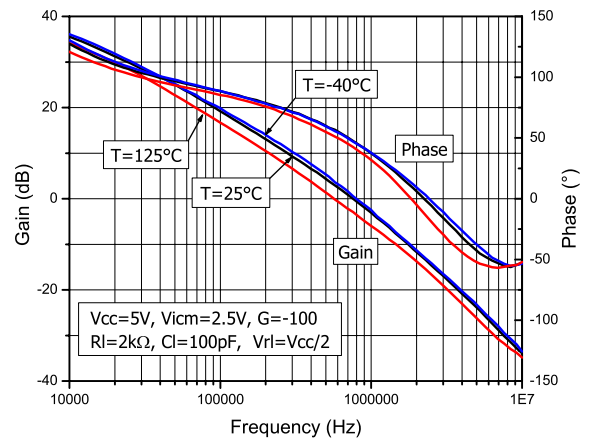


Figure 10. Noise vs. frequency

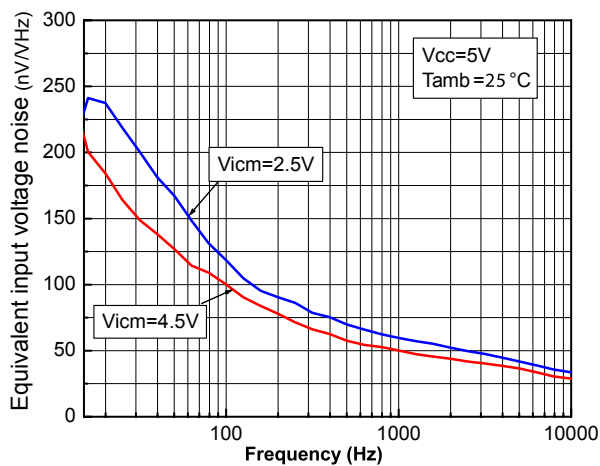
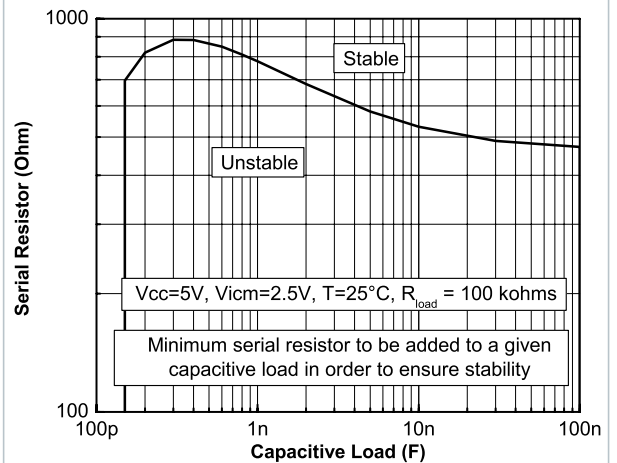


Figure 11. R_{iso} to drive capacitors above 100 pF in follower configuration



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 SC70-5 (or SOT323-5) package information

Figure 12. SC70-5 (or SOT323-5) package outline

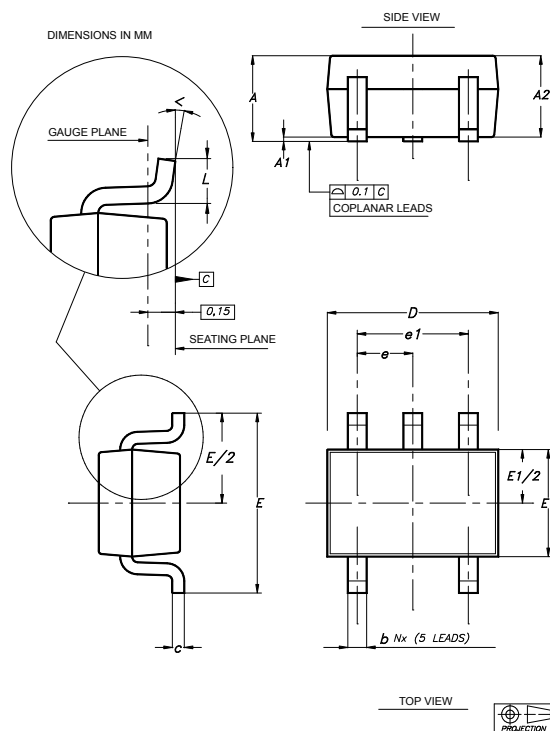


Table 7. SC70-5 (or SOT323-5) package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.80		1.10	0.032		0.043
A1			0.10			0.004
A2	0.80	0.90	1.00	0.032	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°	0°		8°

5.2 SOT23-5 package information

Figure 13. SOT23-5 package outline

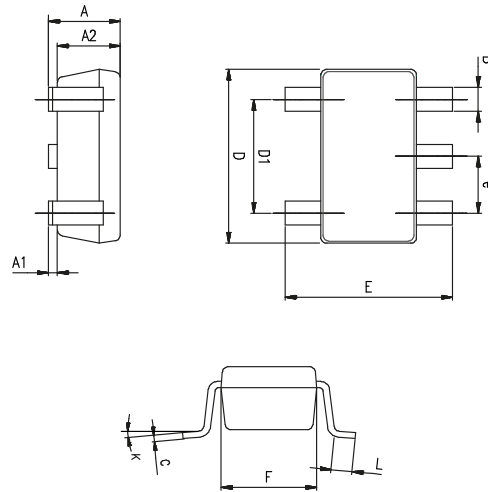


Table 8. SOT23-5 package mechanical data

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	0.014	0.016	0.020
C	0.09	0.15	0.20	0.004	0.006	0.020
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°		10°	0°		10°

5.3 MiniSO8 package information

Figure 14. MiniSO8 package outline

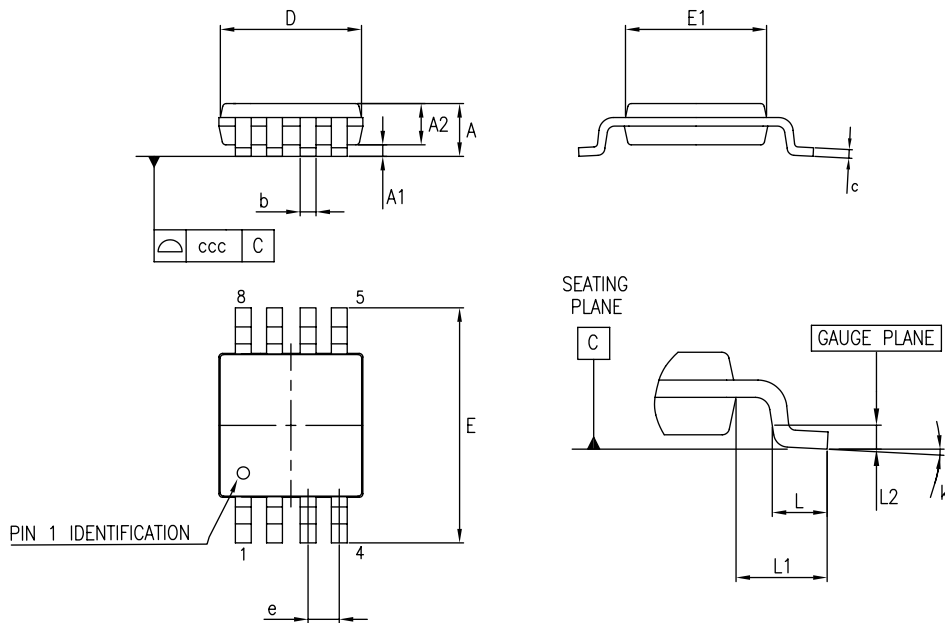


Table 9. MiniSO8 mechanical data

Dim.	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	0.03	0.033	0.037
b	0.22		0.4	0.009		0.016
c	0.08		0.23	0.003		0.009
D	2.8	3	3.2	0.11	0.118	0.126
E	4.65	4.9	5.15	0.183	0.193	0.203
E1	2.8	3	3.1	0.11	0.118	0.122
e		0.65			0.026	
L	0.4	0.6	0.8	0.016	0.024	0.031
L1		0.95			0.037	
L2		0.25			0.01	
k	0°		8°	0°		8°
ccc			0.1			0.004

5.4 SO8 package information

Figure 15. SO8 package outline

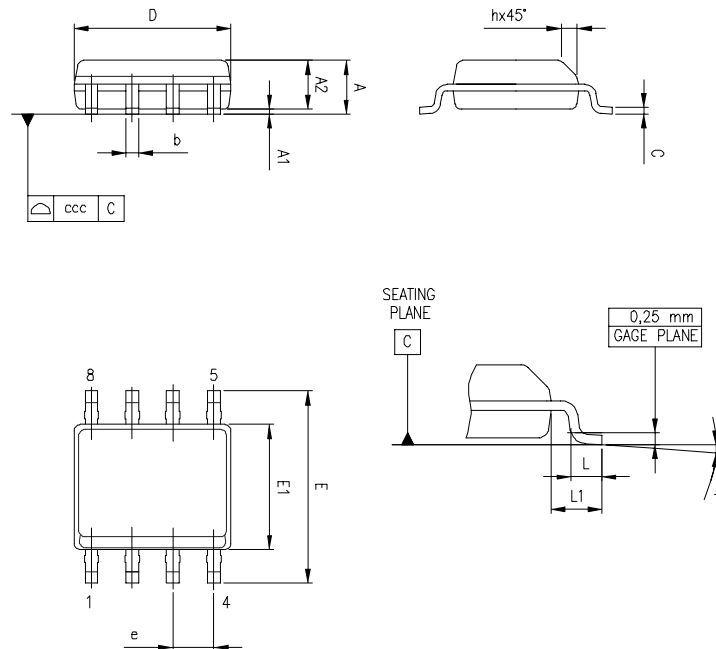


Table 10. SO-8 mechanical data

Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.1		0.25	0.004		0.01
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.01
D	4.8	4.9	5	0.189	0.193	0.197
E	5.8	6	6.2	0.228	0.236	0.244
E1	3.8	3.9	4	0.15	0.154	0.157
e		1.27			0.05	
h	0.25		0.5	0.01		0.02
L	0.4		1.27	0.016		0.05
L1		1.04			0.04	
k	0		8 °	1 °		8 °
ccc			0.1			0.004

5.5 TSSOP-14 package information

Figure 16. TSSOP-14 package outline

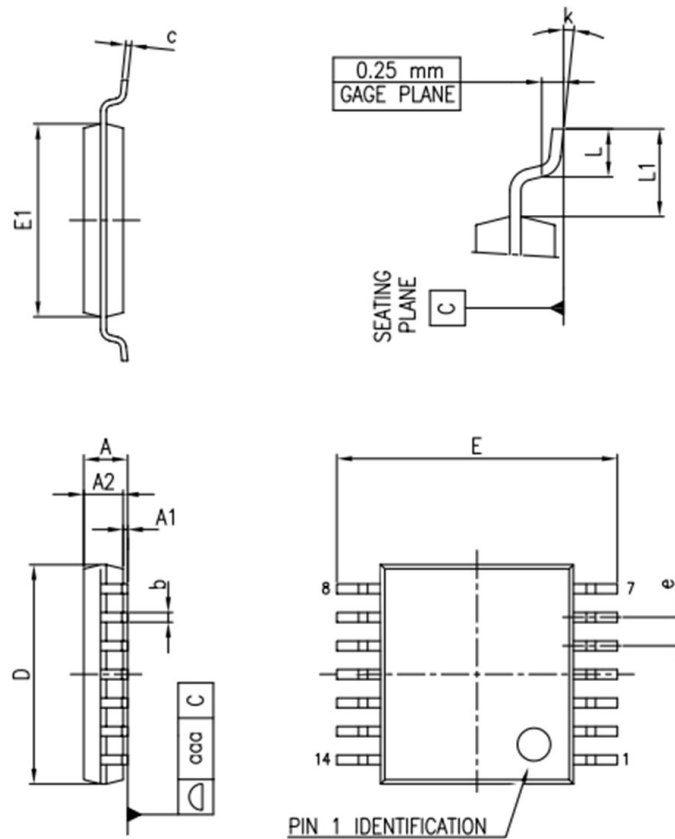


Table 11. TSSOP-14 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A			1.20
A1	0.05		0.15
A2	0.80	1.00	1.05
b	0.19		0.30
c	0.09		0.20
D	4.90	5.00	5.10
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65 BSC		
L	0.45	0.60	0.75
L1		1.00	
k	0		8
aaa			0.10

6 Ordering information

Table 12. Order code

Order code	Temperature range	Package	Marking
TSL6001ICT	-40 °C to 125 °C	SC70-5	KC
TSL6001ILT		SOT23-5	KC
TSL6002IST		MiniSO8	KH
TSL6002IDT		SO8	6002I
TSL6004IPT		TSSOP-14	6004I

Revision history

Table 13. Document revision history

Date	Version	Changes
13-Oct-2021	1	Initial release.

Contents

1	Pin description	2
1.1	TSL6001 single operational amplifier	2
1.2	TSL6002 dual operational amplifier	3
1.3	Quad operational amplifier	4
2	Absolute maximum ratings	5
3	Electrical characteristics	6
4	Typical performance characteristics	7
5	Package information	9
5.1	SC70-5 package information	9
5.2	SOT23-5 package information	11
5.3	MiniSO8 package information	12
5.4	SO8 package information	13
5.5	TSSOP-14 package information	14
6	Ordering information	15
	Revision history	16

List of tables

Table 1.	SC70-5 and SOT23-5 pin description	2
Table 2.	MiniSO8 and SO8 pin description	3
Table 3.	TSSOP-14 pin description	4
Table 4.	Absolute maximum ratings	5
Table 5.	Operating conditions	5
Table 6.	Electrical characteristics at $V_{CC} = 1.8\text{ V to }5.5\text{ V}$, $V_{ICM} = V_{OUT} = V_{CC} / 2$, $T = 25\text{ }^{\circ}\text{C}$ and OUT connected to $V_{CC} / 2$ through $R_L = 10\text{ k}\Omega$ (unless otherwise specified)	6
Table 7.	SC70-5 (or SOT323-5) package mechanical data	10
Table 8.	SOT23-5 package mechanical data	11
Table 9.	MiniSO8 mechanical data	12
Table 10.	SO-8 mechanical data	13
Table 11.	TSSOP-14 mechanical data	14
Table 12.	Order code	15
Table 13.	Document revision history	16

List of figures

Figure 1.	SC70-5 and SOT23-5 pin connections (top view)	2
Figure 2.	MiniSO8 and SO8 pin connection (top view).	3
Figure 3.	TSSOP-14 pin connections (top view)	4
Figure 4.	Supply current vs. supply voltage at $V_{ICM} = V_{CC}/2$	7
Figure 5.	Output current vs. output voltage at $V_{CC} = 5\text{ V}$	7
Figure 6.	Input offset voltage vs. input common mode at $V_{CC} = 5\text{ V}$	7
Figure 7.	Positive slew rate at $V_{CC} = 5\text{ V}$	7
Figure 8.	Negative slew rate at $V_{CC} = 5\text{ V}$	8
Figure 9.	Bode diagram at $V_{CC} = 5\text{ V}$	8
Figure 10.	Noise vs. frequency.	8
Figure 11.	R_{ISO} to drive capacitors above 100 pF in follower configuration	8
Figure 12.	SC70-5 (or SOT323-5) package outline	9
Figure 13.	SOT23-5 package outline	11
Figure 14.	MiniSO8 package outline	12
Figure 15.	SO8 package outline	13
Figure 16.	TSSOP-14 package outline	14