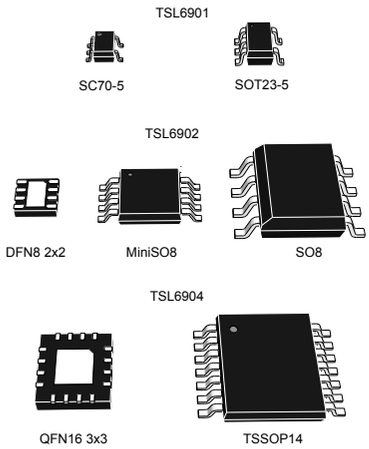
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TSL6901, TSL6902, TSL6904

Datasheet

Very high accuracy (12 µV) zero drift micropower 5 V cost-effective operational amplifiers



Features

- Very high accuracy and stability: offset voltage 12 µV max.
- Rail-to-rail input and output
- Low supply voltage: 1.8 - 5.5 V
- Low power consumption: 40 µA max. at 5 V
- Gain bandwidth product: 375 kHz
- High tolerance to ESD: 4 kV HBM
- Extended temperature range: -40 to 125 °C
- Micro-package: SC70-5, DFN8 2x2 and QFN16 3x3

Applications

- Cost-sensitive applications
- Battery-powered applications

Description

The TSL6901, TSL6902, and TSL6904 are high precision operational amplifiers which offer very low input offset voltages with virtually zero drift.

TSL6901, TSL6902, and TSL6904 are pinouts compatible with industry standards.

The TSL690x family offers rail-to-rail input and output, excellent speed/power consumption ratio, and 375 kHz gain bandwidth product, while consuming less than 40 µA at 5 V. The devices also feature an ultra-low input bias current.

These features make the TSL690x family product ideal for sensor interfaces, battery-powered applications, and portable applications.

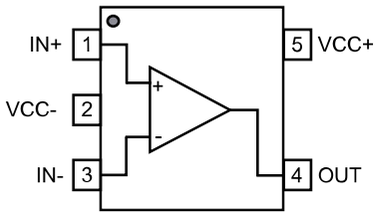
Maturity status link
TSL6901, TSL6902, TSL6904

Related products	
TSL600x	For higher bandwidth (1 MHz)
TSL620x	For higher bandwidth (10 MHz)
TSL640x	For higher bandwidth (50 MHz)
TSL680x	For more power saving

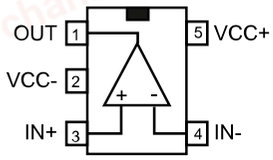
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1 Pin connections

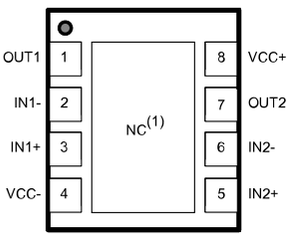
Figure 1. **Pin connections (top view)**



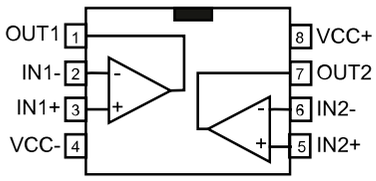
SC70-5



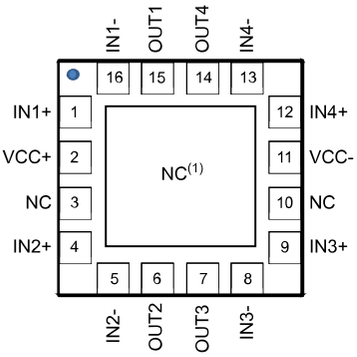
SOT23-5



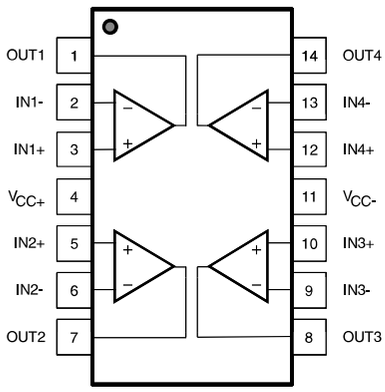
DFN8 2x2



MiniSO8 and SO8



QFN16 3x3



TSSOP14

1. The exposed pads of the DFN8 2x2 and QFN16 3x3 can be connected to VCC- or left floating.

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Table 1. Pin description for SC70 and SOT23-5

Pin n. SC70	Pin n. SOT23-5	Pin name	Description
1	3	IN+	Non-inverting input channel
2	2	VCC-	Negative supply voltage
3	4	IN-	Inverting input channel
4	1	OUT	Output channel
5	5	VCC+	Positive supply voltage

Table 2. Pin description for DFN8, MiniSO8, and SO8

Pin n. DFN8, MiniSO8, and SO8	Pin name	Description
1	OUT1	Output channel
2	IN1-	Inverting input channel
3	IN1+	Non-inverting input channel
4	VCC-	Negative supply voltage
5	IN2+	Non-inverting input channel
6	IN2-	Inverting input channel
7	OUT2	Output channel
8	VCC+	Positive supply voltage

Table 3. Pin description for TSSOP14 and QFN16

Pin n. TSSOP14	Pin n. QFN16	Pin name	Description
1	15	OUT1	Output channel
2	16	IN1-	Inverting input channel
3	1	IN1+	Non-inverting input channel
4	2	VCC+	Positive supply voltage
5	4	IN2+	Non-inverting input channel
6	5	IN2-	Inverting input channel
7	6	OUT2	Output channel
8	7	OUT3	Output channel
9	8	IN3-	Inverting input channel
10	9	IN3+	Non-inverting input channel
11	11	VCC-	Negative supply voltage
12	12	IN4+	Non-inverting input channel
13	13	IN4-	Inverting input channel
14	14	OUT4	Output channel
-	3	NC	-
-	10	NC	-

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2 Absolute maximum ratings and operation conditions

Table 4. Absolute maximum ratings (AMR)

Symbol	Parameter		Value	Unit
V_{CC}	Supply voltage (1)		6	V
V_{id}	Differential input voltage z (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)	SC70-5	205	°C/W
		SOT23-5	250	
		DFN8 (2x2)	57	
		MiniSO8	190	
		SO8	125	
		QFN16 (3x3)	39	
		TSSOP14	100	
ESD	HBM: human body model (7)		4	kV
	MM: machine model (8)		300	V
	CDM: charged device model (9)		1.5	kV

1. *All voltage values, except the differential voltage, are with respect to the network ground terminal.*
2. *The differential voltage is the non-inverting input terminal with respect to the inverting input terminal.*
3. *V_{cc} - V_{in} must not exceed 6 V, V_{in} must not exceed 6 V.*
4. *Input current must be limited by a resistor in series with the inputs.*
5. *R_{th} are typical values.*
6. *Short-circuits can cause excessive heating and destructive dissipation.*
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: 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.*
9. *Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to ground.*

Table 5. Operating conditions

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

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3 Electrical characteristics

Table 6. Electrical characteristics at V_{CC} = 2 V to 5 V, V_{ICM} = V_{OUT} = V_{CC} / 2, T = 25 °C and OUT connected to V_{CC} / 2 through R_L = 10 kΩ (unless otherwise specified). Production screening at V_{CC} = 5 V, operation on the full supply range ensured by design and characterization.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Input offset voltage	T = 25 °C		2	12	µV
ΔV_{io} / ΔT	Input offset voltage drift (1)	-40 °C < T < 125 °C		15		nV/°C
I_{ib}	Input bias current (V_{out} = V_{CC}/2)	T = 25 °C		+/-65		pA
		-40 °C < T < 125 °C		+/-140		
I_{io}	Input offset current (V_{out} = V_{CC}/2)	T = 25 °C		+/-130		
CMR	Common mode rejection ratio, 20 log (ΔV_{icm}/ ΔV_{io}), V_{ic} = 0 V to V_{CC}, V_{out} = V_{CC}/2, R_L > 1 MΩ	T = 25 °C	105	120		dB
SVR	Supply voltage rejection ratio, 20 log (ΔV_{CC}/ ΔV_{io}), V_{CC} = 1.8 V to 5.5 V, V_{out} = V_{CC}/2, R_L > 1 MΩ	T = 25 °C	105	120		
Avd	Large signal voltage gain, V_{out} = 0.5 V to (V_{CC} - 0.5 V)	T = 25 °C	110	134		
V_{OH} / V_{OL}	High / low level output voltage	-40 °C < T < 125 °C			70	mV
I_{sc}	Short-circuit current (V_{out} = +/- V_{CC})	T = 25 °C		+/-5		mA
I_{CC}	Supply current (per amplifier, V_{out} = V_{CC}/2, R_L > 1 MΩ)	-40 °C < T < 125 °C			40	µA
AC performance						
GBP	Gain bandwidth product	R_L = 10 kΩ, C_L = 100 pF		375		kHz
ϕ_m	Phase margin			55		Degrees
SR	Slew rate (2)			0.17		V/µs
e_n	Equivalent input noise density	f = 1 kHz		60		nV/√Hz
$\int_{en}$	Low-frequency peak-to-peak input noise	Bandwidth, f = 0.1 to 10 Hz		1.1		µVpp

1. *Input offset measurements are performed on x100 gain configuration. The amplifiers and the gain setting resistors are at the same temperature.*
2. *Slew rate value is calculated as the average between positive and negative slew rates.*

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4 Package information

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.

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

Figure 2. **SC70-5 (or SOT323-5) package outline**

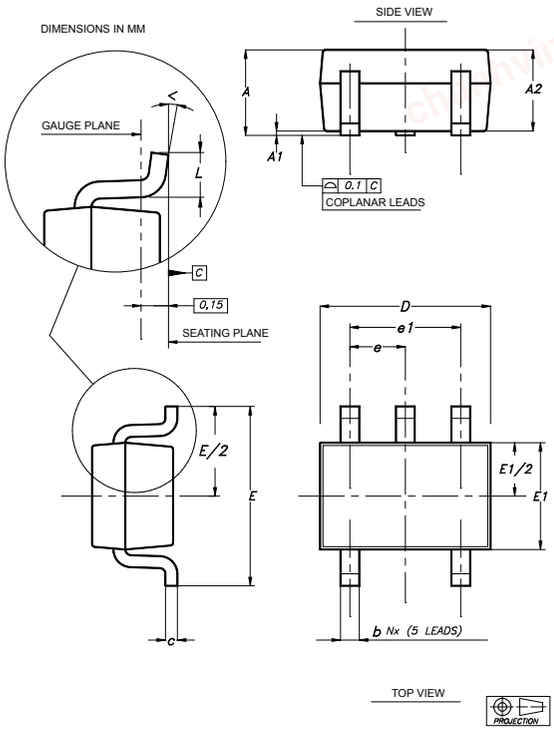


Table 7. **SC70-5 (or SOT323-5) package mechanical data**

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°

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4.2 SOT23-5 package information

Figure 3. **SOT23-5 package outline**

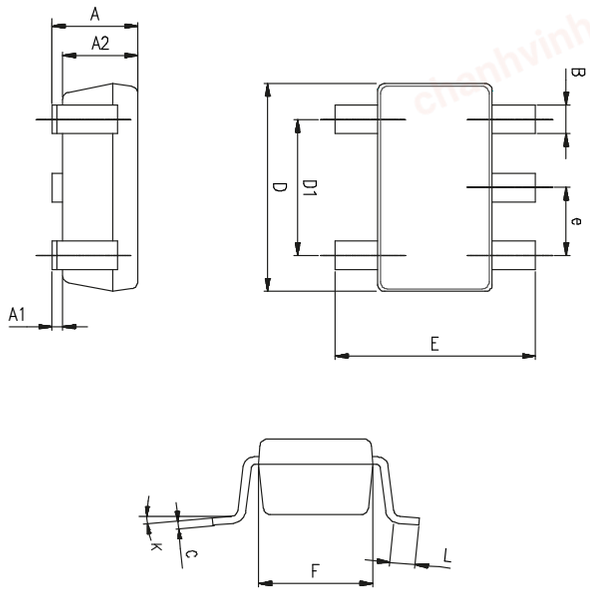


Table 8. **SOT23-5 mechanical data**

Dimensions						
Symbol	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°		0°	0°		0°

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4.3 DFN8 2 x 2 package information

Figure 4. **DFN8 2 x 2 package outline**

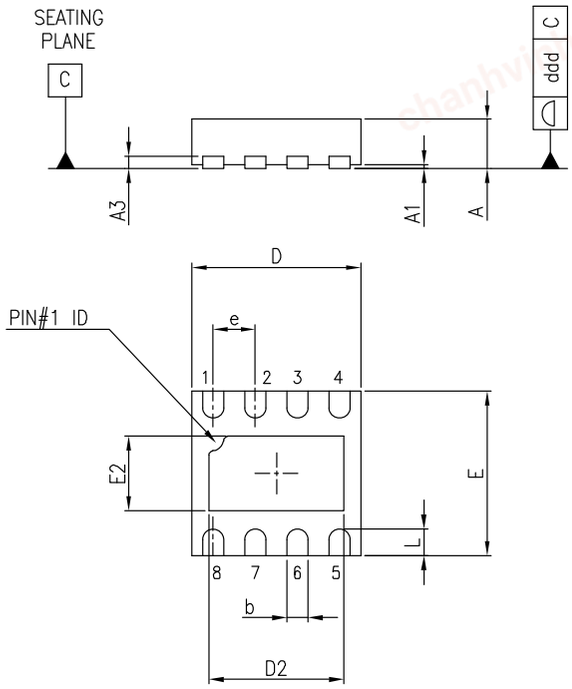
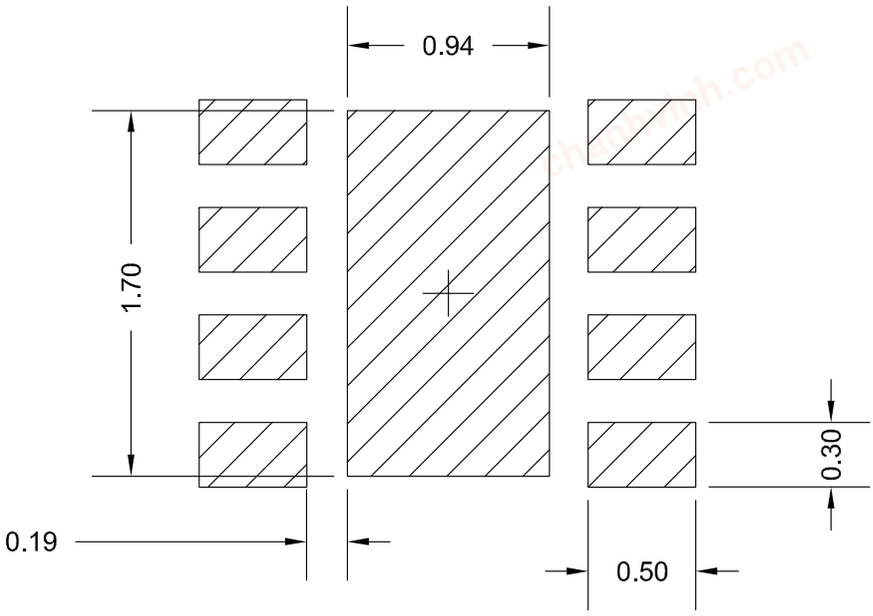


Table 9. **DFN8 2 x 2 mechanical data**

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	0.225	0.325	0.425	0.009	0.013	0.017
ddd			0.08			0.003

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Figure 5. **DFN8 2 x 2 recommended footprint**



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4.4 MiniSO8 package information

Figure 6. **MiniSO8 package outline**

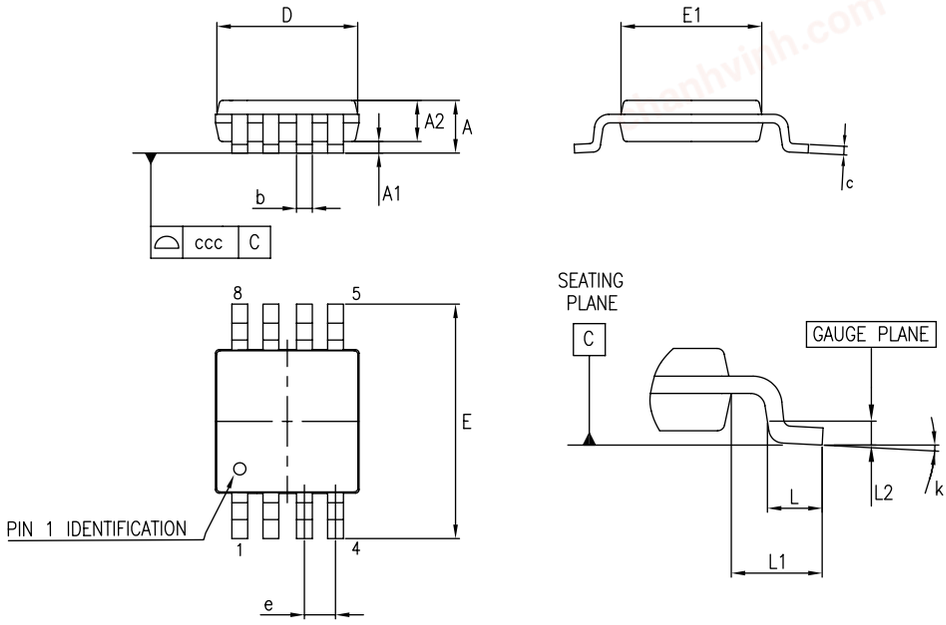


Table 10. **MiniSO8 mechanical data**

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

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4.5 SO8 package information

Figure 7. **SO8 package outline**

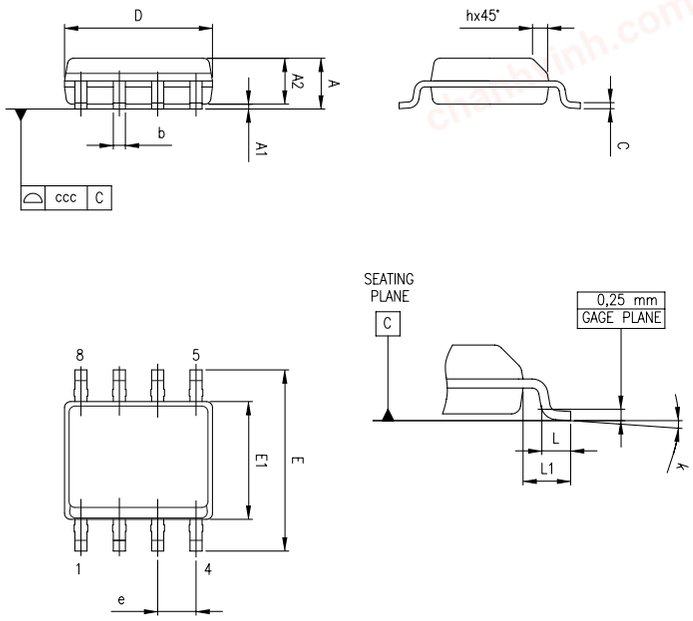


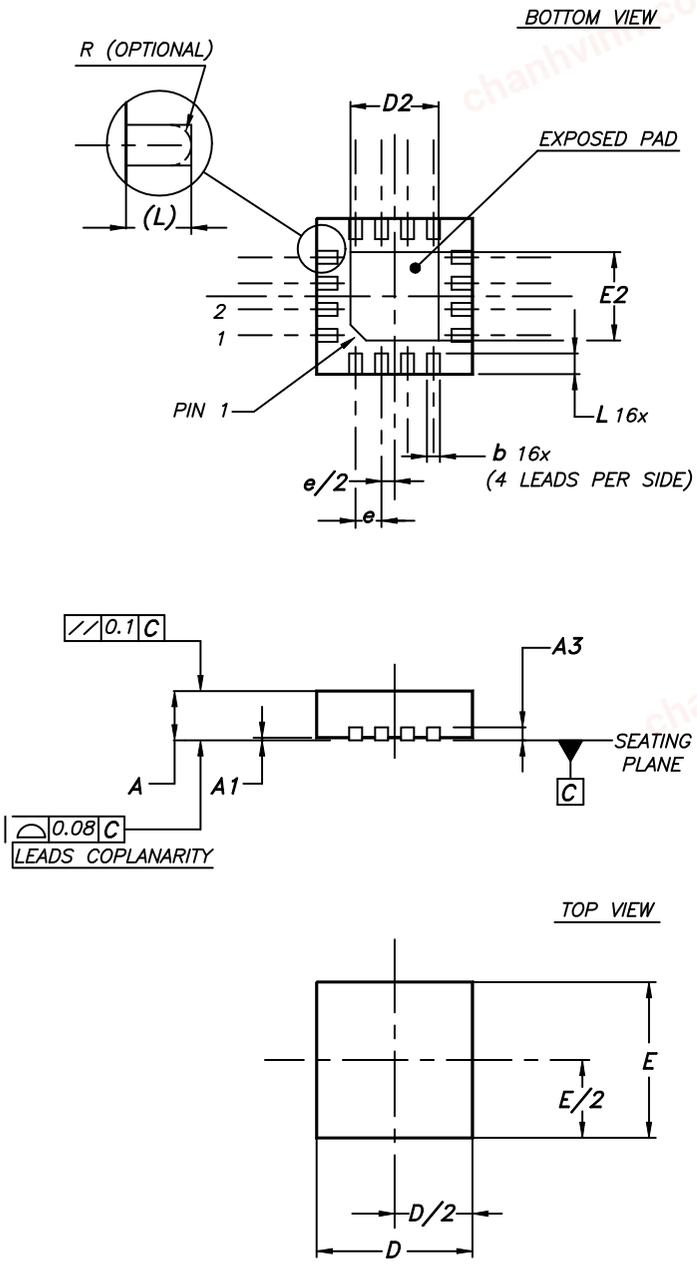
Table 11. **SO8 package mechanical data**

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.04		0.010
A2	1.25			0.049		
b	0.28	0.40	0.48	0.011	0.016	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	0.635	1.27	0.016		0.050
L1		1.04			0.040	
k	1°		8°	1°		8°
ccc			0.10			0.004

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4.6 QFN16 3x3 package information

Figure 8. **QFN16 3x3 package outline**



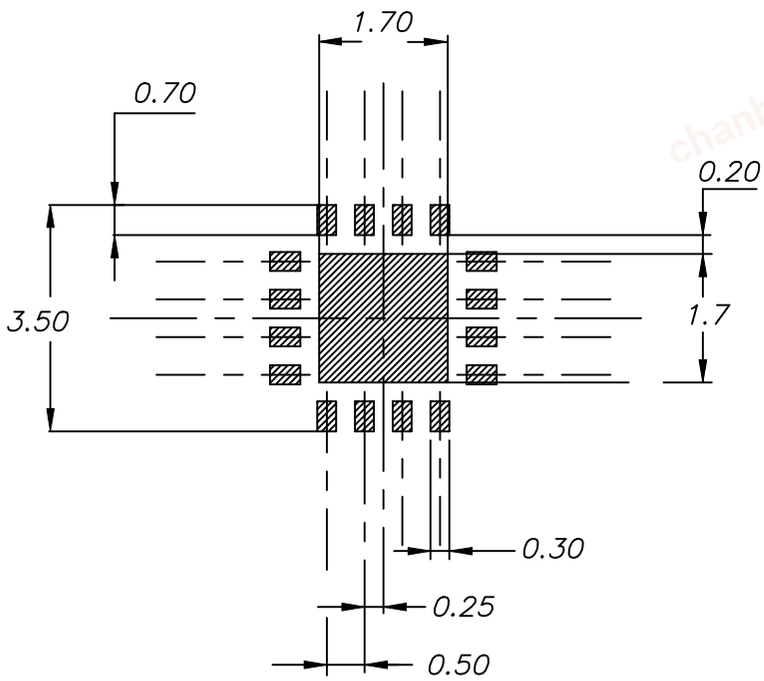
Note: The exposed pad is not internally connected and can be set to ground or left floating.

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Table 12. **QFN16 3x3 mechanical data**

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.80	0.90	1.00	0.031	0.035	0.039
A1	0		0.05	0		0.002
A3		0.20			0.008	
b	0.18		0.30	0.007		0.012
D	2.90	3.00	3.10	0.114	0.118	0.122
D2	1.50		1.80	0.059		0.071
E	2.90	3.00	3.10	0.114	0.118	0.122
E2	1.50		1.80	0.059		0.071
e		0.50			0.020	
L	0.30		0.50	0.012		0.020

Figure 9. **QFN16 3x3 recommended footprint**



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4.7 TSSOP-14 package information

Figure 10. **TSSOP-14 package outline**

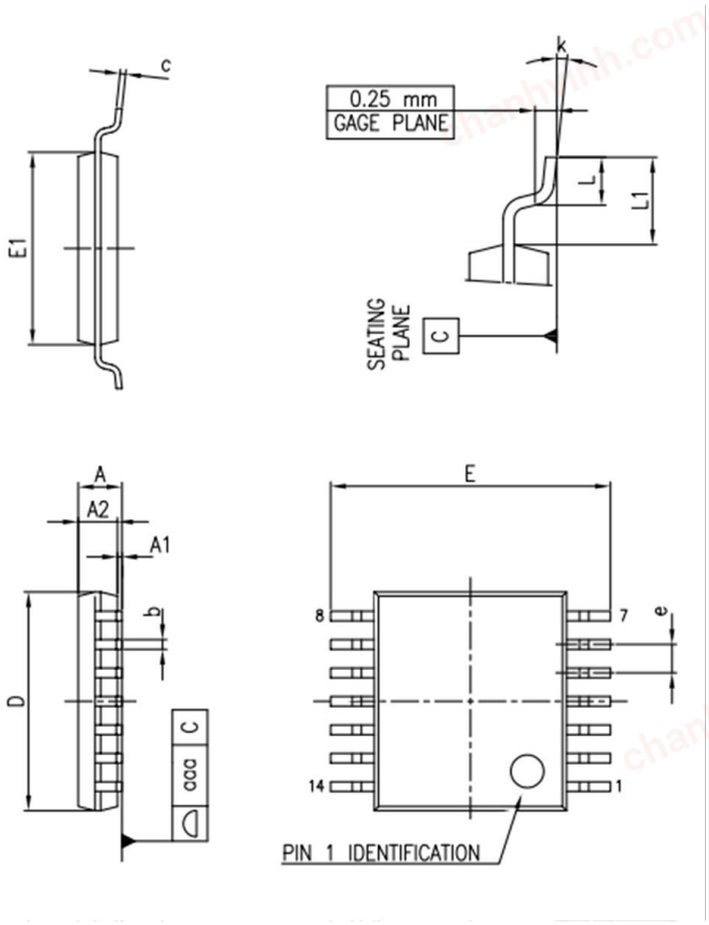


Table 13. **TSSOP-14 mechanical data**

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

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5 Ordering information

Table 14. **Order codes**

Order code	Temperature range	Package	Packaging	Marking
TSL6901ICT	-40 to 125 °C	SC70-5	Tape and reel	K61
TSL6901ILT		SOT23-5		K553
TSL6902IQ2T		DFN82x2		K63
TSL6902IST		MiniSO8		K554
TSL6902IDT		SO8		TSL6902I
TSL6904IQ4T		QFN163x3		K555
TSL6904IPT		TSSOP14		TSL6904I
TSL6901IYCT (1)	-40 to 125 °C automotive grade	SC70-5		K62
TSL6901IYLT (1)		SOT23-5		K556
TSL6902IYDT (1)		SO8		K557
TSL6902IYST (1)		MiniSO8		K558
TSL6904IYPT (1)		TSSOP14		TSL6904IY

1. *Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q002 or equivalent. For qualification status details, check "Maturity status link" on the first page ("Quality & Reliability" tab on www.st.com).*

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Revision history

Table 15. **Document revision history**

Date	Revision	Changes
20-Feb-2025	1	Initial release.

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