



钜地半导体
Tudi Semiconductor

Product Specification

TUDI-TSV911/912/914

Rail-to-Rail Input/Output, 8 MHz Operational Amplifier

网址 www.sztdbdt.com

用芯智造 · 卓越品质

**semiconductor device
manufacturer**

- Design
- research and development
- production
- and sales



Features

- Track-to-track input and output
- Low noise: 18 nV/√ Hz at 1 kHz
- Low power consumption: 550μA (typical value)
- High gain bandwidth: 8MHz
- Power supply voltage range: 2.5V to 5.5V
- Low input bias current: 1 pA (typical value)
- Low input offset voltage: 1.9 mV (maximum value)
- Low offset voltage drift: ±0.5 μV/°C (typical value)
- ESD internal protection: ±4kV Human Body Model (HBM)
- Extended temperature range: -40°C to +125°C

Description

The TSV91x series of single-channel, dual-channel, and four-channel operational amplifiers are designed for general-purpose applications. These devices feature rail-to-rail input and output (RRIO) swing, wide bandwidth (8 MHz), and low offset voltage (typical value of 0.3 mV), making them ideal for applications requiring a good balance between speed and power consumption. With stable unit gain and extremely low input bias current, these operational amplifiers are suitable for applications involving high source impedance. Additionally, their low input bias current makes them ideal for sensor interfaces, battery-powered and portable applications, as well as active filtering.

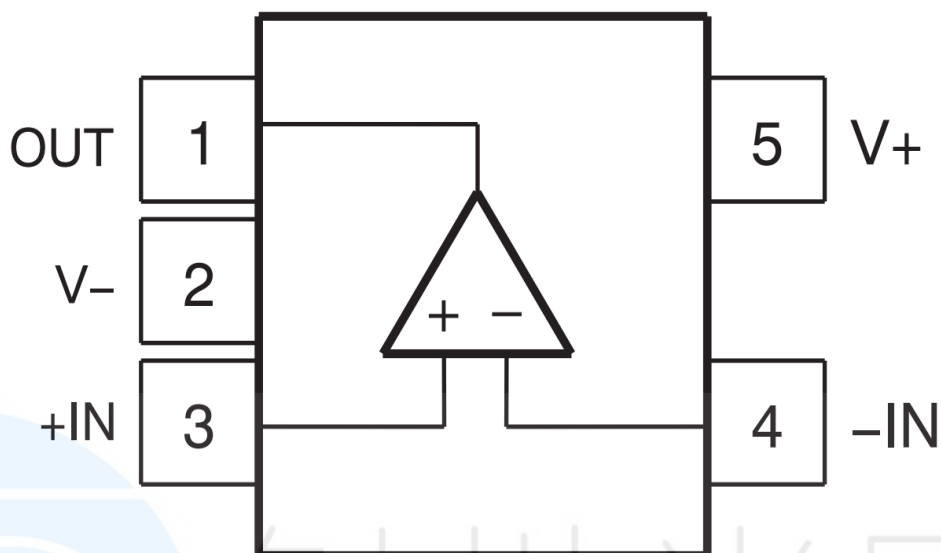
TSV91x features a robust and durable design for easy use by circuit designers. Its characteristics include an integrated RFI-EMI suppression filter with unit gain stability, no inversion under overdrive conditions, and high electrostatic discharge (ESD) protection (4kV HBM).

Applications

- Battery-powered applications
- electric machine control
- power-supply module
- HVAC: Heating, Ventilation, and Air Conditioning
- washing machine
- ice box
- medical instruments
- active filter
- Sensor signal conditioning
- Audio Receiver
- Vehicle infotainment



Pin Diagram and Functions

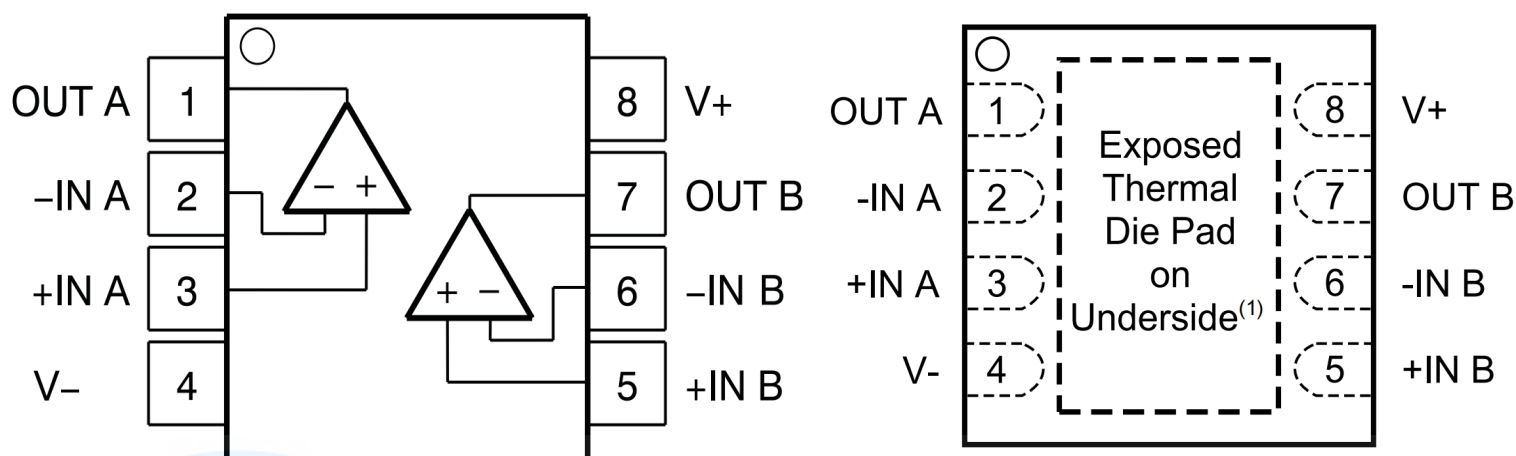


TSV911 SOT23-5/SC70-5 Pin Diagram

NO.	Name	Description
4	-IN	Inverse input
3	+IN	Non-inverting input
1	OUT	Output
2	V-	Negative(minimum)power supply or grounding (for single power supply)
5	V+	Maximum power supply

TSV911 Functions

Pin Diagram and Functions



TSV912 SOT23-8/SOP8/MSOP8/TSSOP8 Pin Diagram

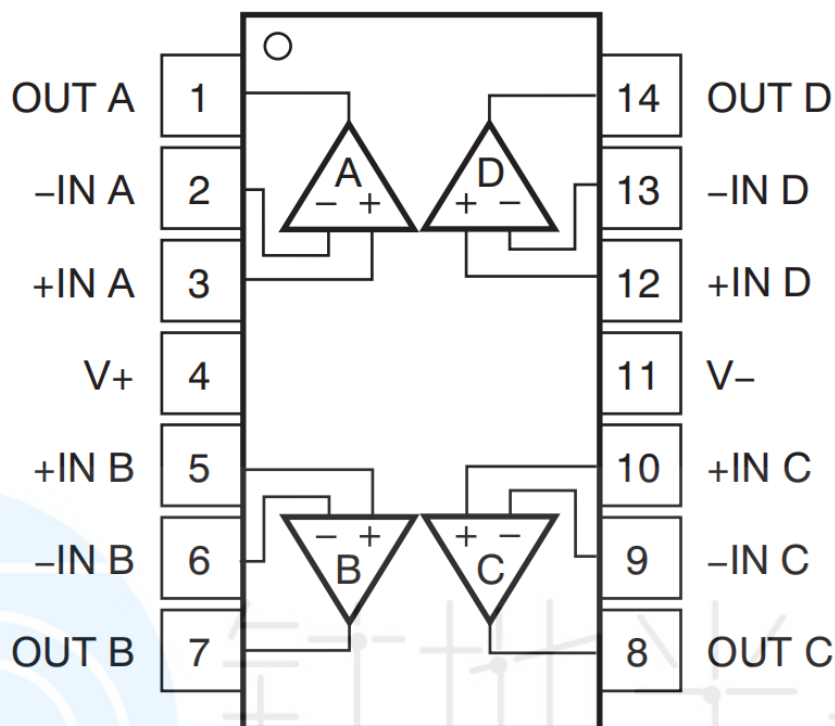
QFN-8(2*2) Pin Diagram

NO.	Name	Description
2	-IN A	Reverse input,Channel A
3	+IN A	Same-phase input,channel A
6	-IN B	Reverse-phase input,channel B
5	+IN B	Same-phase input,channel B
1	OUT A	Output,Channel A
7	OUT B	Output,Channel B
4	V-	Negative(minimum)power supply or grounding(for single power supply)
8	V+	Maximum power supply

TSV912 Functions



Pin Diagram and Functions



TSV914 SOP14/TSSOP14 Pin Diagram

NO.	Name	Description
2	-IN A	Reverse input,Channel A
3	+IN A	Same-phase input,channel A
6	-IN B	Reverse-phase input,channel B
5	+IN B	Same-phase input,channel B
9	-IN C	Inverted input,channel C
10	+IN C	Same-phase input,channel C
13	-IN D	Reverse input,Channel D
12	+IN D	Same-phase input,channel D



1	OUT A	Output,Channel A
7	OUT B	Output,Channel B
8	OUT C	Output,Channel C
14	OUT D	Output,Channel D
11	V-	Negative(minimum)power supply or grounding(for single power supply)
4	V+	Maximum power supply

TSV914 Functions

Product Specification

Parameter	Rating	Unit
DC Supply Voltage	2.5V-5.5V	V
Input common-mode voltage range	-Vs ~ +Vs	V
Operating ambient temperature	-40 to 125	°C

Recommended Operating Conditions



Electrical Characteristics

(+Vs=+5V,-Vs=0,VeM=Vs/2,TA=+25°C,RL=10kΩ to Vs/2,unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Out Characteristics						
Output Voltage Swing from Rail		RL=100kΩ		1		mV
		RL=10kΩ		8		mV
		RL=2kΩ		40		mV
Short-Circuit Current	IoUT	Sourcing		21		mA
		Sinking		22		mA
Input Characteristics						
Input Offset Voltage	Vos			±0.6	±5	mV
Input Offset Voltage Drift	ΔVos/ΔT	-40 to 125°C		±2.0		μV°C
Input Bias Current	IB			±2.5		pA
Input Offset Current	Ios			±2.5		pA
Common-Mode Voltage Range	VcM	Vs =5.5V	-0.1		5.6	V
Common-Mode Rejection Ratio	CMRR	VcM=0.1V to 4.9V		125		dB
Open-Loop Voltage Gain	AOL	Vo=0.2V to 4.8V		120		dB
Dynamic Performance						
Gain Bandwidth Product	GBWP	G=+1		10		MHz
Slew Rate	SR	G=+1,2V Output Step		7.5		V/μs
Noise Performance						
Voltage Noise Density	en	f=1kHz		12		nVl √Hz
Power Supply						
Operating Voltage Range			2.5		5.5	V
Power Supply Rejection Ratio	PSRR	VS = 2.5V-5.5V	80	100		dB
Quiescent Current /Amplifier	Io			650		μA



Absolute Maximum Ratings

Parameter	Rating	Units
Power Supply: +Vs to -Vs	6.0	V
Input Voltage	-Vs -0.5V to +Vs+0.5V	V
Input Current(2)	10	mA
Storage Temperature Range	-65 to 150	°C
Junction Temperature	150	°C
Operating Temperature Range	-40 to 125	°C
ESD Susceptibility,HBM	2000	V

(1) Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

(2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current-limited to 10mA or less.

Application Notes

Driving Capacitive Loads

Driving large capacitive loads can cause stability problems for voltage feedback op amps. As the load capacitance increases, the feedback loop's phase margin decreases, and the closed loop bandwidth is reduced. This produces gain peaking in the frequency response, with overshoot and ringing in the step response. A unity gain buffer ($G = +1$) is the most sensitive to capacitive loads, but all gains show the same general behavior.

When driving large capacitive loads with these op amps (e.g., >100 pF when $G = +1$), a small series resistor at the output (R_{iso} in Figure 1) improves the feedback loop's phase margin (stability) by making the output load resistive at higher frequencies. It does not, however, improve the bandwidth. To select R_{iso} , check the frequency response peaking (or step response overshoot) on the bench. If the response is reasonable, you do not need R_{iso} . Otherwise, start R_{iso} at $1k\Omega$ and modify its value until the response is reasonable.

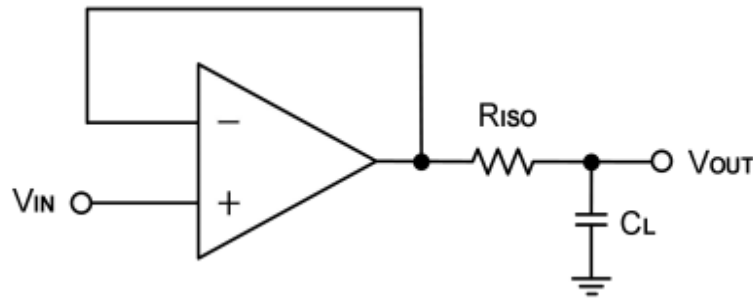


Figure 1. Indirectly Driving Heavy Capacitive Load

An improvement circuit is shown in Figure 2. It provides DC accuracy as well as AC stability. R_F provides the DC accuracy by connecting the inverting signal with the output, C_F and R_{iso} serve to counteract the loss of phase margin by feeding the high frequency component of the output signal back to the amplifier's inverting input, thereby preserving phase margin in the overall feedback loop.

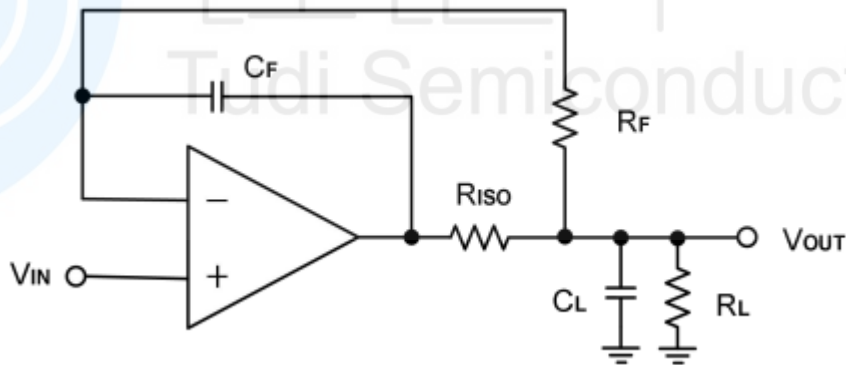


Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy

For non-inverting configuration, there are two others ways to increase the phase margin:

- (a) by increasing the amplifier's gain or
- (b) by placing a capacitor in parallel with the feedback resistor to counteract the parasitic capacitance associated with inverting node, as shown in Figure 3.

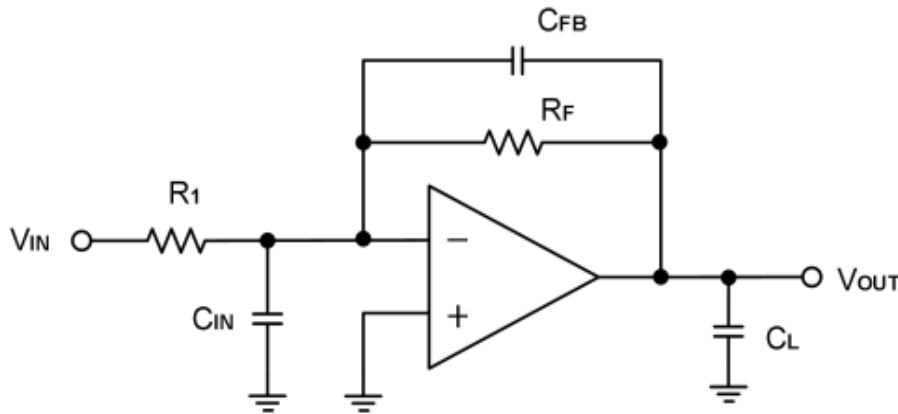


Figure 3. Adding a Feedback Capacitor in the Non-inverting Configuration

Power-Supply Bypassing and Layout

The TSV91x operates from a single +2.5V to +5.5V supply or dual $\pm 1.05\text{V}$ to $\pm 2.75\text{V}$ supplies. For single-supply operation, bypass the power supply +Vs with a $0.1\mu\text{F}$ ceramic capacitor which should be placed close to the +Vs pin. For dual-supply operation, both the +Vs and the -Vs supplies should be bypassed to ground with separate $0.1\mu\text{F}$ ceramic capacitors. $2.2\mu\text{F}$ tantalum capacitor can be added for better performance.

The length of the current path is directly proportional to the magnitude of parasitic inductances and thus the high frequency impedance of the path. High speed currents in an inductive ground return create an unwanted voltage noise. Broad ground plane areas will reduce the parasitic inductance. Thus a ground plane layer is important for high speed circuit design.

Typical Application Circuits

Differential Amplifier

The circuit shown in Figure 4 performs the differential function. If the resistors ratios are equal ($R_4 / R_3 = R_2 / R_1$), then $V_{OUT} = (V_{IP} - V_{IN}) \times R_2 / R_1 + V_{REF}$.

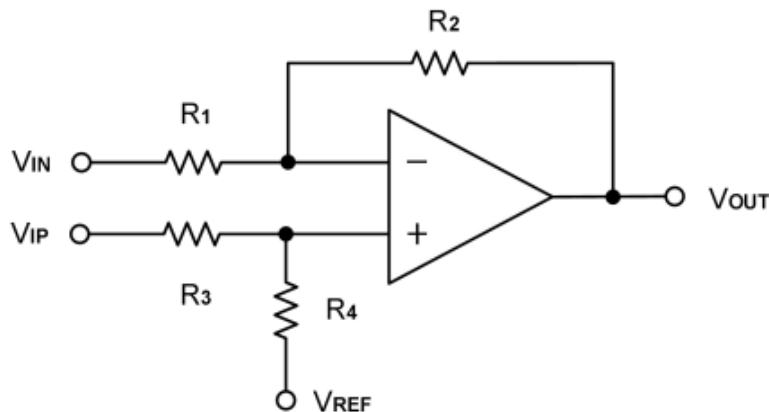


Figure 4. Differential Amplifier

Low Pass Active Filter

When receiving low-level signals, limiting the bandwidth of the incoming signals into the system is often required. The simplest way to establish this limited bandwidth is to place an RC filter at the noninverting terminal of the amplifier. If even more attenuation is needed, a multiple pole filter is required. The Sallen-Key filter can be used for this task, as Figure 5. For best results, the amplifier should have a bandwidth that is 8 to 10 times the filter frequency bandwidth. Failure to follow this guideline can result in reduction of phase margin. The large values of feedback resistors can couple with parasitic capacitance and cause undesired effects such as ringing or oscillation in high-speed amplifiers. Keep resistors value as low as possible and consistent with output loading consideration.

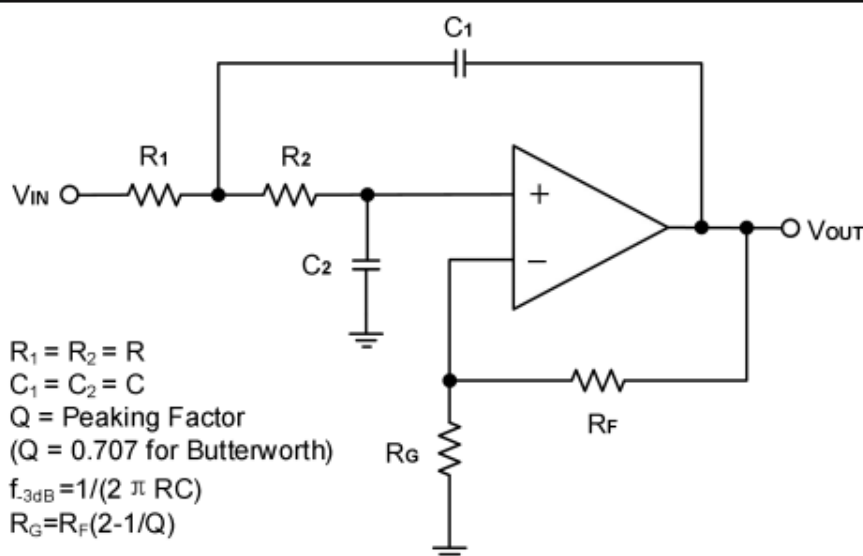
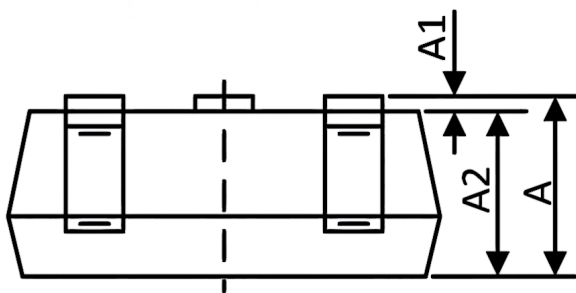
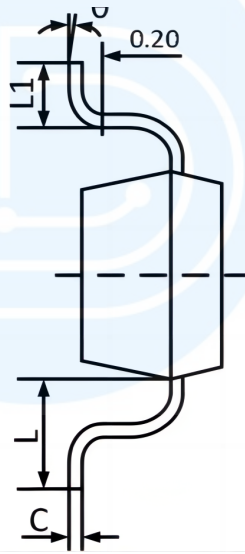
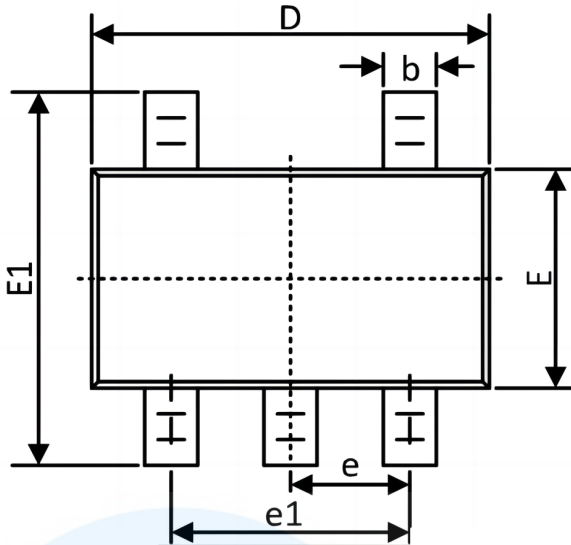


Figure 5. Two-Pole Low-Pass Sallen-Key Active Filter



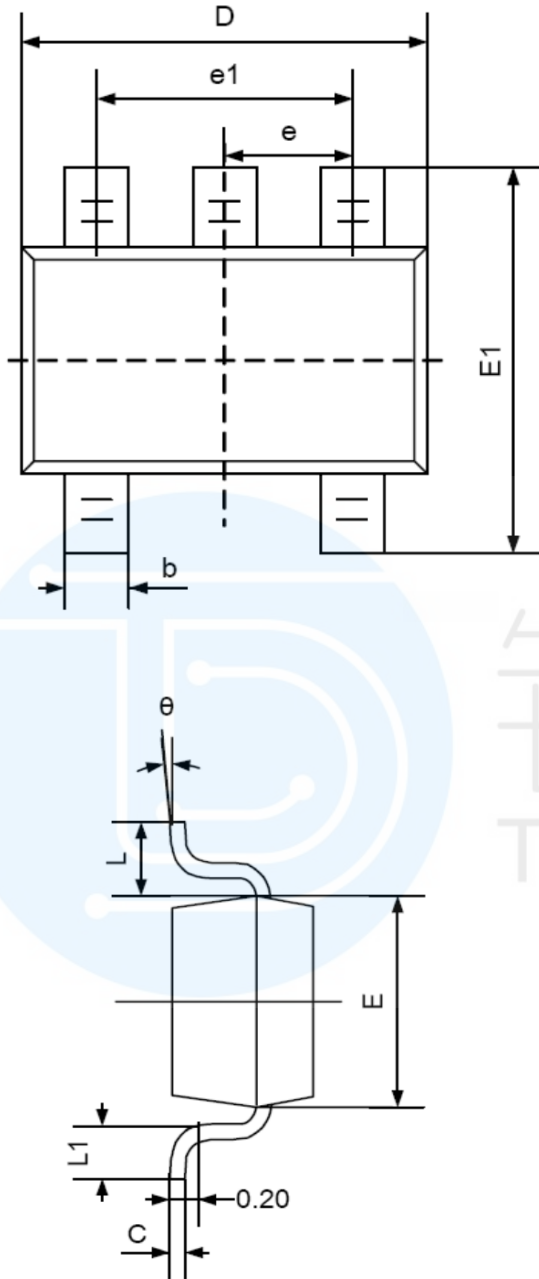
Package SOT23-5



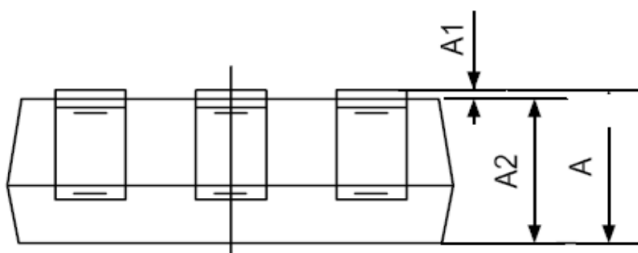
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
C	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
e1	1.800	2.000	0.071	0.079
L	0.700REF		0.028REF	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°



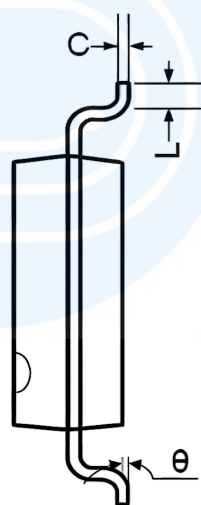
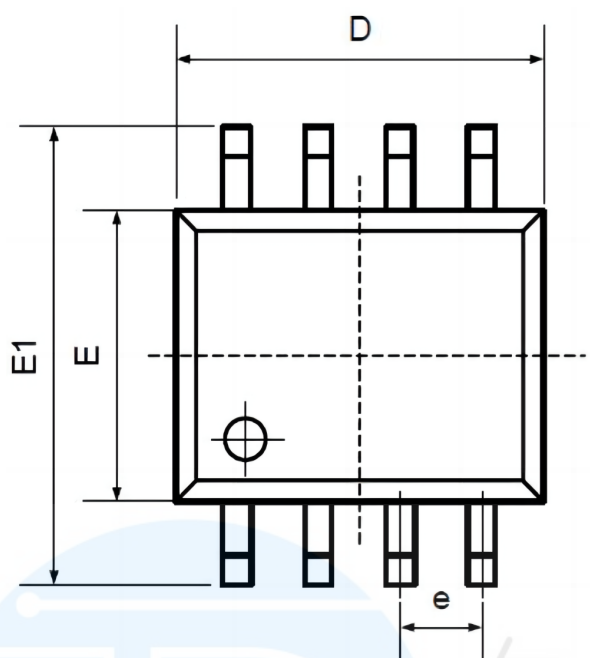
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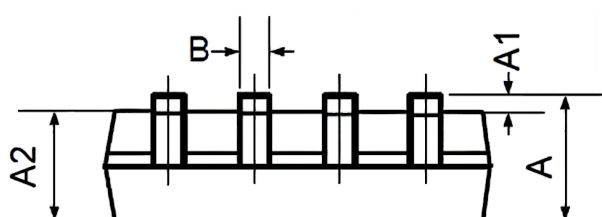
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	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
C	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650TYP		0.026TYP	
e1	1.200	1.400	0.047	0.055
L	0.525REF		0.021REF	
L1	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°



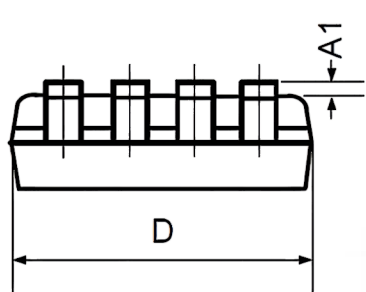
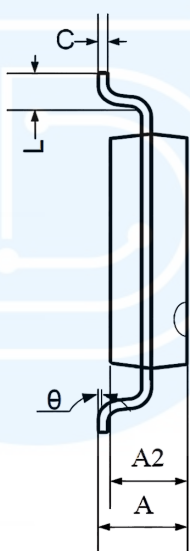
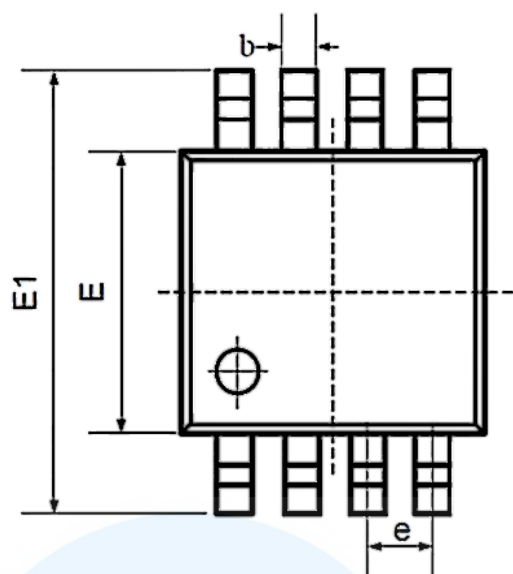
Package SOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.780	5.000	0.188	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270TYP		0.050TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°



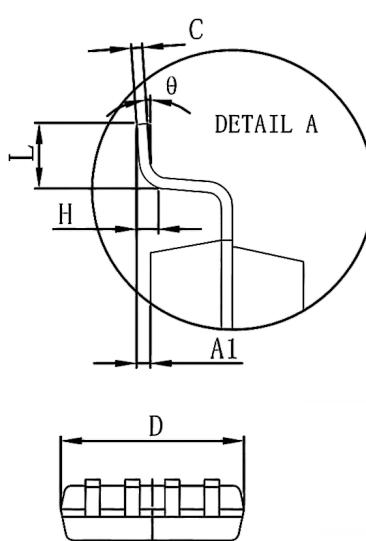
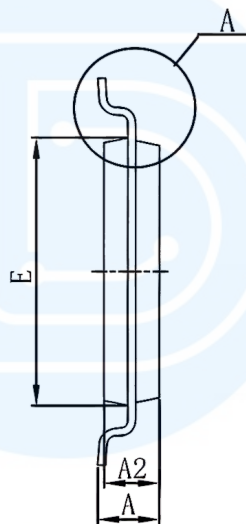
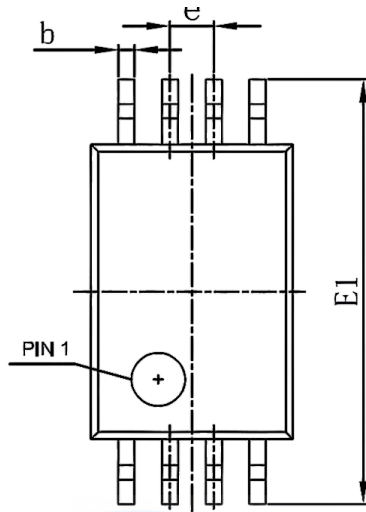
Package MSOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.200	0.031	0.047
A1	0.000	0.200	0.000	0.008
A2	0.760	0.970	0.030	0.038
b	0.30 TYP		0.012 TYP	
C	0.15 TYP		0.006 TYP	
D	2.900	3.100	0.114	0.122
e	0.65 TYP		0.026 TYP	
E	2.900	3.100	0.114	0.122
E1	4.700	5.100	0.185	0.201
L	0.410	0.650	0.016	0.026
θ	0°	6°	0°	6°

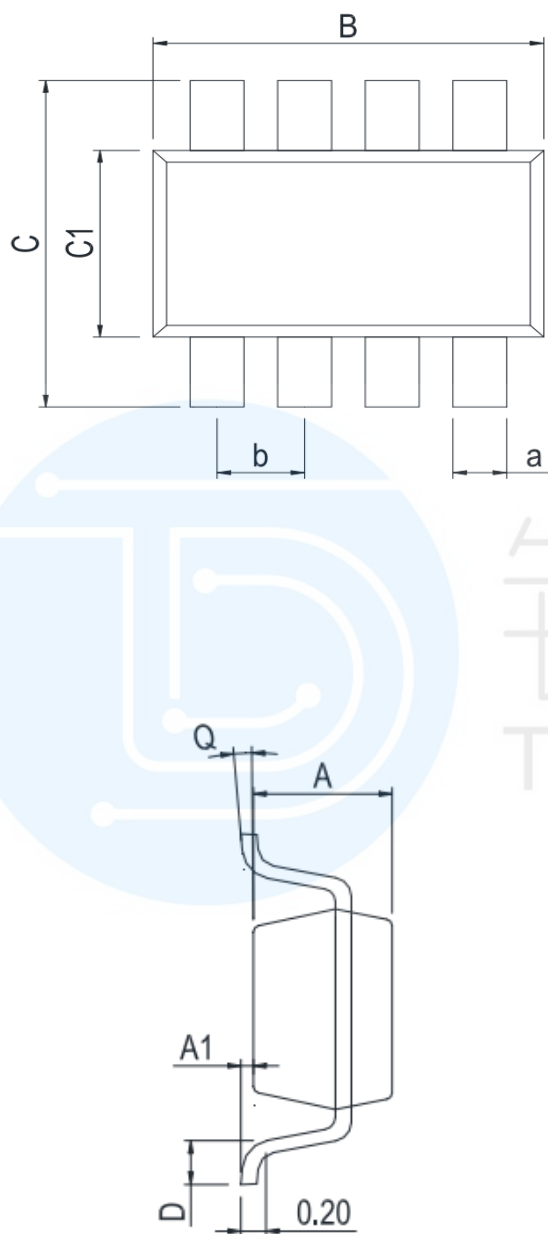


Package TSSOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
D	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
b	0.190	0.300	0.007	0.012
C	0.090	0.200	0.004	0.008
E1	6.250	6.550	0.246	0.258
A		1.200		0.047
A2	0.800	1.000	0.031	0.039
A1	0.050	0.150	0.002	0.006
e	0.65(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°		1°	

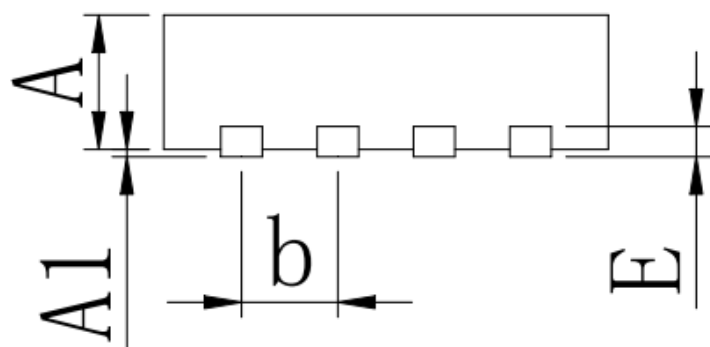
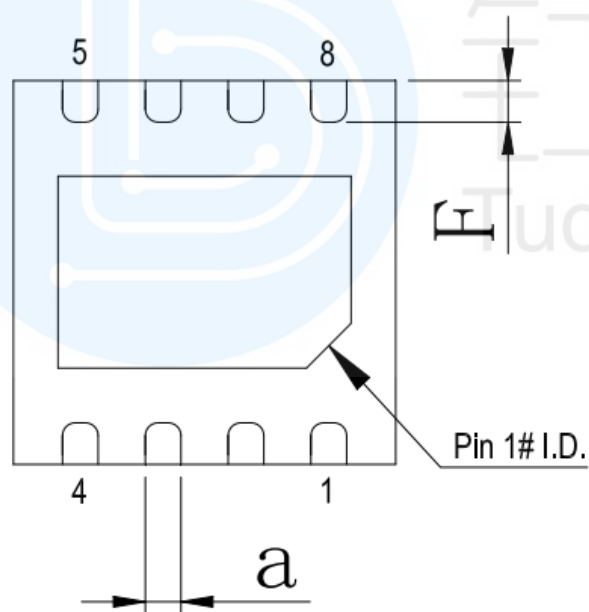
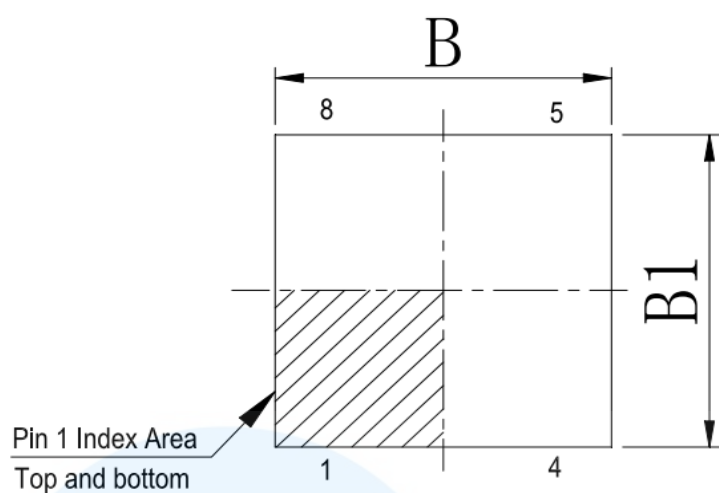
Package SOT23-8



Symbol	Dimensions In Millimeters	
	Min	Max
A	1.050	1.150
A1	0.000	0.150
B	2.820	3.020
C	2.65	2.95
C1	1.5	1.7
D	0.300	0.600
Q	0°	8°
a	0.300	0.400
b	0.65 BSC	



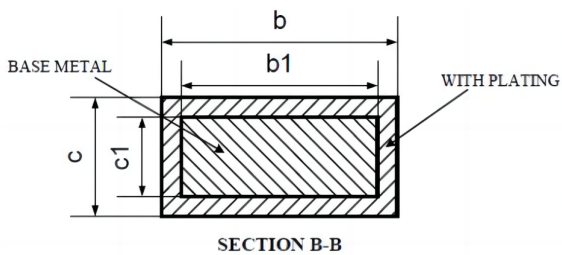
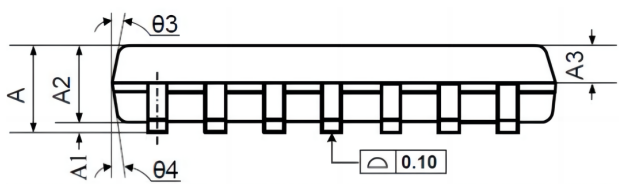
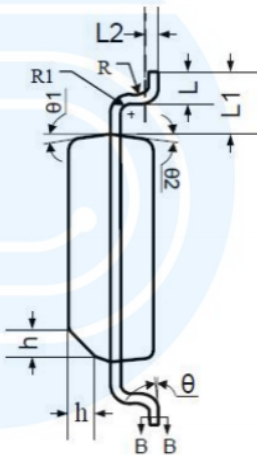
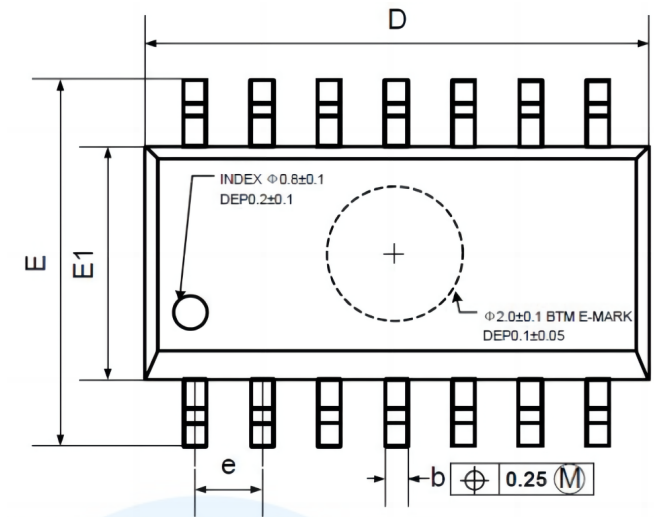
Package DFN-8 2*2



Symbol	Dimensions In Millimeters	
	Min	Max
A	0.850	0.950
A1	0.000	0.050
B	2.900	3.100
B1	2.90	3.10
E	0.2	0.3
F	0.300	0.500
a	0.200	0.340
b	0.65 BSC	



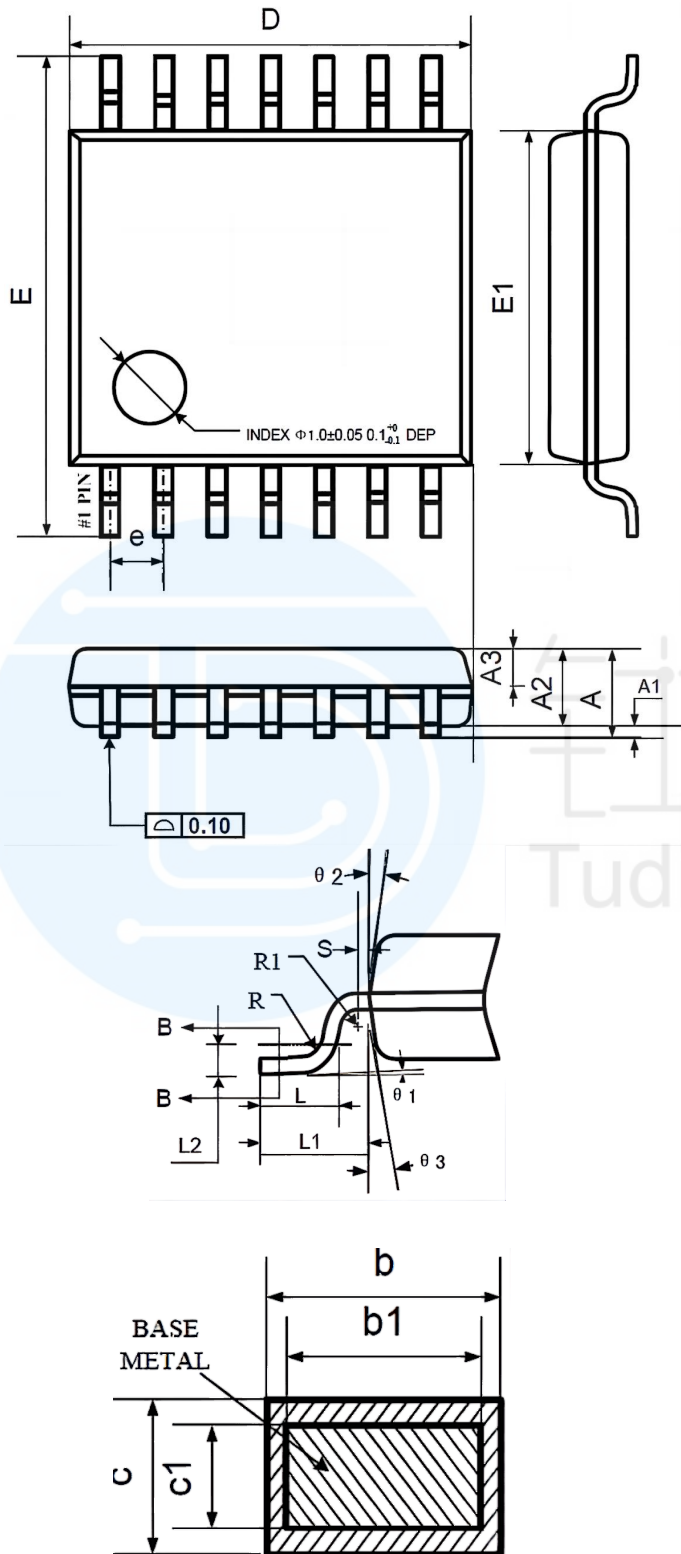
Package SOP14



Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	1.35	1.60	1.75
A1	0.10	0.15	0.25
A2	1.25	1.45	1.65
A3	0.55	0.65	0.75
b	0.36		0.49
b1	0.35	0.40	0.45
C	0.16		0.25
c1	0.15	0.20	0.25
D	8.53	8.63	8.73
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
L	0.45	0.60	0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07		
R1	0.07		
h	0.30	0.40	0.50
theta	0°		8°
theta1	6°	8°	10°
theta2	6°	8°	10°
theta3	5°	7°	9°
theta4	5°	7°	9°



Package TSSOP14



Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.90	1.00	1.05
A3	0.34	0.44	0.54
b	0.20	—	0.28
b1	0.20	0.22	0.24
C	0.10	—	0.19
c1	0.10	0.13	0.15
D	4.86	4.96	5.06
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 REF		
L2	0.25 BSC		
R	0.09	—	—
R1	0.09	—	—
S	0.20	—	—
$\theta 1$	0°	—	8°
$\theta 2$	10°	12°	14°
$\theta 3$	10°	12°	14°



Order information

Order Number	Package	Package Quantity	Marking On The park	Temperature
TSV911AIDBVR-TUDI	SOT23-5	Tape,Reel,3000	1U2F	-40°C to 125°C
TSV911AIDCKR-TUDI	SC70-5	Tape,Reel,3000	1EK	
TSV912AIDDFR-TUDI	SOT23-8	Tape,Reel,3000	T12A	
TSV912AIDGKR-TUDI	MSOP8	Tape,Reel,2500	T912	
TSV912AIDR-TUDI	SOP8	Tape,Reel,2500	TSV912	
TSV912AIDSGR-TUDI	QFN-8	Tape,Reel,3000	T912	
TSV912AIPWR-TUDI	TSSOP8	Tape,Reel,2000	TSV912	
TSV914AIDR-TUDI	SOP14	Tape,Reel,2500	TSV914AD	
TSV914AIPWR-TUDI	TSSOP14	Tape,Reel,2000	TSV914	



Important statement:

- TUDI Semiconductor reserves the right to modify the product manual without prior notice! Before placing an order, customers need to confirm whether the obtained information is the latest version and verify the completeness of the relevant information.
- Any semi-guide product is subject to failure or malfunction under specified conditions. It is the buyer's responsibility to comply with safety standards when using TUDI Semiconductor products for system design and whole machine manufacturing. And take the appropriate safety measures to avoid the potential in the risk of loss of personal injury or loss of property situation!
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