



钜地半导体
Tudi Semiconductor

Product Specification

TUDI-TSV911/TSV912/TSV914

Single, dual, and quad rail-to-rail input/output 8 MHz operational amplifiers

网址 www.sztdbdt.com 🔍

用芯智造 · 卓越品质

**semiconductor device
manufacturer**

- Design
- research and development
- production
- and sales



Features

- Rail-to-rail input and output
- Wide bandwidth
- Low power consumption: 820 μA typ.
- Unity gain stability
- High output current: 35 mA
- Operating from 2.5 V to 5.5 V
- Low input bias current, 1 pA typ.
- Low input offset voltage: 1.5 mV max. (A grade)
- ESD internal protection ≥ 5 kV
- Latch-up immunity

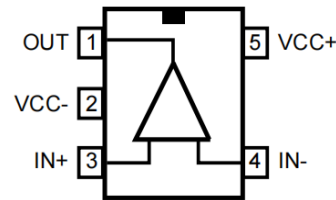
Applications

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

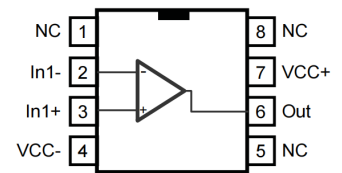
Description

The TSV91x and TSV91xA operational amplifiers (op amps) offer low voltage operation and rail-to-rail input and output, as well as an excellent speed/power consumption ratio, providing an 8 MHz gain-bandwidth product while consuming only 1.1 mA maximum at 5 V. The op amps are unity gain stable and feature an ultra-low input bias current.

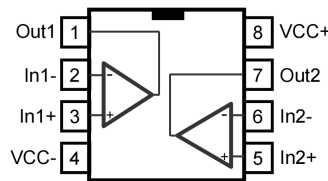
The devices are ideal for sensor interfaces, battery-supplied and portable applications, as well as active filtering.



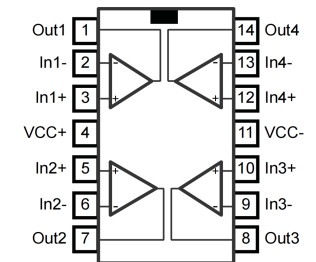
SOT23-5



SOP8 (single)



MiniSO8



SOP14, TSSOP14



2

Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings (AMR)

Symbol	Parameter		Value	Unit
V_{CC}	Supply voltage ⁽¹⁾		6	V
V_{id}	Differential input voltage ⁽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)}	SOT23-5	250	°C/W
		DFN8 2x2	57	
		SO8	125	
		MiniSO8	190	
		SO14	103	
		TSSOP14	100	
R_{thjc}	Thermal resistance junction to case ^{(5) (6)}	SOT23-5	81	
		SO8	40	
		MiniSO8	39	
		SO14	31	
		TSSOP14	32	
ESD	HBM: human body model ⁽⁷⁾		5	kV
	MM: machine model ⁽⁸⁾		400	V
	CDM: charged device model ⁽⁹⁾	SOT23-5, SO8, MiniSO8	1500	
		TSSOP14	750	
		SO14	500	
	Latch-up immunity		200	mA

1. All voltage values, except the 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. $V_{CC} - V_{IN}$ must not exceed 6 V
4. Input current must be limited by a resistor in series with the inputs
5. Short-circuits can cause excessive heating and destructive dissipation.
6. R_{th} are typical values
7. 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.
8. Machine model: 200 pF 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 packages are charged together to the specified voltage and then discharged directly to the ground.



3 Electrical characteristics

Table 3. Electrical characteristics at $V_{CC+} = 2.5\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, with R_L connected to $V_{CC}/2$, $T = 25\text{ }^{\circ}\text{C}$ (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V _{io}	Offset voltage, TSV91x	T _{op} = 25 °C		0.1	4.5	mV
		T _{min} < T _{op} < T _{max}			7.5	
	Offset voltage, TSV91xA	T _{op} = 25 °C			1.5	
		T _{min} < T _{op} < T _{max}			3	
ΔV _{io} /ΔT	Input offset voltage drift			5		μV/°C
I _{io}	Input offset current ⁽¹⁾	T _{op} = 25 °C		1	10	pA
		T _{min} < T _{op} < T _{max}			100	
I _{ib}	Input bias current ⁽¹⁾	T _{op} = 25 °C		1	10	
		T _{min} < T _{op} < T _{max}			100	
CMR	Common mode rejection ratio,20 log (ΔV _{ic} /ΔV _{io})	0 V to 2.5 V, V _{out} = 1.25 V, T _{op} = 25 °C	58	75		dB
		T _{min} < T _{op} < T _{max}	53			
A _{vd}	Large signal voltage gain	R _L = 10 kΩ, V _{out} = 0.5 V to 2 V, T _{op} = 25 °C	80	89		
		T _{min} < T _{op} < T _{max}	75			
V _{CC} - V _{OH}	High-level output voltage	R _L = 10 kΩ		15	40	mV
		T _{min} < T _{op} < T _{max}			40	
		R _L = 600 Ω		45	150	
		T _{min} < T _{op} < T _{max}			150	
V _{OL}	Low-level output voltage	R _L = 10 kΩ		15	40	
		T _{min} < T _{op} < T _{max}			40	
		R _L = 600 Ω		45	150	
		T _{min} < T _{op} < T _{max}			150	
I _{out}	I _{sink}	V _o = 2.5 V, T _{op} = 25 °C	18	32		mA
		T _{min} < T _{op} < T _{max}	16			
	I _{source}	V _o = 0 V, T _{op} = 25 °C	18	35		
		T _{min} < T _{op} < T _{max}	16			
I _{CC}	Supply current (per channel)	No load, V _{out} = V _{CC} /2		0.78	1.1	
		T _{min} < T _{op} < T _{max}			1.1	
AC performance						
GBP	Gain bandwidth product	R _L = 2 kΩ, C _L = 100 pF, f = 100 kHz, T _{op} = 25 °C		8		MHz
F _u	Unity gain frequency	R _L = 2 kΩ, C _L = 100 pF, T _{op} = 25 °C		7.2		
φ _m	Phase margin	R _L = 2 kΩ, C _L = 100 pF, T _{op} = 25 °C		45		Degrees



Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
G_m	Gain margin	$R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $T_{op} = 25\text{ }^\circ\text{C}$		8		dB
SR	Slew rate	$R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $A_v = 1$, $T_{op} = 25\text{ }^\circ\text{C}$		4.5		V/ μs
e_n	Equivalent input noise voltage	$f = 10\text{ kHz}$, $T_{op} = 25\text{ }^\circ\text{C}$		21		nV/ $\sqrt{\text{Hz}}$
THD+ e_n	Total harmonic distortion	$G = 1$, $f = 1\text{ kHz}$, $R_L = 2\text{ k}\Omega$, $BW = 22\text{ kHz}$, $T_{op} = 25\text{ }^\circ\text{C}$, $V_{icm} = (V_{CC} + 1)/2$, $V_{out} = 1.1\text{ V}_{pp}$		0.001		%

1. Guaranteed by design

Table 2. Operating conditions

Symbol	Parameter		Value	Unit
V_{CC}	Supply voltage	$-40\text{ }^\circ\text{C} < T_{op} < 125\text{ }^\circ\text{C}$	2.5 to 5.5	V
		$0\text{ }^\circ\text{C} < T_{op} < 125\text{ }^\circ\text{C}$	2.3 to 5.5	
V_{icm}	Common mode input voltage range		$(V_{CC-}) - 0.1$ to $(V_{CC+}) + 0.1$	
T_{op}	Operating free air temperature range		-40 to 125	$^\circ\text{C}$



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

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V _{io}	Offset voltage, TSV91x	T _{op} = 25 °C		0.1	4.5	mV
		T _{min} < T _{op} < T _{max}			7.5	
	Offset voltage, TSV91xA	T _{op} = 25 °C			1.5	
		T _{min} < T _{op} < T _{max}			3	
ΔV _{io} /ΔT	Input offset voltage drift			5		μV/°C
I _{io}	Input offset current ⁽¹⁾	T _{op} = 25 °C		1	10	pA
		T _{min} < T _{op} < T _{max}			100	
I _{ib}	Input bias current ⁽¹⁾	T _{op} = 25 °C		1	10	
		T _{min} < T _{op} < T _{max}			100	
CMR	Common mode rejection ratio, 20 log (ΔV _{ic} /ΔV _{io})	0 V to 3.3 V, V _{out} = 1.65 V, T _{op} = 25 °C	60	78		dB
		T _{min} < T _{op} < T _{max}	55			
A _{vd}	Large signal voltage gain	R _L = 10 kΩ, V _{out} = 0.5 V to 2.8 V, T _{op} = 25 °C	80	89		
		T _{min} < T _{op} < T _{max}	75			
V _{CC} - V _{OH}	High-level output voltage	R _L = 10 kΩ		15	40	mV
		T _{min} < T _{op} < T _{max}			40	
		R _L = 600 Ω		45	150	
		T _{min} < T _{op} < T _{max}			150	
V _{OL}	Low-level output voltage	R _L = 10 kΩ		15	40	
		T _{min} < T _{op} < T _{max}			40	
		R _L = 600 Ω		45	150	
		T _{min} < T _{op} < T _{max}			150	
I _{out}	I _{sink}	V _o = 3.3 V, T _{op} = 25 °C	18	32		mA
		T _{min} < T _{op} < T _{max}	16			
	I _{source}	V _o = 0 V, T _{op} = 25 °C	18	35		
		T _{min} < T _{op} < T _{max}	16			
I _{CC}	Supply current (per channel)	No load, V _{out} = V _{CC} /2		0.8	1.1	
		T _{min} < T _{op} < T _{max}			1.1	
AC performance						
GBP	Gain bandwidth product	R _L = 2 kΩ, C _L = 100 pF, f = 100 kHz, T _{op} = 25 °C		8		MHz
F _u	Unity gain frequency	R _L = 2 kΩ, C _L = 100 pF, T _{op} = 25 °C		7.2		
φ _m	Phase margin	R _L = 2 kΩ, C _L = 100 pF, T _{op} = 25 °C		45		Degrees
G _m	Gain margin	R _L = 2 kΩ, C _L = 100 pF, T _{op} = 25 °C		8		dB



Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
SR	Slew rate	$R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $A_v = 1$, $T_{op} = 25\text{ }^\circ\text{C}$		4.5		V/ μs
e_n	Equivalent input noise voltage	$f = 10\text{ kHz}$, $T_{op} = 25\text{ }^\circ\text{C}$		21		nV/ $\sqrt{\text{Hz}}$
THD+ e_n	Total harmonic distortion	$G = 1$, $f = 1\text{ kHz}$, $R_L = 2\text{ k}\Omega$, $BW = 22\text{ kHz}$, $T_{op} = 25\text{ }^\circ\text{C}$, $V_{icm} = (V_{CC} + 1)/2$, $V_{out} = 1.9\text{ V}_{pp}$		0.0007		%

1. Guaranteed by design



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

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V _{io}	Offset voltage, TSV91x	T _{op} = 25 °C		0.1	4.5	mV
		T _{min} < T _{op} < T _{max}			7.5	
	Offset voltage, TSV91xA	T _{op} = 25 °C			1.5	
		T _{min} < T _{op} < T _{max}			3	
ΔV _{io} /ΔT	Input offset voltage drift			5		μV/°C
I _{io}	Input offset current ⁽¹⁾	T _{op} = 25 °C		1	10	pA
		T _{min} < T _{op} < T _{max}			100	
I _{ib}	Input bias current ⁽¹⁾	T _{op} = 25 °C		1	10	
		T _{min} < T _{op} < T _{max}			100	
CMR	Common mode rejection ratio, 20 log (ΔV _{ic} /ΔV _{io})	0 V to 5 V, V _{out} = 2.5 V, T _{op} = 25 °C	62	82		dB
		T _{min} < T _{op} < T _{max}	58			
SVR	Supply voltage rejection ratio, 20 log (ΔV _{CC} /ΔV _{io})	V _{CC} = 2.5 to 5 V	70	86		
A _{vd}	Large signal voltage gain	R _L = 10 kΩ, V _{out} = 0.5 V to 4.5 V, T _{op} = 25 °C	80	91		
		T _{min} < T _{op} < T _{max}	75			
V _{CC} - V _{OH}	High-level output voltage	R _L = 10 kΩ		15	40	mV
		T _{min} < T _{op} < T _{max}			40	
		R _L = 600 Ω		45	150	
		T _{min} < T _{op} < T _{max}			150	
V _{OL}	Low-level output voltage	R _L = 10 kΩ		15	40	
		T _{min} < T _{op} < T _{max}			40	
		R _L = 600 Ω		45	150	
		T _{min} < T _{op} < T _{max}			150	
I _{out}	I _{sink}	V _o = 5 V, T _{op} = 25 °C	18	32		mA
		T _{min} < T _{op} < T _{max}	16			
	I _{source}	V _o = 0 V, T _{op} = 25 °C	18	35		
		T _{min} < T _{op} < T _{max}	16			
I _{CC}	Supply current (per channel)	No load, V _{out} = 2.5 V		0.78	1.1	
		T _{min} < T _{op} < T _{max}			1.1	
AC performance						
GBP	Gain bandwidth product	R _L = 2 kΩ, C _L = 100 pF, f = 100 kHz, T _{op} = 25 °C		8		MHz
F _u	Unity gain frequency	R _L = 2 kΩ, C _L = 100 pF, T _{op} = 25 °C		7.5		
φ _m	Phase margin	R _L = 2 kΩ, C _L = 100 pF, T _{op} = 25 °C		45		Degrees
G _m	Gain margin	R _L = 2 kΩ, C _L = 100 pF, T _{op} = 25 °C		8		dB



Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
SR	Slew rate	$R_L = 2\text{ k}\Omega$, $C_L = 100\text{ pF}$, $A_v = 1$, $T_{op} = 25\text{ }^\circ\text{C}$		4.5		V/ μs
e_n	Equivalent input noise voltage	$f = 1\text{ kHz}$, $T_{op} = 25\text{ }^\circ\text{C}$		27		nV/ $\sqrt{\text{Hz}}$
		$f = 10\text{ kHz}$, $T_{op} = 25\text{ }^\circ\text{C}$		21		
THD+ e_n	Total harmonic distortion	$G = 1$, $f = 1\text{ kHz}$, $R_L = 2\text{ k}\Omega$, $BW = 22\text{ kHz}$, $T_{op} = 25\text{ }^\circ\text{C}$, $V_{icm} = (V_{CC} + 1)/2$, $V_{out} = 3.6\text{ V}_{pp}$		0.0004		%

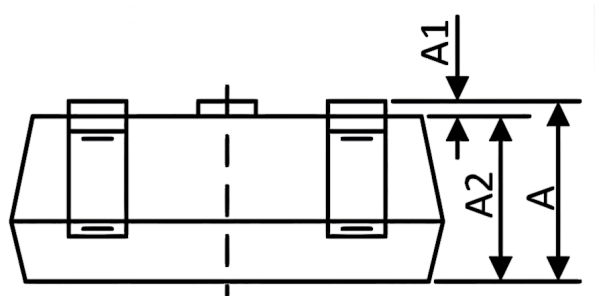
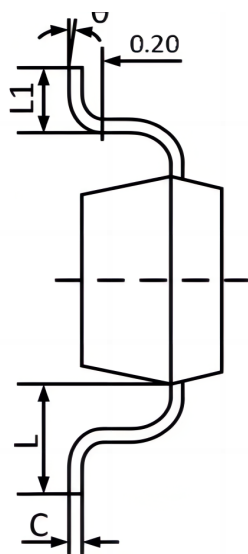
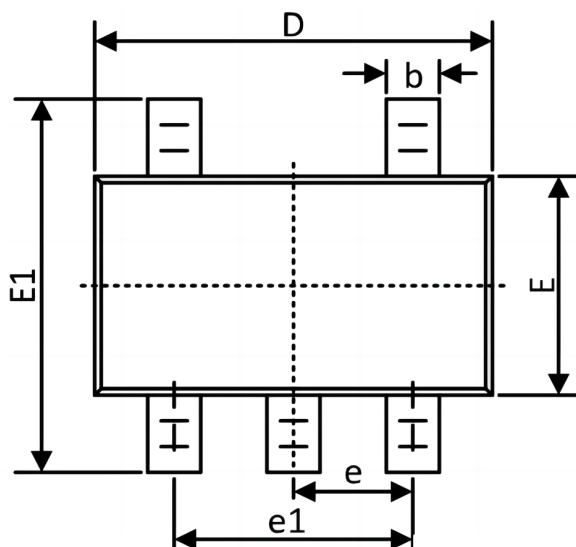
1. Guaranteed by design



Order information

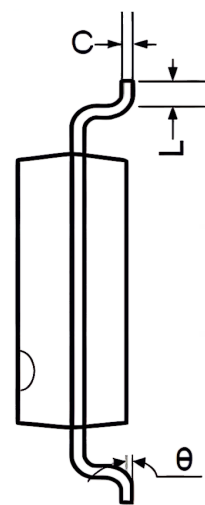
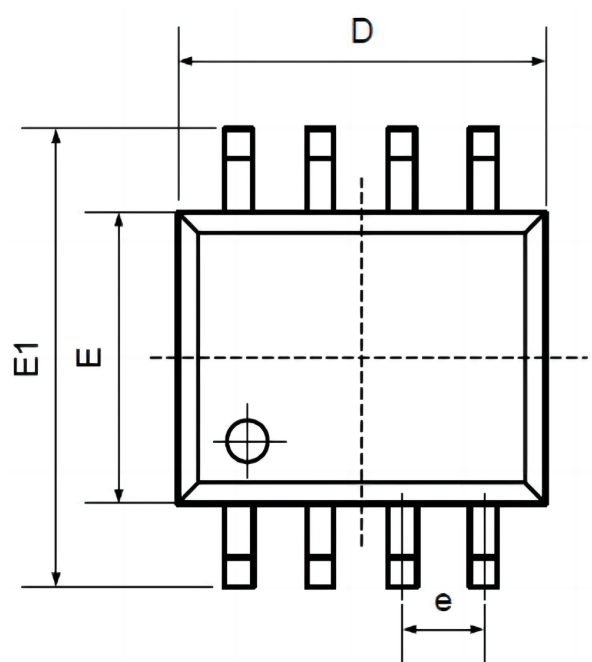
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TSV911IDT-TUDI	SOP8	Tape,Reel,2500	TSV911IDT
TSV911ILT-TUDI	SOT23	Tape,Reel,3000	TSV911ILT
TSV911IYDT-TUDI	SOP8	Tape,Reel,2500	TSV911IYDT
TSV912AIDGKT-TUDI	MSOP8	Tape,Reel,2500	TSV912AIDGKT
TSV912AQDGKRQ1-TUDI	MSOP8	Tape,Reel,2500	TSV912AQDGKRQ1
TSV912AQDRQ1-TUDI	SOP8	Tape,Reel,2500	TSV912AQDRQ1
TSV912HYDT-TUDI	SOP8	Tape,Reel,2500	TSV912HYDT
TSV912IDT-TUDI	SOP8	Tape,Reel,2500	TSV912IDT
TSV912IST-TUDI	MSOP8	Tape,Reel,2500	TSV912IST
TSV914AQDRQ1-TUDI	SOP14	Tape,Reel,2500	TSV914AQDRQ1
TSV914AQPWRQ1-TUDI	TSSOP14	Tape,Reel,2500	TSV914AQPWRQ1
TSV914IDT-TUDI	SOP14	Tape,Reel,2500	TSV914IDT

Package SOT23-5

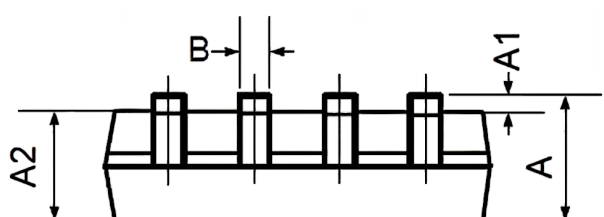


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
C	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
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°

Package SOP8

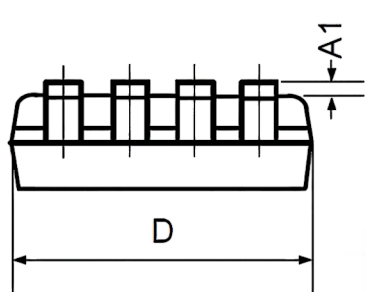
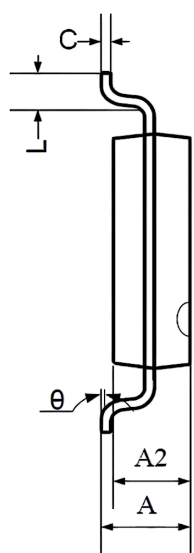
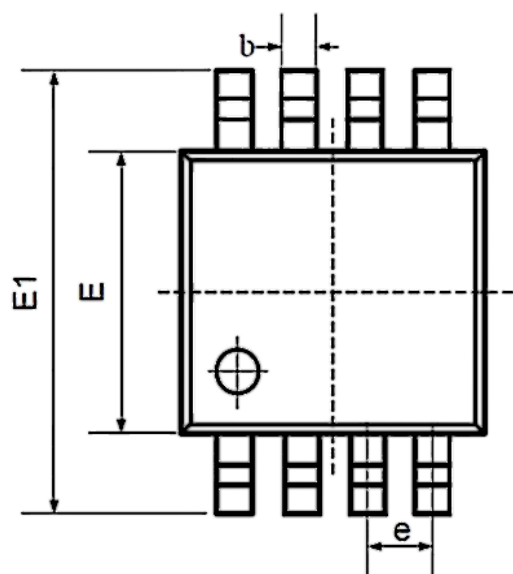


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.780	5.000	0.188	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270TYP		0.050TYP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



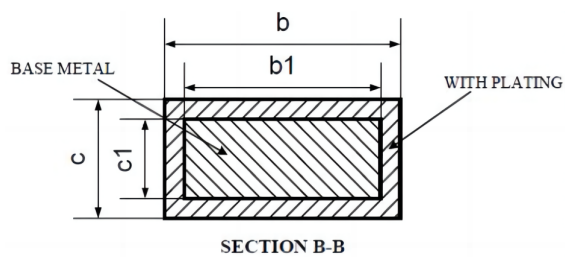
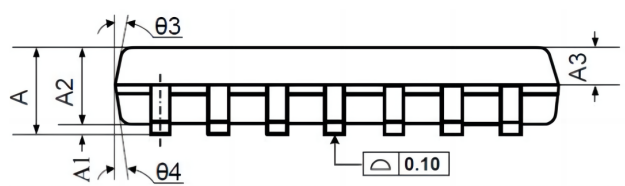
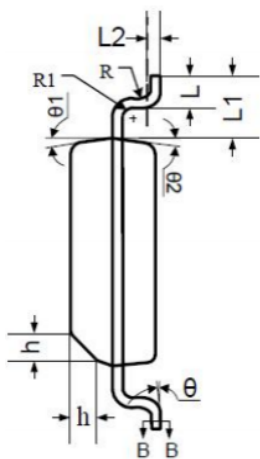
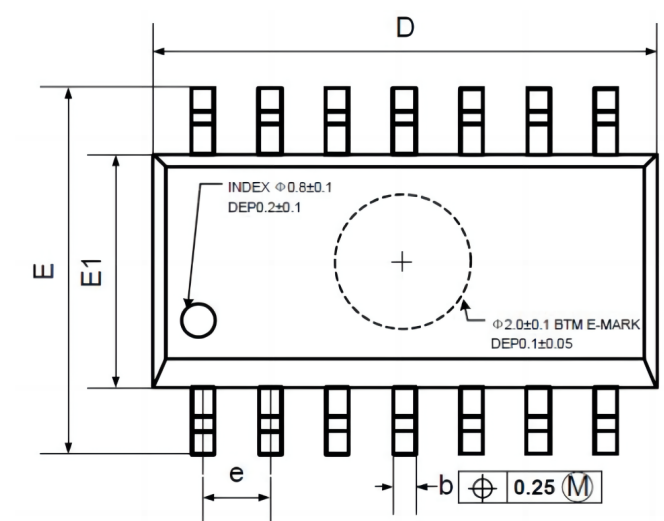


Package MSOP8



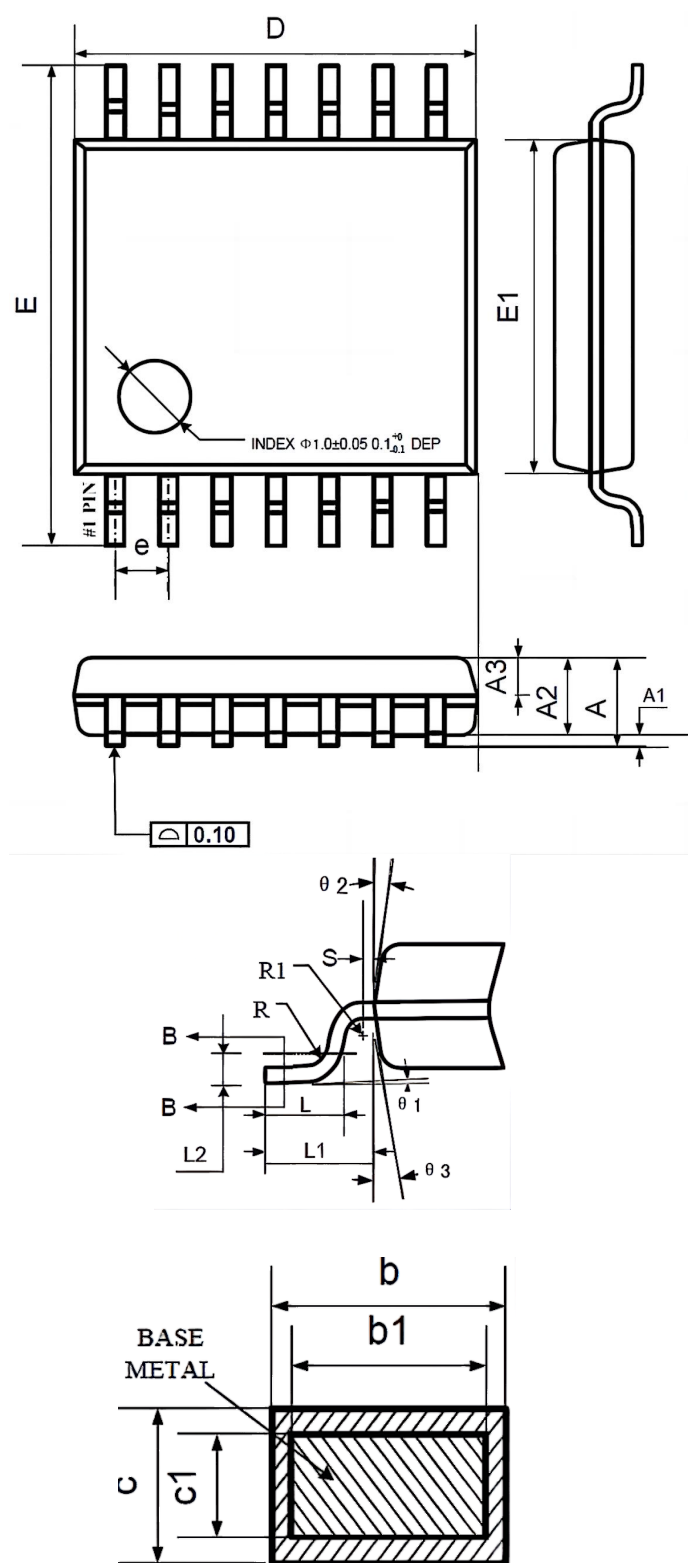
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.200	0.031	0.047
A1	0.000	0.200	0.000	0.008
A2	0.760	0.970	0.030	0.038
b	0.30 TYP		0.012 TYP	
C	0.15 TYP		0.006 TYP	
D	2.900	3.100	0.114	0.122
e	0.65 TYP		0.026 TYP	
E	2.900	3.100	0.114	0.122
E1	4.700	5.100	0.185	0.201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

Package 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
θ	0°		8°
θ1	6°	8°	10°
θ2	6°	8°	10°
θ3	5°	7°	9°
θ4	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°



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