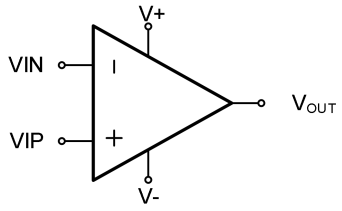
General-Purpose Low-Voltage Open-Drain Output Comparator

1 Features	2 Application
- Supply range: +1.8V to +5.5V **- Low supply current 50μA per channel at Vs =5V** **- Input common-Mode voltage range includes ground** **- Operating temperature from -40℃ to +125℃** **- Low output saturation voltage 170mV typical** **- Open-Drain output for maximum flexibility**	**- Hysteresis comparators** **- Oscillators** **- Window comparators** **- Industrial equipment** **- Test and measurement**

3 Description	Circuit Diagram
The SL331 and SL393 is the single and dual comparator version, the SL339 is quad comparator version, and both are open-drain output comparators for maximum flexibility. It can operate from 1.8V to 5.5V, and have low power consuming 50μA (TYP) per channel. The SL331, SL393 and SL339 are the most cost-effective solutions for applications where low voltage operation, low power and space saving are the primary specifications in circuit design for portable consumer products. The SL331, SL393 and SL339 are available in Green SOT23-5, SC70-5, SOP8, MSOP8, SOP14 and TSSOP14 packages. It operates over an ambient temperature range of -40°C to +125°C.	

4 Device Summary, Pin and Packages

Table. 4-1. Device Summary(1)

Serial Name	Part Name	Package	MSL(2)	Package Qty
SL331	SL331S5	SOT23-5	3	Tape and Reel,3000
SL331	SL331C5	SC70-5	3	Tape and Reel,3000
SL393	SL393P8	SOP8	3	Tape and Reel,4000
SL393	SL393M8	MSOP8	3	Tape and Reel,4000
SL339	SL339PD	SOP14	3	Tape and Reel,4000
SL339	SL339TD	TSSOP14	3	Tape and Reel,4000

(1) For all available packages, please contact product sales.

(2) MSL, The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications.

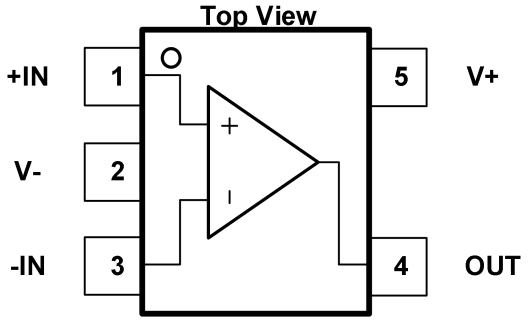


Fig.4-1. SL331: S5 (SOT23-5) Package

SL331: C5 (SC70-5) Package

Table. 4-2. Pin Definition

Pin		I/O	Description
Name	S5 C5		
+IN	1	I	Noninverting input
V-	2	-	Negative (lowest) power supply
-IN	3	I	Inverting input
OUT	4	O	Output
V+	5	-	Positive (highest) power supply

*It is suggested to leave the unconnected pins floating。

4 Device Summary, Pin and Packages(continued)

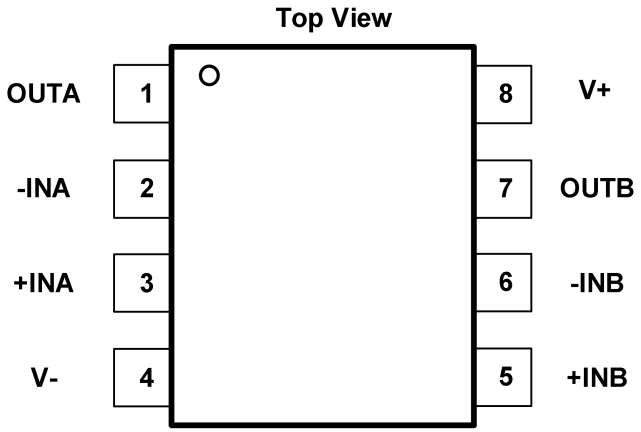


Fig.5-2. SL393: P8 (SOP8) Package

SL393: M8 (MSOP8) Package

Table. 4-3. Pin Definition

Pin		I/O	Description
Name	P8 M8		
OUTA	1	O	Output, channel A
-INA	2	I	Inverting input, channel A
+INA	3	I	Noninverting input, channel A
V-	4	-	Negative (lowest) power supply
+INB	5	I	Noninverting input, channel B
-INB	6	I	Inverting input, channel B
OUTB	7	O	Output, channel B
V+	8	-	Positive (highest) power supply

*It is suggested to leave the unconnected pins floating.

4 Device Summary, Pin and Packages(continued)

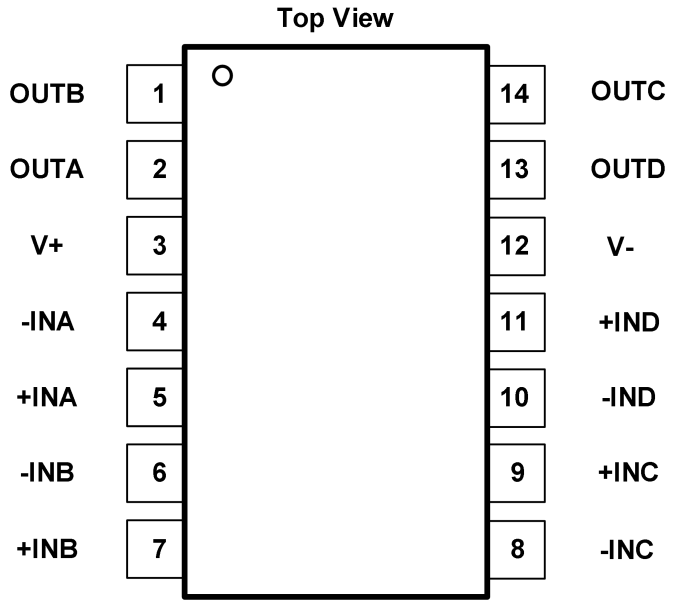


Fig.5-3. SL339:PD (SOP14) Package

SL339:TD (TSSOP14) Package

Table. 4-4. Pin Definition

Pin		I/O	Description
Name	TD PD		
OUTB	1	O	Output, channel B
OUTA	2	O	Output, channel A
V+	3	P	Positive (highest) power supply
-INA	4	I	Inverting input, channel A
+INA	5	I	Noninverting input, channel A
-INB	6	I	Inverting input, channel B
+INB	7	I	Noninverting input, channel B
-INC	8	I	Inverting input, channel C
+INC	9	I	Noninverting input, channel C
-IND	10	I	Inverting input, channel D
+IND	11	I	Noninverting input, channel D
V-	12	P	Negative (lowest) power supply
OUTD	13	O	Output, channel D
OUTC	14	O	Output, channel C

*It is suggested to leave the unconnected pins floating.

5 Voltage, Temperature, ESD and Thermal ratings

5.1 Absolute Maximum Ratings (1)

Parameters		Min.	Max.	Unit
Voltage	Supply, Vs=(V+) - (V-)		6.5	V
	Input pin (IN+, IN-) (2)	(V-)-0.3	(V+) +0.3	
	Signal output pin (3)	(V-)-0.3	(V+) +0.3	
Current	Signal input pin (IN+, IN-) (2)	-10	10	mA
	Signal output pin (3)	-55	55	mA
	Output short-circuit (4)	Continuous		
Temperature	Operating range, TA	-40	125	°C

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.

(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.

(3) Output terminals are diode-clamped to the power-supply rails. Output signals that can swing more than 0.5V beyond the supply rails should be current-limited to ±55mA or less.

(4) Short-circuit from output to VCC can cause excessive heating and eventual destruction.

5.2 ESD Ratings

ESD			Value	Unit
V(ESD)	Electrostatic discharge	Human-body model (HBM)	8 K	V
		Charged device Model (CDM)	2 K	V

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

5.3 Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted)

Parameters		MIN	NOM	MAX	UNIT
Supply voltage， Vs= (V+) - (V-)	Single-supply	1.8		5.5	V
	Dual-supply	±0.9		±2.75	

5.4 Thermal Information

Package Type	θ_{JA}	θ_{JC}	Unit
SC70-5	400	150	°C/W
SOT23-5	250	81	°C/W
MSOP8	210	45	°C/W
SOP8	158	43	°C/W
TSSOP14	180	35	°C/W
SOP4	120	36	°C/W

6 Electrical Specifications

6.1 Electrical characteristics(Vs=5.0V)

At TA=+25°C, VCM=Vs/2.(unless otherwise noted)

PARAMETER		CONDITIONS	SL331/SL393/SL339			
			MIN	TYP	MAX	UINTS
POWER SUPPLY						
Vs	Operating Voltage Range		1.8		5.5	V
IQ	Quiescent Current/per Channel			50	100	μA
PSRR	Power-Supply Rejection Ratio	Vs=1.8V to 5.5V, VCM=(V)+0.5V		57		dB
INPUT						
VOS	Input Offset Voltage		-4.5	±1.1	4.5	mV
ΔVos/ΔT	Input Offset Voltage Drift	VCM=Vs/2, -40°C≤TA≤125°C		3		μV/°C
IB	Input Bias Current			15		pA
IOS	Input Offset Current			15		pA
VCM	Common-Mode Voltage Range	TA=–40°C to 125°C	(V-)-0.1		(V+)+0.1	V
CMRR	Common-Rejection Ratio	VCM=-0.1 to 5.6V		67		dB
OUTPUT						
VSAT	Saturation Voltage	Io≤4mA		170	350	mV
VOH	Output Pull-up Voltage Range				5.6	V
IO	Output Current(sinking)	VO≤1.5V		30		mA
ILEAK	Output Leakage Current			0.01	10	nA
SWITCHING						
TPHL	Propagation Delay H To L	RPU=5.1KΩ , Overdrive=10mV		205		ns
		RPU=5.1KΩ , Overdrive=100mV		190		
TPLH	Propagation Delay L To H	RPU=5.1KΩ , Overdrive=10mV		520		
		RPU=5.1KΩ , Overdrive=100mV		475		
TF	Fall Time	RPU=5.1KΩ , Overdrive=100mV		24		ns

6 Electrical Specifications (continued)

6.2 Electrical characteristics(Vs=2.7V)

At TA=+25°C, VCM=Vs/2.(unless otherwise noted)

PARAMETER		CONDITIONS	SL331/SL393/SL339			
			MIN	TYP	MAX	UINTS
POWER SUPPLY						
Vs	Operating Voltage Range		1.8		5.5	V
IQ	Quiescent Current/per Channel			48	80	μA
PSRR	Power-Supply Rejection Ratio	Vs=1.8V to 5.5V, VCM=(V)+0.5V		57		dB
INPUT						
VOS	Input Offset Voltage		-4.5	1.1	4.5	mV
ΔVos/ΔT	Input Offset Voltage Drift	VCM=Vs/2, -40°C≤TA≤125°C		3		μV/°C
IB	Input Bias Current			15		pA
IOS	Input Offset Current			15		pA
VCM	Common-Mode Voltage Range	TA=–40°C to 125°C	(V-)-0.1		(V+)+0.1	V
CMRR	Common-Rejection Ratio	VCM=-0.1 to 2.8V		67		dB
OUTPUT						
VSAT	Saturation Voltage	Io≤2.2mA		130		mV
VOH	Output Pull-up Voltage Range				5.6	V
IO	Output Current(sinking)	VO≤1.5V		15		mA
ILEAK	Output Leakage Current			0.01	10	nA
SWITCHING						
TPHL	Propagation Delay H To L	RPU=5.1KΩ , Overdrive=10mV		192		ns
		RPU=5.1KΩ, Overdrive=100mV		185		
TPLH	Propagation Delay L To H	RPU=5.1KΩ , Overdrive=10mV		486		
		RPU=5.1KΩ, Overdrive=100mV		483		
TF	Fall Time	RPU=5.1KΩ, Overdrive=100mV		30		ns

6 Electrical Specifications (continued)

6.3 Electrical characteristics(Vs=1.8V)

At TA=+25°C, VCM=Vs/2.(unless otherwise noted)

PARAMETER		CONDITIONS	SL331/SL393/SL339			
			MIN	TYP	MAX	UINTS
POWER SUPPLY						
Vs	Operating Voltage Range		1.8		5.5	V
IQ	Quiescent Current/per Channel			40	70	μA
PSRR	Power-Supply Rejection Ratio	Vs=1.8V to 5.5V, VCM=(V)+0.5V		57		dB
INPUT						
VOS	Input Offset Voltage		-4.5	±1.1	4.5	mV
ΔVos/ΔT	Input Offset Voltage Drift	VCM=Vs/2, -40°C≤TA≤125°C		3		μV/°C
IB	Input Bias Current			15		pA
IOS	Input Offset Current			15		pA
VCM	Common-Mode Voltage Range	TA=–40°C to 125°C	(V-)-0.1		(V+)+0.1	V
CMRR	Common-Rejection Ratio	VCM=-0.1 to 1.9V		67		dB
OUTPUT						
VSAT	Saturation Voltage	Io≤1.5mA		130		mV
VOH	Output Pull-up Voltage Range				5.6	V
IO	Output Current(sinking)	VO≤0.8V		5.8		mA
ILEAK	Output Leakage Current			0.01	10	nA
SWITCHING						
TPHL	Propagation Delay H To L	RPU=5.1KΩ , Overdrive=10mV		271		ns
		RPU=5.1KΩ, Overdrive=100mV		258		
TPLH	Propagation Delay L To H	RPU=5.1KΩ , Overdrive=10mV		520		
		RPU=5.1KΩ, Overdrive=100mV		487		
TF	Fall Time	RPU=5.1KΩ, Overdrive=100mV		60		ns

7 Typical Characteristics

At TA=+25°C, VCM=Vs/2. (unless otherwise noted)

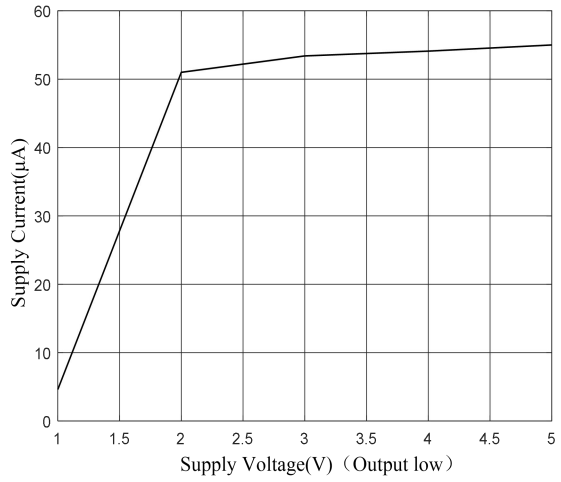


Fig.7-1. Supply Current vs Supply Voltage Output Low

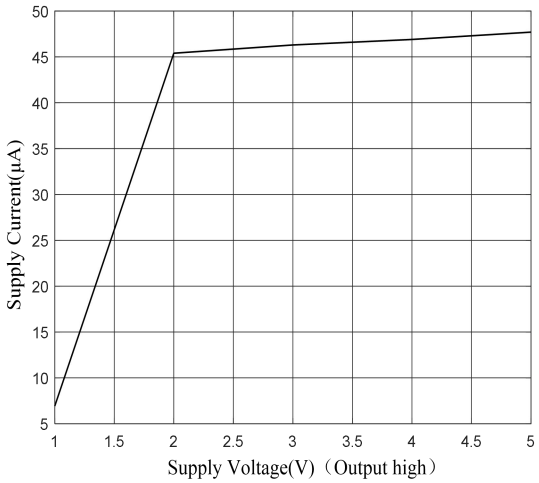


Fig.7-2. Supply Current vs Supply Voltage Output High

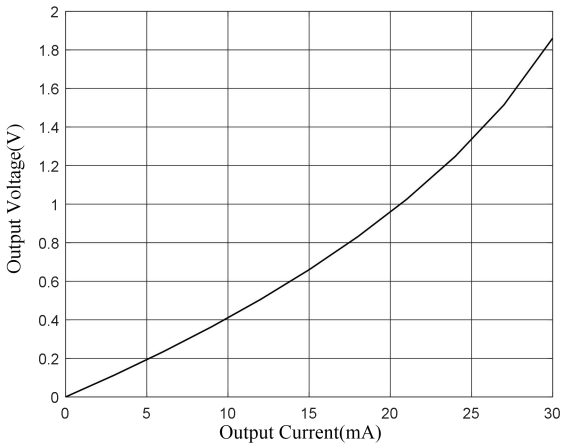


Fig.7-3. Output Voltage vs Output Current

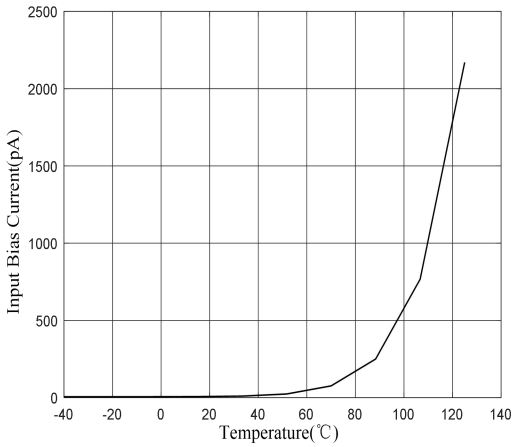


Fig.7-4. Input bias current vs temperature

8 Detailed Description

The SL331, SL393 and SL339 family of comparators can operate up to 5.5V on the supply pin. This standard device has proven ubiquity and versatility across a wide range of applications. This is due to its low power and high speed. The open-drain output allows the user to configure the output's logic low voltage (V_{OL}) and can be utilized to enable the comparator to be used in AND functionality.

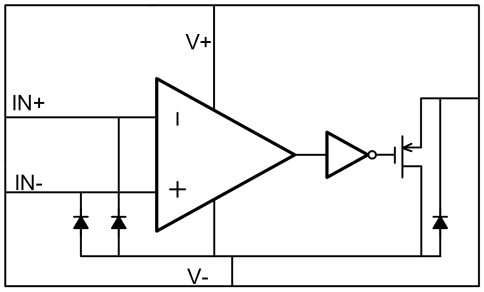


Fig.8-1. Funtional Block Diagram

9 Application Note

SL331, SL393 and SL339 will typically be used to compare a single signal to a reference or two signals against each other. Many users take advantage of the open drain output (logic high with pull-up) to drive the comparison logic output to a logic voltage level to an MCU or logic device.

For fast response and comparison applications with noisy or AC inputs, it is recommended to use a bypass capacitor on the supply pin to reject any variation on the supply voltage. This variation causes temporary fluctuations in the comparator's input common mode range and create an inaccurate comparison.

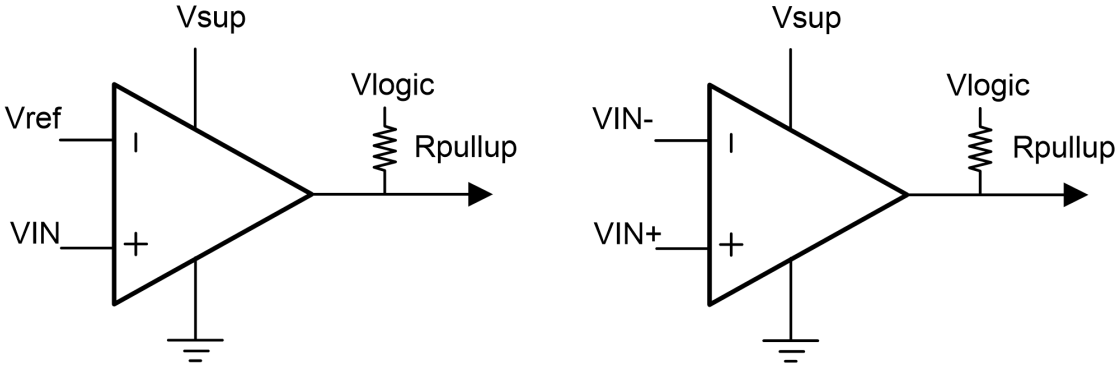
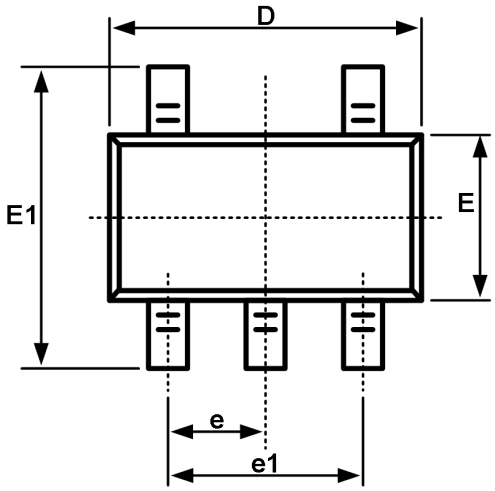
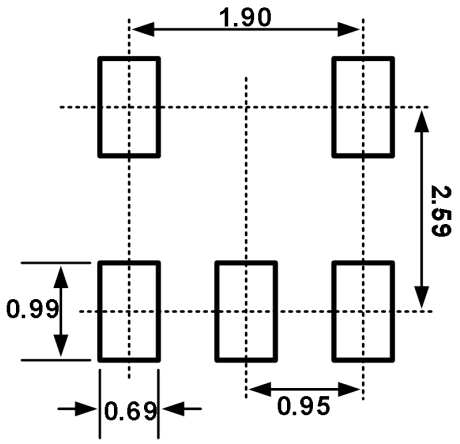


Fig.10-1. Typical Application Schematic

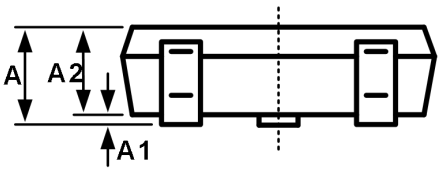
10 Package Outline Dimension

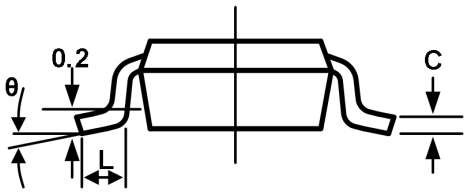
SOT23-5





Recommended Land Pattern (Unit: mm)

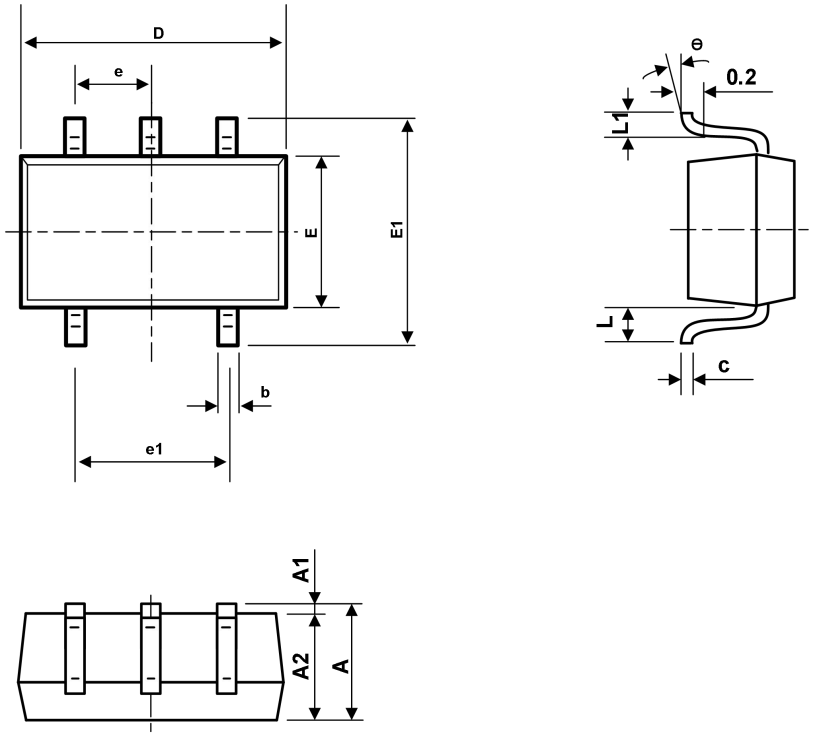




Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min.	Max.	Min.	Max.
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950BSC		0.037BSC	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
L1	0.600REF		0.024REF	
θ	0°	8°	0°	8°

10 Package Outline Dimension(continued)

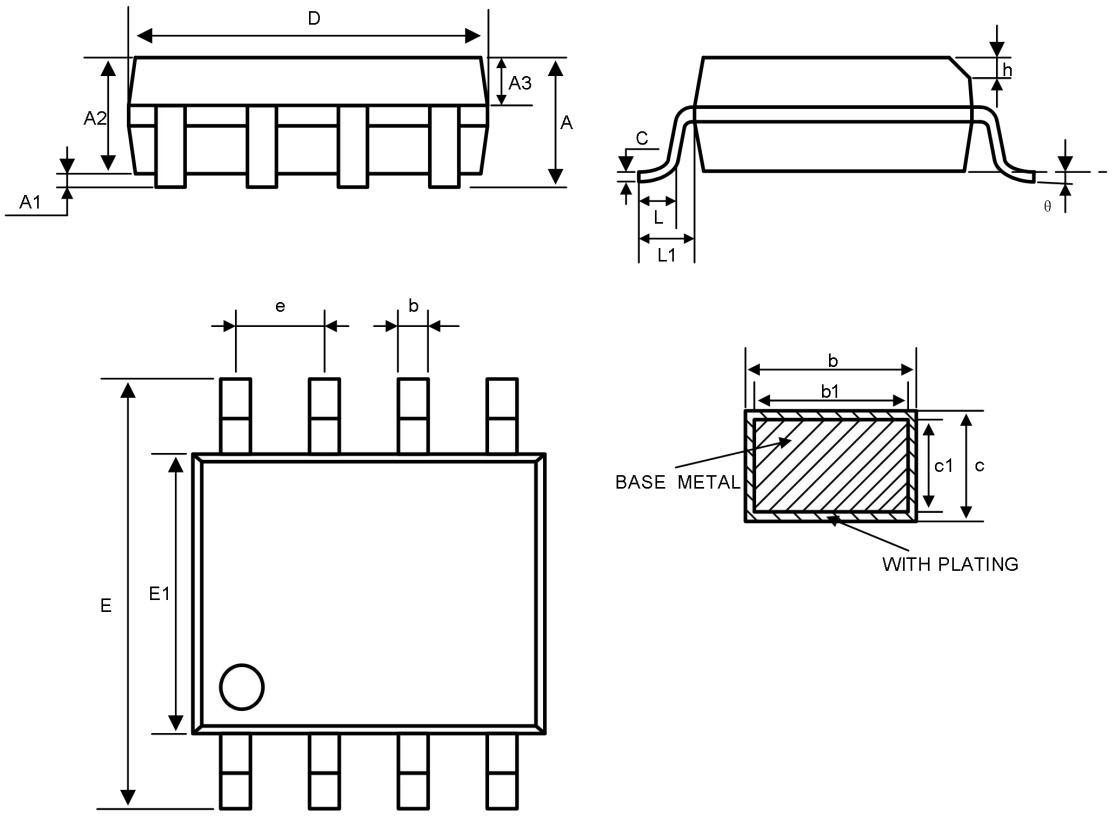
SC70-5



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	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	0.110	0.175	0.004	0.007
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°

10 Package Outline Dimension(continued)

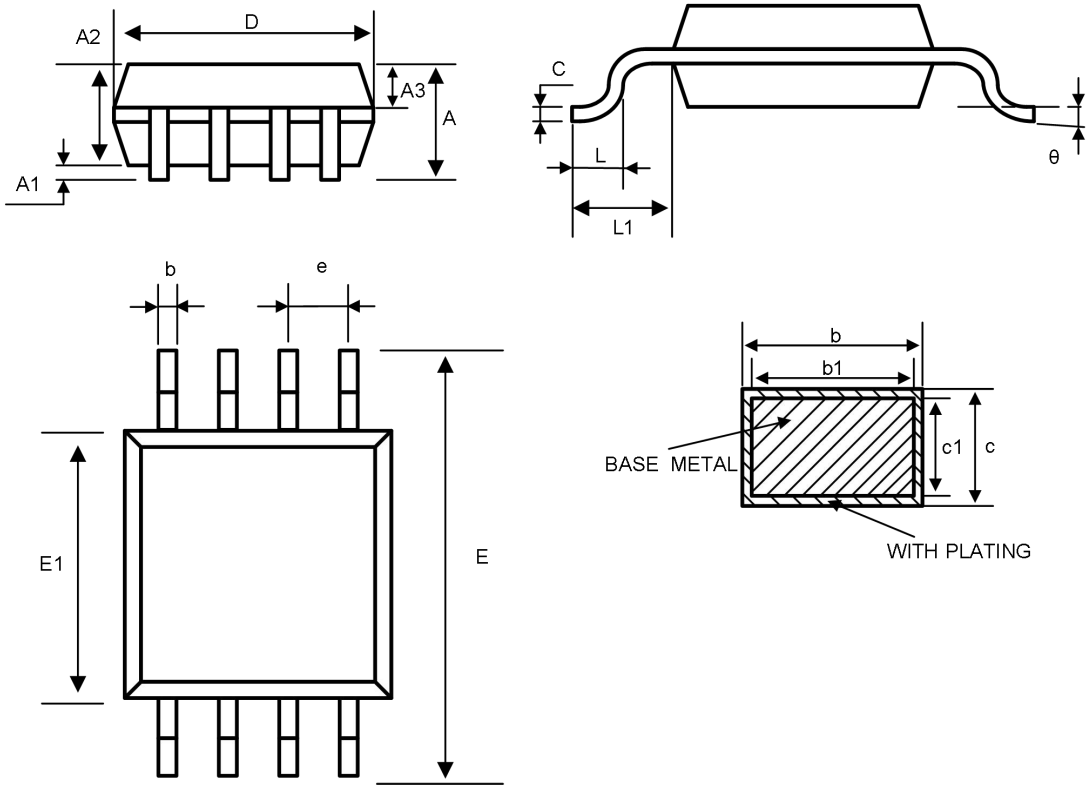
SOP8



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	—	—	1.75	—	—	0.069
A1	0.10	—	0.225	0.004	—	0.009
A2	1.30	1.40	1.50	0.051	0.055	0.059
A3	0.60	0.65	0.70	0.024	0.026	0.028
b	0.39	—	0.47	0.015	—	0.019
b1	0.38	0.41	0.44	0.015	0.016	0.017
c	0.20	—	0.21	0.008	—	0.008
c1	4.80	4.90	5.00	0.189	0.193	0.197
D	5.80	6.00	6.20	0.228	0.236	0.244
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	1.27BSC			0.05BSC		
h	0.25	—	0.50	0.010	—	0.020
L	0.50	—	0.80	0.020	—	0.031
L1	1.05REF			0.041REF		
θ	0	—	8°	0	—	8°

10 Package Outline Dimension(continued)

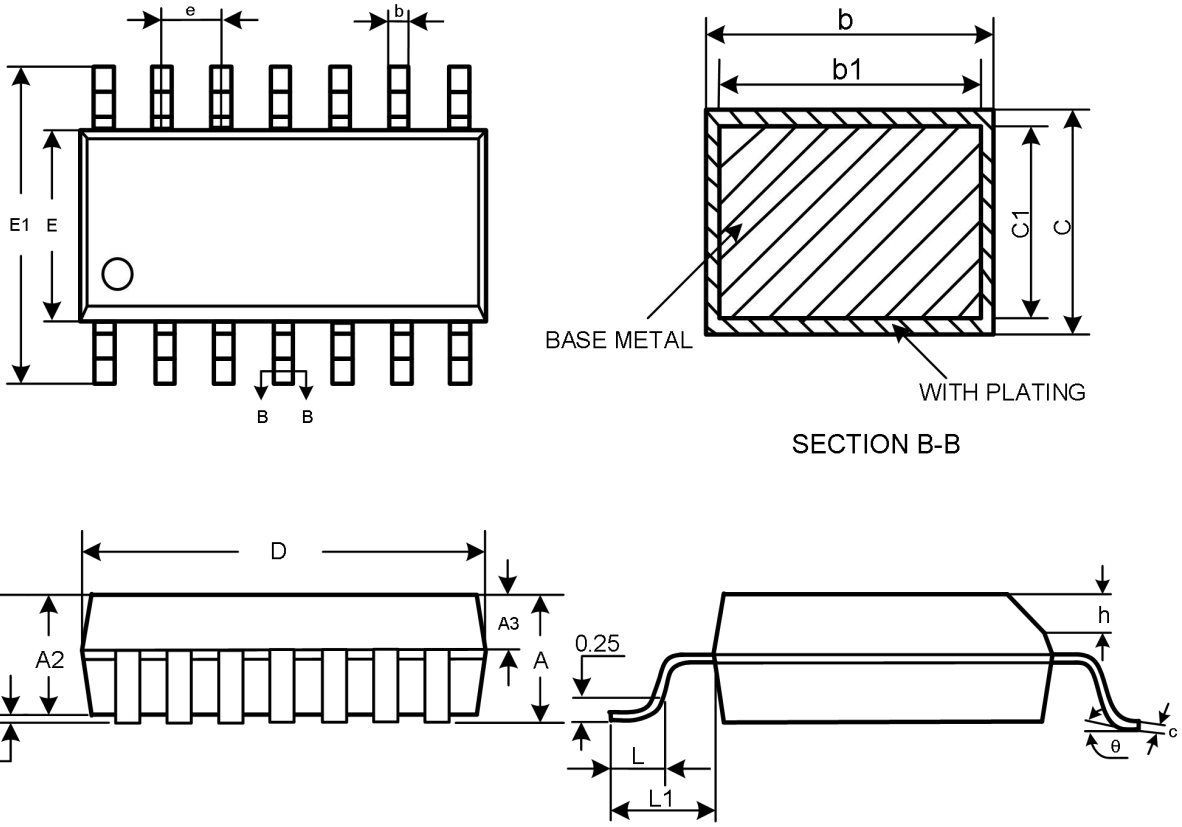
MSOP8



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	—	—	1.10	—	—	0.043
A1	0.05	—	0.15	0.002	—	0.006
A2	0.75	0.85	0.95	0.030	0.033	0.037
A3	0.30	0.35	0.40	0.012	0.014	0.016
b	0.28	—	0.36	0.011	—	0.014
b1	0.27	0.30	0.33	0.011	0.012	0.013
c	0.15	—	0.19	0.006	—	0.007
c1	0.14	0.15	0.16	0.006	0.006	0.006
D	2.90	3.00	3.10	0.114	0.118	0.122
E	4.70	4.90	5.10	0.185	0.193	0.201
E1	2.90	3.00	3.10	0.114	0.118	0.122
e	0.65BSC			0.026BSC		
L	0.40	—	0.70	0.016	—	0.028
L1	0.95REF			0.037REF		
θ	0	—	8°	0	—	8°

10 Package Outline Dimension(continued)

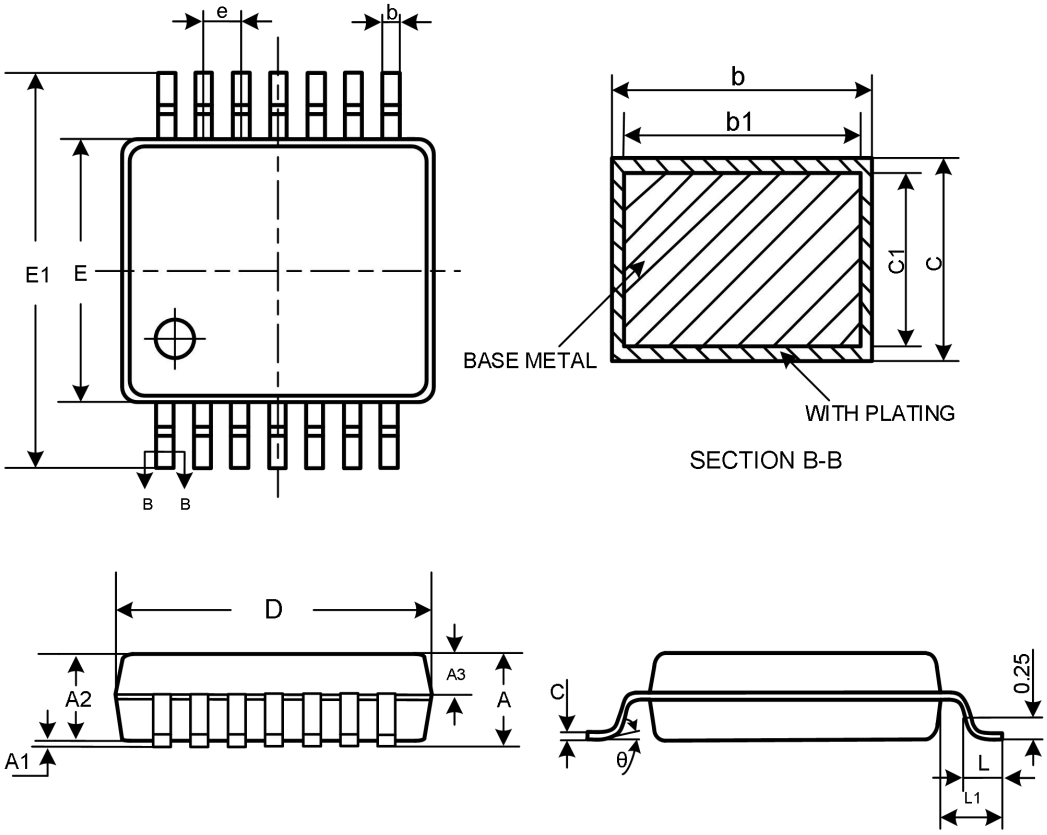
SOP14



SYMBOL	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	——	——	1.75	——	——	0.069
A1	0.10	——	0.225	0.004	——	0.009
A2	1.30	1.40	1.50	0.051	0.055	0.059
A3	0.60	0.65	0.70	0.024	0.026	0.028
b	0.39	——	0.47	0.015	——	0.019
b1	0.38	0.41	0.44	0.015	0.016	0.017
c	0.20	——	0.24	0.20	——	0.24
c1	0.19	0.20	0.21	0.007	0.008	0.008
D	8.55	8.65	8.75	0.337	0.341	0.344
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		1.27BSC			0.05BSC	
h	0.25	——	0.50	0.010	——	0.020
L	0.50	——	0.80	0.020	——	0.031
L1		1.05REF			0.041REF	
θ	0	——	8°	0	——	8°

10 Package Outline Dimension(continued)

TSSOP14



SYMBOL	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	——	——	1.20	——	——	0.047
A1	0.05	——	0.15	0.002	——	0.006
A2	0.90	1.00	1.05	0.035	0.039	0.041
A3	0.39	0.44	0.49	0.015	0.017	0.019
b	0.20	——	0.28	0.008	——	0.011
b1	0.19	0.22	0.25	0.007	0.009	0.010
c	0.13	——	0.17	0.005	——	0.007
c1	0.12	0.13	0.14	0.005	0.005	0.006
D	4.90	5.00	5.10	0.193	0.197	0.201
E1	4.30	4.40	4.50	0.169	0.173	0.177
E	6.20	6.40	6.60	0.244	0.252	0.260
e	0.65BSC			0.026BSC		
L	0.45	0.60	0.75	0.018	0.024	0.030
L1	1.00BCS			0.039BSC		
θ	0	——	8°	0	——	8°