GT8521 GT8522 GT8524
Micro-Power, Low-Offset, Rail-to-Rail I/O CMOS Op Amps

1 Features

- **Low offset voltage: ±1.5 μV**
- **Low offset drift: ±0.008 μV/°C**
- **Low-input bias current: 80 pA**
- **Low noise: 1.1 μV p-p (0.1Hz ~ 10Hz)**
- **Rail-to-rail input and output**
- **High gain, CMRR, PSRR: 115 dB**
- **High slew rate: 0.23 V/μs**
- **Gain bandwidth: 350 KHz**
- **Quiescent current: 21 μA per amplifier**
- **Single supply: 1.8 V to 5.5 V**

2 Application

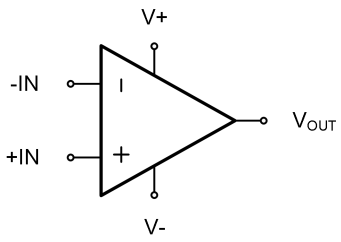
- **Temperature sensors**
- **Medical/industrial instrumentation**
- **Pressure sensors**
- **Battery-powered instrumentation**
- **Active filtering**
- **Weight scale sensor**
- **Strain gage amplifiers**
- **Power converter/inverter**

3 Description

The GT852X, GT8521, GT8522 and GT8524, family of precision amplifiers offers state-of-the-art performance. With chopper stabilized technique, the GT852X offset voltage and offset drift provide unparalleled long-term stability. With a mere 21 μA of quiescent current, the GT852X are able to achieve a 350KHz bandwidth. These small-size, high-precision operational amplifiers have high input impedance and rail-to-rail input and rail-to-rail output swing. The GT852X feature flat bias current over temperature. Therefore, no calibration is needed in high input impedance applications over temperature.

All versions are specified over the temperature range of -40°C to +125°C.

Circuit Diagram



4 Device Summary, Pin and Packages

Table 4-1. Device Summary(1)

Serial Name	Part Name	Package	Body Size (Nom)	Marking(2)	MSL(3)	Package Qty
GT8521	GT8521S5	SOT23-5	2.90mm×1.60mm×1.10mm	GT8521 XXXXX	3	Tape and Reel,3000
	GT8521BS5	SOT23-5	2.90mm×1.60mm×1.10mm	GT8521B XXXXX	3	Tape and Reel,3000
	GT8521M8	MSOP8	3.00mm×3.00mm×1.10mm	GT8521 XXXXXXX	3	Tape and Reel,4000
	GT8521P8	SOP8	6.00mm×3.90mm×1.75mm	GT8521 XXXXXXX	3	Tape and Reel,4000
GT8522	GT8522M8	MSOP8	3.00mm×3.00mm×1.10mm	GT8522 XXXXXXX	3	Tape and Reel,4000
	GT8522P8	SOP8	4.90mm×3.90mm×1.75mm	GT8522 XXXXXXX	3	Tape and Reel,4000
GT8524	GT8524TD	TSSOP14	5.00mm×4.40mm×1.20mm	GT8524 XXXXXXX	3	Tape and Reel,4000
	GT8524PD	SOP14	8.65mm×3.90mm×1.75mm	GT8524 XXXXXXX	3	Tape and Reel,4000

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

(2) There may be additional marking, which relates to the lot trace code information (data code and vendor code), the logo or the environmental category on the device.

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

(4) "XXXXX" in Marking will be appeared as the batch code.

4 Device Summary, Pin and Packages(Continued)

Top View

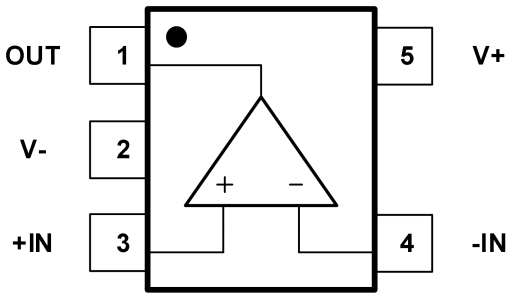


Fig.4-1. GT8521: S5(SOT23-5) Package

Top View

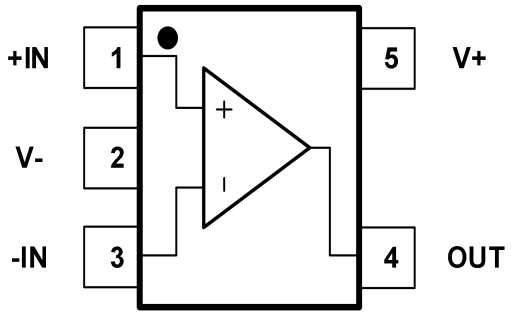


Fig.4-2. GT8391B: S5 (SOT23-5) Package

Top View

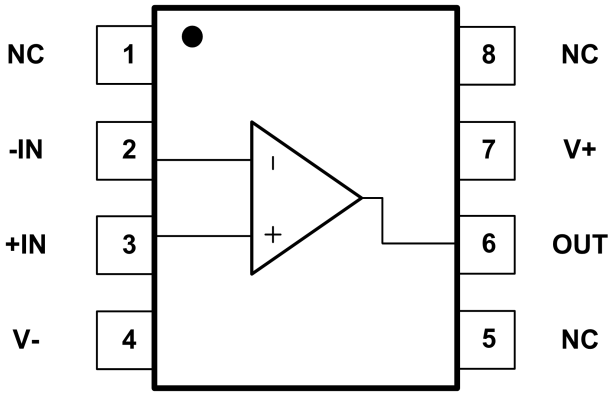


Fig.4-3. GT8521: P8(SOP8) Package

GT8521: M8(MSOP8) Package

Table 4-2 Pin Definition

Name	Pin			I/O	Description
	S5	BS5	P8 M8		
-IN	4	3	2	I	Negative (inverting) input
+IN	3	1	3	I	Positive(noninverting) input
NC	-	-	1,5,8	-	No internal connection (can be left floating)
OUT	1	4	6	O	Output
V-	2	2	4	-	Negative (lowest) power supply
V+	5	5	7	-	Positive (highest) power supply

* It is suggested to leave the unconnected pins floating.

4 Device Summary, Pin and Packages(Continued)

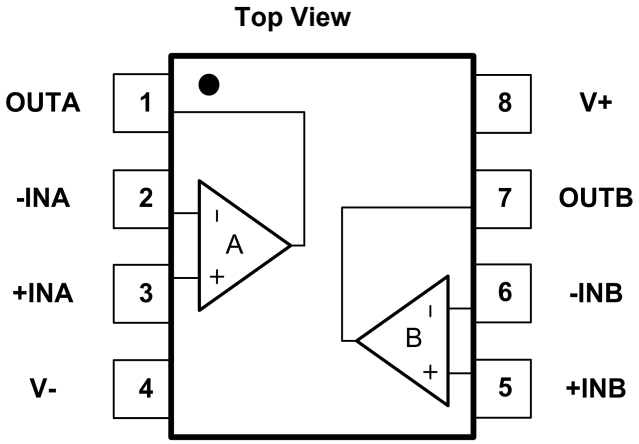


Fig.4-4. GT8522: P8(SOP8) Package

GT8522: M8(MSOP8) Package

Table 4-3 Pin Definition

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

* It is suggested to leave the unconnected pins floating.

4 Device Summary, Pin and Packages(Continued)

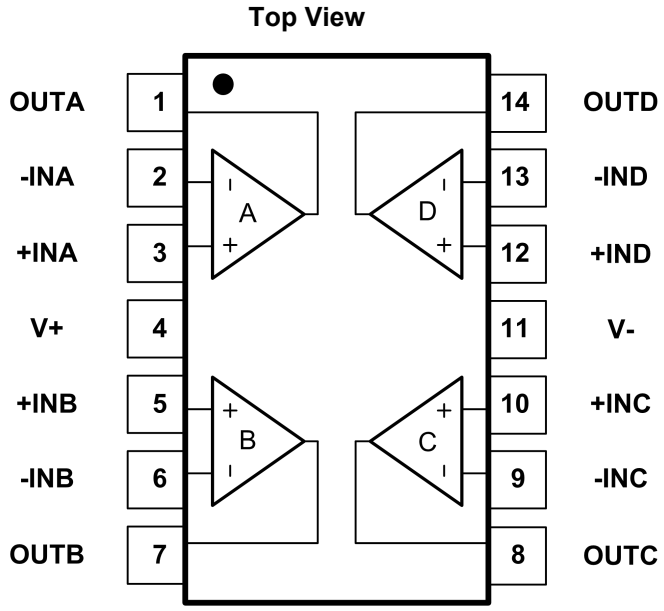


Fig.4-5. GT8524: PD(SOP14) Package

GT8524: TD(TSSOP14) Package

Table 4-4 Pin Definition

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

* It is suggested to leave the unconnected pins floating.

5 Voltage, Temperature, ESD and Thermal Ratings

5.1 Absolute Maximum Ratings

Parameters	Min	Max	Unit
Supply Voltage ,Vs=(V+)-(V-)		6.5	V
Select Input Voltage	(V-)-0.5	(V+)+0.5	V
Maximum Junction Temperature	-55	150	°C
Storage Temperature Range	-55	150	°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 0.3V beyond the supply rails should be current- limited to 10mA or less.

5.2 ESD Ratings

ESD			Value	Unit
V(ESD)	Electrostatic discharge	Human-Body Model (HBM)	6 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)

Symbol	Parameter	Min	Max	Unit
V_{CC}	Single-supply ,Vs=(V+)-(V-)	1.8	5.5	V
V_{CC}	Dual-supply ,Vs=(V+)-(V-)	±0.9	±2.75	V
TA	Operating temperature	-40	125	°C

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
SOP14	120	36	°C/W

6 Electrical Specifications

V_{CC}=1.8V to 5.5V, V_{CM}=V_{CC} /2, and R_L=10kΩ connected to V_{CM}, at TA=+25°C. (unless otherwise noted)

Parameter	Symbol	Condition	GT8521 GT8522 GT8524			
			Min	Typ	Max	Unit
Offset Voltage						
Input Offset Voltage	V_{OS}	V_{CC}=5V	-8	±1.5	8	μV
Input Offset Voltage Average Drift	V_{OS} TC			±0.008	±0.05	μV/°C
Power-Supply Rejection Ratio	PSRR	–40°C to +125°C	105	115		dB
Channel Separation, dc				0.1		μV/V
Input Bias Current						
Input Bias Current	I_B	V_{CM}=V_{CC} /2		±80		pA
Input Offset Current	I_{OS}			±100		pA
Noise Performance						
Input Voltage Noise	enp-p	f=0.1Hz to 10Hz		1.1		μVpp
Input Voltage Noise	enp-p	f=0.01Hz to 1Hz		0.36		μVpp
Input Voltage Noise Density	en	f=1KHz		50		nV/√Hz
Input Current Noise Density	in	f=10Hz		100		fA/√Hz
Input Voltage Range						
Common-Mode Voltage Range	V_{CM}		(V-) -0.1		(V+) +0.1	V
Common-Mode Rejection Ratio	CMRR	(V-) -0.1V < V_{CM} < (V+)+ 0.1V –40°C to +125°C	100	115		dB
Input Capacitance						
Differential				2		pF
Common-Mode				4		pF
Open-Loop Gain						
Open-Loop Voltage Gain	A_{OL}	R_L=10KΩ, (V-) +0.1V < V_O < (V+)- 0.1V TA=-40°C to 125°C	100	115		dB
Dynamic Performance						
Slew Rate	SR	G=+1		0.23		V/μs
Gain-Bandwidth Product	GBW	C_L=100pF		350		KHz
Overload Recovery Time				100		μs
Output Characteristics						
Output Voltage High	V_{OH}	R_L=100 KΩ to GND	4.95	4.99		V
		R_L=10 KΩ to GND	4.9	4.93		V
Output Voltage Low	V_{OL}	R_L=100 KΩ to V+		5	20	mV
		R_L=10 KΩ to V+		30	50	mV
Short-Circuit Current	ISC			±5		mA
Power Supply						
Operating Voltage Range	V_S		1.8		5.5	V
Quiescent Current/ Amplifier	I_Q	–40°C to +125°C		21	30	μA

7 Typical Characteristics

V_{CC}=5.0V, V_{CM}=V_{CC} /2, and R_L=10kΩ , TA=+25°C. (unless otherwise noted)

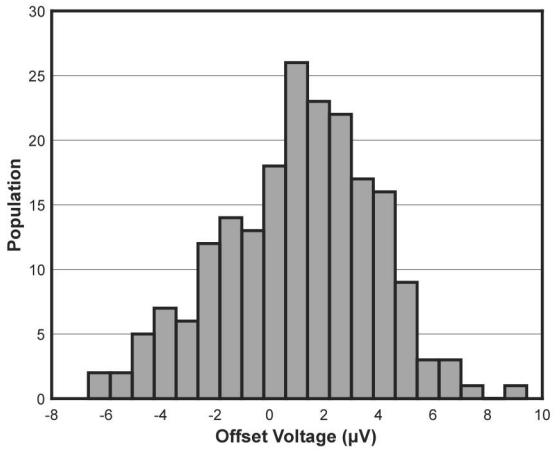


Fig.7-1. Offset Voltage Distribution

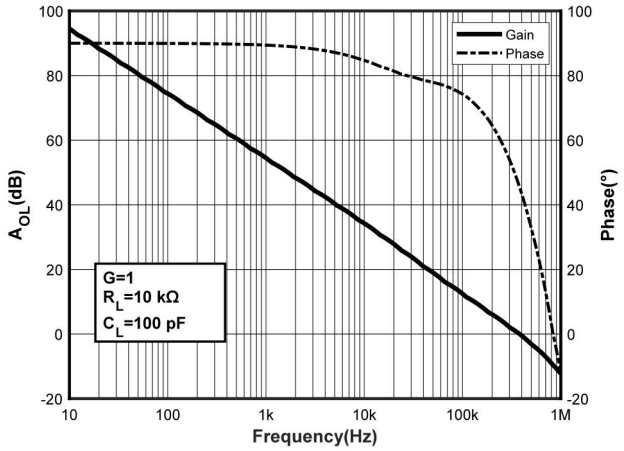


Fig.7-2. Open-Loop Gain and Phase vs Frequency

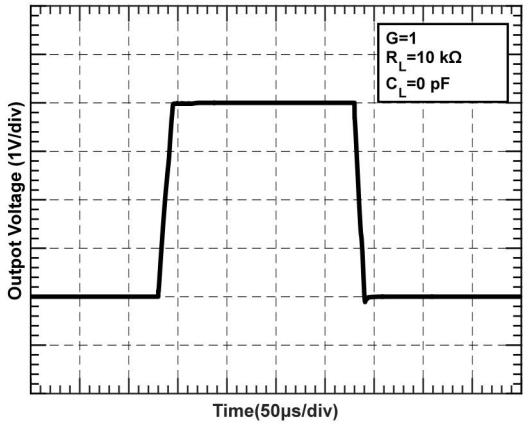


Fig.7-3. Large-Signal Step Response

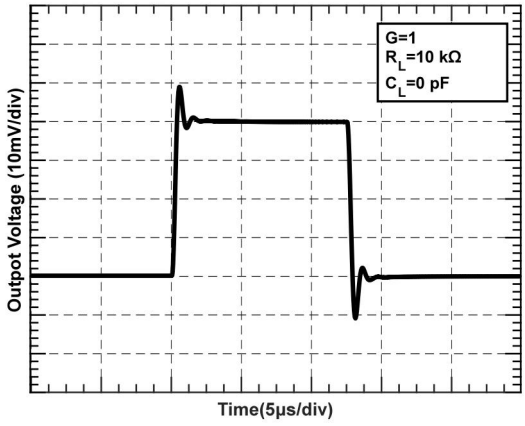


Fig.7-4. Small-Signal Step Response

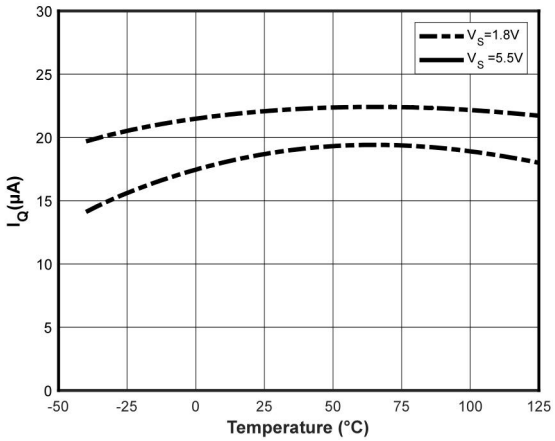


Fig.7-5. Source Current vs Temperature

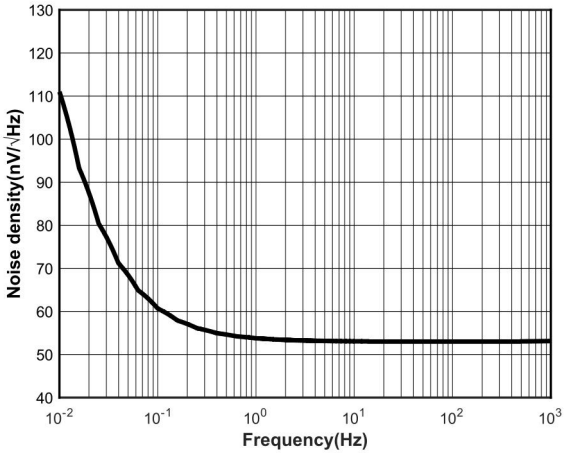


Fig.7-6. Input Voltage Noise Density vs Frequency

8 Detailed Description

8.1 Overview

The GT852X family of zero-drift amplifiers is engineered with state-of-the-art, proprietary, precision zero-drift technology. These amplifiers offer ultra-low input offset voltage and drift, and achieve excellent input and output dynamic linearity. The GT852X operate from 1.8 V to 5.5 V, are unity-gain stable, and are designed for a wide range of general-purpose and precision applications.

8.2 Feature Description

The GT8521, GT8522, GT8524 series op amplifiers operate over a power-supply range of +1.8 V to +5.5V (±0.9V to ±2.75V). Supply voltages higher than 6.5 V (absolute maximum) can permanently damage the amplifier. Parameters that vary over supply voltage or temperature are shown in the Typical Characteristics section of this data sheet.

9 Application Note

The GT8521, GT8522, GT8524 series op amps are unity-gain stable and free from unexpected output phase reversal. They use chopper stabilized techniques to provide low offset voltage and very low drift over time and temperature. Good layout practice mandates use of a 0.1μF capacitor placed closely across the supply pins.

For lowest offset voltage and precision performance, circuit layout and mechanical conditions should be optimized. Avoid temperature gradients that create thermoelectric (See beck) effects in thermocouple junctions formed from connecting dissimilar conductors. These thermally-generated potentials can be made to cancel by assuring that they are equal on both input terminals.

Fig.9-1. shows the GT852X in a Bi-Directional Current Sense Amplifier.

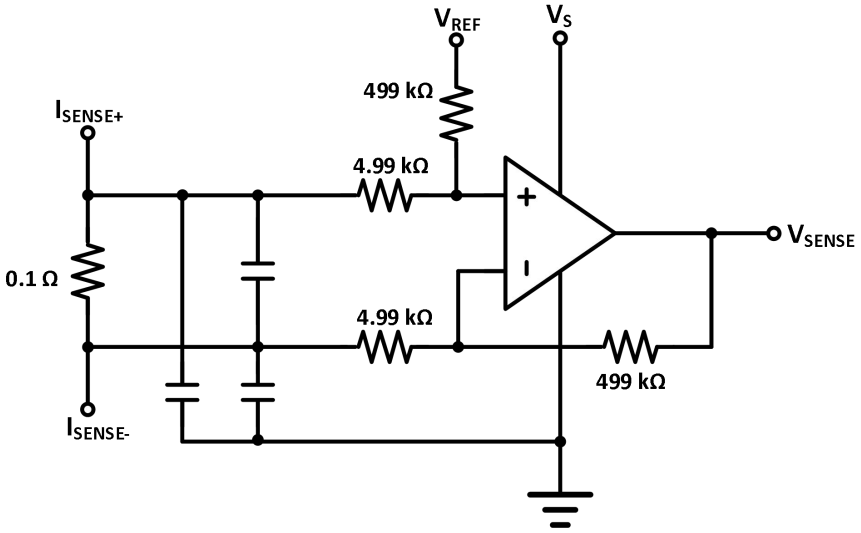
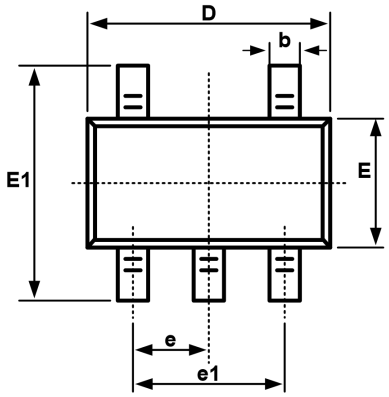
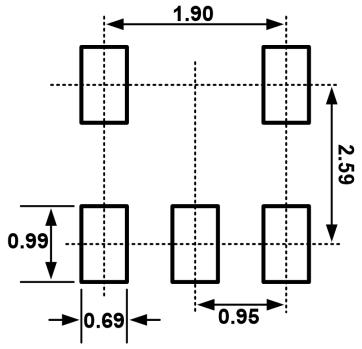


Fig.9-1. Bi-Directional Current Sense Amplifier

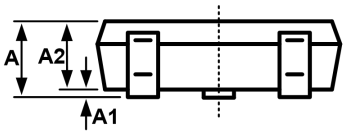
10 Package Outline Dimension

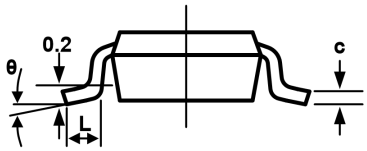
SOT23-5





Recommended Land Pattern (Unit: mm)

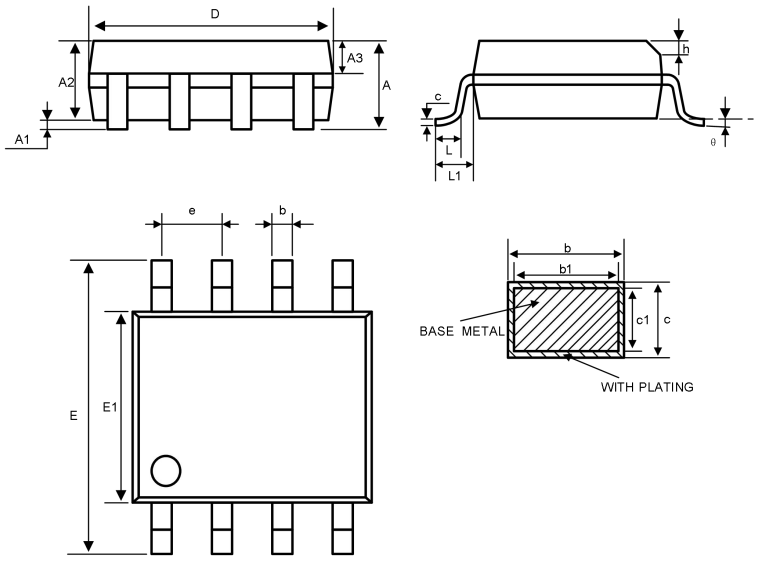




Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
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)

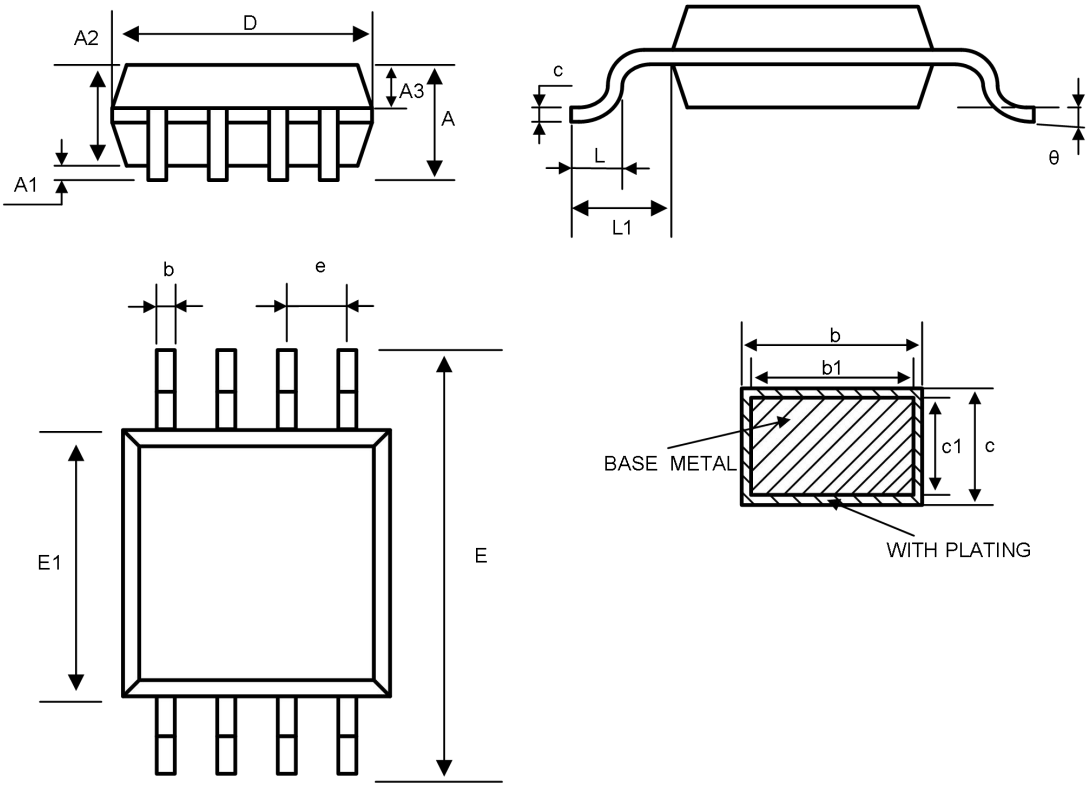
SOP8



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	0.19	0.20	5.00	0.189	0.193	0.197
D	4.80	4.90	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)

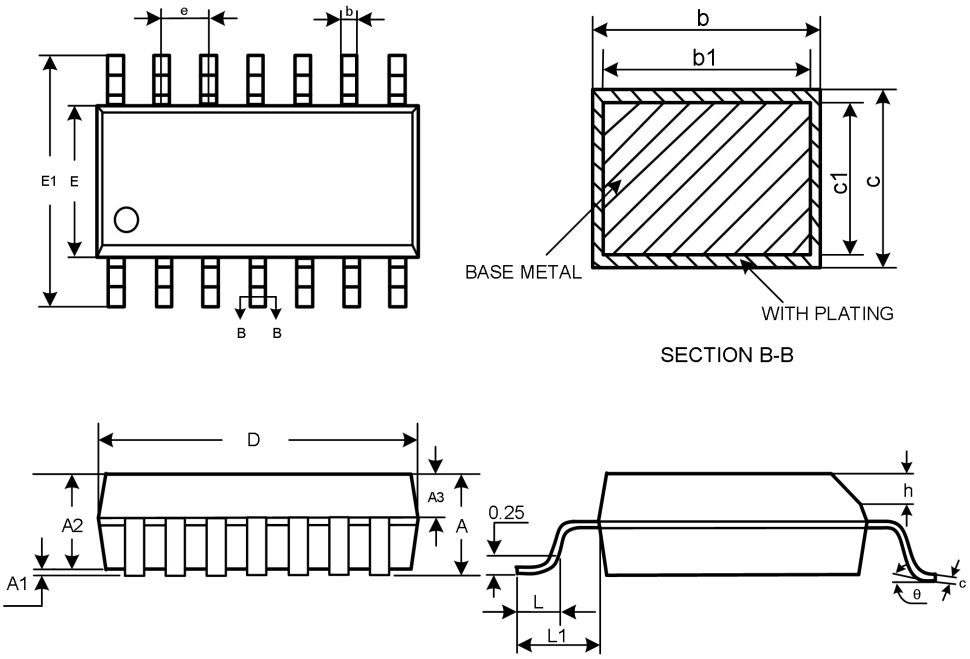
MSOP8



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)

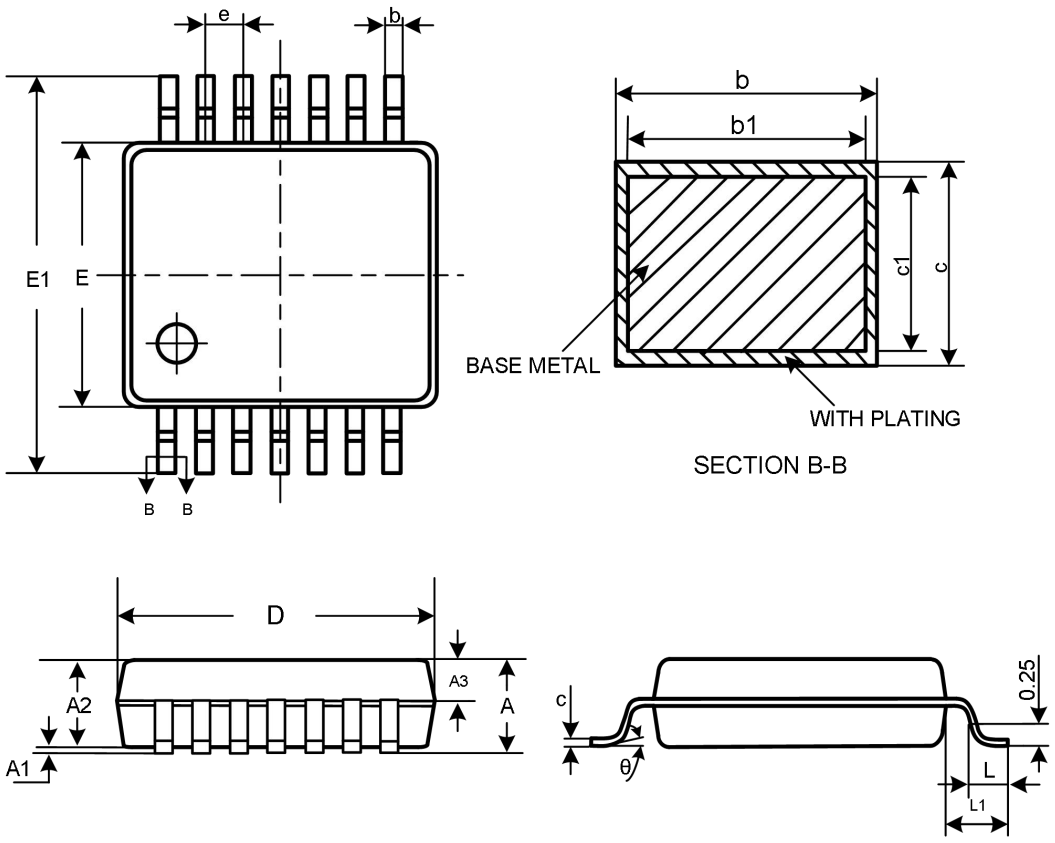
SOP14



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	0.008	——	0.009
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
E1	5.80	6.00	6.20	0.228	0.236	0.244
E	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)

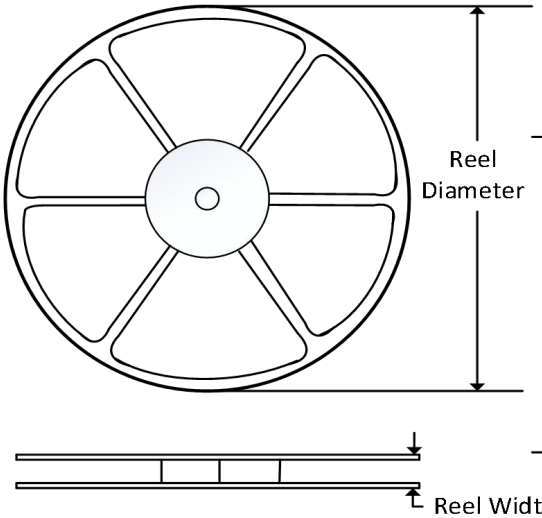
TSSOP14



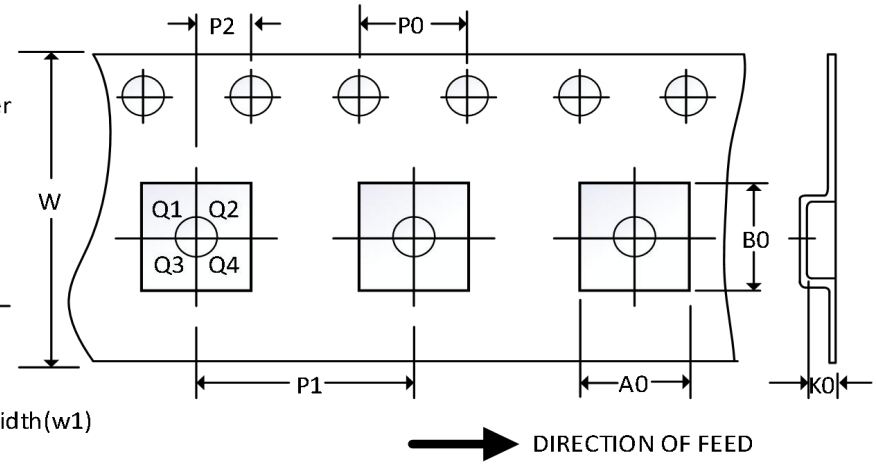
Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min	Nom	Max	Min	Nom	Max
A	——	——	1.20	——	——	0.047
A1	0.05	——	0.15	0.002	——	0.006
A2	0.90	1.00	1.05	0.035	0.039	0.041
A3	0.39	0.44	0.49	0.015	0.017	0.019
b	0.20	——	0.28	0.008	——	0.011
b1	0.19	0.22	0.25	0.007	0.009	0.010
c	0.13	——	0.17	0.005	——	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
E	4.30	4.40	4.50	0.169	0.173	0.177
E1	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	1.00BSC			0.039BSC		
θ	0	——	8°	0	——	8°

11 Tape and Reel Information

Reel Dimensions



Reel Dimensions



NOTE: The picture is only for reference. Please make the object as the standard.

Key Parameter List of Tape and Reel

Package Type	Reel Diameter	Reel Width (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT23-5	7''	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
MSOP8	13''	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
TSSOP14	13''	12.4	6.95	5.60	1.20	4.0	8.0	2.0	12.0	Q1
SOP8	13''	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
SOP14	13''	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	Q1

NOTE:
1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.