

SNA321/358/324 1MHz CMOS Rail-to-Rail IO Opamp with RF Filter

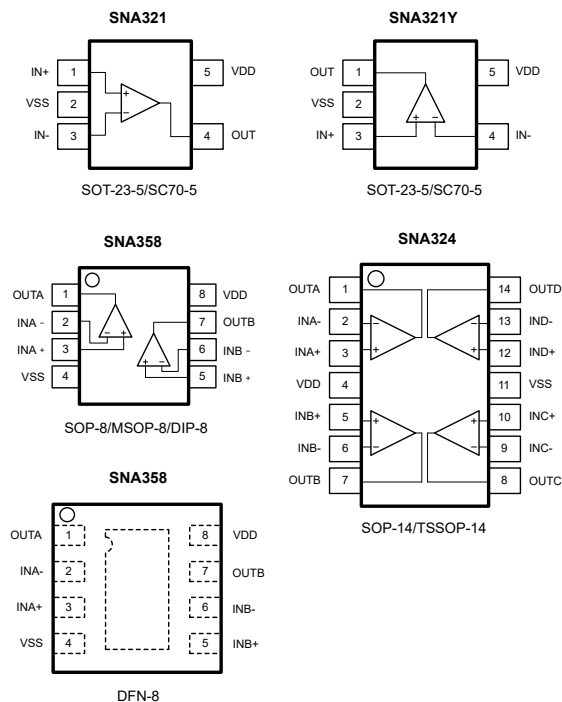
Features

- Single-Supply Operation from +2.1V ~ +5.5V
- Rail-to-Rail Input/Output
- Gain-Bandwidth Product: 1MHz (Typ)
- Low Input Bias Current: 1pA (Typ)
- Low Offset Voltage: 3.5mV (Max)
- Quiescent Current: 40µA per Amplifier (Typ)
- Operating Temperature: -40°C ~ +125°C
- Embedded RF Anti-EMI Filter
- Small Package:
 - SNA321 Available in SOT-23-5 and SC70-5 Packages
 - SNA358 Available in SOP-8, MSOP-8, DIP-8 and DFN-8 Packages
 - SNA324 Available in SOP-14 and TSSOP-14 Packages

General Description

The SNA321/358/324 family have a high gain-bandwidth product of 1MHz, a slew rate of 0.6V/µs, and a quiescent current of 40µA/amplifier at 5V. The SNA321/358/324 family is designed to provide optimal performance in low voltage and low noise systems. They provide rail-to-rail output swing into heavy loads. The input common mode voltage range includes ground, and the maximum input offset voltage is 3.5mV for SNA321/358/324 family. They are specified over the extended industrial temperature range (-40°C to +125°C). The operating range is from 2.1V to 5.5V. The SNA321 single is available in Green SC70-5 and SOT-23-5 packages. The SNA358 Dual is available in Green SOP-8, MSOP-8, DIP-8 and DFN-8 packages. The SNA324 Quad is available in Green SOP-14 and TSSOP-14 packages.

Pin Assignment



Applications

- ASIC Input or Output Amplifier
- Sensor Interface
- Medical Communication
- Smoke Detectors
- Audio Output
- Piezoelectric Transducer Amplifier
- Medical Instrumentation
- Portable Systems

Ordering Information

Model	Channel	Package	Ordering Number	Packing Option
SNA321	Single	SC70-5		Tape and Reel,3000
		SOT-23-5		Tape and Reel,3000
		SC70-5		Tape and Reel,3000
		SOT-23-5		Tape and Reel,3000
SNA358	Dual	SOP-8		Tape and Reel,4000
		MSOP-8		Tape and Reel,3000
		DIP-8		20Tube(1000pcs)
		DFN-8		Tape and Reel,3000
SNA324	Quad	TSSOP-14		Tape and Reel,3000
		SOP-14		Tape and Reel,2500

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1 Specifications

1.1 Absolute Maximum Ratings

Parameter	Min	Max	Unit
Power Supply Voltage (V_{DD} to V_{SS})	-0.5	+7.5	V
Analog Input Voltage (IN+ or IN-)	$V_{SS}-0.5$	$V_{DD}+0.5$	V
PDB Input Voltage	$V_{SS}-0.5$	+7	V
Operating Temperature Range	-40	+125	°C
Junction Temperature		160	°C
Storage Temperature Range	-55	150	°C
Lead Temperature (soldering, 10sec)		260	°C
Package Thermal Resistance, θ_{JA} ($T_A=+25^\circ\text{C}$)	SOP-8	125	°C/W
	MSOP-8	216	°C/W
	SOT-23-5	190	°C/W
	SC70-5	333	°C/W
ESD	HBM	6000	V
	MM	300	V

! Attention: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

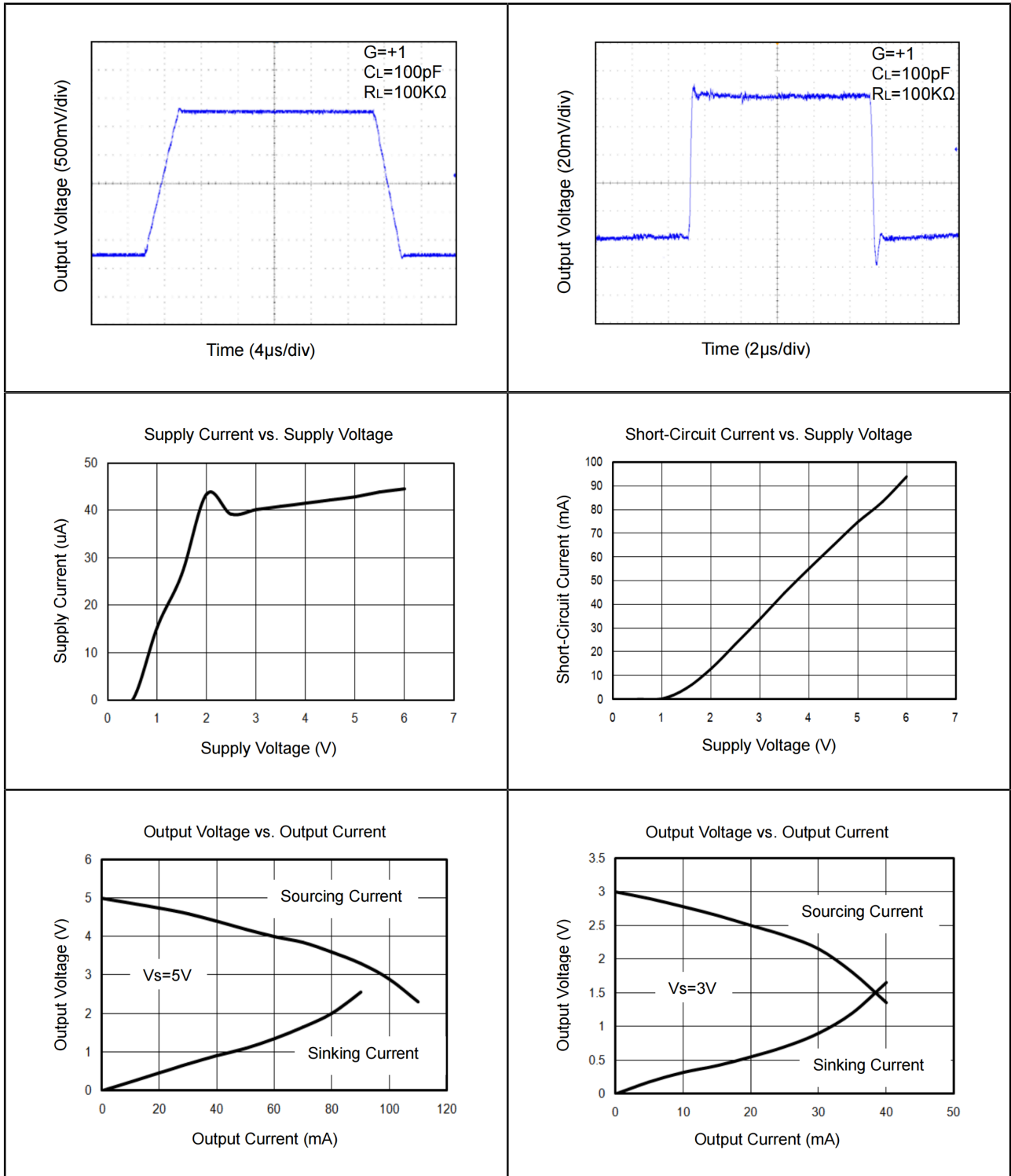
1.2 Electrical Characteristics

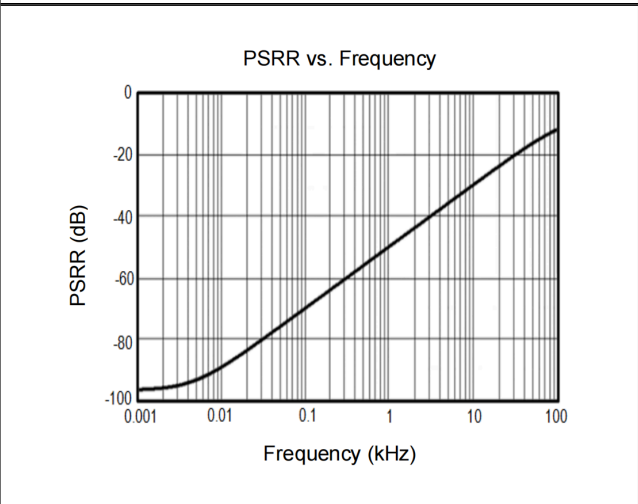
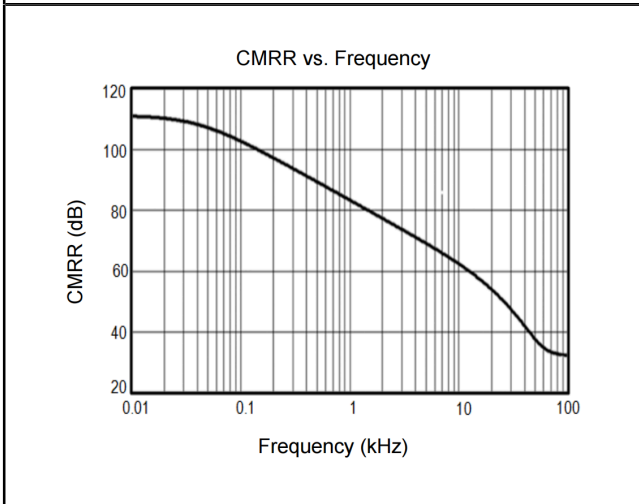
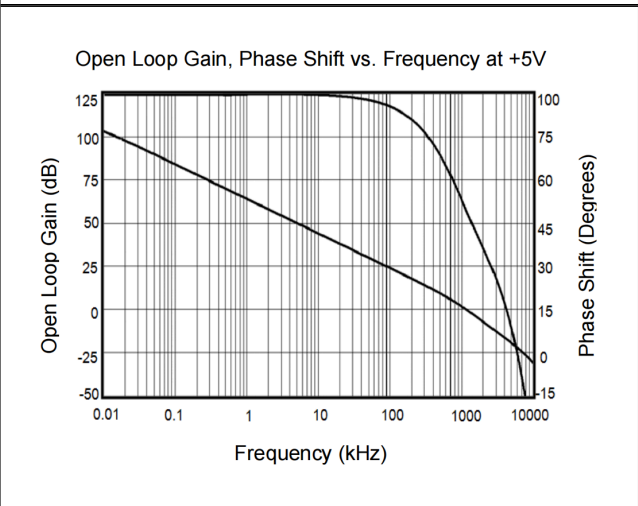
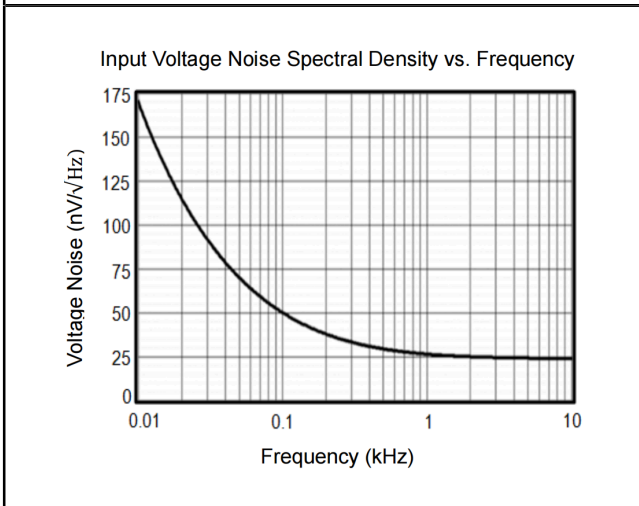
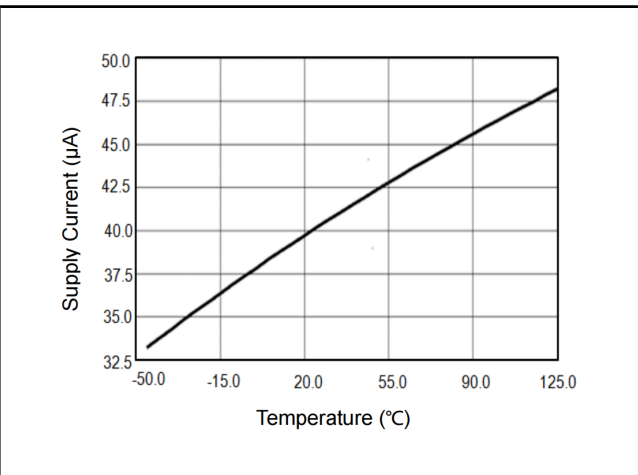
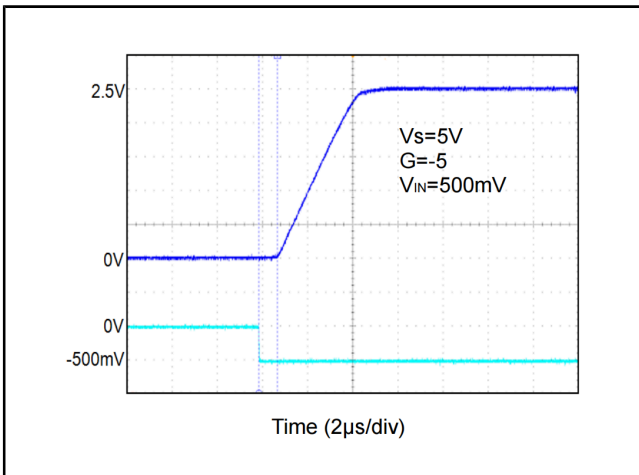
At $V_S = +5\text{V}$, $T_A = 25^\circ\text{C}$, $R_L = 100\text{k}\Omega$ connected to $V_S/2$, and $V_{OUT} = V_S/2$, unless otherwise noted.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Input Offset Voltage	V_{OS}	$V_{CM} = V_S/2$		0.4	3.5	mV
Input Bias Current	I_B			1		pA
Input Offset Current	I_{OS}			1		pA
Common-Mode Voltage Range	V_{CM}	$V_S = 5.5\text{V}$		-0.1~+5.6		V
Common-Mode Rejection Ratio	CMRR	$V_S = 5.5\text{V}$, $V_{CM} = -0.1\text{V to } 4\text{V}$	62	70		dB
		$V_S = 5.5\text{V}$, $V_{CM} = -0.1\text{V to } 5.6\text{V}$	56	68		dB

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Open-Loop Voltage Gain	A_{OL}	$R_L = 5k\Omega$, $V_O = +0.1V$ to $+4.9V$	70	80		dB
		$R_L = 10k\Omega$, $V_O = +0.1V$ to $+4.9V$	94	100		dB
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$			2.7		$\mu V/^\circ C$
OUTPUT CHARACTERISTICS						
Output Voltage Swing from Rail	V_{OH}	$R_L = 100k\Omega$	4.990	4.997		V
	V_{OL}	$R_L = 100k\Omega$		3	10	mV
	V_{OH}	$R_L = 10k\Omega$	4.970	4.992		V
	V_{OL}	$R_L = 10k\Omega$		8	30	mV
Output Current	I_{SOURCE}	$R_L = 10\Omega$ to $V_S/2$	60	84		mA
	I_{SINK}		60	75		mA
POWER SUPPLY						
Operating Voltage Range			2.1		5.5	V
Power Supply Rejection Ratio	PSRR	$V_S = +2.5V$ to $+5.5V$, $V_{CM} = +0.5V$	60	82		dB
Quiescent Current / Amplifier	I_Q			40		μA
DYNAMIC PERFORMANCE ($C_L = 100pF$)						
Gain-Bandwidth Product	GBP			1		MHz
Slew Rate	SR	$G = +1$, 2V Output Step		0.6		V/ μs
Settling Time to 0.1%	t_s	$G = +1$, 2V Output Step		5		μs
Overload Recovery Time		$V_{IN} \cdot Gain = V_S$		2.6		μs
NOISE PERFORMANCE						
Voltage Noise Density	e_n	$f = 1kHz$		27		nV/\sqrt{Hz}
		$f = 10kHz$		20		nV/\sqrt{Hz}

2 Typical Performance Characteristics





3 Application Note

3.1 Size

SNA321/358/324 family series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the SNA321/358/324 family packages save space on printed circuit boards and enable the design of smaller electronic products.

3.2 Power Supply Bypassing and Board Layout

SNA321/358/324 family series operates from a single 2.1V to 5.5V supply or dual $\pm 1.05\text{V}$ to $\pm 2.75\text{V}$ supplies. For best performance, a $0.1\mu\text{F}$ ceramic capacitor should be placed close to the VDD pin in single supply operation. For dual supply operation, both V_{DD} and V_{SS} supplies should be bypassed to ground with separate $0.1\mu\text{F}$ ceramic capacitors.

3.3 Low Supply Current

The low supply current (typical $40\mu\text{A}$ per channel) of SNA321/358/324 family will help to maximize battery life. They are ideal for battery powered systems.

3.4 Operating Voltage

SNA321/358/324 family operates under wide input supply voltage (2.1V to 5.5V). In addition, all temperature specifications apply from -40°C to $+125^{\circ}\text{C}$. Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime.

3.5 Rail-to-Rail Input

The input common-mode range of SNA321/358/324 family extends 100mV beyond the supply rails ($V_{\text{SS}}-0.1\text{V}$ to $V_{\text{DD}}+0.1\text{V}$). This is achieved by using complementary input stage. For normal operation, inputs should be limited to this range.

3.6 Rail-to-Rail Output

Rail-to-Rail output swing provides maximum possible dynamic range at the output. This is particularly important when operating in low supply voltages. The output voltage of SNA321/358/324 family can typically swing to less than 5mV from supply rail in light resistive loads ($>100\text{k}\Omega$), and 30mV of supply rail in moderate resistive loads ($10\text{k}\Omega$).

3.7 Capacitive Load Tolerance

The SNA321/358/324 family is optimized for bandwidth and speed, not for driving capacitive loads. Output capacitance will create a pole in the amplifier's feedback path, leading to excessive peaking and potential oscillation. If dealing with load capacitance is a requirement of the application, the two strategies to consider are (1) using a small resistor in series with the amplifier's output and the load capacitance and (2) reducing the bandwidth of the amplifier's feedback loop by increasing the overall noise gain. Figure 4-1 shows a unity gain follower using the series resistor strategy. The resistor isolates the output from the capacitance and more importantly, creates a zero in the feedback path that compensates for the pole created by the output capacitance.

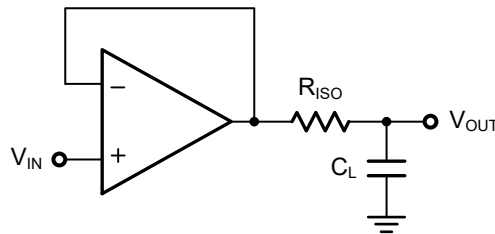


Figure 3-1 Indirectly Driving a Capacitive Load Using Isolation Resistor

The bigger the R_{ISO} resistor value, the more stable V_{OUT} will be. However, if there is a resistive load R_L in parallel with the capacitive load, a voltage divider (proportional to R_{ISO}/R_L) is formed, this will result in a gain error.

The circuit in Figure 4-2 is an improvement to the one in Figure 4-1. R_F provides the DC accuracy by feed-forward the V_{IN} to R_L . 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 the phase margin in the overall feedback loop. Capacitive drive can be increased by increasing the value of C_F . This in turn will slow down the pulse response.

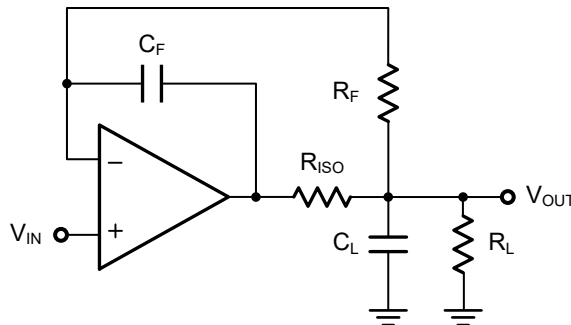


Figure 3-2 Indirectly Driving a Capacitive Load with DC Accuracy

4 Typical Application Circuits

4.1 Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common to the two inputs. It is useful as a computational amplifier in making a differential to single-end conversion or in rejecting a common mode signal. Figure 5-1 shows the differential amplifier using SNA321/358/324 family.

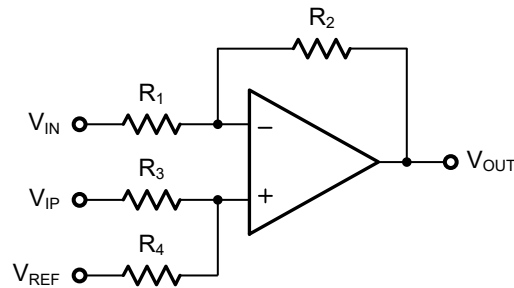


Figure 4-1 Differential Amplifier

$$V_{OUT} = \frac{(R_1 + R_2) R_4}{(R_3 + R_4) R_1} V_{IN} - \frac{R_2}{R_1} V_{IP} + \frac{(R_1 + R_2) R_3}{(R_3 + R_4) R_1} V_{REF}$$

If the resistor ratios are equal (i.e. $R_1 = R_3$ and $R_2 = R_4$), then

$$V_{OUT} = \frac{R_2}{R_1} (V_{IP} - V_{IN}) + V_{REF}$$

4.2 Low Pass Active Filter

The low pass active filter is shown in Figure 5-2. The DC gain is defined by $-R_2/R_1$. The filter has a -20dB/decade roll-off after its corner frequency $f_c = 1/(2\pi R_3 C_1)$.

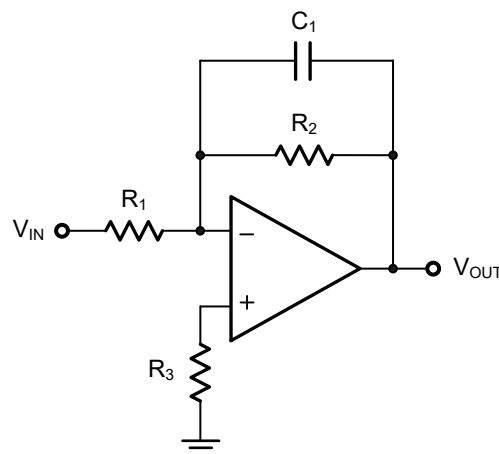


Figure 4-2 Low Pass Active Filter

4.3 Instrumentation Amplifier

The triple SNA321/358/324 family can be used to build a three-op-amp instrumentation amplifier as shown in Figure 5-3. The amplifier in Figure 5-3 is a high input impedance differential amplifier with gain of R_2/R_1 . The two differential voltage followers assure the high input impedance of the amplifier.

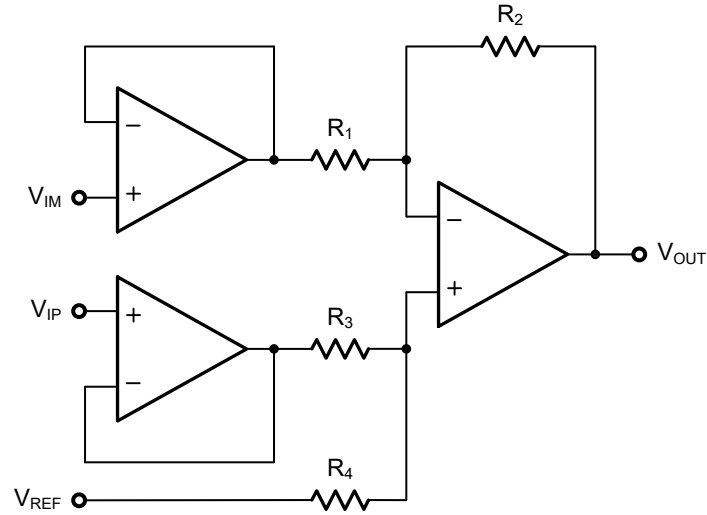
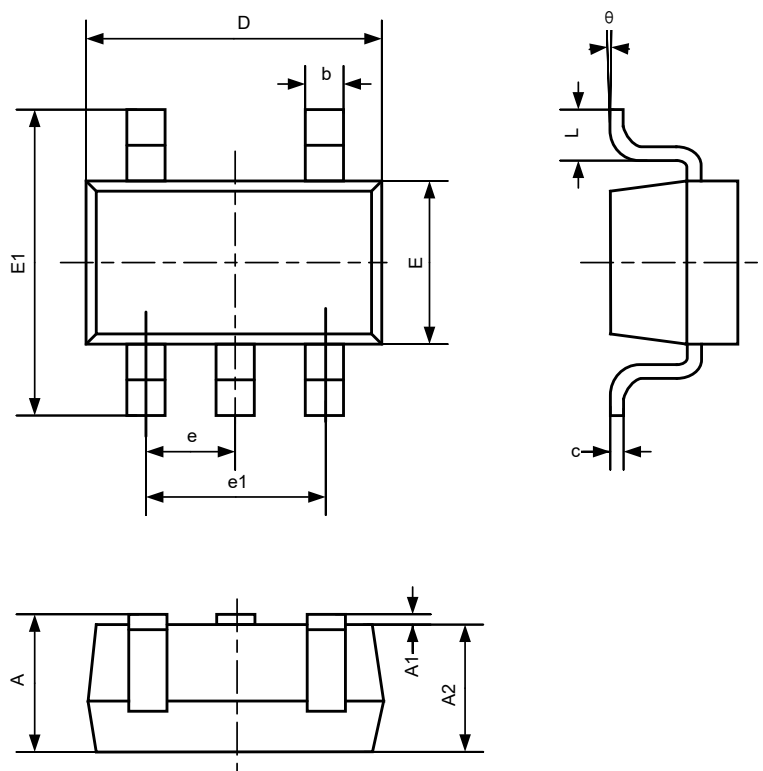


Figure 4-3 Instrument Amplifier

5 Package Information

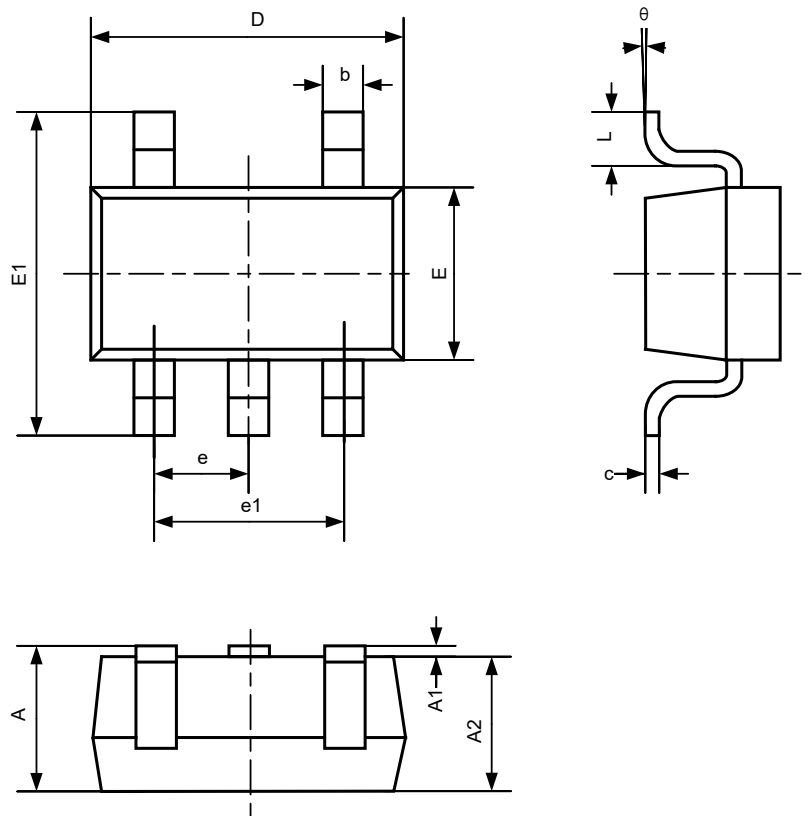
5.1 SC70-5



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	0.080	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	0.650 BSC		0.026 BSC	
e1	1.300 BSC		0.051 BSC	
L	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°

Figure 5-1 SC70-5 Package Dimension

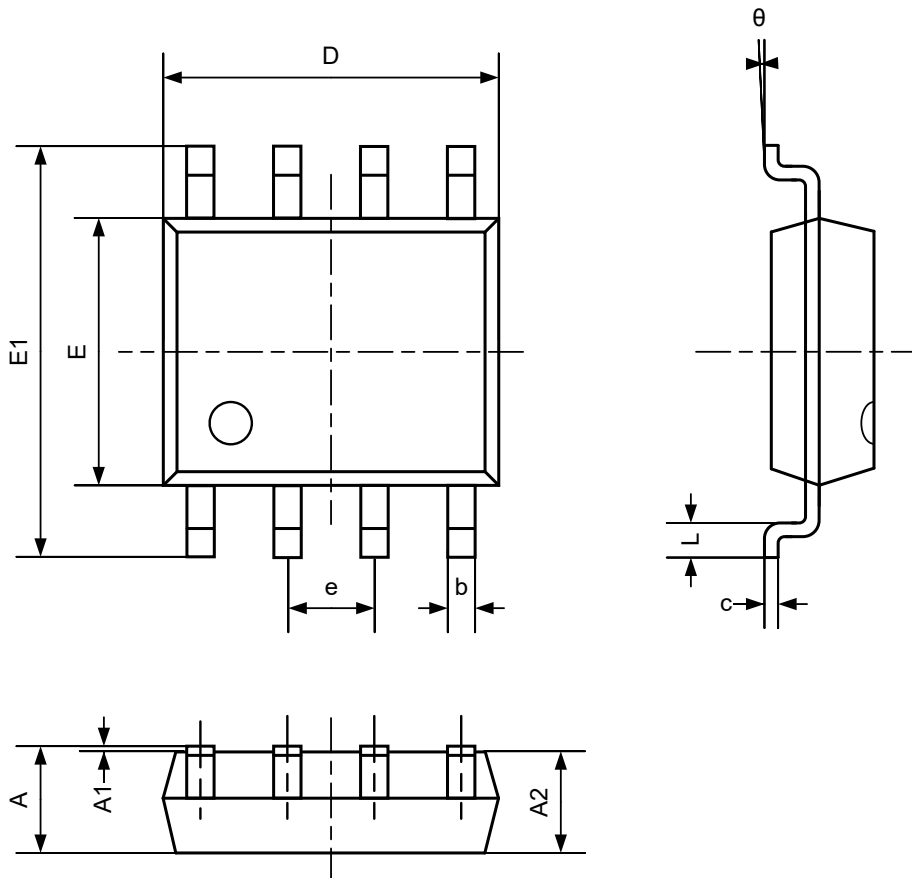
5.2 SOT-23-5



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	0.500	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	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

Figure 5-2 SOT-23-5 Package Dimension

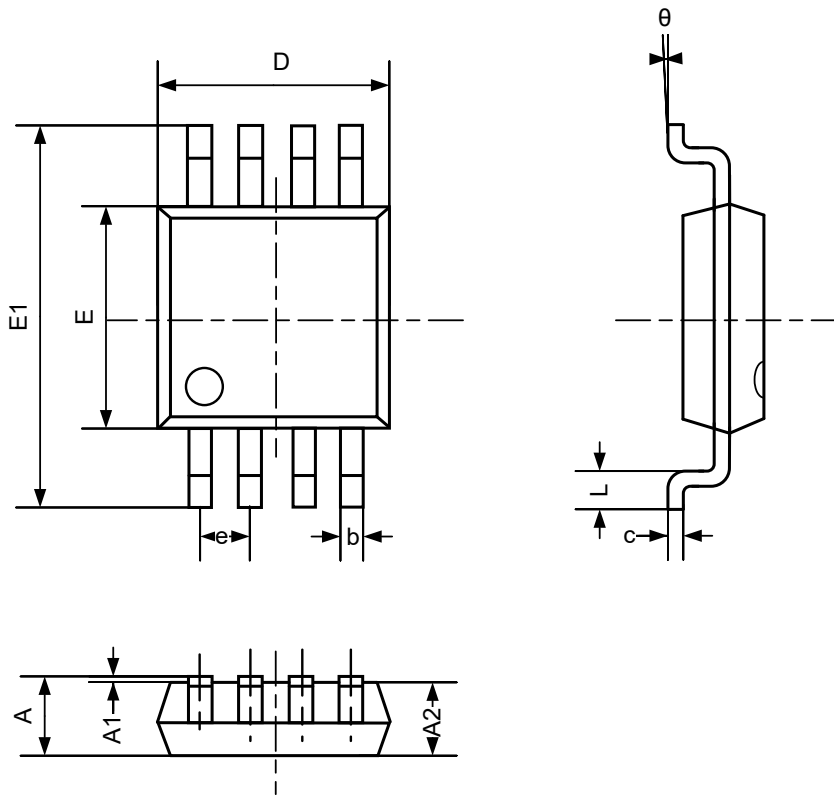
5.3 SOP-8



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	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Figure 5-3 SOP-8 Package Dimension

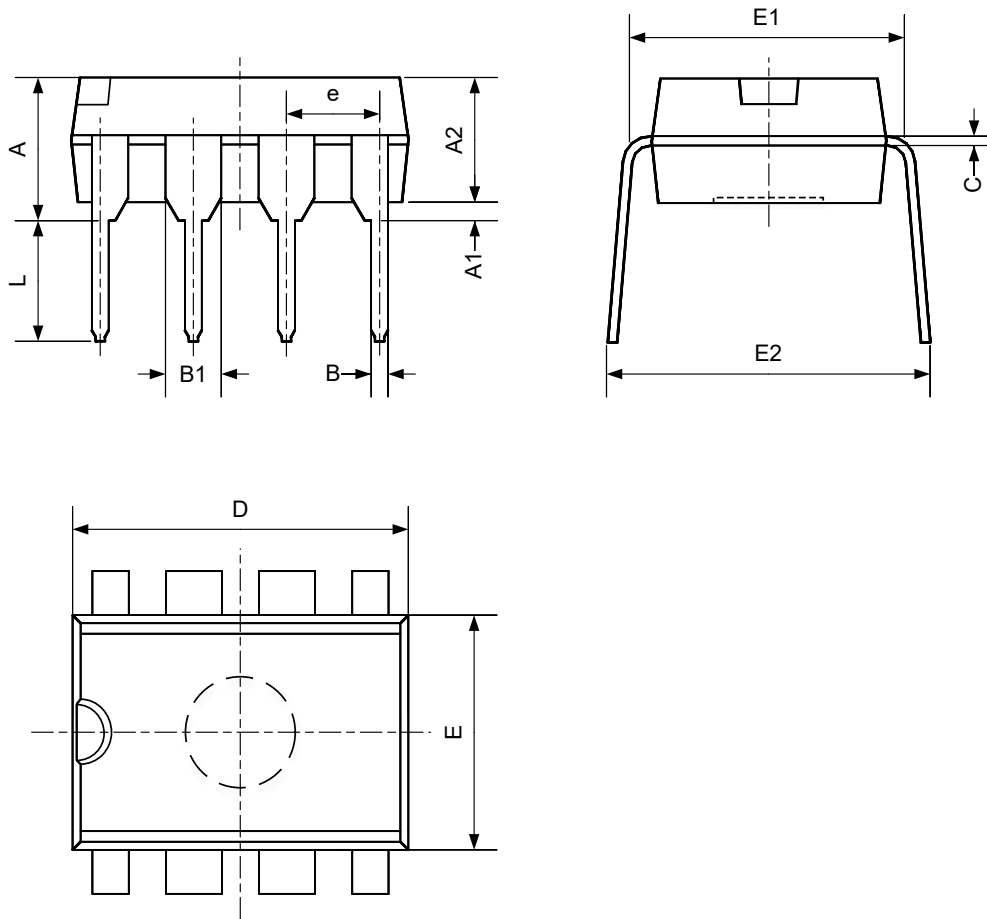
5.4 MSOP-8



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

Figure 5-4 MSOP-8 Package Dimension

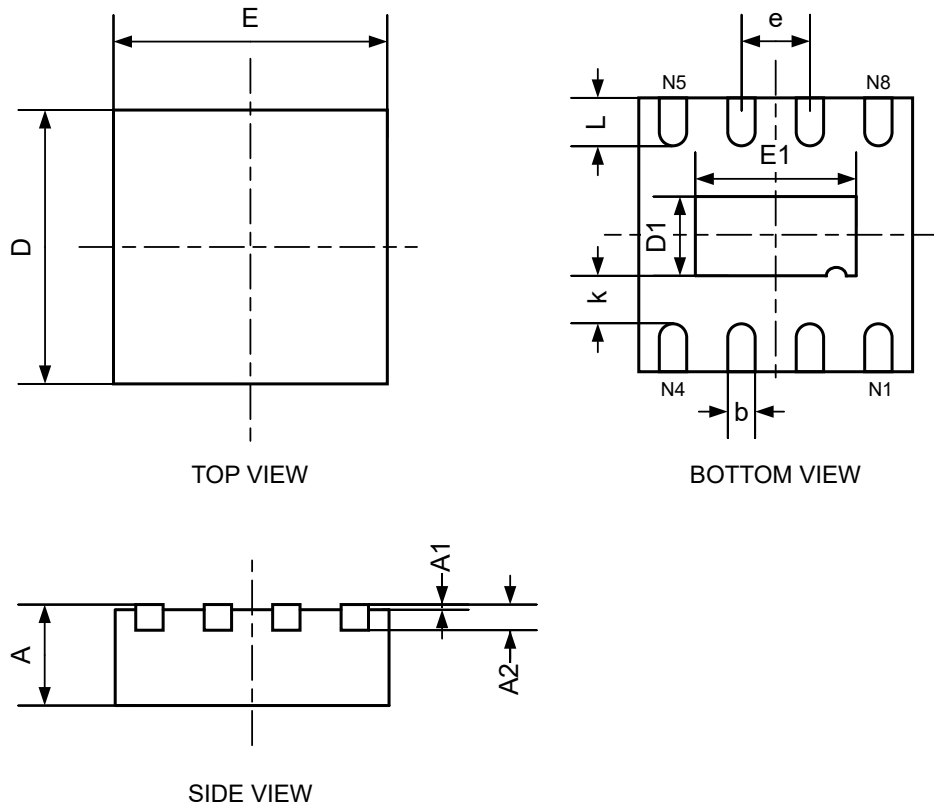
5.5 DIP-8



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	3.710	4.310	0.146	0.170
A1	0.510		0.020	
A2	3.200	3.600	0.126	0.142
B	0.380	0.570	0.015	0.022
B1	1.524 BSC		0.060 BSC	
C	0.204	0.360	0.008	0.014
D	9.000	9.400	0.354	0.370
E	6.200	6.600	0.244	0.260
E1	7.320	7.920	0.288	0.312
e	2.540 BSC		0.100 BSC	
L	3.000	3.600	0.118	0.142
E2	8.400	9.000	0.331	0.354

Figure 5-5 DIP-8 Package Dimension

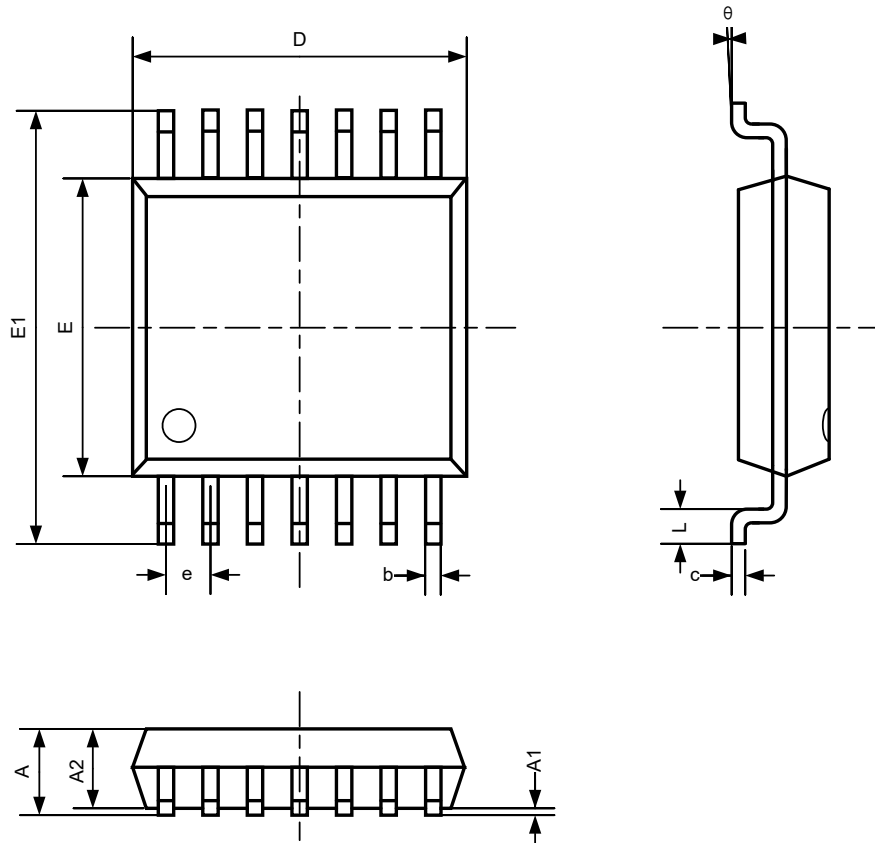
5.6 DFN-8



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min	Nom	Max	Min	Nom	Max
A	0.800	0.850	0.900	0.031	0.033	0.035
A1	0.000	0.020	0.050	0.000	0.001	0.002
A2	0.153	0.203	0.253	0.006	0.008	0.010
b	0.180	0.240	0.300	0.007	0.009	0.012
D	1.900	2.000	2.100	0.075	0.079	0.083
E	1.900	2.000	2.100	0.075	0.079	0.083
D1	0.500	0.600	0.700	0.020	0.024	0.028
E1	1.100	1.200	1.300	0.043	0.047	0.051
e		0.500			0.020	
k	0.200			0.008		
L	0.250	0.350	0.450	0.010	0.014	0.018

Figure 5-6 DFN-8 Package Dimension

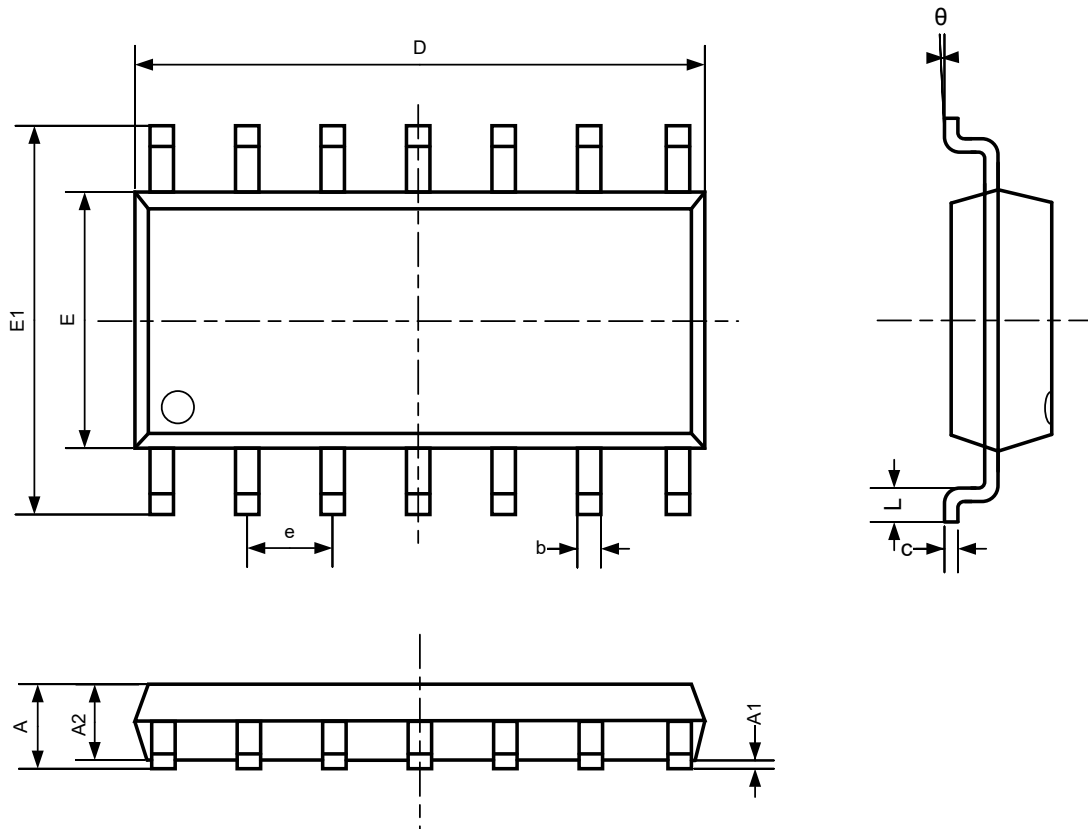
5.7 TSSOP-14



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.000	0.031	0.039
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.020	0.028
θ	1°	7°	1°	7°

Figure 5-7 TSSOP-14 Package Dimension

5.8 SOP-14



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	1.250	1.650	0.049	0.065
b	0.360	0.490	0.014	0.019
c	0.130	0.250	0.005	0.010
D	8.530	8.730	0.336	0.344
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 BSC		0.050 BSC	
L	0.450	0.800	0.018	0.032
θ	0°	8°	0°	8°

Figure 5-8 SOP-14 Package Dimension

6 Revision History

Version	Date	Description
0.1	2022/07/12	Initial release

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