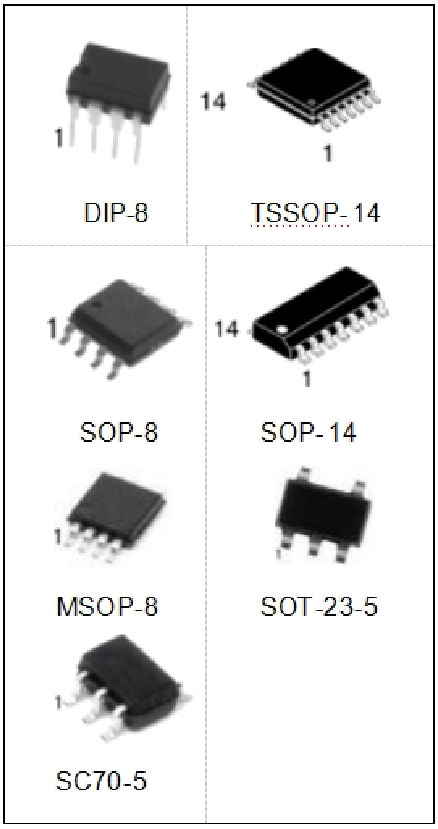
General Description

The LMV321 family have a high gain-bandwidth product of 1MHz, a slew rate of 0.6V/μs, and a quiescent current of 40μ A/amplifier at 5V. The LMV321 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 LMV321 family. They are specified over the extended industrial temperature range (-40℃ to +125℃). The operating range is from 2.1V to 5.5V.



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:
  LMV321 Available in SOT23-5 Packages
  LMV358 Available in SOP-8, MSOP-8, DIP-8 Packages
  LMV324 Available in SOP- 14 and TSSOP- 14 Packages

Applications

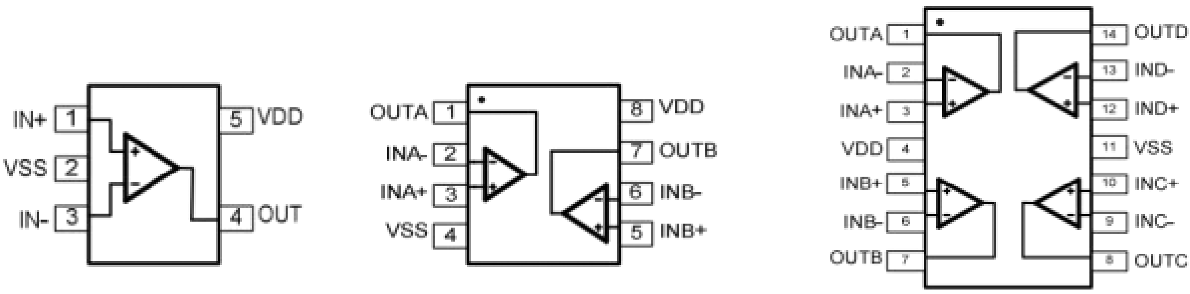
- ASIC Input or Output Amplifier
- Audio Output
- Sensor Interface
- Piezoelectric Transducer Amplifier
- Medical Communication
- Medical Instrumentation
- Smoke Detectors
- Portable Systems

Ordering Information

DEVICE	Package Type	MARKING	Packing	Packing Qty
LMV321M7/TR	SC70-5	A12	REEL	3000/reel
LMV321M5X/TR	SOT-23-5	A13	REEL	3000/reel
LMV358M/TR	SOP-8	LMV358	REEL	2500/reel
LMV358MM/TR	MSOP-8	V358	REEL	3000/reel
LMV358N	DIP-8	LMV358	TUBE	2000/box
LMV324M/TR	SOP-14	LMV324	REEL	2500/reel
LMV324MT/TR	TSSOP-14	V324	REEL	2500/reel

Pin Configuration

SOT23-5/SC70-5 SOP-8/MSOP-8/DIP-8 SOP-14/TSSOP-14



LMV321 LMV358 LMV324

Figure 1. Pin Assignment Diagram

Absolute Maximum Ratings

Condition	Min	Max
Power Supply Voltage (VDD to Vss)	-0.5V	+7.5V
Analog Input Voltage (IN+ or IN-)	Vss-0.5V	VDD+0.5V
PDB Input Voltage	Vss-0.5V	+7V
Operating Temperature Range	-40°C	+125°C
Junction Temperature	+160°C	
Storage Temperature Range	-55°C	+150°C
Lead Temperature (soldering, 10sec)	+245°C	
Package Thermal Resistance (TA=+25℃)		
SOP-8, θJA	125°C/W	
MSOP-8, θJA	216°C/W	
SOT23-5, θJA	190°C/W	
ESD Susceptibility		
HBM	6KV	
MM	300V	

Note: Stress greater than those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions outside those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

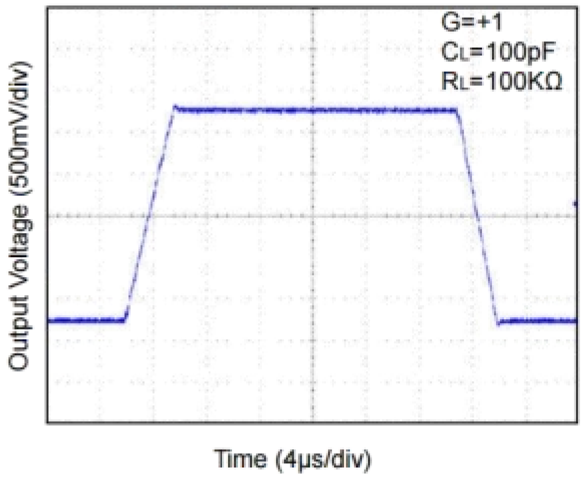
Electrical Characteristics

(At V_S = +5V, R_L = 100kΩ connected to $V_S/2$, and V_{OUT} = $V_S/2$, unless otherwise noted.)

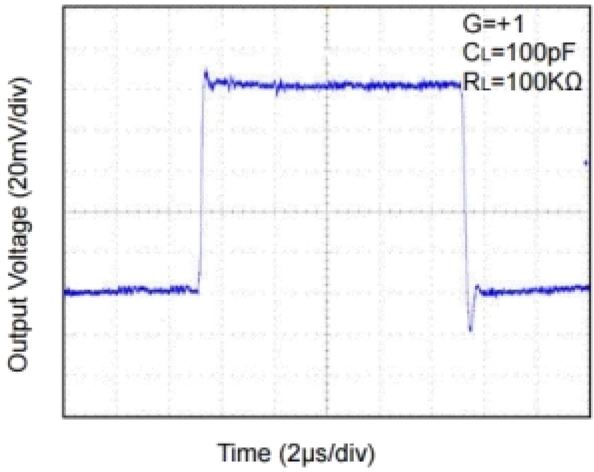
PARAMETER	SYMBOL	CONDITIONS	LMV321/358/324				
			TYP	MIN/MAX OVER TEMPERATURE			
			+25℃	+25℃	-40℃ to +85℃	UNITS	MIN/MAX
INPUT CHARACTERISTICS							
Input Offset Voltage	VOS	VCM = VS/2	0.4	3.5	5.6	mV	MAX
Input Bias Current	IB		1			pA	TYP
Input Offset Current	IOS		1			pA	TYP
Common-Mode Voltage Range	VCM	VS = 5.5V	-0.1 to +5.6			V	TYP
Common-Mode Rejection Ratio	CMRR	VS = 5.5V, VCM = -0.1V to 4V	70	62	62	dB	MIN
		VS = 5.5V, VCM = -0.1V to 5.6V	68	56	55		
Open-Loop Voltage Gain	AOL	RL = 5kΩ, VO = +0.1V to +4.9V	80	70	70	dB	MIN
		RL = 10kΩ, VO = +0.1V to +4.9V	100	90	85		
Input Offset Voltage Drift	ΔVOS/ΔT		2.7			μV/℃	TYP
OUTPUT CHARACTERISTICS							
Output Voltage Swing from Rail	VOH	RL = 100kΩ	4.997	4.990	4.980	V	MIN
	VOL	RL = 100kΩ	3	10	20	mV	MAX
	VOH	RL = 10kΩ	4.992	4.970	4.960	V	MIN
	VOL	RL = 10kΩ	8	30	40	mV	MAX
Output Current	ISOURCE	RL = 10Ω to VS/2	84	60	45	mA	MIN
	ISINK		75	60	45		
POWER SUPPLY							
Operating Voltage Range				2.1	2.5	V	MIN
				5.5	5.5	V	MAX
Power Supply Rejection Ratio	PSRR	VS = +2.5V to +5.5V, VCM = +0.5V	82	60	58	dB	MIN
Quiescent Current / Amplifier	IQ		40	60	80	μA	MAX
DYNAMIC PERFORMANCE (CL = 100pF)							
Gain-Bandwidth Product	GBP		1			MHz	TYP
Slew Rate	SR	G = +1, 2V Output Step	0.6			V/μs	TYP
Settling Time to 0.1%	tS	G = +1, 2V Output Step	5			μs	TYP
Overload Recovery Time		VIN ·Gain = VS	2.6			μs	TYP
NOISE PERFORMANCE							
Voltage Noise Density	en	f = 1kHz	27			nV Hz	TYP
		f = 10kHz	20			nV Hz	TYP

Typical Performance characteristics

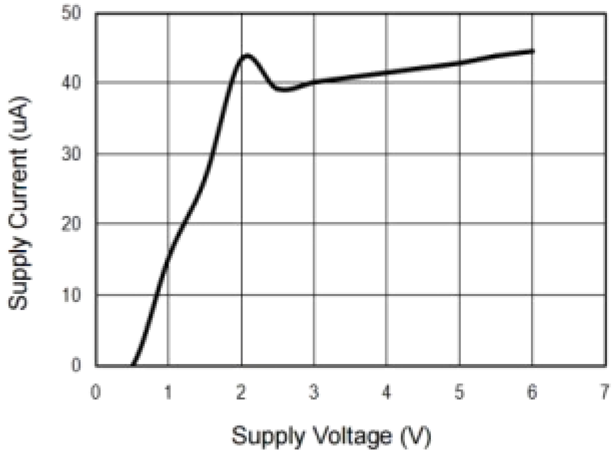
At TA=+25℃, VS=+5V, and RL= 100KΩ connected to VS/2, unless otherwise noted.



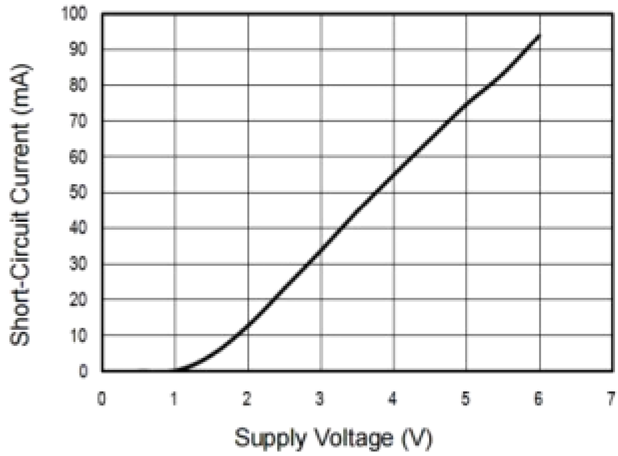
Large-Signal Step Response



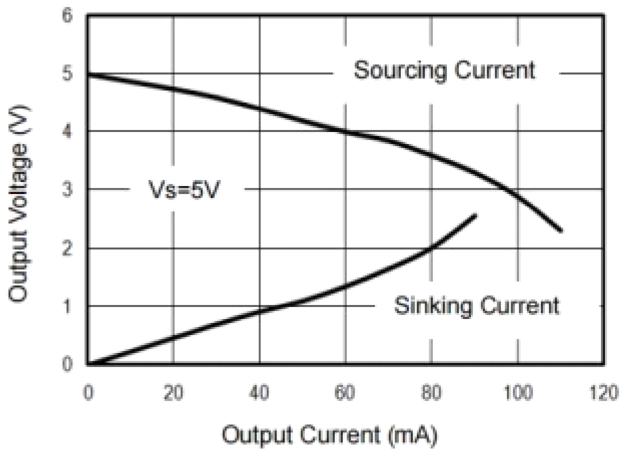
Small-Signal Step Response



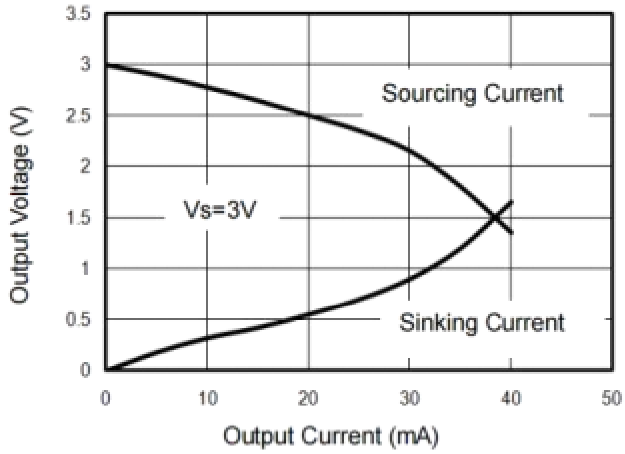
Supply Current vs. Supply Voltage



Short-Circuit Current vs. Supply Voltage



Output Voltage vs. Output Current

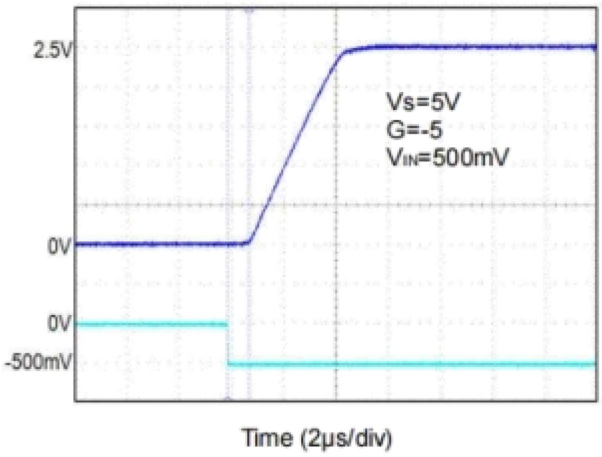


Output Voltage vs. Output Current

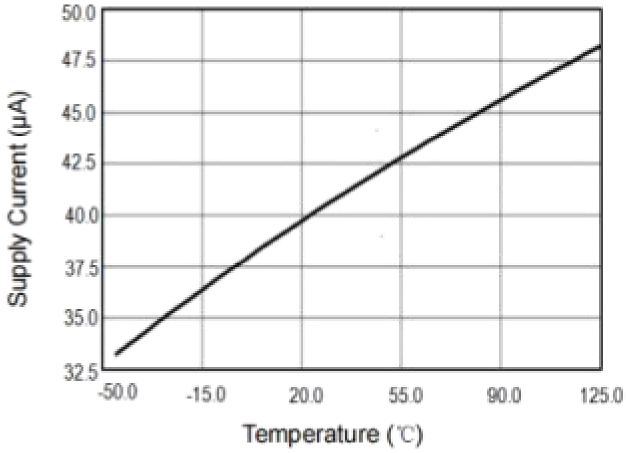
Typical Performance characteristics

At TA=+25℃, VS=+5V, and RL= 100KΩ connected to VS/2, unless otherwise noted.

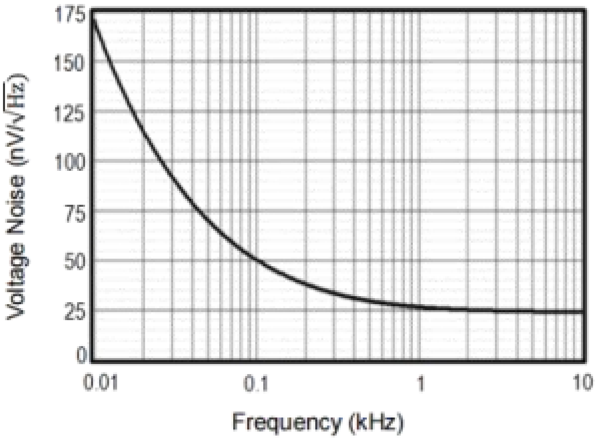
Overload Recovery Time



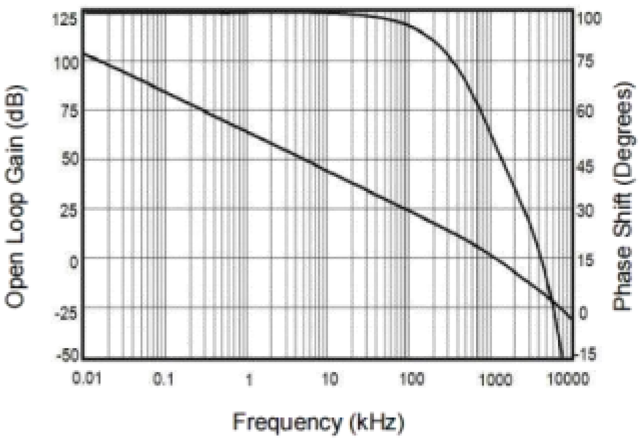
Supply Current vs. Temperature



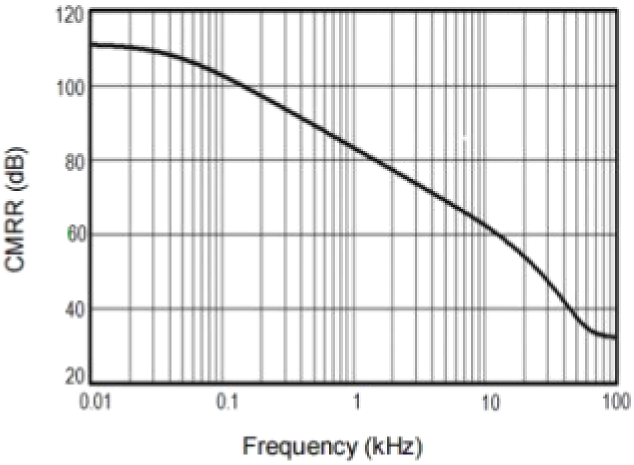
Input Voltage Noise Spectral Density vs. Frequency



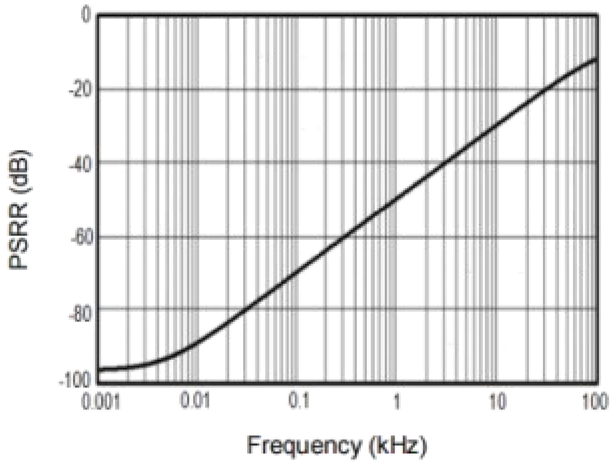
Open Loop Gain, Phase Shift vs. Frequency at +5V



CMRR vs. Frequency



PSRR vs. Frequency



Application Note

Size

LMV321 family series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the LMV321 family packages save space o n printed circuit boards and enable the design of smaller electronic products.

Power Supply Bypassing and Board Layout

LMV321 family series operates from a single 2. 1V to 5.5V supply or dual ±1.05V to ±2.75V supplies. For best performance, a 0. 1μF ceramic capacitor should be placed close to the VDD pin in single supply operation. For dual supply operation, both VDD and VSS supplies should be bypassed to ground with separate 0. 1μF ceramic capacitors.

Low Supply Current

The low supply current (typical 40uA per channel) of LMV321 family will help to maximize battery life. They are ideal for battery powered systems

Operating Voltage

LMV321 family operates under wide input supply voltage (2. 1V to 5.5V). In addition, all temperature specifications apply from -40 °C to +125 °C. Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime

Rail-to-Rail Input

The input common-mode range of LMV321 family extends 100mV beyond the supply rails (VSS-0. 1V to VDD+0. 1V). This is

achieved by using complementary input stage. For normal operation, inputs should be limited to this range.

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 LMV321 family can typically swing to less than 5mV from supply rail in light resistive loads (>100kΩ), and 30mV of supply rail in moderate resistive loads (10kΩ).

Capacitive Load Tolerance

The LMV321 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 2. 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.

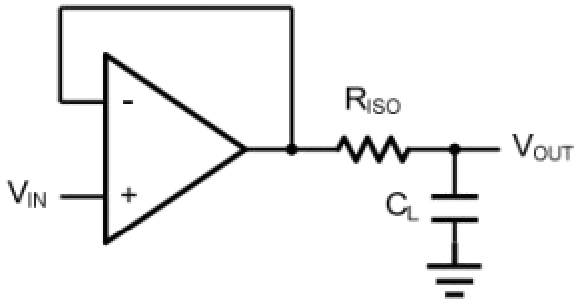


Figure 2. Indirectly Driving a Capacitive Load Using Isolation Resistor

The bigger the RISO resistor value, the more stable VOUT will be. However, if there is a resistive load RL in parallel with the

capacitive load, a voltage divider (proportional to RISO/RL) is formed, this will result in a gain error.

The circuit in Figure 3 is an improvement to the one in Figure 2. RF provides the DC accuracy by feed-forward the VIN to RL. CF and RISO 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 CF. This in turn will slow down the pulse response.

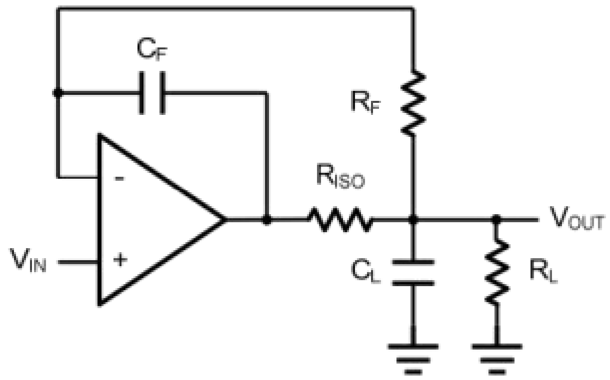


Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy

Typical Application Circuits

Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common 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 4. shown the differential amplifier using LMV321 family.

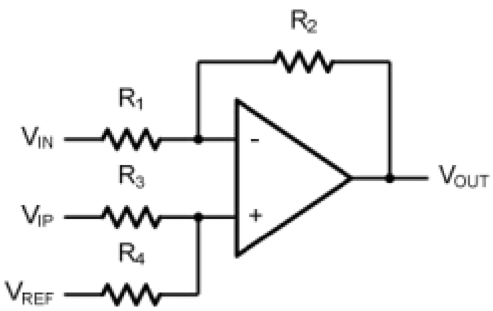


Figure 4. Differential Amplifier

$$V_{OUT} = \left(\frac{R_1 + R_2}{R_3 + R_4}\right)\frac{R_4}{R_1} V_{IN} - \frac{R2}{R1} V_{IP} + \left(\frac{R_1 + R_2}{R_3 + R_4}\right)\frac{R_3}{R_1} V_{REF}$$

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

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

Low Pass Active Filter

The low pass active filter is shown in Figure 5. The DC gain is defined by $-R2/R1$. The filter has a -20dB/decade roll-off after its corner frequency $f C=1/(2\pi R3C1)$.

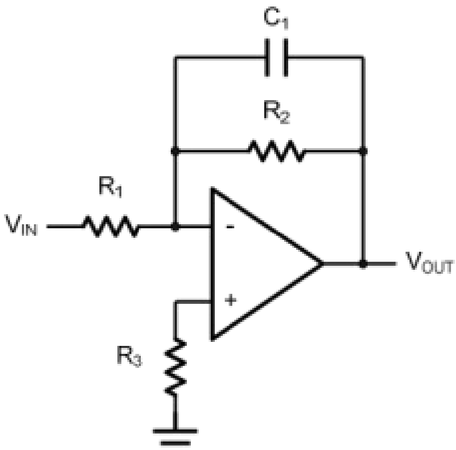


Figure 5. Low Pass Active Filter

Differential Amplifier

The triple LMV321 family can be used to build a three -op-amp differential amplifier as shown in Figure 6. The amplifier in Figure 6 is a high input impedance differential amplifier with gain of R2/R1. The two differential voltage followers assure the high input impedance of the amplifier.

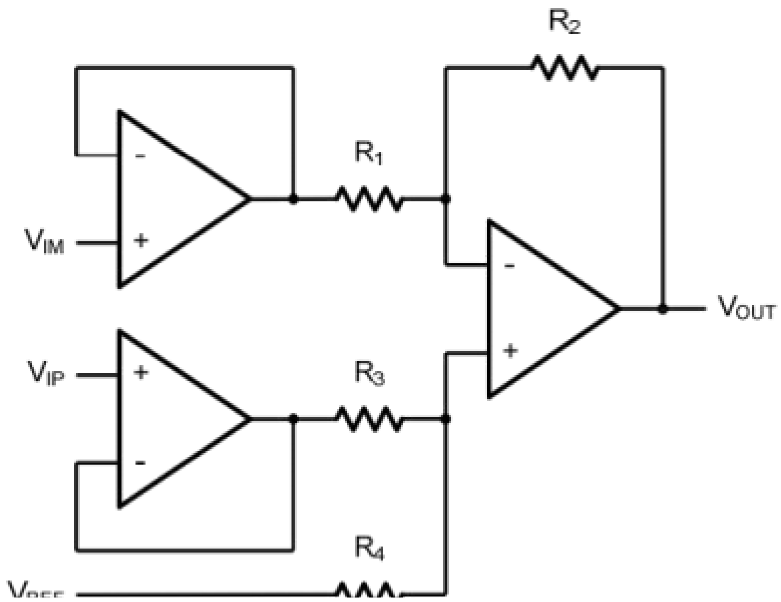
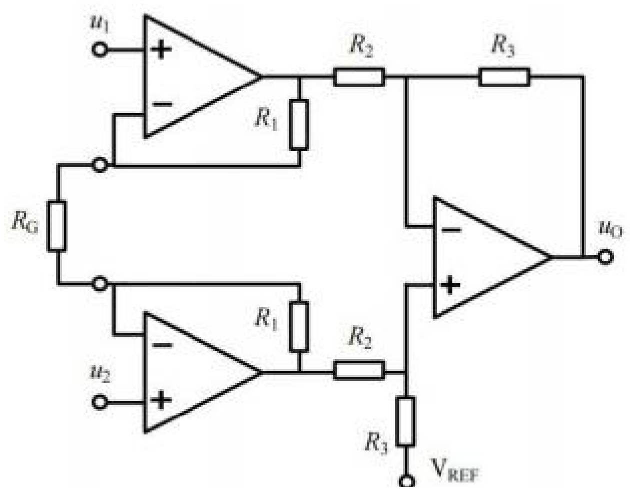


Figure 6. Differential Amplifier

Instrumenton Amplifier



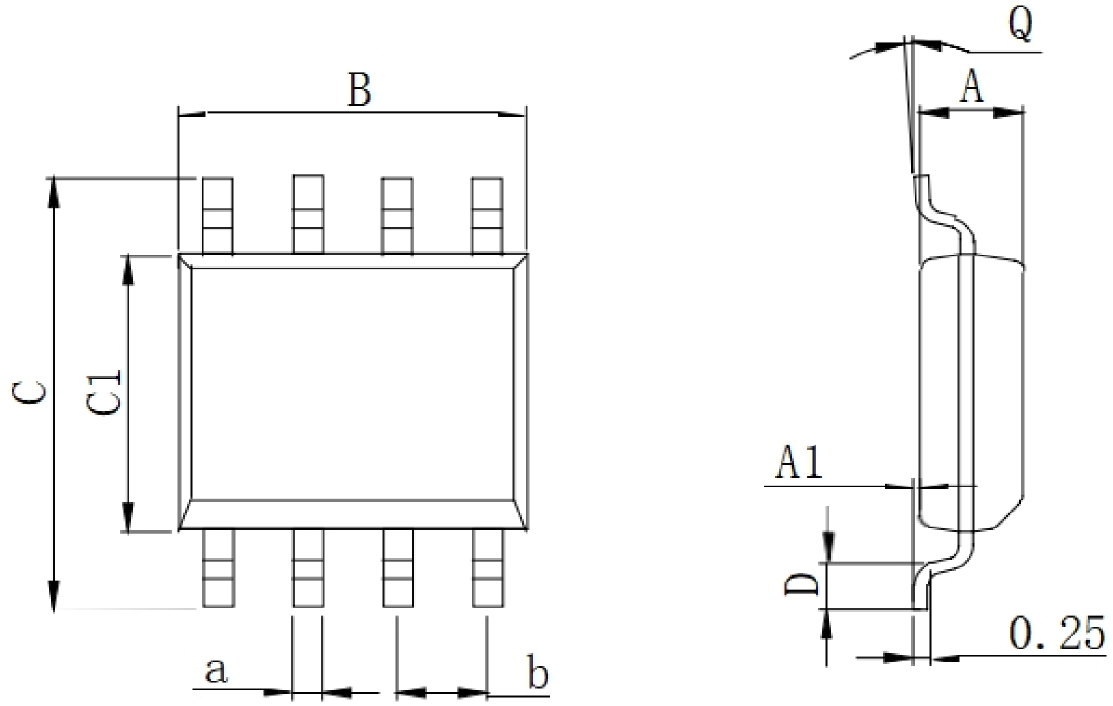
$$G = \frac{R_3}{R_2} \times \frac{R_G + 2R_1}{R_G}$$

Figure 7. Instrumenton Amplifier

By an external resistance R_G. Note that R_G can be suspended but can not short circuit. The V_{REF} pin, used to control the central position of the output voltage. When dual power supply, it is generally grounded. When a single power supply, it is generally connected to 1 / 2 power supply voltage. When R_G is open circuit, and R2=R3, gain G= 1

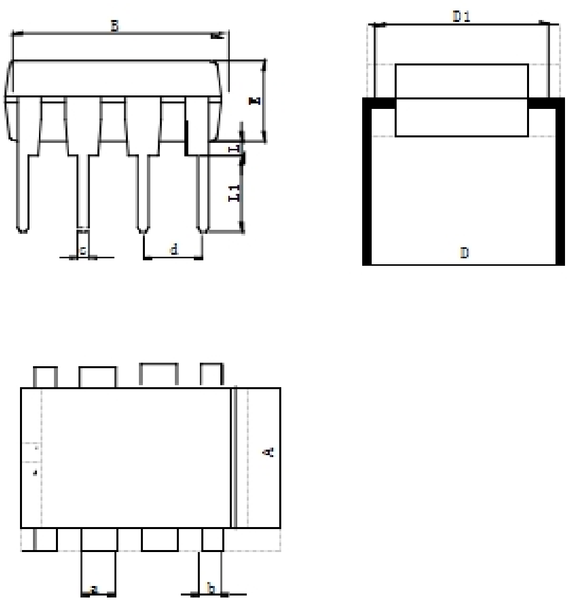
Physical Dimensions

SOP-8（150mil）



Dimensions In Millimeters(SOP-8)									
Symbol :	A	A1	B	C	C1	D	Q	a	b
Min :	1.35	0.05	4.90	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max :	1.55	0.20	5.10	6.20	4.00	0.80	8°	0.45	

DIP-8

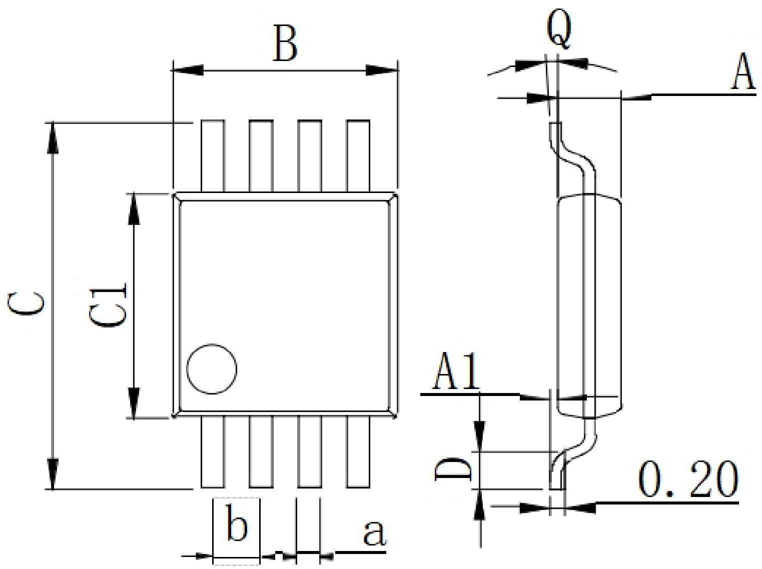


Dimensions In Millimeters(DIP-8)

Symbol :	A	B	D	D1	E	L	L1	a	b	c	d
Min :	6.10	9.00	8.10	7.42	3.10	0.50	3.00	1.50	0.85	0.40	2.54 BSC
Max :	6.68	9.50	10.9	7.82	3.55	0.70	3.60	1.55	0.90	0.50	

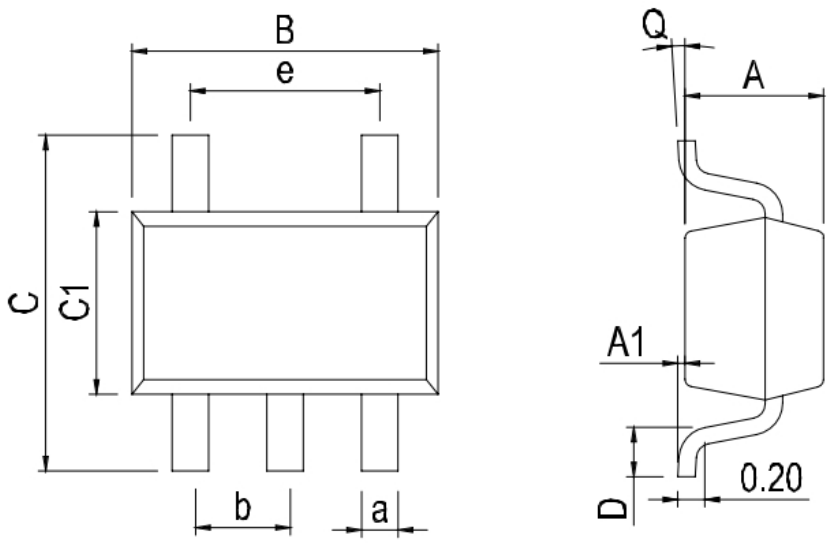
Physical Dimensions

MSOP-8



Dimensions In Millimeters(MSOP-8)									
Symbol :	A	A1	B	C	C1	D	Q	a	b
Min :	0.80	0.05	2.90	4.75	2.90	0.35	0°	0.25	0.65 BSC
Max :	0.90	0.20	3.10	5.05	3.10	0.75	8°	0.35	

SOT-23-5

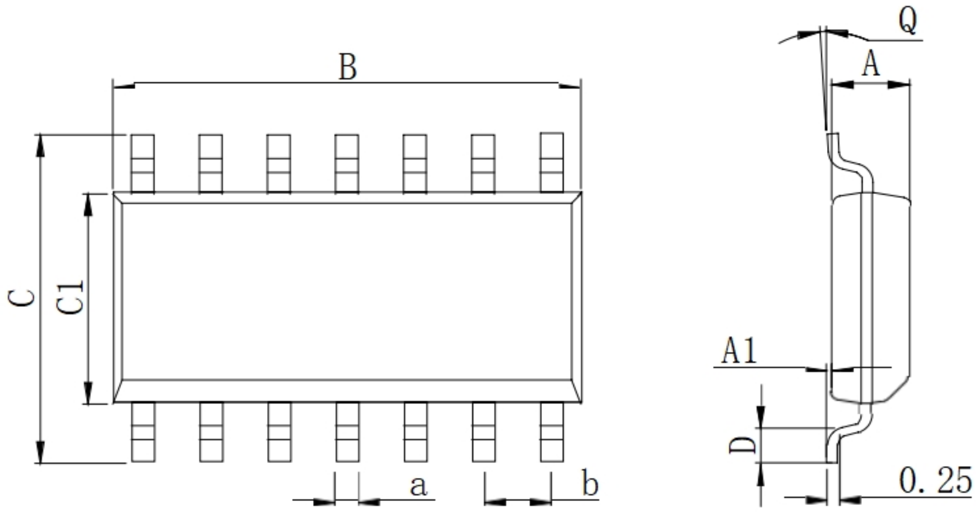


Dimensions In Millimeters(SOT-23-5)										
Symbol :	A	A1	B	C	C1	D	Q	a	b	e

Min :	1.05	0.00	2.82	2.65	1.50	0.30	0°	0.30	0.95 BSC	1.90 BSC

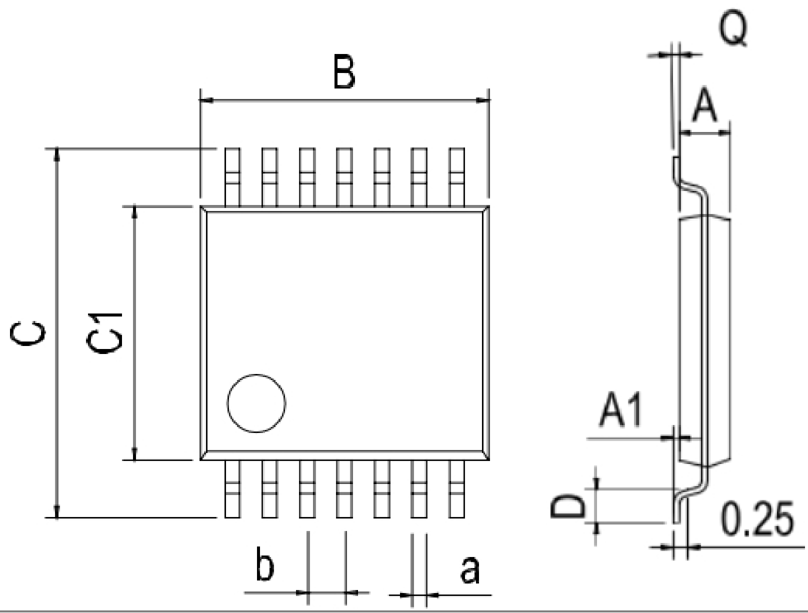
Physical Dimensions

SOP-14



Dimensions In Millimeters(SOP-14)									
Symbol :	A	A1	B	C	C1	D	Q	a	b
Min :	1.35	0.05	8.55	5.80	3.80	0.40	0°	0.35	1.27 BSC
Max :	1.55	0.20	8.75	6.20	4.00	0.80	8°	0.45	

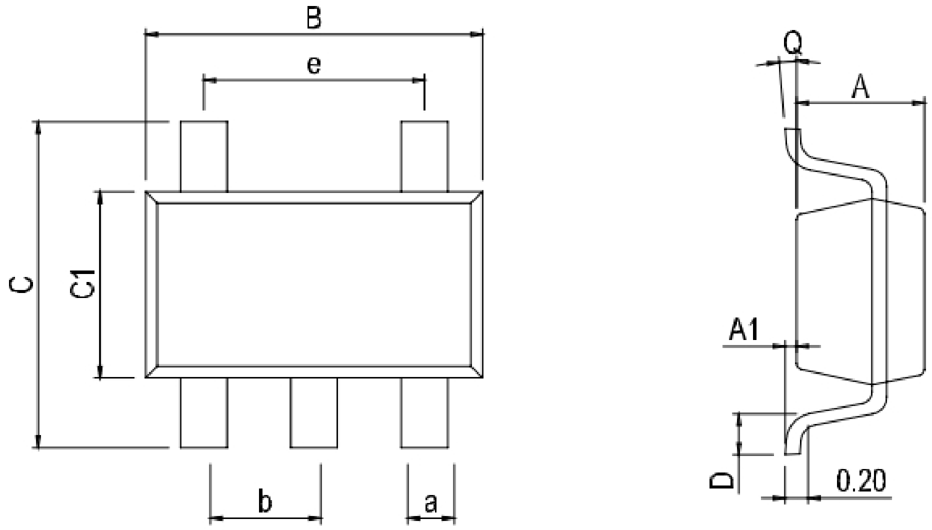
TSSOP-14



Dimensions In Millimeters(TSSOP-14)									
Symbol :	A	A1	B	C	C1	D	Q	a	b
Min :	0.85	0.05	4.90	6.20	4.30	0.40	0°	0.20	0.65 BSC
Max :	0.95	0.20	5.10	6.60	4.50	0.80	8°	0.25	

Physical Dimensions

SC70-5



Dimensions In Millimeters(SC70-5)										
Symbol :	A	A1	B	C	C1	D	Q	a	b	e
Min :	0.90	0.00	2.00	2.15	1.15	0.26	0°	0.15	0.65	1.30 BSC
Max :	1.00	0.15	2.20	2.45	1.35	0.46	8°	0.35	BSC	