Zero Drift, Micro-power Consumption CMOS Operational Amplifier

1 Product features

- Low offset voltage
  - 2μV（the typical）
  - 10μV(Max value)
- Zero drift: 0.05μV/℃ (max. value)
- Low power consumption
  - 17μA (single channel)
  - 30μA(dual channels)
- Rail-to-rail input/output
- Wide working voltage ranges: 1.8V- 5.5V
- Low 0.1Hz-10Hz noise: 1.1μV
- Volt Current Condenser

2 Typical applications

- Sensor
- Temperature detection
- Electronic scale
- Bridge circuit reading
- Medical instrument

3. General Description

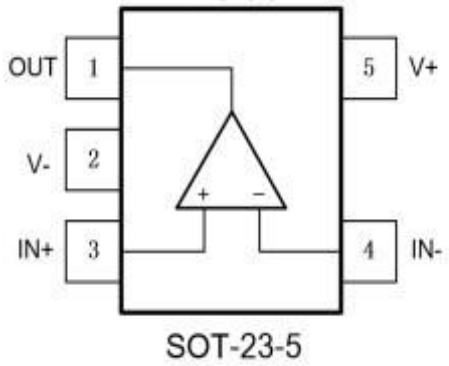
SLAx333 is a CMOS operational amplifier with single power supply and micro power consumption, which can realize rail to rail input/output. The self-calibration technology is adopted to provide extremely low offset voltage2μV（the typical）; at the same time, the drifting along with temperature and time is near to zero. The amplifier can provide high input resistance (the scope of common mode is 100mV higher than the power rail voltage) Single power supply or dual power supply of 1.8V (±0.9V) and even 5.5V (±2.75V) can be adopted. The SLAx333 series of products can provide excellent CMRR performance, with no interaction associated with the traditional mutually complemented input level. The design can achieve excellent performance during driving the analog-digital converter (ADC) by not reducing the differential linearity.

SLA2333 (single-channel version) can provide 5-pin SOT-23-5, SC 70-5 and SOIC-8 package. SLA333 (dual-channel version) can provide SOIC-8, MSOP-8 and DFN-2×2-8 package.

4 Definition of pins and information of signs

SLA2333

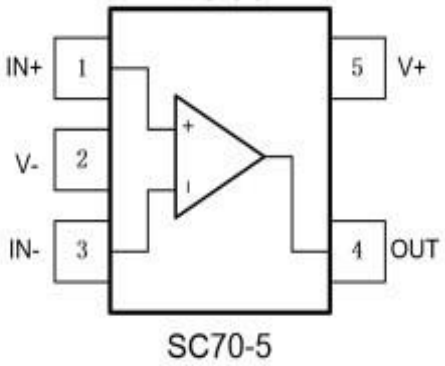
top view



SOT-23-5

SLA2333

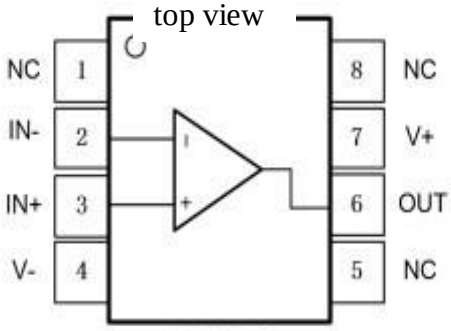
top view



SC70-5

SLA2333

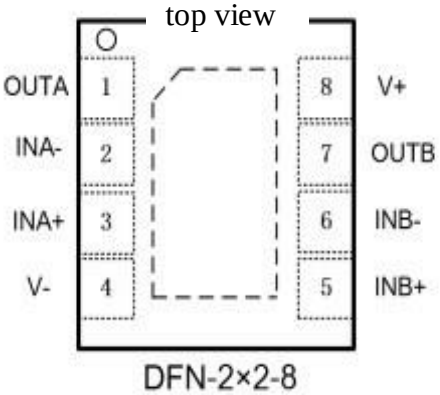
top view



SOIC-8

SLA333

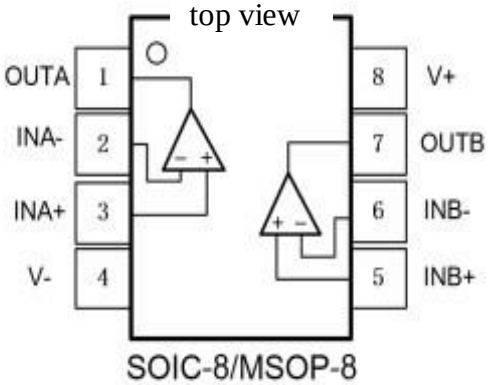
top view



DFN-2×2-8

SLA333

top view



SOIC-8/MSOP-8

Functions of pins: SLA2333

Pins				I/O	Description
Name	SOIC	SOT	SC70		
IN+	3	3	1	I	Same-phase input
IN-	2	4	3	I	Inverted-phase input
NC	1、5、8	—	—	—	No internal chain (can be suspended in midair)
OUT	6	1	4	O	Output
V+	7	5	5	—	Positive power supply (the highest)
V-	4	2	2	—	Negative power supply (the lowest)

Functions of pins: SLA333

Pins			I/O	Description
Name	DFN	SOIC、MSOP-8		
INA+	3	3	I	Same-phase input, channel A
INA-	2	2	I	Inverted-phase input, channel A
INB+	5	5	I	Same-phase input, channel B
INB-	6	6	I	Inverted-phase input, channel B
OUTA	1	1	O	Output, channel A
OUTB	7	7	O	Output, channel B
V+	8	8	—	Positive power supply (the highest)
V-	4	4	—	Negative power supply (the lowest)

5 Specification

5.1 Absolute Max. rated value

Please refer to (1)

	Min	Max	Unit
Supply voltage	6.5		V
Analog input voltage	V_{-} - 0.2	V_{+} + 0.2	V
Operating junction temperature, TJ		150	℃
Storage Temperature, T_{stg}	-65	150	℃

(1)The stress of the listed values exceeding the absolute max. rated values may lead to permanent damages to the device. Such are working conditions at the rated value of stress. Functional operations of the device under the rated values and any other operation other than suggested working conditions are not indicated here. Long-time working at the absolute rated conditions may lead to influences on reliability of the chip.

5.2 ESD Rated value

ESD	Values	Unit
HBM	7K	V

5.3 Working conditions

	Min	Max	Unit
Supply voltage	1.8	5.5	V
Rated temperature range	-40	125	℃

6 Electrical parameters (@TA=+25℃，VCM=Vs/2，VOUT=Vs/2， unless otherwise specified)

Item	Parameter description	Working conditions	Min	Typical value	Max	Unit
Output characteristics						
V_{OS}	Offset voltage	Vs=5V		2	10	μV
dV_{OS}/dT	Low input offset voltage	TA= –40°C to 125°C		0.02	0.05	μV/°C
I_B	Bias current			±100		pA
I_{OS}	offset current			±120		pA
V_{CM}	Common-mode input voltage ranges		(V–) – 0.1		(V+) + 0.1	V
CMRR	Common mode rejection ratio	(V–) – 0.1V < V_{CM} < (V+) + 0.1V，T_A = –40°C to 125°C		120		dB
A_{OL}	Open loop voltage gain	(V–) + 100mV < V_O < (V+) – 100mV，R_L = 10kΩ，T_A = –40°C to 125°C		120		dB
Output characteristics						
Output swing when compared with the power supply rail		R_L=10K		30	70	mV
I_{SC}	Short circuit			±17		mA
Power supply						
V_S	Supply voltage ranges		1.8		5.5	V
I_Q	Quiescent power consumption	IO=0A, TA= –40°C to 125°C (single operational amplifier)		17		μA
		IO=0A, TA= –40°C to 125°C (dual operational amplifier)		30		μA
PSRR	Volt Current Condenser	V_S=1.8V to 5.5V，T_A= –40°C to 125°C		1	5	μV/V
Opening time		V_S=+5V		200		μs
Frequency characteristics						
GBW	Gain bandwidth product	C_L=100pF		350		KHz
SR	Slew rate	G=1		0.16		V/μs
Noise coefficient						
Input		F=0.1Hz to 10Hz		1.1		μV_{PP}
Temperature						
T_A	Rated temperature range		-40		125	℃

7 Typical characteristics (@TA=+25°C, Vs=5V, CL=0pF, unless otherwise specified)

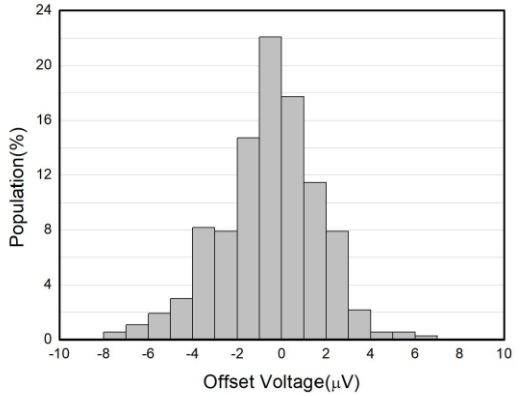


Figure 1 Offset voltage production distribution

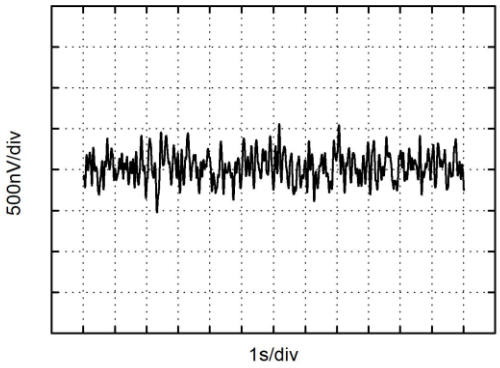


Figure 2 Noises from 0.1Hz to 10Hz

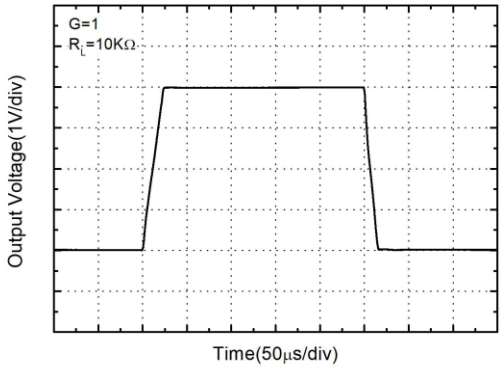


Figure 3 Large signal step response

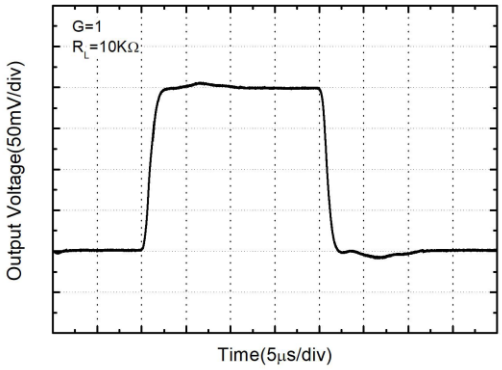


Figure 4 Small signal step response

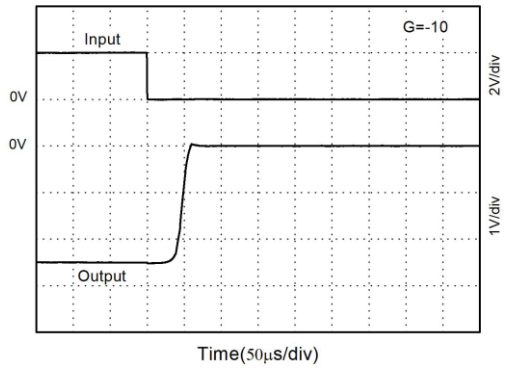


Figure 5 Negative overvoltage recovery

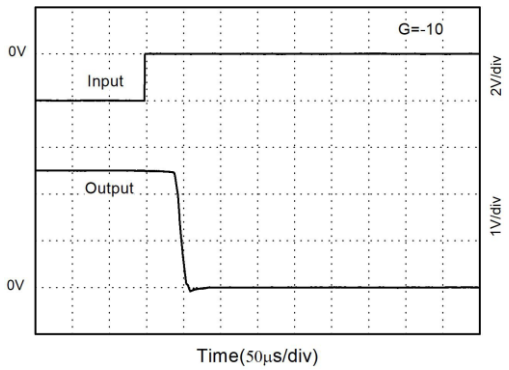


Figure 6 Positive overvoltage recovery

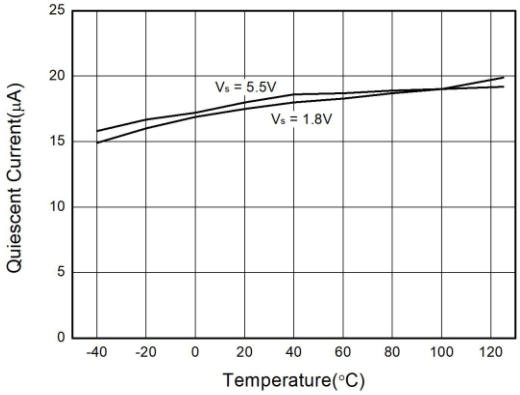


Figure 7 Relationship between quiescent current and temperature

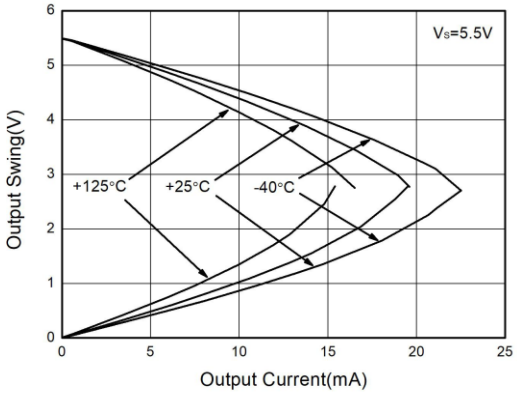


Figure 8 Relationship between output voltage swing and output current

8 Application guide

With the characteristic of unit gain stability, SLAx333 series of operational amplifiers are applicable to various general applications. SLAx333 can provide very low offset voltage and realize extremely low temperature drift with changes in time and temperature.

8.1 Working voltage

SLAx333 series of operational amplifiers can be powered with both single power supply of 1.8V to 5.5V and dual power supplies of ±0.9V to ±2.75V. The supply voltage higher than +6.5V (absolute maximum value) will lead to permanent damages to the device. In order to achieve better performance, it is necessary to set a shunt capacity of 0.1μF near to the power supply pin.

8.2 Rail to rail input and output

SLAx333 series of operational amplifiers have the characteristic of rail-to-rail input and rail-to-rail output. The complementary input pair structure can achieve very wide input common mode voltage scope (100mV higher than the power supply rail). In the resistive load of 10kΩ, the output voltage swing can achieve 100mV lower than the voltage of the power supply rail.

8.3 Input

SLAx333 series of operational amplifiers have two internal ESD protective diodes on the input end, connected between the power supply rail and input, as shown in Figure 9. When the input voltage is 300mV higher than any power rail, the diodes positively break over to amplify the current to protect the internal devices. Generally, the input bias current is about 100pA; however, the input voltage higher than the supply voltage may lead to flowing of the over-current into or out of the pin, and it may lead to permanent damages to the devices if the current is higher than 10mA. Input resistance can be used to realize easy limitation, as shown in Figure 10.

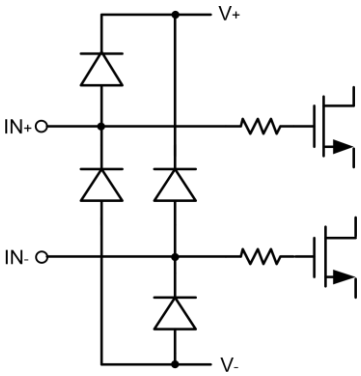


Figure 9 Input ESD structure

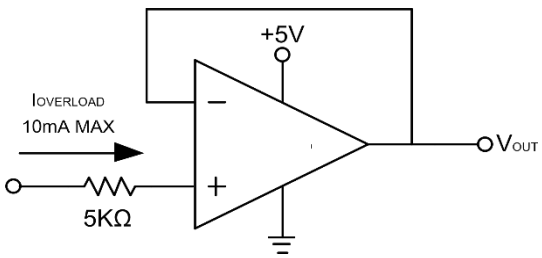


Figure 10 Input current protection

8.4 Internal bias correction

With the chopped wave self-calibration technology and the continuous time signal chain technology, SLAx333 series of operational amplifiers can make offset correction once every about 10μs. The amplifiers need about 200μs to achieve the rated Vos accuracy after start-up. In addition, the chopped wave self-calibration technology can eliminate the flicker noise.

8.5 Residual ripple waves

SLAx333 series of operational amplifiers can eliminate the offset voltage with the chopped wave self-calibration technology; at the same time, SLAx333 can filter the ripple waves caused by chopped wave modulation with the notching filter. Although the ripple wave voltage is restrained, there is still relatively large residual noise energy on chopped wave frequency and the harmonic component. In order to filter the noise at the wave frequency in a more favorable way, it is recommended to set a post-filter at the output end of the operational amplifiers.

9 Typical applications

9.1 Temperature measurement

Figure 11 shows the application of temperature measurement.

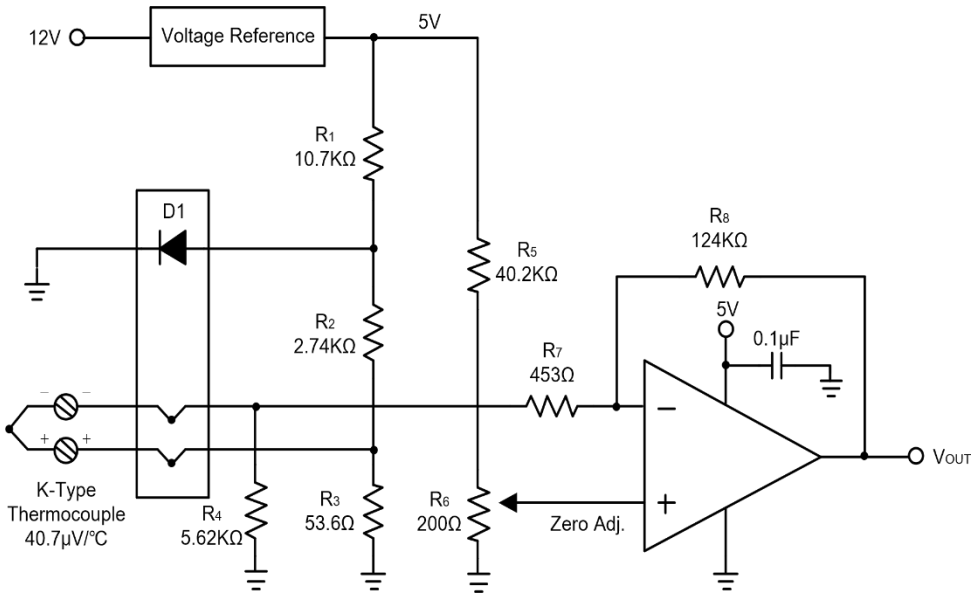


Figure 11. Temperature measurement

9.2 Thermistor measurement

SLA2333

Figure 12 shows the application of thermistor measurement.

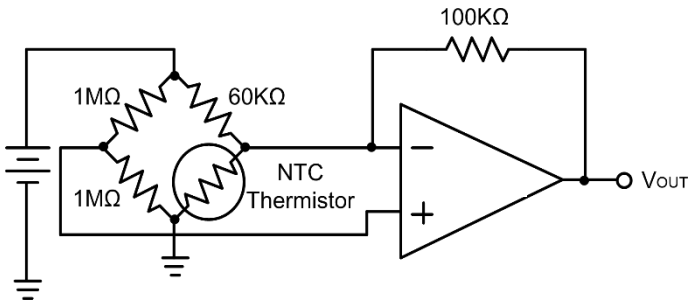


Figure 12. Thermistor measurement

9.3 Low-end current monitoring

Figure 13 shows the application of low-end current monitoring.

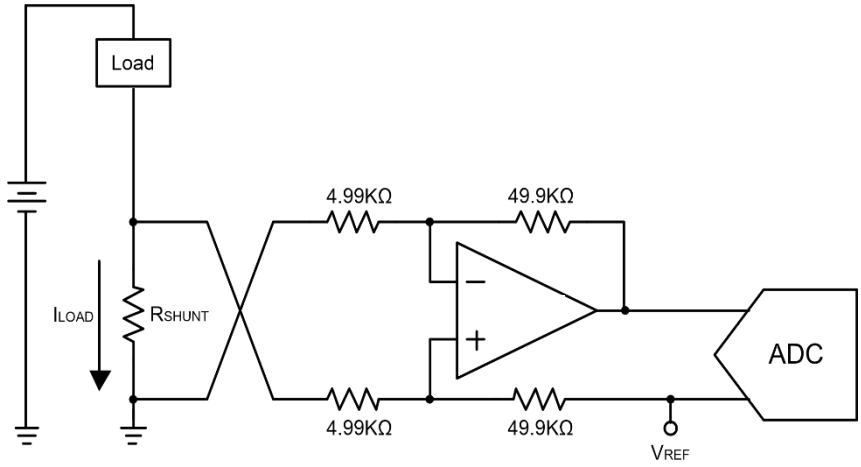


Figure 13. Low end current monitoring

9.4 High end current monitoring

Figure 14 shows the application of high-end current monitoring.

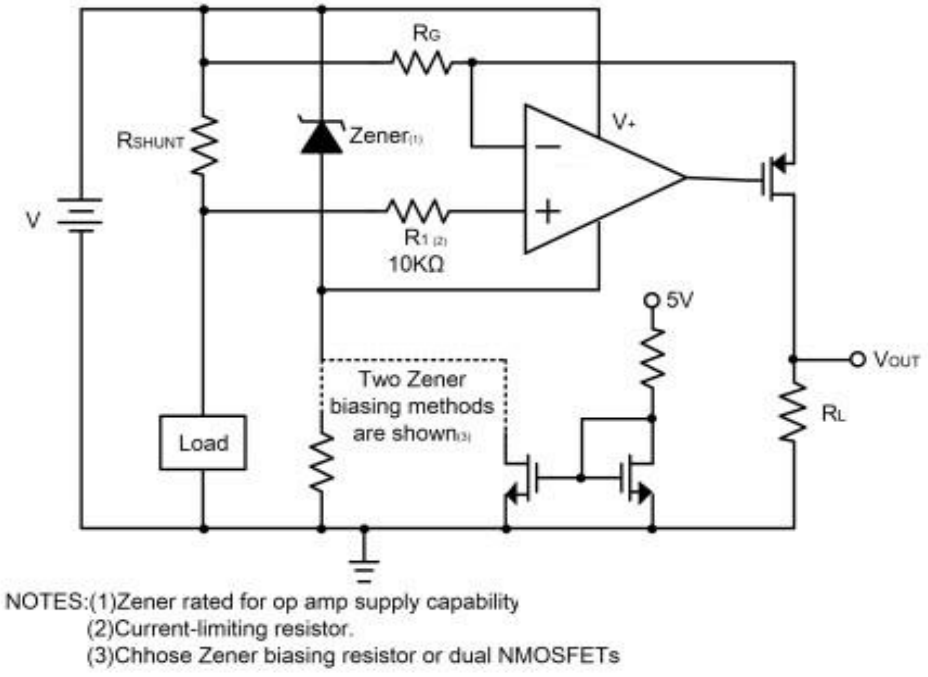


Figure 14. High end current monitoring

9.5 Instrument amplifier

Figure 15 shows the application of instrument amplifier.

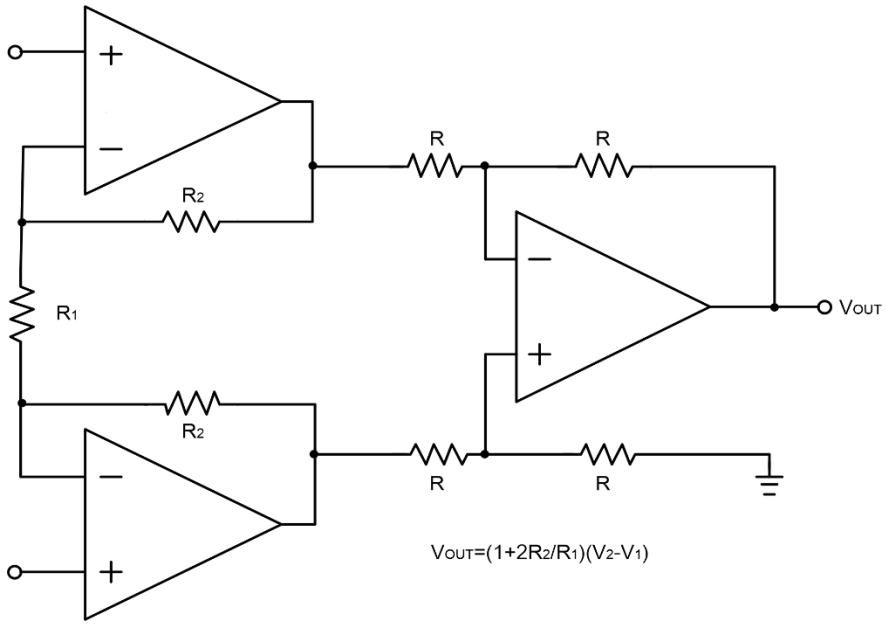
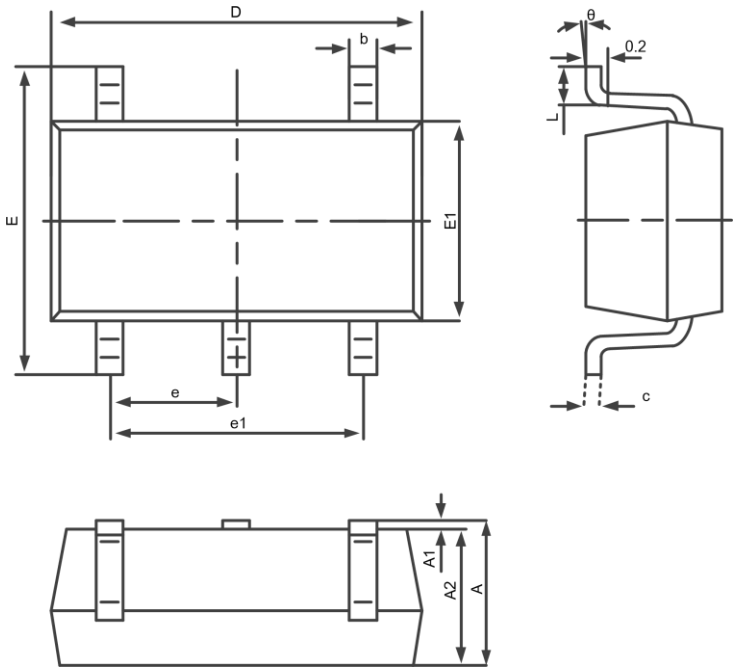


Figure 15. Instrument amplifier

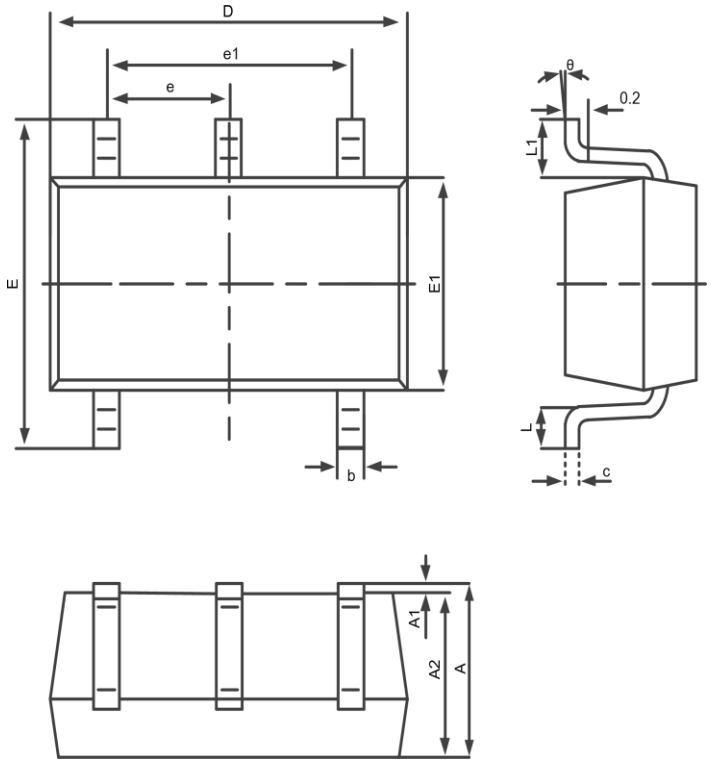
Package size profile drawing

SOT23-5



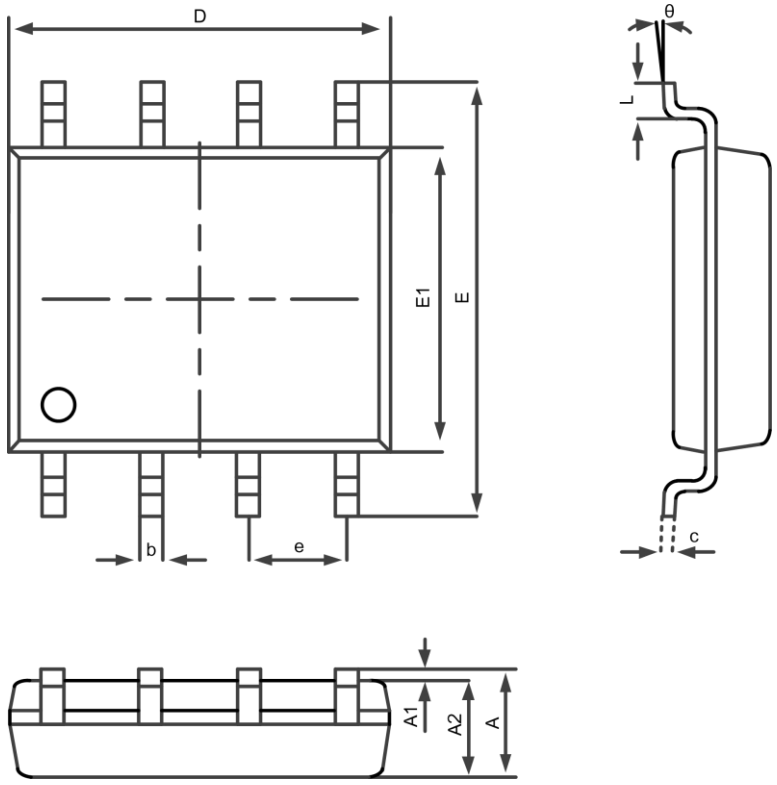
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	2.650	2.950	0.104	0.116
E1	1.500	1.700	0.059	0.067
e	0.950(BSC)		0.037(BSC)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

SC70-5(SOT353)



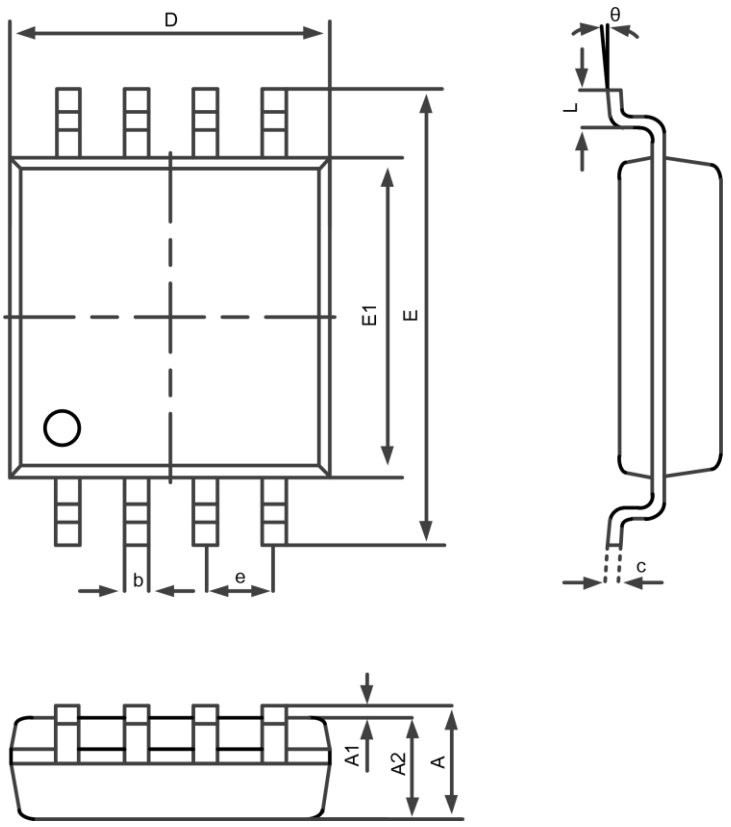
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.110	0.175	0.004	0.007
D	2.000	2.200	0.079	0.087
E	2.150	2.450	0.085	0.096
E1	1.150	1.350	0.045	0.053
e	0.650 TYP.		0.026 TYP.	
e1	1.200	1.400	0.047	0.055
L	0.300	0.600	0.012	0.024
L1	0.525 REF.		0.021 REF.	
θ	0°	8°	0°	8°

SOIC-8(SOP-8)



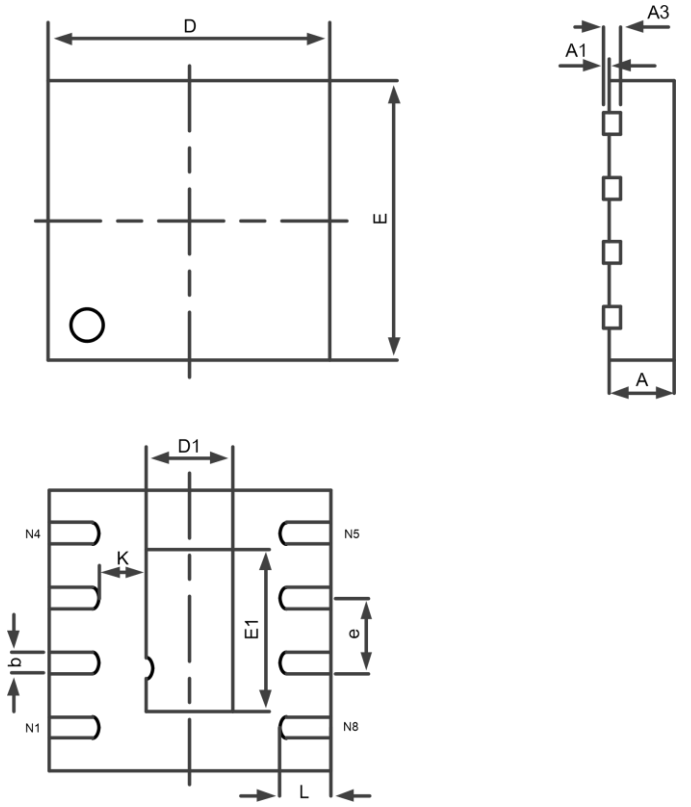
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
e	1.270 TYP.		0.050 TYP.	
L	0.400	0.800	0.016	0.031
θ	0°	8°	0°	8°

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	0.015
D	2.900	3.100	0.114	0.122
E	4.750	5.050	0.187	0.199
E1	2.900	3.100	0.114	0.122
e	0.650 TYP.		0.026 TYP.	
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

DFN-8 2*2



Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.203 REF.		0.008 REF.	
D	1.900	2.100	0.075	0.083
E	1.900	2.100	0.075	0.083
D1	0.500	0.700	0.020	0.028
E1	1.100	1.300	0.043	0.051
K	0.350 REF.		0.014 REF.	
b	0.200	0.300	0.008	0.012
e	0.500 BSC.		0.020 BSC.	
L	0.274	0.426	0.011	0.017