High Precision, Rail-to-Rail Input and Output Operational Amplifier

Overview

SL8551 (single), SL8552 (dual) and SL8554 (quad) are high-precision, rail-to-rail input and output operational amplifiers. The chip uses offset correction technology, so it has very low offset voltage (typical value 2μV), and the offset voltage hardly changes with temperature and time.

The chip supports single power supply and dual power supply. When powered by a single power supply, its power supply voltage range is +2.3V to +5.5V; when powered by a dual power supply, its power supply voltage range is ±1. 15V to ±2.75V.

The package types of SL8551 are mainly SC70-5, SOT23-5, MSOP-8 and SOP-8. The package types of SL8552 are mainly MSOP-8 and SOP-8. The package type of SL8554 is mainly SOP-14. And the operating temperature range for all package types is -40℃ to 125℃.

Features

- Low offset voltage：2μV (typical value)
- Zero drift：0.03μv/℃
- Low noise：30nV/√Hz
  0. 1Hz to 10Hz ：noise0.55μVPP
- High DC accuracy：
  Open loop gain：135dB
  Power Supply Rejection Ratio (PSRR)：110dB
  Common Mode Rejection Ratio (CMRR)：110dB
- Gain bandwidth product：2MHz
- Quiescent current：220μA (typical value)
- Supply voltage range：±1. 15V to ±2.75V
- Input and output rail to rail

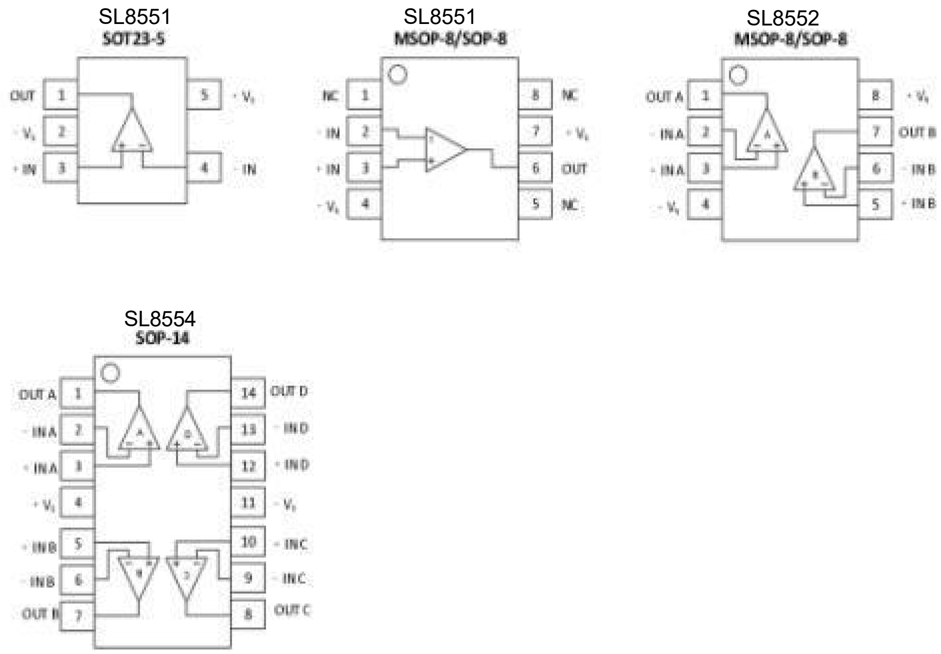
Application

- Bridge amplifier
- Strain gauge
- Sensor applications
- Temperature measurement
- Electronic scale
- Medical devices

Application

- Resistance temperature sensor
- Handheld test equipment

Pin distribution



Pin distribution

Pin description

Pin number	Symbol	Description
1	-IN	The inverting input of the operational amplifier has an input voltage range from (VS-) to (VS+).
2	+IN	The non-inverting input of the operational amplifier has the same input voltage range as the inverting input.
3	+Vs	Positive power supply terminal, whose voltage range is 2.3V to 5.5V (±1.15V to ±2.75V).
4	-Vs	Negative power supply terminal, connected to ground when single power supply is used.
5	OUT	Output of the operational amplifier.
6	N/C	No connection.

Ordering information

Model	Packing	Boxing quantity
SL8551XC5	SC70-5	Reel 3000 PCS
SL8551XT5	SOT23-5	Reel 3000 PCS
SL8551XS8	SOP-8	Reel 4000 PCS
SL8551XV8	MSOP-8	Reel 3000 PCS
SL8552XS8	SOP-8	Reel 4000 PCS
SL8552XV8	MSOP-8	Reel 3000 PCS
SL8554XS14	SOP-14	Reel 2500 PCS

Absolute maximum ratings (ambient temperature 25°C)

Symbol	Parameter	Rating	Unit
Supply voltage		+3， +6 (Single power)	V
Single input	Voltage	V_{S-}–0.5 to V_{S+}+0.5	V
	Differential voltage	±5	V
Temperature range	Operating temperature(2)	-55 to 150	°C
	Storage temperature, T_{STG}	–65 to +150	
	Junction temperature, T_J	150	
Electrostatic discharge （ESD）	Human model（HBM）	8	kV

Note:
1. Exceeding the absolute maximum ratings may cause permanent damage to the device. The above listed parameters are only some of the key parameters, and do not mean that other parameters not listed can exceed the normal range of use. Long-term operation at the absolute maximum ratings may affect the reliability of the device;
2. The device cannot exceed the maximum junction temperature at any time;

Electrical parameters

VS=+5V， TA=+25°C，VCM=VS/2，VO=VS/2，RL= 10kΩ， connect to VS/2， unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Unit
Input characteristics						
V_{OS}	Input offset voltage			2	15	μV
$V_{OS}TC$		T_A=-40℃ to +125℃		0.02		μV/°C
I_B	Input bias current	$V_{CM}=V_S/2$		± 100		PA
I_{OS}	Input offset current			± 100		PA
V_{CM}	Common mode input voltage range	T_A=-40℃to+125℃	V_{S-}		V_{S+}	V
CMRR	Common mode rejection ratio	$V_{S-}<V_{CM}<V_{S+}$	90	110		dB
		T_A=-40℃ to+125℃	85			dB
A_{VOL}	Open loop voltage gain	$V_{S-}+0.3V<V_O<V_{S+}-0.3V$	105	135		dB
		T_A=-40℃ to +125℃	100			dB
Output Characteristics						
V_{OH}		R_L= 10KΩ	$(V_{S+})-12$	$(V_{S+})-4$		mV
		T_A=-40℃ to +125℃	$(V_{S+})-8$			mV
V_{OL}		R_L= 10KΩ		$(V_{S-})+4$	$(V_{S-})+12$	mV
		T_A=-40℃ to +125℃			$(V_{S-})+18$	mV
I_{SC}	Short circuit output current	Source current	55	65		mA
		T_A=-40℃ to +125℃	50			mA
		Sink Current	48	55		mA
		T_A=-40℃ to +125℃	45			mA
Power supply characteristics						
PSRR	Power Supply Rejection Ratio	V_S=2.3V to 5.5V	90	110		dB
		T_A=-40℃ to +125℃	80			dB
I_Q	Quiescent current			220	290	μA
		T_A=-40℃ to +125℃			380	μA
Noise characteristics						
e_n	Input voltage noise	f=0. 1Hz to 10Hz		550		nVpp
	Input voltage noise	f=1KHz		30		nV/√Hz
Dynamic characteristics						
GBW	Gain bandwidth product			2		MHz
SR	Slew rate	G= ± 1		0.8		V/μs
t_{OR}	Overload recovery time	$V_{IN}×G=V_S$		50		μs

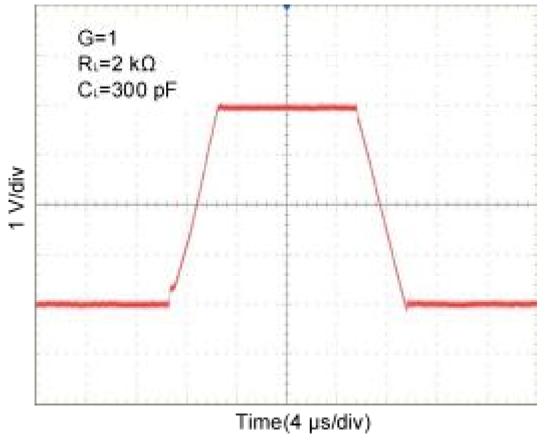
Electrical parameters

VS=±2.7V , TA=+25°C , VCM=VS/2 , VO=VS/2 , RL= 10kΩ , connect to VS/2 , unless otherwise stated.

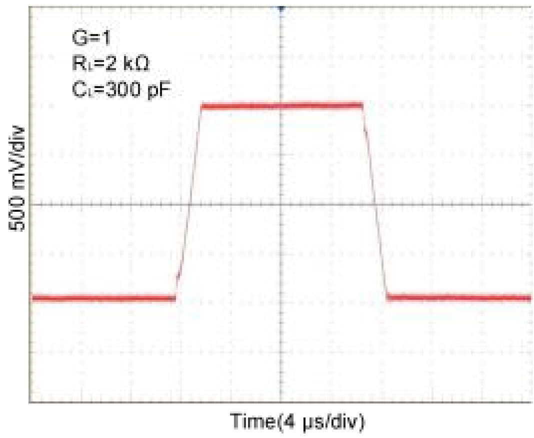
Symbol	Parameter	Condition	Min	Typ	Max	Unit
Input characteristics						
V_{OS}	Input offset voltage			2	15	μV
$V_{OS}TC$		T_A=-40℃to +125℃		0.02		μV/°C
I_B		$V_{CM}=V_S/2$		± 100		PA
I_{OS}	Input offset current			± 100		PA
V_{CM}	Common mode input voltage range	T_A=-40℃ to +125℃	V_{S-}		(V_{S+})	V
CMRR	Common Mode Input Rejection Ratio	$V_{S-}<V_{CM}<V_{S+}$	90	110		dB
		T_A=-40℃ to +125℃	80	100		dB
A_{VOL}	Open loop voltage gain	V_{S-}+0.3V<V_O<V_{S+}-0.3V	105	135		dB
		T_A=-40℃ to +125℃	95			dB
Output characteristics						
V_{OH}		R_L= 10KΩ	(V_{S+})-12	(V_{S+})-3		mV
		T_A=-40℃ to +125℃	(V_{S+})-18			mV
V_{OL}		R_L= 10KΩ		(V_{S-})+3	(V_{S-})+12	mV
		T_A=-40℃ to +125℃			(V_{S-})+18	mV
I_{SC}	Short circuit output current	Source current	17	24		mA
		T_A=-40℃ to +125℃	14			
		Sink current	15	20		mA
		T_A=-40℃ to+125℃	12			
Power supply characteristics						
PSRR	Power supply rejection ratio	V_S=2.3V to 5.5V	90	110		dB
		T_A=-40℃ to +125℃	80			
I_Q	Quiescent current			200	290	μA
		T_A=-40℃ to +125℃			380	
Noise characteristics						
e_n	Input voltage noise	f=0. 1Hz to 10Hz		550		nVpp
	Input voltage noise density	f=1KHz		30		nV/√Hz
Dynamic characteristics						
GBW	Gain bandwidth product			2		MHz
SR	Slew rate	G = ± 1		0.8		V/μs

Typical performance characteristics

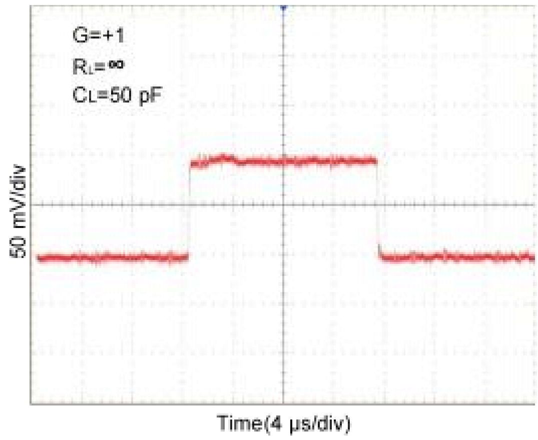
VS=+5V, TA=+25°C, VCM=VS/2, VO=VS/2, RL=10kΩ connect to VS/2, unless otherwise stated.



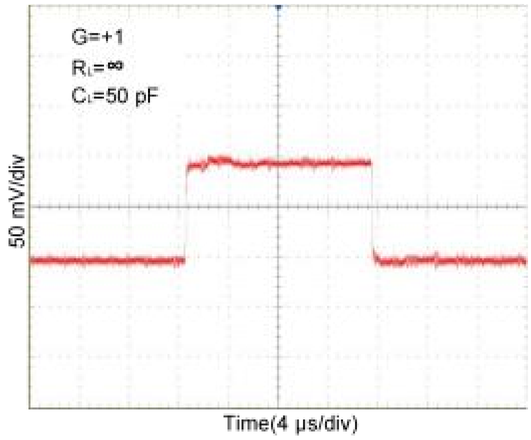
Large Signal Step Response+5V



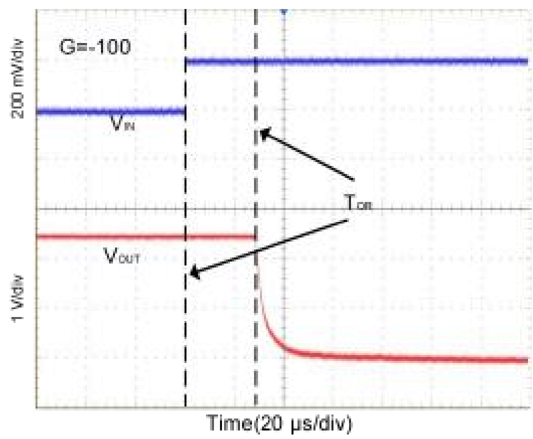
Large Signal Step Response+2.7V



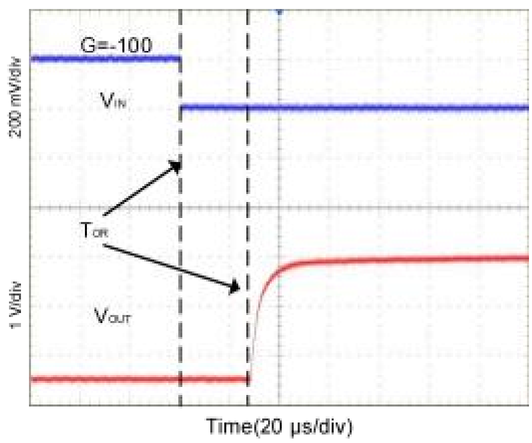
Small Signal Step Response+5V



Small Signal Step Response++2.7V



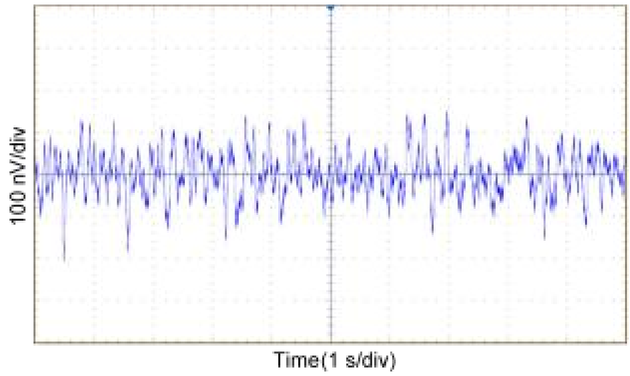
Positive overload recovery



Negative overload recovery

Typical performance characteristics

VS=+5V, TA=+25℃, VCM=VS/2, VO=VS/2, RL= 10kΩ connect to VS/2， unless otherwise stated



0. 1Hz to 10Hz noise

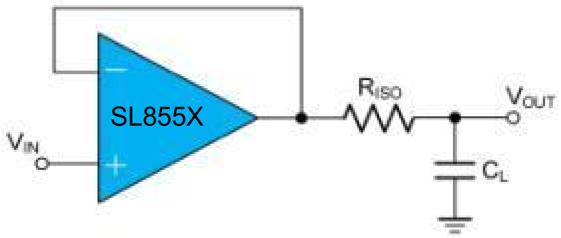
Application notes

1. Working characteristics

The specified supply voltage of the SL855X series is 2.3V to 5.5V (±1.15V to ±2.75V). The specified operating temperature is -40℃ to +125℃. Parameters related to supply voltage and temperature can be found in the Classic Characteristics section.

2. Capacitive loads and their stability

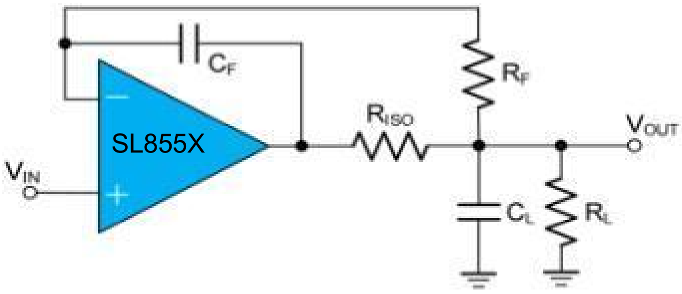
The unity gain follower (buffer) is the circuit most sensitive to capacitive loads. Directly driving a capacitive load will reduce the phase margin of the operational amplifier, resulting in output ringing or even oscillation. In applications that require a larger capacitive load drive, an isolation resistor RISO needs to be added between the output and the capacitive load, as shown in Figure 1. The isolation resistor RISO and the capacitive load CL will add a zero point, thereby improving stability. The larger the value of RISO, the more stable its output. However, this treatment method will reduce the accuracy of the gain because RISO and the load resistor RL form a voltage divider network.



Picture 1. Introduction driving heavy capacitive loads

A better circuit is shown in Figure 2. This circuit has good stability and high DC accuracy. Using an RF resistor to connect the inverting terminal to the output can effectively improve the DC accuracy. CF and RISO are used to compensate for the loss of phase margin. The output signal is fed back to the inverting input through a high-pass element to ensure the phase margin of the overall feedback loop.
For circuits without buffers, there are two other ways to improve the phase margin: 1) increase the gain of the operational amplifier, or 2) prevent a capacitor in parallel with the feedback resistor to compensate for the parasitic capacitance of the inverting input.

Application notes



Picture 2. Directly drives capacitive loads with high DC accuracy

3. Input bias current clock feed through

The SL855X series uses switches to correct the inherent offset and drift of the operational amplifier. However, the internal switch will cause a certain sudden change in the input bias current at the moment of switching. These pulses are very short-lived and are not enough to be amplified by the amplifier, but they can be coupled to the output through the feedback network. The most effective way to prevent this phenomenon is to use a low-pass filter, such as an RC network.

4. Layout guide

In order to achieve the best performance of the device, the following layout principles should be followed when designing the PCB.

A. Divide the ground into two parts: digital ground and analog ground, and reasonably plan the path for current to return to the ground to avoid the return of digital signals to analog signals. If a multi-layer PCB is used, set one of the layers as the ground, which not only helps to dissipate heat, but also effectively reduces EMI noise.

B. In order to minimize the size of parasitic capacitance and Seebeck effect, external devices (such as feedback resistors, etc.) should be as close to the device as possible.

C. The wire of the input signal should be as short as possible and should be away from the power line or other digital signal lines.

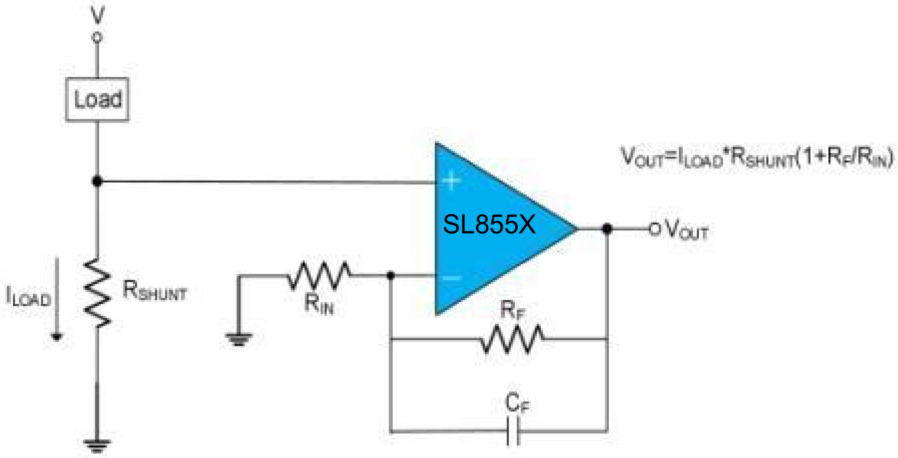
D. A low ESR, 0.1μF ceramic bypass capacitor should be connected between each power pin and the ground, and as close to the device as possible. In the case of a single power supply, use a capacitor connected between V+ and ground.

E. Consider adding a low-resistance, driven guard ring around the critical wiring. The guard ring can significantly reduce the leakage current of different potentials nearby.

5. Low-side current sensing

Application notes

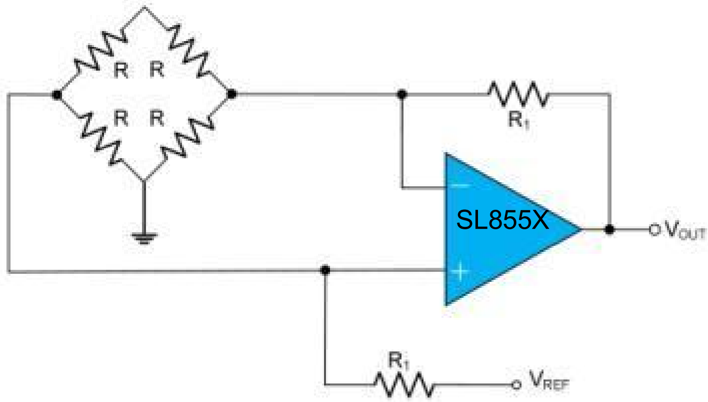
As shown in Figure 3, the operational amplifier forms a low-side current sampling circuit. The load current (I_{LOAD}) generates a voltage difference across the resistor R_{SHUNT} and is amplified by the SL855X. When the power supply voltage remains unchanged, the output voltage range can be changed by changing the resistor R_{SHUNT} and the closed-loop amplification factor.



Picture 3. Low-side current sensing circuit

6. Bridge amplifier

As shown in Figure 4, the SL855X series forms a bridge amplifier.

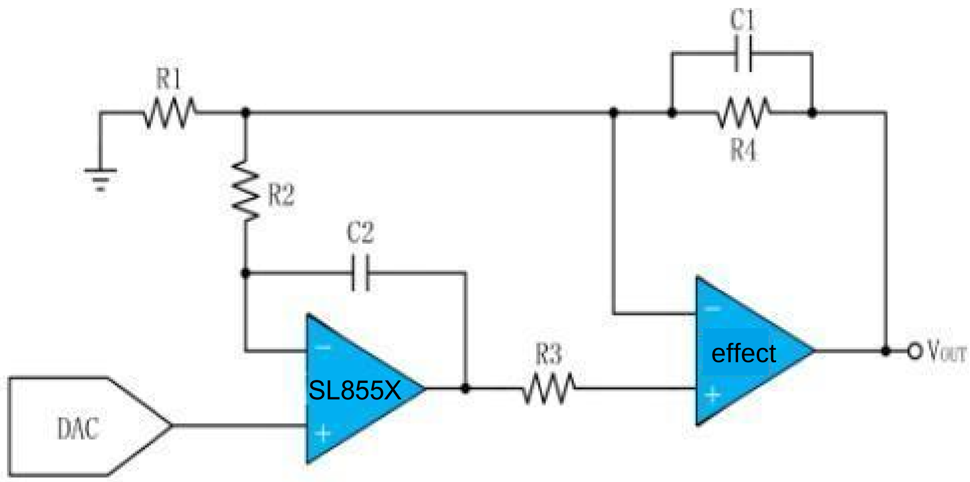


Picture 4. Bridge amplifier

7. Programmable voltage source

Application notes

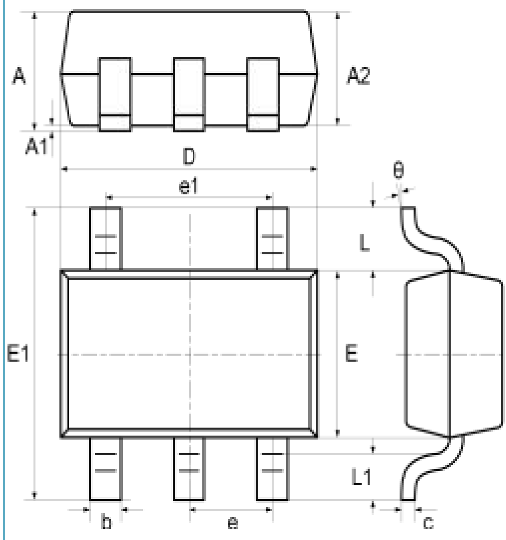
As shown in Figure 5, the SL855X series, DAC, and power amplifier form a high-precision programmable power supply. The amplifier circuit is built using capacitors and resistors to amplify the output voltage of the DAC by a factor of 1+R4/R1. In situations where the input voltage varies over a wide range, the SL855X has the characteristics of high precision and low drift.



Picture 5. Programmable voltage source

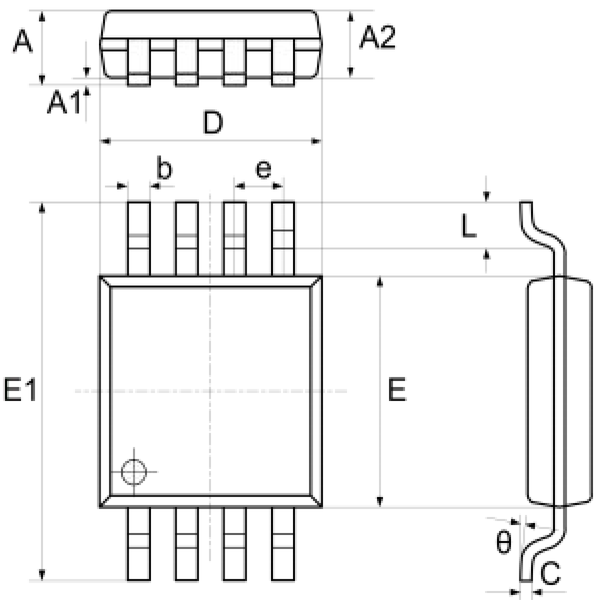
Package information

SOT23-5



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.040	1.350	0.042	0.055
A1	0.040	0.150	0.002	0.006
A2	1.000	1.200	0.041	0.049
b	0.380	0.480	0.015	0.020
c	0.110	0.210	0.004	0.009
D	2.720	3.120	0.111	0.127
E	1.400	1.800	0.057	0.073
E1	2.600	3.000	0.106	0.122
e	0.950 typ.		0.037 typ.	
e1	1.900 typ.		0.078 typ.	
L	0.700 ref.		0.028 ref.	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

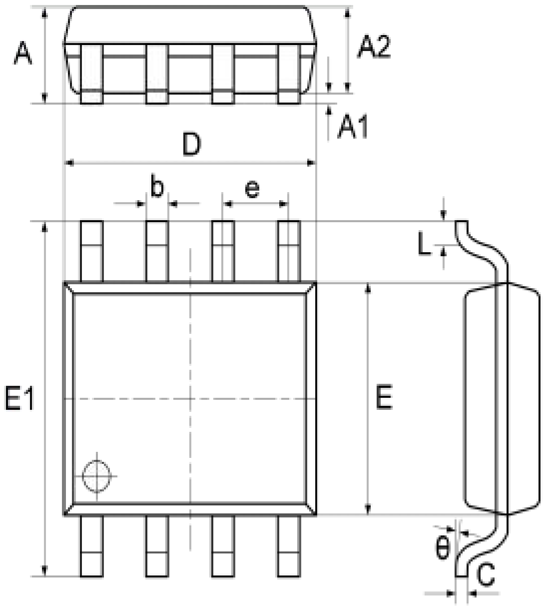
MSOP-8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.100	0.033	0.045
A1	0.050	0.150	0.002	0.006
A2	0.750	0.950	0.031	0.039
b	0.290	0.380	0.012	0.016
C	0.150	0.200	0.006	0.008
D	2.900	3.100	0.118	0.127
E	2.900	3.100	0.118	0.127
E1	4.700	5.100	0.192	0.208
e	0.650 typ.		0.026 typ.	
L	0.400	0.700	0.016	0.029
θ	0°	8°	0°	8°

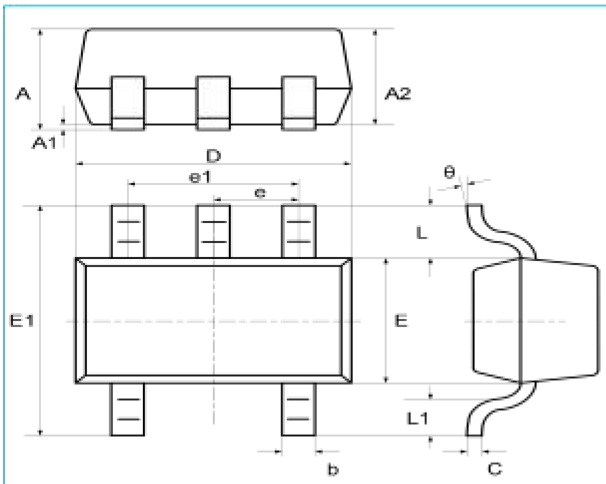
Package information

SOP-8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.370	1.670	0.056	0.068
A1	0.070	0.170	0.003	0.007
A2	1.300	1.500	0.053	0.061
b	0.306	0.506	0.013	0.021
C	0.203 typ.		0.008 typ.	
D	4.700	5.100	0.192	0.208
E	3.820	4.020	0.156	0.164
E1	5.800	6.200	0.237	0.253
e	1.270 typ.		0.050 typ.	
L	0.450	0.750	0.018	0.306
θ	0°	8°	0°	8°

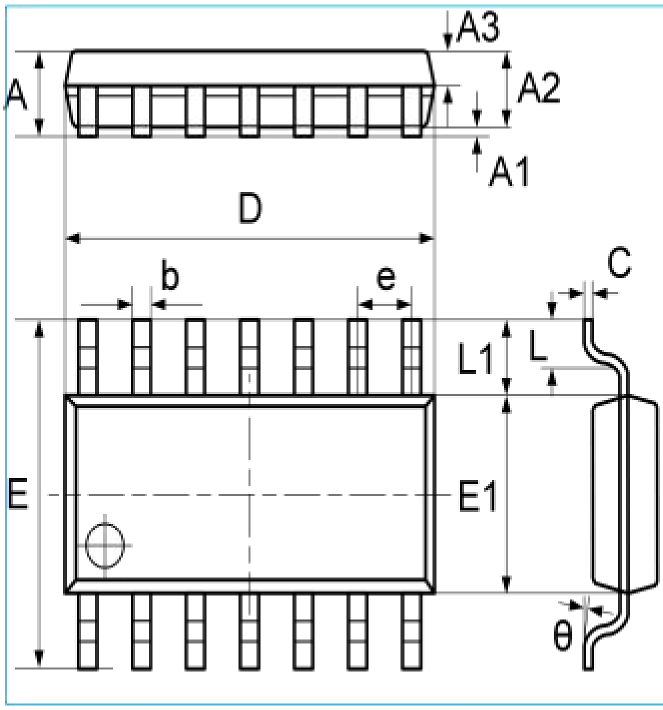
SC70-5



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.800	0.900	0.035	0.039
b	0.150	0.350	0.006	0.014
C	0.080	0.150	0.003	0.006
D	1.8500	2.150	0.079	0.087
E	1.100	1.400	0.045	0.053
E1	1.950	2.200	0.085	0.096
e	0.850 typ.		0.026 typ.	
e1	1.200	1.400	0.047	0.055
L	0.42 ref.		0.021 ref.	
L1	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°

Package information

SOP-14



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.450	1.850	0.059	0.076
A1	0.100	0.300	0.004	0.012
A2	1.350	1.550	0.055	0.063
A3	0.550	0.750	0.022	0.031
b	0.406 typ.		0.017 typ.	
C	0.203 typ.		0.008 typ.	
D	8.630	8.830	0.352	0.360
E	5.840	6.240	0.238	0.255
E1	3.850	4.050	0.157	0.165
e	1.270 typ.		0.050 typ.	
L1	1.040 ref.		0.041 ref.	
L	0.350	0.750	0.014	0.031
θ	2°	8°	2°	8°