

High-Precision, Rail-to-Rail I/O Operational Amplifier

General Description

The SL8581(single) and SL8582(dual) are high-precision, low-quiescent current amplifier which can offer high input impedance and rail to rail input and output. The amplifier uses auto-zeroing techniques to provide low offset voltage(25 μ V type) and near zero-drift over time and temperature.

Either single or dual supplies can be used in the range from 2.3V to 5.5V (± 1.15 V to ± 2.75 V)

The SL8581 is available in SC70-5,SOT23-5, MSOP-8 and SOP-8.The SL8582 is available in MSOP-8 and SOP-8. All versions are specified for operation from -40 °C to +125 °C.

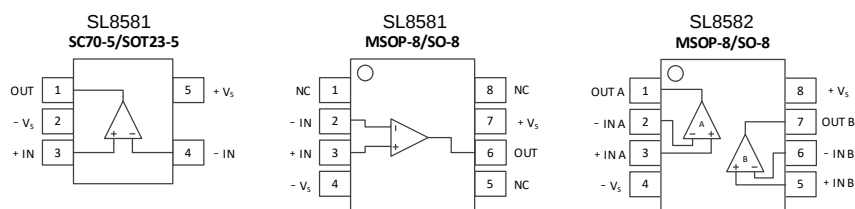
Features

- Low Offset Voltage: 25 μ V(Type)
- Zero-Drift: 0.03 μ V/°C
- Low Noise: 45 nV/ $\sqrt{\text{Hz}}$
 - 0.1-Hz to 10-Hz Noise: 0.55 μ Vpp
- Excellent DC Precision:
 - Open-Loop Gain: 135dB
 - PSRR: 110dB
 - CMRR: 110dB
- Gain Bandwidth: 1.8MHz
- Quiescent Current: 350 μ A(Type)
- Supply Range: ± 1.15 V to ± 2.75 V
- Rail-to-Rail Input and Output

Application

- Bridge Amplifier
- Strain Gauges
- Transducer Applications
- Temperature Measurement
- Electronic Scales
- Medical Instrumentation
- Resistance Temperature Detectors
- Handheld Test Equipment

Pin Configurations



Pin Description

Symbol	Description
–IN	Inverting Input of the Amplifier. The Voltage can go from (V_{S-}) to (V_{S+}).
+IN	Non-Inverting Input of Amplifier. This pin has the same voltage range as –IN.
+V _S	Positive Power Supply. The Voltage is from 2.3V to 5.5V ($\pm 1.15V$ to $\pm 2.75V$).
–V _S	Negative Power Supply. It is normally tied to ground.
OUT	Amplifier Output.
N/C	No Connection.

Ordering Information

Type Number	Package Name	Package Quantity	
SL8581XC5	SC70-5	Tape and Reel,3000	
SL8581XT5	SOT23-5	Tape and Reel,3000	
SL8581XS8	SOP-8	Tape and Reel,4000	
SL8581XV8	MSOP-8	Tape and Reel,3000	
SL8582XS8	SOP-8	Tape and Reel,4000	
SL8582XV8	MSOP-8	Tape and Reel,3000	

Recommended Operating Conditions

- Operating voltage range: 2.3V to 5.5V ($\pm 1.15V$ to $\pm 2.75V$)
- Specified temperature range: -40°C to 125°C

Absolute Maximum Ratings

Attention: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Parameter	Symbol	Absolute Maximum Rating	Unit
Supply Voltage		$\pm 3, +6(\text{Single})$	V
Input terminal	Voltage	$V_{S-}-0.5$ to $V_{S+}+0.5$	V
	Differential Voltage	± 5	V
Temperature	Operating ⁽²⁾ , T_A	-55 to 150	°C
	Storage, T_{stg}	-65 to 150	°C
	Junction, T_J	150	°C
Electrostatic Discharge Voltage	HBM	8	kV
	MM	1	kV

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) Provided device does not exceed maximum junction temperature (T_J) at any time.

Electrical Characteristics

$V_S=+5V, T_A=25^{\circ}C, V_{CM}=V_S/2, V_O=V_S/2, R_L=10k\Omega$ connected to $V_S/2$, unless otherwise noted.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
INPUT CHARACTERISTICS						
V _{OS}	Input offset Voltage			25	90	μV
V _{OS} TC	Offset voltage drift	T _A =-40°C to + 125°C		0.03		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 Voltage range	T _A =-40°C to + 125°C	V _{S-}		V _{S+}	V
CMRR	Common-mode rejection ratio	V _{S-} <V _{CM} < V _{S+}	90	110		dB
		T _A =-40°C to + 125°C	85			dB
A _{VOL}	Open-loop voltage gain	V _{S-} +0.3V<V _O <V _{S+} -0.3V	105	135		dB
		T _A =-40°C to + 125°C	100			dB
OUTPUT CHARACTERISTICS						
V _{OH}	High output voltage swing	R _L =10kΩ	(V _{S+}) -12	(V _{S+}) -4		mV
		T _A =-40°C to + 125°C	(V _{S+}) -18			mV
V _{OL}	Low output voltage swing	R _L =10kΩ		(V _{S-}) +4	(V _{S-}) +12	mV
		T _A =-40°C to + 125°C			(V _{S-}) +18	mV
I _{SC}	Short-circuit current	Source current	55	65		mA
		T _A =-40°C to + 125°C	50			mA
		Sink current	48	55		mA
		T _A =-40°C to + 125°C	45			mA
POWER SUPPLY						
PSRR	Power supply rejection ratio	V _S =2.3V to 5.5V	90	110		dB
		T _A =-40°C to +125°C	80			
I _Q	Quiescent current			350	480	μA
		T _A =-40°C to + 125°C			600	
NOISE						
e _n	Input voltage noise	f=0.1Hz to 10Hz F=1KHz		550 45		nV _{pp} nV/√Hz
DYNAMIC PERFORMANCE						
GBW	Gain bandwidth product			1.8		MHz
SR	Slew rate	G = ± 1		0.7		V/μs
t _{OR}	Overload recovery time	V _{IN} × G=V _S		50		μs

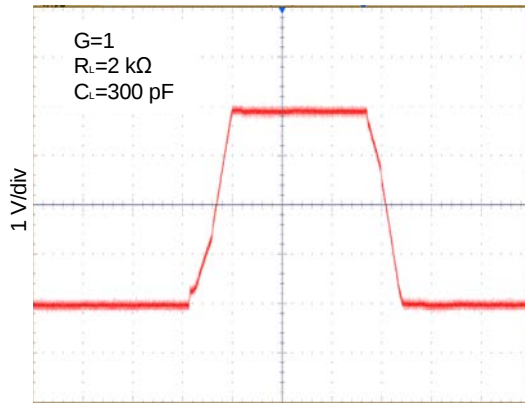
Electrical Characteristics

$V_S=+2.7V, T_A=25^{\circ}C, V_{CM}=V_S/2, V_O=V_S/2, R_L=10k\Omega, R_I=10k\Omega$ connected to $V_S/2$, unless otherwise noted.

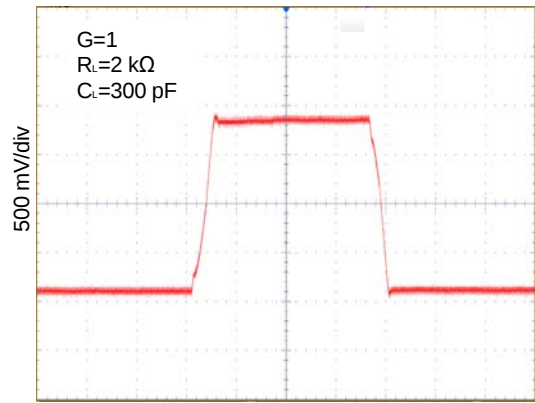
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
INPUT CHARACTERISTICS						
V _{OS}	Input offset Voltage			25	90	μV
V _{OS} TC	Offset voltage drift	T _A =-40°C to + 125°C		0.03		μV/°C
I _B	Input bias current	V _{CM} =V _S /2		±100		pA
I _{OS}	Input offset current			±100		pA
V _{CM}	Common-mode Voltage range	T _A =-40°C to + 125°C	V _{S-}		V _{S+}	V
CMRR	Common-mode rejection ratio	V _{S-} <V _{CM} < V _{S+}	90	110		dB
		T _A =-40°C to + 125°C	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°C to + 125°C	95			dB
OUTPUT CHARACTERISTICS						
V _{OH}	High output voltage swing	R _L =10kΩ	(V _{S+}) -12	(V _{S+}) -3		mV
		T _A =-40°C to + 125°C	(V _{S+}) -18			mV
V _{OL}	Low output voltage swing	R _L =10kΩ		(V _{S-}) +3	(V _{S-}) +12	mV
		T _A =-40°C to + 125°C			(V _{S-}) +18	mV
I _{SC}	Short-circuit current	Source current	17	24		mA
		T _A =-40°C to + 125°C	14			mA
		Sink current	15	20		mA
		T _A =-40°C to + 125°C	12			mA
POWER SUPPLY						
PSRR	Power supply rejection ratio	V _S =2.3V to 5.5V	90	110		dB
		T _A =-40°C to +125°C	80			
I _Q	Quiescent current			350	480	μA
		T _A =-40°C to + 125°C			600	
NOISE						
e _n	Input voltage noise	f=0.1Hz to 10Hz f=1KHz		550 45		nV _{pp} nV/√Hz
DYNAMIC PERFORMANCE						
GBW	Gain bandwidth product			1.8		MHz
SR	Slew rate	G = ± 1		0.7		V/μs
t _{OR}	Overload recovery time	V _{IN} × G=V _S		50		μs

Type Performance Characteristics

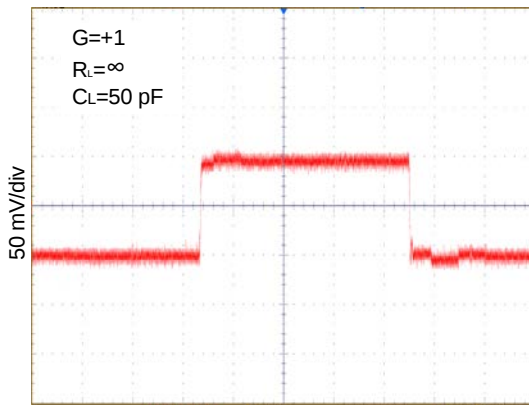
$V_S=+5V, T_A=25^\circ C, V_{CM}=V_S/2, V_O=V_S/2, R_L=10k\Omega$ connected to $V_S/2$, unless otherwise noted.



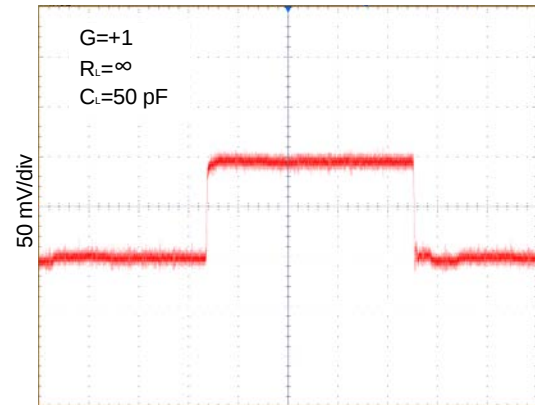
LARGE-SIGNAL STEP RESPONSE at +5V



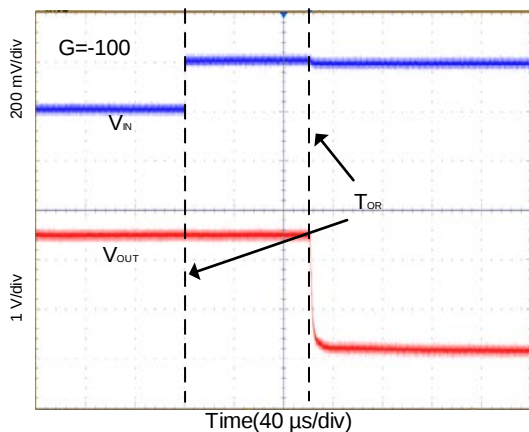
LARGE-SIGNAL STEP RESPONSE at +2.7V



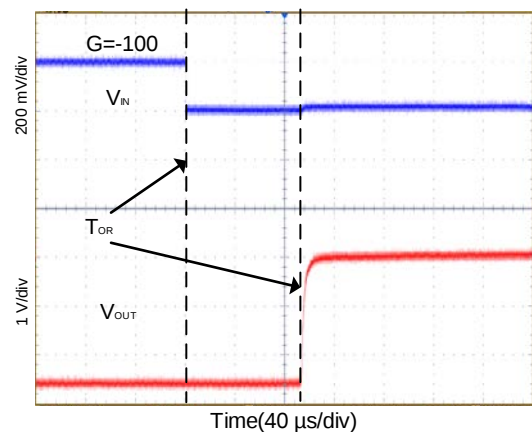
SMALL-SIGNAL STEP RESPONSE at +5V



SMALL-SIGNAL STEP RESPONSE at +2.7V



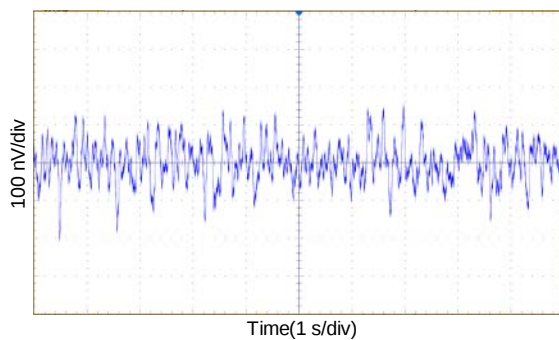
POSITIVE OVERLOAD RECOVERY



NEGATIVE OVERLOAD RECOVERY

Type Performance Characteristics

$V_S=+5V$, $T_A=25^\circ\text{C}$, $V_{CM}=V_S/2$, $V_O=V_S/2$, $R_L=10\text{k}\Omega$, $R_I=10\text{k}\Omega$ connected to $V_S/2$, unless otherwise noted.



0.1Hz to 10Hz noise

Application Notes

Application Information

The SL858X operational amplifier combines precision offset and drift with excellent overall performance, making it ideal for many precision applications. The precision offset drift of only $0.085 \mu\text{V}/^\circ\text{C}$ provides stability over the entire temperature range. In addition, the device pairs excellent CMRR, PSRR, and AOL dc performance with outstanding low-noise operation. As with all amplifiers, applications with noisy or high-impedance power supplies require decoupling capacitors close to the device pins. In most cases, $0.1\text{-}\mu\text{F}$ capacitors are adequate.

Operating Characteristics

The SL858X is specified for operation from 2.3 V to 5.5 V ($\pm 1.15\text{ V}$ to $\pm 2.75\text{ V}$). Many specifications apply from -40°C to $+125^\circ\text{C}$. Parameters that can exhibit significant variance with regard to operating voltage or temperature are presented in *Typical Characteristics*.

Capacitive Load and Stability

The unity-gain follower (buffer) is the most sensitive configuration to capacitive loading. Direct capacitive loading reduces the phase margin of amplifiers and this results in ringing or even oscillation. Applications that require greater capacitive drive capability should use an isolation resistor between the output and the capacitive load like the circuit in Figure 2. The isolation resistor R_{ISO} and the load capacitor C_L form a zero to increase stability. The bigger the R_{ISO} resistor value, the more stable V_{out} will be. Note that this method results in a loss of gain accuracy because R_{ISO} forms a voltage divider with the R_L .

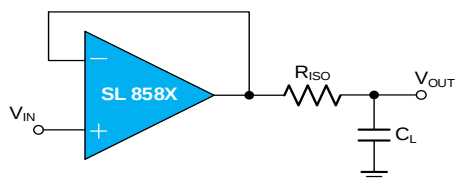


Figure 2. Indirectly Driving Heavy Capacitive Load

An improvement circuit is shown in Figure 3. It provides DC accuracy as well as AC stability. The R_F provides the DC accuracy by connecting the inverting signal with the output.

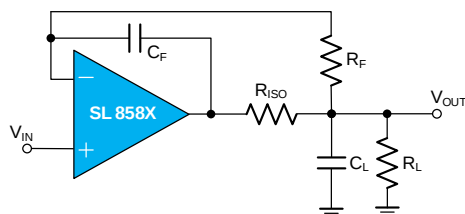


Figure3. Indirectly Driving Capacitive Load with DC Accuracy

Input Bias Current Clock Feedthrough

The SL858X use switching on the inputs to correct for the intrinsic offset and drift of the amplifier. Charge injection from the integrated switches on the inputs can introduce very short transients in the input bias current of the amplifier. The extremely short duration of these pulses prevents the device from being amplified. However, the devices may be coupled to the output of the amplifier through the feedback network. The most effective method to prevent transients in the input bias current from producing additional noise at the amplifier output is to use a low-pass filter such as an RC network.

Application Notes

Layout Guidelines

For best operational performance of the device, use good printed circuit board (PCB) layout practices, including:

- Place the external components as close to the device as possible. This configuration prevents parasitic errors (such as the Seebeck effect) from occurring.
- To reduce parasitic coupling, run the input traces as far away from the supply lines and digital signal as possible.
- Low-ESR, 0.1- μ F ceramic bypass capacitors must be connected between each supply pin and ground, placed as close to the device as possible. A single bypass capacitor from V+ to ground is applicable to single supply applications.
- Consider a driven, low-impedance guard ring around the critical traces. A guard ring can significantly reduce leakage currents from nearby traces that are at different potentials.

Low-side Current Monitor

Figure 4 shows the SL858X configured in a low-side current-sensing application. The load current (I_{LOAD}) creates a voltage drop across the shunt resistor (R_{SHUNT}). This voltage is amplified by the SL858X.

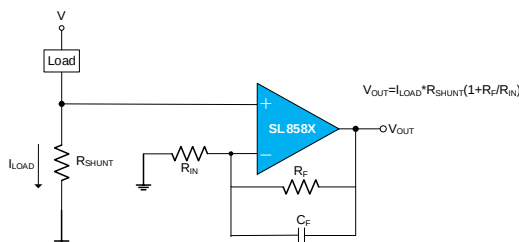


Figure 4. Low-Side Current Monitor

Bridge Amplifier

Figure 5 shows the basic configuration for a bridge amplifier.

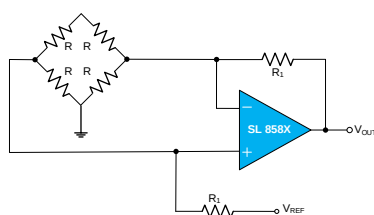


Figure 5. Bridge Amplifier

Programmable Power Supply

Figure 6 shows the SL858X configured as a precision programmable power supply using DAC and power amplifier. The SL858X in the front-end provides precision and low drift across a wide range of inputs and conditions.

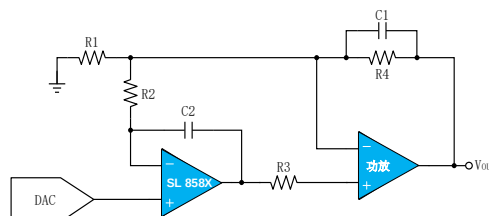
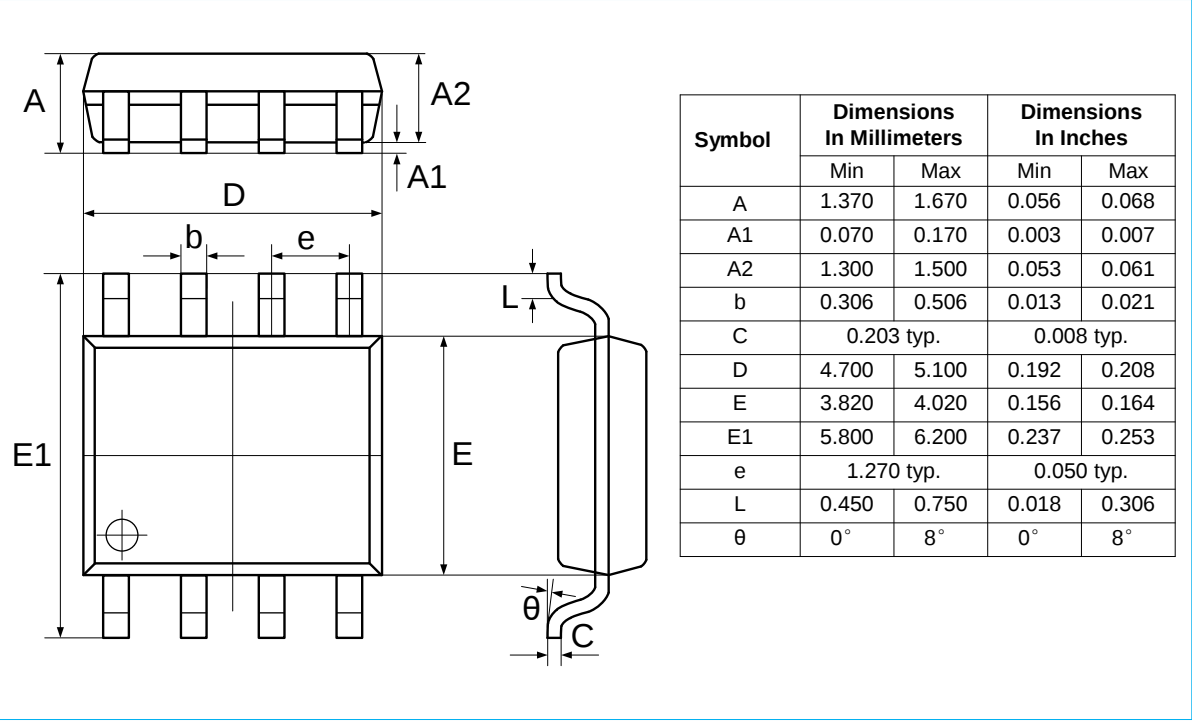


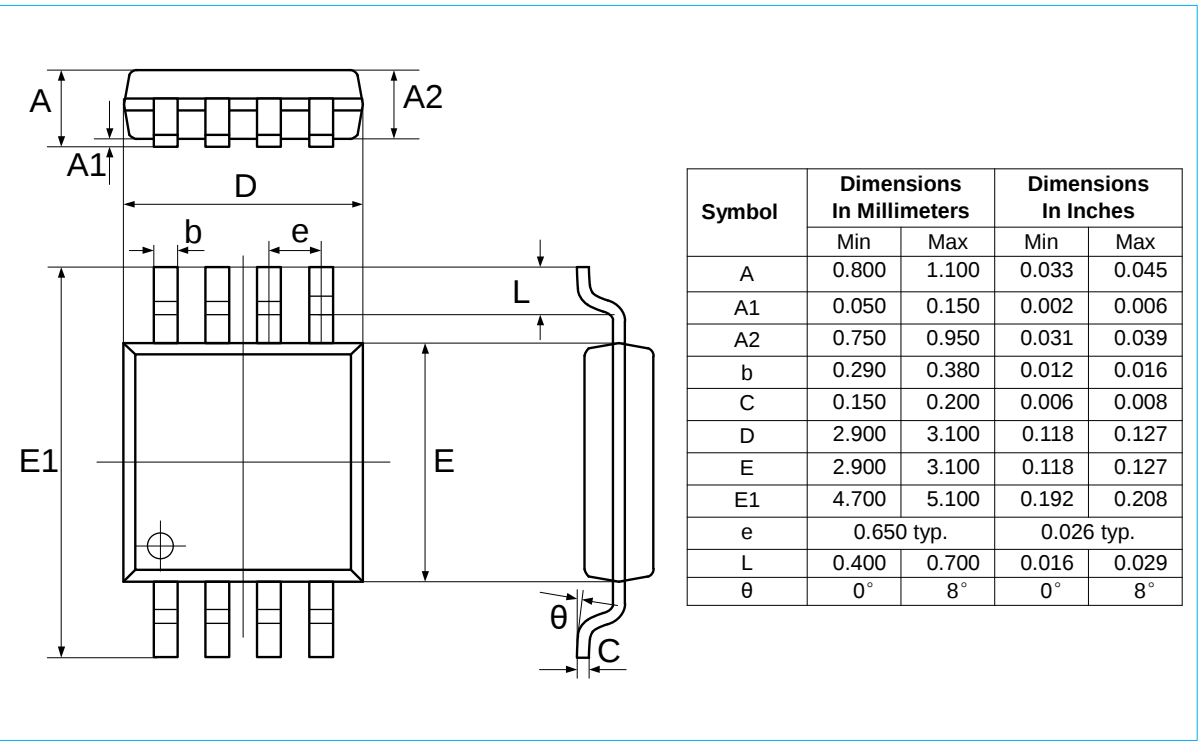
Figure 6. Programmable Power Supply

Package Outlines

SOP-8



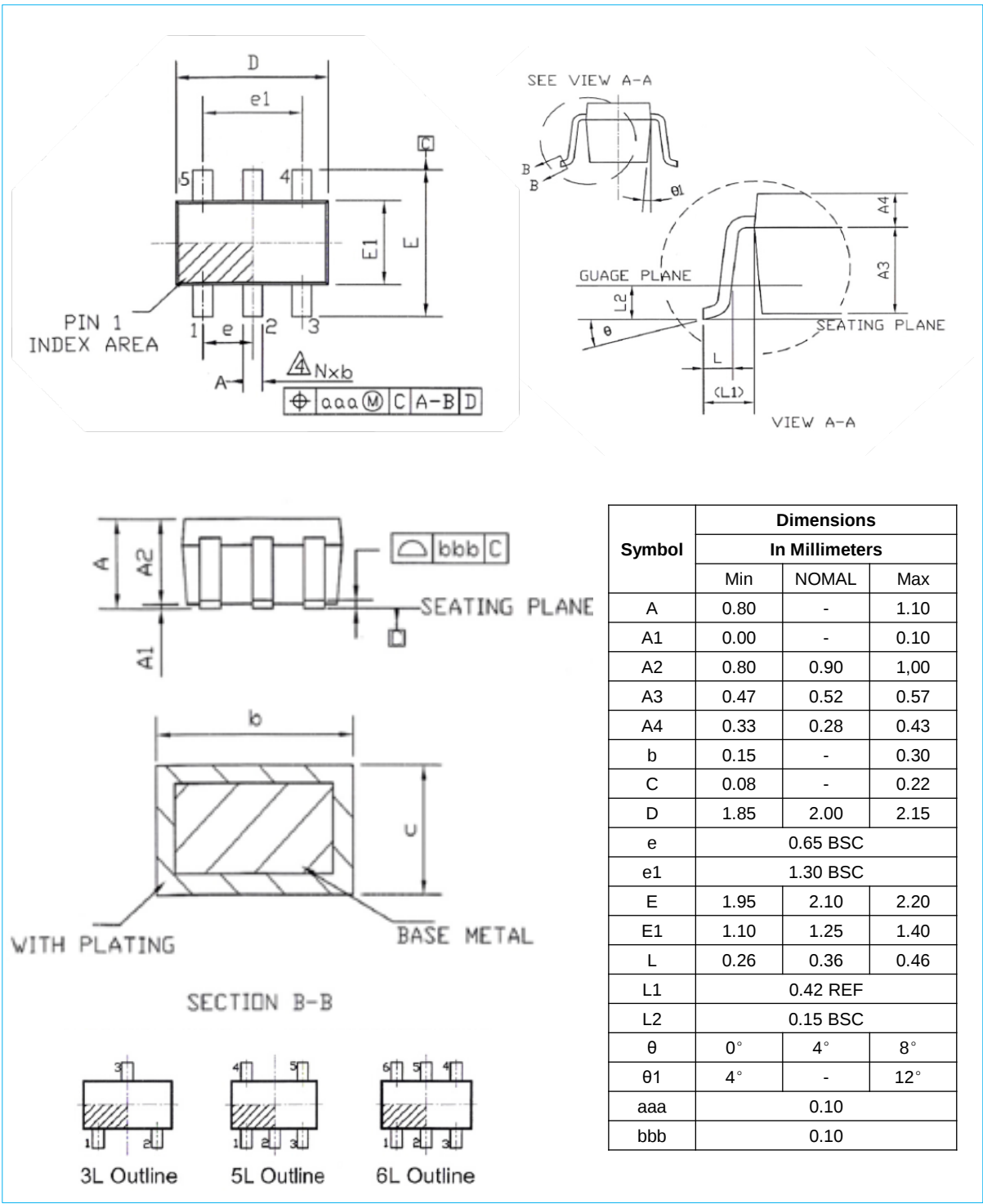
MSOP-8



Operational Amplifier

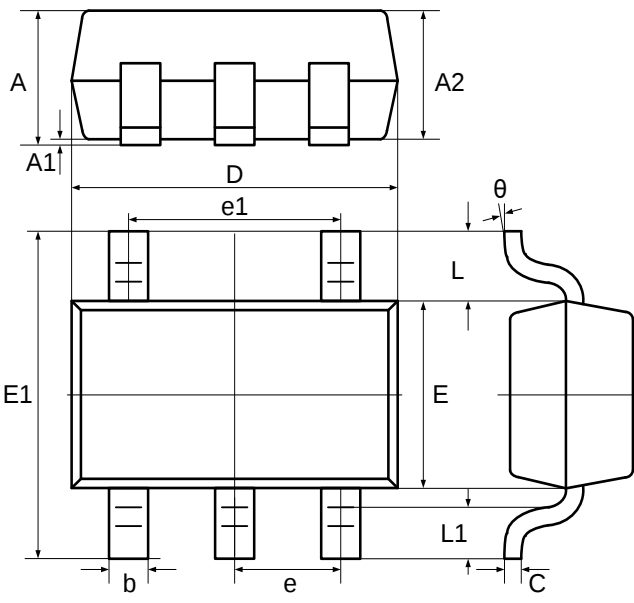
Package Outlines

SC70-5



Package Outlines

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°

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