25MHz RRIO Operational Amplifiers (Dual/Quad)

Description

The SL9062 (dual), and SL9064 (quad) are dual and quad low voltage (1.5V to 5.5V) operational amplifiers (opamps) with rail-to-rail input and output swing capabilities. These devices are very suitable for applications where low voltage operation, a small footprint, and high capacitive load drive are required. SL9062S and SL9064S are with Shutdown function.

Features

- Excellent THD+N 100dB
- Excellent SNR 110dB
- Rail-to-rail input and output
- Low input offset voltage: ±0.5mV typ
- Unity-gain bandwidth: 25MHz
- Low quiescent current (per opamp): 400μA typ
- Operational at supply voltages as low as 1.5V
- Easier to stabilize with higher capacitive load due to resistive open-loop output impedance
- Shutdown function (SL9062S and SL9064S)

Applications

- Infotainment system
- HVAC: heating, ventilating, and air conditioning
- Motor control
- Wearable devices
- Sensor signal conditioning
- Power modules
- Active filters

Table 1 Device Summary

Order code	Package	Packing
SL9062A	TSSOP8	Reel
SL9062B	DFN8	Reel
SL9062C	SOP8	Reel
SL9062D	SOT23-8L	Reel
SL9062SA	DFN10	Reel
SL9062SB	SSOP10	Reel
SL9064A	QFN14	Reel
SL9064B	TSSOP14	Reel
SL9064SA	QFN16	Reel
SL9064SB	SOP16	Reel

1 Block Diagram and Application Circuit

Figure 1 Block Diagram

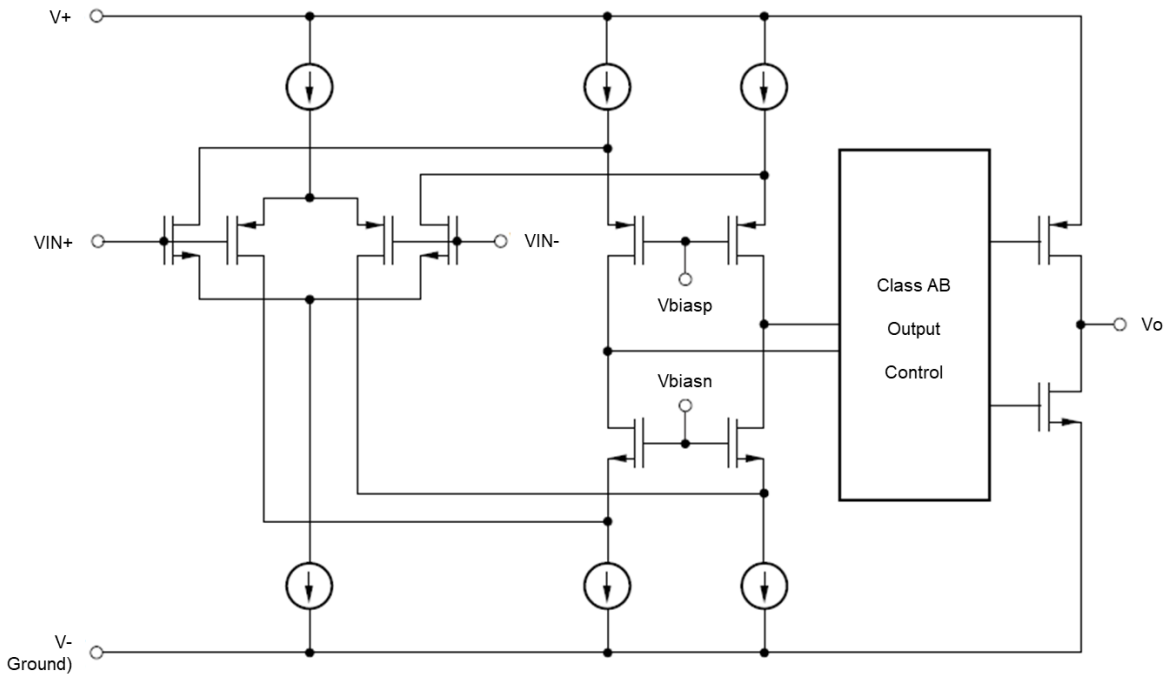
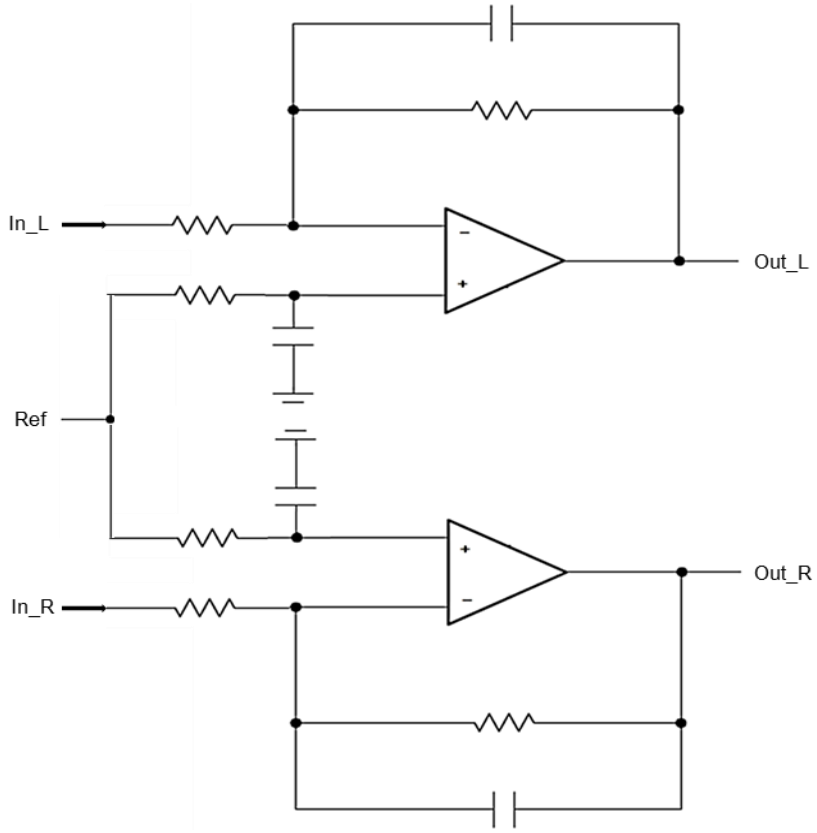


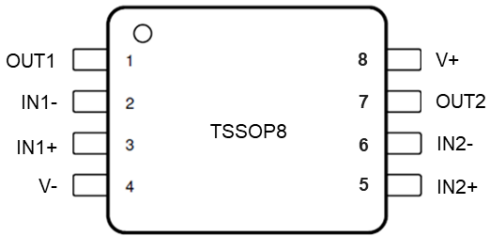
Figure 2 Typical Application Circuit **(Stereo Sound Input Amplifier)**



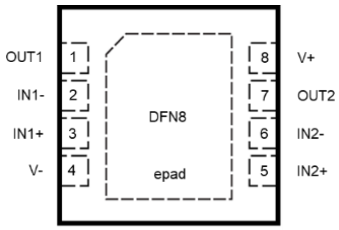
2 Pin Description

2.1 SL9062A/B/C/D Pinouts

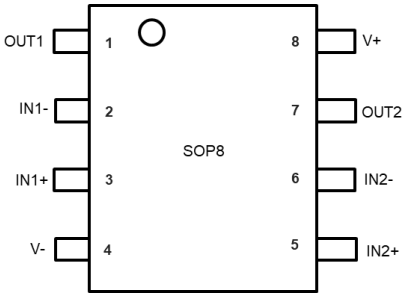
Figure 3 SL9062A/B/C/D Pinouts



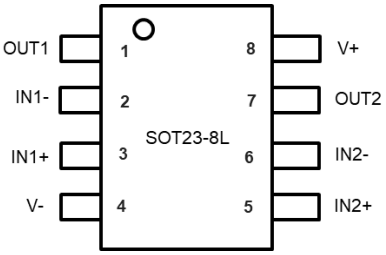
SL9062A



SL9062B



SL9062C

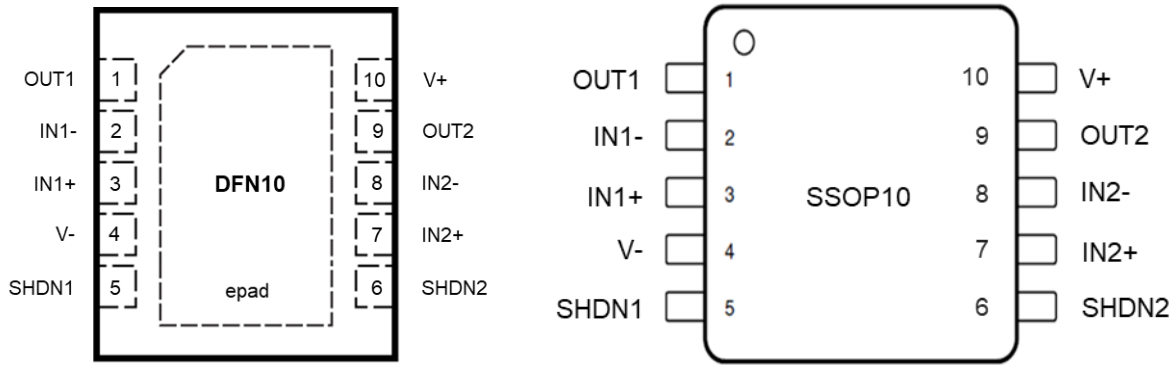


SL9062D

Pin number	Pin name	Description
1	OUT1	Output 1
2	IN1-	Inverting input 1
3	IN1+	Non-inverting input 1
4	V-	Negative supply or ground
5	IN2+	Non-inverting input 2
6	IN2-	Inverting input 2
7	OUT2	Output 2
8	V+	Positive supply

2.2 SL9062SA/B Pinouts

Figure 4 SL9062SA/B Pinouts

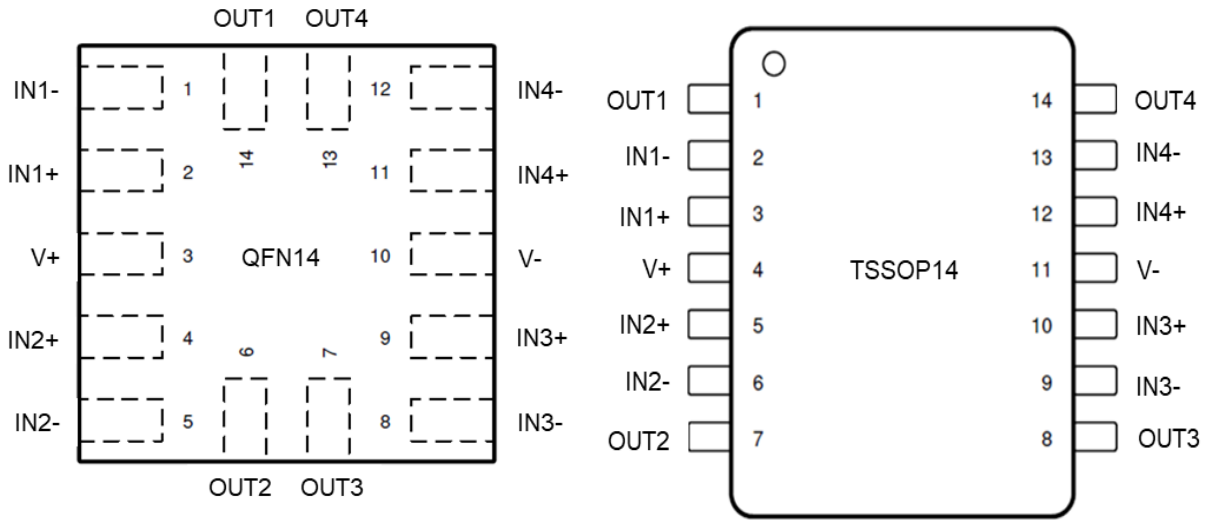


SL9062SA SL9062SB

Pin number	Pin name	Description
1	OUT1	Output 1
2	IN1-	Inverting input 1
3	IN1+	Non-inverting input 1
4	V-	Negative supply or ground
5	SHDN1	Shutdown1: “low” = opamp 1 disabled
6	SHDN2	Shutdown2: “low” = opamp 2 disabled
7	IN2+	Non-inverting input 2
8	IN2-	Inverting input 2
9	OUT2	Output 2
10	V+	Positive supply

2.3 SL9064A/B Pinouts

Figure 5 SL9064A/B Pinouts



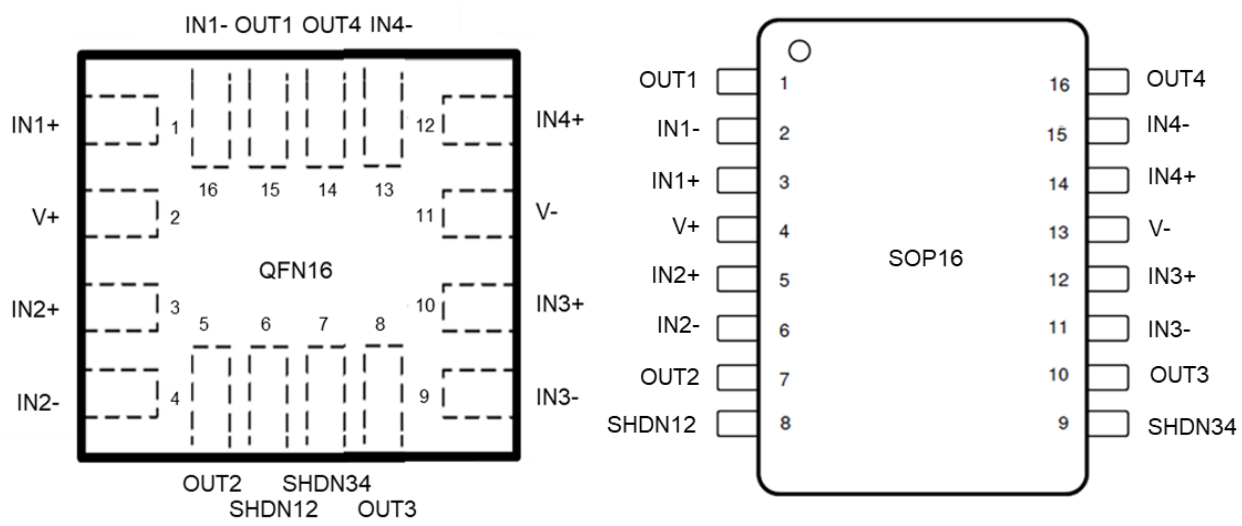
SL9064A

SL9064B

	SL9064A			SL9064B	
Pin number	**QFN14 Pin name**	**QFN14 Description**	**TSSOP14 Pin name**	**TSSOP14 Description**
1	IN1-	Inverting input 1	OUT1	Output 1
2	IN1+	Non-inverting input 1	IN1-	Inverting input 1
3	V+	Positive supply	IN1+	Non-inverting input 1
4	IN2+	Non-inverting input 2	V+	Positive supply
5	IN2-	Inverting input 2	IN2+	Non-inverting input 2
6	OUT2	Output 2	IN2-	Inverting input 2
7	OUT3	Output 3	OUT2	Output 2
8	IN3-	Inverting input 3	OUT3	Output 3
9	IN3+	Non-inverting input 3	IN3-	Inverting input 3
10	V-	Negative supply or ground	IN3+	Non-inverting input 3
11	IN4+	Non-inverting input 4	V-	Negative supply or ground
12	IN4-	Inverting input 4	IN4+	Non-inverting input 4
13	OUT4	Output 4	IN4-	Inverting input 4
14	OUT1	Output 1	OUT4	Output 4

2.4 SL9064SA/B Pinouts

Figure 6 SL9064SA/B Pinouts



SL9064SA SL9064SB

	SL9064SA			SL9064SB	
Pin number	QFN16 Pin name	QFN16 Description		SOP16 Pin name	SOP16 Description
1	IN1+	Non-inverting input 1		OUT1	Output 1
2	V+	Positive supply		IN1-	Inverting input 1
3	IN2+	Non-inverting input 2		IN1+	Non-inverting input 1
4	IN2-	Inverting input 2		V+	Positive supply
5	OUT2	Output 2		IN2+	Non-inverting input 2
6	SHDN12	Shutdown12: “low” = opamp 1&2 disabled		IN2-	Inverting input 2
7	SHDN34	Shutdown34: “low” = opamp 3&4 disabled		SHDN12	Shutdown12: “low” = opamp 1&2 disabled
8	OUT3	Output 3		SHDN34	Shutdown34: “low” = opamp 3&4 disabled
9	IN3-	Inverting input 3		IN3-	Inverting input 3
10	IN3+	Non-inverting input 3		OUT3	Output 3
11	V-	Negative supply or ground		IN3-	Inverting input 3
12	IN4+	Non-inverting input 4		IN3+	Non-inverting input 3
13	IN4-	Inverting input 4		V-	Negative supply or ground
14	OUT4	Output 4		IN4+	Non-inverting input 4
15	OUT1	Output 1		IN4-	Inverting input 4
16	IN1-	Inverting input 1		OUT4	Output 4

3 Electrical Specifications

3.1 Absolute Maximum Ratings

Table 2 Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
Vs	Supply voltage (V+) - (V-)	-0.3 to +6	V
IN+, IN-	Input pin voltage	(V-) - 0.5 to (V+) +0.5	V
OUT	Output pin voltage	(V-) - 0.5 to (V+) +0.5	V
Tj	Junction temperature	150	°C
Tstg	Storage temperature	-55 to +150	°C

3.2 Thermal Data

Table 3 Thermal Data

Package	Rth j-amb	Rth j-case	Unit
TSSOP8	206	98	°C/W
DFN8	43	5	°C/W
SOP8	136	77	°C/W
SOT23-8L	184	100	°C/W
DFN10	42	6	°C/W
MSOP10	160	45	°C/W
QFN14	47	4	°C/W
TSSOP14	113	62	°C/W
QFN16	45	5	°C/W

3.3 ESD and Latch Up

Table 4 ESD and Latch up

Symbol	Parameter	Value	Unit
All pins	ESD (HBM) ESD (CDM)	±6,000 ±500	V V
All pins	Latch Up JESD78, Class A	≥ 100	mA

3.4 Electrical Characteristics

For Vs = (V+) - (V-) = 5V at Ta = 25°C, RL = 10kΩ connected to Vs/2, Vcm = Vs/2, and Vout = Vs/2 (unless otherwise noted).

Table 5 Electrical Characteristics

Symbol	Parameter	Test condition	Min	Typ	Max	Unit
Vs	Supply voltage (V+) - (V-)		1.5		5.5	V
Ta	Operating ambient temperature		-40		125	°C
Power Supply						
Iq	Quiescent current per amplifier	Vs=5.5V, Io=0mA		400	500	μA
		all temp			600	
Offset Voltage						
Vos	Input offset voltage			±0.5	±2.0	mV
		all temp			±3.0	mV
dVos/dT	Drift	all temp		±0.5		μV/°C
PSRR	Power-supply rejection ratio	At DC		100		dB
Csep	Channel separation	At DC		120		dB
Input Voltage Range						
Vcm	Common mode voltage range	Vs=1.5V to 5V	(V-)-0.1		(V+)+0.1	V
CMRR	Common mode rejection ratio	At DC		100		dB
Input Bias Current						
Ib	Input bias current			±0.5		pA
Ios	Input offset current			±0.05		pA
Noise						
En	Input voltage noise	f=20Hz to 20kHz		1.5		μV
en	Input voltage noise density	f=10kHz		7		nV/√Hz
		f=1kHz		15		
Input Capacitance						
Cid	Differential			2		pF
Cic	Common mode			4		pF
Open Loop Gain						
Aol	Open loop voltage gain			110		dB
Frequency Response						
GBP	Gain bandwidth product	G=+1, CL=10pF		25		MHz
φ	Phase margin	G=+1, CL=10pF		60		°
Cload	Capacitive load	G=+1			1	nF
SR	Slew rate	G=+1, CL=100pF		8		V/μs

Ts	Settling time	To 0.1%, 2V step, G=+1, CL=100pF		0.5		μs
Tor	Overload recovery time	VIN x gain > Vs, CL=100pF		50		ns
THD+N	Total harmonic distortion + Noise (3rd order filter; BW= 80kHz at -3dB.)	Vs=5.5V, Vcm=2.5V, Vo=1Vrms, G=+1, f=1kHz		100		dB
SNR	Signal to Noise Ratio			110		dB
Output						
Vo	Voltage output swing from supply rails	RL=10kΩ		5	10	mV
		RL=2kΩ		15	30	
Isc	Short circuit current			±50		mA
Zo	Open loop output impedance	f=10MHz		100		Ω
Shutdown						
Iqsd	Quiescent current per amplifier	Vs=1.5V to 5.5V, all amplifiers disabled, SHDN = Low		0.5	1.5	μA
Vsdh	High level shutdown threshold	Vs=1.5V to 5.5V, amplifier enabled	Vs-0.5V			V
Vsdl	Low level shutdown threshold	Vs=1.5V to 5.5V, amplifier disabled			0.5	V
ton	Amplifier enable time	Vs=1.5V to 5.5V, full shutdown; G=+1, Vo = 0.9×Vs/2, RL connected to V-		10		μs
toff	Amplifier disable time	Vs=1.5V to 5.5V, G=+1, Vo=0.1×Vs/2, RL connected to V-		0.6		μs

Disable time (toff) and enable time (ton) are defined as the time interval between the 50% point of the signal applied to the SHDN pin and the point at which the output voltage reaches the 10% (disable) or 90% (enable) level.

3.5 Typical Electrical Characteristics

Figure 7 Vos Distribution

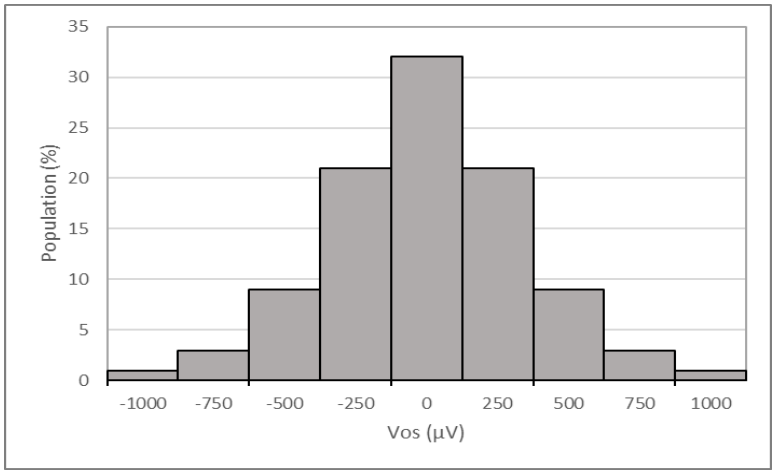


Figure 8 Vos vs Input Common Mode Voltage

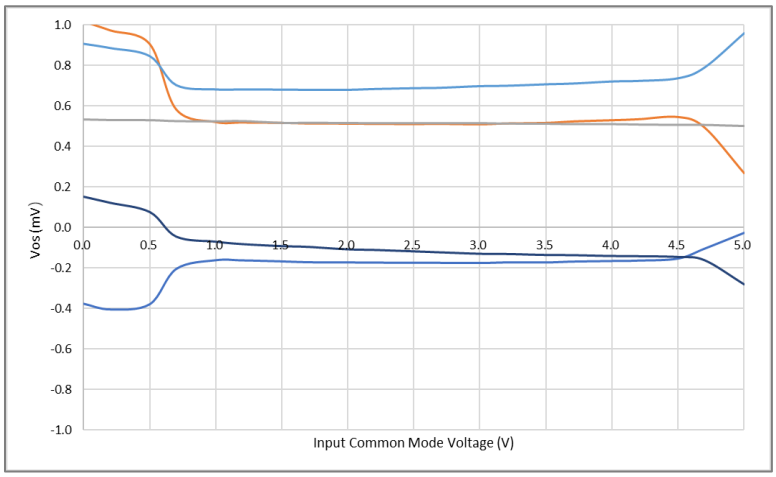


Figure 9 Vos vs Vs

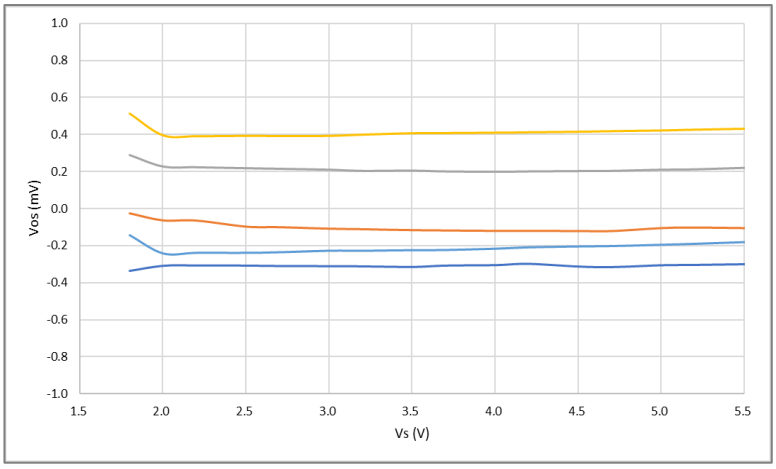


Figure 10 Iq (per opamp) vs Input Common Mode Voltage

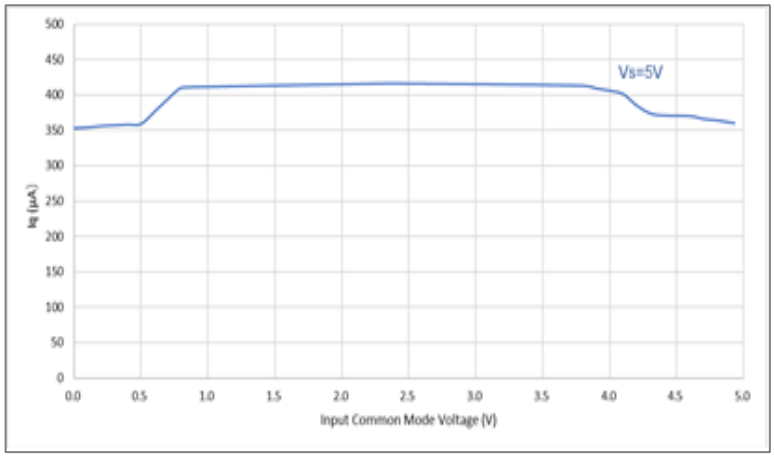


Figure 11 Iq (per opamp) vs Vs

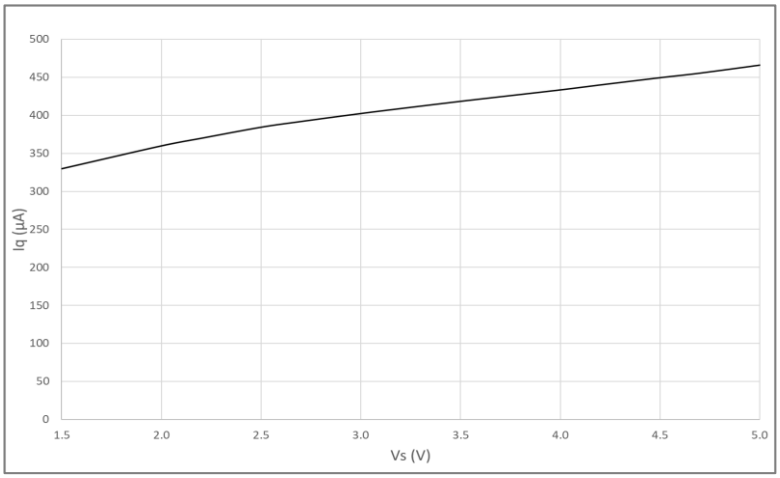


Figure 12 THD+N vs Frequency

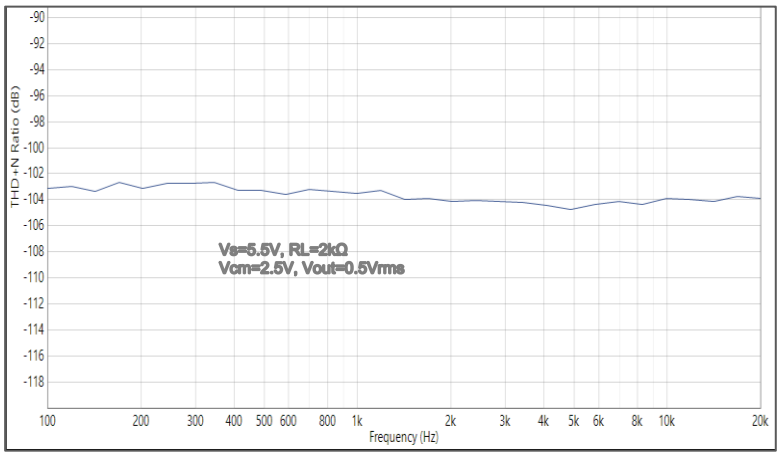


Figure 13 Large Signal Step Response

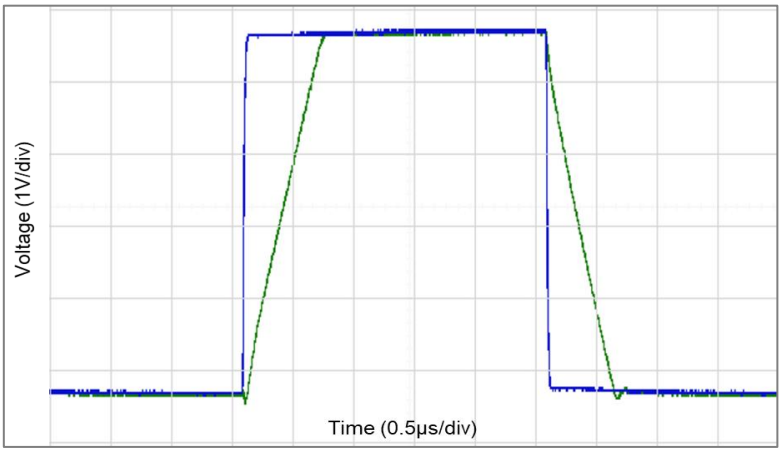
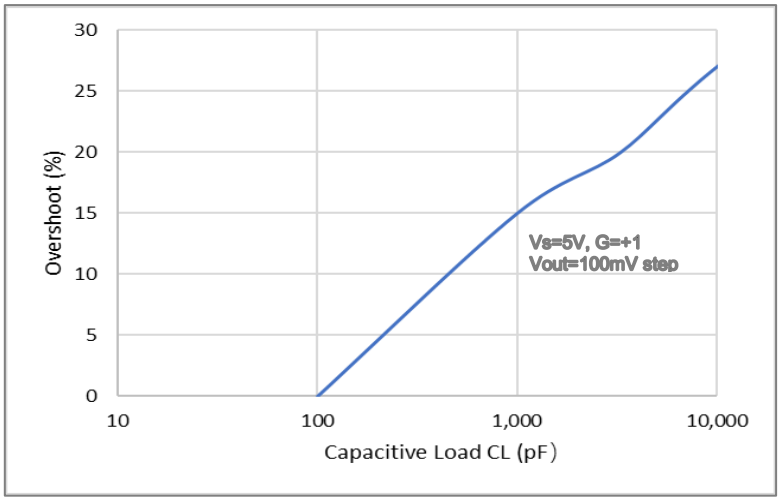


Figure 14 Small Signal Overshoot vs Capacitive Load



4 Functional Description

4.1 Overview

The SL 906x devices are a family of low power, rail-to-rail input and output opamps. These devices operate from 1.5V to 5.5V, are unity gain stable, and are designed for a wide range of applications and used in virtually any single supply application.

4.2 Rail to Rail Input

The input common mode voltage range of the SL 906x family extends 100mV beyond the supply rails for the full supply voltage range of 1.5V to 5.5V. This performance is achieved with a complementary input stage: a N-channel input differential pair in parallel with a P-channel differential pair, as shown in Figure 1. The N-channel pair is active for input voltages close to the positive rail, typically (V+)-1.4V to 200mV above the positive supply, whereas the P-channel pair is active for inputs from 200mV below the negative supply to approximately (V+)-1.4V. There is a transition region, in which both pairs are on. Within this transition region, PSRR, CMRR, offset voltage, offset drift, and THD can degrade compared to device operation outside this region.

4.3 Rail to Rail Output

Designed as a low power, low voltage operational amplifier, the SL 906x series delivers a robust output drive capability. A class AB output stage with common source Mosfets achieves full rail-to-rail output swing capability. For resistive loads of 10kΩ, the output swings to within 10mV (typ) of either supply rail, regardless of the applied power supply voltage. Different load conditions change the ability of the amplifier to swing close to the rails.

4.4 Overload Recovery

Overload recovery is defined as the time required for the opamp output to recover from a saturated state to a linear state. The output devices of the opamp enter a saturation region when the output voltage exceeds the rated operating voltage, because of the high input voltage or the high gain. After the device enters the saturation region, the charge carriers in the output devices require time to return to the linear state. After the charge carriers return to the linear state, the device begins to slew at the specified slew rate. The overload recovery time for the SL 906x family is approximately 300ns.

4.5 EMI Rejection

The SL906x uses integrated electromagnetic interference (EMI) filtering to reduce the effects of EMI from sources such as wireless communications and densely populated boards with a mix of analog signal chain and digital components.

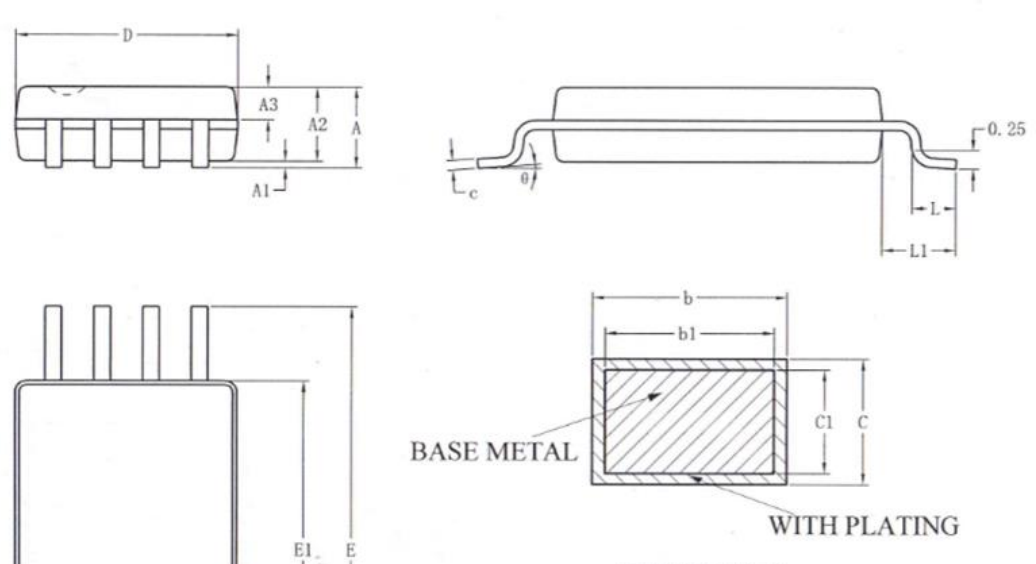
4.6 Shutdown

The SL906xS has shutdown function. The amplifiers can be shut down by enabling the respective shutdown pin.

5 Package Information

5.1 Package Dimensions

Figure 15 TSSOP8 Mechanical Data and Package Dimensions



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	—	0.28
b1	0.19	0.22	0.25
c	0.13	—	0.17
c1	0.12	0.13	0.14
D	2.90	3.00	3.10
E1	4.30	4.40	4.50
E	6.20	6.40	6.60
e	0.65BSC		
L	0.45	—	0.75
L1	1.00REF		
θ	0	—	8°

Figure 16 DFN8 Mechanical Data and Package Dimensions

	Min (mm)	Typ (mm)	Max (mm)		Min (mm)	Typ (mm)	Max (mm)
A	0.70	0.75	0.80	e	0.50BSC		
A1	0.00	0.02	0.05	E	1.95	2.00	2.05
b	0.18	0.25	0.30	E2	0.65	0.70	0.75
b1	0.18REF			L	0.25	0.30	0.35
c	0.20REF			h	0.15	0.20	0.25
D	1.95	2.00	2.05				
D2	1.15	1.20	1.25				

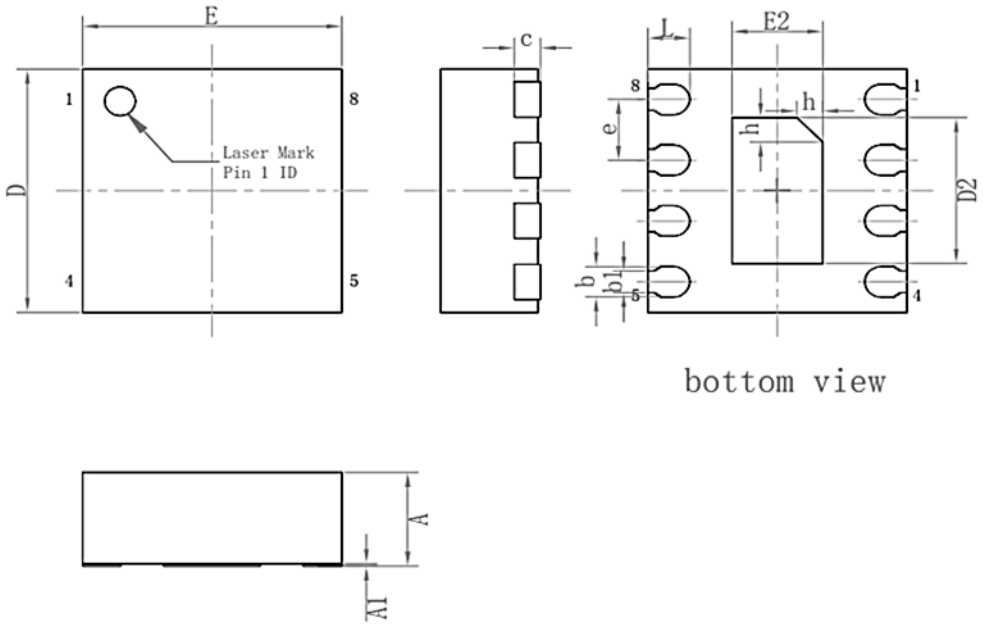
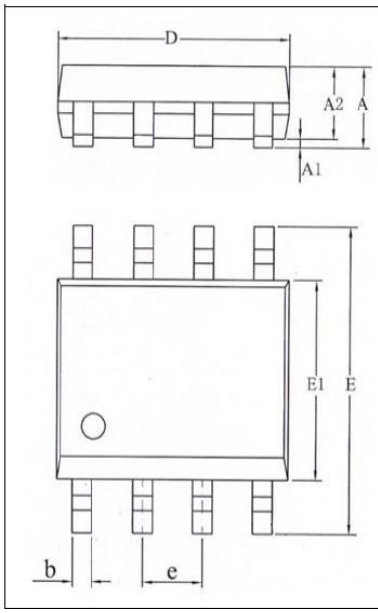
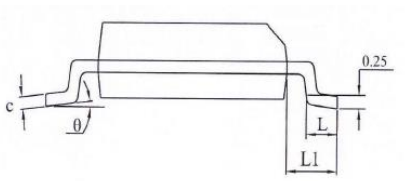


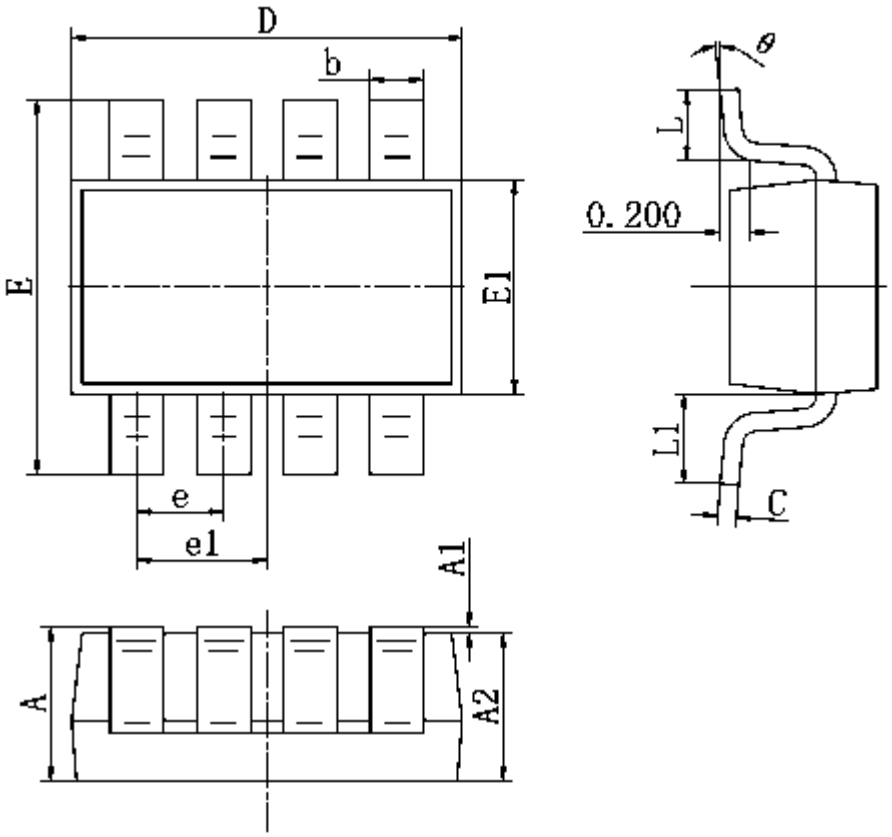
Figure 17 SOP8 Mechanical Data and Package Dimensions





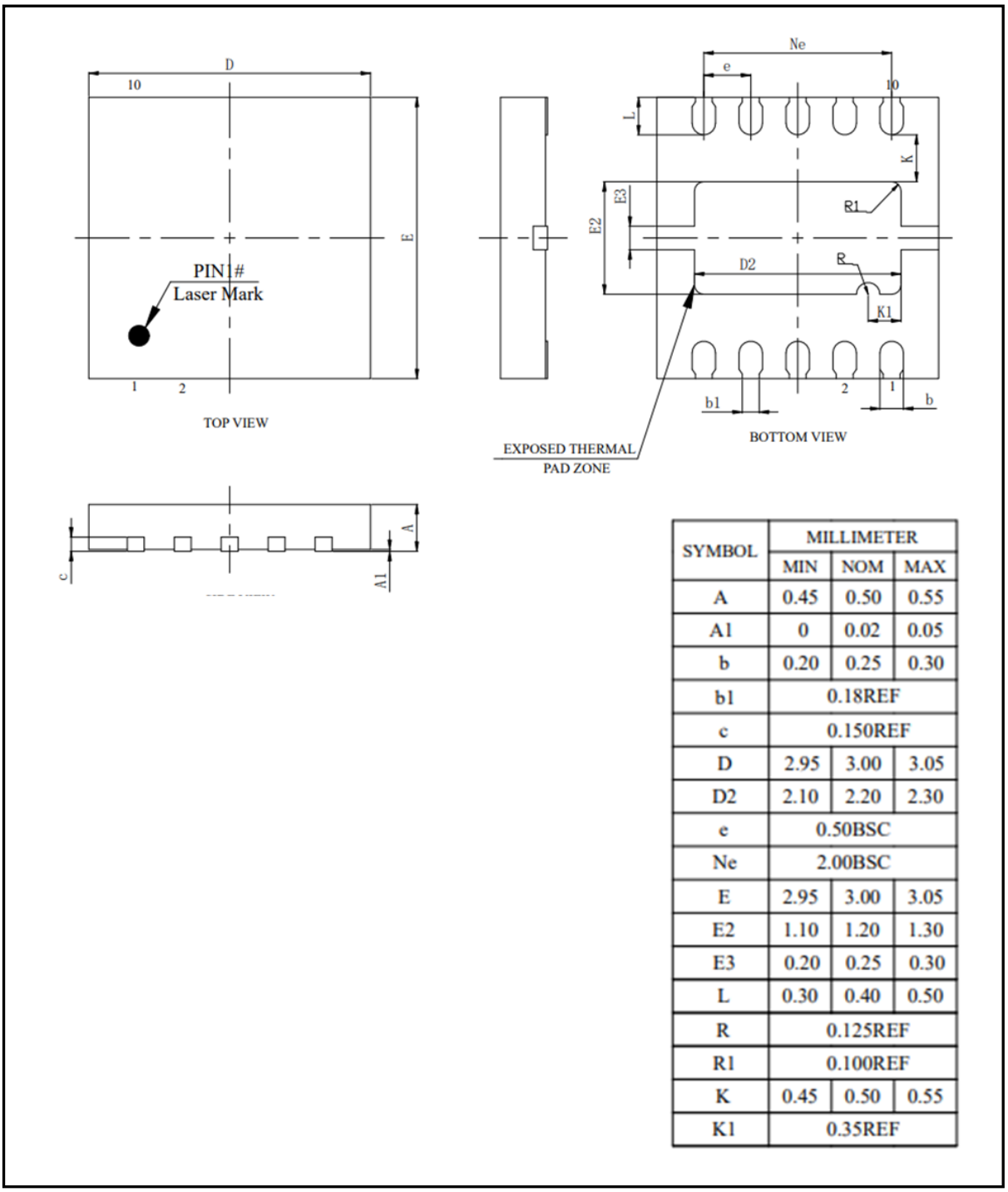
SYOMBOL	MIN	MON	MAX
A	1.5	-	1.7
A1	0.1	-	0.25
A2	1.3	1.4	1.5
b	0.33	0.4	0.47
c	0.2	-	0.25
D	4.7	4.9	5.1
E	5.9	6	6.1
E1	3.8	3.9	4
e	1.27(BSC)		
L	0.55	0.6	0.75
L1	1.05(BSC)		
θ	0°	4°	8°

Figure 18 SOT23-8L Mechanical Data and Package Dimensions



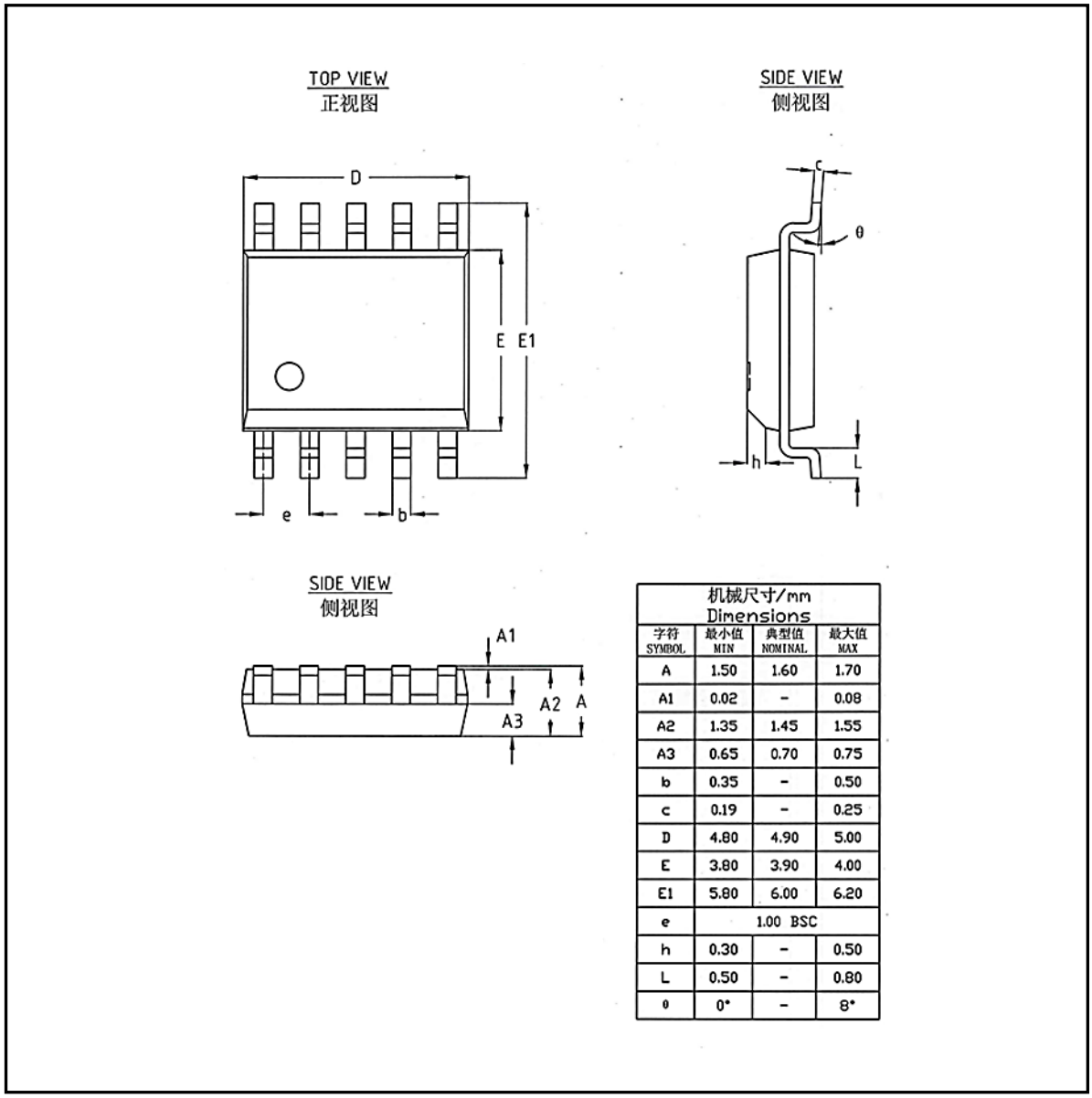
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E1	1.500	1.700	0.059	0.067
E	2.650	2.950	0.104	0.116
e	0.650BSC.		0.026BSC.	
e1	0.975BSC.		0.038BSC.	
L	0.300	0.600	0.012	0.024
L1	0.600REF.		0.024REF.	
θ	0°	8°	0°	8°

Figure 19 DFN10 Mechanical Data and Package Dimensions



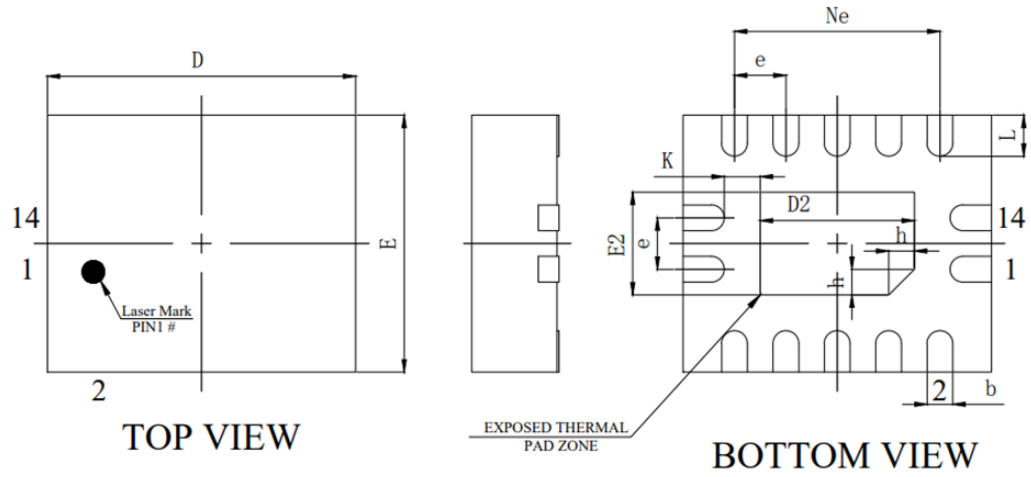
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.45	0.50	0.55
A1	0	0.02	0.05
b	0.20	0.25	0.30
b1	0.18REF		
c	0.150REF		
D	2.95	3.00	3.05
D2	2.10	2.20	2.30
e	0.50BSC		
Ne	2.00BSC		
E	2.95	3.00	3.05
E2	1.10	1.20	1.30
E3	0.20	0.25	0.30
L	0.30	0.40	0.50
R	0.125REF		
R1	0.100REF		
K	0.45	0.50	0.55
K1	0.35REF		

Figure 20 SSOP10 Mechanical Data and Package Dimensions



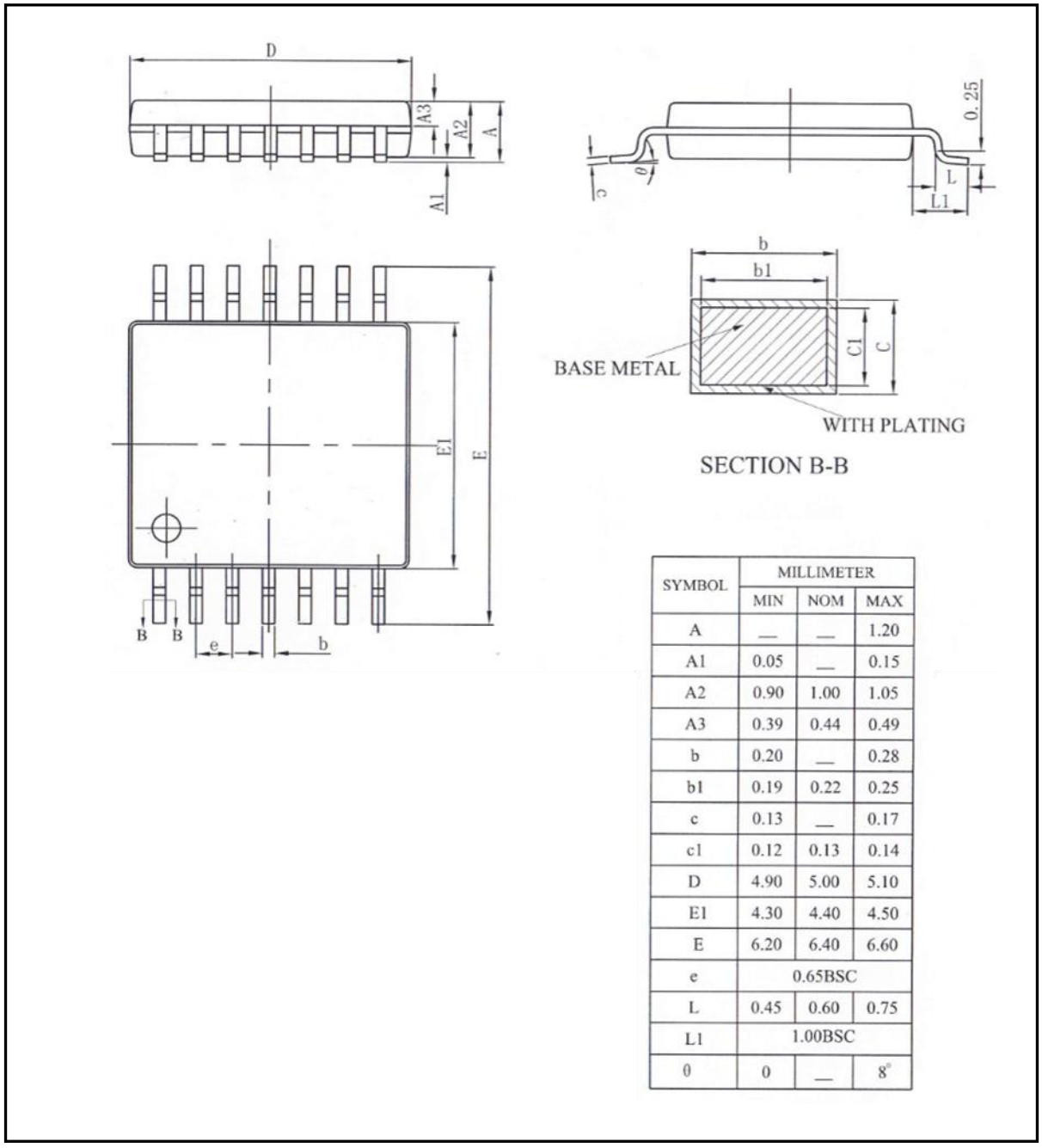
机械尺寸/mm Dimensions			
字符 SYMBOL	最小值 MIN	典型值 NOMINAL	最大值 MAX
A	1.50	1.60	1.70
A1	0.02	-	0.08
A2	1.35	1.45	1.55
A3	0.65	0.70	0.75
b	0.35	-	0.50
c	0.19	-	0.25
D	4.80	4.90	5.00
E	3.80	3.90	4.00
E1	5.80	6.00	6.20
e	1.00 BSC		
h	0.30	-	0.50
L	0.50	-	0.80
θ	0°	-	8°

Figure 21 QFN14 Mechanical Data and Package Dimensions



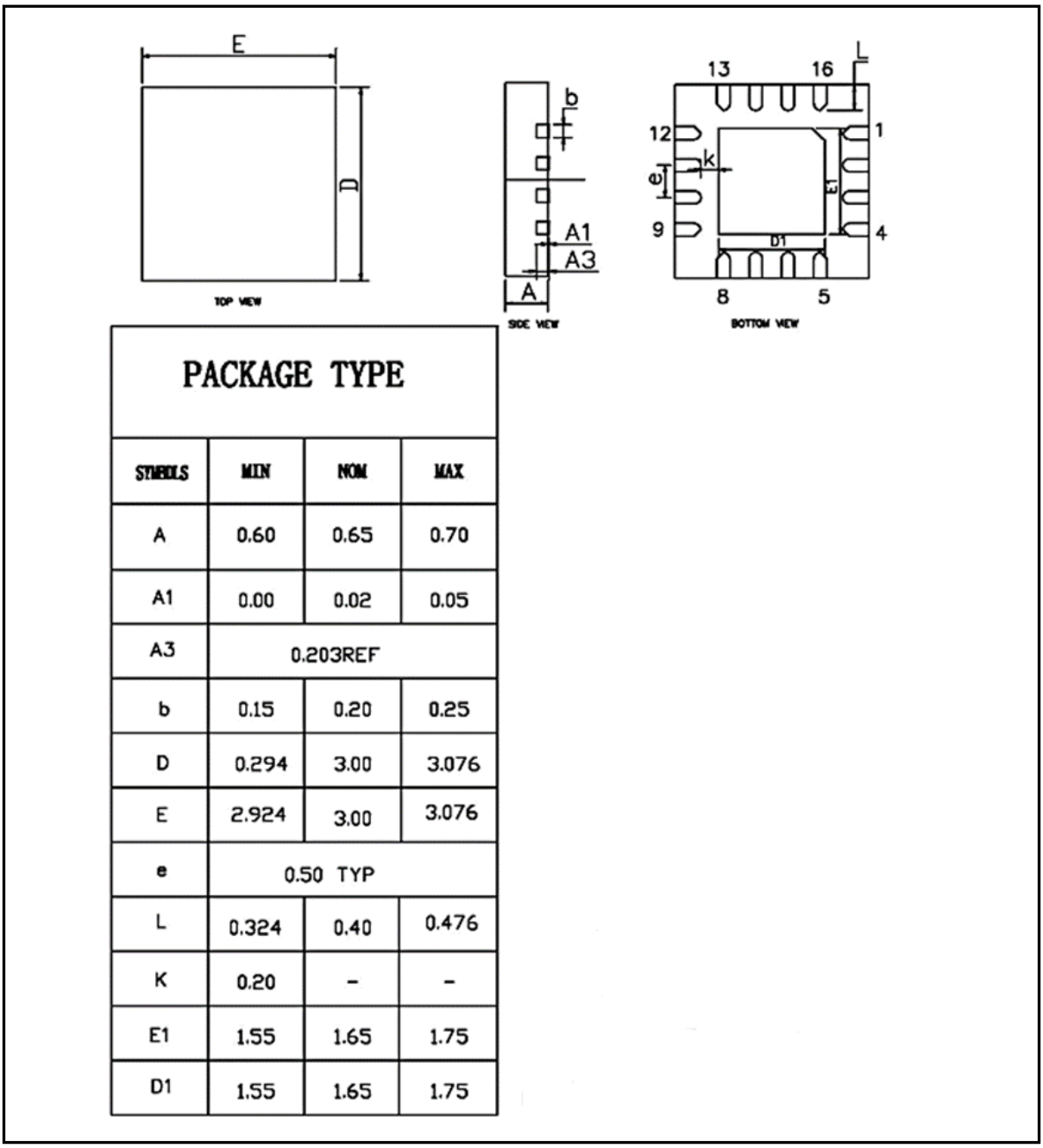
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.80	0.85	0.90
A1	0	0.02	0.05
b	0.20	0.25	0.30
c	0.20REF		
D	2.90	3.00	3.10
D2	1.40	1.50	1.60
e	0.50BSC		
Ne	2.00BSC		
E	2.40	2.50	2.60
E2	0.90	1.00	1.10
L	0.35	0.40	0.45
h	0.25REF		
K	0.20	–	–

Figure 22 TSSOP14 Mechanical Data and Package Dimensions



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	—	0.28
b1	0.19	0.22	0.25
c	0.13	—	0.17
c1	0.12	0.13	0.14
D	4.90	5.00	5.10
E1	4.30	4.40	4.50
E	6.20	6.40	6.60
e	0.65BSC		
L	0.45	0.60	0.75
L1	1.00BSC		
θ	0	—	8°

Figure 23 QFN16 Mechanical Data and Package Dimensions



PACKAGE TYPE			
SYMBOLS	MIN	NOM	MAX
A	0.60	0.65	0.70
A1	0.00	0.02	0.05
A3	0.203REF		
b	0.15	0.20	0.25
D	0.294	3.00	3.076
E	2.924	3.00	3.076
e	0.50 TYP		
L	0.324	0.40	0.476
K	0.20	-	-
E1	1.55	1.65	1.75
D1	1.55	1.65	1.75

Figure 24 SOP16 Mechanical Data and Package Dimensions