AXOP321x2/4/S

0.5μV Input Noise, RRIO Operational Amplifiers (Dual/Quad)

Datasheet – Jan 2024

Description

The AXOP321x2 (dual), and AXOP321x4 (quad) are ultra-low noise dual and quad mid voltage operational amplifiers (opamps) with rail-to-rail input and output swing capabilities. These devices are very suitable for applications where ultra-low noise, high voltage operation and a small footprint. AXOP321x2S and AXOP321x4S are with Shutdown function.

Features

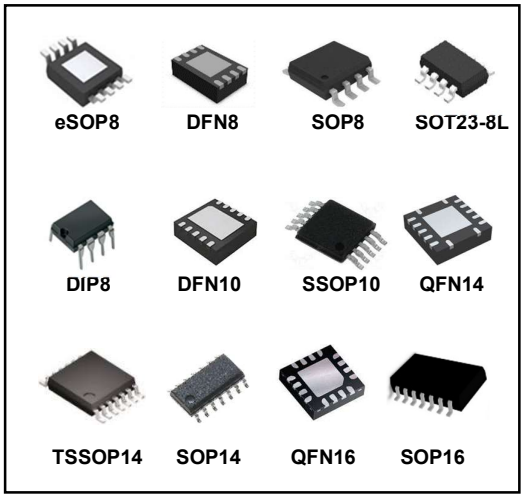
- Supply voltages Vs options: Vs= 5V (AXOP32112/4S) Vs=14V (AXOP32122/4S)
  Vs=18V (AXOP32132/4S) Vs=24V (AXOP32142/4S)
- Ultra-low input voltage noise (20Hz to 20kHz) 0.5μV (AXOP32122/4S option)
- Excellent THD+N 96dB
- Excellent SNR 115dB
- Rail-to-rail input and output
- Low input offset voltage: ±0.1mV typ
- Unity-gain bandwidth: 20MHz
- Low quiescent current (per opamp): 1.2mA typ @14V
- Shutdown function (AXOP321x2S and AXOP321x4S)

Applications

- Infotainment system
- Industrial control
- Test equipment
- Active filters
- Data acquisition system

Table 1 Device Summary

Order code	Package	Packing	MOQ
AXOP321x2A	eSOP8	Reel	2500
AXOP321x2B	DFN8	Reel	3000
AXOP321x2C	SOP8	Reel	4000
AXOP321x2D	SOT23-8L	Reel	3000
AXOP321x2E	DIP8	Tube	2000
AXOP321x2SA	DFN10	Reel	5000
AXOP321x2SB	SSOP10	Reel	2500
AXOP321x4A	QFN14	Reel	6000
AXOP321x4B	TSSOP14	Reel	3000
AXOP321x4C	SOP14	Reel	2500
AXOP321x4SA	QFN16	Reel	6000
AXOP321x4SB	SOP16	Reel	4000



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1 Block Diagram and Application Circuit

Figure 1 Block Diagram

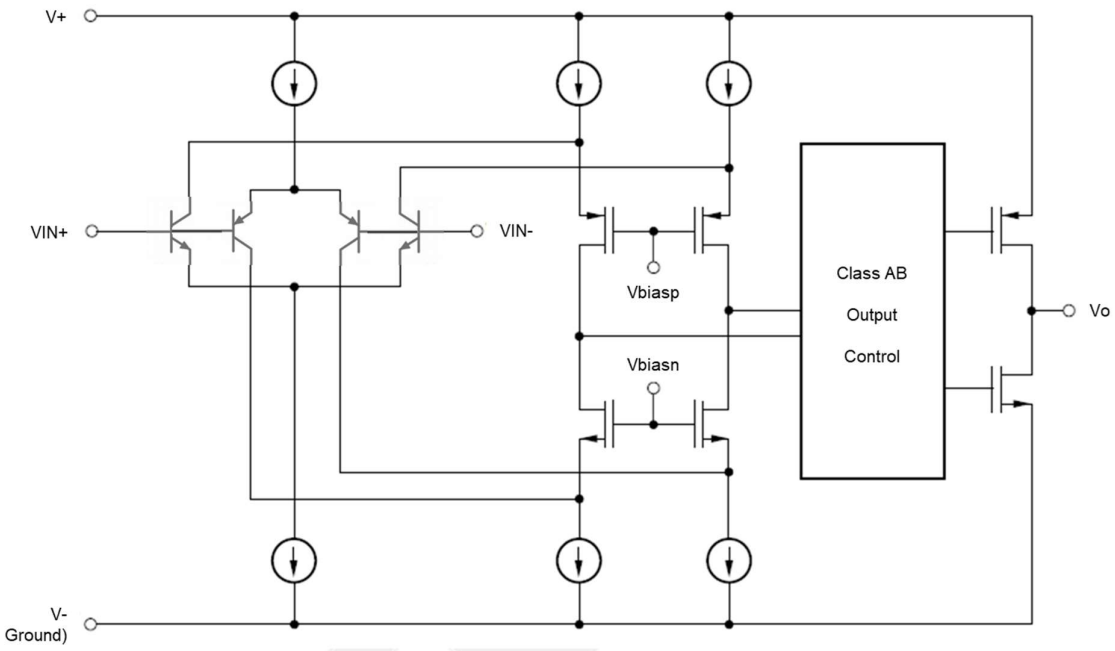
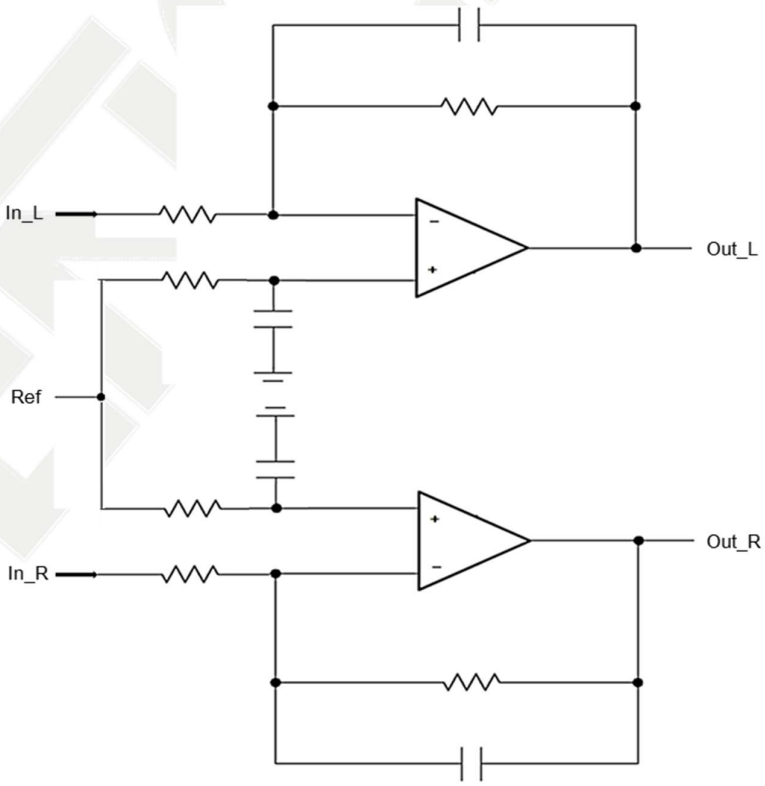


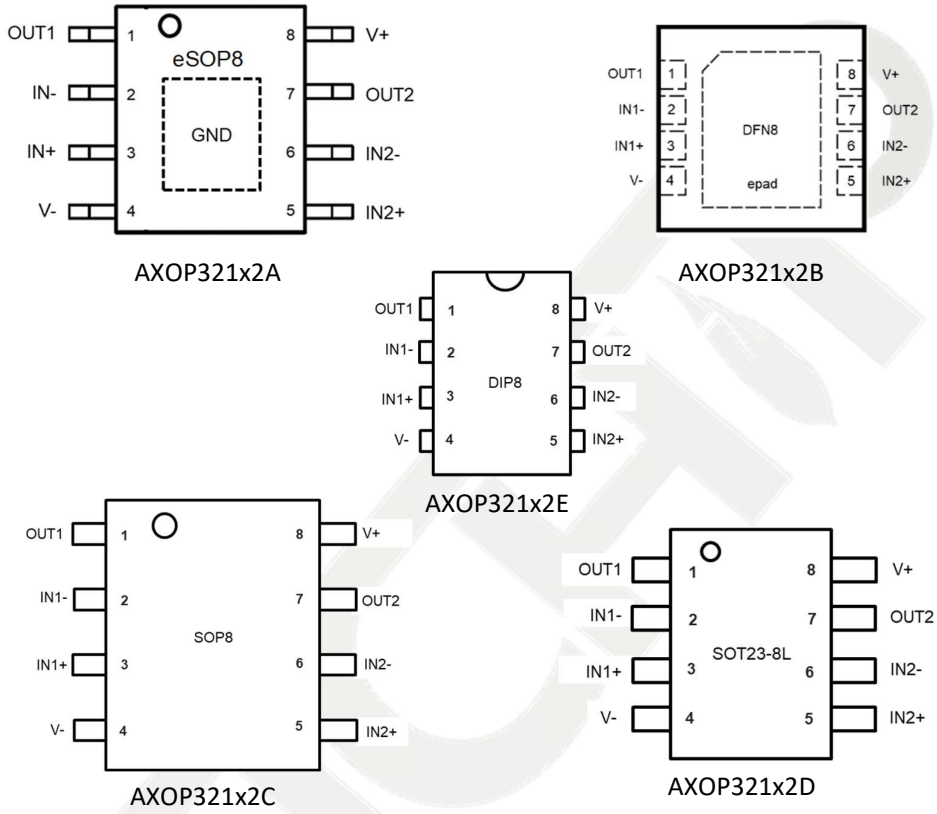
Figure 2 Typical Application Circuit (Stereo Sound Input Amplifier)



2 Pin Description

2.1 AXOP321x2A/B/C/D/E Pinouts

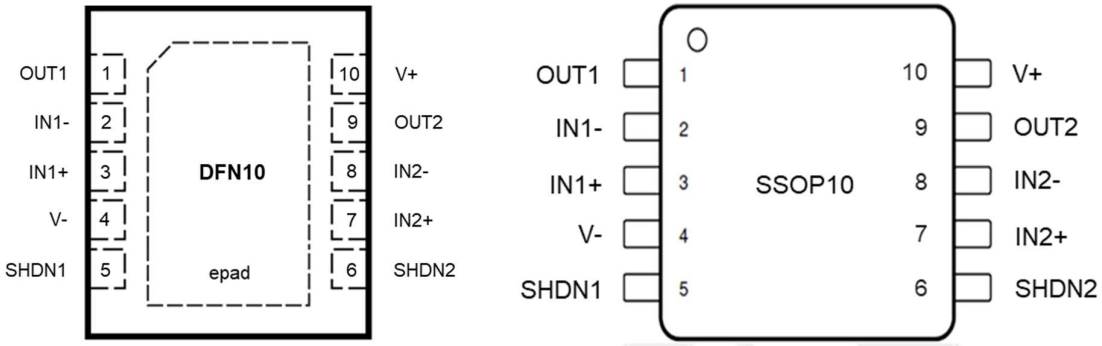
Figure 3 AXOP321x2A/B/C/D/E Pinouts



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 AXOP321x2SA/B Pinouts

Figure 4 AXOP321x2SA/B Pinouts

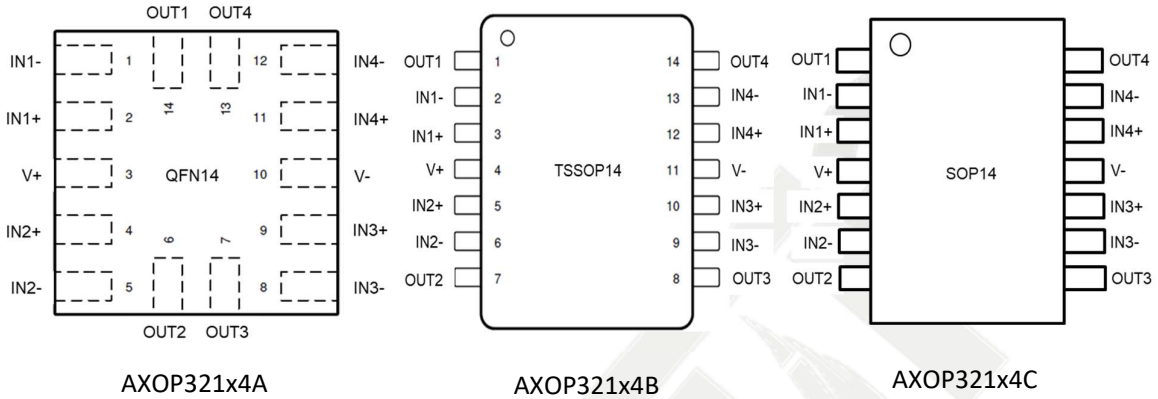


AXOP321x2SA AXOP321x2SB

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: “High” = opamp 1 disabled Shutdown1: “Low” = opamp 1 enabled Shutdown1: “Float” = opamp 1 enabled
6	SHDN2	Shutdown2: “High” = opamp 1 disabled Shutdown2: “Low” = opamp 1 enabled Shutdown2: “Float” = opamp 1 enabled
7	IN2+	Non-inverting input 2
8	IN2-	Inverting input 2
9	OUT2	Output 2
10	V+	Positive supply

2.3 AXOP321x4A/B/C Pinouts

Figure 5 AXOP321x4A/B/C Pinouts

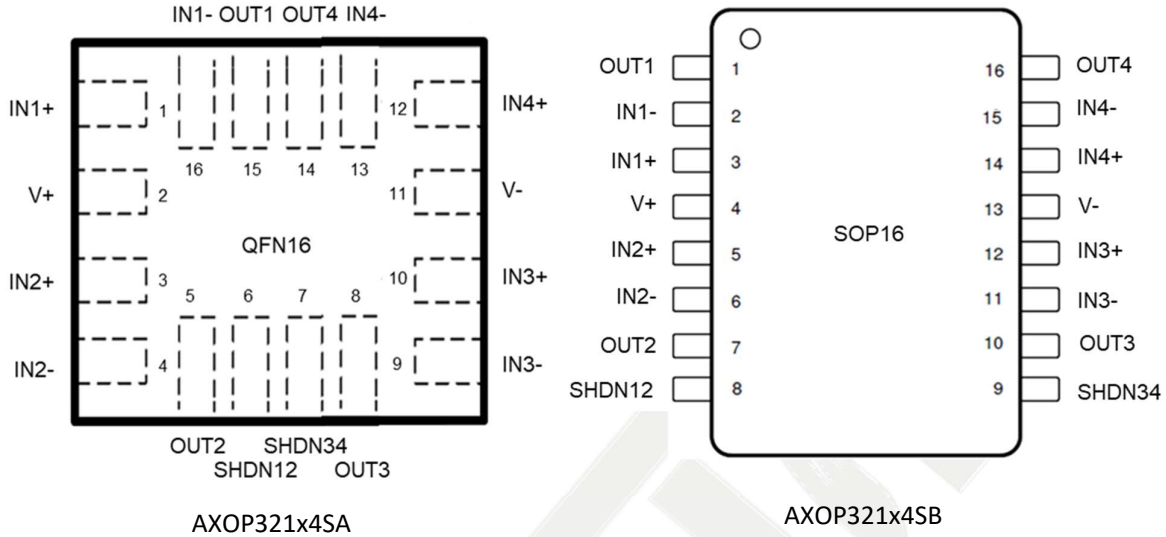


AXOP321x4A AXOP321x4B AXOP321x4C

	AXOP321x4A			AXOP321x4B/C	
Pin number	**QFN14 Pin name**	**QFN14 Description**		**TSSOP14/ SOP14 Pin name**	**TSSOP14/SOP14 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 AXOP321x4SA/B Pinouts

Figure 6 AXOP321x4SA/B Pinouts



AXOP321x4SA AXOP321x4SB

	AXOP321x4SA			AXOP321x4SB	
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: “High” = opamp 1&2 disabled		IN2-	Inverting input 2
7	SHDN34	Shutdown34: “High” = opamp 3&4 disabled		SHDN12	Shutdown12: “High” = opamp 1&2 disabled
8	OUT3	Output 3		SHDN34	Shutdown34: “High” = 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 +27	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
eSOP8	60	10	°C/W
DFN8	43	5	°C/W
SOP8	136	77	°C/W
SOT23-8L	184	100	°C/W
DIP8	85	41	°C/W
DFN10	42	6	°C/W
SSOP10	160	45	°C/W
QFN14	47	4	°C/W
TSSOP14	113	62	°C/W
SOP14	106	64	°C/W
QFN16	45	5	°C/W
SOP16	80	30	°C/W

3.3 ESD

Table 4 ESD

Symbol	Parameter	Value	Unit
All pins	ESD (HBM)	±2,000	V

3.4 Electrical Characteristics

For Vs = (V+) - (V-) = 14V 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-)	AXOP32112/4S (5V)	3		5	V
		AXOP32122/4S (14V)	3		14	
		AXOP32132/4S (18V)	3		18	
		AXOP32142/4S (24V)	3		24	
Ta	Operating ambient temperature		-40		85	°C
Power Supply						
Iq	Quiescent current per amplifier	Vs=14V, Io=0mA		1.2	2.0	mA
		all temp			3.0	
Offset Voltage						
Vos	Input offset voltage			±0.1	±1	mV
		all temp			±2	mV
dVos/dT	Drift	all temp		±0.5		μV/°C
PSRR	Power-supply rejection ratio	At DC		120		dB
Csep	Channel separation	At DC		120		dB
Input Voltage Range						
Vcm	Common mode voltage range		(V-)-0.1		(V+)+0.1	V
CMRR	Common mode rejection ratio	At DC		100		dB
Input Bias Current						
Ib	Input bias current				±1	μA
Ios	Input offset current				±0.1	μA
Noise						
En	Input voltage noise f=20Hz to 20kHz	AXOP32112/4S (5V)		0.49		μV
		AXOP32122/4S (14V)		0.51		
		AXOP32132/4S (18V)		0.56		
		AXOP32142/4S (24V)		0.67		
Open Loop Gain						
Aol	Open loop voltage gain			130		dB
Frequency Response						
GBP	Gain bandwidth product	G=+1, CL=10pF		20		MHz
SR	Slew rate	G=+1, CL=10pF		13		V/μs
Ts	Settling time	To 0.1%, 2V step, G=+1, CL=10pF		0.25		μs

THD+N	Total harmonic distortion + Noise (3rd order filter; BW= 80kHz at -3dB.)	Vs=14V, Vcm=10V, Vo=1Vrms, G=+1, f=1kHz, no load		96		dB
SNR	Signal to Noise Ratio	Vs=14V, Vin=1Vrms, G=+1, f=1kHz		115		dB
Output						
Vo	Voltage output swing from supply rails	RL=10kΩ		30		mV
		RL=2kΩ		150		
Isc	Short circuit current			±20		mA
		AXOP321x2A only eSOP8 package		±100		mA
Shutdown (AXOP321x2S and AXOP321x4S only)						
Iqsd	Quiescent current per amplifier	Vs=3V to 24V, amplifier disabled, SHDN = “High”		20	40	μA
Vsd	Shutdown threshold	Vs=3V to 24V, amplifier disabled, SHDN = “High”	4			V
Vsdl	Low level shutdown threshold	Vs=3V to 24V, amplifier enabled, SHDN = “Float” or SHDN = “Low”			1	V
ton	Amplifier enable time	Vs=3V to 24V, full shutdown; G=+1, Vo = 0.9×Vs/2, RL connected to V-		10		μs
toff	Amplifier disable time	Vs=3V to 24V, G=+1, Vo=0.1×Vs/2, RL connected to V-		1		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

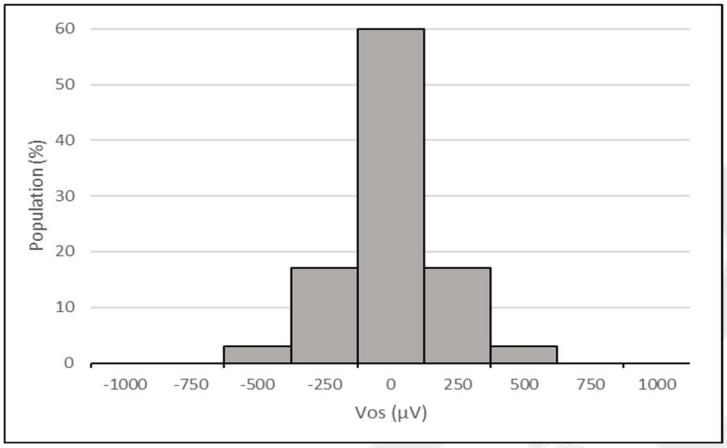


Figure 8 Vos vs Input Common Mode Voltage

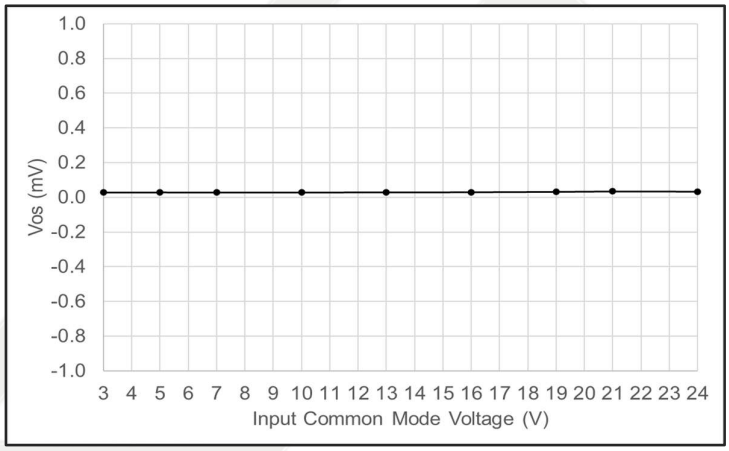


Figure 9 Vos vs Vs

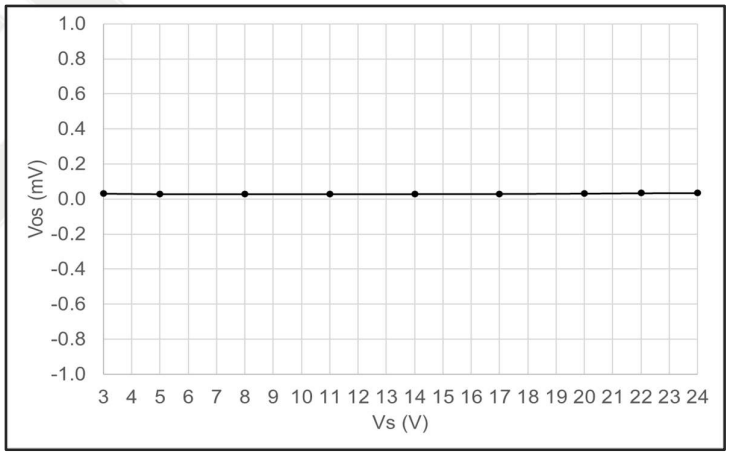


Figure 10 Iq (per opamp) vs Input Common Mode Voltage

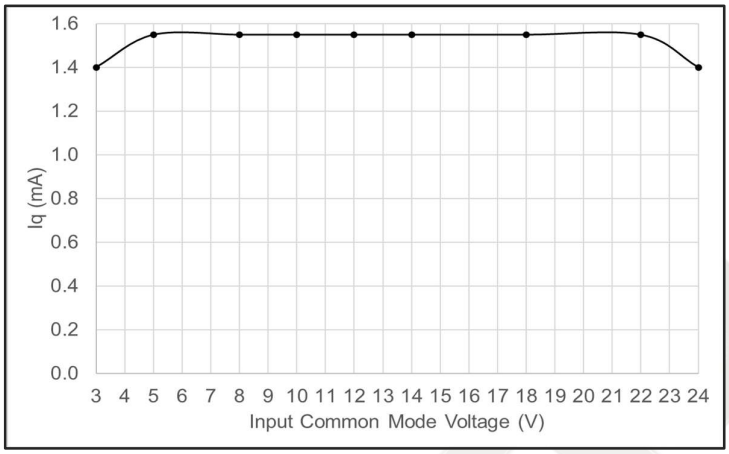


Figure 11 Iq (per opamp) vs Vs

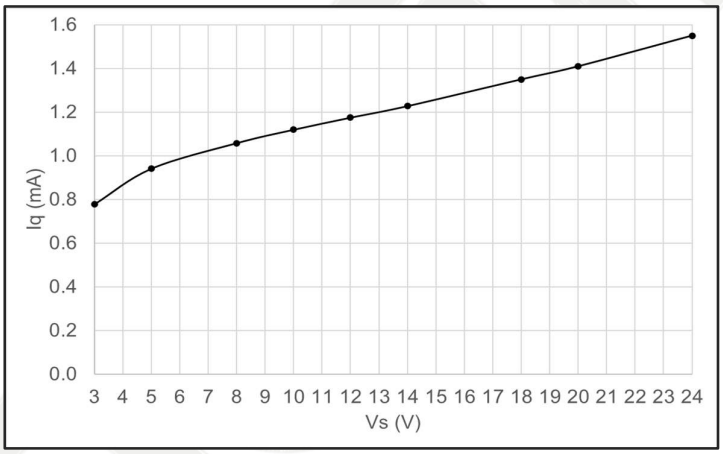


Figure 12 THD+N vs Frequency

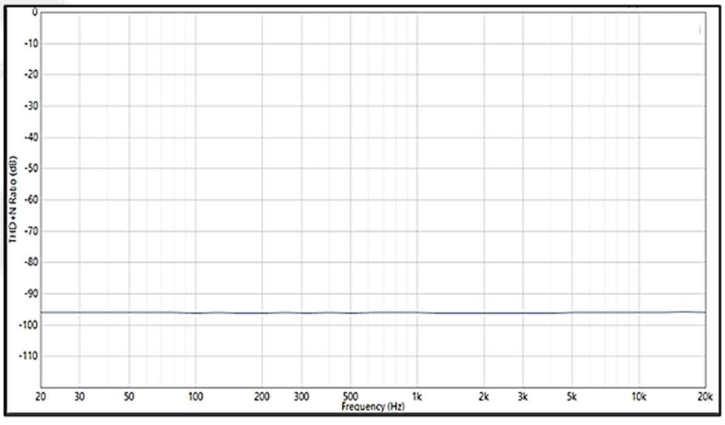
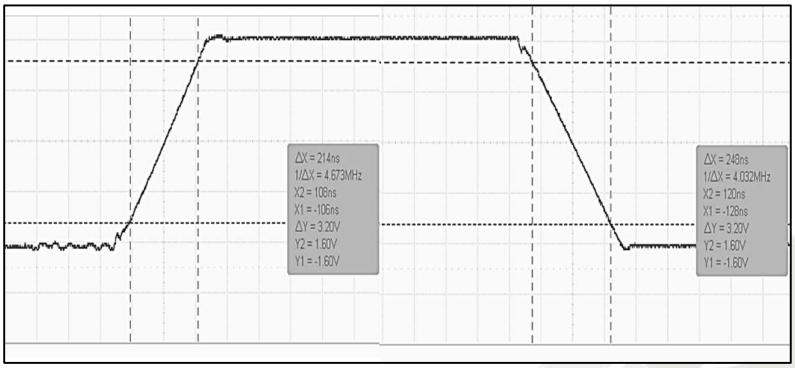


Figure 13 Large Signal Step Response



4 Functional Description

4.1 Overview

The AXOP321x2/4S devices are a family of high voltage, rail-to-rail input and output opamps. These devices 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 and Output

The input common mode voltage range of the AXOP321x2/4S family extends 100mV beyond the supply rails for the full supply voltage range. This performance is achieved with a complementary input stage: a NPN input differential pair in parallel with a PNP differential pair, as shown in Figure 1.

Designed as a high voltage operational amplifier, the AXOP321x2/4S 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 30mV (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.

4.3 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 AXOP321x2/4S family is approximately 20ns.

4.4 EMI Rejection

The AXOP321x2/4S 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.

4.5 Shutdown

The AXOP321x2/4S has shutdown function. The amplifiers can be shut down by enabling the respective shutdown pin.

5 Package Information

5.1 Package Dimensions

Figure 14 eSOP8 Mechanical Data and Package Dimensions

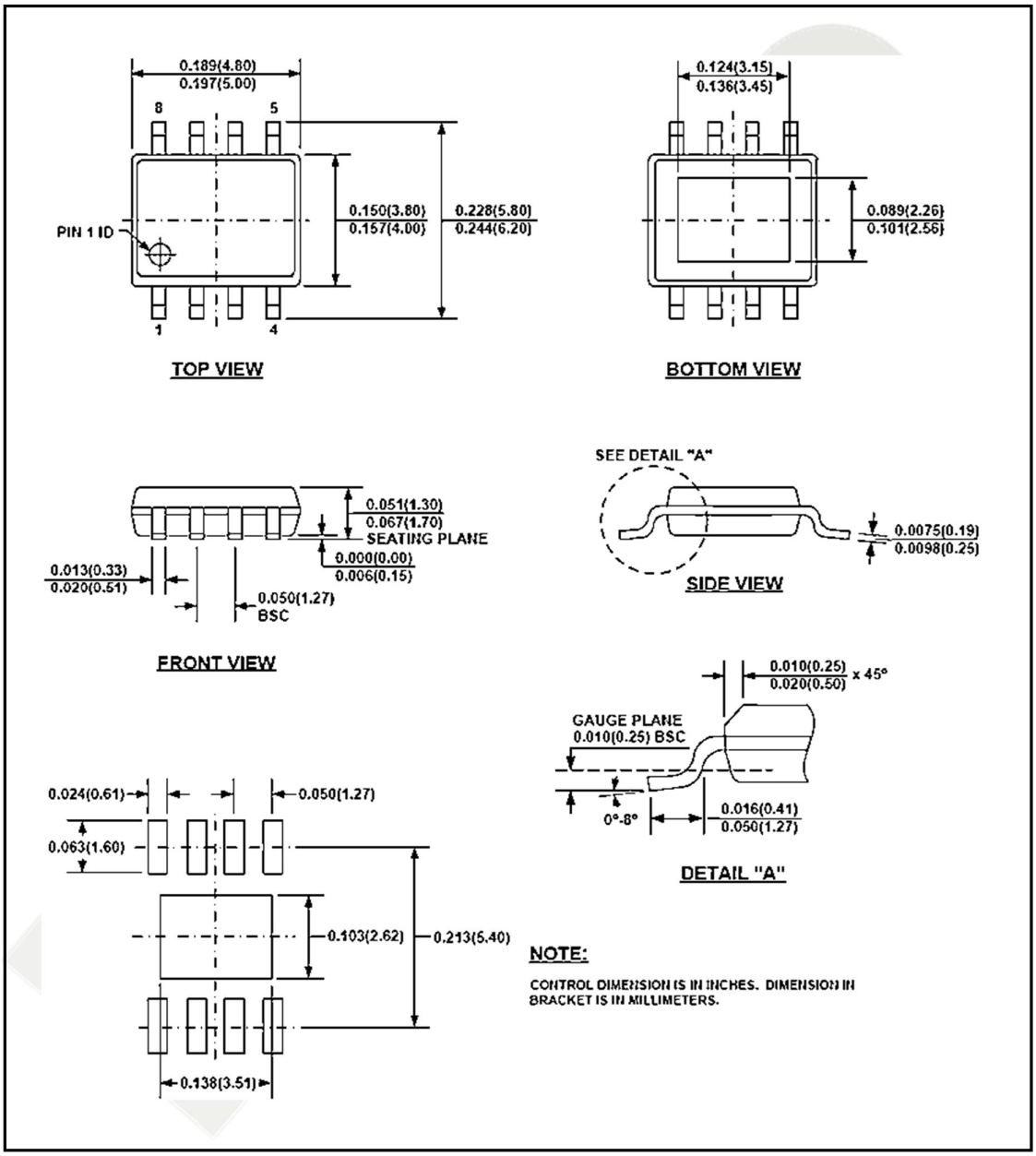


Figure 15 DFN8 Mechanical Data and Package Dimensions

	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				

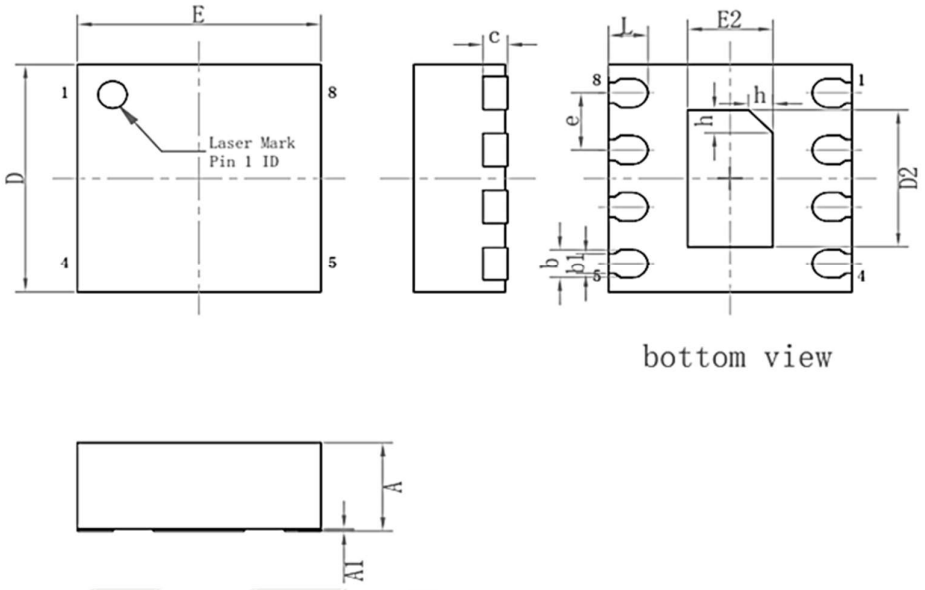
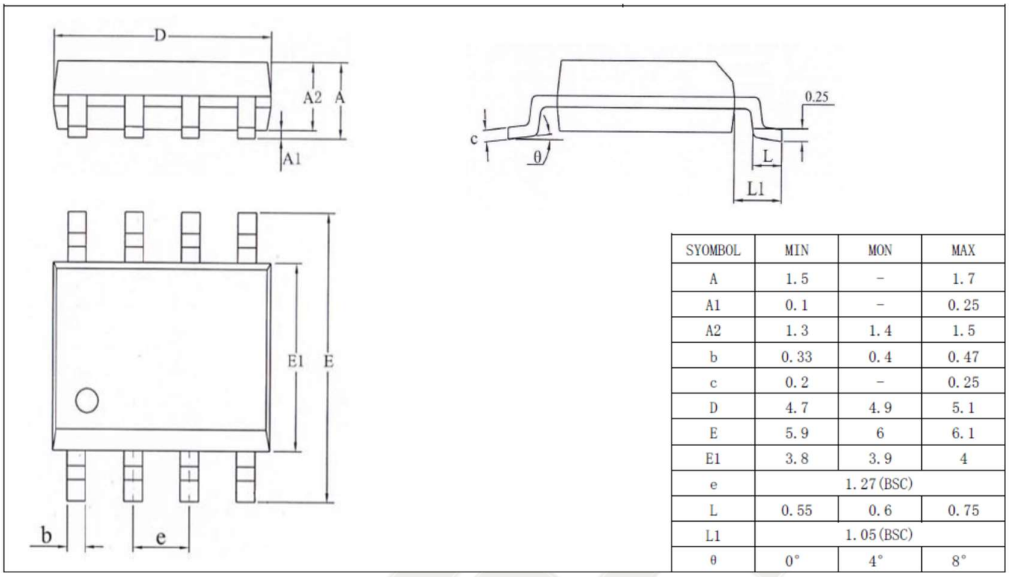
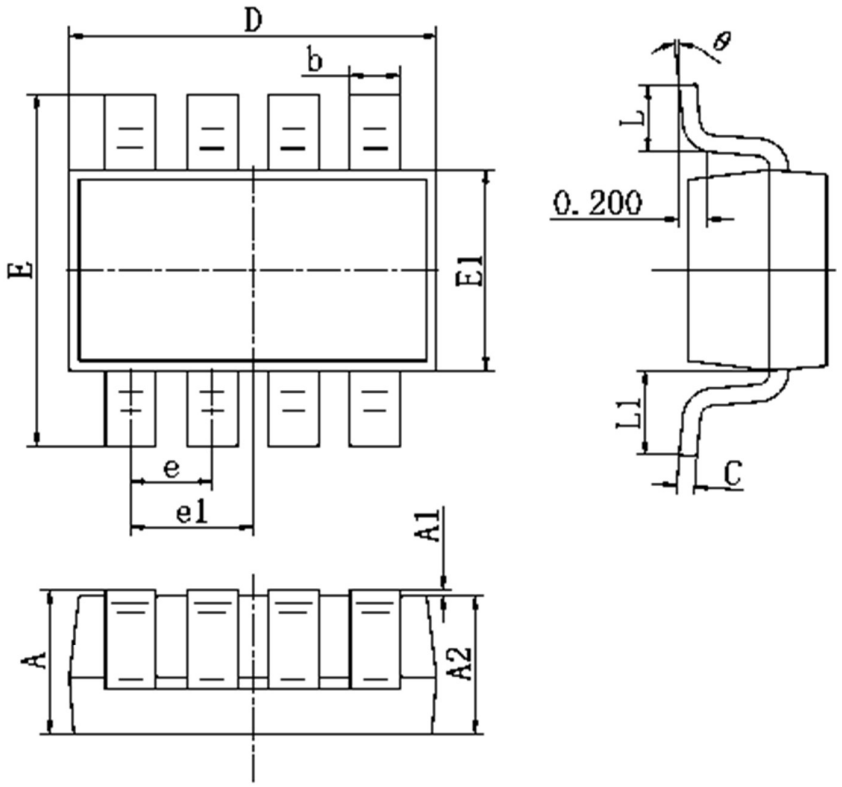


Figure 16 SOP8 Mechanical Data and Package Dimensions



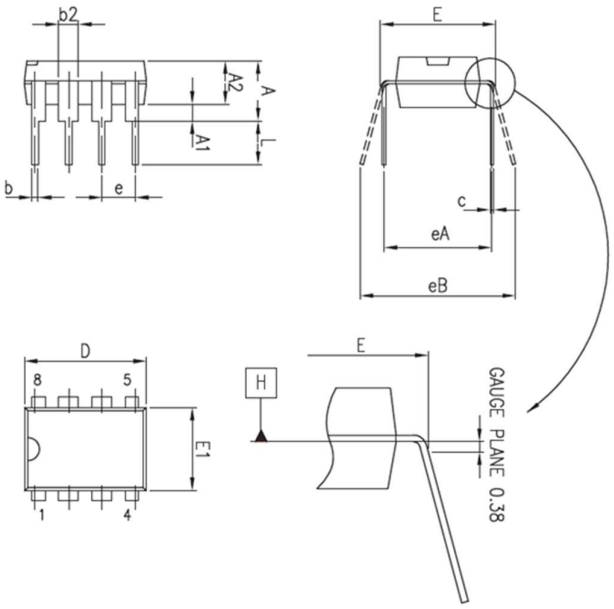
SYOMBOL	MIN	MON	MAX
A	1.5	-	1.7
A1	0.1	-	0.25
A2	1.3	1.4	1.5
b	0.33	0.4	0.47
c	0.2	-	0.25
D	4.7	4.9	5.1
E	5.9	6	6.1
E1	3.8	3.9	4
e	1.27(BSC)		
L	0.55	0.6	0.75
L1	1.05(BSC)		
θ	0°	4°	8°

Figure 17 SOT23-8L Mechanical Data and Package Dimensions



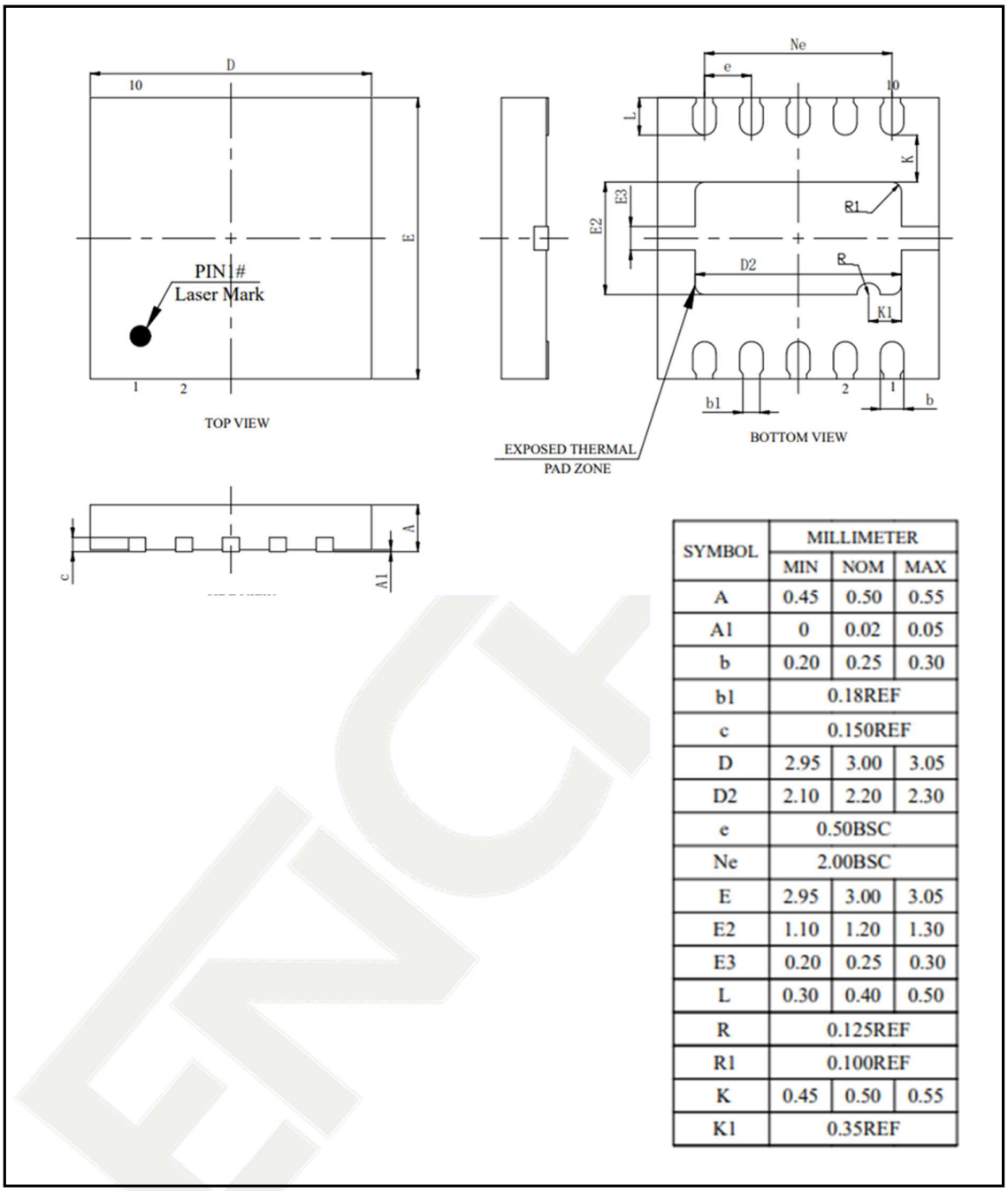
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E1	1.500	1.700	0.059	0.067
E	2.650	2.950	0.104	0.116
e	0.650BSC.		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 18 DIP8 Mechanical Data and Package Dimensions



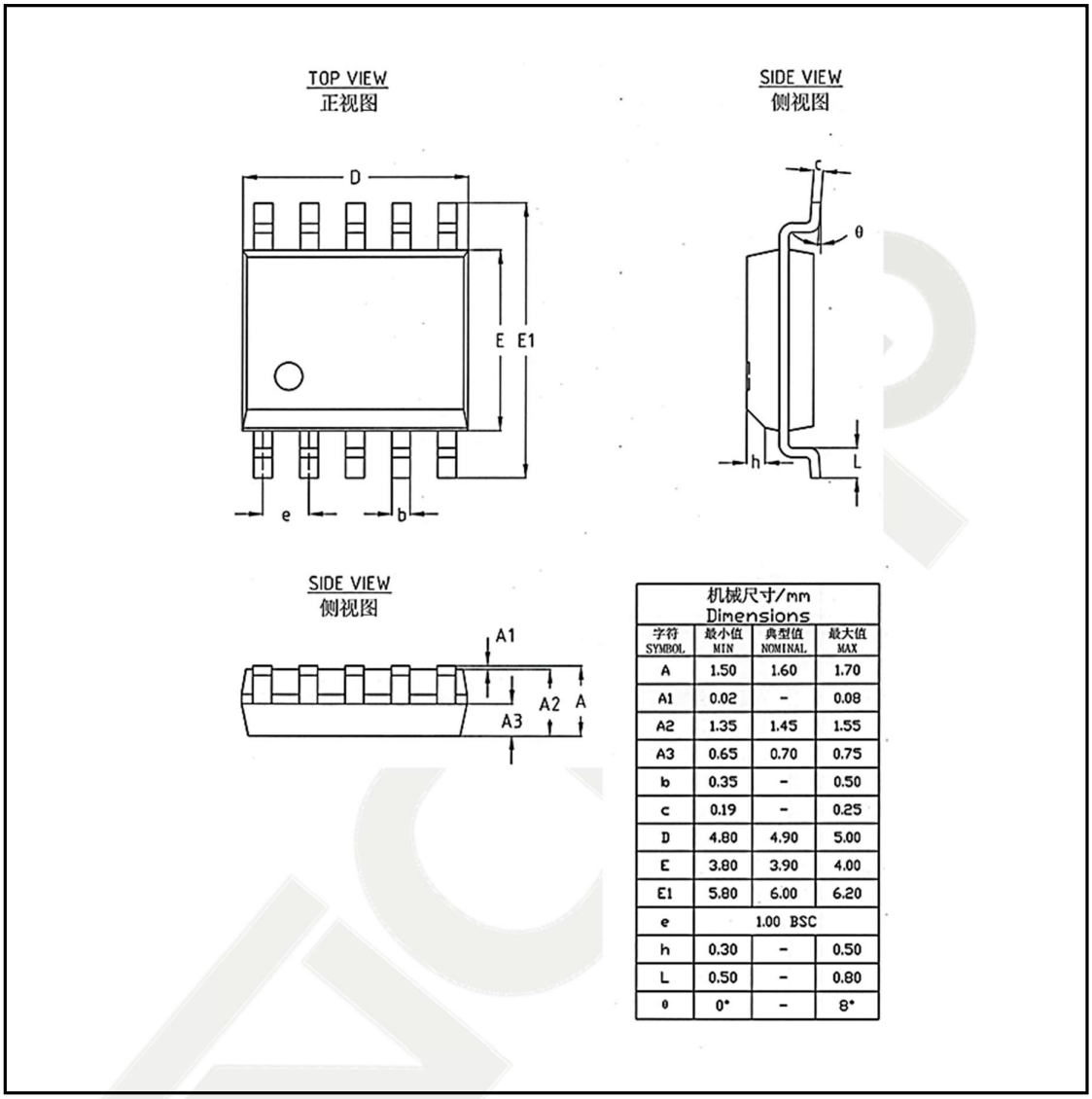
Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			5.33			0.210
A1	0.38			0.015		
A2	2.92	3.30	4.95	0.115	0.130	0.195
b	0.36	0.46	0.56	0.014	0.018	0.022
b2	1.14	1.52	1.78	0.045	0.060	0.070
c	0.20	0.25	0.36	0.008	0.010	0.014
D	9.02	9.27	10.16	0.355	0.365	0.400
E	7.62	7.87	8.26	0.300	0.310	0.325
E1	6.10	6.35	7.11	0.240	0.250	0.280
e		2.54			0.100	
eA		7.62			0.300	
eB			10.92			0.430
L	2.92	3.30	3.81	0.115	0.130	0.150

Figure 19 DFN10 Mechanical Data and Package Dimensions



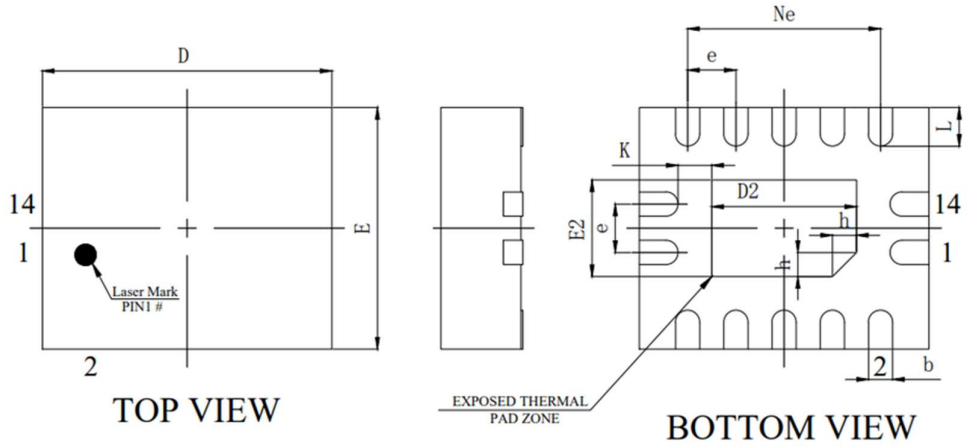
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.45	0.50	0.55
A1	0	0.02	0.05
b	0.20	0.25	0.30
b1	0.18REF		
c	0.150REF		
D	2.95	3.00	3.05
D2	2.10	2.20	2.30
e	0.50BSC		
Ne	2.00BSC		
E	2.95	3.00	3.05
E2	1.10	1.20	1.30
E3	0.20	0.25	0.30
L	0.30	0.40	0.50
R	0.125REF		
R1	0.100REF		
K	0.45	0.50	0.55
K1	0.35REF		

Figure 20 SSOP10 Mechanical Data and Package Dimensions



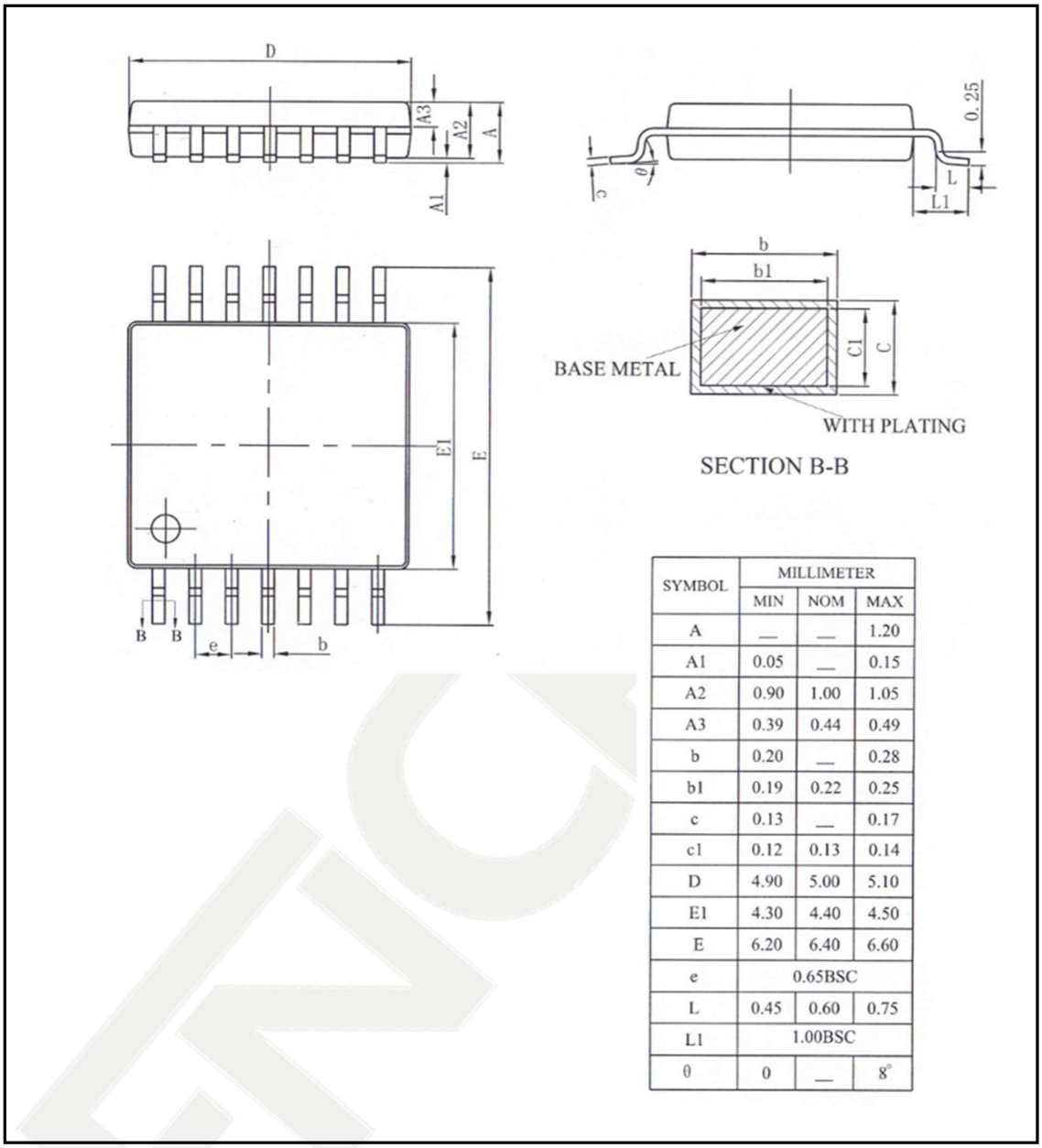
机械尺寸/mm Dimensions			
字符 SYMBOL	最小值 MIN	典型值 NOMINAL	最大值 MAX
A	1.50	1.60	1.70
A1	0.02	-	0.08
A2	1.35	1.45	1.55
A3	0.65	0.70	0.75
b	0.35	-	0.50
c	0.19	-	0.25
D	4.80	4.90	5.00
E	3.80	3.90	4.00
E1	5.80	6.00	6.20
e	1.00 BSC		
h	0.30	-	0.50
L	0.50	-	0.80
θ	0°	-	8°

Figure 21 QFN14 Mechanical Data and Package Dimensions



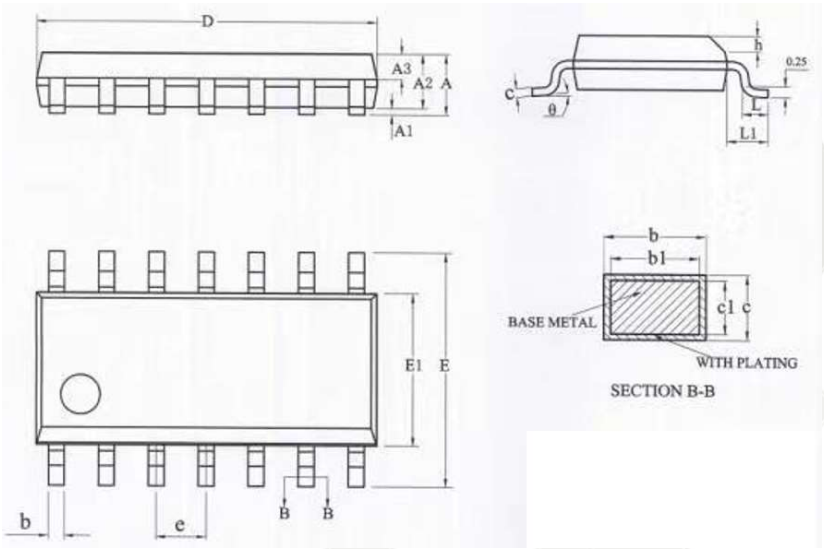
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.80	0.85	0.90
A1	0	0.02	0.05
b	0.20	0.25	0.30
c	0.20REF		
D	2.90	3.00	3.10
D2	1.40	1.50	1.60
e	0.50BSC		
Ne	2.00BSC		
E	2.40	2.50	2.60
E2	0.90	1.00	1.10
L	0.35	0.40	0.45
h	0.25REF		
K	0.20	–	–

Figure 22 TSSOP14 Mechanical Data and Package Dimensions



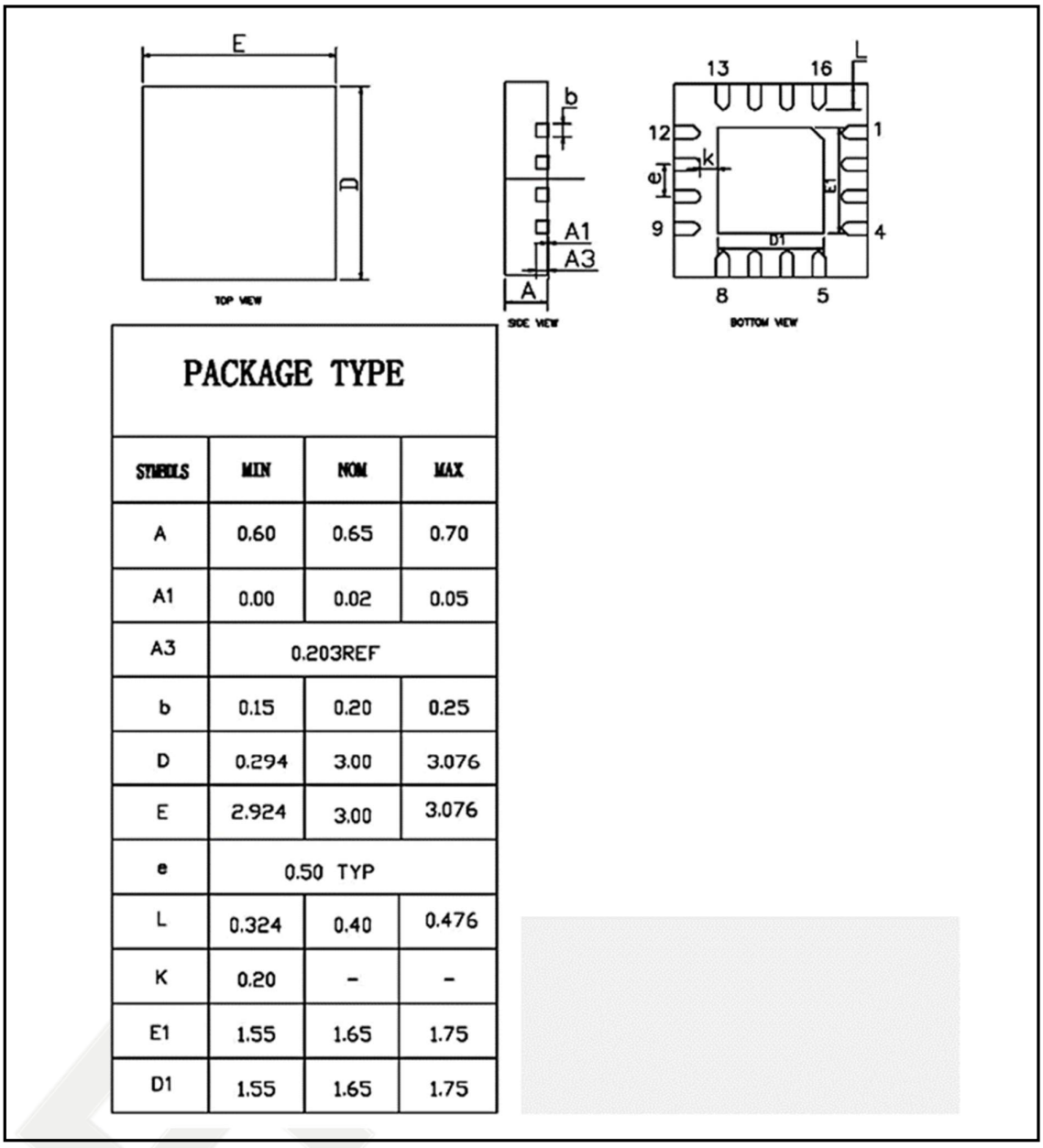
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	—	0.28
b1	0.19	0.22	0.25
c	0.13	—	0.17
c1	0.12	0.13	0.14
D	4.90	5.00	5.10
E1	4.30	4.40	4.50
E	6.20	6.40	6.60
e	0.65BSC		
L	0.45	0.60	0.75
L1	1.00BSC		
θ	0	—	8°

Figure 23 SOP14 Mechanical Data and Package Dimensions



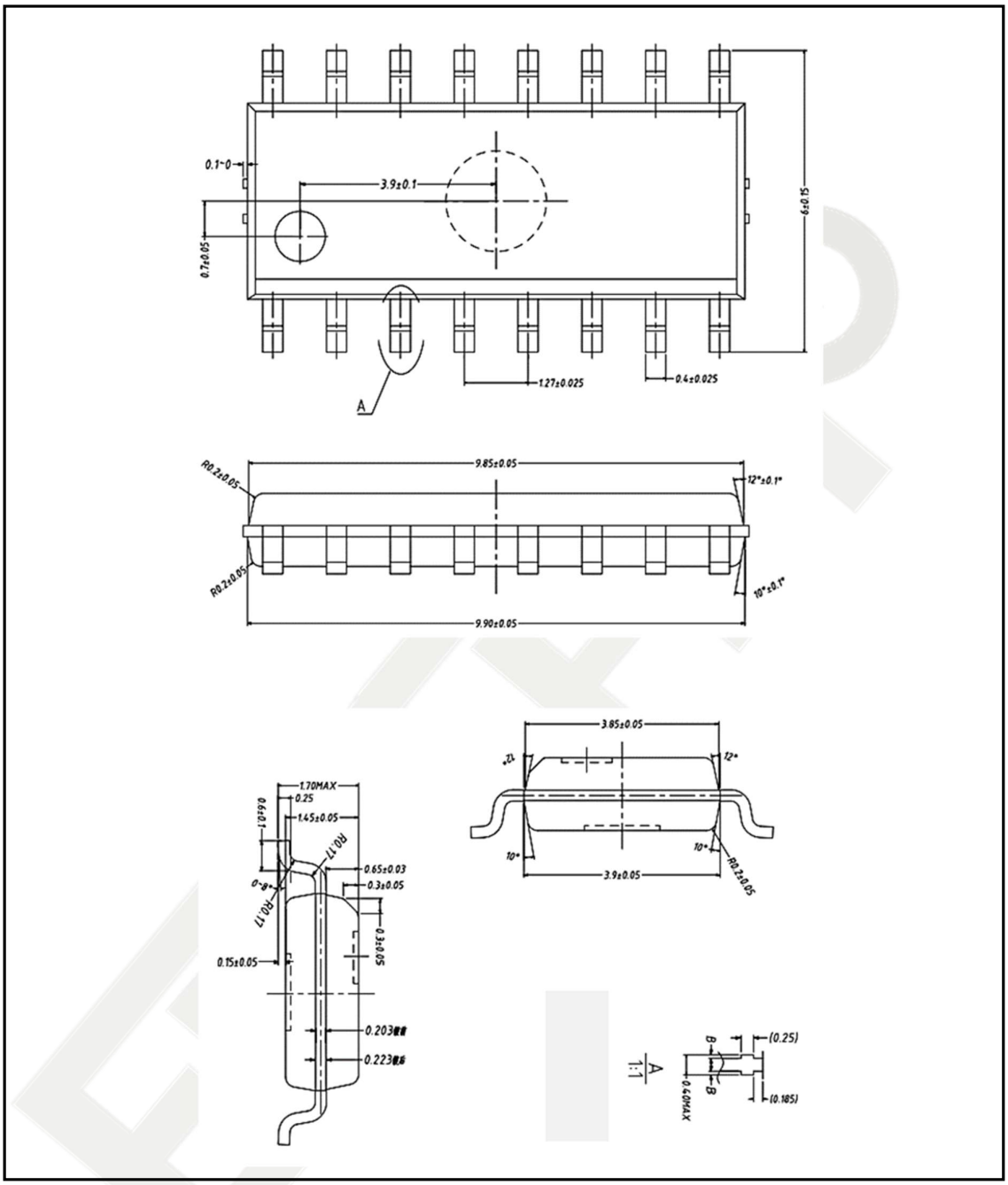
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.75
② A1	0.10	—	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
① b	0.39	—	0.47
① b1	0.38	0.41	0.44
① c	0.20	—	0.24
c1	0.19	0.20	0.21
① D	8.55	8.65	8.75
E	5.80	6.00	6.20
① E1	3.80	3.90	4.00
e	1.27BSC		
h	0.25	—	0.50
L	0.50	—	0.80
L1	1.05REF		
θ	0	—	8°

Figure 24 QFN16 Mechanical Data and Package Dimensions



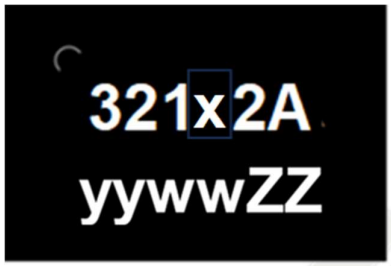
PACKAGE TYPE			
SYMBOLS	MIN	NOM	MAX
A	0.60	0.65	0.70
A1	0.00	0.02	0.05
A3	0.203REF		
b	0.15	0.20	0.25
D	0.294	3.00	3.076
E	2.924	3.00	3.076
e	0.50 TYP		
L	0.324	0.40	0.476
K	0.20	-	-
E1	1.55	1.65	1.75
D1	1.55	1.65	1.75

Figure 25 SOP16 Mechanical Data and Package Dimensions



5.2 Marking Information

Figure 26 eSOP8 Marking Information



Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: "321x2A" characters to indicate AXOP321x2A where x=1,2,3 or 4

Line 2: "yy" to indicate year of production

"ww" to indicate week of production

"ZZ" Reserved ID markings

Figure 27 DFN8 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: "x2B" characters to indicate AXOP321x2B where x=1,2,3 or 4

Line 2: "y" to indicate year of production

"ww" to indicate week of production

Figure 28 SOP8 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: “321x2C” characters to indicate AXOP321x2C where x=1,2,3 or 4

Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“ZZ” Reserved ID markings

Figure 29 SOT23-8L Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

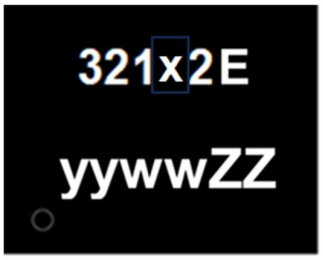
Line 1: “321x2D” characters to indicate AXOP321x2D where x=1,2,3 or 4

Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“ZZ” Reserved ID markings

Figure 30 DIP8L Marking Information



Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: "321x2E" characters to indicate AXOP321x2E where x=1,2,3 or 4

Line 2: "yy" to indicate year of production

"ww" to indicate week of production

"ZZ" Reserved ID markings

Figure 31 DFN10 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: "321x2SA" characters to indicate AXOP321x2SA where x=1,2,3 or 4

Line 2: "yy" to indicate year of production

"ww" to indicate week of production

"ZZ" Reserved ID markings

Figure 32 SSOP10 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: “321x2SB” characters to indicate AXOP321x2SB where x=1,2,3 or 4

Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“ZZ” Reserved ID markings

Figure 33 QFN14 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

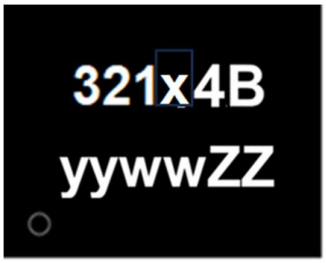
Line 1: “321x4A” characters to indicate AXOP321x4A where x=1,2,3 or 4

Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“ZZ” Reserved ID markings

Figure 34 TSSOP14 Marking Information



Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: "321x4B" characters to indicate AXOP321x4B

Line 2: "yy" to indicate year of production

"ww" to indicate week of production

"ZZ" Reserved ID markings

Figure 35 SOP14 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: "321x4C" characters to indicate AXOP321x4C where x=1,2,3 or 4

Line 2: "yy" to indicate year of production

"ww" to indicate week of production

"ZZ" Reserved ID markings

Figure 36 QFN16 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: “321x4SA” characters to indicate AXOP321x4SA where x=1,2,3 or 4

Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“ZZ” Reserved ID markings

Figure 37 SOP16 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: “AXOP321x4SB” characters to indicate AXOP321x4SB where x=1,2,3 or 4

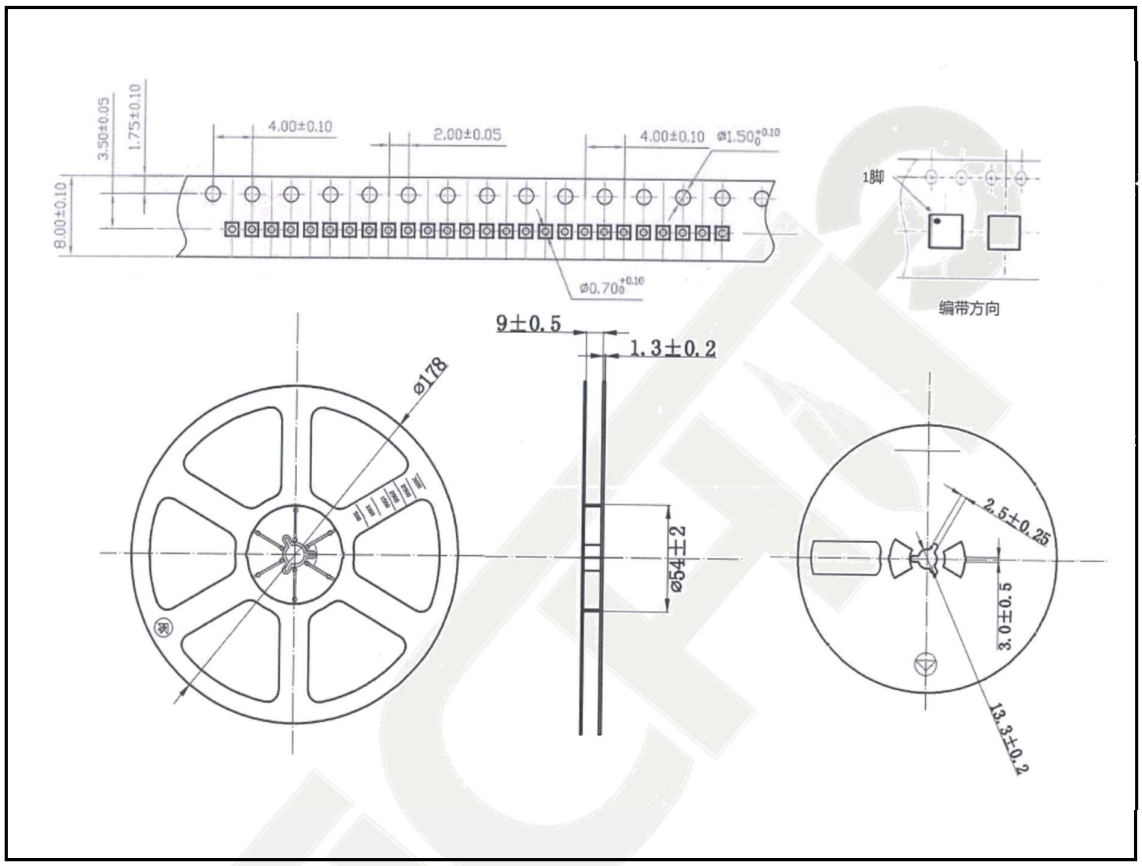
Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“ZZ” Reserved ID markings

6 Packing Information

Figure 38 Reel Packing Information



7 Revision History

Table 6 Document Revision History

Date	Version	Description
Jan 2024	1.00	V1.00 version.