AXOP32121/2/4

0.45μV Input Noise, 24V Operational Amplifiers (Single/Dual/Quad)

Datasheet – Dec 2024

Description

The AXOP32121 (single), AXOP32122 (dual) and AXOP32124 (quad) are ultra-low noise, ultra-low offset dual, quad and single mid voltage (3V to 24V) operational amplifiers (opamps) with rail-to-rail output swing capabilities. These devices are very suitable for applications where ultra-low noise, high voltage operation and a small footprint.

Features

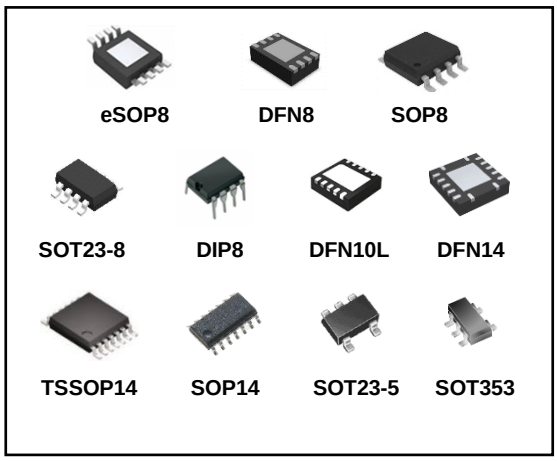
- Supply voltages from 3V to 24V
- Ultra-low input voltage noise (20Hz to 20kHz) G=+1, 0.45μV
- Excellent THD 114dB
- Excellent SNR 120dB
- Output rail-to-rail
- Low input offset voltage: ±0.1mV typ
- Unity-gain bandwidth: 30MHz
- Low quiescent current (per opamp): 1.2mA typ @14V, 0.5mA typ @3.3V

Applications

- Infotainment system
- HVAC: heating, ventilating, and air conditioning
- Industrial control
- Test equipment
- Portable Equipment
- Active filters
- Data acquisition system

Table 1 Device Summary

Order code	Package	Packing	MOQ
AXOP32122A	eSOP8	Reel	2500
AXOP32122B	DFN8	Reel	3000
AXOP32122C	SOP8	Reel	4000
AXOP32122D	SOT23-8	Reel	3000
AXOP32122E	DIP8	Tube	2000
AXOP32122F	DFN10L	Reel	3000
AXOP32124A	QFN14	Reel	6000
AXOP32124B	TSSOP14	Reel	3000
AXOP32124C	SOP14	Reel	2500
AXOP32121A	SOT23-5	Reel	3000
AXOP32121C	SOT353	Reel	3000



Contents

List of Figures

List of Tables

1 Block Diagram and Application Circuit

Figure 1 Block Diagram

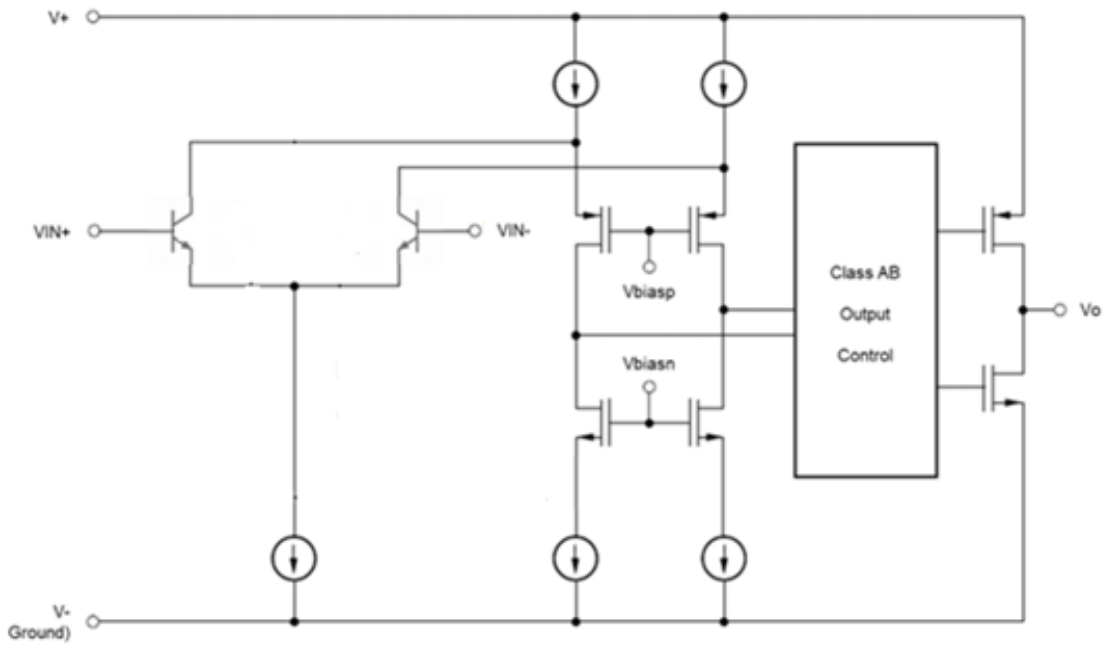
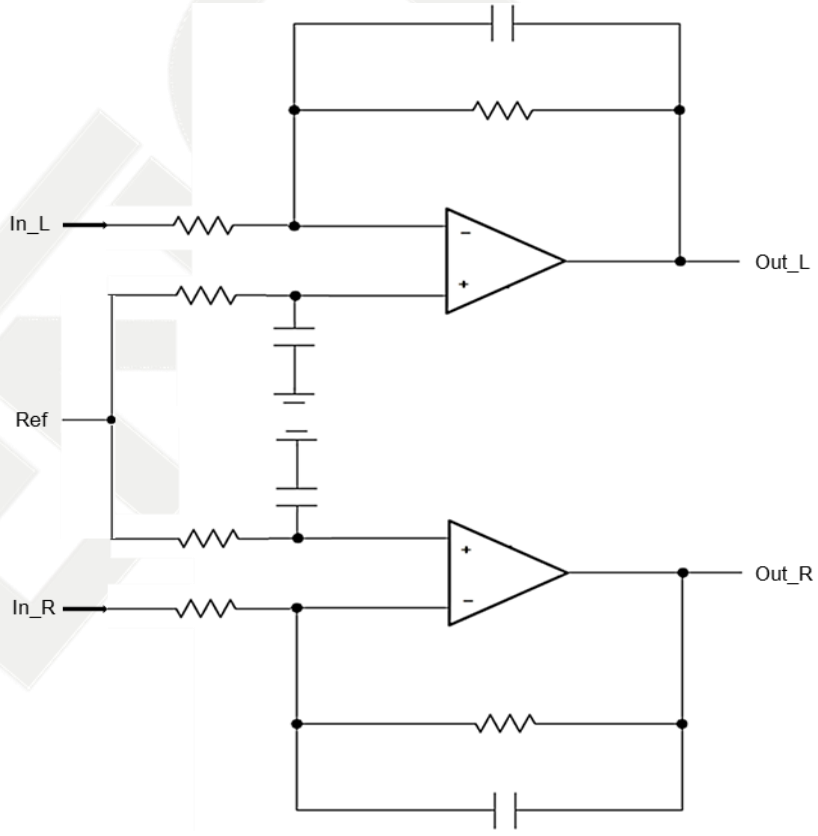


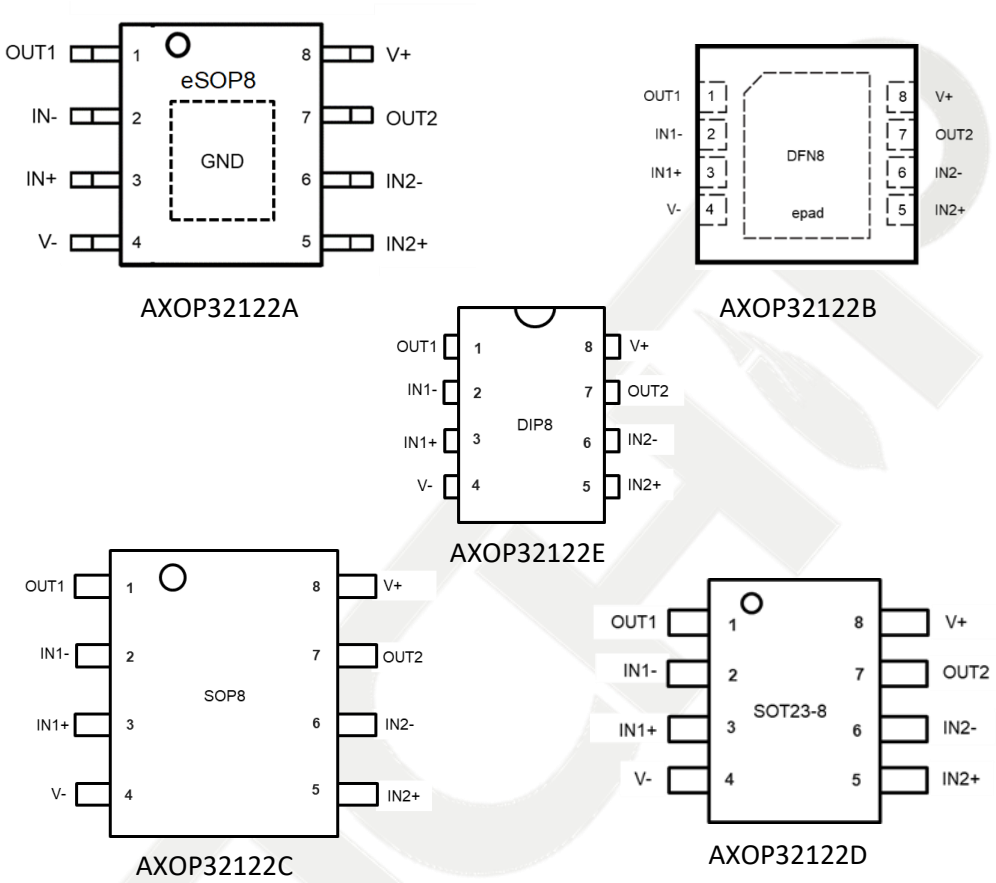
Figure 2 Typical Application Circuit (Stereo Sound Input Amplifier)



2 Pin Description

2.1 AXOP32122A/B/C/D/E Pinouts

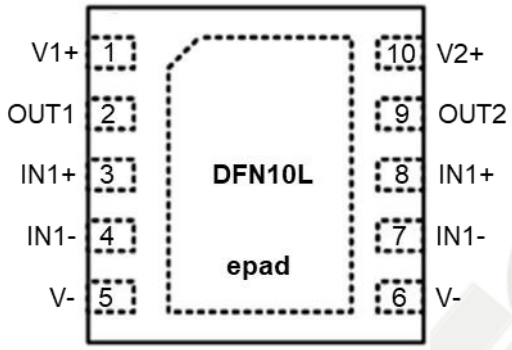
Figure 3 AXOP32122A/B/C/D/E Pinouts



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 AXOP32122F Pinout

Figure 4 AXOP32122F Pinout

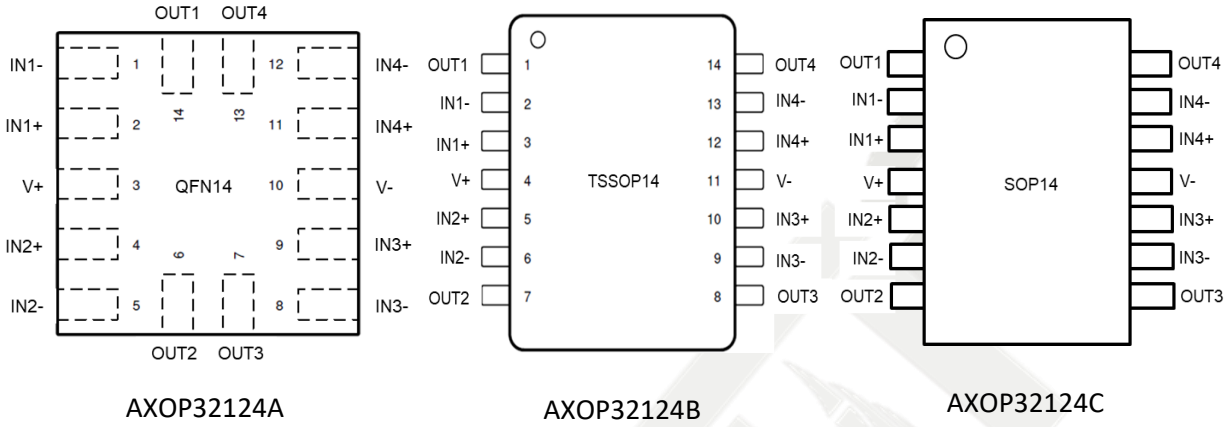


AXOP32122F

Pin number	Pin name	Description
1	V1+	Positive supply channel 1
2	OUT1	Output channel 1
3	IN1+	Non-inverting input channel 1
4	IN1-	Inverting input channel 1
5	V1-	Negative supply or ground channel 1
6	V2-	Negative supply or ground channel 2
7	IN2-	Inverting input channel 2
8	IN2+	Non-inverting input channel 2
9	OUT2	Output channel 2
10	V2+	Positive supply channel 2

2.3 AXOP32124A/B/C Pinouts

Figure 5 AXOP32124A/B/C Pinouts

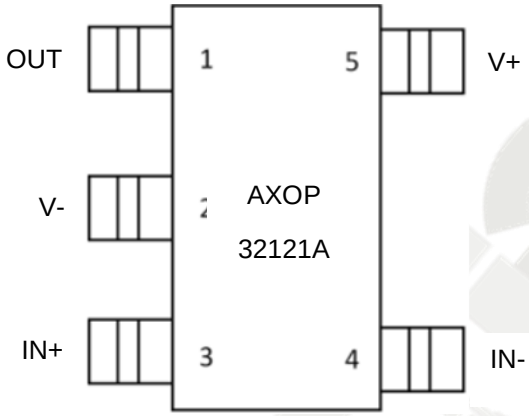


AXOP32124A AXOP32124B AXOP32124C

	AXOP32124A			AXOP32124B/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 AXOP32121A Pinout

Figure 6 AXOP32121A Pinouts

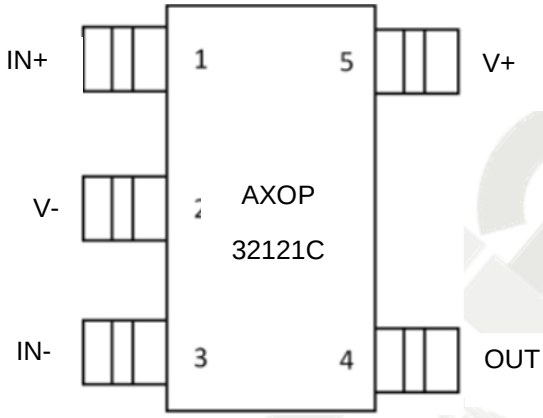


AXOP32121A

Pin number	Pin name	Description
1	OUT	Output
2	V-	Negative supply or ground
3	IN+	Non-inverting input
4	IN-	Inverting input
5	V+	Positive supply

2.5 AXOP32121C Pinout

Figure 7 AXOP32121C Pinouts



AXOP32121C

Pin number	Pin name	Description
1	IN+	Non-inverting input
2	V-	Negative supply or ground
3	IN-	Inverting input
4	OUT	Output
5	V+	Positive supply

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 +26	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
SOT23-8	184	100	°C/W
DIP8	85	41	°C/W
DFN10L	45	10	°C/W
QFN14	47	4	°C/W
TSSOP14	113	62	°C/W
SOP14	106	64	°C/W
SOT23-5	184	100	°C/W
SOT353	184	100	°C/W

3.3 ESD

Table 4 ESD0

Symbol	Parameter	Value	Unit
All pins	ESD (HBM)	±6,000	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-)		3		24	V
Ta	Operating ambient temperature		-40		85	°C
Power Supply						
Iq	Quiescent current per amplifier	Vs=14V, Io=0mA		1.2	1.6	mA
		Vs=24V, Io=0mA		1.6	2.2	
		Vs=5.0V, Io=0mA		1.0		
		Vs=3.3V, Io=0mA		0.5		
		all temp			3.0	
Offset Voltage						
Vos	Input offset voltage			±0.1	±0.5	mV
		all temp			±1	mV
dVos/dT	Drift	all temp		±0.2		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	Vs=3V to 24V	1		Vs	V
CMRR	Common mode rejection ratio	At DC		100		dB
Input Bias Current						
Ib	Input bias current			0.4		μA
Ios	Input offset current			±0.01		μA
Noise						
En	Input voltage noise	f=20Hz to 20kHz G=+1		0.45		μV
Open Loop Gain						
Aol	Open loop voltage gain			130		dB
Frequency Response						
GBP	Gain bandwidth product	G=+1, CL=10pF		30		MHz
SR	Slew rate	G=+1, CL=10pF		12		V/μs

Ts	Settling time	To 0.1%, 2V step, G=+1, CL=10pF		0.25		μs
THD	Total harmonic distortion (3rd order filter; BW= 80kHz at -3dB.)	Vs=24V, Vcm=12V, Vo=1Vp, G=+1, f=1kHz, no load		114		dB
		Vs=3V, Vcm=1.5V, Vo=0.5Vp, G=+1, f=1kHz, no load				
SNR	Signal to Noise Ratio	Vs=24V, Vin=1Vrms, G=+1, f=1kHz		120		dB
Output						
Vo	Voltage output swing from supply rails	RL=10kΩ		25	40	mV
		RL=2kΩ		110	150	
Vs,sc	Max Vs for output short circuit protection	G=+1			14	V
		G=non-unity			24	
Isc	Short circuit current			±20		mA
		AXOP32122A only eSOP8 package		±100		mA

3.5 Typical Electrical Characteristics

Figure 8 Vos Distribution

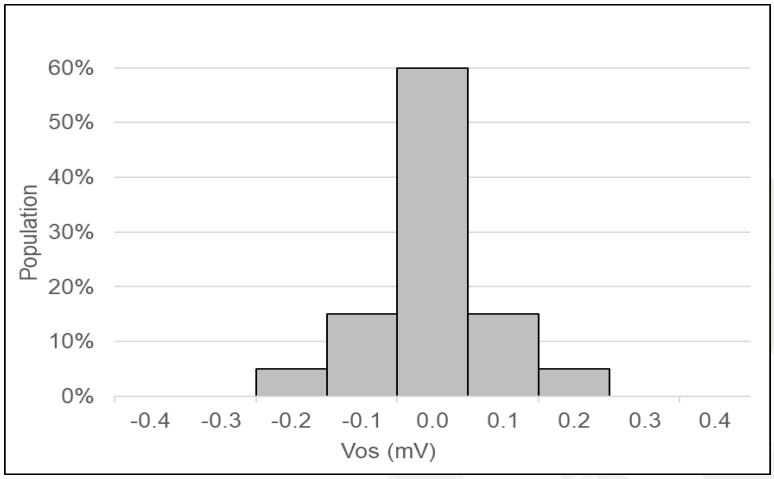


Figure 9 Vos vs Input Common Mode Voltage

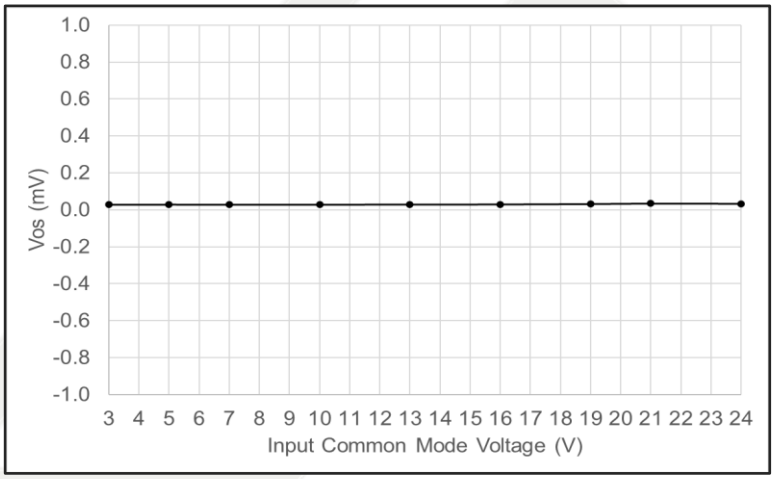


Figure 10 Vos vs Vs

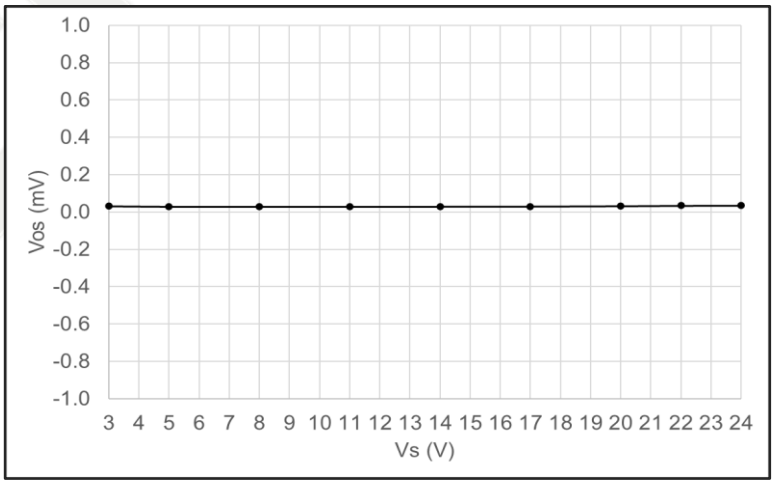


Figure 11 Iq (per opamp) vs Input Common Mode Voltage

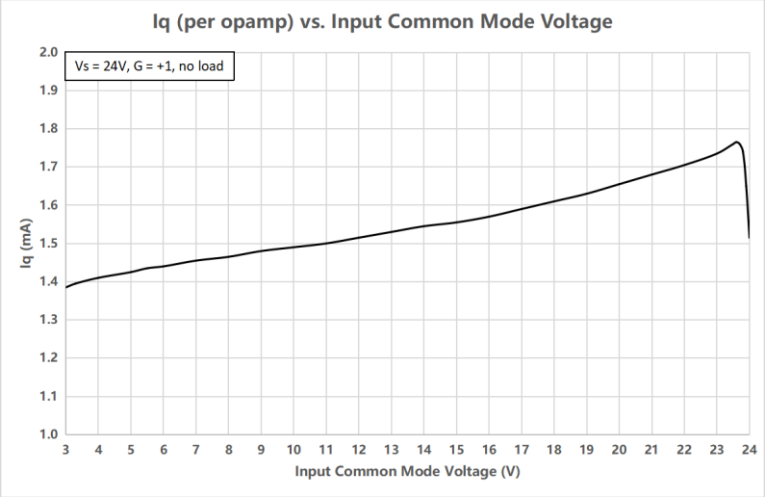


Figure 12 Iq (per opamp) vs Vs

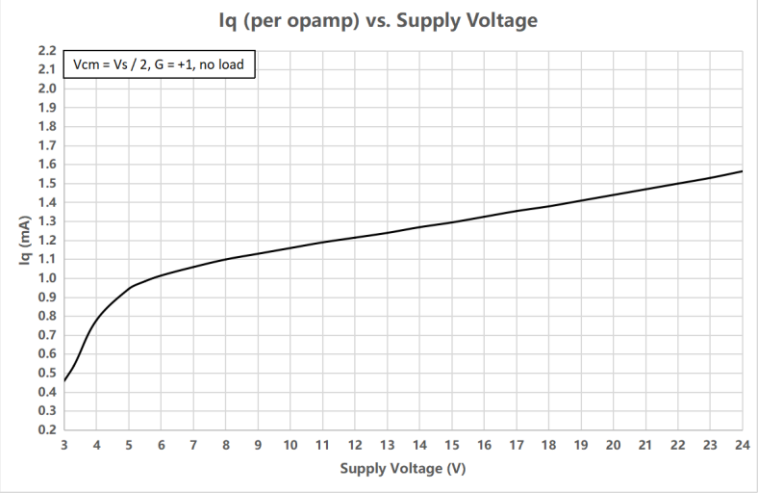


Figure 13 THD vs Output Voltage

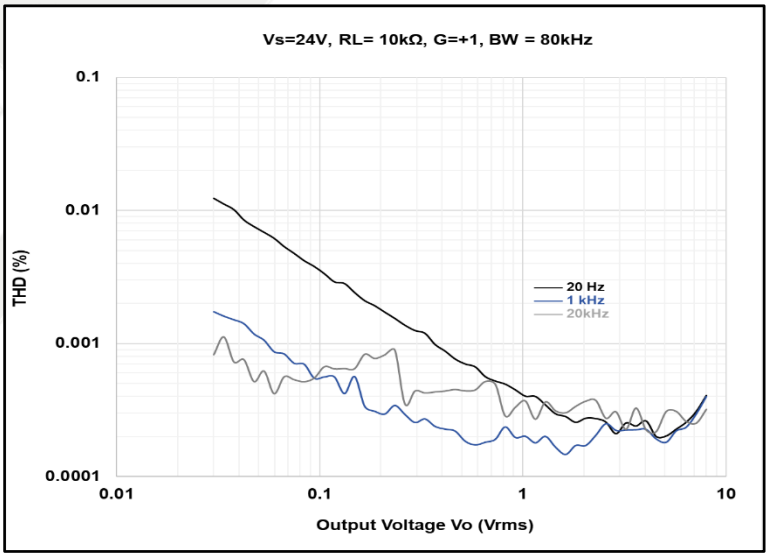


Figure 14 Voltage Noise Spectral Density

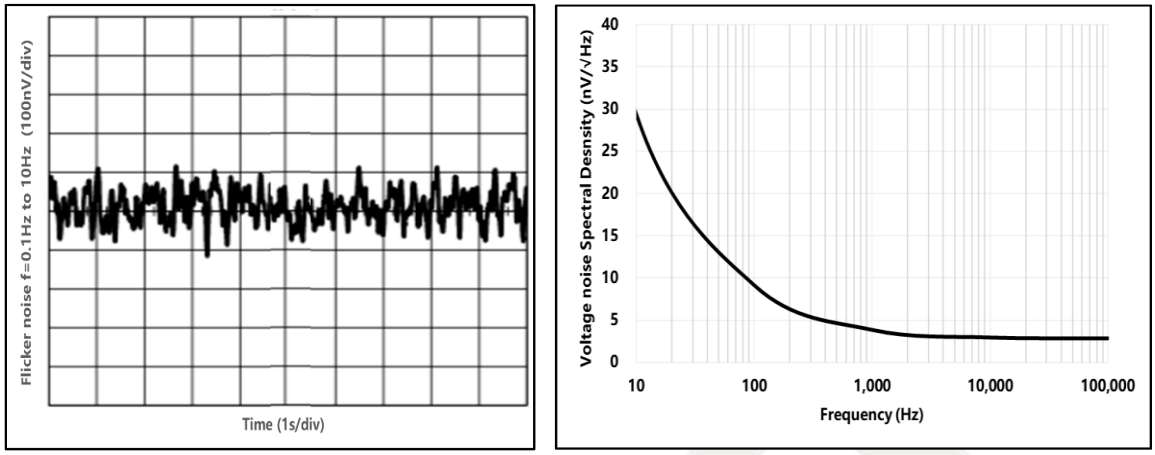
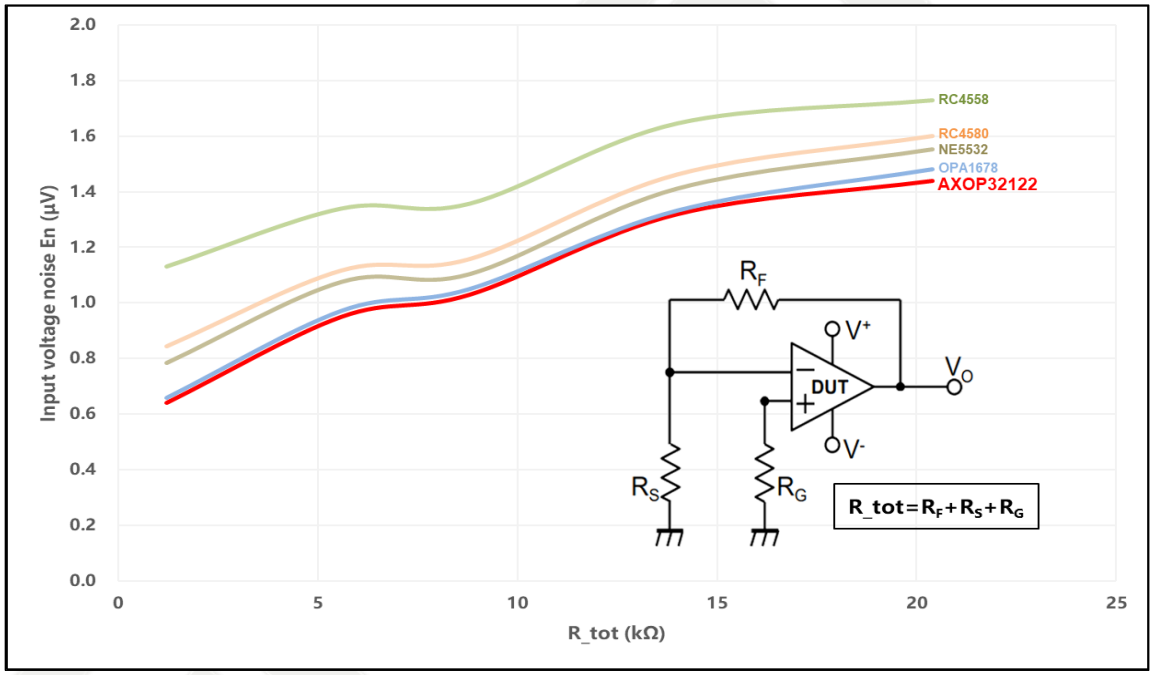


Figure 15 Input Voltage Noise Comparison



4 Functional Description

4.1 Overview

The AXOP3212x devices are a family of mid voltage, rail-to-rail output opamps. These devices operate from 3V to 24V, 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 Output

The input common mode voltage range of the AXOP3212x family extends from 1V to Vs for the full supply voltage range of 3V to 24V. This performance is achieved with a NPN input differential pair, as shown in Figure 1.

Designed as a high voltage operational amplifier, the AXOP3212x 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 25mV (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 AXOP3212x family is approximately 20ns.

4.4 EMI Rejection

The AXOP3212x 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.

5 Package Information

5.1 Package Dimensions

Figure 16 eSOP8 Mechanical Data and Package Dimensions

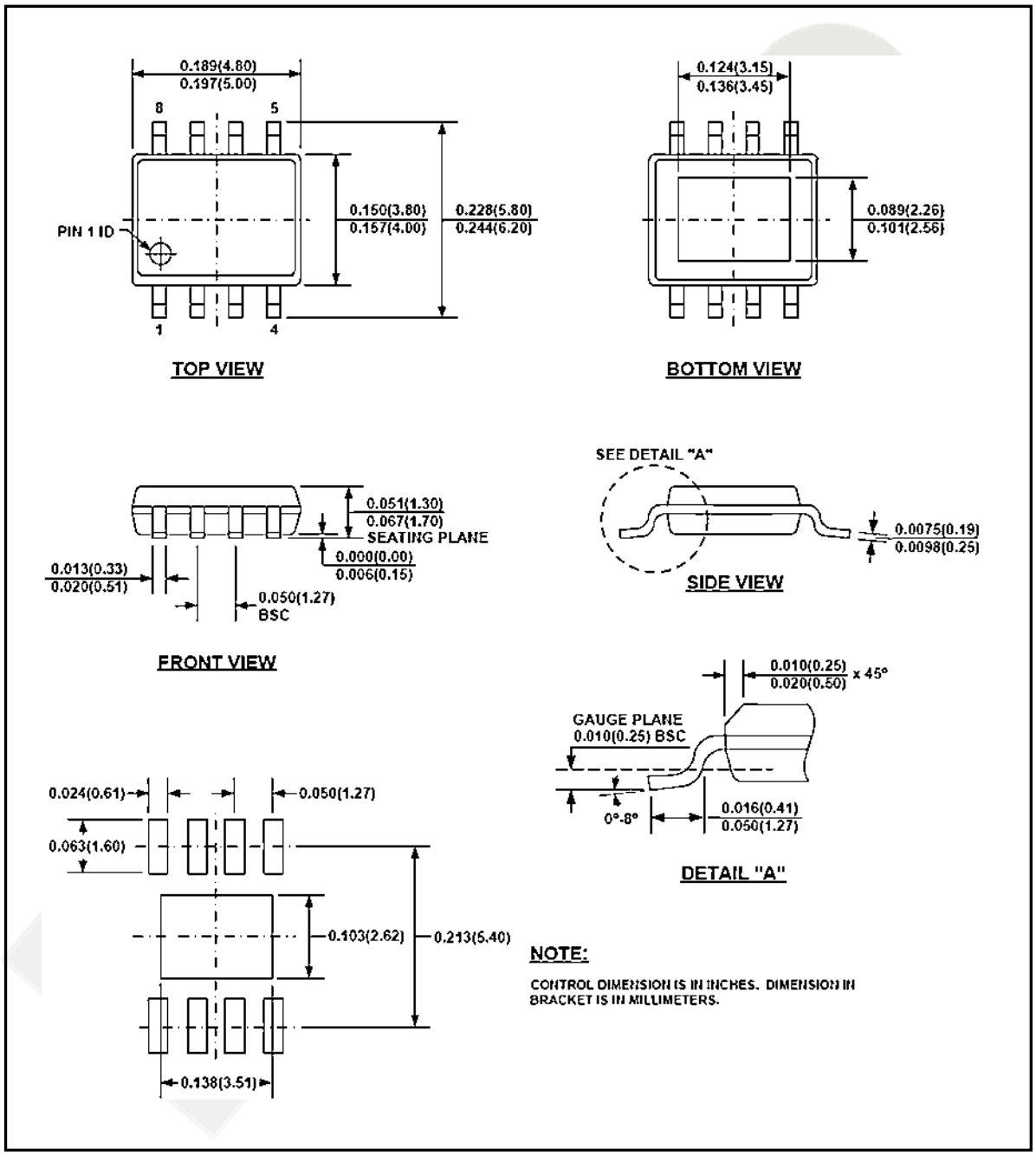


Figure 17 DFN8 Mechanical Data and Package Dimensions

	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				

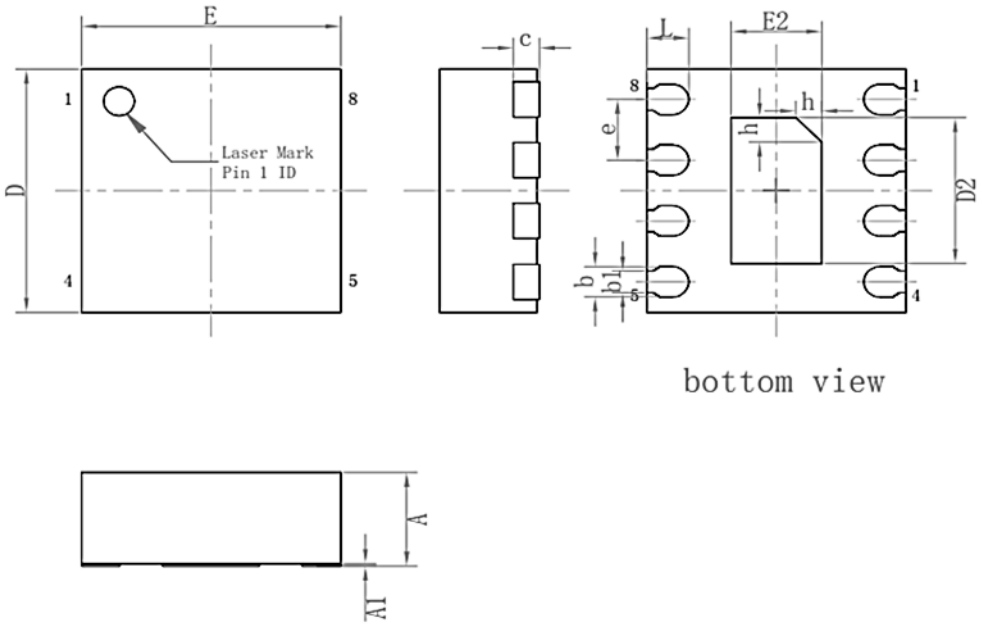
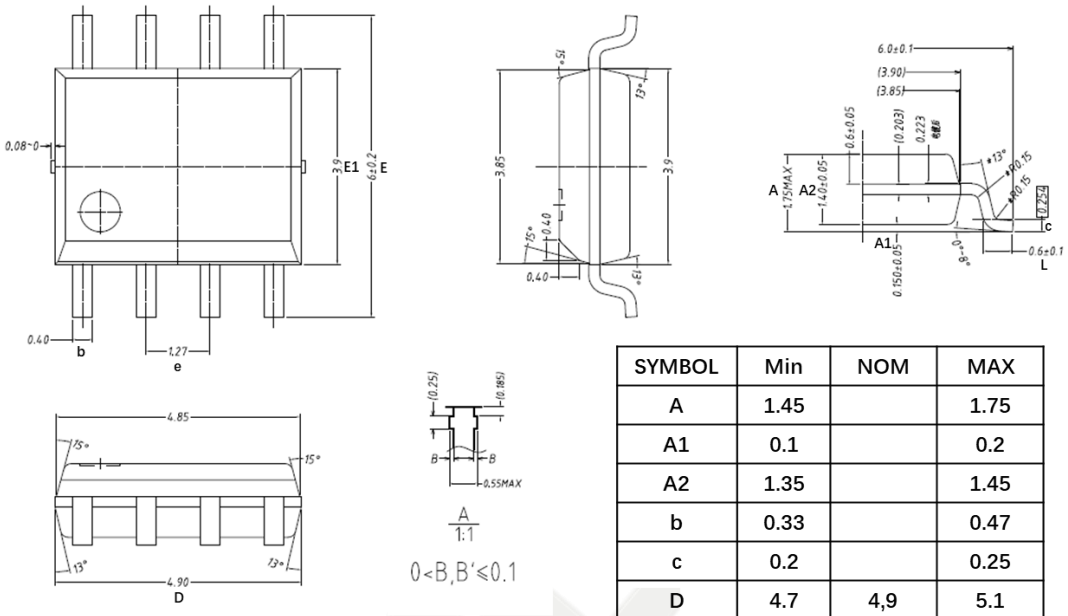
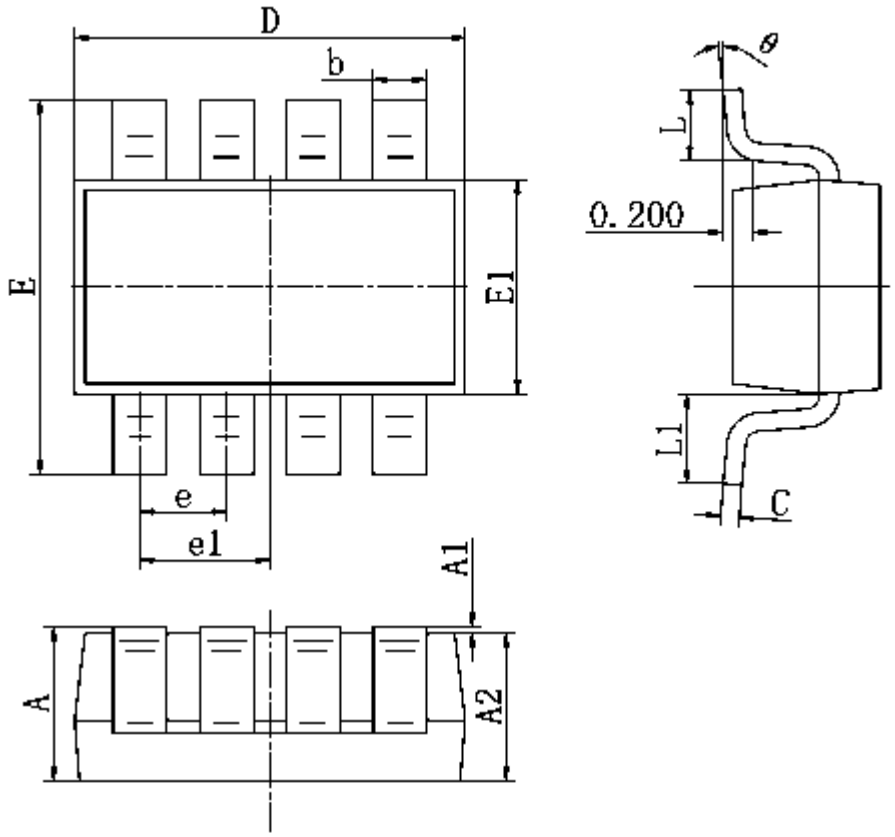


Figure 18 SOP8 Mechanical Data and Package Dimensions



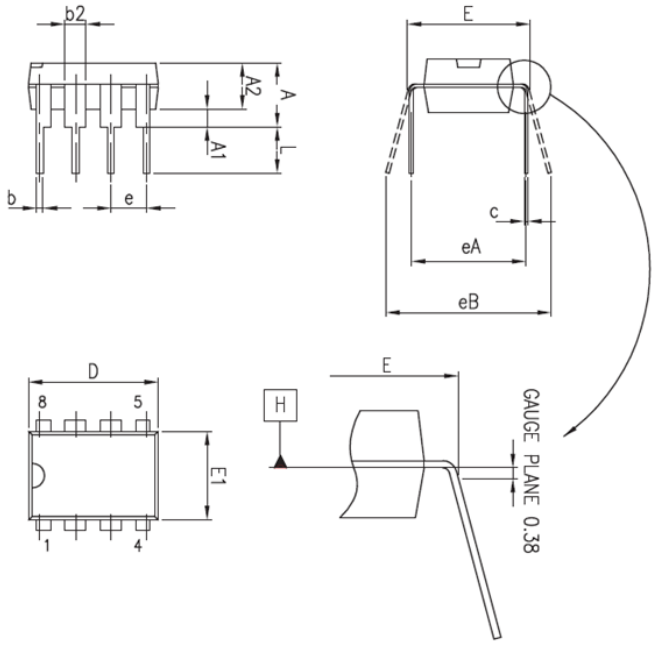
SYMBOL	Min	NOM	MAX
A	1.45		1.75
A1	0.1		0.2
A2	1.35		1.45
b	0.33		0.47
c	0.2		0.25
D	4.7	4,9	5.1
E	5.8		6.2
E1	3.8		4
e	1.27(BSC)		
L	0.5		0.7
ɵ	0”		8”

Figure 19 SOT23-8 Mechanical Data and Package Dimensions



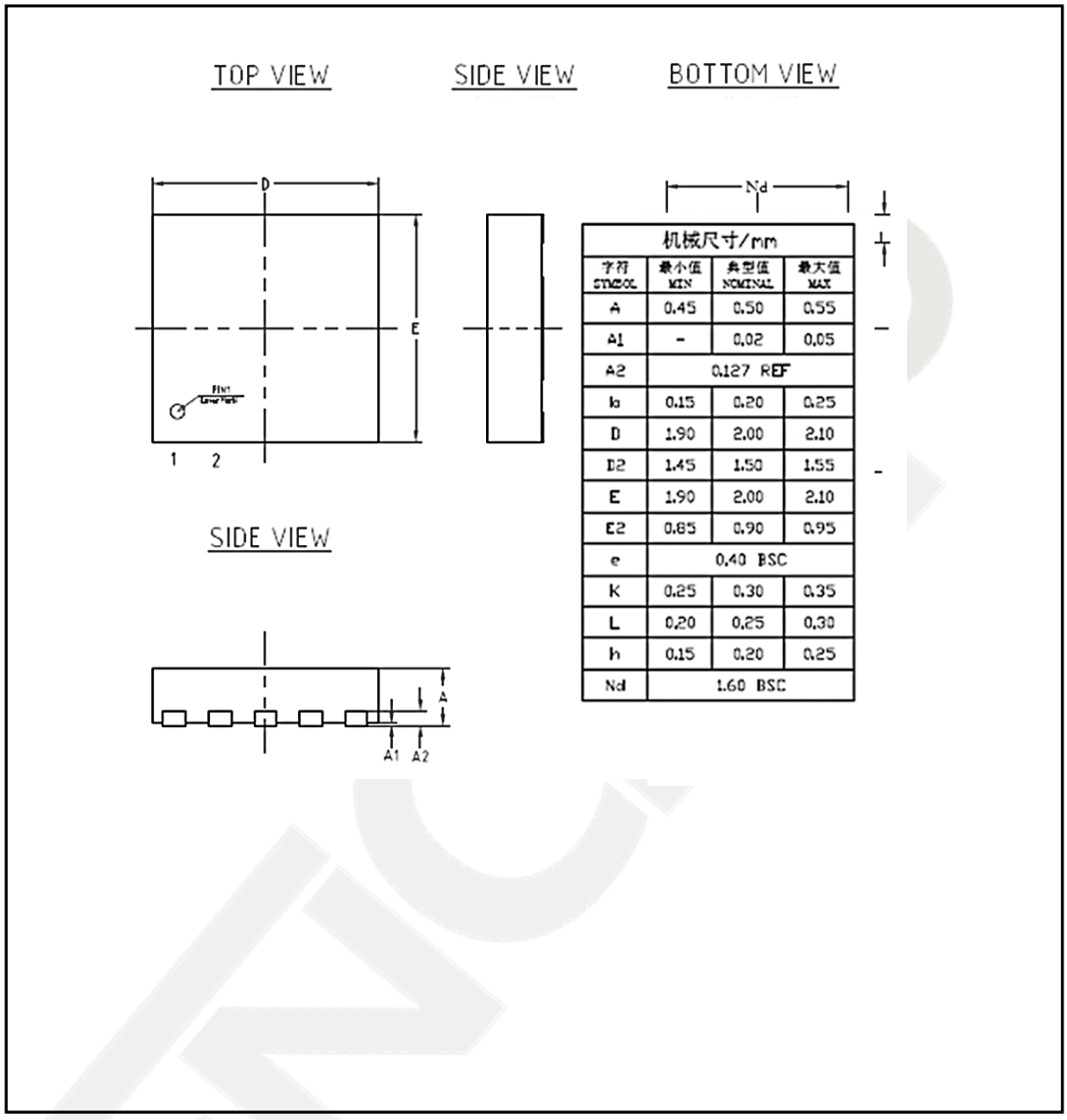
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E1	1.500	1.700	0.059	0.067
E	2.650	2.950	0.104	0.116
e	0.650BSC.		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 20 DIP8 Mechanical Data and Package Dimensions



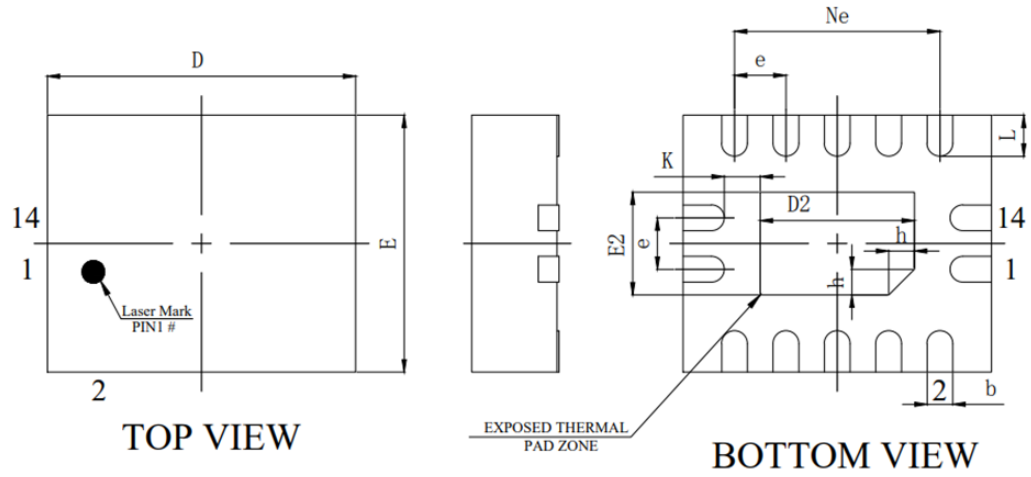
Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			5.33			0.210
A1	0.38			0.015		
A2	2.92	3.30	4.95	0.115	0.130	0.195
b	0.36	0.46	0.56	0.014	0.018	0.022
b2	1.14	1.52	1.78	0.045	0.060	0.070
c	0.20	0.25	0.36	0.008	0.010	0.014
D	9.02	9.27	10.16	0.355	0.365	0.400
E	7.62	7.87	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 21 DFN10L Mechanical Data and Package Dimensions



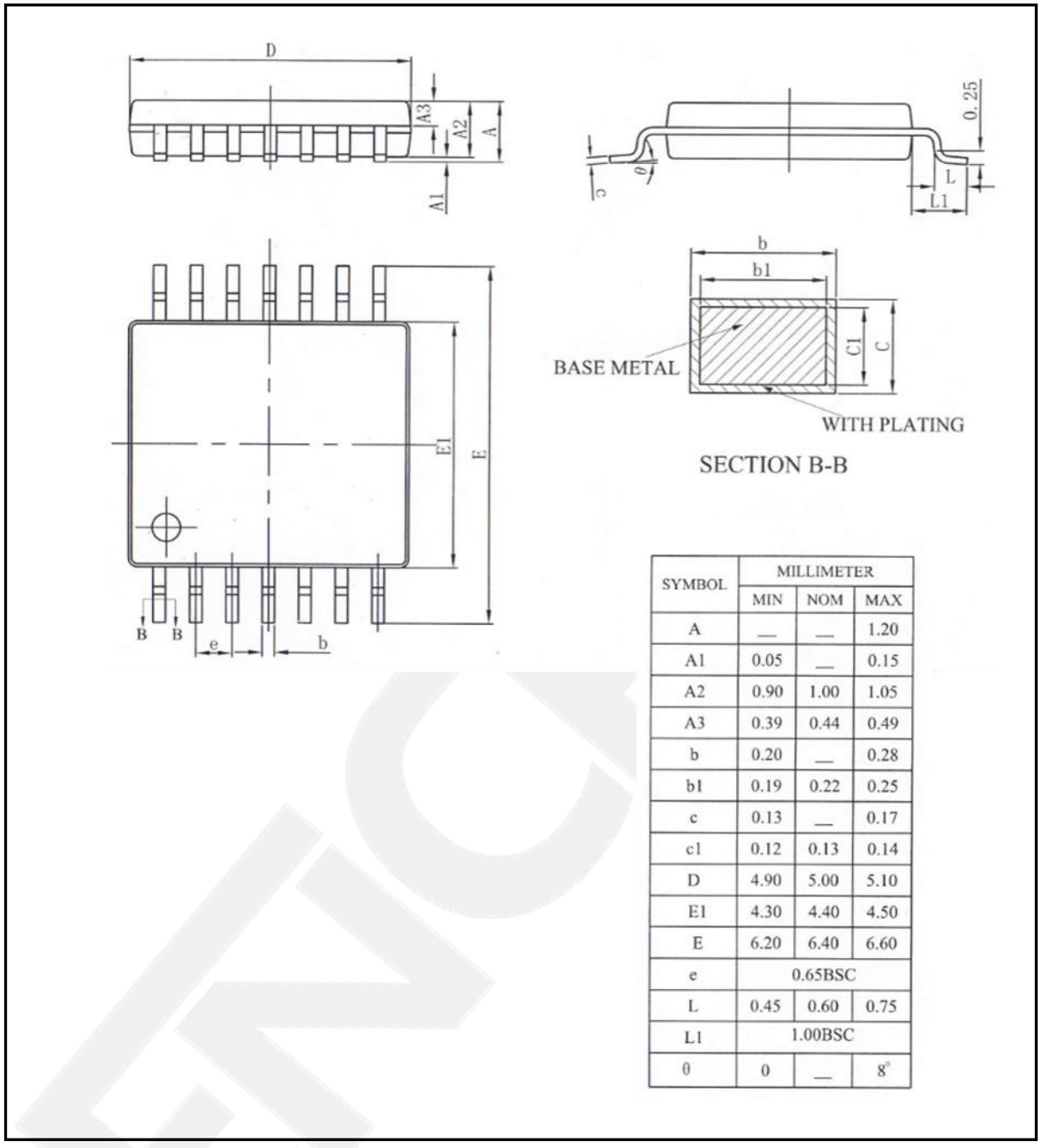
机械尺寸/mm			
字符 SYMBOL	最小值 MIN	典型值 NOMINAL	最大值 MAX
A	0.45	0.50	0.55
A1	-	0.02	0.05
A2	0.127 REF		
b	0.15	0.20	0.25
D	1.90	2.00	2.10
D2	1.45	1.50	1.55
E	1.90	2.00	2.10
E2	0.85	0.90	0.95
e	0.40 BSC		
K	0.25	0.30	0.35
L	0.20	0.25	0.30
h	0.15	0.20	0.25
Nd	1.60 BSC		

Figure 22 QFN14 Mechanical Data and Package Dimensions



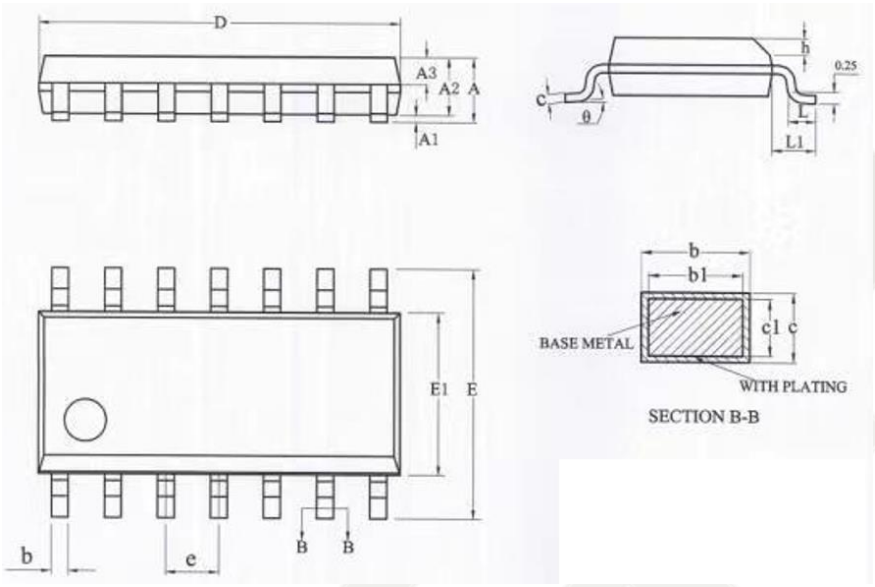
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.80	0.85	0.90
A1	0	0.02	0.05
b	0.20	0.25	0.30
c	0.20REF		
D	2.90	3.00	3.10
D2	1.40	1.50	1.60
e	0.50BSC		
Ne	2.00BSC		
E	2.40	2.50	2.60
E2	0.90	1.00	1.10
L	0.35	0.40	0.45
h	0.25REF		
K	0.20	–	–

Figure 23 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 24 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 25 SOT23-5 Mechanical Data and Package Dimensions

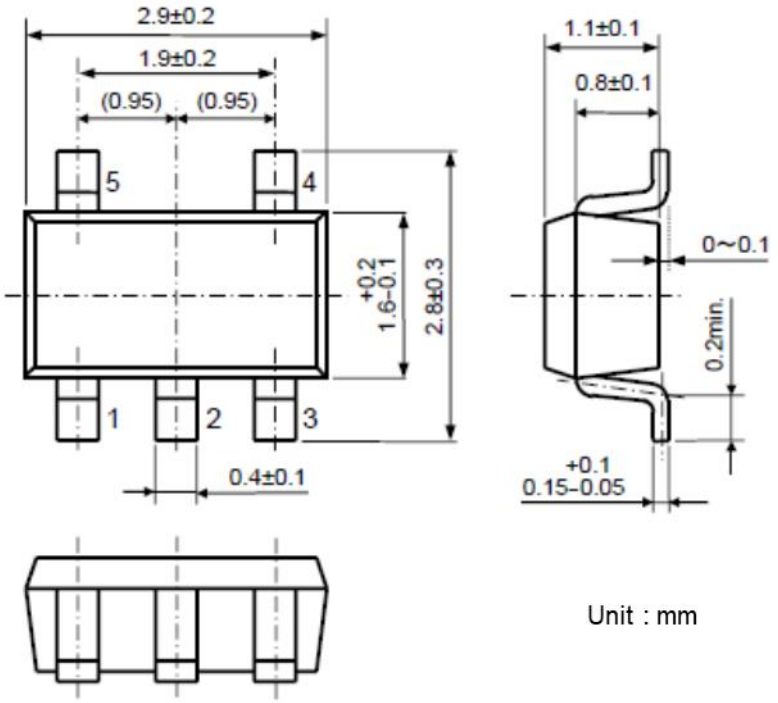
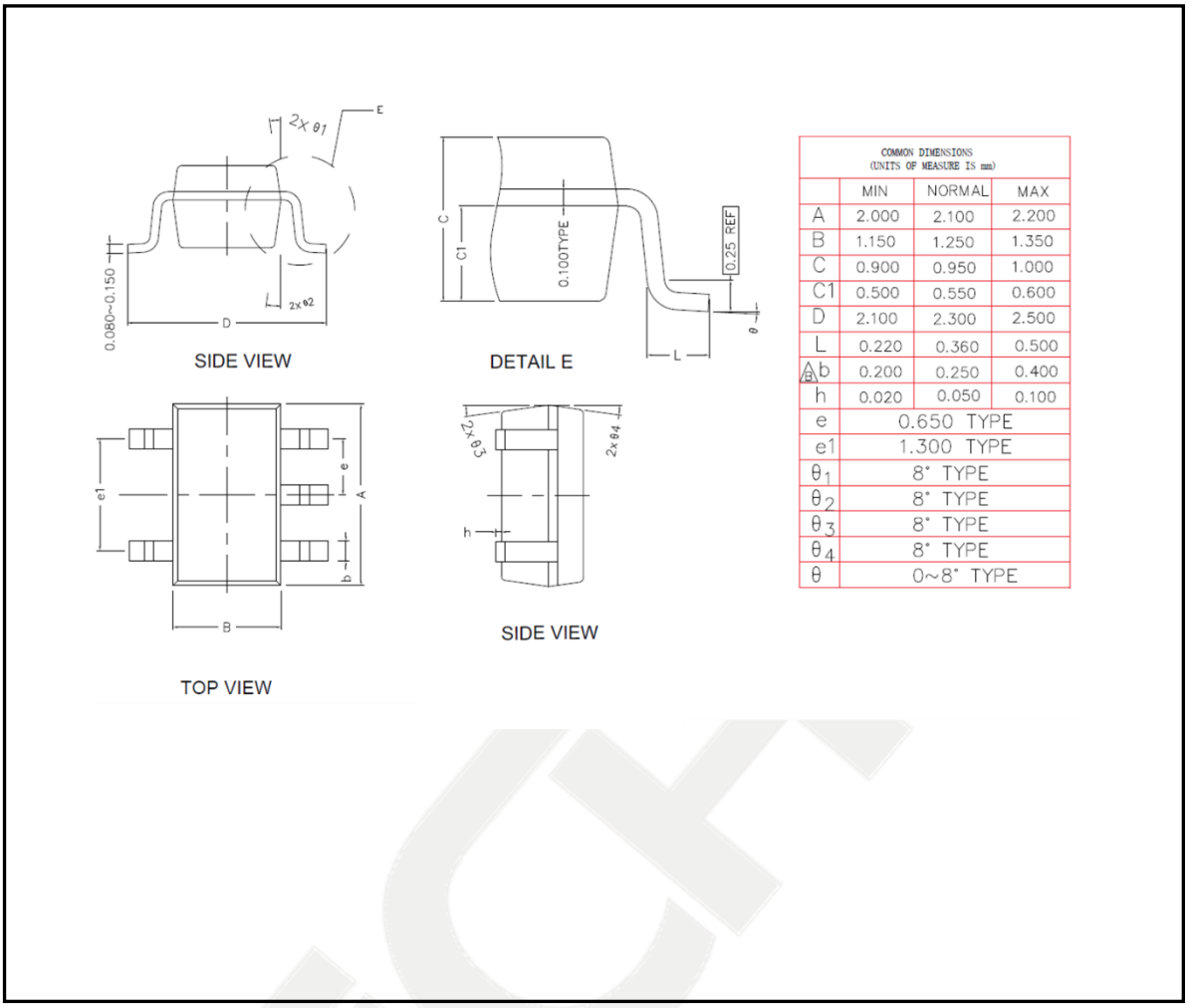


Figure 26 SOT353 Mechanical Data and Package Dimensions



COMMON DIMENSIONS (UNITS OF MEASURE IS mm)			
	MIN	NORMAL	MAX
A	2.000	2.100	2.200
B	1.150	1.250	1.350
C	0.900	0.950	1.000
C1	0.500	0.550	0.600
D	2.100	2.300	2.500
L	0.220	0.360	0.500
b	0.200	0.250	0.400
h	0.020	0.050	0.100
e	0.650 TYPE		
e1	1.300 TYPE		
θ_1	8° TYPE		
θ_2	8° TYPE		
θ_3	8° TYPE		
θ_4	8° TYPE		
θ	0~8° TYPE		

5.2 Marking Information

Figure 27 eSOP8 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

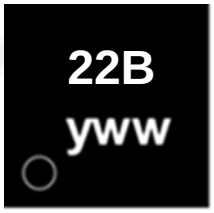
Line 1: “32122A” characters to indicate AXOP32122A

Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“ZZ” Reserved ID markings

Figure 28 DFN8 Marking Information



Laser mark circle to indicate pin 1

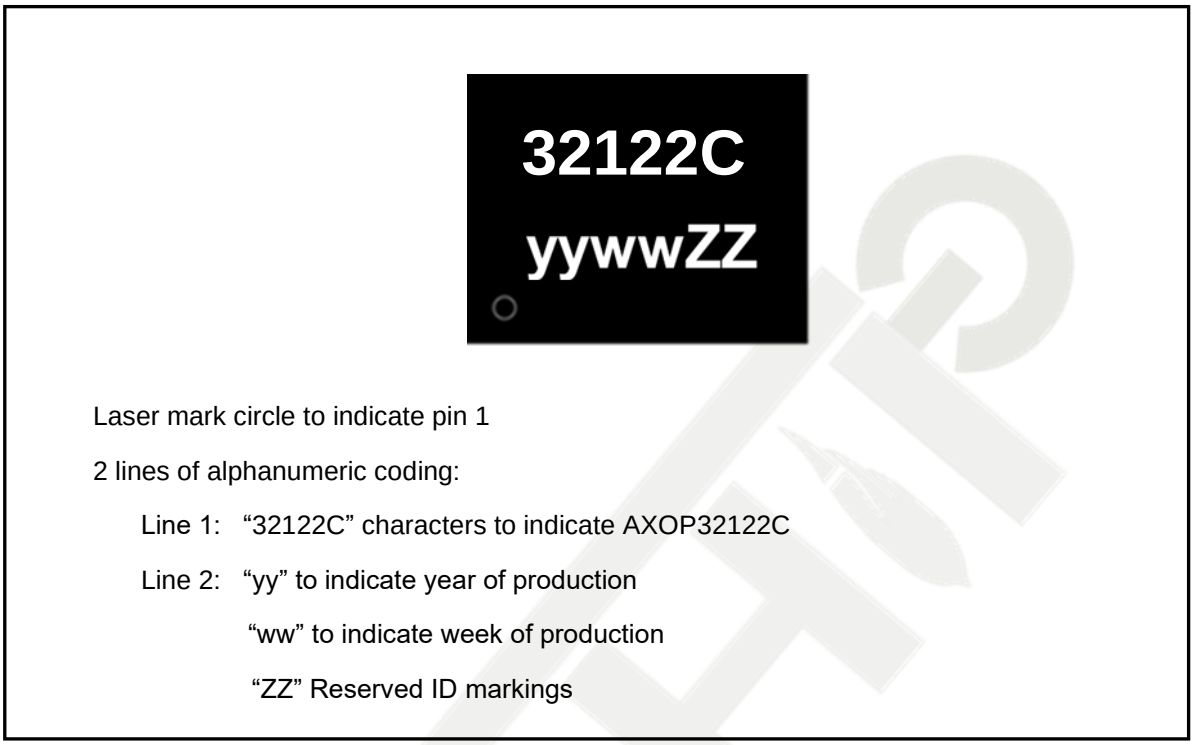
2 lines of alphanumeric coding:

Line 1: “42B” characters to indicate AXOP32122B

Line 2: “y” to indicate year of production

“ww” to indicate week of production

Figure 29 SOP8 Marking Information



Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

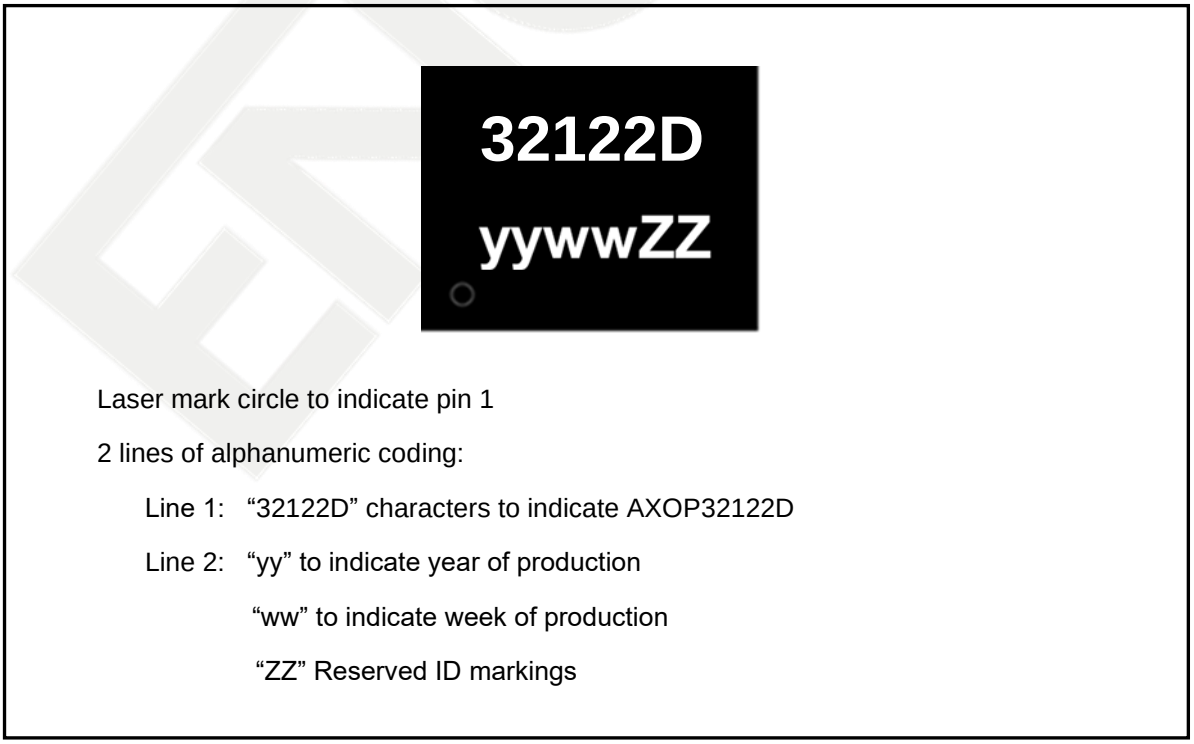
Line 1: “32122C” characters to indicate AXOP32122C

Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“ZZ” Reserved ID markings

Figure 30 SOT23-8 Marking Information



Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: “32122D” characters to indicate AXOP32122D

Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“ZZ” Reserved ID markings

Figure 31 DIP8 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: “32122E” characters to indicate AXOP32122E

Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“ZZ” Reserved ID markings

Figure 32 DFN10L Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: “32122F” characters to indicate AXOP32122F

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:

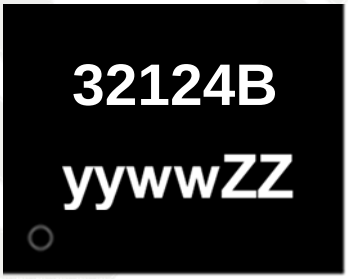
Line 1: “32124A” characters to indicate AXOP32124A

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: “32124B” characters to indicate AXOP32124B

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: “32124C” characters to indicate AXOP32124C

Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“ZZ” Reserved ID markings

Figure 36 SOT23-5 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: “32121A” characters to indicate AXOP32121A

Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“zz” reserved markings

Figure 37 SOT353 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: “32121C” characters to indicate AXOP32121C

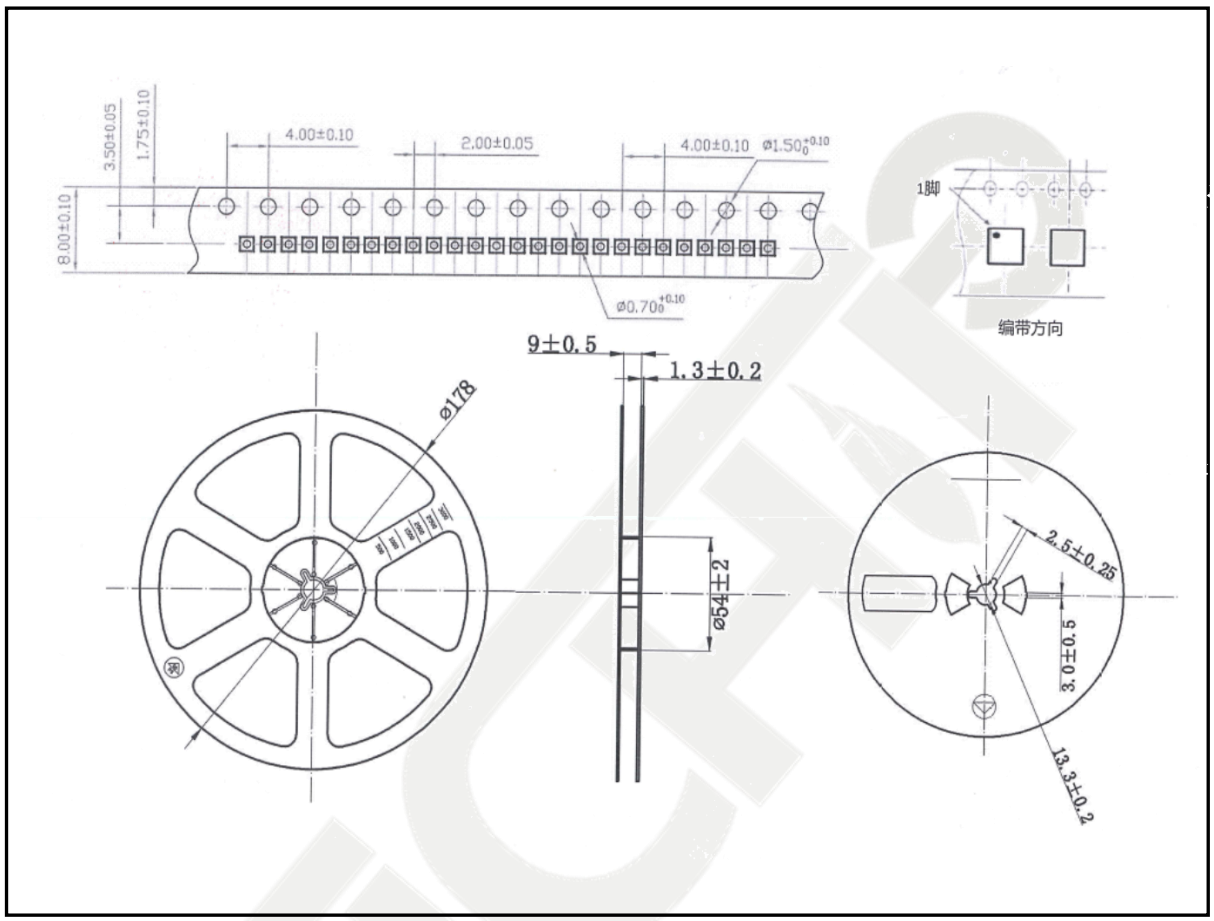
Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“zz” reserved markings

6 Packing Information

Figure 38 Reel Packing Information



7 Revision History

Table 6 Document Revision History

Date	Version	Description
Jun 2024	1.00	V1.00 version.
Jul 2024	1.01	Updated Figure 11
Aug 2024	1.02	Replaced Figure 12: Large Signal Step Response by Figure 12: Voltage Noise Spectral Density
Sep 2024	1.03	Added THD test at Vs=3V
Oct 2024	1.04	Added in SOT353 and DFN10L
Dec 2024	1.05	Added Iq for Vs=5.0V and 3.3V