AXOP33552/3

400MHz RRIO Operational Amplifiers (Dual/Triple)

Datasheet – Aug **2023**

Description

The AXOP33552 (dual), and AXOP33553 (triple) are dual and triple low voltage (2V to 5.5V), high speed 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 speed are required. AXOP33552S and AXOP33553S are with Shutdown function.

Features

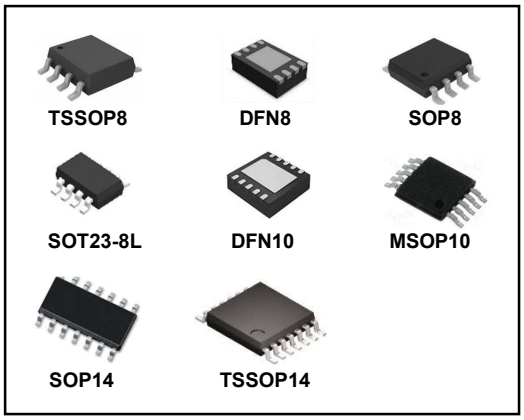
- Unity-gain bandwidth: 400MHz
- Differential Gain: 0.02%
- Differential Phase: 0.05°
- 0.1-dB Gain Flatness: 120MHz
- Rail-to-rail input and output
- Low input offset voltage: ±1mV typ
- Low noise: 5nV/√Hz @1MHz
- Quiescent current (per opamp): 10mA typ
- Easier to stabilize with higher capacitive load due to resistive open-loop output impedance
- Shutdown function (AXOP33552S and AXOP33553S)

Applications

- Video processing
- Ultrasound
- Optical networking, tunable lasers
- Photodiode transimpedance amplifiers
- ADC input buffers
- DAC output buffers
- Barcode scanners

Table 1 Device Summary

Order code	Package	Packing
AXOP33552A	TSSOP8	Reel
AXOP33552B	DFN8	Reel
AXOP33552C	SOP8	Reel
AXOP33552D	SOT23-8L	Reel
AXOP33552SA	DFN10	Reel
AXOP33552SB	MSOP10	Reel
AXOP33553SA	SOP14	Reel
AXOP33553SB	TSSOP14	Reel



Contents

List of Figures

List of Tables

1 Block Diagram and Application Circuit

Figure 1 Block Diagram

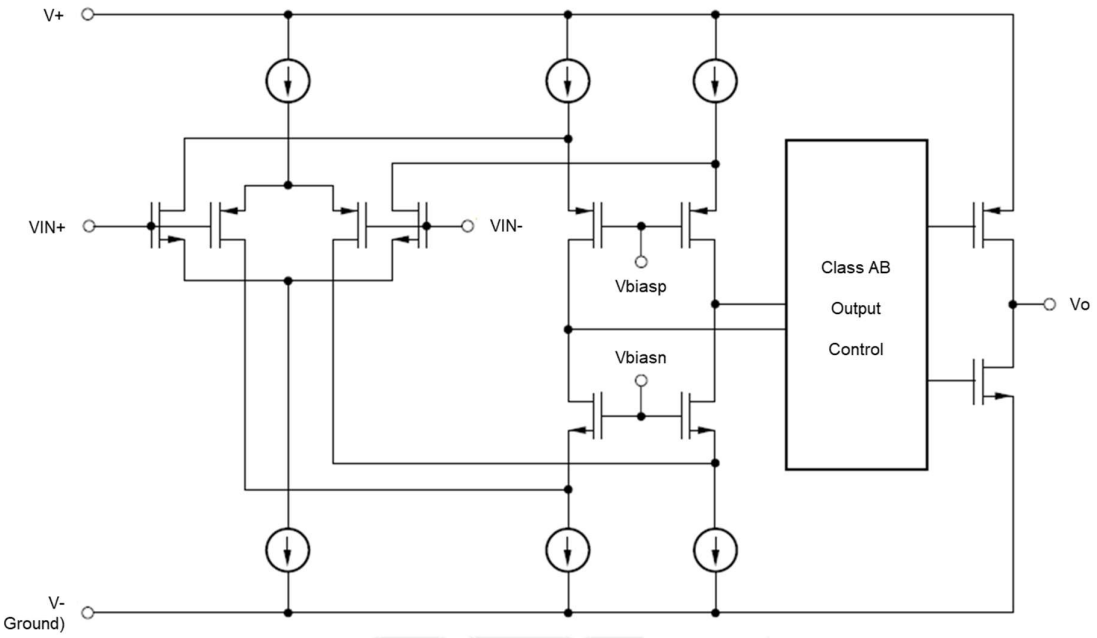


Figure 2 Typical Application Circuit (Transimpedance Amplifier)

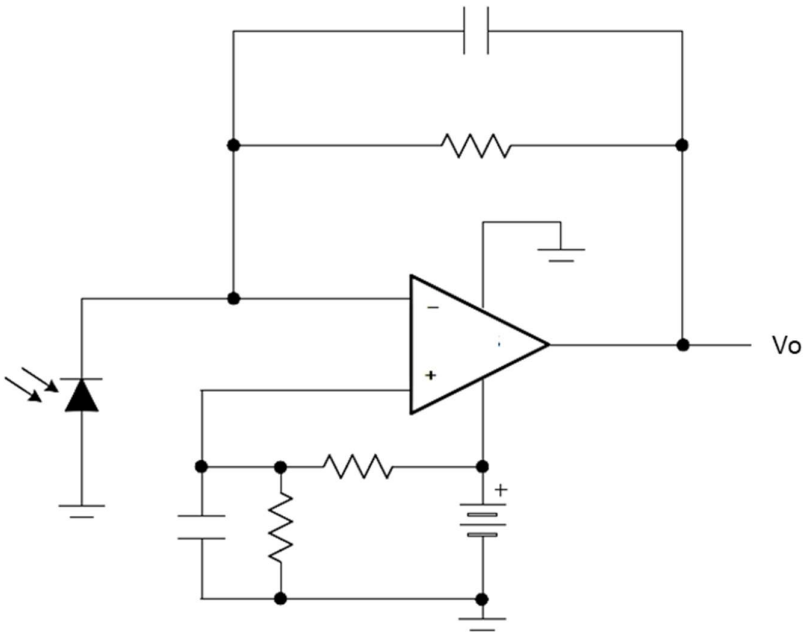


Figure 3 Typical Application Circuit (RGB Cable Driver)

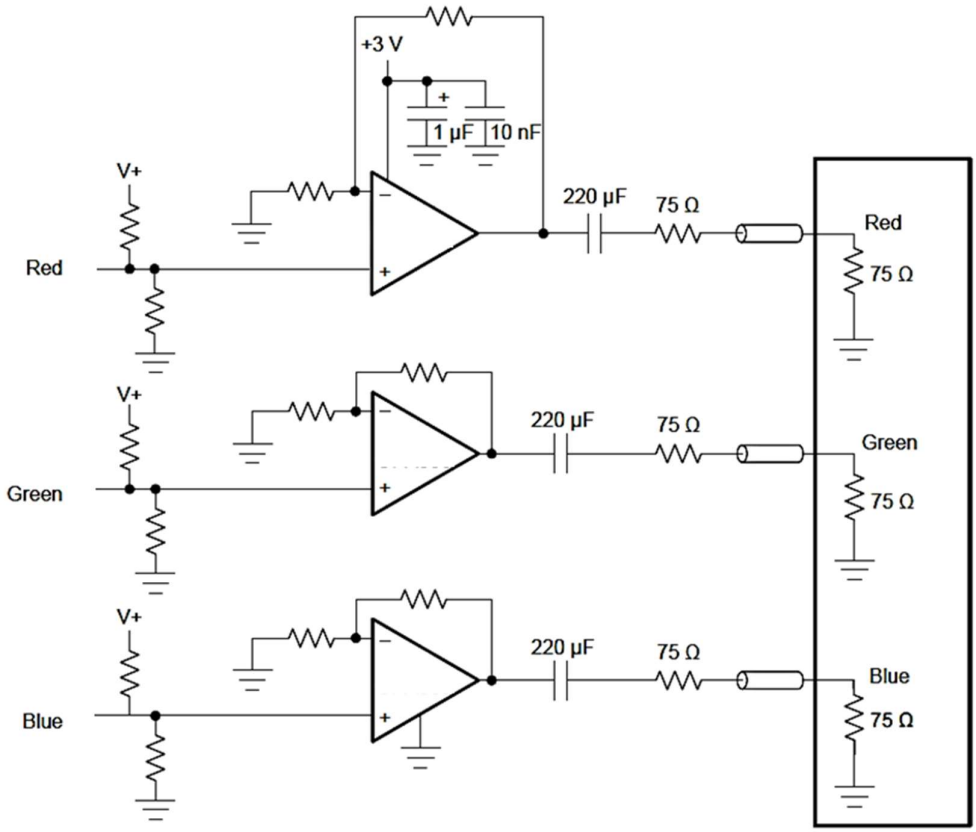
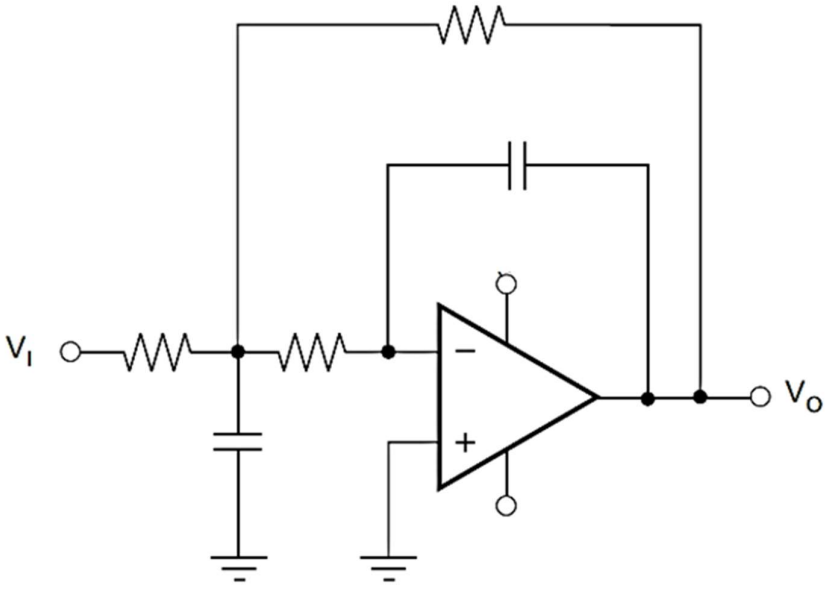


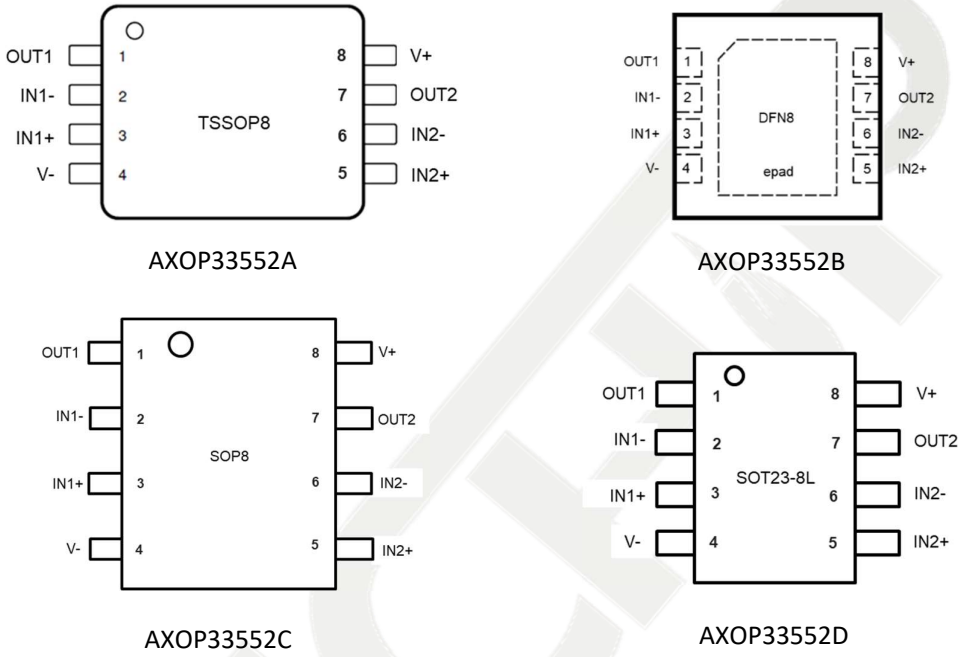
Figure 4 Typical Application Circuit (Active Filter)



2 Pin Description

2.1 AXOP33552A/B/C/D Pinouts

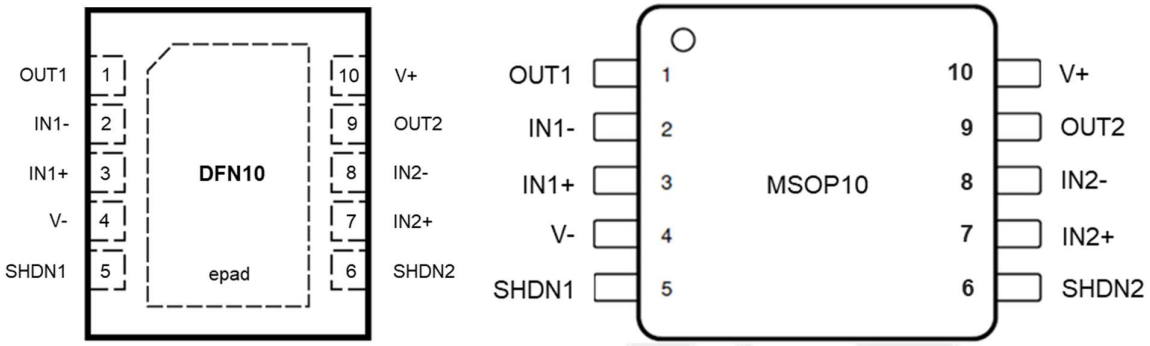
Figure 5 AXOP33552A/B/C/D Pinouts



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 AXOP33552SA/B Pinouts

Figure 6 AXOP33552SA/B Pinouts

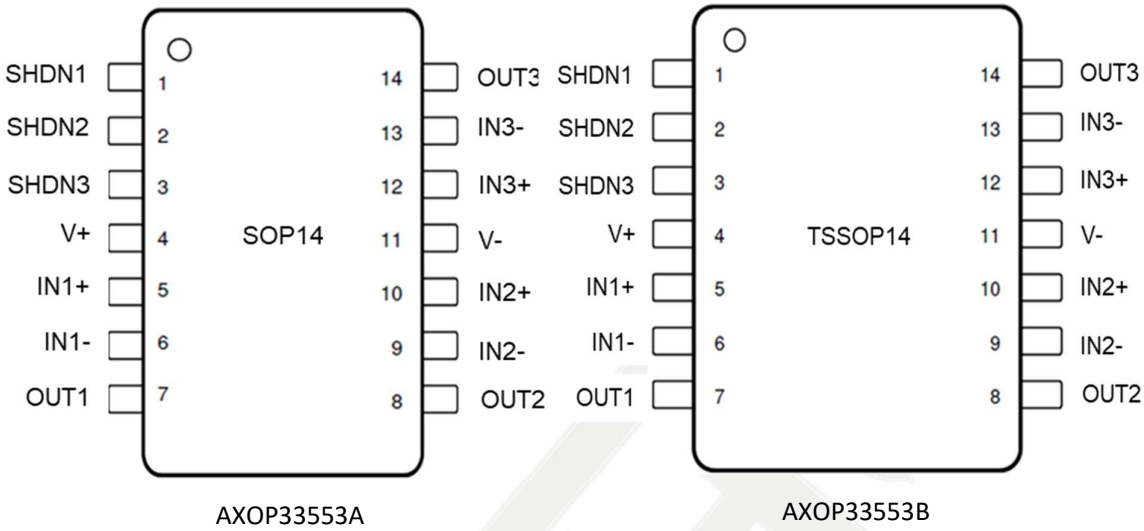


AXOP33552SA AXOP33552SB

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 AXOP33553SA/B Pinouts

Figure 7 AXOP33553SA/B Pinouts



Pin number	Pin name	Description
1	SHDN1	Shutdown1: “low” = opamp 1 disabled
2	SHDN2	Shutdown2: “low” = opamp 2 disabled
3	SHDN3	Shutdown3: “low” = opamp 3 disabled
4	V+	Positive supply
5	IN1+	Non-inverting input 1
6	IN1-	Inverting input 1
7	OUT1	Output 1
8	OUT2	Output 2
9	IN2-	Inverting input 2
10	IN2+	Non-inverting input 2
11	V-	Negative supply or ground
12	IN3+	Non-inverting input 3
13	IN3-	Inverting input 3
14	OUT3	Output 3

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
SOP14	85	40	°C/W
TSSOP14	113	62	°C/W

3.3 ESD

Table 4 ESD

Symbol	Parameter	Value	Unit
All pins	ESD (HBM) ESD (CDM)	±2,000 ±250	V V

3.4 Electrical Characteristics

For Vs = (V+) - (V-) = 5V at Ta = 25°C, RF = 604Ω, RL = 150Ω, and 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-)		2		5.5	V
Ta	Operating ambient temperature		-40		85	°C
Power Supply						
Iq	Quiescent current per amplifier	Vs=5.5V, Io=0mA		10	12	mA
		all temp			15	
Offset Voltage						
Vos	Input offset voltage			±1.0	±5.0	mV
		all temp			±10.0	mV
dVos/dT	Drift	all temp		±2.0		μV/°C
PSRR	Power-supply rejection ratio	At DC, RL=150Ω		95		dB
Csep	Channel separation	At f=5MHz		90		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		95		dB
Input Bias Current						
Ib	Input bias current			±1		pA
Ios	Input offset current			±0.5		pA
Noise						
en	Input voltage noise density	f=1MHz		5		nV/$\sqrt{\text{Hz}}$
Open Loop Gain						
Aol	Open loop voltage gain			90		dB
Frequency Response						
BW	Unity gain bandwidth	G=1, Vo=100mVpp, RF=0Ω		400		MHz
f0.1dB	Bandwidth for 0.1dB gain flatness	G=2, Vo=100mVpp, RF=560Ω		120		MHz
SR	Slew rate	G=2, 4V Vo step		100		V/μs
Tr, tf	Rise and fall time	G=2, Vo=200mVpp, 10% to 90%		8		ns
Ts	Settling time	To 0.1%, G=2, 2V Vo step		50		ns
HD2	Second harmonic distortion	G=2, f=1MHz, Vo=2Vpp, RL=200Ω		-88		dBc

HD3	Third harmonic distortion	G=2, f=1MHz, Vo=2Vpp, RL=200Ω		-98		dBc
Δgain	Differential gain error	NTSC, RL=150Ω		0.02		%
Δphase	Differential phase error	NTSC, RL=150Ω		0.05		°
Output						
Vo	Voltage output swing from supply rails	Vs=5V, RL=150Ω		0.2	0.3	V
		Vs=5V, RL=1kΩ		0.03		
Isc	Short circuit current	Vs=5V		±100		mA
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			100		ns
toff	Amplifier disable time			30		ns

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 8 Vos Distribution

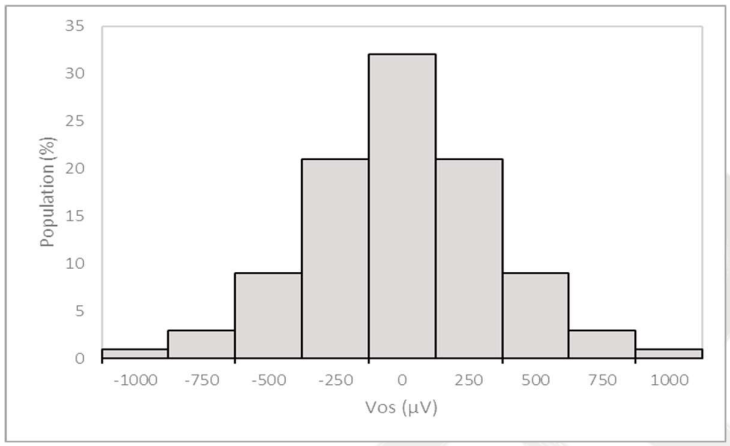


Figure 9 Vos vs Input Common Mode Voltage

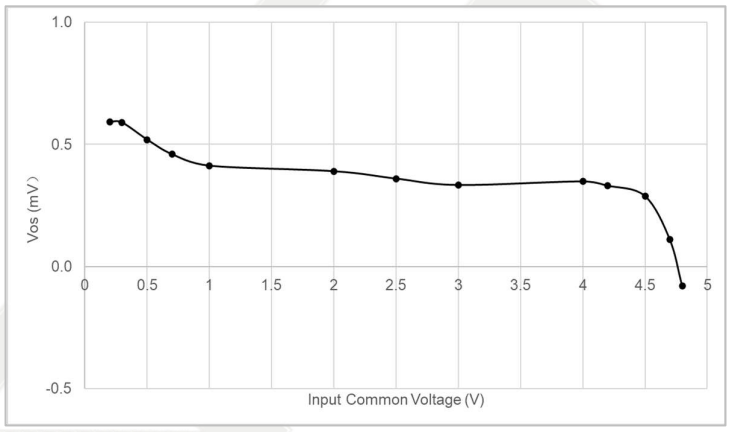


Figure 10 Vos vs Vs

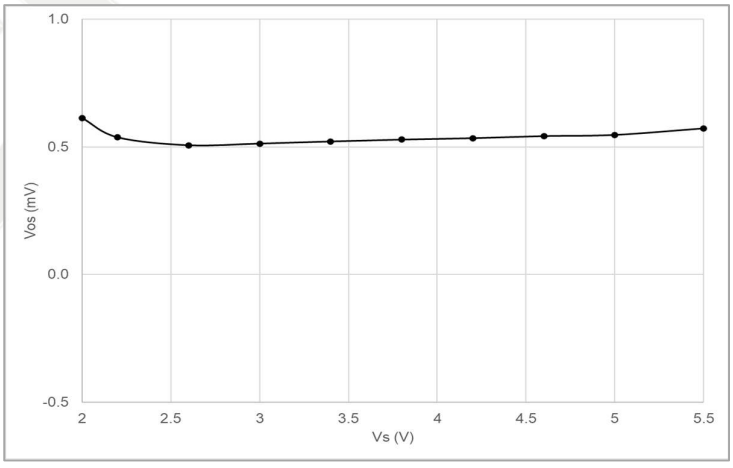


Figure 11 Iq (per opamp) vs Input Common Voltage

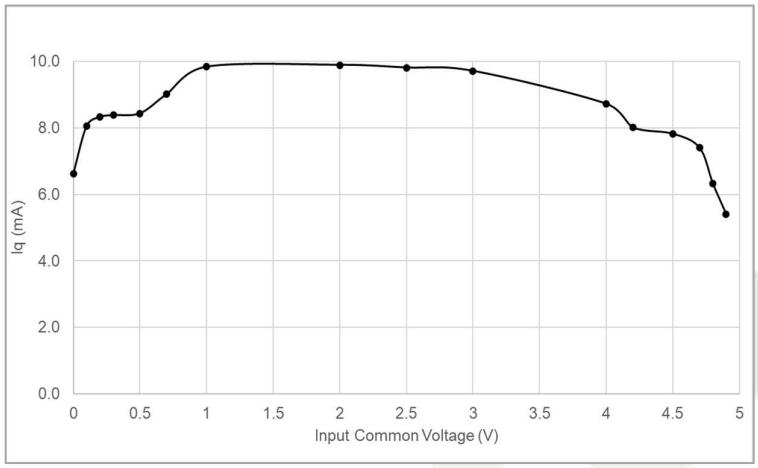


Figure 12 Iq (per opamp) vs Vs

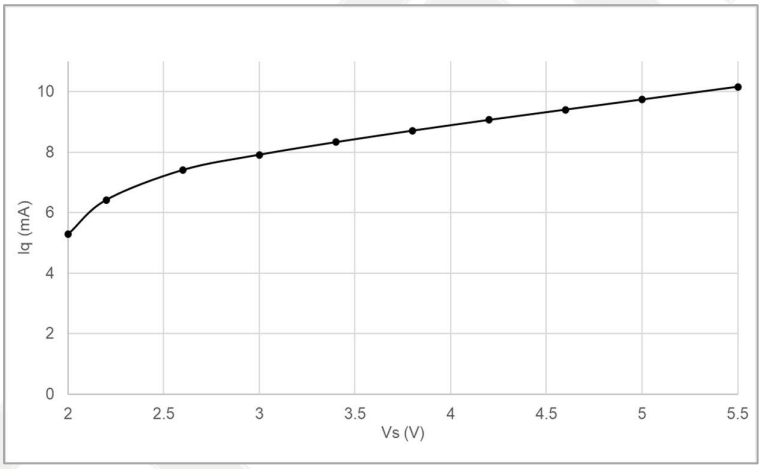


Figure 13 Large Signal Step (4V) Response

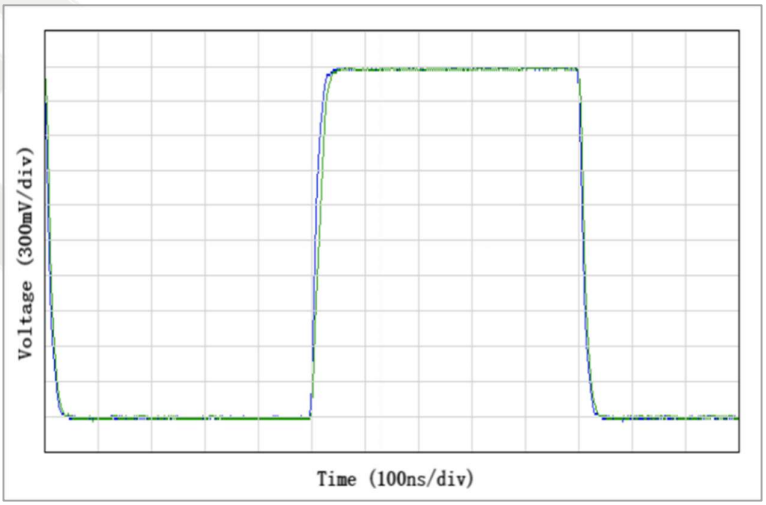


Figure 14 HD2, HD3 @ 1MHz

f

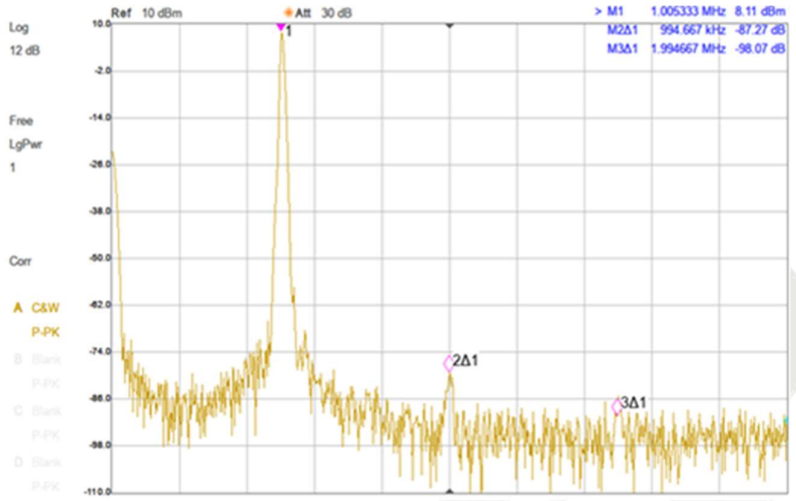
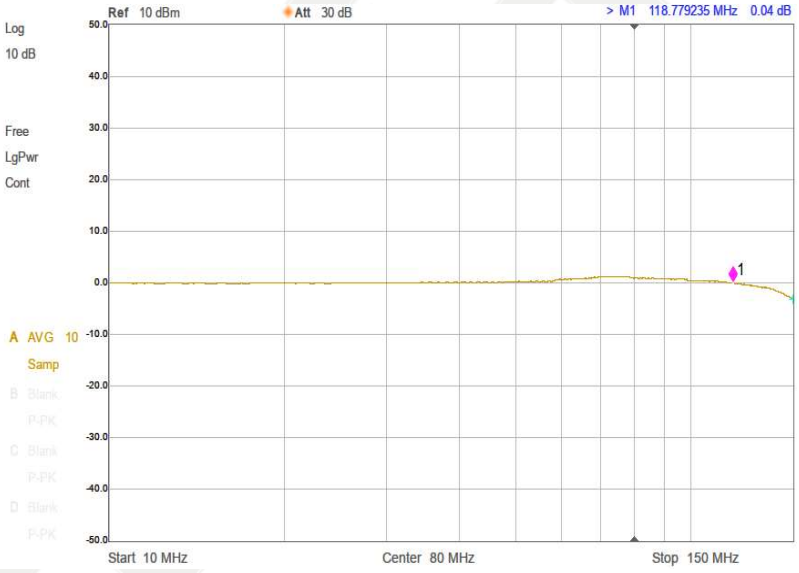


Figure 15 Bandwidth for 0.1dB Gain Flatness



4 Functional Description

4.1 Overview

The AXOP3355x devices are a family of low power, high speed, rail-to-rail input and output opamps. These devices operate from 2V to 5.5V, are unity gain stable, and are designed for a wide range of high-speed applications and used in virtually any single supply application.

4.2 Rail to Rail Input

The input common mode voltage range of the AXOP3355x family extends 100mV beyond the supply rails for the full supply voltage range of 2V 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 AXOP3355x 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 1kΩ, 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.

4.4 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 AXOP3355x family is approximately 2ns.

4.5 EMI Rejection

The AXOP3355x 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.

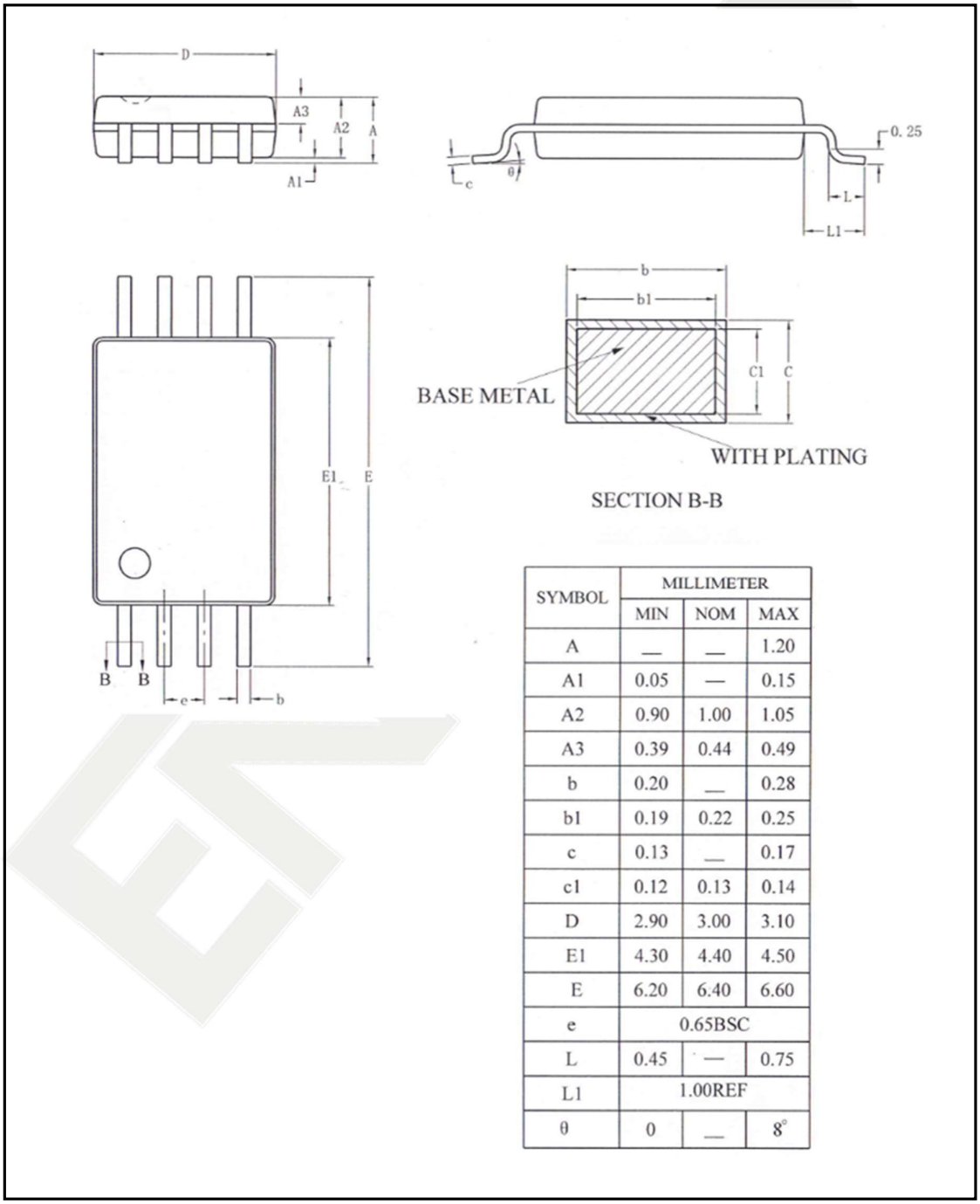
4.6 Shutdown

The AXOP3355xS has shutdown function. The amplifiers can be shut down by enabling the respective shutdown pin.

5 Package Information

5.1 Package Dimensions

Figure 16 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 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				

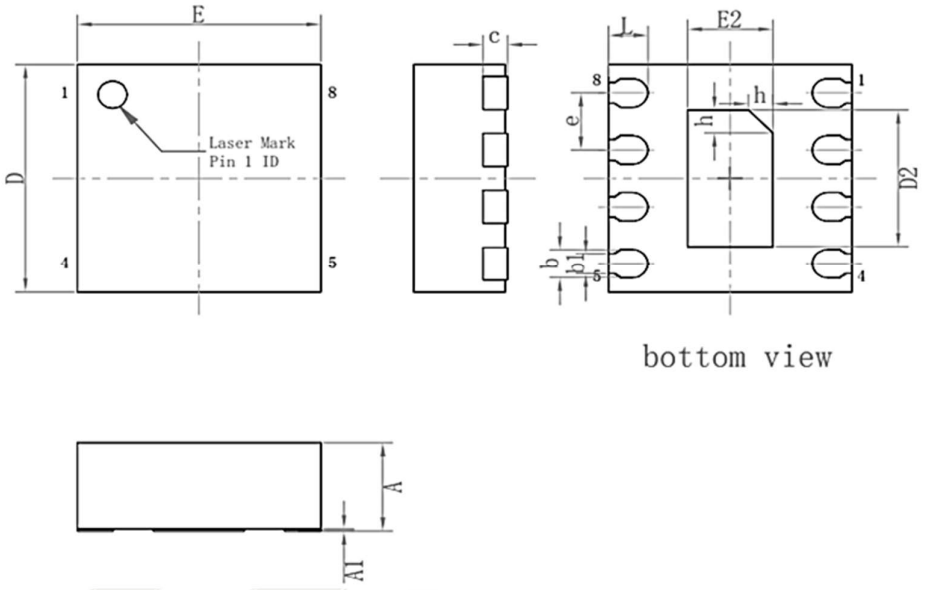
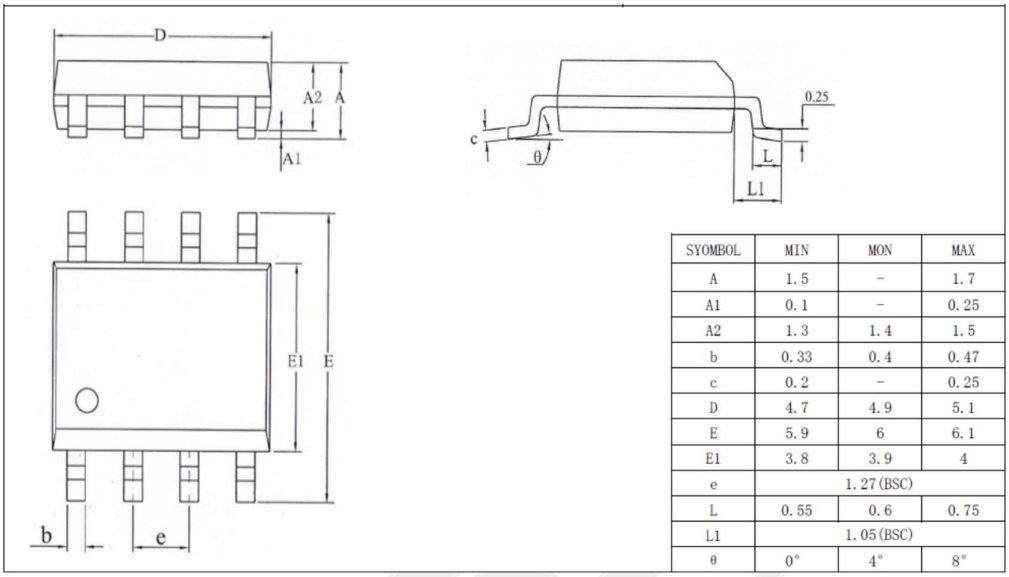
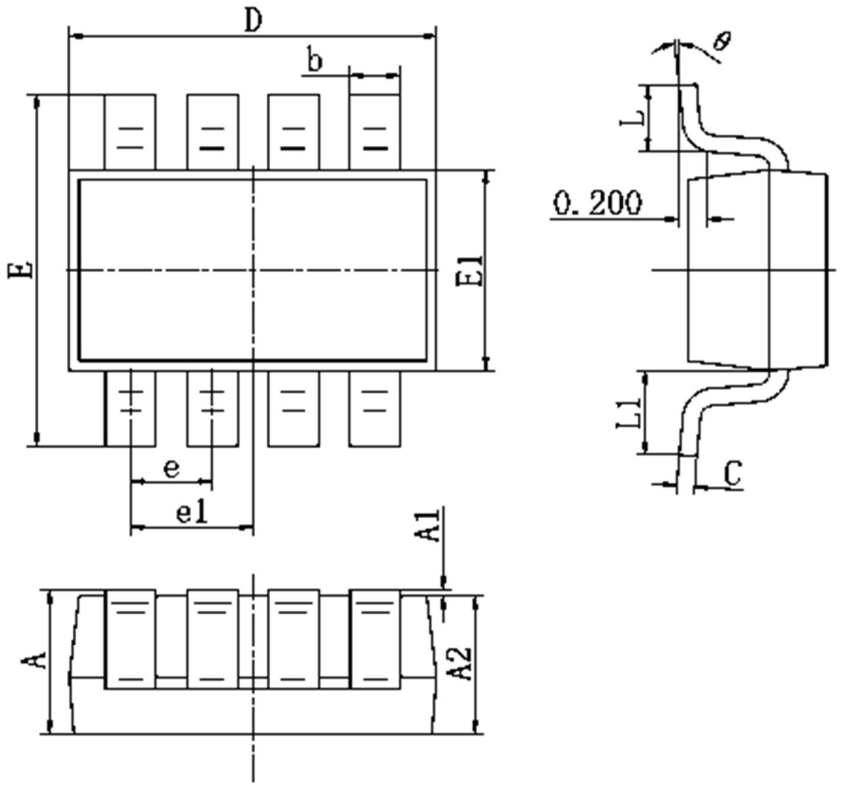


Figure 18 SOP8 Mechanical Data and Package Dimensions



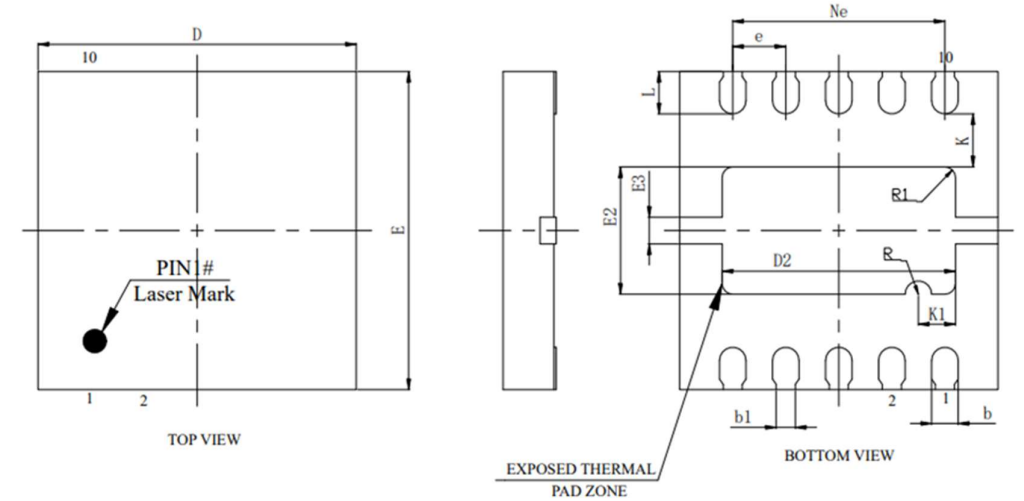
SYOMBOL	MIN	MON	MAX
A	1.5	-	1.7
A1	0.1	-	0.25
A2	1.3	1.4	1.5
b	0.33	0.4	0.47
c	0.2	-	0.25
D	4.7	4.9	5.1
E	5.9	6	6.1
E1	3.8	3.9	4
e	1.27(BSC)		
L	0.55	0.6	0.75
L1	1.05(BSC)		
θ	0°	4°	8°

Figure 19 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 20 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 21 MSOP10 Mechanical Data and Package Dimensions

标注 \ 尺寸	最小(mm)	最大(mm)	标注 \ 尺寸	最小(mm)	最大(mm)
A	2.90	3.10	C3	0.152	
A1	0.18	0.25	C4	0.15	0.23
A2	0.50TYP		H	0.00	0.09
A3	0.40TYP		θ	15° TYP4	
B	2.90	3.10	θ1	12° TYP4	
B1	4.70	5.10	θ2	14° TYP	
B2	0.45	0.75	θ3	0° ～ 6°	
C	0.75	0.95	R	0.15TYP	
C1	--	1.10	R1	0.15TYP	
C2	0.328TYP				

＊ 注EMSOP10产品共用此图所有数据，Die pad exposure大小是根据引线框架设计。

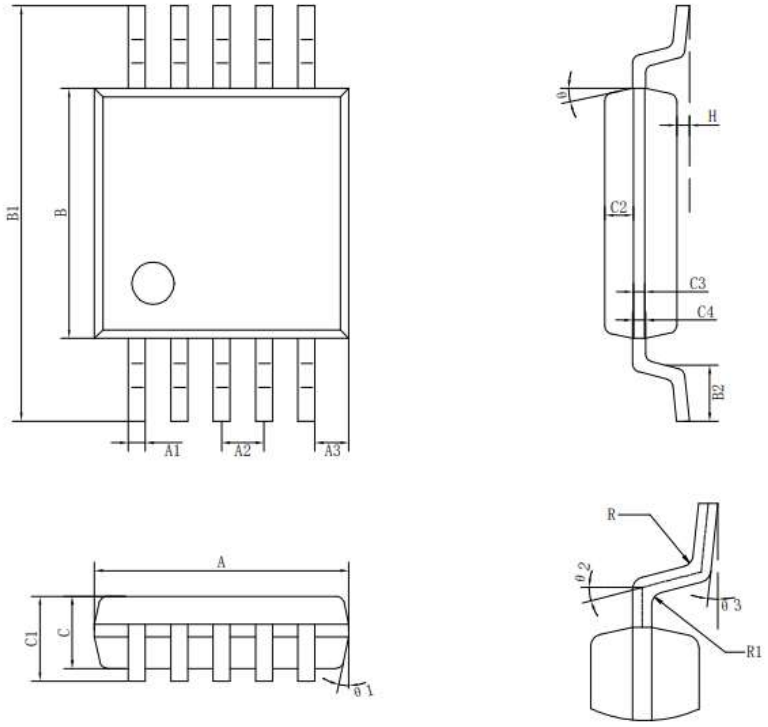
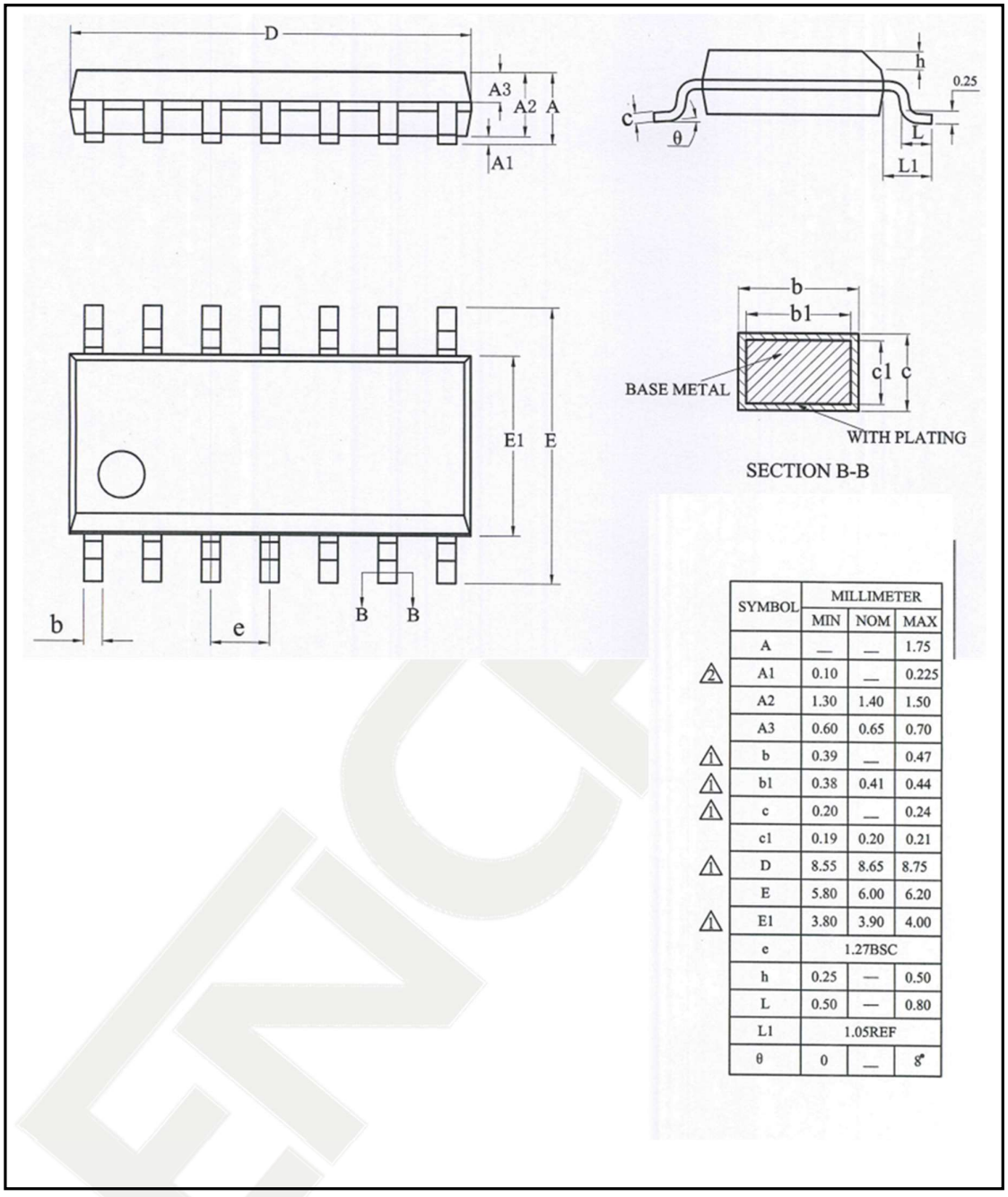
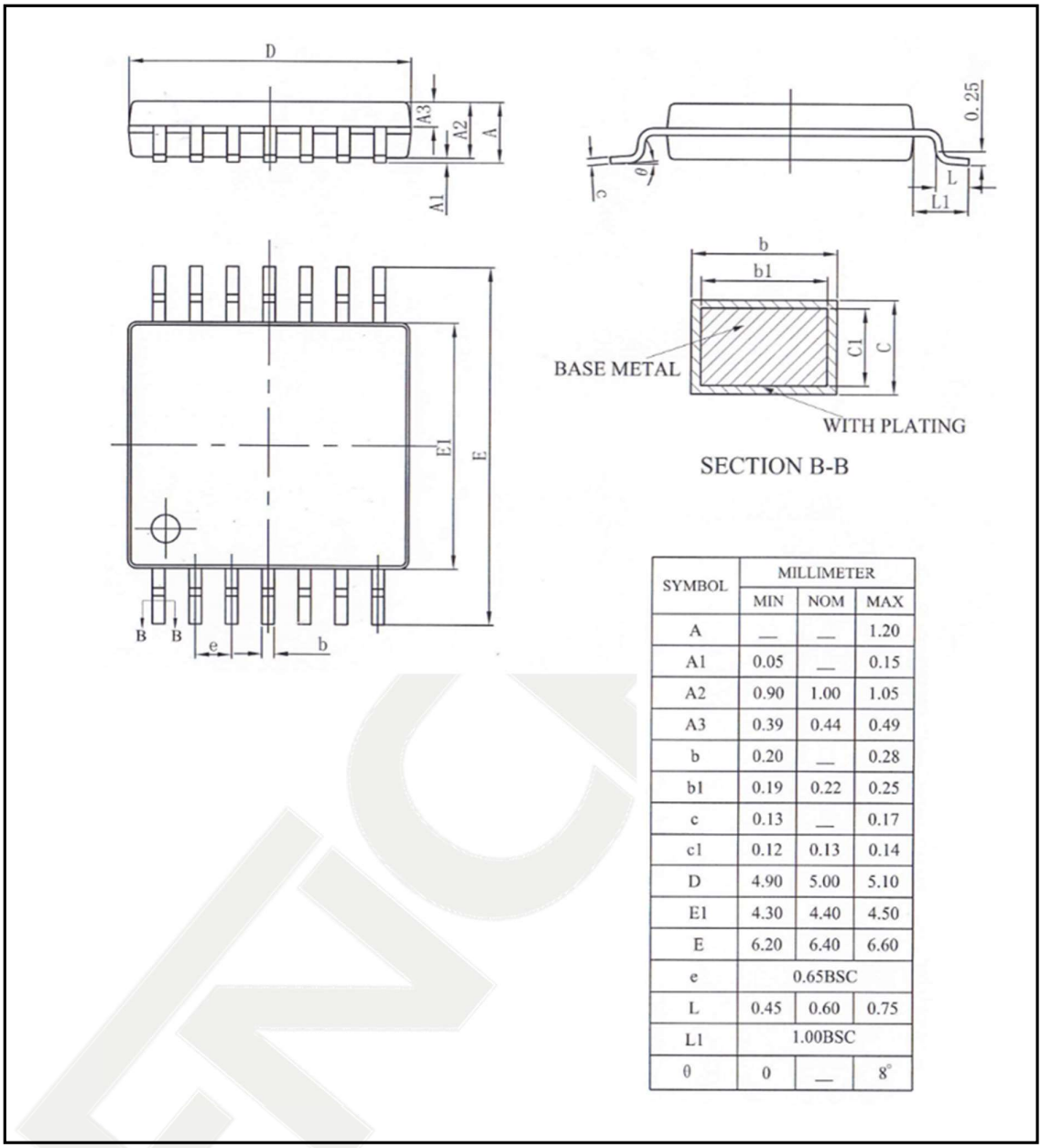


Figure 22 SOP14 Mechanical Data and Package Dimensions



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.75
A1	0.10	—	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.47
b1	0.38	0.41	0.44
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	8.55	8.65	8.75
E	5.80	6.00	6.20
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 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°

5.2 Marking Information

Figure 24 TSSOP8 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: “33552A” characters to indicate AXOP33552A

Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“C” to indicate the location of assembly

Figure 25 DFN8 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: “52B” characters to indicate AXOP33552B

Line 2: “y” to indicate year of production

“ww” to indicate week of production

Figure 26 SOP8 Marking Information

Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

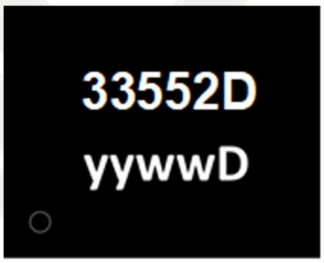
Line 1: “33552C” characters to indicate AXOP33552C

Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“F” to indicate the location of assembly

Figure 27 SOT23-8L Marking Information



Laser mark circle to indicate pin 1

2 lines of alphanumeric coding:

Line 1: “33552D” characters to indicate AXOP33552D

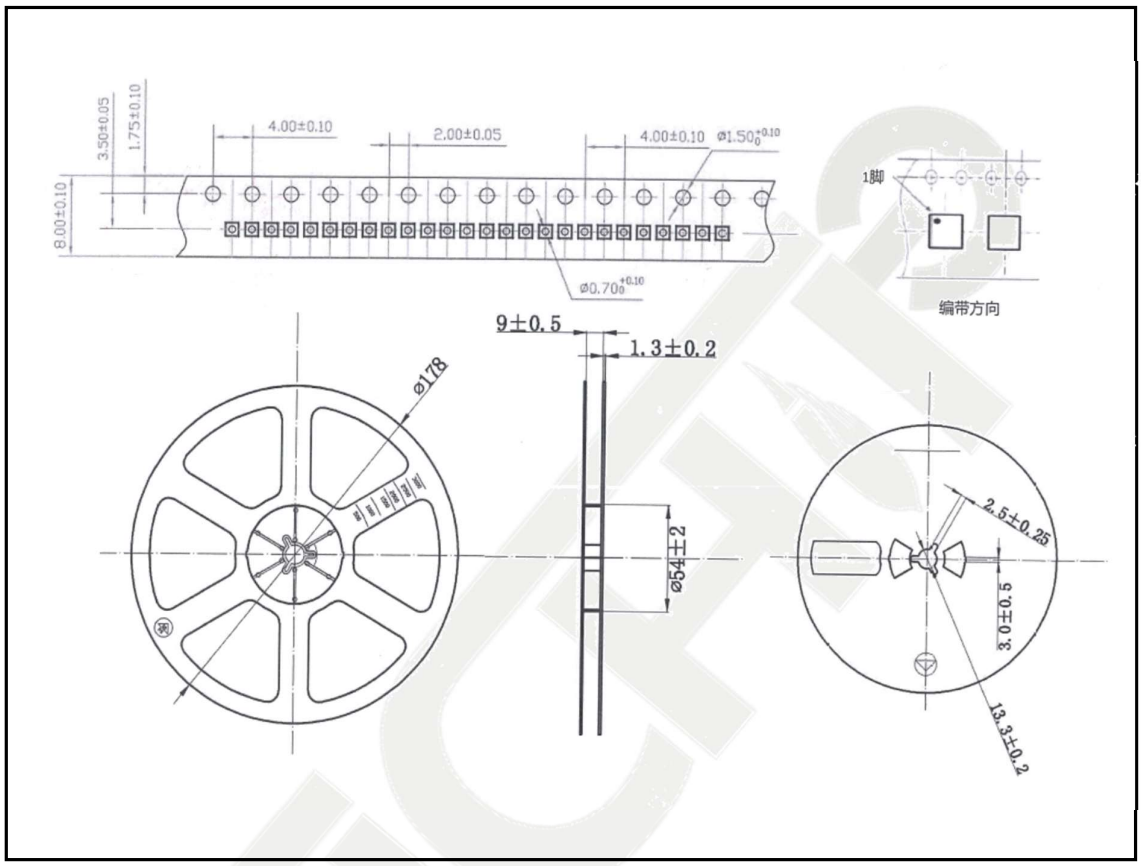
Line 2: “yy” to indicate year of production

“ww” to indicate week of production

“D” to indicate the location of assembly

6 Packing Information

Figure 28 Reel Packing Information



7 Revision History

Table 6 Document Revision History

Date	Version	Description
Mar 2023	1.00	V1.00 version.