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SEMICONDUCTOR



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PLED

OPA376AIDBVR-MS/OPA2376AIDR-MS

Product specification

Ultra Low Noise Rail-to-Rail I/O CMOS Precision OPERATIONAL AMPLIFIERS

GENERAL DESCRIPTION

The OPA376 family represents a new generation of low-noise operational amplifiers, offering outstanding dc precision and ac performance. Rail-to-Rail input and output, low offset ($2\mu\text{V}$), low noise ($6\text{nV}/\sqrt{\text{Hz}}$), quiescent current of $600\mu\text{A}$, and a 6-MHz bandwidth make this part very attractive for a variety of precision and portable applications.

In addition, this device has a reasonably wide supply range (2V to 5.5V) with excellent PSRR, making it attractive for applications that run directly from batteries without regulation.

The OPA376AIDBVR-MS (single), OPA2376AIDR-MS (dual) families of operational amplifiers are specified for operation from -25°C to $+125^{\circ}\text{C}$.

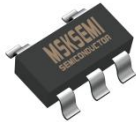



FEATURES

- Input Offset Voltage: $2\mu\text{V}$ (Typical)
- Zero Drift: $0.03\mu\text{V}/^{\circ}\text{C}$ (Typical)
- Ultra Low Noise: $6\text{nV}/\sqrt{\text{Hz}}$ at 1kHz
- Supply Range: 2V to 5.5V
- Gain Bandwidth: 6 MHz
- Slew rate: $5\text{V}/\mu\text{s}$
- Quiescent current: $600\mu\text{A}$ ($V_{\text{S}}=5\text{V}$)
- Rail-to-Rail Input and Output
- Micro size Packages:
OPA376AIDBVR-MS: SOT-23-5
OPA2376AIDR-MS: SOP-8

APPLICATIONS

- ADC Buffer
- Audio Equipment
- Medical Instrumentation
- Handheld Test Equipment
- Active Filtering
- Sensor Signal Conditioning

Reference News

MODEL	Op Temp($^{\circ}\text{C}$)	PACKAGE OUTLINE		Marking	Minimum packaging (PCS)
OPA376AIDBVR-MS	$-25^{\circ}\text{C} \sim 125^{\circ}\text{C}$	SOT-23-5			3000
OPA2376AIDR-MS	$-25^{\circ}\text{C} \sim 125^{\circ}\text{C}$	SOP-8			2500

TYPICAL APPLICATION

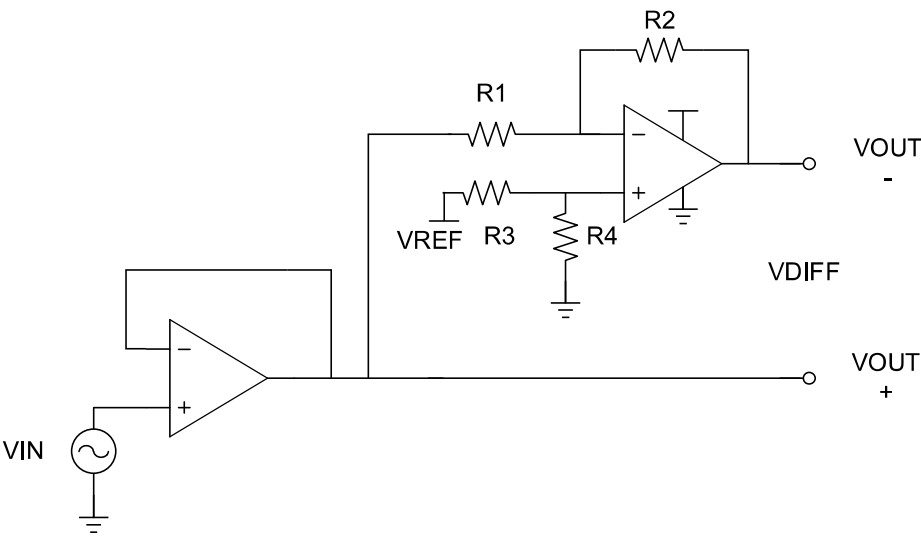
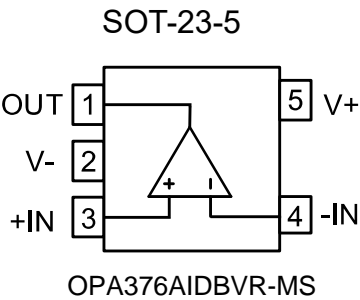


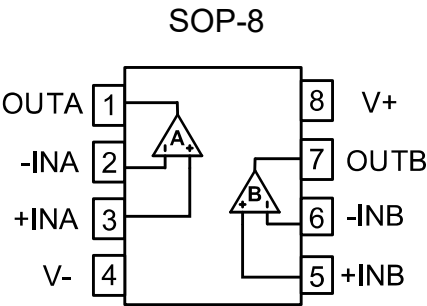
Figure 1. Typical Application

Pin Configuration and Functions (Top View)
Pin Description



PIN		I/O	DESCRIPTION
NAME	Number		
+IN	3	I	Positive (noninverting) input
-IN	4	I	Negative (inverting) input
OUT	1	O	Output
V-	2	—	Positive (highest) power supply
V+	5	—	Negative (lowest) power supply

Pin Configuration and Functions (Top View)
Pin Description



PIN		1/0	DESCRIPTION
NAME	Number		
+INA	3		Noninverting input, channel A
+INB	5		Noninverting input, channel B
-INA	2		Inverting input, channel A
-INB	6		Inverting input, channel B
OUTA	1	0	Output, channel A
OUTB	7	0	Output, channel B
V-	4	—	Negative (lowest) power supply
V+	8	—	Positive (highest) power supply

SPECIFICATIONS

Absolute Maximum Ratings⁽¹⁾

		MIN	MAX	UNIT
Voltage	Supply Voltage		6	V
	Signal Input Terminals Voltage ⁽²⁾	(V-) - 0.5	(V+) + 0.5	V
	Signal Input Terminals Voltage ⁽³⁾	(V-) - 0.5	(V+) + 0.5	V
Current	Signal Input Terminals Current ⁽²⁾	-10	10	mA
	Signal output Terminals Current ⁽³⁾	-200	200	mA
	Output Short-Circuit ⁽⁴⁾	Continuous		
θ_{JA}	Operating Temperature Range	-25	125	°C
	Storage Temperature Range	-65	150	°C
	Junction Temperature	-40	150	°C

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.

(2) Input terminals are diode clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current limited to 10mA or less.

(3) Output terminals are diode-clamped to the power-supply rails. Output signals that can swing more than 0.5V beyond the supply rails should be current-limited to ± 200 mA or less.

(4) Short-circuit to ground, one amplifier per package.

ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-Body Model (HBM)	± 4000	V
		Charged-Device Model (CDM)	± 500	V
		Machine Model	100	V

Recommended Operating Conditions

		MIN	MAX	UNIT
Supply voltage, $V_s = (V+) - (V-)$	Single-supply	2	5.5	V
	Dual-supply	± 1	± 2.75	V

ELECTRICAL CHARACTERISTICS(V_S = +5V)

At T_A = 25°C, V_{CM}=V_{OUT}= V_S /2, unless otherwise noted.

PARAMETER		CONDITIONS	MIN	TYP	MAX	UNIT
OFFSET VOLTAGE						
V _{OS}	Input Offset Voltage			2	10	μV
dV _{OS} /dT	Input Offset Voltage Average Drift	T _A = -25°C to 125°C		0.03		μV/°C
INPUT CURRENT						
I _B	Input Bias Current			500		pA
I _{OS}	Input Offset Current			50		pA
NOISE						
V _N	Input Voltage Noise	f=0.1Hz to 10Hz		0.3		μV _{PP}
e _n	Input Voltage Noise Density	f=1kHz		6		nV/√Hz
INPUT VOLTAGE						
V _{CM}	Common-Mode Voltage Range		V _S -0.1		V _S +0.1	V
CMRR	Common-Mode Rejection Ratio	V _{CM} =0.1V to 4V	110	130		dB
FREQUENCY RESPONSE						
GBW	Gain-Bandwidth Product	C _L =100pF		6		MHz
SR	Slew Rate	G = +1, V _{IN} =2V Step		5		V/us
t _s	Settling Time to 0.1%	G = +1, V _{IN} =2V Step		0.7		us
THD+N	Total Harmonic Distortion +Noise	G=1, V _O =1V _{RMS} , f=1kHz, R _L =10kΩ		0.0004		%
OUTPUT						
A _v	Open-Loop Voltage Gain	V _{OUT} =0.1V to 4.9V R _L =10kΩ	135	150		dB
V _{OH}	High output voltage swing	R _L =10kΩ		10	20	mV
		R _L =2kΩ		50	60	mV

V_{OL}	Low output voltage swing	$R_L=10k\Omega$		10	20	mV
		$R_L=2k\Omega$		35	45	mV
I_{sc}	Output Short-Circuit Current	Source current		30		mA
		Sink current		65		mA
$C_L^{(1)}$	Capacitive Load Drive	$G = +1,$ $V_{IN}=0.2V$ Step			560	pF
POWER SUPPLY						
PSRR	Power-Supply Rejection Ratio	$V_S=1.5V$ to $5.5V$	110	130		dB
V_S	Operating Voltage Range		2		5.5	V
I_Q	Quiescent Current/Amplifier	$I_O=0A$		600	700	μA

(1) Capacitive load drive means that above a given maximum value, the output waveform will oscillate under the step response.

TYPICAL CHARACTERISTICS

At $T_A = 25^\circ\text{C}$, $V_S = +5\text{V}$, $G=+1$, $V_{IN}=V_{OUT}= V_S /2$, unless otherwise noted.

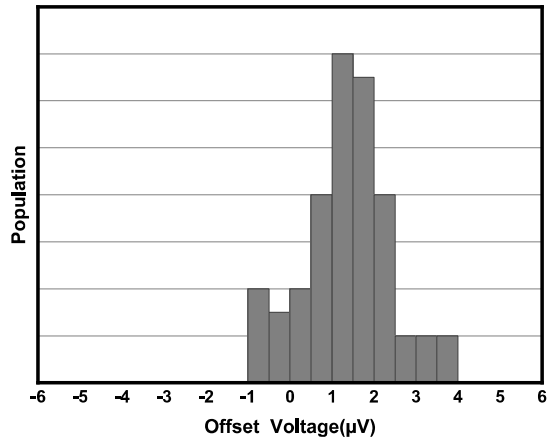


Figure 2. Offset Voltage Production Distribution

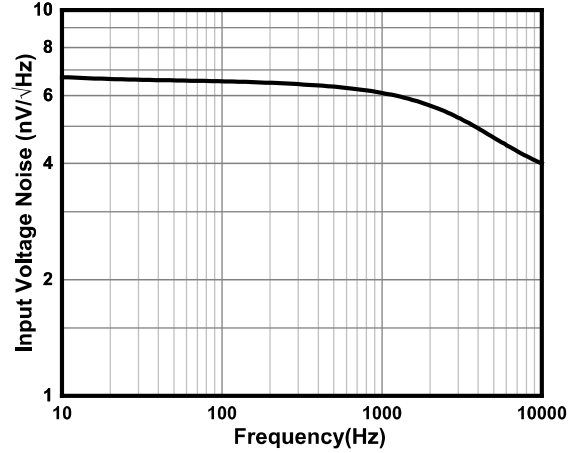


Figure 3. Input Voltage Noise Spectral Density

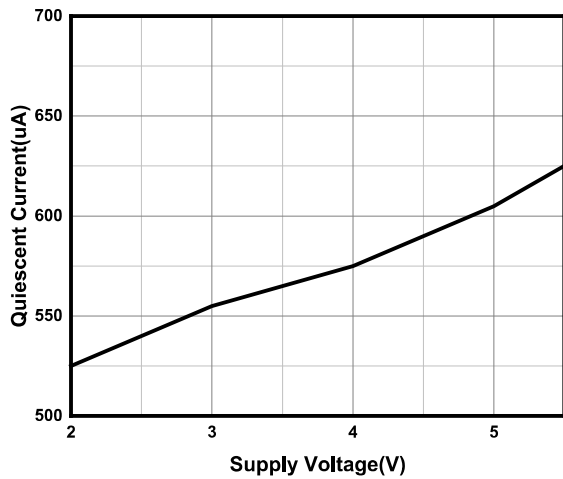


Figure 4. Quiescent Current vs Supply Voltage

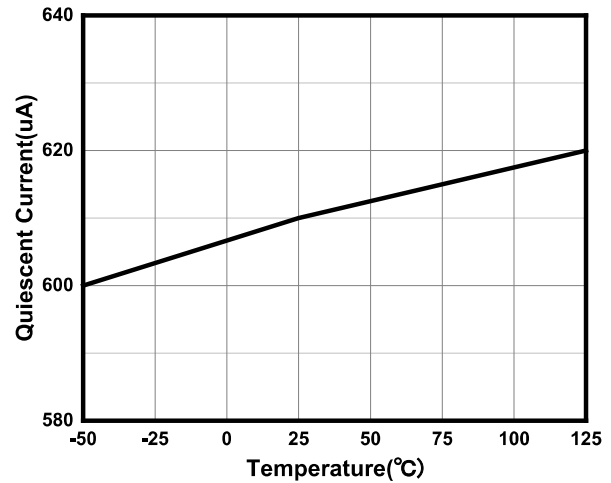


Figure 5. Quiescent Current vs Temperature

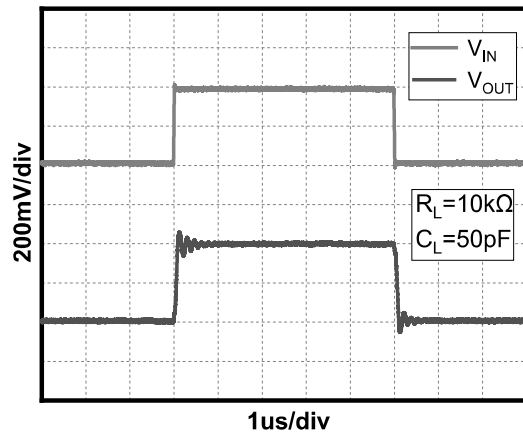


Figure 6. Small-Signal Step Response($V_S=5\text{V}$)

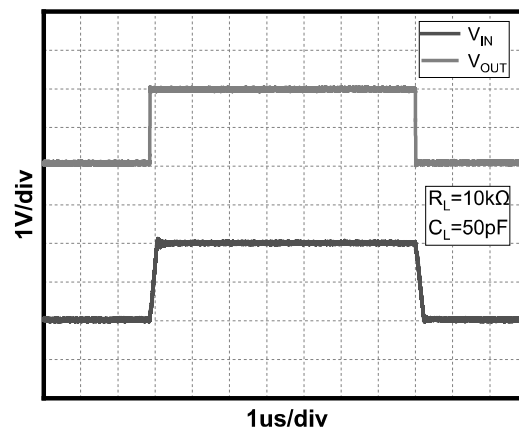


Figure 7. Large-Signal Step Response($V_S=5\text{V}$)

TYPICAL CHARACTERISTICS

At $T_A = 25^\circ\text{C}$, $V_S = +5\text{V}$, $G=+1$, $V_{IN}=V_{OUT}= V_S /2$, unless otherwise noted.

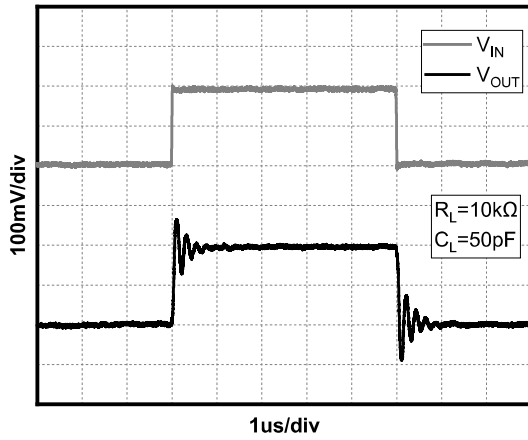


Figure 8. Small-Signal Step Response($V_S=2\text{V}$)

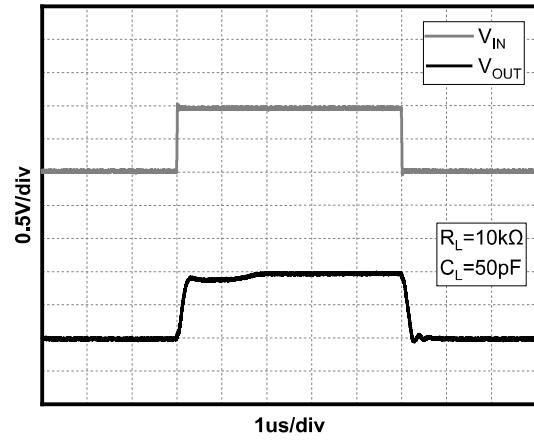


Figure 9. Large-Signal Step Response($V_S=2\text{V}$)

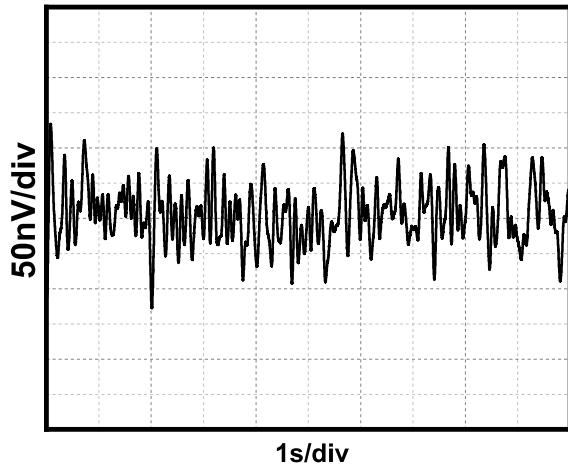


Figure 10. 0.1Hz to 10Hz Noise

Detailed Description

Overview

The OPA376AIDBVR-MS OPA2376AIDR-MS devices are a low noise, unity-gain stable, rail-to-rail precision operational amplifier that operate in a single-supply voltage range of 2V to 5.5V ($\pm 1V$ to $\pm 2.75V$). A high supply voltage of 6V (absolute maximum) can permanently damage the amplifier. Rail-to-rail input and output wobbles significantly increase the dynamic range, especially in low-supply applications. Good layout practices require that a 0.1 μ F capacitor be used where it is tightly threaded through the power supply pin.

Phase Reversal Protection

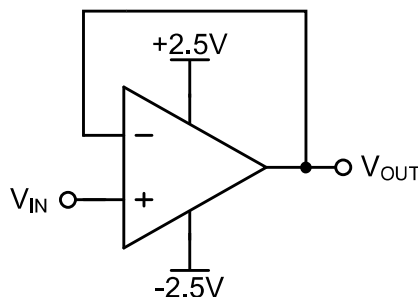
The OPA376AIDBVR-MS OPA2376AIDR-MS devices have internal phase-reversal protection. Many op amps exhibit phase reversal when the input is driven beyond the linear common-mode range. This condition is most often encountered in noninverting circuits when the input is driven beyond the specified common-mode voltage range, causing the output to reverse into the opposite rail. The input of the OPA376AIDBVR-MS OPA2376AIDR-MS prevents phase reversal with excessive common-mode voltage. Instead, the appropriate rail limits the output voltage.

Typical Applications

1 Voltage Follower

As shown in Figure 11, the voltage gain is 1. With this circuit, the output voltage V_{OUT} is configured to be equal to the input voltage V_{IN} . Due to the high input impedance and low output impedance, the circuit can also stabilize the output voltage, the output voltage expression is

$$V_{OUT} = V_{IN} \quad (1)$$



2 Inverting Proportional Amplifier

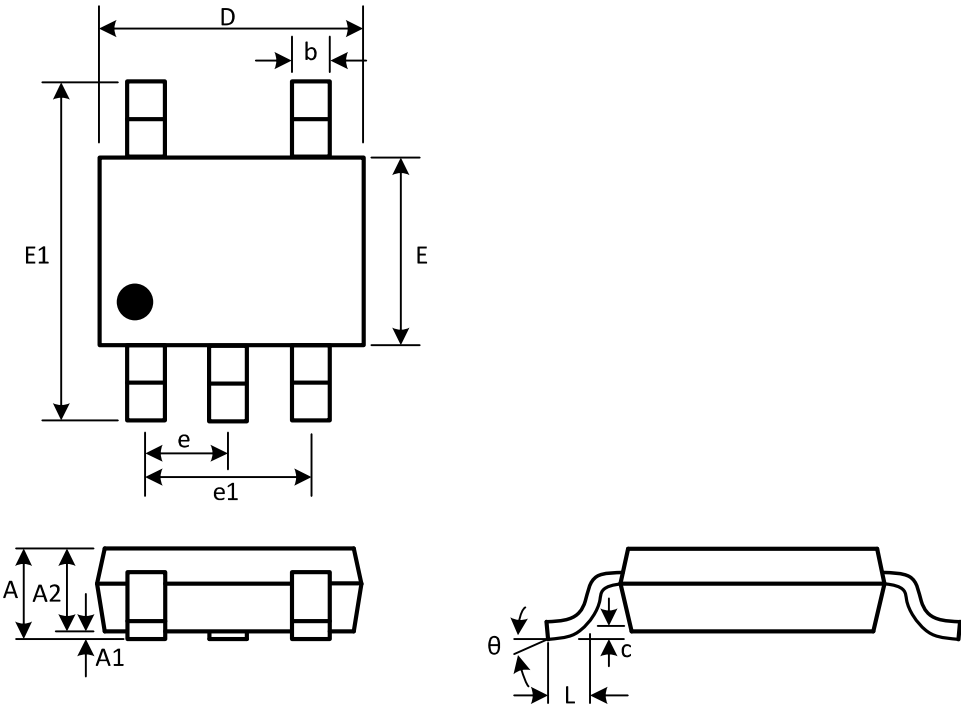
As shown in Figure 12, for a reverse-phase proportional amplifier, the input voltage V_{IN} is amplified by a voltage gain that depends on the ratio of R_1 to R_2 . The output voltage V_{OUT} is inversely with the input voltage V_{IN} . The input impedance of the circuit is equal to R_1 , and the output voltage expression is

(2)

$$V_{OUT} = -\frac{R_2}{R_1} V_{IN}$$

PACKAGE DESCRIPTION

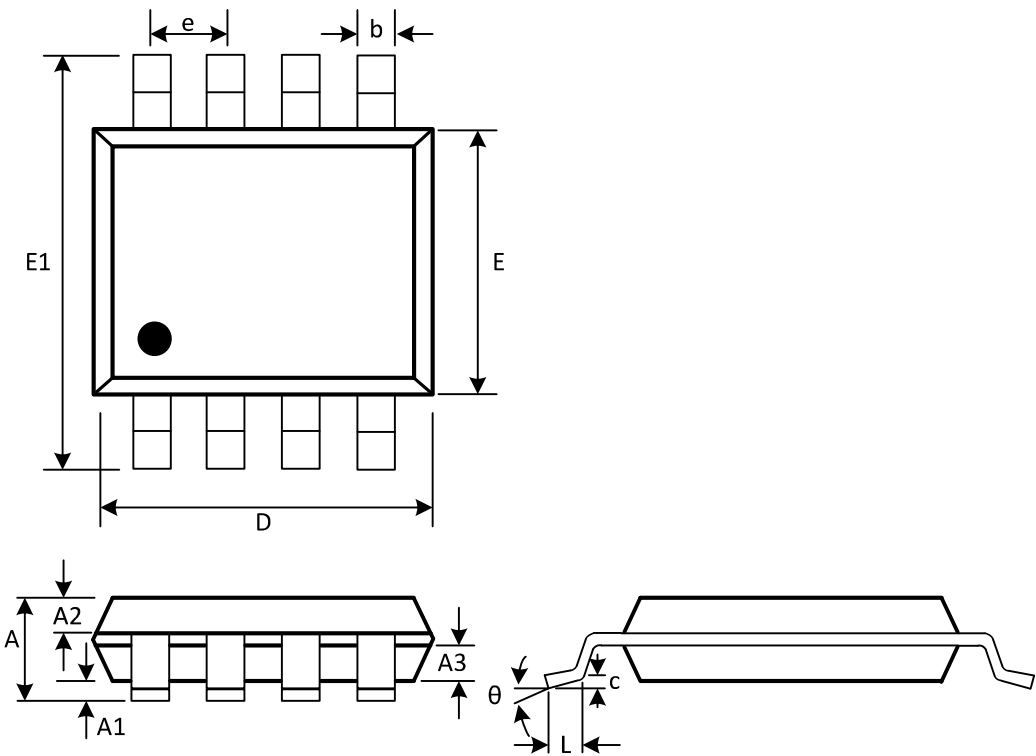
SOT23-5



(Unit: mm)

Symbol	Min	Max
A	1.050	1.250
A1	0.000	0.100
A2	1.050	1.150
b	0.300	0.500
c	0.100	0.200
D	2.820	3.020
e	0.950(BSC)	
e1	1.800	2.000
E	1.500	1.700
E1	2.650	2.950
L	0.300	0.600
θ	0°	8°

SOP-8



(Unit: mm)

Symbol	Min	Max
A	1.300	1.600
A1	0.050	0.200
A2	0.550	0.650
A3	0.550	0.650
b	0.356	0.456
c	0.203	0.233
D	4.800	5.000
e	1.270(BSC)	
E	3.800	4.000
E1	5.800	6.200
L	0.400	0.800
θ	0°	8°

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