AK2973

Zero Drift operational amplifiers

1. Device Outline

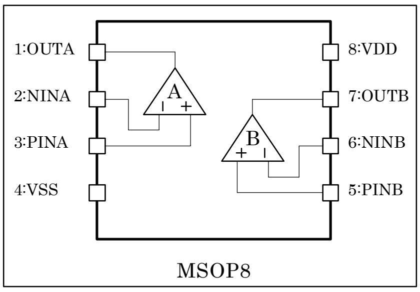
AK2973 is the dual channel CMOS operational amplifires which is available to output with very low input offset voltage (± 10μV) and near zero input offset dirft.
It's operated with very small current consumptions, 17μA/ch. Typ.(VDD:5.0V), which is available to operate full swing signals in input and output.
AK2973 is appropriate to portable Sensor Pre Amp. applications.

2. Feature

☐ Wide Supply Operation Range: 1.6V ~ 5.5V (±0.8V ~ ±2.75V)
☐ Very Low Input Offset Voltage : ±1μV typ.
☐ Near Zero Dirft over time and temperature : ±10nV/°C typ.
☐ Input Rabge : VSS to VDD
☐ Full Swing Outputs to 50kΩ Load @[VDD/2]
☐ Power Supply Current : 34μA typ.(VDD: 5.0V, No Load)
☐ Gain Bandwidth : 80kHz typ.
☐ Slew Rate : 30mV/μsec typ.
☐ Operating Temperature Range : −40 ~ 125°C
☐ Package : MSOP8

Part Name	Channel Number	Package
AK2973H	2	MSOP8

3. Pin Location



(AK2973H)

4. Table of contents

1. Device Outline 1
2. Feature 1
3. Pin Location 1
4. Table of contents 2
5. Pin Function Descriptions 2
6. Absolute Maximum Ratings 2
7. Recommended Operating Conditions 3
8. Electrical Characteristics 3
9. Typical Operating Characteristics (for reference) 6
10. Restriction of Comparator Operation 15
11. Notes for a board design 15
12. Package 16
13. Ordering Guide 17

5. Pin Function Descriptions

Pin number	Name	I/O (* 1)	Function
1	OUTA	AO	Amplifier A Output
2	NINA	AI	Amplifier A Inverted Input
3	PINA	AI	Amplifier A No Inverted Input
4	VSS	PWR	Power Supply Ground
5	PINB	AI	Amplifier B No Inverted Input
6	NINB	AI	Amplifier B Inverted Input
7	OUTB	AO	Amplifier B Output
8	VDD	PWR	Positive Power Supply

Note
* 1. PWR : Power Supply
  AI : Analog Input
  AO : Analog Output

6. Absolute Maximum Ratings

(VSS = 0V, * 2)

Parameter	Symbol	Min	Max	Units
Supply Voltage	VDD	–0.3	6.5	V
Input Voltage	V_{TD}	–0.3	VDD + 0.3	V
Input Current	I_{IN}	–10	+10	mA
Storage Temperature Range	T_{stg}	–65	150	°C

Note
* 2. All voltage with respect to VSS(ground).

[WARNING] Operational at or beyond these limits may result in permanent damage to the device. Normal operation is not guaranteed at these extremes.

7. Recommended Operating Conditions

(VSS = 0V, * 2)

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Operationg Temperature Range	T_a	–40		125	°C	
Ground level (* 2)	VSS	0	0	0	V	
Supply Voltage	VDD	1.6		5.5	V	

[WARNING] We asuumes no responsibility for the usage beyond the conditions in this datasheet.

8. Electrical Characteristics

☐ DC Characteristics (typ. : VDD=5V,V_{CM}=VDD/2 (* 3) , Ta=25°C)
VDD=1.6V~5.5V, Vcm=VDD/2, Ta=–40~125°C, unless otherwise noted

Item	Symbol	Condition	min	typ	max	Unit
Input Voltage Offset	V_{IO}	V_{CM} = VDD/2 (* 3)		±1	±10	µV
Input Voltage Offset Drift	V_{IOD}	(* 4)		±10	±50	nV/°C
Input Bias Current	I_S			±10	±200	pA
Input Common Mode Range	V_{ICM}		VSS		VDD	V
Output Voltage Swing	V_{OM}	RL≥50kΩ (@VDD/2)	0.05		VDD-0.05	V
Common Mode Rejection Ratio (* 5)	CMR	VSS ≤ Vcm ≤ VDD	100	130		dB
Power Supply Rejection Ratio (* 6)	SVR	VDD = 1.6V to 5.5V	110	130		dB
Large Signal Voltage Gain (* 7)	Av	0.1 V< Vout < VDD–0.1V RL ≥ 50kΩ(to VDD/2)	100	130		dB
Output short current	I_{OS}	Isource: Vout node forced Vdd Isink: Vout node forced Vss		7		mA
Output current	I_O	Isource: Vcm=Vdd Vout node forced Vdd-1 Isink: Vcm=Vss Vout node forced Vss+1		3		mA
Power Supply Current	Idd	Vcm=Vout=VDD/2 (* 8)		34	60	µA

Notes

* 3. V_{CM} means the common voltage of an input pin (PIN/NIN).
* 4. V_{IOD} = [(high temperature side WST(**)) –(low temperature side WST(**))]/[125°C－(－40°C))]
  ** WST is MIN. or MAX. value of V_{IO}.
  ex.) If high temperature side is MAX. and low temperature side is MIN. the V_{IOD} polarity is positive. And if high temperature side is MIN. and low temperature side is MAX. the V_{IOD} polarity is negative.
* 5. CMRR = 20 x Log[(VDD-VSS) / (α)]
  '(α) is a Max. value among [(Offset at input = VDD)-(Offset at Input = VSS)] and
  [(Offset at input = VDD)-(Offset at input = VDD/2)] and
  [(Offset at input = VDD/2)-(Offset at input = VSS)].
* 6. PSRR = 20 x Log[(Max. supply voltage – Min. supply voltage) / (Offset at Max. supply voltage – Offset at Min. supply voltage)]
* 7. A_V = 20×LOG [((VDD-0.1)－(VSS+0.1)) / ((Offset at output= VDD－0.1) － (Offset at output = VSS+0.1))]
* 8. It contains consumption of two OPAmp circuits. It doesn't include an output drive current.

☐ AC Characteristics (Typ. VDD= 5V, VCM= VDD/2, Ta= 25ºC)
VDD:1.6~5.5V, VCM= VDD/2, VSS=0V, Ta= –40~125ºC, unless otherwise noted

Item		Symbol	Condition	min	typ	max	Unit
Gain Bandwidth		GB			80		kHz
Slew Rate		SR	AV=1 Vin=4Vpp CL=100pF 10%-90%		30		mV/µs
Input Voltage Noise		VNI1	@1kHz		200		nVrms $/\sqrt{Hz}$
		VNI2	0.1~10Hz (* 9)		4.2		µVpp
		VNI3	0.1~1Hz (* 10)		1.3		µVpp
Overload Recovery Time (* 11)		TOR	Av=–10, Load: 20pF Vin: 2.0V (±2.5V)@90%		80		µsec
Input capacitance	Diff.	CIND			18		pF
	common	CINC			30		pF
Maximum Capacitance Loads		CL				100	pF

Notes.

* 9. VNI2 is calculated by the following numerical expression from VNI1.

VNI2 = 200nVrms/√Hz × $\sqrt{(10\text{Hz} - 0.1\text{Hz})}$ × 6.6 = 4.16µVpp

* 10. VNI3 is calculated by the following numerical expression from VNI1.

VNI3 = 200nVrms/√Hz × $\sqrt{(1\text{Hz} - 0.1\text{Hz})}$ × 6.6 = 1.26µVpp

* 11. The definition of “Overload Recovery Time”

- Positive side overload recovery time (Time until it returns to VDD/2 from VDD saturation)

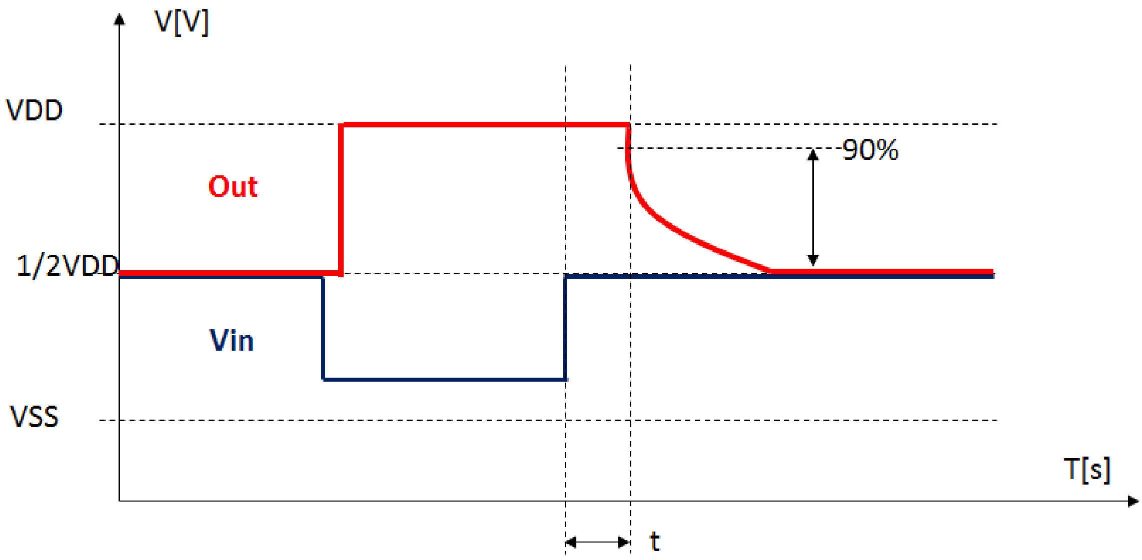


Figure 8.1 Positive side overload recovery time

- Negative side overload recovery time (Time until it returns to VDD/2 from VSS saturation)

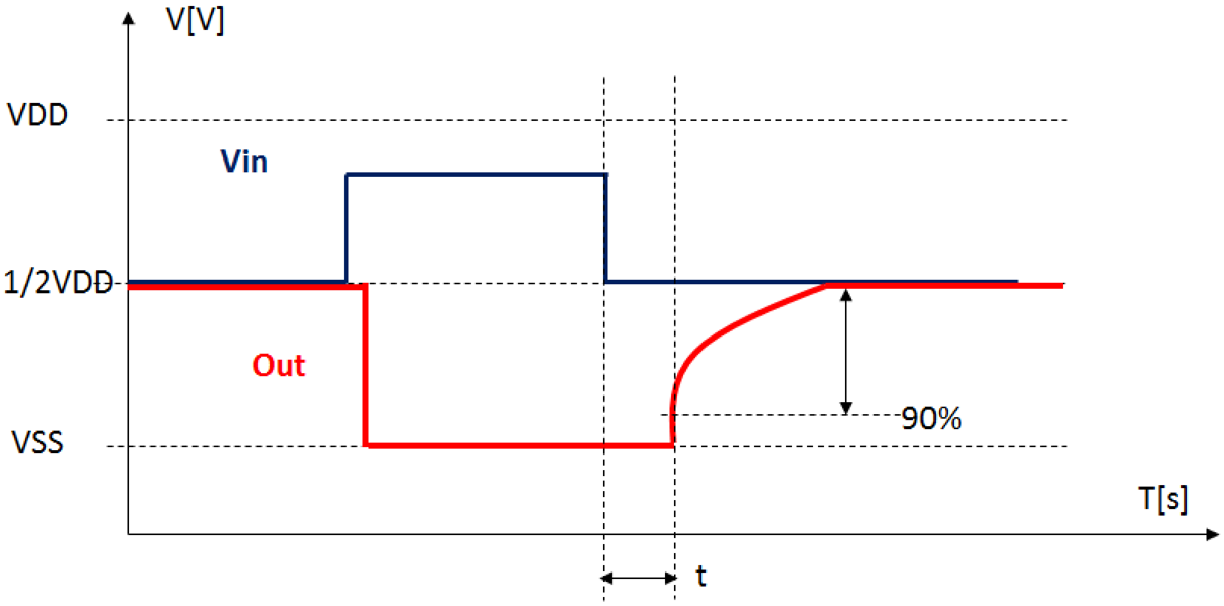


Figure 8.2 Negative side overload recovery time

9. Typical Operating Characteristics (for reference)

■Current consumption - Operationg temperature characteristic (Vin,Vout:VDD/2)

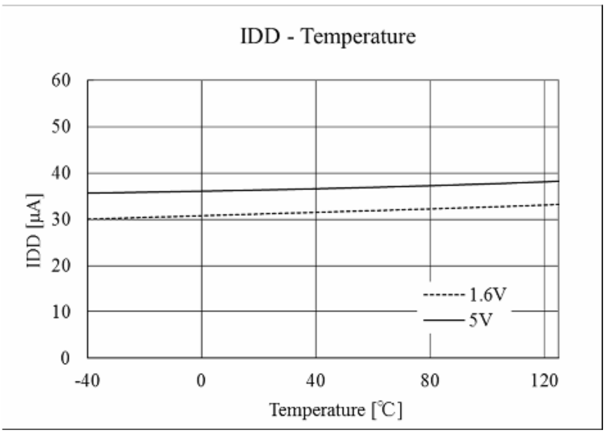


Figure 9.1 Current consumption vs. Operationg temperature

■Current consumption – Power supply Voltage characteristic (Vin,Vout:VDD/2)

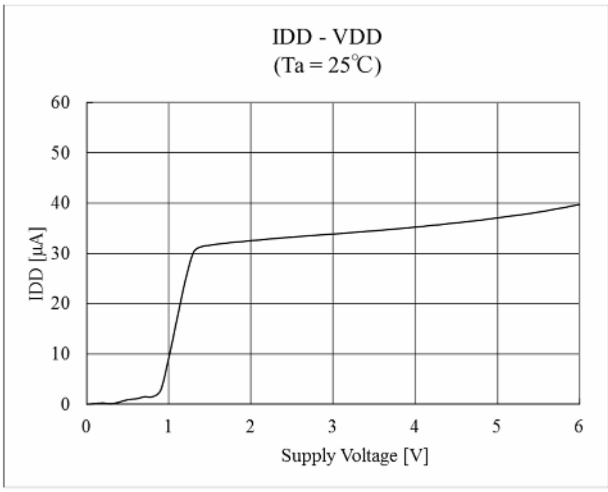


Figure 9.2 Current consumption vs. Power supply Voltage

[9. Typical Operating Characteristics (for reference) continuation]

■Output voltage – Output current characteristic (VDD=1.6V、Ta=25°C)

■Output voltage – Output current characteristic (VDD=5V、Ta=25°C)

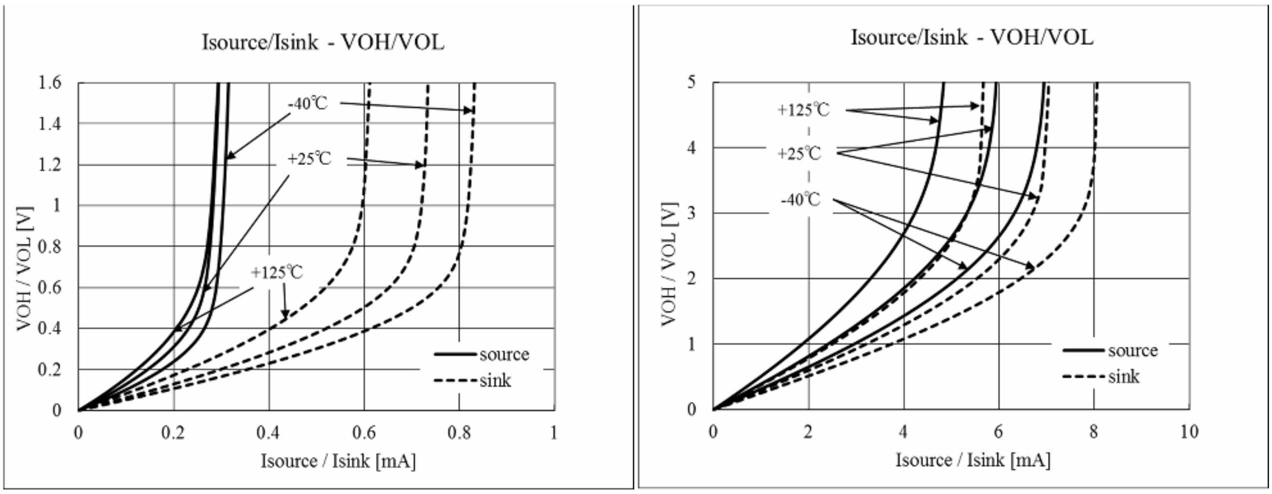


Figure 9.3 Output voltage vs. Output current

■Closed loop gain – frequency characteristic (VDD=1.6V , Ta=25°C)

■Closed loop gain – frequency characteristic (VDD=1.6V , Ta=25°C)

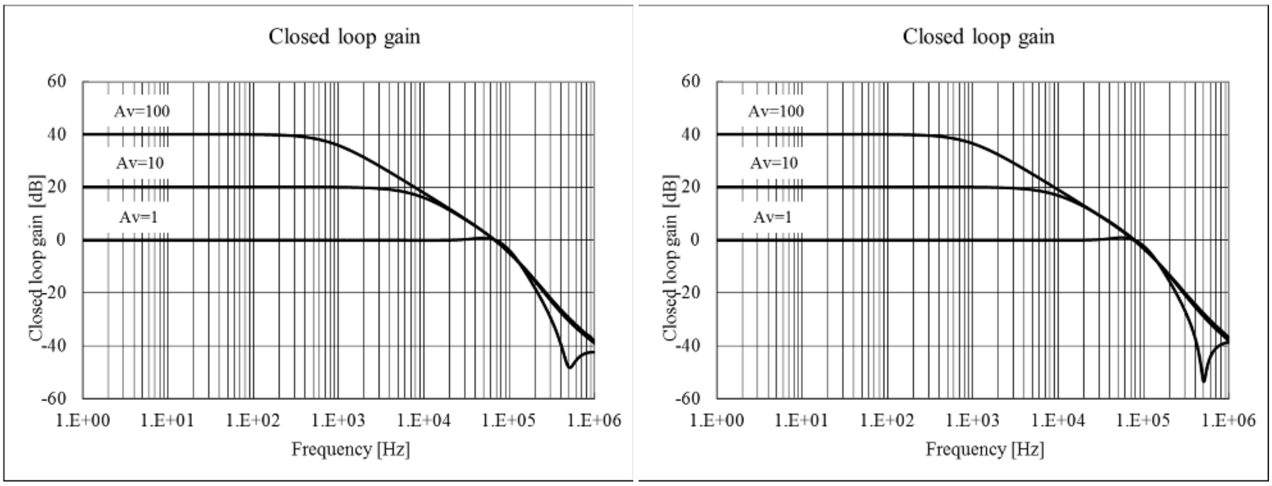


Figure 9.4 Closed loop gain vs. Frequency

[9. Typical Operating Characteristics (for reference) continuation]

■Open loop gain/phase – frequency characteristic (VDD=1.6V、Ta=25°C)

■Open loop gain/phase – frequency characteristic (VDD=5V、Ta=25°C)

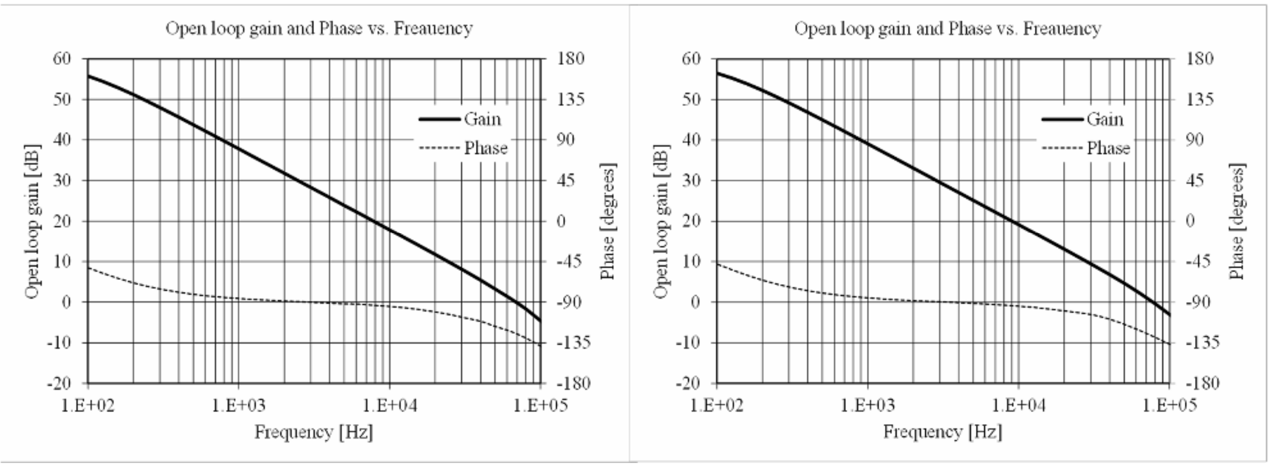


Figure 9.5 Open loop gain/phase vs. Frequency

■Output impedance – frequency characteristic (VDD=1.6V , Ta=25°C)

■Output impedance – frequency characteristic (VDD=5.0V , Ta=25°C)

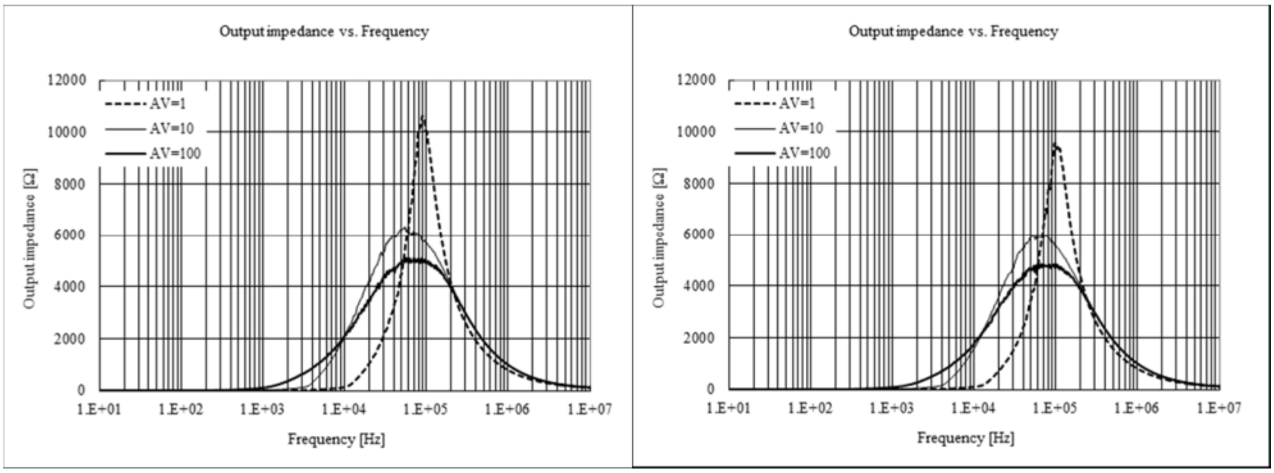


Figure 9.6 Output impedance vs. Frequency

[9. Typical Operating Characteristics (for reference) continuation]

■Large signal pulse response
(VDD/VSS=+0.8V / -0.8V, Ta=25°C,CL=100pF)

■Large signal pulse response
(VDD/VSS=+2.5V / -2.5V, Ta=25°C , CL=100pF)

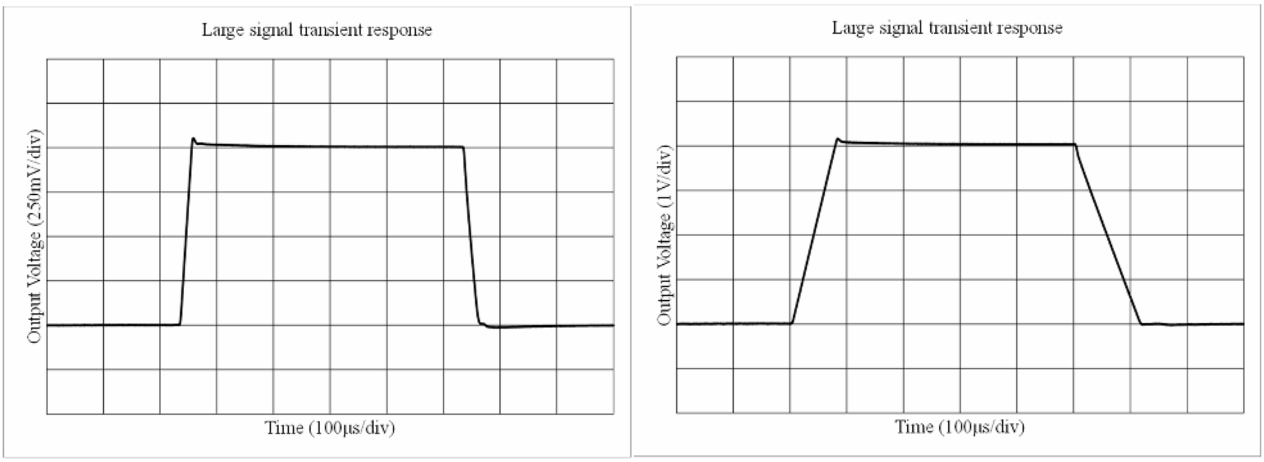


Figure 9.7 Large signal pulse response

■Small signal pulse response
(VDD/VSS=+0.8V / -0.8V, Ta=25°C,CL=100pF)

■Small signal pulse response
(VDD/VSS=+2.5V / -2.5V, Ta=25°C , CL=100pF)

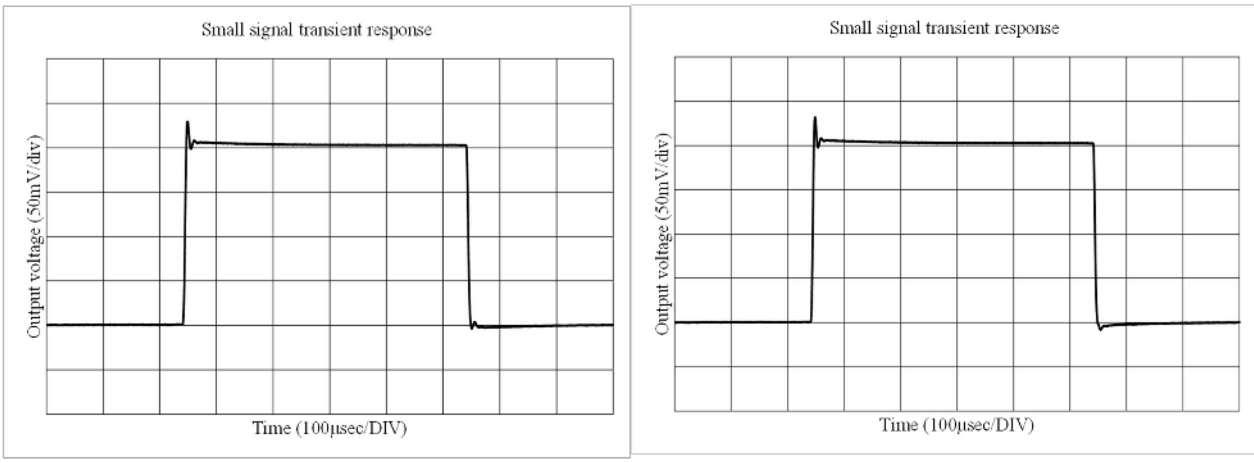


Figure 9.8 Small signal pulse response

[9. Typical Operating Characteristics (for reference) continuation]

■Negative side overload recovery time
(VDD/VSS=+2.5V/-2.5V , Ta=25°C)

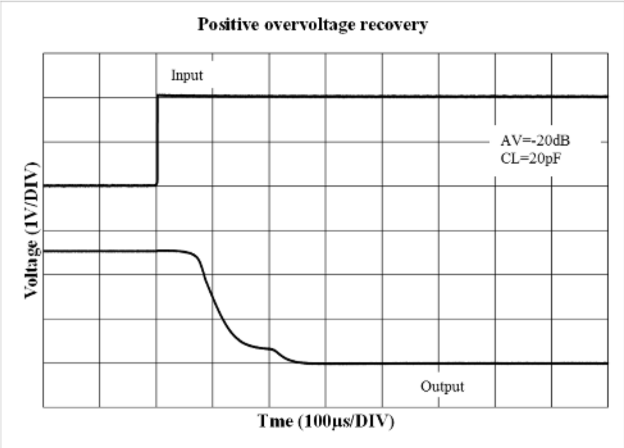


Figure 9.9 Positive side overload recovery time

■Negative side overload recovery time
(VDD/VSS=+2.5V/-2.5V , Ta=25°C)

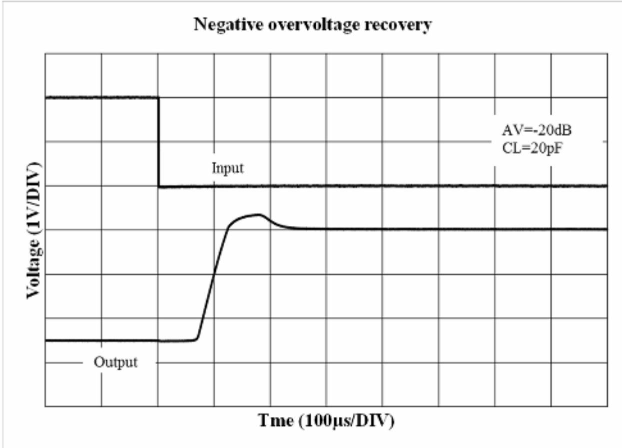


Figure 9.10 Negative side overload recovery

■CMRR characteristic

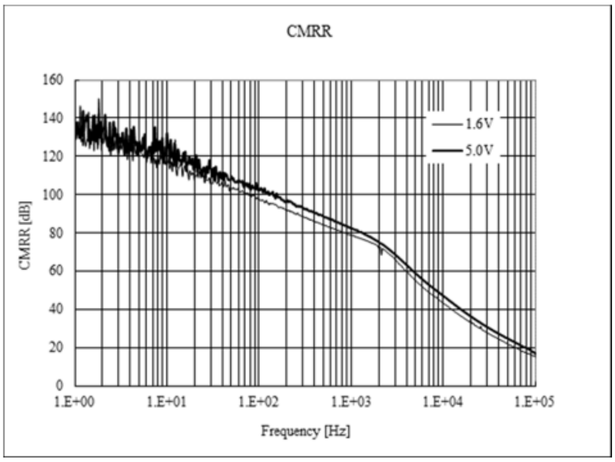


Figure 9.11 CMRR vs. Frequency

[9. Typical Operating Characteristics (for reference) continuation]

■PSRR (VDD=1.6V , Ta=25°C)

■PSRR (VDD=5.0V , Ta=25°C)

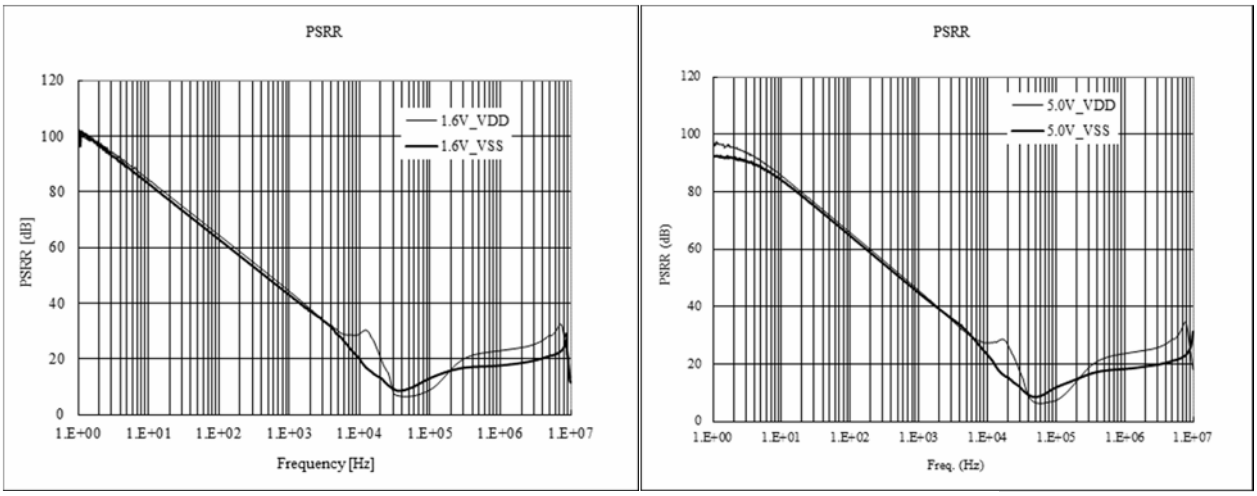


Figure 9.12 PSRR vs. Frequency

■Max. output voltage – frequency characteristic
(VDD =1.6V, Ta=25°C,Av=1 , RL=47kΩ)

■Max. output voltage – frequency characteristic
(VDD =5V, Ta=25°C,Av=1 , RL=47kΩ)

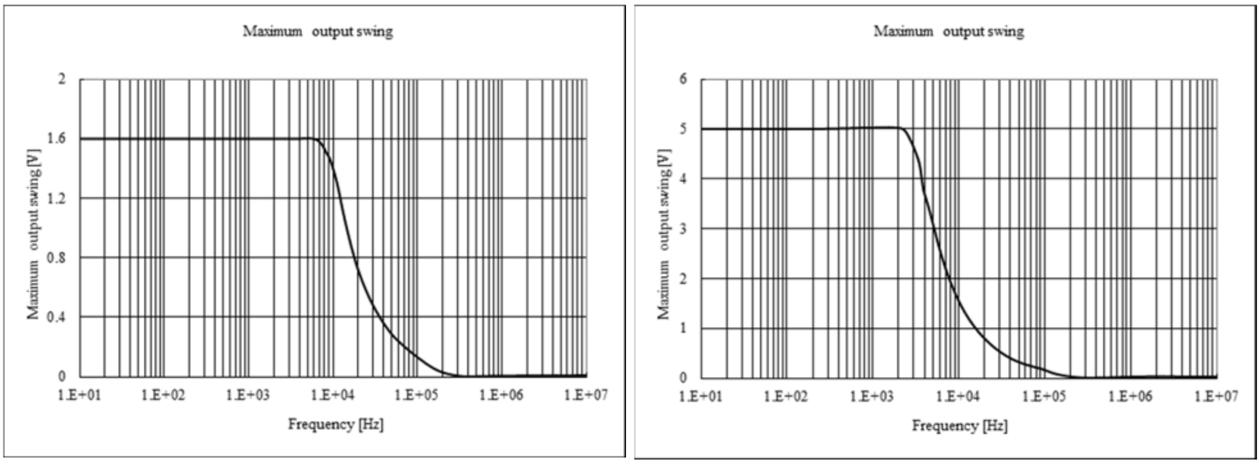
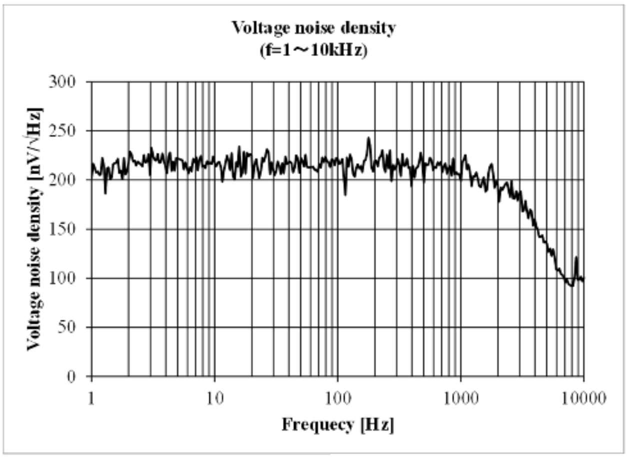


Figure 9.13 Max. output voltage vs. Frequency

[9. Typical Operating Characteristics (for reference) continuation]

■Input voltage noise – frequency characteristic
(VDD=1.6V , Ta=25°C , f=1~10kHz)



■Input voltage noise – frequency characteristic
(VDD=5.0V , Ta=25°C , f=1~10kHz)

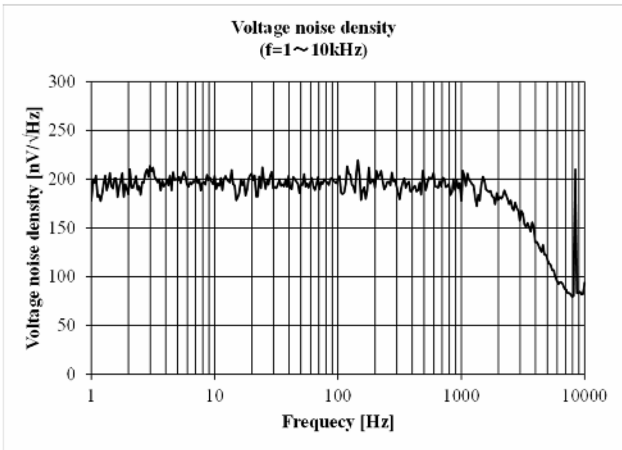
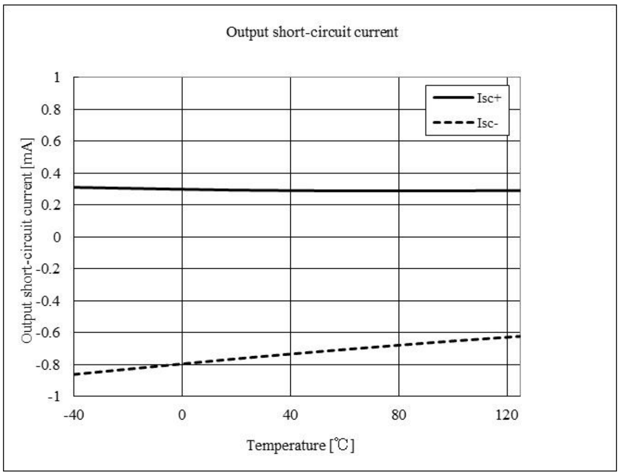


Figure 9.14 Input voltage noise vs. Frequency

■Output short current – temperature characteristic
(VDD =1.6V , Ta=-40 to 125°C)



■Output short current – temperature characteristic
(VDD =5.0V , Ta=-40 to 125°C)

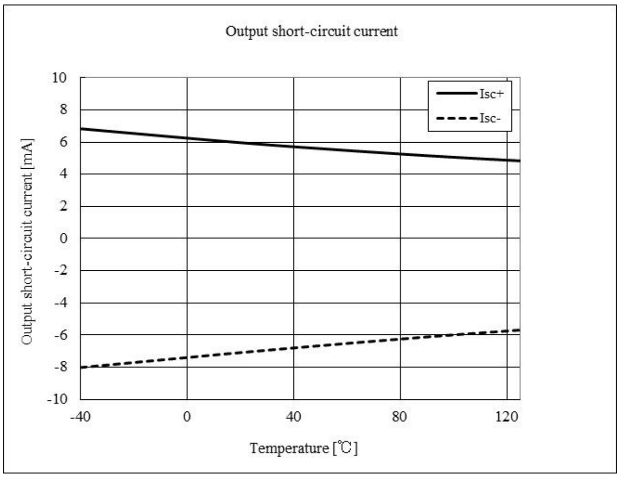


Figure 9.15 Output short current vs. Temperature

[9. Typical Operating Characteristics (for reference) continuation]

■Output short current – power supply characteristic

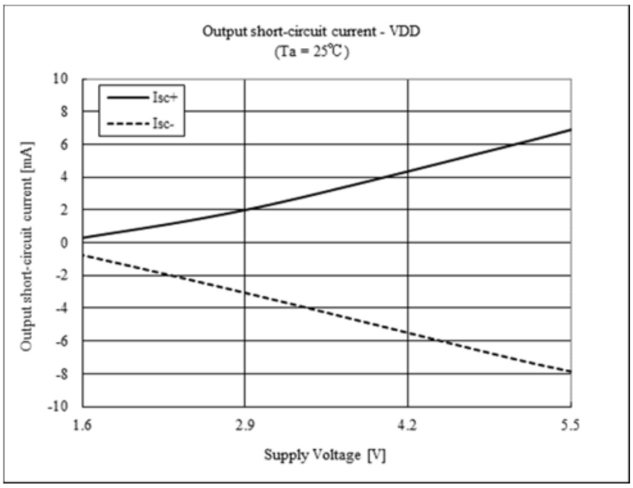


Figure 9.16 Output short current vs. Supply voltage

■Input Bias current - temperature

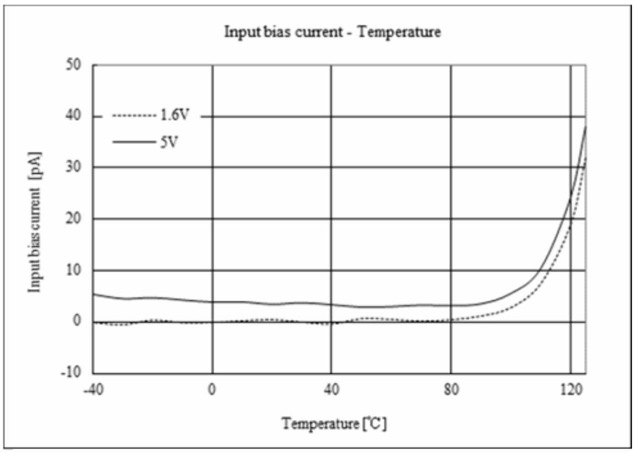


Figure 9.17 Input Bias current vs. Temperature

[9. Typical Operating Characteristics (for reference) continuation]

■Input offset voltage – temperature characteristic

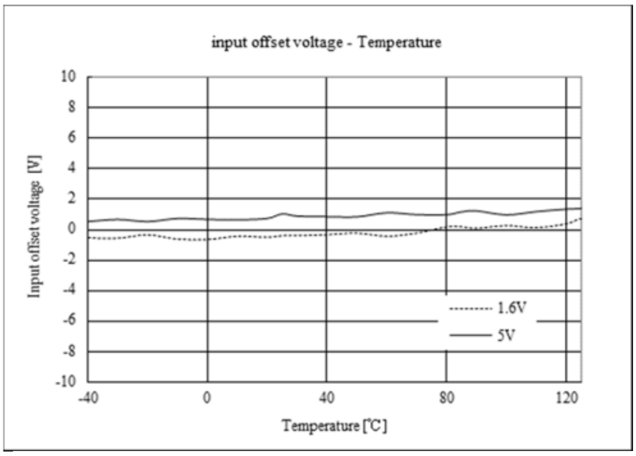


Figure 9.18 Input offset voltage vs. Temperature

■Distribution of Input offset drift (VDD=5V , Ta=-40 to 125°C)

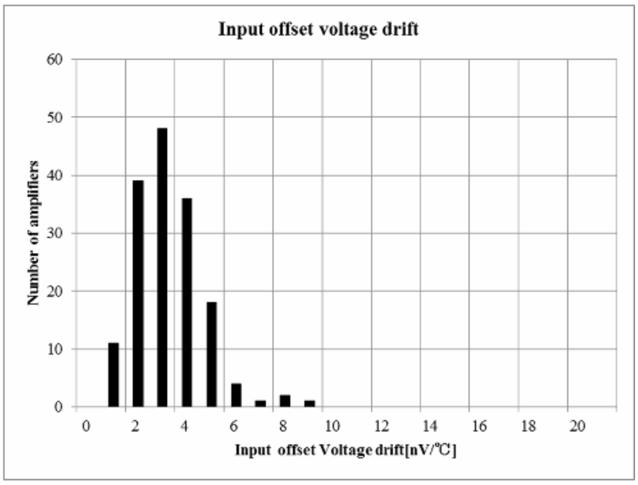


Figure 9.19 Distribution of Input offset drift

10. Restriction of Comparator Operation

Although an operational amplifier may be used as a comparator, in case of AK8473 this is not recommended.

In order that AK2973 may realize low power consumption, the output stage is designed optimally. The output stage is adjusting consumption current by closing a loop. But, since the loop does not close when AK2973 is used by an open-loop, adjustment of consumption current may become impossible. Therefore, as shown in this Figure 10.1, consumption current may become very large if this is used as a comparator.

In addition, even when designed as a voltage follower(BUFFER), In the outside of the range of large amplitude voltage gain conditions[0.1V<Vout<VDD-0.1V], since the element of an output stage separates from a saturated area and a loop does not close, consumption current may become large.

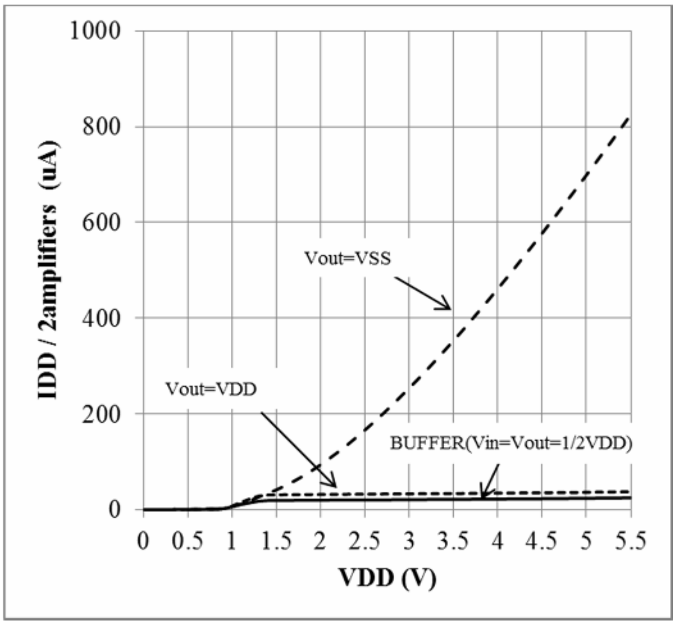


Figure 10.1 Current consumption vs. Supply voltage

11. Notes for a board design

The features of AK2973 are a maximum of ±10μV, super-low offset, and a zero drift. Therefore, also in a board design, especially cautions are required. In an unsuitable board layout, it has big influence on the characteristic.

11.1. About connection of a decoupling capacitor

If AK2973 is influenced to the impedance and inductance of a power supply, the characteristic may deteriorate. If possible, please connect the decoupling capacitor between power supplies near the power supply pin.

11.2. About the Seebeck effect

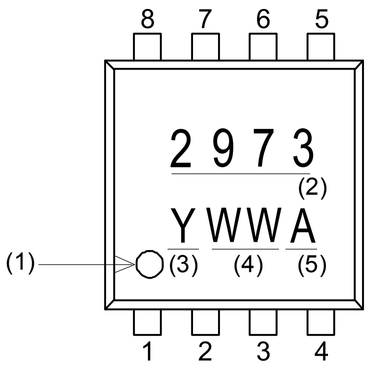
The thermoelectric voltage which occurs in the connection of a different metal is known as the Seebeck effect. On a board, it generates in the bonded surface of solder, substrate wiring, a pin, etc. Therefore, please take care that a difference in temperature does not occur over the whole substrate. If the Seebeck effect occurs, AK2973 will amplify this voltage. In order to prevent this, keep a thermal equilibrium state and be careful also about the leak path on a board.

A) Lay out dummy parts. (Make environment of a difference input terminal the same.)
B) Lay out a guard ring for differential input pin.
C) Lay out a ground plane etc. and extend heat on the whole board.

12. Package

12.1 Marking

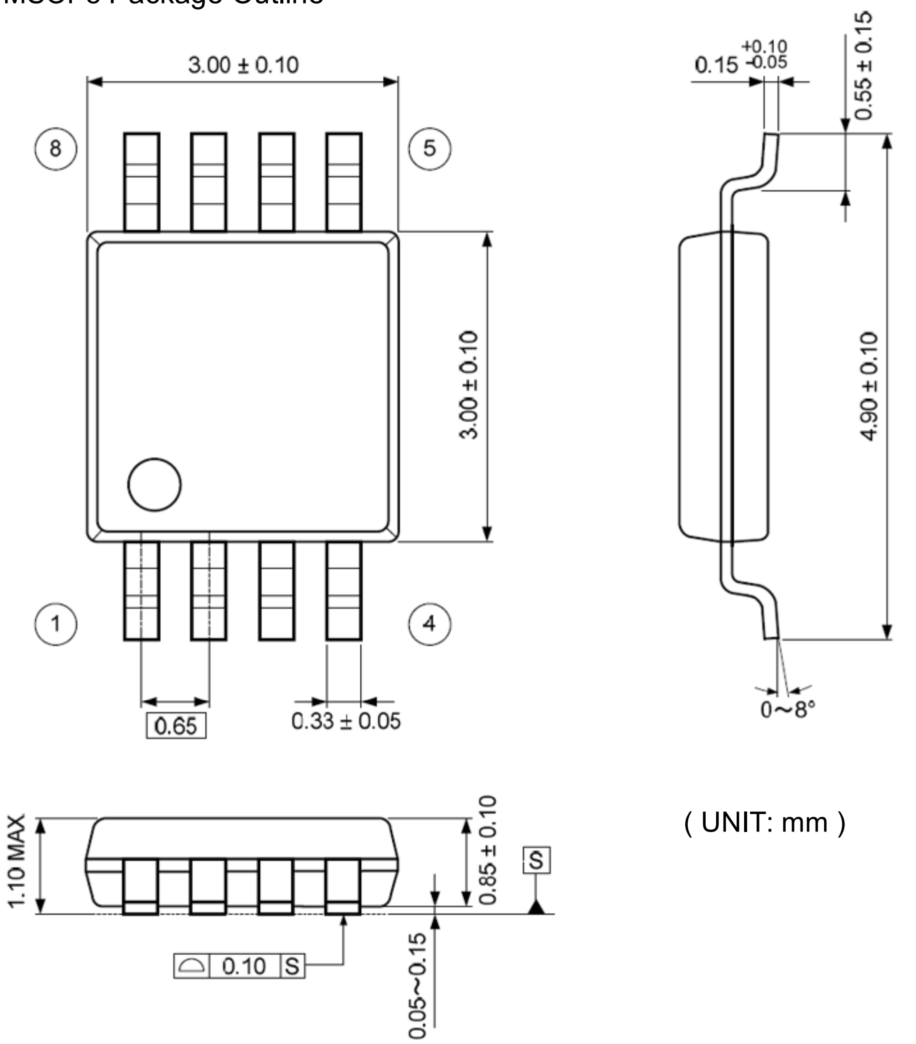
- MSOP8



(1) 1 pin
(2) Part No.（AK2973:2973）
(3) Date code (Year)
(4) Date code (Week)
(5) In-house control code

12.2 Outline Dimensions

- MSOP8 Package Outline



(UNIT: mm)

-

13. Ordering Guide

AK2973H	–40 ~ 125°C	8-pin MSOP

IMPORTANT NOTICE

0. Asahi Kasei Microdevices Corporation (“AKM”) reserves the right to make changes to the information contained in this document without notice. When you consider any use or application of AKM product stipulated in this document (“Product”), please make inquiries the sales office of AKM or authorized distributors as to current status of the Products.
1. All information included in this document are provided only to illustrate the operation and application examples of AKM Products. AKM neither makes warranties or representations with respect to the accuracy or completeness of the information contained in this document nor grants any license to any intellectual property rights or any other rights of AKM or any third party with respect to the information in this document. You are fully responsible for use of such information contained in this document in your product design or applications. AKM ASSUMES NO LIABILITY FOR ANY LOSSES INCURRED BY YOU OR THIRD PARTIES ARISING FROM THE USE OF SUCH INFORMATION IN YOUR PRODUCT DESIGN OR APPLICATIONS.
2. The Product is neither intended nor warranted for use in equipment or systems that require extraordinarily high levels of quality and/or reliability and/or a malfunction or failure of which may cause loss of human life, bodily injury, serious property damage or serious public impact, including but not limited to, equipment used in nuclear facilities, equipment used in the aerospace industry, medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, devices related to electric power, and equipment used in finance-related fields. Do not use Product for the above use unless specifically agreed by AKM in writing.
3. Though AKM works continually to improve the Product’s quality and reliability, you are responsible for complying with safety standards and for providing adequate designs and safeguards for your hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of the Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption.
4. Do not use or otherwise make available the Product or related technology or any information contained in this document for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). When exporting the Products or related technology or any information contained in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. The Products and related technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
5. Please contact AKM sales representative for details as to environmental matters such as the RoHS compatibility of the Product. Please use the Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. AKM assumes no liability for damages or losses occurring as a result of noncompliance with applicable laws and regulations.
6. Resale of the Product with provisions different from the statement and/or technical features set forth in this document shall immediately void any warranty granted by AKM for the Product and shall not create or extend in any manner whatsoever, any liability of AKM.
7. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of AKM.