

## Precision, Low Noise, Rail-to-Rail Output, CMOS Operational Amplifier

### ■ GENERAL DESCRIPTION

The NJU7076/NJU7077/NJU7078 is a high precision Rail-to-Rail output Single/Dual/Quad CMOS operational amplifier featuring a low noise of 10nV/ $\sqrt{\text{Hz}}$  typ., low input offset voltage of 150 $\mu\text{V}$  max., low temperature drift of 0.5 $\mu\text{V}/^\circ\text{C}$  typ. and low bias current of 1pA typ..

The output swing can reach 20 mV from the rails, while driving a 10k $\Omega$  load (at 5V operation). The NJU7076/NJU7077/NJU7078 also has a high RF noise immunity which can reduce malfunctions caused by RF noises from mobile phones and others. The combination of these specifications makes the NJU7076/ NJU7077/NJU7078 well-suited for sensor applications such as a temperature sensor, weight sensor and others, high precision current sensing amplifiers and current voltage converters.

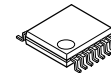
### ■ PACKAGE OUTLINE



NJU7076F  
(SOT-23-5)



NJU7077R  
(MSOP8(VSP8))



NJU7078V  
(SSOP14)

### ■ FEATURES

- High Precision
  - Low Offset Voltage
 

NJU7076/NJU7077	150 $\mu\text{V}$ max.
NJU7078	200 $\mu\text{V}$ max.
  - Low Offset Voltage Drift
 

	0.5 $\mu\text{V}/^\circ\text{C}$ typ.
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- Low Noise
 

	10nV/ $\sqrt{\text{Hz}}$ typ.
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- Low Input Bias Current
 

	1pA typ.
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- Rail-to-Rail Output
 

$R_L=10\text{k}\Omega$	0.02V to 4.98V typ. ( $V^+=5\text{V}$ )
$R_L=600\Omega$	0.08V to 4.92V typ. ( $V^+=5\text{V}$ )
- Ground sense
- RF Noise Immunity
- Operating Voltage
 

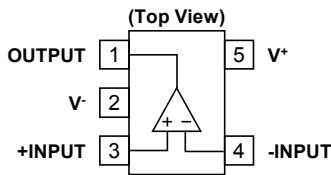
	2.2V to 5.5V
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- Unity-Gain Stable
- Package
 

NJU7076	SOT-23-5
NJU7077	MSOP8(VSP8)*
	*MEET JEDEC MO-187-DA
NJU7078	SSOP14

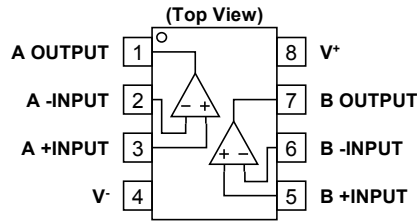
### ■ APPLICATIONS

- Thermocouple / Thermopile Amplifiers
- Strain Gauge / Pressure sensor Amplifiers
- Load Cell and Bridge Transducer Amplifiers
- High Resolution Data Acquisition
- Precision Current Sensing
- Battery monitoring
- Photo-Diode pre amplifier

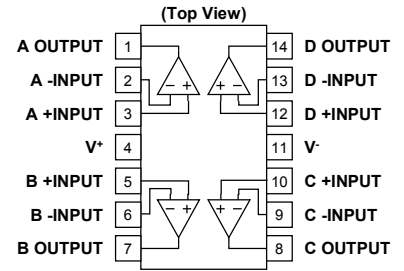
## ■ PIN CONFIGURATION



NJU7076F



NJU7077R



NJU7078V

## ■ ABSOLUTE MAXIMUM RATINGS(Ta=25°C, unless otherwise noted.)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	$V^+ - V^-$	7 <sup>(1)</sup>	V
Differential Input Voltage <sup>(2)</sup>	$V_{ID}$	$\pm 7$ <sup>(3)</sup>	V
Input Voltage	$V_{IN}$	$V^- - 0.3$ to $V^+ + 0.3$	V
Power Dissipation <sup>(4)</sup>		(2-layer / 4-layer)	mW
SOT-23-5	$P_D$	480 / 650	mW
MSOP8(VSP8)		500 / 660	mW
SSOP14		555 / 690	mW
Operating Temperature Range	$T_{opr}$	-40 to +125	°C
Storage Temperature Range	$T_{stg}$	-55 to +150	°C

(1) Supply Voltage is the voltage difference between  $V^+$  and  $V^-$ .

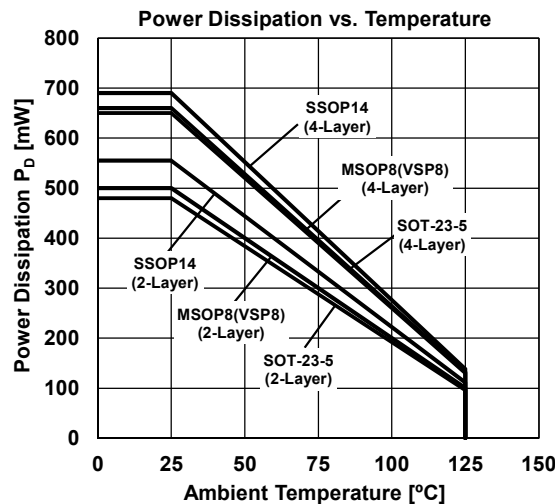
(2) Differential voltage is the voltage difference between +INPUT and -INPUT.

(3) For supply voltage less than 7V, the absolute maximum rating is equal to the supply voltage.

(4) Power dissipation is the power that can be consumed by the IC at  $T_a=25^\circ\text{C}$ , and is the typical measured value based on JEDEC condition. When using the IC over  $T_a=25^\circ\text{C}$  subtract the value  $[\text{mW}/^\circ\text{C}] = P_D / (T_{stg}(\text{MAX}) - 25)$  per temperature.

2-layer: EIA/JEDEC STANDARD Test board (76.2x114.3x1.6mm, 2layers, FR-4) mounting

4-layer: EIA/JEDEC STANDARD Test board (76.2x114.3x1.6mm, 4layers, FR-4) mounting



## ■ RECOMMENDED OPERATING CONDITIONS(Ta=25°C)

PARAMETER	Value	UNIT
Supply Voltage	+2.2 to +5.5 ( $\pm 1.1$ to $\pm 2.75$ )	V

**■ ELECTRICAL CHARACTERISTICS**( $V^+=5V$ ,  $V^-=0V$ ,  $V_{COM}=V^+/2$ ,  $T_a=25^\circ C$ , unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
<b>DC CHARACTERISTICS</b>						
Input Offset Voltage NJU7076/NJU7077	$V_{IO}$	$T_a=-40^\circ C$ to $125^\circ C$	-	20	150	$\mu V$
			-	-	400	$\mu V$
			-	20	200	$\mu V$
			-	-	400	$\mu V$
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$T_a=-40^\circ C$ to $125^\circ C$ <sup>(5)</sup>	-	0.5	5	$\mu V/^\circ C$
			-	-	-	-
Input Bias Current	$I_B$		-	1	-	pA
Input Offset Current	$I_{IO}$		-	1	-	pA
Open-Loop Voltage Gain	$A_V$	$V_O=0.5V$ to $4.5V$ , $R_L=10k\Omega$ to $2.5V$	100	130	-	dB
		$V_O=0.5V$ to $4.5V$ , $R_L=10k\Omega$ to $2.5V$ , $T_a=-40^\circ C$ to $125^\circ C$	100	-	-	dB
Common-Mode Rejection Ratio	CMR	$V_{ICM}=0V$ to $4V$	70	90	-	dB
		$V_{ICM}=0V$ to $4V$ , $T_a=-40^\circ C$ to $125^\circ C$	70	-	-	dB
Supply Voltage Rejection Ratio	SVR	$V^+=2.2V$ to $5.5V$	70	90	-	dB
		$V^+=2.2V$ to $5.5V$ , $T_a=-40^\circ C$ to $125^\circ C$	70	-	-	dB
High-level Output Voltage	$V_{OH}$	$R_L=10k\Omega$ to $2.5V$	4.95	4.98	-	V
		$R_L=10k\Omega$ to $2.5V$ , $T_a=-40^\circ C$ to $125^\circ C$	4.95	-	-	V
		$R_L=600\Omega$ to $2.5V$	4.85	4.92	-	V
		$R_L=600\Omega$ to $2.5V$ , $T_a=-40^\circ C$ to $125^\circ C$	4.85	-	-	V
		$I_{SOURCE}=2mA$	4.9	4.96	-	V
		$I_{SOURCE}=2mA$ , $T_a=-40^\circ C$ to $125^\circ C$	4.85	-	-	V
Low-level Output Voltage	$V_{OL}$	$R_L=10k\Omega$ to $2.5V$	-	0.02	0.05	V
		$R_L=10k\Omega$ to $2.5V$ , $T_a=-40^\circ C$ to $125^\circ C$	-	-	0.05	V
		$R_L=600\Omega$ to $2.5V$	-	0.08	0.15	V
		$R_L=600\Omega$ to $2.5V$ , $T_a=-40^\circ C$ to $125^\circ C$	-	-	0.2	V
		$I_{SINK}=2mA$	-	0.04	0.1	V
		$I_{SINK}=2mA$ , $T_a=-40^\circ C$ to $125^\circ C$	-	-	0.15	V
Common-Mode Input Voltage Range	$V_{ICM}$	CMR $\geq$ 70dB	0	-	4	V
		CMR $\geq$ 70dB, $T_a=-40^\circ C$ to $125^\circ C$	0	-	4	V
Supply Current(All Amplifiers)	$I_{SUPPLY}$	No Signal, $R_L=OPEN$	-	0.6	0.9	mA
		No Signal, $R_L=OPEN$ , $T_a=-40^\circ C$ to $125^\circ C$	-	-	0.9	mA
		No Signal, $R_L=OPEN$	-	1.2	1.8	mA
		No Signal, $R_L=OPEN$ , $T_a=-40^\circ C$ to $125^\circ C$	-	-	1.8	mA
		No Signal, $R_L=OPEN$	-	2.3	3.5	mA
		No Signal, $R_L=OPEN$ , $T_a=-40^\circ C$ to $125^\circ C$	-	-	3.5	mA
<b>AC CHARACTERISTICS</b>						
Gain Bandwidth Product	GBW	$G_V=40dB$ , $R_F=100k\Omega$ , $R_L=10k\Omega$ to $2.5V$ , $C_L=20pF$ , $f=100kHz$	-	1.3	-	MHz
Phase Margin	$\Phi_m$	$G_V=40dB$ , $R_F=100k\Omega$ , $R_L=10k\Omega$ to $2.5V$ , $C_L=20pF$	-	60	-	deg
Gain Margin	$G_m$	$G_V=40dB$ , $R_F=100k\Omega$ , $R_L=10k\Omega$ to $2.5V$ , $C_L=20pF$	-	12	-	dB
Equivalent Input Noise Voltage	$e_n$	$f=1kHz$	-	10	-	nV/ $\sqrt{Hz}$
Slew Rate	SR	$G_V=0dB$ , $R_L=10k\Omega$ to $2.5V$ , $C_L=20pF$ , $V_{IN}=3V_{PP}$	-	0.5	-	V/ $\mu s$
Total Harmonic Distortion + Noise	THD+N	$G_V=20dB$ , $R_L=10k\Omega$ to $2.5V$ , $f=1kHz$ , $V_O=3V_{PP}$	-	0.01	-	%
Channel Separation	CS	$f=1kHz$ , NJU7077/NJU7078	-	140	-	dB

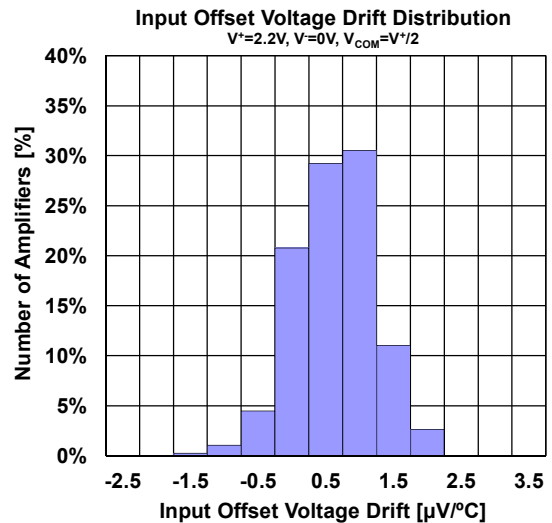
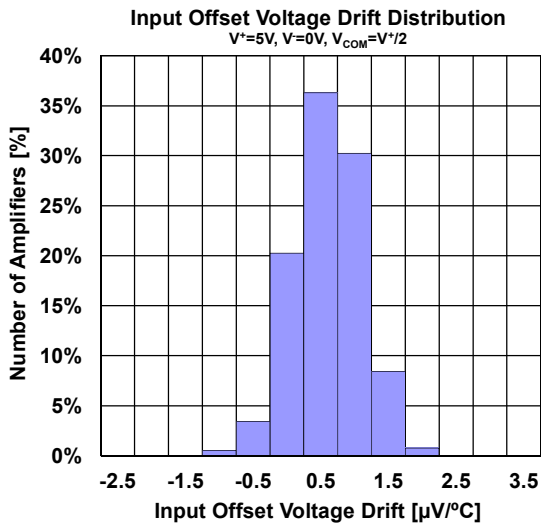
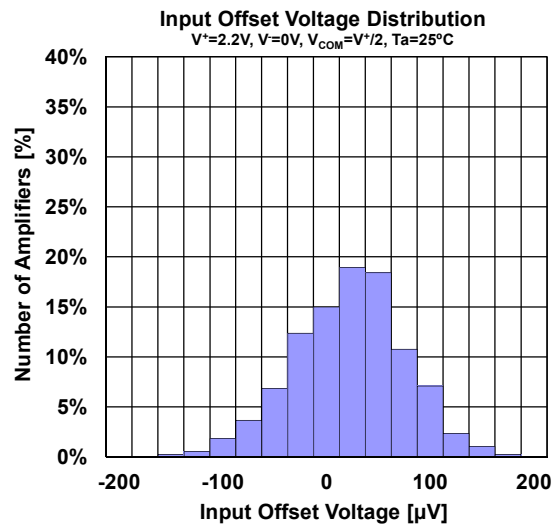
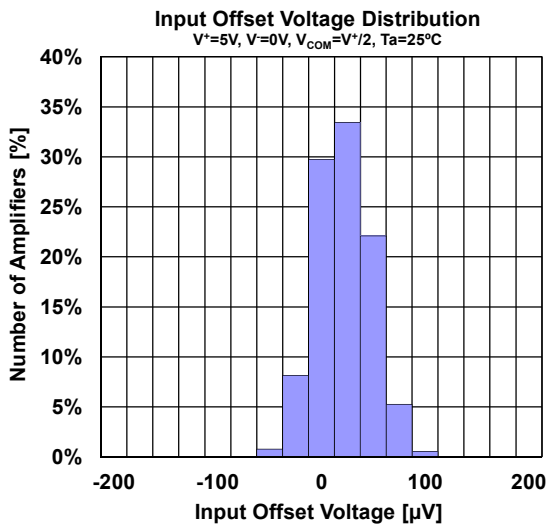
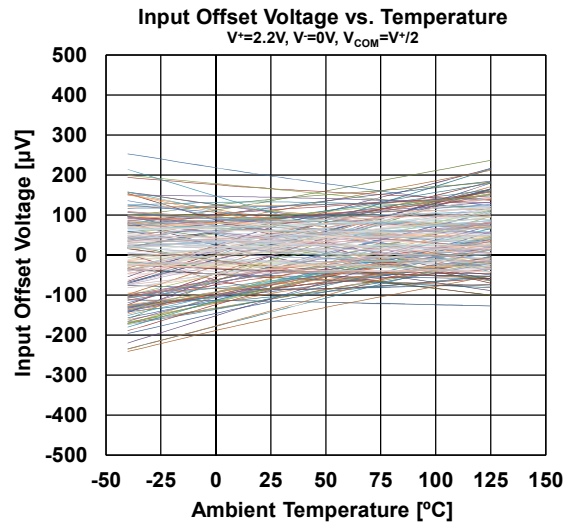
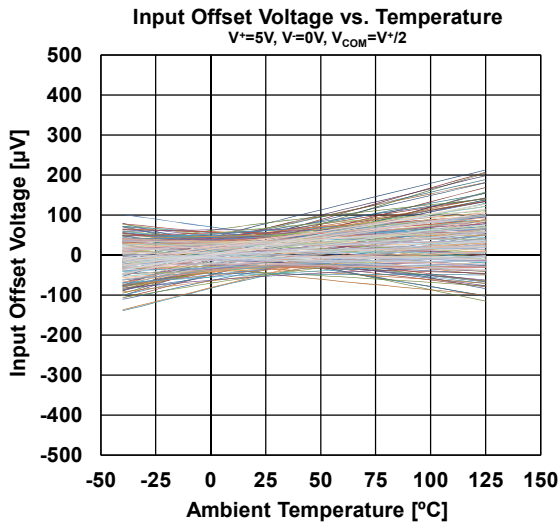
(5) Guaranteed by two points of Temperature  $-40^\circ C$  and  $+125^\circ C$

■ **ELECTRICAL CHARACTERISTICS** ( $V^+=2.2V$ ,  $V^-=0V$ ,  $V_{COM}=V^+/2$ ,  $T_a=25^\circ C$ , unless otherwise noted.)

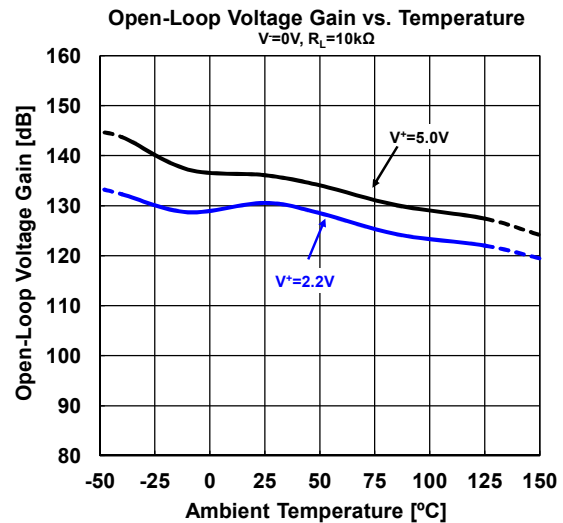
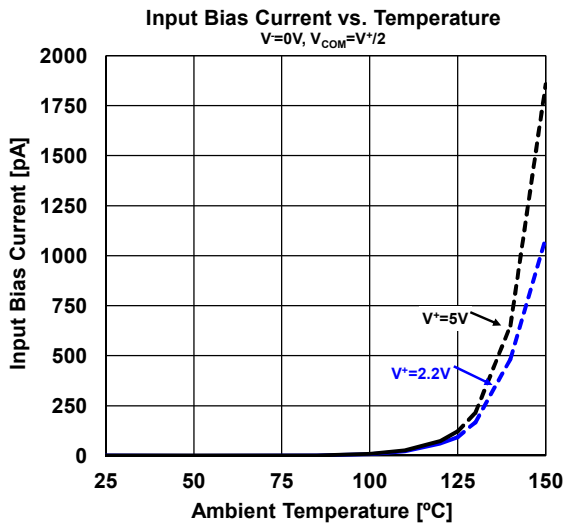
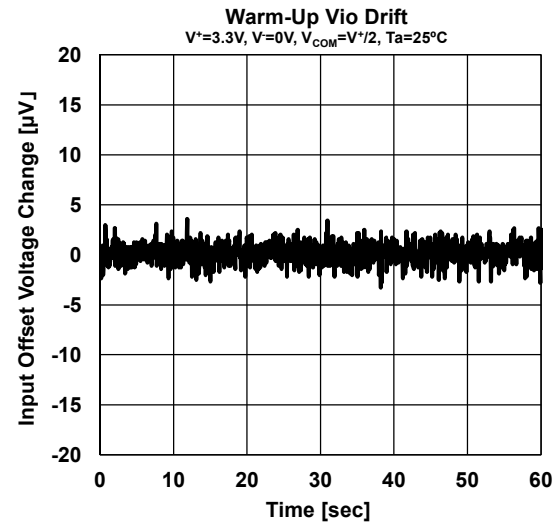
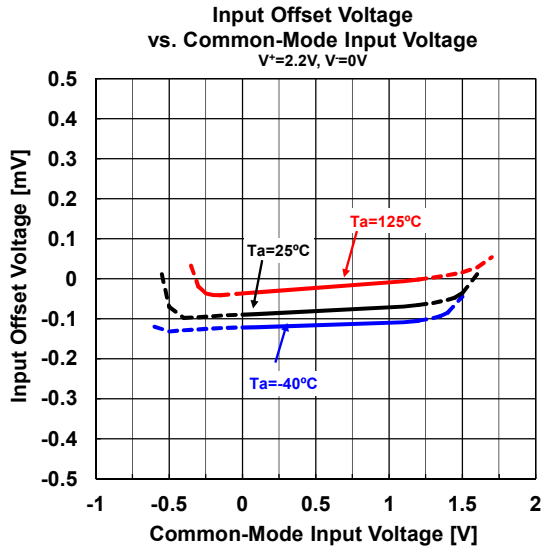
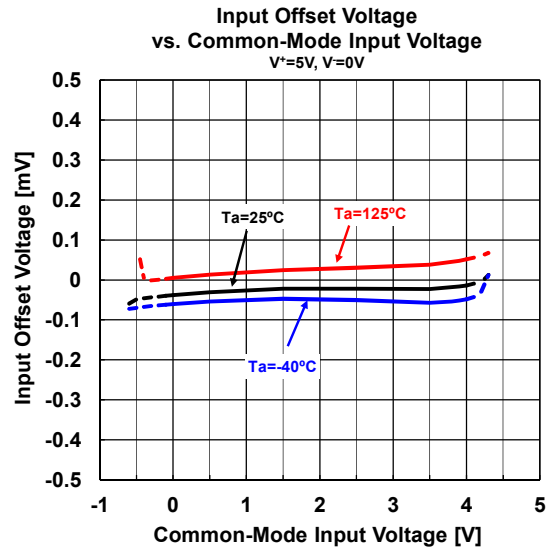
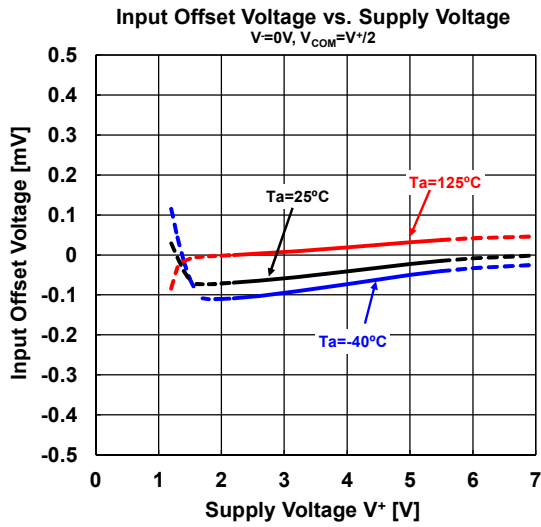
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT					
<b>DC CHARACTERISTICS</b>											
Input Offset Voltage NJU7076/NJU7077	$V_{IO}$	$T_a = -40^\circ C$ to $125^\circ C$	-	60	250	$\mu V$					
			-	-	400	$\mu V$					
NJU7078		$T_a = -40^\circ C$ to $125^\circ C$	-	60	300	$\mu V$					
			-	-	400	$\mu V$					
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$T_a = -40^\circ C$ to $125^\circ C$ <sup>(5)</sup>	-	0.6	5	$\mu V/^\circ C$					
Input Bias Current	$I_B$		-	1	-	pA					
Input Offset Current	$I_{IO}$		-	1	-	pA					
Open-Loop Voltage Gain	$A_V$	$V_O=0.6V$ to $1.6V$ , $R_L=10k\Omega$ to $1.1V$	100	130	-	dB					
		$V_O=0.6V$ to $1.6V$ , $R_L=10k\Omega$ to $1.1V$ , $T_a = -40^\circ C$ to $125^\circ C$	100	-	-	dB					
Common-Mode Rejection Ratio	CMR	$V_{ICM}=0V$ to $1.2V$	70	90	-	dB					
		$V_{ICM}=0V$ to $1.2V$ , $T_a = -40^\circ C$ to $125^\circ C$	70	-	-	dB					
High-level Output Voltage	$V_{OH}$	$R_L=10k\Omega$ to $1.1V$	2.15	2.18	-	V					
		$R_L=10k\Omega$ to $1.1V$ , $T_a = -40^\circ C$ to $125^\circ C$	2.15	-	-	V					
		$R_L=600\Omega$ to $1.1V$	2.1	2.14	-	V					
		$R_L=600\Omega$ to $1.1V$ , $T_a = -40^\circ C$ to $125^\circ C$	2.05	-	-	V					
		$I_{SOURCE}=2mA$	2.05	2.13	-	V					
		$I_{SOURCE}=2mA$ , $T_a = -40^\circ C$ to $125^\circ C$	2	-	-	V					
Low-level Output Voltage	$V_{OL}$	$R_L=10k\Omega$ to $1.1V$	-	0.02	0.05	V					
		$R_L=10k\Omega$ to $1.1V$ , $T_a = -40^\circ C$ to $125^\circ C$	-	-	0.05	V					
		$R_L=600\Omega$ to $1.1V$	-	0.06	0.1	V					
		$R_L=600\Omega$ to $1.1V$ , $T_a = -40^\circ C$ to $125^\circ C$	-	-	0.15	V					
		$I_{SINK}=2mA$	-	0.07	0.15	V					
		$I_{SINK}=2mA$ , $T_a = -40^\circ C$ to $125^\circ C$	-	-	0.2	V					
Common-Mode Input Voltage Range	$V_{ICM}$	CMR $\geq 70dB$	0	-	1.2	V					
		CMR $\geq 70dB$ , $T_a = -40^\circ C$ to $125^\circ C$	0	-	1.2	V					
Supply Current(All Amplifiers)	$I_{SUPPLY}$	No Signal, $R_L=OPEN$	-	0.55	0.82	mA					
NJU7076											
NJU7077							No Signal, $R_L=OPEN$ , $T_a = -40^\circ C$ to $125^\circ C$	-	-	0.82	mA
								-	1.0	1.5	mA
NJU7078							No Signal, $R_L=OPEN$ , $T_a = -40^\circ C$ to $125^\circ C$	-	-	1.5	mA
								-	2.0	3.0	mA
	No Signal, $R_L=OPEN$ , $T_a = -40^\circ C$ to $125^\circ C$	-	-	3.0	mA						
<b>AC CHARACTERISTICS</b>											
Gain Bandwidth Product	GBW	$G_V=40dB$ , $R_F=100k\Omega$ , $R_L=10k\Omega$ to $1.1V$ , $C_L=20pF$ , $f=100kHz$	-	1.2	-	MHz					
Phase Margin	$\Phi_m$	$G_V=40dB$ , $R_F=100k\Omega$ , $R_L=10k\Omega$ to $1.1V$ , $C_L=20pF$	-	60	-	deg					
Gain Margin	$G_m$	$G_V=40dB$ , $R_F=100k\Omega$ , $R_L=10k\Omega$ to $1.1V$ , $C_L=20pF$	-	12	-	dB					
Equivalent Input Noise Voltage	$e_n$	$f=1kHz$	-	10	-	$nV/\sqrt{Hz}$					
Slew Rate	SR	$G_V=0dB$ , $R_L=10k\Omega$ to $1.1V$ , $C_L=20pF$ , $V_{IN}=1V_{PP}$	-	0.5	-	$V/\mu s$					
Total Harmonic Distortion + Noise	THD+N	$G_V=20dB$ , $R_L=10k\Omega$ to $1.1V$ , $f=1kHz$ , $V_O=1V_{PP}$	-	0.01	-	%					
Channel Separation	CS	$f=1kHz$ , NJU7077/NJU7078	-	140	-	dB					

(5) Guaranteed by two points of Temperature  $-40^\circ C$  and  $+125^\circ C$

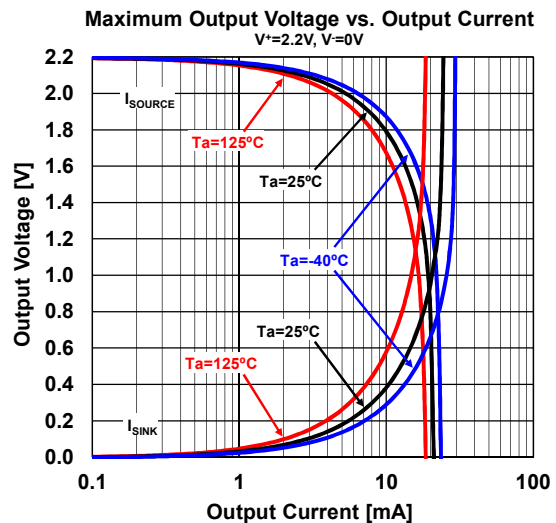
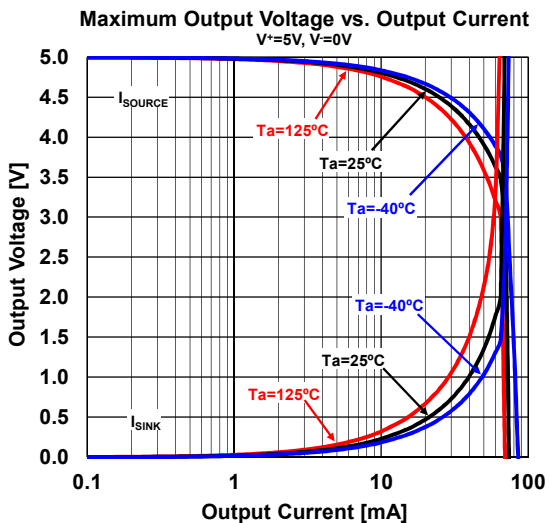
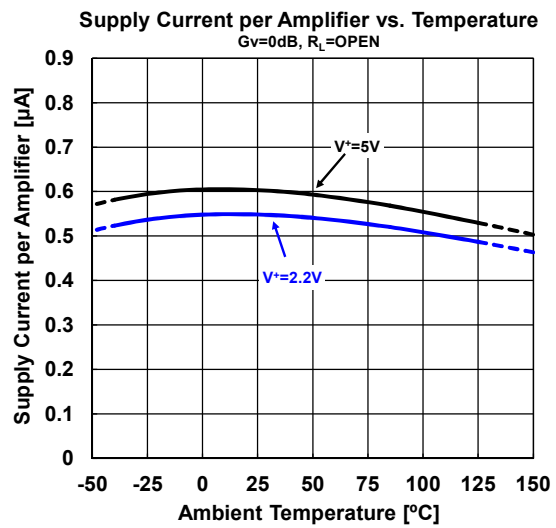
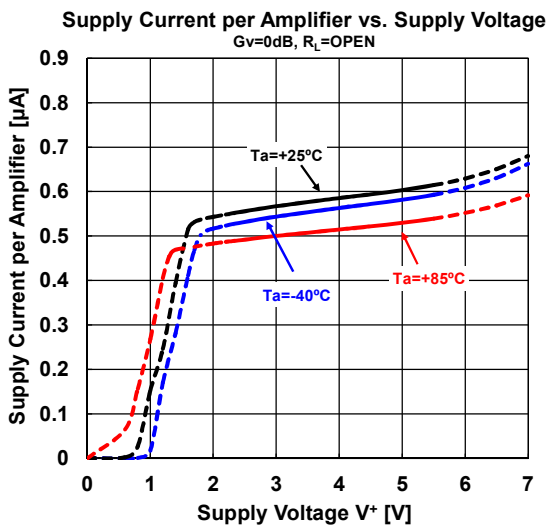
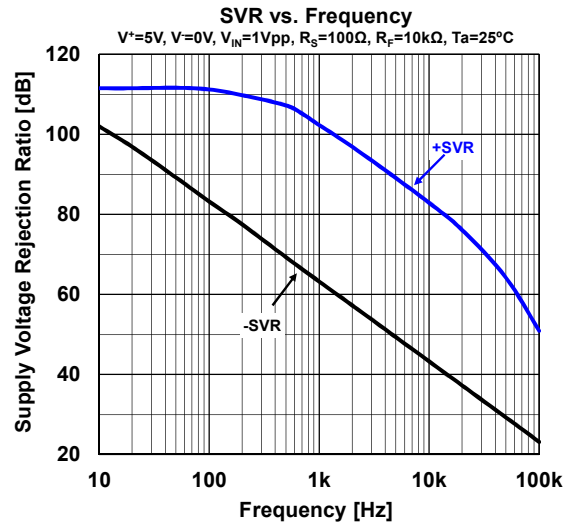
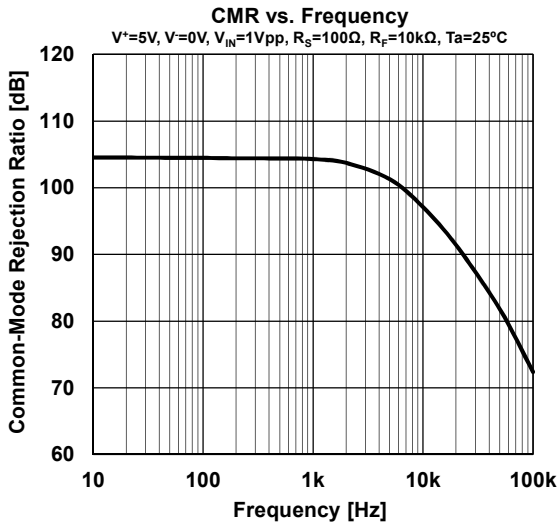
## ■ TYPICAL CHARACTERISTICS



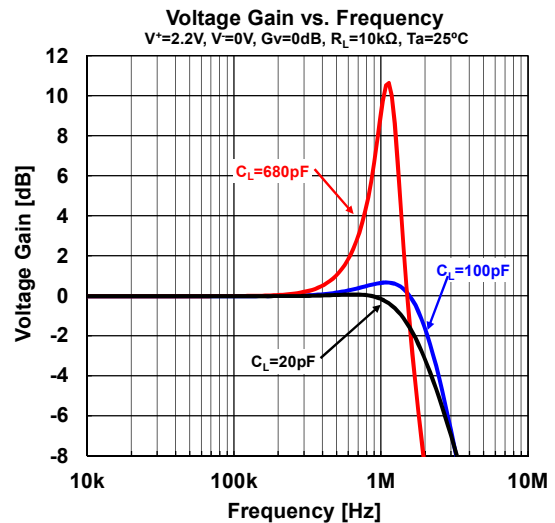
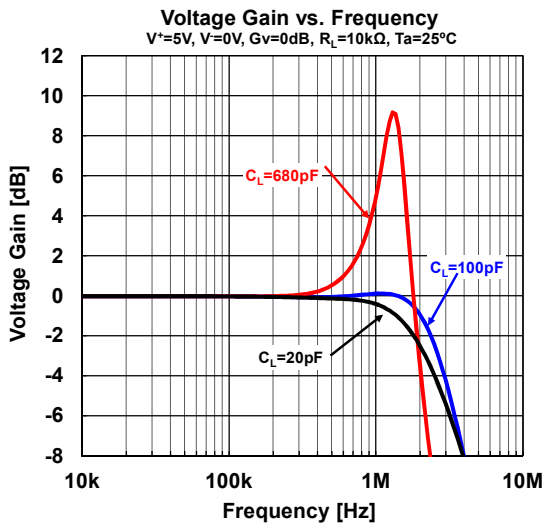
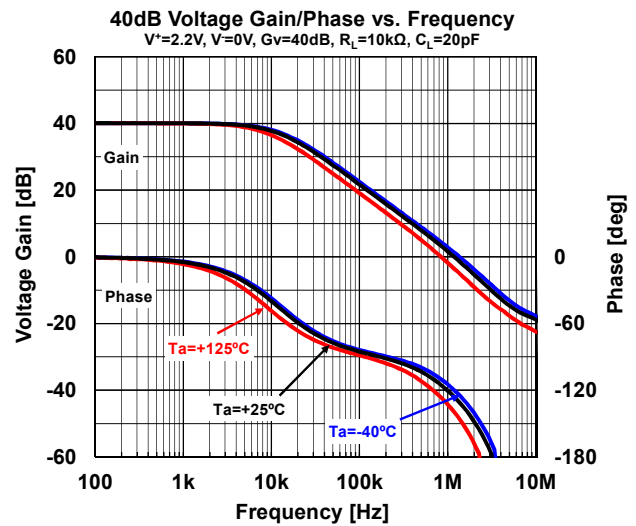
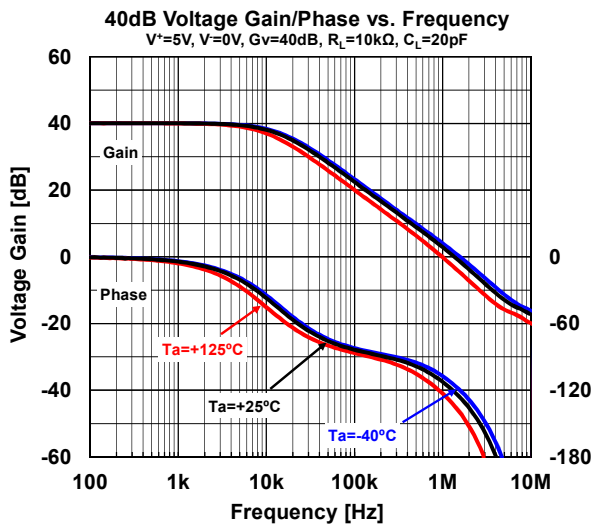
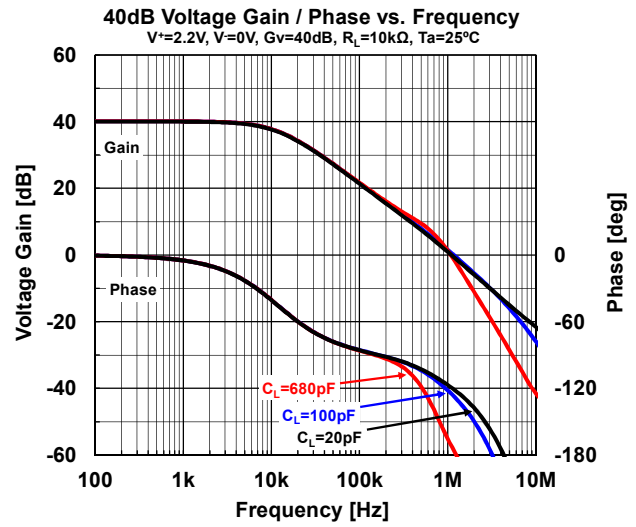
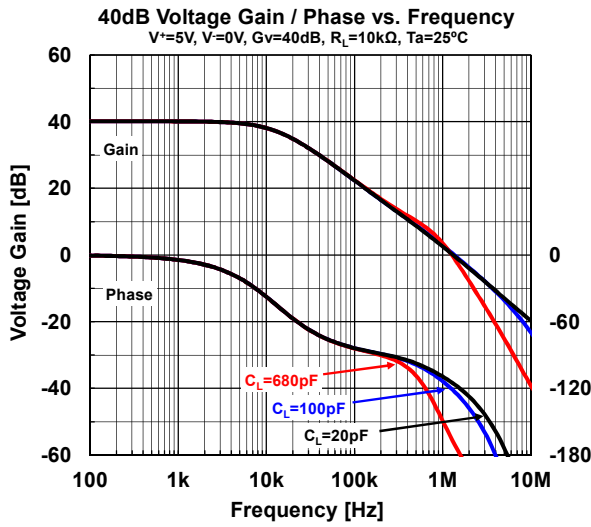
## TYPICAL CHARACTERISTICS



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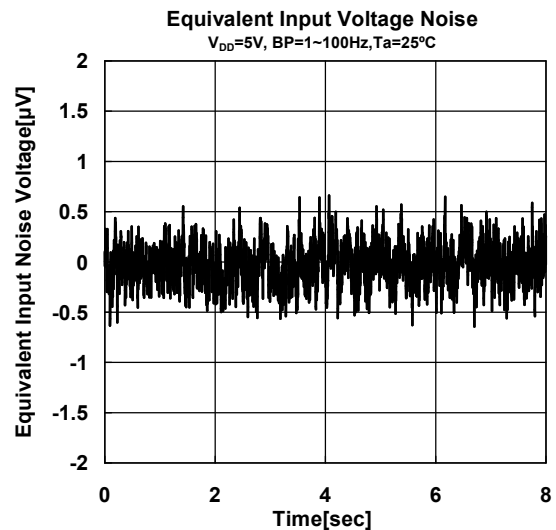
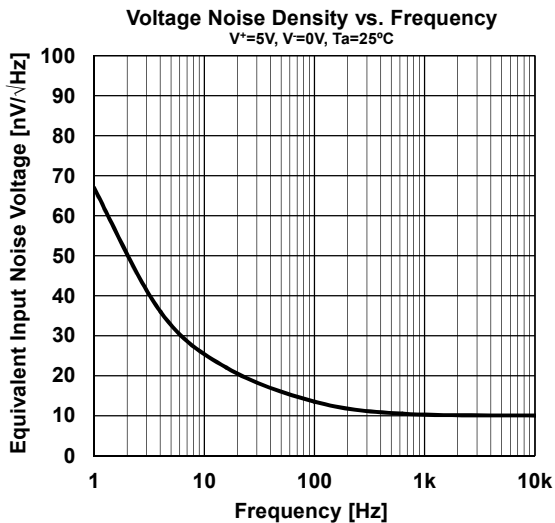
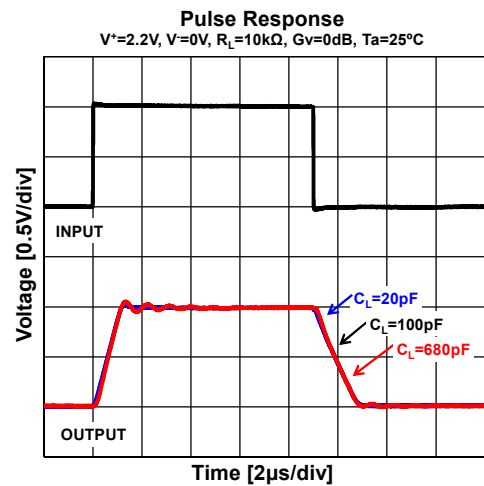
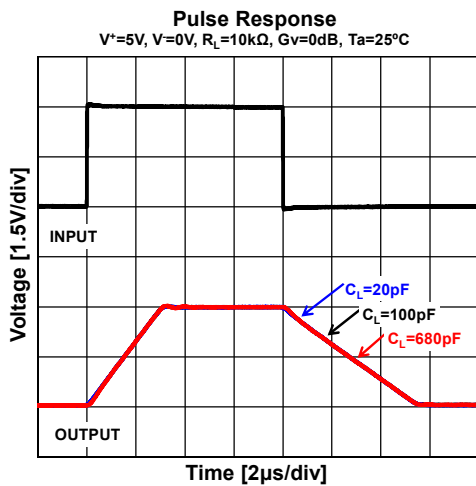
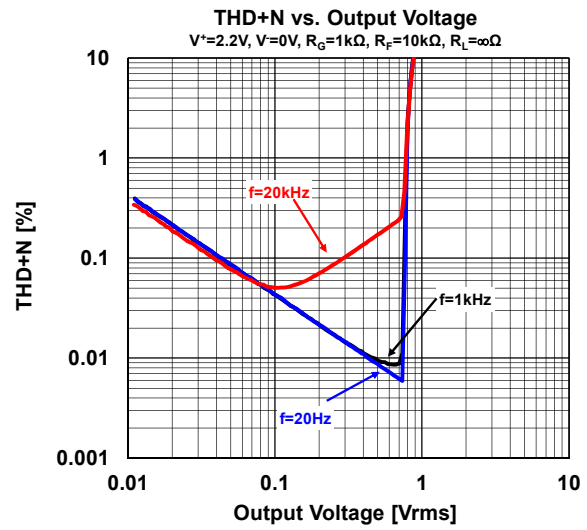
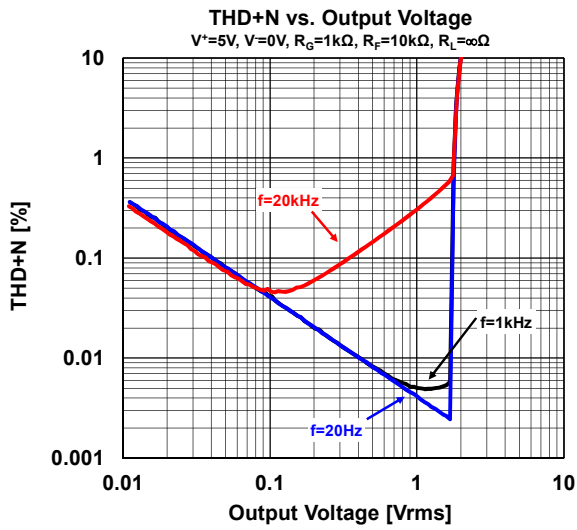


## ■ TYPICAL CHARACTERISTICS

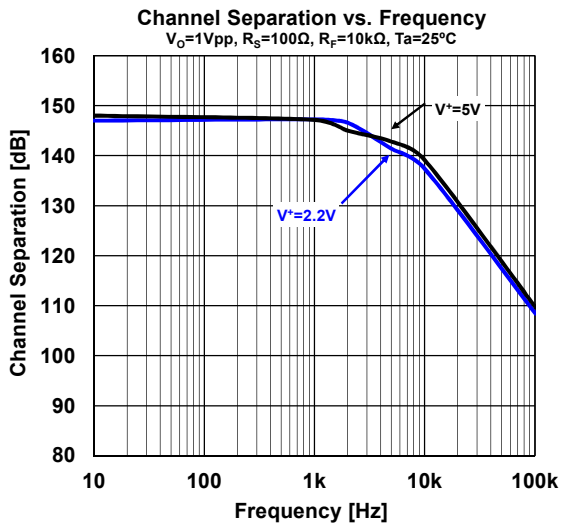




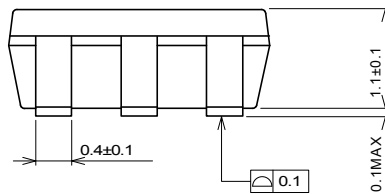
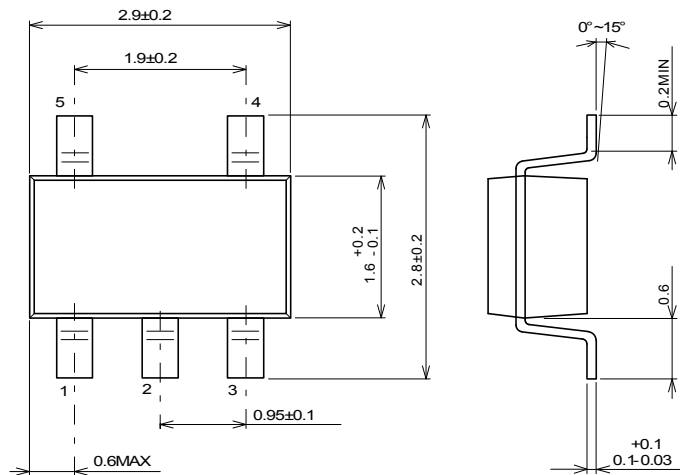
## ■ TYPICAL CHARACTERISTICS



## ■ TYPICAL CHARACTERISTICS

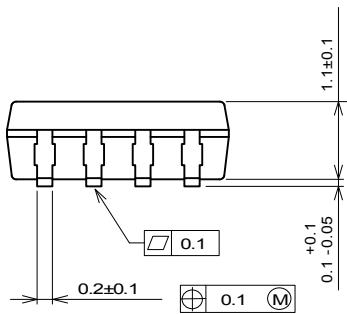
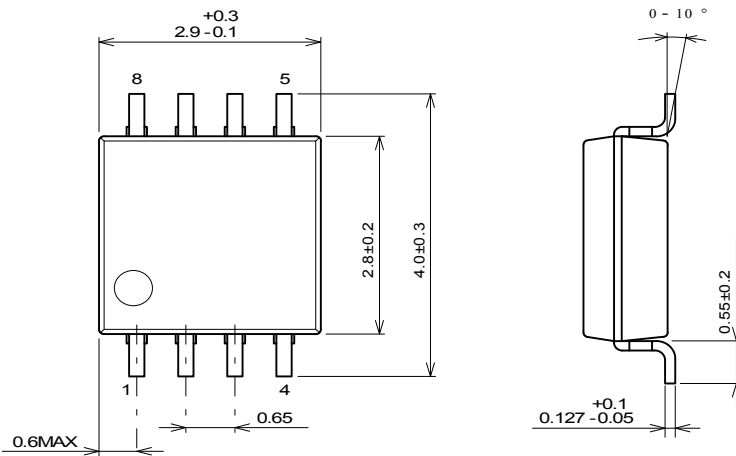


■ PACKAGE DIMENSIONS



Unit: mm

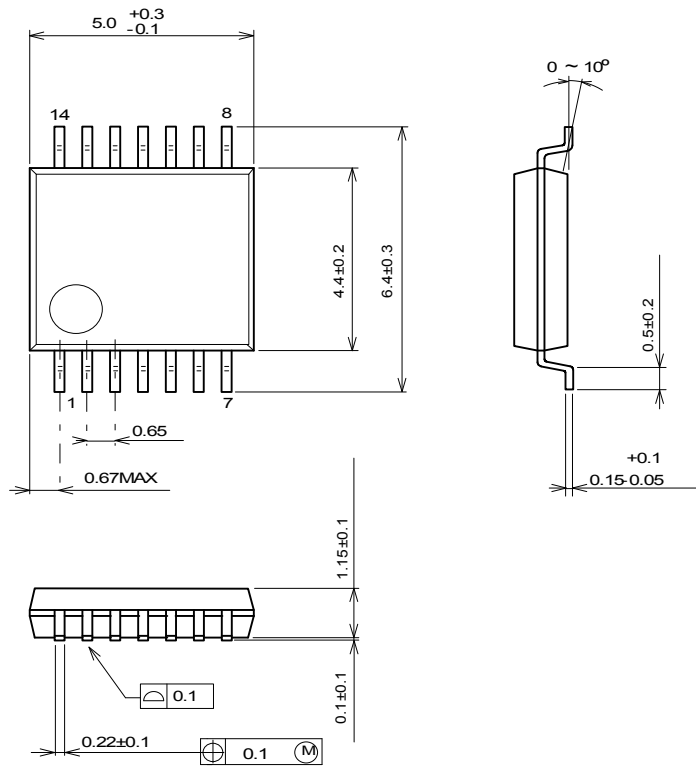
SOT-23-5 Package



Unit: mm

MSOP8(VSP8)\* Package  
\*MEET JEDEC MO-187-DA

## ■ PACKAGE DIMENSIONS



Unit: mm

**SSOP14 Package**

**[CAUTION]**  
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