

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 μV 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 Ω 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.

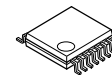
■ PACKAGE OUTLINE



NJU7076F
(SOT-23-5)



NJU7077R
(MSOP8(VSP8))



NJU7078V
(SSOP14)

■ FEATURES

- High Precision
 - Low Offset Voltage

NJU7076/NJU7077	150 μV max.
NJU7078	200 μV 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

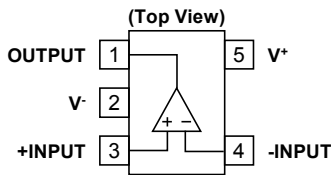
	2.2V to 5.5V
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- Unity-Gain Stable
- Package

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

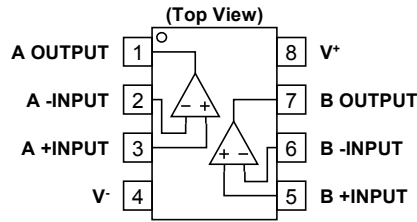
■ APPLICATIONS

- 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

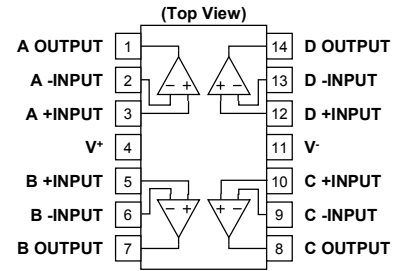
■ PIN CONFIGURATION



NJU7076F



NJU7077R



NJU7078V

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

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	$V^+ - V^-$	7 ⁽¹⁾	V
Differential Input Voltage ⁽²⁾	V_{ID}	± 7 ⁽³⁾	V
Input Voltage	V_{IN}	$V^- - 0.3$ to $V^+ + 0.3$	V
Power Dissipation ⁽⁴⁾		(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^- .

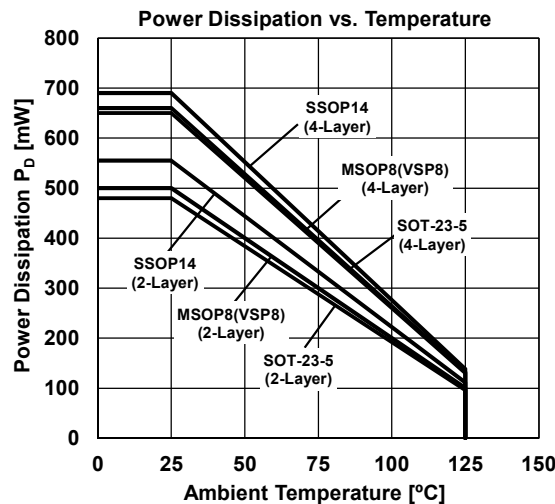
(2) Differential voltage is the voltage difference between +INPUT and -INPUT.

(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 (± 1.1 to ± 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
DC CHARACTERISTICS						
Input Offset Voltage NJU7076/NJU7077 NJU7078	V_{IO}	$T_a=-40^\circ C$ to $125^\circ C$	-	20	150	μV
			-	-	400	μV
		$T_a=-40^\circ C$ to $125^\circ C$	-	20	200	μV
			-	-	400	μV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$T_a=-40^\circ C$ to $125^\circ C$ ⁽⁵⁾	-	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) NJU7076 NJU7077 NJU7078	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
AC CHARACTERISTICS						
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	Φ_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

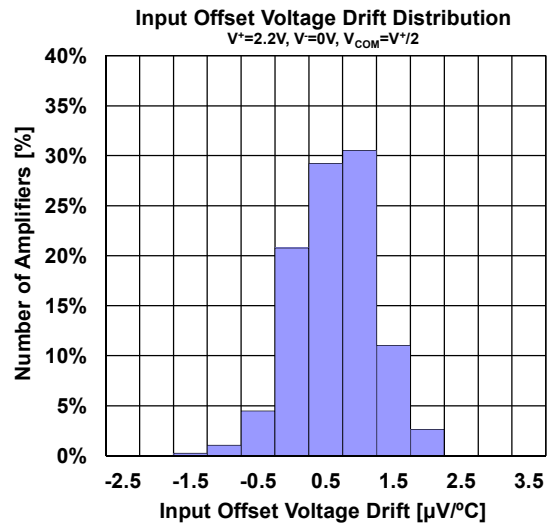
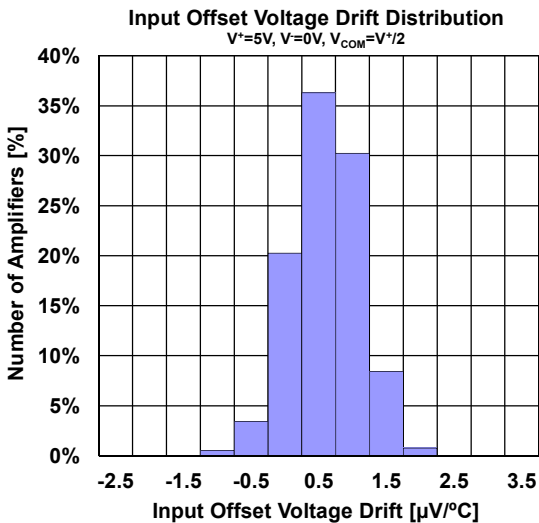
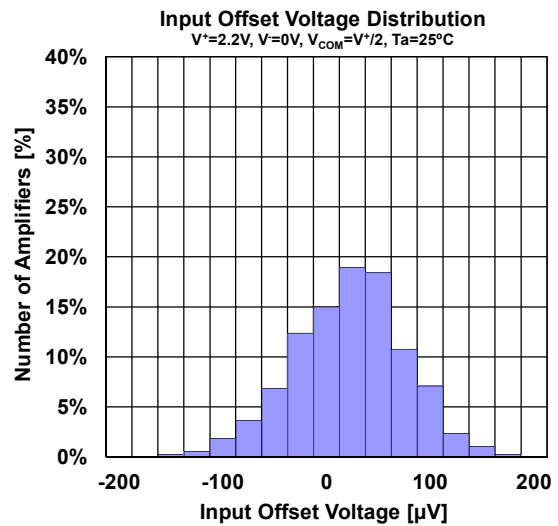
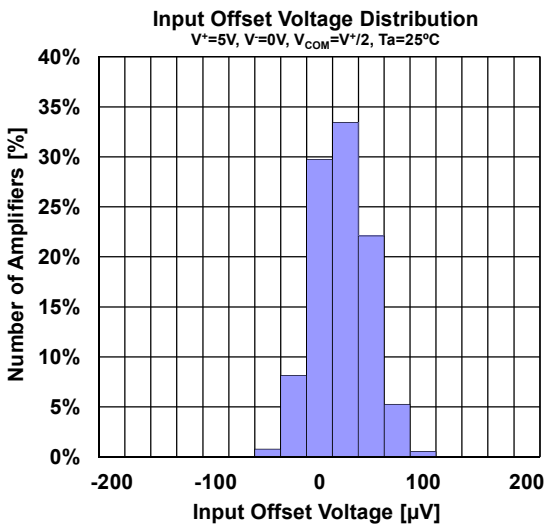
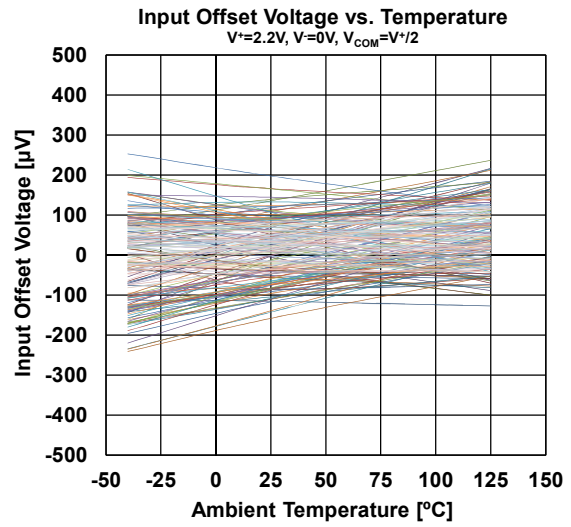
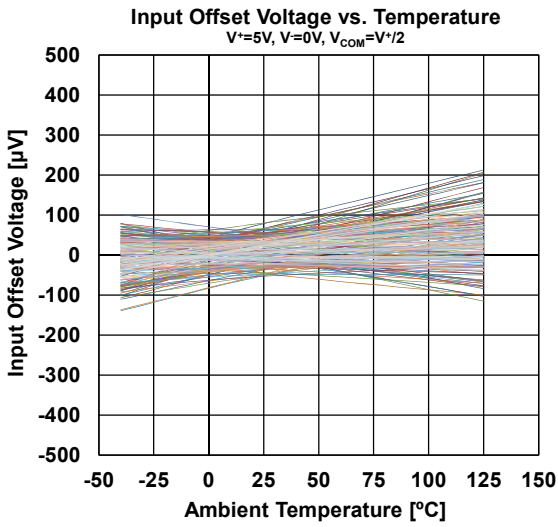
(5) Guaranteed by two points of Temperature $-40^\circ C$ and $+125^\circ C$

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

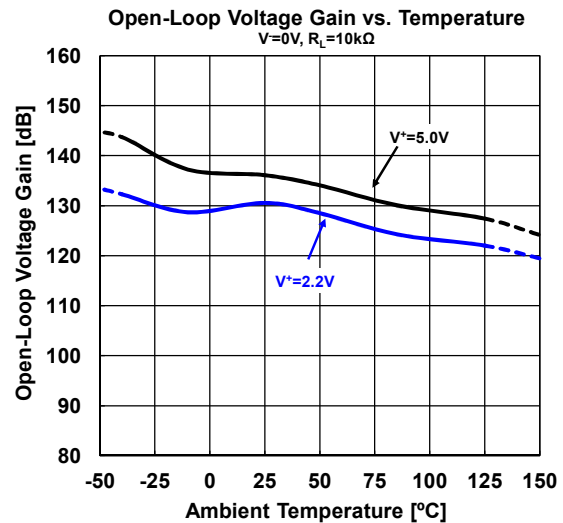
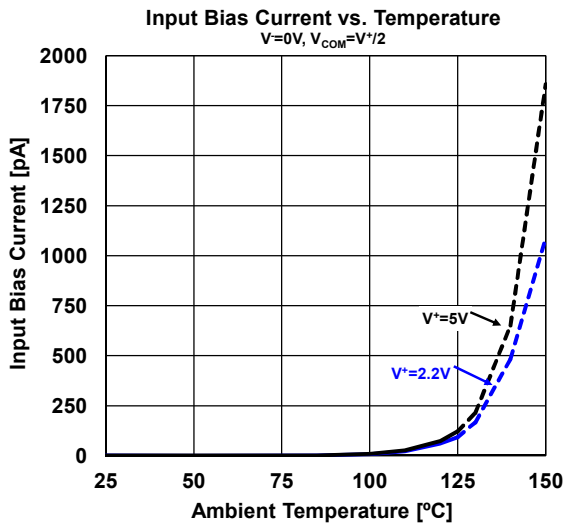
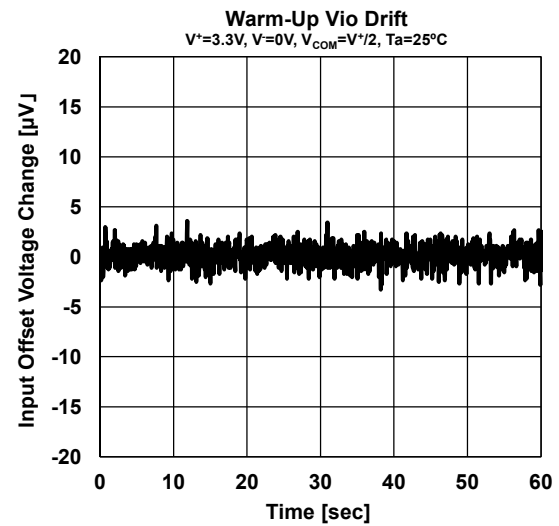
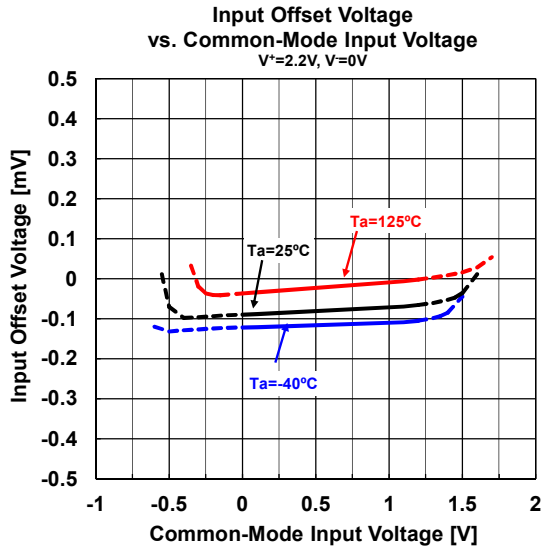
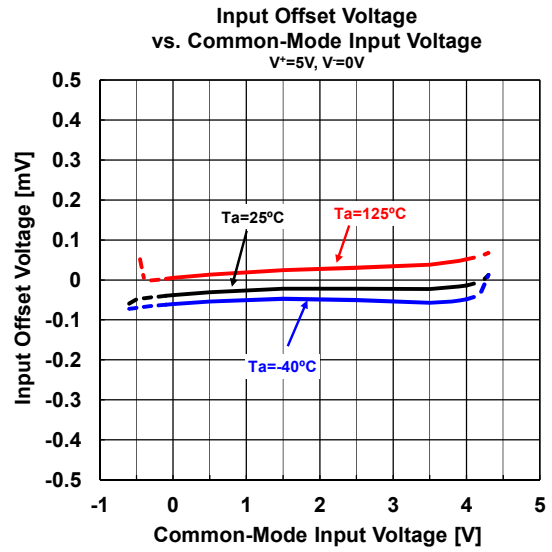
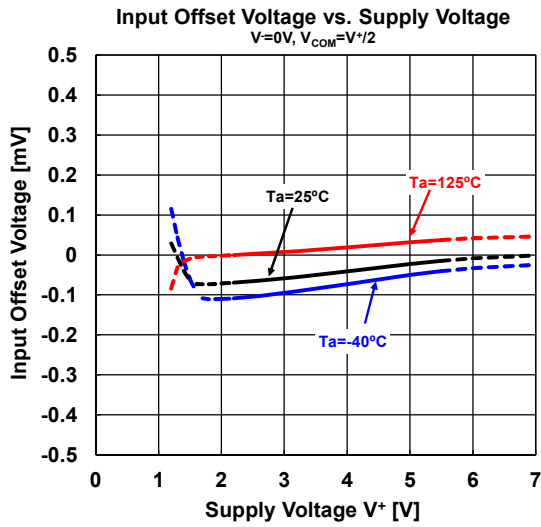
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
DC CHARACTERISTICS						
Input Offset Voltage NJU7076/NJU7077	V_{IO}	$T_a = -40^\circ C$ to $125^\circ C$	-	60	250	μV
			-	-	400	μV
NJU7078			-	60	300	μV
			-	-	400	μV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$T_a = -40^\circ C$ to $125^\circ C$ ⁽⁵⁾	-	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		No Signal, $R_L=OPEN$, $T_a = -40^\circ C$ to $125^\circ C$	-	-	0.82	mA
NJU7077		No Signal, $R_L=OPEN$	-	1.0	1.5	mA
		No Signal, $R_L=OPEN$, $T_a = -40^\circ C$ to $125^\circ C$	-	-	1.5	mA
NJU7078		No Signal, $R_L=OPEN$	-	2.0	3.0	mA
		No Signal, $R_L=OPEN$, $T_a = -40^\circ C$ to $125^\circ C$	-	-	3.0	mA
AC CHARACTERISTICS						
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	Φ_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 $+125^\circ C$

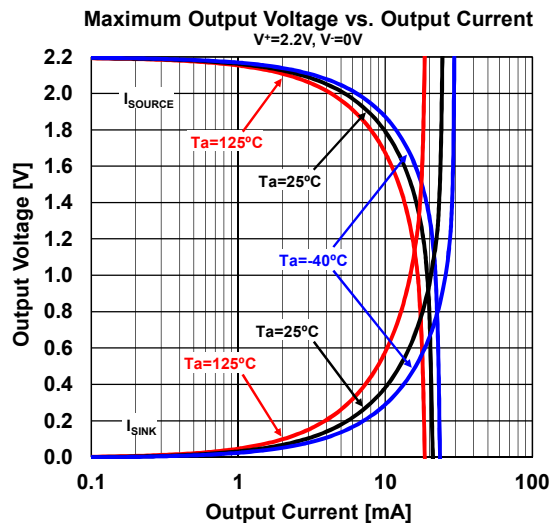
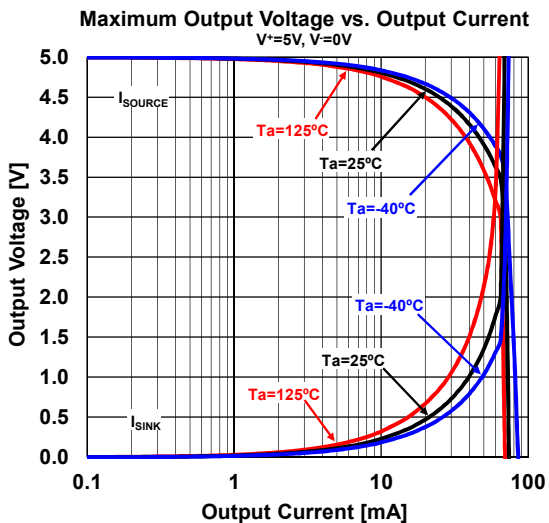
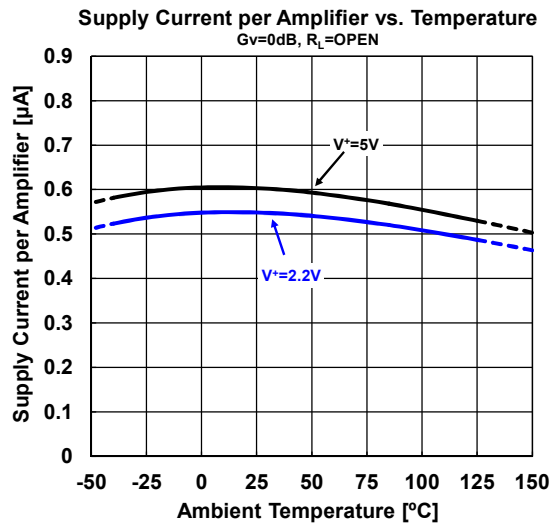
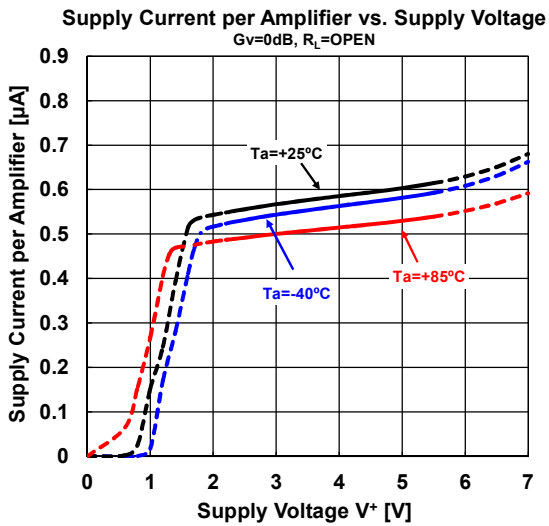
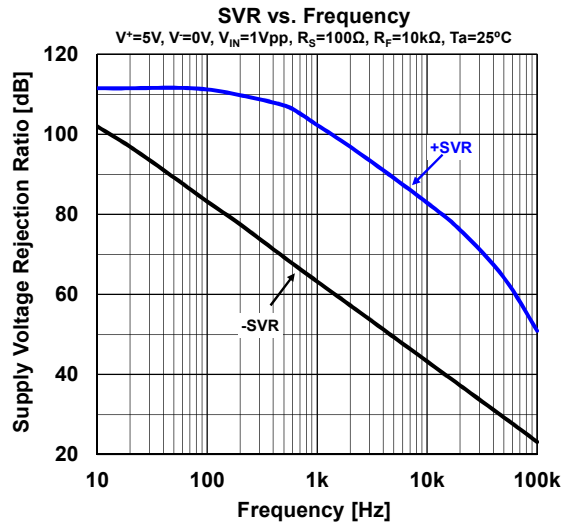
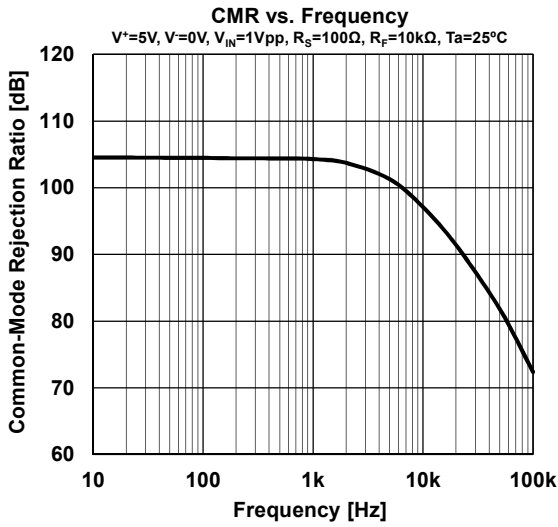
■ TYPICAL CHARACTERISTICS



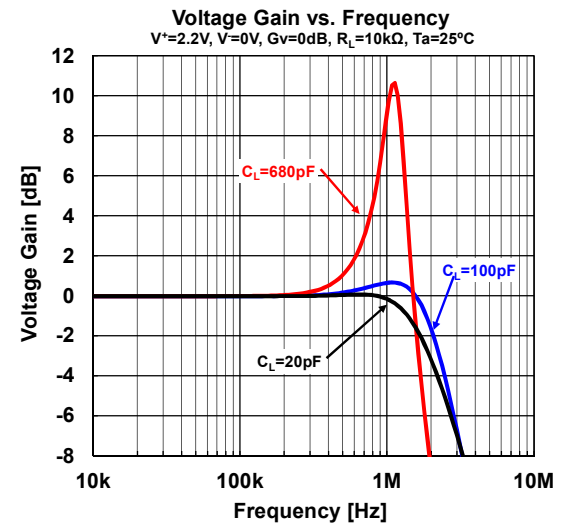
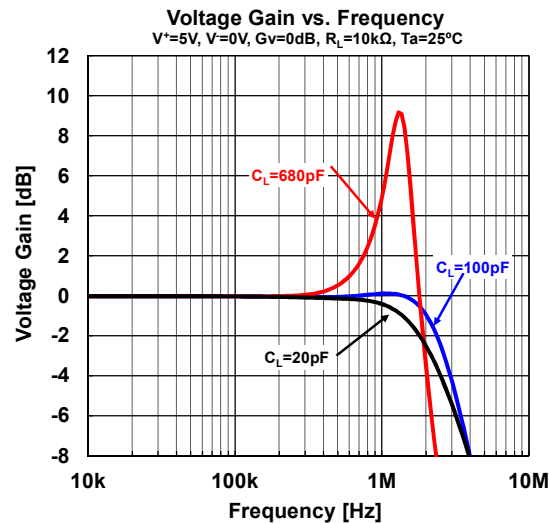
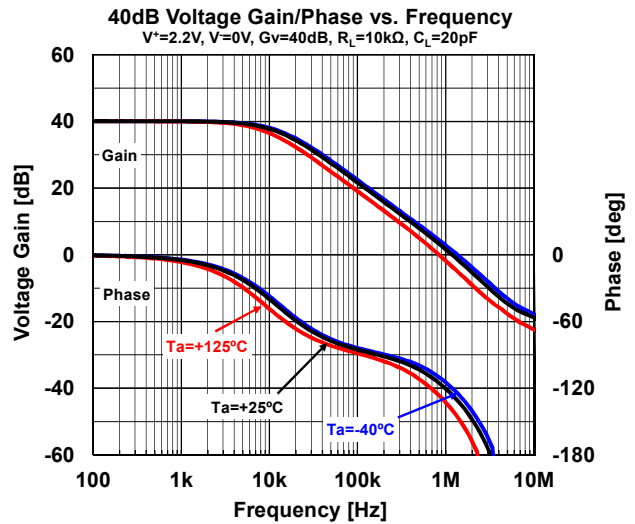
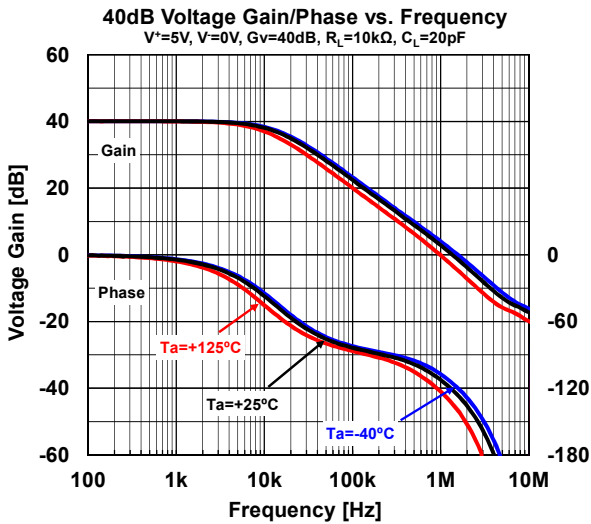
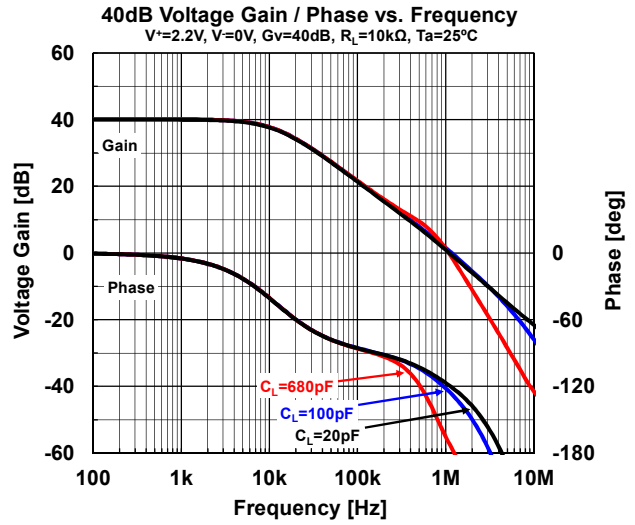
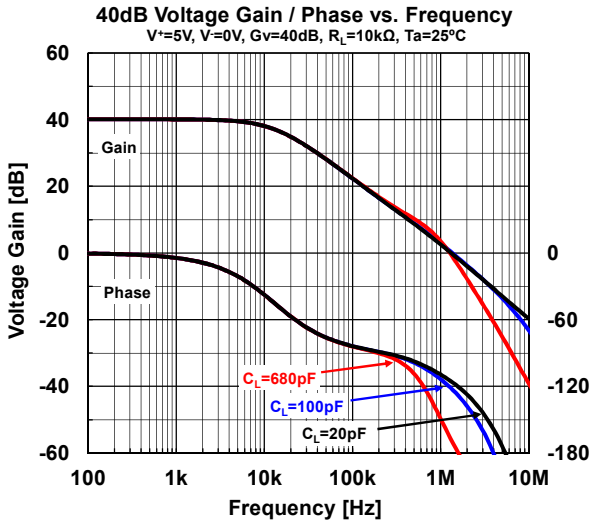
TYPICAL CHARACTERISTICS



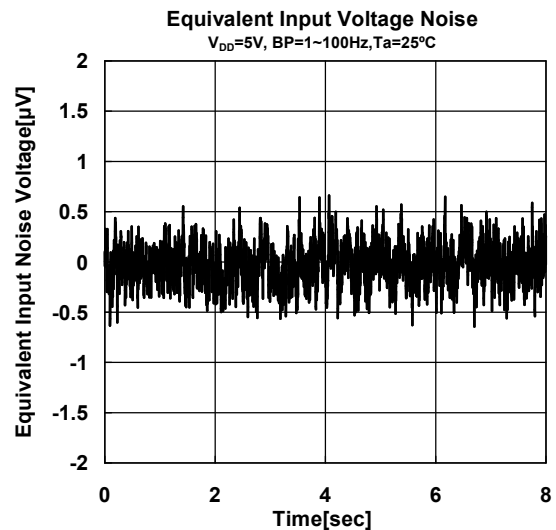
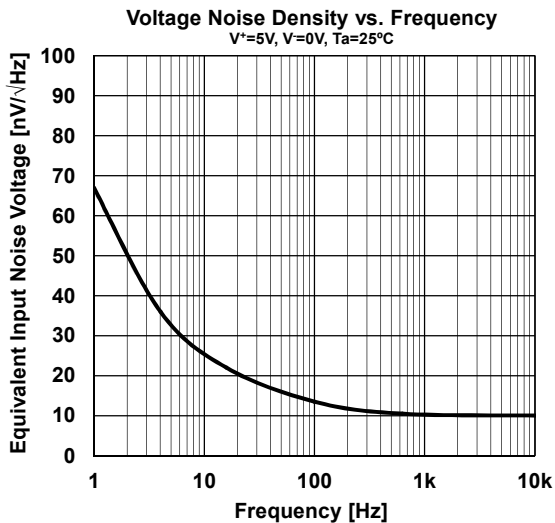
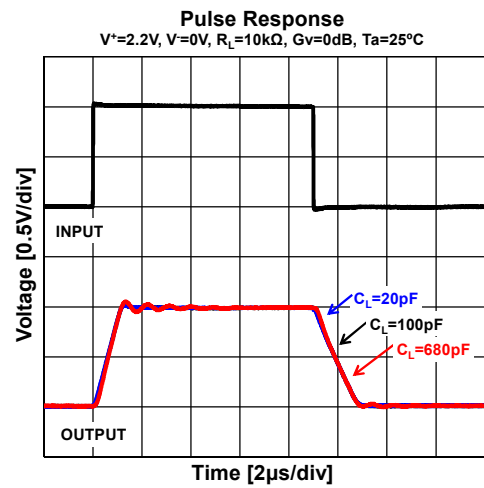
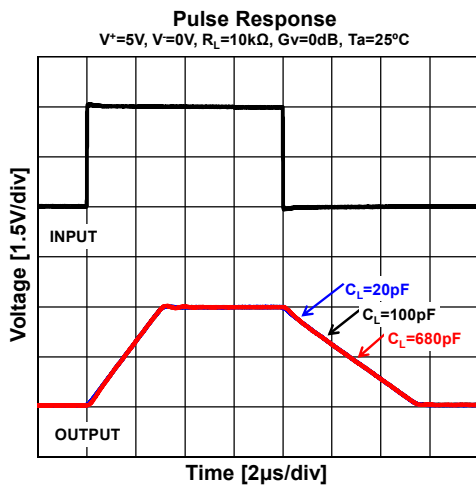
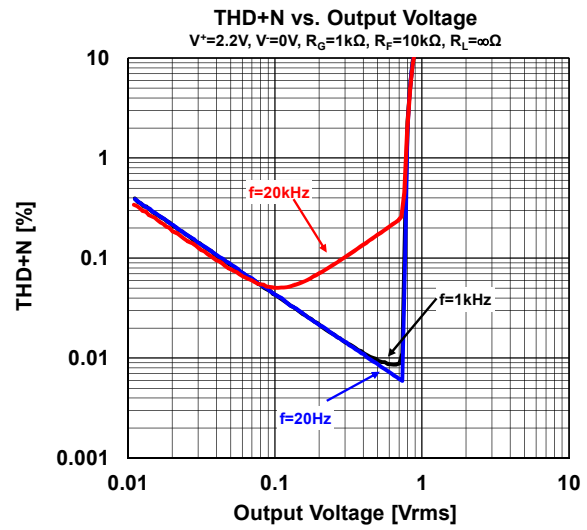
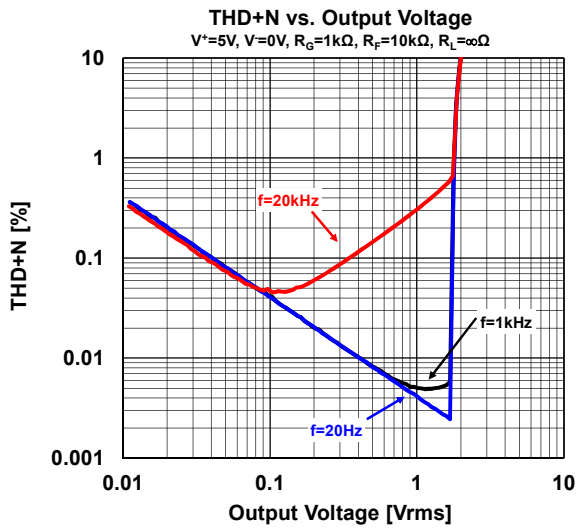
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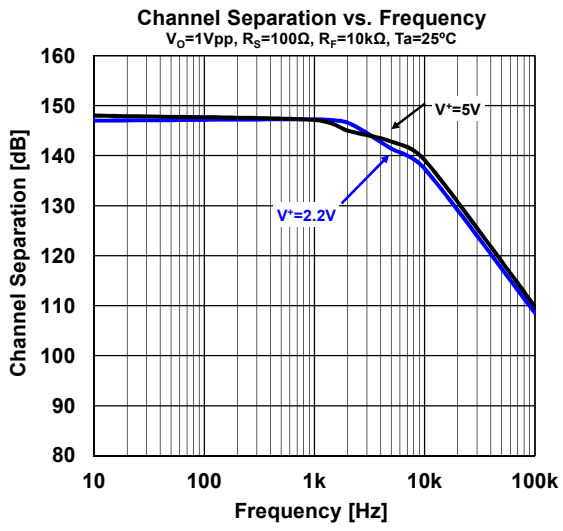
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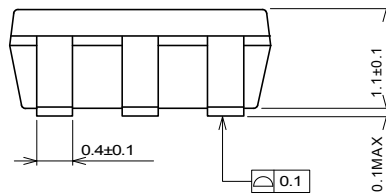
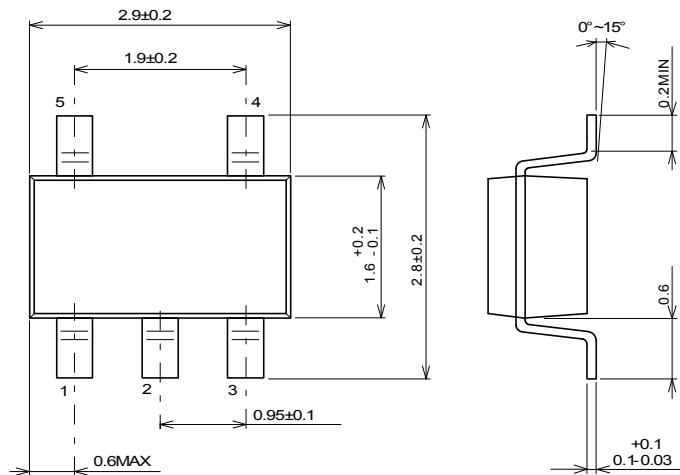
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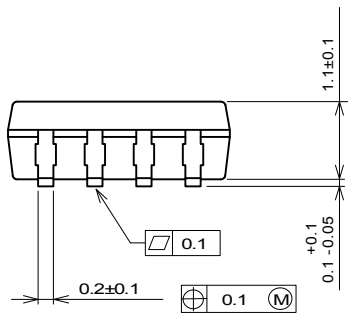
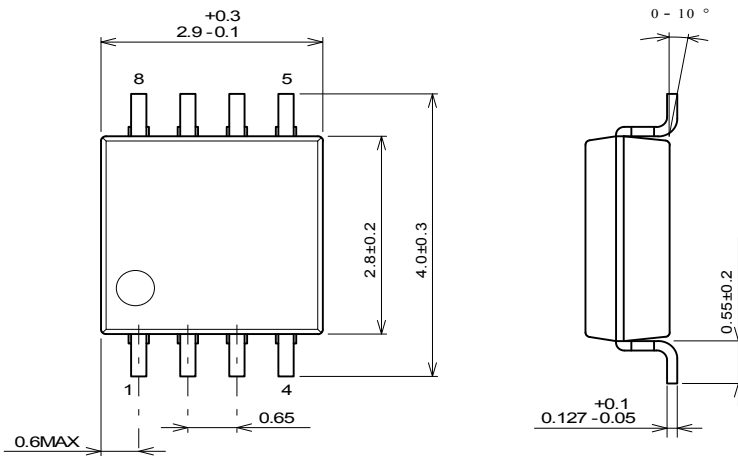


■ PACKAGE DIMENSIONS



Unit: mm

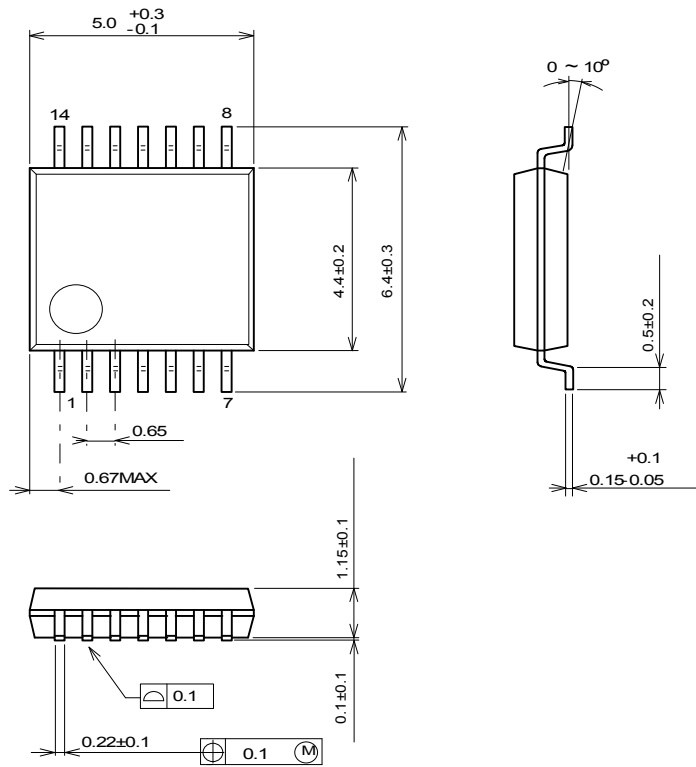
SOT-23-5 Package



Unit: mm

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

■ PACKAGE DIMENSIONS



Unit: mm

SSOP14 Package

[CAUTION]
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