

1.5V, 0.23μA/ch, Ultralow Power, Rail-to-Rail Input/Output Single/Dual/Quad CMOS Operational Amplifier

FEATURES (V⁺=5V)

•Supply Current	
NJU77000/NJU77001	0.29μA typ.
NJU77002/NJU77004	0.23μA/ch typ.
•Operating Voltage	1.5V to 5.5V
•Input Offset Voltage	
NJU77000/NJU77001	1.0mV max.
NJU77002/NJU77004	1.3mV max.
•Input Offset Voltage Drift	0.65μV/°C typ.
•Input Bias Current	10pA max.
•Unity Gain Frequency	1.0kHz
•Slew Rate	0.7V/ms
•Rail-to-Rail Input/Output	
•RF Noise Immunity	
•CMOS Technology	
•Package	
NJU77000	SOT-23-5
NJU77001	SC-88A, SOT-23-5
NJU77002	SOP8 JEDEC 150mil MSOP8 (TVSP)*
	*JEDEC MO-187-DA / thin type
NJU77004 (U.D.)	SSOP14

APPLICATIONS

- Battery powered Instruments
- Micro power oxygen sensor and gas sensor
- Power line monitoring
- Micropower current sensing
- Healthcare instruments

DESCRIPTION

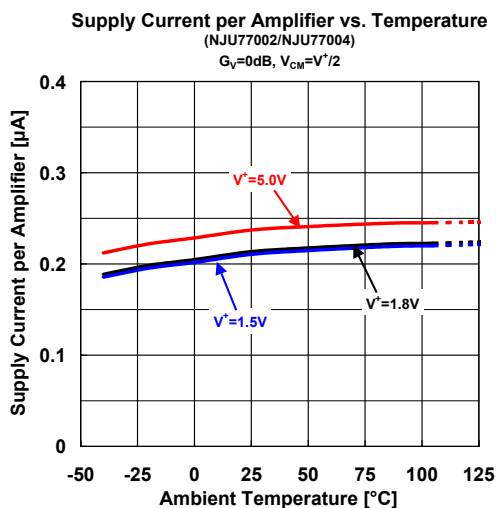
The NJU77000/NJU77001/NJU77002/NJU77004 are single/dual/quad ultralow power 345nW/ch operational amplifiers designed to extend battery life and performance for portable applications. The operating voltage range of 1.5V to 5.5V and supply current of 0.29μA(single), 0.23μA/ch(dual/quad) typical, with stable over temperature and input voltage change make them ideal for micropower oxygen sensors, gas sensors and remote sensor applications.

In addition to the ultralow power and low operating voltage, rail-to-rail input and output, input offset voltage of 1.0mV(single), 1.3mV(dual/quad), maximum with 0.65μV/°C drift, input bias current of 10pA maximum and ability to drive 470pF loads, make the NJU77000 series ideal when requiring excellent performance in battery powered applications.

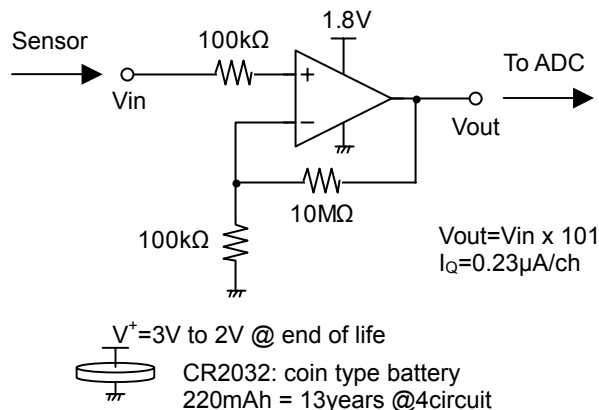
NJU77000 series are specified normal grade (NJU7700x) and A-Grade (NJU7700xA). A-Grade is guaranteed lower offset voltage and supply voltage from -40 to +105 °C than the normal grade.

The NJU77000 is available in the 5-pin SOT-23 package. NJU77001 is available in the 5-pin SOT-23 and SC-88A package. NJU77000 and NJU77001 have difference pin function (see pin configuration). The NJU77002 is available in the 8-pin SOP8: JEDEC 150mil and MSOP8 (TVSP8): JEDEC MO-187-DA / thin type packages. The NJU77004 is available in 14-pin SSOP14 package.

TYPICAL CHARACTERISTIC



TYPICAL APPLICATION



40dB micropower sensor amplifier

■ PIN CONFIGURATION / PRODUCT INFORMATION

Pin Function				
Package	SOT-23-5		SOT-23-5	SC88A
Product Name	NJU77000F NJU77000AF		NJU77001F NJU77001AF	NJU77001F3 NJU77001AF3
Pin Function				
Package	SOP8 JEDEC 150 mil	MSOP8 (TVSP8)	SSOP14	
Product Name	NJU77002E NJU77002AE	NJU77002RB1 NJU77002ARB1	NJU77004V NJU77004AV	

■ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	$V^+ - V^-$	7	V
Differential Input Voltage ⁽¹⁾	V_{ID}	± 7 ⁽²⁾	V
Input Voltage	V_{IN}	$V^- - 0.3$ to $V^+ + 0.3$	V
Power Dissipation ⁽³⁾	P_D	(2-layer)	mW
SOT23-5		390	
SC88A-5		280	
SOP8 JEDEC 150 mil		500	
MSOP8 (TVSP8)		410	
SSOP14	400		
Operating Temperature Range	T_{opr}	-40 to +105	°C
Storage Temperature Range	T_{stg}	-55 to +125	°C

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

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

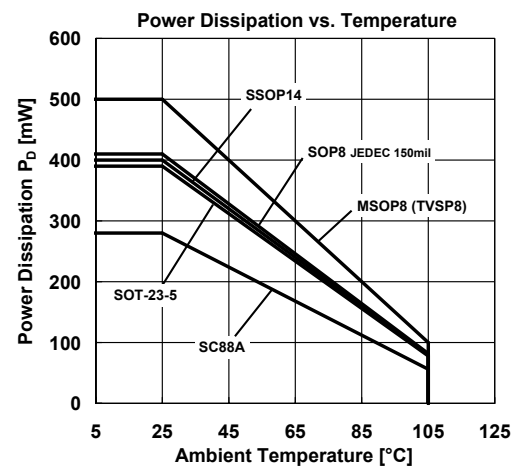
(3) Power dissipation is the power that can be consumed by the IC at $T_a=25^\circ\text{C}$, and is the typical measured value based on JEDEC condition.

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 (76.2x114.3x 1.6mm, 2layers, FR-4) mounting

■ RECOMMENDED OPERATING CONDITION ($T_a=25^\circ\text{C}$)

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	$V^+ - V^-$		1.5	-	5.5	V





■ ELECTRICAL CHARACTERISTICS

($V^+=5V$, $V^-=0V$, $V_{CM}=2.5V$, $R_L=100k\Omega$ to $2.5V$, $T_a=25^\circ C$, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	NJU7700xA			NJU7700x			UNIT
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
DC CHARACTERISTICS									
Supply Current (all channel) NJU77000/NJU77001	I_Q	No Signal	-	0.29	0.39	-	0.29	0.49	μA
		$T_a=-40^\circ C$ to $105^\circ C$	-	-	0.39	-	-	-	
NJU77002			-	0.46	0.66	-	0.46	0.76	
NJU77004			-	0.92	1.22	-	0.92	1.32	
Input Offset Voltage NJU77000/NJU77001	V_{IO}	$V_{CM}=0V$	-	0.35	1	-	0.35	1.8	mV
		$T_a=-40^\circ C$ to $105^\circ C$	-	-	1.2	-	-	-	
NJU77002/NJU77004			-	0.35	1.3	-	0.35	2.0	
		$T_a=-40^\circ C$ to $105^\circ C$	-	-	1.5	-	-	-	
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$V_{CM}=0V$, $T_a=-40^\circ C$ to $105^\circ C$	-	0.65	21	-	0.65	-	$\mu V/deg$
Input Bias Current	I_B	$T_a=-40^\circ C$ to $105^\circ C$	-10 -100	1 -	10 100	-	1 -	-	pA
Input Offset Current	I_{IO}	$T_a=-40^\circ C$ to $105^\circ C$	-10 -100	1 -	10 100	-	1 -	-	pA
Voltage Gain	A_V	$V_{out}=0.5V$ to $4.5V$ $T_a=-40^\circ C$ to $105^\circ C$	70 70	100 -	- -	70 -	100 -	-	dB
Common-Mode Rejection Ratio	CMR	$V_{CM}=0V$ to $5V$ $T_a=-40^\circ C$ to $105^\circ C$	60 60	80 -	- -	60 -	80 -	-	dB
Supply Voltage Rejection Ratio	SVR	$V^+=1.5V$ to $5.5V$, $V_{CM}=0V$ $T_a=-40^\circ C$ to $105^\circ C$	70 70	90 -	- -	70 -	90 -	-	dB
Maximum Output Voltage	V_{OH}	$R_L=100k\Omega$ to $2.5V$ $T_a=-40^\circ C$ to $105^\circ C$	4.9 4.9	4.95 -	- -	4.9 -	4.95 -	-	V
	V_{OL}	$R_L=100k\Omega$ to $2.5V$ $T_a=-40^\circ C$ to $105^\circ C$	- -	0.05 -	0.1 0.1	- -	0.05 -	0.1 -	V
Common-Mode Input Voltage Range	V_{ICM}	CMR $\geq 60dB$ $T_a=-40^\circ C$ to $105^\circ C$	0 0	- -	5 5	0 -	- -	5 -	V
AC CHARACTERISTICS									
Slew Rate NJU77000/NJU77001 NJU77002/NJU77004	SR	$G_v=0dB$, $C_L=20pF$, $V_{IN}=1V_{pp}$	- -	0.8 0.7	- -	- -	0.8 0.7	- -	V/ms
unity-Gain Frequency NJU77000/NJU77001 NJU77002/NJU77004	f_T	$G_v=20dB$, $C_L=20pF$	- -	1.1 1.0	- -	- -	1.1 1.0	- -	kHz
Phase Margin	Φ_M	$C_L=20pF$	-	60	-	-	60	-	deg
Gain Margin	G_M	$C_L=20pF$	-	30	-	-	30	-	dB
Equivalent Input Noise Voltage NJU77000/NJU77001 NJU77002/NJU77004	V_{NI}	$f=100Hz$	- -	600 700	- -	- -	600 700	- -	nV/\sqrt{Hz}



■ ELECTRICAL CHARACTERISTICS

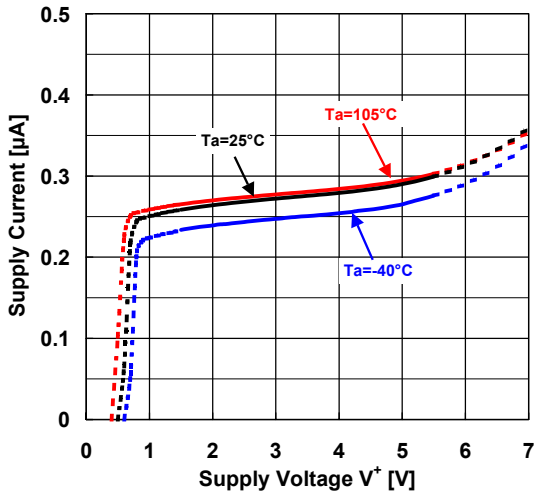
($V^+=1.8V$, $V^-=0V$, $V_{CM}=0.9V$, $R_L=100k\Omega$ to $0.9V$, $T_a=25^\circ C$, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	NJU7700xA			NJU7700x			UNIT
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
DC CHARACTERISTICS									
Supply Current (all channel) NJU77000/NJU77001	I_Q	No Signal	-	0.26	0.36	-	0.26	0.46	μA
		$T_a=-40^\circ C$ to $105^\circ C$	-	-	0.36	-	-	-	
NJU77002			-	0.42	0.62	-	0.42	0.72	
NJU77004			-	0.84	1.17	-	0.84	1.27	
Input Offset Voltage NJU77000/NJU77001	V_{IO}	$V_{CM}=0V$	-	0.35	1	-	0.35	1.8	mV
		$T_a=-40^\circ C$ to $105^\circ C$	-	-	1.2	-	-	-	
NJU77002/NJU77004			-	0.35	1.3	-	0.35	2.0	
		$T_a=-40^\circ C$ to $105^\circ C$	-	-	1.5	-	-	-	
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$V_{CM}=0V$, $T_a=-40^\circ C$ to $105^\circ C$	-	0.65	21	-	0.65	-	$\mu V/deg$
Input Bias Current	I_B	$T_a=-40^\circ C$ to $105^\circ C$	-10 -100	1 -	10 100	-	1 -	-	pA
Input Offset Current	I_{IO}	$T_a=-40^\circ C$ to $105^\circ C$	-10 -100	1 -	10 100	-	1 -	-	pA
Voltage Gain	A_V	$V_{out}=0.5V$ to $1.3V$ $T_a=-40^\circ C$ to $105^\circ C$	70 70	100 -	- -	70 -	100 -	-	dB
Common-Mode Rejection Ratio	CMR	$V_{CM}=0V$ to $1.8V$ $T_a=-40^\circ C$ to $105^\circ C$	55 55	80 -	- -	55 -	80 -	-	dB
Supply Voltage Rejection Ratio	SVR	$V^+=1.5V$ to $5.5V$, $V_{CM}=0V$ $T_a=-40^\circ C$ to $105^\circ C$	70 70	90 -	- -	70 -	90 -	-	dB
Maximum Output Voltage	V_{OH}	$R_L=100k\Omega$ to $0.9V$ $T_a=-40^\circ C$ to $105^\circ C$	1.7 1.7	1.75 -	- -	1.7 -	1.75 -	-	V
	V_{OL}	$R_L=100k\Omega$ to $0.9V$ $T_a=-40^\circ C$ to $105^\circ C$	- -	0.05 -	0.1 0.1	- -	0.05 -	0.1 -	V
Common-Mode Input Voltage Range	V_{ICM}	CMR $\geq 55dB$ $T_a=-40^\circ C$ to $105^\circ C$	0 0	- -	1.8 1.8	0 -	- -	1.8 -	V
AC CHARACTERISTICS									
Slew Rate NJU77000/NJU77001 NJU77002/NJU77004	SR	$G_v=0dB$, $C_L=20pF$, $V_{IN}=1V_{pp}$	- -	0.7 0.6	- -	- -	0.7 0.6	- -	V/ms
Unity-Gain Frequency NJU77000/NJU77001 NJU77002/NJU77004			f_T	$G_v=20dB$, $C_L=20pF$	- -	1.0 0.9	- -	- -	1.0 0.9
Phase Margin	Φ_M	$C_L=20pF$			-	60	-	-	60
Gain Margin	G_M	$C_L=20pF$	-	30	-	-	30	-	dB
Equivalent Input Noise Voltage NJU77000/NJU77001 NJU77002/NJU77004	V_{NI}	$f=100Hz$	- -	700 800	- -	- -	700 800	- -	nV/\sqrt{Hz}

■ TYPICAL CHARACTERISTICS

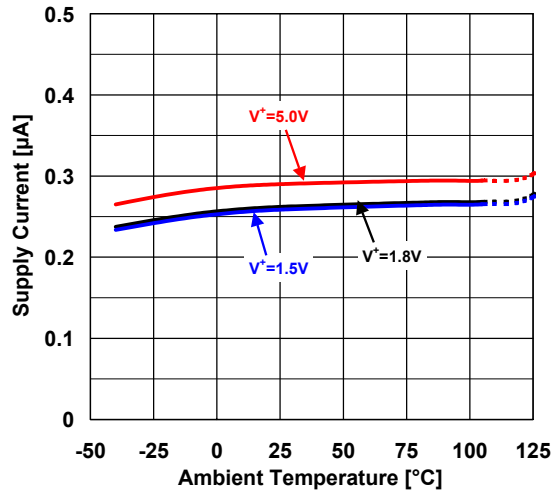
Supply Current vs. Supply Voltage

(NJU77000/NJU77001)
 $G_V=0\text{dB}$, $V_{CM}=V^*/2$



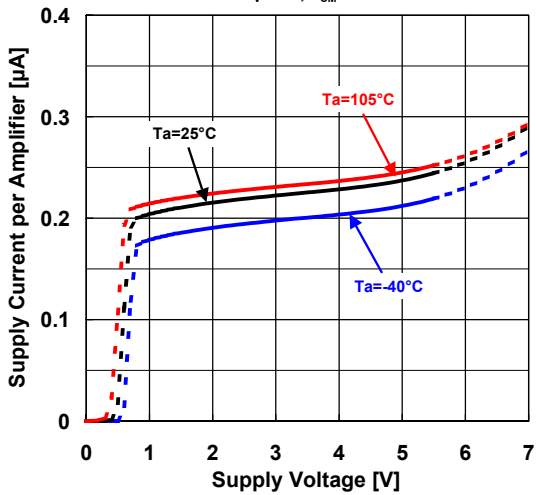
Supply Current vs. Temperature

(NJU77000/NJU77001)
 $G_V=0\text{dB}$, $V_{CM}=V^*/2$



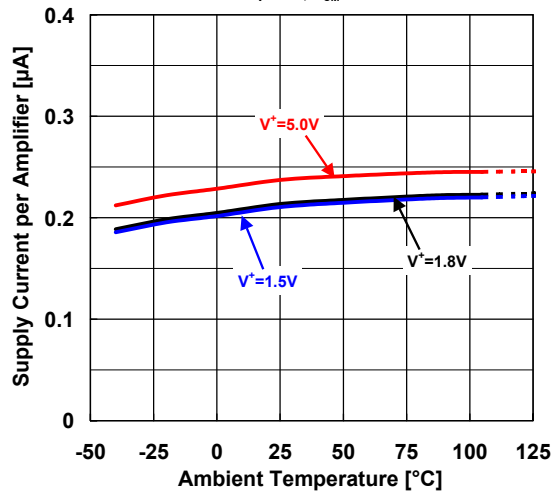
Supply Current per Amplifier vs. Supply Voltage

(NJU77002/NJU77004)
 $G_V=0\text{dB}$, $V_{CM}=V^*/2$



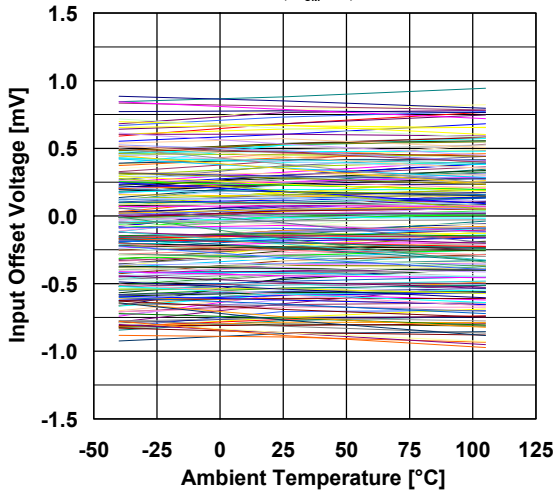
Supply Current per Amplifier vs. Temperature

(NJU77002/NJU77004)
 $G_V=0\text{dB}$, $V_{CM}=V^*/2$



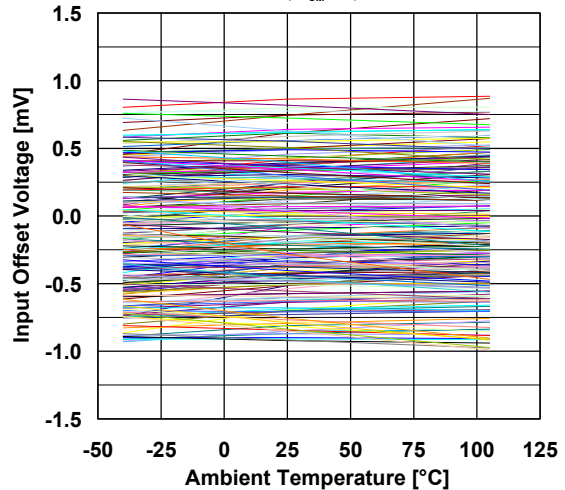
Input Offset Voltage vs. Temperature

$V^*=5.0\text{V}$, $V_{CM}=0\text{V}$, $n=200$

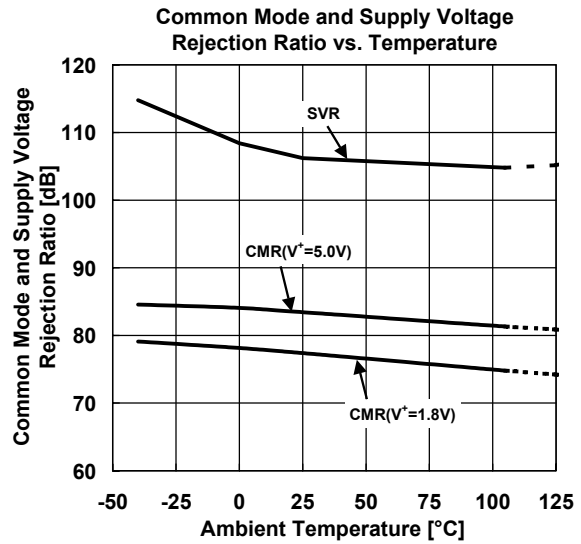
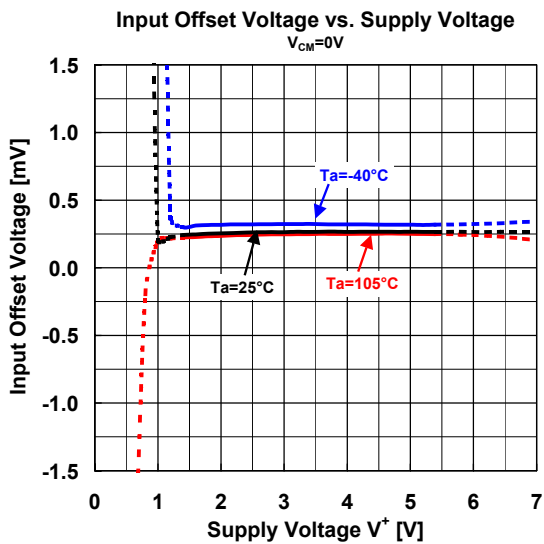
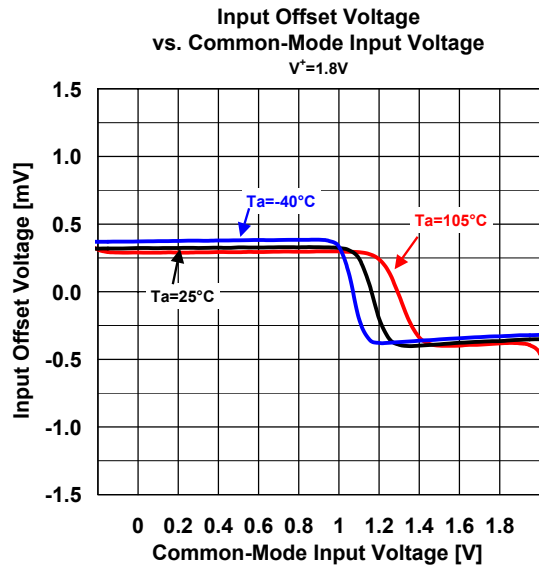
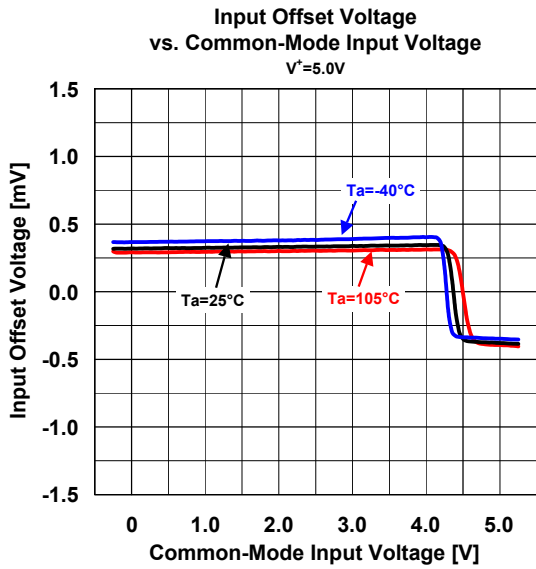
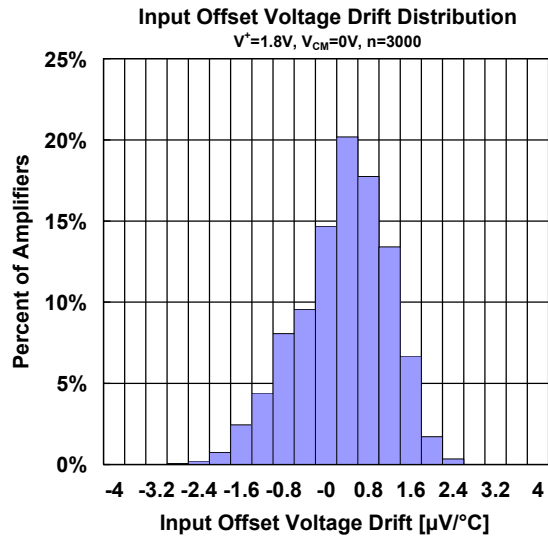
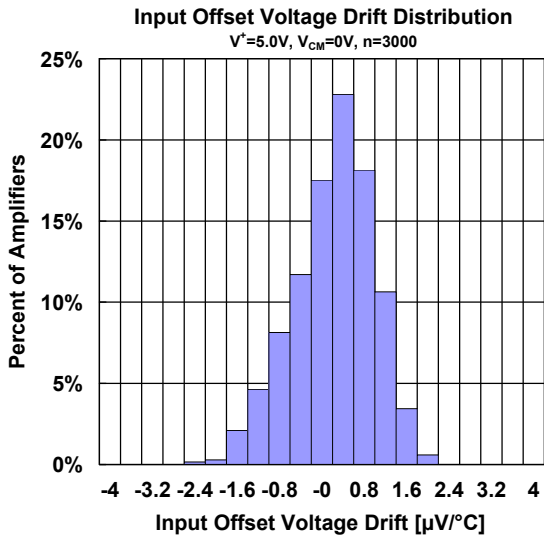


Input Offset Voltage vs. Temperature

$V^*=1.8\text{V}$, $V_{CM}=0\text{V}$, $n=200$

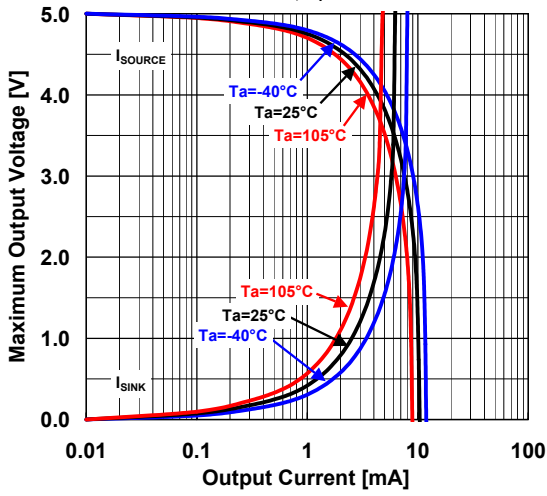


■ TYPICAL CHARACTERISTICS

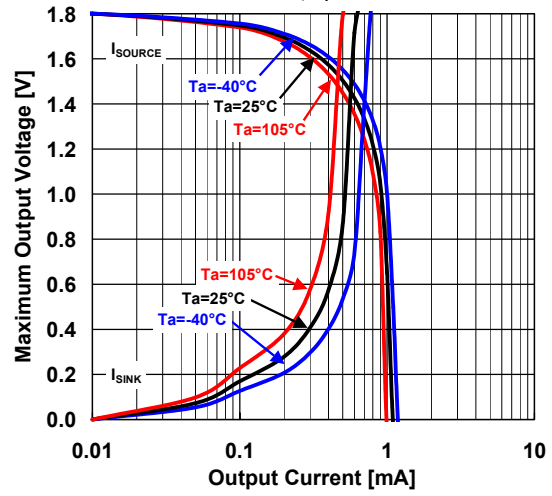


■ TYPICAL CHARACTERISTICS

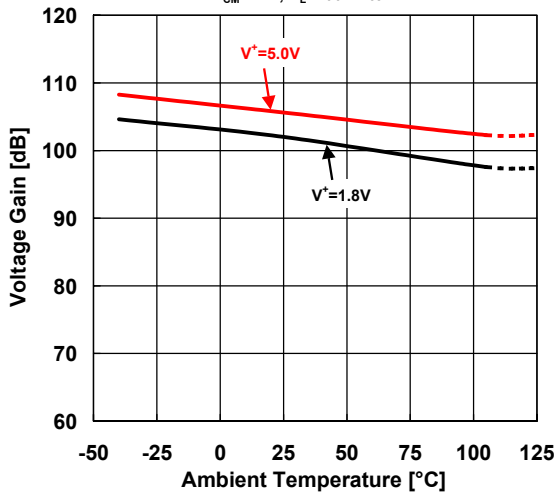
Maximum Output Voltage vs. Output Current
 $V^+ = 5.0V, G_V = OPEN$



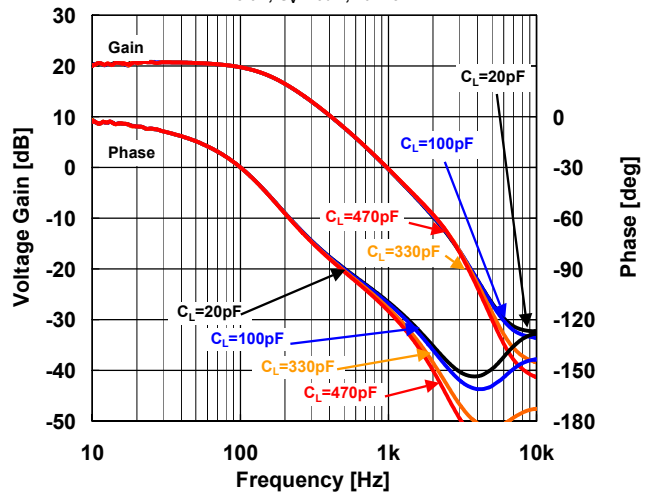
Maximum Output Voltage vs. Output Current
 $V^+ = 1.8V, G_V = OPEN$



Voltage Gain vs. Temperature
 $V_{CM} = V^+/2, R_L = 100k\Omega \text{ to } V^+/2$

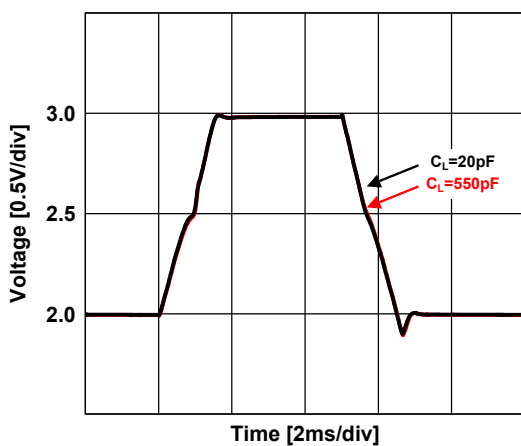


Voltage Gain/Phase vs. Frequency
 $V^+ = 5.0V, G_V = 20dB, T_a = 25^\circ C$



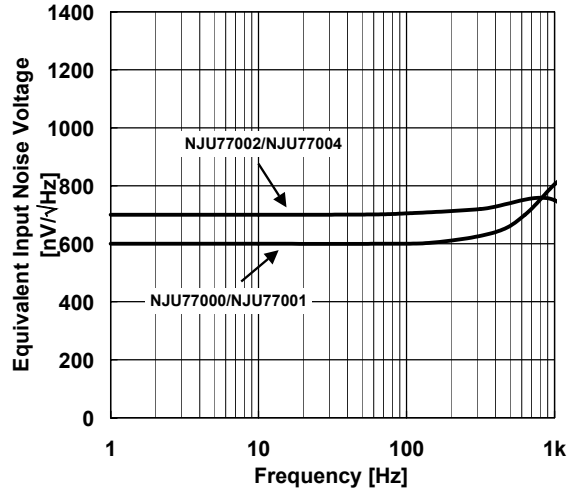
Pulse Response

$V^+ = 5.0V, G_V = 0dB, R_L = 100k\Omega \text{ to } 2.5V, T_a = 25^\circ C$

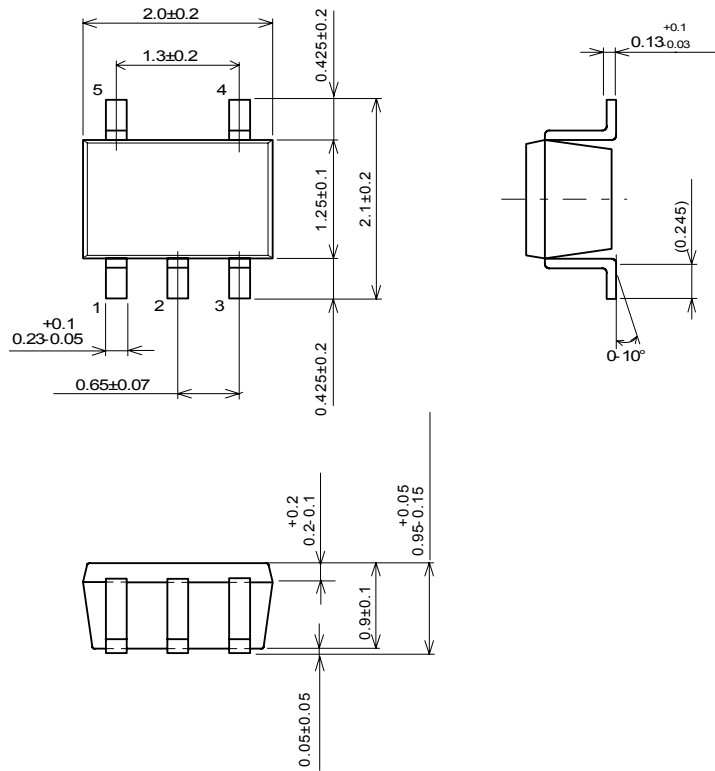


Voltage Noise vs. Frequency

$V^+ = 5.0V, G_V = 0dB, R_L = 100k\Omega, T_a = 25^\circ C$

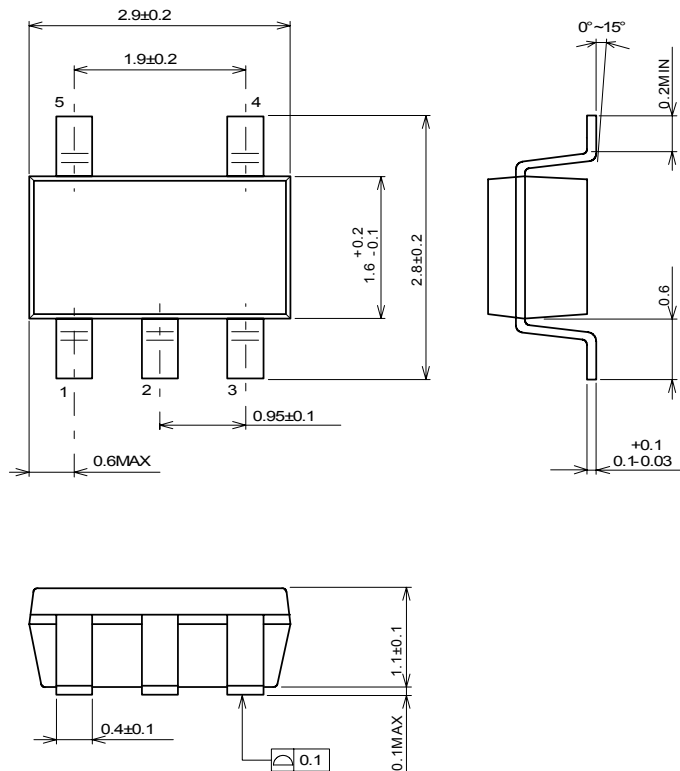


■ PACKAGE DIMENSIONS



Unit: mm

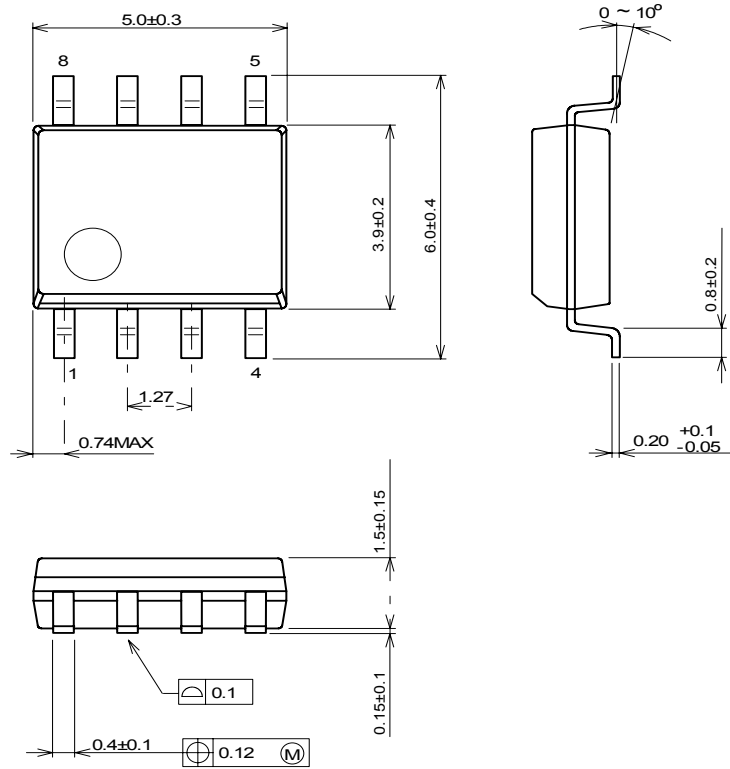
SC88A Package



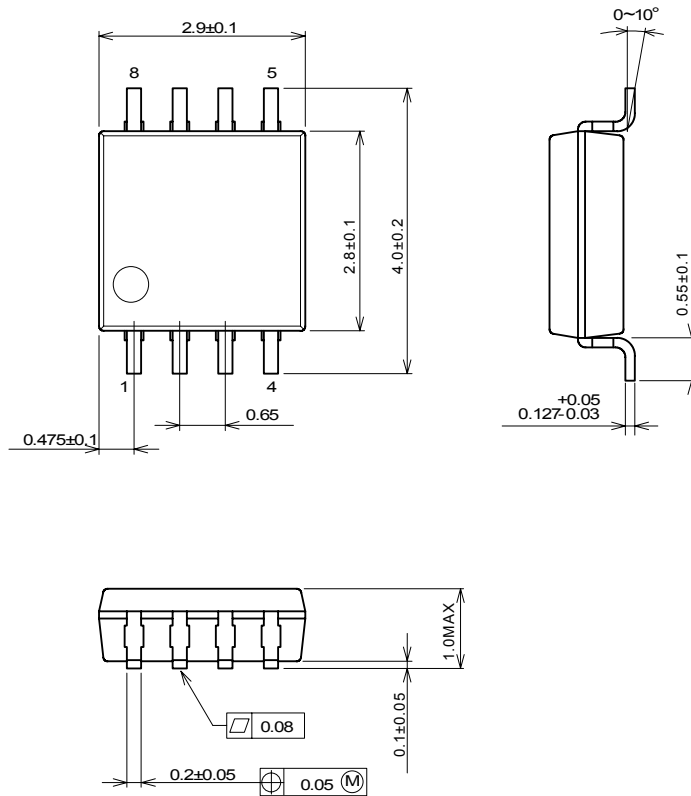
Unit: mm

SOT-23-5 Package

■ PACKAGE DIMENSIONS

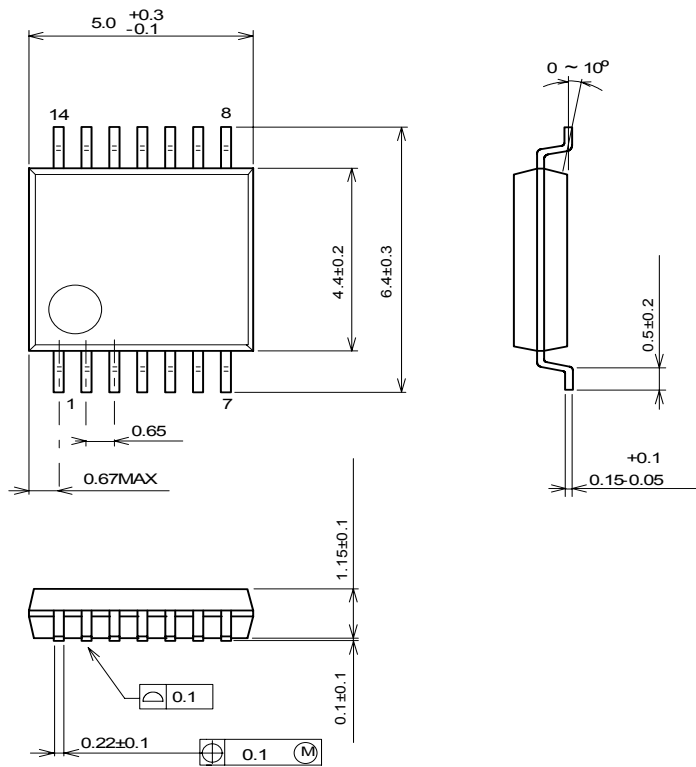


SOP8 JEDEC 150mil Package



MSOP8 (TVSP8) JEDEC MO-187-DA / thin type Package

■ PACKAGE DIMENSIONS



Unit: mm

SSOP14 Package

[CAUTION]
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