

1.5V, 0.29 μ A, Ultralow Power, Rail-to-Rail Input/Output Single CMOS Operational Amplifier

FEATURES ($V^+=5V$)

- Supply Current: 0.29 μ A typ.
- Operating Voltage: 1.5V to 5.5V
- Input Offset Voltage: 1mV max.
- Offset Voltage Drift: 0.65 μ V/ $^{\circ}$ C typ.
- Input Bias Current: 10pA max.
- Unity gain Frequency: 1.1kHz
- Slew Rate: 0.8V/ms
- Rail-to-Rail Input /Output
- RF Noise Immunity
- CMOS Technology
- Package: SOT-23-5
SC-88A

APPLICATIONS

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

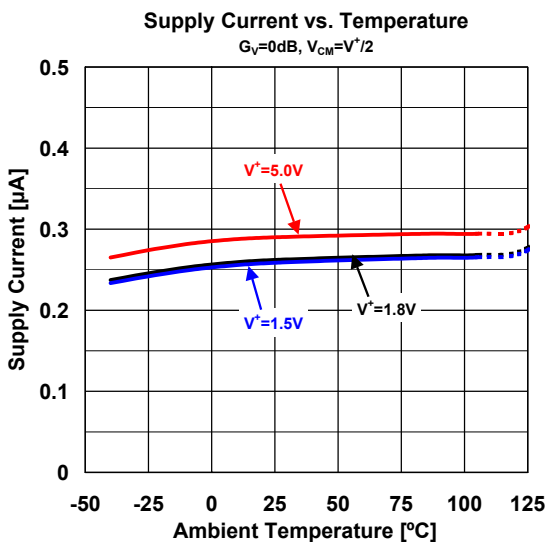
DESCRIPTION

The NJU77000/NJU77001 are single ultralow power 435nW 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 0.29 μ A typical with stable over temperature and input voltage change makes it ideal for micropower oxygen sensors, gas sensors and remote sensor applications.

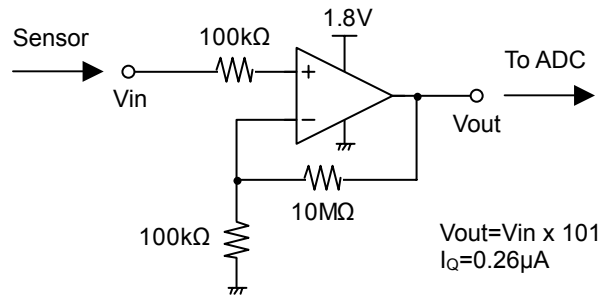
In addition to the ultralow power and low operating voltage, rail-to-rail input and output, input offset voltage of 1mV maximum with 0.65 μ V/ $^{\circ}$ C drift, input bias current of 10pA maximum and ability to drive 470pF loads, make the NJU77001/NJU77001 ideal when requiring excellent performance in battery powered applications.

The NJU77000 is available in the 5-pin SC-88A 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 NJU7700xA have the higher performance and offer guaranteed specifications over the extended temperature range from -40 $^{\circ}$ C to +105 $^{\circ}$ C.

TYPICAL CHARACTERISTIC



TYPICAL APPLICATION



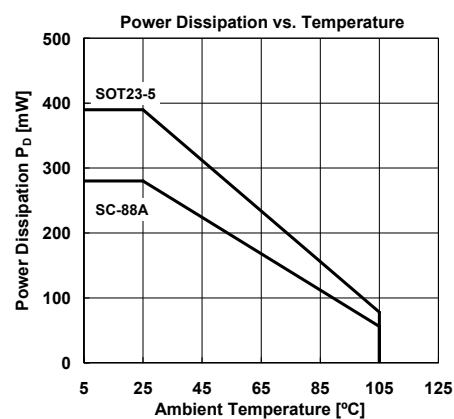
40dB micropower sensor amplifier

■ PIN CONFIGURATION / PRODUCT INFORMATION

Pin Function	(Top View)		(Top View)	
	OUTPUT 1	5 V^+	V^+ 1	5 V^+
	V^- 2		V^- 2	
	+INPUT 3	-INPUT 4	-INPUT 3	OUTPUT 4
Package	SOT-23-5		SOT-23-5	SC-88A
Product Name	NJU77000F NJU77000AF		NJU77001F NJU77001AF	NJU77001F3 NJU77001AF3

■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

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⁾		(2-layer)	
SOT23-5	P_D	390	mW
SC-88A		280	
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 Ta=25°C, and is the typical measured value based on JEDEC condition.

When using the IC over Ta=25°C subtract the value [mW/°C]= $P_D/(T_{stg}(MAX)-25)$ per temperature.

2-layer: EIA/JEDEC STANDARD Test board (76.2x114.3x 1.6mm, 2layers, FR-4) mounting

■ RECOMMENDED OPERATING CONDITIONS (Ta=25°C)

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

■ ELECTRICAL CHARACTERISTICS

● DC CHARACTERISTICS ($V^+=5V$, $V^-=0V$, $V_{CM}=2.5V$, $T_a=25^\circ C$, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	NJU77000A NJU77001A			NJU77000 NJU77001			UNIT
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Supply Current	I_Q	No Signal	-	0.29	0.39	-	0.29	0.49	μA
		$T_a=-40^\circ C$ to $+105^\circ C$	-	-	0.39	-	-	-	
Input Offset Voltage	V_{IO}	$V_{CM}=0V$	-	0.35	1	-	0.35	1.8	mV
		$T_a=-40^\circ C$ to $+105^\circ C$	-	0.35	1.2	-	-	-	
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$V_{CM}=0V$, $T_a=-40^\circ C$ to $+105^\circ C$	-	0.65	17	-	0.65	-	$\mu V/deg$
Input Bias Current	I_B	$T_a=-40^\circ C$ to $+105^\circ C$	-10	1	10	-	1	-	pA
			-100	-	100	-	-	-	
Input Offset Current	I_{IO}	$T_a=-40^\circ C$ to $+105^\circ C$	-10	1	10	-	1	-	pA
			-100	-	100	-	-	-	
Voltage Gain	A_V	$V_{out}=0.5V$ to $4.5V$, $R_L=100k\Omega$ to $2.5V$	70	100	-	70	100	-	dB
		$T_a=-40^\circ C$ to $+105^\circ C$	70	100	-	-	-	-	
Common-Mode Rejection Ratio	CMR	$V_{CM}=0V$ to $5V$	60	80	-	60	80	-	dB
		$T_a=-40^\circ C$ to $+105^\circ C$	60	80	-	-	-	-	
Supply Voltage Rejection Ratio	SVR	$V^+=1.5V$ to $5.5V$, $V_{CM}=0V$	70	90	-	70	90	-	dB
		$T_a=-40^\circ C$ to $+105^\circ C$	70	90	-	-	-	-	
Maximum Output Voltage	V_{OH}	$R_L=100k\Omega$ to $2.5V$ $T_a=-40^\circ C$ to $+105^\circ C$	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	-	0.05	0.1	V
Common-Mode Input Voltage Range	V_{ICM}	CMR $\geq 60dB$	0	-	5	0	-	5	V
		$T_a=-40^\circ C$ to $+105^\circ C$	0	-	5	-	-	-	

● AC CHARACTERISTICS ($V^+=5V$, $V^-=0V$, $V_{CM}=2.5V$, $T_a=25^\circ C$, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	NJU77000A NJU77001A			NJU77000 NJU77001			UNIT
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Slew Rate	SR	$G_v=0dB$, $R_L=100k\Omega$ to $2.5V$, $C_L=20pF$, $V_{IN}=1V_{pp}$	-	0.8	-	-	0.8	-	V/ms
unity-Gain Frequency	f_T	$R_L=100k\Omega$ to $2.5V$, $C_L=20pF$, $G_v=20dB$	-	1.1	-	-	1.1	-	kHz
Phase Margin	Φ_M	$R_L=100k\Omega$ to $2.5V$, $C_L=20pF$	-	60	-	-	60	-	deg
Gain Margin	G_M	$R_L=100k\Omega$ to $2.5V$, $C_L=20pF$	-	30	-	-	30	-	dB
Equivalent Input Noise Voltage	V_{NI}	$f=100Hz$	-	600	-	-	600	-	nV/ \sqrt{Hz}

■ ELECTRICAL CHARACTERISTICS

● DC CHARACTERISTICS ($V^+=1.8V$, $V=0V$, $V_{CM}=0.9V$, $T_a=25^\circ C$, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	NJU77000A NJU77001A			NJU77000 NJU77001			UNIT
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Supply Current	I_Q	No Signal $T_a=-40^\circ C$ to $+105^\circ C$	-	0.26	0.36	-	0.26	0.46	μA
			-	-	0.36	-	-	-	
Input Offset Voltage	V_{IO}	$V_{CM}=0V$ $T_a=-40^\circ C$ to $+105^\circ C$	-	0.35	1	-	0.35	1.8	mV
			-	0.35	1.2	-	-	-	
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$V_{CM}=0V$, $T_a=-40^\circ C$ to $+105^\circ C$	-	0.65	17	-	0.65	-	$\mu V/deg$
Input Bias Current	I_B	$T_a=-40^\circ C$ to $+105^\circ C$	-10	1	10	-	1	-	pA
			-100	-	100	-	-	-	
Input Offset Current	I_{IO}	$T_a=-40^\circ C$ to $+105^\circ C$	-10	1	10	-	1	-	pA
			-100	-	100	-	-	-	
Voltage Gain	A_V	$V_{out}=0.5V$ to $1.3V$, $R_L=100k\Omega$ to $0.9V$ $T_a=-40^\circ C$ to $+105^\circ C$	70	100	-	70	100	-	dB
			70	100	-	-	-	-	
Common-Mode Rejection Ratio	CMR	$V_{CM}=0V$ to $1.8V$ $T_a=-40^\circ C$ to $+105^\circ C$	55	80	-	55	80	-	dB
			55	80	-	-	-	-	
Supply Voltage Rejection Ratio	SVR	$V^+=1.5V$ to $5.5V$, $V_{CM}=0V$ $T_a=-40^\circ C$ to $+105^\circ C$	70	90	-	70	90	-	dB
			70	90	-	-	-	-	
Maximum Output Voltage	V_{OH}	$R_L=100k\Omega$ to $0.9V$ $T_a=-40^\circ C$ to $+105^\circ C$	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	-	0.05	0.1	V
Common-Mode Input Voltage Range	V_{ICM}	CMR ≥ 55 dB $T_a=-40^\circ C$ to $+105^\circ C$	0	-	1.8	0	-	1.8	V
			0	-	1.8	-	-	-	

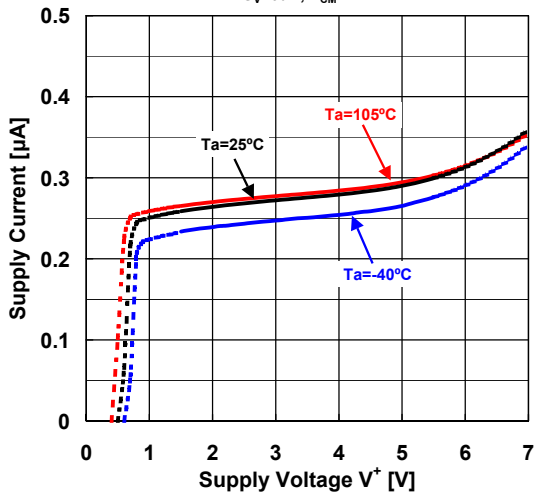
● AC CHARACTERISTICS ($V^+=1.8V$, $V=0V$, $V_{CM}=0.9V$, $T_a=25^\circ C$, unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	NJU77000A NJU77001A			NJU77000 NJU77001			UNIT
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Slew Rate	SR	$G_v=0$ dB, $R_L=100k\Omega$ to $0.9V$, $C_L=20$ pF, $V_{IN}=1$ Vpp	-	0.7	-	-	0.7	-	V/ms
Unity Gain Frequency	f_T	$R_L=100k\Omega$ to $0.9V$, $C_L=20$ pF, $G_v=20$ dB	-	1.0	-	-	1.0	-	kHz
Phase Margin	Φ_M	$R_L=100k\Omega$ to $0.9V$, $C_L=20$ pF	-	60	-	-	60	-	deg
Gain Margin	G_M	$R_L=100k\Omega$ to $0.9V$, $C_L=20$ pF	-	30	-	-	30	-	dB
Equivalent Input Noise Voltage	V_{NI}	$f=100$ Hz	-	700	-	-	700	-	nV/ \sqrt{Hz}

TYPICAL CHARACTERISTICS

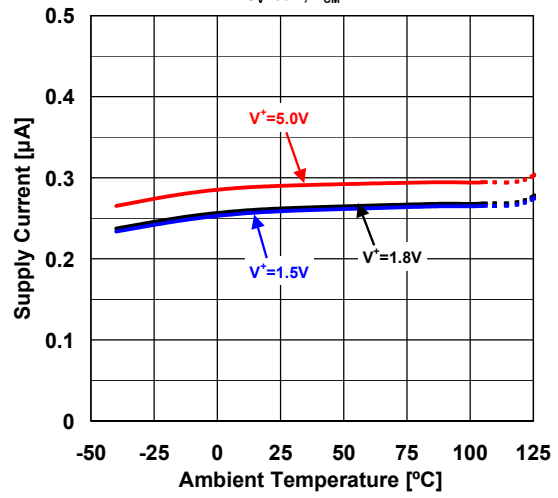
Supply Current vs. Supply Voltage

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



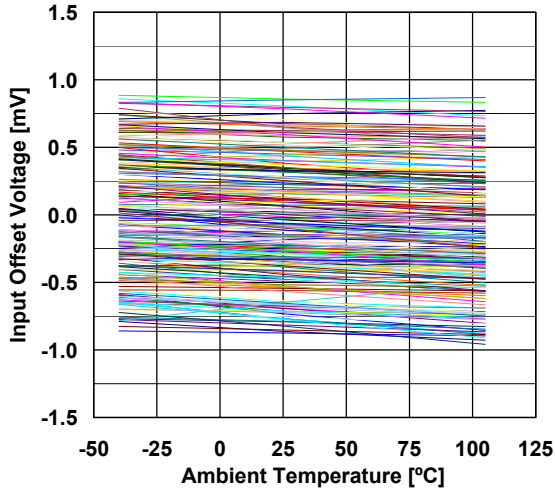
Supply Current vs. Temperature

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



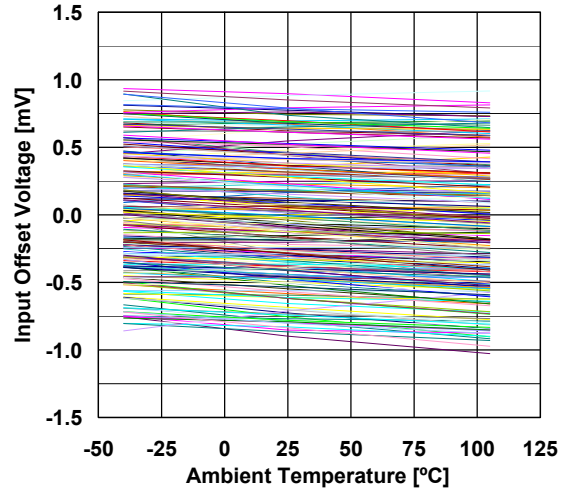
Input Offset Voltage vs. Temperature

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



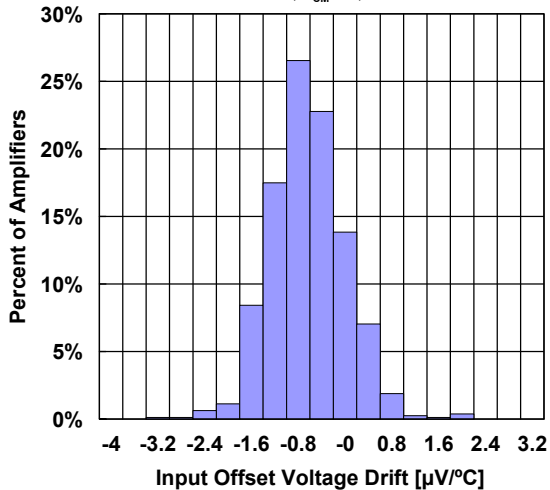
Input Offset Voltage vs. Temperature

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



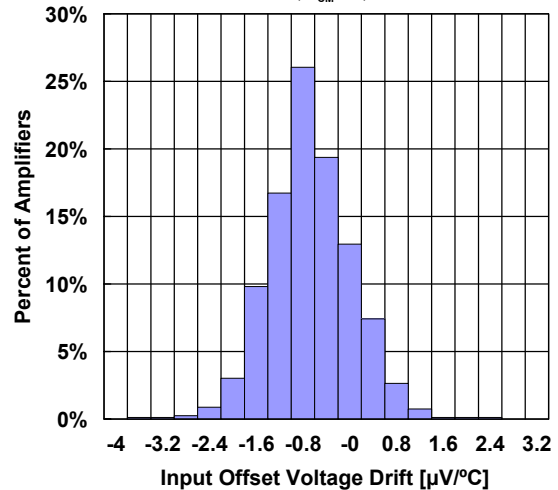
Input Offset Voltage Drift Distribution

$V^*=5.0\text{V}$, $V_{CM}=0\text{V}$, $n=800$



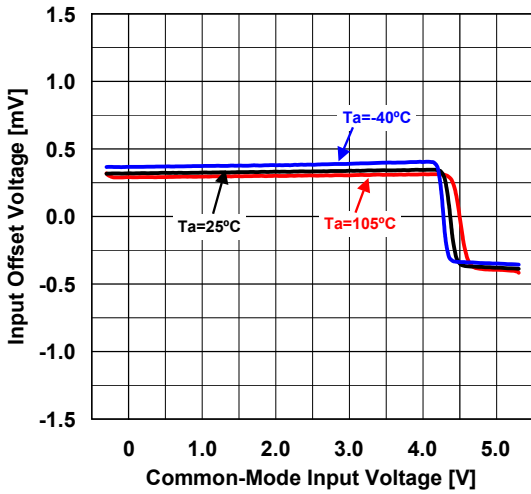
Input Offset Voltage Drift Distribution

$V^*=1.8\text{V}$, $V_{CM}=0\text{V}$, $n=800$

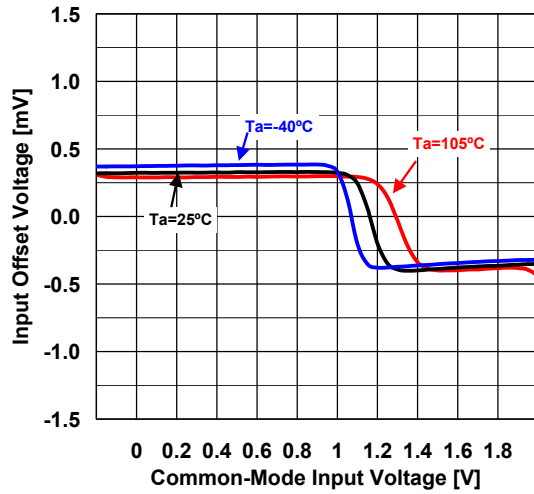


■ TYPICAL CHARACTERISTICS

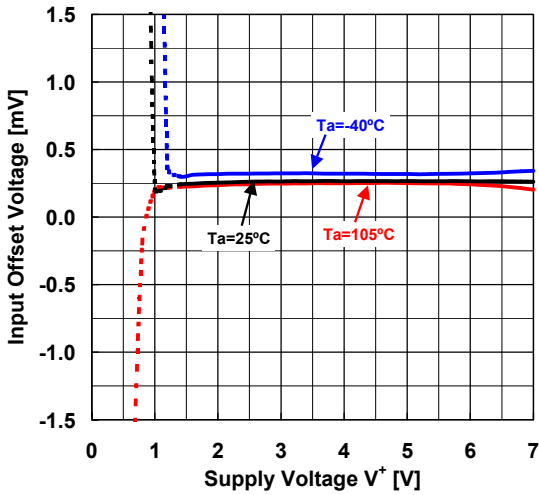
Input Offset Voltage vs. Common-Mode Input Voltage
 $V^+ = 5.0V$



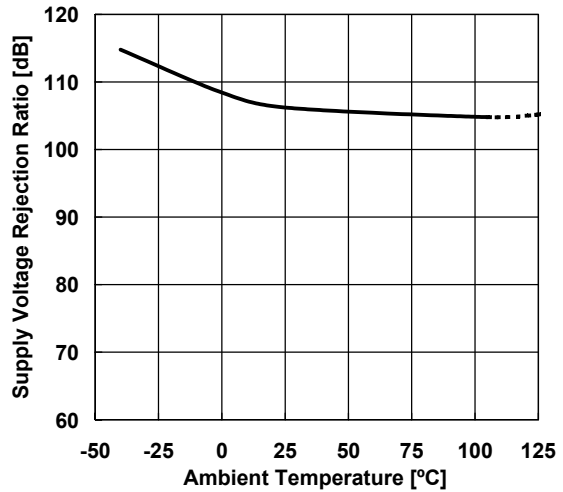
Input Offset Voltage vs. Common-Mode Input Voltage
 $V^+ = 1.8V$



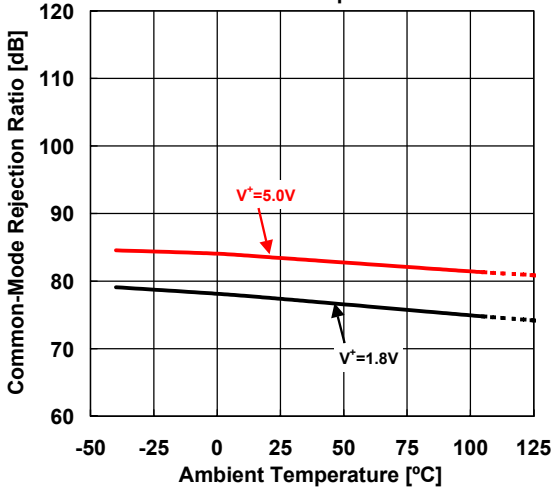
Input Offset Voltage vs. Supply Voltage
 $V_{CM} = 0V$



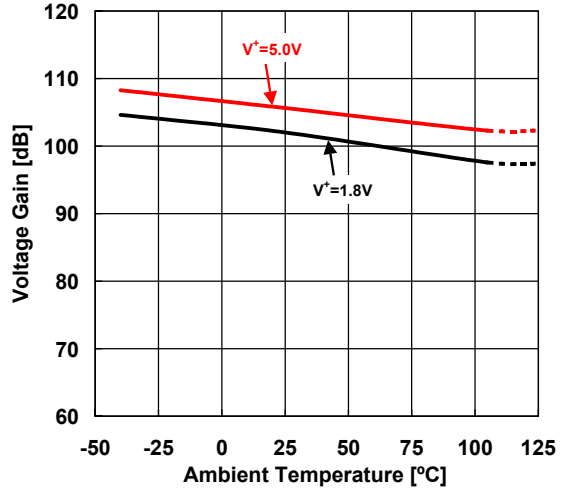
SVR vs. Temperature
 $V_{CM} = 0V$



CMR vs. Temperature

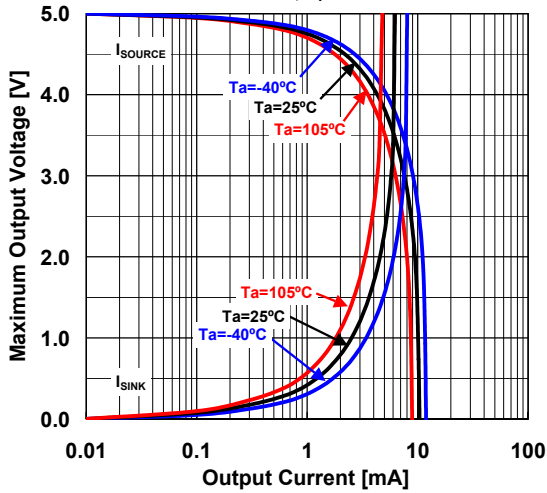


Voltage Gain vs. Temperature
 $V_{CM} = V^+/2, R_L = 100k\Omega \text{ to } V^+/2$

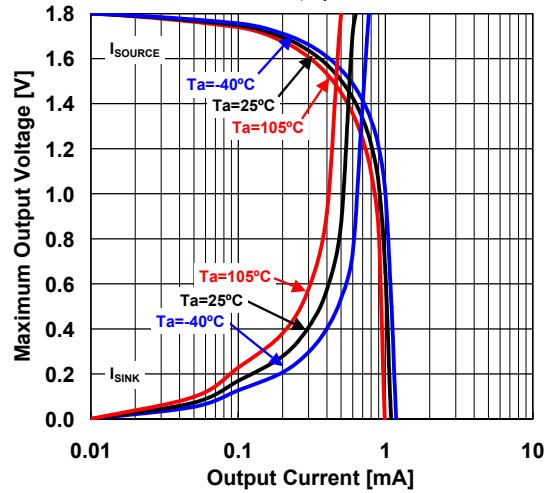


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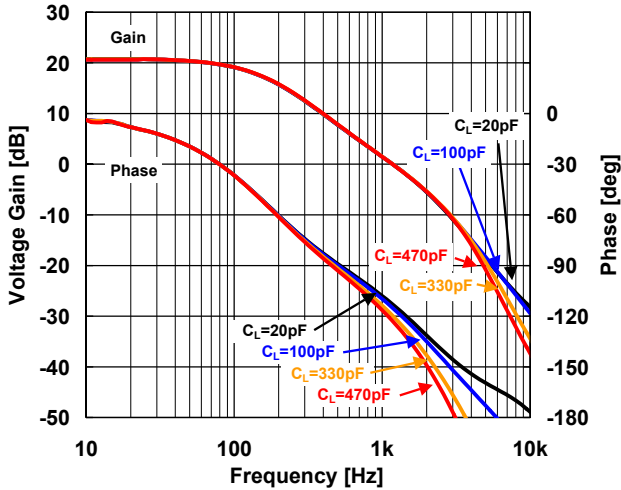
Maximum Output Voltage vs. Output Current
 $V^+=5.0V, G_V=OPEN$



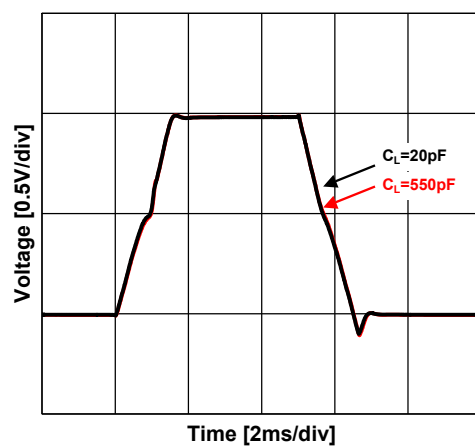
Maximum Output Voltage vs. Output Current
 $V^+=1.8V, G_V=OPEN$



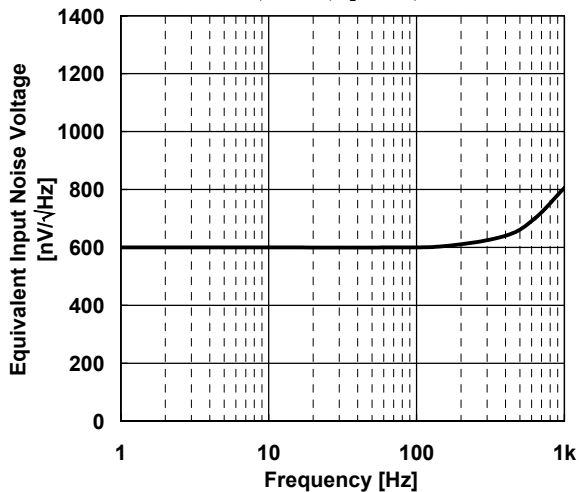
Voltage Gain/Phase vs. Frequency
 $V^+=5.0V, G_V=20dB, T_a=25^\circ C$



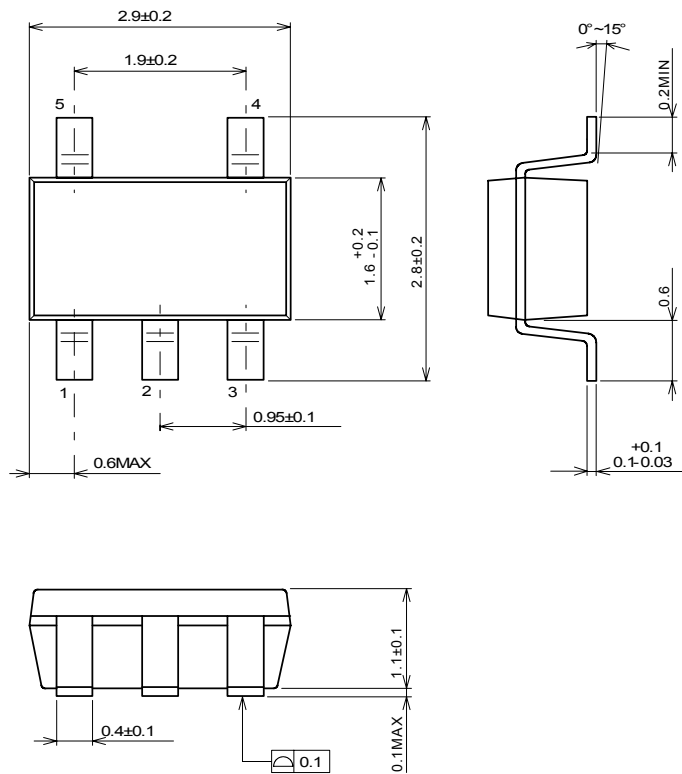
Pulse Response
 $V^+=5.0V, G_V=0dB, R_L=100k\Omega \text{ to } 2.5V, T_a=25^\circ C$



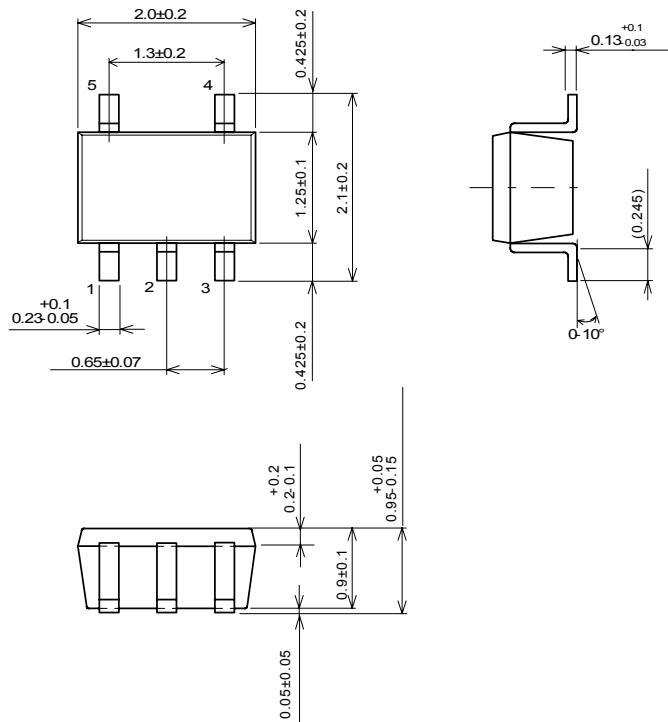
Voltage Noise vs. Frequency
 $V^+=5.0V, G_V=0dB, R_L=100k\Omega, T_a=25^\circ C$



■ PACKAGE DIMENSIONS



SOT-23-5 Package



SC-88A Package

[CAUTION]
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