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

FEATURES (V^+=5V)

- Supply Current: 0.29µA typ.
- Operating Voltage: 1.5V to 5.5V
- Input Offset Voltage: 1mV max.
- Offset Voltage Drift: 0.65µV/ºC 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

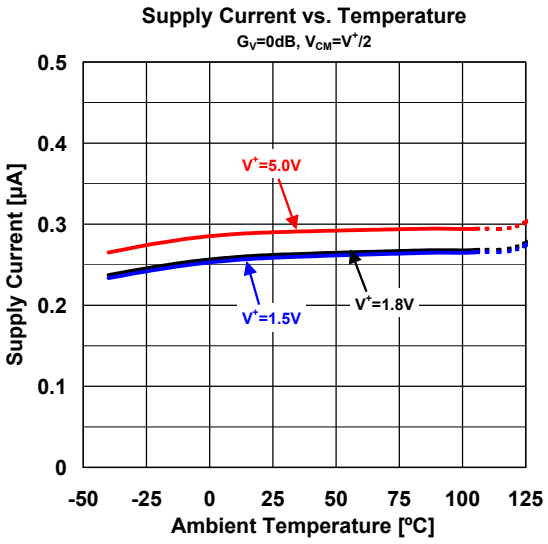
DESCRIPTION

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 0.29uA typical with stable over temperature and input voltage change makes it ideal for micropower oxygen sensors, gas sensors and remote sensor applications.

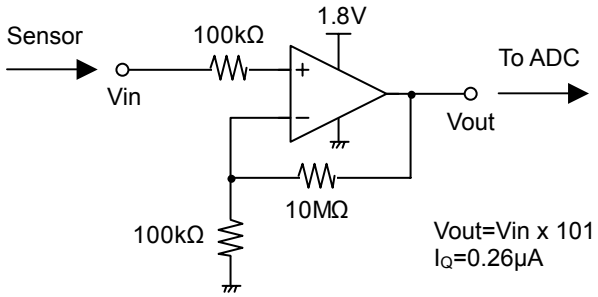
In addition to the ultralow power and low operating voltage, rail-to-rail input and output, input offset voltage of 1mV maximum with 0.65uV/ºC drift, input bias current of 10pA maximum and ability to drive 470pF loads, make the NJU77001/NJU77001 ideal when requiring excellent performance in battery powered 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 -40ºC to +105ºC.

TYPICAL CHARACTEREISTIC

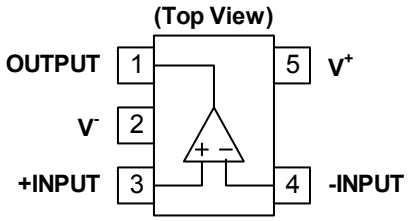
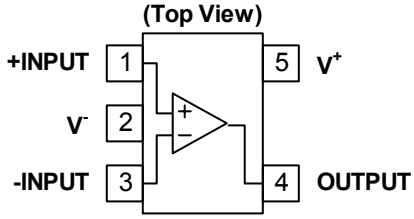


TYPICAL APPLICATION



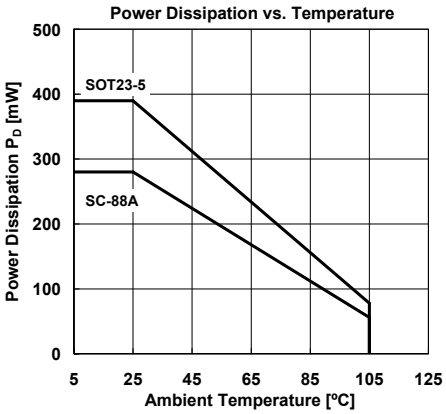
40dB micropower sensor amplifier

■PIN CONFIGURATION / PRODUCT INFORMATION

Pin Function			
Package	SOT-23-5	SOT-23-5	SC-88A
Product Name	**NJU77000F** **NJU77000AF**	**NJU77001F** **NJU77001AF**	**NJU77001F3** **NJU77001AF3**

■ ABSOLUTE MAXIMUM RATINGS (Ta=25ºC)

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	ºC
Storage Temperature Range	T_{stg}	-55 to +125	ºC



(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=25ºC, and is the typical measured value based on JEDEC condition.
When using the IC over Ta=25ºC subtract the value [mW/ºC]=$P_D/(T_{stg}(MAX)-25)$ per temperature.
2-layer: EIA/JEDEC STANDARD Test board (76.2x114.3x 1.6mm, 2layers, FR-4) mounting

■ RECOMMENDED OPERATING CONDITIONS (Ta=25ºC)

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, Ta=25ºC, 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
		Ta=-40ºC to +105ºC	-	-	0.39	-	-	-	
Input Offset Voltage	V_{IO}	V_{CM}=0V	-	0.35	1	-	0.35	1.8	mV
		Ta=-40ºC to +105ºC	-	0.35	1.2	-	-	-	
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	V_{CM}=0V, Ta=-40ºC to +105ºC	-	0.65	17	-	0.65	-	μV/deg
Input Bias Current	I_B		-10	1	10	-	1	-	pA
		Ta=-40ºC to +105ºC	-100	-	100	-	-	-	
Input Offset Current	I_{IO}		-10	1	10	-	1	-	pA
		Ta=-40ºC to +105ºC	-100	-	100	-	-	-	
Voltage Gain	A_V	Vout=0.5V to 4.5V, R_L=100kΩ to 2.5V	70	100	-	70	100	-	dB
		Ta=-40ºC to +105ºC	70	100	-	-	-	-	
Common-Mode Rejection Ratio	CMR	V_{CM}=0V to 5V	60	80	-	60	80	-	dB
		Ta=-40ºC to +105ºC	60	80	-	-	-	-	
Supply Voltage Rejection Ratio	SVR	V^+=1.5V to 5.5V, V_{CM}=0V	70	90	-	70	90	-	dB
		Ta=-40ºC to +105ºC	70	90	-	-	-	-	
Maximum Output Voltage	V_{OH}	R_L=100kΩ to 2.5V	4.9	4.95	-	4.9	4.95	-	V
		Ta=-40ºC to +105ºC	4.9	4.95	-	-	-	-	
	V_{OL}	R_L=100kΩ to 2.5V	-	0.05	0.1	-	0.05	0.1	V
		Ta=-40ºC to +105ºC	-	0.05	0.1	-	-	-	
Common-Mode Input Voltage Range	V_{ICM}	CMR≥60dB	0	-	5	0	-	5	V
		Ta=-40ºC to +105ºC	0	-	5	-	-	-	

●AC CHARACTERISTICS (V^+=5V, V^-=0V, V_{CM}=2.5V, Ta=25ºC, unless otherwise noted.)

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

■ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS (V^+=1.8V, V^-=0V, V_{CM}=0.9V, Ta=25ºC, unless otherwise noted.)

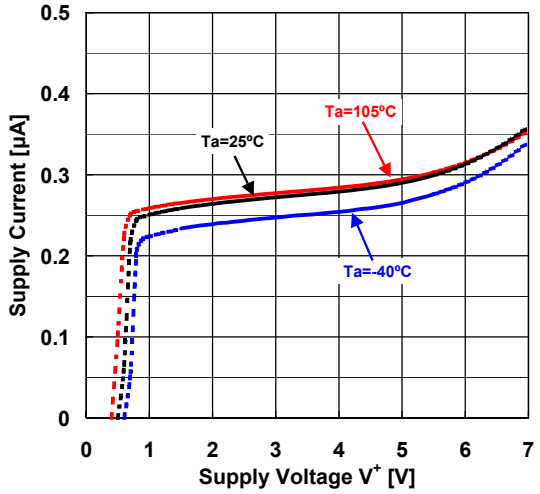
PARAMETER	SYMBOL	TEST CONDITION	NJU77000A NJU77001A			NJU77000 NJU77001			UNIT
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Supply Current	I_Q	No Signal	-	0.26	0.36	-	0.26	0.46	µA
		Ta=-40ºC to +105ºC	-	-	0.36	-	-	-	
Input Offset Voltage	V_{IO}	V_{CM}=0V	-	0.35	1	-	0.35	1.8	mV
		Ta=-40ºC to +105ºC	-	0.35	1.2	-	-	-	
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	V_{CM}=0V, Ta=-40ºC to +105ºC	-	0.65	17	-	0.65	-	µV/deg
Input Bias Current	I_B		-10	1	10	-	1	-	pA
		Ta=-40ºC to +105ºC	-100	-	100	-	-	-	
Input Offset Current	I_{IO}		-10	1	10	-	1	-	pA
		Ta=-40ºC to +105ºC	-100	-	100	-	-	-	
Voltage Gain	A_V	Vout=0.5V to 1.3V, R_L=100kΩ to 0.9V	70	100	-	70	100	-	dB
		Ta=-40ºC to +105ºC	70	100	-	-	-	-	
Common-Mode Rejection Ratio	CMR	V_{CM}=0V to 1.8V	55	80	-	55	80	-	dB
		Ta=-40ºC to +105ºC	55	80	-	-	-	-	
Supply Voltage Rejection Ratio	SVR	V^+=1.5V to 5.5V, V_{CM}=0V	70	90	-	70	90	-	dB
		Ta=-40ºC to +105ºC	70	90	-	-	-	-	
Maximum Output Voltage	V_{OH}	R_L=100kΩ to 0.9V	1.7	1.75	-	1.7	1.75	-	V
		Ta=-40ºC to +105ºC	1.7	1.75	-	-	-	-	
	V_{OL}	R_L=100kΩ to 0.9V	-	0.05	0.1	-	0.05	0.1	V
		Ta=-40ºC to +105ºC	-	0.05	0.1	-	-	-	
Common-Mode Input Voltage Range	V_{ICM}	CMR≥55dB	0	-	1.8	0	-	1.8	V
		Ta=-40ºC to +105ºC	0	-	1.8	-	-	-	

●AC CHARACTERISTICS (V^+=1.8V, V^-=0V, V_{CM}=0.9V, Ta=25ºC, unless otherwise noted.)

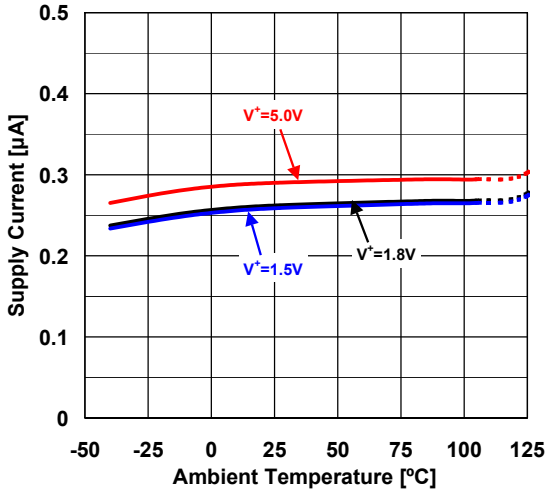
PARAMETER	SYMBOL	TEST CONDITION	NJU77000A NJU77001A			NJU77000 NJU77001			UNIT
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Slew Rate	SR	Gv=0dB, R_L=100kΩ to 0.9V, C_L=20pF, V_{IN}=1Vpp	-	0.7	-	-	0.7	-	V/ms
Unity Gain Frequency	f_T	R_L=100kΩ to 0.9V, C_L=20pF, Gv=20dB	-	1.0	-	-	1.0	-	kHz
Phase Margin	Φ_M	R_L=100kΩ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

■ TYPICAL CHARACTERISTICS

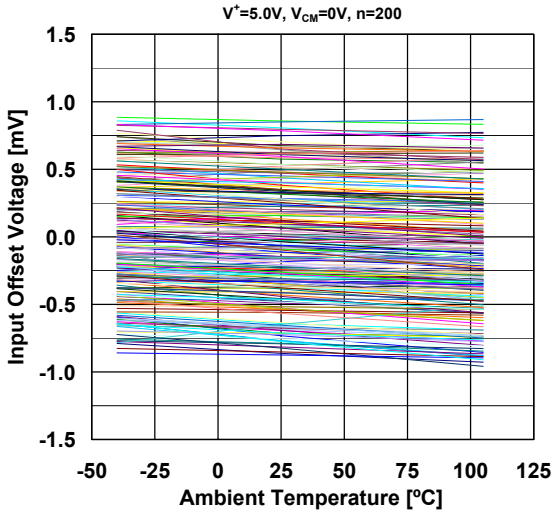
Supply Current vs. Supply Voltage
G_V=0dB, V_{CM}=V^+/2



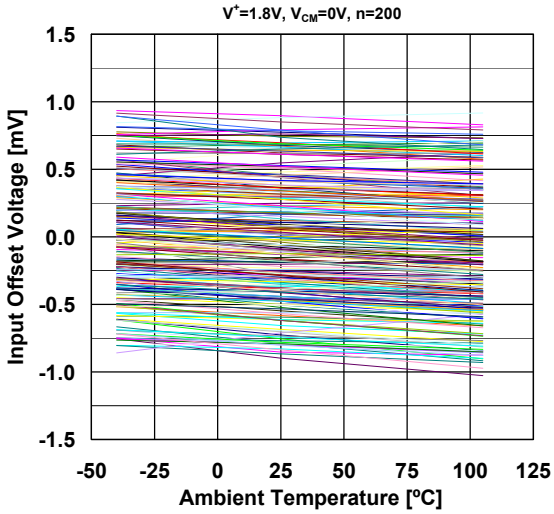
Supply Current vs. Temperature
G_V=0dB, V_{CM}=V^+/2



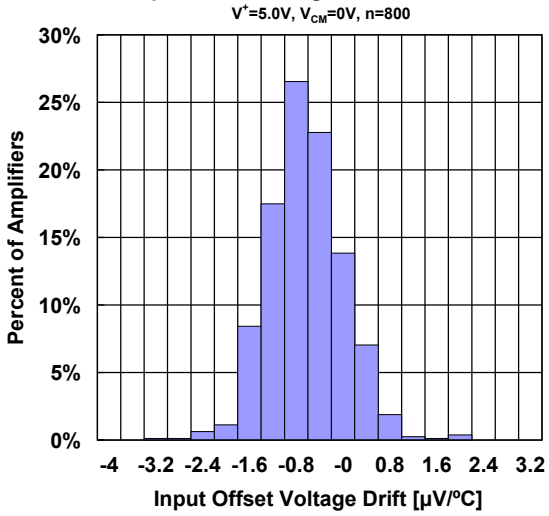
Input Offset Voltage vs. Temperature
V^+=5.0V, V_{CM}=0V, n=200



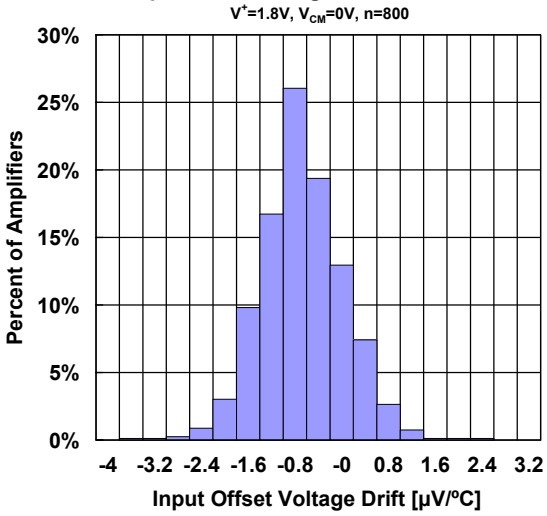
Input Offset Voltage vs. Temperature
V^+=1.8V, V_{CM}=0V, n=200



Input Offset Voltage Drift Distribution
V^+=5.0V, V_{CM}=0V, n=800

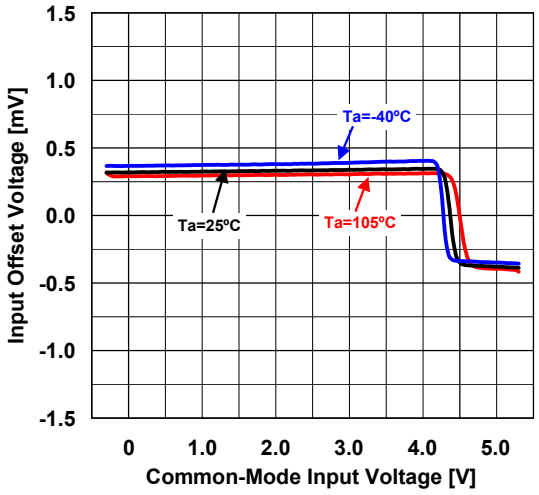


Input Offset Voltage Drift Distribution
V^+=1.8V, V_{CM}=0V, n=800

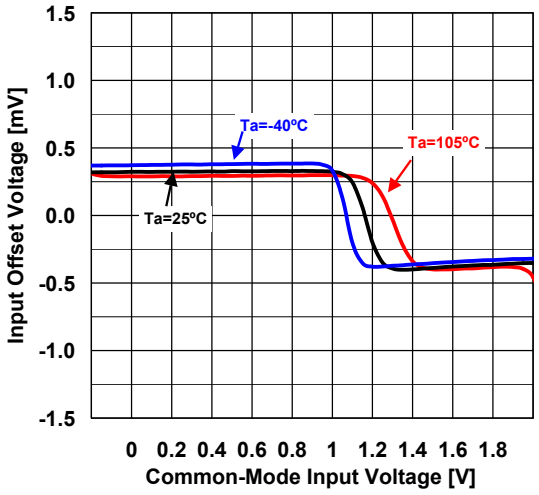


■TYPICAL CHARACTERISTICS

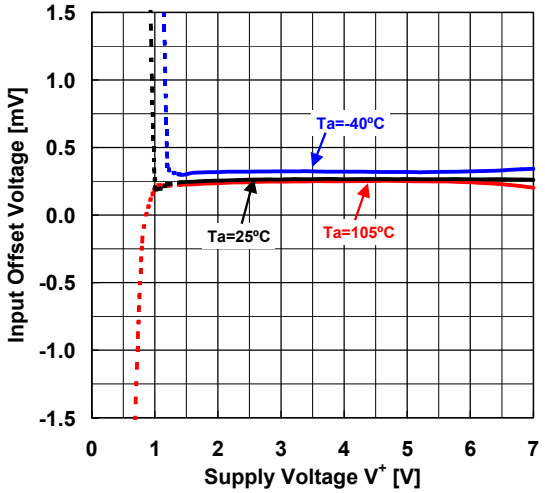
Input Offset Voltage
vs. Common-Mode Input Voltage
V^+=5.0V



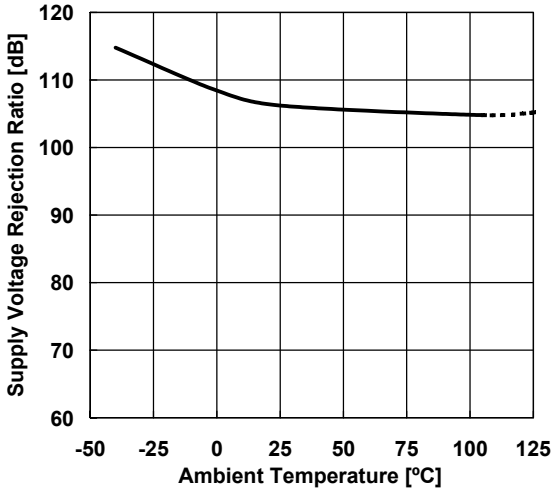
Input Offset Voltage
vs. Common-Mode Input Voltage
V^+=1.8V



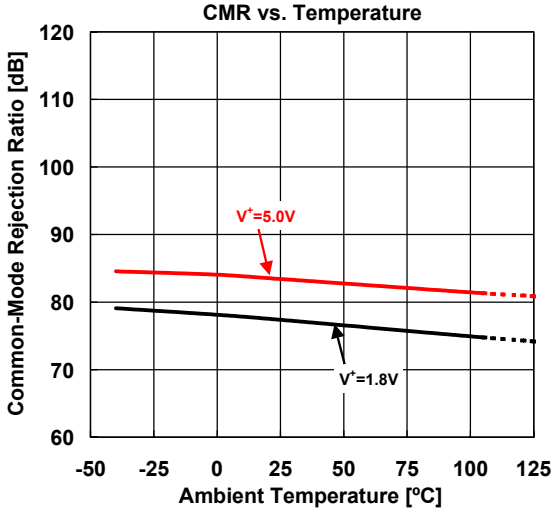
Input Offset Voltage vs. Supply Voltage
V_{CM}=0V



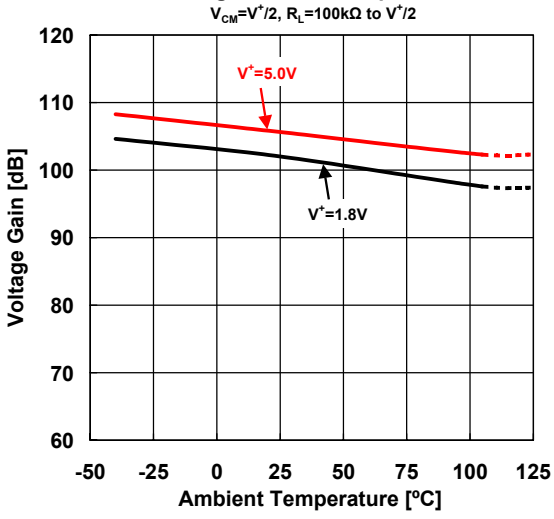
SVR vs. Temperature
V_{CM}=0V



CMR vs. Temperature



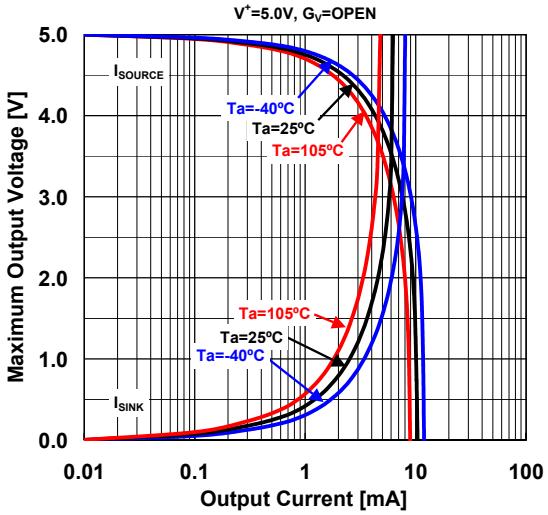
Voltage Gain vs. Temperature
V_{CM}=V^+/2, R_L=100kΩ to V^+/2



■ TYPICAL CHARACTERISTICS

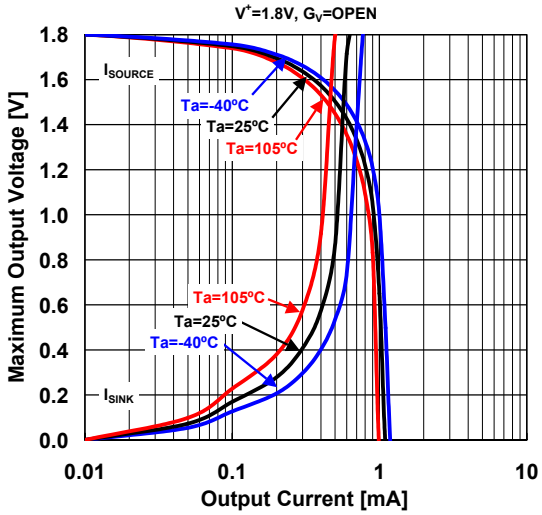
Maximum Output Voltage vs. Output Current

V^+=5.0V, G_V=OPEN



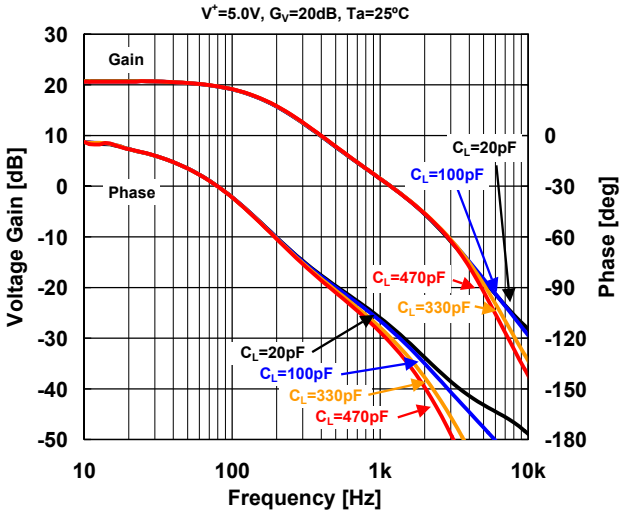
Maximum Output Voltage vs. Output Current

V^+=1.8V, G_V=OPEN



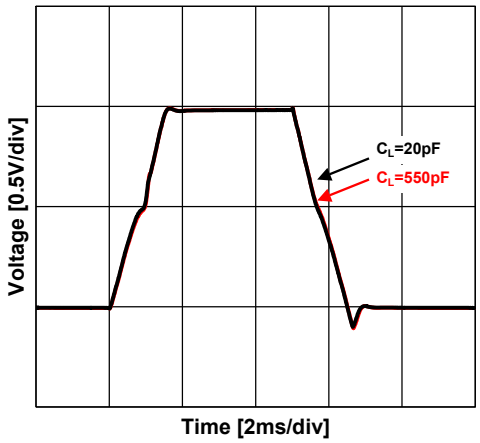
Voltage Gain/Phase vs. Frequency

V^+=5.0V, G_V=20dB, Ta=25°C



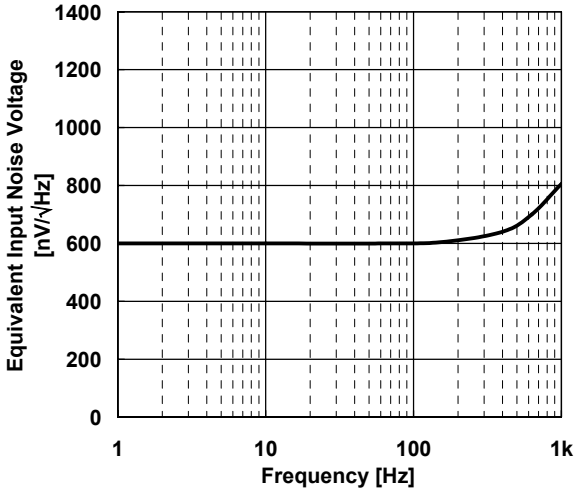
Pulse Response

V^+=5.0V, G_V=0dB, R_L=100kΩ to 2.5V, Ta=25°C

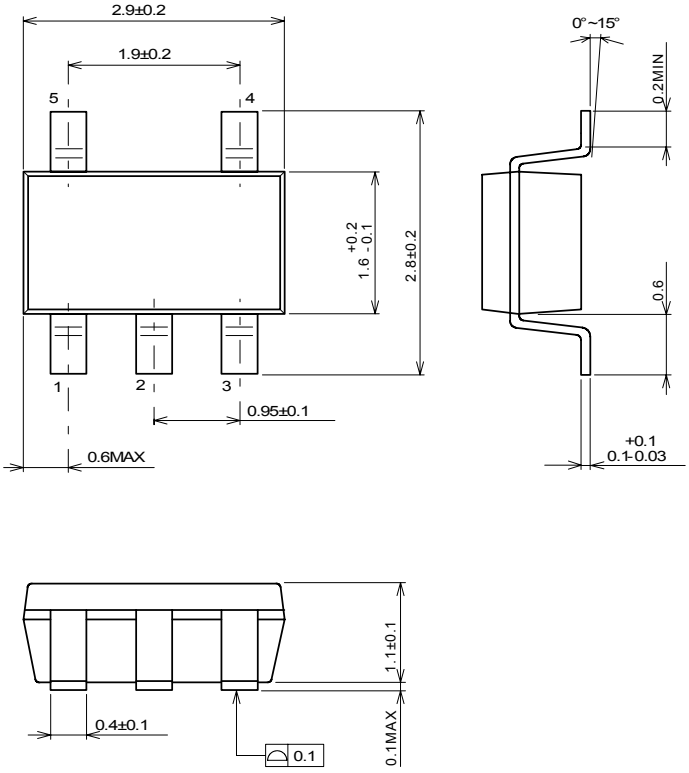


Voltage Noise vs. Frequency

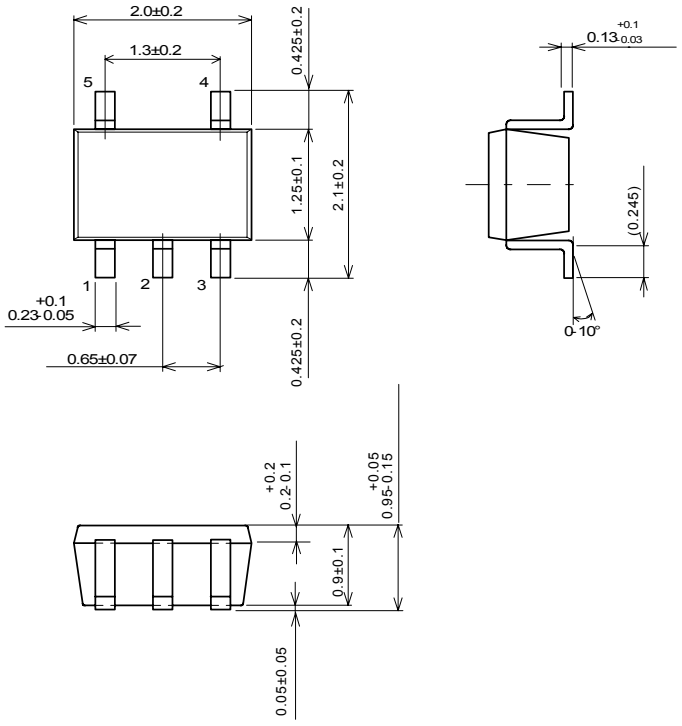
V^+=5.0V, Gv=0dB, R_L=100kΩ, Ta=25°C



■ PACKAGE DIMENSIONS



SOT-23-5 Package



SC-88A Package

[CAUTION]
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