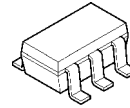


## Small Package, 13 $\mu$ A, Rail-to-Rail Output Single CMOS Operational Amplifier

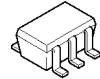
### ■ GENERAL DESCRIPTION

The NJU7026 is a low power, single CMOS operational amplifier available in small packages, SC88A and SOT-23-5. The NJU7026 can operate from a single-supply voltage of +1.8V to +5.5V. In addition, this amplifier features Rail-to-Rail output and low input bias current (1pA). Because of these features, the NJU7026 is ideal for low side current sense amplifier. The very low supply current of the NJU7026 (13 $\mu$ A) makes it suitable for battery-operated application.

### ■ PACKAGE OUTLINE



**NJU7026F**  
(SOT-23-5)



**NJU7026F3**  
(SC88A)

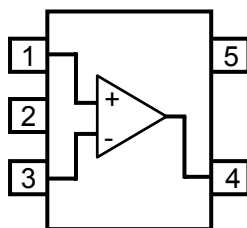
### ■ FEATURES

- Low Supply Current      13 $\mu$ A typ. (at  $V_{DD}$ = 5V), 12 $\mu$ A typ. (at  $V_{DD}$ = 3V, 1.8V)
- Low Operating Voltage     $V_{opr}$ = 1.8V to 5.5V
- Rail-to-Rail Output       $V_{OH}$ =4.9V min./  $V_{OL}$ =0.1V max. (at  $V_{DD}$ = 5V,  $R_L$ =100k $\Omega$ )  
 $V_{OH}$ =4.8V min./  $V_{OL}$ =0.2V max. (at  $V_{DD}$ = 5V,  $I_O$ =1mA)
- Small Package            SC88A, SOT-23-5
- Enhanced RF Noise Immunity
- CMOS Process

### ■ APPLICATION

- Battery-operated application
- Battery monitor
- Current sensor
- Photodiode amplification

### ■ PIN CONFIGURATION (Top View)



#### PIN FUNCTION

- 1: +INPUT
- 2: GND
- 3: -INPUT
- 4: OUTPUT
- 5: VDD

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

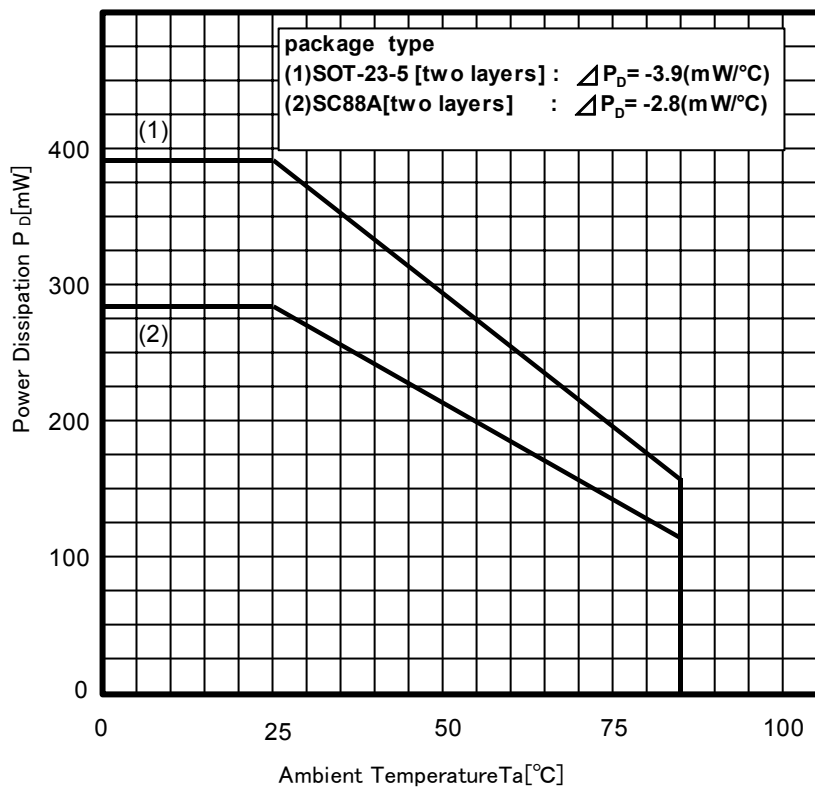
PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V <sub>DD</sub>	+7	V
Input Common Mode Voltage	V <sub>ICM</sub>	V <sub>SS</sub> -0.3 to V <sub>DD</sub> +0.3	V
Differential Input Voltage	V <sub>ID</sub>	±7 (Note1)	V
Power Dissipation	P <sub>D</sub>	390[SOT-23-5] *2), 280[SC88A] *2)	mW
Operating Temperature Range	T <sub>opr</sub>	-40 to +85	°C
Storage Temperature Range	T <sub>stg</sub>	-55 to +125	°C

(Note1) For supply voltage less than +7V, the absolute maximum rating is equal to the supply voltage.

(Note2) EIA/JEDEC STANDARD Test board (76.2 x 114.3 x 1.6mm, 2layers, FR-4) mounting.

(Note3) Do not exceed "Power dissipation: P<sub>D</sub>" in which power dissipation in IC is shown by the absolute maximum rating.

See Figure "Power Dissipation Curve" when ambient temperature is over 25°C.



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

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V <sub>DD</sub>	1.8 to 5.5	V

## ■ ELECTRICAL CHARACTERISTICS

### DC CHARACTER ( $V_{DD}=5V$ , $V_{SS}=0V$ , $T_a=25^\circ C$ , unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	$I_{DD}$	No Signal	-	13	20	$\mu A$
Input Offset Voltage	$V_{IO}$	$V_{ic}=0V$ , $R_S=50\Omega$	-	0.9	4	mV
Input Offset Voltage drift	$\Delta V_{IO}/\Delta T$		-	1.5	-	$\mu V/^\circ C$
Input Bias Current	$I_B$		-	1	-	pA
Input Offset Current	$I_{IO}$		-	1	-	pA
Open loop gain	$A_V$	$V_o=0.5V$ to $4.5V$ , $R_L=100k\Omega$ to $2.5V$	70	90	-	dB
Common Mode Rejection Ratio	CMR	$V_{ICM}=0V$ to $4.1V$	65	80	-	dB
Supply Voltage Rejection Ratio	SVR	$V_{DD}=1.8V$ to $5.5V$	70	90	-	dB
Maximum Output Voltage 1	$V_{OH1}$	$R_L=100k\Omega$ to $2.5V$	4.9	4.95	-	V
	$V_{OL1}$	$R_L=100k\Omega$ to $2.5V$	-	0.05	0.1	V
Maximum Output Voltage 2	$V_{OH2}$	$R_L=100k\Omega$ to $0V$	4.9	4.95	-	V
	$V_{OL2}$	$R_L=100k\Omega$ to $0V$	-	0.02	0.05	V
Maximum Output Voltage 3	$V_{OH3}$	$I_{source}=1mA$	4.8	4.85	-	V
	$V_{OL3}$	$I_{sink}=1mA$	-	0.15	0.2	V
Common Mode Input Voltage Range	$V_{ICM}$	CMR $\geq$ 65dB	0	-	4.1	V

### AC CHARACTER ( $V_{DD}=5V$ , $V_{SS}=0V$ , $T_a=25^\circ C$ , unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gain Bandwidth Product	GBW	$R_L=100k\Omega$ to $2.5V$ , $C_L=20pF$ , $f=10kHz$	-	160	-	kHz
Phase Margin	$\phi_M$	$R_L=100k\Omega$ to $2.5V$ , $C_L=20pF$	-	80	-	deg
Gain Margin	$G_M$	$R_L=100k\Omega$ to $2.5V$ , $C_L=20pF$	-	15	-	dB
Equivalent Input Noise Voltage	$e_n$	$f=1kHz$	-	50	-	$nV/\sqrt{Hz}$
Slew Rate	SR	$G_V=0dB$ , $R_L=100k\Omega$ to $2.5V$ , $C_L=20pF$ , $V_{in}=3V_{pp}$ (1V to 4V) (Note4) (Note5)	-	0.05	-	V/us
Power Bandwidth	PBW	$G_V=6dB$ , $R_F=50k\Omega$ , $R_G=50k\Omega$ , $C_L=20pF$ , $V_{in}=2.5V_{pp}$ (1.25V to 3.75V), $V_o\geq 4.8V_{pp}$ (Note6)	-	5	-	kHz
Total Harmonic Distortion	THD	$G_V=6dB$ , $R_F=50k\Omega$ , $R_G=50k\Omega$ , $C_L=20pF$ , $V_o=4V_{pp}$ , $f=100Hz$ (Note6)	-	0.01	-	%

(Note4) Slew rate is defined by the lower value of the rise or fall.

(Note5) See figure2-1 for test circuit.

(Note6) See figure2-3 for test circuit.

## ■ ELECTRICAL CHARACTERISTICS

**DC CHARACTER** ( $V_{DD}=3V$ ,  $V_{SS}=0V$ ,  $T_a=25^\circ C$ , unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	$I_{DD}$	No Signal	-	12	19	$\mu A$
Input Offset Voltage	$V_{IO}$	$V_{ic}=0V$ , $R_S=50\Omega$	-	0.9	4	mV
Input Offset Voltage drift	$\Delta V_{IO}/\Delta T$		-	1.5	-	$\mu V/^\circ C$
Input Bias Current	$I_B$		-	1	-	pA
Input Offset Current	$I_{IO}$		-	1	-	pA
Open loop gain	$A_V$	$V_o=0.5V$ to $2.5V$ , $R_L=100k\Omega$ to $1.5V$	70	90	-	dB
Common Mode Rejection Ratio	CMR	$V_{ICM}=0V$ to $2.1V$	65	80	-	dB
Supply Voltage Rejection Ratio	SVR	$V_{DD}=1.8V$ to $5.5V$	70	90	-	dB
Maximum Output Voltage 1	$V_{OH1}$	$R_L=100k\Omega$ to $1.5V$	2.9	2.95	-	V
	$V_{OL1}$	$R_L=100k\Omega$ to $1.5V$	-	0.05	0.1	V
Maximum Output Voltage 2	$V_{OH2}$	$R_L=100k\Omega$ to $0V$	2.9	2.95	-	V
	$V_{OL2}$	$R_L=100k\Omega$ to $0V$	-	0.02	0.05	V
Maximum Output Voltage 3	$V_{OH3}$	$I_{source}=1mA$	2.8	2.85	-	V
	$V_{OL3}$	$I_{sink}=1mA$	-	0.15	0.2	V
Common Mode Input Voltage Range	$V_{ICM}$	CMR $\geq$ 65dB	0	-	2.1	V

**AC CHARACTER** ( $V_{DD}=3V$ ,  $V_{SS}=0V$ ,  $T_a=25^\circ C$ , unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gain Bandwidth Product	GBW	$R_L=100k\Omega$ to $1.5V$ , $C_L=20pF$ , $f=10kHz$	-	150	-	kHz
Phase Margin	$\phi_M$	$R_L=100k\Omega$ to $1.5V$ , $C_L=20pF$	-	80	-	deg
Gain Margin	$G_M$	$R_L=100k\Omega$ to $1.5V$ , $C_L=20pF$	-	15	-	dB
Equivalent Input Noise Voltage	$e_n$	$f=1kHz$	-	50	-	$nV/\sqrt{Hz}$
Slew Rate	SR	$G_V=0dB$ , $R_L=100k\Omega$ to $1.5V$ , $C_L=20pF$ , $V_{in}=1V_{pp}$ (1V to 2V) (Note4) (Note5)	-	0.05	-	V/us
Power Bandwidth	PBW	$G_V=6dB$ , $R_F=50k\Omega$ , $R_G=50k\Omega$ , $C_L=20pF$ , $V_{in}=1.5V_{pp}$ (0.75V to 2.25V), $V_o\geq 2.8V_{pp}$ (Note6)	-	8	-	kHz
Total Harmonic Distortion	THD	$G_V=6dB$ , $R_F=50k\Omega$ , $R_G=50k\Omega$ , $C_L=20pF$ , $V_o=2V_{pp}$ , $f=100Hz$ (Note6)	-	0.01	-	%

(Note4) Slew rate is defined by the lower value of the rise or fall.

(Note5) See figure2-1 for test circuit.

(Note6) See figure2-3 for test circuit.

## ■ ELECTRICAL CHARACTERISTICS

**DC CHARACTER** ( $V_{DD}=1.8V$ ,  $V_{SS}=0V$ ,  $T_a=25^\circ C$ , unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current	$I_{DD}$	No Signal	-	12	18	$\mu A$
Input Offset Voltage	$V_{IO}$	$V_{ic}=0V$ , $R_S=50\Omega$	-	0.9	4	mV
Input Offset Voltage drift	$\Delta V_{io}/\Delta T$		-	1.5	-	$\mu V/^\circ C$
Input Bias Current	$I_B$		-	1	-	pA
Input Offset Current	$I_{IO}$		-	1	-	pA
Open loop gain	$A_V$	$V_o=0.5V$ to $2.5V$ , $R_L=100k\Omega$ to $0.9V$	70	90	-	dB
Common Mode Rejection Ratio	CMR	$V_{ICM}=0V$ to $0.9V$	65	80	-	dB
Supply Voltage Rejection Ratio	SVR	$V_{DD}=1.8V$ to $5.5V$	70	90	-	dB
Maximum Output Voltage 1	$V_{OH1}$	$R_L=100k\Omega$ to $0.9V$	1.7	1.75	-	V
	$V_{OL1}$	$R_L=100k\Omega$ to $0.9V$	-	0.05	0.1	V
Maximum Output Voltage 2	$V_{OH2}$	$R_L=100k\Omega$ to $0V$	1.7	1.75	-	V
	$V_{OL2}$	$R_L=100k\Omega$ to $0V$	-	0.02	0.05	V
Maximum Output Voltage 3	$V_{OH3}$	$I_{source}=0.5mA$	1.5	1.55	-	V
	$V_{OL3}$	$I_{sink}=0.5mA$	-	0.25	0.3	V
Common Mode Input Voltage Range	$V_{ICM}$	CMR $\geq$ 65dB	0	-	0.9	V

**AC CHARACTER** ( $V_{DD}=1.8V$ ,  $V_{SS}=0V$ ,  $T_a=25^\circ C$ , unless otherwise noted.)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gain Bandwidth Product	GBW	$R_L=100k\Omega$ to $0.9V$ , $C_L=20pF$ , $f=10kHz$	-	140	-	kHz
Phase Margin	$\phi_M$	$R_L=100k\Omega$ to $0.9V$ , $C_L=20pF$	-	80	-	deg
Gain Margin	$G_M$	$R_L=100k\Omega$ to $0.9V$ , $C_L=20pF$	-	15	-	dB
Equivalent Input Noise Voltage	$e_n$	$f=1kHz$	-	50	-	$nV/\sqrt{Hz}$
Slew Rate	SR	$G_V=0dB$ , $R_L=100k\Omega$ to $1.5V$ , $C_L=20pF$ , $V_{in}=0.5V_{pp}$ ( $0.3V$ to $0.8V$ ) (Note4) (Note7)	-	0.05	-	V/us
Power Bandwidth	PBW	$G_V=6dB$ , $R_F=50k\Omega$ , $R_G=50k\Omega$ , $C_L=20pF$ , $V_{in}=0.9V_{pp}$ ( $0V$ to $0.9V$ ), $V_o\geq 1.6V_{pp}$ (Note8)	-	14	-	kHz
Total Harmonic Distortion	THD	$G_V=6dB$ , $R_F=50k\Omega$ , $R_G=50k\Omega$ , $C_L=20pF$ , $V_o=1V_{pp}$ , $f=100Hz$ (Note8)	-	0.01	-	%

(Note4) Slew rate is defined by the lower value of the rise or fall.

(Note7) See figure2-2 for test circuit.

(Note8) See figure2-4 for test circuit.

## MEASUREMENT CIRCUITS

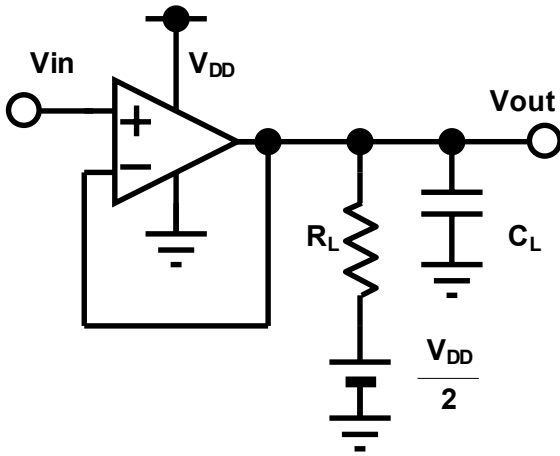


Figure 2-1: Measurement circuit 1

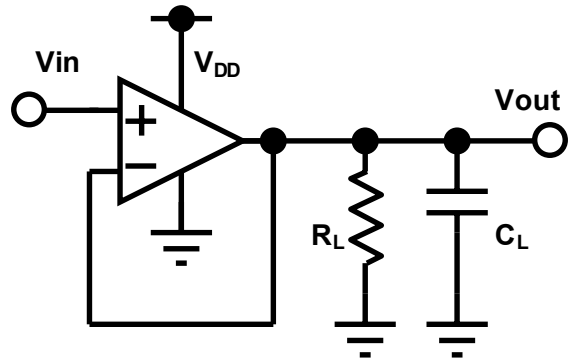


Figure 2-2: Measurement circuit 2

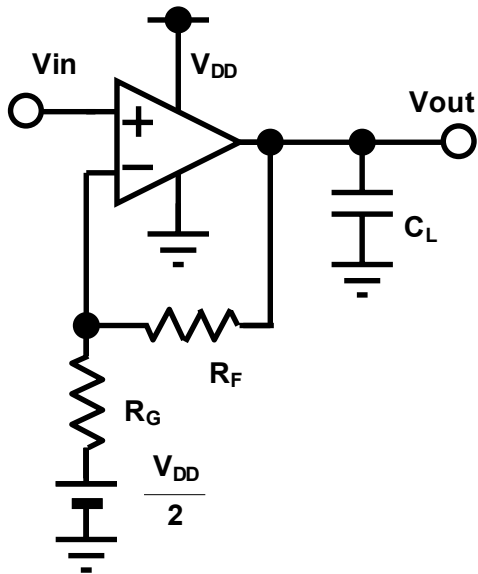


Figure 2-3: Measurement circuit 3

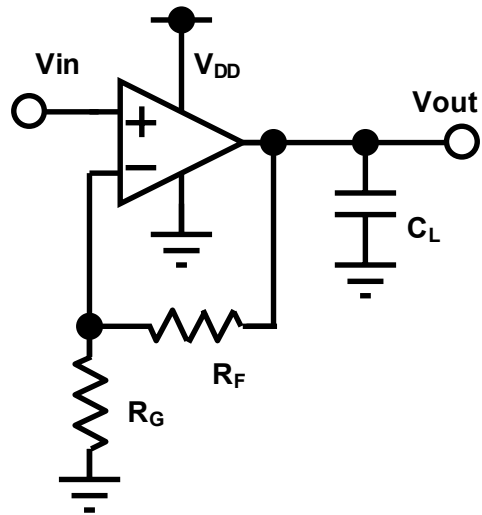
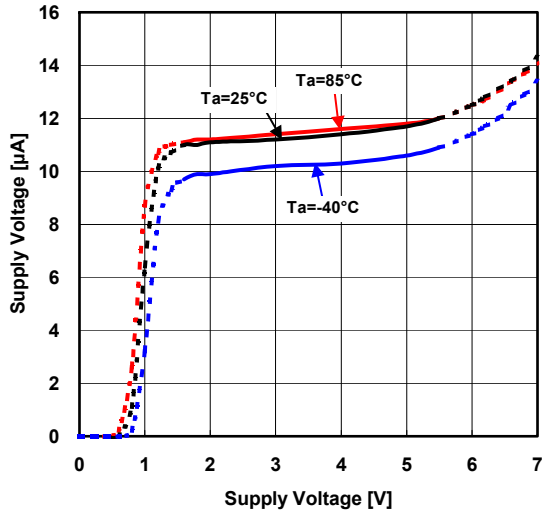


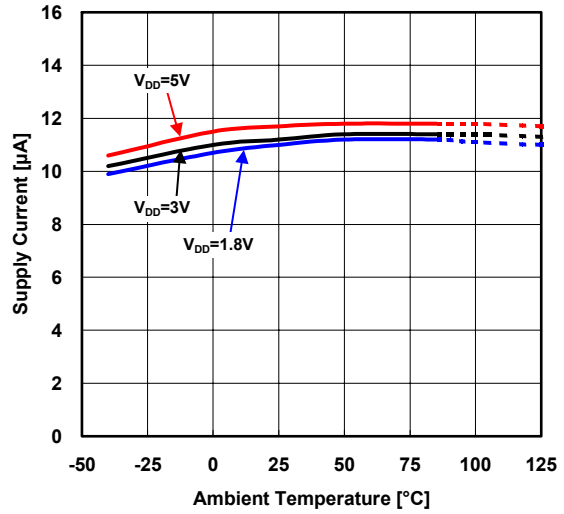
Figure 2-4: Measurement circuit 4

## ■ TYPICAL CHARACTERISTICS

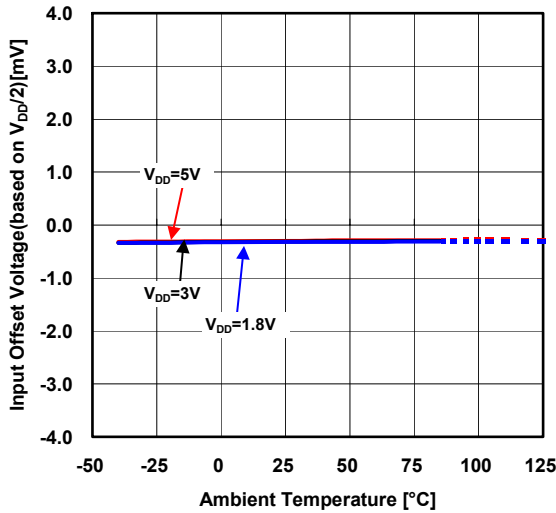
**Supply Current vs. Supply Voltage**  
 $G_V=0dB, V_{ICM}=V_{DD}/2$



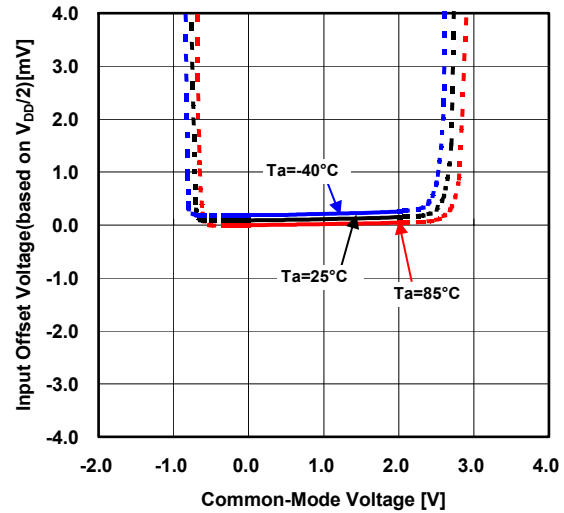
**Supply Current vs. Temperature**  
 $G_V=0dB, V_{ICM}=V_{DD}/2$



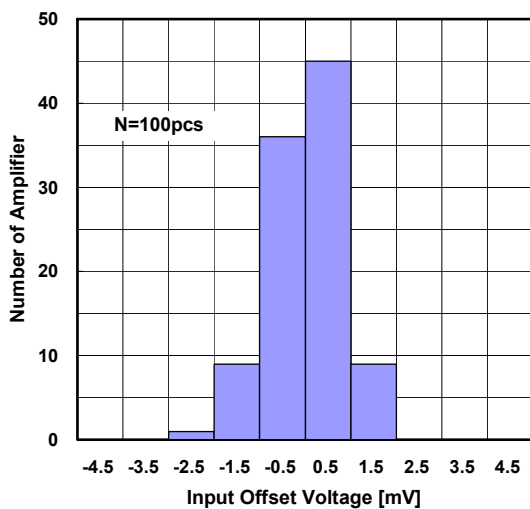
**Input Offset Voltage vs. Temperature**  
 $V_{ICM}=V_{DD}/2$



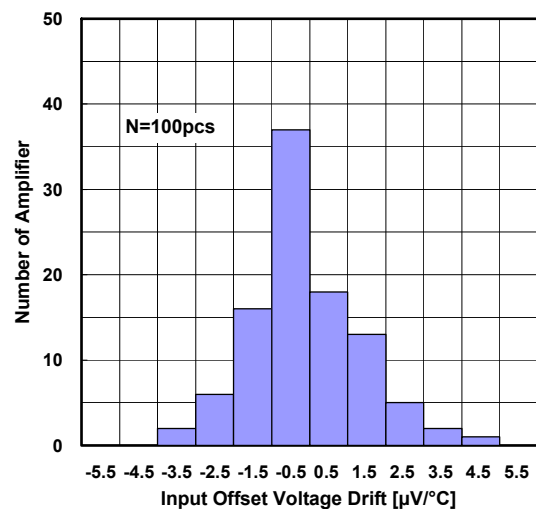
**Input Offset Voltage vs. Common-Mode Voltage**  
 $V_{DD}=3V$



**Input Offset Voltage Distribution**  
 $V_{DD}=3V, V_{ICM}=0V, T_a=25^\circ C$

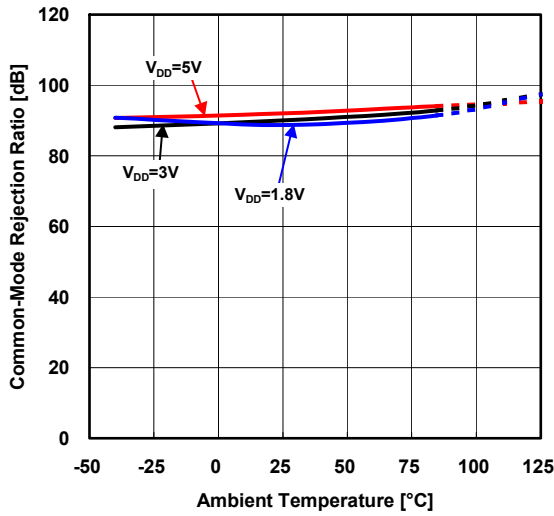


**Input Offset Voltage Drift Distribution**  
 $V_{DD}=3V, V_{ICM}=0V, T_a=-40^\circ C \text{ to } 85^\circ C$

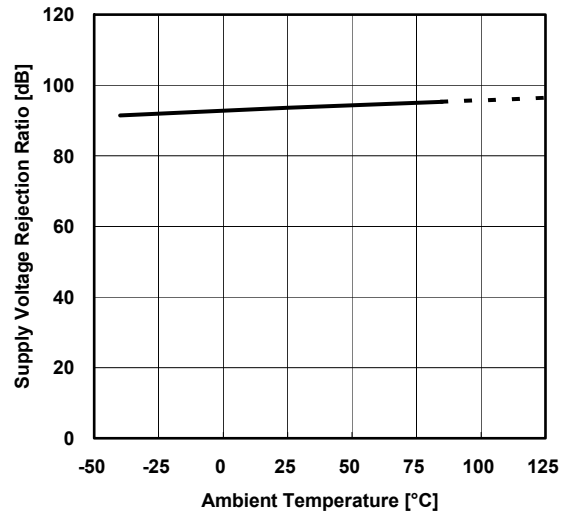


## ■ TYPICAL CHARACTERISTICS

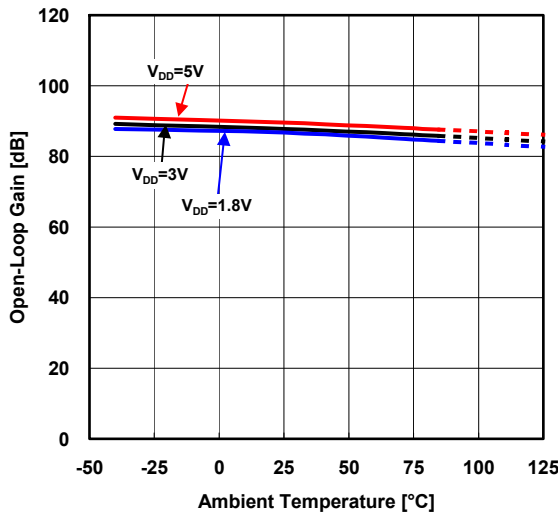
Common-Mode Rejection Ratio vs. Temperature  
 $V_{CM}=0V$  to  $V_{DD}-0.9V$



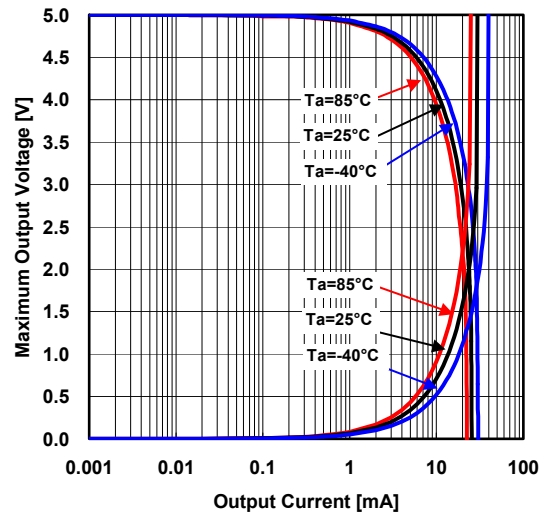
Supply Voltage Rejection Ratio vs. Temperature  
 $V_{DD}=1.8V$  to  $5.5V$



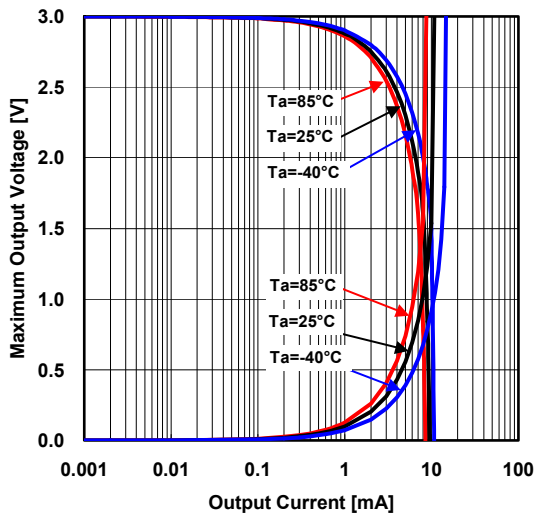
Open-Loop Gain vs. Temperature  
 $V_{OUT}=0.5V$  to  $V_{DD}-0.5V$ ,  $R_L=100k\Omega$



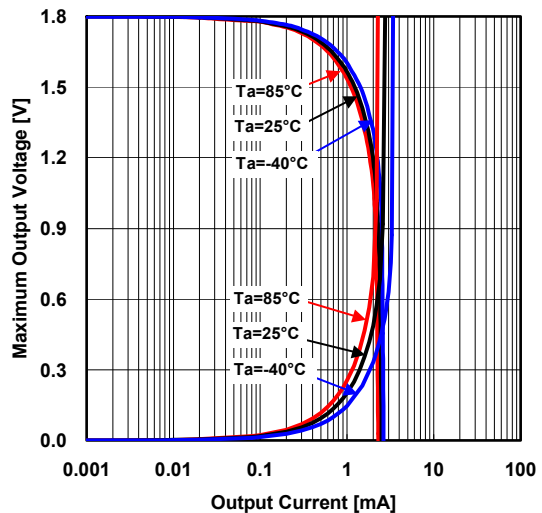
Maximum Output Voltage vs. Output Current  
 $V_{DD}=5V$ ,  $V_{CM}=2.5V$ ,  $V_{IN}=\pm 0.1V$



Maximum Output Voltage vs. Output Current  
 $V_{DD}=3V$ ,  $V_{CM}=1.5V$ ,  $V_{IN}=\pm 0.1V$



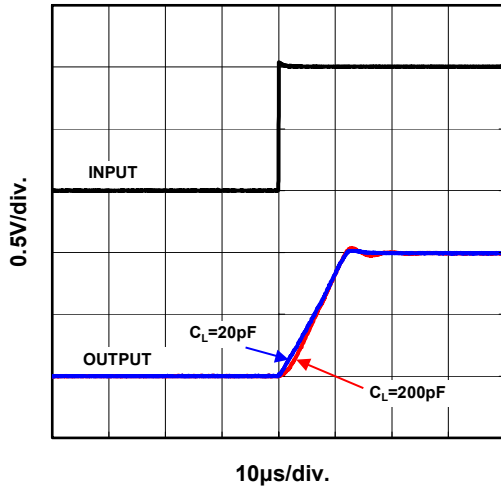
Maximum Output Voltage vs. Output Current  
 $V_{DD}=1.8V$ ,  $V_{CM}=0.9V$ ,  $V_{IN}=\pm 0.1V$



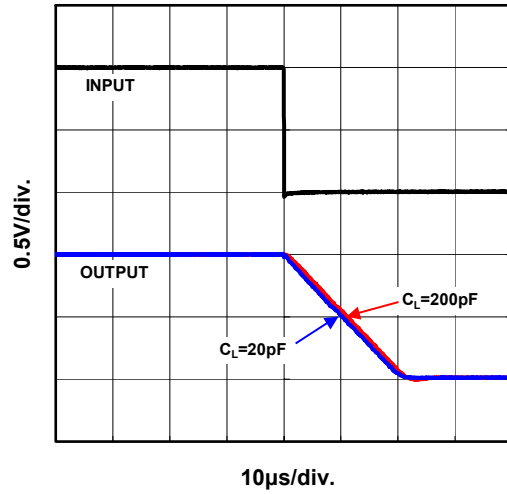


## ■ TYPICAL CHARACTERISTICS

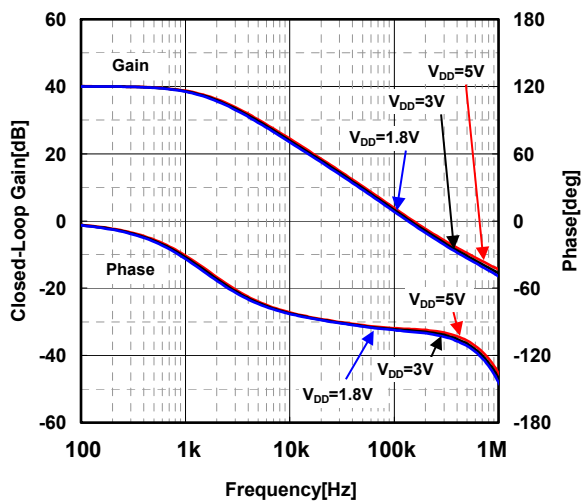
**Pulse Response(Load Capacitance)**  
 $V_{DD}=3V, G_V=0dB, R_L=100k\Omega, T_a=25^\circ C$



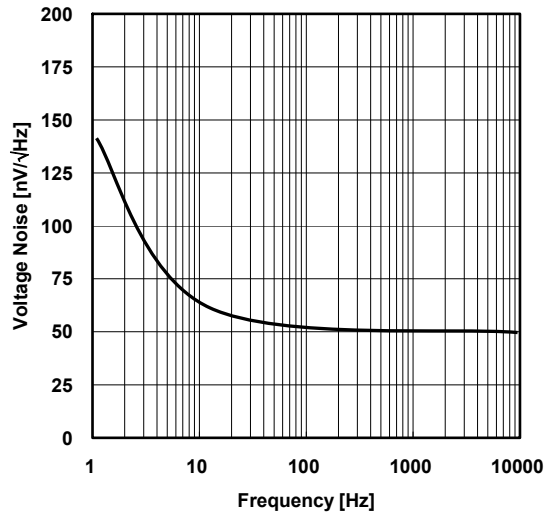
**Pulse Response(Load Capacitance)**  
 $V_{DD}=3V, G_V=0dB, R_L=100k\Omega, T_a=25^\circ C$



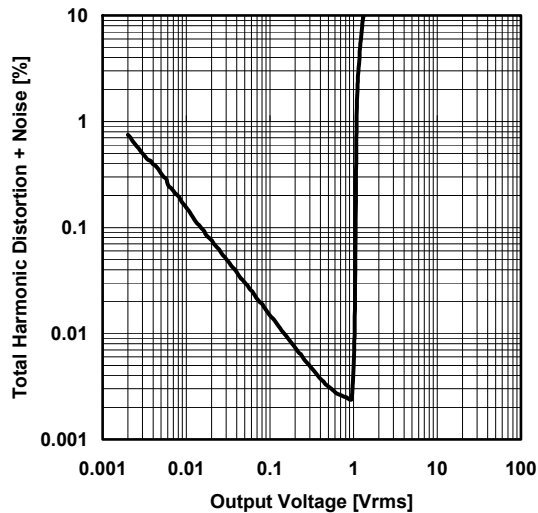
**Closed-Loop Gain, Phase vs. Frequency**  
 $R_F=1M\Omega, R_G=10k\Omega, R_L=100k\Omega, C_L=20pF, T_a=25^\circ C$



**Input Voltage Noise vs. Frequency**  
 $V_{DD}=3V, R_F=100k\Omega, R_G=10k\Omega, R_S=100\Omega, T_a=25^\circ C$



**THD + Noise vs. Output Voltage**  
 $V_{DD}=3V, f=100Hz, G_V=6dB, R_F=50k\Omega, T_a=25^\circ C$



## ■ MEMO

[CAUTION]  
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- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
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- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

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- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

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