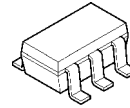


## Small Package, 13 $\mu$ A, Rail-to-Rail Output Single CMOS Operational Amplifier

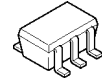
### ■ GENERAL DESCRIPTION

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)**

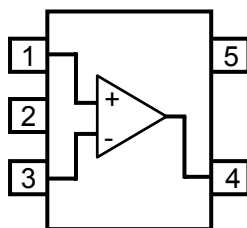
### ■ FEATURES

- 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

# NJU7026

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

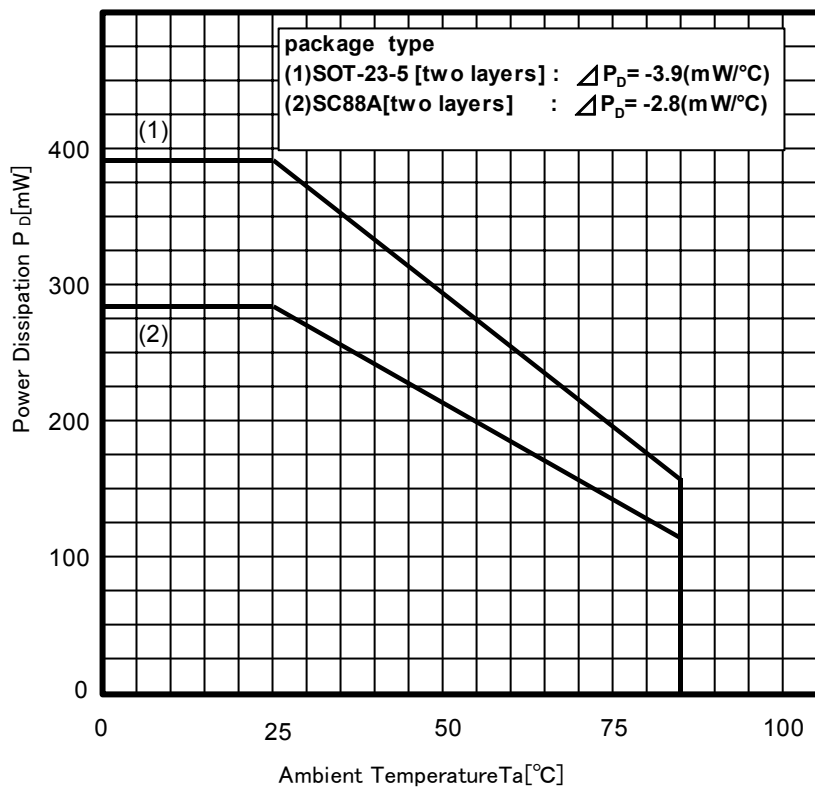
| PARAMETER                   | SYMBOL           | RATINGS                                      | UNIT |
|-----------------------------|------------------|--|------|
| Supply Voltage              | V <sub>DD</sub>  | +7   | V    |
| Input Common Mode Voltage   | V <sub>ICM</sub> | V <sub>SS</sub> -0.3 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 $2.5V$ , $C_L=20pF$ ,<br>$V_{in}=3V_{pp}$ (1V to 4V)<br>(Note4) (Note5)                             | -    | 0.05 | -    | V/us           |
| Power Bandwidth                | PBW      | $G_V=6dB$ , $R_F=50k\Omega$ , $R_G=50k\Omega$ , $C_L=20pF$ ,<br>$V_{in}=2.5V_{pp}$ (1.25V to 3.75V), $V_o\geq 4.8V_{pp}$<br>(Note6) | -    | 5    | -    | kHz            |
| Total Harmonic Distortion      | THD      | $G_V=6dB$ , $R_F=50k\Omega$ , $R_G=50k\Omega$ , $C_L=20pF$ ,<br>$V_o=4V_{pp}$ , $f=100Hz$<br>(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 $1.5V$ , $C_L=20pF$ ,<br>$V_{in}=1V_{pp}$ (1V to 2V)<br>(Note4) (Note5)                             | -    | 0.05 | -    | V/us           |
| Power Bandwidth                | PBW      | $G_V=6dB$ , $R_F=50k\Omega$ , $R_G=50k\Omega$ , $C_L=20pF$ ,<br>$V_{in}=1.5V_{pp}$ (0.75V to 2.25V), $V_o\geq 2.8V_{pp}$<br>(Note6) | -    | 8    | -    | kHz            |
| Total Harmonic Distortion      | THD      | $G_V=6dB$ , $R_F=50k\Omega$ , $R_G=50k\Omega$ , $C_L=20pF$ ,<br>$V_o=2V_{pp}$ , $f=100Hz$<br>(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 $1.5V$ , $C_L=20pF$ ,<br>$V_{in}=0.5V_{pp}$ ( $0.3V$ to $0.8V$ )<br>(Note4) (Note7)                    | -    | 0.05 | -    | V/us           |
| Power Bandwidth                | PBW      | $G_V=6dB$ , $R_F=50k\Omega$ , $R_G=50k\Omega$ , $C_L=20pF$ ,<br>$V_{in}=0.9V_{pp}$ ( $0V$ to $0.9V$ ), $V_o \geq 1.6V_{pp}$<br>(Note8) | -    | 14   | -    | kHz            |
| Total Harmonic Distortion      | THD      | $G_V=6dB$ , $R_F=50k\Omega$ , $R_G=50k\Omega$ , $C_L=20pF$ ,<br>$V_o=1V_{pp}$ , $f=100Hz$<br>(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

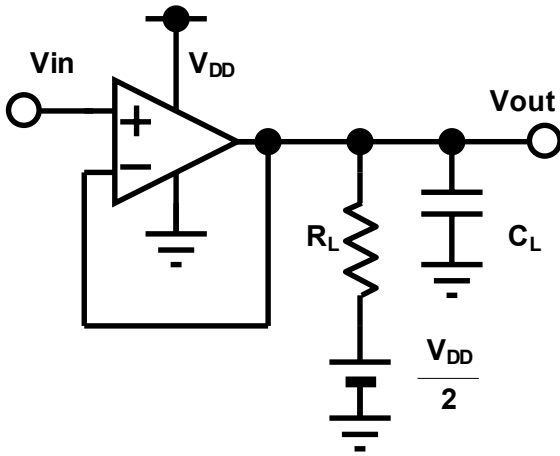


Figure 2-1: Measurement circuit 1

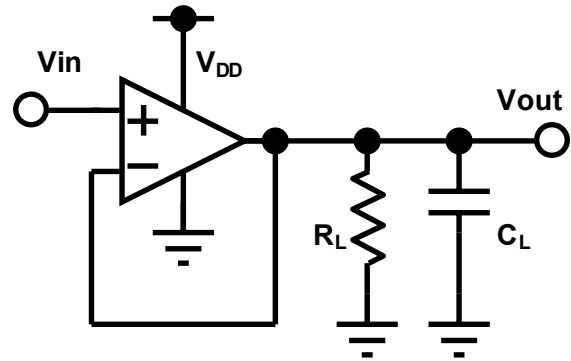


Figure 2-2: Measurement circuit 2

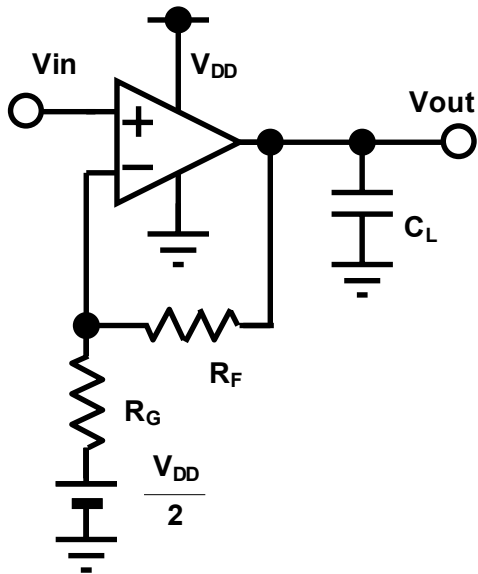


Figure 2-3: Measurement circuit 3

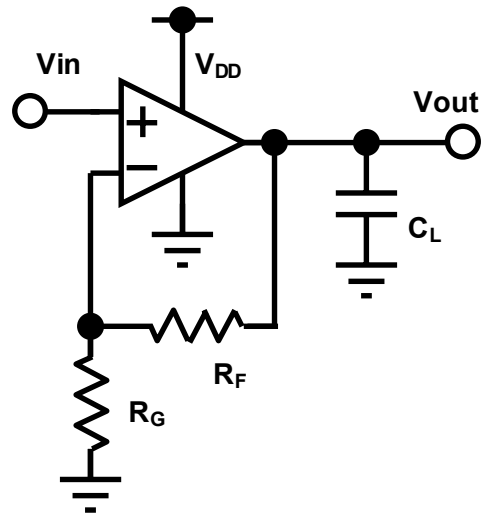
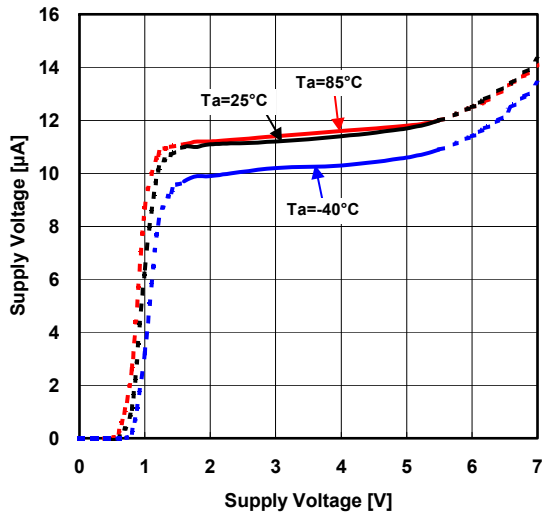


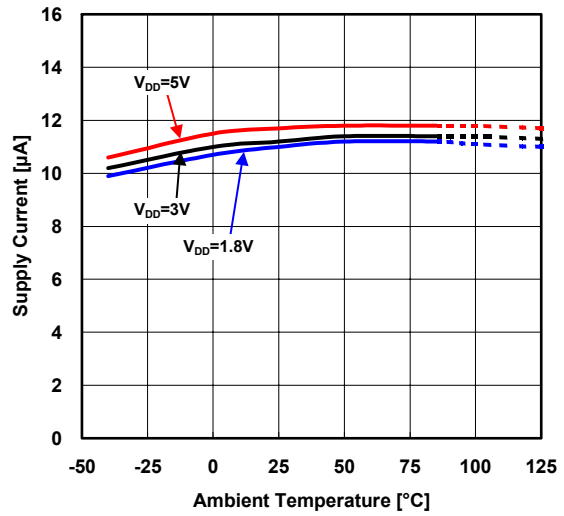
Figure 2-4: Measurement circuit 4

## ■ TYPICAL CHARACTERISTICS

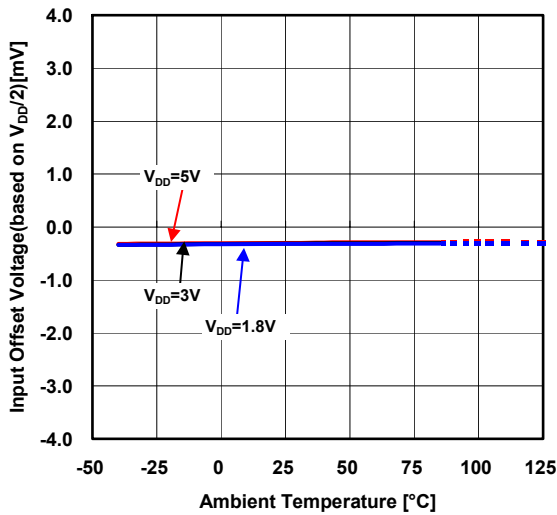
**Supply Current vs. Supply Voltage**  
 $G_V=0dB, V_{ICM}=V_{DD}/2$



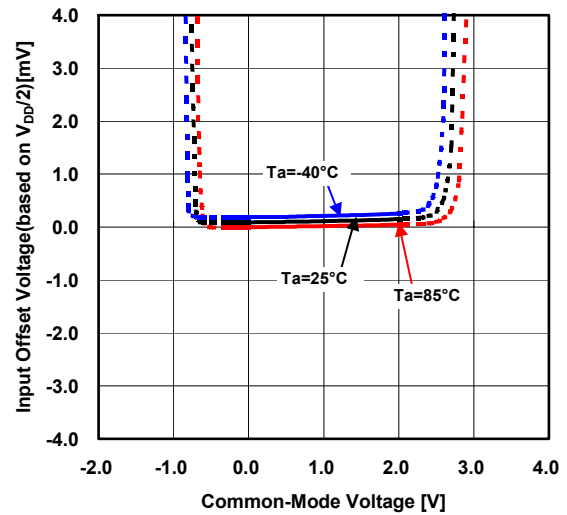
**Supply Current vs. Temperature**  
 $G_V=0dB, V_{ICM}=V_{DD}/2$



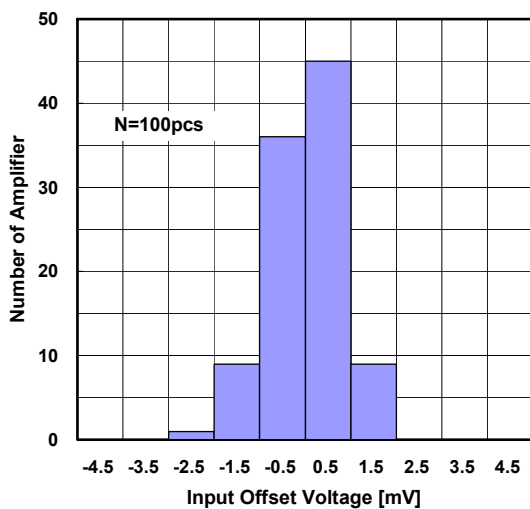
**Input Offset Voltage vs. Temperature**  
 $V_{ICM}=V_{DD}/2$



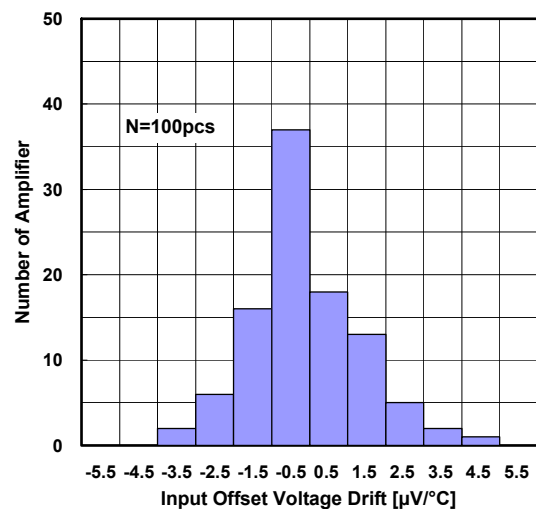
**Input Offset Voltage vs. Common-Mode Voltage**  
 $V_{DD}=3V$



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

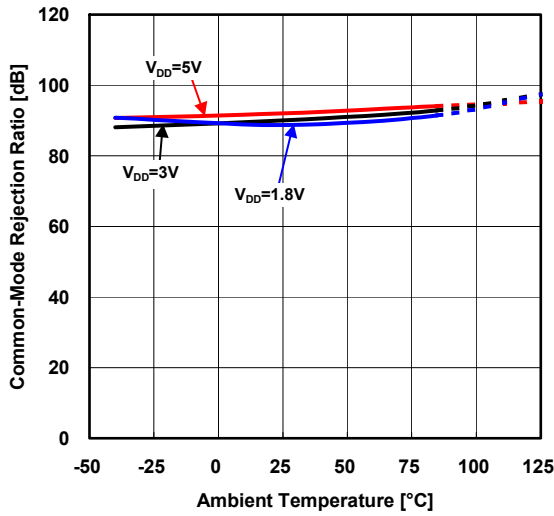


**Input Offset Voltage Drift Distribution**  
 $V_{DD}=3V, V_{ICM}=0V, T_a=-40^\circ C \text{ to } 85^\circ C$

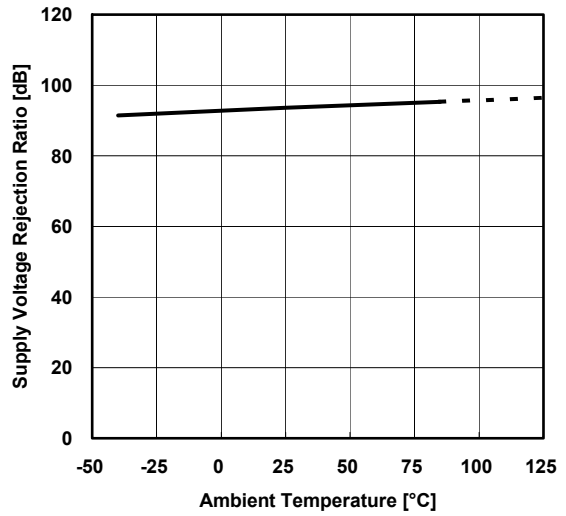


## ■ TYPICAL CHARACTERISTICS

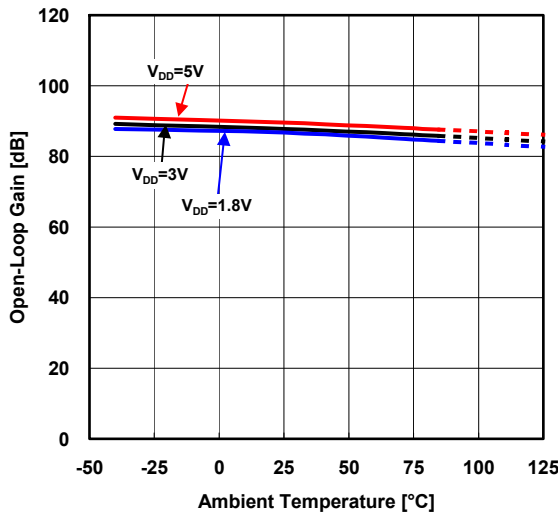
Common-Mode Rejection Ratio vs. Temperature  
 $V_{CM}=0V$  to  $V_{DD}-0.9V$



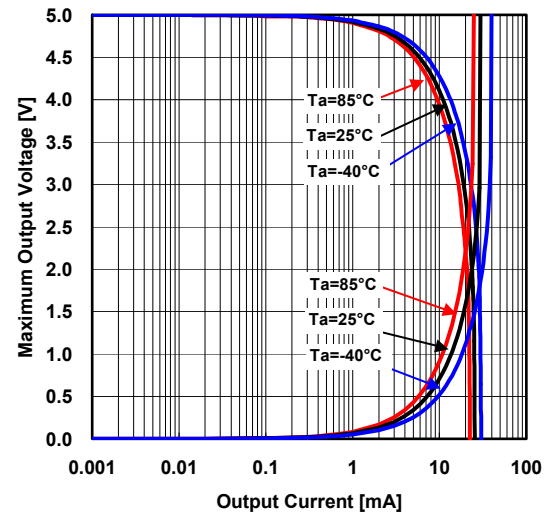
Supply Voltage Rejection Ratio vs. Temperature  
 $V_{DD}=1.8V$  to  $5.5V$



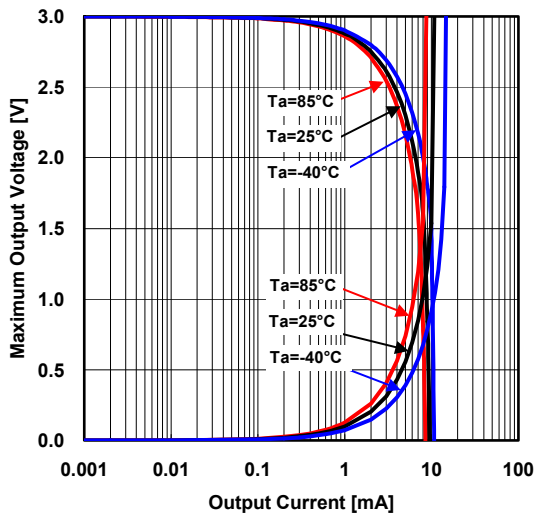
Open-Loop Gain vs. Temperature  
 $V_{OUT}=0.5V$  to  $V_{DD}-0.5V$ ,  $R_L=100k\Omega$



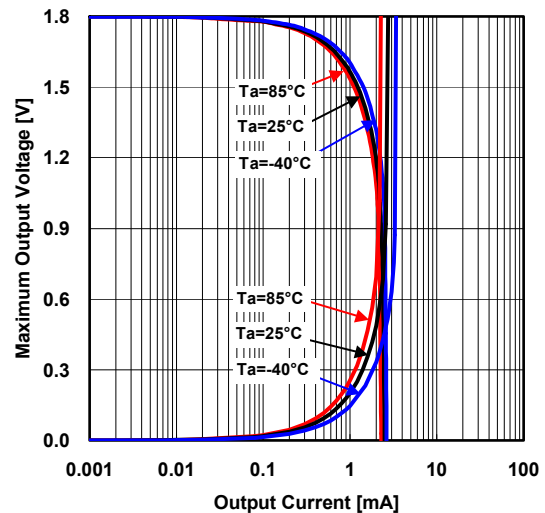
Maximum Output Voltage vs. Output Current  
 $V_{DD}=5V$ ,  $V_{CM}=2.5V$ ,  $V_{IN}=\pm 0.1V$



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



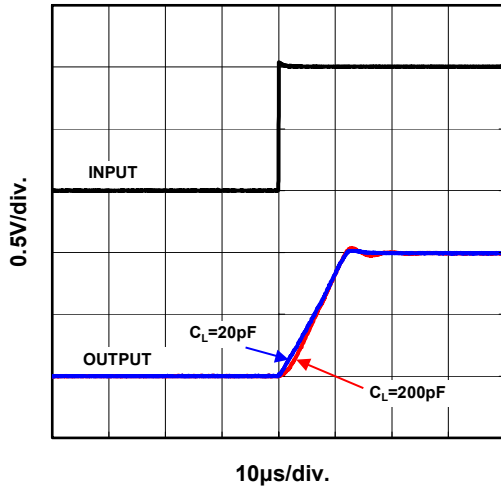
Maximum Output Voltage vs. Output Current  
 $V_{DD}=1.8V$ ,  $V_{CM}=0.9V$ ,  $V_{IN}=\pm 0.1V$



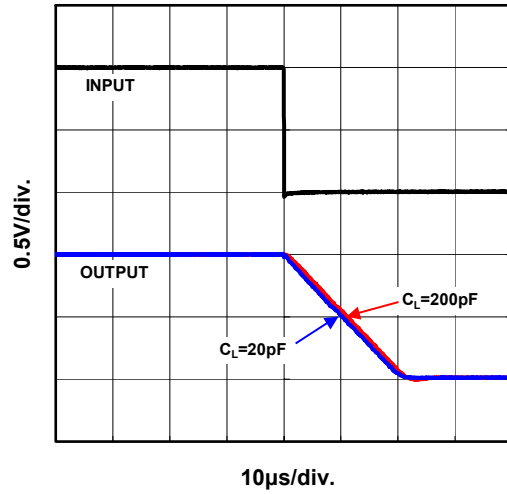


## ■ TYPICAL CHARACTERISTICS

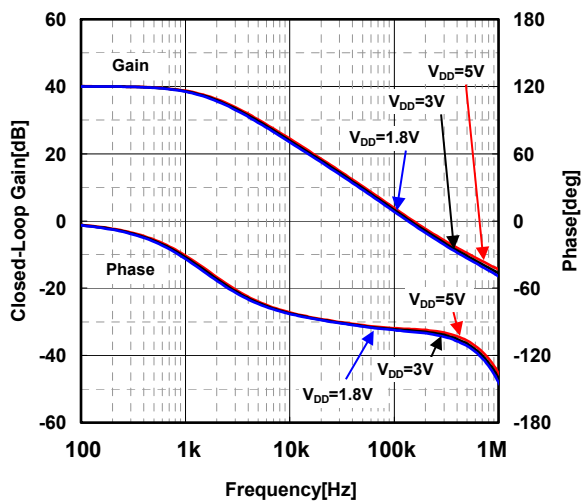
**Pulse Response(Load Capacitance)**  
 $V_{DD}=3V, G_V=0dB, R_L=100k\Omega, T_a=25^\circ C$



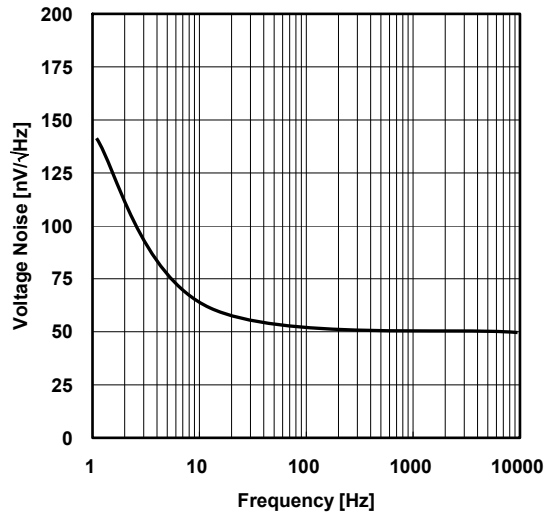
**Pulse Response(Load Capacitance)**  
 $V_{DD}=3V, G_V=0dB, R_L=100k\Omega, T_a=25^\circ C$



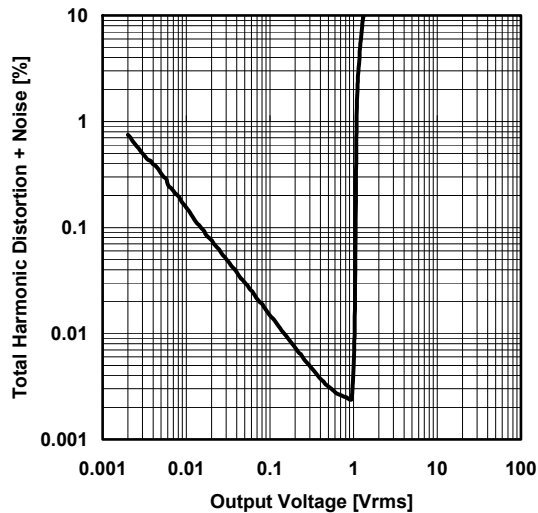
**Closed-Loop Gain, Phase vs. Frequency**  
 $R_F=1M\Omega, R_G=10k\Omega, R_L=100k\Omega, C_L=20pF, T_a=25^\circ C$



**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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Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- 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;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- 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.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- 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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