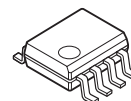


Single Precision Operational Amplifier

■ GENERAL DESCRIPTION

- Precision $V_{IO}=60\mu\text{V max.}$
 $V_{IO}=100\mu\text{V max. (Ta}=-40^{\circ}\text{C to }+85^{\circ}\text{C)}$
- Low Offset Drift $\Delta V_{IO}/\Delta T=1.2\mu\text{V}/^{\circ}\text{C max. (Ta}=-40 \text{ to } +85^{\circ}\text{C)}$
- CMR 115dB min.
- Low Noise $V_N=80\text{nVrms typ. at f=1 to 100Hz}$
 $e_n=8\text{nV}/\sqrt{\text{Hz typ. at f=100Hz}}$
- Open Loop Gain $A_v=126\text{dB min.}$
- Operating Temperature $T_a=-40^{\circ}\text{C to }+105^{\circ}\text{C}$
- Guaranteed Temperature $T_a=-40^{\circ}\text{C to }+85^{\circ}\text{C}$
- Unity Gain Stable
- Operating Voltage $V_{opr}=\pm 3\text{V to } \pm 18\text{V}$
- Unity Gain Frequency $f_T=1.1\text{MHz typ.}$
- Supply Current $I_{cc}=2\text{mA max.}$
- Package SOP8
- REPLACES INDUSTRY-STANDARD OPAMPS: OP-07, OP-77, OP-177, OPA-177, AD707, etc.

■ PACKAGE OUTLINE



NJMOP177GE

■ FEATURES

The NJMOP177 is a high precision operational amplifier features very low offset voltage and drift.

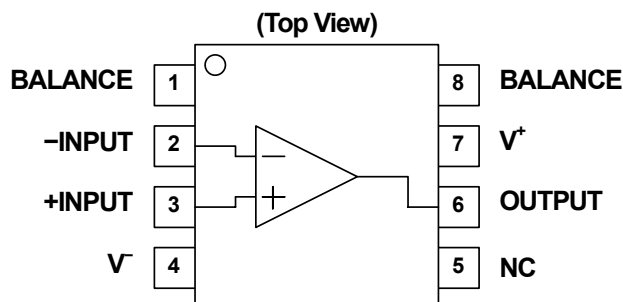
It also achieves high common mode rejection, low noise and high open loop gain. DC characteristics are 100% tested and specified from -40 to 85°C .

The NJMOP177 is suitable for high gain circuit amplified small signal and sets required stable behavior over a wide temperature range.

■ APPLICATION

- Thermocouple sensor
- Bridge Amplifier
- Current Sensor
- Instrumentation Amplifier
- Reference Voltage Circuit

■ PACKAGE DESCRIPTION



NJMOP177

■ ABSOLUTE MAXIMUM RATING (Ta=25°C Unless Otherwise Specified)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V^+V^-	±20	V
Common Mode Input Voltage (Note1)	V_{ICM}	±20	V
Differential Input Voltage	V_{ID}	±30	V
Power Dissipation (Note 2)	P_D	640	mW
Operating Temperature	T_{opr}	-40 to +105	°C
Storage Temperature	T_{stg}	-50 to +125	°C

(Note1) For supply voltage less than ±20V, the maximum input voltage is equal to the supply voltage.

(Note2) Mounted on the EIA/JEDEC standard board (76.2×114.3×1.6mm, two layer, FR-4).

Refer to following Fig. A for a permissible loss when ambient temperature (T_a) is $T_a \geq 25^\circ\text{C}$.

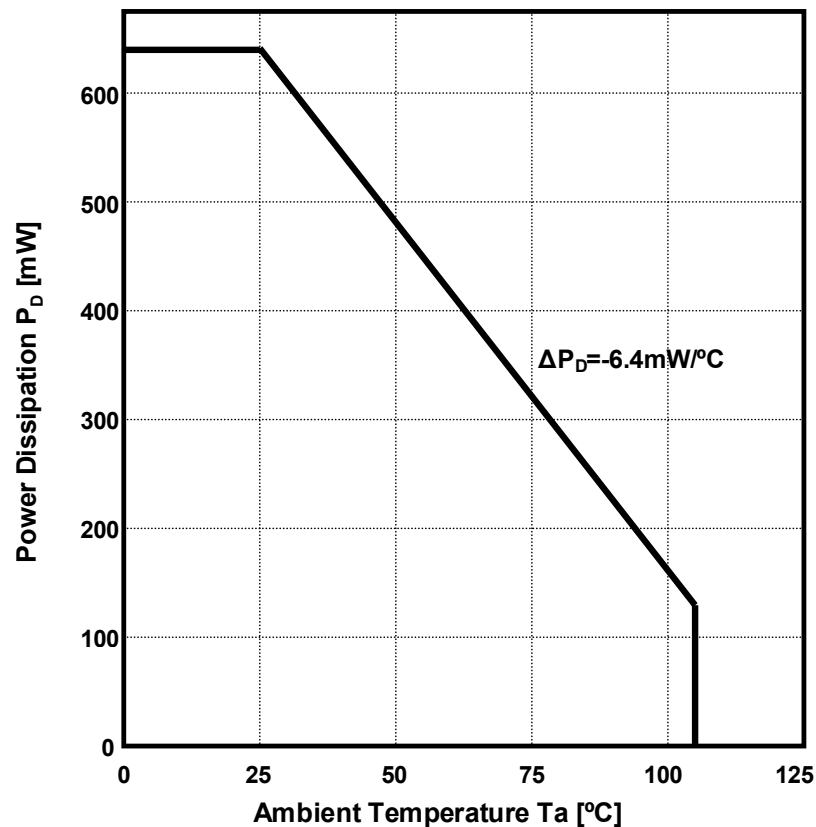


Fig. A: Power Dissipation vs. Temperature

■ RECOMMENDED OPERATING VOLTAGE

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V^+V^-		±3	-	±18	V

■ **ELECTRONIC CHARACTERISTICS** ($V^+ / V^- = \pm 15V$, $T_a = +25^\circ C$, $V_{CM} = 0V$ unless otherwise specified)

● **DC CHARACTERISTICS**

PARAMETER	SYMBOL	TEST CONDITION	NJMOP177G			UNIT
			MIN.	TYP.	MAX.	
Input Characteristics						
Input Offset Voltage	V _{IO1}	Ta = -40 to +85°C	-	20	60	μV
	V _{IO2}		-	20	100	μV
Input Offset Voltage Drift	ΔV _{IO} /ΔT	Ta = -40 → +25°C / Ta = +25°C → +85°C	-	0.3	1.2	μV/°C
Common Mode Input Voltage Range	V _{ICM1}	Ta = -40 to +85°C	±13	±14	-	V
	V _{ICM2}		±13	±13.5	-	V
Common Mode Rejection Ratio	CMR1	V _{CM} = 0V → -13V / V _{CM} = 0V → +13V	115	140	-	dB
	CMR2	Ta = -40 to +85°C, V _{CM} = 0V → -13V / V _{CM} = 0V → +13V	110	140	-	dB
Supply Voltage Rejection Ratio	SVR1	V ⁺ /V ⁻ = ±3V to ±18V	110	125	-	dB
	SVR2	Ta = -40 to +85°C, V ⁺ /V ⁻ = ±3V to ±18V	106	120	-	dB
Input Bias Current	I _{B1}	Ta = -40 to +85°C	-2.8	1.2	2.8	nA
	I _{B2}		-6	1.7	6	nA
Input Bias Current Drift	ΔI _B /ΔT	Ta = -40 → +85°C	-	8	60	pA/°C
Input Offset Current	I _{IO1}	Ta = -40 to +85°C	-	0.3	2.8	nA
	I _{IO2}		-	0.3	4.5	nA
Input Offset Current Drift	ΔI _{IO} /ΔT	Ta = -40 → +85°C	-	1.5	72	pA/°C
Differential Input Impedance	R _{ID}	Theoretical value by design.	-	90	-	MΩ
Common-Mode Input Impedance	R _{IC}	Theoretical value by design.	-	800	-	GΩ
Input Offset Voltage Trim	V _{iotri}	R _p = 20kΩ	-	±3	-	mV
Voltage Gain	Av1	R _L = 2kΩ, Vo = -10V→0V / 0V→+10V / -10V→+10V	126	142	-	dB
	Av2	Ta = -40 to +85°C, R _L = 2kΩ, Vo = -10V→0V / 0V→+10V / -10V→+10V	120	136	-	dB
Output Characteristics						
Maximum Output Voltage	V _{OM1}	R _L = 10kΩ	±13.5	±14.0	-	V
	V _{OM2}	Ta = -40 to +85°C, R _L = 10kΩ	±13.0	±14.0	-	V
	V _{OM3}	R _L = 2kΩ	±12.5	±13.0	-	V
	V _{OM4}	Ta = -40 to +85°C, R _L = 2kΩ	±12.0	±13.0	-	V
	V _{OM5}	R _L = 1kΩ	±12.0	±12.5	-	V
Output Impedance	R _O	Open-Loop	-	60	-	Ω
Supply Characteristics						
Supply Current	I _{CC1}	Av = +1, R _L = ∞	-	1.6	2	mA
	I _{CC2}	Ta = -40 to +85°C, Av = +1, R _L = ∞	-	1.7	2.5	mA
	I _{CC3}	V ⁺ /V ⁻ = ±3V, Av = +1, R _L = ∞	-	0.7	0.75	mA
Power Dissipation	P _{D1}	Av = +1, R _L = ∞	-	50	60	mW
	P _{D1}	V ⁺ /V ⁻ = ±3V, Av = +1, R _L = ∞	-	4.2	4.5	mW

NJMOP177

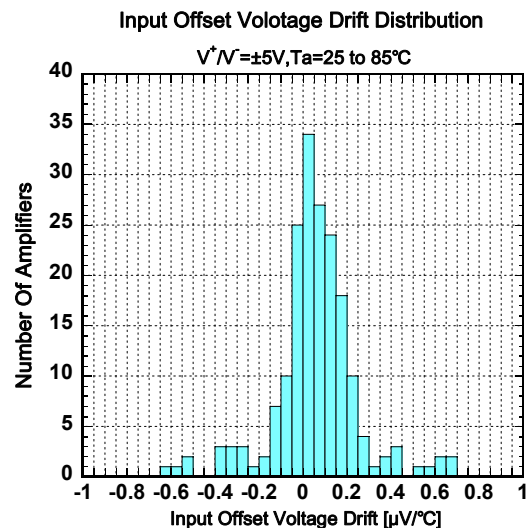
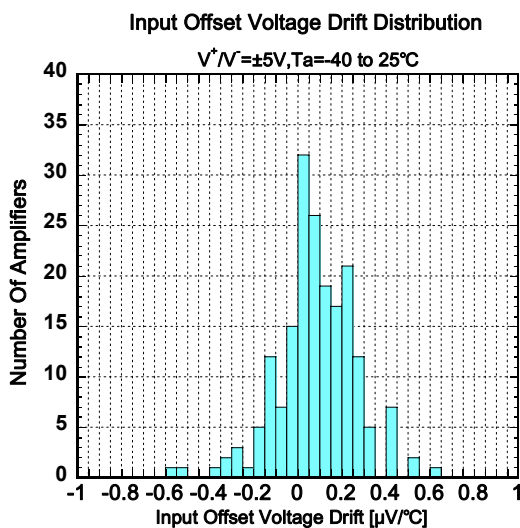
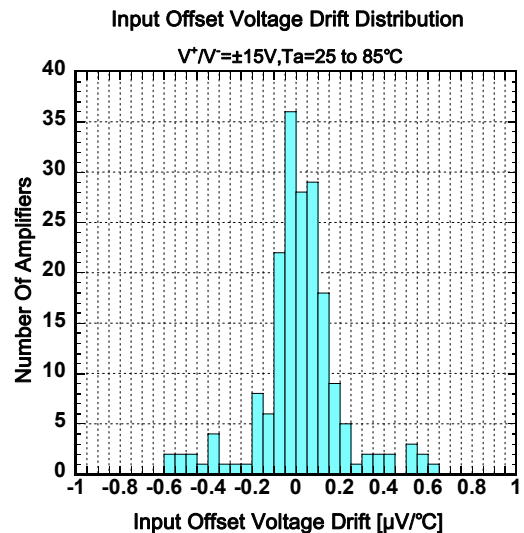
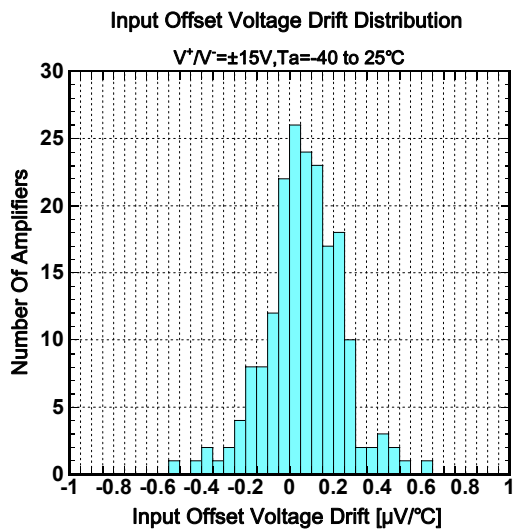
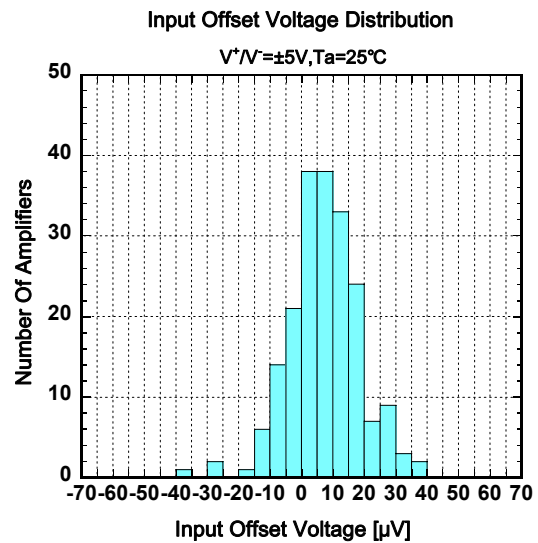
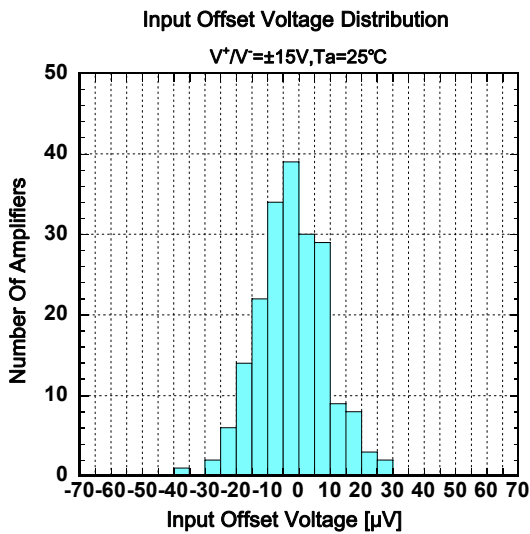
• AC CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITION	NJMOP177G			UNIT
			MIN.	TYP.	MAX.	
Frequency Characteristics						
Unity Gain Frequency	f _T	A _V =+100, R _L =2kΩ, C _L =10pF	-	1.1	-	MHz
Slew Rate	+SR	RISE, A _V =+1, V _{IN} =1Vpp, R _L =2kΩ, C _L =10pF	0.1	0.3	-	V/μs
	-SR	FALL, A _V =+1, V _{IN} =1Vpp, R _L =2kΩ, C _L =10pF	0.1	0.3	-	V/μs
Noise Characteristics						
Equivalent Input Noise Voltage	V _{NI}	fo=1Hz to 100Hz	-	80	-	nVrms
Equivalent Input Noise Current	I _{NI}	fo=1Hz to 100Hz	-	3	-	pArms

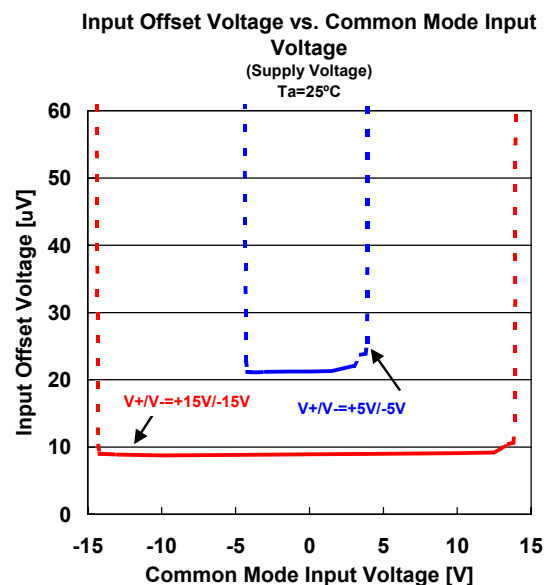
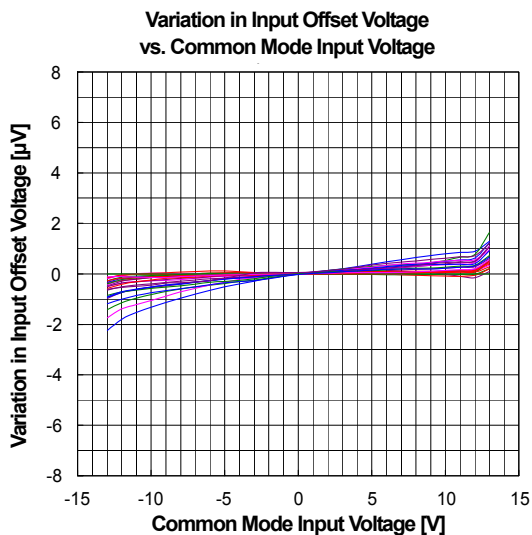
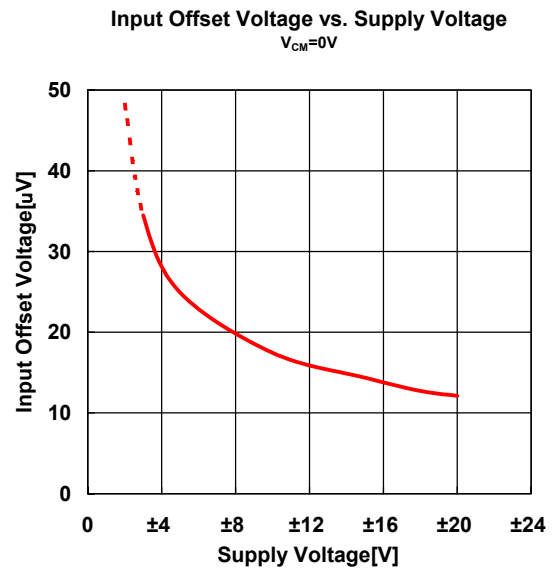
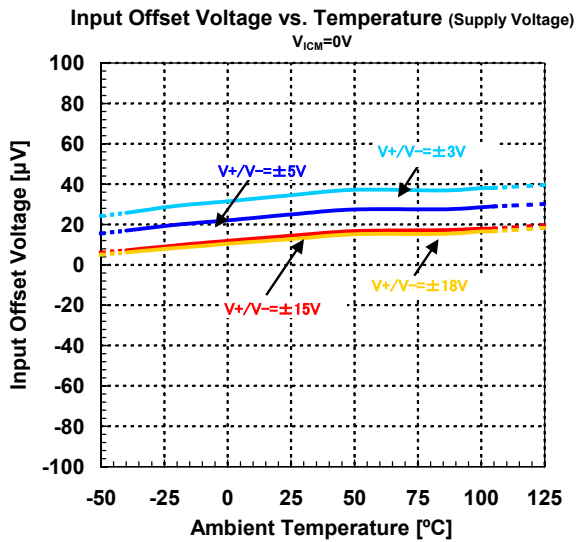
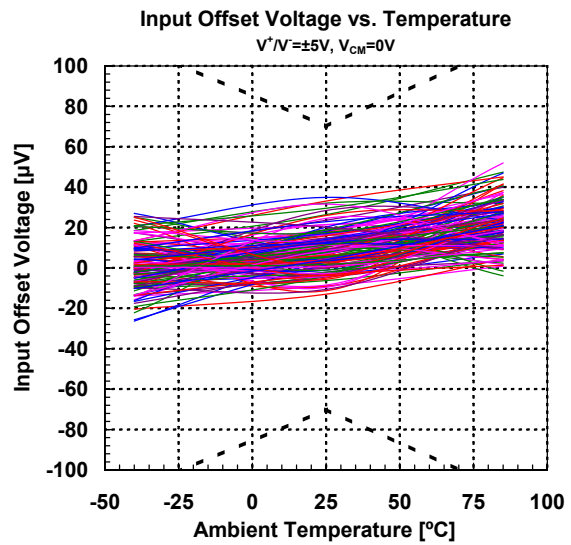
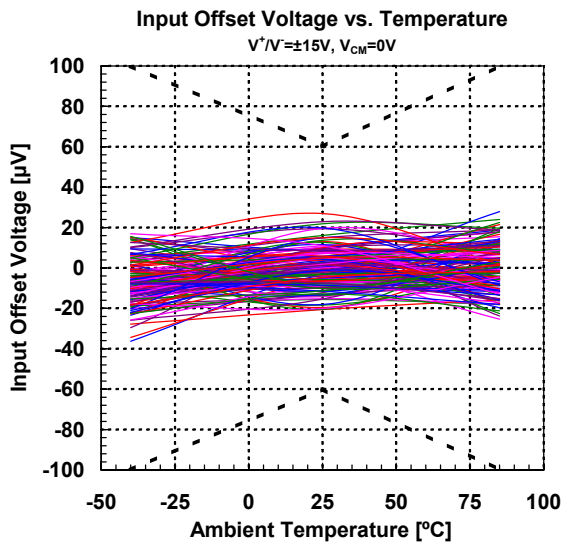
• EXPLANATION OF MEASUREMENT CONDITION

PARAMETER	Explanation
Input Offset Voltage Drift	$\text{Input Offset Voltage Drift} = \Delta V_{IO} / \Delta T$ ΔT : Amount of Temperature Change. ΔV_{IO} : Amount of Input Offset Voltage.
Common Mode Input Voltage range	A range of input voltage at which the operational amplifier can function.
Common Mode Rejection Ratio	$CMR = 20\log (\Delta V_{CM} / \Delta V_{IO}) $ ΔV_{CM} : Amount of Input Voltage. ΔV_{IO} : Amount of Input Offset Voltage.
Supply Voltage Rejection Ratio	$SVR = 20\log (\Delta V_S / \Delta V_{IO}) $ ΔV_S : Amount of Supply Voltage. ΔV_{IO} : Amount of Input Offset Voltage.
Common Mode Input Impedance	$R_{IC} = \Delta V_{CM} / \Delta I_B$ ΔV_{CM} : Amount of Input Voltage. ΔI_B : Amount of Input Bias Current.
Voltage Gain	$AV = 20\log (\Delta V_O / \Delta V_{IO}) $ ΔV_O : Amount of Output Voltage. ΔV_{IO} : Amount of Input Offset Voltage.

■ TYPICAL CHARACTERISTICS

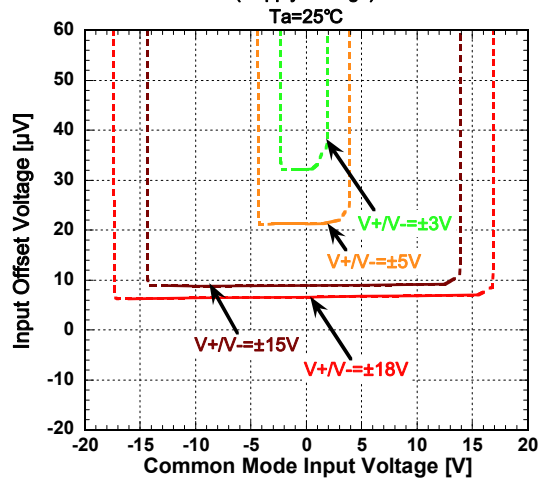


■ TYPICAL CHARACTERISTICS

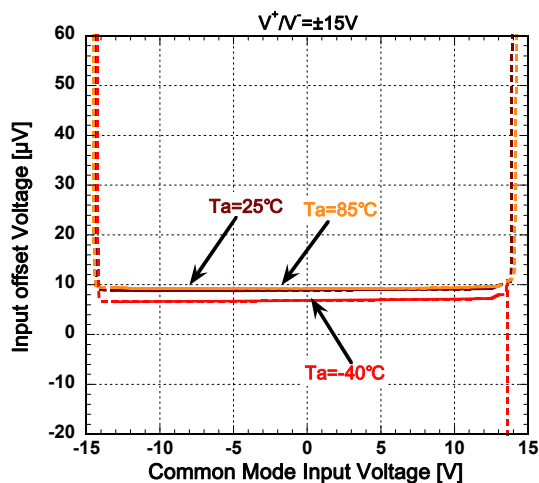


■ TYPICAL CHARACTERISTICS

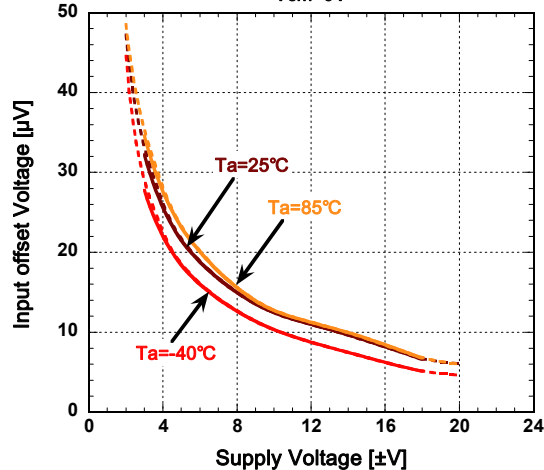
Input Offset Voltage vs. Common Mode Input Voltage
(Supply Voltage)



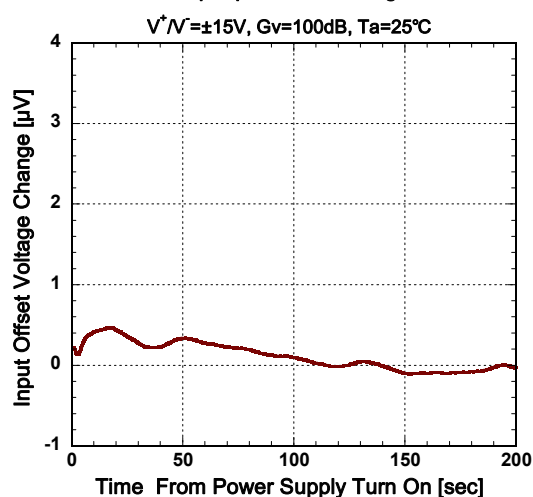
Input Offset Voltage vs. Common Mode Input Voltage
(Temperature)



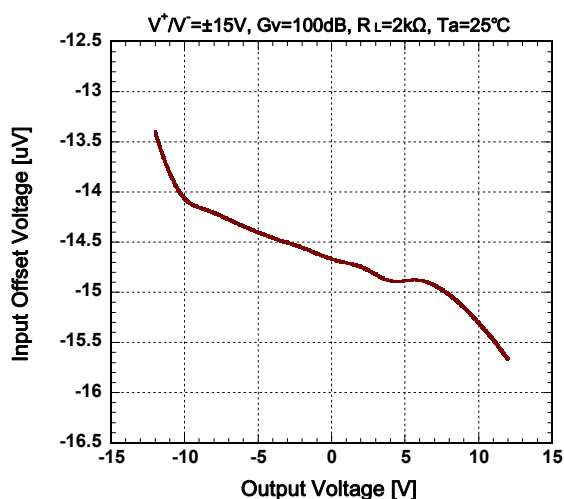
Input Offset Voltage vs. Supply Voltage
(Temperature)



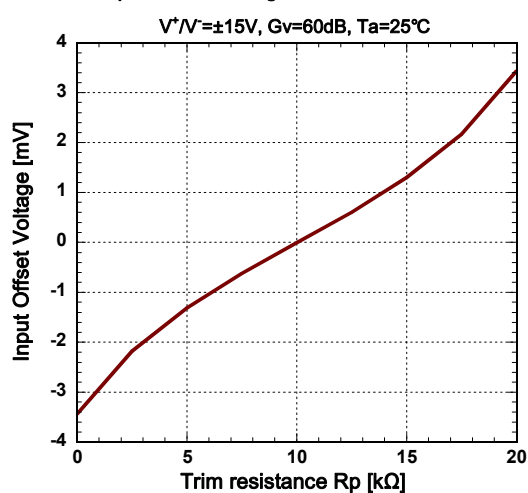
Warm Up Input Offset Voltage Drift



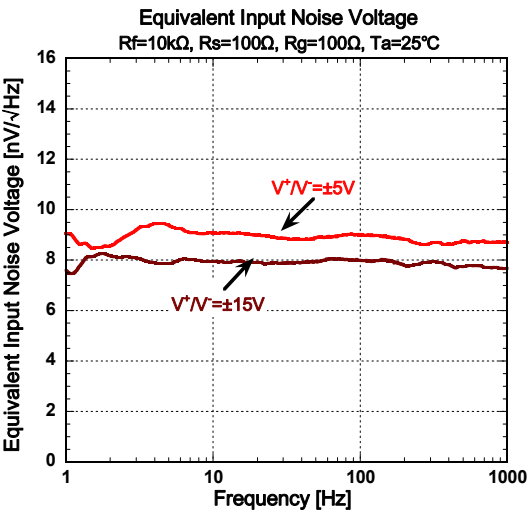
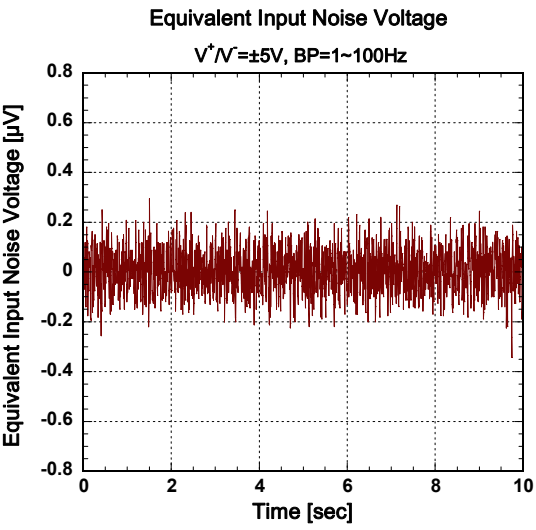
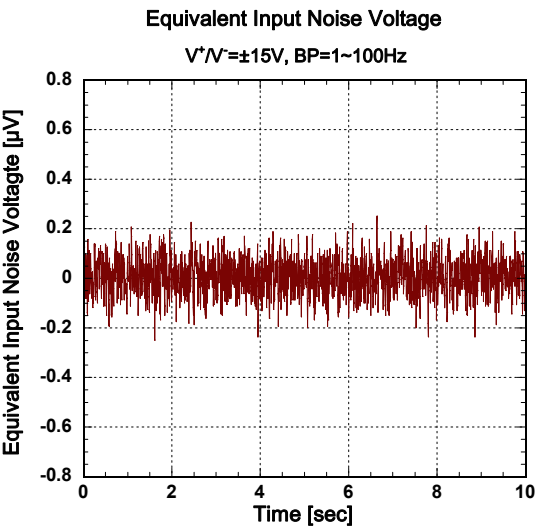
Input Offset Voltage vs. Output Voltage



Input Offset Voltage vs. Trim Resistance

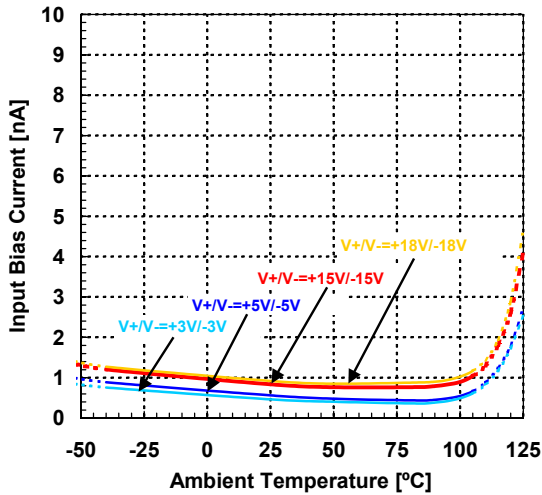


■ TYPICAL CHARACTERISTICS

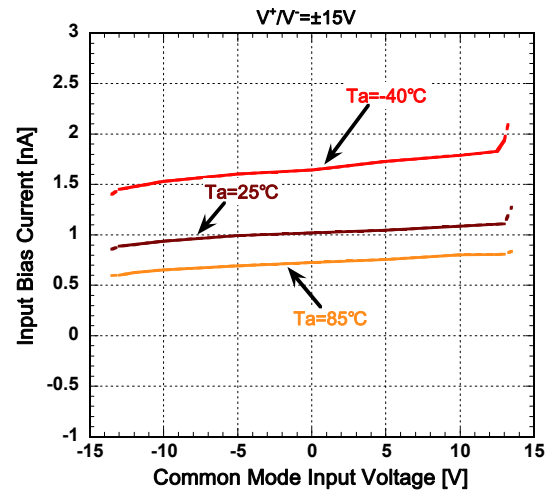


■ TYPICAL CHARACTERISTICS

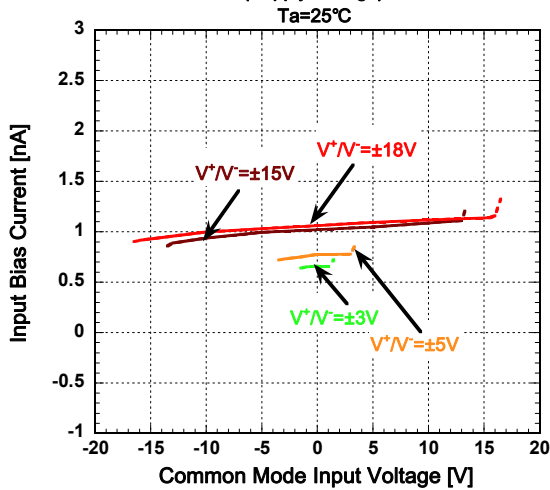
Input Bias Current vs. Temperature



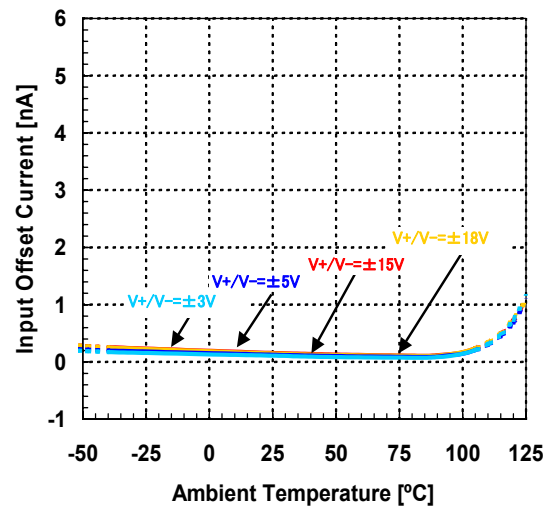
Input Bias Current vs. Common Mode Input Voltage (Temperature)



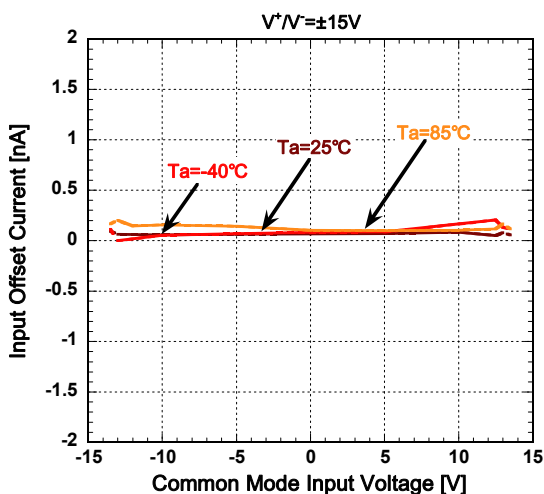
Input Bias Current vs. Common Mode Input Voltage (Supply Voltage)



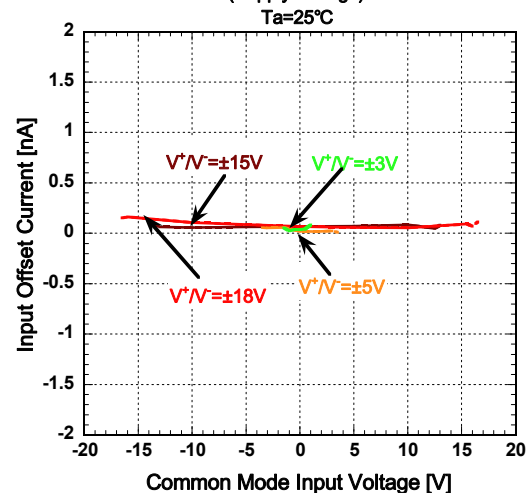
Input Offset Current vs. Temperature



Input Offset Current vs. Common Mode Input Voltage (Temperature)

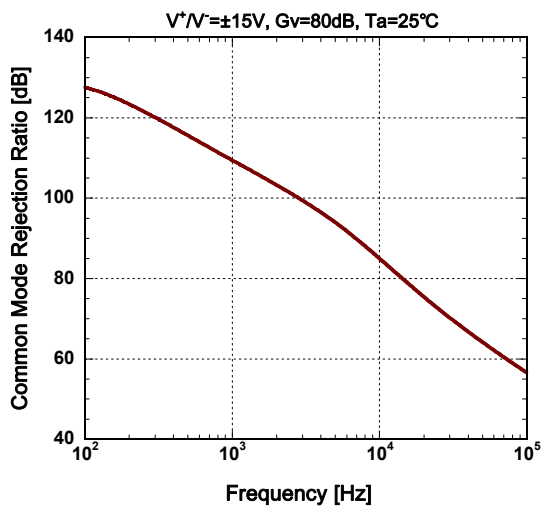


Input Offset Current vs. Common Mode Input Voltage (Supply Voltage)

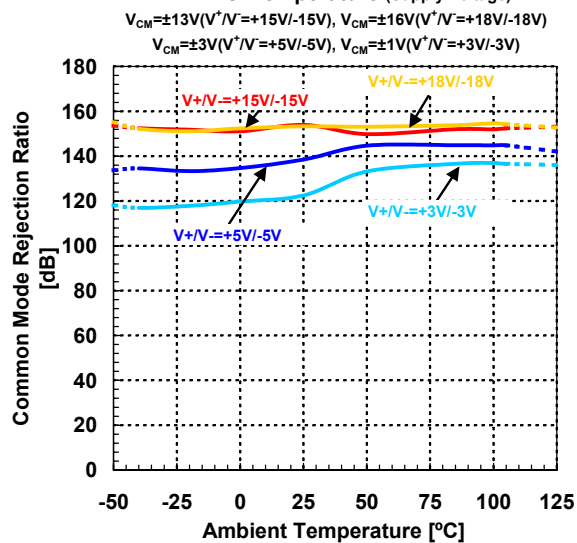


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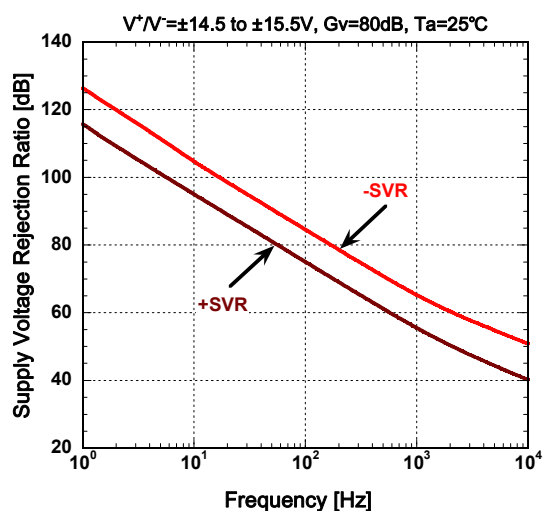
Common Mode Rejection Ratio vs. Frequency



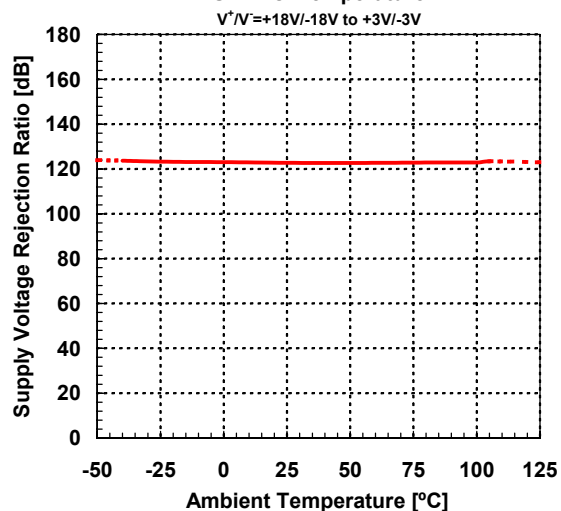
CMR vs. Temperature (Supply Voltage)



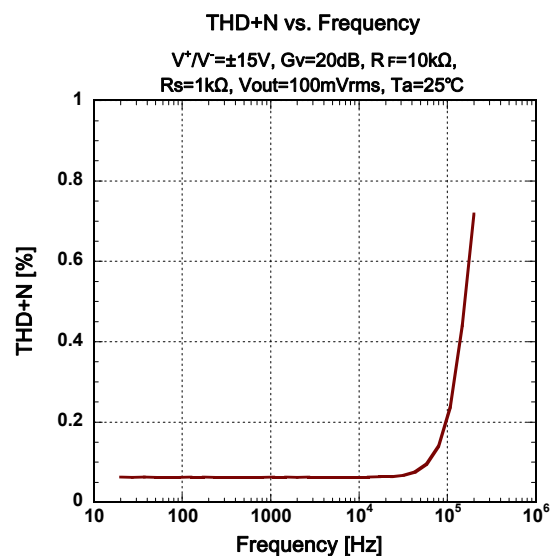
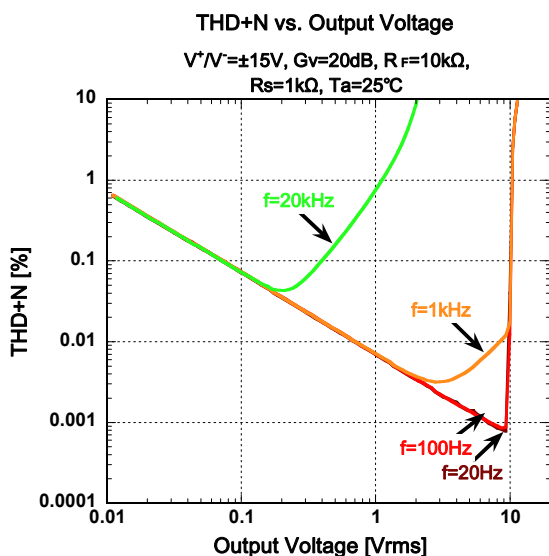
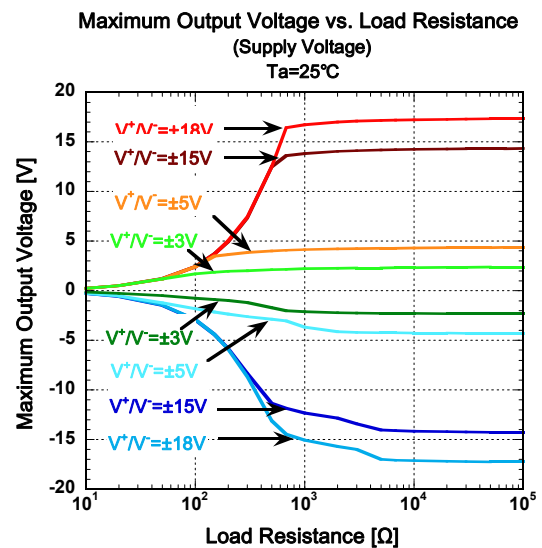
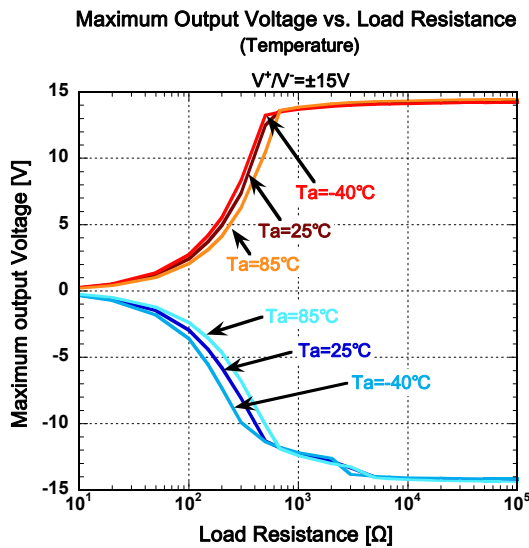
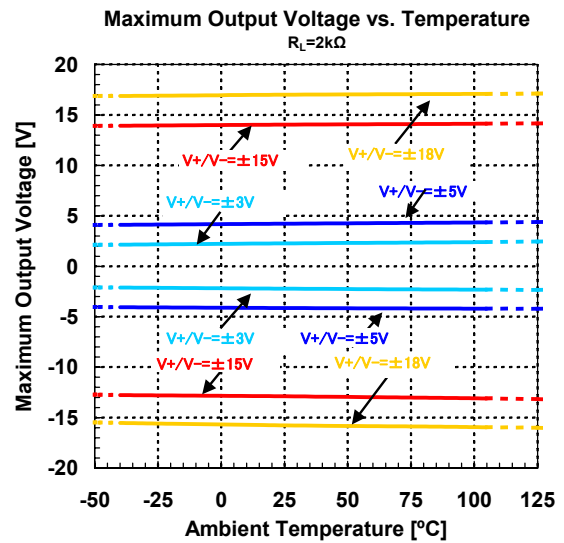
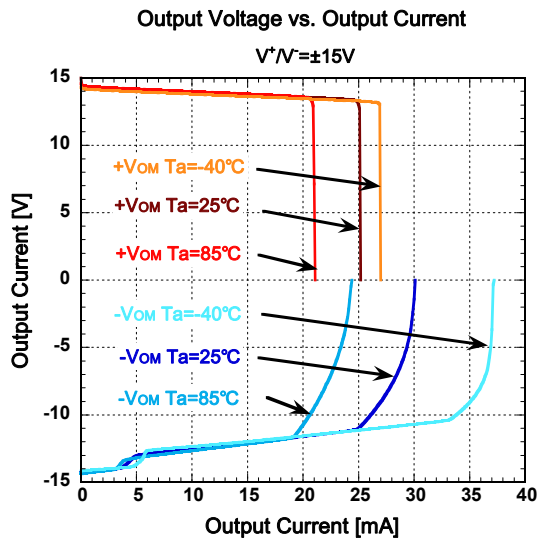
Supply Voltage Rejection Ratio vs. Frequency



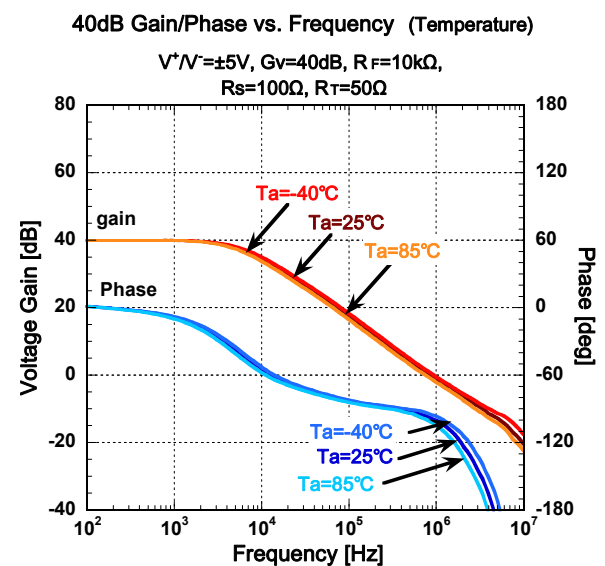
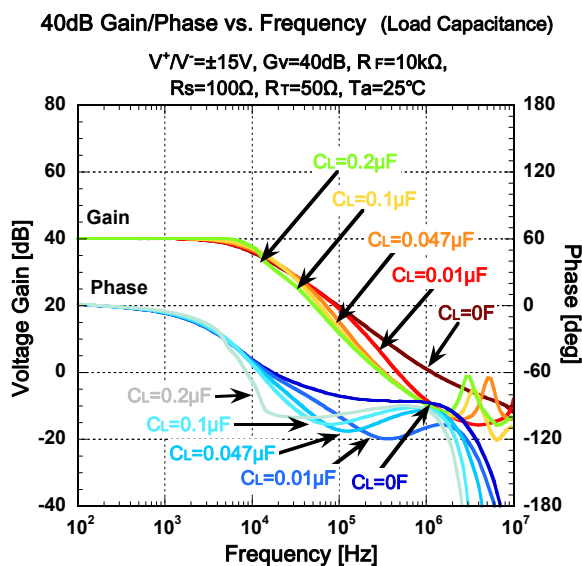
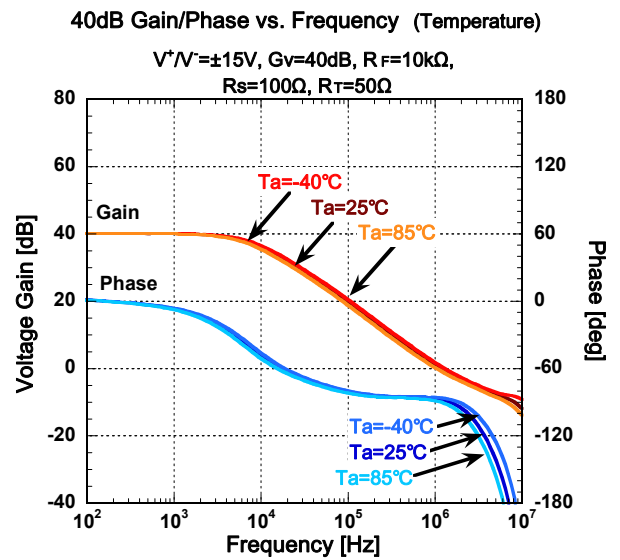
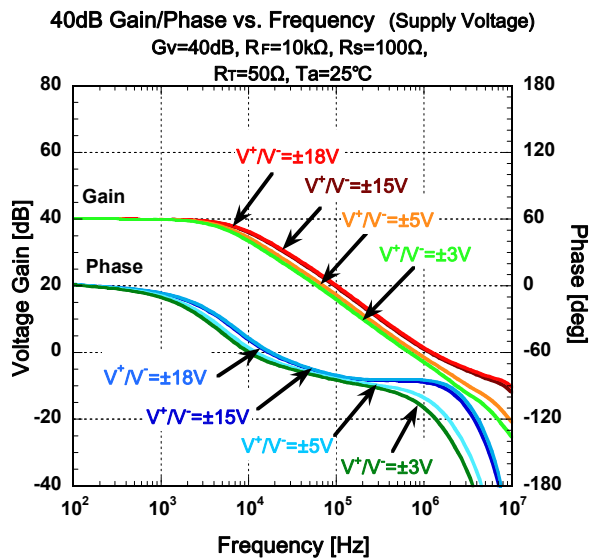
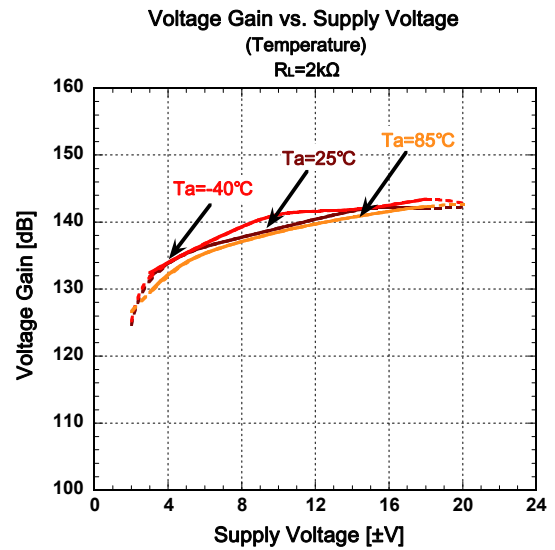
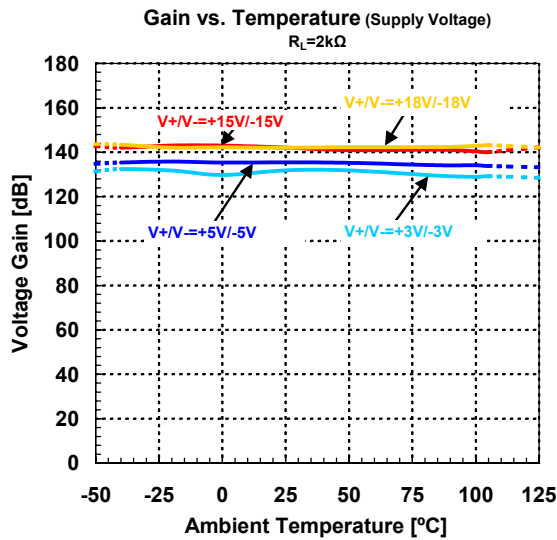
SVR vs. Temperature



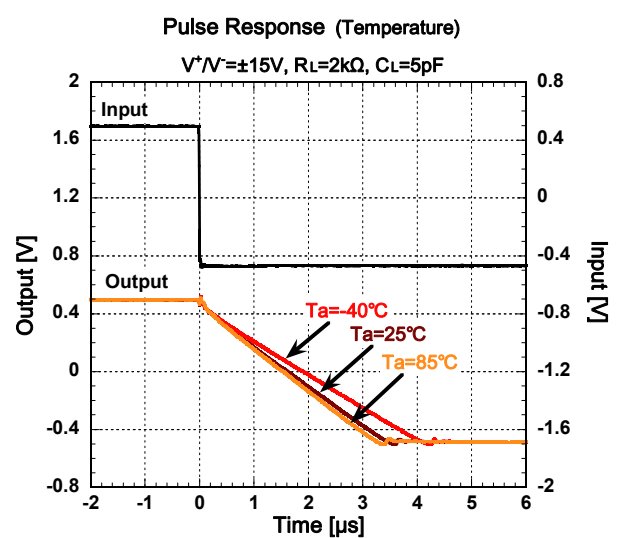
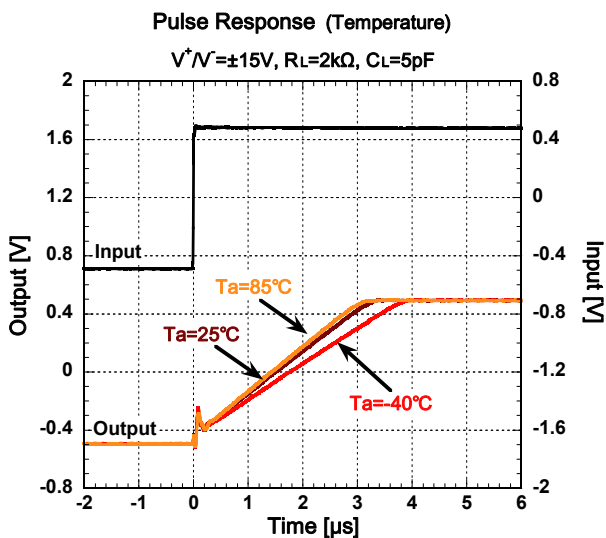
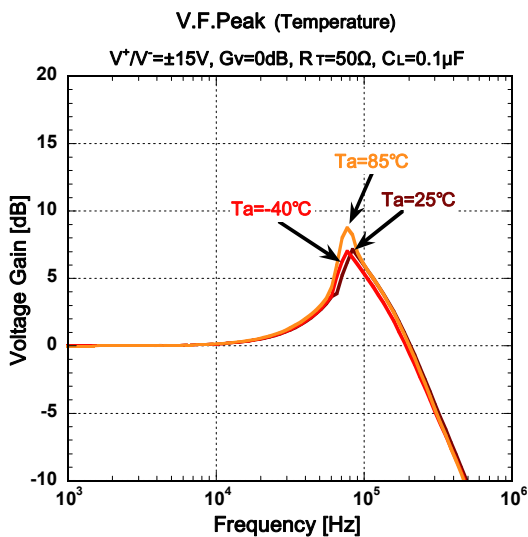
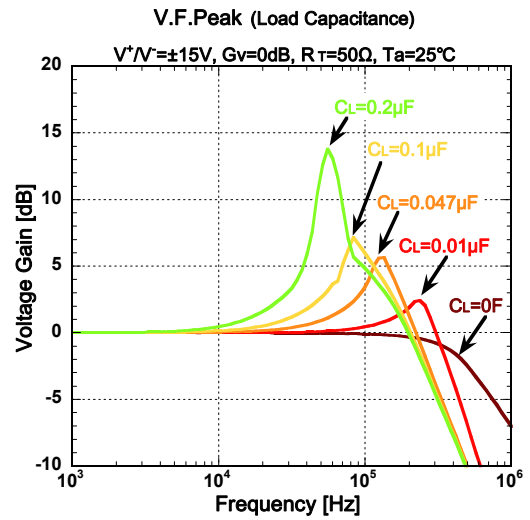
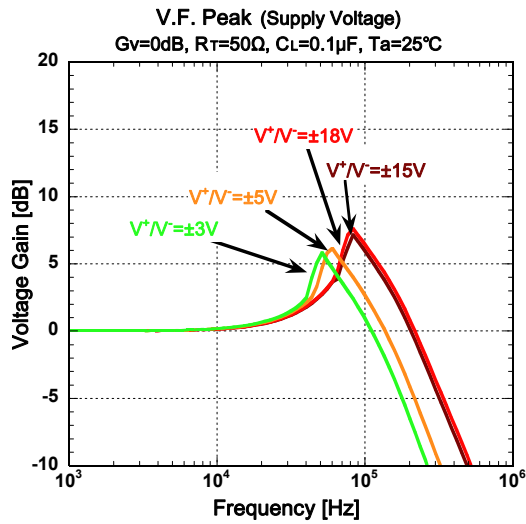
■ TYPICAL CHARACTERISTICS



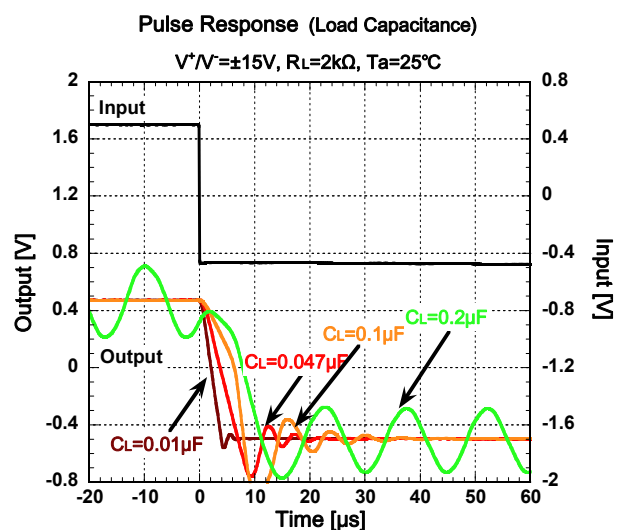
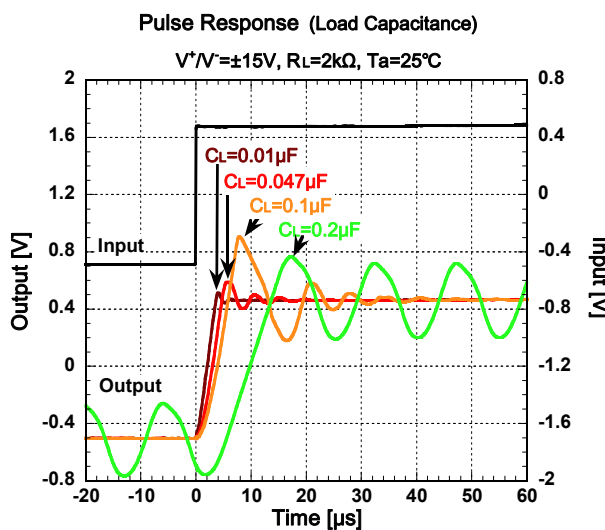
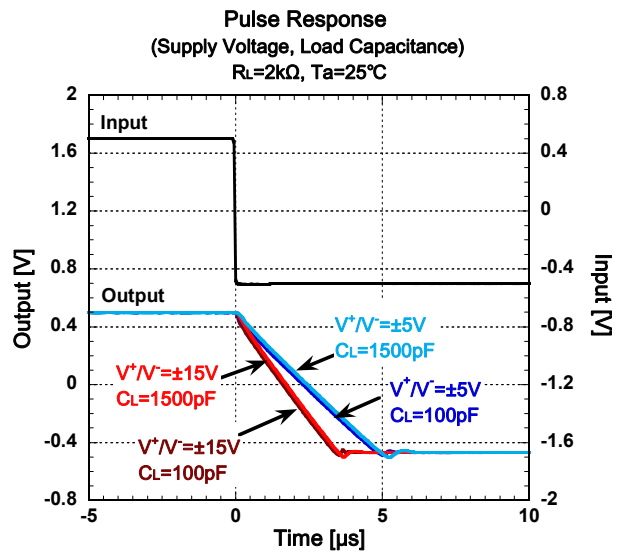
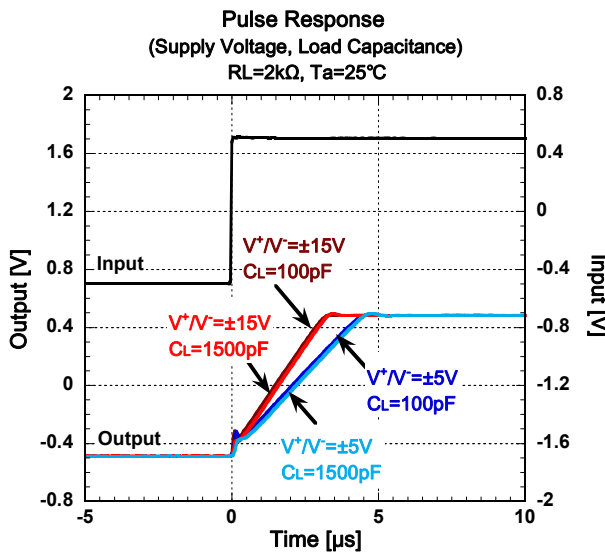
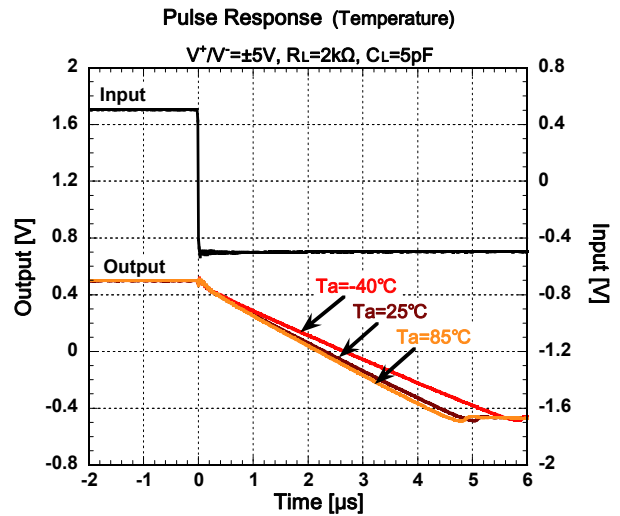
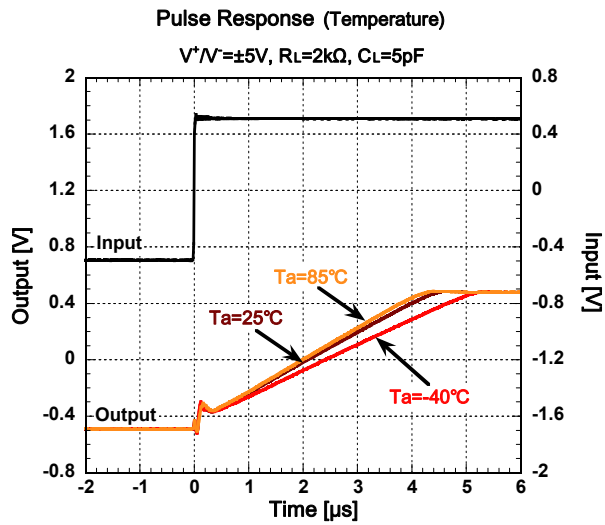
■ TYPICAL CHARACTERISTICS



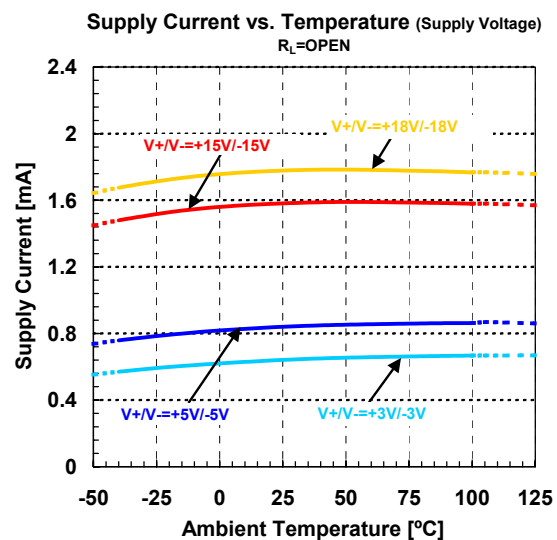
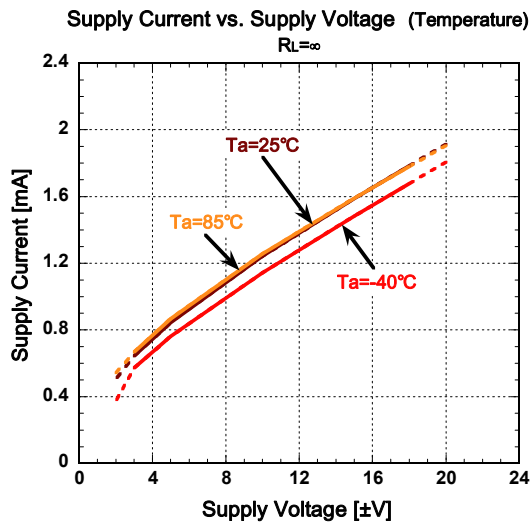
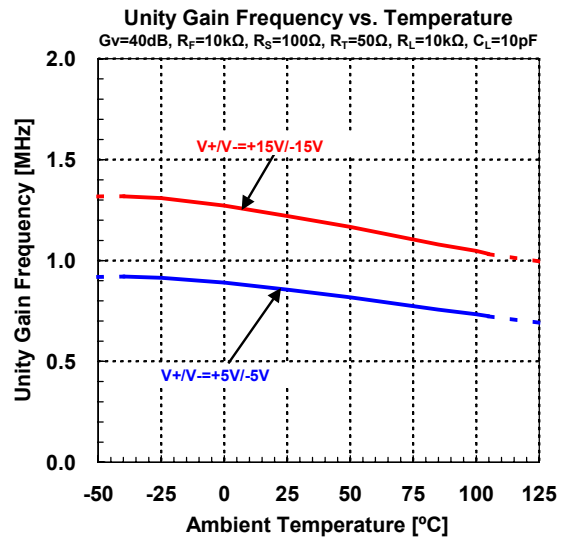
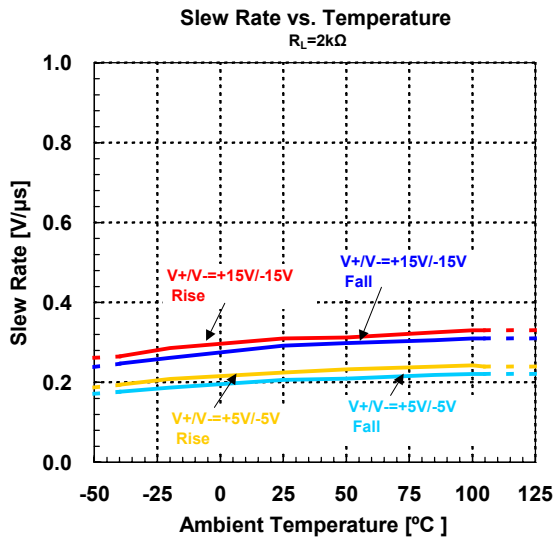
■ TYPICAL CHARACTERISTICS



■ TYPICAL CHARACTERISTICS



■ TYPICAL CHARACTERISTICS



NJMOP177

■ Application Information

● Power Supply Bypassing

The NJMOP177 is a high precision operational amplifier featuring low offset voltage, high voltage gain, high CMR, high SVR and so on. To maximize such a high performance with stable operation, the NJMOP177 should be operated by clean and low impedance supply voltage. So, the bypass capacitor should be connected to the NJMOP177's both power supply terminals (V+ and V-) as shown in Fig.1. The bypass capacitors should be placed as close as possible to IC package

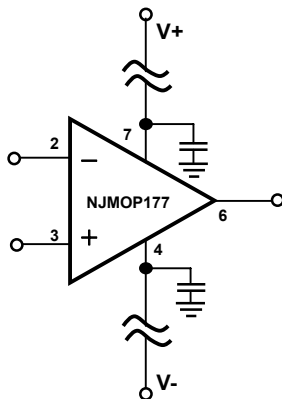


Fig.1 Power Supply Bypassing Circuit

● Thermoelectric Effect

The NJMOP177 is a high precision operational amplifier featuring low offset voltage and low offset voltage thermal drift.

To achieve such a high performance, take care about thermoelectric effect possibly occurs on each input terminal of the NJMOP177. Generally, if there are thermal mismatches at the junction of different types of metals, the thermoelectric voltage (Seebeck effect) occurs at the junction. The thermoelectric voltages possibly occur at the junction of PCB metal patterns and NJMOP177's each input terminal metal. If there is thermal mismatch in-between NJMOP177's each input terminal metal, the thermoelectric voltages generated on each input terminal possibly have different voltage each. This voltage difference causes offset voltage and offset voltage thermal drift of the NJMOP177.

To minimize this voltage difference, the thermal mismatch in-between NJMOP177's each input terminal and PCB metal should be minimized.

● Offset Voltage Adjustment

The NJMOP177 has offset voltage trim terminals (pin1 and pin8) as shown in below Fig.2. By connecting external potentiometer in the range of 20Kohm, the offset voltage trim range is $\pm 3\text{mV}$. This offset voltage trim is effective only for offset voltage at room temperature, not for offset voltage thermal drift.

If offset voltage adjustment is not in use, leave pin1 and pin8 open (un-connected).

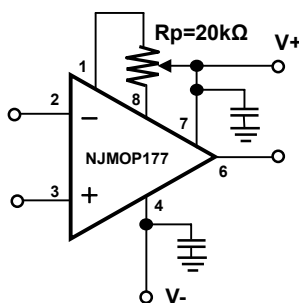


Fig.2 Offset Voltage Trim Circuit

•Differential Amplifier

Differential amplifier (see below Fig.3) is used in high accuracy circuit to improve common mode rejection ratio (CMR).

A matching between the ratio $R_1/R_2 = R_3/R_4$ and $R_1=R_3$ makes the high CMR.

For example, acceptable error range to obtain CMR of 130dB or more is about 0.1ppm.

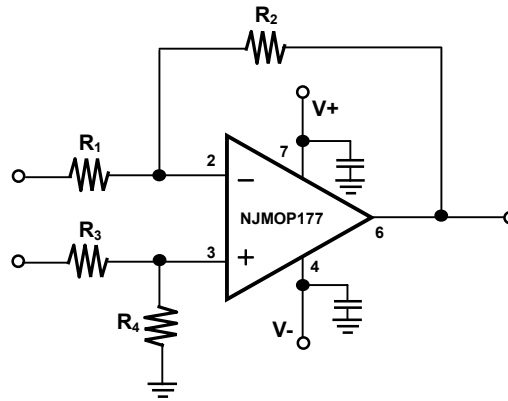
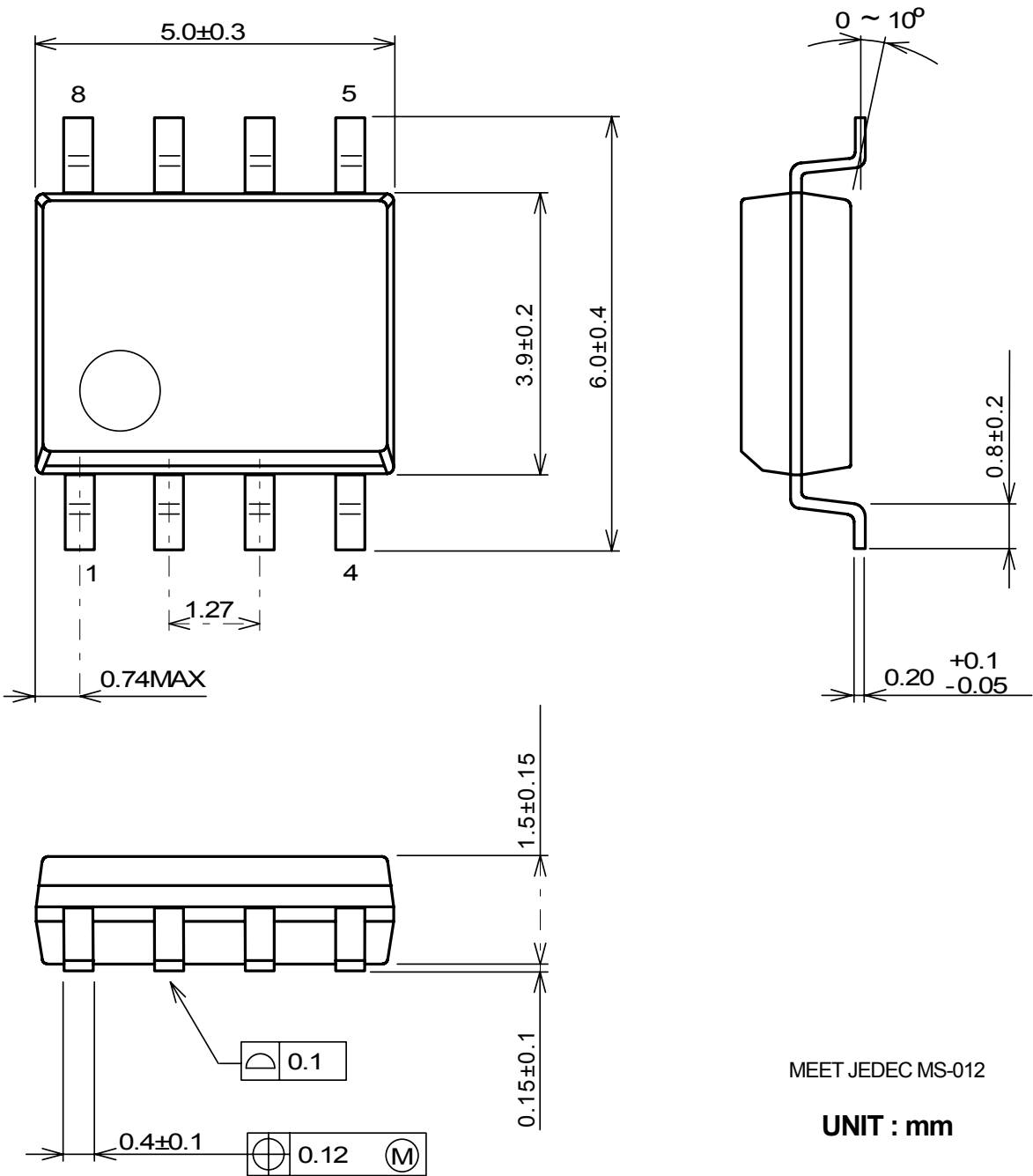


Fig.3 Differential Amplifier

NJMOP177

■ PACKAGE DIMENSIONS

SOP8 JEDEC 150 mil



MEET JEDEC MS-012

UNIT : mm

[CAUTION]
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