High Quality Audio , J-FET Input, Dual Operational Amplifier

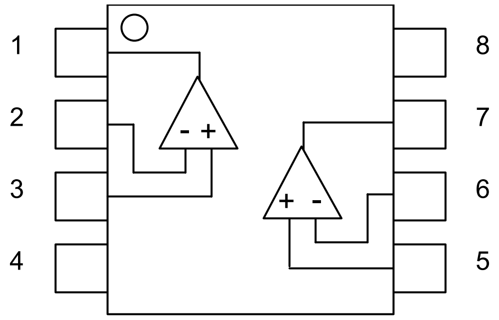
The **MUSES01** is a dual J-FET input high quality audio operational amplifier, which is optimized for high-end audio and professional audio applications with advanced circuitry and layout, unique material and assembled technology by skilled-craftwork.

It is the best for audio preamplifiers, active filters, and line amplifiers with excellent sound.

■ FEATURES

●Operating Voltage	Vopr=±9V to ±16V
●Output noise	9.5nV/√Hz at f=1kHz
●Input Offset Voltage	0.8mV typ. 5mV max.
●Input Bias Current	200pA typ. 800pA max. at Ta=25°C
●Voltage Gain	105dB typ.
●Slew Rate	12V/µs typ.
●Bipolar Technology	
●Package Outline	DIP8

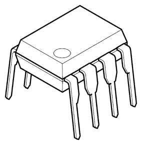
■ PIN CONFIGURATION



PIN FUNCTION

1. A OUTPUT
2. A -INPUT
3. A +INPUT
4. V-
5. B +INPUT
6. B -INPUT
7. B OUTPUT
8. V+

■ PACKAGE OUTLINE



MUSES01D

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■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V^+/V^-	±18	V
Common Mode Input Voltage	V_{ICM}	±15 (Note1)	V
Differential Input Voltage	V_{ID}	±30	V
Power Dissipation	P_D	910	mW
Output Current	I_O	±25	mA
Operating Temperature Range	T_{opr}	-40 to +85	°C
Storage Temperature Range	T_{stg}	-50 to +150	°C

(Note1) For supply Voltages less than ±15 V, the maximum input voltage is equal to the Supply Voltage.

■ RECOMMENDED OPERATING CONDITION (Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V^+/V^-	-	±9	-	±16	V

■ ELECTRIC CHARACTERISTICS

DC CHARACTERISTICS (V^+/V^-=±15V, Ta=25°C unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I_{cc}	No Signal, $R_L=\infty$	-	8.5	12.0	mA
Input Offset Voltage	V_{IO}	$Rs \leq 10k\Omega$ (Note2, 3)	-	0.8	5.0	mV
Input Bias Current	I_B	(Note2, 3)	-	200	800	pA
Input Offset Current	I_{IO}	(Note2, 3)	-	100	400	pA
Voltage Gain	A_V	$R_L \geq 2k\Omega$, $V_o=\pm 10V$	90	105	-	dB
Common Mode Rejection Ratio	CMR	$V_{ICM}=\pm 8V$ (Note4)	60	75	-	dB
Supply Voltage Rejection Ratio	SVR	$V^+/V^-=\pm 9.0$ to $\pm 16.0V$ (Note2, 5)	70	83	-	dB
Max Output Voltage 1	V_{OM1}	$R_L=10k\Omega$	±12	±13.5	-	V
Max Output Voltage 2	V_{OM2}	$R_L=2k\Omega$	±10	±12.5	-	V
Input Common Mode Voltage Range	V_{ICM}	CMR≥60dB	±8	±9.5	-	V

(Note2) Measured at VICM=0V

(Note3) Written by the absolute rate.

(Note4) CMR is calculated by specified change in offset voltage. (VICM=0V to +8V and VICM=0V to −8V)

(Note5) SVR is calculated by specified change in offset voltage. (V+/V−=±9V to ±16V)

AC CHARACTERISTICS (V^+/V^-=±15V, Ta=25°C unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gain Bandwidth Product	GB	f=10kHz	-	3.3	-	MHz
Unity Gain Frequency	f_T	A_V=+100, R_S=100Ω, R_L=2kΩ, C_L=10pF	-	3.0	-	MHz
Phase Margin	ϕ_M	A_V=+100, R_S=100Ω, R_L=2kΩ,C_L=10pF	-	60	-	deg
Input Noise Voltage1	V_{NI}	f=1kHz, A_V=+100, R_S=100Ω	-	9.5	-	nV/√Hz
Input Noise Voltage2	V_{N2}	RIAA, R_S =2.2kΩ, 30kHz LPF	-	1.2	3.0	μVrms
Total Harmonic Distortion	THD	f=1kHz, A_V=+10, R_L=2kΩ, Vo=5Vrms	-	0.002	-	%
Channel Separation	CS	f=1kHz, A_V=-+100, R_S=1kΩ, R_L=2kΩ	-	150	-	dB
Positive Slew Rate	+SR	A_V=1, V_{IN}=2V_{p-p}, R_L=2kΩ, C_L=10pF	-	12	-	V/μs
Negative Slew Rate	-SR	A_V=1, V_{IN}=2V_{p-p}, R_L=2kΩ, C_L=10pF	-	13	-	V/μs

■ Application Notes

•Package Power, Power Dissipation and Output Power

IC is heated by own operation and possibly gets damage when the junction power exceeds the acceptable value called Power Dissipation P_D. The dependence of the MUSES01 P_D on ambient temperature is shown in Fig 1. The plots are depended on following two points. The first is P_D on ambient temperature 25°C, which is the maximum power dissipation. The second is 0W, which means that the IC cannot radiate any more. Conforming the maximum junction temperature Tjmax to the storage temperature Tstg derives this point. Fig.1 is drawn by connecting those points and conforming the P_D lower than 25°C to it on 25°C. The P_D is shown following formula as a function of the ambient temperature between those points.

$$\text{Dissipation Power} \quad P_D = \frac{\text{Tjmax - Ta}}{\theta\text{ja}} \quad \text{[W] (Ta=25°C to Ta=150°C)}$$

Where, θja is heat thermal resistance which depends on parameters such as package material, frame material and so on. Therefore, P_D is different in each package.

While, the actual measurement of dissipation power on MUSES01 is obtained using following equation.

(Actual Dissipation Power) = (Supply Voltage V_{DD}) X (Supply Current I_{DD}) – (Output Power Po)

The MUSES01 should be operated in lower than P_D of the actual dissipation power.

To sustain the steady state operation, take account of the Dissipation Power and thermal design.

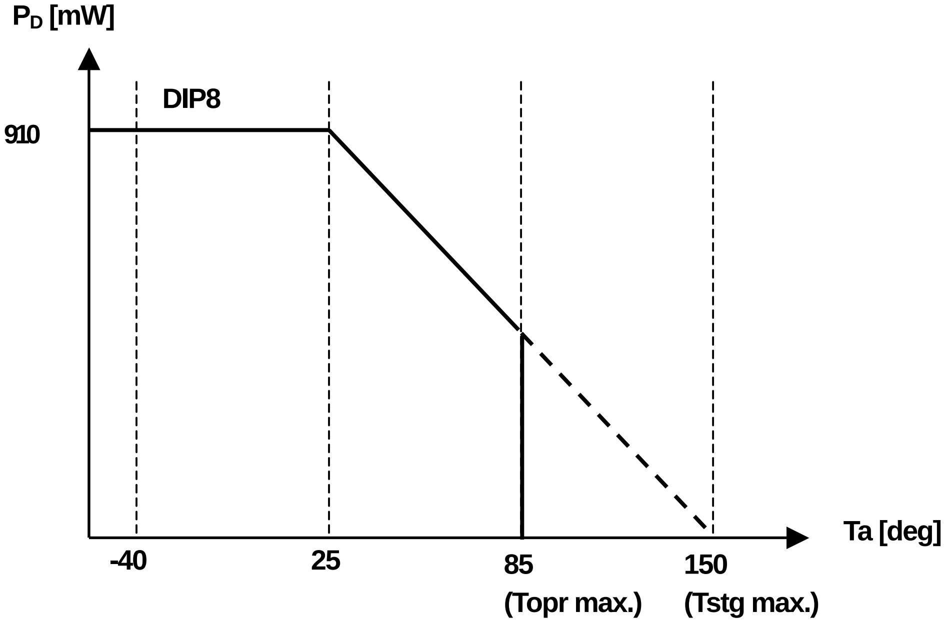
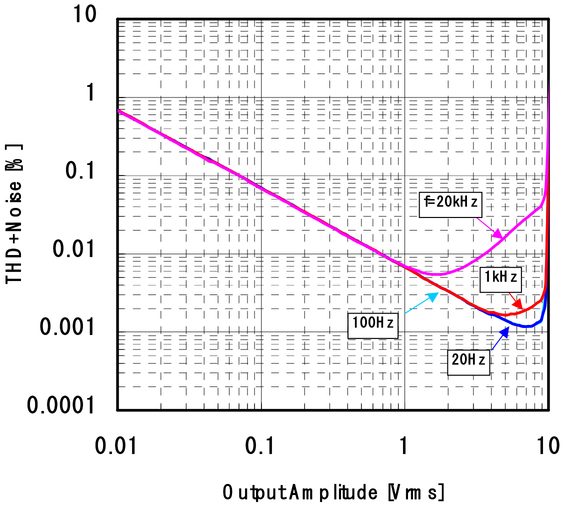


Fig.1 Power Dissipations vs. Ambient Temperature on the MUSES01

■ TYPICAL CHARACTERISTICS

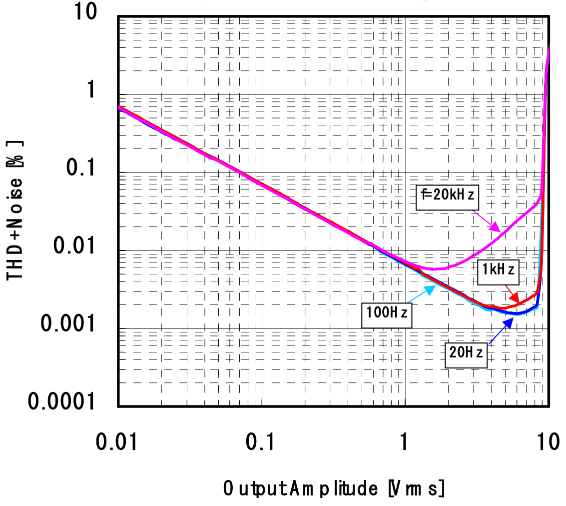
TOTAL HARMONIC DISTORTION + NOISE
vs OUTPUT AMPLITUDE (FREQUENCY)

$V^+/V^-=\pm16V, A_V=+10, Rg=1kohm, Rf=9.1kohm, R_L=2kohm, Ta=25°C$



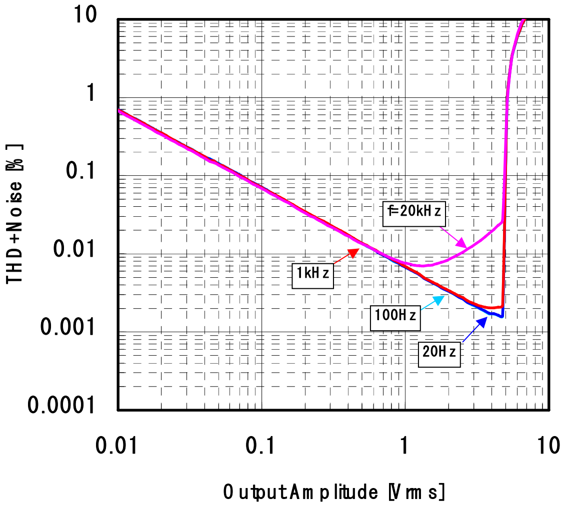
TOTAL HARMONIC DISTORTION + NOISE
vs OUTPUT AMPLITUDE (FREQUENCY)

$V^+/V^-=\pm15V, A_V=+10, Rg=1kohm, Rf=9.1kohm, R_L=2kohm, Ta=25°C$



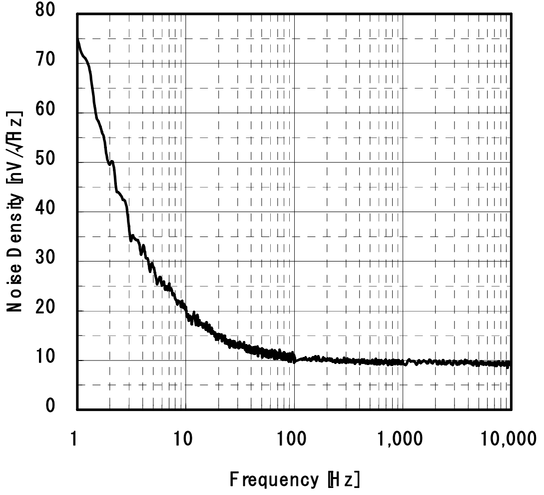
TOTAL HARMONIC DISTORTION + NOISE
vs OUTPUT AMPLITUDE (FREQUENCY)

$V^+/V^-=\pm9V, A_V=+10, Rg=1kohm, Rf=9.1kohm, R_L=2kohm, Ta=25°C$



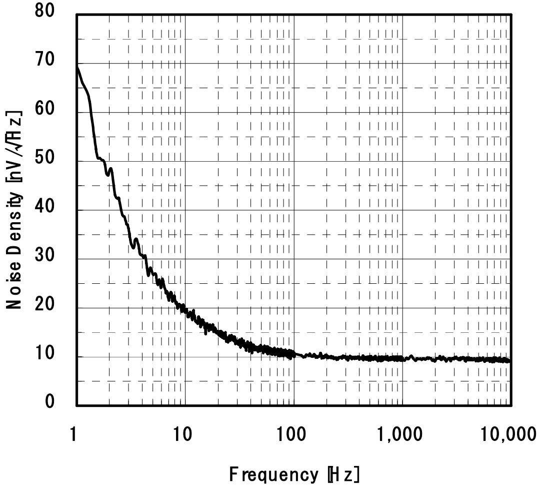
EQUIVALENT INPUT NOISE DENSITY vs
FREQUENCY

$V^+/V^-=\pm16V, A_V=+100, Rs=100ohm, R_L=\infty, Ta=25°C$



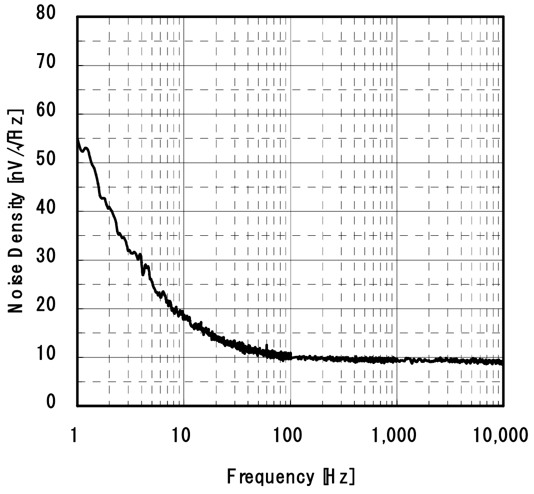
EQUIVALENT INPUT NOISE DENSITY vs
FREQUENCY

$V^+/V^-=\pm15V, A_V=+100, Rs=100ohm, R_L=\infty, Ta=25°C$



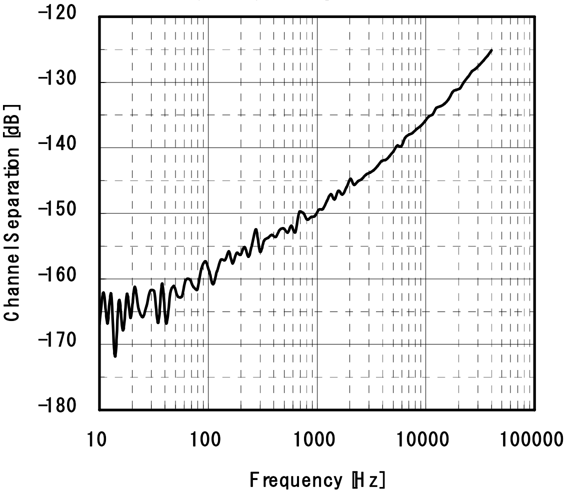
EQUIVALENT INPUT NOISE DENSITY vs
FREQUENCY

$V^+/V^-=\pm9V, A_V=+100, Rs=100ohm, R_L=\infty, Ta=25°C$



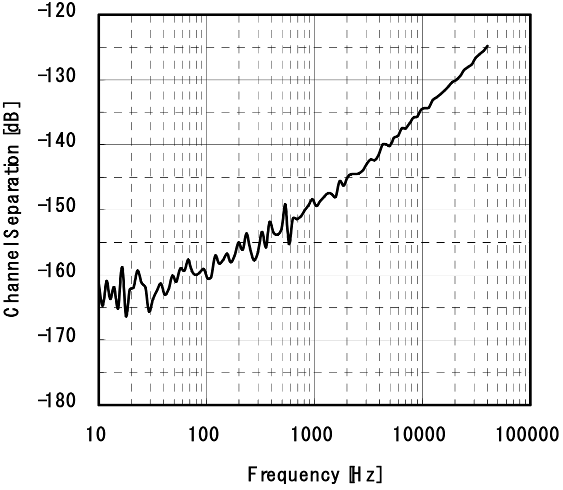
CHANNEL SEPARATION vs FREQUENCY

$V^+/V^-=\pm16V, A_V=-100, R_S=1kohm, R_L=2kohm$, Vo=5Vrms, Ta=25℃



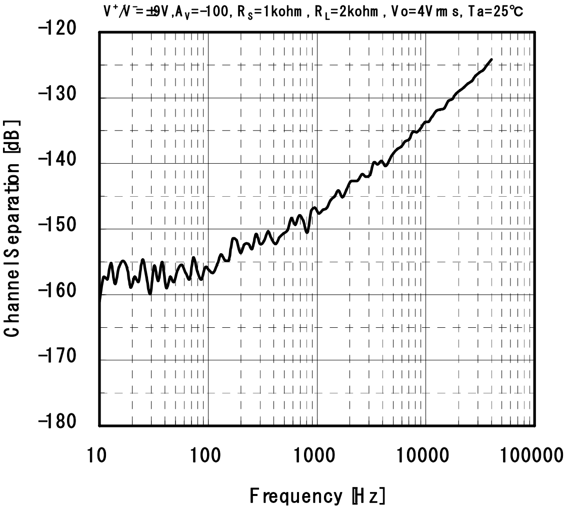
CHANNEL SEPARATION vs FREQUENCY

$V^+/V^-=\pm15V, A_V=-100, R_S=1kohm, R_L=2kohm$, Vo=5Vrms, Ta=25℃



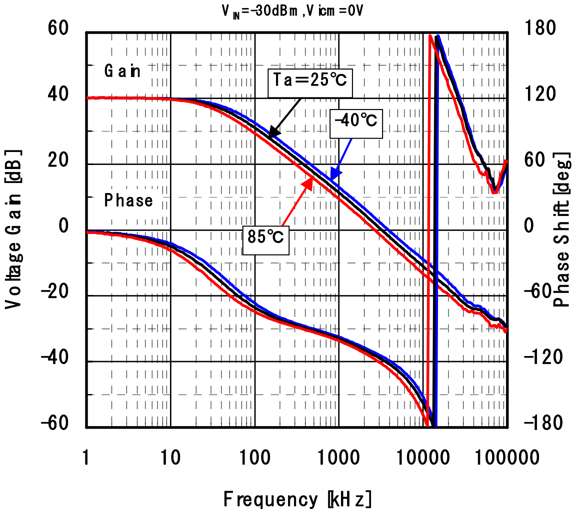
CHANNEL SEPARATION vs FREQUENCY

$V^+/V^-=\pm9V, A_V=-100, R_S=1kohm, R_L=2kohm$, Vo=4Vrms, Ta=25℃



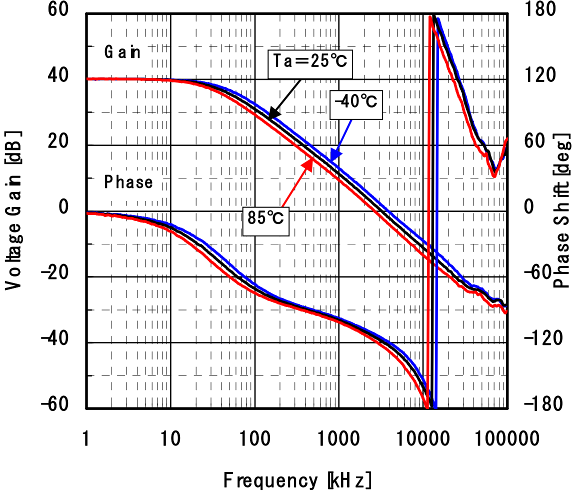
CLOSED-LOOP GAIN/PHASE vs FREQUENCY (TEMPERATURE)

$V^+/V^-=\pm16V, A_V=+100, R_S=100ohm, R_T=50ohm, R_L=2kohm, C_L=10pF$
$V_{IN}=-30dBm, V_{icm}=0V$



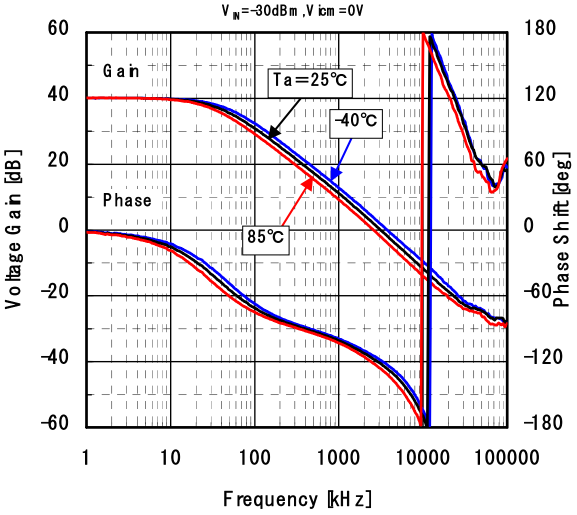
CLOSED-LOOP GAIN/PHASE vs FREQUENCY (TEMPERATURE)

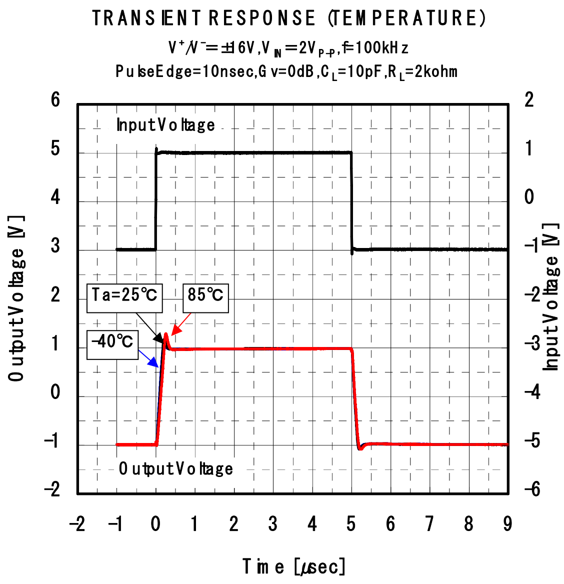
$V^+/V^-=\pm15V, A_V=+100, R_S=100ohm, R_T=50ohm, R_L=2kohm, C_L=10pF$
$V_{IN}=-30dBm, V_{icm}=0V$

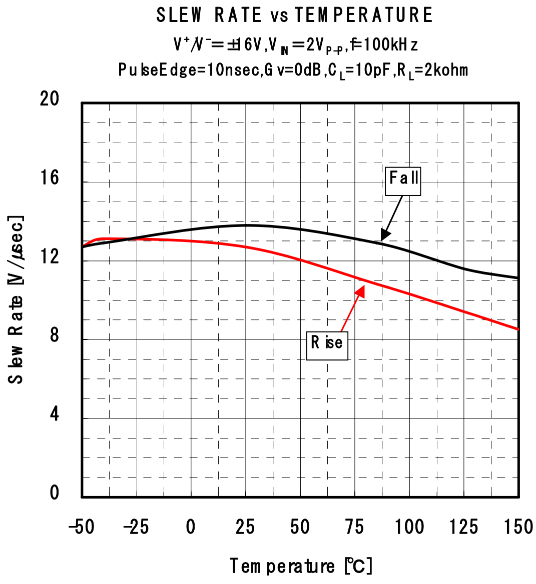


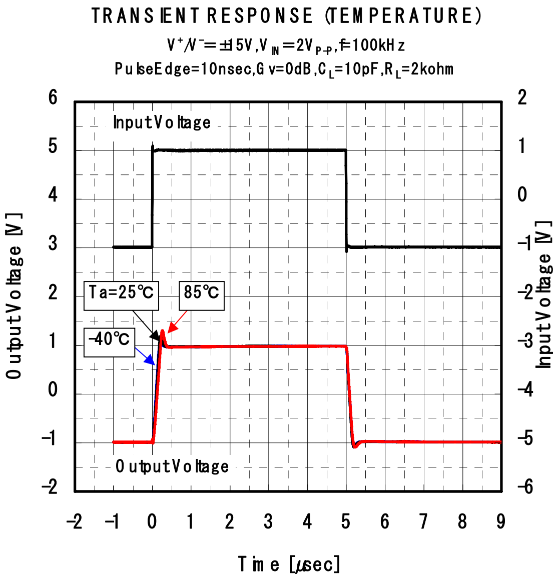
CLOSED LOOP GAIN/PHASE vs FREQUENCY (TEMPERATURE)

$V^+/V^-=\pm9V, A_V=+100, R_S=100ohm, R_T=50ohm, R_L=2kohm, C_L=10pF$
$V_{IN}=-30dBm, V_{icm}=0V$




TRANSIENT RESPONSE (TEMPERATURE)
V+/V−=±16V,VIN=2VP-P,f=100kHz
PulseEdge=10nsec,Gv=0dB,CL=10pF,RL=2kohm
Input Voltage
Ta=25℃
85℃
-40℃
Output Voltage
Output Voltage [V]
Input Voltage [V]
Time [μsec]
6
5
4
3
2
1
0
-1
-2
2
1
0
-1
-2
-3
-4
-5
-6
-2
-1
0
1
2
3
4
5
6
7
8
9


SLEW RATE vs TEMPERATURE
V+/V−=±16V,VIN=2VP-P,f=100kHz
PulseEdge=10nsec,Gv=0dB,CL=10pF,RL=2kohm
Fall
Rise
Slew Rate [V/μsec]
Temperature [℃]
20
16
12
8
4
0
-50
-25
0
25
50
75
100
125
150


TRANSIENT RESPONSE (TEMPERATURE)
V+/V−=±15V,VIN=2VP-P,f=100kHz
PulseEdge=10nsec,Gv=0dB,CL=10pF,RL=2kohm
Input Voltage
Ta=25℃
85℃
-40℃
Output Voltage
Output Voltage [V]
Input Voltage [V]
Time [μsec]
6
5
4
3
2
1
0
-1
-2
2
1
0
-1
-2
-3
-4
-5
-6
-2
-1
0
1
2
3
4
5
6
7
8
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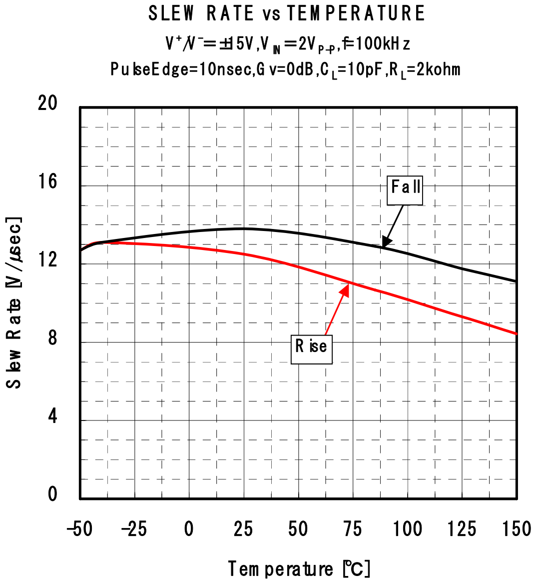
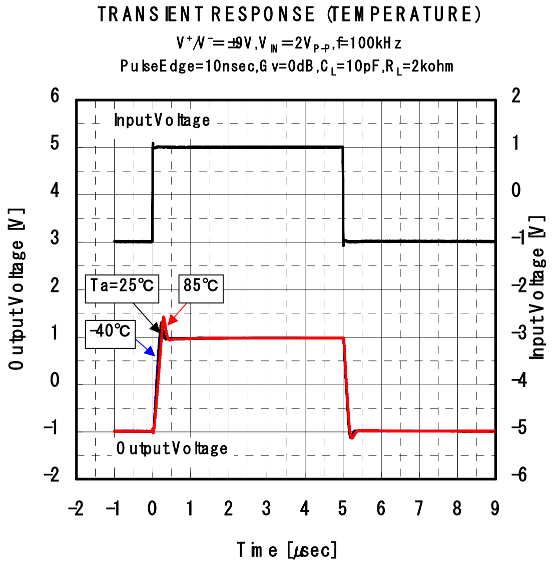

SLEW RATE vs TEMPERATURE
V+/V−=±15V,VIN=2VP-P,f=100kHz
PulseEdge=10nsec,Gv=0dB,CL=10pF,RL=2kohm
Fall
Rise
Slew Rate [V/μsec]
Temperature [℃]
20
16
12
8
4
0
-50
-25
0
25
50
75
100
125
150


TRANSIENT RESPONSE (TEMPERATURE)
V+/V−=±9V,VIN=2VP-P,f=100kHz
PulseEdge=10nsec,Gv=0dB,CL=10pF,RL=2kohm
Input Voltage
Ta=25℃
85℃
-40℃
Output Voltage
Output Voltage [V]
Input Voltage [V]
Time [μsec]
6
5
4
3
2
1
0
-1
-2
2
1
0
-1
-2
-3
-4
-5
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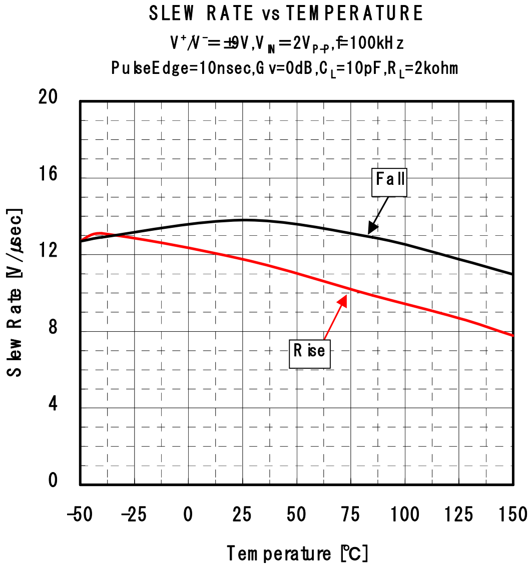
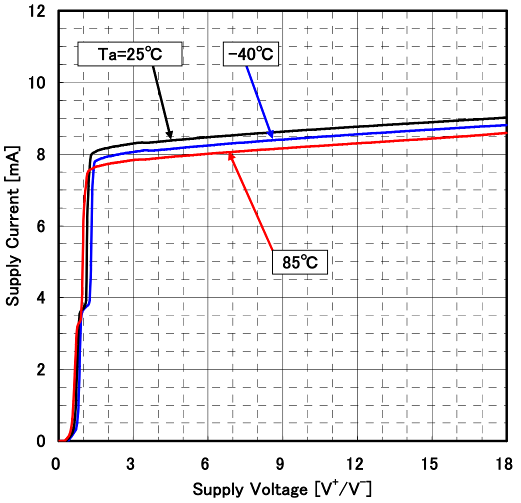
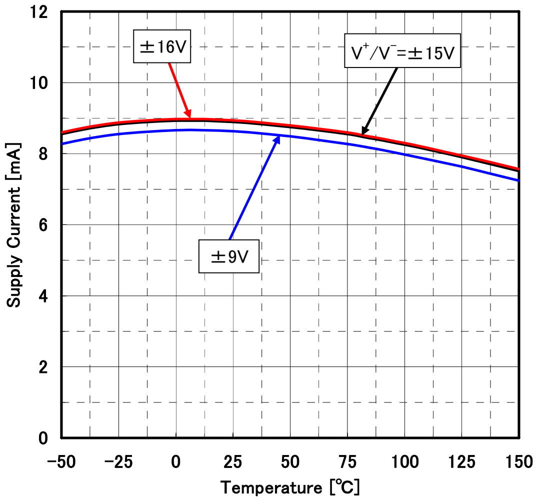

SLEW RATE vs TEMPERATURE
V+/V−=±9V,VIN=2VP-P,f=100kHz
PulseEdge=10nsec,Gv=0dB,CL=10pF,RL=2kohm
Fall
Rise
Slew Rate [V/μsec]
Temperature [℃]
20
16
12
8
4
0
-50
-25
0
25
50
75
100
125
150

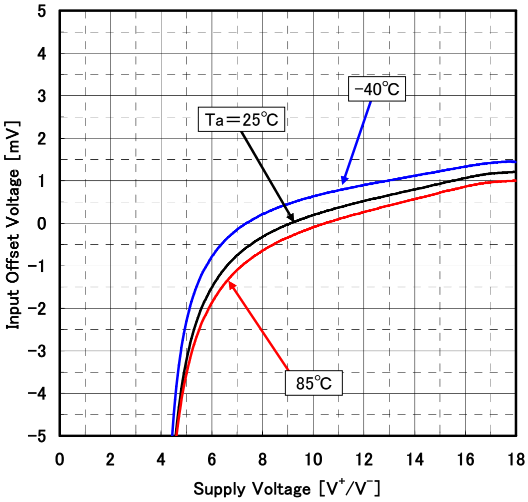
SUPPLY CURRENT vs SUPPLY VOLTAGE
(TEMPERATURE)
G_V=0dB, Vin=0V



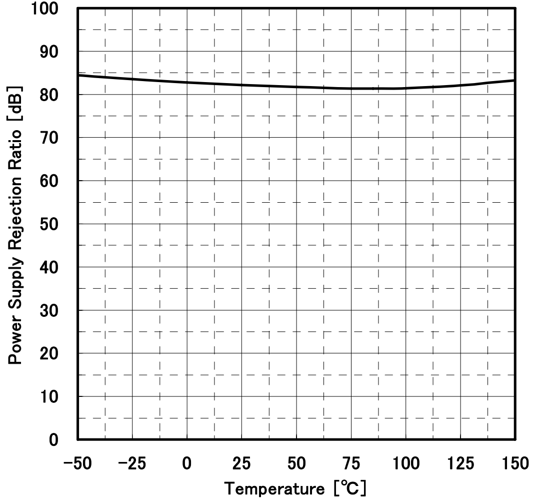
SUPPLY CURRENT vs TEMPERATURE
(SUPPLY VOLTAGE)
G_V=0dB, Vin=0V



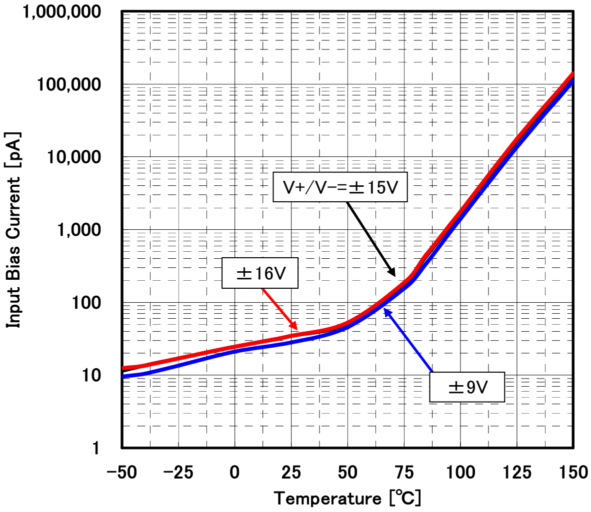
INPUT OFFSET VOLTAGE vs SUPPLY VOLTAGE
(TEMPERATURE)
V_{ICM}=0V,Vin=0V



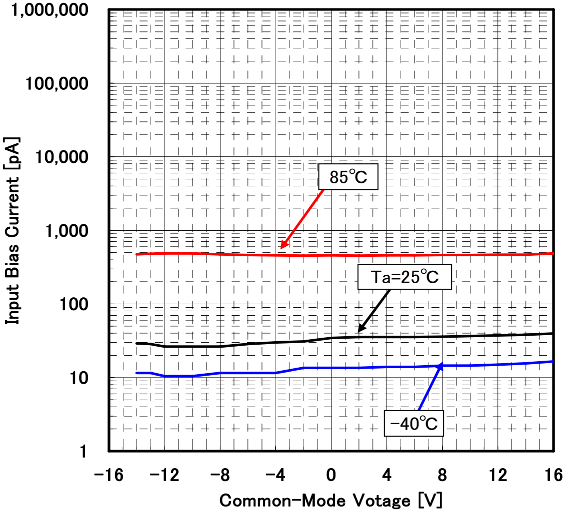
POWER SUPPLY REJECTION RATIO vs
TEMPERATURE
V_{ICM}=0V , V+/V−=±9V to ±16V



INPUT BIAS CURRENT vs TEMPERATURE
(SUPPLY VOLTAGE)
V_{ICM}=0V

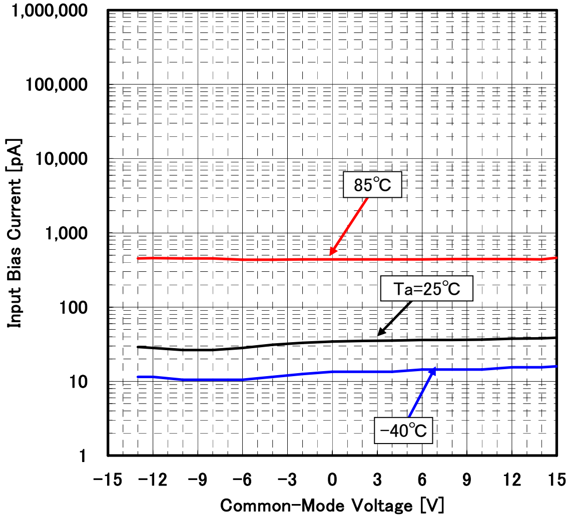


INPUT BIAS CURRENT vs INPUT COMMON-MODE
VOLTAGE (TEMPERATURE)
V+/V−=±16V



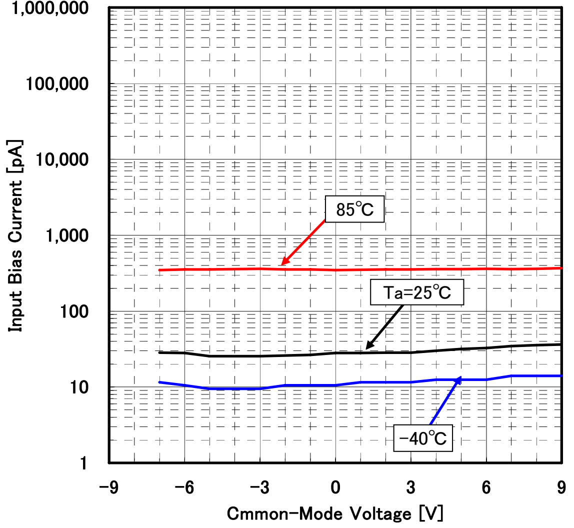
INPUT BIAS CURRENT vs INPUT COMMON-MODE VOLTAGE (TEMPERATURE)

$V^+/V^-=\pm15V$



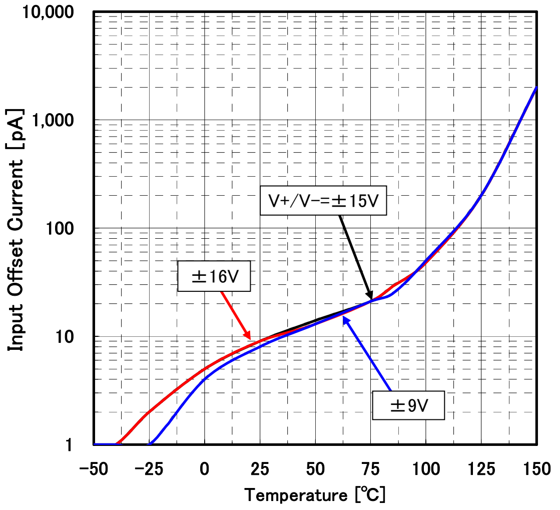
INPUT BIAS CURRENT vs INPUT COMMON-MODE VOLTAGE (TEMPERATURE)

$V^+/V^-=\pm9V$



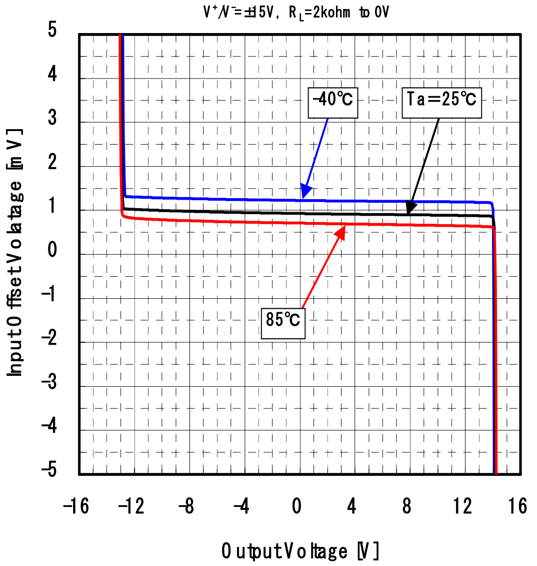
INPUT OFFSET CURRENT vs TEMPERATURE (SUPPLY VOLTAGE)

V_{ICM}=0V



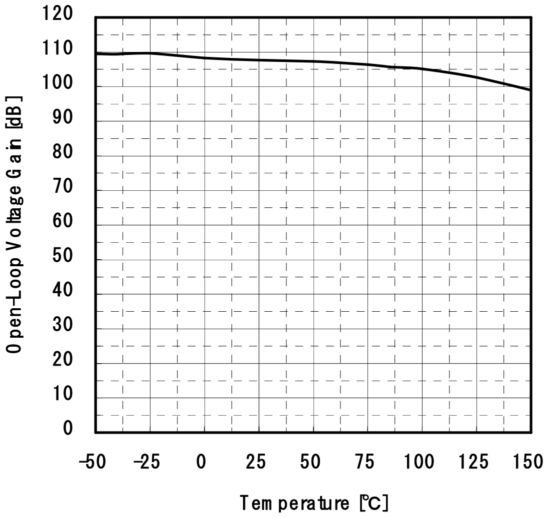
INPUT OFFSET VOLTAGE vs OUTPUT VOLTAGE (TEMPERATURE)

$V^+/V^-=\pm15V$, R_L=2kohm to 0V



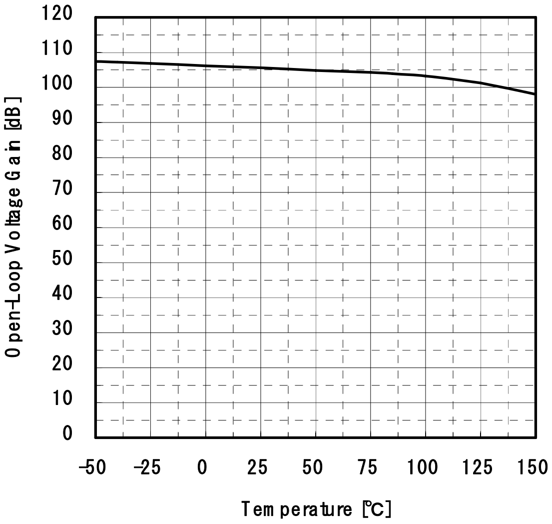
OPEN-LOOP VOLTAGE GAIN vs TEMPERATURE

R_L=2kohm to 0V, $V^+/V^-=\pm16V$, Vo=-11V to +11V

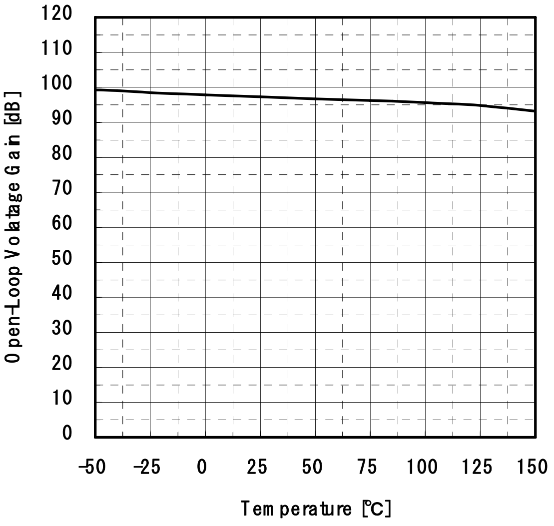


OPEN-LOOP VOLTAGE GAIN vs TEMPERATURE

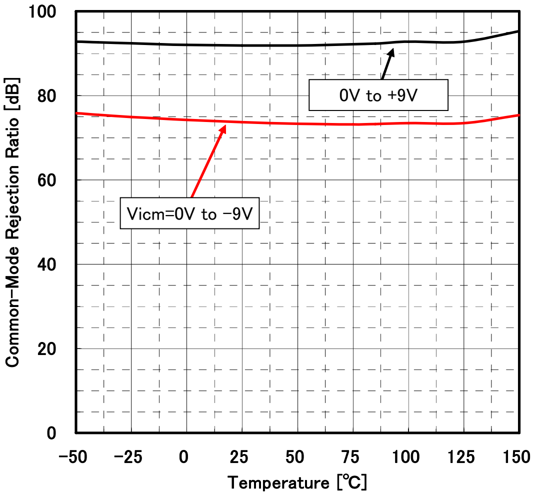
R_L=2kohm to 0V, $V^+/V^-=\pm15V$, Vo=-10V to +10V



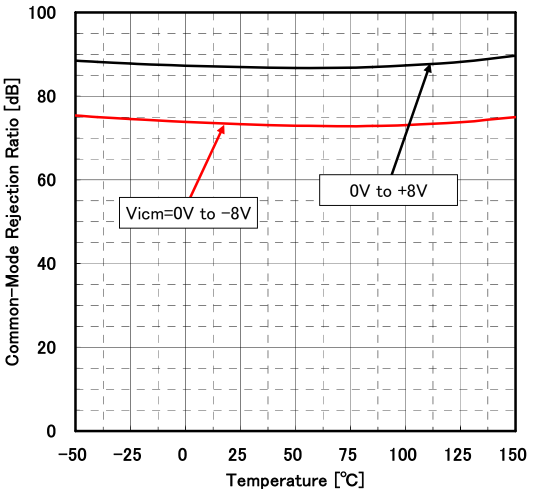
OPEN-LOOP VOLTAGE GAIN vs TEMPERATURE
R_L=2kohm to 0V, V^+/V^-=±9V, Vo=-4V to +4V



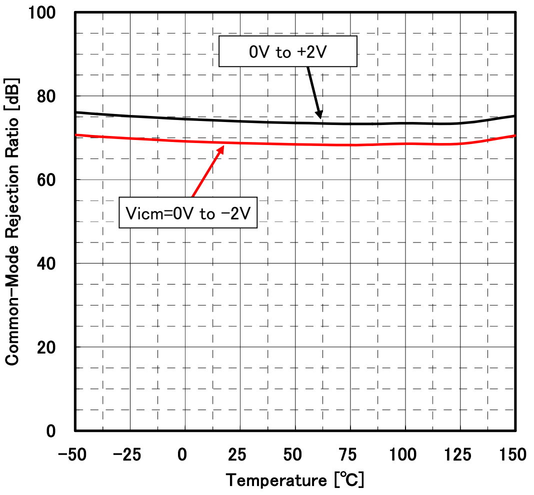
COMMON-MODE REJECTION RATIO vs TEMPERATUER
(INPUT COMMON-MODE VOLTAGE)
V^+/V^-=±16V



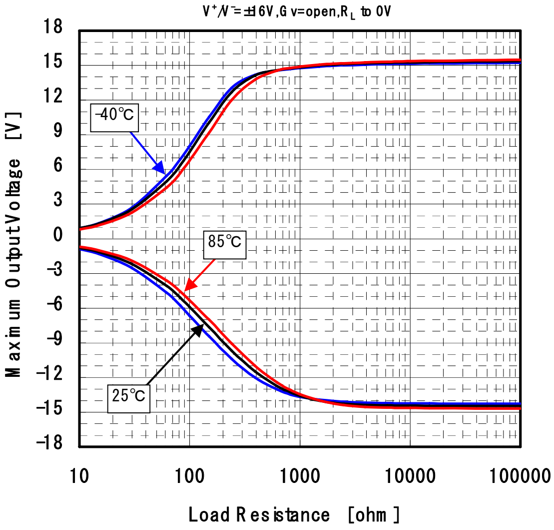
COMMON-MODE REJECTION RATIO vs TEMPERATURE
(INPUT COMMON-MODE VOLTAGE)
V^+/V^-=±15V



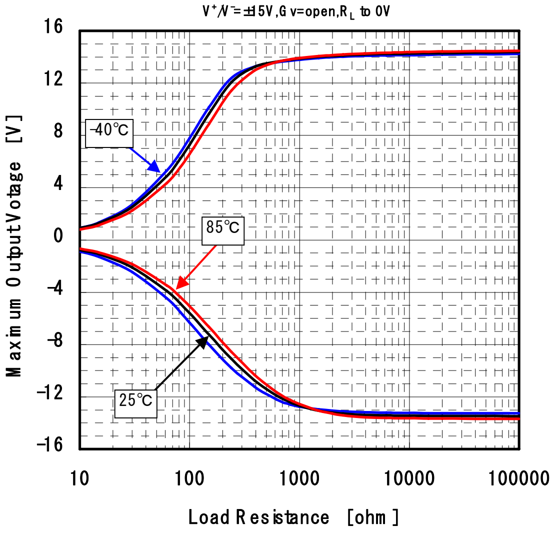
COMMON-MODE REJECTION RATIO vs TEMPERATURE
(INPUT COMMON-MODE VOLTAGE)
V^+/V^-=±9V



MAXIMUM OUTPUT VOLTAGE vs
LOAD RESISTANCE (TEMPERATURE)
V^+/V^-=±16V,Gv=open,R_L to 0V

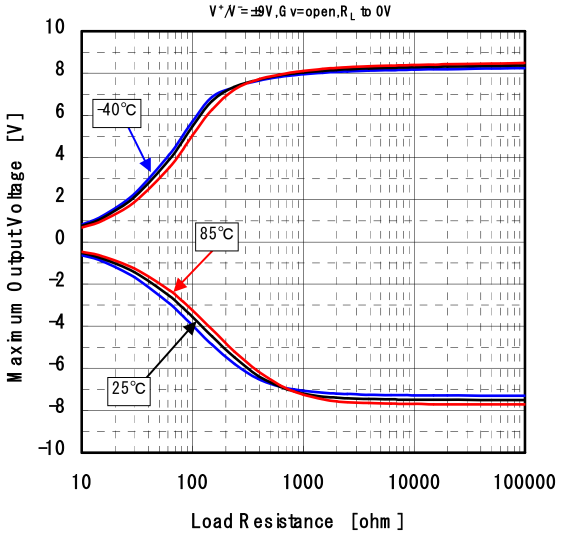


MAXIMUM OUTPUT VOLTAGE vs
LOAD RESISTANCE (TEMPERATURE)
V^+/V^-=±15V,Gv=open,R_L to 0V



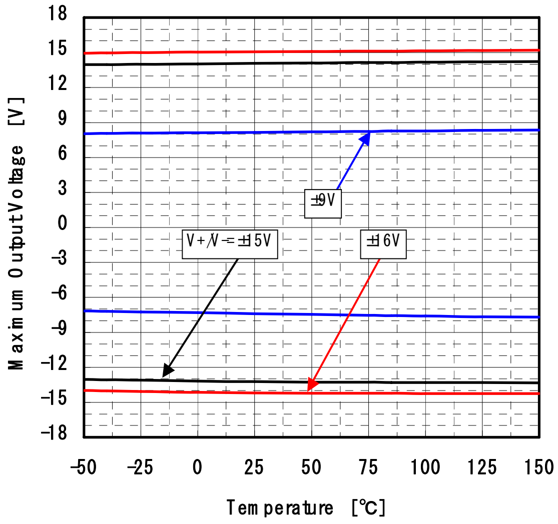
MAXIMUM OUTPUT VOLTAGE vs LOAD RESISTANCE (TEMPERATURE)

$V^+/V^-=\pm 9V$, Gv=open, R_L to 0V



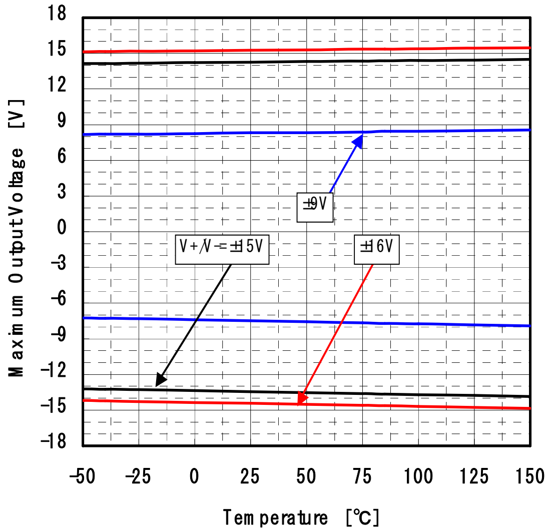
MAXIMUM OUTPUT VOLTAGE vs TEMPERATURE (SUPPLY VOLTAGE)

Gv=open, R_L=2kohm to 0V



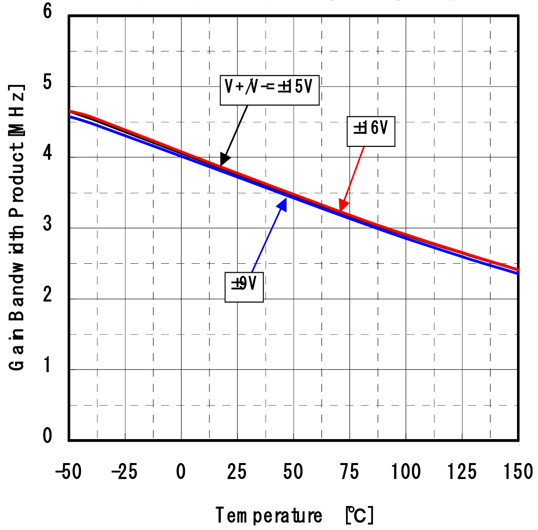
MAXIMUM OUTPUT VOLTAGE vs TEMPERATURE (SUPPLY VOLTAGE)

Gv=open, R_L=10kohm to 0V



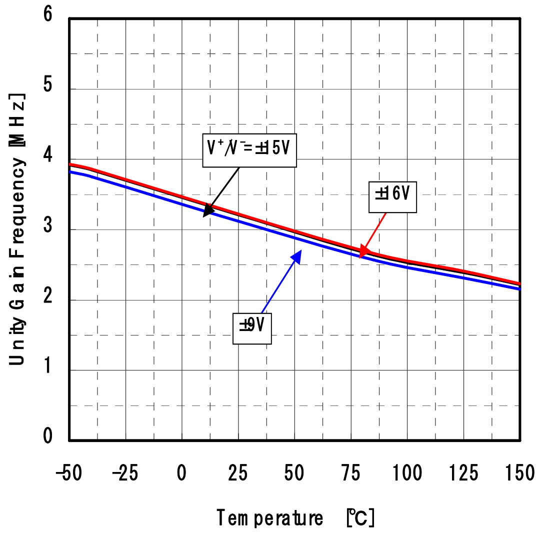
GAIN BANDWIDTH PRODUCT vs TEMPERATURE (SUPPLY VOLTAGE)

f=10kHz, A_V=80dB, R_S=10ohm, R_T=50ohm, R_L=2kohm, C_L=10pF, V_{IN}=-50dBm



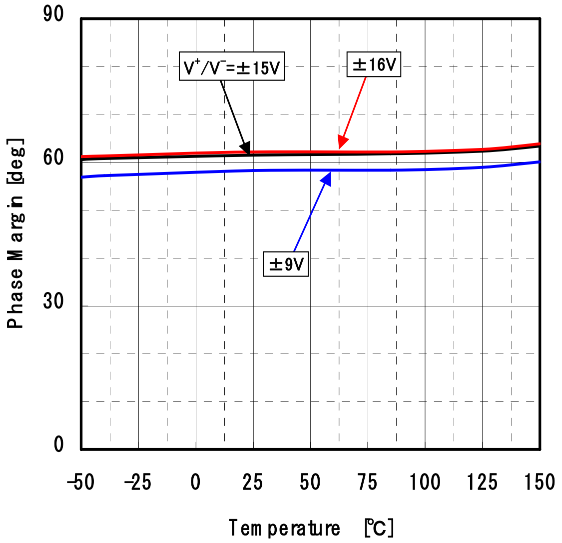
UNITY GAIN FREQUENCY vs TEMPERATURE (SUPPLY VOLTAGE)

A_V=+100, R_S=100ohm, R_T=50ohm, R_L=2kohm, C_L=56pF, V_{IN}=-30dBm



PHASE MARGIN vs TEMPERATURE (SUPPLY VOLTAGE)

A_V=+100, R_S=100ohm, R_T=50ohm, R_L=2kohm, C_L=10pF, V_{IN}=-30dBm



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