



## High Quality Audio, Bipolar Input, Dual Operational Amplifier

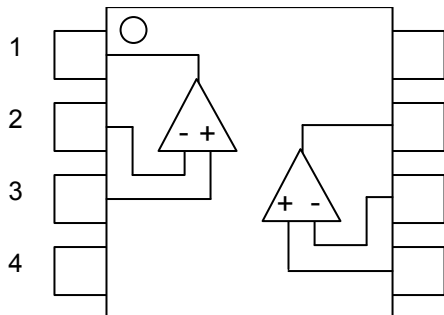
The **MUSES02** is a dual bipolar input high quality audio operational amplifier, which is optimized for high-end audio and professional audio applications with advanced circuitry and layout, unique material and assembled technology by skilled-craftwork.

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

### ■ FEATURES

- |                        |   |
|------------------------|---|
| ● Operating Voltage    | $V_{opr} = \pm 3.5V$ to $\pm 16V$         |
| ● Output noise         | $4.5nV/\sqrt{Hz}$ at $f=1kHz$             |
| ● Input Offset Voltage | 0.3mV typ. 3mV max.                       |
| ● Input Bias Current   | 100nA typ. 500nA max. at $T_a=25^\circ C$ |
| ● Voltage Gain         | 110dB typ.                                |
| ● Slew Rate            | $5V/\mu s$ typ.                           |
| ● Bipolar Technology   |   |
| ● Package Outline      | DIP8                                      |

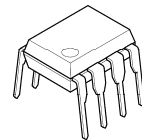
### ■ PIN CONFIGURATION



### PIN FUNCTION

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

### ■ PACKAGE OUTLINE



**MUSES02**



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# MUSES02

## ■ 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	$I_O$	±50	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	$V^+V^-$	-	±3.5	-	±16	V

## ■ ELECTRIC CHARACTERISTICS

DC CHARACTERISTICS ( $V^+V^- = \pm 15V$ , Ta=25°C unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	$I_{cc}$	No Signal, $R_L = \infty$	-	8.0	12.0	mA
Input Offset Voltage	$V_{IO}$	$R_s \leq 10k\Omega$ (Note2)	-	0.3	3.0	mV
Input Bias Current	$I_B$	(Note2, 3)	-	100	500	nA
Input Offset Current	$I_{IO}$	(Note2, 3)	-	5	200	nA
Voltage Gain	$A_V$	$R_L \geq 2k\Omega$ , $V_o = \pm 10V$ $R_s \leq 10k\Omega$	90	110	-	dB
Common Mode Rejection Ratio	CMR	$V_{ICM} = \pm 12V$ (Note4) $R_s \leq 10k\Omega$	80	110	-	dB
Supply Voltage Rejection Ratio	SVR	$V^+V^- = \pm 3.5$ to $\pm 16.0V$ $R_s \leq 10k\Omega$ (Note2, 5)	80	110	-	dB
Max Output Voltage	$V_{OM}$	$R_L = 2k\Omega$	±12	±13.5	-	V
Input Common Mode Voltage Range	$V_{ICM}$	CMR ≥ 80dB	±12	±13.5	-	V

(Note2) Measured at  $V_{ICM} = 0V$

(Note3) Written by the absolute rate.

(Note4) CMR is calculated by specified change in offset voltage. ( $V_{ICM} = 0V$  to +12V and  $V_{ICM} = 0V$  to -12V)

(Note5) SVR is calculated by specified change in offset voltage. ( $V^+V^- = \pm 3.5V$  to  $\pm 16V$ )

■ AC CHARACTERISTICS ( $V^+V^- = \pm 15V$ ,  $T_a = 25^\circ C$  unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gain Bandwidth Product	GB	$f = 10kHz$	-	11	-	MHz
Unity Gain Frequency	$f_T$	$A_V = +100, R_S = 100\Omega,$ $R_L = 2k\Omega, C_L = 10pF$	-	5.8	-	MHz
Phase Margin	$\phi_M$	$A_V = +100, R_S = 100\Omega,$ $R_L = 2k\Omega, C_L = 10pF$	-	48	-	deg
Input Noise Voltage1	$V_{NI}$	$f = 1kHz, A_V = +100,$ $R_S = 100\Omega, R_L = \infty$	-	4.5	-	nV/ $\sqrt{Hz}$
Input Noise Voltage2	$V_{N2}$	$f = 1kHz, A_V = +10$ $R_S = 2.2k\Omega,$ RIAA, 30kHz LPF	-	0.8	1.4	$\mu V_{rms}$
Total Harmonic Distortion	THD	$f = 1kHz, A_V = +10,$ $R_L = 2k\Omega, V_o = 5V_{rms}$	-	0.001	-	%
Channel Separation	CS	$f = 1kHz, A_V = +100,$ $R_S = 1k\Omega, R_L = 2k\Omega$	-	150	-	dB
Positive Slew Rate	+SR	$A_V = 1, V_{IN} = 2V_{p-p},$ $R_L = 2k\Omega, C_L = 10pF$	-	5	-	V/ $\mu s$
Negative Slew Rate	-SR	$A_V = 1, V_{IN} = 2V_{p-p},$ $R_L = 2k\Omega, C_L = 10pF$	-	5	-	V/ $\mu s$

## ■ 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 MUSES02  $P_D$  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  $T_{jmax}$  to the storage temperature  $T_{stg}$  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.

$$\text{Dissipation Power } P_D = \frac{T_{jmax} - T_a}{\theta_{ja}} \text{ [W]} \quad (T_a=25^\circ\text{C to } T_a=150^\circ\text{C})$$

Where,  $\theta_{ja}$  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 MUSES02 is obtained using following equation.

$$(\text{Actual Dissipation Power}) = (\text{Supply Voltage } V_{DD}) \times (\text{Supply Current } I_{DD}) - (\text{Output Power } P_o)$$

The MUSES02 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.

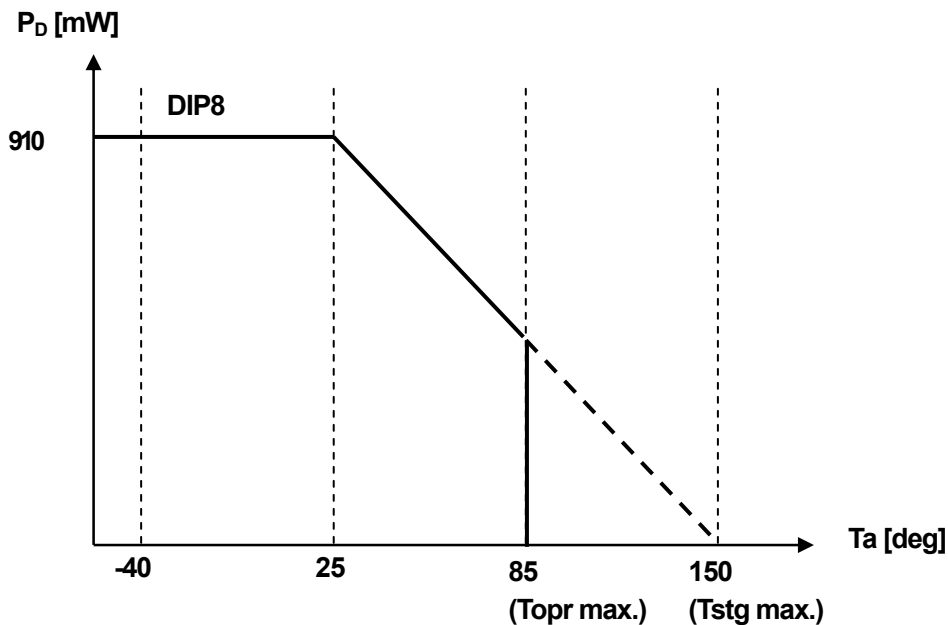
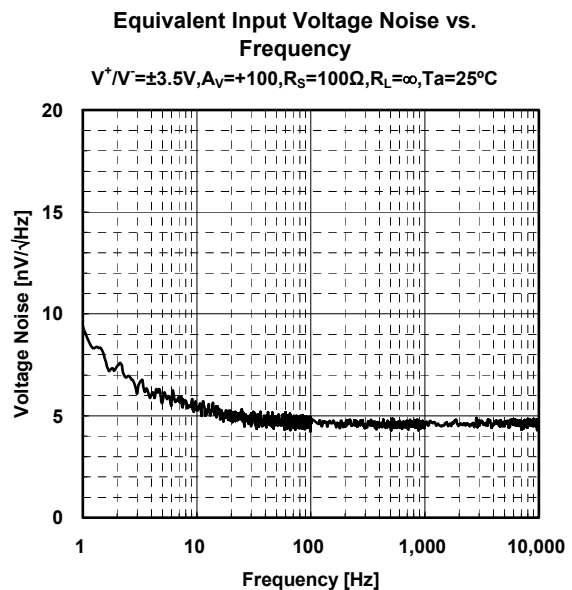
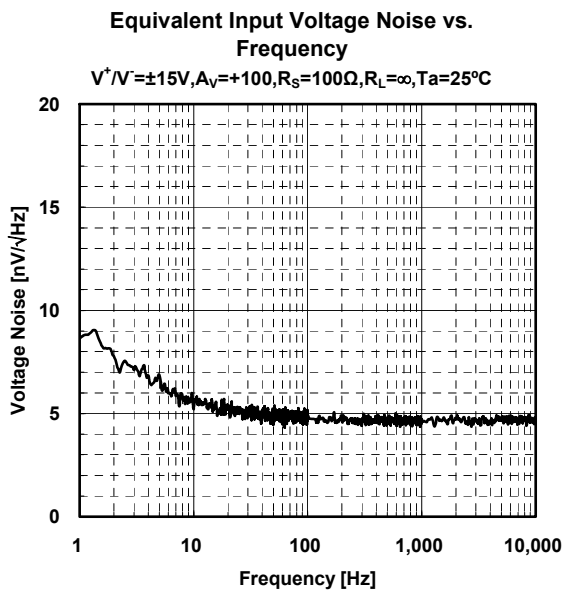
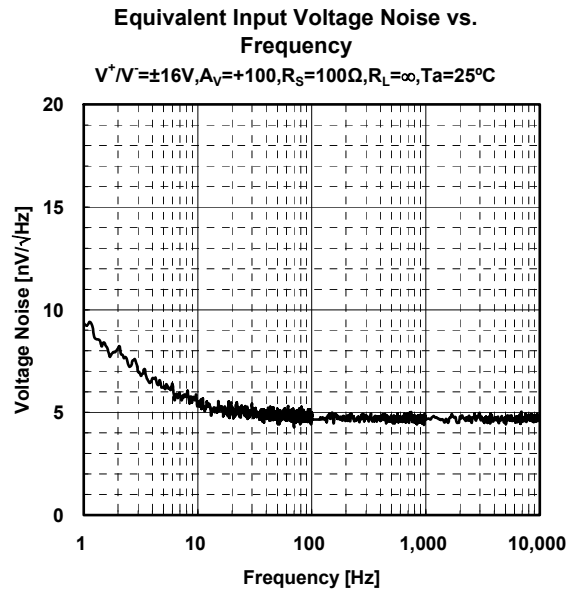
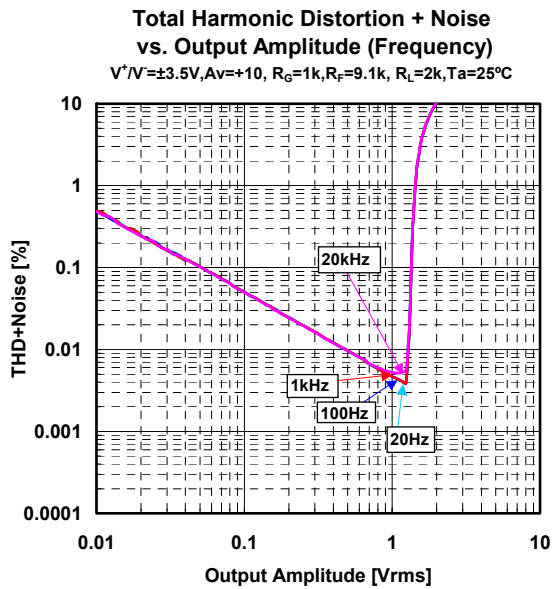
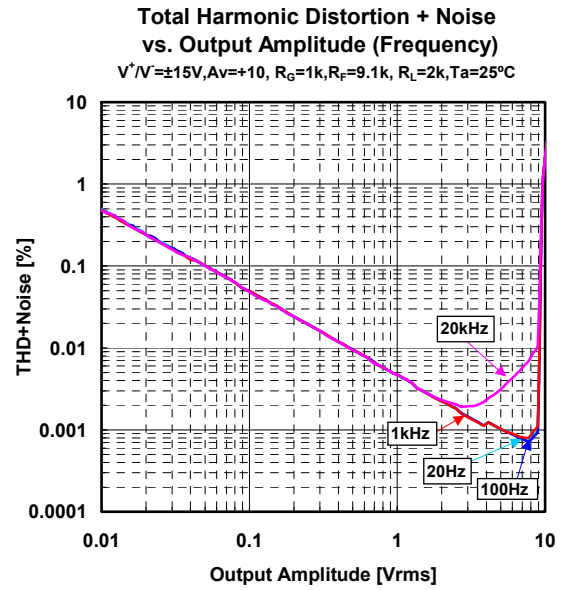
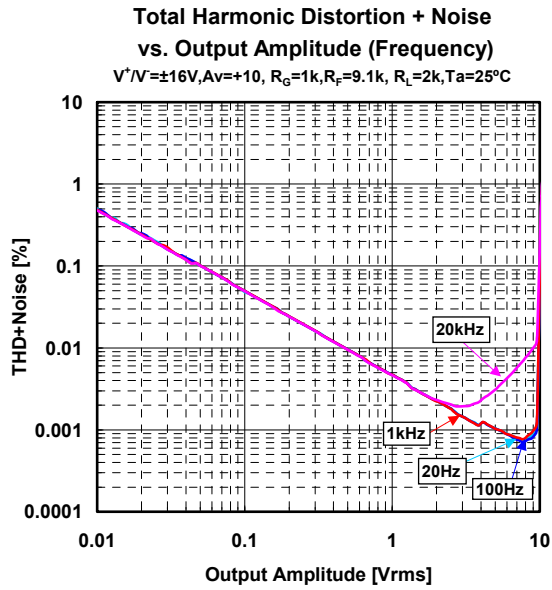
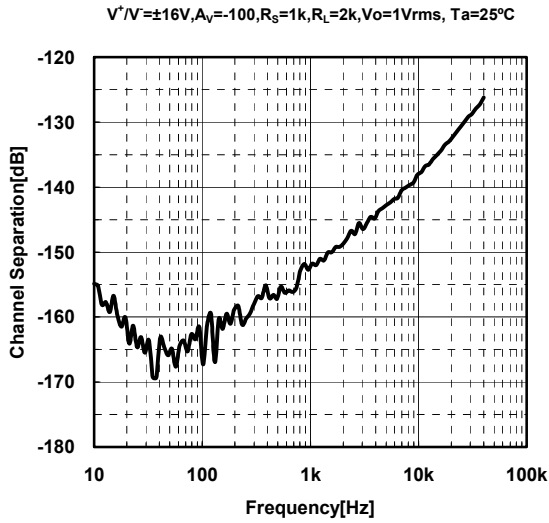


Fig.1 Power Dissipations vs. Ambient Temperature on the MUSES02

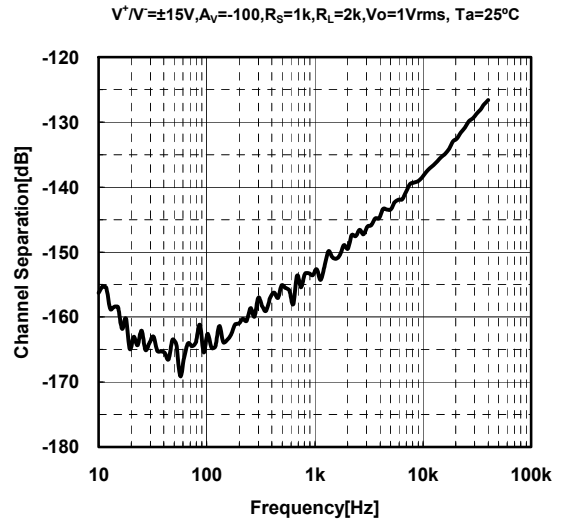
## ■ TYPICAL CHARACTERISTICS



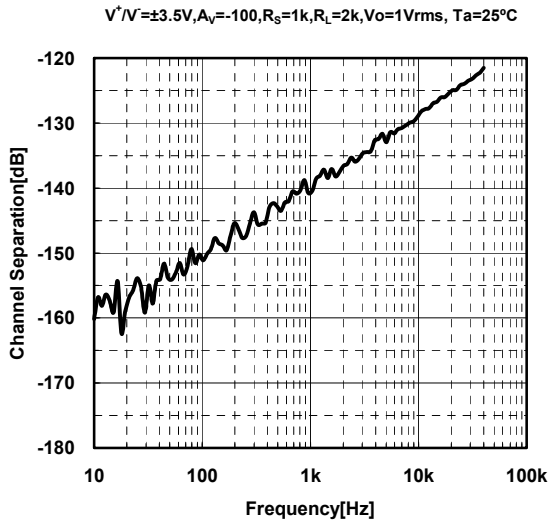
Channel Separation vs. Frequency



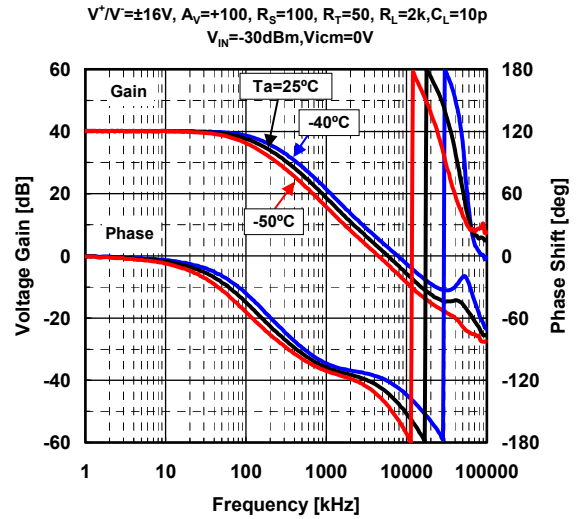
Channel Separation vs. Frequency



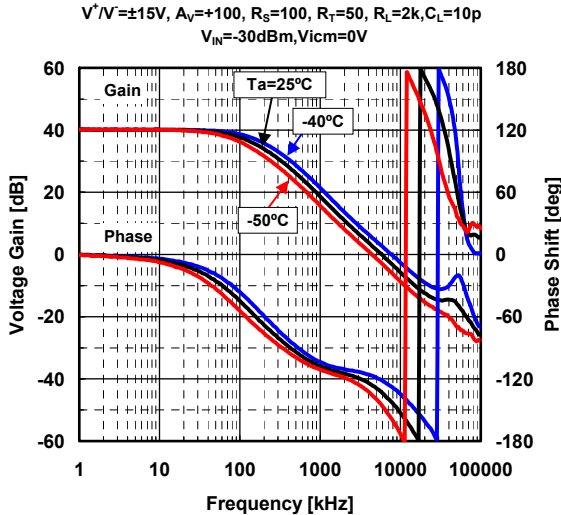
Channel Separation vs. Frequency



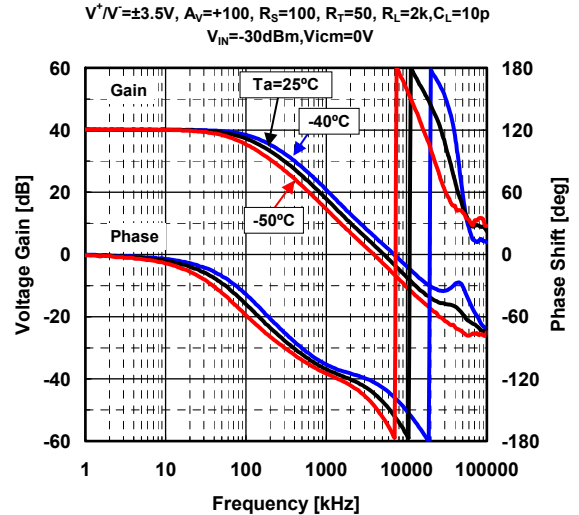
Closed-Loop Gain/Phase vs. Frequency(Temperature)



Closed-Loop Gain/Phase vs. Frequency(Temperature)

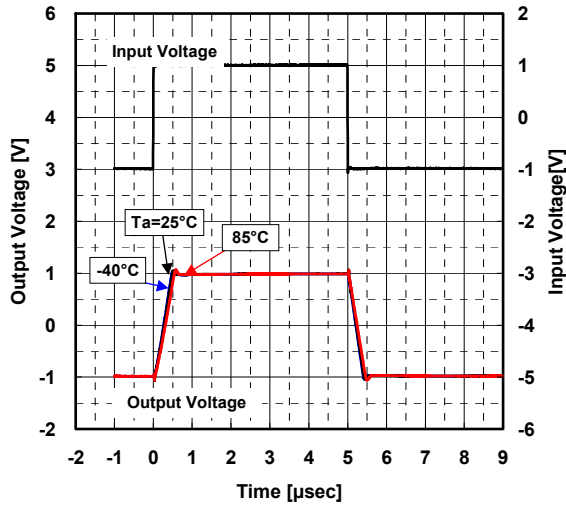


Closed-Loop Gain/Phase vs. Frequency(Temperature)



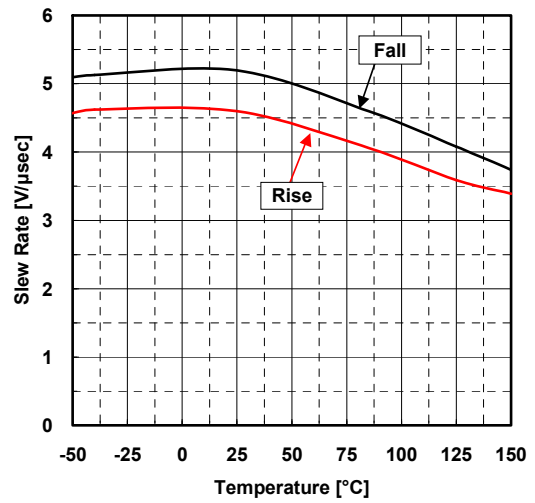
**Transient Response (Temperature)**

$V^+/V^- = \pm 16V, V_{IN} = 2V_{P-P}, f = 100kHz$   
 PulseEdge=10nsec, Gv=0dB, CL=10p, RL=2k



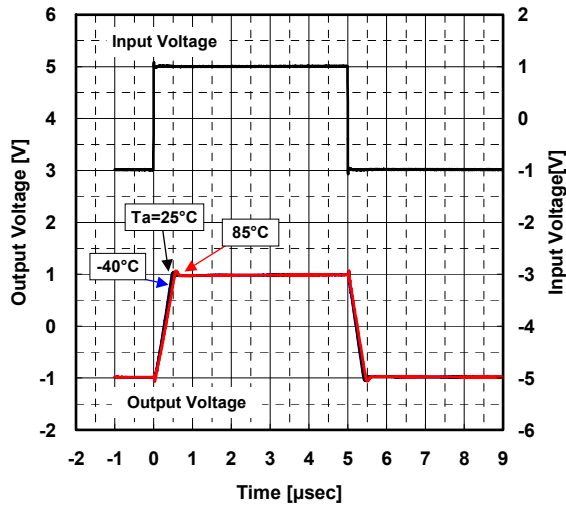
**Slew Rate vs. Temperature**

$V^+/V^- = \pm 16V, V_{IN} = 2V_{P-P}, f = 100kHz$   
 PulseEdge=10nsec, Gv=0dB, CL=10p, RL=2k



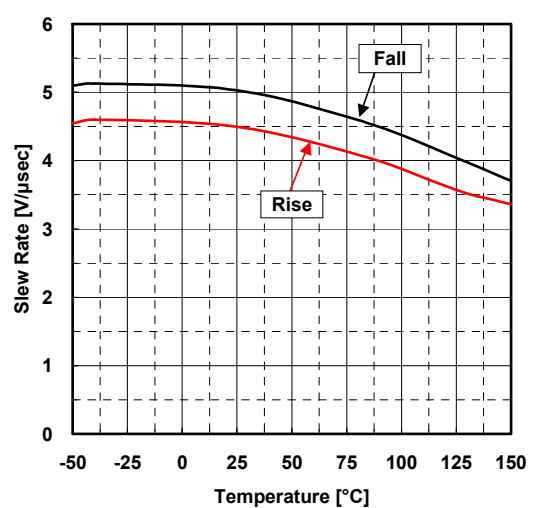
**Transient Response (Temperature)**

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 PulseEdge=10nsec, Gv=0dB, CL=10p, RL=2k



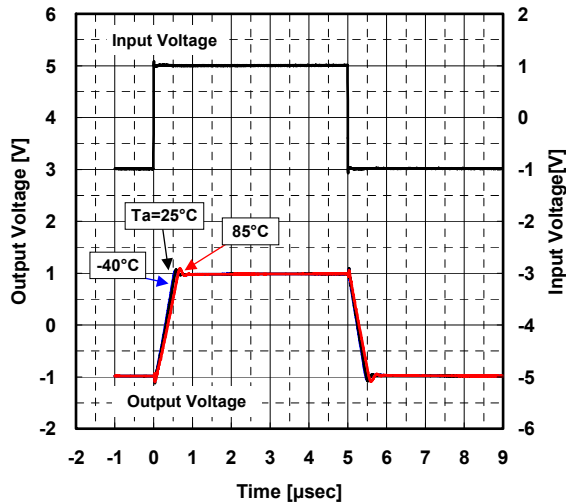
**Slew Rate vs. Temperature**

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 PulseEdge=10nsec, Gv=0dB, CL=10p, RL=2k



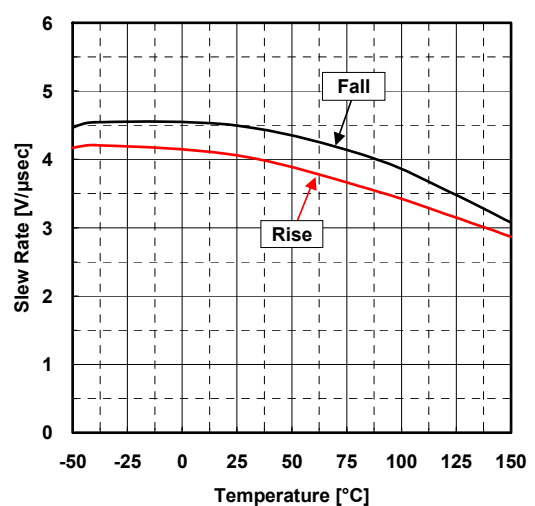
**Transient Response (Temperature)**

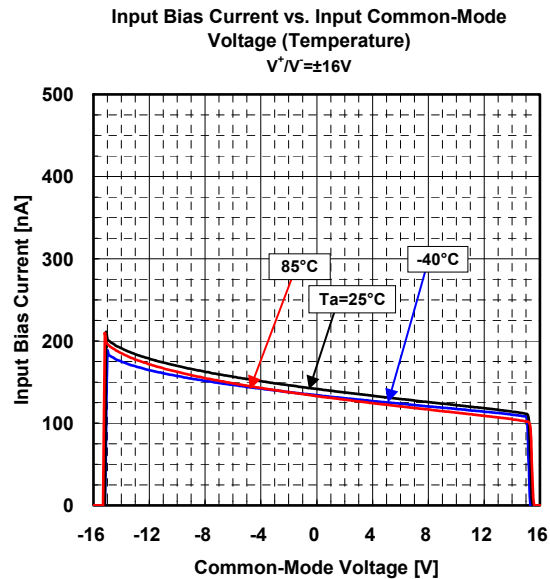
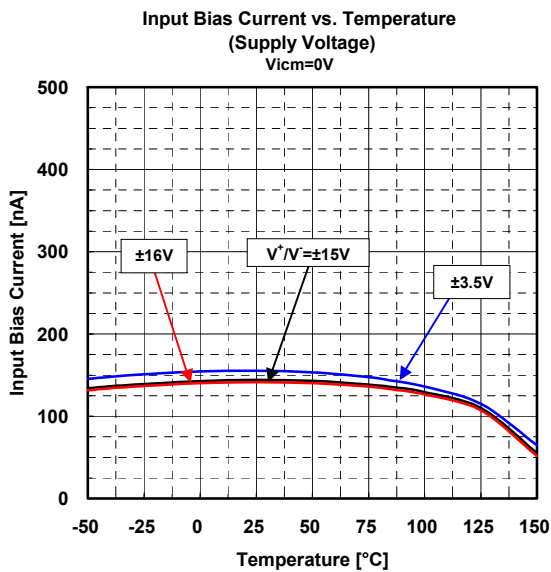
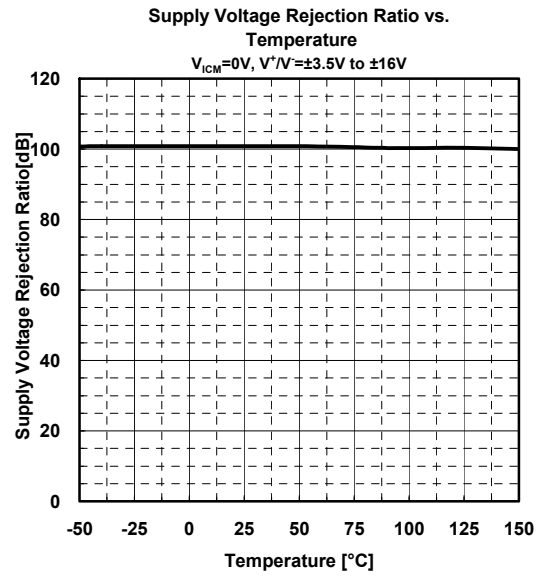
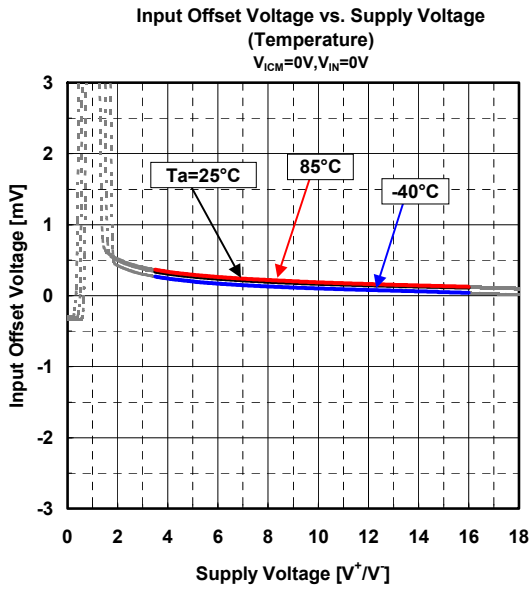
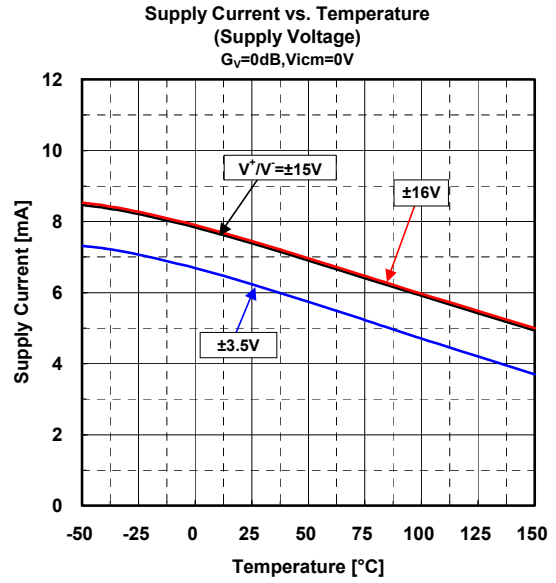
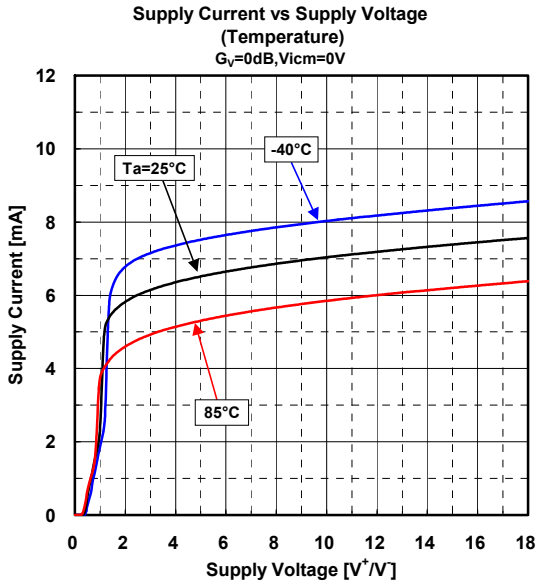
$V^+/V^- = \pm 3.5V, V_{IN} = 2V_{P-P}, f = 100kHz$   
 PulseEdge=10nsec, Gv=0dB, CL=10p, RL=2k



**Slew Rate vs. Temperature**

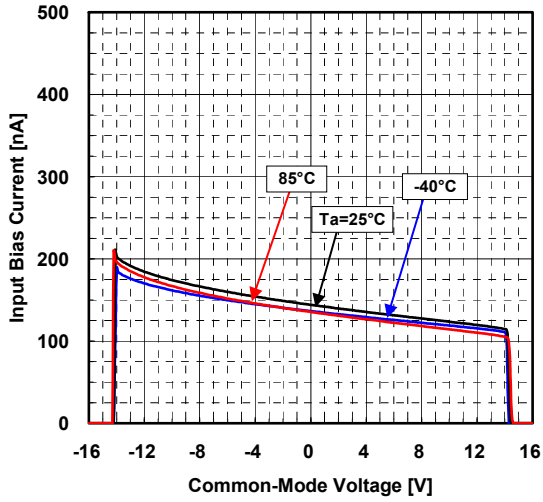
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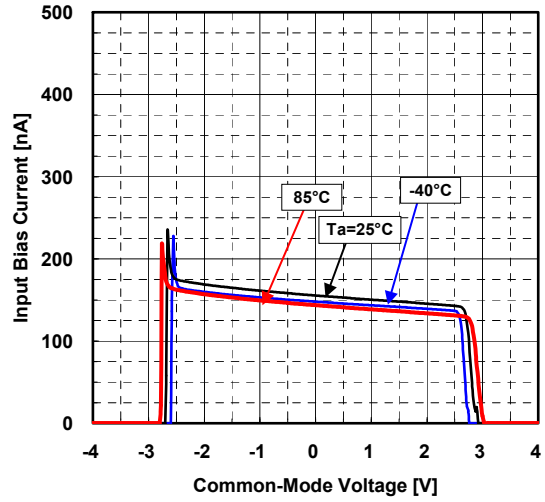




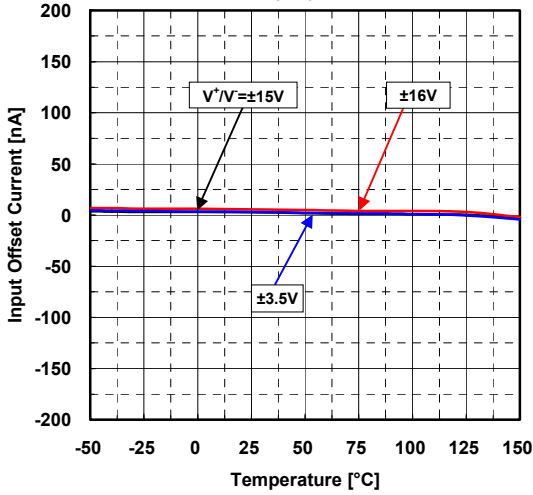
Input Bias Current vs. Input Common-Mode Voltage (Temperature)  
 $V^+/V^-\pm 15V$



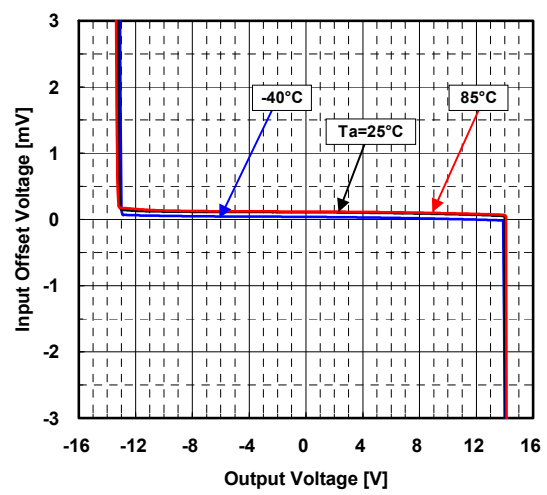
Input Bias Current vs. Input Common-Mode Voltage (Temperature)  
 $V^+/V^-\pm 3.5V$



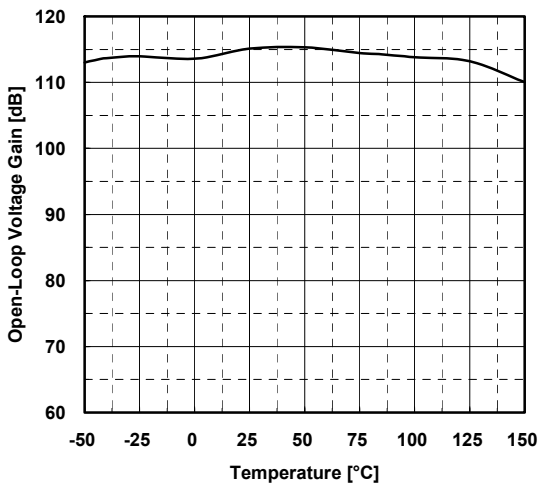
Input Offset Current vs. Temperature (Supply Voltage)  
 $V_{icm}=0V$



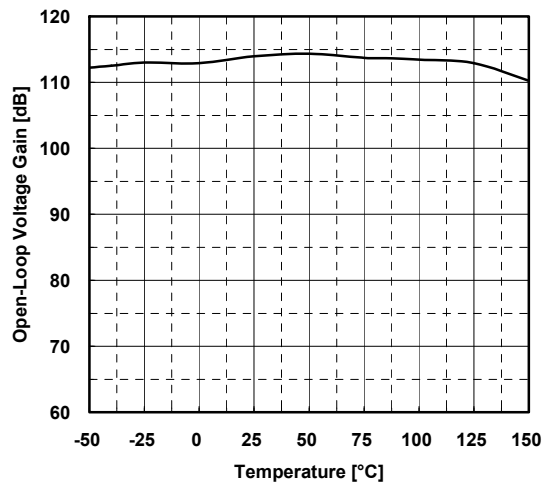
Input Offset Voltage vs. Output Voltage (Temperature)  
 $V^+/V^-\pm 15V, R_L=2k\Omega$  to  $0V$



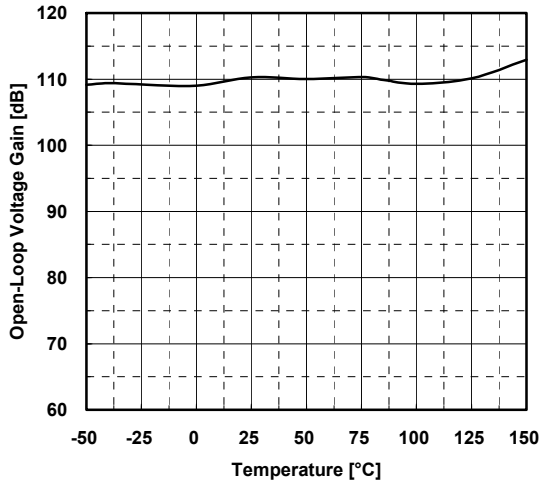
Open-Loop Voltage Gain vs. Temperature  
 $R_L=2k\Omega$  to  $0V, V^+/V^-\pm 16V, V_o=-11V$  to  $+11V$



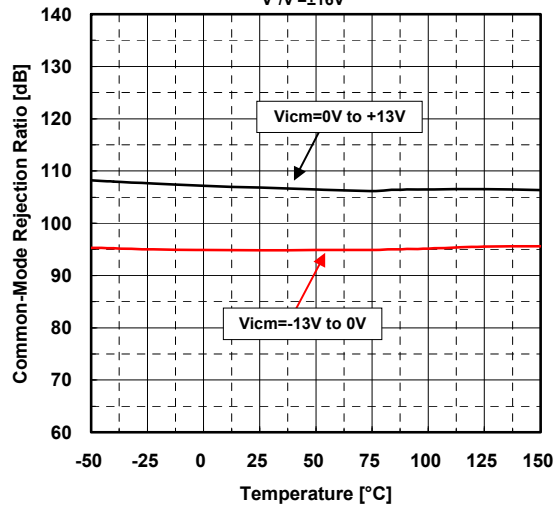
Open-Loop Voltage Gain vs. Temperature  
 $R_L=2k\Omega$  to  $0V, V^+/V^-\pm 15V, V_o=-10V$  to  $+10V$



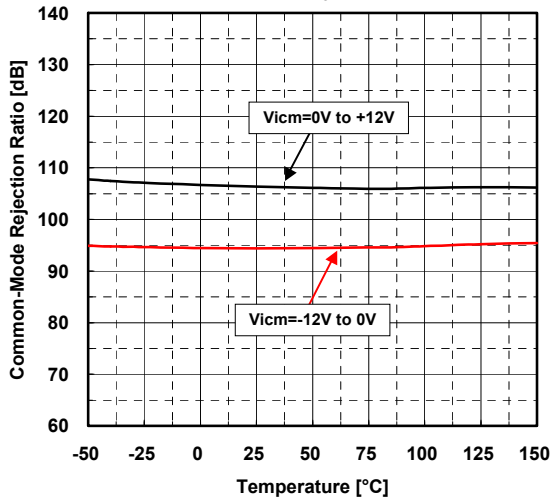
Open-Loop Voltage Gain vs. Temperature  
 $R_L=2k\Omega$  to  $0V$ ,  $V^+/V^-=\pm 3.5V$ ,  $V_o=-1V$  to  $+1V$



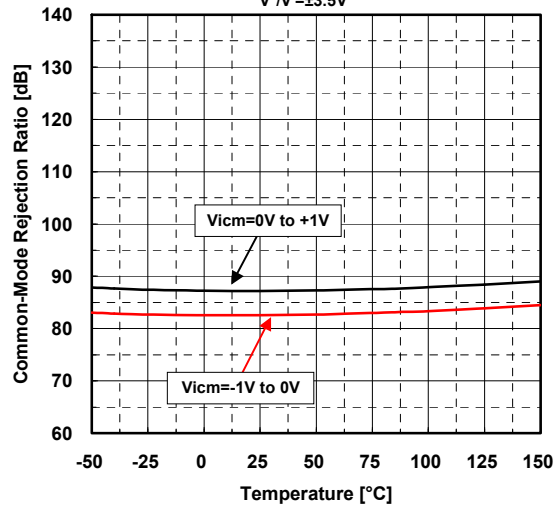
Common-Mode Rejection Ratio vs. Temperature  
 (Input Common-Mode Voltage)  
 $V^+/V^-=\pm 16V$



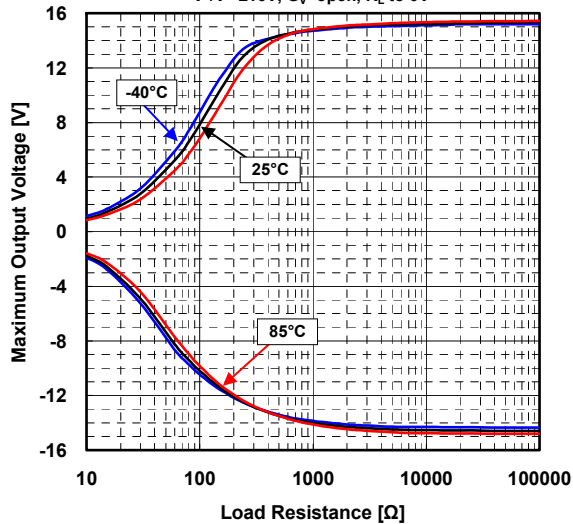
Common-Mode Rejection Ratio vs. Temperature  
 (Input Common-Mode Voltage)  
 $V^+/V^-=\pm 15V$



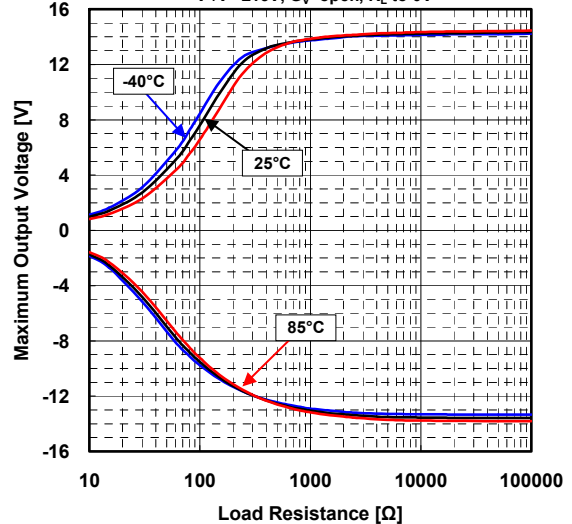
Common-Mode Rejection Ratio vs. Temperature  
 (Input Common-Mode Voltage)  
 $V^+/V^-=\pm 3.5V$

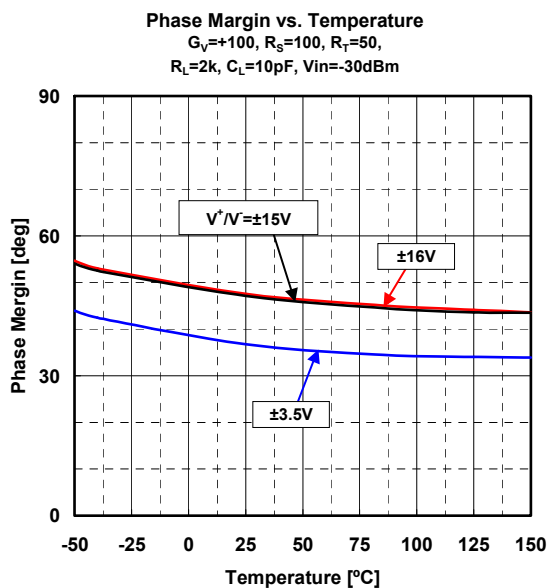
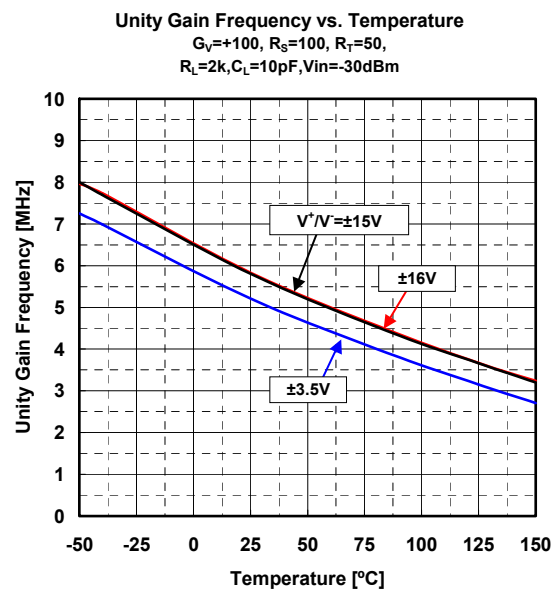
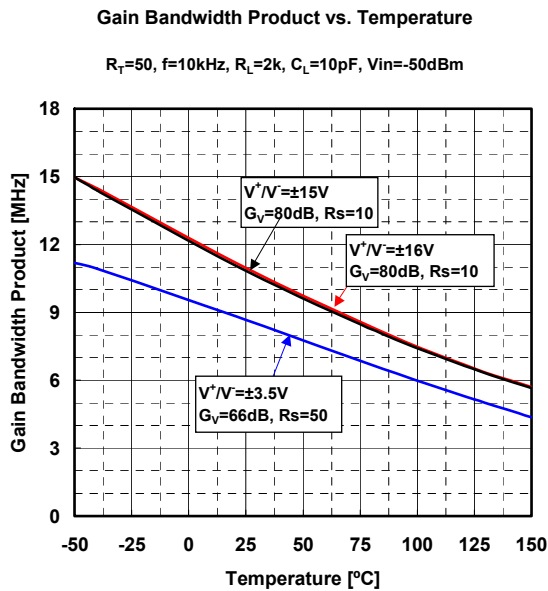
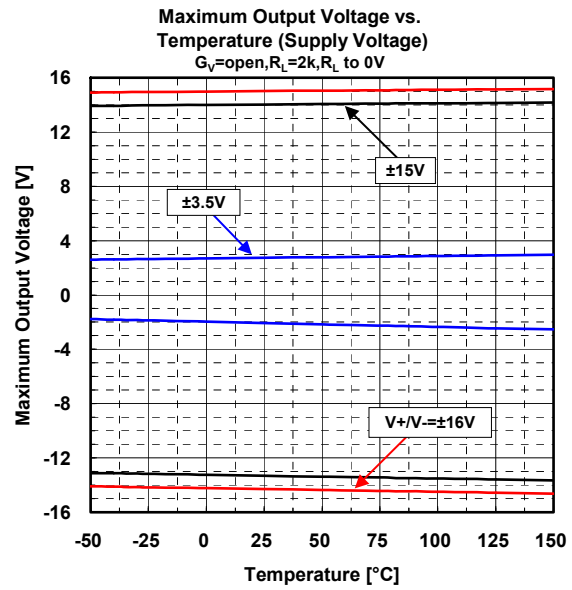
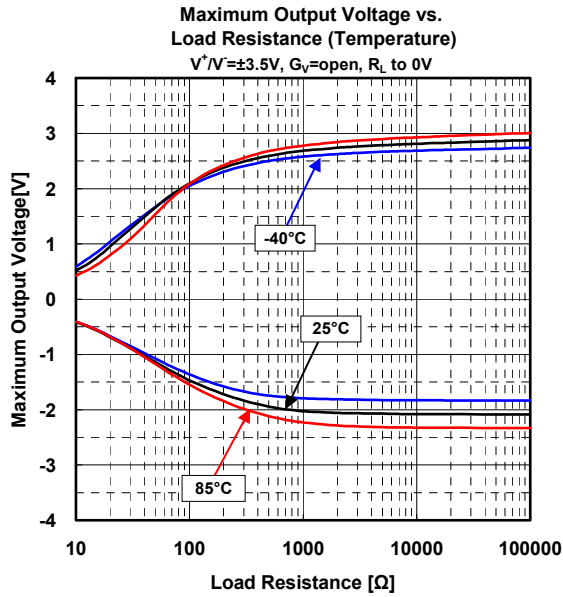


Maximum Output Voltage vs.  
 Load Resistance (Temperature)  
 $V^+/V^-=\pm 16V$ ,  $G_v=open$ ,  $R_L$  to  $0V$



Maximum Output Voltage vs.  
 Load Resistance (Temperature)  
 $V^+/V^-=\pm 15V$ ,  $G_v=open$ ,  $R_L$  to  $0V$





## MEMO

**[CAUTION]**

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