High Quality Audio, Bipolar Input, Dual Operational Amplifier

MUSES

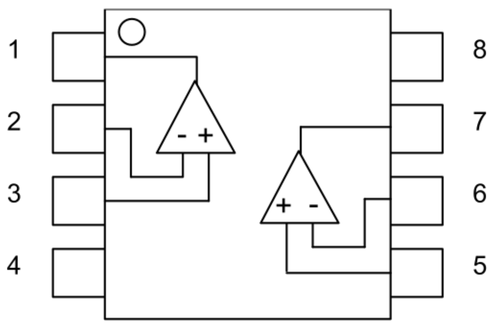
The **MUSES02** is a dual bipolar input high quality audio operational amplifier, which is optimized for high-end audio and professional audio applications with advanced circuitry and layout, unique material and assembled technology by skilled-craftwork.

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

■ FEATURES

- Operating Voltage — Vopr = ±3.5V to ±16V
- Output noise — 4.5nV/√Hz at f=1kHz
- Input Offset Voltage — 0.3mV typ. 3mV max.
- Input Bias Current — 100nA typ. 500nA max. at Ta=25°C
- Voltage Gain — 110dB typ.
- Slew Rate — 5V/µs typ.
- Bipolar Technology
- Package Outline — DIP8

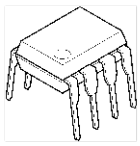
■ PIN CONFIGURATION



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



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^-=±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}	Rs≤10kΩ (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≥2kΩ, V_o=±10V Rs≤10kΩ	90	110	-	dB
Common Mode Rejection Ratio	CMR	V_{ICM}=±12V (Note4) Rs≤10kΩ	80	110	-	dB
Supply Voltage Rejection Ratio	SVR	V^+/V^-=±3.5 to ±16.0V Rs≤10kΩ (Note2, 5)	80	110	-	dB
Max Output Voltage	V_{OM}	R_L=2kΩ	±12	±13.5	-	V
Input Common Mode Voltage Range	V_{ICM}	CMR≥80dB	±12	±13.5	-	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 +12V and VICM=0V to −12V)

(Note5) SVR is calculated by specified change in offset voltage. (V+/V−=±3.5V 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	-	11	-	MHz
Unity Gain Frequency	f_T	A_V=+100, R_S=100Ω, R_L=2kΩ, C_L=10pF	-	5.8	-	MHz
Phase Margin	ϕ_M	A_V=+100, R_S=100Ω, R_L=2kΩ,C_L=10pF	-	48	-	deg
Input Noise Voltage1	V_{NI}	f=1kHz, A_V=+100, R_S=100Ω,R_L=∞	-	4.5	-	nV/√Hz
Input Noise Voltage2	V_{N2}	f=1kHz, A_V=+10 R_S =2.2kΩ, RIAA, 30kHz LPF	-	0.8	1.4	μVrms
Total Harmonic Distortion	THD	f=1kHz, A_V=+10, R_L=2kΩ, Vo=5Vrms	-	0.001	-	%
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	-	5	-	V/μs
Negative Slew Rate	-SR	A_V=1, V_{IN}=2V_{p-p}, R_L=2kΩ, C_L=10pF	-	5	-	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 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 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.

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

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 MUSES02 is obtained using following equation.

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

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.

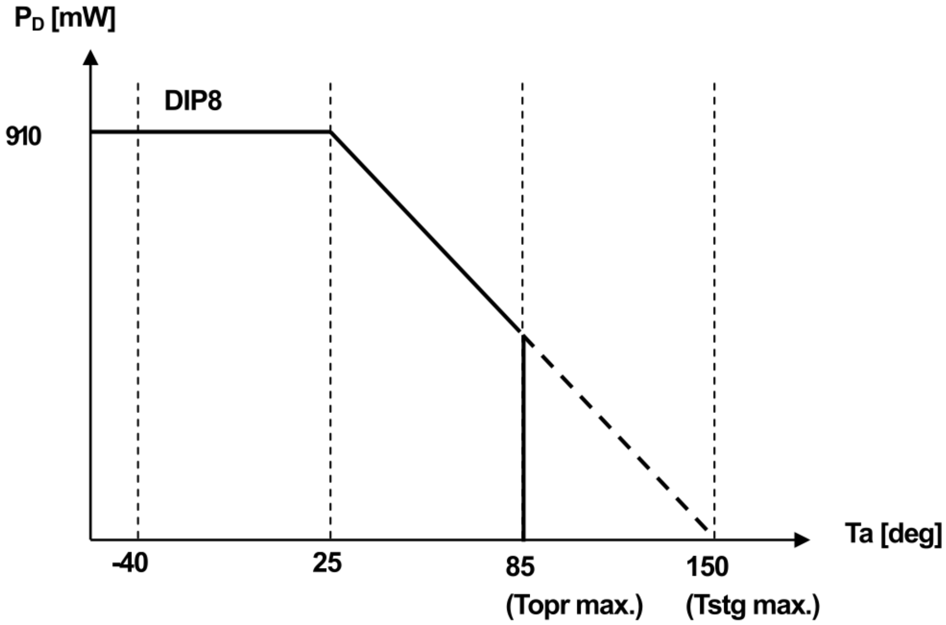
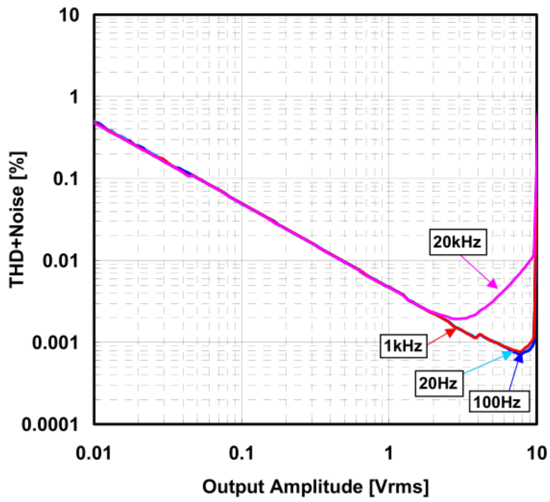


Fig.1 Power Dissipations vs. Ambient Temperature on the MUSES02

■ TYPICAL CHARACTERISTICS

Total Harmonic Distortion + Noise vs. Output Amplitude (Frequency)

V^+/V^-=±16V,Av=+10, R_G=1k,R_F=9.1k, R_L=2k,Ta=25ºC



Total Harmonic Distortion + Noise vs. Output Amplitude (Frequency)

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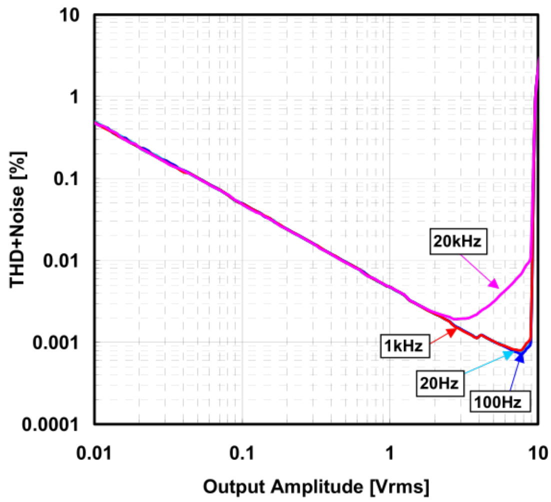
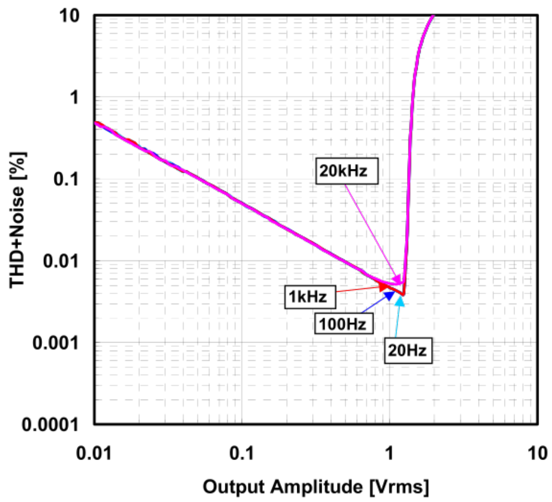


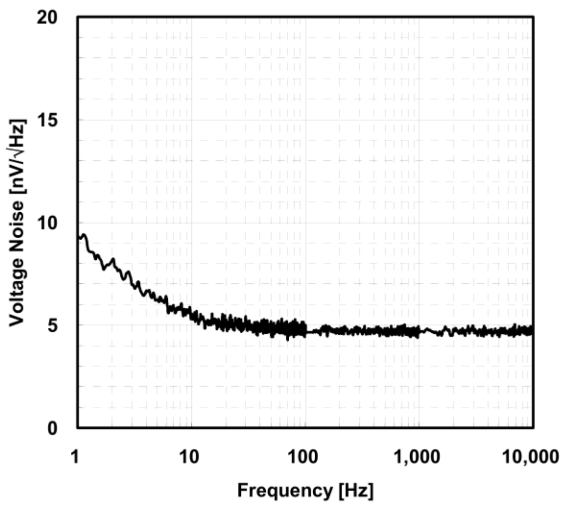
Total Harmonic Distortion + Noise vs. Output Amplitude (Frequency)

V^+/V^-=±3.5V,Av=+10, R_G=1k,R_F=9.1k, R_L=2k,Ta=25ºC



Equivalent Input Voltage Noise vs. Frequency

V^+/V^-=±16V,A_V=+100,R_S=100Ω,R_L=∞,Ta=25ºC



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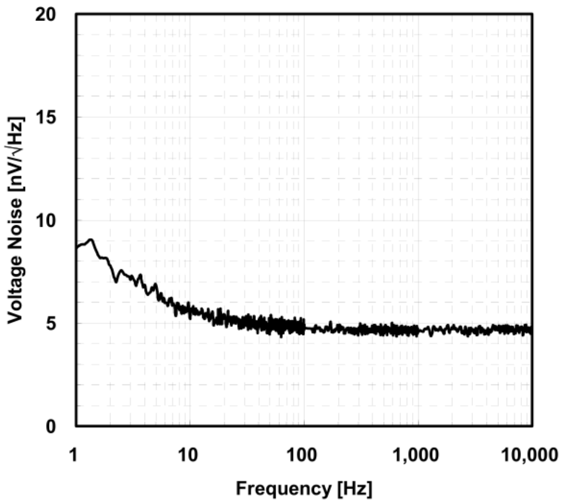

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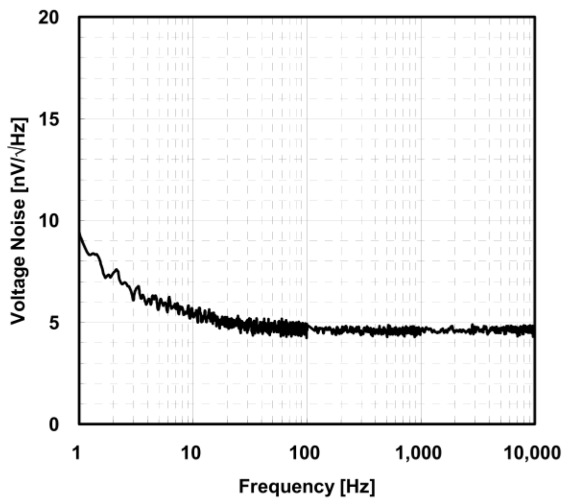
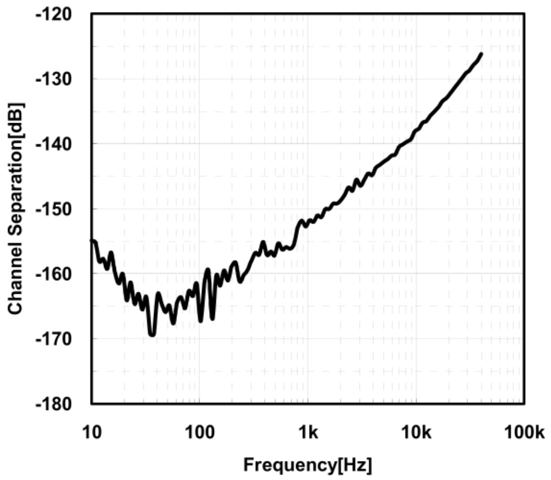


Channel Separation vs. Frequency

V+/V-=±16V,AV=-100,RS=1k,RL=2k,Vo=1Vrms, Ta=25ºC



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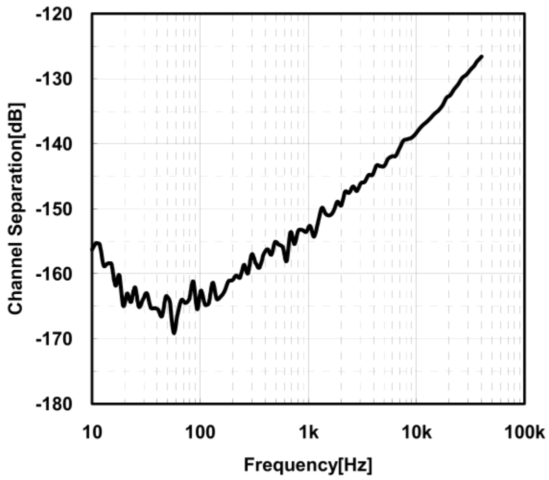
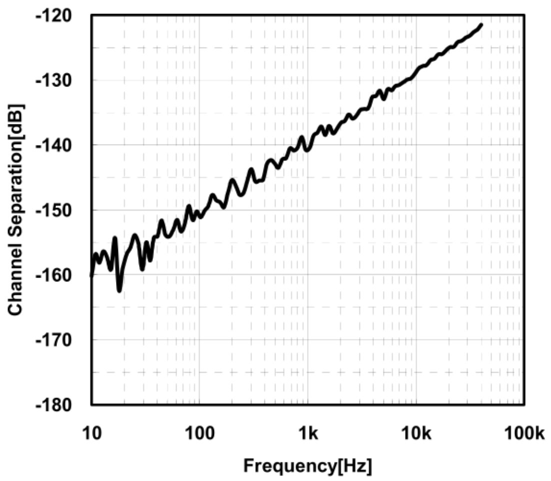


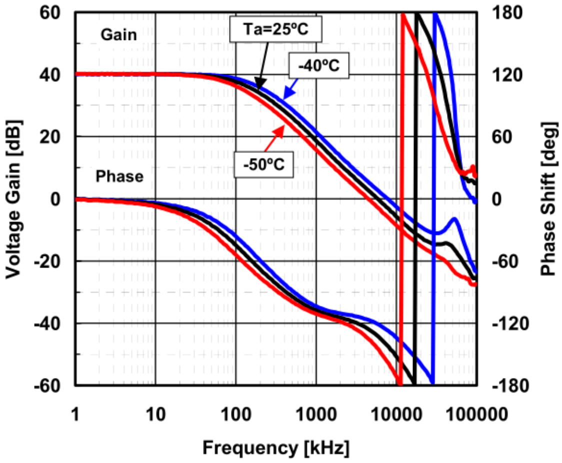
Channel Separation vs. Frequency

V+/V-=±3.5V,AV=-100,RS=1k,RL=2k,Vo=1Vrms, Ta=25ºC



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

V+/V-=±16V, AV=+100, RS=100, RT=50, RL=2k,CL=10p
VIN=-30dBm,Vicm=0V



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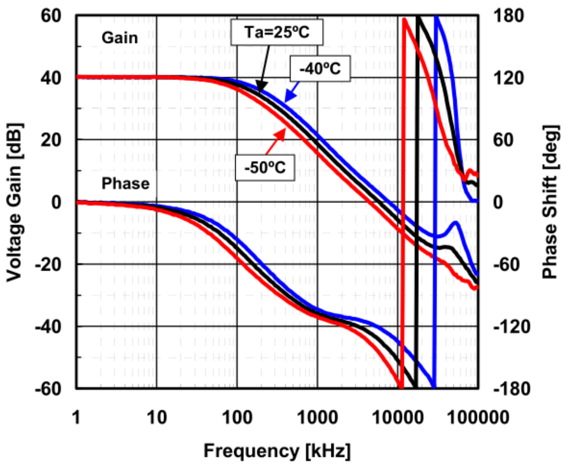

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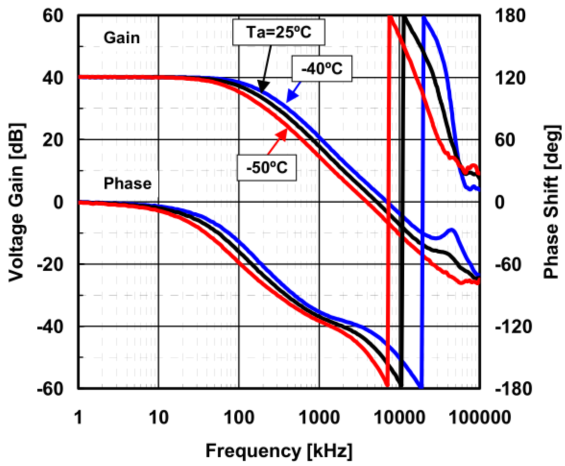
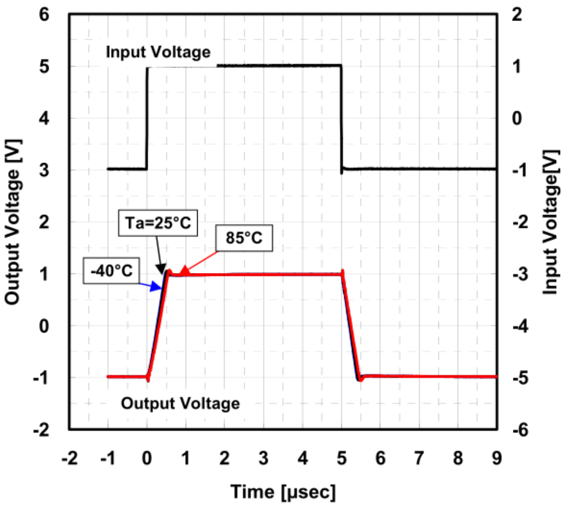
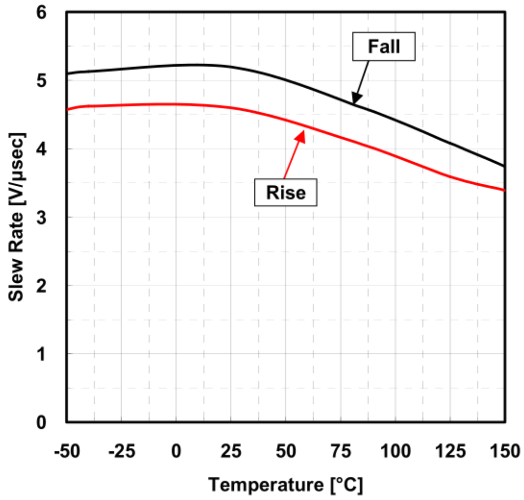


Transient Response (Temperature)
V+/V-=±16V,VIN=2VP-P,f=100kHz
PulseEdge=10nsec,Gv=0dB,CL=10p,RL=2k



Slew Rate vs. Temperature
V^{+}/V^{-}=±16V,V_{IN}=2V_{P-P},f=100kHz
PulseEdge=10nsec,Gv=0dB,C_L=10p,R_L=2k



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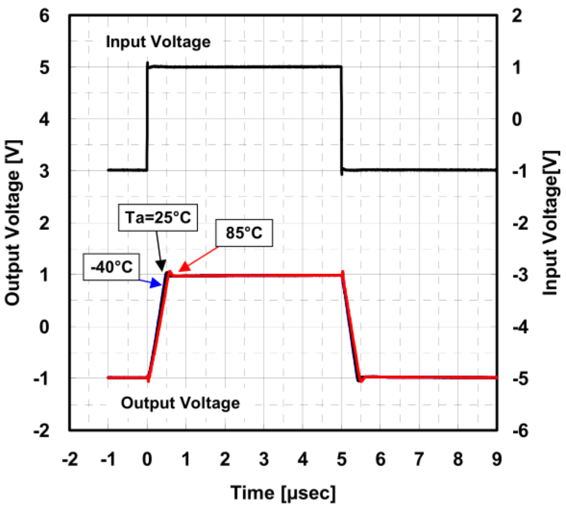

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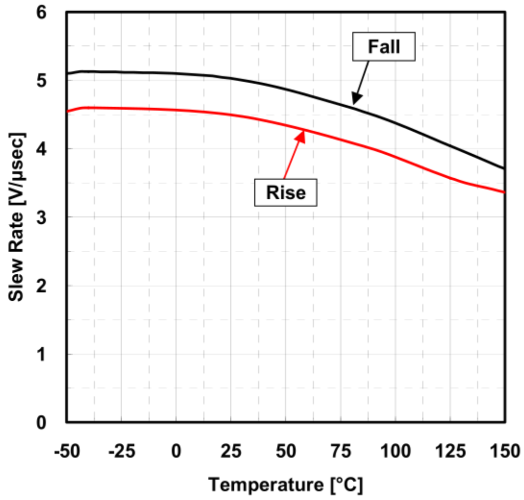
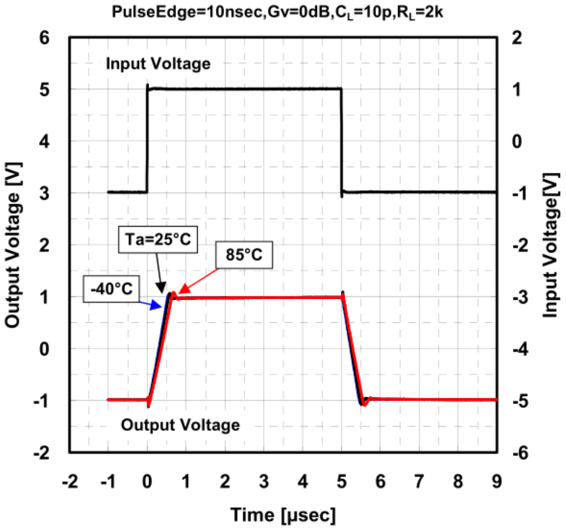
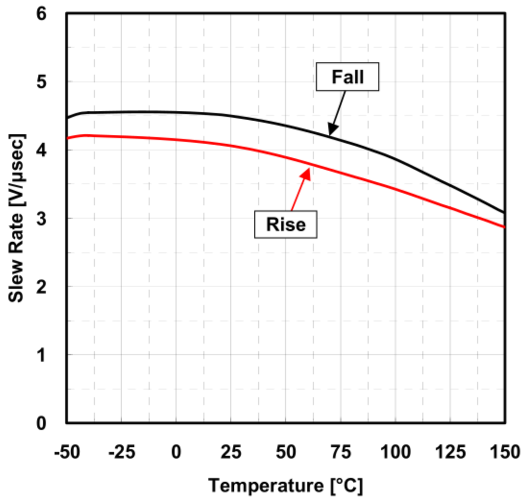


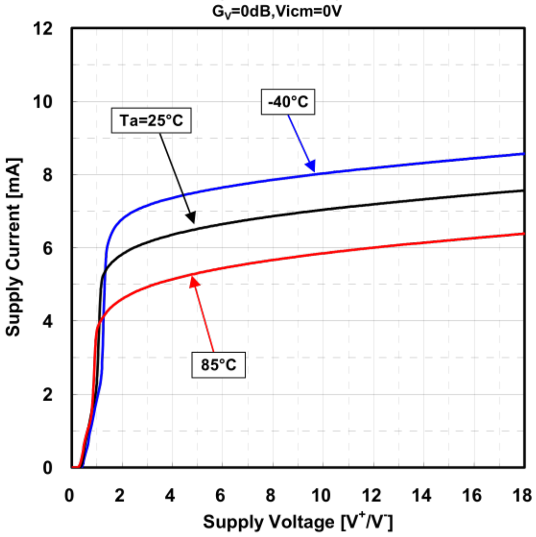
Transient Response (Temperature)
V^{+}/V^{-}=±3.5V,V_{IN}=2V_{P-P},f=100kHz
PulseEdge=10nsec,Gv=0dB,C_L=10p,R_L=2k



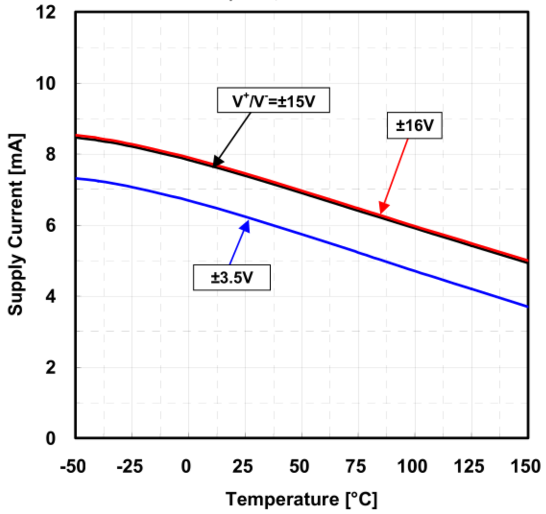
Slew Rate vs. Temperature
V^{+}/V^{-}=±3.5V,V_{IN}=2V_{P-P},f=100kHz
PulseEdge=10nsec,Gv=0dB,C_L=10p,R_L=2k



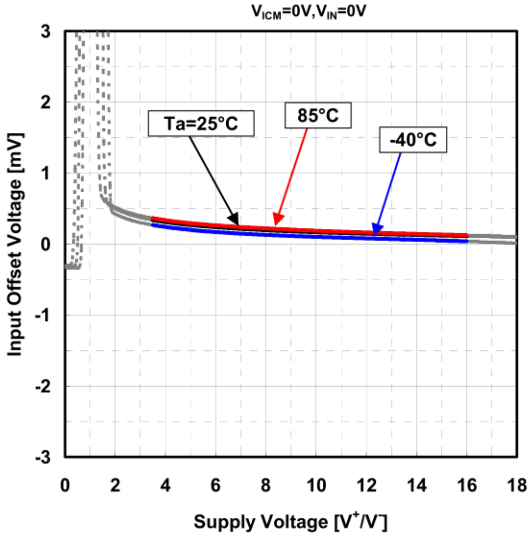
Supply Current vs Supply Voltage (Temperature)
G_V=0dB,Vicm=0V



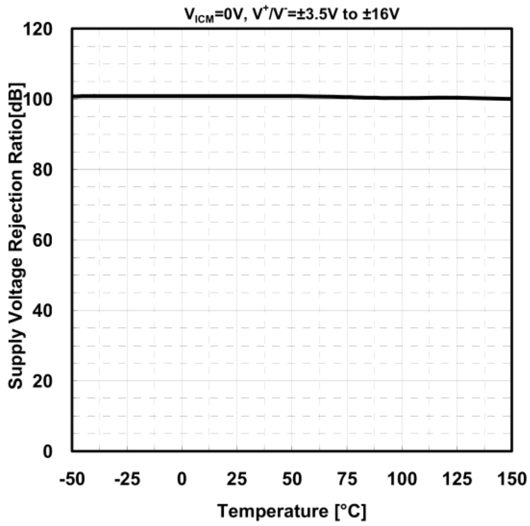
Supply Current vs. Temperature (Supply Voltage)
G_V=0dB,Vicm=0V



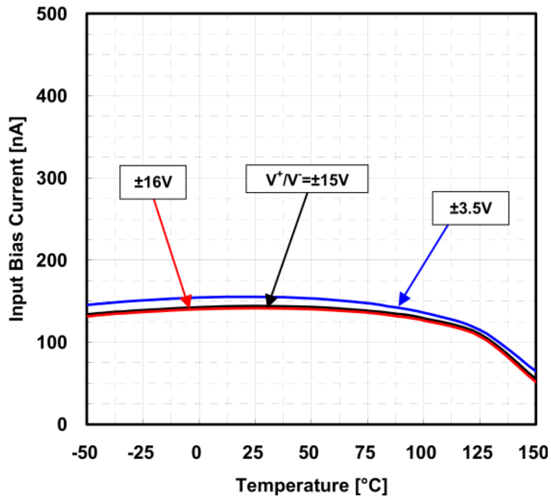
Input Offset Voltage vs. Supply Voltage (Temperature)
V_{ICM}=0V,V_{IN}=0V



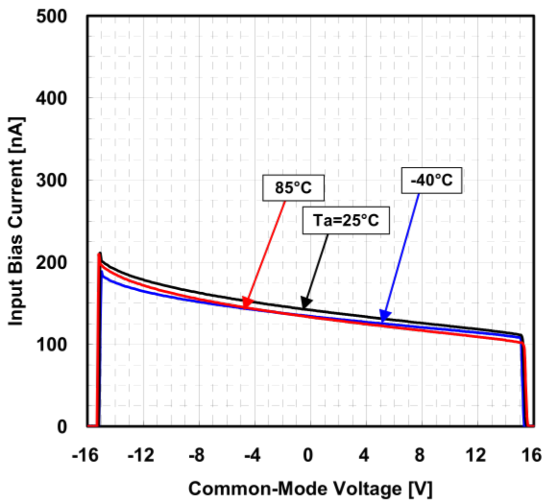
Supply Voltage Rejection Ratio vs. Temperature
V_{ICM}=0V, V^+/V^-=±3.5V to ±16V



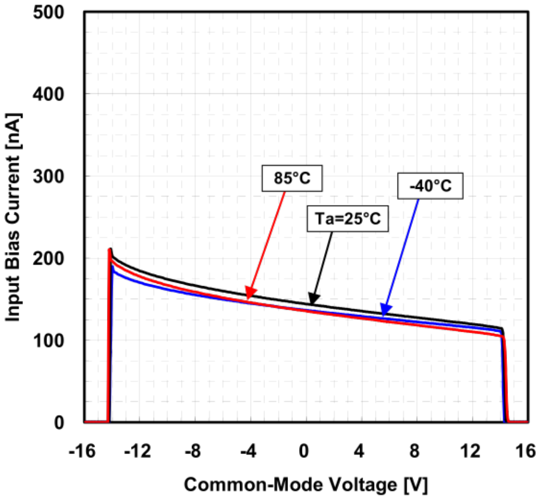
Input Bias Current vs. Temperature (Supply Voltage)
Vicm=0V



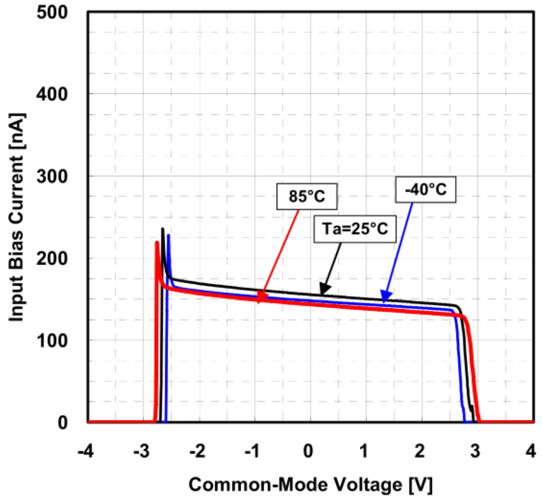
Input Bias Current vs. Input Common-Mode Voltage (Temperature)
V^+/V^-=±16V



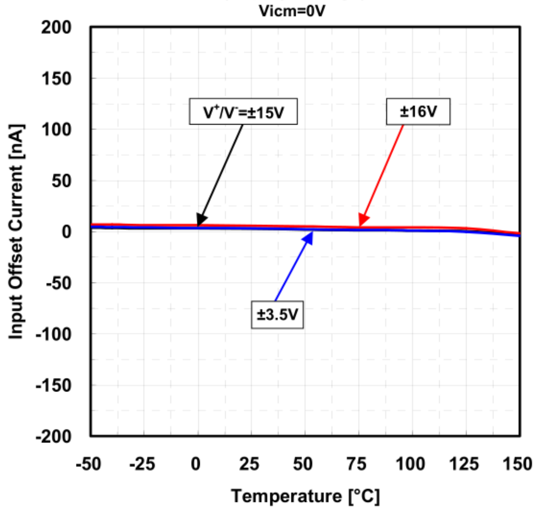
Input Bias Current vs. Input Common-Mode Voltage (Temperature)
V^+/V^-=±15V



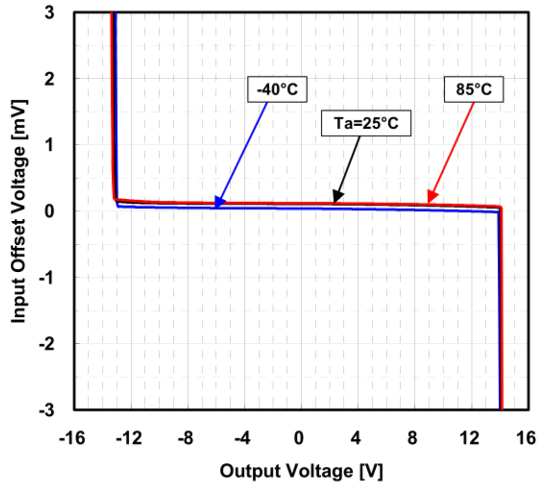
Input Bias Current vs. Input Common-Mode Voltage (Temperature)
V^+/V^-=±3.5V



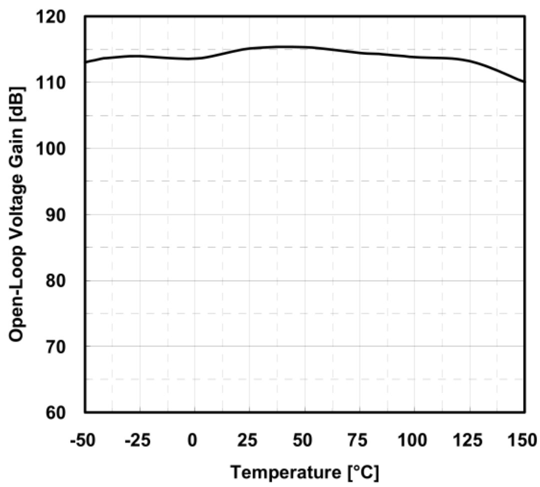
Input Offset Current vs. Temperature (Supply Voltage)
Vicm=0V



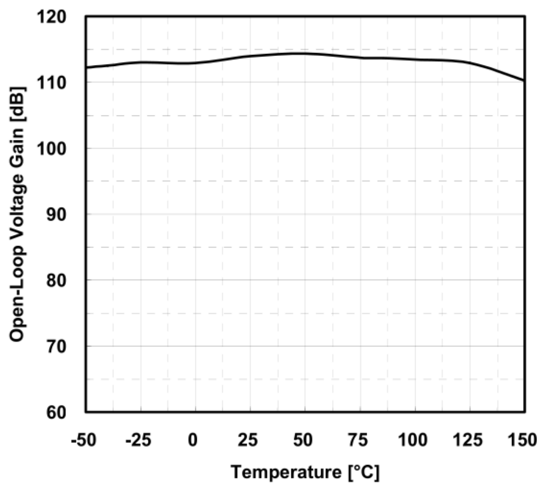
Input Offset Voltage vs. Output Voltage (Temperature)
V^+/V^-=±15V, R_L=2kΩ to 0V

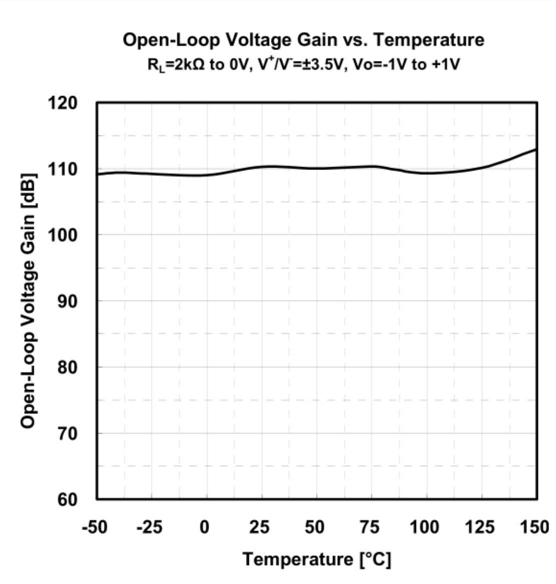


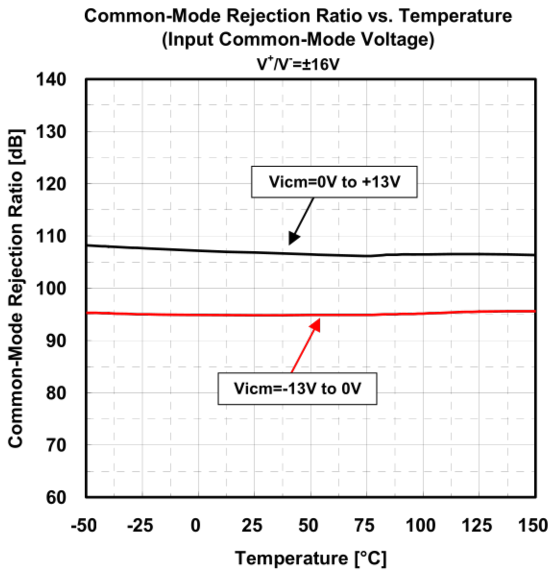
Open-Loop Voltage Gain vs. Temperature
R_L=2kΩ to 0V, V^+/V^-=±16V, Vo=-11V to +11V

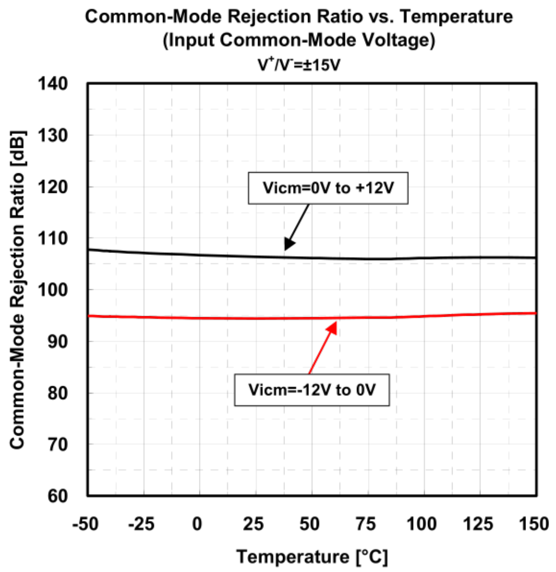


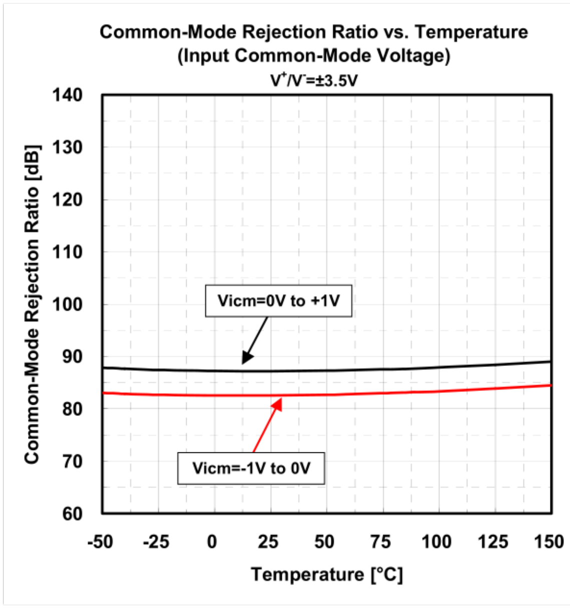
Open-Loop Voltage Gain vs. Temperature
R_L=2kΩ to 0V, V^+/V^-=±15V, Vo=-10V to +10V

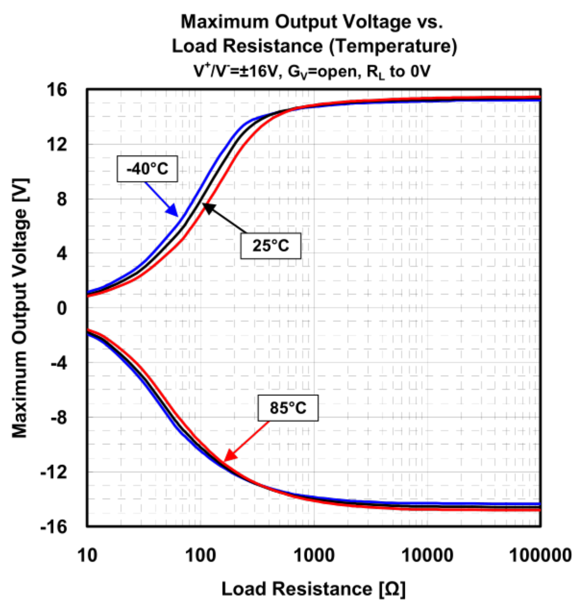


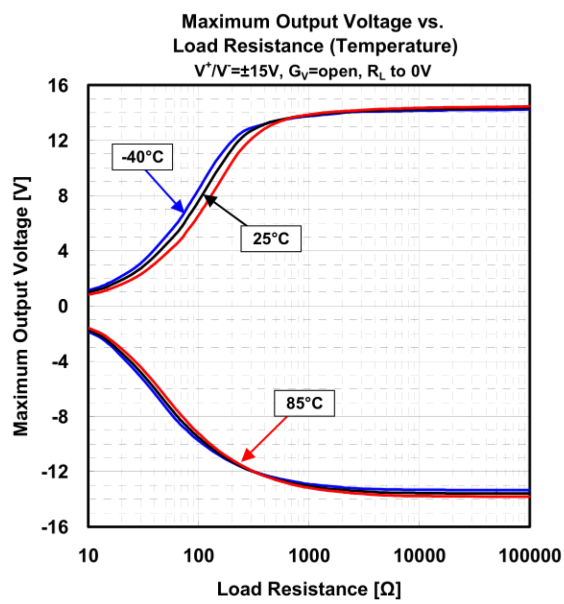

Open-Loop Voltage Gain vs. Temperature
RL=2kΩ to 0V, V+/V-=±3.5V, Vo=-1V to +1V
Open-Loop Voltage Gain [dB]
Temperature [°C]
120
110
100
90
80
70
60
-50
-25
0
25
50
75
100
125
150

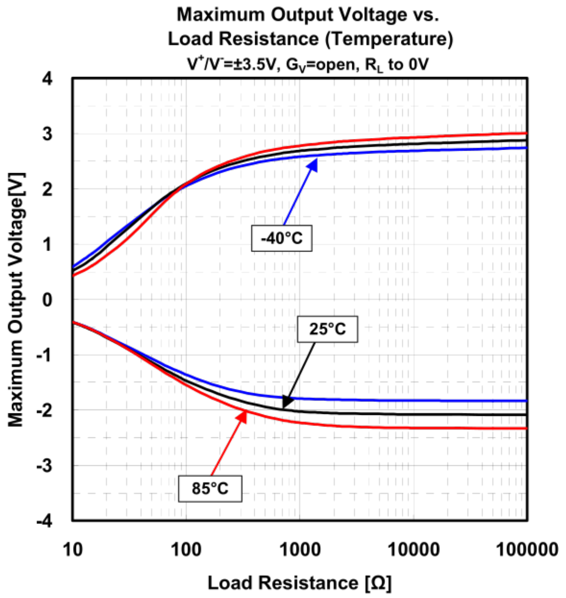

Common-Mode Rejection Ratio vs. Temperature
(Input Common-Mode Voltage)
V+/V-=±16V
Common-Mode Rejection Ratio [dB]
Temperature [°C]
Vicm=0V to +13V
Vicm=-13V to 0V

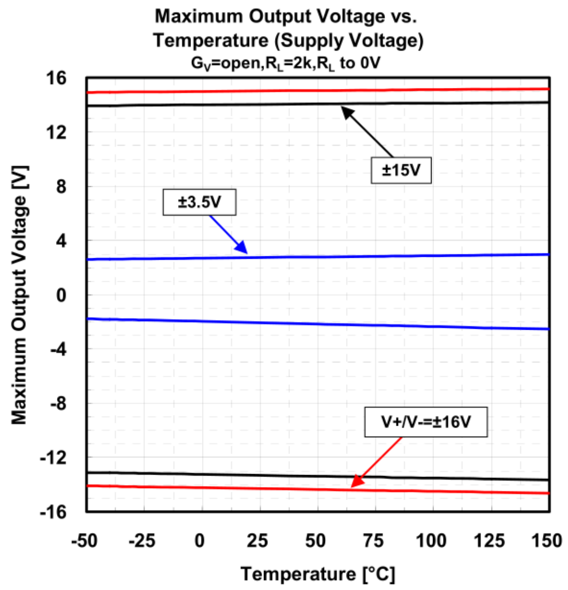

Common-Mode Rejection Ratio vs. Temperature
(Input Common-Mode Voltage)
V+/V-=±15V
Common-Mode Rejection Ratio [dB]
Temperature [°C]
Vicm=0V to +12V
Vicm=-12V to 0V

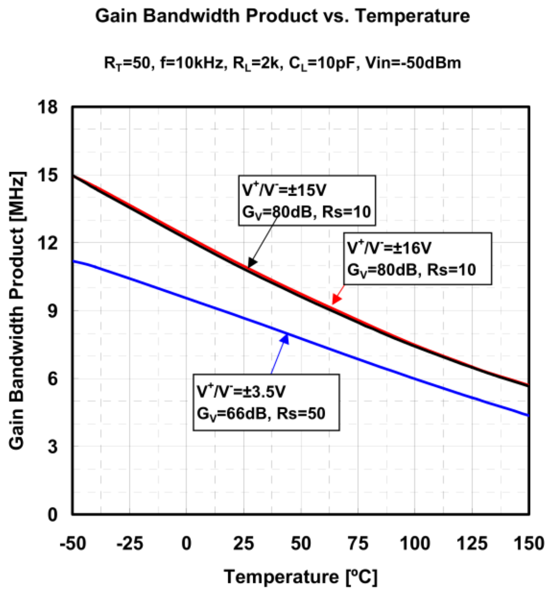

Common-Mode Rejection Ratio vs. Temperature
(Input Common-Mode Voltage)
V+/V-=±3.5V
Common-Mode Rejection Ratio [dB]
Temperature [°C]
Vicm=0V to +1V
Vicm=-1V to 0V

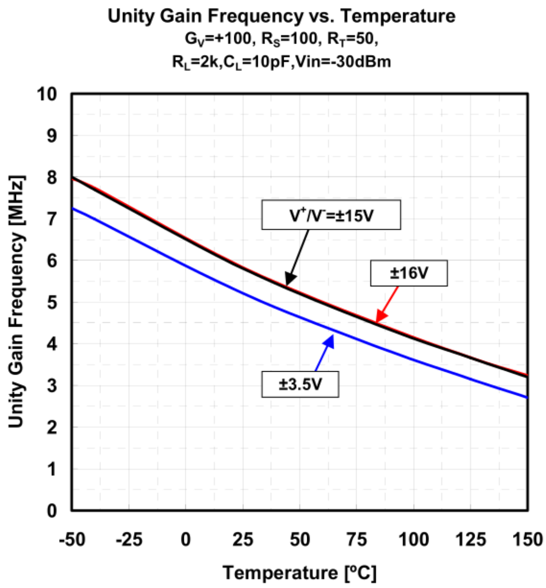

Maximum Output Voltage vs.
Load Resistance (Temperature)
V+/V-=±16V, GV=open, RL to 0V
Maximum Output Voltage [V]
Load Resistance [Ω]
-40°C
25°C
85°C
10
100
1000
10000
100000

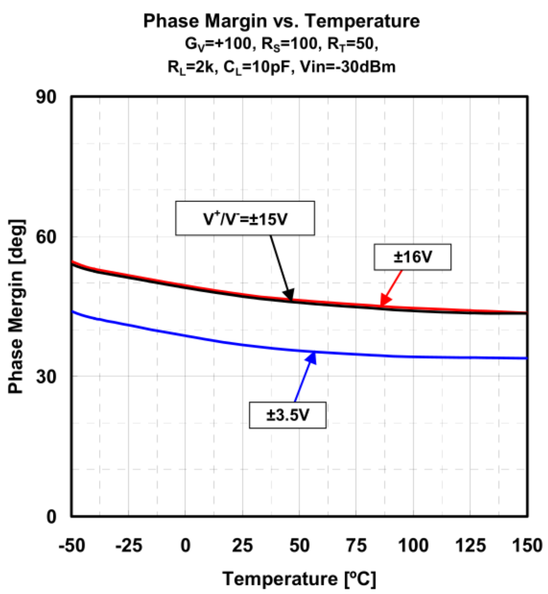

Maximum Output Voltage vs.
Load Resistance (Temperature)
V+/V-=±15V, GV=open, RL to 0V
Maximum Output Voltage [V]
Load Resistance [Ω]
-40°C
25°C
85°C
10
100
1000
10000
100000


Maximum Output Voltage vs.
Load Resistance (Temperature)
V+/V-=±3.5V, GV=open, RL to 0V
Maximum Output Voltage[V]
Load Resistance [Ω]
-40°C
25°C
85°C
4
3
2
1
0
-1
-2
-3
-4
10
100
1000
10000
100000


Maximum Output Voltage vs.
Temperature (Supply Voltage)
GV=open,RL=2k,RL to 0V
Maximum Output Voltage [V]
Temperature [°C]
±15V
±3.5V
V+/V-=±16V
16
12
8
4
0
-4
-8
-12
-16
-50
-25
0
25
50
75
100
125
150


Gain Bandwidth Product vs. Temperature
RT=50, f=10kHz, RL=2k, CL=10pF, Vin=-50dBm
Gain Bandwidth Product [MHz]
Temperature [ºC]
V+/V-=±15V
GV=80dB, Rs=10
V+/V-=±16V
GV=80dB, Rs=10
V+/V-=±3.5V
GV=66dB, Rs=50
18
15
12
9
6
3
0
-50
-25
0
25
50
75
100
125
150


Unity Gain Frequency vs. Temperature
GV=+100, RS=100, RT=50,
RL=2k,CL=10pF,Vin=-30dBm
Unity Gain Frequency [MHz]
Temperature [ºC]
V+/V-=±15V
±16V
±3.5V
10
9
8
7
6
5
4
3
2
1
0
-50
-25
0
25
50
75
100
125
150


Phase Margin vs. Temperature
GV=+100, RS=100, RT=50,
RL=2k, CL=10pF, Vin=-30dBm
Phase Mergin [deg]
Temperature [ºC]
V+/V-=±15V
±16V
±3.5V
90
60
30
0
-50
-25
0
25
50
75
100
125
150

MEMO