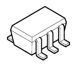
Low Noise C-MOS Single Operational Amplifier with Output Full-Swing

■ GENERAL DESCRIPTION

The NJU7009 is single CMOS operational amplifier that feature low noise as 10nV/√Hz typ. @ f=1kHz, low operating voltage.

FET input devices provide very low input bias current and suitable for applications uses current signal such as accelerometers, shock sensors and photodiode amplifiers.

■PACKAGE OUTLINE



NJU7009F3

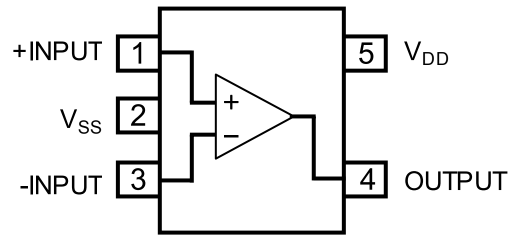
■ FEATURES

- ●Input-Referred Voltage Noise: 10nV/√Hz Typ. @ f=1kHz; 3μVrms max. @ f=20Hz~20kHz
- ●Input Bias Current: 1pA Typ. @ Ta=25°C
- ●Unity Gain Band Width: f_T=3MHz Typ.
- ●Slew Rate: 1V/μs Typ. @ R_L=50kΩ
- ●Output Full Swing
- ●Operating Voltage: 2.2V to 5.5V
- ●CMOS Technology
- ●Small Package: SC88A [F3 Type] (SC70-5)

■ Application

- ●Shock sensors, Accelerometers
- ●Charge amplifiers
- ●Photodiode amplifiers
- ●Low noise signal processing applications
- ●Microphone amplifiers

■ PIN CONFIGURATION



SC88A [Top View]

■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{DD}	7	V
Common Mode Input Voltage Range	V_{ICM}	-0.3 to 7 (Note 1)	V
Differential Input Voltage Range	V_{ID}	±7 (Note 1)	V
Power Dissipation	P_D	280 [SC88A] (Note 2)	mW
Operating Temperature Range	T_{opr}	-40 to +85	°C
Storage Temperature Range	T_{stg}	-55 to +125	°C

(Note 1) For supply voltage less than 7V, the absolute maximum input voltage is equal to the supply voltage.

(Note 2) On the PCB " EIA/JEDEC (76.2x114.3x1.6mm, two layers, FR-4) "

■ OPERATING VOLTAGE (Ta=25°C)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{DD}	2.2 to 5.5	V

■ ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS (V_{DD}=5V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I_{DD}	No Signal Apply	-	450	600	µA
Input Offset Voltage	V_{IO}		-	2	5	mV
Input Offset Voltage Drift	$\Delta V_{io}/\Delta T$	$V_{IN}=V_{DD}/2$ Ta=-40°C~+85°C	-	2	-	µV/deg
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Large Signal Voltage Gain	A_V	R_L=50kΩ to 2.5V, V_O=2.5V±2V	65	80	-	dB
Common Mode Rejection Ratio1	CMR1	V_{ICM}=0V~4.1V	65	80	-	dB
Common Mode Rejection Ratio2	CMR2	V_{ICM}=0V~0.2V	60	80	-	dB
Supply Voltage Rejection Ratio	SVR	2.2V ≤ V_{DD} ≤ 5.5V	65	80	-	dB
Output Voltage1	$V_{OH}1$	R_L=50kΩ to 2.5V	4.9	-	-	V
	$V_{OL}1$	R_L=50kΩ to 2.5V	-	-	0.1	V
Output Voltage2	$V_{OH}2$	R_L=10kΩ to 2.5V	4.5	-	-	V
	$V_{OL}2$	R_L=10kΩ to 2.5V	-	-	0.2	V
Input Common Mode Voltage Range	V_{ICM}	CMR ≥ 65dB	0	-	4.1	V

●AC CHARACTERISTICS (V_{DD}=5V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Frequency	f_T	G_V=40dB, C_L=10pF, R_L=50kΩ to 2.5V	-	3	-	MHz
Equivalent Input Noise Voltage	V_{NI}	f=1kHz, G_V=40dB, R_L=50kΩ to 2.5V	-	10	-	nV/√Hz
	V_{NIrms}	R_L=50kΩ to 2.5V, G_V=40dB, BPW=20Hz ~ 20kHz	-	1.7	3	µVrms
Total Harmonic Distortion	THD	G_V=20dB, R_L=50kΩ to 2.5V, fin=1kHz, Vout=3Vpp, BPW=400Hz ~ 80kHz	-	0.01	-	%

●TRANSIENT CHARACTERISTICS (V_{DD}=5V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	G_V=0dB, C_L=15pF, R_T=50Ω to 2.5V, R_L=50kΩ to 2.5V	-	1	-	V/µs

■ ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS (V_{DD}=3V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I_{DD}	No Signal Apply	-	330	500	μA
Input Offset Voltage	V_{IO}		-	2	5	mV
Input Offset Voltage Drift	$\Delta V_{io}/\Delta T$	$V_{IN}=V_{DD}/2$ Ta=-40˚C~+85˚C	-	2	-	μV/deg
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Large Signal Voltage Gain	A_V	R_L=50kΩ to 1.5V, V_O=1.5V±1V	65	80	-	dB
Common Mode Rejection Ratio1	CMR1	V_{ICM}=0V~2.1V	65	80	-	dB
Common Mode Rejection Ratio2	CMR2	V_{ICM}=0V~0.2V	60	80	-	dB
Supply Voltage Rejection Ratio	SVR	2.2V ≤ V_{DD} ≤ 5.5V	65	80	-	dB
Output Voltage1	V_{OH}1	R_L=50kΩ to 1.5V	2.9	-	-	V
	V_{OL}1	R_L=50kΩ to 1.5V	-	-	0.1	V
Input Common Mode Voltage Range	V_{ICM}	CMR ≥ 65dB	0	-	2.1	V

●AC CHARACTERISTICS (V_{DD}=3V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Frequency	f_T	G_V=40dB, C_L=10pF, R_L=50kΩ to 1.5V	-	3	-	MHz
Equivalent Input Noise Voltage	V_{NI}	f=1kHz, G_V=40dB, R_L=50kΩ to 1.5V	-	10	-	nV/√Hz
	V_{NIrms}	R_L=50kΩ to 1.5V, G_V=40dB, BPW=20Hz ~ 20kHz	-	1.7	3.0	μVrms
Total Harmonic Distortion	THD	G_V=20dB, R_L=50kΩ to 1.5V, fin=1kHz, Vout=1Vpp, BPW=400Hz ~ 80kHz	-	0.02	-	%

●TRANSIENT CHARACTERISTICS (V_{DD}=3V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	G_V=0dB, C_L=15pF, R_T=50Ω to 1.5V, R_L=50kΩ to 1.5V	-	1	-	V/μs

■ ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS (V_{DD}=2.2V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I_{DD}	No Signal Apply	-	300	470	μA
Input Offset Voltage	V_{IO}		-	2	5	mV
Input Offset Voltage Drift	$\Delta V_{io}/\Delta T$	$V_{IN}=V_{DD}/2$ Ta=-40°C~+85°C	-	2	-	μV/deg
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Large Signal Voltage Gain	A_V	R_L=50kΩ to 1.1V, V_O=1.1V±0.5V	60	80	-	dB
Common Mode Rejection Ratio1	CMR1	V_{ICM}=0V~1.3V	60	80	-	dB
Common Mode Rejection Ratio2	CMR2	V_{ICM}=0V~0.2V	60	80	-	dB
Supply Voltage Rejection Ratio	SVR	2.2V ≤ V_{DD} ≤ 5.5V	65	80	-	dB
Output Voltage1	$V_{OH}1$	R_L=50kΩ to 1.1V	2.1	-	-	V
	$V_{OL}1$	R_L=50kΩ to 1.1V	-	-	0.1	V
Input Common Mode Voltage Range	V_{ICM}	CMR ≥ 60dB	0	-	1.3	V

●AC CHARACTERISTICS (V_{DD}=2.2V, Ta=25°C)

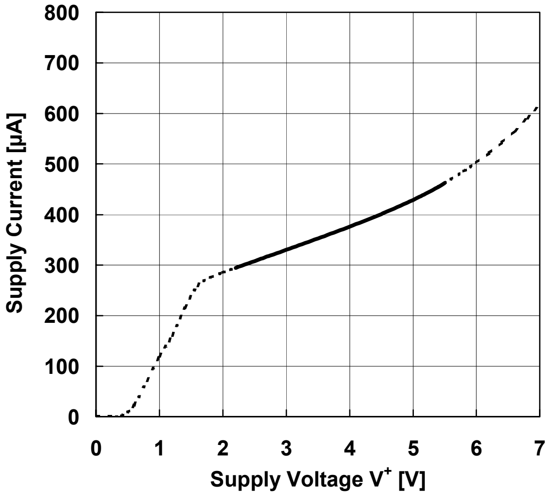
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Frequency	f_T	G_V=40dB, C_L=10pF, R_L=50kΩ to 1.1V	-	3	-	MHz
Equivalent Input Noise Voltage	V_{NI}	f=1kHz, G_V=40dB, R_L=50kΩ to 1.1V	-	10	-	nV/√Hz
	V_{NIrms}	R_L=50kΩ to 1.1V, G_V=40dB, BPW=20Hz ~ 20kHz	-	1.7	3.0	μVrms
Total Harmonic Distortion	THD	G_V=20dB, R_L=50kΩ to 1.1V, fin=1kHz, Vout=0.5Vpp, BPW=400Hz ~ 80kHz	-	0.02	-	%

●TRANSIENT CHARACTERISTICS (V_{DD}=2.2V, Ta=25°C)

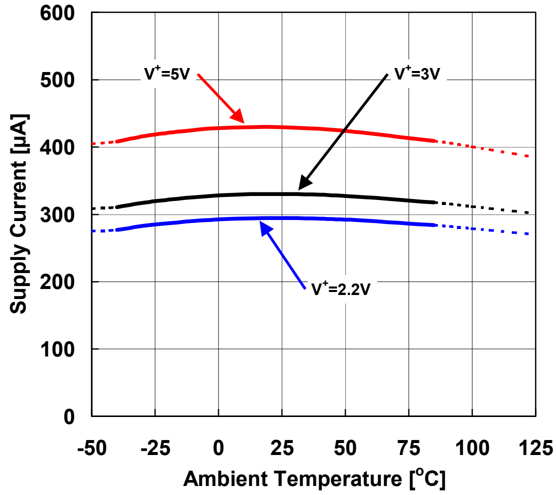
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	G_V=0dB, C_L=15pF, R_T=50Ω to 1.1V, R_L=50kΩ to 1.1V	-	1	-	V/μs

■ TYPICAL CHARACTERISTICS

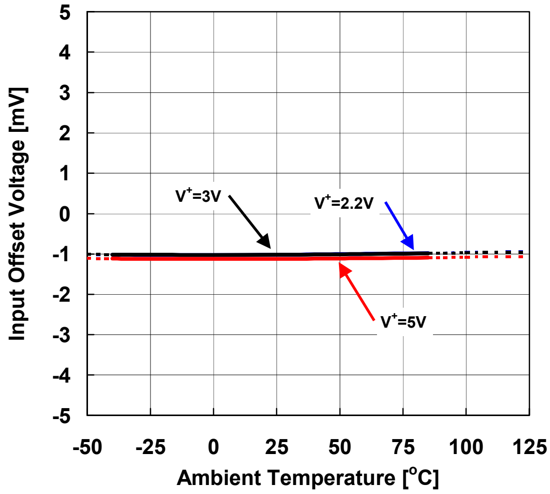
Supply Current vs. Supply Voltage
No Signal, Ta=25°C



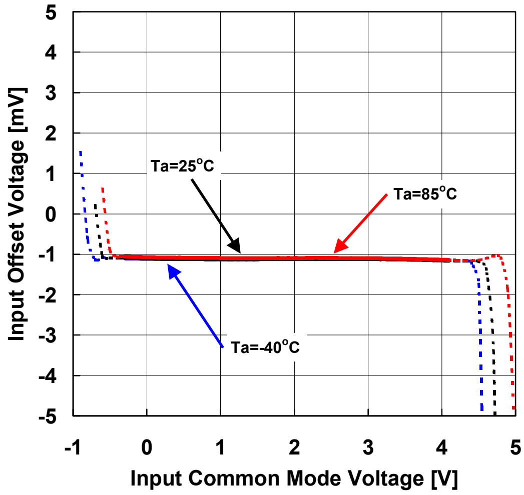
Supply Current vs. Ambient Temperature
(Supply Voltage)
No Signal



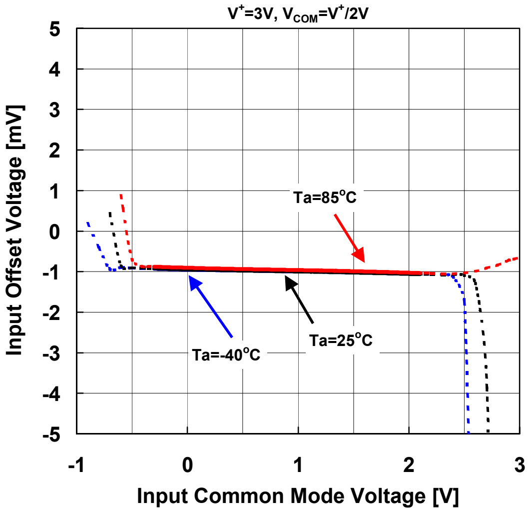
Input Offset Voltage vs. Ambient Temperature
(Supply Voltage)
$V_{ICM}=V^+/2V$, $V_{COM}=V^+/2V$



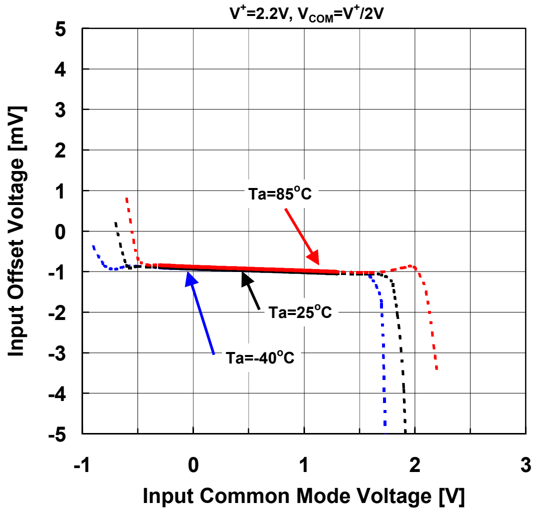
Input Offset Voltage vs. Input Common Mode Voltage
(Ambient Temperature)
$V^+=5V$, $V_{COM}=V^+/2V$



Input Offset Voltage vs. Input Common Mode Voltage
(Ambient Temperature)
$V^+=3V$, $V_{COM}=V^+/2V$

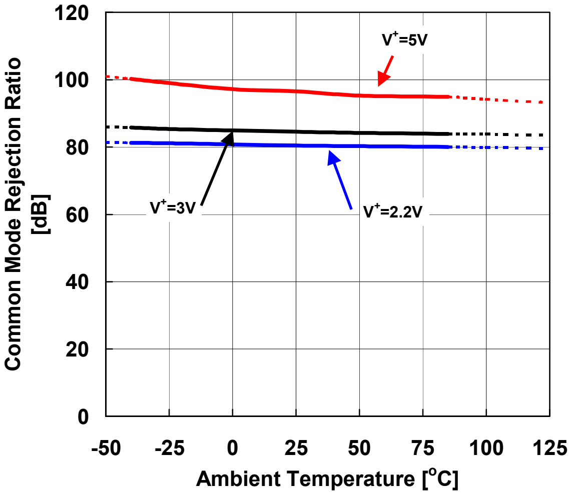


Input Offset Voltage vs. Input Common Mode Voltage
(Ambient Temperature)
$V^+=2.2V$, $V_{COM}=V^+/2V$

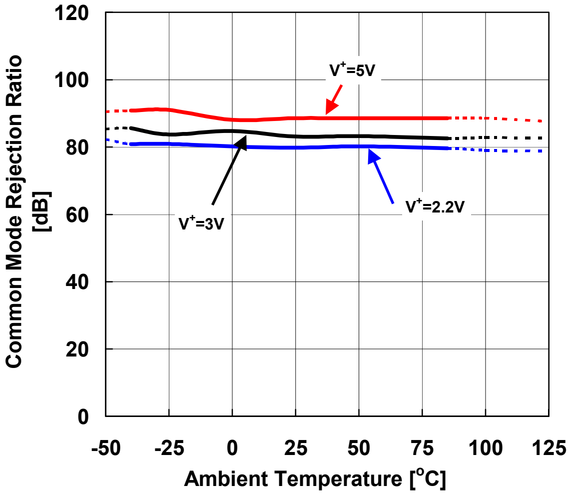


■ TYPICAL CHARACTERISTICS

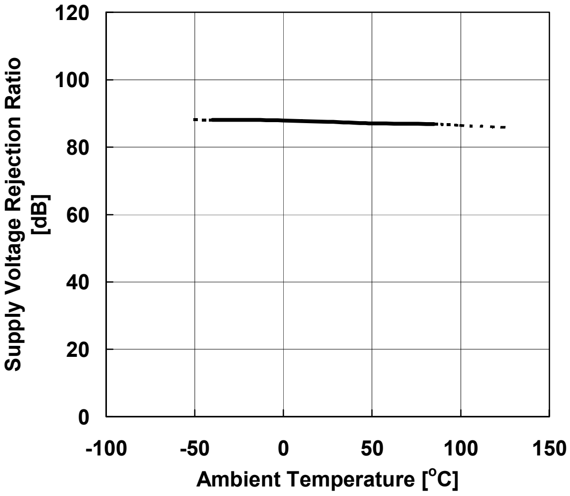
Common Mode Rejection Ratio1
vs. Ambient Temperature
V_{ICM}=0V to V^+-0.9V, V_{COM}=V^+/2V



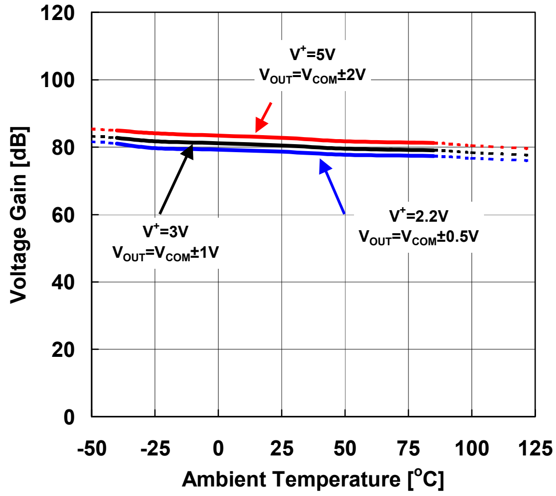
Common Mode Rejection Ratio2
vs. Ambient Temperature
V_{ICM}=0V to 0.2V, V_{COM}=V^+/2V



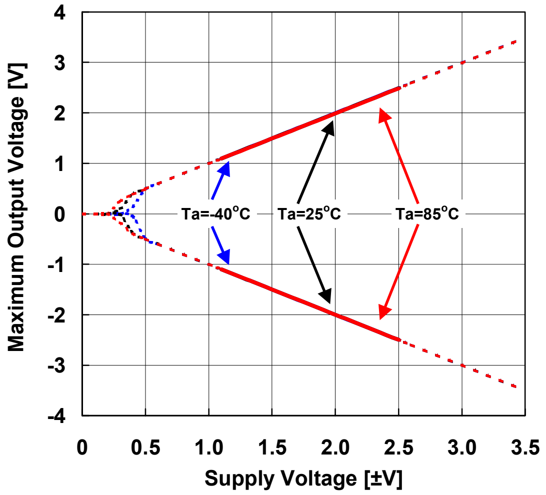
Supply Voltage Rejection Ratio
vs. Ambient Temperature
V^+=2.2V to 5.5V, V_{ICM}=V^+/2, V_{COM}=V^+/2V



Voltage Gain vs. Ambient Temperature
V_{COM}=V^+/2V, R_L=50kΩ to V_{COM}

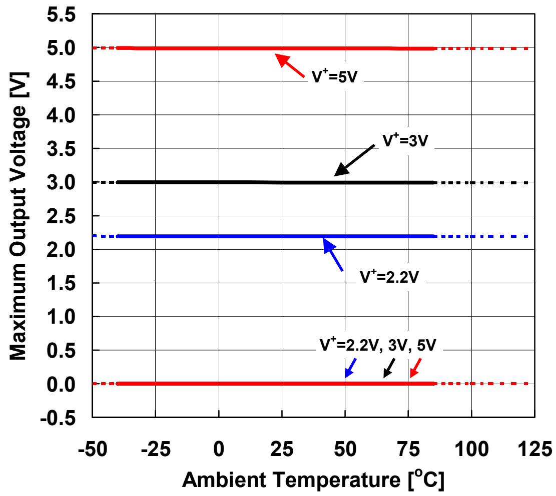


Maximum Output Voltage vs. Supply Voltage
(Ambient Temperature)
V_{IN}=±0.5V, V_{COM}=0V, R_L=50kΩ

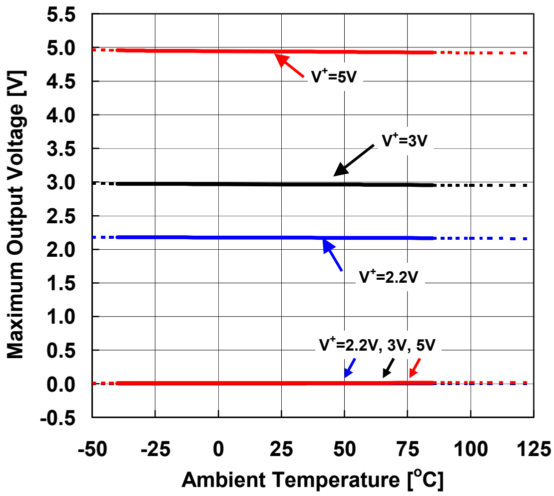


■ TYPICAL CHARACTERISTICS

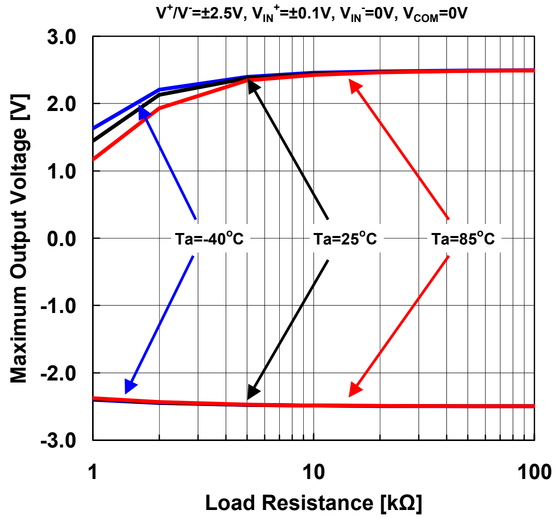
Maximum Output Voltage vs. Ambient Temperature
R_L=50kΩ to V_{COM}



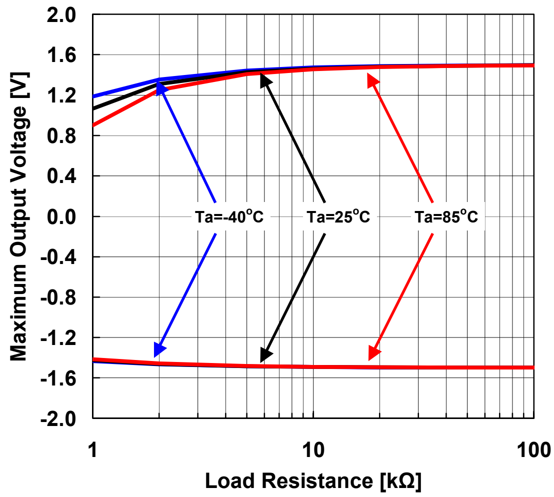
Maximum Output Voltage vs. Ambient Temperature
R_L=10kΩ to V_{COM}



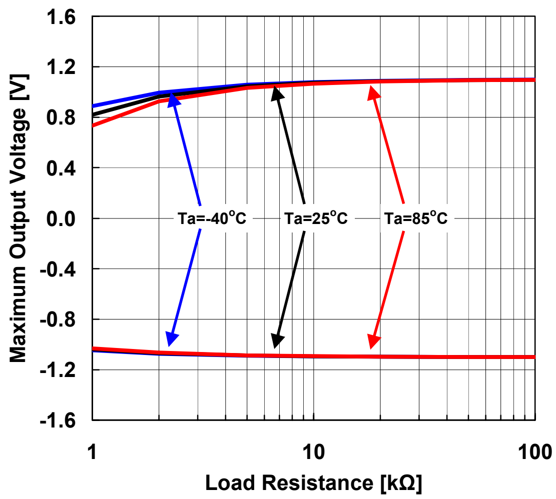
Maximum Output Voltage vs. Load Resistance
(Ambient Temperature)
V^+/V^-=±2.5V, V_{IN}^+=±0.1V, V_{IN}^-=0V, V_{COM}=0V



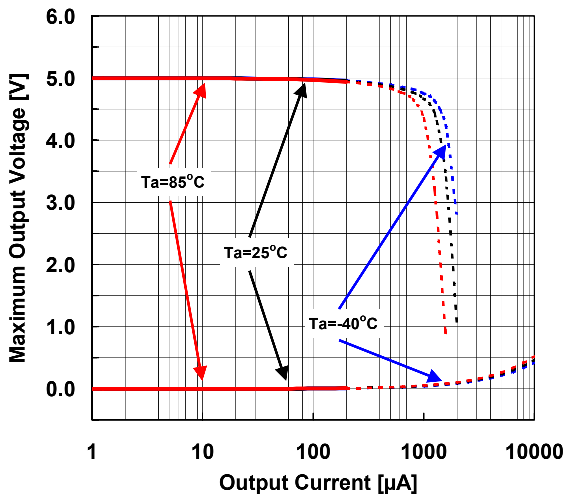
Maximum Output Voltage vs. Load Resistance
(Ambient Temperature)
V^+/V^-=±1.5V, V_{IN}^+=±0.1V, V_{IN}^-=0V, V_{COM}=0V



Maximum Output Voltage vs. Load Resistance
(Ambient Temperature)
V^+/V^-=±1.1V, V_{IN}^+=±0.1V, V_{IN}^-=0V, V_{COM}=0V

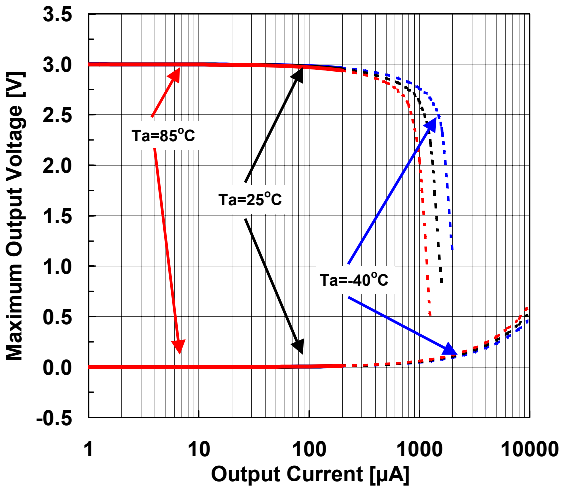


Maximum Output Voltage vs. Output Current
(Ambient Temperature)
V^+=5V

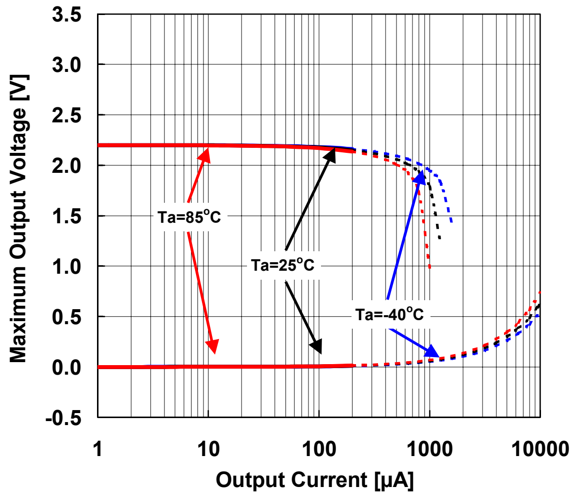


■ TYPICAL CHARACTERISTICS

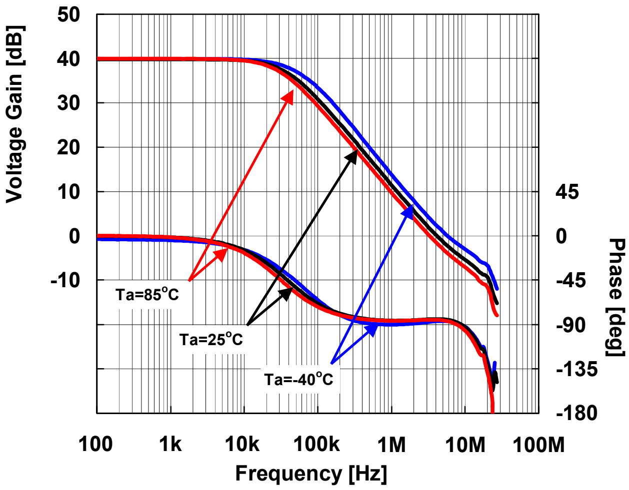
Maximum Output Voltage vs. Output Current
(Ambient Temperature)
V^+=3V



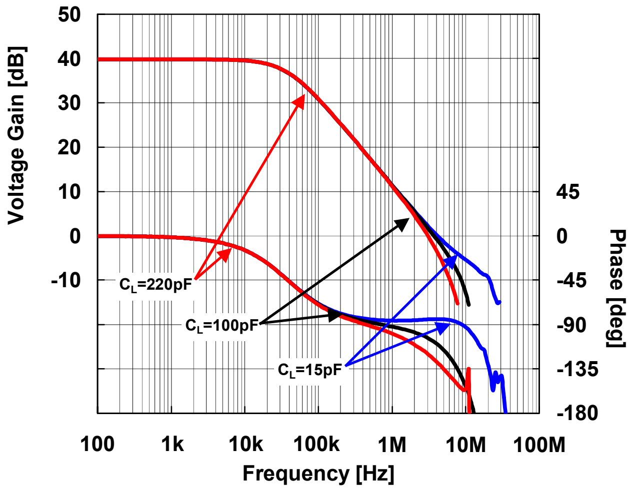
Maximum Output Voltage vs. Output Current
(Ambient Temperature)
V^+=2.2V



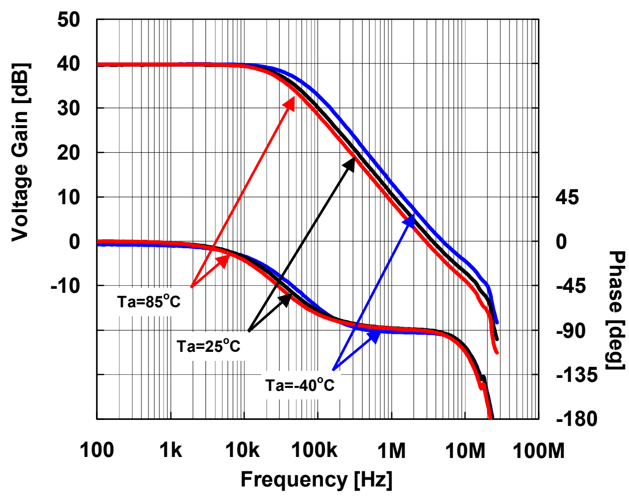
40dB Gain/Phase vs. Frequency (Temperature)
V^+=5V, V_{COM}=V^+/2, G_V=40dB, R_T=50Ω, R_L=50kΩ, C_L=15pF



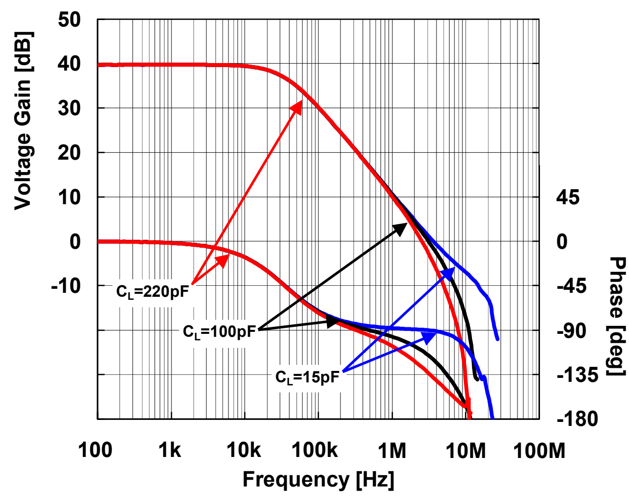
40dB Gain/Phase vs. Frequency (Load Capacitance)
V^+=5V, V_{COM}=V^+/2, G_V=40dB, R_S=50Ω, R_L=50kΩ, Ta=25°C



40dB Gain/Phase vs. Frequency (Temperature)
V^+=3V, V_{COM}=V^+/2, G_V=40dB, R_T=50Ω, R_L=50kΩ, C_L=15pF



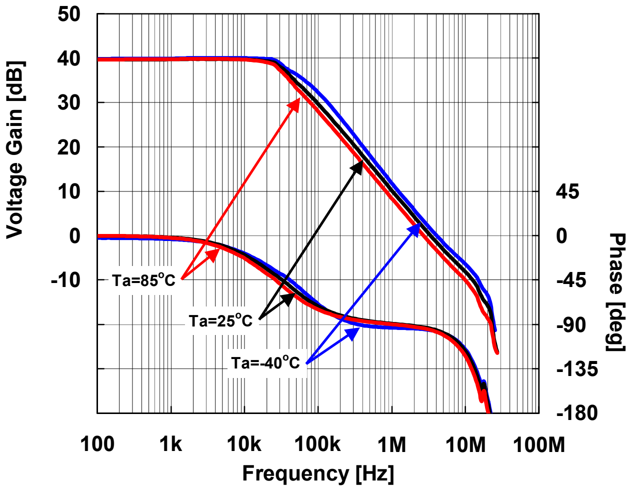
40dB Gain/Phase vs. Frequency (Load Capacitance)
V^+=3V, V_{COM}=V^+/2, G_V=40dB, R_S=50Ω, R_L=50kΩ, Ta=25°C



■ TYPICAL CHARACTERISTICS

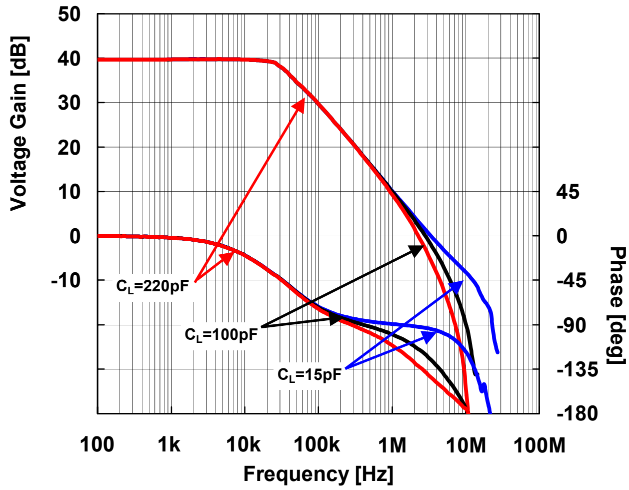
40dB Gain/Phase vs. Frequency (Temperature)

V^{+}=2.2V, V_{COM}=V^{+}/2, G_V=40dB, R_T=50Ω, R_L=50kΩ, C_L=15pF



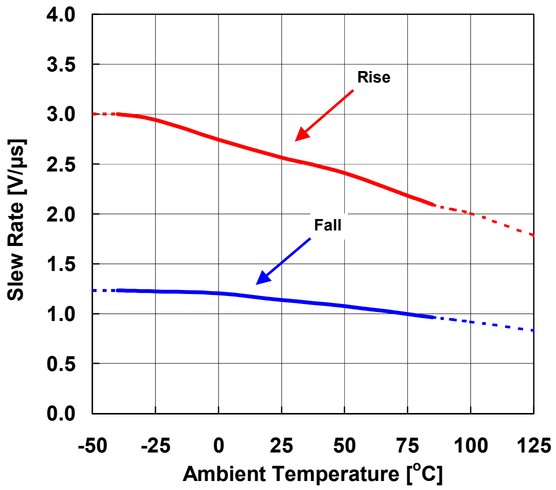
40dB Gain/Phase vs. Frequency (Load Capacitance)

V^{+}=2.2V, V_{COM}=V^{+}/2, G_V=40dB, R_S=50Ω, R_L=50kΩ, Ta=25°C



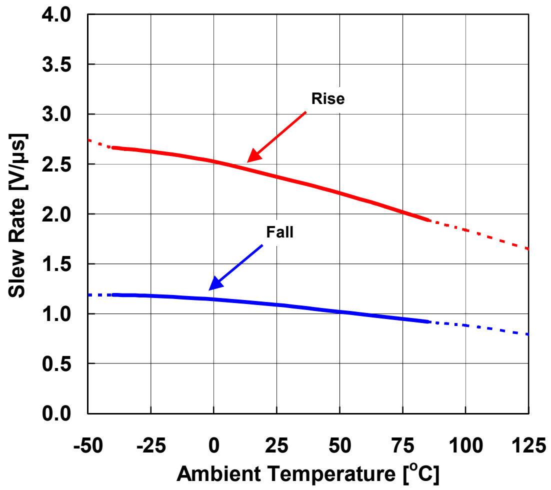
Slew Rate vs. Ambient Temperature

V^{+}/V^{-}=±2.5V, G_V=0dB, R_T=50Ω, R_L=50kΩ, C_L=15pF,
V_{IN}=2V_{PP}, f_{IN}=1kHz, V_{COM}=0V



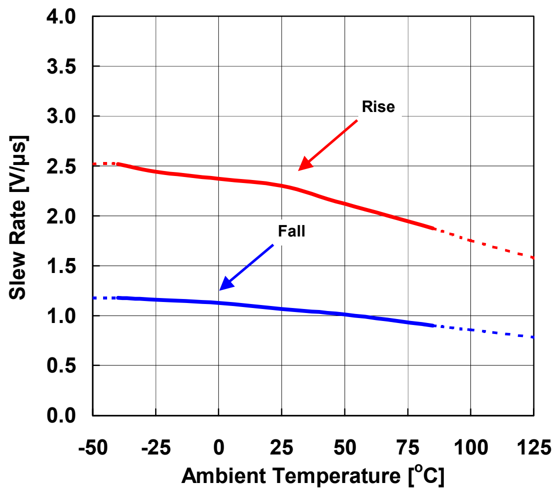
Slew Rate vs. Ambient Temperature

V^{+}/V^{-}=±1.5V, G_V=0dB, R_T=50Ω, R_L=50kΩ, C_L=15pF,
V_{IN}=1V_{PP}, f_{IN}=1kHz, V_{COM}=0V



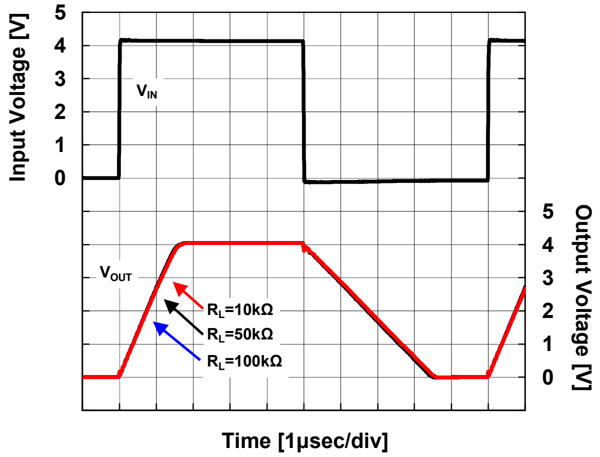
Slew Rate vs. Ambient Temperature

V^{+}/V^{-}=±1.1V, G_V=0dB, R_T=50Ω, R_L=50kΩ, C_L=15pF,
V_{IN}=1V_{PP} ,f_{IN}=1kHz, V_{COM}=0V

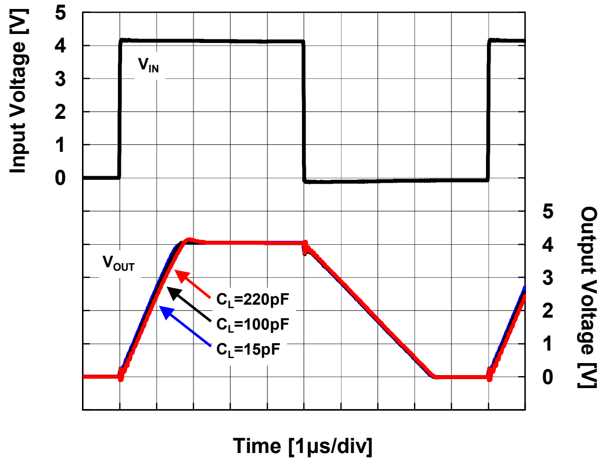


■ TYPICAL CHARACTERISTICS

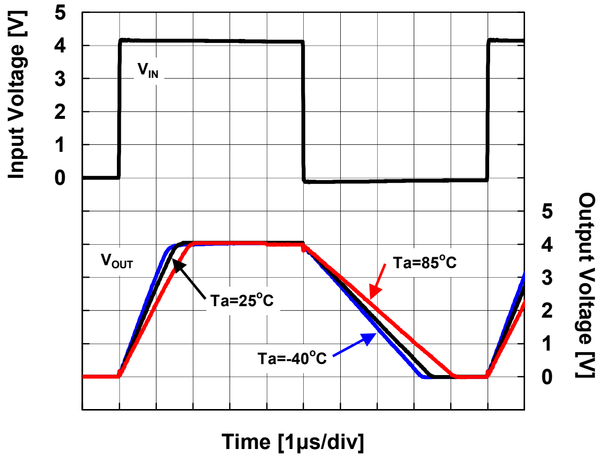
Pulse Response (Load Resistance)
V^+=5V, V_{COM}=V^+/2, V_{IN}=4V_{PP}, f_{IN}=1kHz, C_L=15pF, Ta=25°C



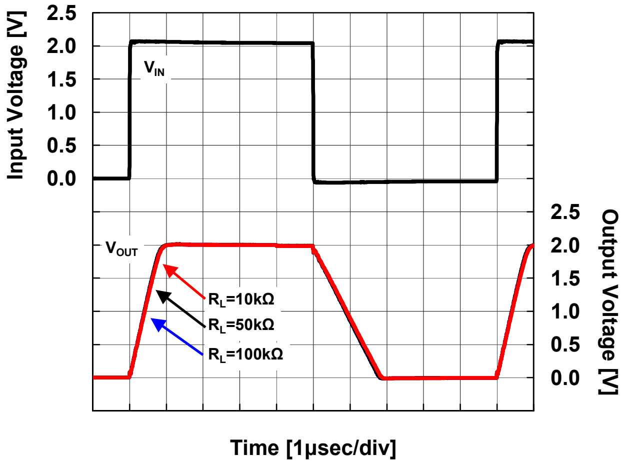
Pulse Response (Load Capacitance)
V^+=5V, V_{COM}=V^+/2, V_{IN}=4V_{PP}, f_{IN}=1kHz, R_L=50kΩ, Ta=25°C



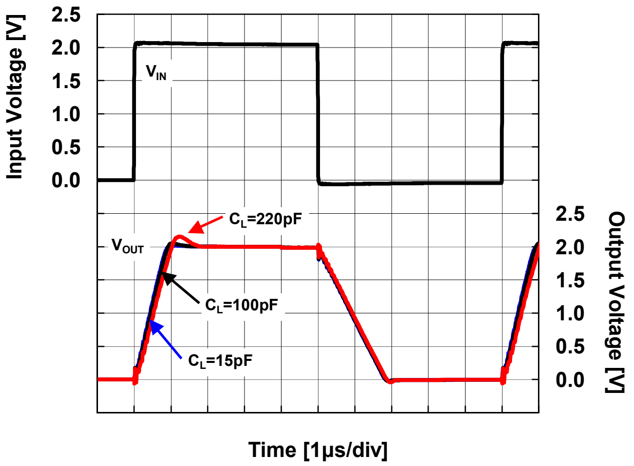
Pulse Response (Ambient Temperature)
V^+=5V, V_{COM}=V^+/2, V_{IN}=4V_{PP}, f_{IN}=1kHz, R_L=50kΩ, C_L=15pF



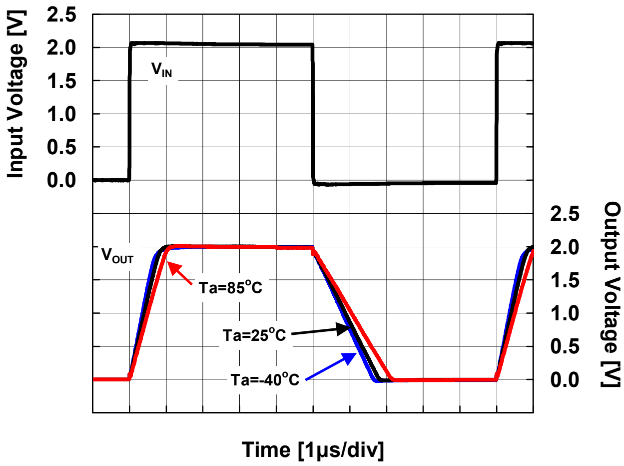
Pulse Response (Load Resistance)
V^+=3V, V_{COM}=V^+/2, V_{IN}=2V_{PP}, f_{IN}=1kHz, C_L=15pF, Ta=25°C



Pulse Response (Load Capacitance)
V^+=3V, V_{COM}=V^+/2, V_{IN}=2V_{PP}, f_{IN}=1kHz, R_L=50kΩ, Ta=25°C



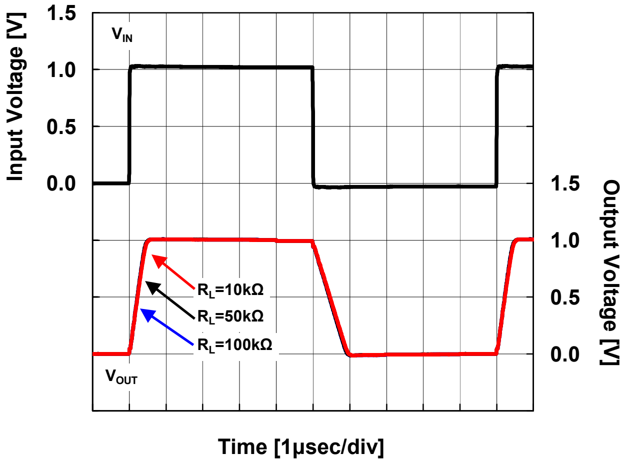
Pulse Response (Ambient Temperature)
V^+=3V, V_{COM}=V^+/2, V_{IN}=2V_{PP}, f_{IN}=1kHz, R_L=50kΩ, C_L=15pF



■ TYPICAL CHARACTERISTICS

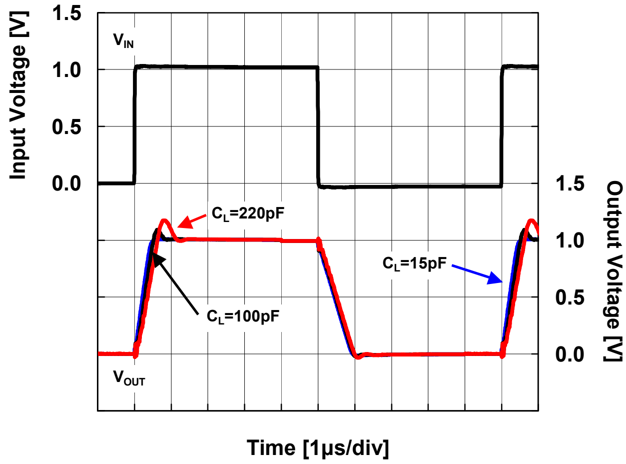
Pulse Response (Load Resistance)

V^+=2.2V, V_{COM}=V^+/2, V_{IN}=1V_{PP}, f_{IN}=1kHz, C_L=15pF, Ta=25°C



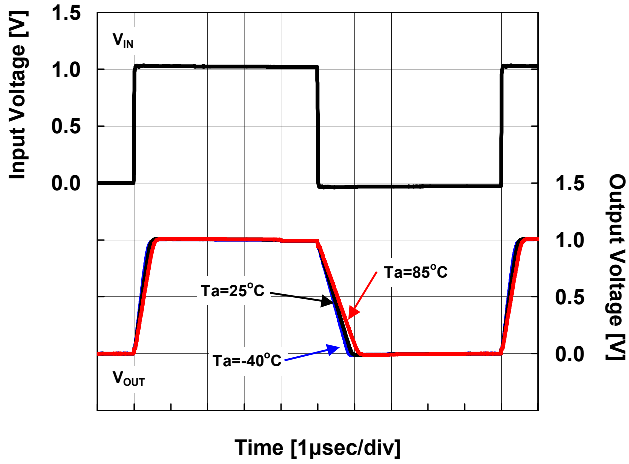
Pulse Response (Load Capacitance)

V^+=2.2V, V_{COM}=V^+/2, V_{IN}=1V_{PP}, f_{IN}=1kHz, R_L=50kΩ, Ta=25°C



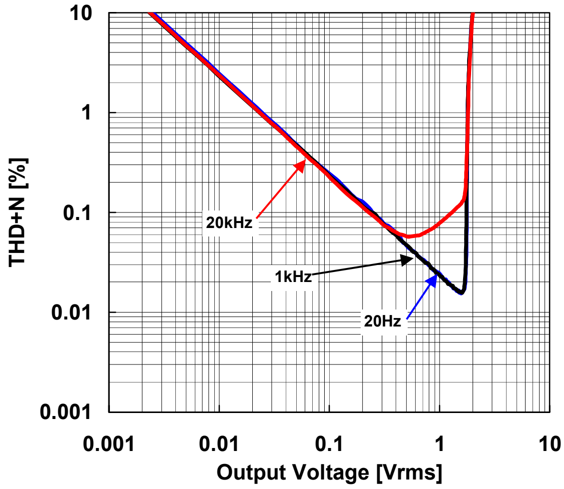
Pulse Response (Ambient Temperature)

V^+=2.2V, V_{COM}=V^+/2, V_{IN}=1V_{PP}, f_{IN}=1kHz, R_L=50kΩ, C_L=15pF



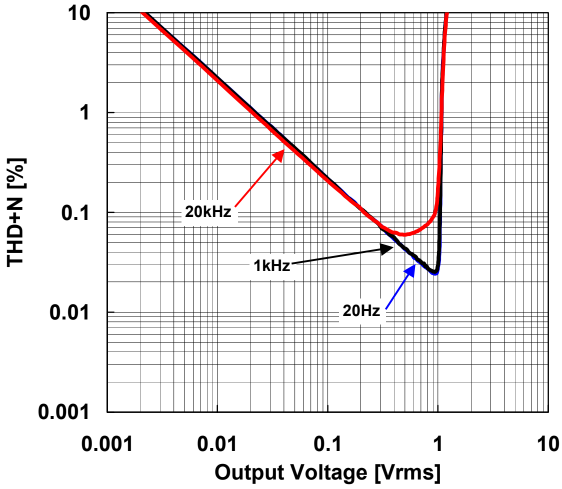
THD+N vs. Output Voltage (Frequency)

V^+/V^-=±2.5V, G_V=20dB, R_L=50kΩ, BW:~80kHz, Ta=25°C



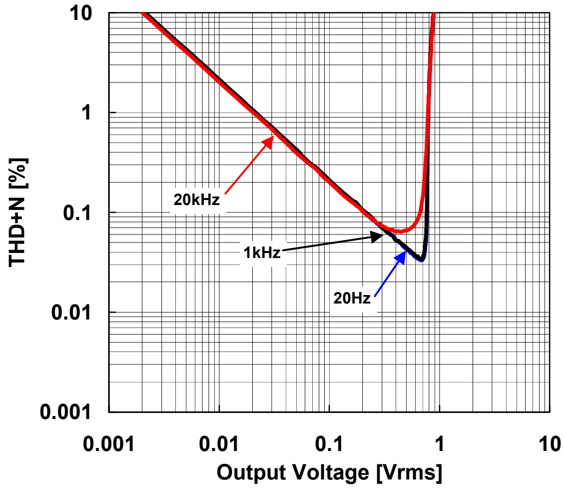
THD+N vs. Output Voltage (Frequency)

V^+/V^-=±1.5V, G_V=20dB, R_L=50kΩ, BW:~80kHz, Ta=25°C

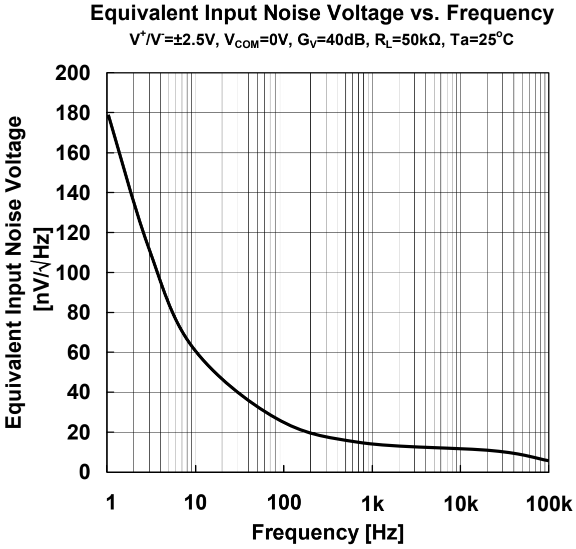


THD+N vs. Output Voltage (Frequency)

V^+/V^-=±1.1V, G_V=20dB, R_L=50kΩ, BW: ~80kHz, Ta=25°C



■ TYPICAL CHARACTERISTICS



[CAUTION]
The specifications on this data book are only given for information, without any guarantee as regards either mistakes or omissions. The application circuits in this data book are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial rights.