Chipsmall

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Low Noise, Rail-to-Rail Output Single CMOS Operational Amplifier

■ GENERAL DESCRIPTION

The NJU7009 is a CMOS operational amplifier that feature low noise as 13nV/√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   13nV/√Hz Typ. @ f=1kHz
                                      3μVrms max. @ f=100Hz~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
●Rail-to-Rail Output
●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]

NJU7009
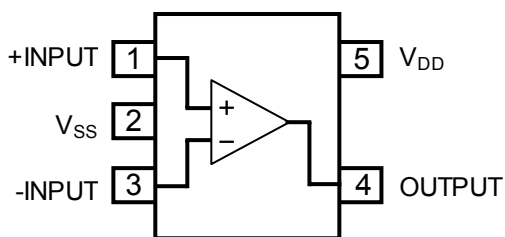
■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

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	-	13	-	nV/√Hz
	V_{NIrms}	R_L=50kΩ to 2.5V, G_V=40dB, BPW=100Hz ~ 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

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■ 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	-	13	-	nV/√Hz
	V_{NIrms}	R_L=50kΩ to 1.5V, G_V=40dB, BPW=100Hz ~ 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

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■ 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	-	13	-	nV/√Hz
	V_{NIrms}	R_L=50kΩ to 1.1V, G_V=40dB, BPW=100Hz ~ 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
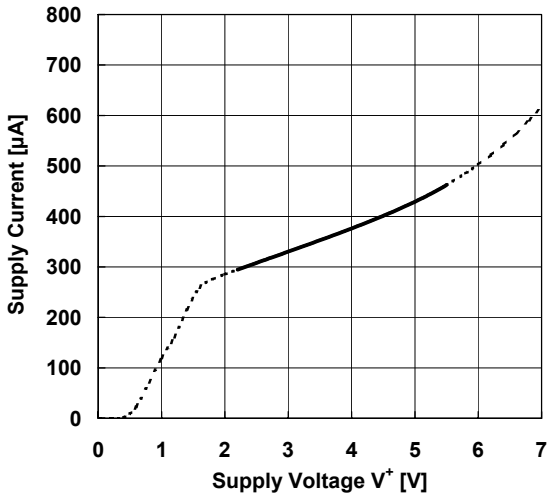
Supply Current vs. Ambient Temperature
(Supply Voltage)
No Signal
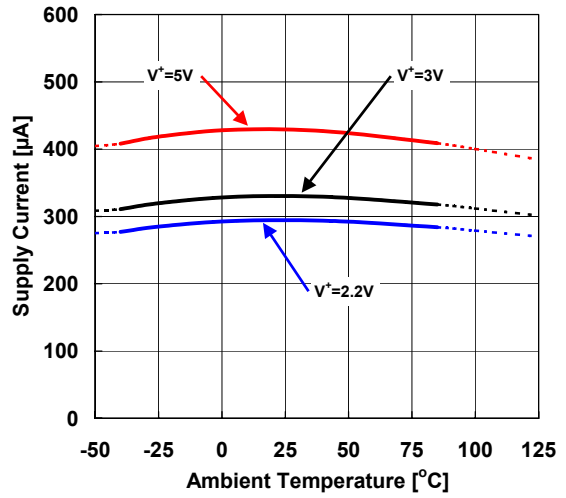
Input Offset Voltage vs. Ambient Temperature
(Supply Voltage)
$V_{ICM}=V^+/2V$, $V_{COM}=V^+/2V$
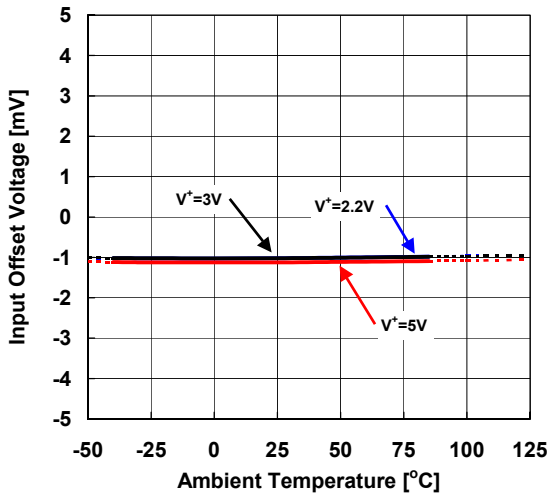
Input Offset Voltage vs. Input Common Mode Voltage
(Ambient Temperature)
$V^+=5V$, $V_{COM}=V^+/2V$
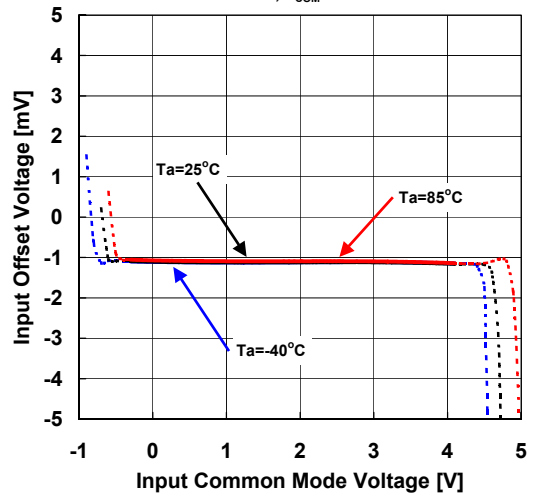
Input Offset Voltage vs. Input Common Mode Voltage
(Ambient Temperature)
$V^+=3V$, $V_{COM}=V^+/2V$

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

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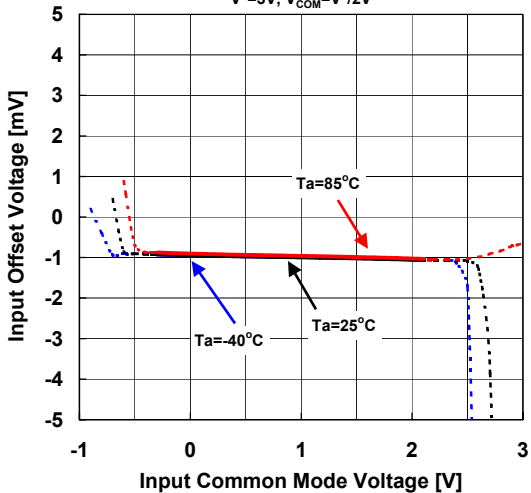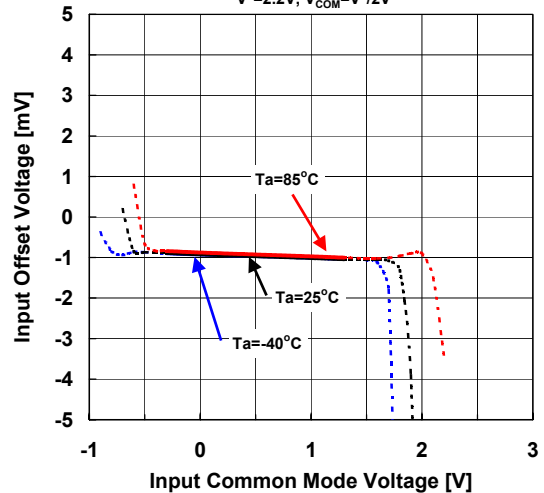
■ **TYPICAL CHARACTERISTICS**

**Common Mode Rejection Ratio1
vs. Ambient Temperature**
V_{ICM}=0V to V^+-0.9V, V_{COM}=V^+/2V
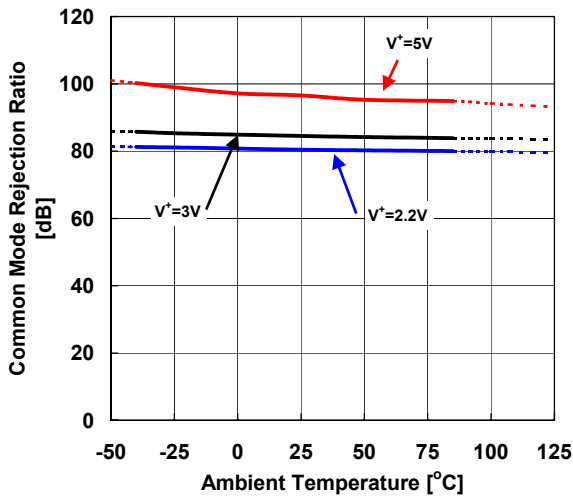
**Common Mode Rejection Ratio2
vs. Ambient Temperature**
V_{ICM}=0V to 0.2V, V_{COM}=V^+/2V
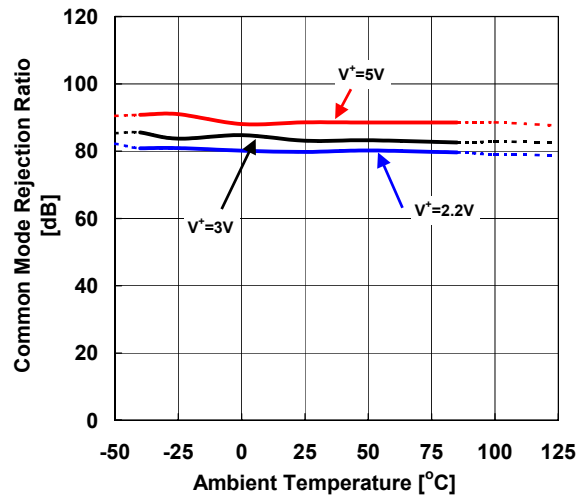
**Supply Voltage Rejection Ratio
vs. Ambient Temperature**
V^+=2.2V to 5.5V, V_{ICM}=V^+/2, V_{COM}=V^+/2V
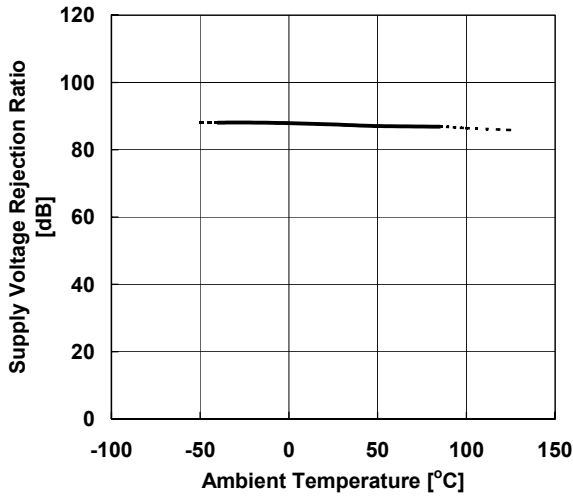
Voltage Gain vs. Ambient Temperature
V_{COM}=V^+/2V, R_L=50kΩ to V_{COM}
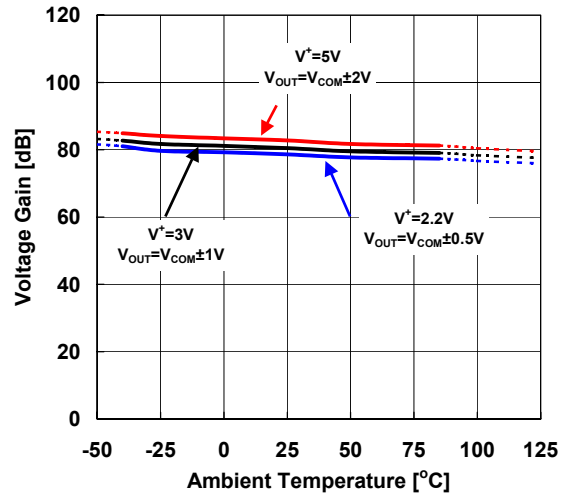
Maximum Output Voltage vs. Supply Voltage
(Ambient Temperature)
V_{IN}=±0.5V, V_{COM}=0V, R_L=50kΩ
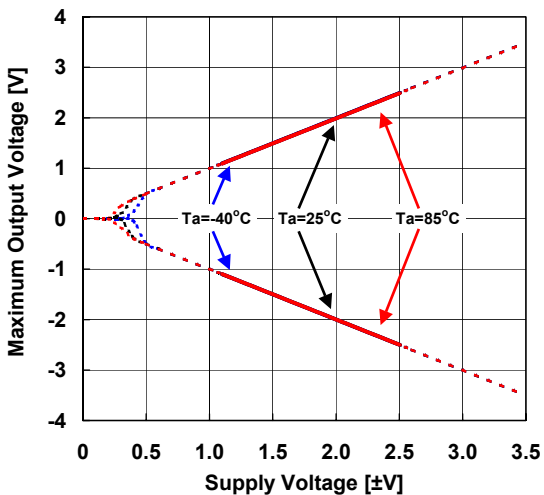
■ **TYPICAL CHARACTERISTICS**

Maximum Output Voltage vs. Ambient Temperature
$R_L=50k\Omega$ to V_{COM}
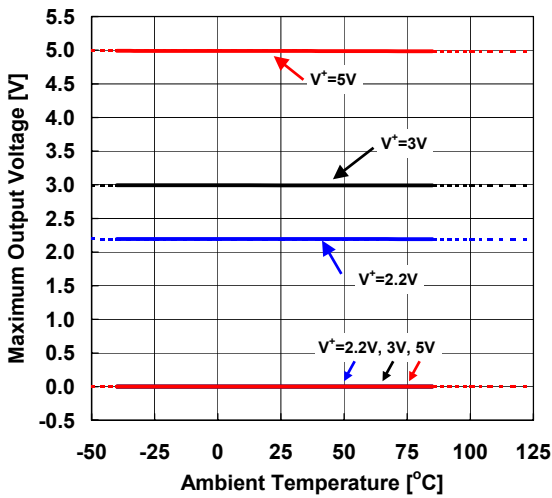
Maximum Output Voltage vs. Ambient Temperature
$R_L=10k\Omega$ to V_{COM}
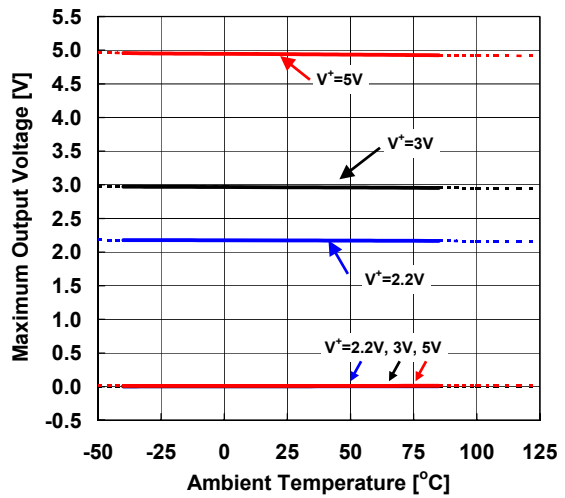
Maximum Output Voltage vs. Load Resistance
(Ambient Temperature)
$V^+/V^-=\pm2.5V$, $V_{IN}^+=\pm0.1V$, $V_{IN}^-=0V$, $V_{COM}=0V$
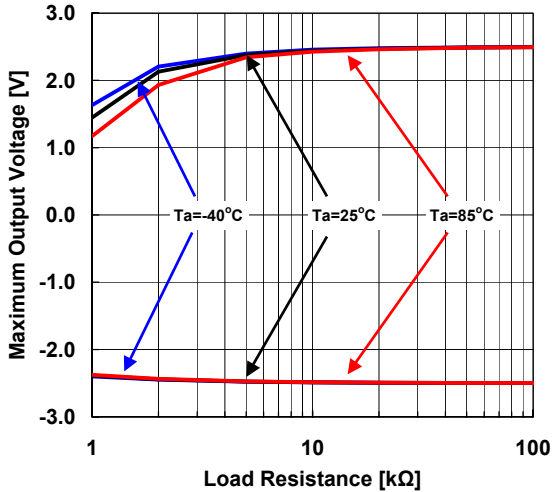
Maximum Output Voltage vs. Load Resistance
(Ambient Temperature)
$V^+/V^-=\pm1.5V$, $V_{IN}^+=\pm0.1V$, $V_{IN}^-=0V$, $V_{COM}=0V$
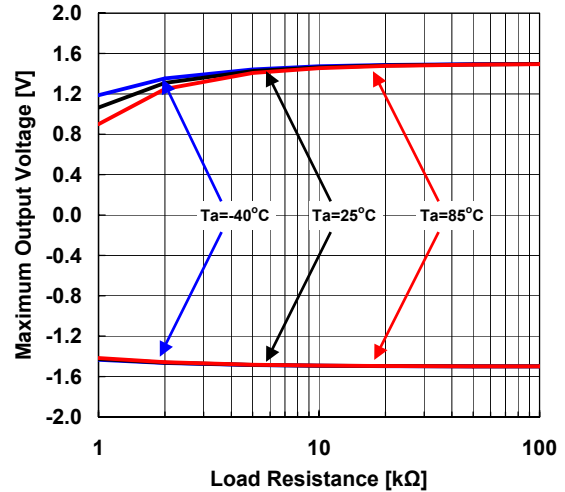
Maximum Output Voltage vs. Load Resistance
(Ambient Temperature)
$V^+/V^-=\pm1.1V$, $V_{IN}^+=\pm0.1V$, $V_{IN}^-=0V$, $V_{COM}=0V$
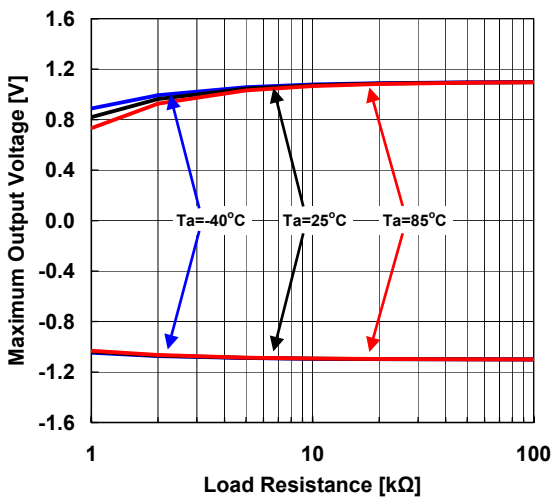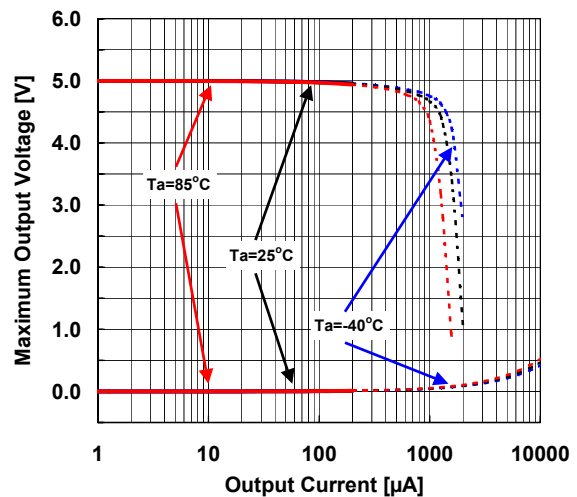
Maximum Output Voltage vs. Output Current
(Ambient Temperature)
$V^+=5V$

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■ TYPICAL CHARACTERISTICS

Maximum Output Voltage vs. Output Current
(Ambient Temperature)
V⁺=3V
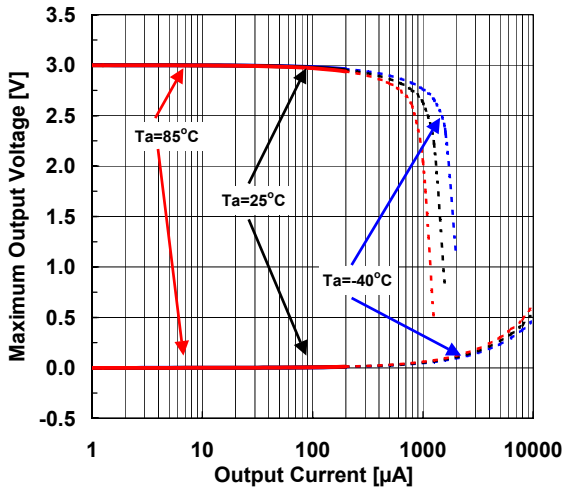
Maximum Output Voltage vs. Output Current
(Ambient Temperature)
V⁺=2.2V
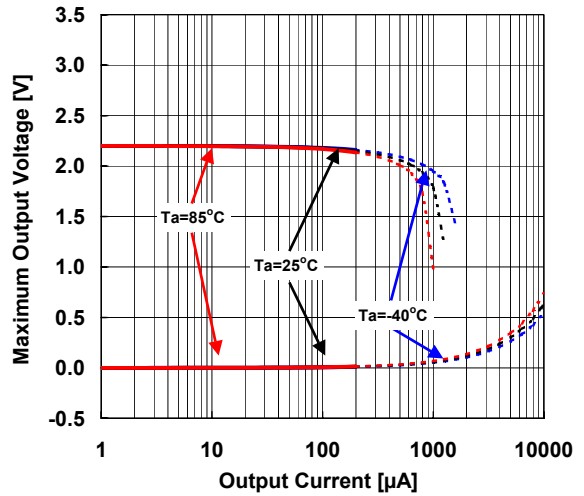
40dB Gain/Phase vs. Frequency (Temperature)
V⁺=5V, V_COM=V⁺/2, G_V=40dB, R_T=50Ω, R_L=50kΩ, C_L=15pF
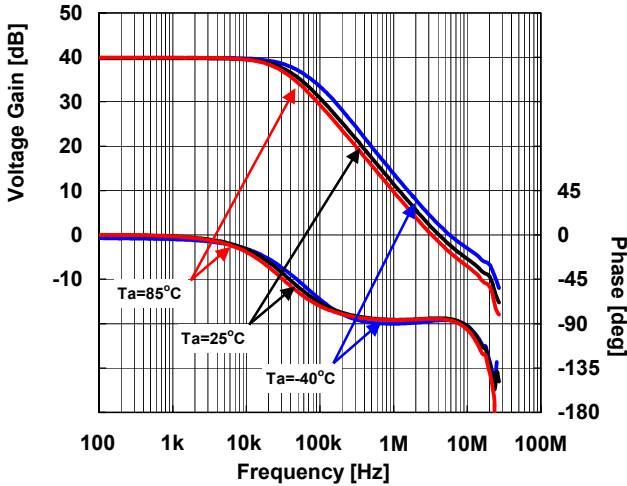
40dB Gain/Phase vs. Frequency (Load Capacitance)
V⁺=5V, V_COM=V⁺/2, G_V=40dB, R_S=50Ω, R_L=50kΩ, Ta=25°C
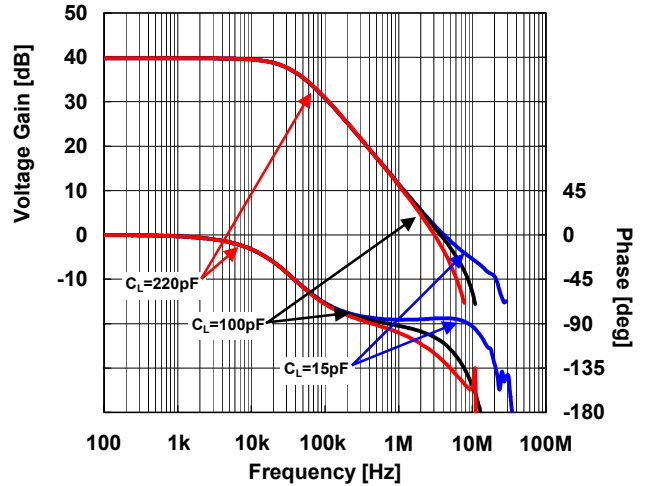
40dB Gain/Phase vs. Frequency (Temperature)
V⁺=3V, V_COM=V⁺/2, G_V=40dB, R_T=50Ω, R_L=50kΩ, C_L=15pF
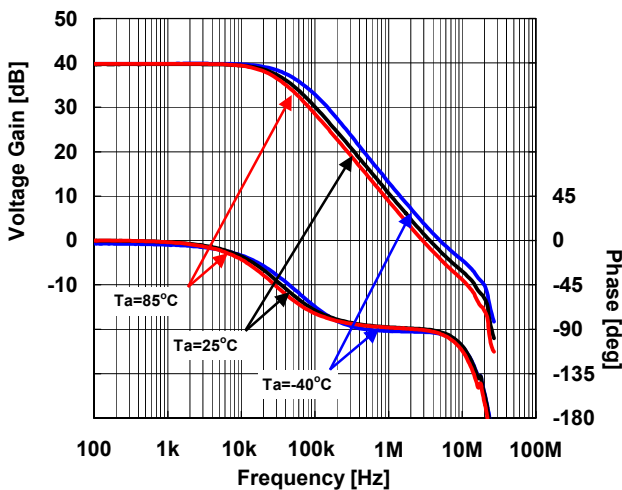
40dB Gain/Phase vs. Frequency (Load Capacitance)
V⁺=3V, V_COM=V⁺/2, G_V=40dB, R_S=50Ω, R_L=50kΩ, Ta=25°C

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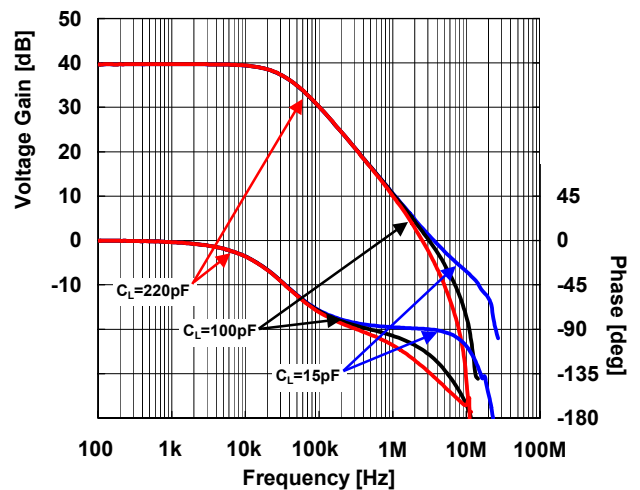
■ **TYPICAL CHARACTERISTICS**

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
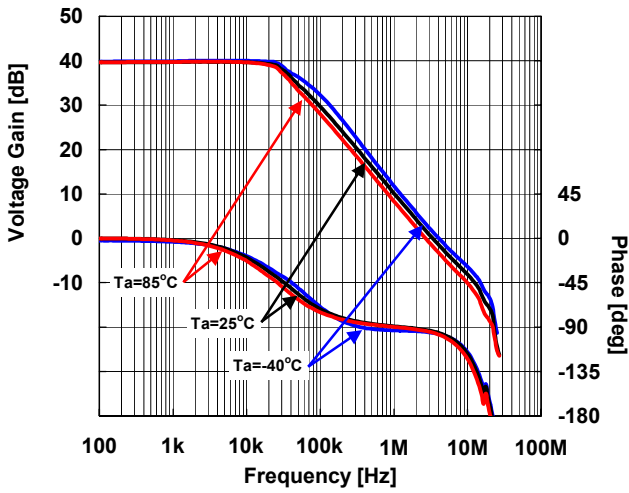
40dB Gain/Phase vs. Frequency (Load Capacitance)
V^+=2.2V, V_{COM}=V^+/2, G_V=40dB, R_S=50Ω, R_L=50kΩ, Ta=25°C
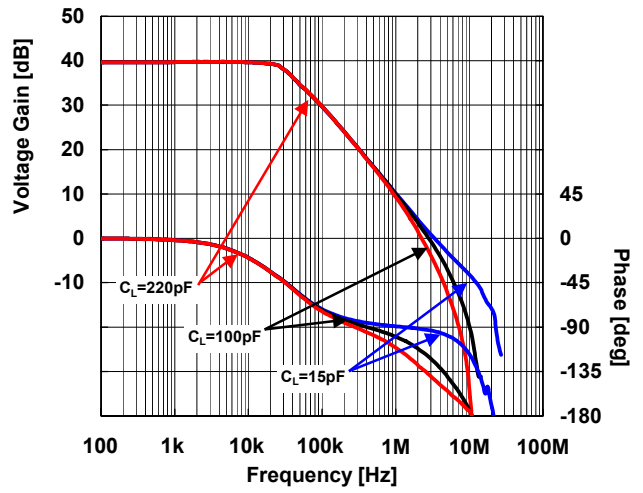
Slew Rate vs. Ambient Temperature
V^+/V^-=±2.5V, G_V=0dB, R_T=50Ω, R_L=50kΩ, C_L=15pF,
V_{IN}=2V_{PP}, f_{IN}=1kHz, V_{COM}=0V
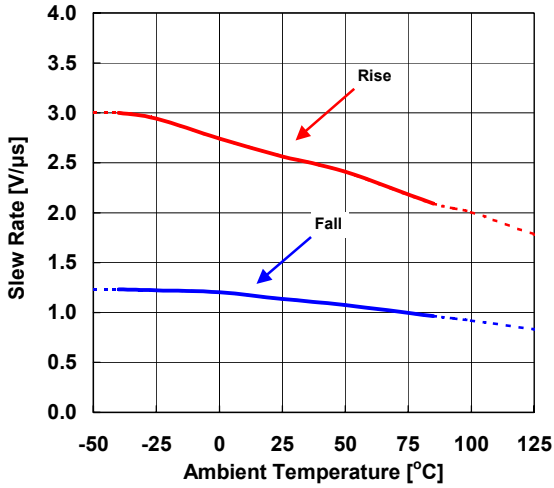
Slew Rate vs. Ambient Temperature
V^+/V^-=±1.5V, G_V=0dB, R_T=50Ω, R_L=50kΩ, C_L=15pF,
V_{IN}=1V_{PP}, f_{IN}=1kHz, V_{COM}=0V
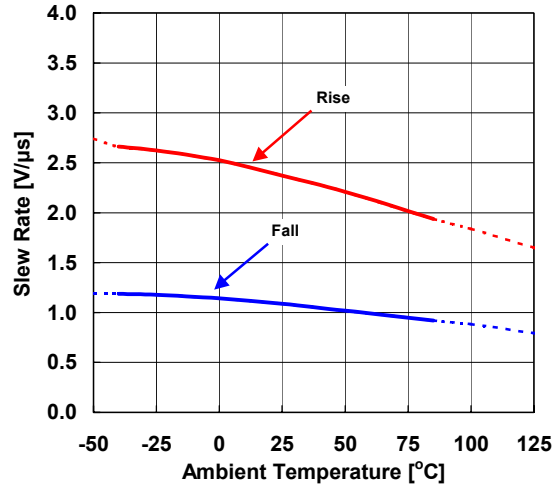
Slew Rate vs. Ambient Temperature
V^+/V^-=±1.1V, G_V=0dB, R_T=50Ω, R_L=50kΩ, C_L=15pF,
V_{IN}=1V_{PP}, f_{IN}=1kHz, V_{COM}=0V

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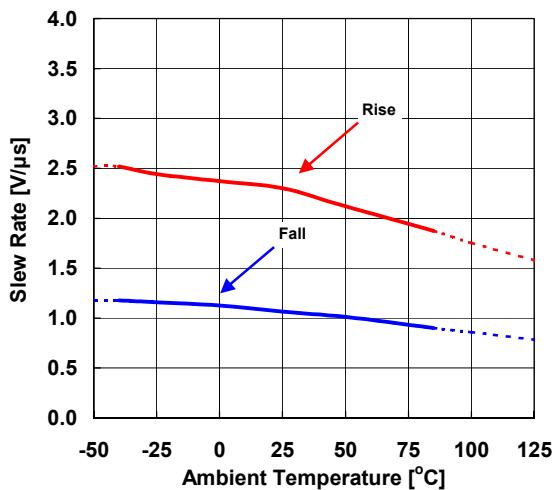
■ **TYPICAL CHARACTERISTICS**

Pulse Response (Load Resistance)
V⁺=5V, V_COM=V⁺/2, V_IN=4V_PP, f_IN=100kHz, C_L=15pF, Ta=25°C
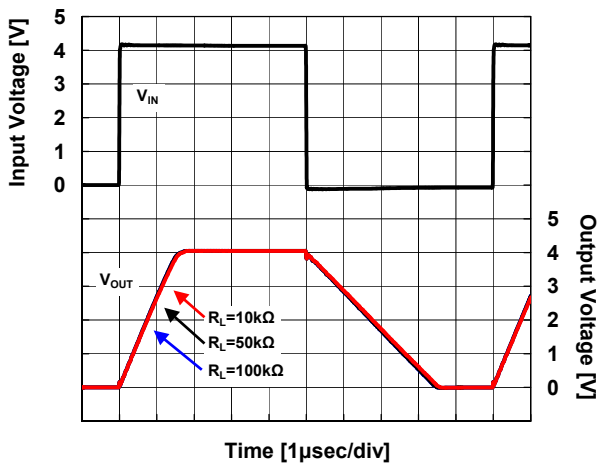
Pulse Response (Load Capacitance)
V⁺=5V, V_COM=V⁺/2, V_IN=4V_PP, f_IN=100kHz, R_L=50kΩ, Ta=25°C
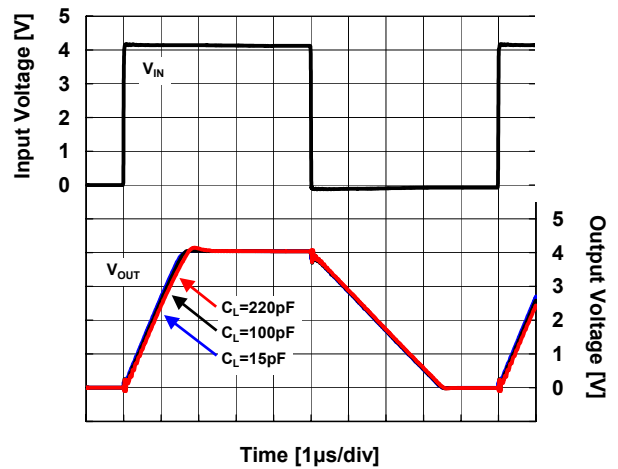
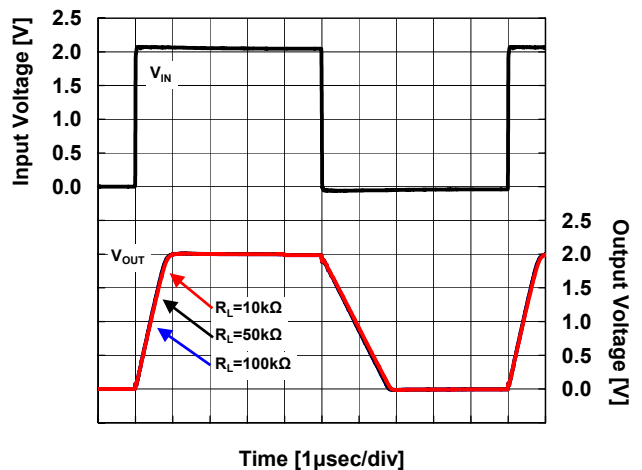**Pulse Response** (Ambient Temperature)
V⁺=5V, V_COM=V⁺/2, V_IN=4V_PP, f_IN=100kHz, R_L=50kΩ, C_L=15pF
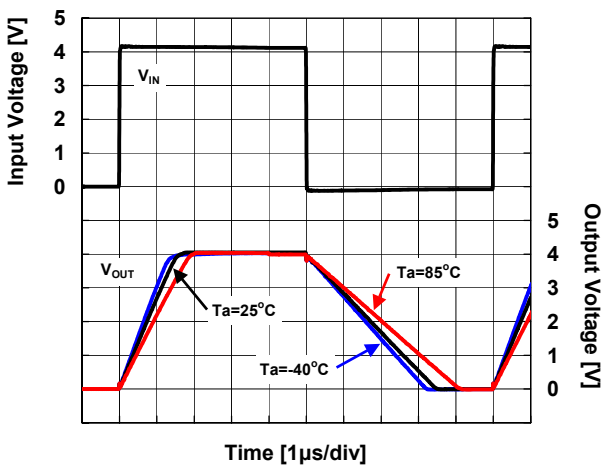
Pulse Response (Load Resistance)
V⁺=3V, V_COM=V⁺/2, V_IN=2V_PP, f_IN=100kHz, C_L=15pF, Ta=25°C

Pulse Response (Load Capacitance)
V⁺=3V, V_COM=V⁺/2, V_IN=2V_PP, f_IN=100kHz, R_L=50kΩ, Ta=25°C
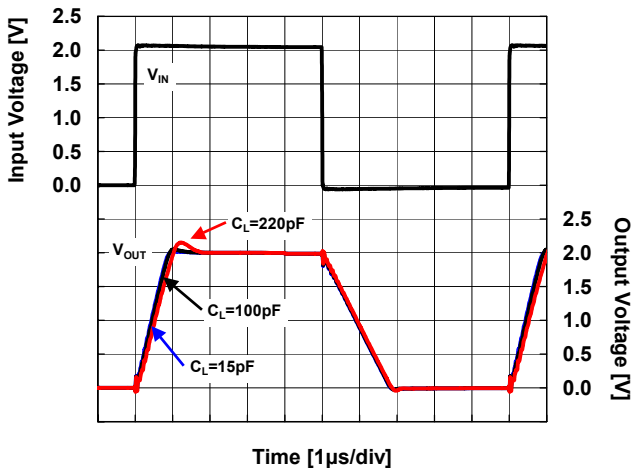
Pulse Response (Ambient Temperature)
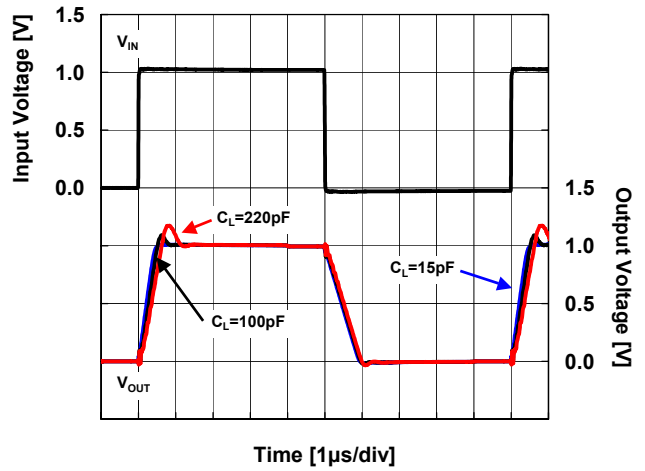V⁺=3V, V_COM=V⁺/2, V_IN=2V_PP, f_IN=100kHz, R_L=50kΩ, C_L=15pF
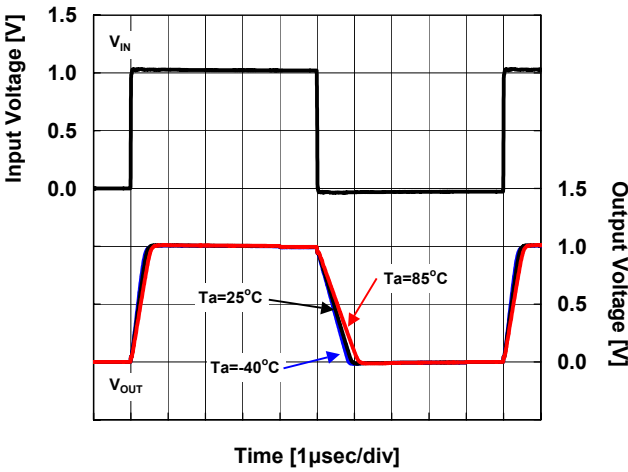
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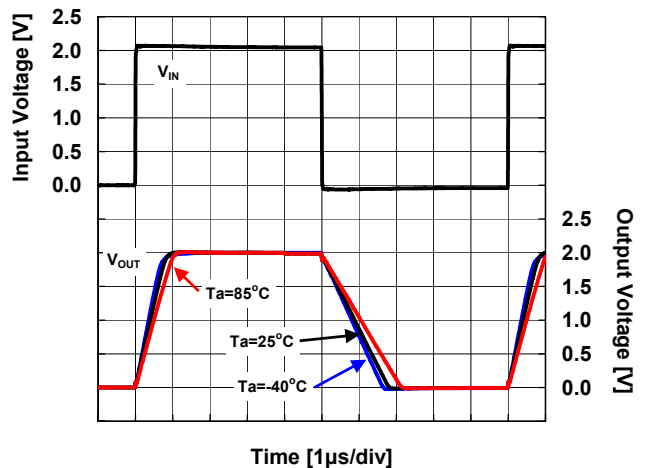
■ **TYPICAL CHARACTERISTICS**

Pulse Response (Load Resistance)
V^+=2.2V, V_{COM}=V^+/2, V_{IN}=1V_{PP}, f_{IN}=100kHz, C_L=15pF, Ta=25°C
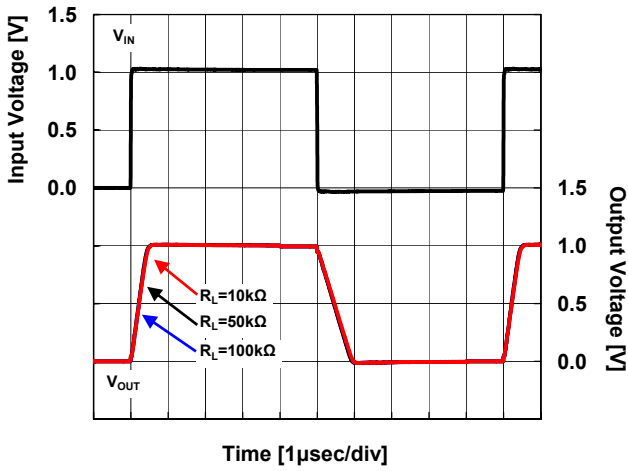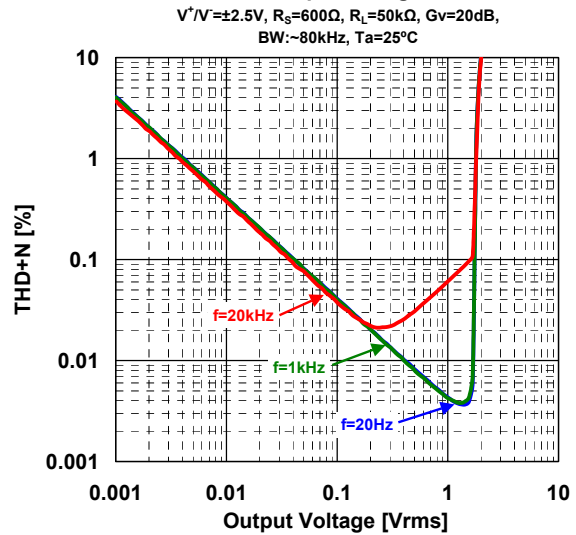

Pulse Response (Load Capacitance)
V^+=2.2V, V_{COM}=V^+/2, V_{IN}=1V_{PP}, f_{IN}=100kHz, R_L=50kΩ, Ta=25°C
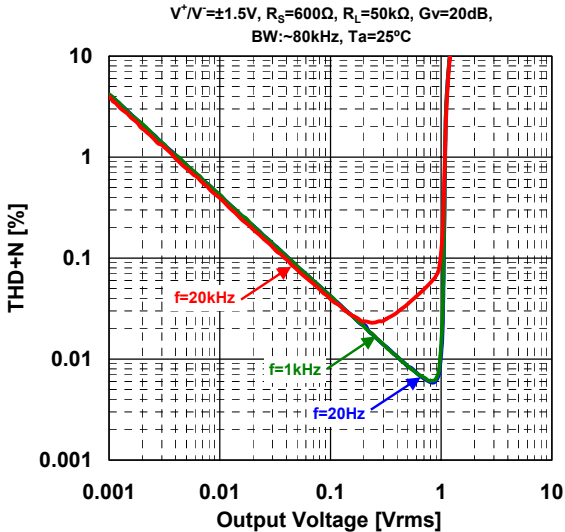

Pulse Response (Ambient Temperature)
V^+=2.2V, V_{COM}=V^+/2, V_{IN}=1V_{PP}, f_{IN}=100kHz, R_L=50kΩ, C_L=15pF

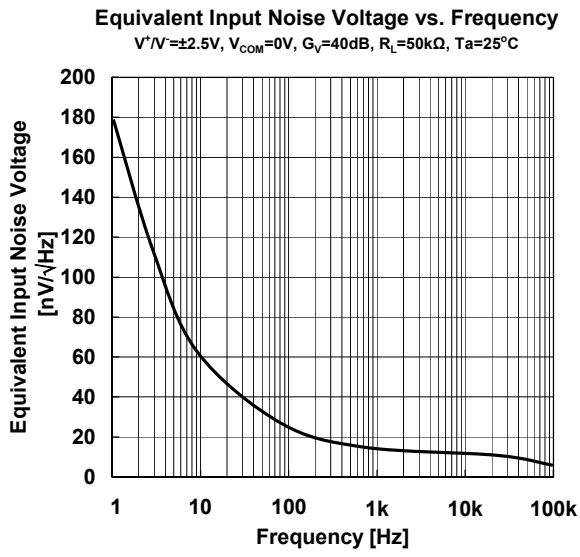### THD+N vs. Output Voltage (Frequency)
V^+/V^-=±2.5V, R_S=600Ω, R_L=50kΩ, Gv=20dB, BW:~80kHz, Ta=25°C

THD+N vs. Output Voltage (Frequency)
V^+/V^-=±1.5V, R_S=600Ω, R_L=50kΩ, Gv=20dB, BW:~80kHz, Ta=25°C

THD+N vs. Output Voltage (Frequency)
V^+/V^-=±1.1V, R_S=600Ω, R_L=50kΩ, Gv=20dB, BW:~80kHz, Ta=25°C

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■ **TYPICAL CHARACTERISTICS**

Equivalent Input Noise Voltage vs. Frequency

$V^+/V^-=\pm2.5V$, $V_{COM}=0V$, $G_V=40dB$, $R_L=50k\Omega$, Ta=25°C

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