

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

■ GENERAL DESCRIPTION

The NJU7029 is a CMOS operational amplifier that feature low noise as $V_{NI}=13\text{V}/\sqrt{\text{Hz}}$ (typ.) @ $f=1\text{kHz}$, 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.

■ FEATURES

Low Noise

- Voltage Noise $13\text{nV}/\sqrt{\text{Hz}}$ (typ.) @ $f=1\text{kHz}$
 $3\mu\text{V}_{\text{rms}}$ (max.) @ $f=100\text{Hz}\sim 20\text{kHz}$

Easy to Use

- Gain Bandwidth 3MHz
- Slew Rate $1\text{V}/\mu\text{s}$ (typ.) @ $R_L=50\text{k}\Omega$
- $I_{\text{source}} / I_{\text{sink}}$ $200\mu\text{A}$
- Specified for +5V, +3V and +2.2V operation

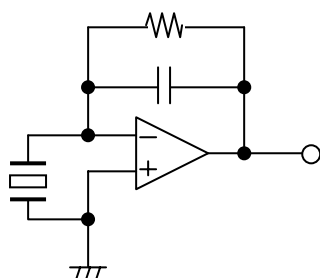
CMOS Process

- Input Bias Current 1pA (typ.)
- Rail-to-Rail Output
- Offset Voltage 5mV (max.)
- Offset Voltage Drift $2\mu\text{V}/^\circ\text{C}$ (typ.)
- Supply Range $2.2\text{V} \sim 5.5\text{V}$
- Supply Current $850\mu\text{A}$ /all ch (typ.) @ $V_{DD}=+5\text{V}$
- Package SSOP8, TVSP8

■ Application

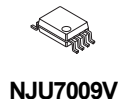
- Shock sensors, Accelerometers
- Charge amplifiers
- Photodiode amplifiers
- Low noise signal processing applications
- Microphone amplifiers

■ Typical Application Circuit



Charge Amplifier

■ PACKAGE OUTLINE

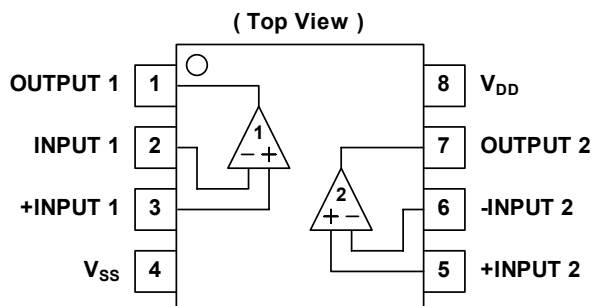


NJU7009V



NJU7009RB1

■ PIN CONFIGURATION



■ 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~+7 (Note1)	V
Differential Input Voltage Range	V _{ID}	±7 (Note1)	V
Power Dissipation	P _D	SSOP8:330 (Note2) TVSP8:410 (Note2)	mW
Operating Temperature Range	Topr	-40~+85	°C
Storage Temperature Range	Tstg	-55~+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 (6.2x114.3x1.6mm, two layers FR-4)"

Refer to following Figure 1 for a permissible loss when ambient temperature (Ta) is Ta≥25°C.

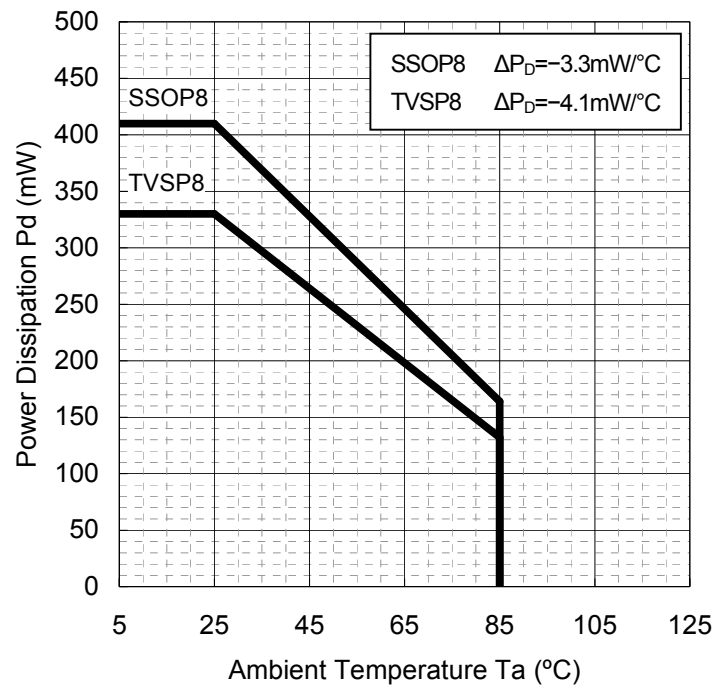


Figure1 Power Dissipation vs. Ambient Temperature

■ OPERATING VOLTAGE (Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	V _{DD}		2.2	-	5.5	V

■ +5V ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS ($V_{DD}=5V$, $T_a=25^{\circ}C$)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I_{DD}	No Signal	-	850	1150	μA
Input offset Voltage	V_{IO}		-	2	5	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$V_{IN}=V_{DD}/2$, $T_a=-40^{\circ}C \sim +85^{\circ}C$	-	2	-	$\mu V/^{\circ}C$
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Large Signal Voltage Gain	A_V	$R_L=50k\Omega$ to 2.5V, $V_o=2.5V \pm 2V$	65	80	-	dB
Common Mode Rejection Ratio	CMR	$V_{ICM}=0V \sim 4.1V$	65	80	-	dB
Supply Voltage Rejection Ratio	SVR	$2.2V \leq V_{DD} \leq 5.5V$	65	80	-	dB
Output Voltage1	V_{OH1}	$R_L=50k\Omega$ to 2.5V	4.9	-	-	V
	V_{OL1}	$R_L=50k\Omega$ to 2.5V	-	-	0.1	V
Output Voltage2	V_{OH2}	$I_{source}=200\mu A$	4.8	-	-	V
	V_{OL2}	$I_{sink}=200\mu A$	-	-	0.2	V
Input Common Mode Voltage Range	V_{ICM}	CMR ≥ 65 dB	0	-	4.1	V

●AC CHARACTERISTICS ($V_{DD}=5V$, $T_a=25^{\circ}C$)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Frequency	f_T	$G_v=40$ dB, $R_L=50k\Omega$ to 2.5V, $C_L=10$ pF	-	3	-	MHz
Equivalent Input Noise Voltage	V_{NI}	$G_v=40$ dB, $R_L=50k\Omega$ to 2.5V, $f=1$ kHz,	-	13	-	nV/ $\sqrt{Hz}$
	V_{Nlms}	$G_v=40$ dB, $R_L=50k\Omega$ to 2.5V BPW=100Hz~20kHz	-	1.7	3	μV_{rms}
Total Harmonic Distortion	THD	$G_v=20$ dB, $R_L=50k\Omega$ to 2.5V, $f_{in}=1$ kHz, $V_{out}=3V_{pp}$, BPW=400Hz~80kHz	-	0.01	-	%
Channel separation	CS	$f=1$ kHz	-	130	-	dB

●TRANSIENT CHARACTERISTICS ($V_{DD}=5V$, $T_a=25^{\circ}C$)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	$G_v=0$ dB, $R_T=50\Omega$ to 2.5V, $R_L=50k\Omega$ to 2.5V, $C_L=15$ pF	-	1	-	V/ μs

■ +3V ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS ($V_{DD}=3V$, $T_a=25^\circ C$)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I_{DD}	No Signal	-	610	950	μA
Input offset Voltage	V_{IO}		-	2	5	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$V_{IN}=V_{DD}/2$, $T_a=-40^\circ C \sim +85^\circ C$	-	2	-	$\mu V/deg$
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Large Signal Voltage Gain	A_V	$R_L=50k\Omega$ to 1.5V, $V_o=1.5V \pm 1V$	65	80	-	dB
Common Mode Rejection Ratio	CMR	$V_{ICM}=0V \sim 2.1V$	65	80	-	dB
Supply Voltage Rejection Ratio	SVR	$2.2V \leq V_{DD} \leq 5.5V$	65	80	-	dB
Output Voltage1	V_{OH1}	$R_L=50k\Omega$ to 1.5V	2.9	-	-	V
	V_{OL1}	$R_L=50k\Omega$ to 1.5V	-	-	0.1	V
Output Voltage2	V_{OH2}	$I_{source}=200\mu A$	2.8	-	-	V
	V_{OL2}	$I_{sink}=200\mu A$	-	-	0.2	V
Input Common Mode Voltage Range	V_{ICM}	CMR ≥ 65 dB	0	-	2.1	V

●AC CHARACTERISTICS ($V_{DD}=3V$, $T_a=25^\circ C$)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Frequency	f_T	$G_v=40$ dB, $R_L=50k\Omega$ to 1.5V, $C_L=10$ pF	-	3	-	MHz
Equivalent Input Noise Voltage	V_{NI}	$G_v=40$ dB, $R_L=50k\Omega$ to 1.5V, $f=1$ kHz	-	13	-	nV/ $\sqrt{Hz}$
	V_{Nlms}	$G_v=40$ dB, $R_L=50k\Omega$ to 1.5V, BPW=100Hz~20kHz	-	1.7	3	μV_{rms}
Total Harmonic Distortion	THD	$G_v=20$ dB, $R_L=50k\Omega$ to 1.5V, $f_{in}=1$ kHz, $V_{out}=1V_{pp}$, BPW=400Hz~80kHz	-	0.02	-	%
Channel separation	CS	$f=1$ kHz	-	120	-	dB

●TRANSIENT CHARACTERISTICS ($V_{DD}=3V$, $T_a=25^\circ C$)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	$G_v=0$ dB, $R_T=50\Omega$ to 1.5V, $R_L=50k\Omega$ to 1.5V, $C_L=15$ pF	-	1	-	V/ μs

■ +2.2V ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS ($V_{DD}=2.2V$, $T_a=25^\circ C$)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I_{DD}	No Signal	-	550	890	μA
Input offset Voltage	V_{IO}		-	2	5	mV
Input Offset Voltage Drift	$\Delta V_{IO}/\Delta T$	$V_{IN}=V_{DD}/2$, $T_a=-40^\circ C \sim +85^\circ C$	-	2	-	$\mu V/deg$
Input Bias Current	I_B		-	1	-	pA
Input Offset Current	I_{IO}		-	1	-	pA
Large Signal Voltage Gain	A_V	$R_L=50k\Omega$ to 1.5V, $V_o=1.1V \pm 0.5V$	60	80	-	dB
Common Mode Rejection Ratio	CMR	$V_{ICM}=0V \sim 1.3V$	60	80	-	dB
Supply Voltage Rejection Ratio	SVR	$2.2V \leq V_{DD} \leq 5.5V$	65	80	-	dB
Output Voltage1	V_{OH1}	$R_L=50k\Omega$ to 1.1V	2.1	-	-	V
	V_{OL1}	$R_L=50k\Omega$ to 1.1V	-	-	0.1	V
Output Voltage2	V_{OH2}	$I_{source}=200\mu A$	2.0	-	-	V
	V_{OL2}	$I_{sink}=200\mu A$	-	-	0.2	V
Input Common Mode Voltage Range	V_{ICM}	CMR ≥ 60 dB	0	-	1.3	V

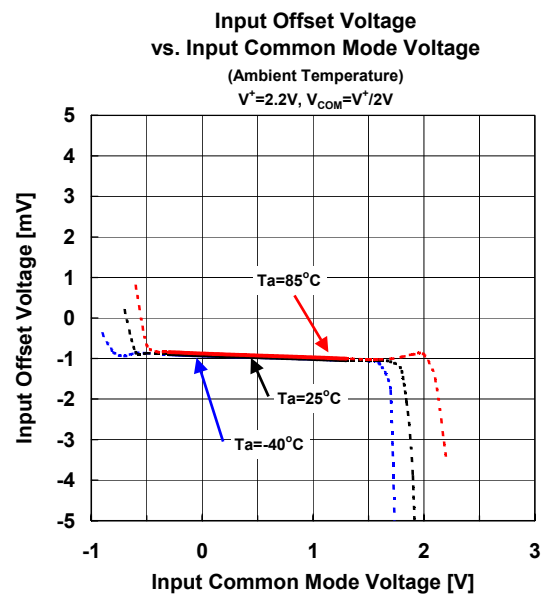
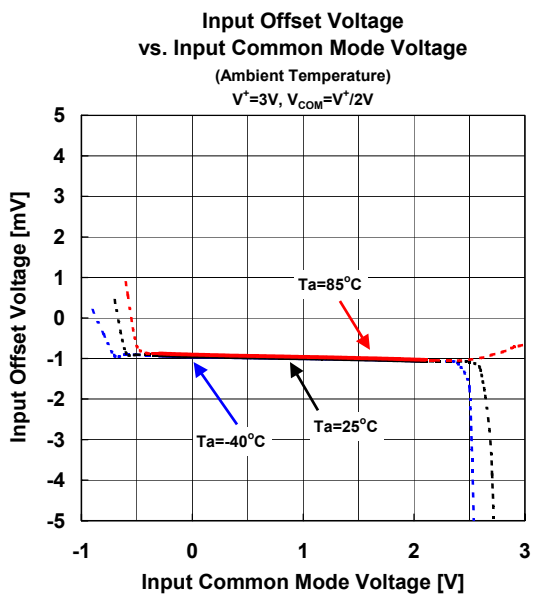
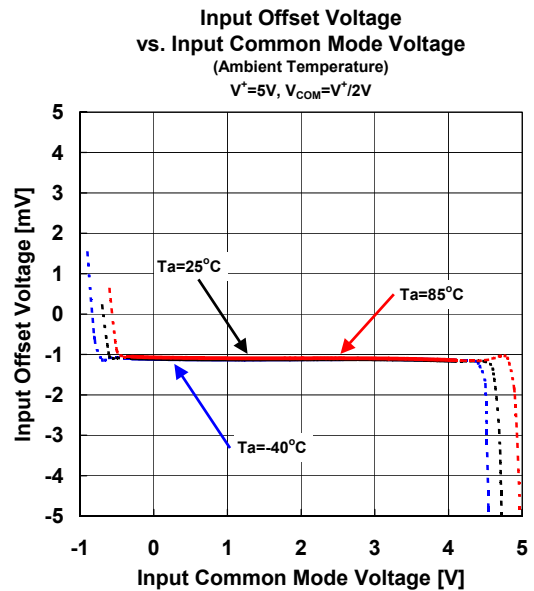
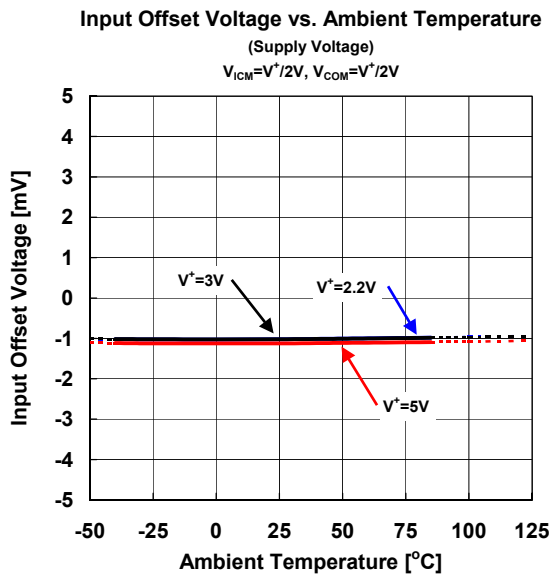
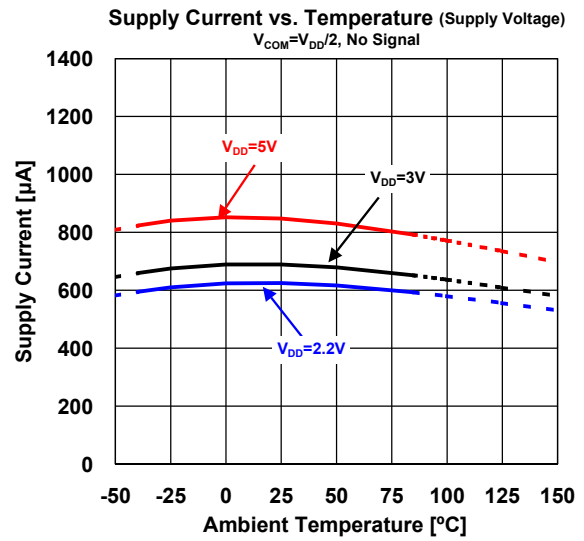
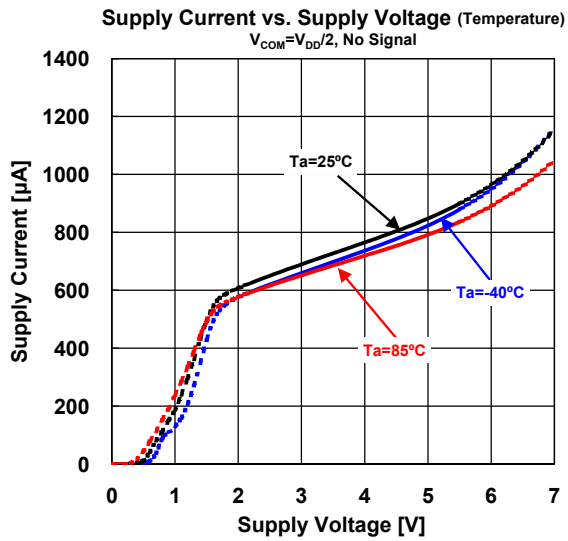
●AC CHARACTERISTICS ($V_{DD}=2.2V$, $T_a=25^\circ C$)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Frequency	f_T	$G_v=40$ dB, $R_L=50k\Omega$ to 1.1V, $C_L=10$ pF	-	3	-	MHz
Equivalent Input Noise Voltage	V_{NI}	$G_v=40$ dB, $R_L=50k\Omega$ to 1.1V, $f=1$ kHz	-	13	-	nV/ $\sqrt{Hz}$
	V_{NIrms}	$G_v=40$ dB, $R_L=50k\Omega$ to 1.1V, BPW=100Hz~20kHz	-	1.7	3	μV_{rms}
Total Harmonic Distortion	THD	$G_v=20$ dB, $R_L=50k\Omega$ to 1.1V, $f_{in}=1$ kHz, $V_{out}=0.5V_{pp}$, BPW=400Hz~80kHz	-	0.02	-	%
Channel separation	CS	$f=1$ kHz	-	115	-	dB

●TRANSIENT CHARACTERISTICS ($V_{DD}=2.2V$, $T_a=25^\circ C$)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	$G_v=0$ dB, $R_T=50\Omega$ to 1.1V, $R_L=50k\Omega$ to 1.5V, $C_L=15$ pF	-	1	-	V/ μs

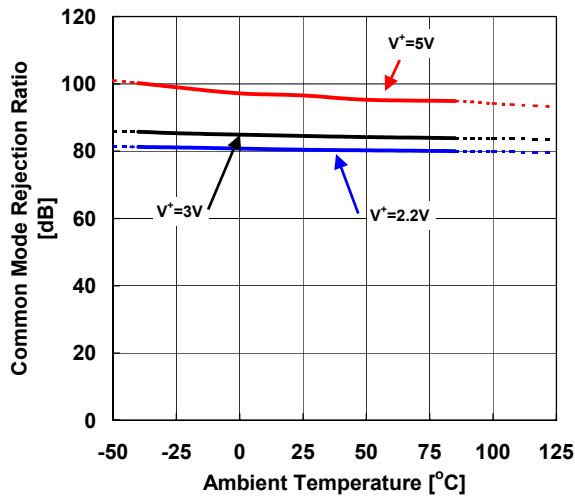
■ TYPICAL CHARACTERISTICS



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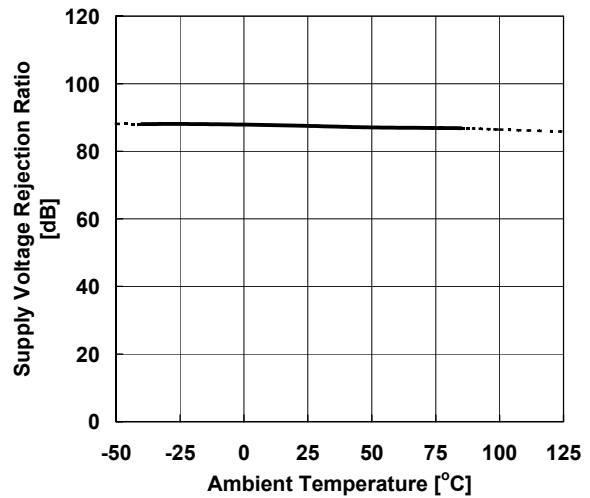
Common Mode Rejection Ratio
vs. Ambient Temperature

$V_{ICM}=0V$ to $V^*-0.9V$, $V_{COM}=V^*/2V$



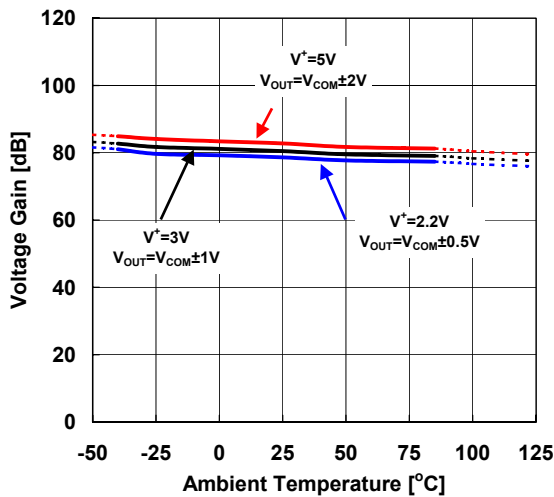
Supply Voltage Rejection Ratio
vs. Ambient Temperature

$V^*=2.2V$ to $5.5V$, $V_{ICM}=V^*/2$, $V_{COM}=V^*/2V$



Voltage Gain vs. Ambient Temperature

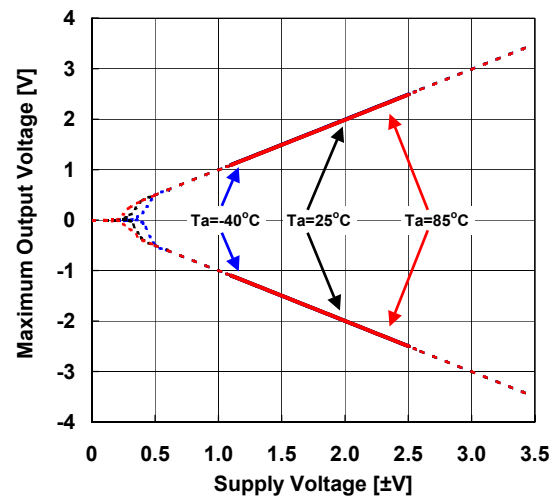
$V_{COM}=V^*/2V$, $R_L=50k\Omega$ to V_{COM}



Maximum Output Voltage vs. Supply Voltage

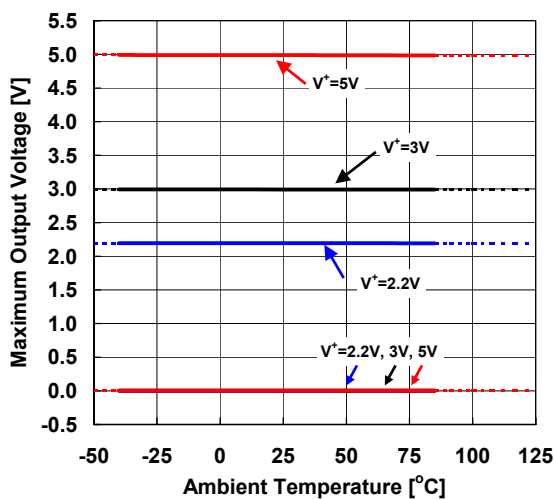
(Ambient Temperature)

$V_{IN}=\pm 0.5V$, $V_{COM}=0V$, $R_L=50k\Omega$



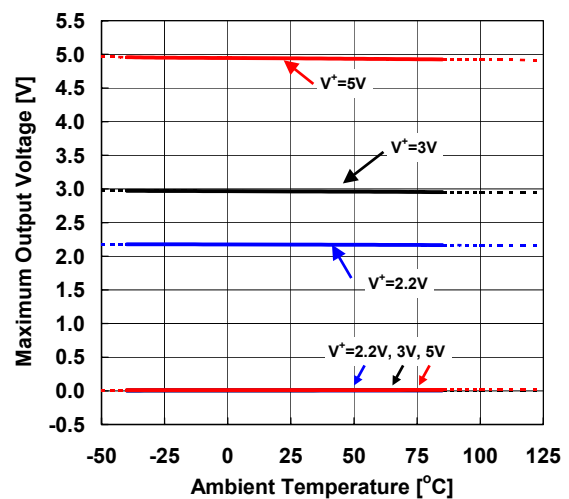
Maximum Output Voltage vs. Ambient Temperature

$R_L=50k\Omega$ to V_{COM}



Maximum Output Voltage vs. Ambient Temperature

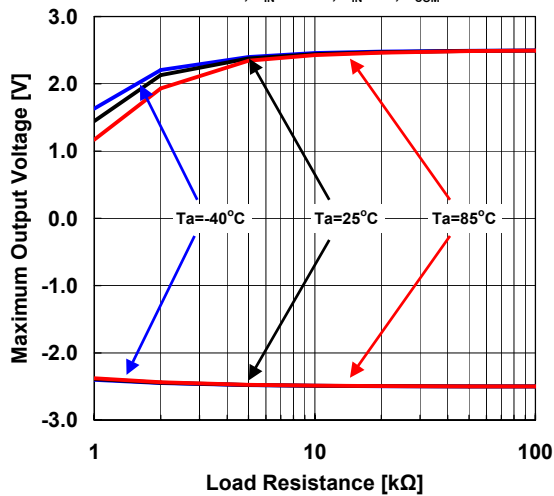
$R_L=10k\Omega$ to V_{COM}



■ TYPICAL CHARACTERISTICS

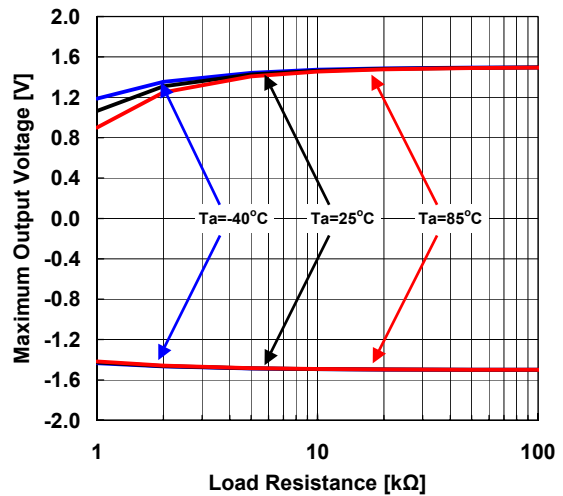
Maximum Output Voltage vs. Load Resistance
(Ambient Temperature)

$V^+/V^- = \pm 2.5V$, $V_{IN}^+ = \pm 0.1V$, $V_{IN}^- = 0V$, $V_{COM} = 0V$



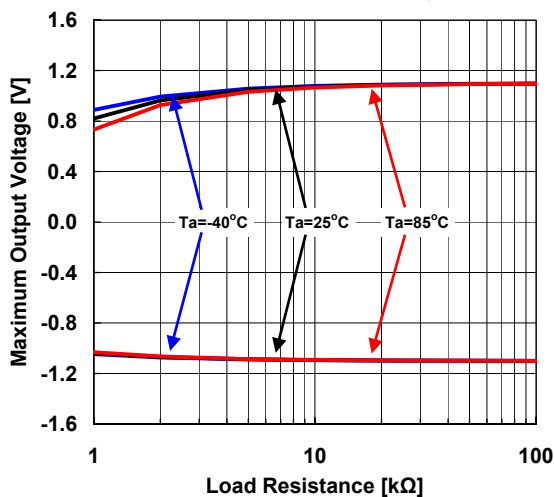
Maximum Output Voltage vs. Load Resistance
(Ambient Temperature)

$V^+/V^- = \pm 1.5V$, $V_{IN}^+ = \pm 0.1V$, $V_{IN}^- = 0V$, $V_{COM} = 0V$



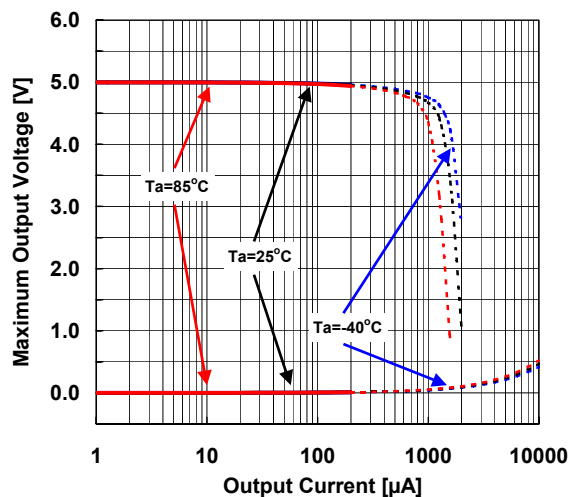
Maximum Output Voltage vs. Load Resistance
(Ambient Temperature)

$V^+/V^- = \pm 1.1V$, $V_{IN}^+ = \pm 0.1V$, $V_{IN}^- = 0V$, $V_{COM} = 0V$



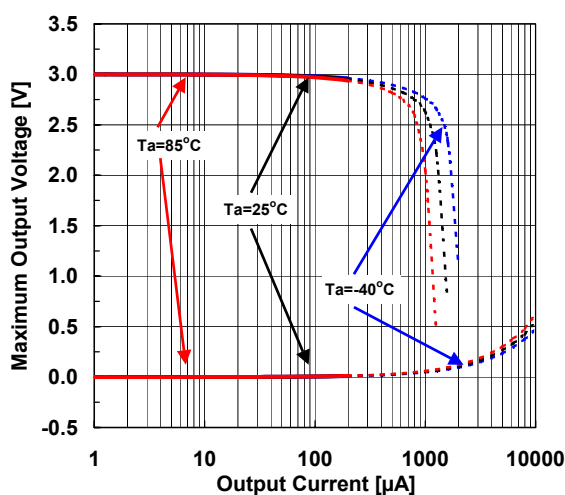
Maximum Output Voltage vs. Output Current
(Ambient Temperature)

$V^+ = 5V$



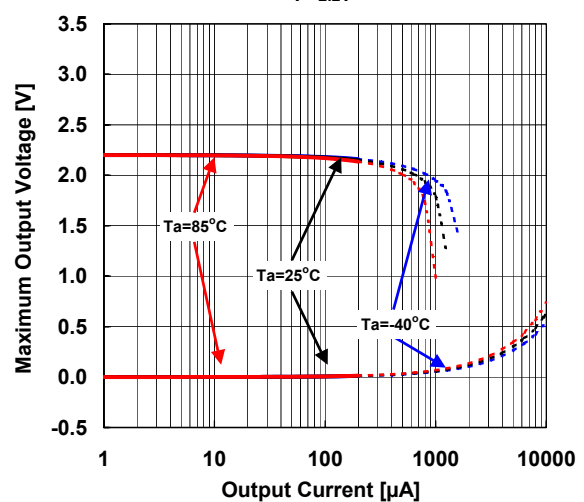
Maximum Output Voltage vs. Output Current
(Ambient Temperature)

$V^+ = 3V$



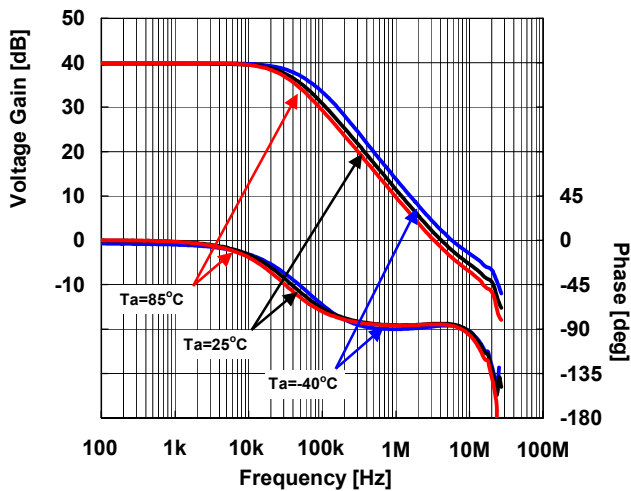
Maximum Output Voltage vs. Output Current
(Ambient Temperature)

$V^+ = 2.2V$

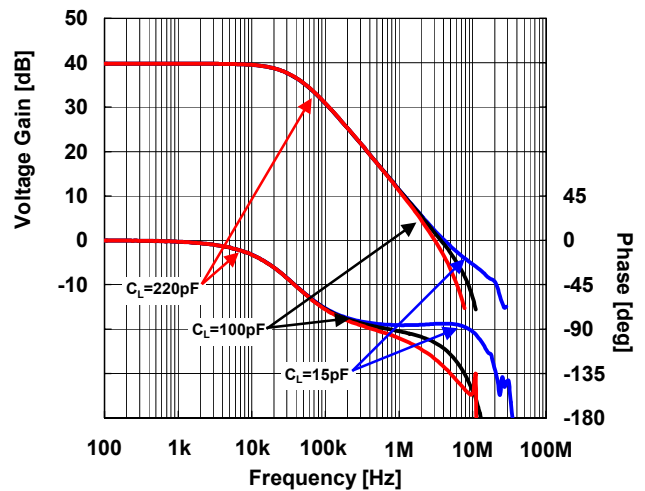


■ TYPICAL CHARACTERISTICS

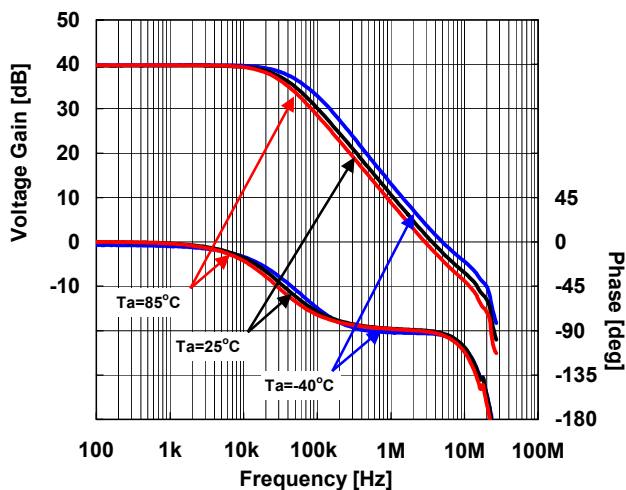
40dB Gain/Phase vs. Frequency (Temperature)
 $V^+=5V$, $V_{COM}=V^+/2$, $G_V=40dB$, $R_T=50\Omega$, $R_L=50k\Omega$, $C_L=15pF$



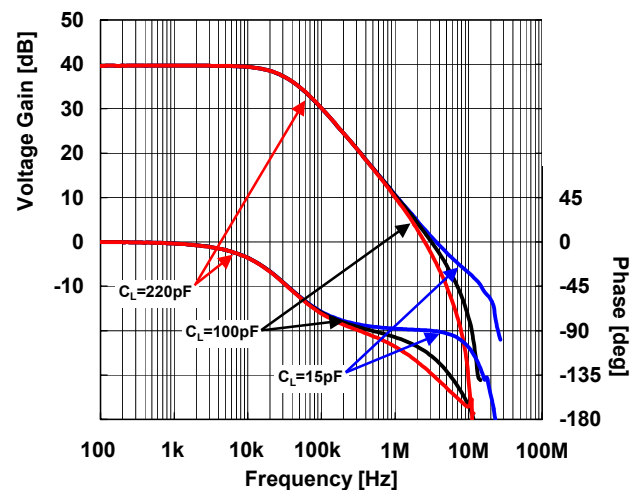
40dB Gain/Phase vs. Frequency (Load Capacitance)
 $V^+=5V$, $V_{COM}=V^+/2$, $G_V=40dB$, $R_S=50\Omega$, $R_L=50k\Omega$, $T_a=25^\circ C$



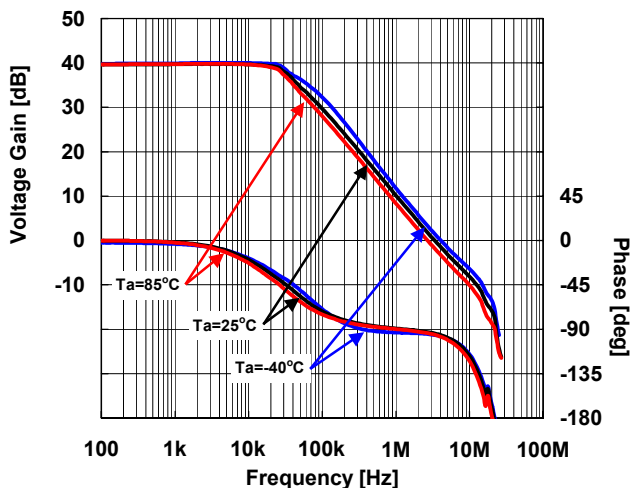
40dB Gain/Phase vs. Frequency (Temperature)
 $V^+=3V$, $V_{COM}=V^+/2$, $G_V=40dB$, $R_T=50\Omega$, $R_L=50k\Omega$, $C_L=15pF$



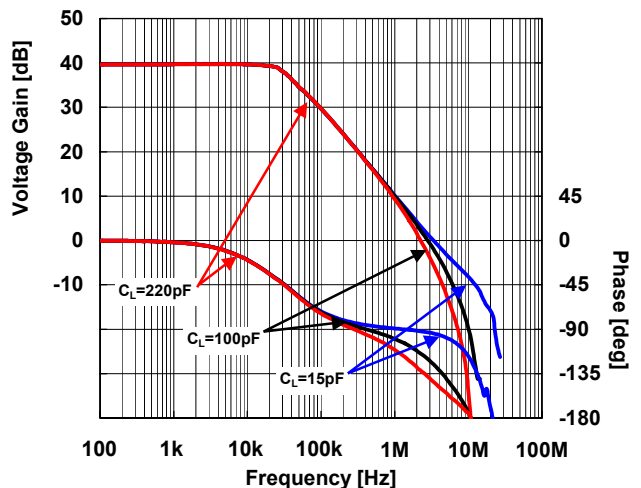
40dB Gain/Phase vs. Frequency (Load Capacitance)
 $V^+=3V$, $V_{COM}=V^+/2$, $G_V=40dB$, $R_S=50\Omega$, $R_L=50k\Omega$, $T_a=25^\circ C$



40dB Gain/Phase vs. Frequency (Temperature)
 $V^+=2.2V$, $V_{COM}=V^+/2$, $G_V=40dB$, $R_T=50\Omega$, $R_L=50k\Omega$, $C_L=15pF$



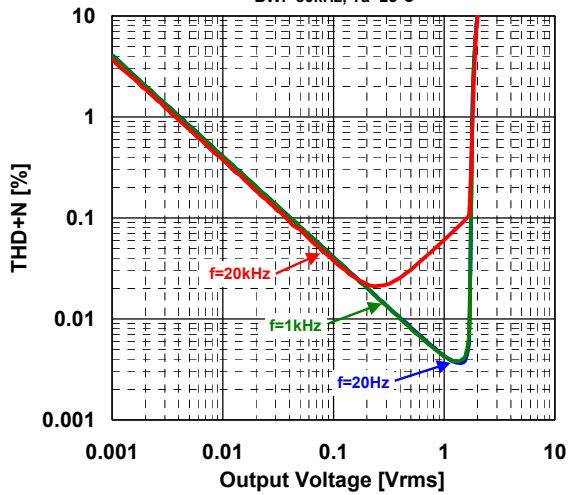
40dB Gain/Phase vs. Frequency (Load Capacitance)
 $V^+=2.2V$, $V_{COM}=V^+/2$, $G_V=40dB$, $R_S=50\Omega$, $R_L=50k\Omega$, $T_a=25^\circ C$



■ TYPICAL CHARACTERISTICS

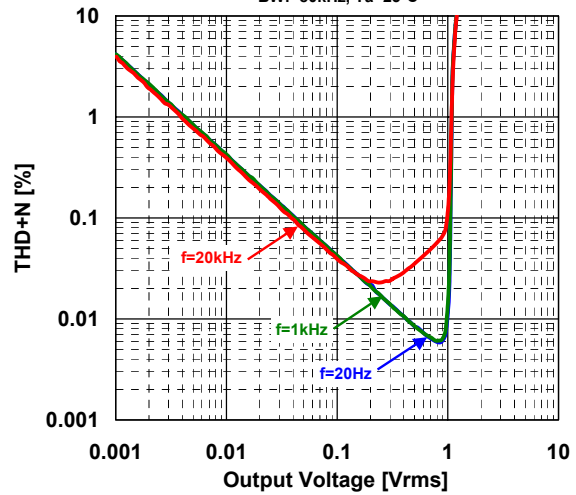
THD+N vs. Output Voltage (Frequency)

$V^+ / V^- = \pm 2.5V$, $R_S = 600\Omega$, $R_L = 50k\Omega$, $G_V = 20dB$,
BW: ~80kHz, $T_a = 25^\circ C$



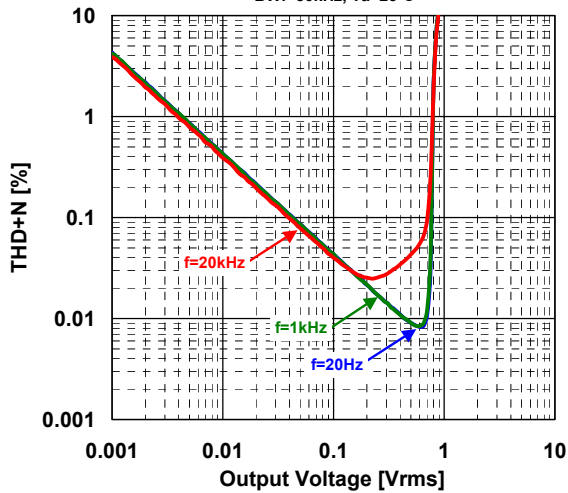
THD+N vs. Output Voltage (Frequency)

$V^+ / V^- = \pm 1.5V$, $R_S = 600\Omega$, $R_L = 50k\Omega$, $G_V = 20dB$,
BW: ~80kHz, $T_a = 25^\circ C$



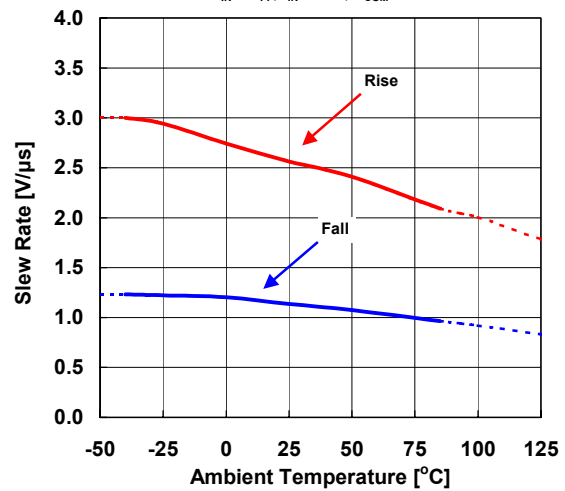
THD+N vs. Output Voltage (Frequency)

$V^+ / V^- = \pm 1.1V$, $R_S = 600\Omega$, $R_L = 50k\Omega$, $G_V = 20dB$,
BW: ~80kHz, $T_a = 25^\circ C$



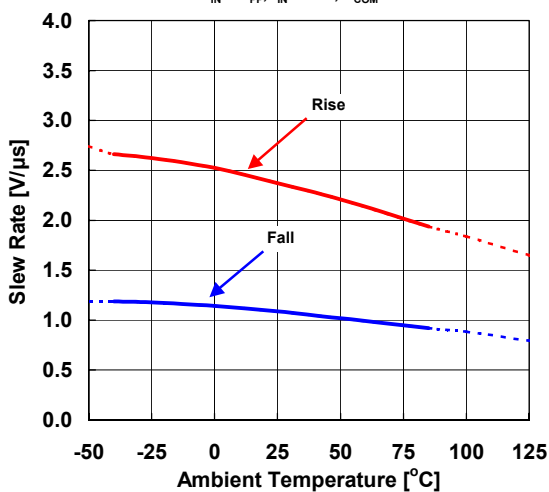
Slew Rate vs. Ambient Temperature

$V^+ / V^- = \pm 2.5V$, $G_V = 0dB$, $R_I = 50\Omega$, $R_L = 50k\Omega$, $C_L = 15pF$,
 $V_{IN} = 2V_{PP}$, $f_{IN} = 1kHz$, $V_{COM} = 0V$



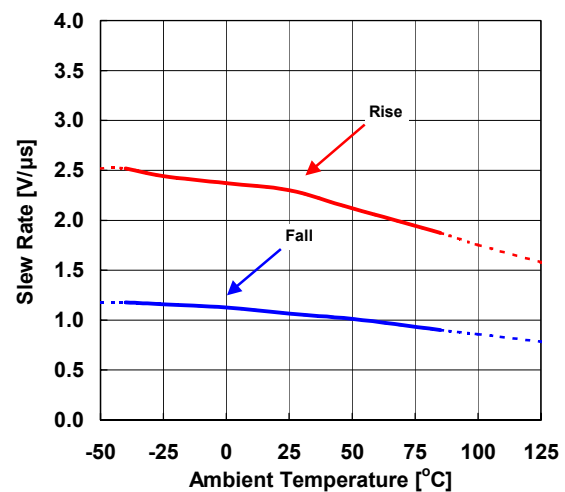
Slew Rate vs. Ambient Temperature

$V^+ / V^- = \pm 1.5V$, $G_V = 0dB$, $R_I = 50\Omega$, $R_L = 50k\Omega$, $C_L = 15pF$,
 $V_{IN} = 1V_{PP}$, $f_{IN} = 1kHz$, $V_{COM} = 0V$

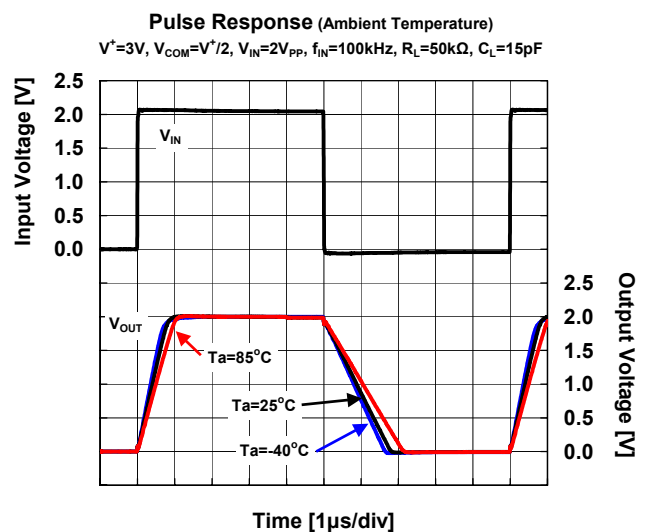
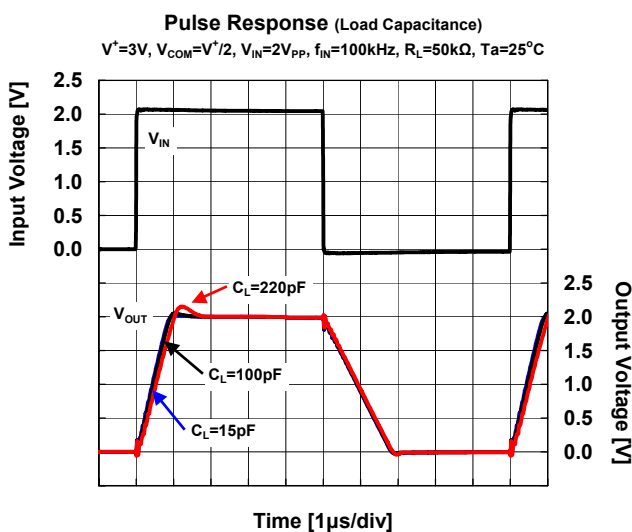
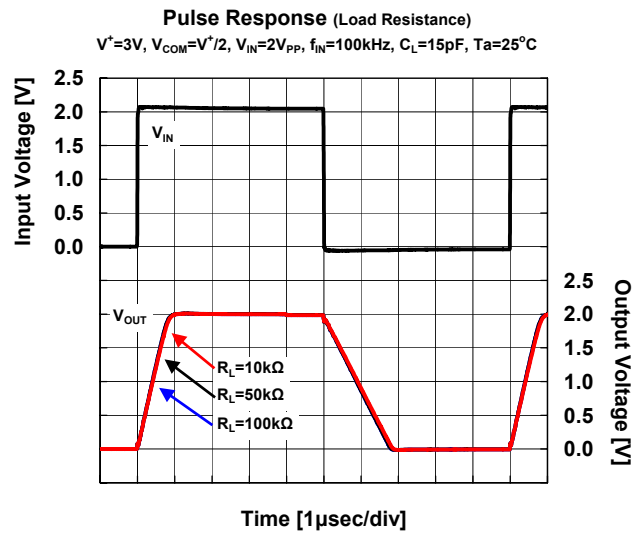
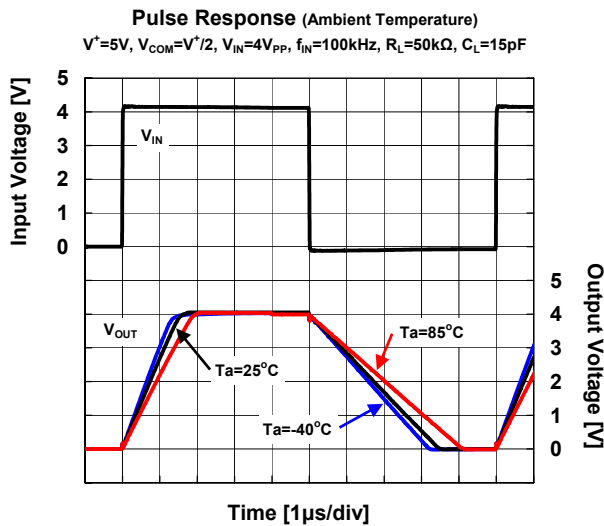
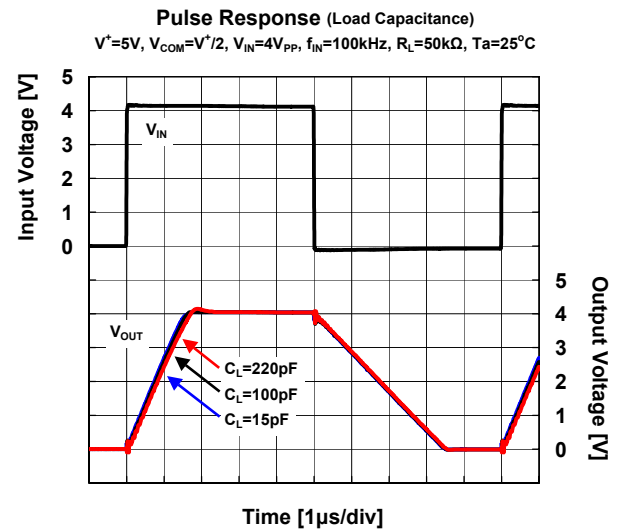
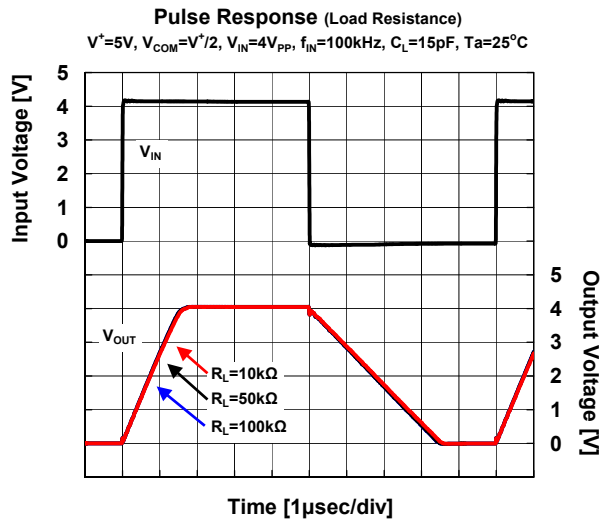


Slew Rate vs. Ambient Temperature

$V^+ / V^- = \pm 1.1V$, $G_V = 0dB$, $R_I = 50\Omega$, $R_L = 50k\Omega$, $C_L = 15pF$,
 $V_{IN} = 1V_{PP}$, $f_{IN} = 1kHz$, $V_{COM} = 0V$

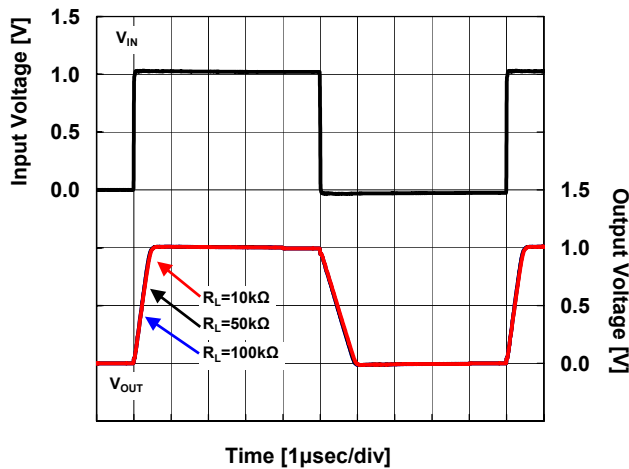


■ TYPICAL CHARACTERISTICS

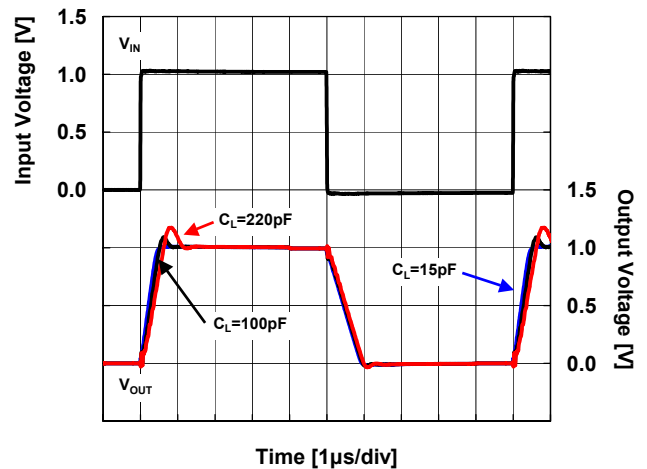


■ TYPICAL CHARACTERISTICS

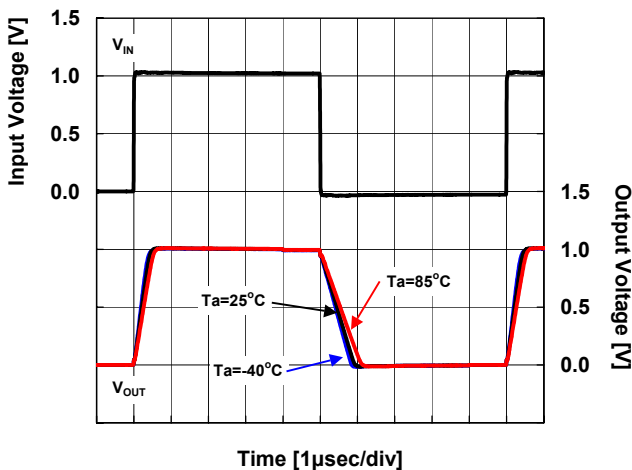
Pulse Response (Load Resistance)
 $V^+=2.2V$, $V_{COM}=V^+/2$, $V_{IN}=1V_{PP}$, $f_{IN}=100kHz$, $C_L=15pF$, $T_a=25^\circ C$



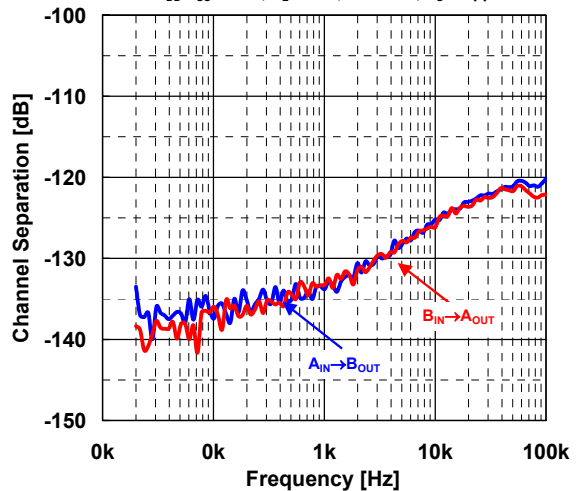
Pulse Response (Load Capacitance)
 $V^+=2.2V$, $V_{COM}=V^+/2$, $V_{IN}=1V_{PP}$, $f_{IN}=100kHz$, $R_L=50k\Omega$, $T_a=25^\circ C$



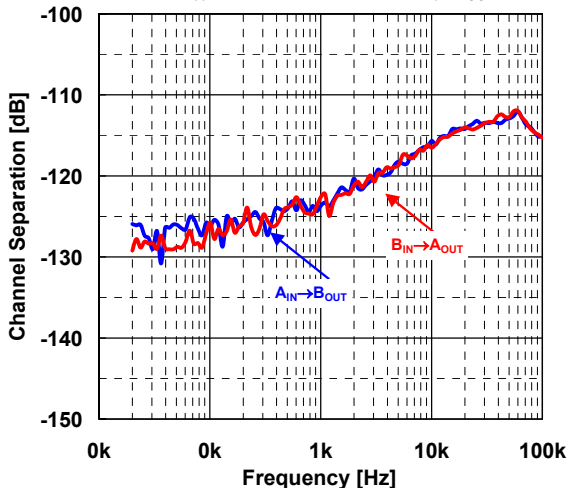
Pulse Response (Ambient Temperature)
 $V^+=2.2V$, $V_{COM}=V^+/2$, $V_{IN}=1V_{PP}$, $f_{IN}=100kHz$, $R_L=50k\Omega$, $C_L=15pF$



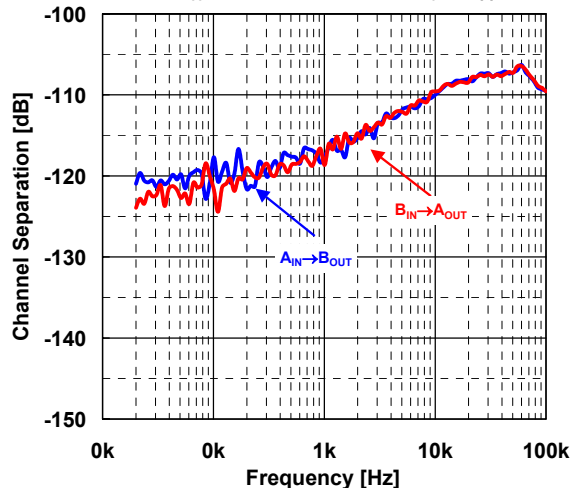
Channel Separation vs. Frequency
 $V_{DD}/V_{SS}=\pm 2.5V$, $R_L=50k\Omega$, $G_v=40dB$, $V_O=3V_{PP}$



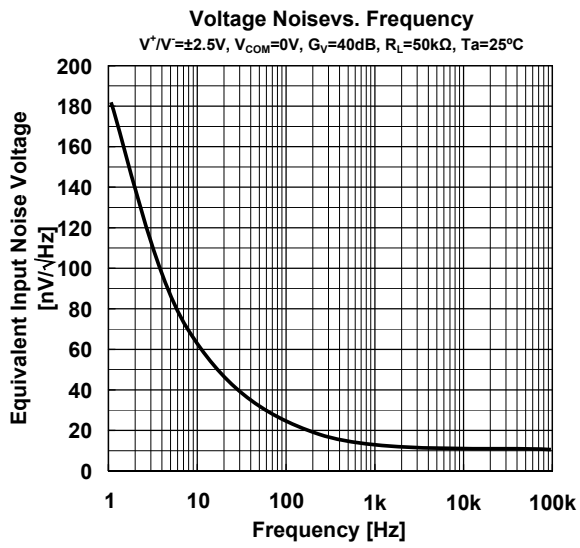
Channel Separation vs. Frequency
 $V_{DD}/V_{SS}=\pm 1.5V$, $R_L=50k\Omega$, $G_v=40dB$, $V_O=1V_{PP}$



Channel Separation vs. Frequency
 $V_{DD}/V_{SS}=\pm 1.1V$, $R_L=50k\Omega$, $G_v=40dB$, $V_O=0.5V_{PP}$



■ TYPICAL CHARACTERISTICS



[CAUTION]
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