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

■ GENERAL DESCRIPTION

The NJU7029 is a dual CMOS operational amplifier with a low noise of VNI=13nV/√Hz (typ. @f=1kHz), Rail-to-Rail output and low operating voltage. It offers a single supply voltage operation from +2.2V to +5.5V, rail-to-rail output swing in both supply rails and input voltage range from ground. Further the NJU7029 has a low bias current of 1pA, which makes it well-suited for current sense amplifiers such as an acceleration sensor, shock sensor and photodiode amplifier. The NJU7029 is available in small surface mount packages of SSOP8, MSOP8 (TVSP8) and an ultra small lead-less package of ESON8 which allows high-density mounting.

■ PACKAGE OUTLINE

NJU7029V
(SSOP8)

NJU7029RB1
(MSOP8(TVSP8))

NJU7029KU1
(ESON8)

■ FEATURES

Low Noise

- ●Voltage Noise 13nV/√Hz (typ.) @f=1kHz
  3μVrms (max.) @f=100Hz~20kHz

Easy to Use

- ●Gain Bandwidth 3MHz
- ●Slew Rate 1V/μs (typ.) @R_L=50kΩ
- ●Isource / Isink 200μA
- ●Specified for +5V, +3V and +2.2V operation

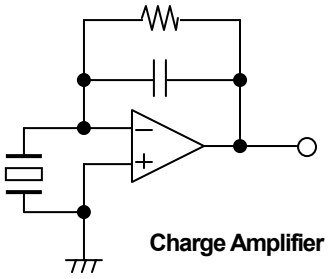
CMOS Process

- ●Input Bias Current 1pA (typ.)
- ●Rail-to-Rail Output
- ●Offset Voltage 5mV (max.)
- ●Offset Voltage Drift 2μV/ºC (typ.)
- ●Supply Range 2.2V ~ 5.5V
- ●Supply Current 850μA /all ch (typ.) @V_{DD}=+5V
- ●Package SSOP8, ESON8
  MSOP8 (TVSP8)MEET JEDEC MO-187-DA / THIN TYPE

■ Application

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

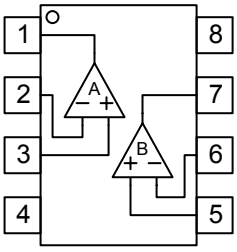
■ Typical Application Circuit



Charge Amplifier

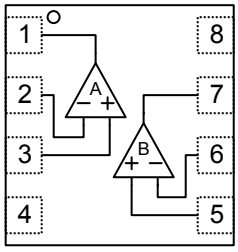
■ PIN CONFIGURATION

(Top View)

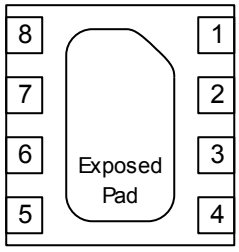


NJU7029V
NJU7029RB1

(Top View)



(Bottom View)



NJU7029KU1

About Exposed Pad
Connect the Exposed Pad on the GND.

1. A OUTPUT
2. A -INPUT
3. A +INPUT
4. GND(V⁻)
5. B +INPUT
6. B –INPUT
7. B OUTPUT
8. V_{DD}

■ 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) MSOP8(TVSP8):410 (Note2) ESON8:360 (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 (76.2x114.3x1.6mm, two layers FR-4)"

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

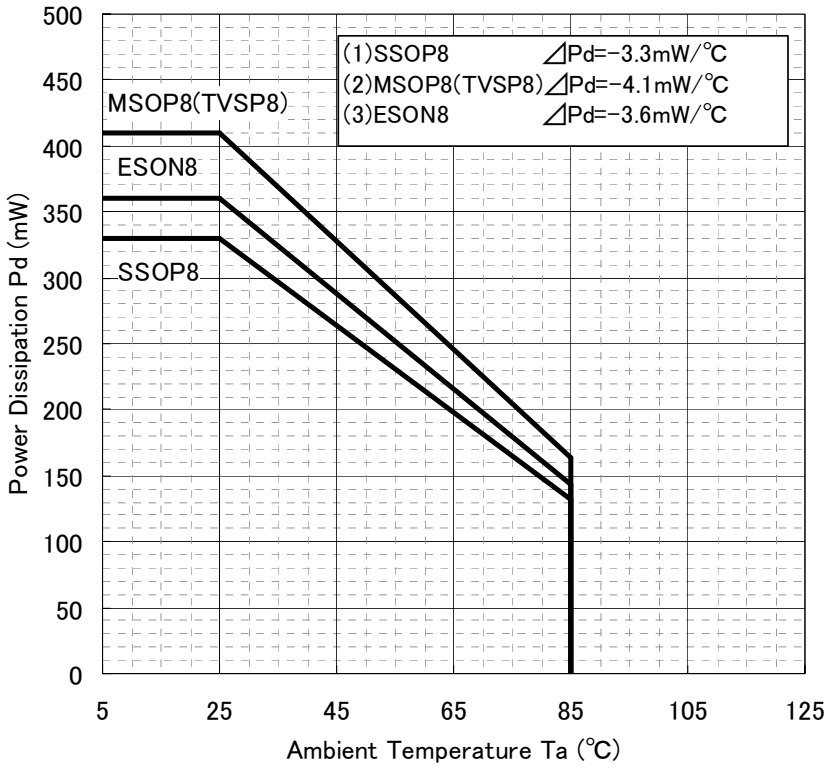


Figure 1 Power Dissipation vs. Ambient Temperature

■ 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, Ta=25˚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	ΔVio/ΔT	V_{IN}=V_{DD}/2, Ta=-40°C~+85°C	-	2	-	μV/°C
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, Vo=2.5V±2V	65	80	-	dB
Common Mode Rejection Ratio	CMR	V_{ICM}=0V~4.1V	65	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	Isource =200uA	4.8	-	-	V
	V_{OL}2	Isink=200uA	-	-	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	Gv=40dB, R_L=50kΩ to 2.5V, C_L=10pF	-	3	-	MHz
Equivalent Input Noise Voltage	V_{NI}	Gv=40dB, R_L=50kΩ to 2.5V, f=1kHz,	-	13	-	nV/√Hz
	V_{NIrms}	Gv=40dB, R_L=50kΩ to 2.5V BPW=100Hz~20kHz	-	1.7	3	μVrms
Total Harmonic Distortion	THD	Gv=20dB, R_L=50kΩ to 2.5V, fin=1kHz, Vout=3Vpp, BPW=400Hz~80kHz	-	0.01	-	%
Channel separation	CS	f=1kHz	-	130	-	dB

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

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

■ +3V ELECTRICAL CHARACTERISTICS

●DC CHARACTERISTICS (V_{DD}=3V, Ta=25˚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	ΔVio/ΔT	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, Vo=1.5V±1V	65	80	-	dB
Common Mode Rejection Ratio	CMR	V_{ICM}=0V~2.1V	65	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
Output Voltage2	V_{OH}2	Isource =200μA	2.8	-	-	V
	V_{OL}2	Isink=200μA	-	-	0.2	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	Gv=40dB, R_L=50kΩ to 1.5V, C_L=10pF	-	3	-	MHz
Equivalent Input Noise Voltage	V_{NI}	Gv=40dB, R_L=50kΩ to 1.5V, f=1kHz	-	13	-	nV/√Hz
	V_{NIrms}	Gv=40dB, R_L=50kΩ to 1.5V, BPW=100Hz~20kHz	-	1.7	3	μVrms
Total Harmonic Distortion	THD	Gv=20dB, R_L=50kΩ to 1.5V, fin=1kHz, Vout=1Vpp, BPW=400Hz~80kHz	-	0.02	-	%
Channel separation	CS	f=1kHz	-	120	-	dB

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

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

■ +2.2V 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	-	550	890	μA
Input offset Voltage	V_{IO}		-	2	5	mV
Input Offset Voltage Drift	ΔVio/ΔT	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, Vo=1.1V±0.5V	60	80	-	dB
Common Mode Rejection Ratio	CMR	V_{ICM}=0V~1.3V	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
Output Voltage2	V_{OH}2	Isource =200μA	2.0	-	-	V
	V_{OL}2	Isink=200μA	-	-	0.2	V
Input Common Mode Voltage Range	V_{ICM}	CMR≥60dB	0	-	1.3	V

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

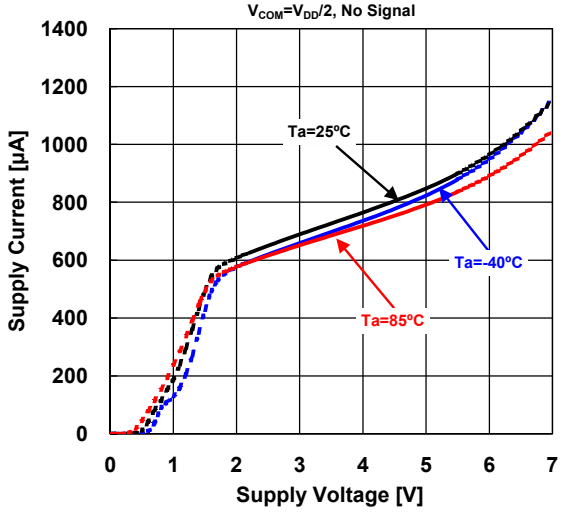
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Frequency	f_T	Gv=40dB, R_L=50kΩ to 1.1V, C_L=10pF	-	3	-	MHz
Equivalent Input Noise Voltage	V_{NI}	Gv=40dB, R_L=50kΩ to 1.1V, f=1kHz	-	13	-	nV/√Hz
	V_{NIrms}	Gv=40dB, R_L=50kΩ to 1.1V, BPW=100Hz~20kHz	-	1.7	3	μVrms
Total Harmonic Distortion	THD	Gv=20dB, R_L=50kΩ to 1.1V, fin=1kHz, Vout=0.5Vpp, BPW=400Hz~80kHz	-	0.02	-	%
Channel separation	CS	f=1kHz	-	115	-	dB

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

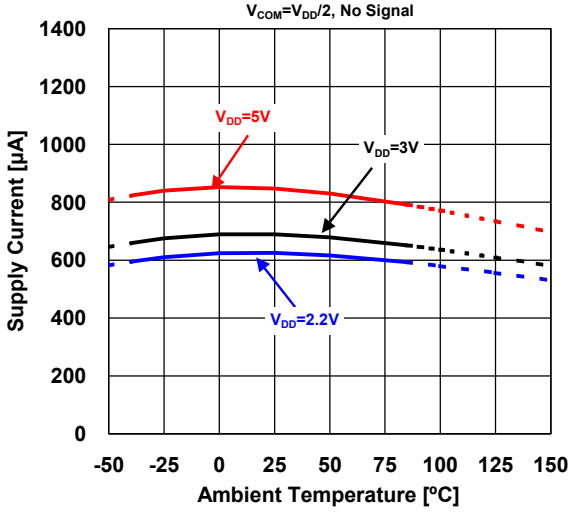
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	Gv=0dB, R_T=50Ω to 1.1V, R_L=50kΩ to 1.5V, C_L=15pF	-	1	-	V/μs

TYPICAL CHARACTERISTICS

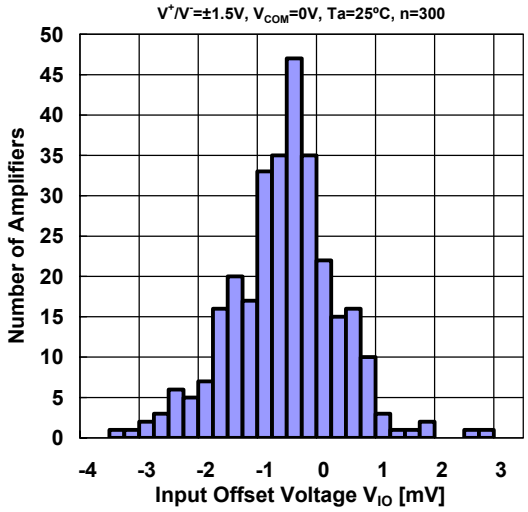
Supply Current vs. Supply Voltage
$V_{COM}=V_{DD}/2$, No Signal



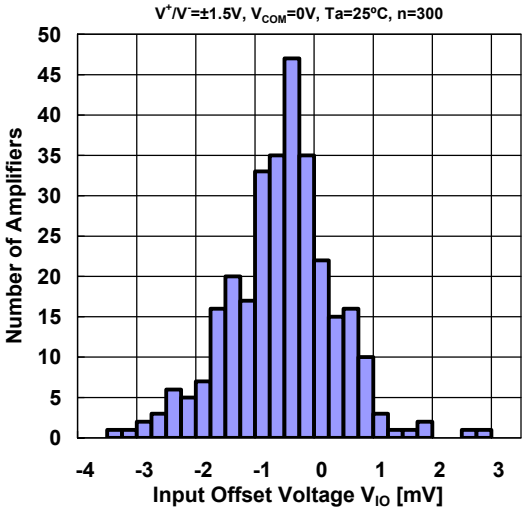
Supply Current vs. Temperature
$V_{COM}=V_{DD}/2$, No Signal



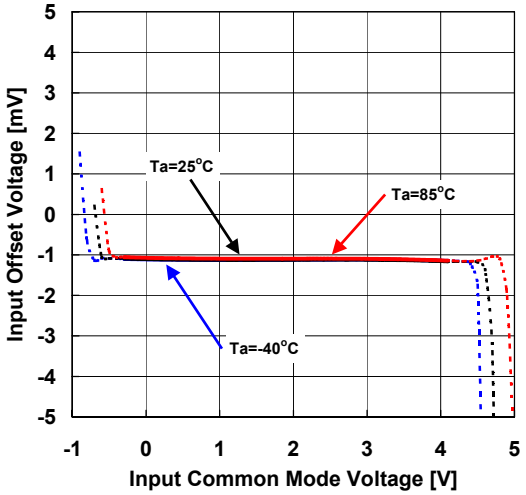
Input Offset Voltage Distribution
V^+/V^-=±1.5V, V_{COM}=0V, Ta=25°C, n=300



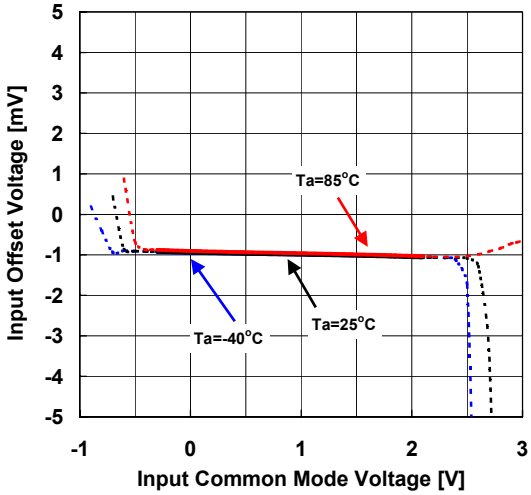
Input Offset Voltage Distribution
V^+/V^-=±1.5V, V_{COM}=0V, Ta=25°C, n=300



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

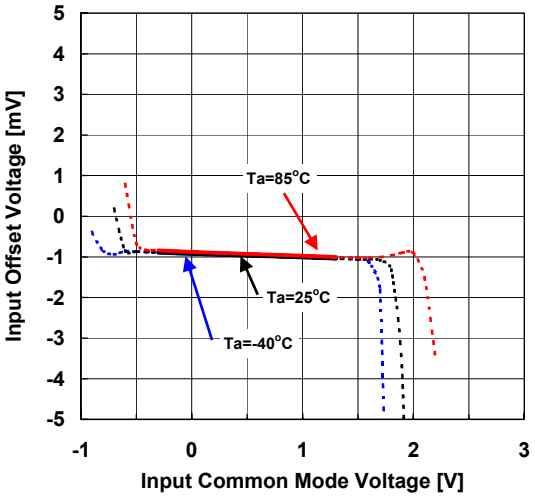


Input Offset Voltage
vs. Input Common Mode Voltage
V^+=3V, $V_{CM}=V^+/2$

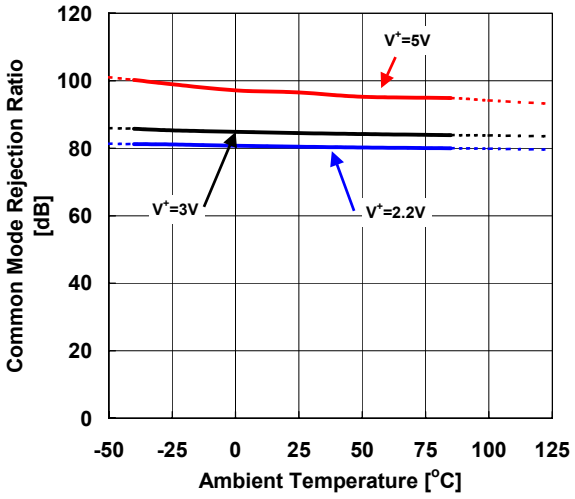


■ TYPICAL CHARACTERISTICS

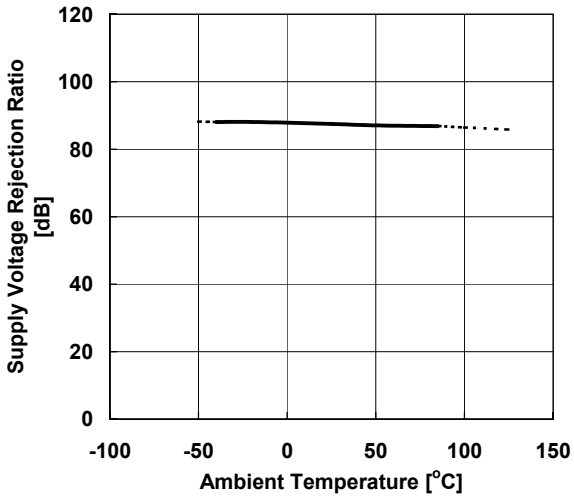
Input Offset Voltage
vs. Input Common Mode Voltage
V^+=2.2V, V_{COM}=V^+/2



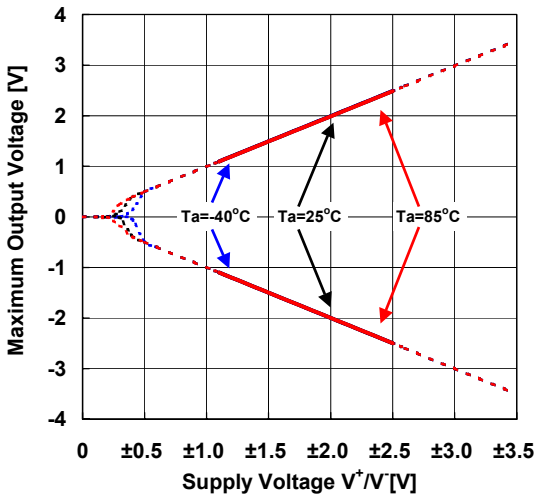
Common Mode Rejection Ratio
vs. Ambient Temperature
V_{ICM}=0V to V^+-0.9V, V_{COM}=V^+/2



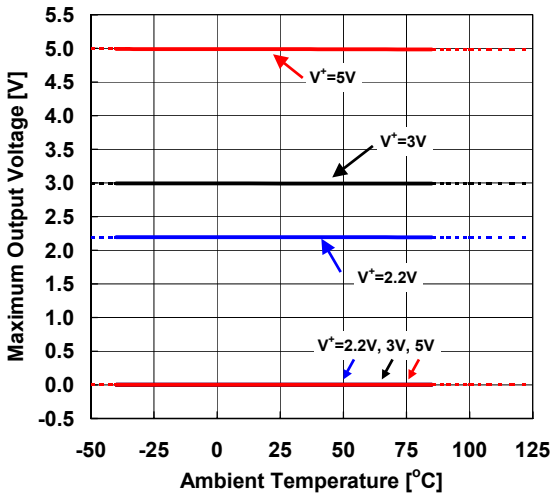
Supply Voltage Rejection Ratio
vs. Ambient Temperature
V^+=2.2V to 5.5V, V_{ICM}=V^+/2, V_{COM}=V^+/2



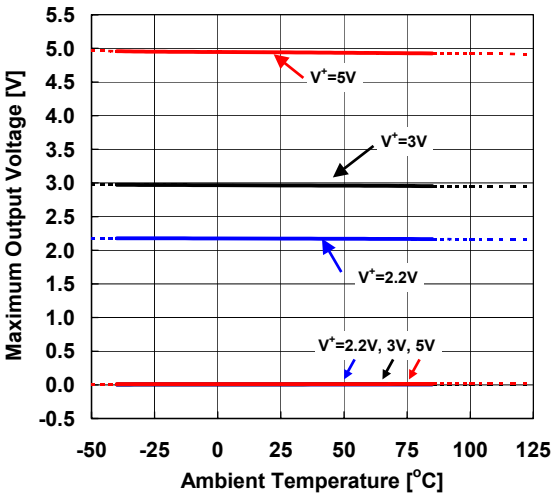
Maximum Output Voltage vs. Supply Voltage
V_{IN}=±0.5V, V_{COM}=0V, R_L=50kΩ



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

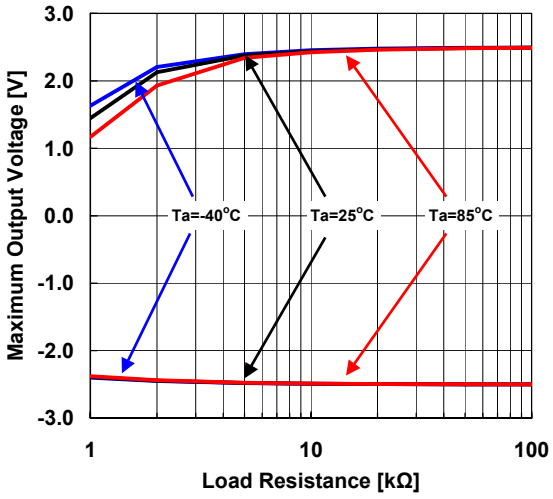


Maximum Output Voltage vs. Ambient Temperature
R_L=10kΩ to V_{COM}

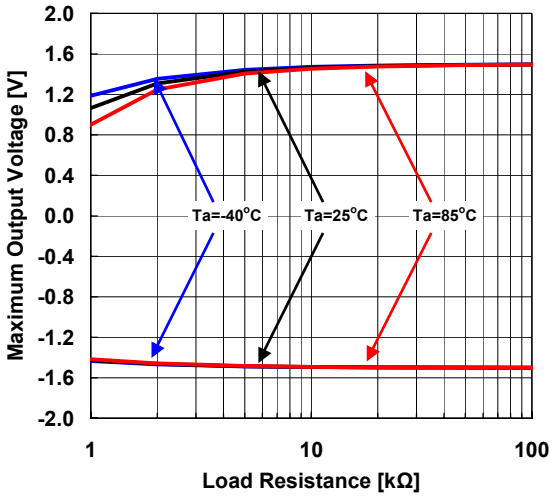


■ TYPICAL CHARACTERISTICS

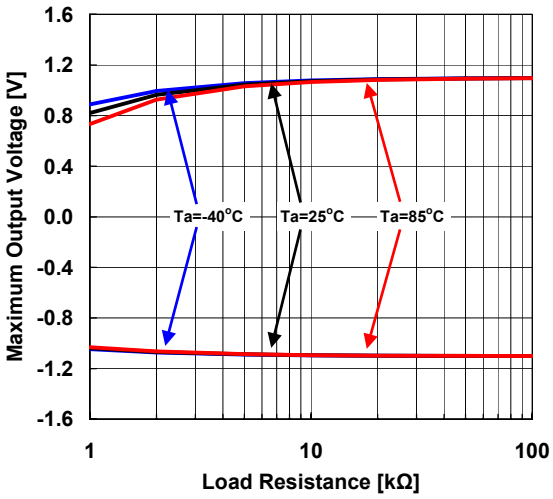
Maximum Output Voltage vs. Load Resistance
V^+/V^-=±2.5V, V_{IN}^+=±0.1V, V_{IN}^-=0V, V_{COM}=0V



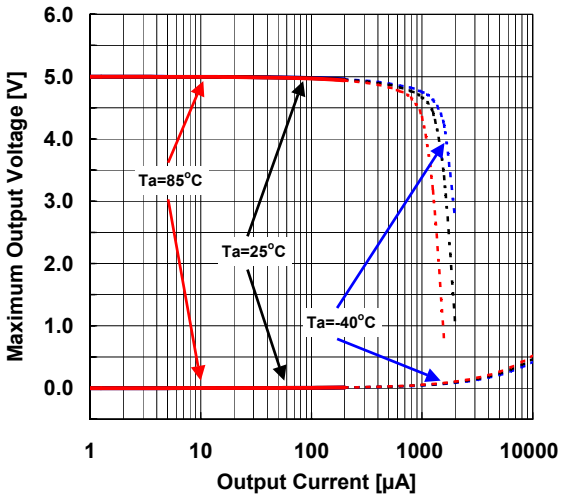
Maximum Output Voltage vs. Load Resistance
V^+/V^-=±1.5V, V_{IN}^+=±0.1V, V_{IN}^-=0V, V_{COM}=0V



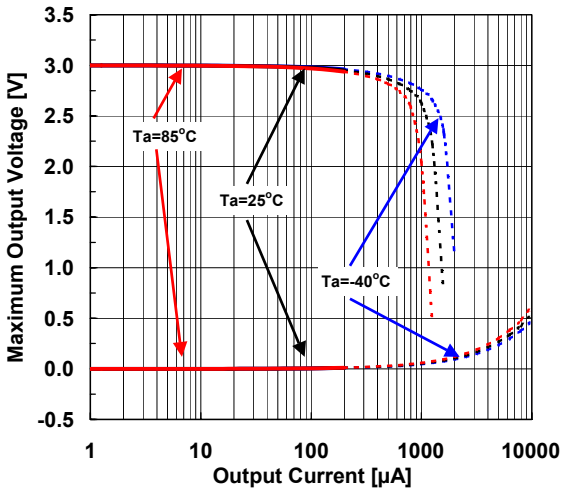
Maximum Output Voltage vs. Load Resistance
V^+/V^-=±1.1V, V_{IN}^+=±0.1V, V_{IN}^-=0V, V_{COM}=0V



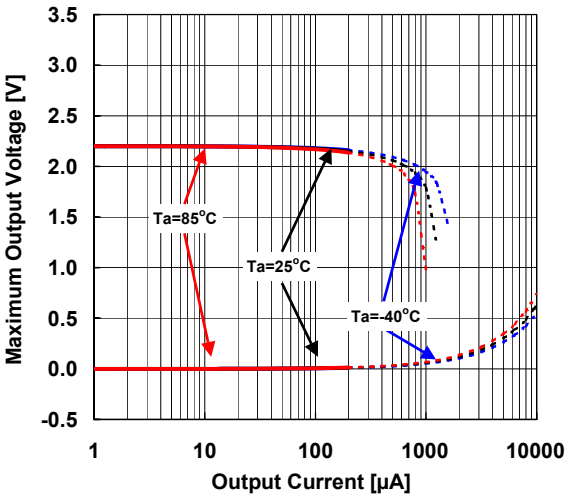
Maximum Output Voltage vs. Output Current
V^+=5V



Maximum Output Voltage vs. Output Current
V^+=3V



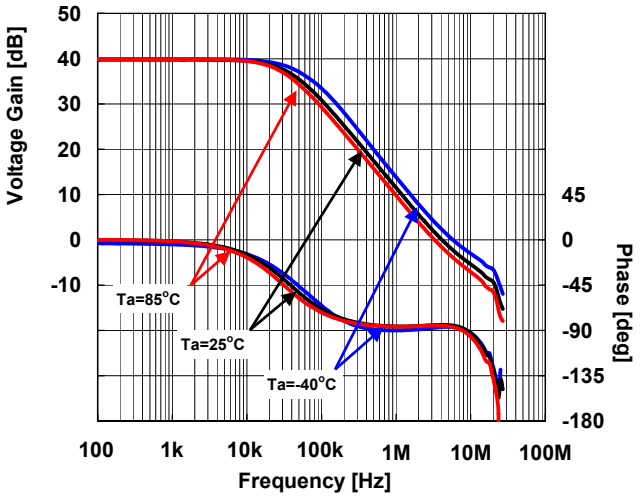
Maximum Output Voltage vs. Output Current
V^+=2.2V



■ TYPICAL CHARACTERISTICS

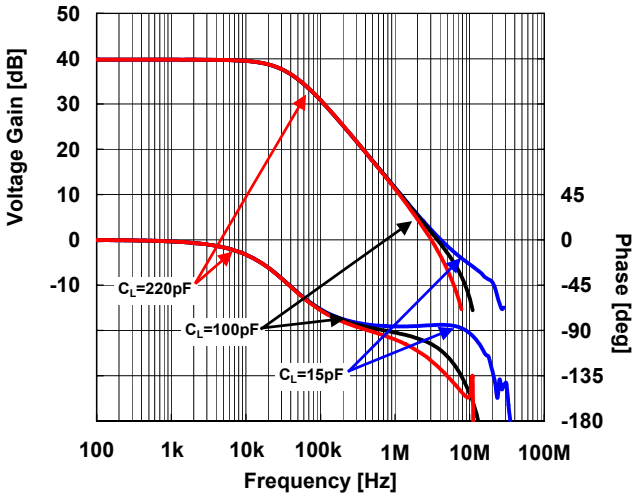
40dB Gain/Phase vs. Frequency

V^+=5V, V_{COM}=V^+/2, G_V=40dB, R_T=50Ω, R_L=50kΩ, C_L=15pF



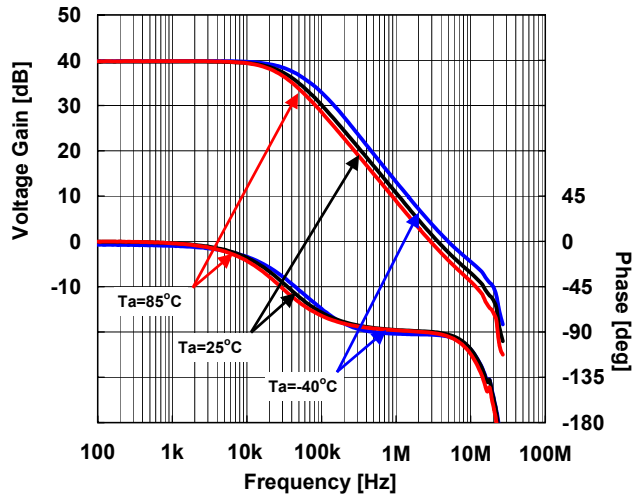
40dB Gain/Phase vs. Frequency

V^+=5V, V_{COM}=V^+/2, G_V=40dB, R_S=50Ω, R_L=50kΩ, Ta=25°C



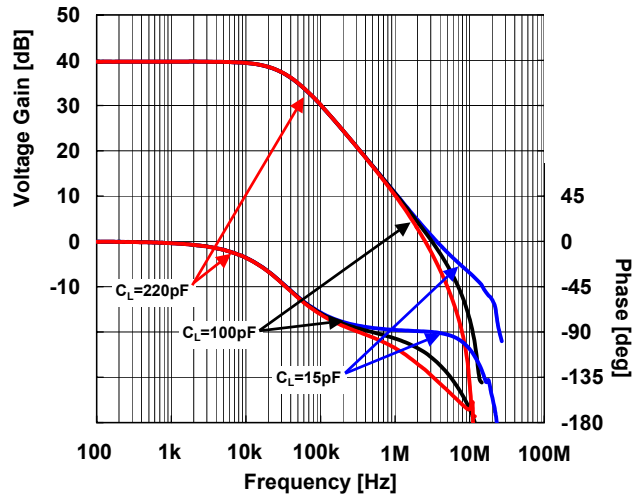
40dB Gain/Phase vs. Frequency

V^+=3V, V_{COM}=V^+/2, G_V=40dB, R_T=50Ω, R_L=50kΩ, C_L=15pF



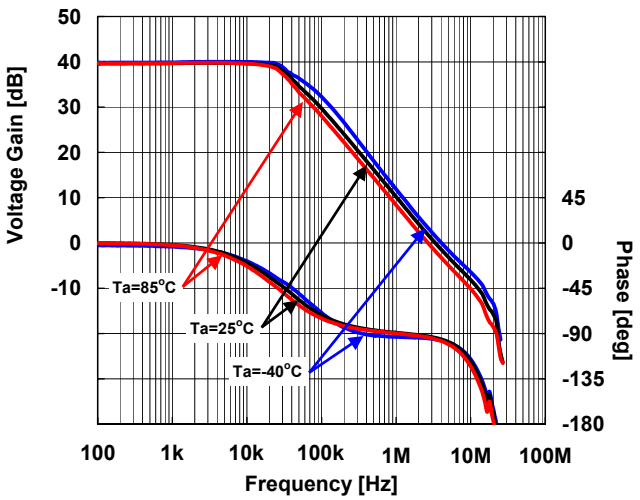
40dB Gain/Phase vs. Frequency

V^+=3V, V_{COM}=V^+/2, G_V=40dB, R_S=50Ω, R_L=50kΩ, Ta=25°C



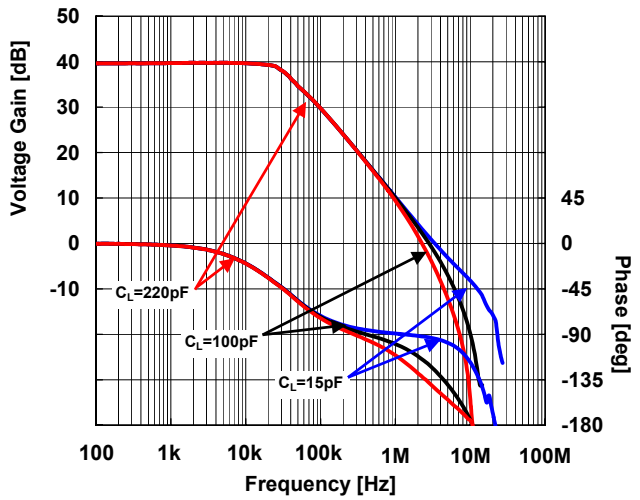
40dB Gain/Phase vs. Frequency

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



40dB Gain/Phase vs. Frequency

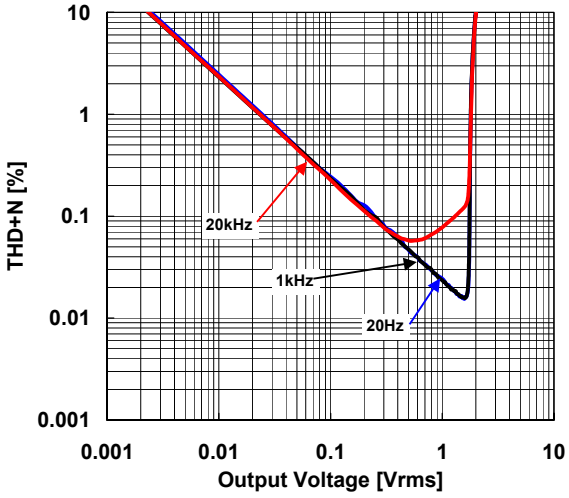
V^+=2.2V, V_{COM}=V^+/2, G_V=40dB, R_S=50Ω, R_L=50kΩ, Ta=25°C



■ TYPICAL CHARACTERISTICS

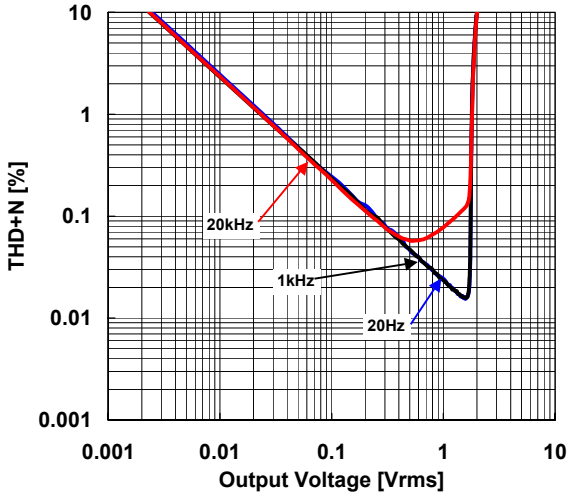
THD+N vs. Output Voltage

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



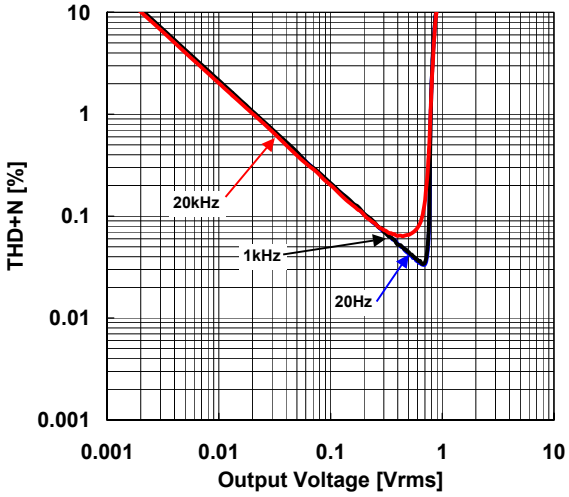
THD+N vs. Output Voltage

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



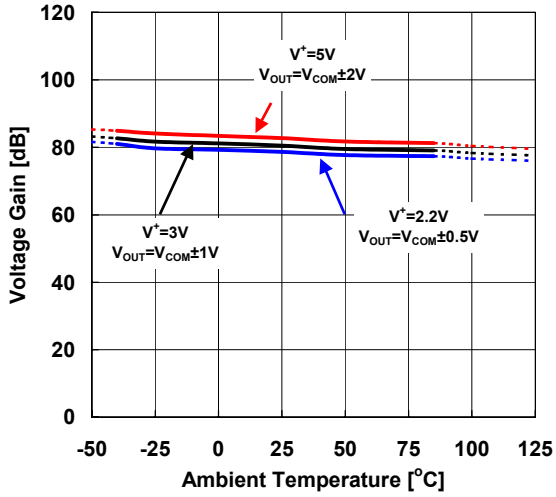
THD+N vs. Output Voltage

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



Voltage Gain vs. Ambient Temperature

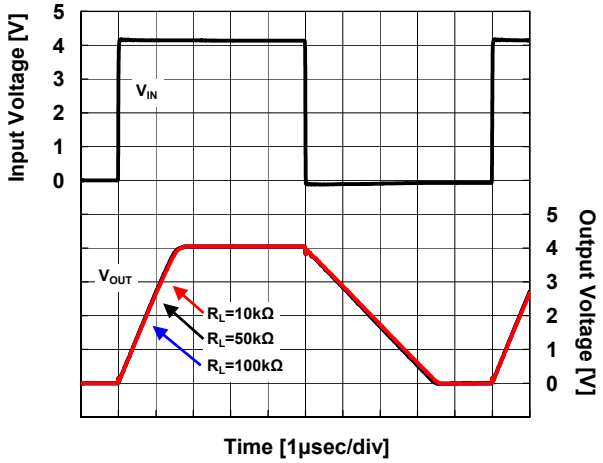
$V_{COM}=V^+/2$, R_L=50kΩ to V_{COM}



■ TYPICAL CHARACTERISTICS

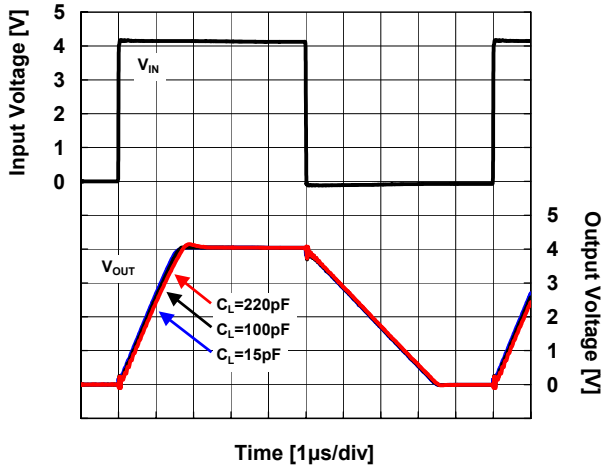
Pulse Response

V^+=5V, V_{COM}=V^+/2, V_{IN}=4V_{PP}, f_{IN}=100kHz, C_L=15pF, Ta=25°C



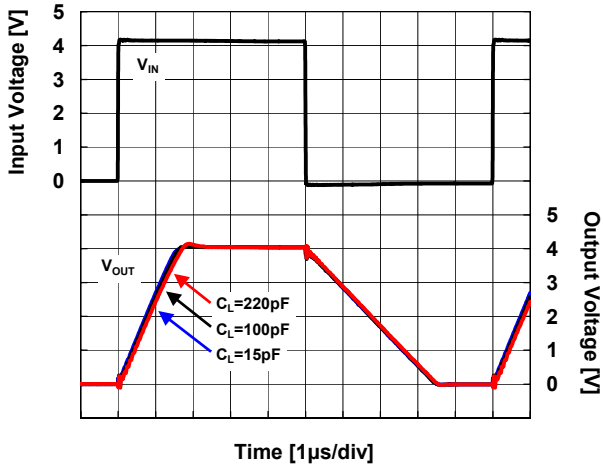
Pulse Response

V^+=5V, V_{COM}=V^+/2, V_{IN}=4V_{PP}, f_{IN}=100kHz, R_L=50kΩ, Ta=25°C



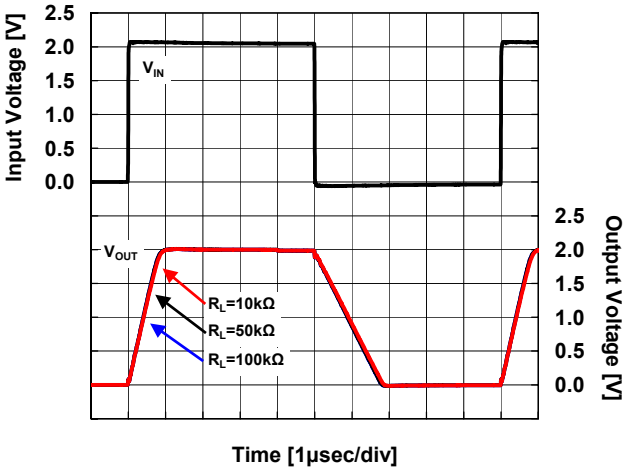
Pulse Response

V^+=5V, V_{COM}=V^+/2, V_{IN}=4V_{PP}, f_{IN}=100kHz, R_L=50kΩ, Ta=25°C



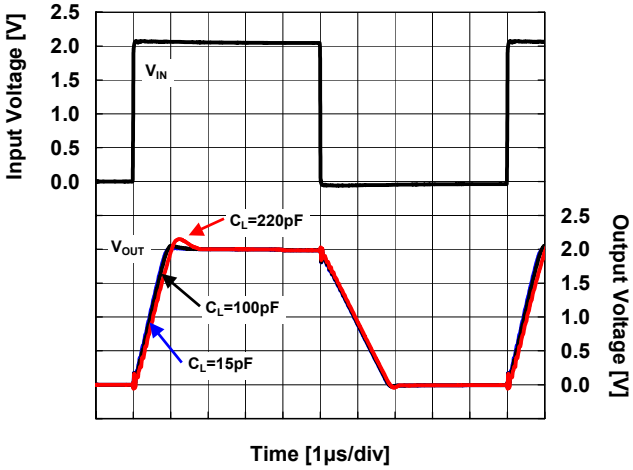
Pulse Response

V^+=3V, V_{COM}=V^+/2, V_{IN}=2V_{PP}, f_{IN}=100kHz, C_L=15pF, Ta=25°C



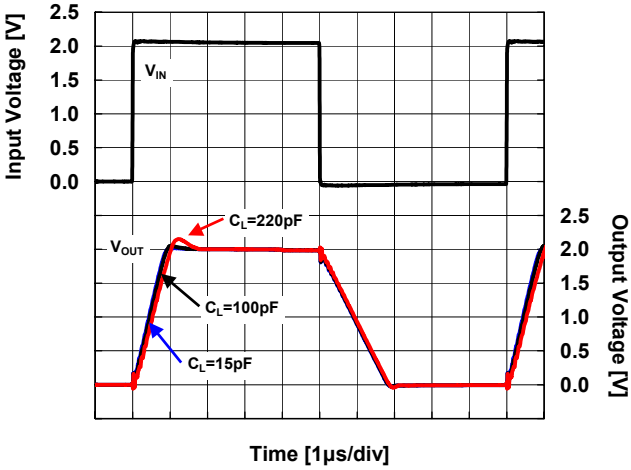
Pulse Response

V^+=3V, V_{COM}=V^+/2, V_{IN}=2V_{PP}, f_{IN}=100kHz, R_L=50kΩ, Ta=25°C



Pulse Response

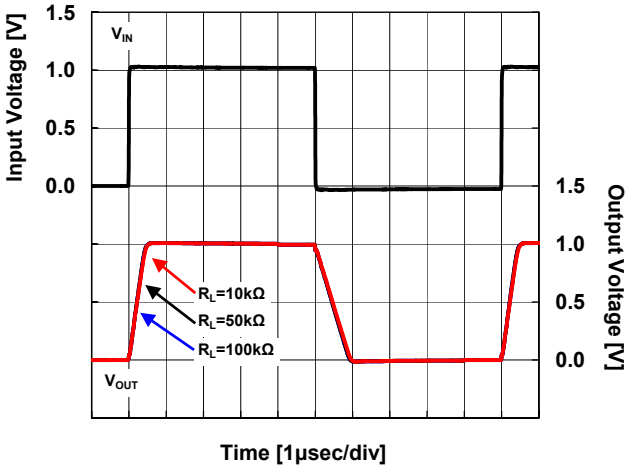
V^+=3V, V_{COM}=V^+/2, V_{IN}=2V_{PP}, f_{IN}=100kHz, R_L=50kΩ, Ta=25°C



■ TYPICAL CHARACTERISTICS

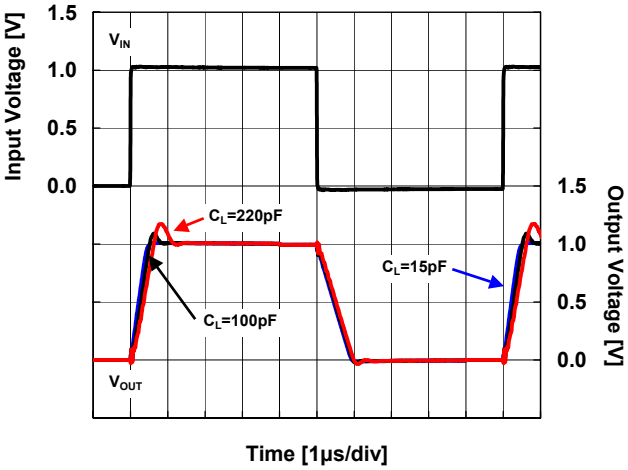
Pulse Response

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



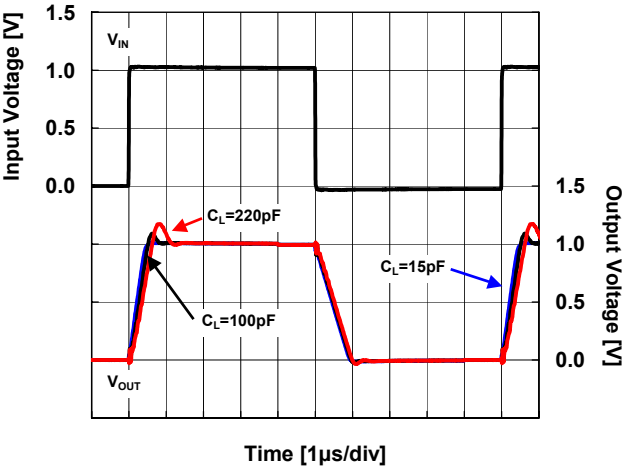
Pulse Response

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



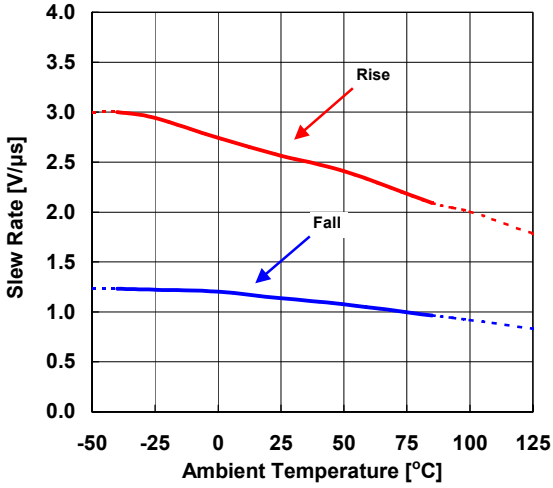
Pulse Response

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



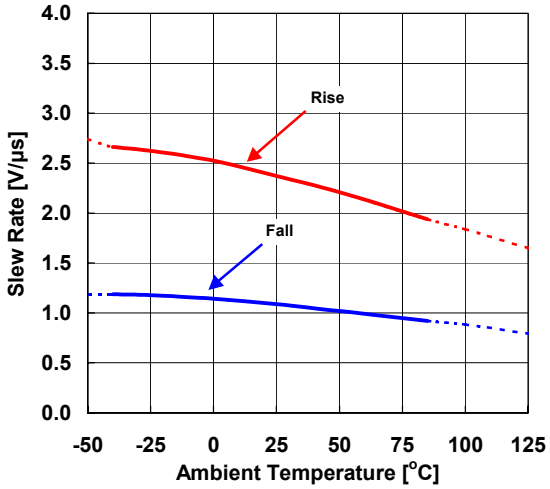
Slew Rate vs. Ambient Temperature

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



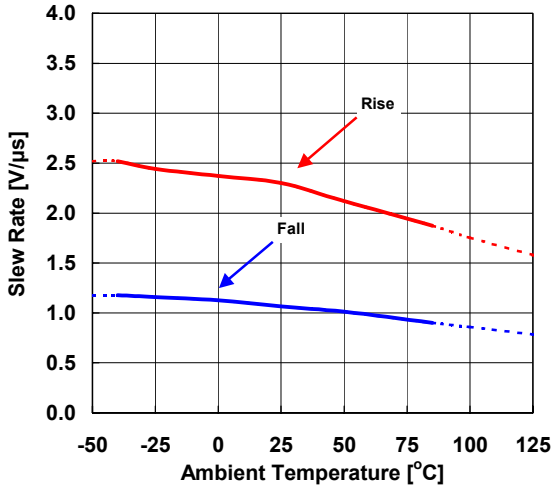
Slew Rate vs. Ambient Temperature

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

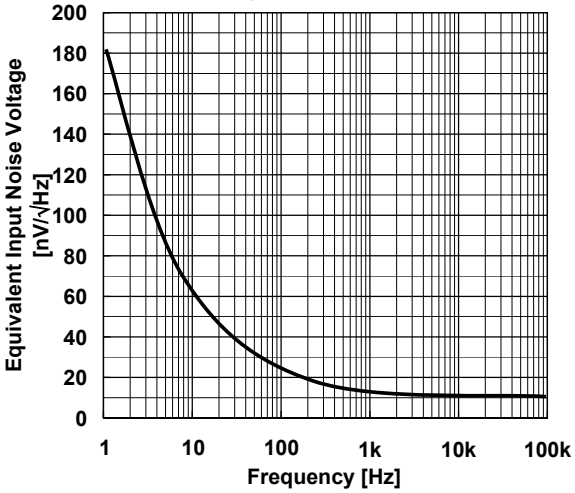
V^+/V^-=±1.1V, G_V=0dB, R_T=50Ω, R_L=50kΩ, C_L=15pF,
V_{IN}=1V_{PP},f_{IN}=1kHz, V_{COM}=0V



■ TYPICAL CHARACTERISTICS

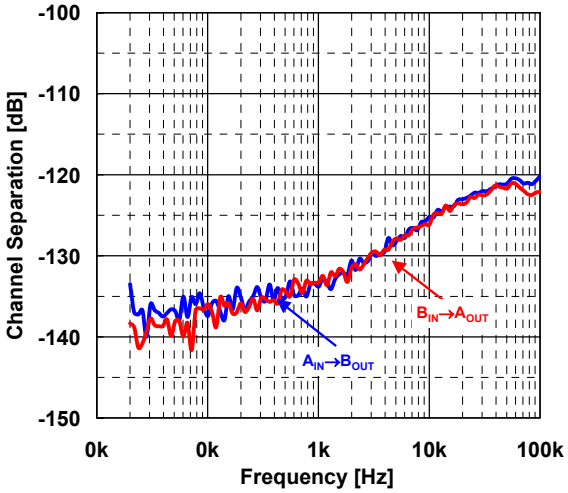
Voltage Noisevs. Frequency

V^+/V^-=±2.5V, V_{COM}=0V, G_V=40dB, R_L=50kΩ, Ta=25ºC



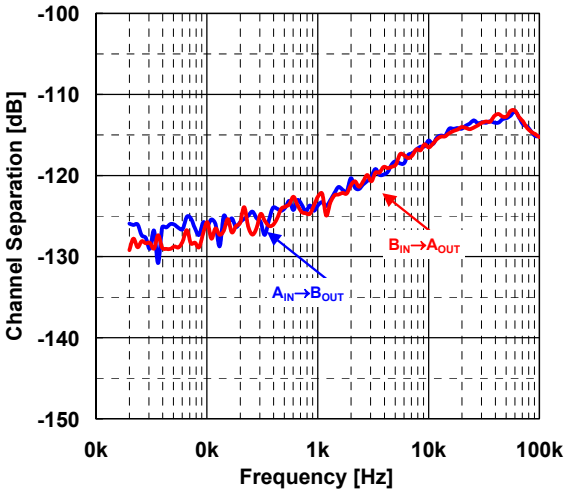
Channel Separation vs. Frequency

V_{DD}/V_{SS}=±2.5V, R_L=50kΩ, Gv=40dB, V_O=3Vpp



Channel Separation vs. Frequency

V_{DD}/V_{SS}=±1.5V, R_L=50kΩ, Gv=40dB, V_O=1Vpp



Channel Separation vs. Frequency

V_{DD}/V_{SS}=±1.1V, R_L=50kΩ, Gv=40dB, V_O=0.5Vpp