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}=13V/√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

NJU7009V

NJU7009RB1

■ 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

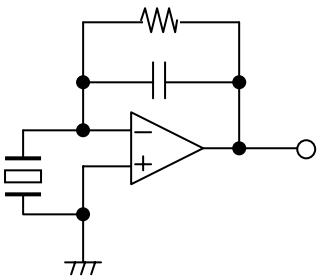
- ●Input Bias Current 1pA (typ.)
- ●Rail-to-Rail Output

- ●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, TVSP8

■ Application

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

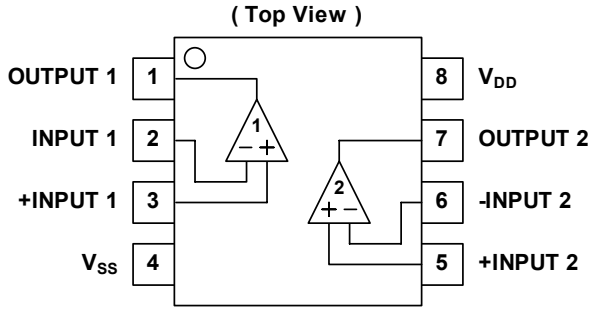
■ Typical Application Circuit



Charge Amplifier

■ PIN CONFIGURATION

(Top View)



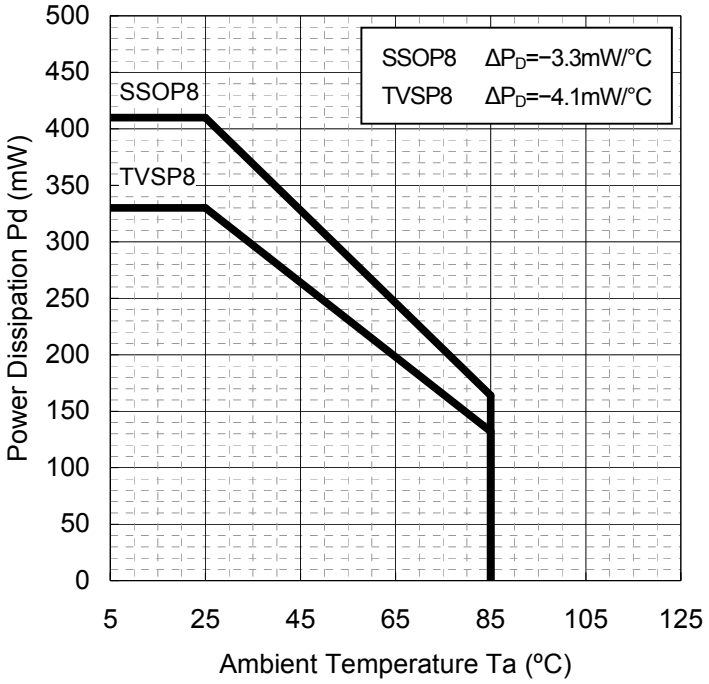
■ ABSOLUTE MAXIMUM RATINGS (Ta=25˚C)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V_{DD}	+7	V
Common Mode Input Voltage Range	V_{ICM}	-0.3~+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.



Fifure1 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)

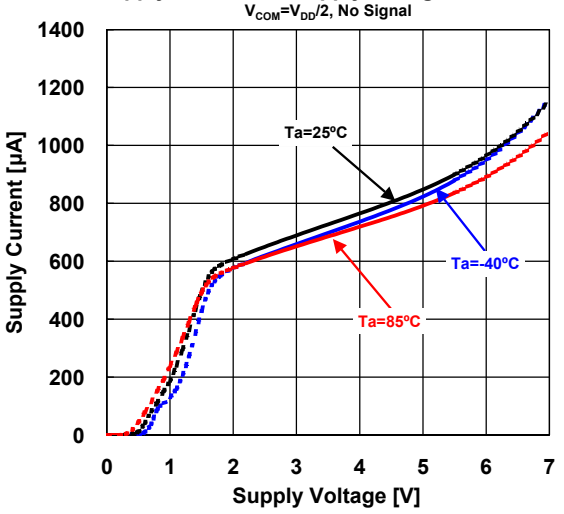
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Frequency	f_T	Gv=40dB, R_L=50kΩ to 1.1V, C_L=10pF	-	3	-	MHz
Equivalent Input Noise Voltage	V_{NI}	Gv=40dB, R_L=50kΩ to 1.1V, f=1kHz	-	13	-	nV/√Hz
	V_{NIrms}	Gv=40dB, R_L=50kΩ to 1.1V, BPW=100Hz~20kHz	-	1.7	3	µVrms
Total Harmonic Distortion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

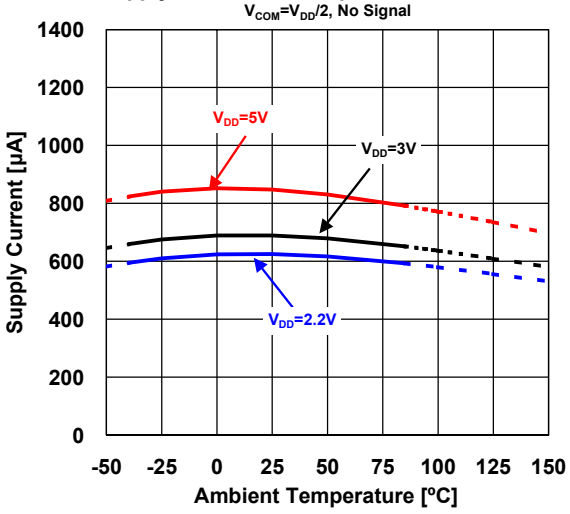
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	Gv=0dB, R_T=50Ω to 1.1V, R_L=50kΩ to 1.5V, C_L=15pF	-	1	-	V/µs

■ TYPICAL CHARACTERISTICS

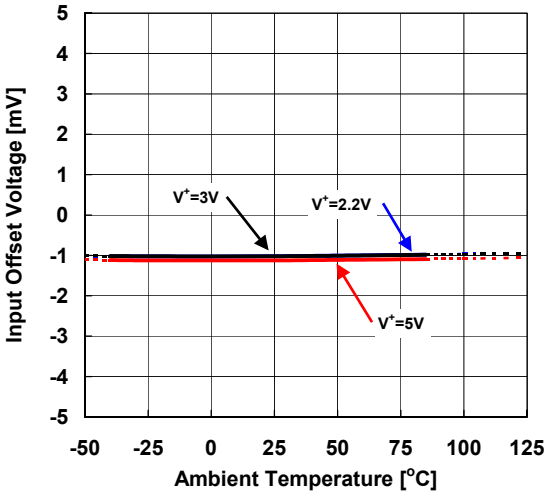
Supply Current vs. Supply Voltage (Temperature)
$V_{COM}=V_{DD}/2$, No Signal



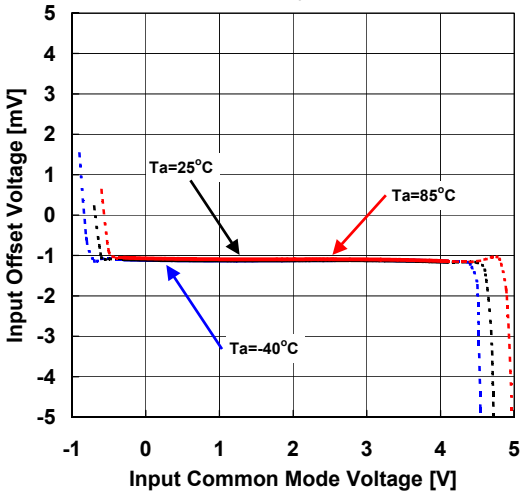
Supply Current vs. Temperature (Supply Voltage)
$V_{COM}=V_{DD}/2$, No Signal



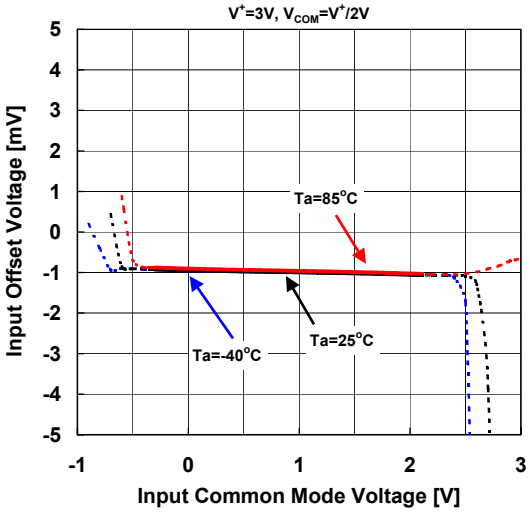
Input Offset Voltage vs. Ambient Temperature
(Supply Voltage)
$V_{ICM}=V^+/2V$, $V_{COM}=V^+/2V$



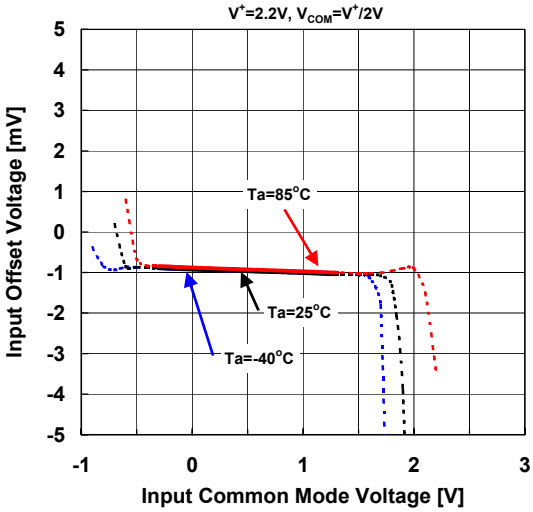
Input Offset Voltage vs. Input Common Mode Voltage
(Ambient Temperature)
$V^+=5V$, $V_{COM}=V^+/2V$



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

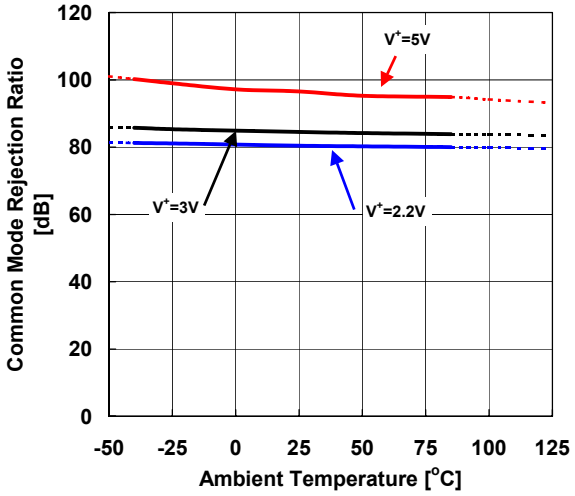


Input Offset Voltage vs. Input Common Mode Voltage
(Ambient Temperature)
$V^+=2.2V$, $V_{COM}=V^+/2V$

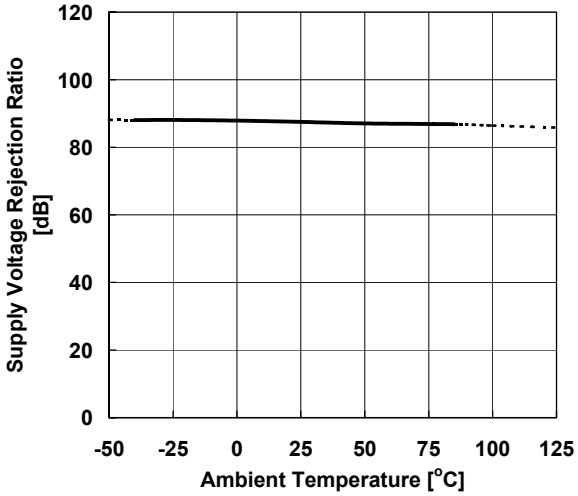


■ TYPICAL CHARACTERISTICS

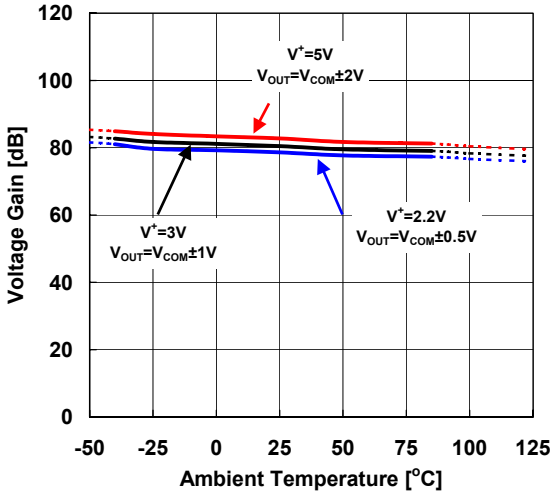
Common Mode Rejection Ratio1
vs. Ambient Temperature
V_{ICM}=0V to V^+-0.9V, V_{COM}=V^+/2V



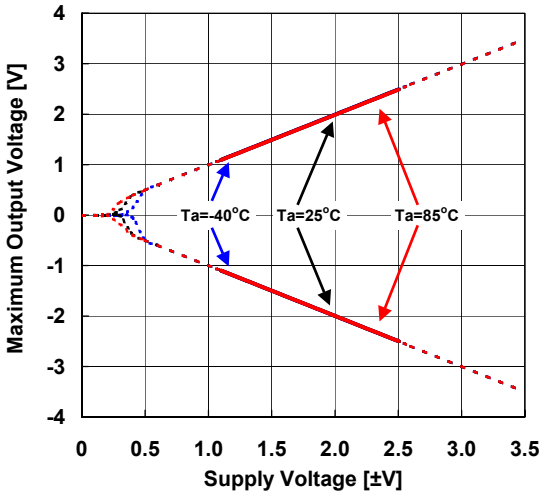
Supply Voltage Rejection Ratio
vs. Ambient Temperature
V^+=2.2V to 5.5V, V_{ICM}=V^+/2, V_{COM}=V^+/2V



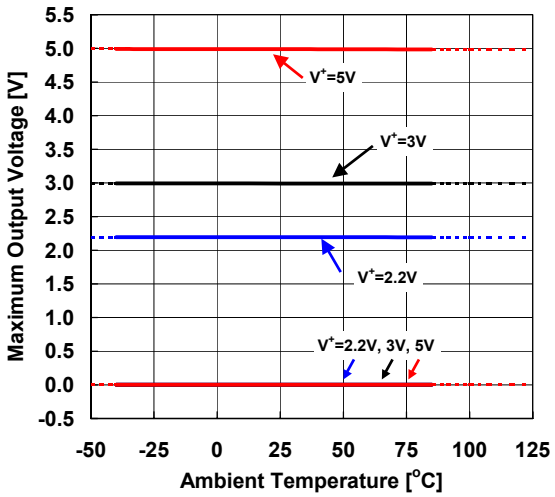
Voltage Gain vs. Ambient Temperature
V_{COM}=V^+/2V, R_L=50kΩ to V_{COM}



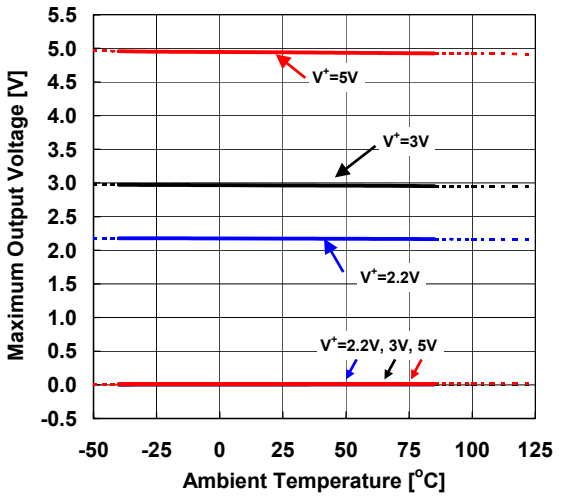
Maximum Output Voltage vs. Supply Voltage
(Ambient Temperature)
V_{IN}=±0.5V, V_{COM}=0V, R_L=50kΩ



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

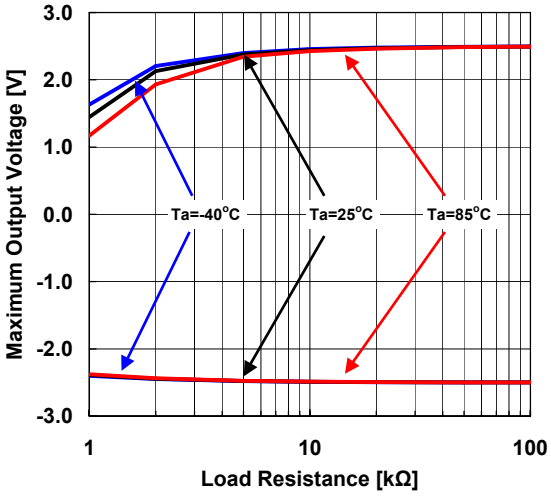


Maximum Output Voltage vs. Ambient Temperature
R_L=10kΩ to V_{COM}

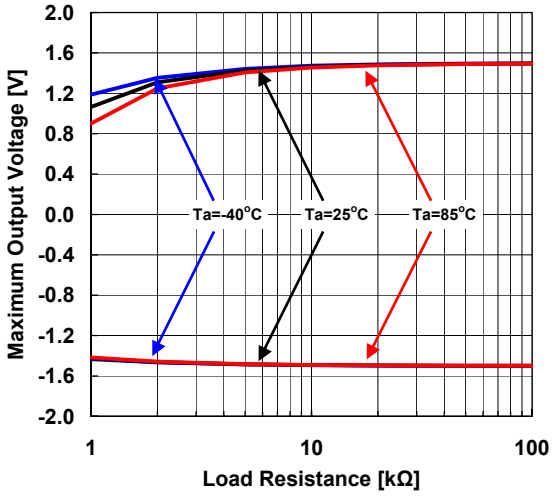


■ TYPICAL CHARACTERISTICS

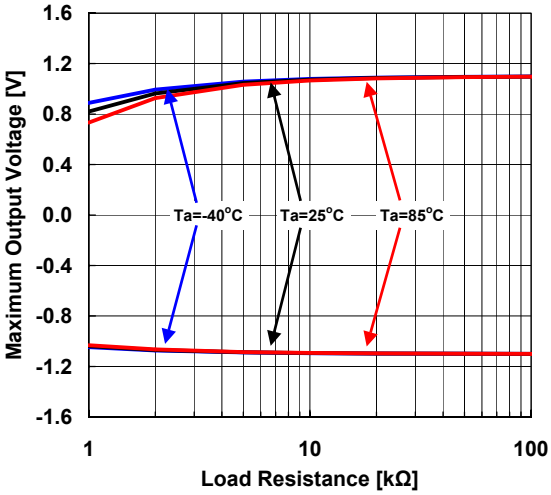
Maximum Output Voltage vs. Load Resistance
(Ambient Temperature)
V^+/V^-=±2.5V, V_{IN}^+=±0.1V, V_{IN}^-=0V, V_{COM}=0V



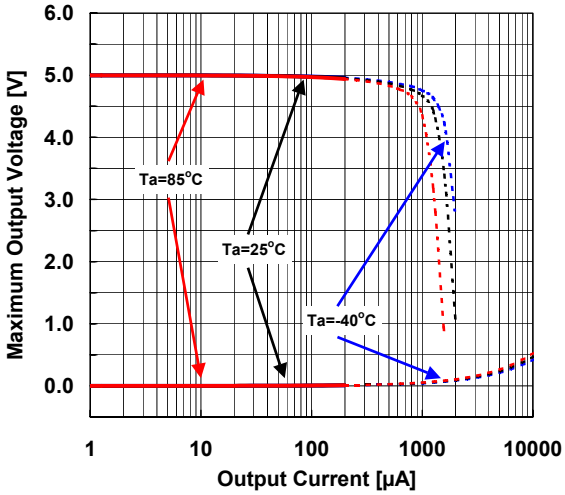
Maximum Output Voltage vs. Load Resistance
(Ambient Temperature)
V^+/V^-=±1.5V, V_{IN}^+=±0.1V, V_{IN}^-=0V, V_{COM}=0V



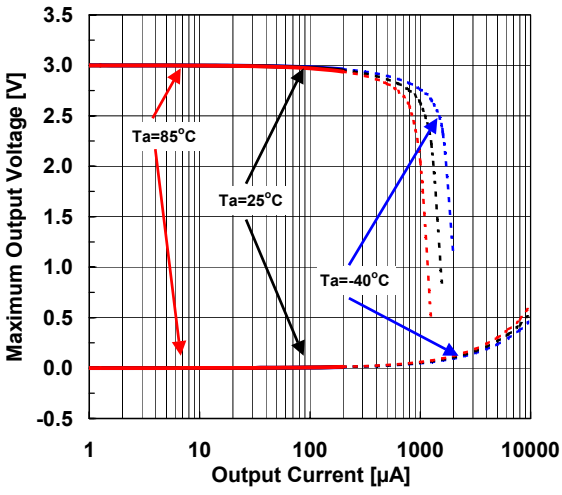
Maximum Output Voltage vs. Load Resistance
(Ambient Temperature)
V^+/V^-=±1.1V, V_{IN}^+=±0.1V, V_{IN}^-=0V, V_{COM}=0V



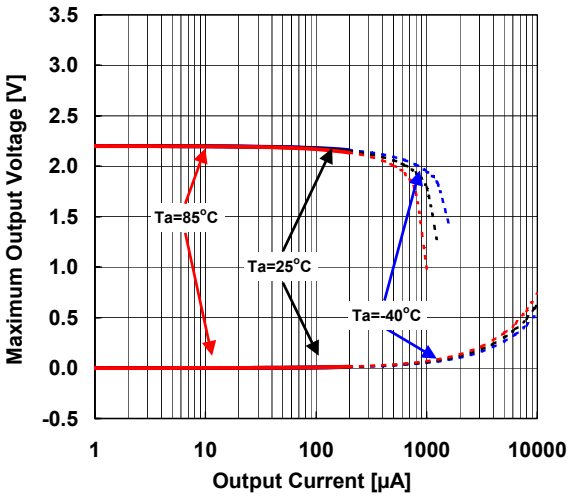
Maximum Output Voltage vs. Output Current
(Ambient Temperature)
V^+=5V



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



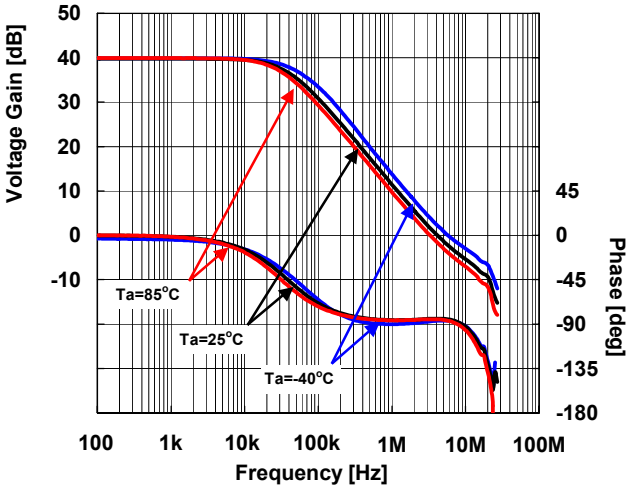
Maximum Output Voltage vs. Output Current
(Ambient Temperature)
V^+=2.2V



■ TYPICAL CHARACTERISTICS

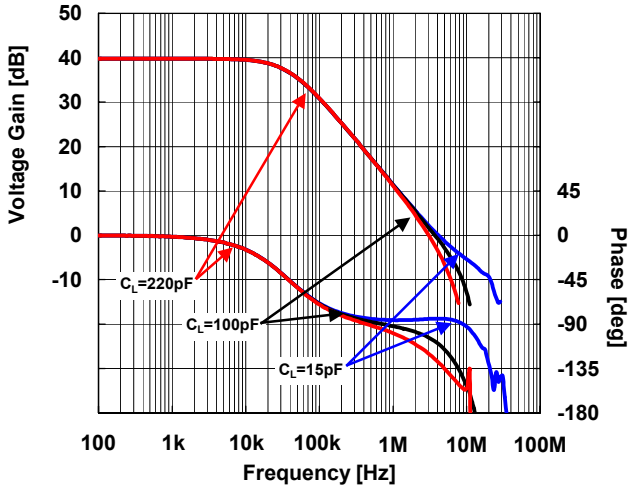
40dB Gain/Phase vs. Frequency (Temperature)

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



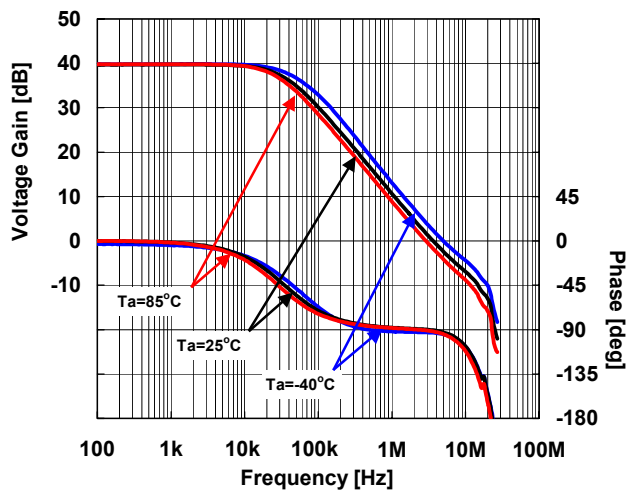
40dB Gain/Phase vs. Frequency (Load Capacitance)

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



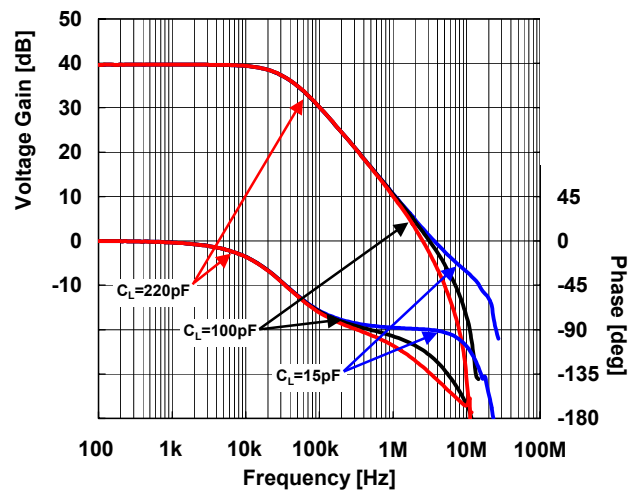
40dB Gain/Phase vs. Frequency (Temperature)

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



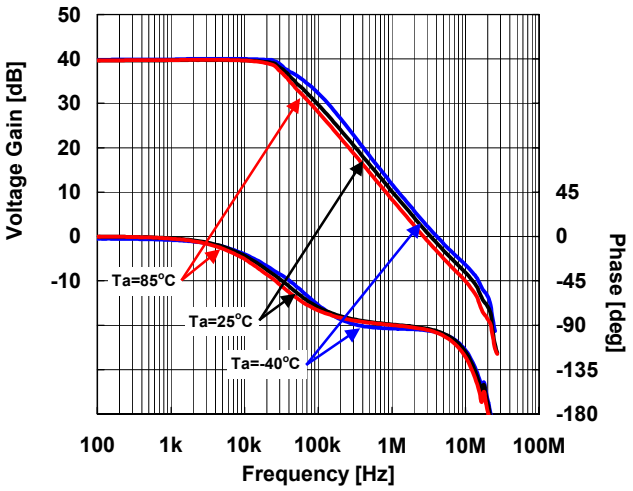
40dB Gain/Phase vs. Frequency (Load Capacitance)

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



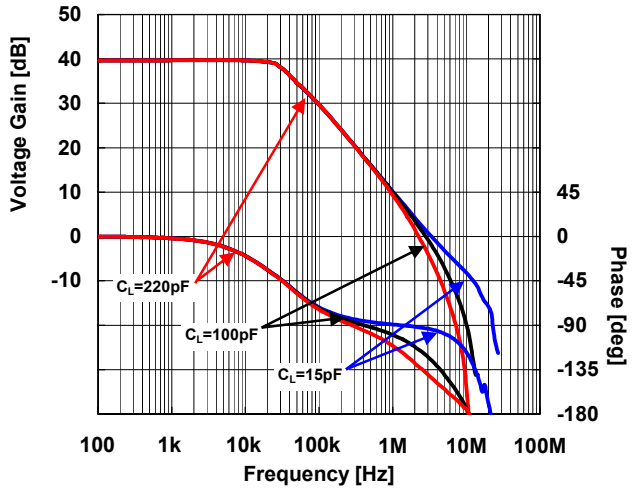
40dB Gain/Phase vs. Frequency (Temperature)

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



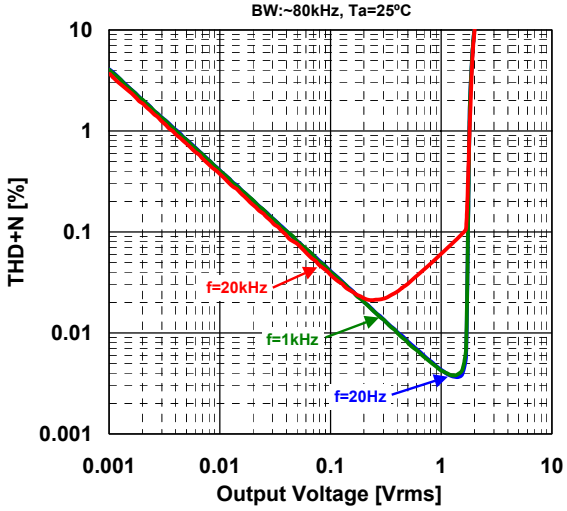
40dB Gain/Phase vs. Frequency (Load Capacitance)

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

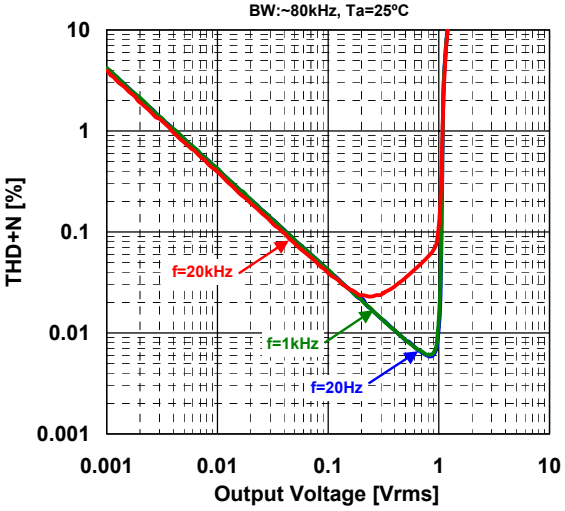


■ TYPICAL CHARACTERISTICS

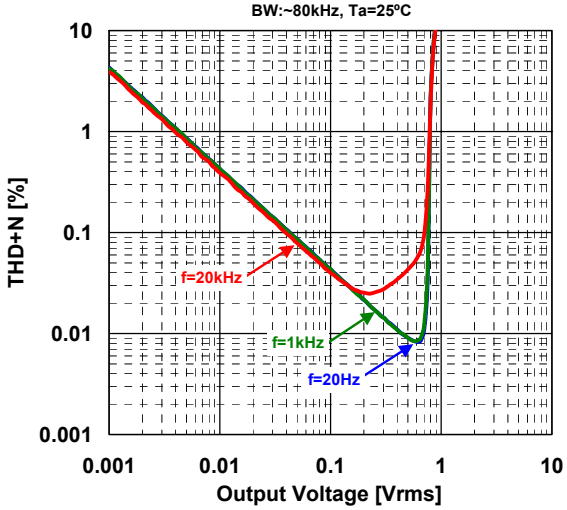
THD+N vs. Output Voltage (Frequency)
V^+/V^-=±2.5V, R_S=600Ω, R_L=50kΩ, Gv=20dB,
BW:~80kHz, Ta=25ºC



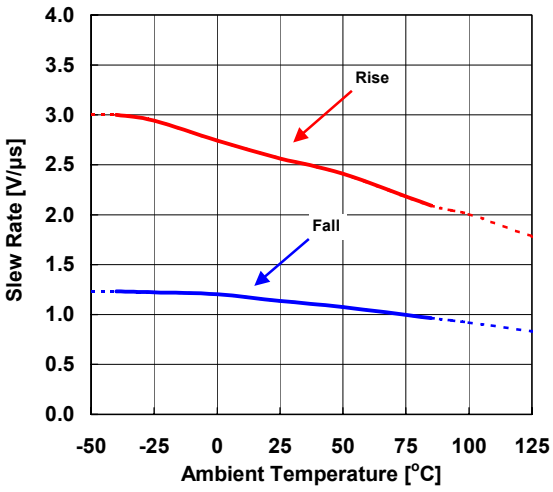
THD+N vs. Output Voltage (Frequency)
V^+/V^-=±1.5V, R_S=600Ω, R_L=50kΩ, Gv=20dB,
BW:~80kHz, Ta=25ºC



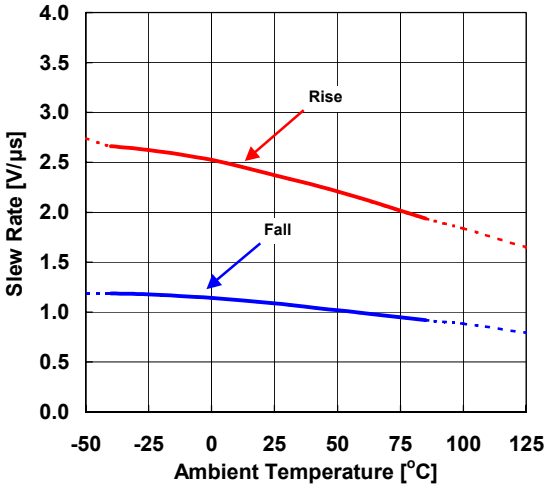
THD+N vs. Output Voltage (Frequency)
V^+/V^-=±1.1V, R_S=600Ω, R_L=50kΩ, Gv=20dB,
BW:~80kHz, Ta=25ºC



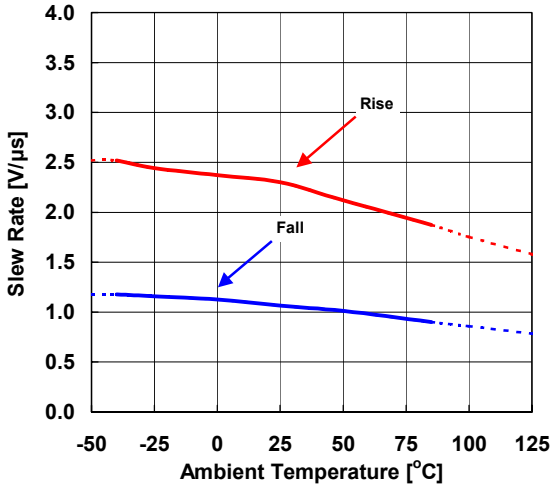
Slew Rate vs. Ambient Temperature
V^+/V^-=±2.5V, G_V=0dB, R_T=50Ω, R_L=50kΩ, C_L=15pF,
V_{IN}=$2V_{PP}$, f_{IN}=1kHz, V_{COM}=0V



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



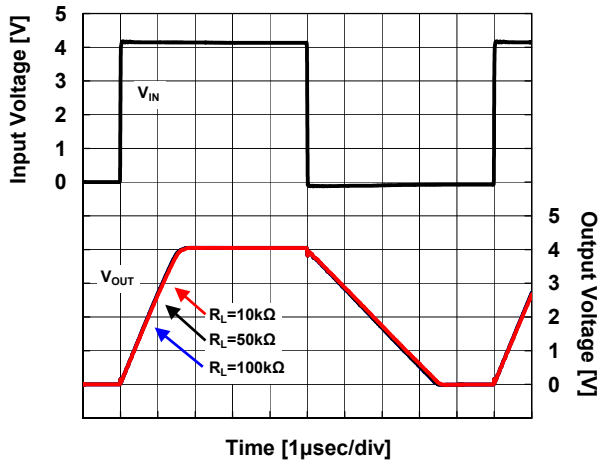
Slew Rate vs. Ambient Temperature
V^+/V^-=±1.1V, G_V=0dB, R_T=50Ω, R_L=50kΩ, C_L=15pF,
V_{IN}=$1V_{PP}$, f_{IN}=1kHz, V_{COM}=0V



■ TYPICAL CHARACTERISTICS

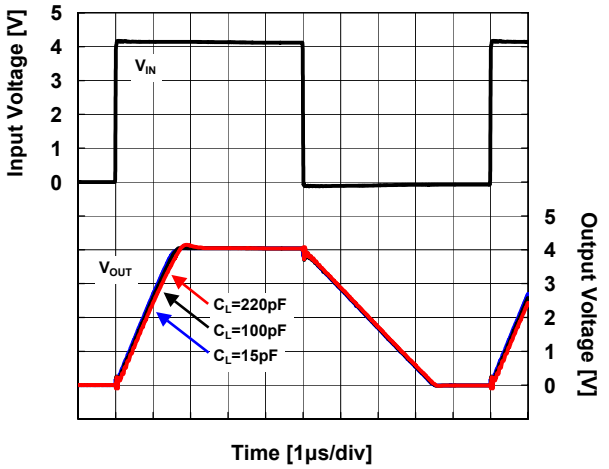
Pulse Response (Load Resistance)

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



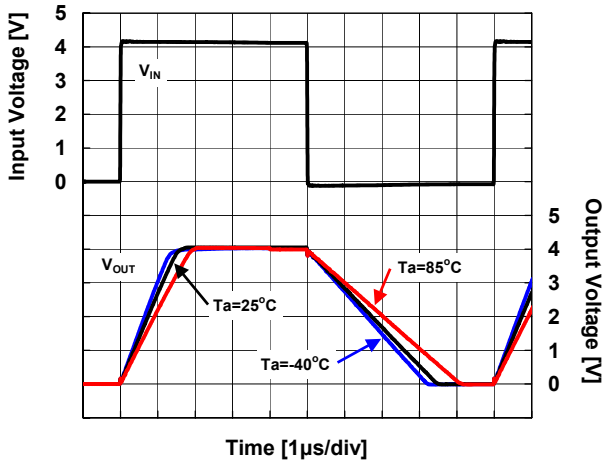
Pulse Response (Load Capacitance)

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



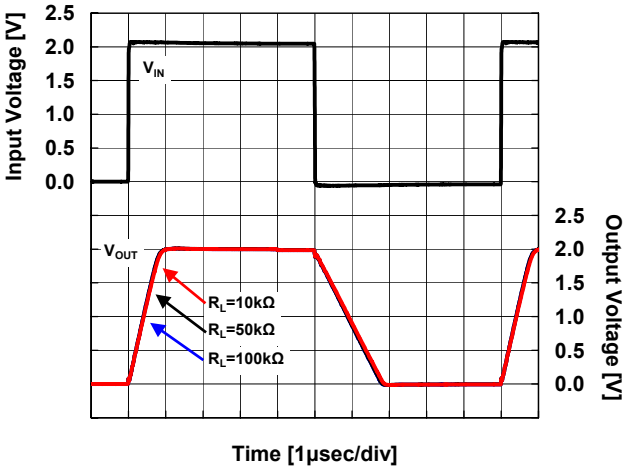
Pulse Response (Ambient Temperature)

V^+=5V, V_{COM}=V^+/2, V_{IN}=4V_{PP}, f_{IN}=100kHz, R_L=50kΩ, C_L=15pF



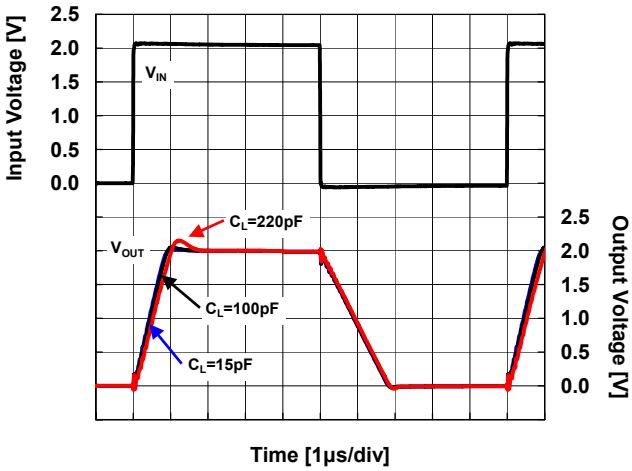
Pulse Response (Load Resistance)

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



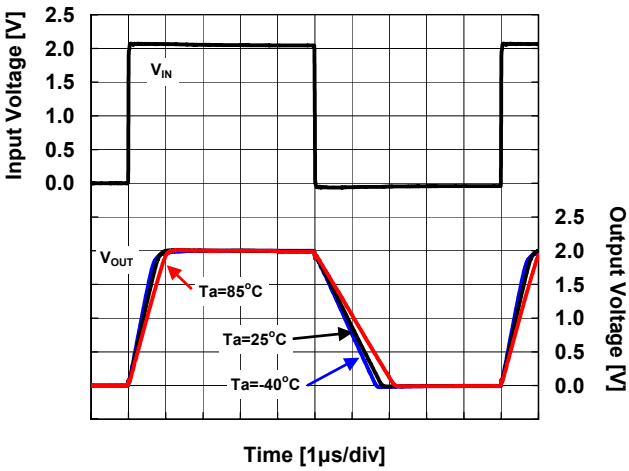
Pulse Response (Load Capacitance)

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



Pulse Response (Ambient Temperature)

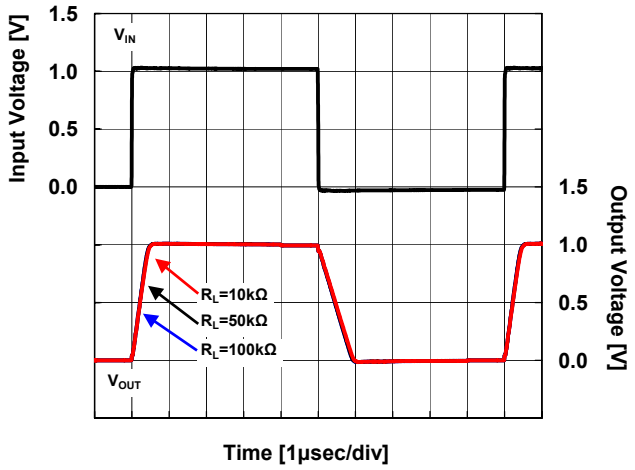
V^+=3V, V_{COM}=V^+/2, V_{IN}=2V_{PP}, f_{IN}=100kHz, R_L=50kΩ, C_L=15pF



■ TYPICAL CHARACTERISTICS

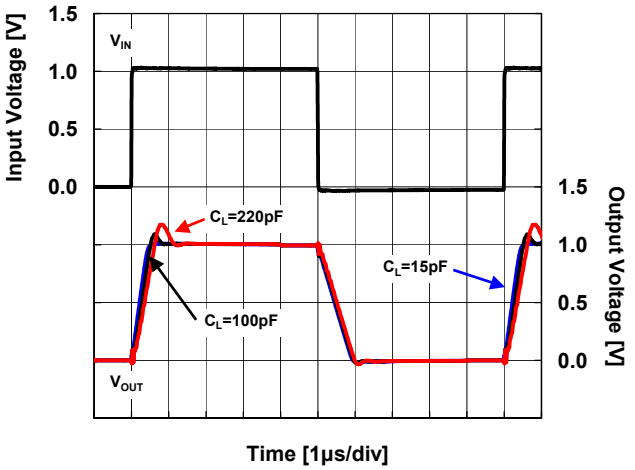
Pulse Response (Load Resistance)

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



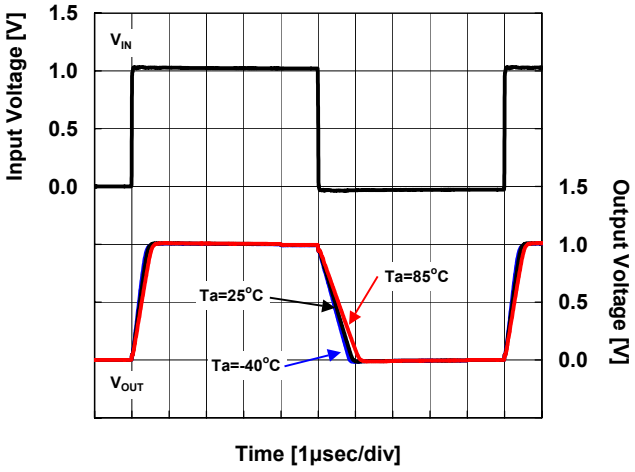
Pulse Response (Load Capacitance)

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



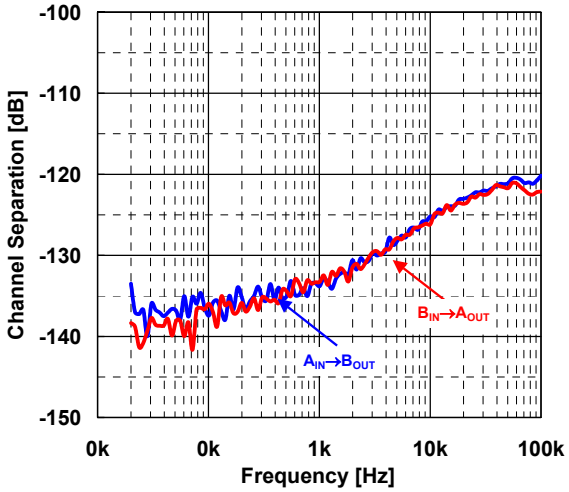
Pulse Response (Ambient Temperature)

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



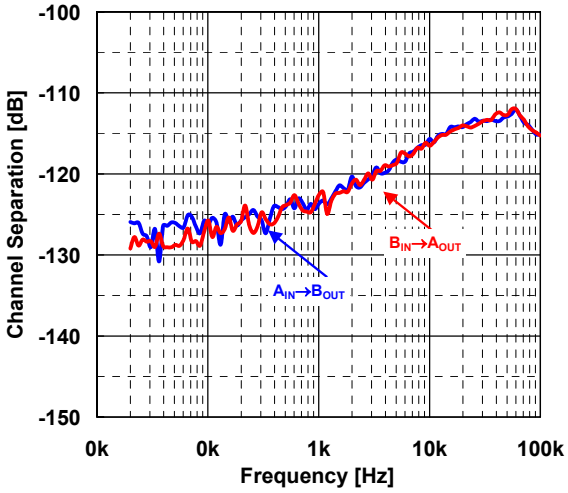
Channel Separation vs. Frequency

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



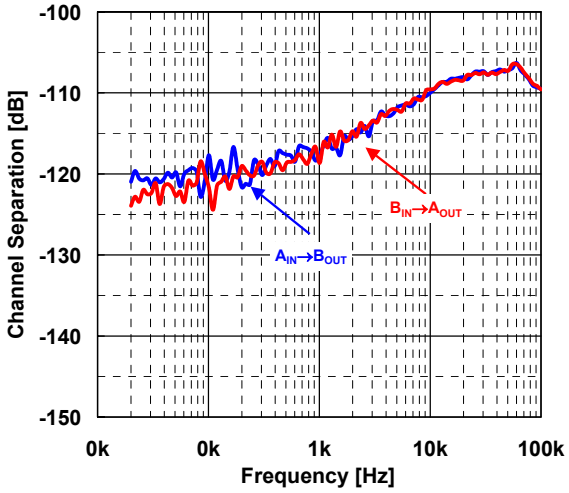
Channel Separation vs. Frequency

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



■ TYPICAL CHARACTERISTICS