Rail-to-Rail Input/Output Dual Operational Amplifier

■ GENERAL DESCRIPTION

The NJM2732 is a Rail-to-Rail Input/Output dual operational amplifier featuring low power, low noise and a low voltage operation from 1.8V.

The Rail-to-Rail Input/Output offers a wide input/output dynamic range from ground level to supply line, which provides both ground and Hi-side sensing applications.

The excellent features of low noise, low operating voltage and high phase margin make the NJM2732 well-suited for various applications such as battery powered devices, portable audio devices, sensor applications and others.

■ PACKAGE OUTLINE

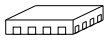
NJM2732D (DIP8)

NJM2732M (DMP8)

NJM2732E (EMP8)

NJM2732V (SSOP8)

NJM2732RB1 (TVSP8)



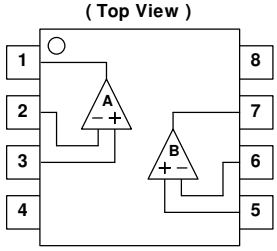
NJM2732SCC (PCSP20-CC)

■ FEATURES

●Operating Voltage	1.8 to 6.0V
●Rail-to-Rail Input	V_{ICM}= 0 to 5.0V, (at V^+=5V)
●Rail-to-Rail Output	V_{OH}≥4.9V/ V_{OL}≤0.1V, (at V^+=5V, R_L=20kΩ)
●Load Drivability	V_{OH}≥4.75V/ V_{OL}≤0.25V, (at V^+=5V, R_L=2kΩ)
●Offset Voltage	5mV max.
●Slew Rate	0.4V/μs typ.
●Low Input Voltage Noise	10nV/√Hz typ. (at f=1kHz)
●Adequate phase margin	Φ_M=75deg. typ. (at R_L=2kΩ, voltage follower)
●Bipolar Technology	
●Package Outline	DIP8, DMP8, SOP8 JEDEC 150mil, SSOP8, PCSP20-CC MSOP8 (TVSP8) MEET JEDEC MO-187-DA / THIN TYPE

■ PIN CONFIGURATION

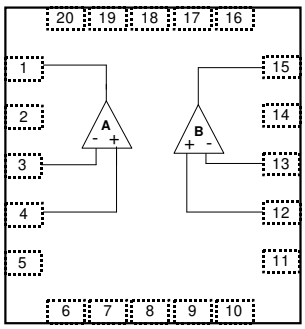
○ NJM2732D,E,M,V,RB1

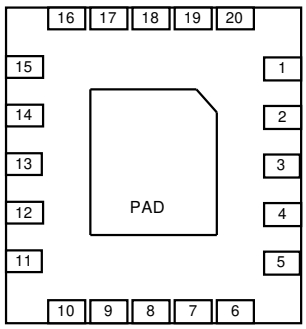


PIN FUNCTION

1. A OUTPUT
2. A -INPUT
3. A +INPUT
4. GND(V^-)
5. B +INPUT
6. B –INPUT
7. B OUTPUT
8. V^+

○ NJM2732SCC





PIN FUNCTION

1. A OUTPUT	11. NC
2. NC	12. B +INPUT
3. A -INPUT	13. B –INPUT
4. A +INPUT	14. NC
5. NC	15. B OUTPUT
6. NC	16. NC
7. NC	17. NC
8. GND(V^-)	18. V^+
9. NC	19. NC
10. NC	20. NC

(Note1) The NC pin and the PAD should connect with a GND terminal.

(Note2) The NC pin is electrically not connected to the die in a package.

(Note3) The PAD is electrically not connected to the backside of the die. The PAD cannot be used as GND pin.

■ ABSOLUTE MAXIMUM RATINGS

(Ta=25˚C)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V^+	7.0	V
Differential Input Voltage Range	V_{ID}	±1.0	V
Common Mode Input Voltage Range	V_{IC}	0 ~ 7.0 (Note4)	V
Power Dissipation	P_D	(DIP8) 500 (DMP8) 300 (SOP8) 300 (SSOP8) 250 (MSOP8 (TVSP8))320 (PCSP20−CC)400 (Note5)	mW
Operating Temperature Range	T_{opr}	-40~+85	˚C
Storage Temperature Range	T_{stg}	-40~+125	˚C

(Note4) For supply voltage less than 7V, the absolute maximum input voltage is equal to the supply voltage.

(Note5) On the PCB " EIA/JEDEC (76.2x114.3x1.6mm, two layers, FR-4).

■ RECOMMENDED OPERATING CONDITION

(Ta=25˚C)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V^+	1.8 to 6.0	V

■ ELECTRICAL CHARACTERISTICS (V^+=5V, Ta=25˚C)

●DC CHARACTERISTICS (V^+=5V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I_{CC}	No signal applied	-	580	900	μA
Input Offset Voltage	V_{IO}		-	1	5	mV
Input Bias Current	I_B		-	50	250	nA
Input Offset Current	I_{IO}		-	5	100	nA
Large Signal Voltage Gain	A_V	R_L=2kΩ	60	85	-	dB
Common Mode Rejection Ratio	CMR	CMR+: 2.5V≤V_{CM}≤5V CMR-: 0V≤V_{CM}≤2.5V (Note6)	55	70	-	dB
Supply Voltage Rejection Ratio	SVR	V^+/V^-=±2.0V ~ ±3.0V	70	85	-	dB
Maximum Output Voltage 1	V_{OH1}	R_L=20kΩ	4.9	4.95	-	V
	V_{OL1}	R_L=20kΩ	-	0.05	0.1	V
Maximum Output Voltage 2	V_{OH2}	R_L=2kΩ	4.75	4.85	-	V
	V_{OL2}	R_L=2kΩ	-	0.15	0.25	V
Input Common Mode Voltage Range	V_{ICM}	CMR≥55dB	0	-	5	V

(Note6) CMR is represented by either CMR+ or CMR- has lower value.

CMR+ is measured with 2.5V≤V_{CM}≤5.0 and CMR- is measured with 0V≤V_{CM}≤2.5V.

●AC CHARACTERISTICS (V^+=5V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Bandwidth	GB	R_L=2kΩ	-	1	-	MHz
Phase Margin	Φ_M	R_L=2kΩ	-	75	-	Deg
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	10	-	nV/√Hz

●TRANSIENT CHARACTERISTICS (V^+=5V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	R_L=2kΩ	-	0.4	-	V/μs

■ **ELECTRICAL CHARACTERISTICS** (V^+=3V, Ta=25˚C)

●DC CHARACTERISTICS (V^+=3V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I_{CC}	No signal applied	-	510	880	μA
Input Offset Voltage	V_{IO}		-	1	5	mV
Input Bias Current	I_B		-	50	250	nA
Input Offset Current	I_{IO}		-	5	100	nA
Large Signal Voltage Gain	A_V	R_L=2kΩ	60	84	-	dB
Common Mode Rejection Ratio	CMR	CMR+: 1.5V≤V_{CM}≤3V CMR-: 0V≤V_{CM}≤1.5V (Note7)	48	63	-	dB
Supply Voltage Rejection Ratio	SVR	V^+/V^-=±1.2V ~ ±2.0V	68	83	-	dB
Maximum Output Voltage 1	V_{OH1}	R_L=20kΩ	2.9	2.95	-	V
	V_{OL1}	R_L=20kΩ	-	0.05	0.1	V
Maximum Output Voltage 2	V_{OH2}	R_L=2kΩ	2.75	2.85	-	V
	V_{OL2}	R_L=2kΩ	-	0.15	0.25	V
Input Common Mode Voltage Range	V_{ICM}	CMR≥48dB	0	-	3	V

(Note7) CMR is represented by either CMR+ or CMR-has lower value.

CMR+ is measured with 1.5V≤V_{CM}≤3.0 and CMR- is measured with 0V≤V_{CM}≤1.5V.

●AC CHARACTERISTICS (V^+=3V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Bandwidth	GB	R_L=2kΩ	-	1	-	MHz
Phase Margin	Φ_M	R_L=2kΩ	-	75	-	Deg
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	10	-	nV/√Hz

●TRANSIENT CHARACTERISTICS (V^+=3V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	R_L=2kΩ	-	0.35	-	V/μs

■ **ELECTRICAL CHARACTERISTICS** (V^+=1.8V, Ta=25˚C)

●DC CHARACTERISTICS (V^+=1.8V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I_{CC}	No signal applied	-	460	800	μA
Input Offset Voltage	V_{IO}		-	1	5	mV
Input Bias Current	I_B		-	50	250	nA
Input Offset Current	I_{IO}		-	5	100	nA
Large Signal Voltage Gain	A_V	R_L=2kΩ	60	83	-	dB
Common Mode Rejection Ratio	CMR	CMR+: 0. 9V≤V_{CM}≤1.8V CMR-: 0V≤V_{CM}≤0.9V (Note8)	40	55	-	dB
Supply Voltage Rejection Ratio	SVR	V^+/V^-=±1.2V ~ ±2.0V	65	80	-	dB
Maximum Output Voltage 1	V_{OH1}	R_L=20kΩ	1.7	1.75	-	V
	V_{OL1}	R_L=20kΩ	-	0.05	0.1	V
Maximum Output Voltage 2	V_{OH2}	R_L=2kΩ	1.55	1.65	-	V
	V_{OL2}	R_L=2kΩ	-	0.15	0.25	V
Input Common Mode Voltage Range	V_{ICM}	CMR≥40dB	0	-	1.8	V

(Note8) CMR is represented by either CMR+ or CMR-has lower value.

CMR+ is measured with 0.9V≤V_{CM}≤1.8 and CMR- is measured with 0V≤V_{CM}≤0.9V.

●AC CHARACTERISTICS (V^+=1.8V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Unity Gain Bandwidth	GB	R_L=2kΩ	-	1	-	MHz
Phase Margin	Φ_M	R_L=2kΩ	-	75	-	Deg
Equivalent Input Noise Voltage	V_{NI}	f=1kHz	-	10	-	nV/√Hz

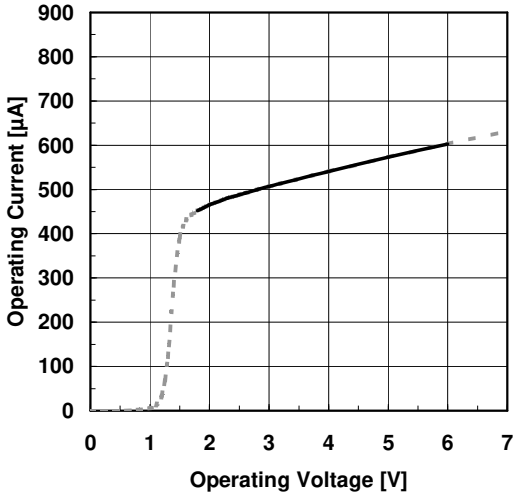
●TRANSIENT CHARACTERISTICS (V^+=1.8V, Ta=25˚C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	R_L=2kΩ	-	0.3	-	V/μs

■ TYPICAL CHARACTERISTICS

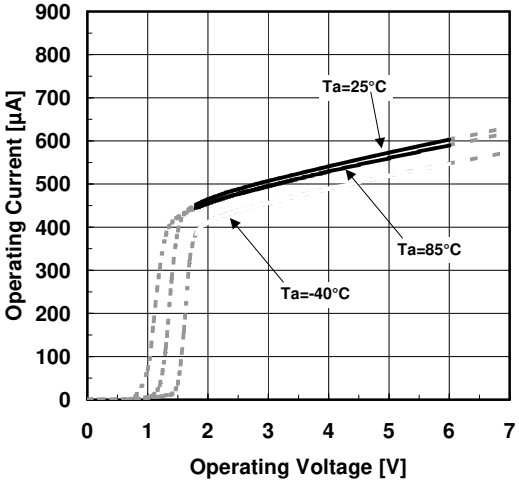
Operating Current vs Operating Voltage

G_V=0dB, Ta=25°C



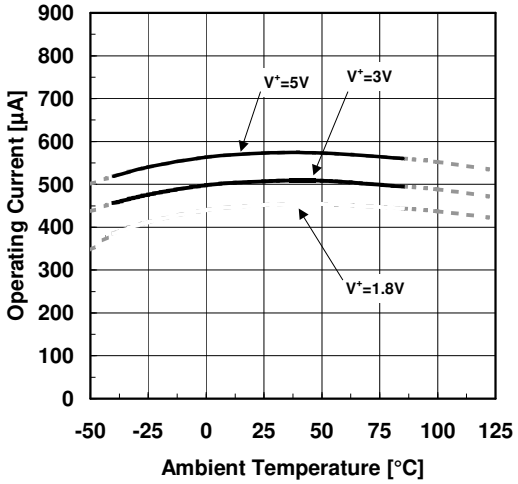
Operating Current vs. Operating Voltage

G_V=0dB, Ta=25°C



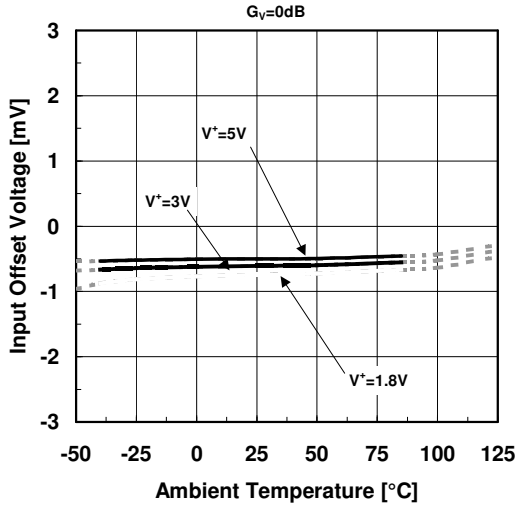
Operating Current vs. Ambient Temperature

G_V=0dB



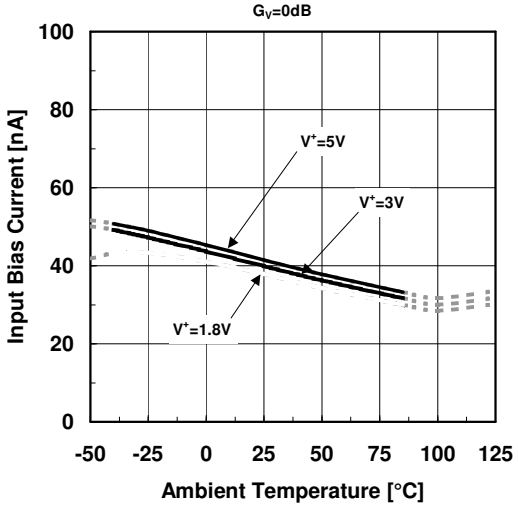
Input Offset Voltage vs. Ambient Temperature

G_V=0dB



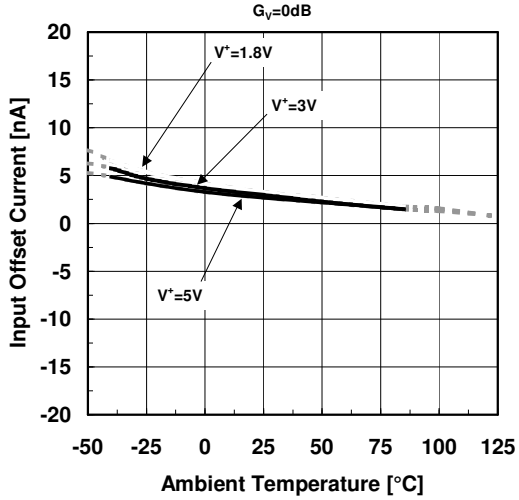
Input Bias Current vs. Ambient Temperature

G_V=0dB



Input Offset Current vs. Ambient Temperature

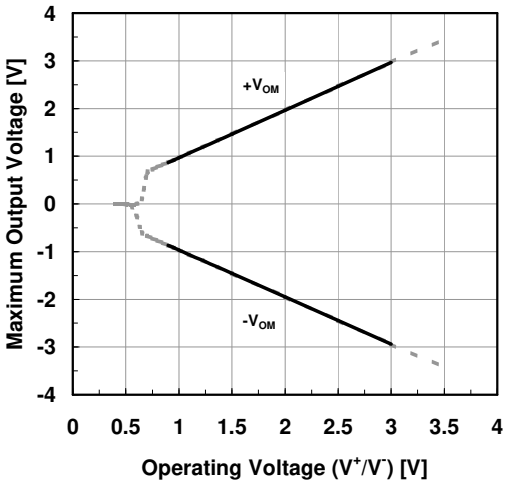
G_V=0dB



■ TYPICAL CHARACTERISTICS

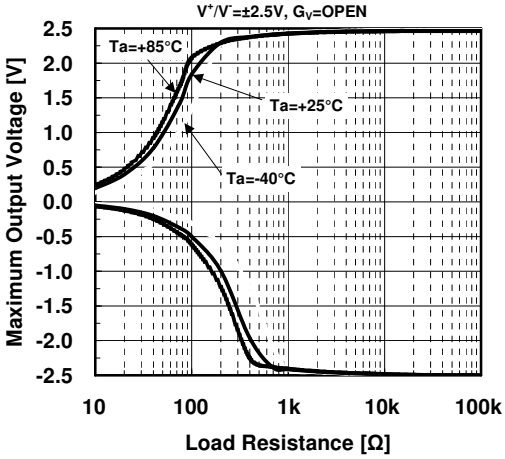
Maximum Output Voltage vs. Operating Voltage

G_V=OPEN, R_L=2kΩ to 0V, Ta=25°C



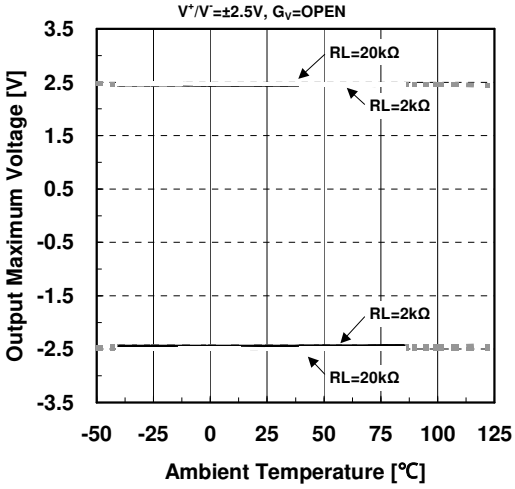
Maximum Output Voltage vs. Load Resistance

V+/V-=±2.5V, G_V=OPEN



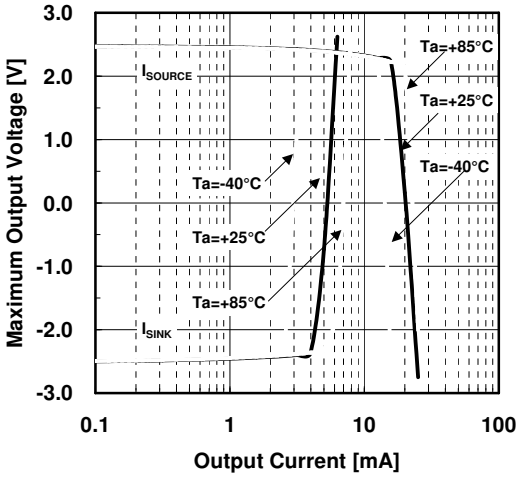
Maximum Output Voltage vs. Ambient Temperature

V+/V-=±2.5V, G_V=OPEN



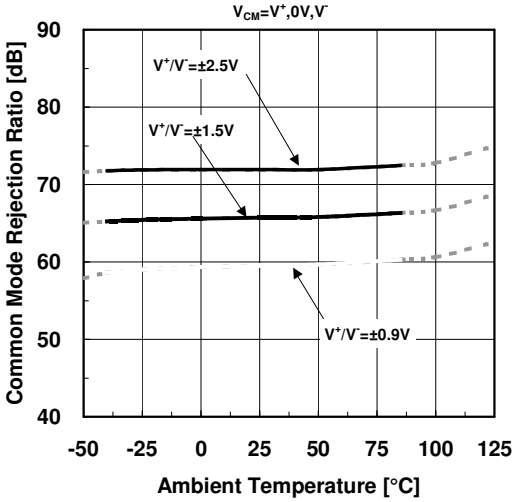
Output Voltage vs. Output Current

V+/V-=±2.5V, G_V=OPEN

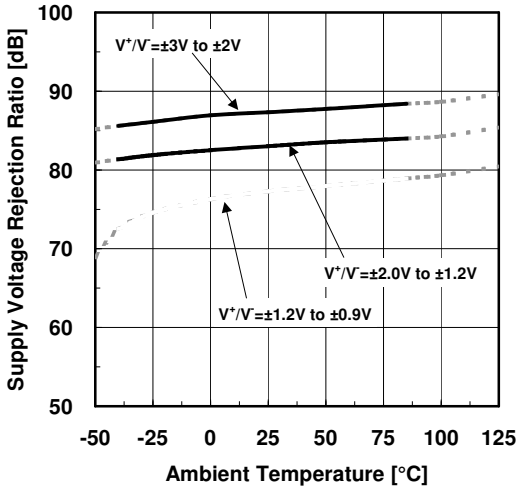


Common Mode Rejection Ratio vs. Ambient Temperature

V_{CM}=V+,0V,V-



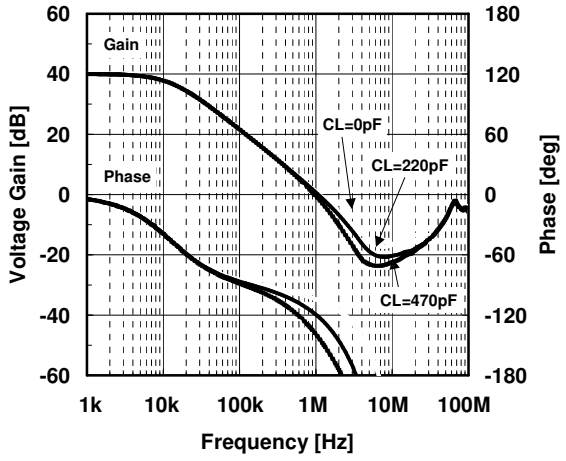
Supply Voltage Rejection Ratio vs. Ambient Temperature



■ TYPICAL CHARACTERISTICS

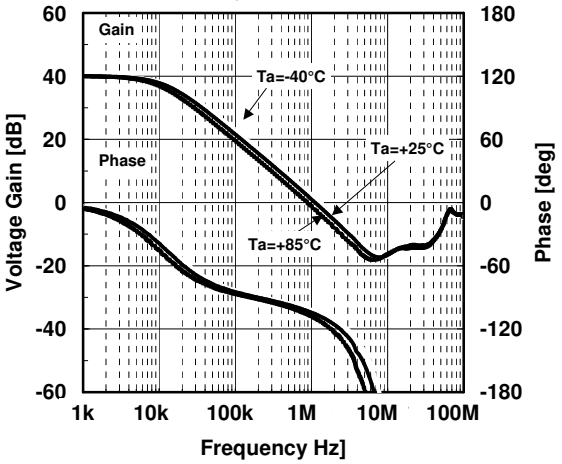
Voltage Gain/Phase vs. Frequency

V^+/V^-=±2.5V, G_V=40dB, R_F=2kΩ,
R_G=20Ω, R_L=2kΩ, Ta=+25°C



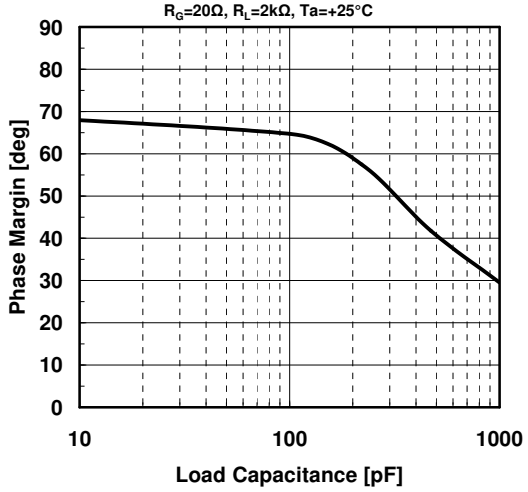
Voltage Gain/Phase vs. Frequency

V^+/V^-=±2.5V, G_V=40dB
R_F=2kΩ, R_G=20Ω, R_L=2kΩ, C_L=0pF



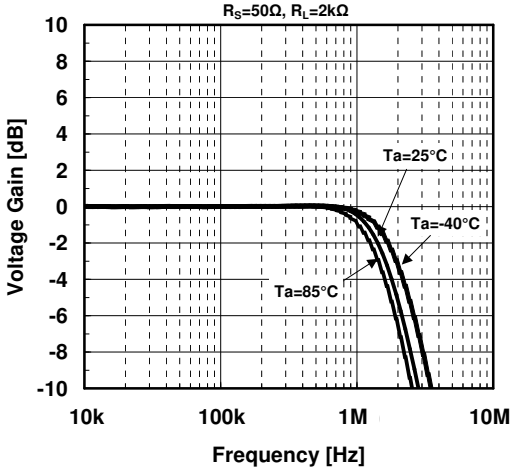
Phase Margin vs. Load Capacitance

V^+/V^-=±1.5V, G_V=40dB, R_F=2kΩ
R_G=20Ω, R_L=2kΩ, Ta=+25°C



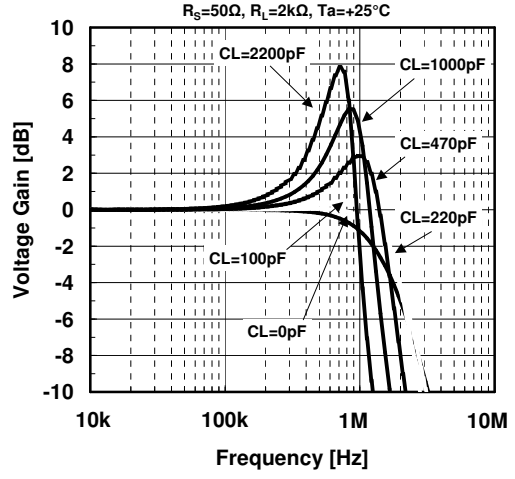
Voltage Gain vs. Frequency

V^+/V^-=±2.5V, G_V=0dB, C_L=100pF
R_S=50Ω, R_L=2kΩ



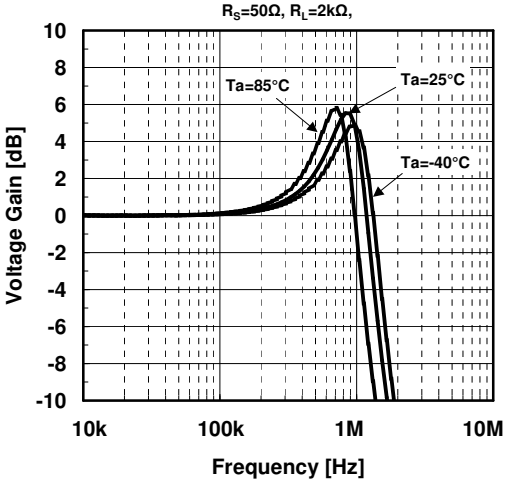
Voltage Gain vs. Frequency

V^+/V^-=±2.5V, G_V=0dB
R_S=50Ω, R_L=2kΩ, Ta=+25°C



Voltage Gain vs. Frequency

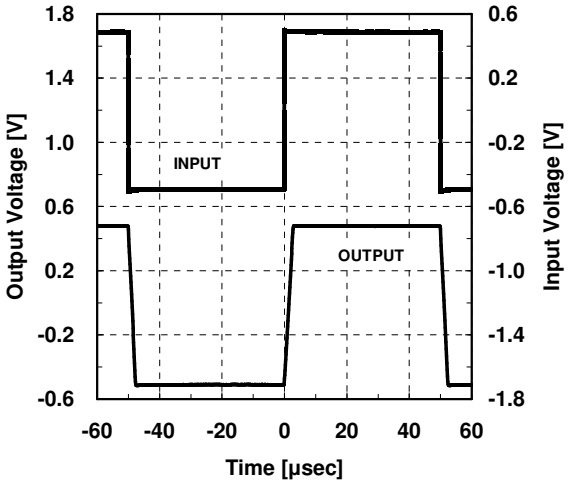
V^+/V^-=±2.5V, G_V=0dB, C_L=1000pF
R_S=50Ω, R_L=2kΩ,



■ TYPICAL CHARACTERISTICS

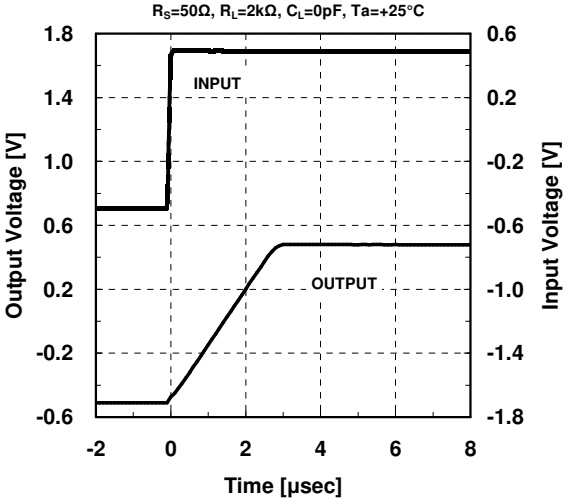
Pulse Response

V^+/V^-=±2.5V, G_V=0dB, f=10kHz, V_{IN}=1V_{PP}
R_S=50Ω, R_L=2kΩ, C_L=0pF, Ta=+25°C



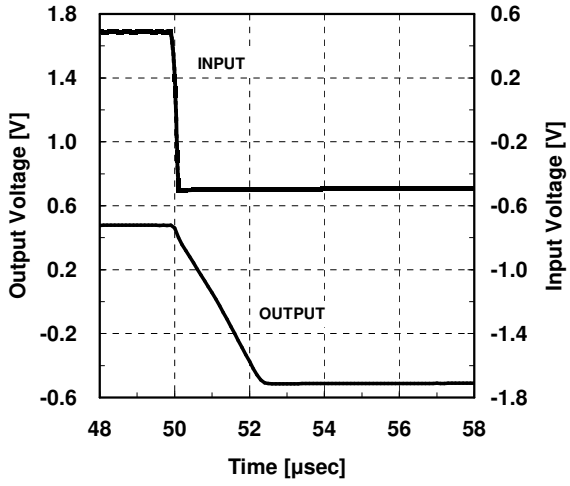
Pulse Response (Rise)

V^+/V^-=±2.5V, G_V=0dB, f=10kHz, V_{IN}=1V_{PP}
R_S=50Ω, R_L=2kΩ, C_L=0pF, Ta=+25°C



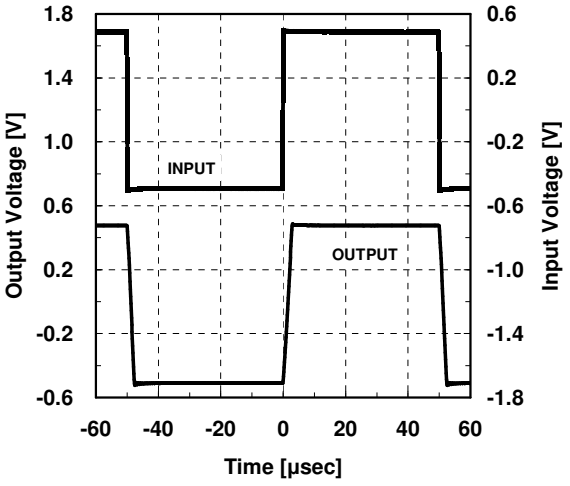
Pulse Response (Fall)

V^+/V^-=±2.5V, G_V=0dB, f=10kHz, V_{IN}=1V_{PP}
R_S=50Ω, R_L=2kΩ, C_L=0pF, Ta=+25°C



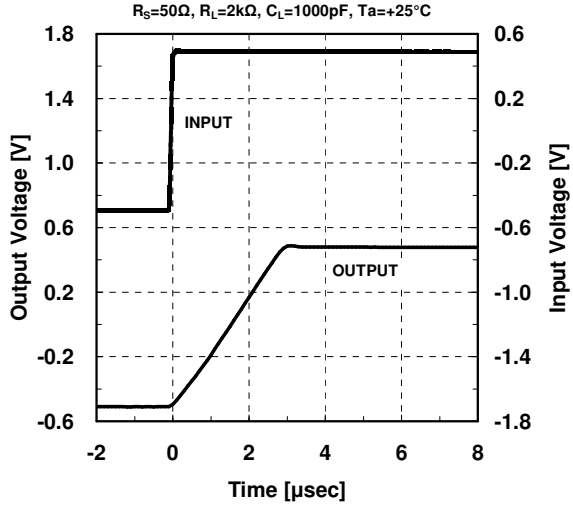
Pulse Response

V^+/V^-=±2.5V, G_V=0dB, f=10kHz, V_{IN}=1V_{PP}
R_S=50Ω, R_L=2kΩ, C_L=1000pF, Ta=+25°C



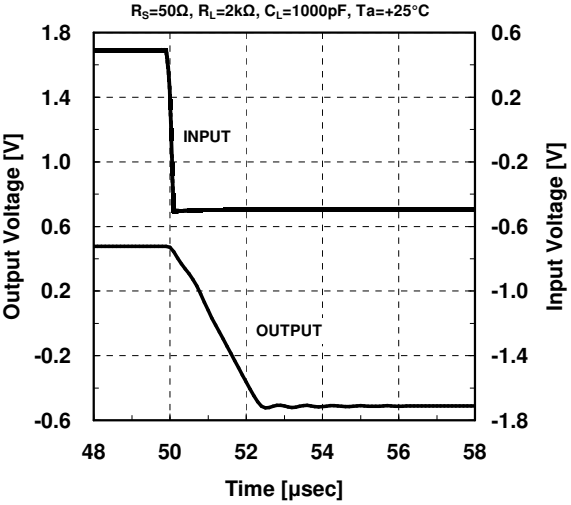
Pulse Response (Rise)

V^+/V^-=±2.5V, G_V=0dB, f=10kHz, V_{IN}=1V_{PP}
R_S=50Ω, R_L=2kΩ, C_L=1000pF, Ta=+25°C



Pulse Response (Fall)

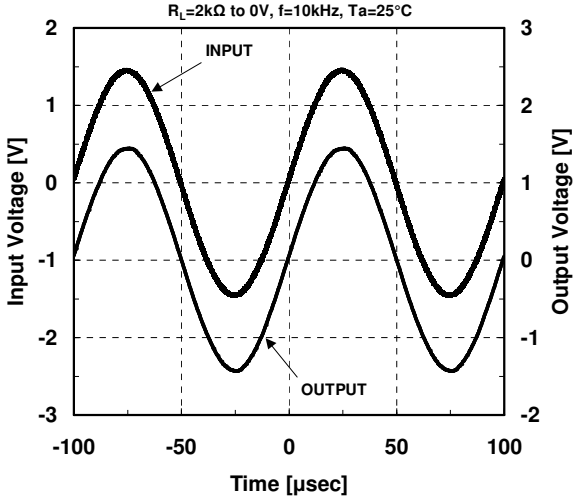
V^+/V^-=±2.5V, G_V=0dB, f=10kHz, V_{IN}=1V_{PP}
R_S=50Ω, R_L=2kΩ, C_L=1000pF, Ta=+25°C



■ TYPICAL CHARACTERISTICS

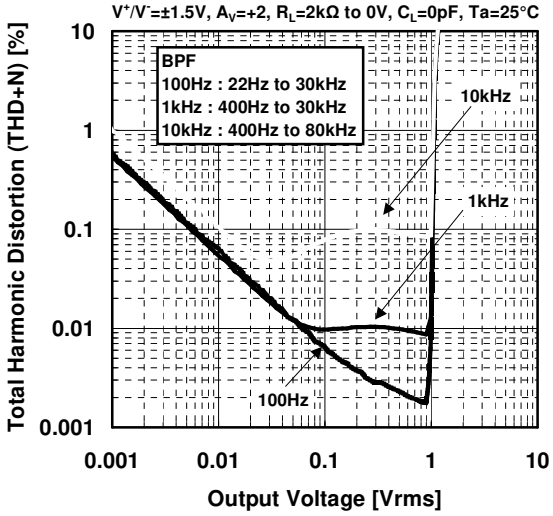
Sin Wave Response

V^+/V^-=±1.5V, A_V=0dB, V_{IN}=3V_{PP}
R_L=2kΩ to 0V, f=10kHz, Ta=25°C



Total Harmonic Distortion vs. Output Voltage

V^+/V^-=±1.5V, A_V=+2, R_L=2kΩ to 0V, C_L=0pF, Ta=25°C



Equivalent Input Noise Voltage vs. Frequency

V^+/V^-=±2.5V, G_V=40dB, R_S=20Ω
R_G=20Ω, R_F=2kΩ, C_L=0, Ta=25ºC