

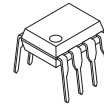
## Low Noise, Rail-to-Rail Input/Output Dual Operational Amplifier

### ■ GENERAL DESCRIPTION

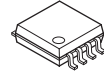
The NJM2737 is a Rail-to-Rail Input/Output single supply dual operational amplifier featuring low voltage operation, low power and low noise. It is designed to offer a low voltage operating from 1.8V with a  $5\text{nV}/\sqrt{\text{Hz}}$  low noise of the conventional low noise operational amplifiers such as the NJM4580 and NJM 5532.

The Combination of Rail-to-Rail Input/Output, low voltage operation and low noise makes the NJM2737 well-suited for single supply low voltage operation applications such as PC audio, portable audio and others. The NJM2737 is available in a wide variety packages 8-lead DIP, and 8-lead surface-mount packages of SOP (DMP), SSOP and MSOP (TVSP).

### ■ PACKAGE OUTLINE



**NJM2737D  
(DIP8)**



**NJM2737M  
(DMP8)**



**NJM2737V  
(SSOP8)**

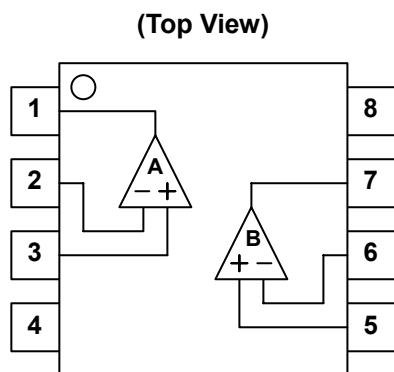


**NJM2737RB1  
(MSOP8 (TVSP8))**

### ■ FEATURES

- Operating Voltage 1.8 to 6.0V
- Low Input Voltage Noise  $5\text{nV}/\sqrt{\text{Hz}}$  typ.
- Gain Band Width product  $3.1\text{MHz}$  typ. (at  $V^+=5\text{V}, R_L=2\text{k}\Omega$ )
- Slew Rate  $0.7\text{V}/\mu\text{s}$  typ. (at  $V^+=5\text{V}, R_L=2\text{k}\Omega$ )
- Offset Voltage  $5\text{mV}$  max
- Rail-to-Rail Input  $V_{\text{ICM}}=0$  to  $5.0\text{V}$  (at  $V^+=5\text{V}$ )
- Rail-to-Rail Output  $V_{\text{OH}} \geq 4.9\text{V} / V_{\text{OL}} \leq 0.15\text{V}$  (at  $V^+=5\text{V}, R_L=20\text{k}\Omega$ )
- Load Drivability  $V_{\text{OH}} \geq 4.75\text{V} / V_{\text{OL}} \leq 0.25\text{V}$  (at  $V^+=5\text{V}, R_L=2\text{k}\Omega$ )
- Bipolar Technology
- Package Outline DIP8, DMP8, SSOP8, MSOP8 (TVSP8) MEET JEDEC MO-187-DA / THIN TYPE

### ■ PIN CONFIGURATION



#### PIN CONFIGURATION

1. OUTPUT1
2. -INPUT1
3. +INPUT1
4. GND(  $V^-$  )
5. +INPUT2
6. -INPUT2
7. OUTPUT2
8.  $V^+$

# NJM2737

## ■ ABSOLUTE MAXIMUM RATINGS

(Ta=25°C)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V <sup>+</sup>	7.0	V
Differential Input Voltage	V <sub>ID</sub>	±1.0	V
Input Common Mode Voltage Range	V <sub>ICM</sub>	0 to 7.0	V
Power Dissipation	P <sub>D</sub>	500(DIP8) 300(DMP8) 250(SSOP8) 320(MSOP8 (TVSP8))	mW
Operating Temperature Range	T <sub>opr</sub>	-40 to +85	°C
Storage Temperature Range	T <sub>stg</sub>	-40 to +125	°C

(Note1) If the supply voltage (V<sup>+</sup>) is less than 7V, the input voltage must not over the V<sup>+</sup> level through 7V is limit specified.

## ■ RECOMMENDED OPERATING CONDITION

(Ta=25°C)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V <sup>+</sup>	1.8 to 6.0	V

## ■ ELECTRICAL CHARACTERISTICS

### ● DC CHARACTERISTICS

(V<sup>+</sup>=5V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Operating Current	I <sub>CC</sub>	No Signal	-	1200	1600	μA
Input Offset Voltage	V <sub>IO</sub>		-	1	5	mV
Input Bias Current	I <sub>B</sub>		-	200	800	nA
Input Offset Current	I <sub>IO</sub>		-	5	100	nA
Voltage Gain	A <sub>V</sub>	R <sub>L</sub> =2kΩ	60	85	-	dB
Common Mode Rejection Ratio	CMR	CMR+: 2.5V ≤ V <sub>CM</sub> ≤ 5.0V, CMR-: 0 ≤ V <sub>CM</sub> ≤ 2.5V (Note2)	55	70	-	dB
Supply Voltage Rejection Ratio	SVR	V <sup>+</sup> /GND = ±2.0 to ±3.0V	70	85	-	dB
Maximum Output Voltage 1	V <sub>OH1</sub>	R <sub>L</sub> =20kΩ	4.9	4.95	-	V
	V <sub>OL1</sub>	R <sub>L</sub> =20kΩ	-	0.05	0.1	
Maximum Output Voltage 2	V <sub>OH2</sub>	R <sub>L</sub> =2kΩ	4.75	4.85	-	V
	V <sub>OL2</sub>	R <sub>L</sub> =2kΩ	-	0.15	0.25	
Input Common Mode Voltage Range	V <sub>ICM</sub>	CMR > 55dB	0	-	5	V

(Note2) CMR is represented by either CMR+ or CMR- which has lower value.

CMR+ is measured with 2.5V ≤ V<sub>CM</sub> ≤ 5V and CMR- is measured with 0V ≤ V<sub>CM</sub> ≤ 2.5V.

### ● AC CHARACTERISTICS

(V<sup>+</sup>=5V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Unity Gain Bandwidth	f <sub>T</sub>	R <sub>L</sub> =2kΩ	-	3.1	-	MHz
Phase Margin	Φ <sub>M</sub>	R <sub>L</sub> =2kΩ	-	85	-	Deg
Equivalent Input Noise Voltage	V <sub>N</sub>	f=1kHz	-	5	-	nV/ √Hz

## • TRANSIENT CHARACTERISTICS

(V<sup>+</sup>=5V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Slew Rate	SR	R <sub>L</sub> =2kΩ	-	0.7	-	V/μs

## • DC CHARACTERISTICS

(V<sup>+</sup>=3V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Operating Current	I <sub>CC</sub>	No Signal	-	1000	1500	μA
Input Offset Voltage	V <sub>IO</sub>		-	1	5	mV
Input Bias Current	I <sub>B</sub>		-	200	800	nA
Input Offset Current	I <sub>IO</sub>		-	5	100	nA
Voltage Gain	A <sub>V</sub>	R <sub>L</sub> =2kΩ	60	85	-	dB
Common Mode Rejection Ratio	CMR	CMR+: 1.5V ≤ V <sub>CM</sub> ≤ 3.0V, CMR-: 0 ≤ V <sub>CM</sub> ≤ 1.5V (Note3)	48	63	-	dB
Supply Voltage Rejection Ratio	SVR	V <sup>+</sup> /GND = ±1.2 to ±2.0V	68	83	-	dB
Maximum Output Voltage 1	V <sub>OH1</sub>	R <sub>L</sub> =20kΩ	2.9	2.95	-	V
	V <sub>OL1</sub>	R <sub>L</sub> =20kΩ	-	0.05	0.1	
Maximum Output Voltage 2	V <sub>OH2</sub>	R <sub>L</sub> =2kΩ	2.75	2.85	-	V
	V <sub>OL2</sub>	R <sub>L</sub> =2kΩ	-	0.15	0.25	
Input Common Mode Voltage Range	V <sub>ICM</sub>	CMR > 48dB	0	-	3	V

(Note3) CMR is represented by either CMR+ or CMR- which has lower value.

CMR+ is measured with 1.5V ≤ V<sub>CM</sub> ≤ 3V and CMR- is measured with 0V ≤ V<sub>CM</sub> ≤ 1.5V.

## • AC CHARACTERISTICS

(V<sup>+</sup>=3V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Unity Gain Bandwidth	f <sub>T</sub>	R <sub>L</sub> =2kΩ	-	2.6	-	MHz
Phase Margin	Φ <sub>M</sub>	R <sub>L</sub> =2kΩ	-	85	-	Deg
Equivalent Input Noise Voltage	V <sub>N</sub>	f=1kHz	-	5	-	nV/ √Hz

## • TRANSIENT CHARACTERISTICS

(V<sup>+</sup>=3V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Slew Rate	SR	R <sub>L</sub> =2kΩ	-	0.6	-	V/μs

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## • DC CHARACTERISTICS

(V<sup>+</sup>=1.8V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Operating Current	I <sub>CC</sub>	No Signal	-	1000	1500	μA
Input Offset Voltage	V <sub>IO</sub>		-	1	5	mV
Input Bias Current	I <sub>B</sub>		-	200	800	nA
Input Offset Current	I <sub>IO</sub>		-	5	100	nA
Voltage Gain	A <sub>V</sub>	R <sub>L</sub> =2kΩ	60	85	-	dB
Common Mode Rejection Ratio	CMR	CMR+: 0.9V ≤ V <sub>CM</sub> ≤ 1.8V, CMR-: 0 ≤ V <sub>CM</sub> ≤ 0.9V (Note4)	40	55	-	dB
Supply Voltage Rejection Ratio	SVR	V <sup>+</sup> /GND = ±0.9 to ±1.2V	65	80	-	dB
Maximum Output Voltage 1	V <sub>OH1</sub>	R <sub>L</sub> =20kΩ	1.7	1.75	-	V
	V <sub>OL1</sub>	R <sub>L</sub> =20kΩ	-	0.1	0.15	
Maximum Output Voltage 2	V <sub>OH2</sub>	R <sub>L</sub> =2kΩ	1.6	1.65	-	V
	V <sub>OL2</sub>	R <sub>L</sub> =2kΩ	-	0.15	0.25	
Input Common Mode Voltage Range	V <sub>ICM</sub>	CMR > 40dB	0	-	1.8	V

(Note4) CMR is represented by either CMR+ or CMR- which has lower value.

CMR+ is measured with 0.9V ≤ V<sub>CM</sub> ≤ 1.8V and CMR- is measured with 0V ≤ V<sub>CM</sub> ≤ 0.9V .

## • AC CHARACTERISTICS

(V<sup>+</sup>=1.8V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Unity Gain Bandwidth	f <sub>T</sub>	R <sub>L</sub> =2kΩ	-	2.3	-	MHz
Phase Margin	Φ <sub>M</sub>	R <sub>L</sub> =2kΩ	-	85	-	Deg
Equivalent Input Noise Voltage	V <sub>N</sub>	f=1kHz	-	5	-	nV/ √Hz

## • TRANSIENT CHARACTERISTICS

(V<sup>+</sup>=1.8V, Ta=25°C)

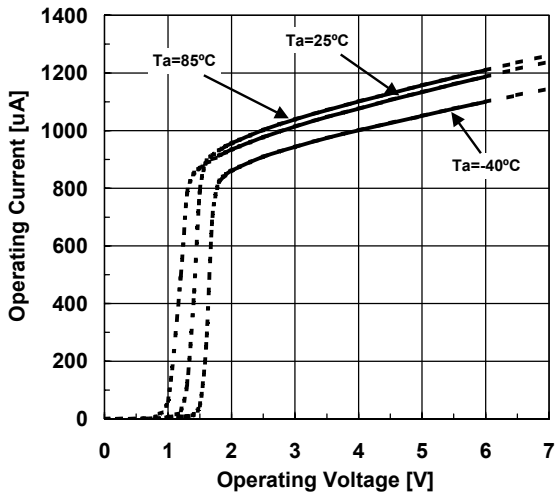
PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Slew Rate	SR	R <sub>L</sub> =2kΩ	-	0.5	-	V/μs

## ■ TERMINAL CHARACTERISTICS

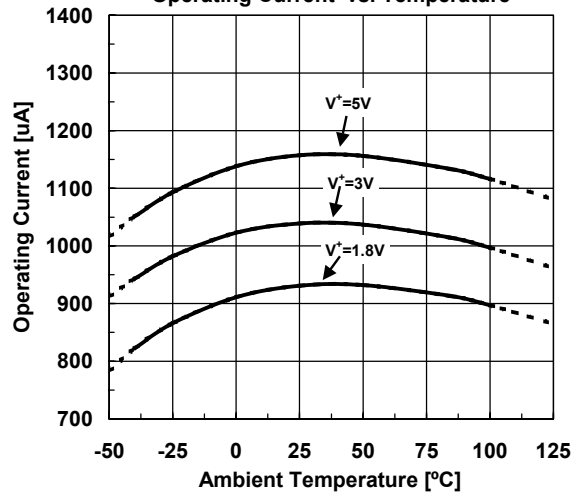
No.	Symbol	Equivalent Circuit	Typ.DC Voltage(V)	Function
3,5	+INPUT			non-inverting input
2,6	-INPUT			inverting input
1,7	VOUT			output

## ■ TYPICAL CHARACTERISTICS

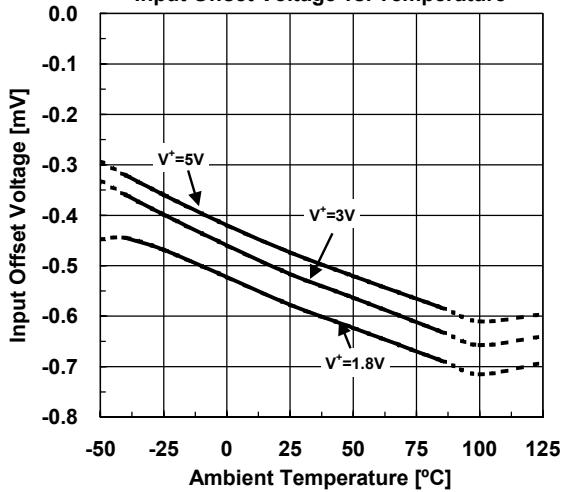
Operating Current vs. Operating Voltage



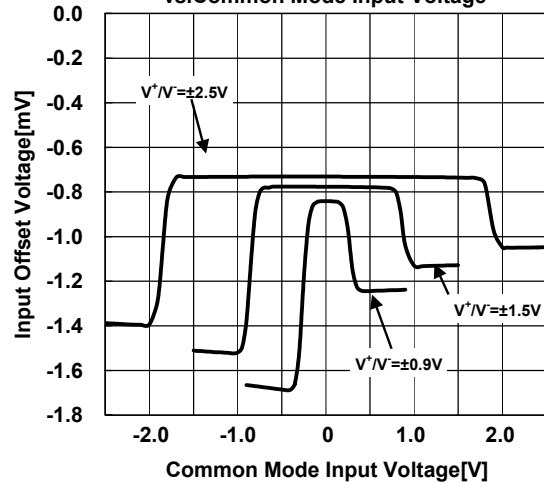
Operating Current vs. Temperature



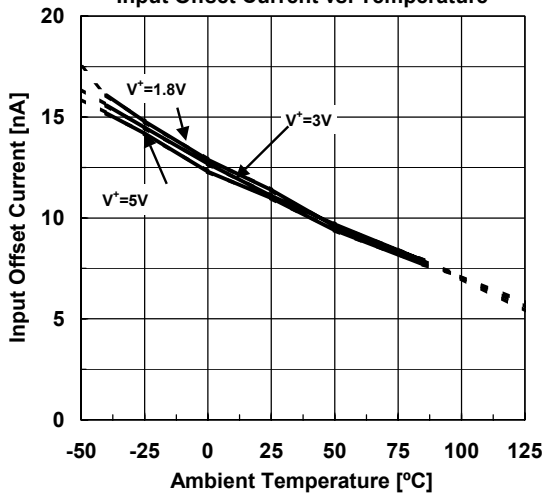
Input Offset Voltage vs. Temperature



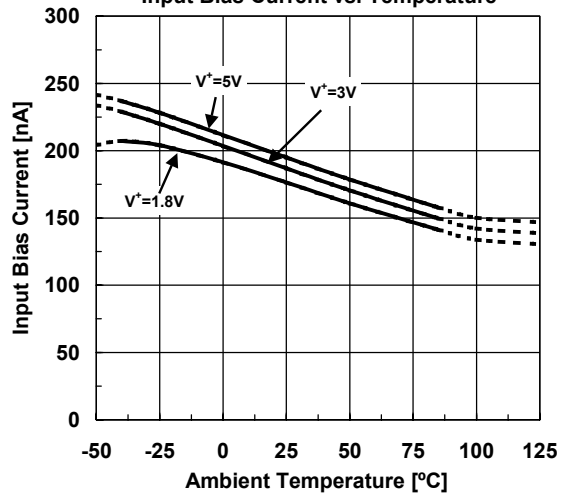
Input Offset Voltage vs. Common Mode Input Voltage



Input Offset Current vs. Temperature

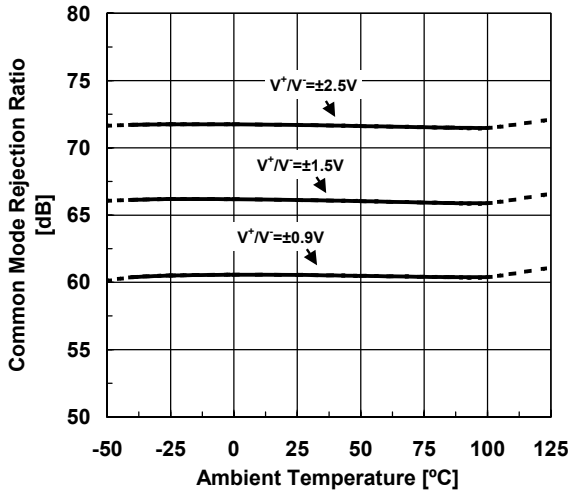


Input Bias Current vs. Temperature

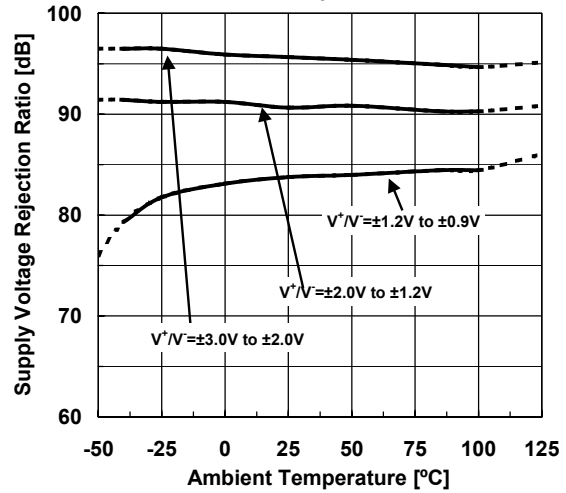


**Common Mode Rejection Ratio vs. Temperature**

$V_{ic}=V^+, 0, V^-$

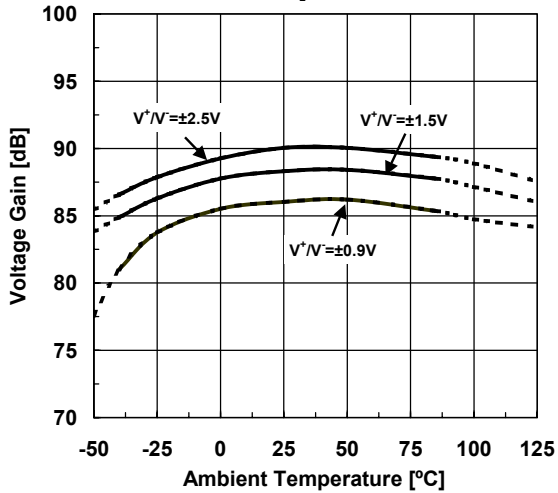


**Supply Voltage Rejection Ratio vs. Temperature**



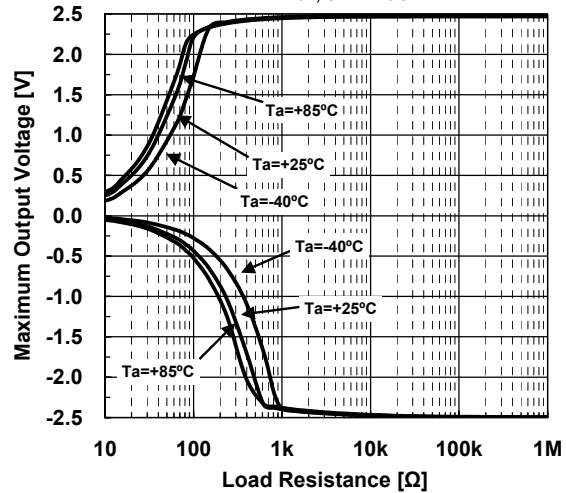
**Voltage Gain vs. Temperature**

$R_L=2k\Omega$



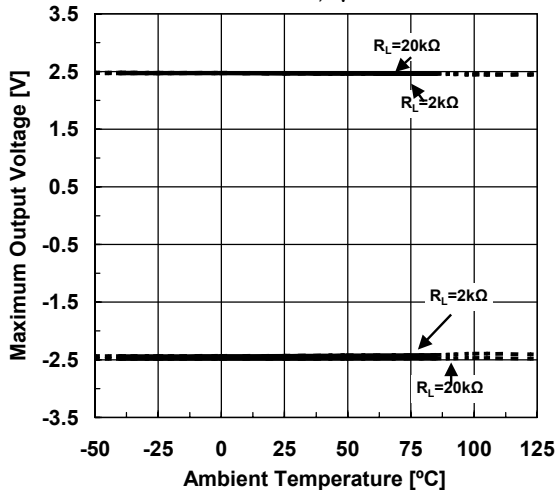
**Maximum Output Voltage vs. Load Resistance**

$V^+/V^- = \pm 2.5V, \text{ OPEN LOOP}$



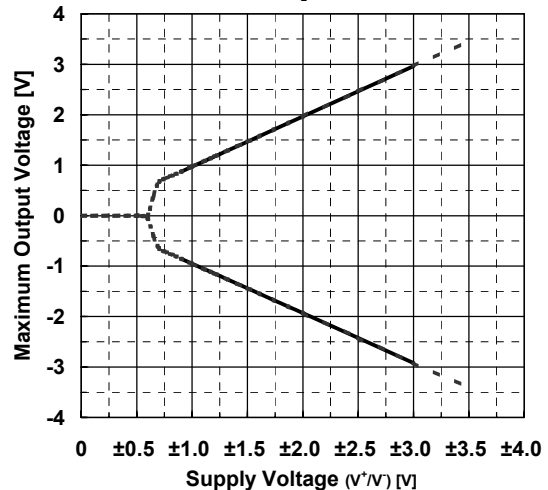
**Maximum Output Voltage vs. Temperature**

$V^+/V^- = \pm 2.5V, G_v = \text{OPEN}$

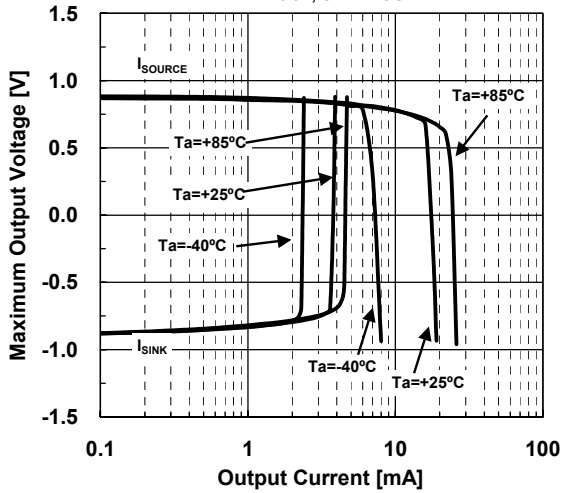


**Maximum Output Voltage vs. Supply Voltage**

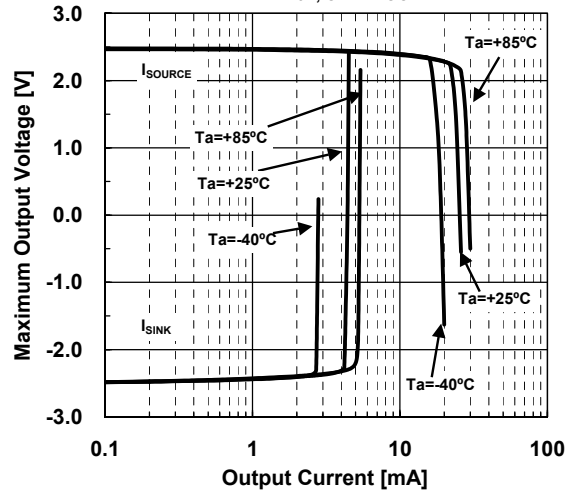
$\text{OPEN LOOP}, R_L=2k\Omega, T_a=25^\circ\text{C}$



**Maximum Output Voltage vs. Output Current**  
 $V^+ / V^- = \pm 0.9V$ , OPEN LOOP

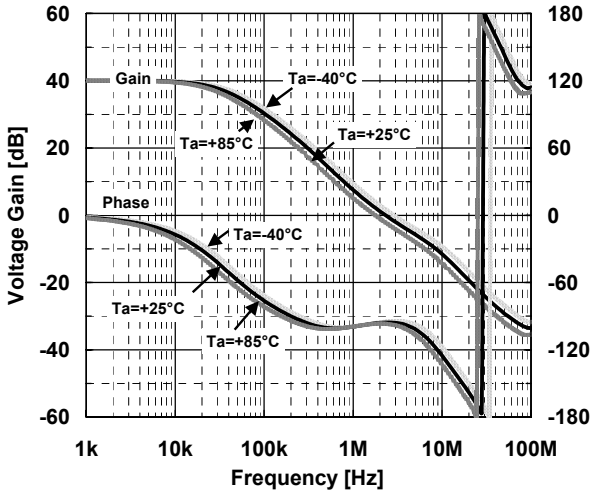


**Maximum Output Voltage vs. Output Current**  
 $V^+ / V^- = \pm 2.5V$ , OPEN LOOP



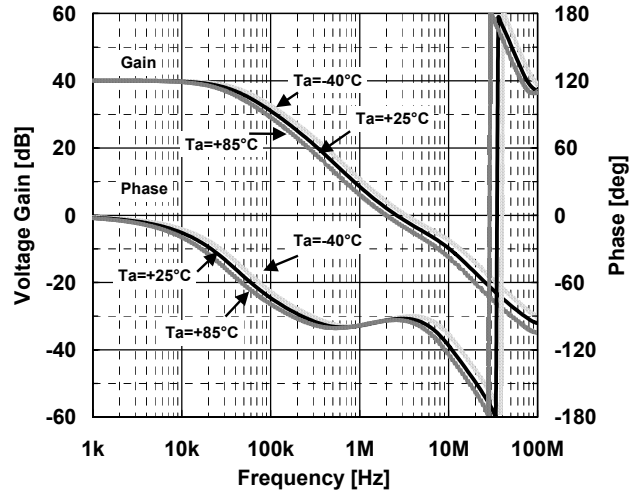
**Voltage Gain · Phase vs. Frequency**

$V^+ / V^- = \pm 0.9V$ ,  $G_v = 40dB$   
 $R_f = 20\Omega$ ,  $R_G = 2k\Omega$ ,  $R_L = \infty$ ,  $C_L = 0pF$



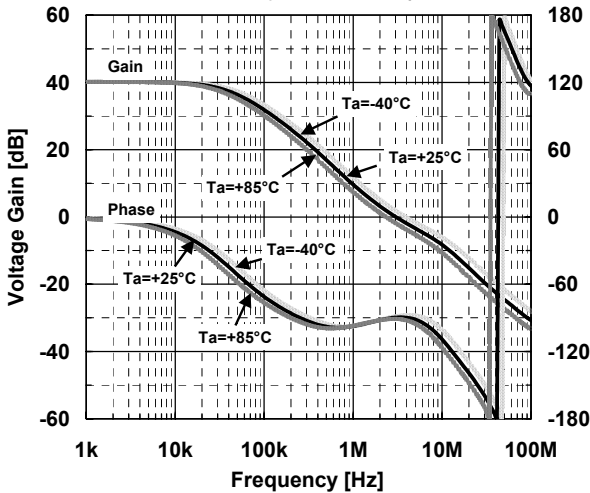
**Voltage Gain · Phase vs. Frequency**

$V^+ / V^- = \pm 1.5V$ ,  $G_v = 40dB$   
 $R_f = 20\Omega$ ,  $R_G = 2k\Omega$ ,  $R_L = \infty$ ,  $C_L = 0pF$



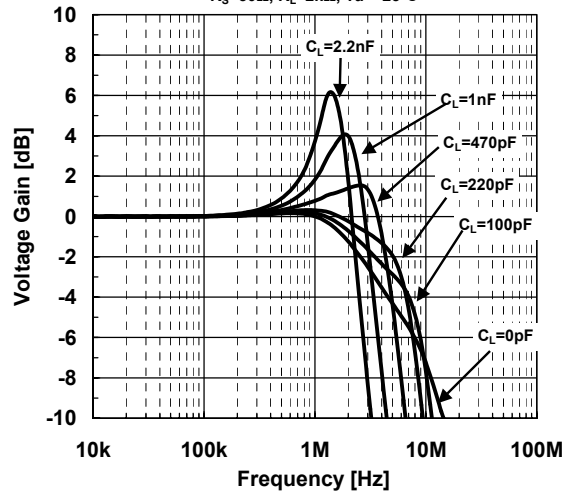
**Voltage Gain · Phase vs. Frequency**

$V^+ / V^- = \pm 2.5V$ ,  $G_v = 40dB$   
 $R_f = 20\Omega$ ,  $R_G = 2k\Omega$ ,  $R_L = \infty$ ,  $C_L = 0pF$



**Peak Gain of Voltage Follower**

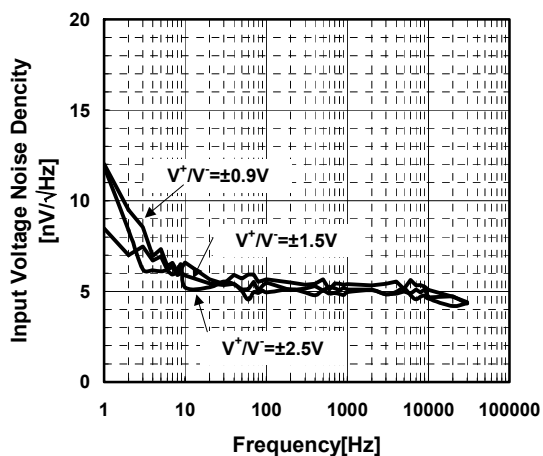
$V^+ / V^- = \pm 2.5V$ ,  $G_v = 0dB$   
 $R_S = 50\Omega$ ,  $R_L = 2k\Omega$ ,  $T_a = +25^\circ C$





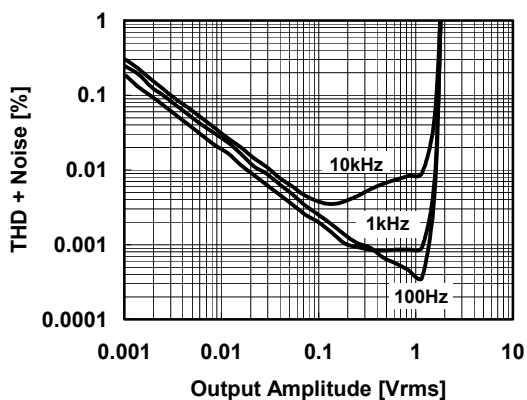
### Input Voltage Noise Density vs. Frequency

$G_V=40\text{dB}, R_S=50\Omega, R_G=20\Omega,$   
 $R_F=2\text{k}\Omega, C_L=0\text{pF}, T_a=25^\circ\text{C}$



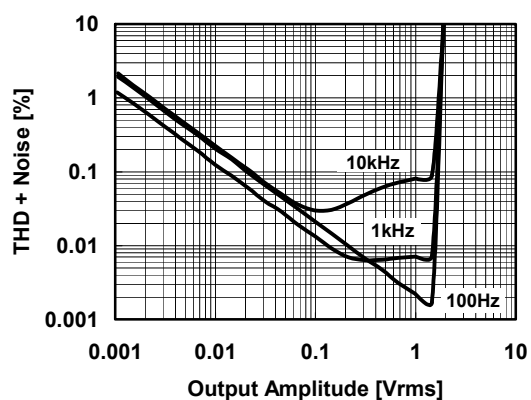
### TOTAL HARMONIC DISTORTION + NOISE vs OUTPUT AMPLITUDE

(Voltage Follower)  
 $V^+/V^-=\pm 2.5\text{V}, G_V=20\text{dB}$   
 $R_L=2\text{k}\Omega, T_a=25^\circ\text{C}$



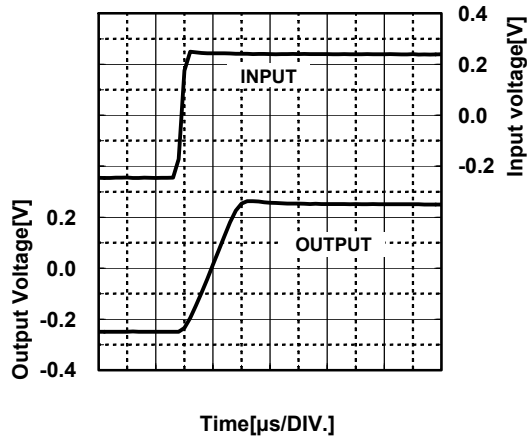
### TOTAL HARMONIC DISTORTION + NOISE vs OUTPUT AMPLITUDE

( $\times 10$  Amplifier)  
 $V^+/V^-=\pm 2.5\text{V}, G_V=20\text{dB}$   
 $R_L=2\text{k}\Omega, T_a=25^\circ\text{C}$



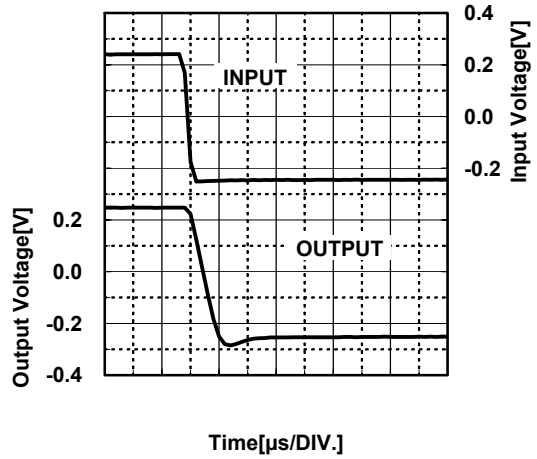
### Positive Transient Response

$V^+/V^- = \pm 0.9V, GV=0dB, f=10kHz, V_{IN}=0.5V_{PP}$   
 $R_S=50\Omega, R_L=2k\Omega, C_L=0pF, T_a=+25^\circ C$



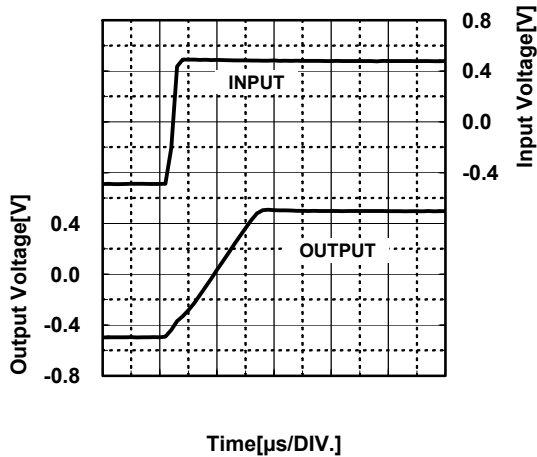
### Negative Transient Response

$V^+/V^- = \pm 0.9V, GV=0dB, f=10kHz, V_{IN}=0.5V_{PP}$   
 $R_S=50\Omega, R_L=2k\Omega, C_L=0pF, T_a=+25^\circ C$



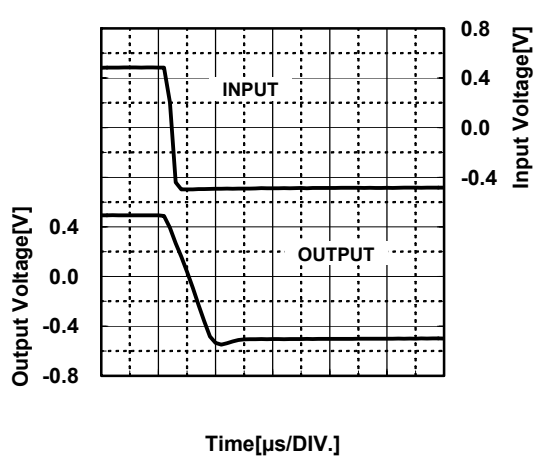
### Positive Transient Response

$V^+/V^- = \pm 1.5V, GV=0dB, f=10kHz, V_{IN}=1V_{PP}$   
 $R_S=50\Omega, R_L=2k\Omega, C_L=0pF, T_a=+25^\circ C$



### Negative Transient Response

$V^+/V^- = \pm 1.5V, GV=0dB, f=10kHz, V_{IN}=1V_{PP}$   
 $R_S=50\Omega, R_L=2k\Omega, C_L=0pF, T_a=+25^\circ C$



**[CAUTION]**

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