

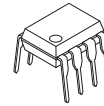
Low Noise, Rail-to-Rail Input/Output Dual Operational Amplifier

■ GENERAL DESCRIPTION

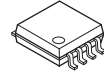
The NJM2737 is a Rail-to-Rail Input/Output single supply dual operational amplifier featuring low voltage operation, low power and low noise. It is designed to offer a low voltage operating from 1.8V with a $5\text{nV}/\sqrt{\text{Hz}}$ low noise of the conventional low noise operational amplifiers such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

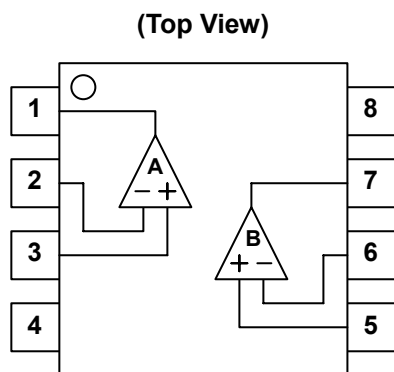


**NJM2737RB1
(MSOP8 (TVSP8))**

■ FEATURES

- Operating Voltage 1.8 to 6.0V
- Low Input Voltage Noise $5\text{nV}/\sqrt{\text{Hz}}$ typ.
- Gain Band Width product 3.1MHz 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 5mV max
- Rail-to-Rail Input $V_{\text{ICM}}=0$ to 5.0V (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 ⁺ | 7.0 | V |
| Differential Input Voltage | V _{ID} | ±1.0 | V |
| Input Common Mode Voltage Range | V _{ICM} | 0 to 7.0 | V |
| Power Dissipation | P _D | 500(DIP8) 300(DMP8) 250(SSOP8) 320(MSOP8 (TVSP8)) | mW |
| Operating Temperature Range | T _{opr} | -40 to +85 | °C |
| Storage Temperature Range | T _{stg} | -40 to +125 | °C |

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

■ RECOMMENDED OPERATING CONDITION

(Ta=25°C)

| PARAMETER | SYMBOL | RATING | UNIT |
|----------------|----------------|------------|------|
| Supply Voltage | V ⁺ | 1.8 to 6.0 | V |

■ ELECTRICAL CHARACTERISTICS

● DC CHARACTERISTICS

(V⁺=5V, Ta=25°C)

| PARAMETER | SYMBOL | TEST CONDITION | MIN | TYP | MAX | UNIT |
|---------------------------------|------------------|--|------|------|------|------|
| Operating Current | I _{CC} | No Signal | - | 1200 | 1600 | μA |
| Input Offset Voltage | V _{IO} | | - | 1 | 5 | mV |
| Input Bias Current | I _B | | - | 200 | 800 | nA |
| Input Offset Current | I _{IO} | | - | 5 | 100 | nA |
| Voltage Gain | A _V | R _L =2kΩ | 60 | 85 | - | dB |
| Common Mode Rejection Ratio | CMR | CMR+: 2.5V ≤ V _{CM} ≤ 5.0V, CMR-: 0 ≤ V _{CM} ≤ 2.5V (Note2) | 55 | 70 | - | dB |
| Supply Voltage Rejection Ratio | SVR | V ⁺ /GND = ±2.0 to ±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 | |
| Maximum Output Voltage 2 | V _{OH2} | R _L =2kΩ | 4.75 | 4.85 | - | V |
| | V _{OL2} | R _L =2kΩ | - | 0.15 | 0.25 | |
| Input Common Mode Voltage Range | V _{ICM} | 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_{CM} ≤ 5V 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 | f _T | R _L =2kΩ | - | 3.1 | - | MHz |
| Phase Margin | Φ _M | R _L =2kΩ | - | 85 | - | Deg |
| Equivalent Input Noise Voltage | V _N | f=1kHz | - | 5 | - | nV/ √Hz |

• TRANSIENT CHARACTERISTICS

(V⁺=5V, Ta=25°C)

| PARAMETER | SYMBOL | TEST CONDITION | MIN | TYP | MAX | UNIT |
|-----------|--------|---------------------|-----|-----|-----|------|
| Slew Rate | SR | R _L =2kΩ | - | 0.7 | - | V/μs |

• DC CHARACTERISTICS

(V⁺=3V, Ta=25°C)

| PARAMETER | SYMBOL | TEST CONDITION | MIN | TYP | MAX | UNIT |
|---------------------------------|------------------|--|------|------|------|------|
| Operating Current | I _{CC} | No Signal | - | 1000 | 1500 | μA |
| Input Offset Voltage | V _{IO} | | - | 1 | 5 | mV |
| Input Bias Current | I _B | | - | 200 | 800 | nA |
| Input Offset Current | I _{IO} | | - | 5 | 100 | nA |
| Voltage Gain | A _V | R _L =2kΩ | 60 | 85 | - | dB |
| Common Mode Rejection Ratio | CMR | CMR+: 1.5V ≤ V _{CM} ≤ 3.0V, CMR-: 0 ≤ V _{CM} ≤ 1.5V (Note3) | 48 | 63 | - | dB |
| Supply Voltage Rejection Ratio | SVR | V ⁺ /GND = ±1.2 to ±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 | |
| Maximum Output Voltage 2 | V _{OH2} | R _L =2kΩ | 2.75 | 2.85 | - | V |
| | V _{OL2} | R _L =2kΩ | - | 0.15 | 0.25 | |
| Input Common Mode Voltage Range | V _{ICM} | 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_{CM} ≤ 3V 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 | f _T | R _L =2kΩ | - | 2.6 | - | MHz |
| Phase Margin | Φ _M | R _L =2kΩ | - | 85 | - | Deg |
| Equivalent Input Noise Voltage | V _N | f=1kHz | - | 5 | - | nV/ √Hz |

• TRANSIENT CHARACTERISTICS

(V⁺=3V, Ta=25°C)

| PARAMETER | SYMBOL | TEST CONDITION | MIN | TYP | MAX | UNIT |
|-----------|--------|---------------------|-----|-----|-----|------|
| Slew Rate | SR | R _L =2kΩ | - | 0.6 | - | V/μs |

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• DC CHARACTERISTICS

(V⁺=1.8V, Ta=25°C)

| PARAMETER | SYMBOL | TEST CONDITION | MIN | TYP | MAX | UNIT |
|---------------------------------|------------------|--|-----|------|------|------|
| Operating Current | I _{CC} | No Signal | - | 1000 | 1500 | μA |
| Input Offset Voltage | V _{IO} | | - | 1 | 5 | mV |
| Input Bias Current | I _B | | - | 200 | 800 | nA |
| Input Offset Current | I _{IO} | | - | 5 | 100 | nA |
| Voltage Gain | A _V | R _L =2kΩ | 60 | 85 | - | dB |
| Common Mode Rejection Ratio | CMR | CMR+: 0.9V ≤ V _{CM} ≤ 1.8V, CMR-: 0 ≤ V _{CM} ≤ 0.9V (Note4) | 40 | 55 | - | dB |
| Supply Voltage Rejection Ratio | SVR | V ⁺ /GND = ±0.9 to ±1.2V | 65 | 80 | - | dB |
| Maximum Output Voltage 1 | V _{OH1} | R _L =20kΩ | 1.7 | 1.75 | - | V |
| | V _{OL1} | R _L =20kΩ | - | 0.1 | 0.15 | |
| Maximum Output Voltage 2 | V _{OH2} | R _L =2kΩ | 1.6 | 1.65 | - | V |
| | V _{OL2} | R _L =2kΩ | - | 0.15 | 0.25 | |
| Input Common Mode Voltage Range | V _{ICM} | 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_{CM} ≤ 1.8V 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 | f _T | R _L =2kΩ | - | 2.3 | - | MHz |
| Phase Margin | Φ _M | R _L =2kΩ | - | 85 | - | Deg |
| Equivalent Input Noise Voltage | V _N | f=1kHz | - | 5 | - | nV/ √Hz |

• TRANSIENT CHARACTERISTICS

(V⁺=1.8V, Ta=25°C)

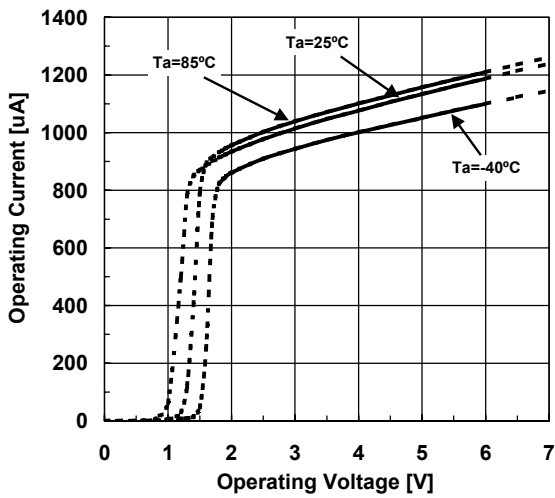
| PARAMETER | SYMBOL | TEST CONDITION | MIN | TYP | MAX | UNIT |
|-----------|--------|---------------------|-----|-----|-----|------|
| Slew Rate | SR | R _L =2kΩ | - | 0.5 | - | V/μs |

■ TERMINAL CHARACTERISTICS

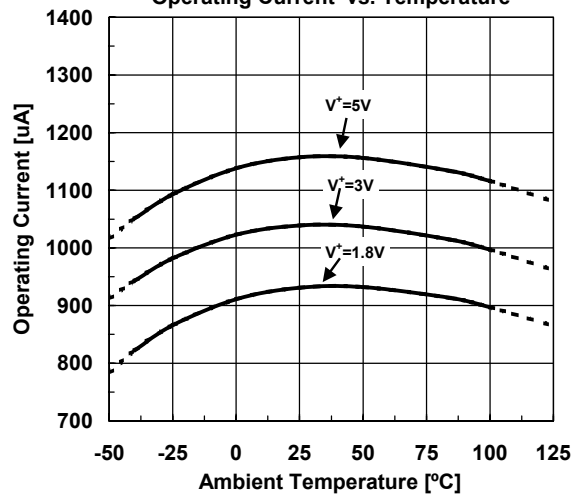
| No. | Symbol | Equivalent Circuit | Typ.DC Voltage(V) | Function |
|-----|--------|--------------------|-------------------|---------------------|
| 3,5 | +INPUT | | | non-inverting input |
| 2,6 | -INPUT | | | inverting input |
| 1,7 | VOUT | | | output |

■ TYPICAL CHARACTERISTICS

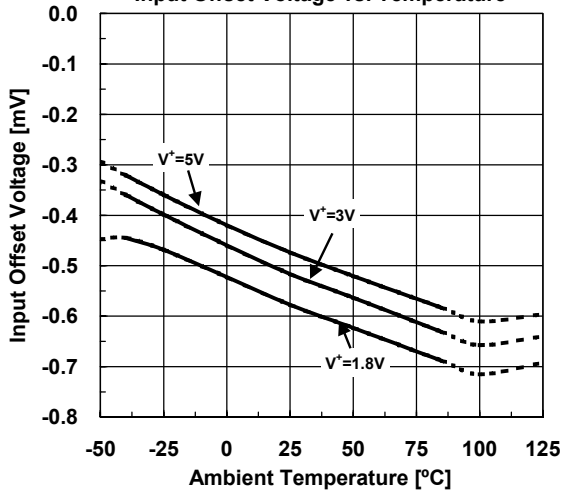
Operating Current vs. Operating Voltage



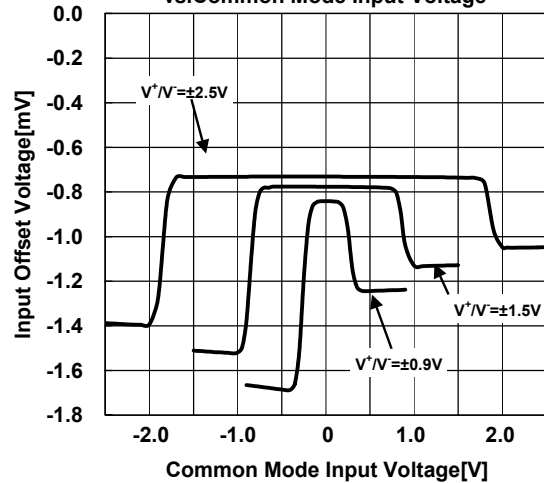
Operating Current vs. Temperature



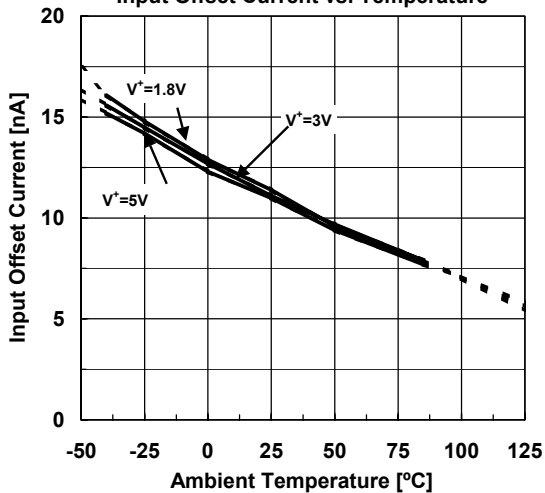
Input Offset Voltage vs. Temperature



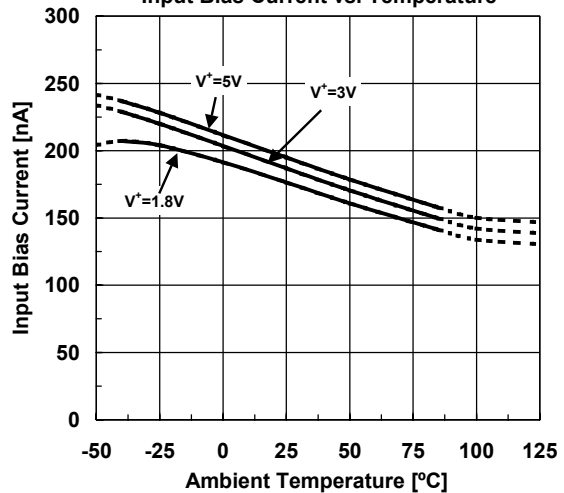
Input Offset Voltage vs. Common Mode Input Voltage



Input Offset Current vs. Temperature

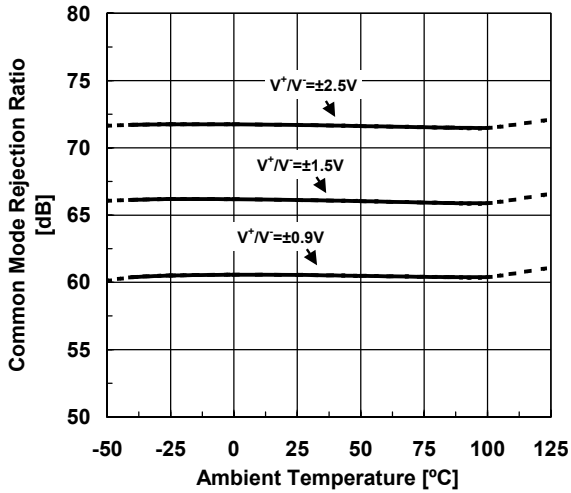


Input Bias Current vs. Temperature

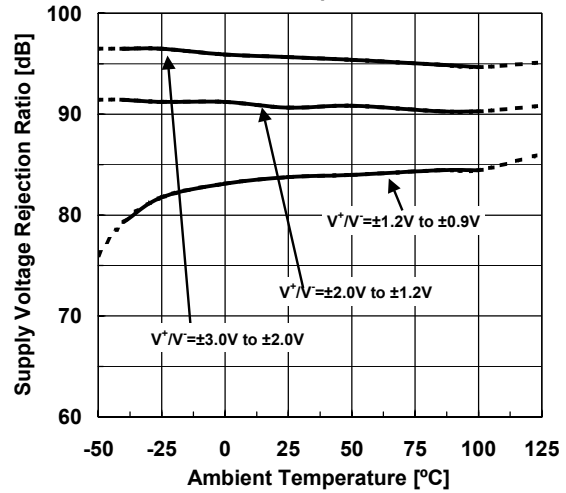


Common Mode Rejection Ratio vs. Temperature

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

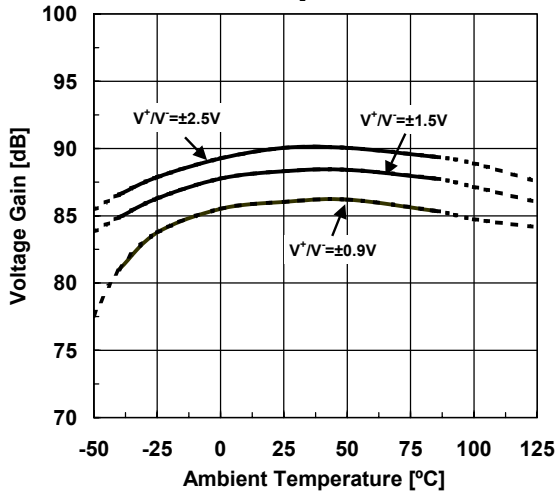


Supply Voltage Rejection Ratio vs. Temperature



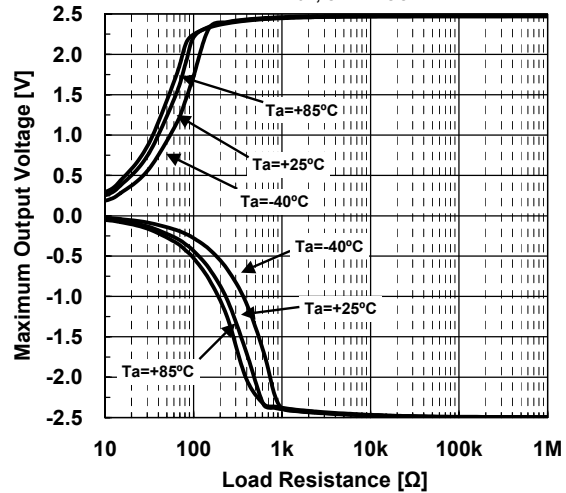
Voltage Gain vs. Temperature

$R_L=2k\Omega$



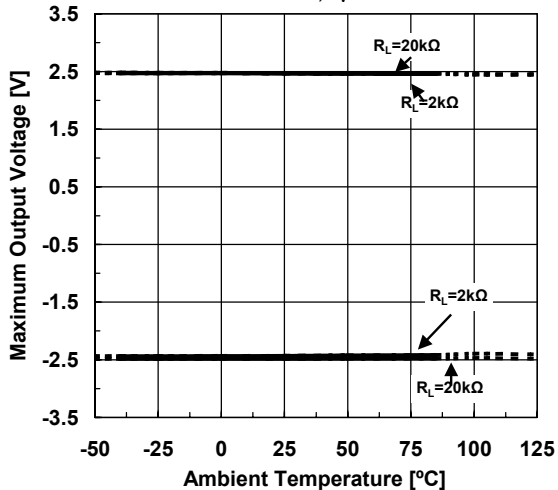
Maximum Output Voltage vs. Load Resistance

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



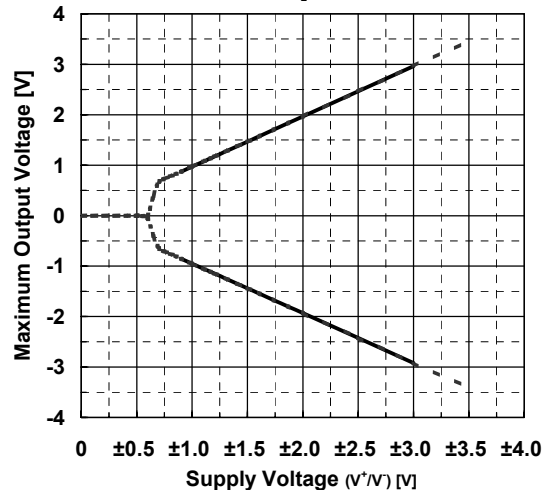
Maximum Output Voltage vs. Temperature

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

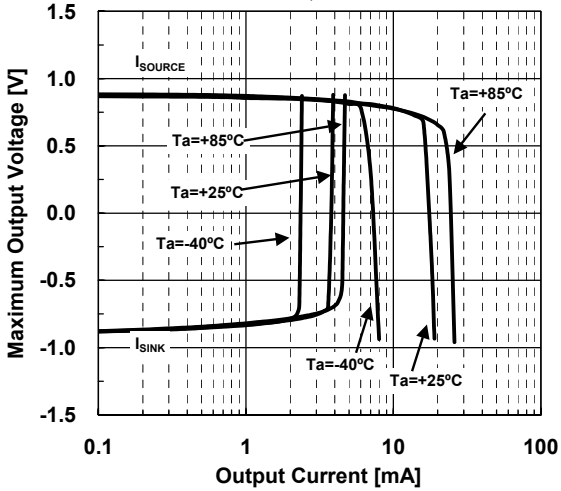


Maximum Output Voltage vs. Supply Voltage

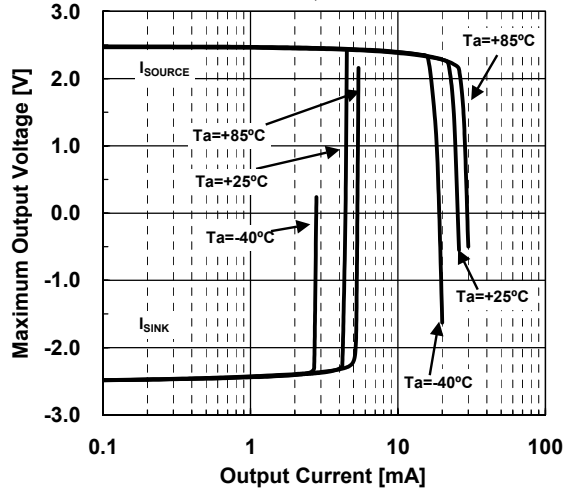
$\text{OPEN LOOP}, R_L=2k\Omega, T_a=25^\circ\text{C}$



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

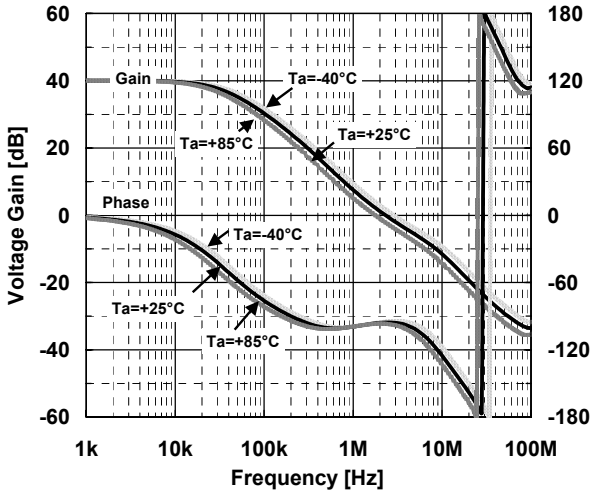


Maximum Output Voltage vs. Output Current
 $V^+ / V^- = \pm 2.5V$, OPEN LOOP



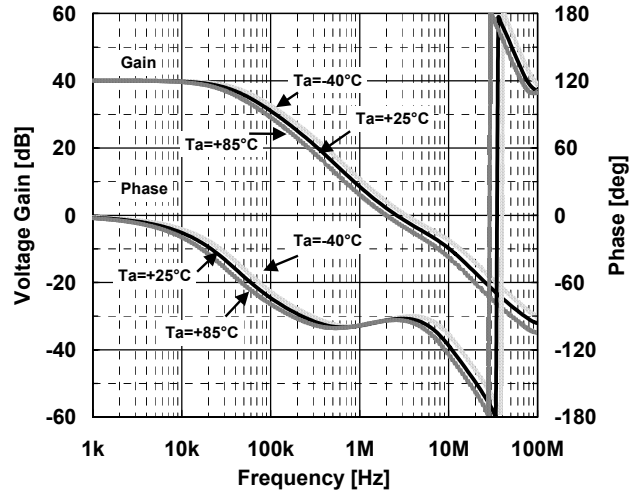
Voltage Gain · Phase vs. Frequency

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



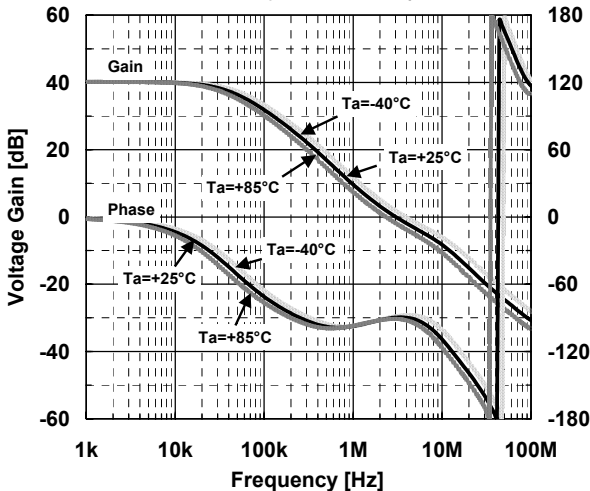
Voltage Gain · Phase vs. Frequency

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



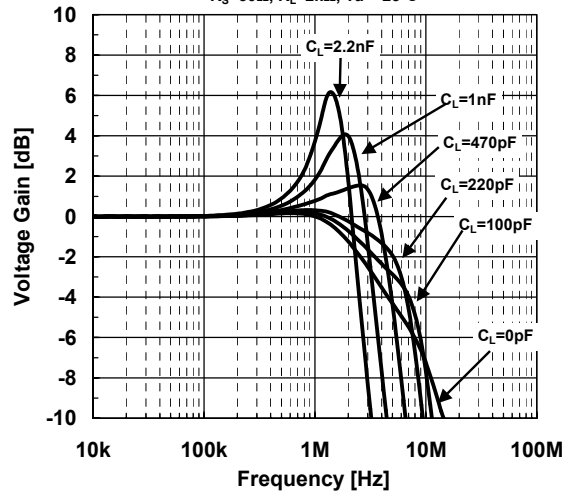
Voltage Gain · Phase vs. Frequency

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



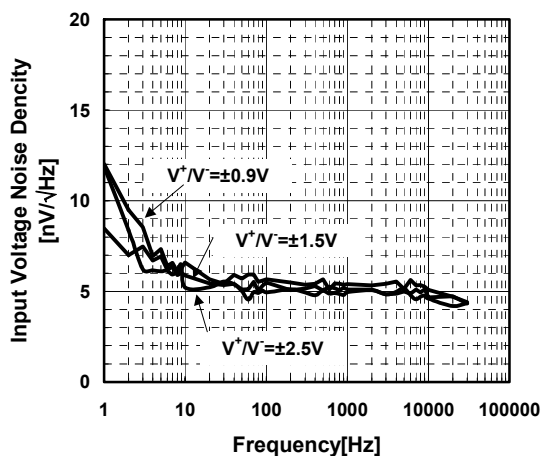
Peak Gain of Voltage Follower

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



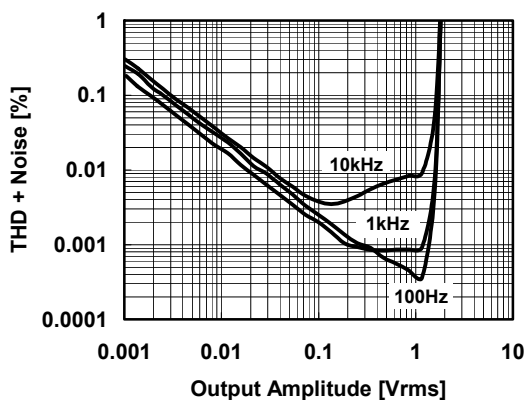
Input Voltage Noise Density vs. Frequency

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



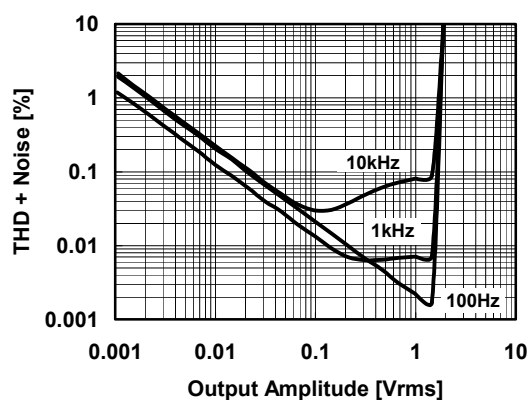
TOTAL HARMONIC DISTORTION + NOISE vs OUTPUT AMPLITUDE

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



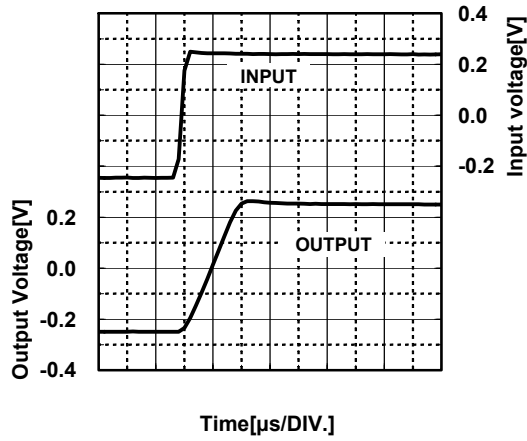
TOTAL HARMONIC DISTORTION + NOISE vs OUTPUT AMPLITUDE

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



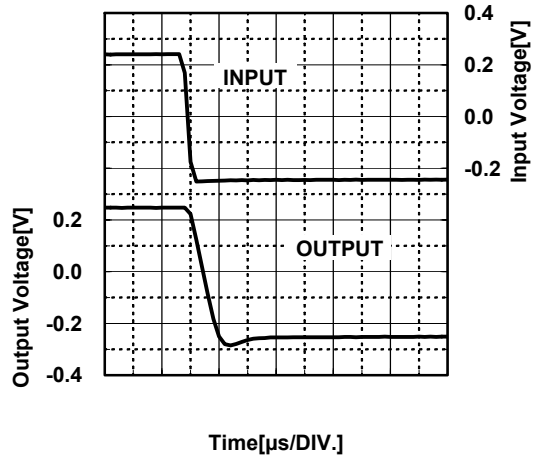
Positive Transient Response

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



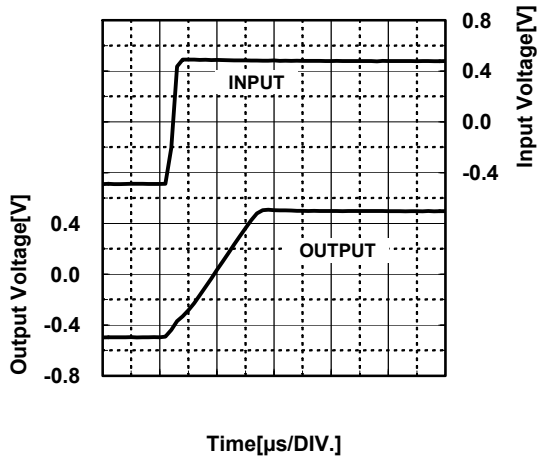
Negative Transient Response

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



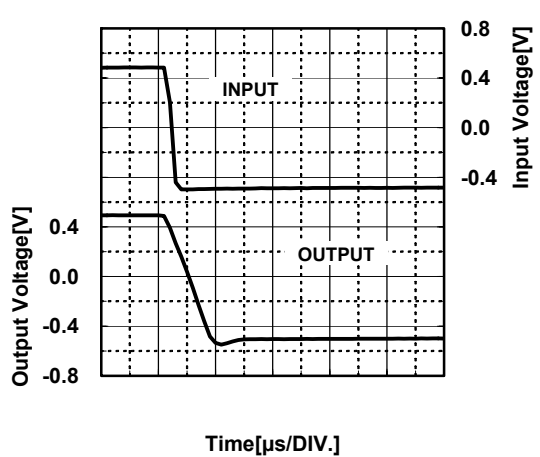
Positive Transient Response

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



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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