

## 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.

### ■ 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  $V_{OH} \geq 4.9V / V_{OL} \leq 0.1V$ , (at  $V^+ = 5V, R_L = 20k\Omega$ )
- Load Drivability  $V_{OH} \geq 4.75V / V_{OL} \leq 0.25V$ , (at  $V^+ = 5V, R_L = 2k\Omega$ )
- Offset Voltage 5mV max.
- Slew Rate 0.4V/ $\mu$ s typ.
- Low Input Voltage Noise 10nV/ $\sqrt{\text{Hz}}$  typ. (at f=1kHz)
- Adequate phase margin  $\Phi_M = 75\text{deg}$ . typ., (at  $R_L = 2k\Omega$ , voltage follower)
- Bipolar Technology
- Package Outline DIP8, DMP8, SOP8 JEDEC 150mil, SSOP8, MSOP8 (TVSP8) MEET JEDEC MO-187-DA / THIN TYPE

### ■ PACKAGE OUTLINE



NJM2732D  
(DIP8)



NJM2732M  
(DMP8)



NJM2732E  
(SOP8)



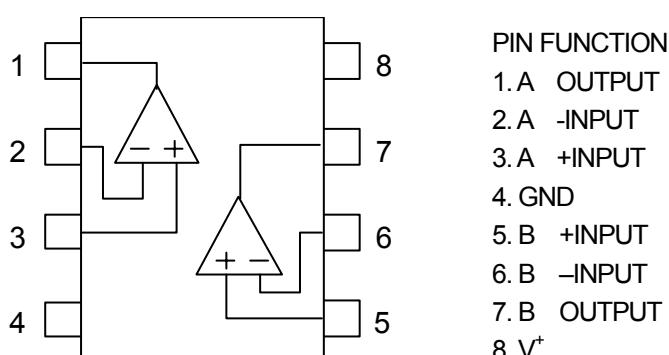
NJM2732V  
(SSOP8)



NJM2732RB1  
(MSOP8 (TVSP8))

### ■ PIN CONFIGURATION

(Top View)



NJM2732D

NJM2732M

NJM2732E

NJM2732V

NJM2732RB1

# NJM2732

## ■ ABSOLUTE MAXIMUM RATINGS

(Ta=25°C)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage	V <sup>+</sup>	7.0	V
Differential Input Voltage Range	V <sub>ID</sub>	±1.0	V
Common Mode Input Voltage Range	V <sub>IC</sub>	0 ~ 7.0 (Note1)	V
Power Dissipation	P <sub>D</sub>	(DIP8) 500 (DMP8) 300 (SOP8) 300 (SSOP8) 250 (MSOP8 (TVSP8))320	mW
Operating Temperature Range	T <sub>opr</sub>	-40~+85	°C
Storage Temperature Range	T <sub>stg</sub>	-40~+125	°C

(Note1) For supply voltage less than 7V, the absolute maximum input voltage is equal to the supply voltage.

## ■ RECOMMENDED OPERATING CONDITION

(Ta=25°C)

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

## ■ ELECTRICAL CHARACTERISTICS (V<sup>+</sup>=5V, Ta=25°C)

### •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 applied	-	580	900	µA
Input Offset Voltage	V <sub>IO</sub>		-	1	5	mV
Input Bias Current	I <sub>B</sub>		-	50	250	nA
Input Offset Current	I <sub>IO</sub>		-	5	100	nA
Large Signal 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> ≤5V CMR-: 0V≤V <sub>CM</sub> ≤2.5V (Note2)	55	70	-	dB
Supply Voltage Rejection Ratio	SVR	V <sup>+</sup> /V=±2.0V ~ ±3.0V	70	85	-	dB
Maximum Output Voltage 1	V <sub>OH1</sub>	R <sub>L</sub> =20kΩ	4.9	4.95	-	V
Maximum Output Voltage 2	V <sub>OL1</sub>	R <sub>L</sub> =20kΩ	-	0.05	0.1	V
Input Common Mode Voltage Range	V <sub>ICM</sub>	V <sub>CM</sub> =2.5V	4.75	4.85	-	V
Input Common Mode Voltage Range	V <sub>ICM</sub>	CMR≥55dB	-	0.15	0.25	V
Input Common Mode Voltage Range	V <sub>ICM</sub>	CMR<55dB	0	-	5	V

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

CMR+ is measured with 2.5V≤V<sub>CM</sub>≤5.0 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	GB	R <sub>L</sub> =2kΩ	-	1	-	MHz
Phase Margin	Φ <sub>M</sub>	R <sub>L</sub> =2kΩ	-	75	-	Deg
Equivalent Input Noise Voltage	V <sub>NI</sub>	f=1kHz	-	10	-	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	-	0.4	-	V/µs

■ ELECTRICAL CHARACTERISTICS ( $V^+=3V$ ,  $T_a=25^\circ C$ )

## ● 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 applied	-	510	880	µA
Input Offset Voltage	V <sub>IO</sub>		-	1	5	mV
Input Bias Current	I <sub>B</sub>		-	50	250	nA
Input Offset Current	I <sub>IO</sub>		-	5	100	nA
Large Signal Voltage Gain	A <sub>V</sub>	R <sub>L</sub> =2kΩ	60	84	-	dB
Common Mode Rejection Ratio	CMR	CMR+: 1.5V≤V <sub>CM</sub> ≤3V CMR-: 0V≤V <sub>CM</sub> ≤1.5V (Note3)	48	63	-	dB
Supply Voltage Rejection Ratio	SVR	V <sup>+</sup> /V=±1.2V ~ ±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	V
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	V
Input Common Mode Voltage Range	V <sub>ICM</sub>	CMR≥48dB	0	-	3	V

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

CMR+ is measured with 1.5V≤V<sub>CM</sub>≤3.0 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	GB	R <sub>L</sub> =2kΩ	-	1	-	MHz
Phase Margin	Φ <sub>M</sub>	R <sub>L</sub> =2kΩ	-	75	-	Deg
Equivalent Input Noise Voltage	V <sub>NI</sub>	f=1kHz	-	10	-	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	-	0.35	-	V/µs

■ ELECTRICAL CHARACTERISTICS ( $V^+=1.8V$ ,  $T_a=25^\circ C$ )

## ● 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 applied	-	460	800	µA
Input Offset Voltage	V <sub>IO</sub>		-	1	5	mV
Input Bias Current	I <sub>B</sub>		-	50	250	nA
Input Offset Current	I <sub>IO</sub>		-	5	100	nA
Large Signal Voltage Gain	A <sub>V</sub>	R <sub>L</sub> =2kΩ	60	83	-	dB
Common Mode Rejection Ratio	CMR	CMR+: 0.9V≤V <sub>CM</sub> ≤1.8V CMR-: 0V≤V <sub>CM</sub> ≤0.9V (Note4)	48	55	-	dB
Supply Voltage Rejection Ratio	SVR	V <sup>+</sup> /V=±1.2V ~ ±2.0V	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	-	0.05	0.1	V
Maximum Output Voltage 2	V <sub>OH2</sub>	R <sub>L</sub> =2kΩ	1.55	1.65	-	V
	V <sub>OL2</sub>	R <sub>L</sub> =2kΩ	-	0.15	0.25	V
Input Common Mode Voltage Range	V <sub>ICM</sub>	CMR≥40dB	0	-	1.8	V

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

CMR+ is measured with 0.9V≤V<sub>CM</sub>≤1.8 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	GB	R <sub>L</sub> =2kΩ	-	1	-	MHz
Phase Margin	Φ <sub>M</sub>	R <sub>L</sub> =2kΩ	-	75	-	Deg
Equivalent Input Noise Voltage	V <sub>NI</sub>	f=1kHz	-	10	-	nV/√Hz

## ● TRANSIENT CHARACTERISTICS

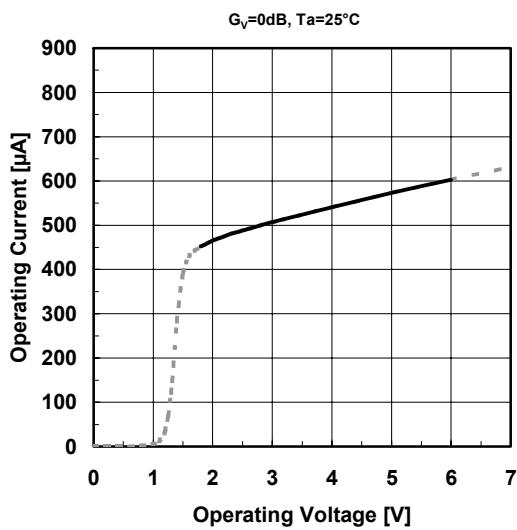
(V<sup>+</sup>=1.8V, Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Slew Rate	SR	R <sub>L</sub> =2kΩ	-	0.3	-	V/µs

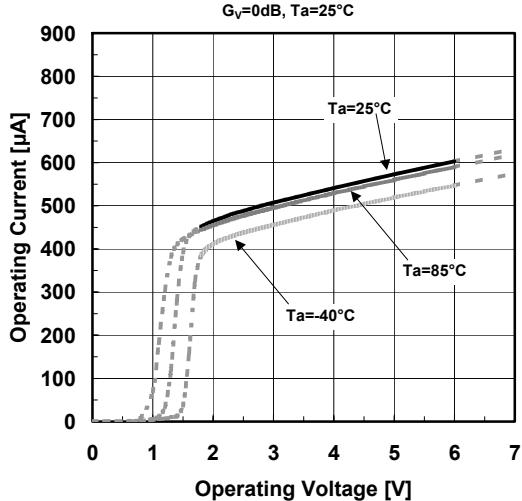
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## ■ TYPICAL CHARACTERISTICS

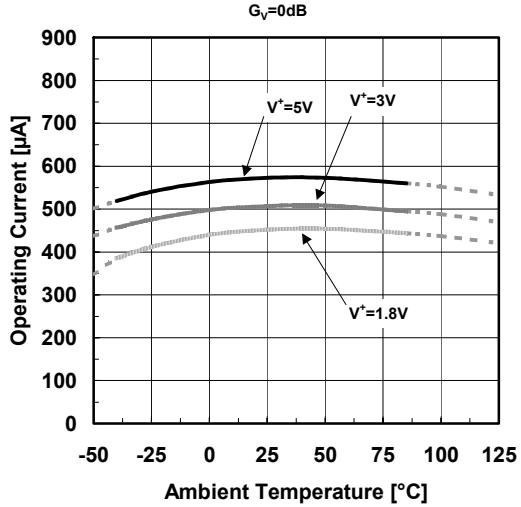
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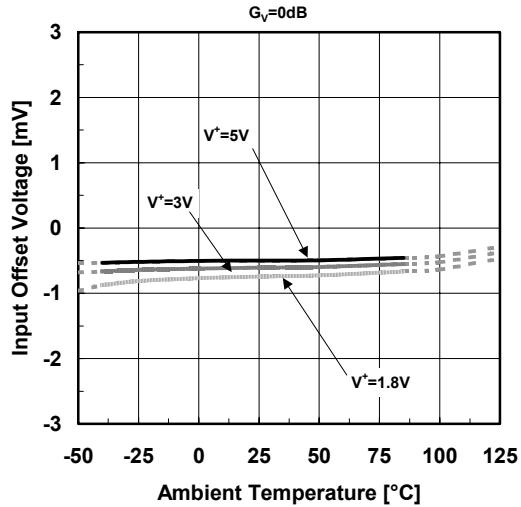
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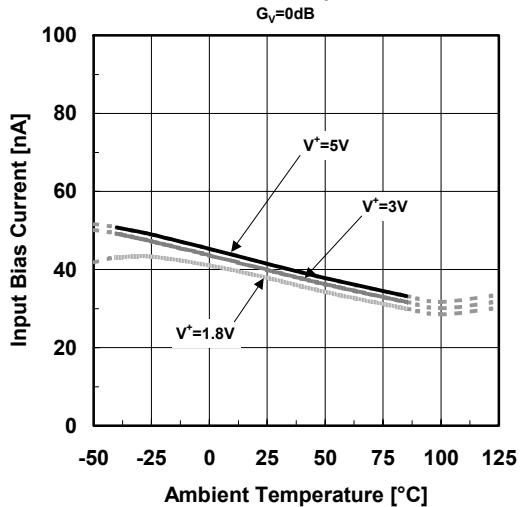
Operating Current  
vs. Ambient Temperature



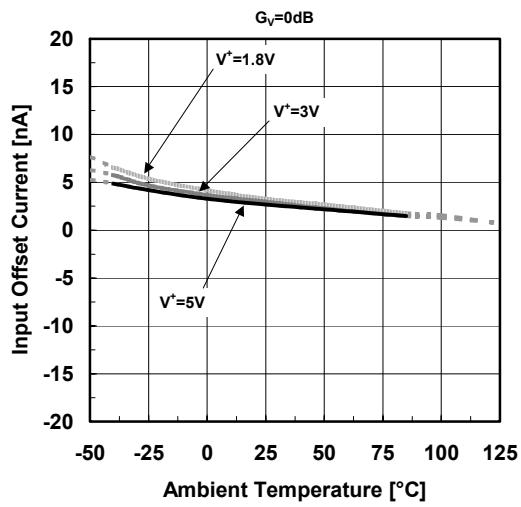
Input Offset Voltage  
vs. Ambient Temperature



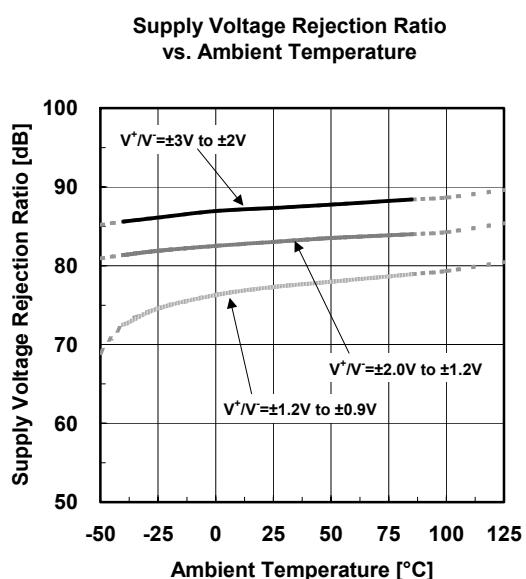
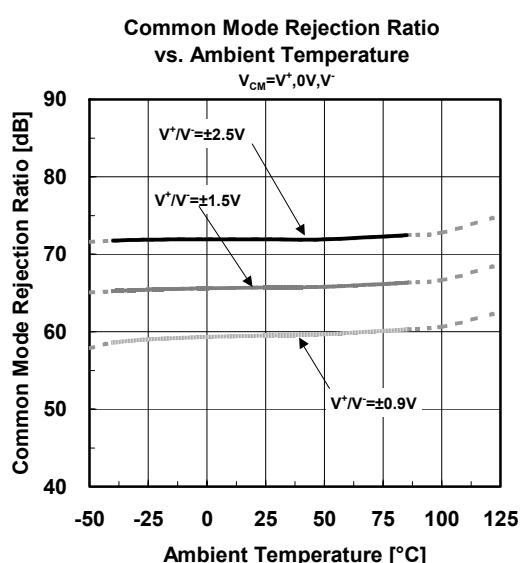
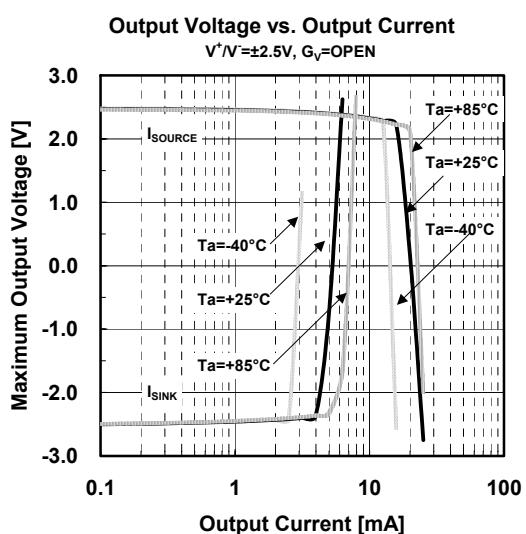
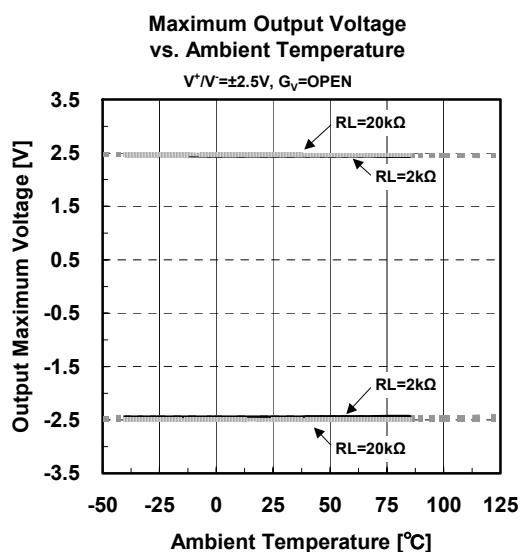
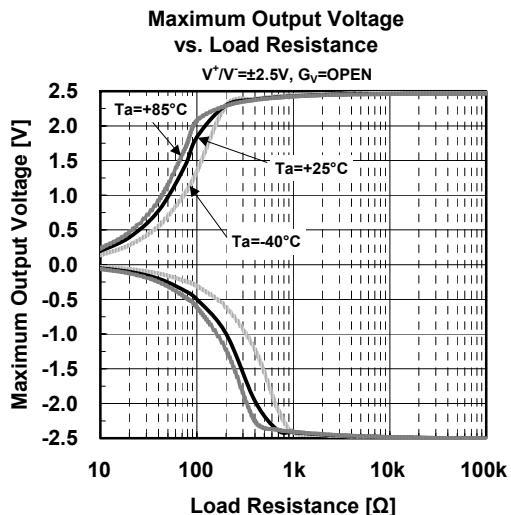
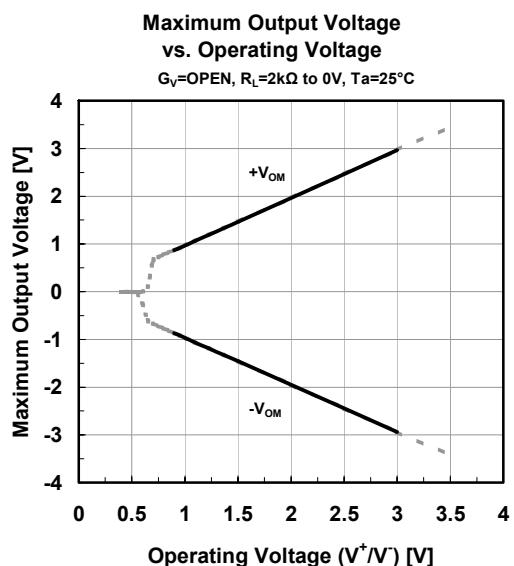
Input Bias Current  
vs. Ambient Temperature



Input Offset Current  
vs. Ambient Temperature

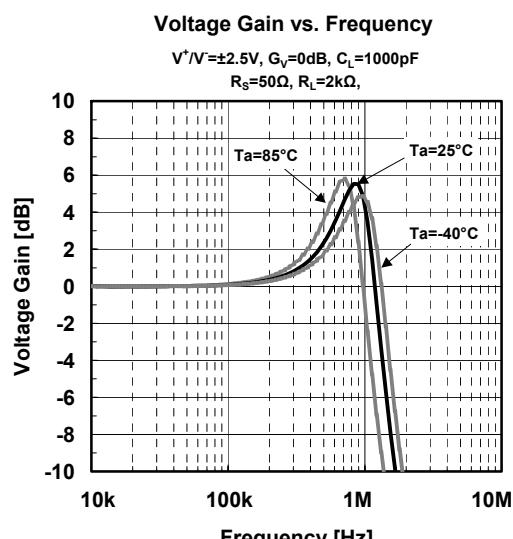
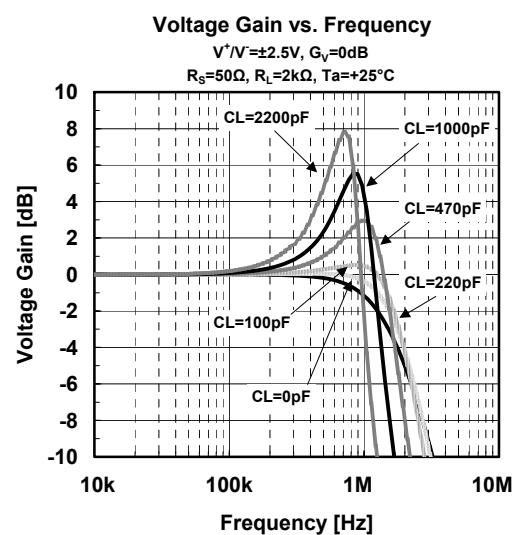
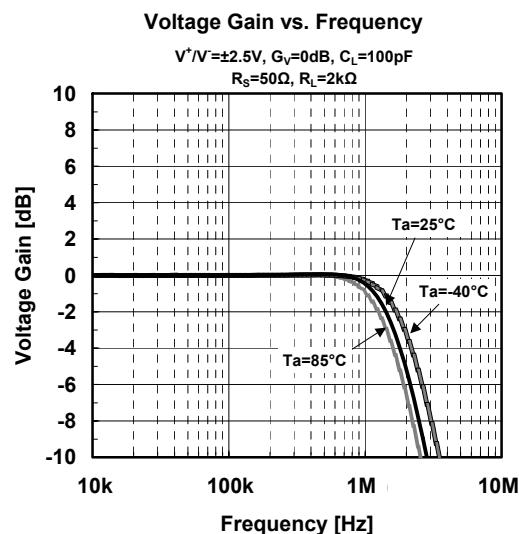
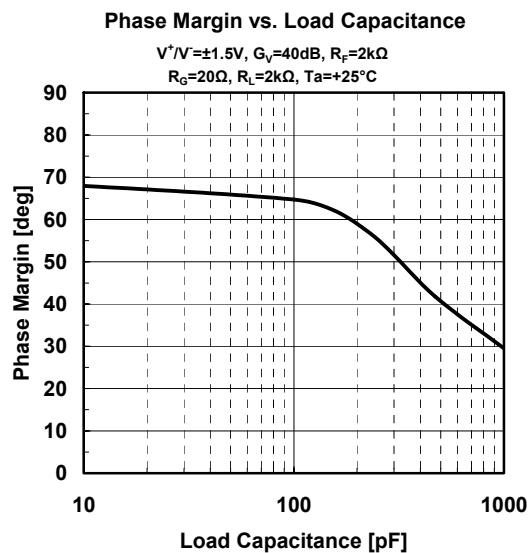
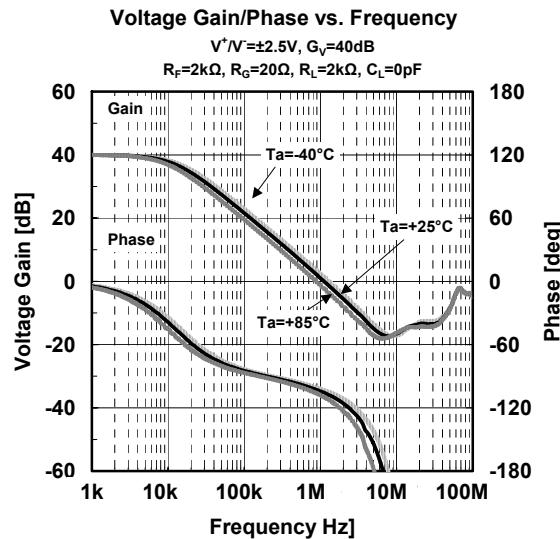
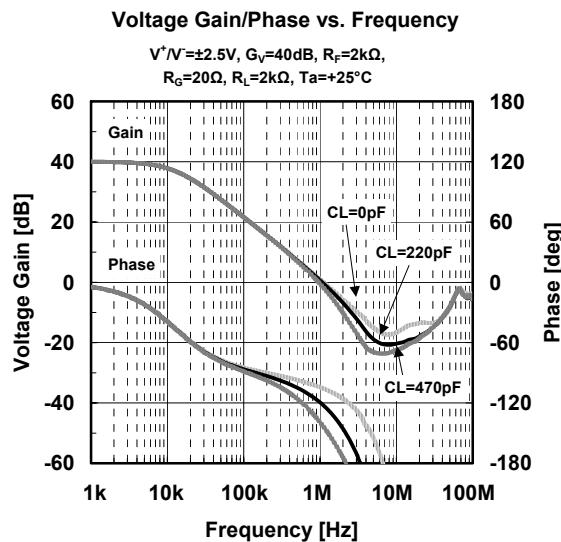


## ■ TYPICAL CHARACTERISTICS

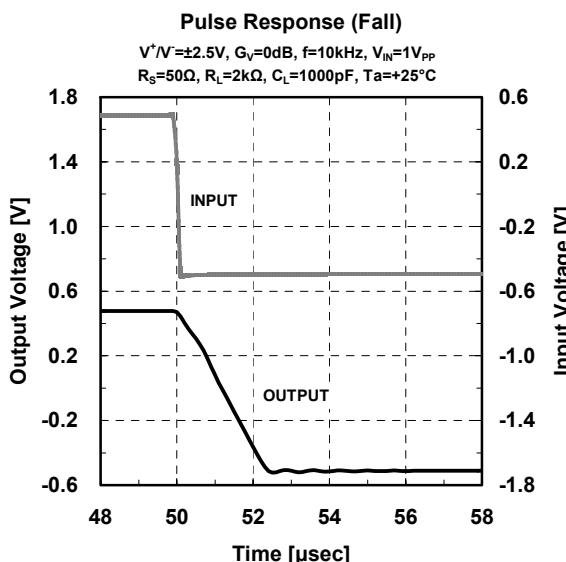
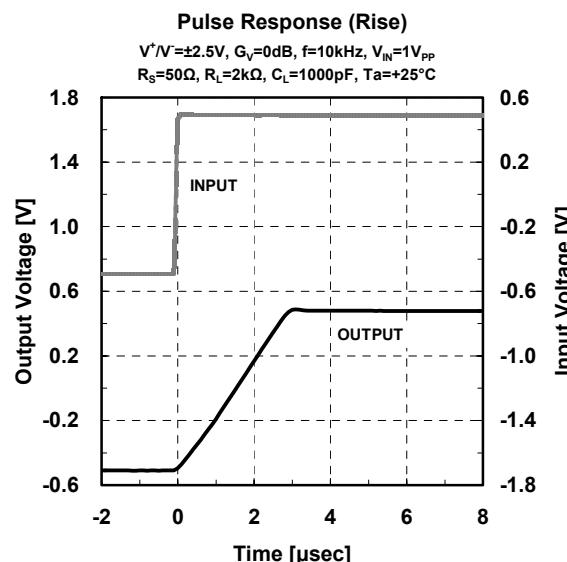
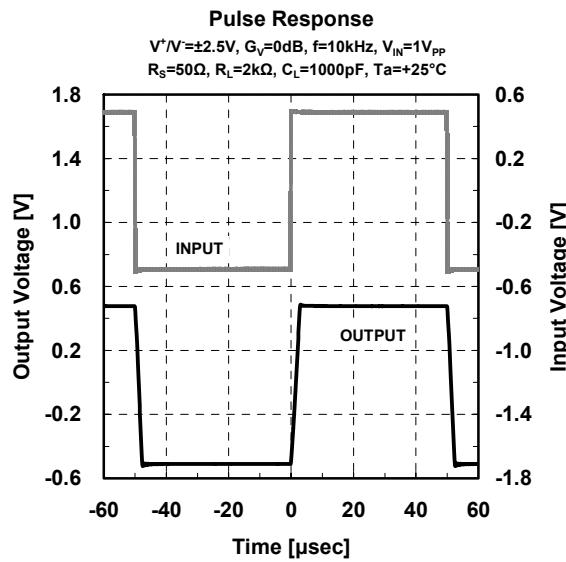
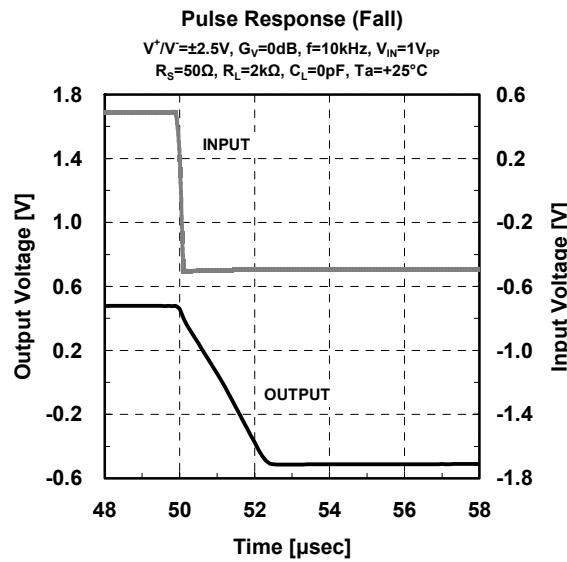
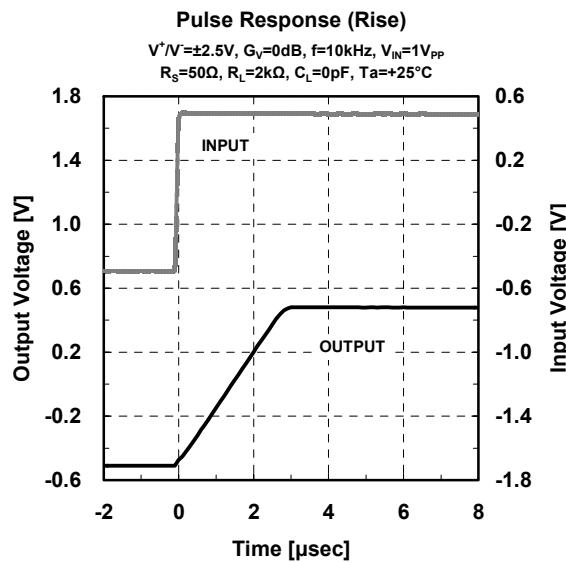
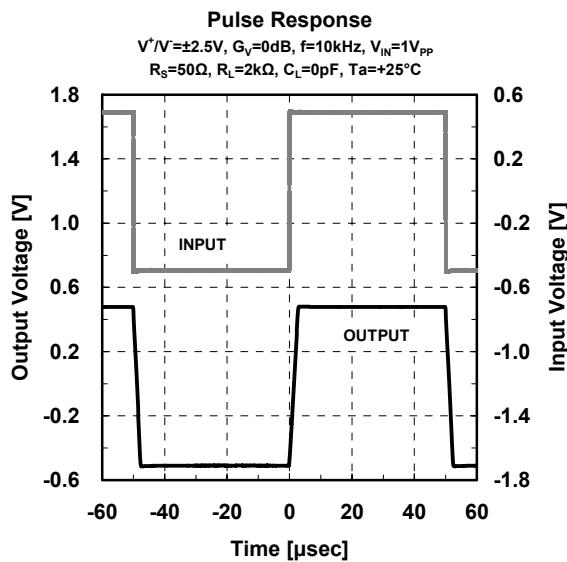


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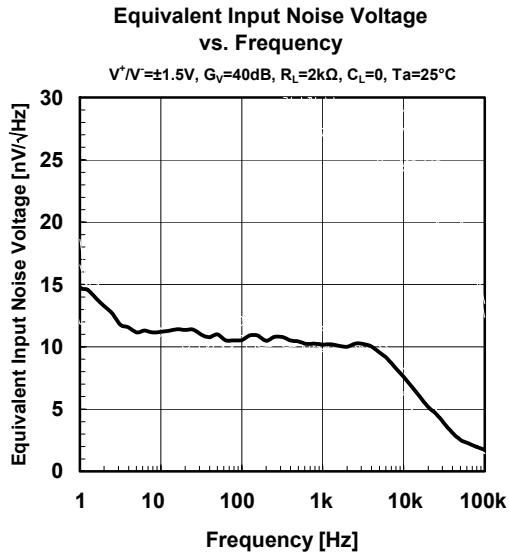
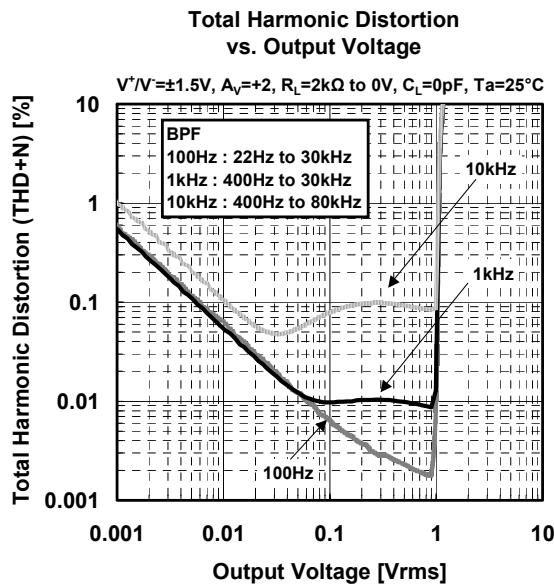
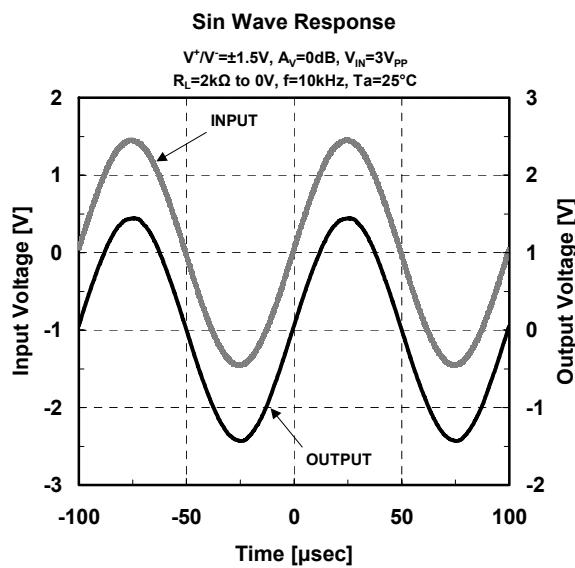


## ■ TYPICAL CHARACTERISTICS



# NJM2732

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