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## OPERATIONAL AMPLIFIER WITH EVR

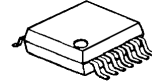
### ■ GENERAL DESCRIPTION

The NJM2172 is single supply, dual OP-AMP with electric variable resistor (EVR), which contains buffer amplifier, OP-AMP, reference voltage circuit, EVR and EVR control circuit.

The reference is fixed around  $1/2 V^+$  level internally, and only required few external parts.

The A and B EVR is control separately, and amp drive up to  $100\Omega$ (typ.) load. The NJM2172 is suitable for camcorder, CD, MD, and other audio signal process system.

### ■ PACKAGE OUTLINE



NJM2172V

### ■ FEATURES

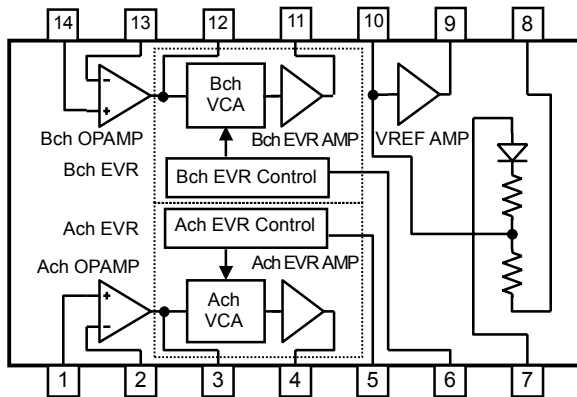
- Low Power Supply Voltage
- Low Operating Current
- A/Bch EVR adjust is separately
- EVR range
- Drivability
- Bipolar Technology
- Package Outline

$V^+ = 2.7$  to  $5.5V$   
 $I_{cc} = 5.0mA$  typ.

$-3.0$  to  $-95dB$   
 $100\Omega$  typ.

SSOP14

### ■ BLOCK DIAGRAM



### ■ PIN CONFIGURATION

- 1: OP<sub>+IN</sub>A
- 2: OP<sub>-IN</sub>A
- 3: OP<sub>OUT</sub>A
- 4: EVR<sub>OUT</sub>A
- 5: V<sub>CNT</sub>A
- 6: V<sub>CNT</sub>B
- 7: V<sup>+</sup>
- 8: GND
- 9: V<sub>ref</sub>
- 10: REF<sub>IN</sub>
- 11: EVR<sub>OUT</sub>B
- 12: OP<sub>OUT</sub>B
- 13: OP<sub>-IN</sub>B
- 14: OP<sub>+IN</sub>B

# NJM2172

## ■ ABSOLUTE MAXIMUM RATING

(Ta=25°C)

PARAMETER	RATINGS	SYMBOL(UNIT)	OTHERS
Supply Voltage	+7.0	V <sub>DD</sub> (V)	
Storage Temperature Range	-50 to +150	T <sub>stg</sub> (°C)	
Operating Temperature Range	-40 to +85	T <sub>opr</sub> (°C)	
Power Dissipation	300	P <sub>D</sub> (mW)	SSOP14 (ONLY)

## ■ ELECTRICAL CHARACTERISTICS (V<sup>+</sup>=3.5V, C<sub>refin</sub>=10pF, C<sub>ref</sub>=1μF, f=1kHz, Ta=25°C unless otherwise noted)

### ● SUPPLY

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	TEST CIRCUIT
Operating Current	I <sub>CC</sub>	R <sub>L</sub> =∞	-	5.0	7.5	mA	1
Reference Voltage	V <sub>ref</sub>	R <sub>L</sub> =∞	1.45	1.55	1.65	V	1

### ● OP-AMP SECTION

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	TEST CIRCUIT
Input Offset Voltage	V <sub>IO</sub>	R <sub>S</sub> ≤10kΩ	-	1.0	6.0	mV	3
Input Bias Current	I <sub>IB</sub>		-	100	300	nA	3
Voltage Gain 1	G <sub>V1</sub>	R <sub>L</sub> ≤10kΩ	60	80	-	dB	3
Maximum Output Voltage Swing 1	V <sub>OM1</sub>	THD=1%, R <sub>L</sub> ≥2.5kΩ	-3.0 (0.7)	0 (1.0)	- (-)	dBV (V <sub>rms</sub> )	2
Input Common Mode Voltage Range	V <sub>ICM</sub>	-	0.55 to 2.55	-	-	V	-
Output Noise Voltage	V <sub>ON1</sub>	R <sub>s</sub> =600Ω / A-Weighted	-	-100 (10.0)	-90 (30.0)	dBV (μV <sub>rms</sub> )	1
Common Mode Rejection Ratio	CMR	R <sub>S</sub> ≤10kΩ	60	74	-	dB	3
Supply Voltage Rejection Ratio	SVR	R <sub>S</sub> ≤10kΩ	60	80	-	dB	3
Gain Bandwidth Product	GB		-	2	-	MHz	-

● EVR SECTION (V<sub>CNT</sub>=2.7V, R<sub>L</sub>=100Ω unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT	TEST CIRCUIT
Voltage Gain 2	G <sub>V2</sub>	V <sub>IN</sub> = -10dBV	-6.0	-3.0	0.0	dB	1
Total Harmonic Distortion	THD	V <sub>IN</sub> = -10dBV	-	0.15	1.0	%	2
EVR Gain	G <sub>EVR</sub>	V <sub>IN</sub> =-10dBV/V <sub>CNT</sub> =2.7Vto GND	80	90	-	dB	1
Output Noise Voltage 2	V <sub>NO2</sub>	R <sub>S</sub> = 600Ω / A - Weighted	-	-95 (18.0)	-85 (56.0)	dBV (μVrms)	1
Maximum Output Voltage Swing 2	V <sub>OM2</sub>	THD = 1%	-5.0 (0.56)	-3.0 (0.71)	-	dBV (Vrms)	2
Channel Separation	CS	V <sub>IN</sub> =-10dBV / A - Weighted	-	-79 (110)	-70 (320)	dBV (μVrms)	1
EVR Deviation	A/B1	V <sub>CNT</sub> =1.5V, V <sub>INA</sub> =V <sub>INB</sub> =-50dBV f=1kHz, A/B ; *1	-3.0	0.0	3.0	dB	1
	A/B2	V <sub>CNT</sub> =2.0V, V <sub>INA</sub> =V <sub>INB</sub> =-50dBV f=1kHz, A/B ; *1	-3.0	0.0	3.0		

\*1: Ach Amp with Bch=0dB



## ■ TEST CIRCUIT 2

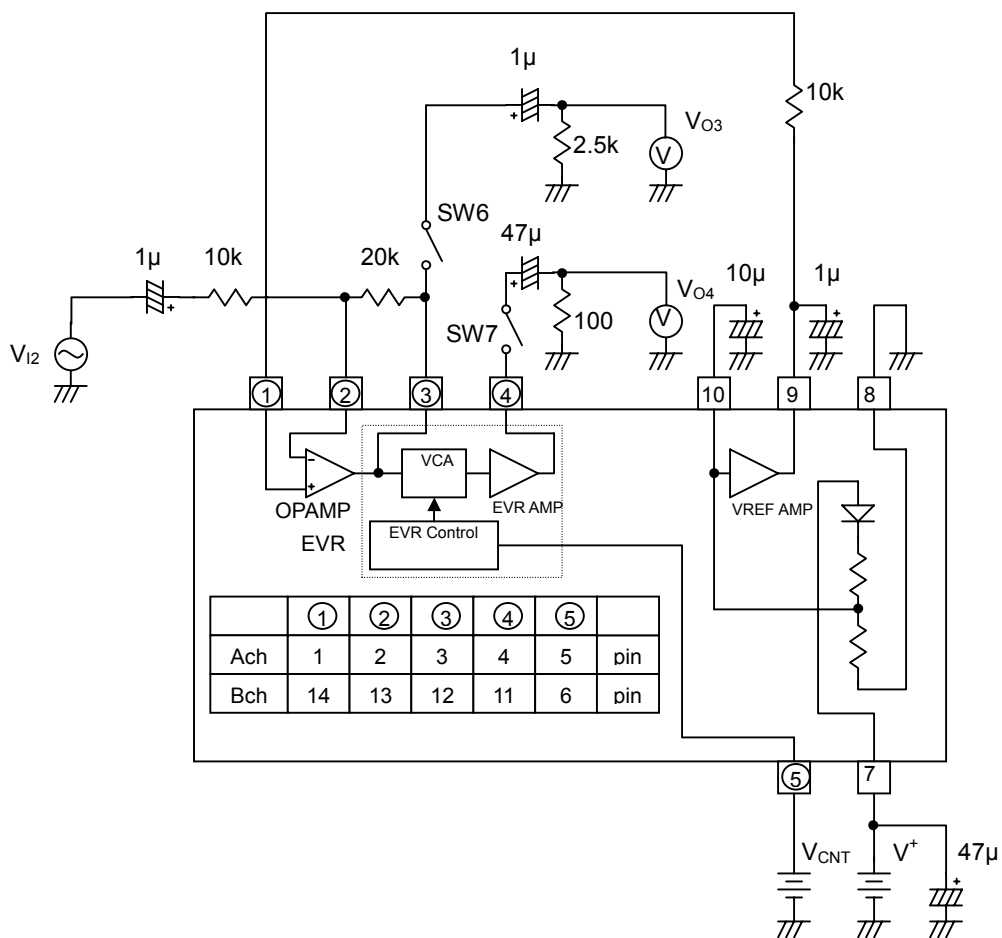


Fig.2

Test circuit 2 shows only Ach.

# NJM2172

## ■ TEST CIRCUIT 3

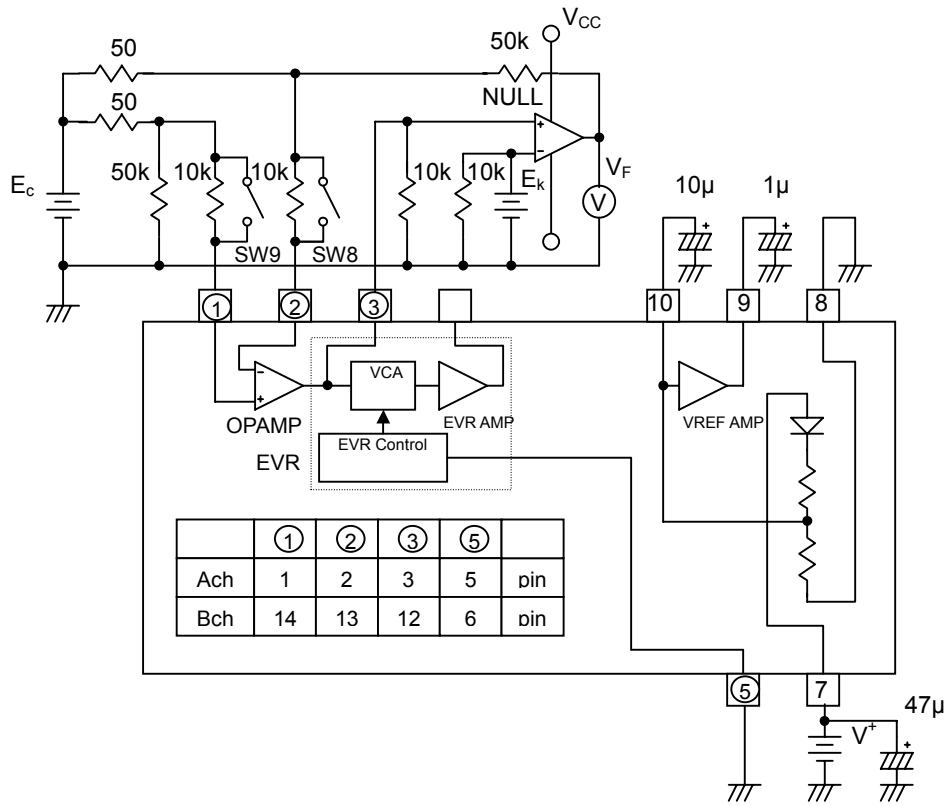


Fig.3

Test circuit 3 shows only Ach.

## ■ PIN INFORMATION

Pin No.	Pin Name	Function
1	OP+IN A	Ach OP-AMP + Input
2	OP-IN A	Ach OP-AMP - Input
3	OPOUTA	Ach OP-AMP Output / EVR Input
4	EVROUT A	Ach EVR Output
5	VCNT A	Ach EVR Control
6	VCNT B	Bch EVR Control
7	V <sup>+</sup>	Power Supply
8	GND	GND
9	VREF	Internal Reference Output
10	REFIN	Internal Reference Input
11	EVROUT B	Bch EVR Output
12	OPOUT B	Bch OP-AMP Output / EVR Input
13	OP-IN B	Bch OP-AMP - Input
14	OP+IN B	Bch OP-AMP + Input



# NJM2172

## ■ EQUIVALENT CIRCUIT

Term. No.	Term. Name	Equivalent Circuit	Terminal Voltage	Note
1 2 13 14	OP+INA OP-INA OP-INB OP+INB		1.55V	-
3 12	OPOUTA OPOUTB		1.55V	OPOUTA / OPOUTB Load: $RL \geq 2.5k\Omega$
4 11	EVROUTA EVROUTB		1.55V	EVROUTA / EVROUTB Load: $RL \geq 100\Omega$

Term. No.	Term. Name	Equivalent Circuit	Terminal Voltage	Note
5 6	VCNT A VCNT B		-	Input EVR control voltage
9 10	VREF REFIN		-	Terminal Voltage is $52 / (52+40) \times (V^+ - V_{BE})$ $R_L \geq 2K\Omega$

# NJM2172

## APPLICATION CIRCUIT 1 Voltage follower

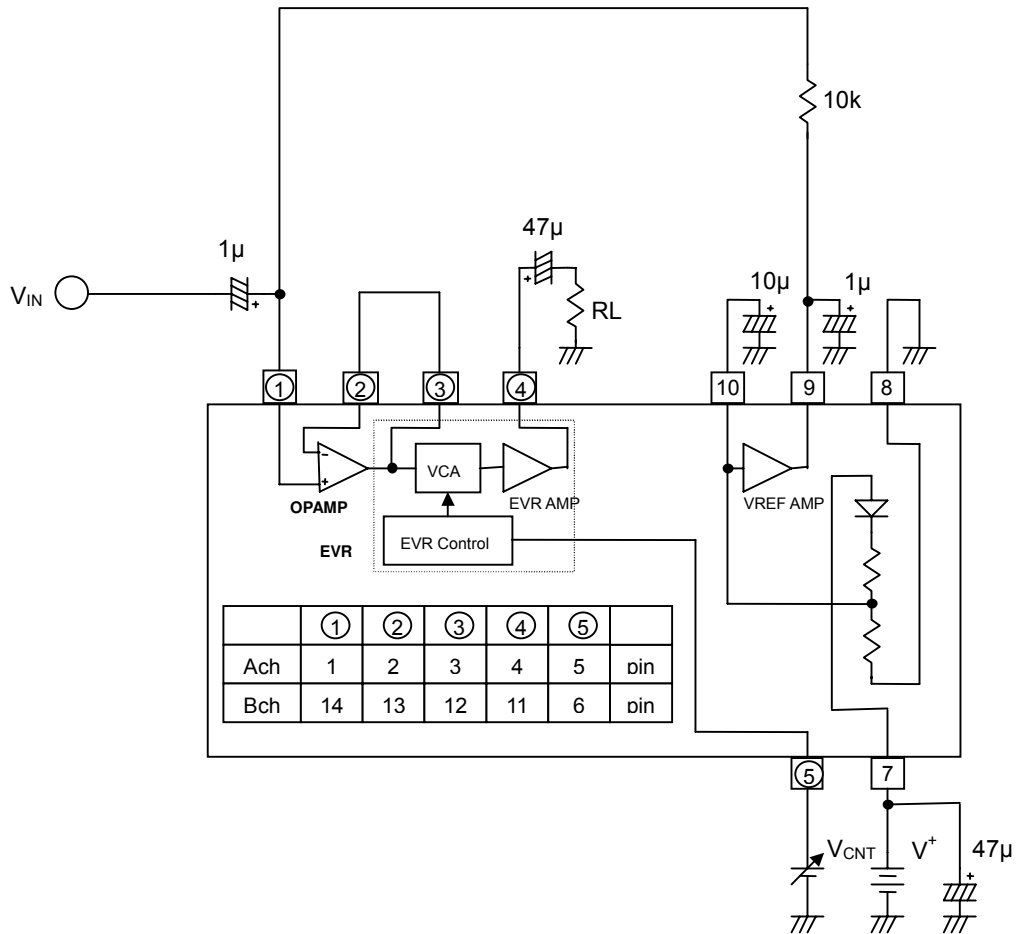


Fig.4

Application circuit 1 shows only Ach.

■ APPLICATION CIRCUIT 2  
Invert Circuit ( $G_v=6\text{dB}$ )

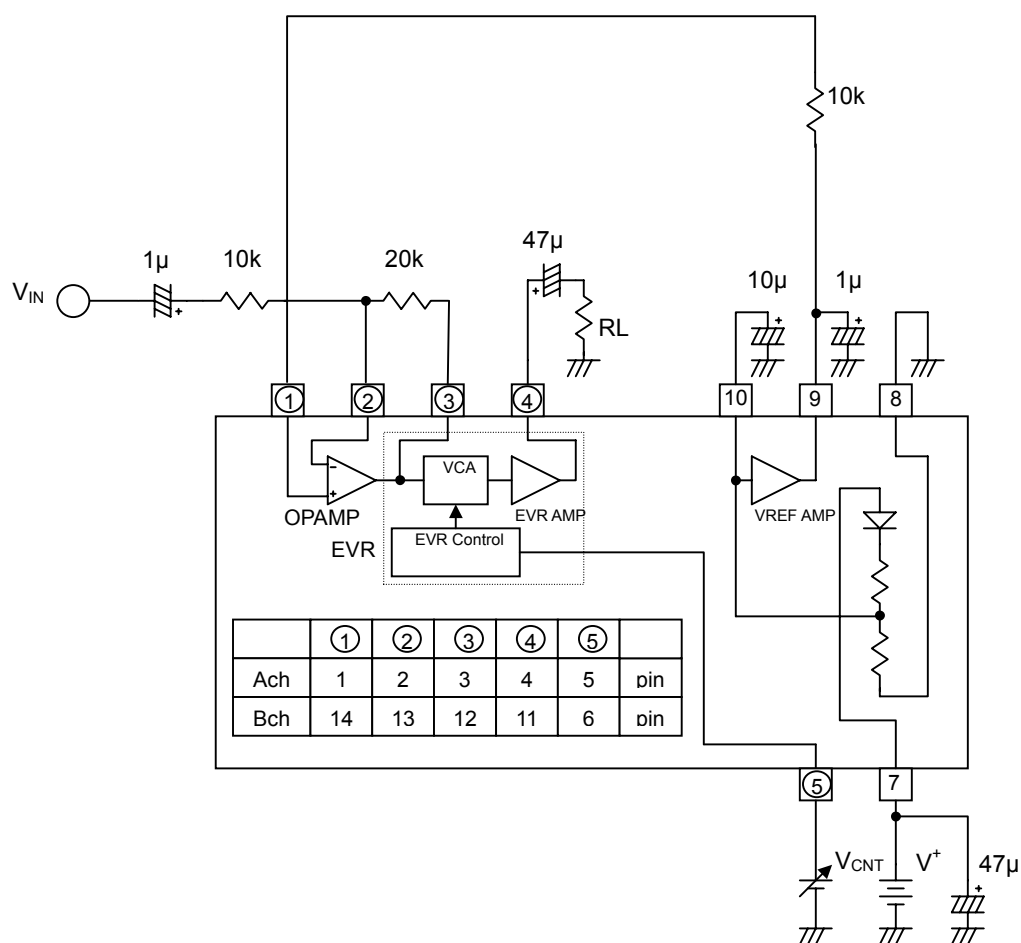


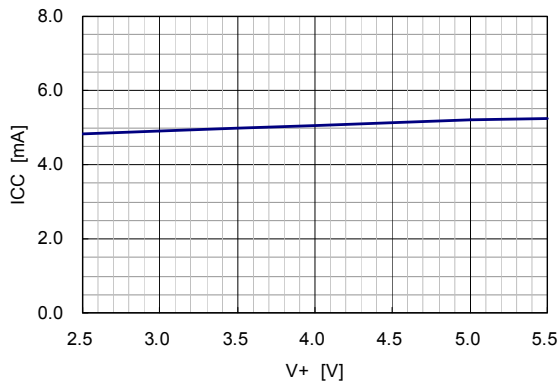
Fig.5

Application circuit 2 shows only Ach.

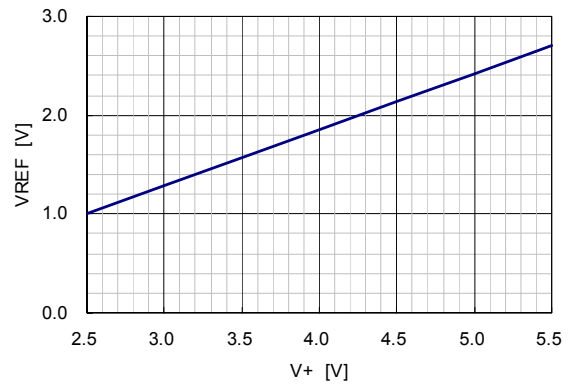
# NJM2172

## ■ TYPICAL CHARACTERISTICS

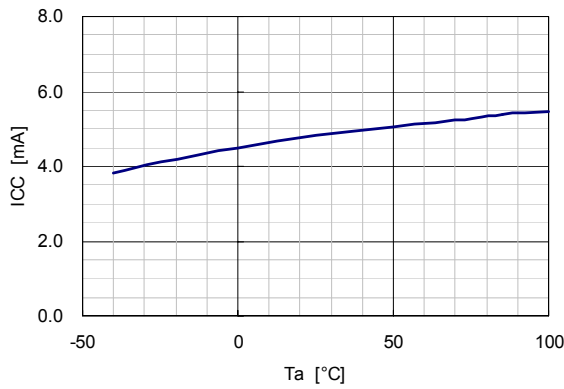
Quiescent Current vs. Supply Voltage  $T_a=25^\circ\text{C}$



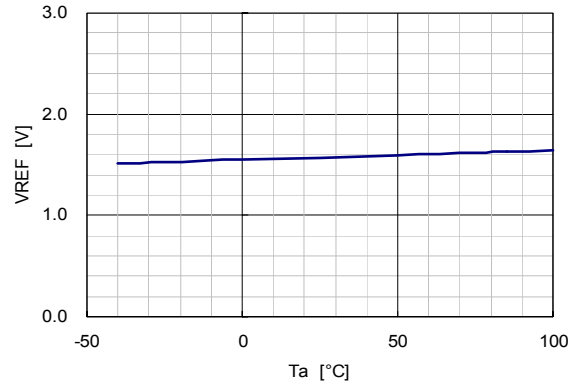
Internal Reference Voltage vs. Supply Voltage  $T_a=25^\circ\text{C}$



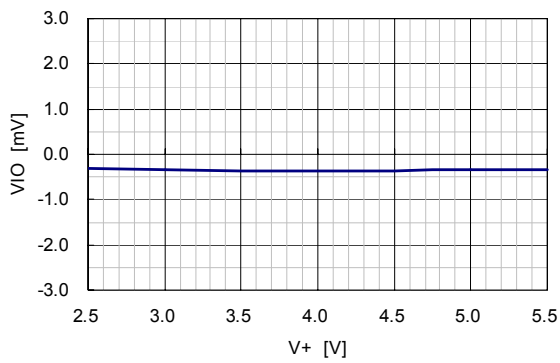
Quiescent Current vs. Temperature  $V+=3.5\text{V}$



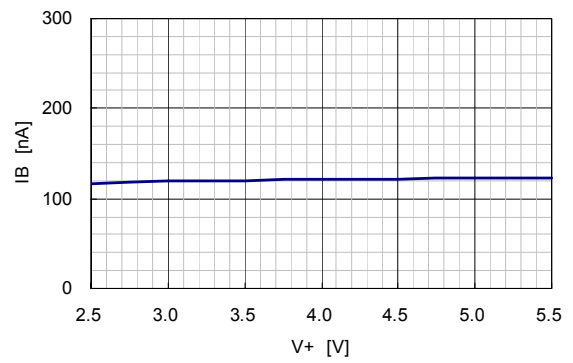
Internal Reference Voltage vs. Temperature  $V+=3.5\text{V}$



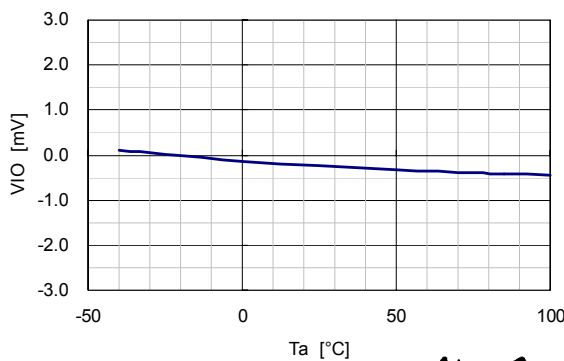
Input Offset Voltage vs. Supply Voltage  $T_a=25^\circ\text{C}$



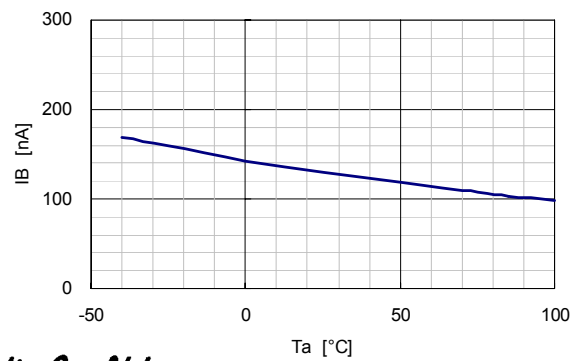
Input Bias Current vs. Supply Voltage  $T_a=25^\circ\text{C}$



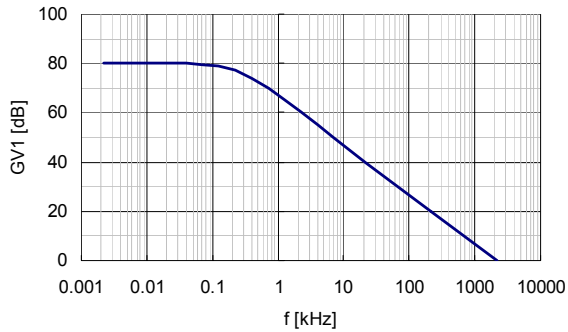
Input Offset Voltage vs. Temperature  $V+=3.5\text{V}$



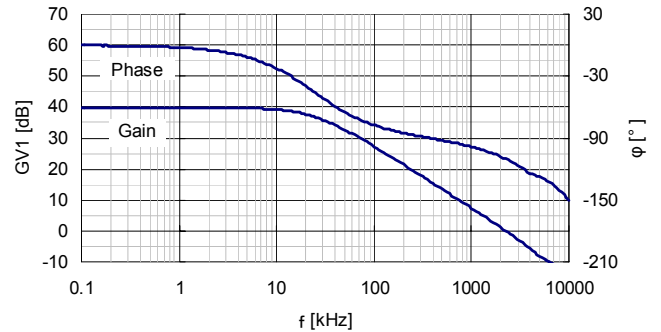
Input Bias Current vs. Temperature  $V+=3.5\text{V}$



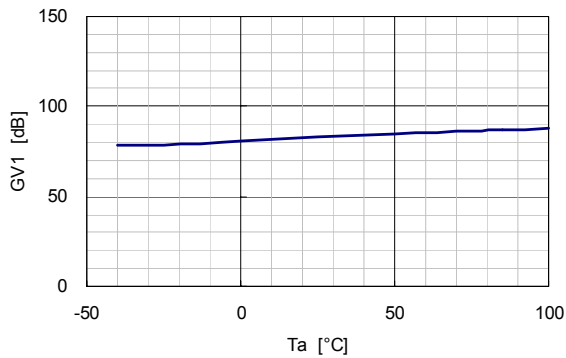
Voltage Gain 1 vs. Frequency  
 $V+=3.5V, T_a=25^\circ C, R_L=2.5k\Omega$



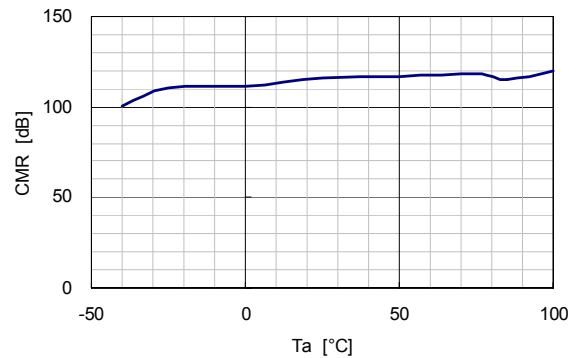
Voltage Gain 1 / Phase vs. Frequency  
 $V+=3.5V, T_a=25^\circ C, R_L=2.5k\Omega, 40dB$  Inverted Amp



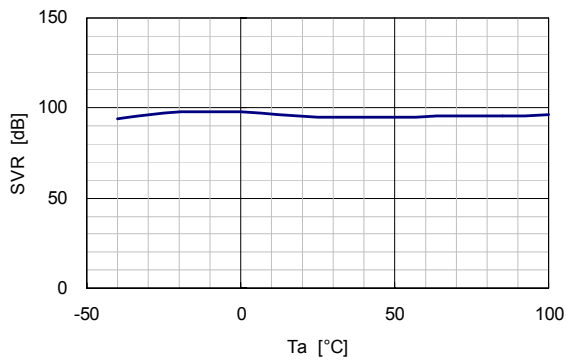
Voltage Gain1 vs. Temperature  $V+=3.5V$



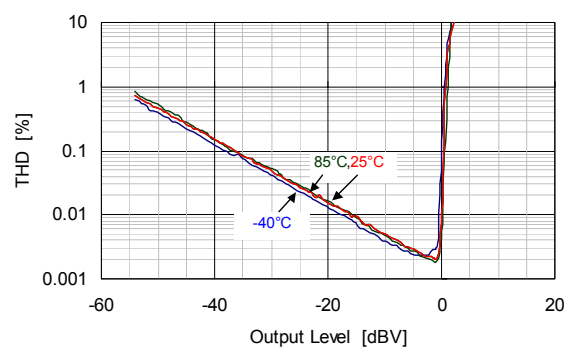
Common Mode Rejection Ratio vs. Temperature  $V+=3.5V$



Supply Voltage Rejection Ratio vs. Temperature  $V+=3.5V$

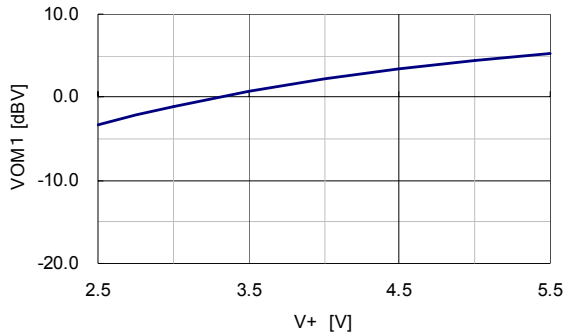


Total Harmonic Distortion (OPAMP) vs. Output Level  
 (Temperature)  
 $V+=3.5V, f=1kHz, BW=400Hz-30kHz$

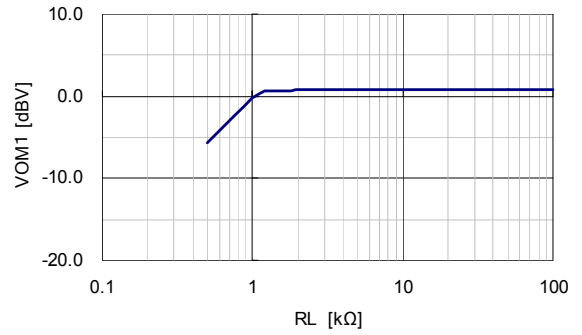


# NJM2172

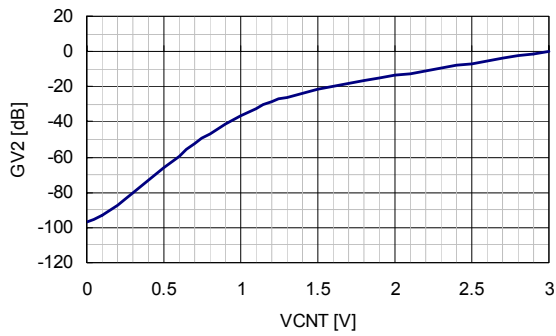
Maximum Output Voltage 1 vs. Supply Voltage  
 $R_L=2.5k\Omega, f=1kHz, THD=1\%, T_a=25^\circ C$



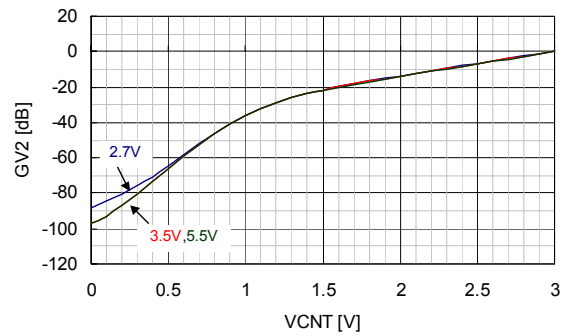
Maximum Output Voltage 1 vs. Load Resistance  
 $V+=3.5V, f=1kHz, THD=1\%, T_a=25^\circ C$



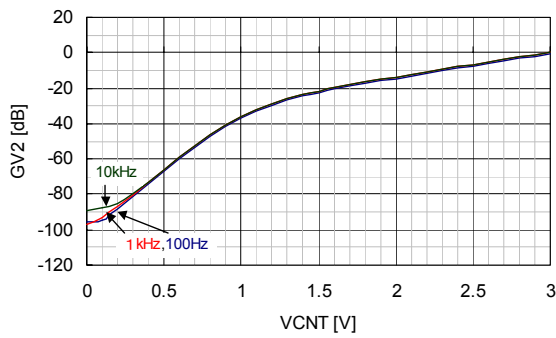
Voltage Gain 2 vs. EVR Control Voltage  
 $V+=3.5V, f=1kHz, Vin=-10dBV, T_a=25^\circ C$



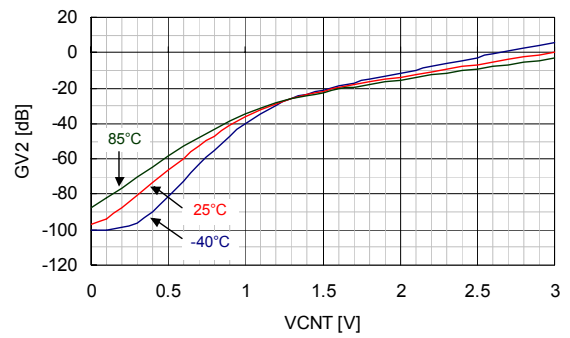
Voltage Gain 2 / Supply Voltage vs. EVR Control Voltage  
 $f=1kHz, Vin=-10dBV, T_a=25^\circ C$



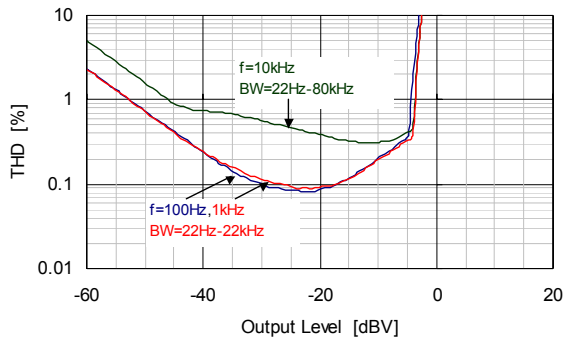
Voltage Gain 2 / Frequency vs. EVR Control Voltage  
 $V+=3.5V, Vin=-10dBV, T_a=25^\circ C$



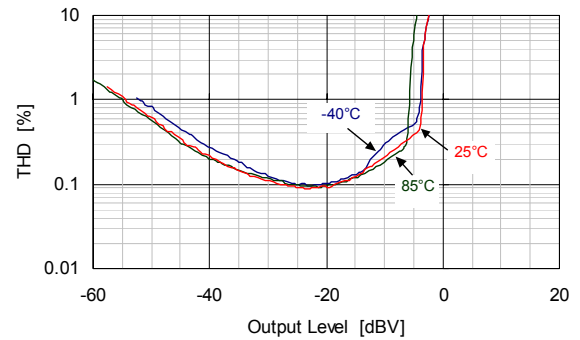
Voltage Gain 2 / Temperature vs. EVR Control Voltage  
 $V+=3.5V, f=1kHz, Vin=-10dBV$



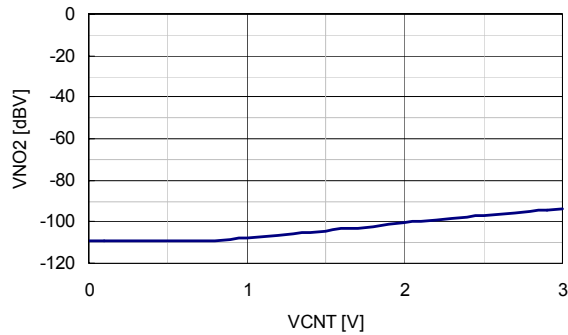
Total Harmonic Distortion (EVR) vs. Output Level  
(Frequency)  
V+=3.5V, Ta=25°C



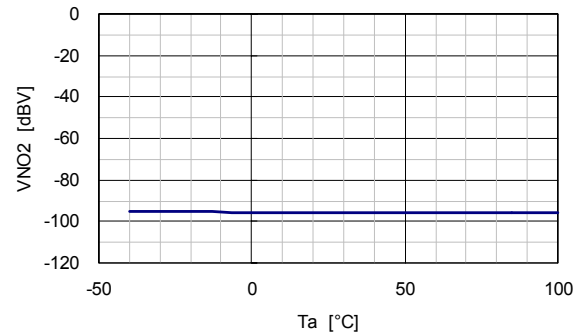
Total Harmonic Distortion (EVR) vs. Output Level  
(Temperature)  
V+=3.5V, f=1kHz, BW=400Hz-30kHz



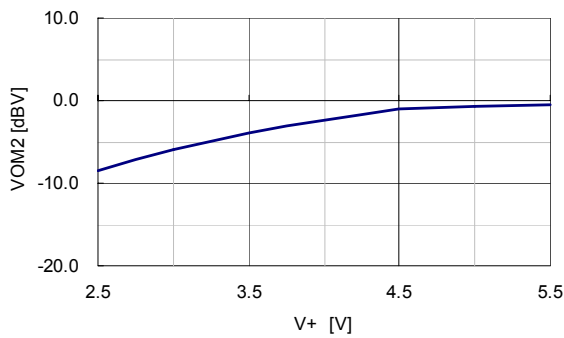
Output Noise Voltage 2 vs. EVR Control Voltage  
V+=3.5V, Ta=25°C, A-Weighted



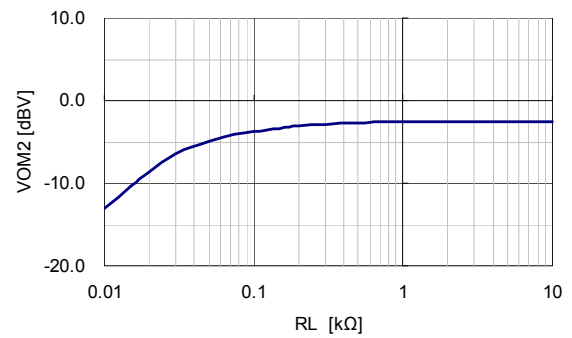
Output Noise Voltage 2 vs. Temperature  
V+=3.5V, VCNT=2.7V, A-Weighted



Maximum Output Voltage 2 vs. Supply Voltage  
RL=100Ω, f=1kHz, THD=1%, Ta=25°C

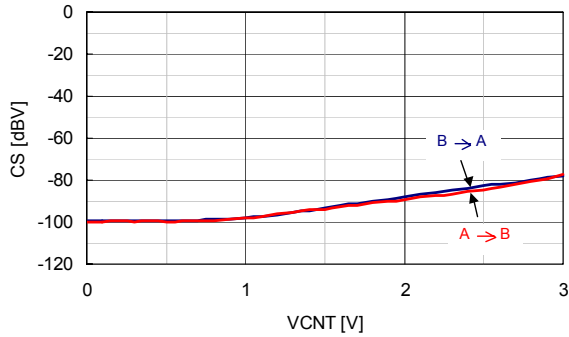


Maximum Output Voltage 2 vs. Load Resistance  
V+=3.5V, f=1kHz, THD=1%, Ta=25°C

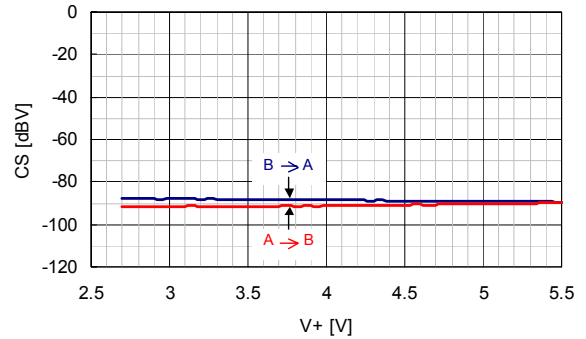




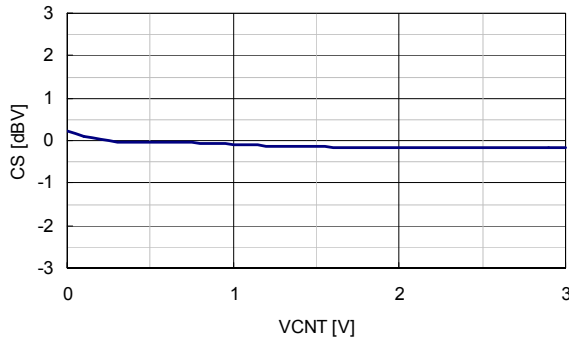
Channel Separation vs. EVR Control Voltage  
 $V+ = 3.5V, Vin = -10dBV, f = 1kHz, Ta = 25^{\circ}C, A\text{-Weighted}$



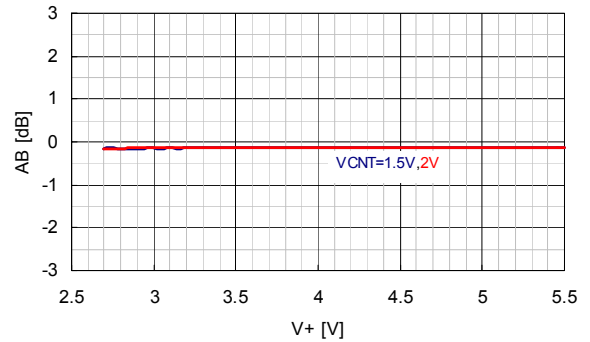
Channel Separation vs. Supply Voltage  
 $VCNT = 2.7V, Vin = -10dBV, f = 1kHz, Ta = 25^{\circ}C, A\text{-Weighted}$



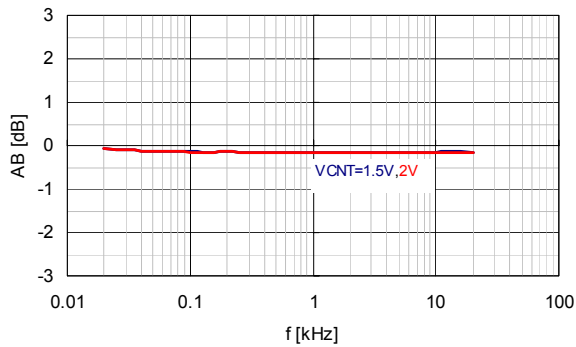
Channel Separation vs. EVR Control Voltage  
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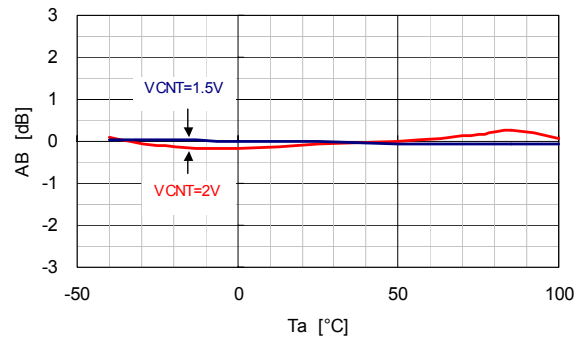
EVR Deviation vs. Supply Voltage  
 $VCNT = 2.7V, Vin = -50dBV, f = 1kHz, Ta = 25^{\circ}C, A\text{-Weighted}$



EVR Deviation vs. Frequency  
 $VCNT = 2.7V, Vin = -50dBV, Ta = 25^{\circ}C$



EVR Deviation vs. Temperature  
 $V+ = 3.5V, Vin = -50dBV, f = 1kHz, VCNT = 2.7V, A\text{-Weighted}$



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