

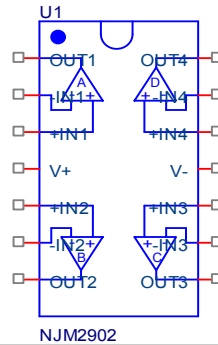
# Device Modeling Report

COMPONENTS : OPERATIONAL AMPLIFIER  
PART NUMBER : NJM2902  
MANUFACTURER: NEW JAPAN RADIO CO.,LTD



**Bee Technologies Inc.**

## SPICE MODEL



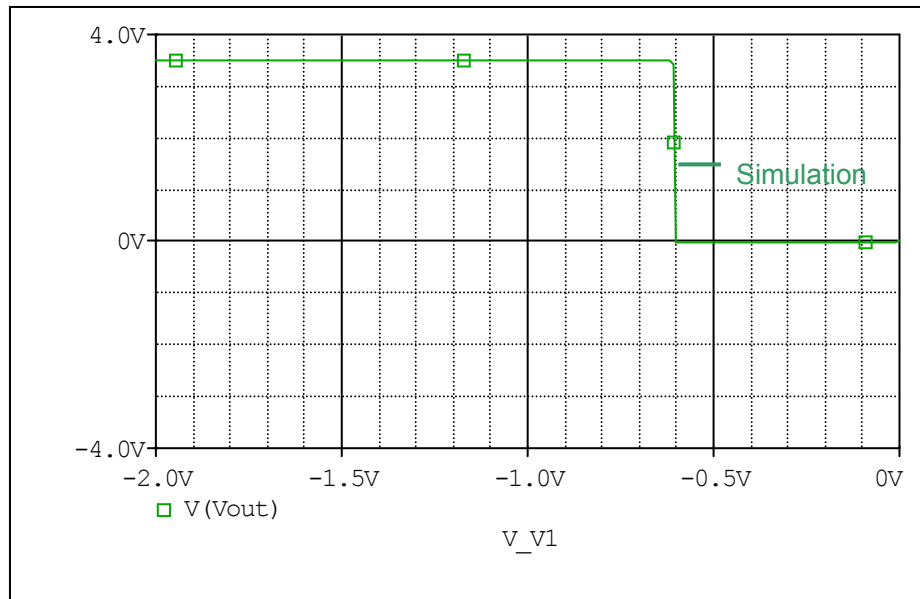
```

*$
*PART NUMBER: NJM2902
*MANUFACTURER: NEW JAPAN RADIO
* All Rights Reserved Copyright (c) Bee Technologies Inc. 2007
.SUBCKT NJM2902 OUT1 -IN1 +IN1 V+ +IN2 -IN2 OUT2 OUT3 -IN3 +IN3 V-
+ +IN4 -IN4 OUT4
X_U1      +IN1 -IN1 V+ V- OUT1 NJM2902_S
X_U2      +IN2 -IN2 V+ V- OUT2 NJM2902_S
X_U3      +IN3 -IN3 V+ V- OUT3 NJM2902_S
X_U4      +IN4 -IN4 V+ V- OUT4 NJM2902_S
.ENDS NJM2902
.SUBCKT NJM2902_S 1 2 3 4 5
c1 11 12 52.660E-12
c2 6 7 29.000E-12
dc 5 53 dy
de 54 5 dy
dlp 90 91 dx
dln 92 90 dx
dp 4 3 dx
egnd 99 0 poly(2) (3,0) (4,0) 0 .5 .5
fb 7 99 poly(5) vb vc ve vlp vln 0 22.343E6 -1E3 1E3 22E6 -22E6
ga 6 0 11 12 188.50E-6
gcm 0 6 10 99 10.600E-9
iee 3 10 dc 15.040E-6
hlim 90 0 vlim 1K
q1 11 2 13 qx1
q2 12 1 14 qx2
r2 6 9 100.00E3
rc1 4 11 5.3052E3
rc2 4 12 5.3052E3
re1 13 10 1.8517E3
re2 14 10 1.8517E3
ree 10 99 13.298E6
ro1 8 5 50
ro2 7 99 25
rp 3 4 1023.5
vb 9 0 dc 0
vc 3 53 dc 2.2879
ve 54 4 dc .79791
vlim 7 8 dc 0
vlp 91 0 dc 20
vln 0 92 dc 20
.MODEL dx D(Is=800.00E-18)
.MODEL dy D(Is=800.00E-18 Rs=1m Cjo=10p)
.MODEL qx1 PNP(Is=800.00E-18 Bf=410.65)
.MODEL qx2 PNP(Is=868.6645E-18 Bf=337.03)
.ENDS
*$

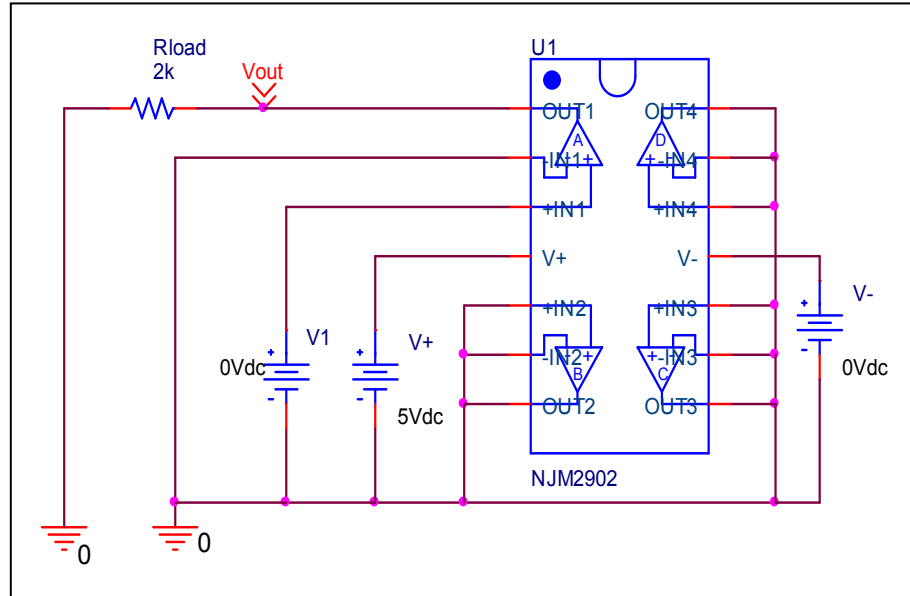
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## Output Voltage Swing, +Vout and -Vout

### Simulation result



### Evaluation circuit

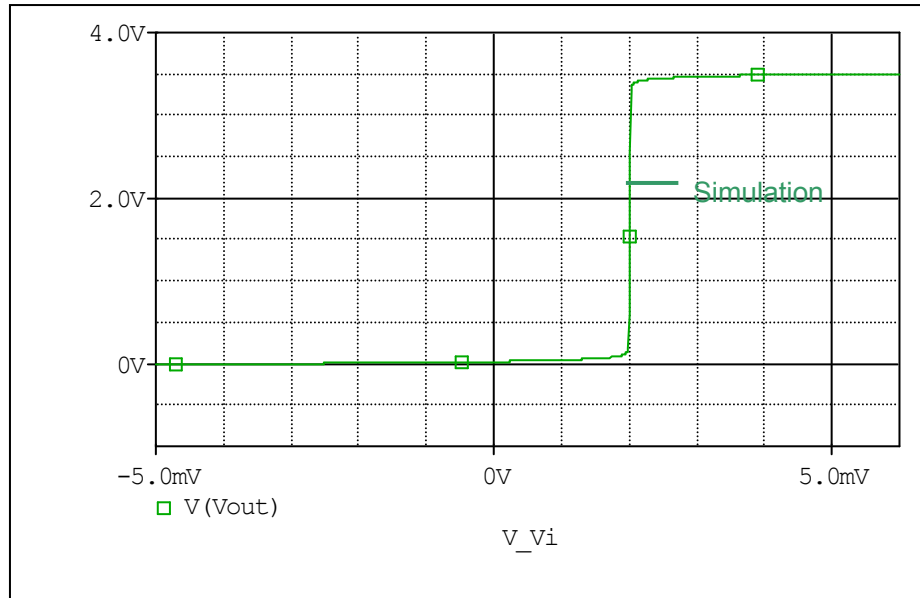


### Comparison Table

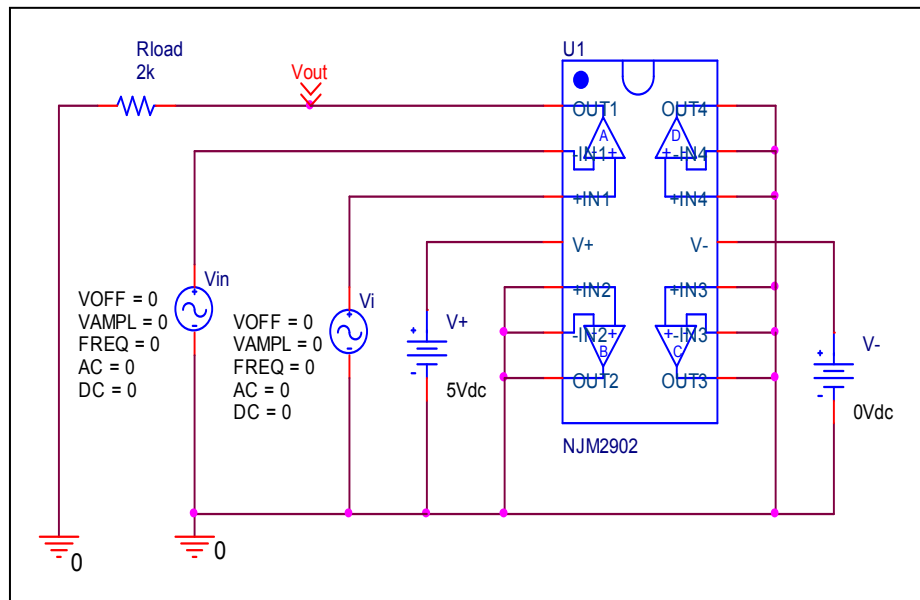
Output Voltage Swing	Data sheet	Simulation	%Error
+Vout(V)	3.5	3.5086	0.246
-Vout(V)	0	0	0

# Input Offset Voltage

## Simulation result



## Evaluation Circuit

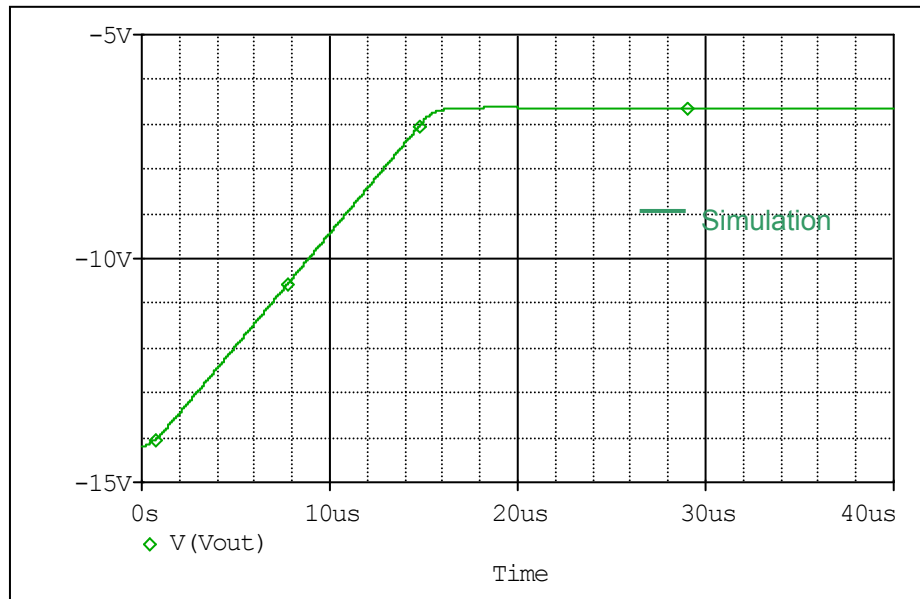


## Comparison Table

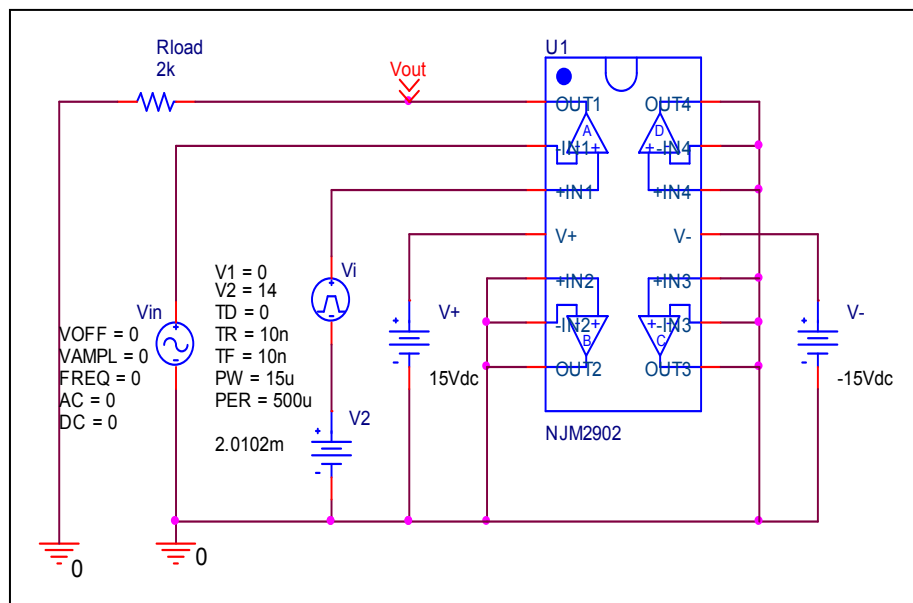
Input offset Voltage	Data sheet	Simulation	%Error
$V_{os}$ (mV)	2	2.0102	0.510

## Slew Rate

### Simulation result



### Evaluation Circuit

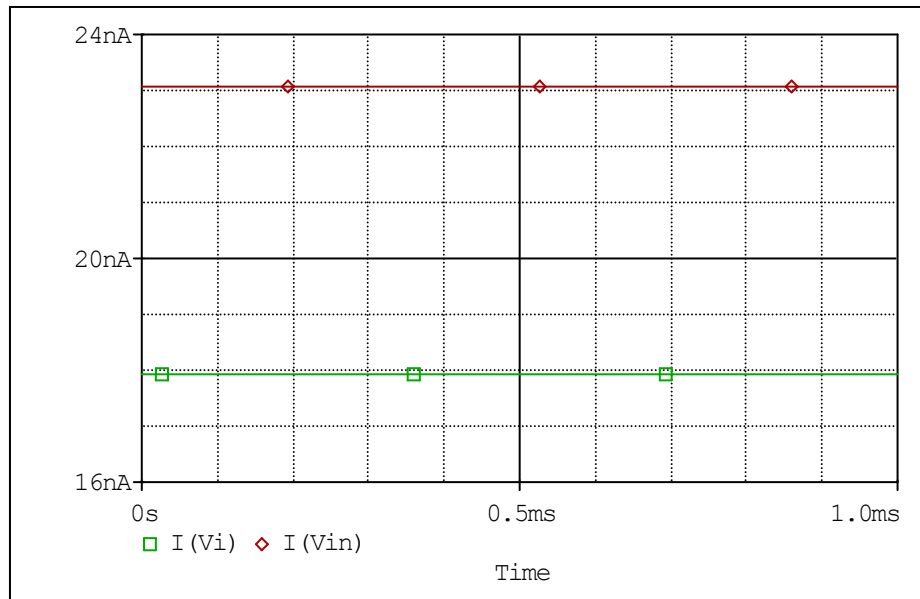


### Comparison Table

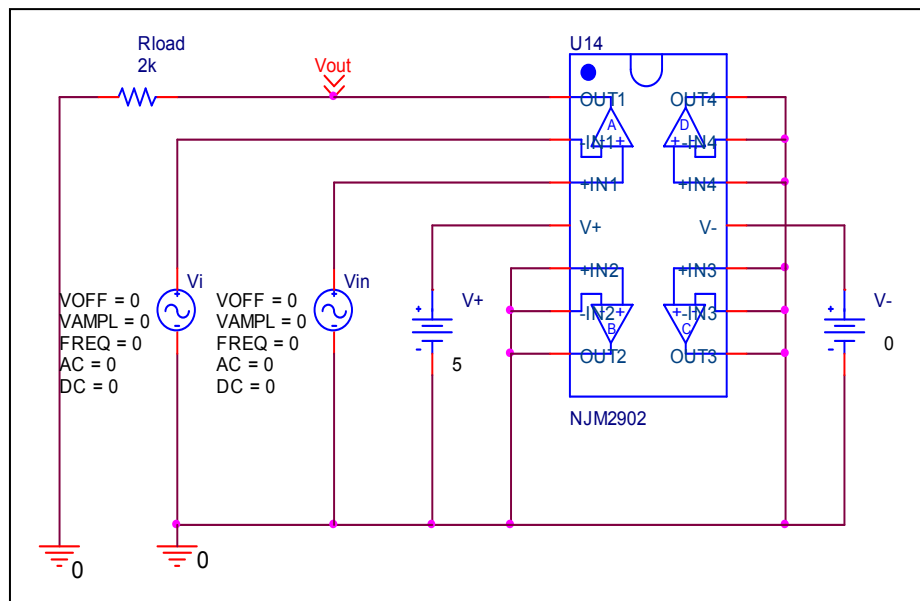
$V^+ / V^- = \pm 15V$	Data sheet	Simulation	%Error
SR (V/us)	0.5	0.502	0.4

# Input Current

## Simulation result



## Evaluation Circuit

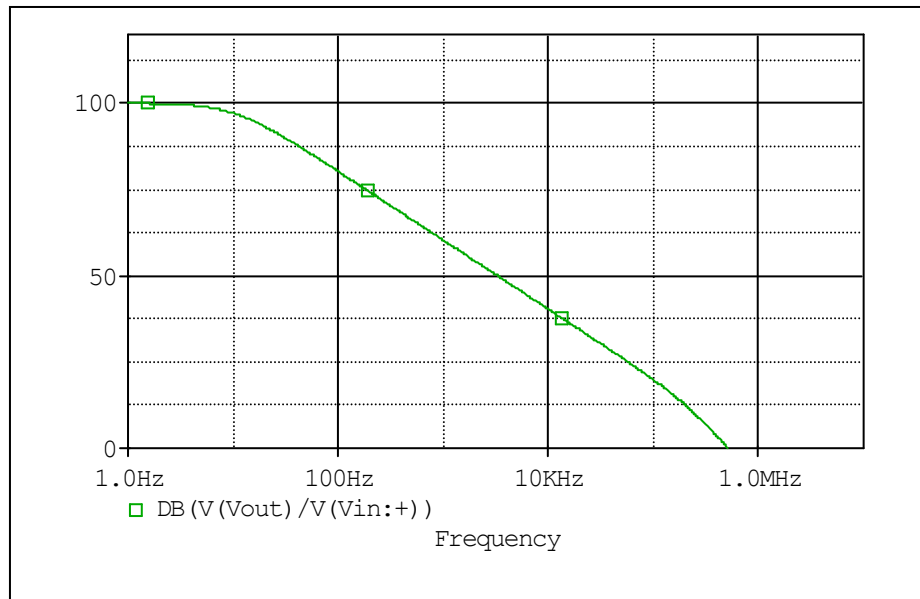


## Comparison Table

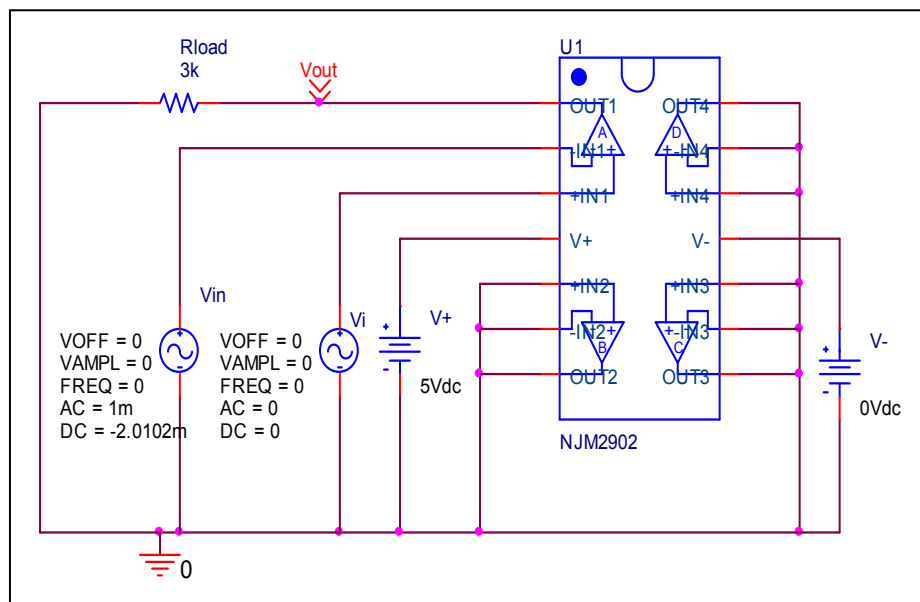
Input Current	Data sheet	Simulation	% Error
$I_b$ (nA)	20	20.503	2.515
$I_{bos}$ (nA)	5	5.1141	2.282

## Open loop Voltage Gain vs. Frequency , Av-dc, f-0dB

### Simulation result



### Evaluation Circuit

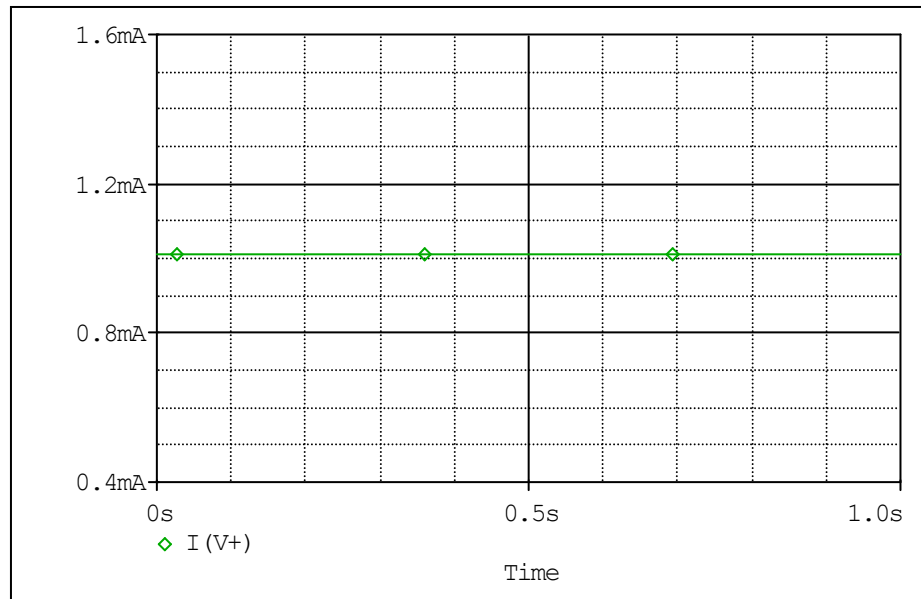


### Comparison Table

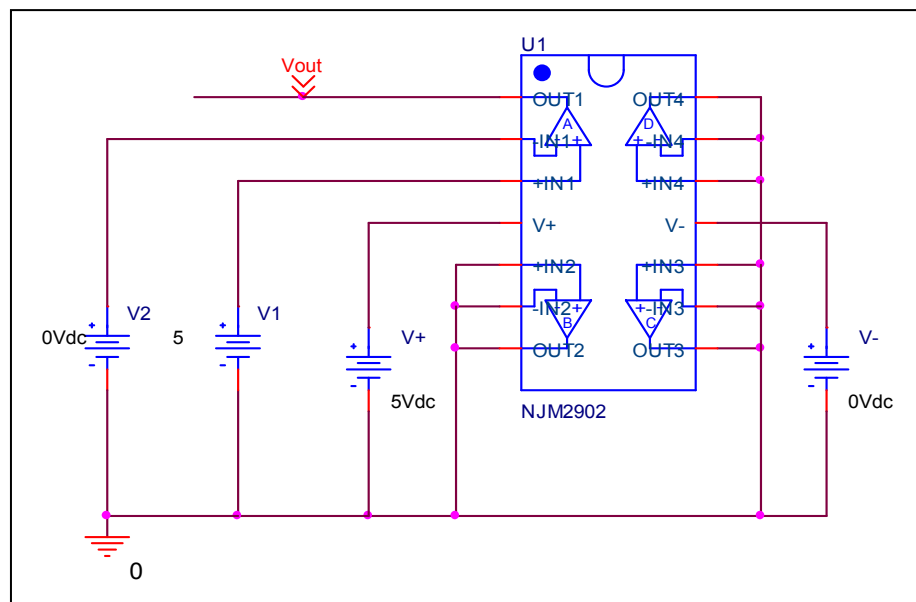
	Data sheet	Simulation	% Error
<b>Av (dB)</b>	100	100.242	0.242
<b>f-0dB (MHz)</b>	0.5	0.504	0.800

## Operating Current

### Simulation result



### Evaluation Circuit



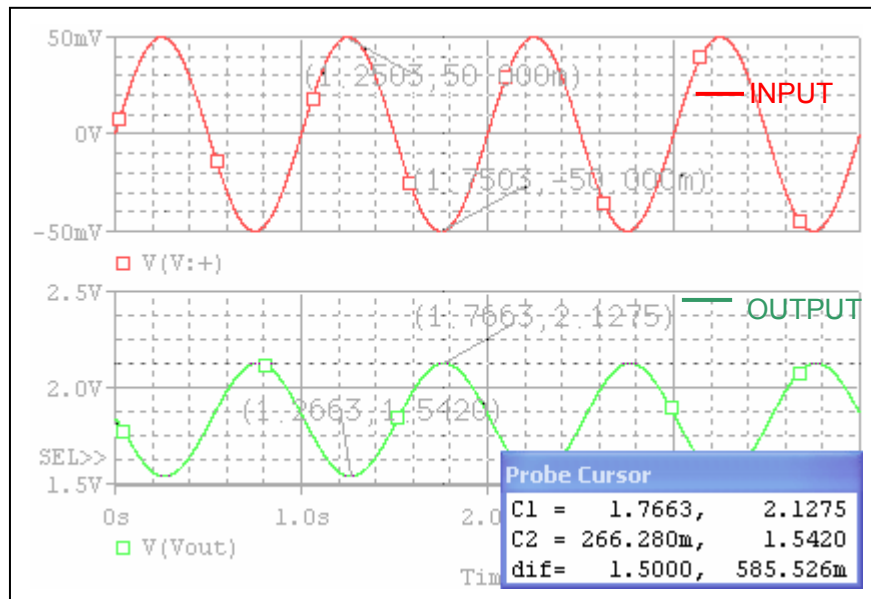
### Comparison Table

Operating Current	Data sheet	Simulation	% Error
$I_{CC}$ (mA)	1	1.0099	0.99

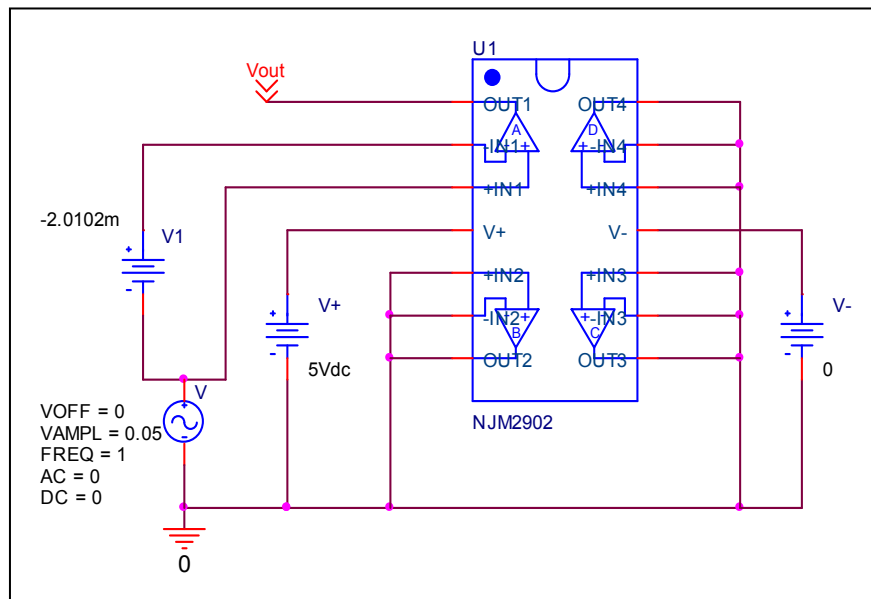


## Common-Mode Rejection Ratio

### Simulation result



### Evaluation Circuit



$$\text{CMRR} = \frac{A_V}{A_{CM}}$$

$$= \frac{100000}{(0.585526/0.1)}$$

### Comparison Table

	Data sheet	Simulation	% Error
CMRR (dB)	85	84.649	-0.413