

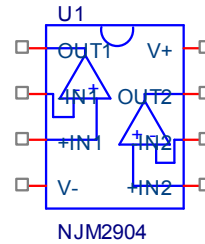
Device Modeling Report

COMPONENTS : OPERATIONAL AMPLIFIER
PART NUMBER : NJM2904
MANUFACTURER: NEW JAPAN RADIO CO.,LTD



Bee Technologies Inc.

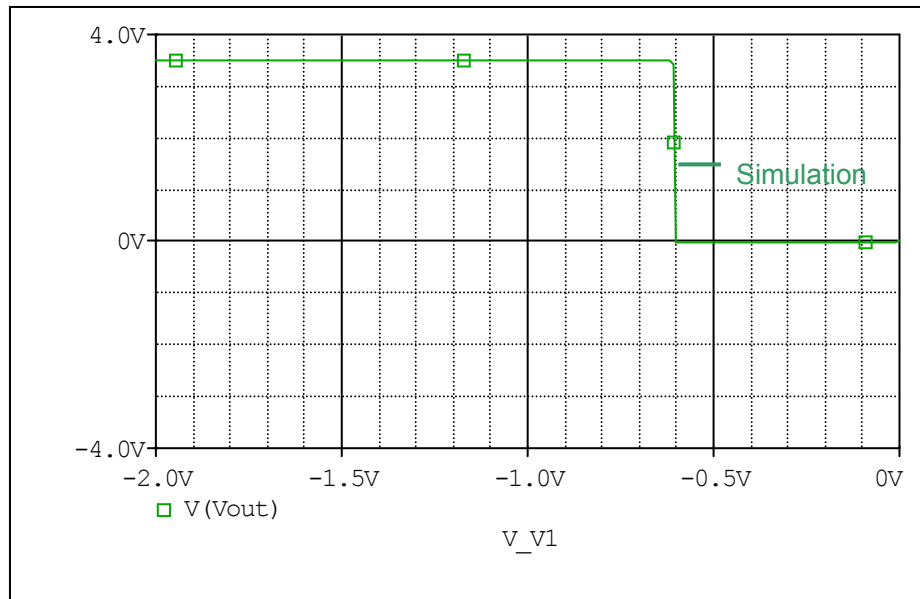
SPICE MODEL



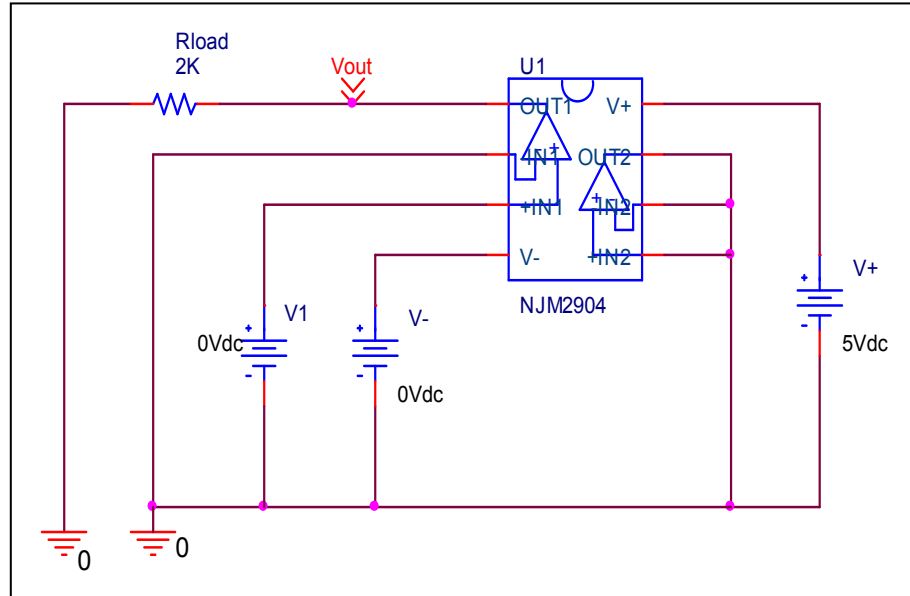
```
*$
* PART NUMBER: NJM2904
* MANUFACTURER: NEW JAPAN RADIO
* All Rights Reserved Copyright (c) Bee Technologies Inc. 2007
.SUBCKT NJM2904 OUT1 -IN1 +IN1 V- +IN2 -IN2 OUT2 V+
X_U1      +IN1 -IN1 V+ V- OUT1 NJM2904_SUB
X_U2      +IN2 -IN2 V+ V- OUT2 NJM2904_SUB
.ENDS NJM2904
.SUBCKT NJM2904_SUB 1 2 3 4 5
c1 11 12 13.6603E-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 0 100.84E6 -1E3 1E3 100E6 -100E6
ga 6 0 11 12 47.124E-6
gcm 0 6 10 99 2.5472E-9
iee 3 10 dc 15.050E-6
hlim 90 0 vlim 1K
q1 11 2 13 qx1
q2 12 1 14 qx2
r2 6 9 100.00E3
rc1 4 11 21.221E3
rc2 4 12 21.221E3
re1 13 10 17.714E3
re2 14 10 17.714E3
ree 10 99 13.289E6
ro1 8 5 50
ro2 7 99 25
rp 3 4 503.0
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=333.70)
.MODEL qx2 PNP(Is=870.6645E-18 Bf=276.50)
.ENDS
*$
```

Output Voltage Swing, +Vout and -Vout

Simulation result



Evaluation circuit

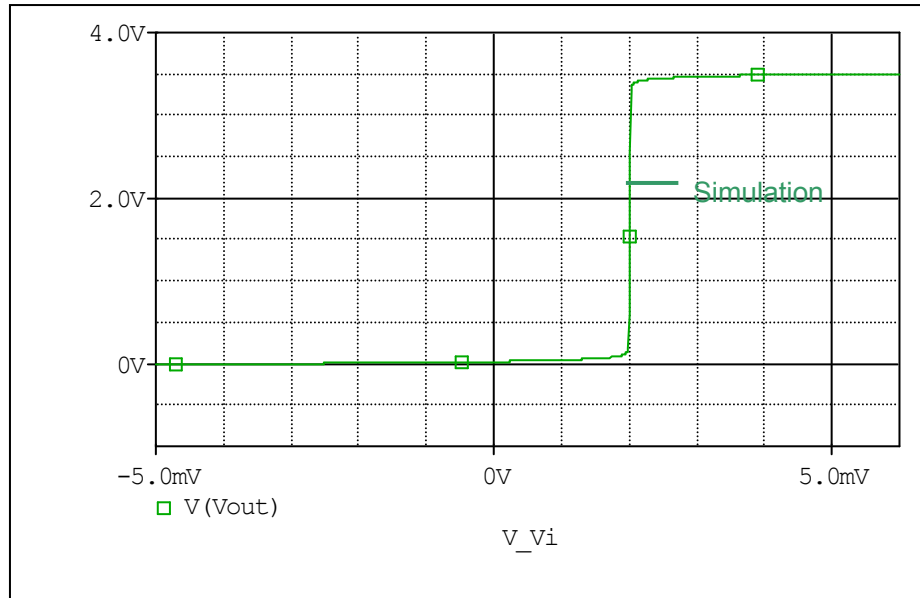


Comparison Table

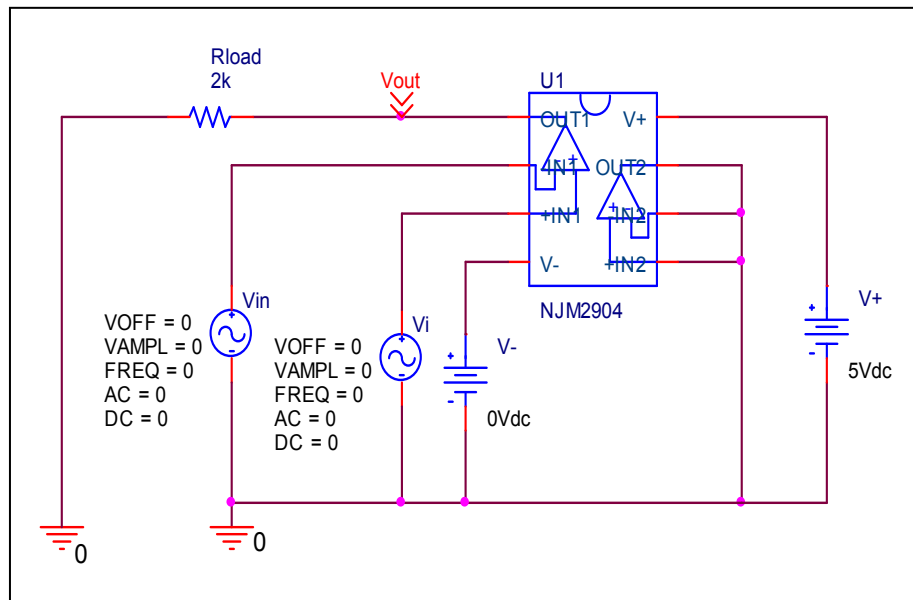
Output Voltage Swing	Data sheet	Simulation	%Error
+Vout(V)	3.5	3.5085	0.243
-Vout(V)	0	0	0

Input Offset Voltage

Simulation result



Evaluation Circuit

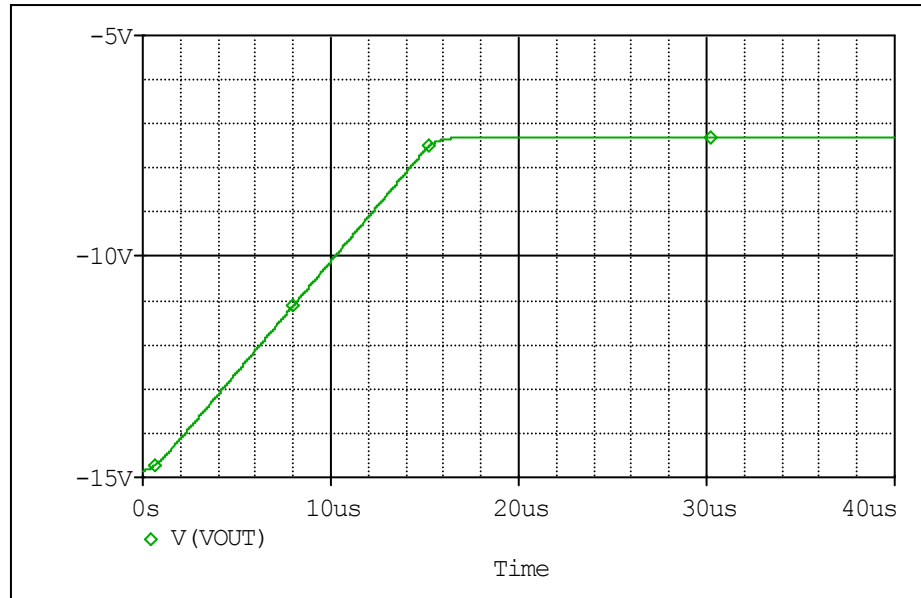


Comparison Table

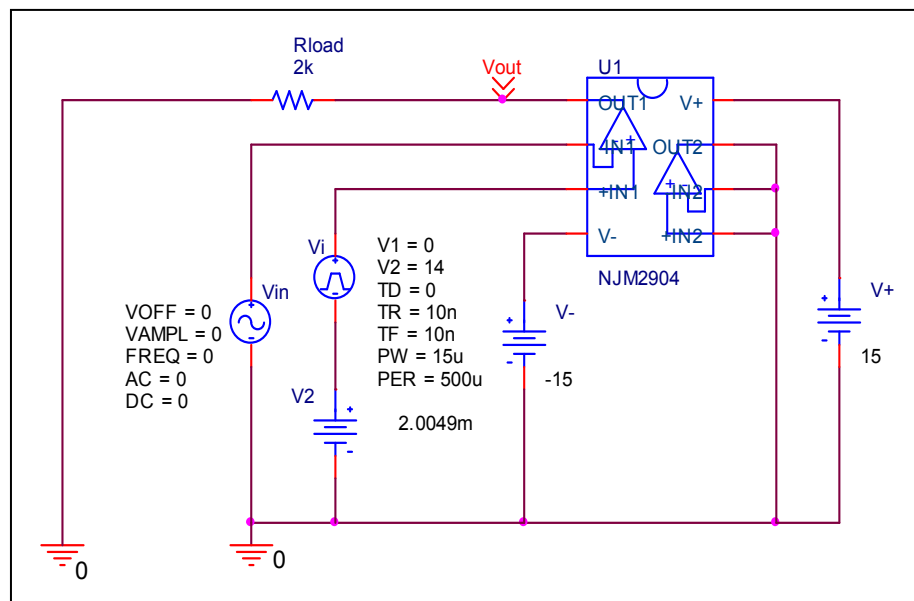
Input offset Voltage	Data sheet	Simulation	%Error
V_{os} (mV)	2	2.0049	0.245

Slew Rate

Simulation result



Evaluation Circuit

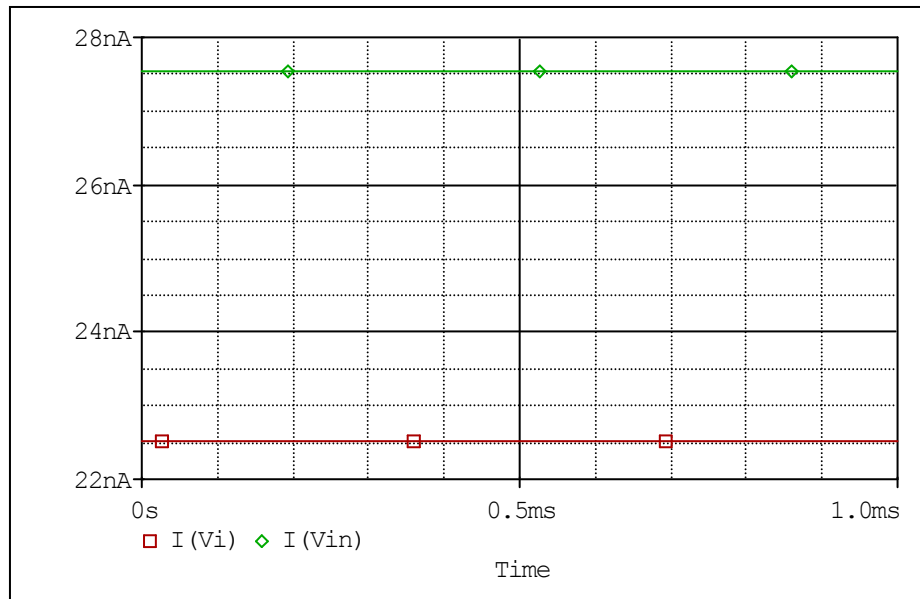


Comparison Table

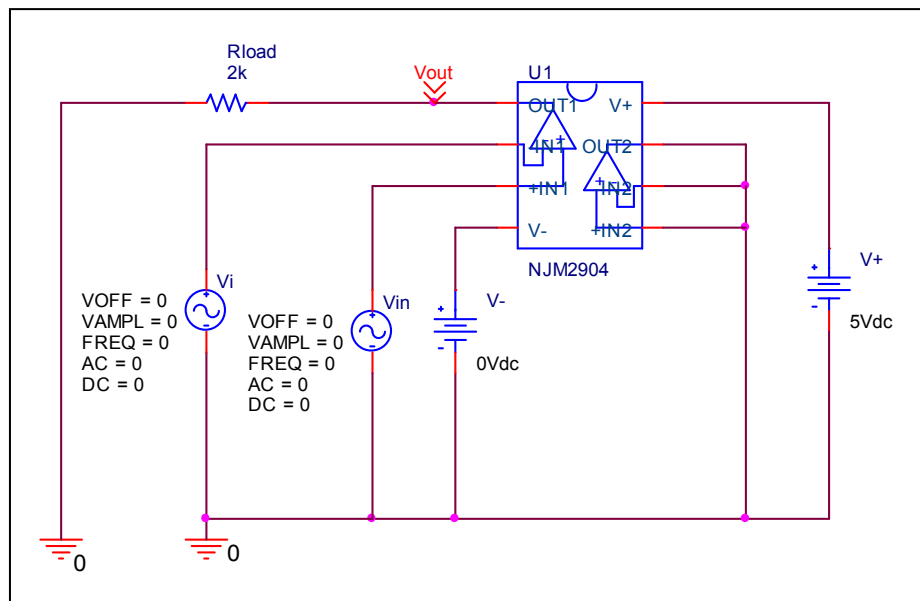
$V^+ / V^- = \pm 15V$	Data sheet	Simulation	%Error
SR (V/us)	0.5	0.4995	-0.1

Input Current

Simulation result



Evaluation Circuit

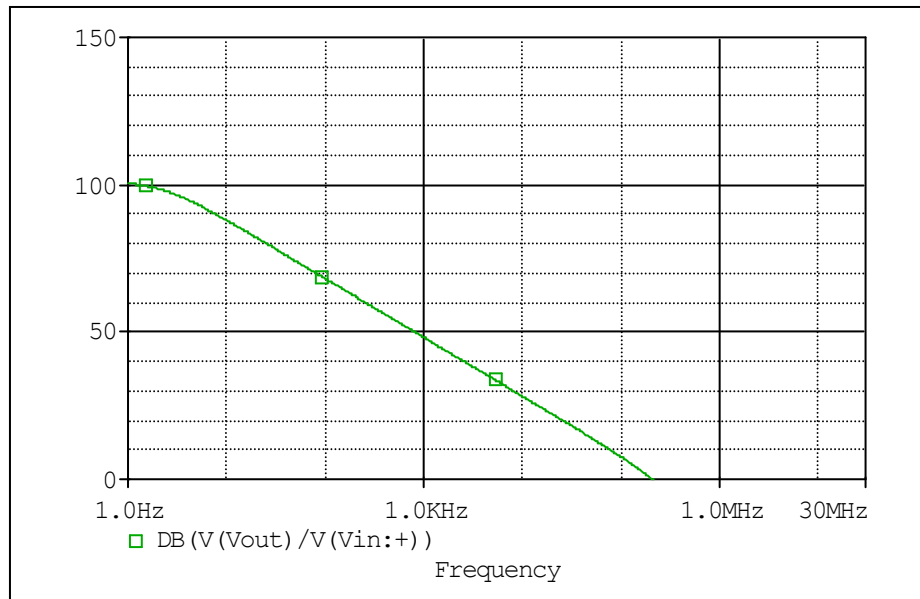


Comparison Table

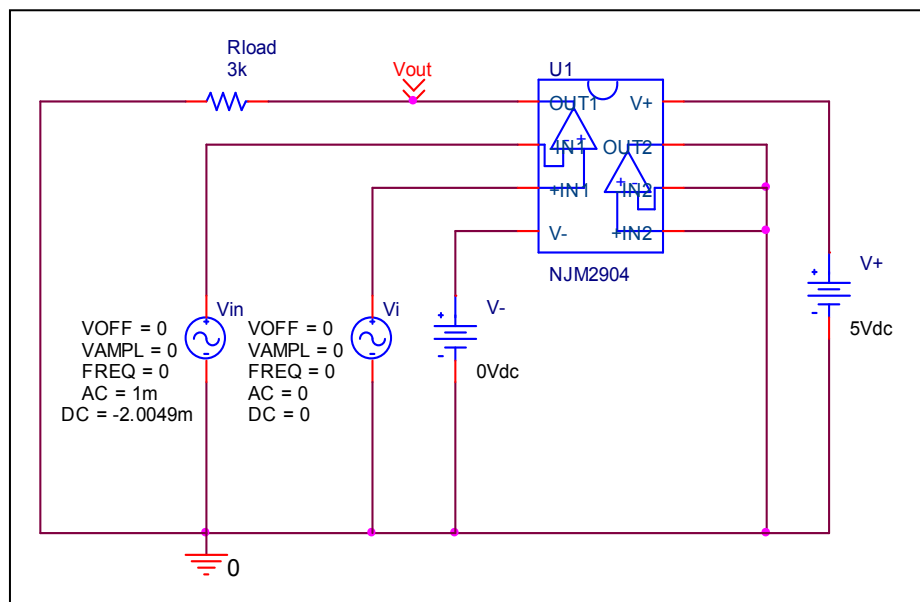
Input Current	Data sheet	Simulation	% Error
I_b (nA)	25	25.036	0.144
I_{bos} (nA)	5	5.0196	0.392

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

Simulation result



Evaluation Circuit

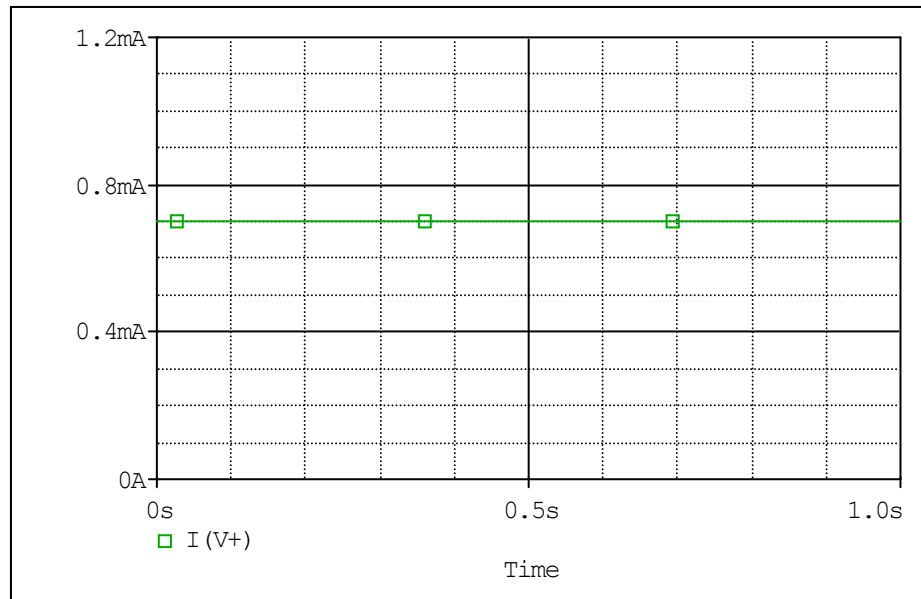


Comparison Table

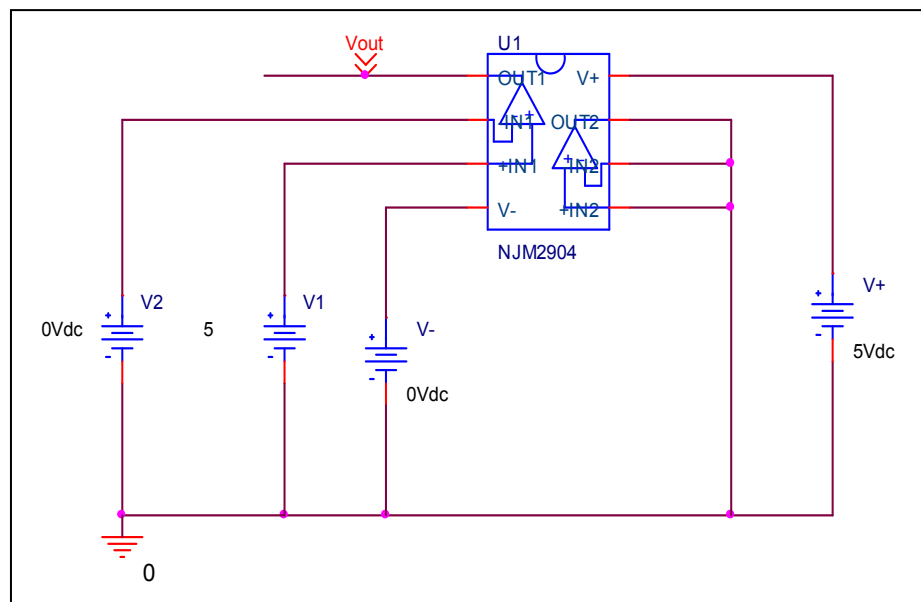
	Data sheet	Simulation	% Error
Av (dB)	100	100.475	0.475
f-0dB (MHz)	0.2	0.204343	2.171

Operating Current

Simulation result



Evaluation Circuit

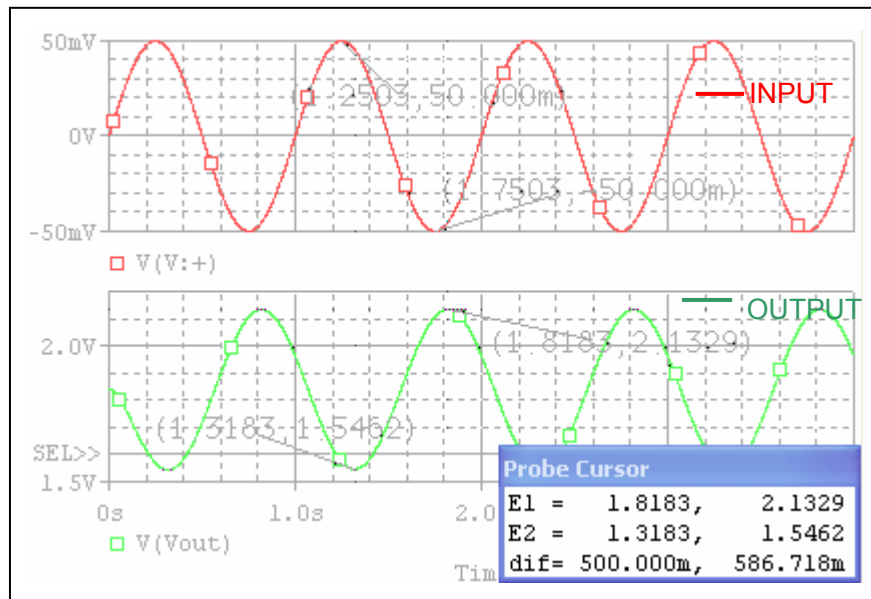


Comparison Table

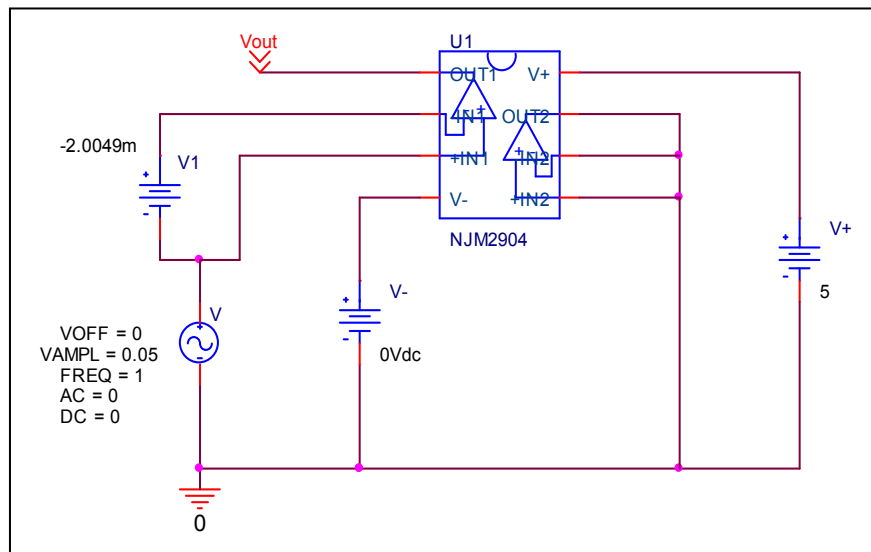
Operating Current	Data sheet	Simulation	% Error
I_{cc} (mA)	0.7	0.701	0.143

Common-Mode Rejection Ratio

Simulation result



Evaluation Circuit



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

$$= \frac{100000}{(0.586718/0.1)}$$

Comparison Table

	Data sheet	Simulation	% Error
CMRR (dB)	85	84.631	-0.434