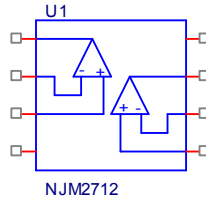# Device Modeling Report

COMPONENTS: OPERATIONAL AMPLIFIER
PART NUMBER: NJM2712
MANUFACTURER: NEW JAPAN RADIO CO., LTD.

Bee Technologies Inc.

Spice Model

U1

NJM2712

```
*$
* PART NUMBER:NJM2712
* MANUFACTURER: NEW JAPAN RADIO
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.Subckt NJM2712 OUT1 -IN1 +IN1 V- +IN2 -IN2 OUT2 V+
X_U1    +IN1 -IN1 V+ V- OUT1 NJM2712_ME
X_U2    +IN2 -IN2 V+ V- OUT2 NJM2712_ME
.ends  NJM2712
.subckt NJM2712_ME 1 2 3 4 5
  c1   11 12 25.0E-12
  c2    6  7 61.200E-13
  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 5.06296E3 -1E3 1E3 5E3 -5E3
  ga    6  0 11 12 33.929E-3
  gcm   0  6 10 99 33.529E-6
  iee   3 10 dc 7.8040E-3
  hlim 90  0 vlim 1k
  q1   11  2 13 qx1
  q2   12  1 14 qx2
  r2    6  9 100.00E3
  rc1   4 11 29.473
  rc2   4 12 29.473
  re1  13 10 22.830
  re2  14 10 22.830
  ree  10 99 250.628E3
  ro1   8  5 70
  ro2   7 99 35
  rp    3  4 155.29
  vb    9  0 dc 0
  vc    3 53 dc 1.7979
  ve   54  4 dc 1.7979
  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)
.model qx1 PNP(Is=800.00E-18 Bf=1.7807E3)
.model qx2 PNP(Is=836.50E-18 Bf=2.1497E3 CJC=58.179E-12)
.ends
*$
```
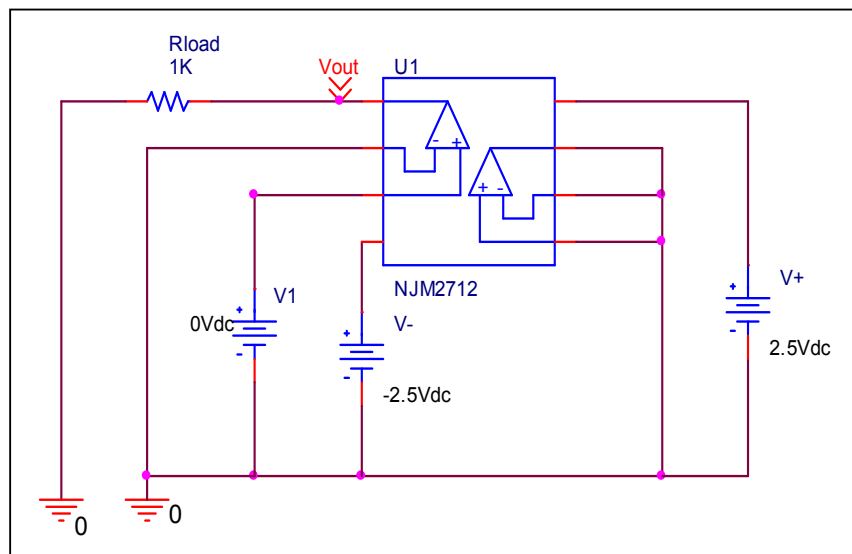
Output Voltage Swing

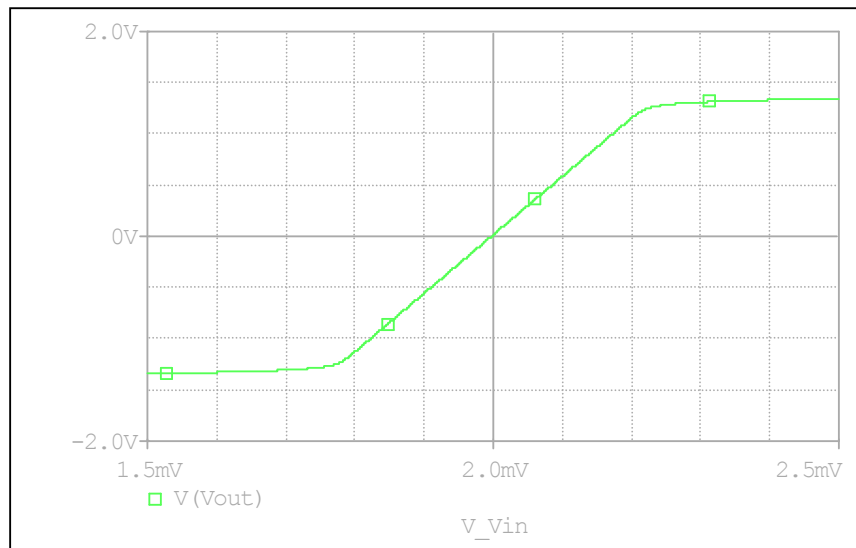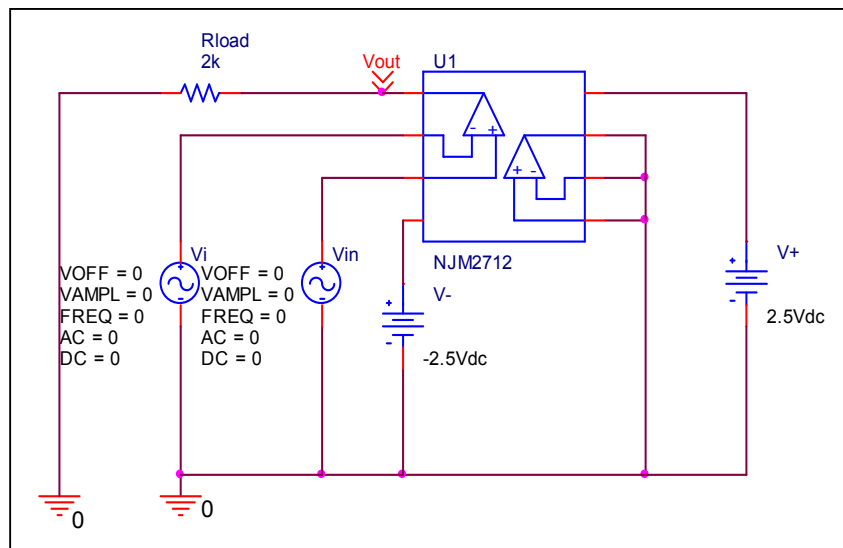Simulation result
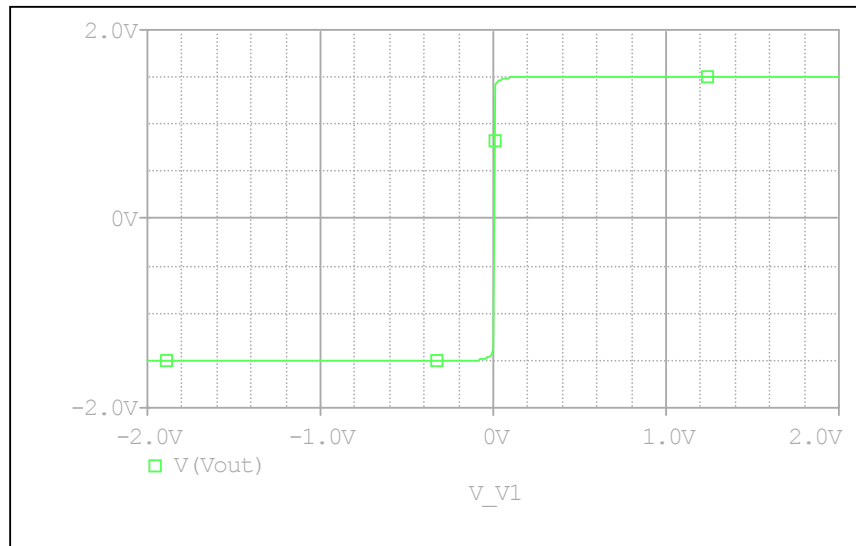
Evaluation circuit

Comparison table

Output Voltage Swing	Measurement	Simulation	%Error
+Vout(V)	+1.500	+1.4991	-0.060
-Vout(V)	-1.500	-1.4991	-0.060

Input Offset Voltage

	Measurement	Simulation	%Error
Vos (mV)	2	1.9977	-0.115

Slew Rate
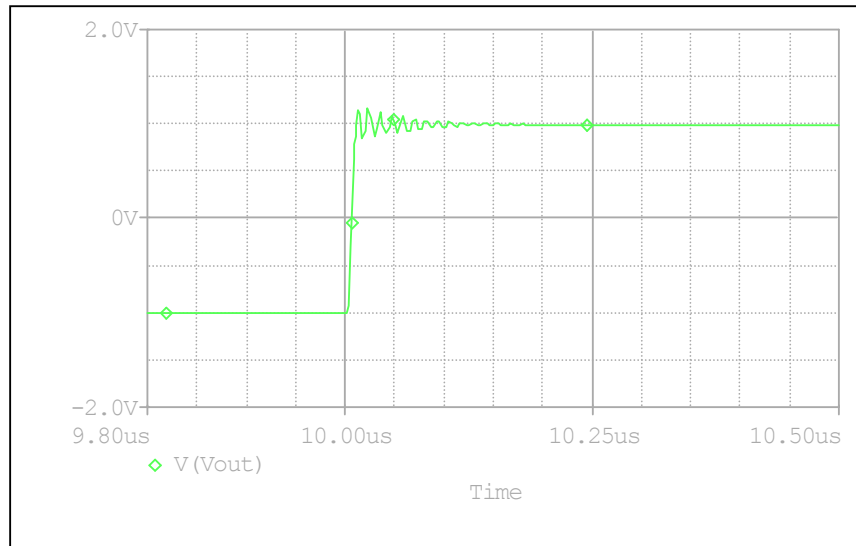
Evaluation circuit
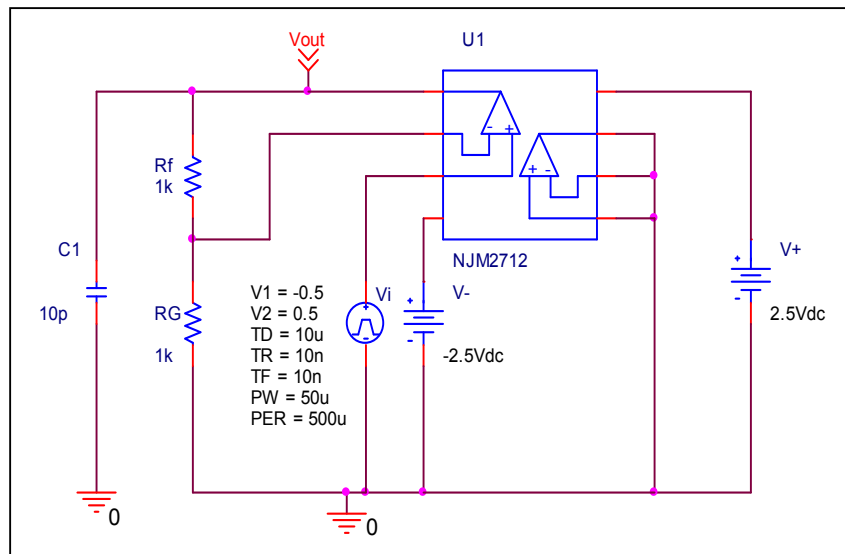
Comparison table

	Measurement	Simulation	%Error
Slew Rate(v/us)	260	251.798	-3.155

Input current
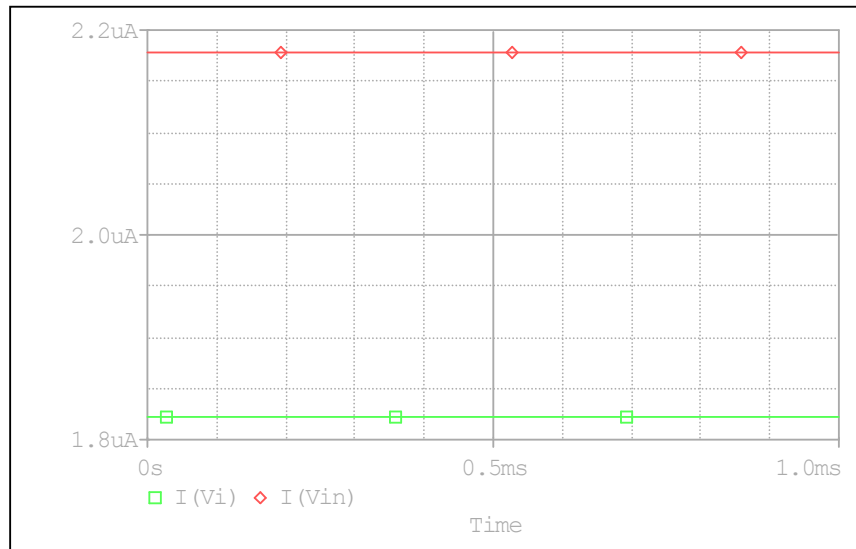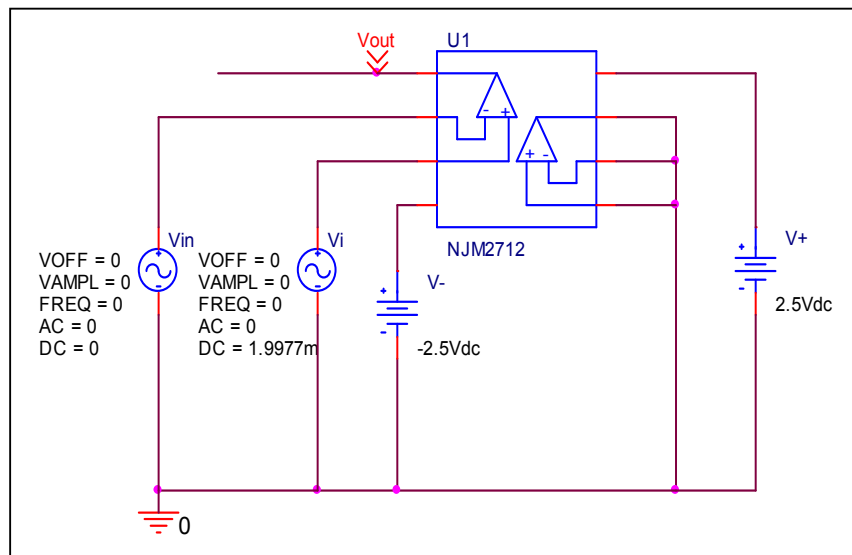
	Measurement	Simulation	%Error
Ib(uA)	2.000	2.0004	0.020
Ibos(nA)	350.000	355.534	1.581

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Open Loop Voltage Gain

Simulation result
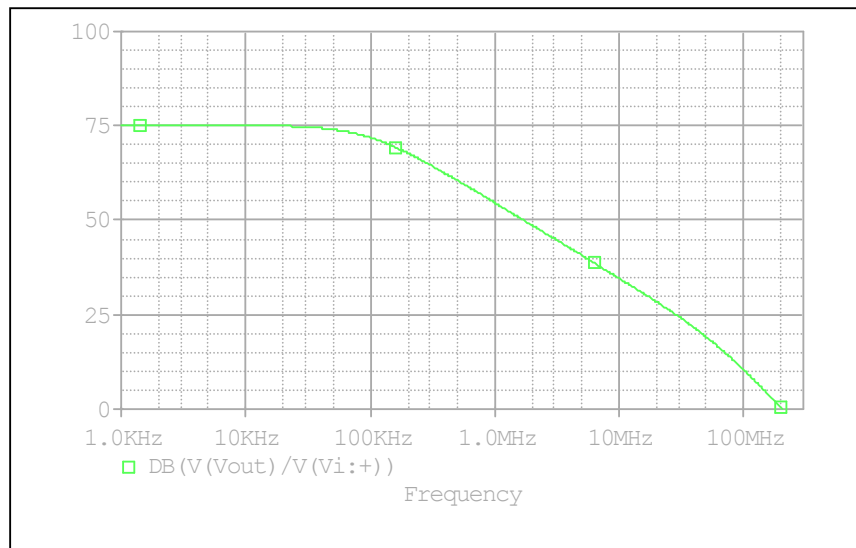
Evaluation circuit
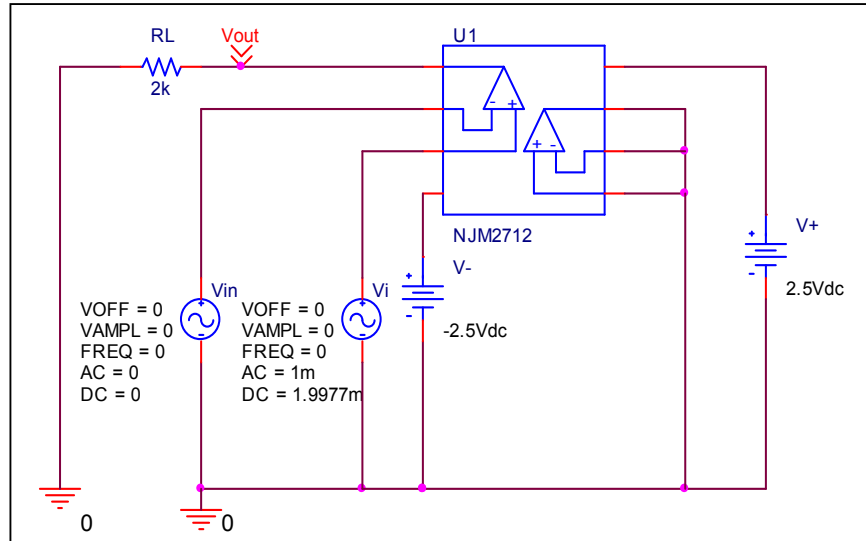
Comparison table

	Measurement	Simulation	%Error
Av-dc(dB)	75.000	75.131	0.175

Unity Gain Bandwidth

Simulation result
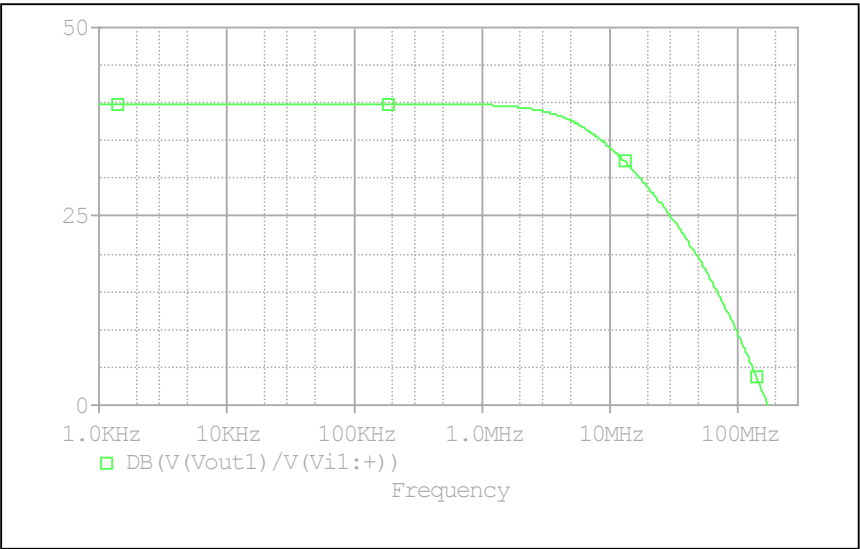
Evaluation circuit
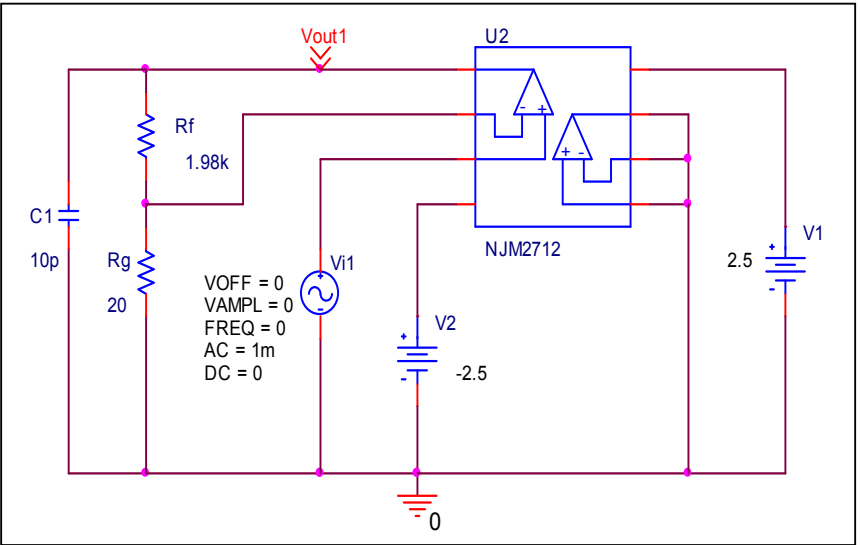
Comparison table

	Measurement	Simulation	%Error
f-0dB(MHz)	180	173.814	-3.437

Common-Mode Rejection Voltage gain
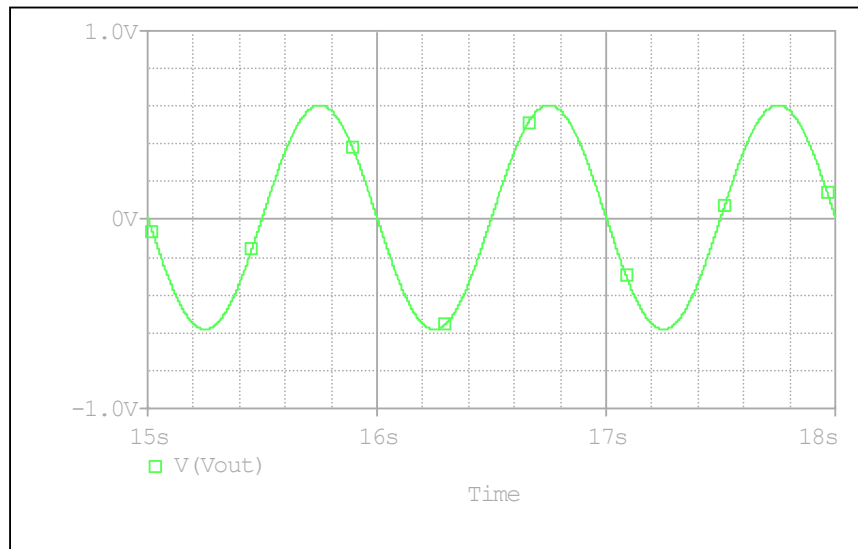
Evaluation circuit
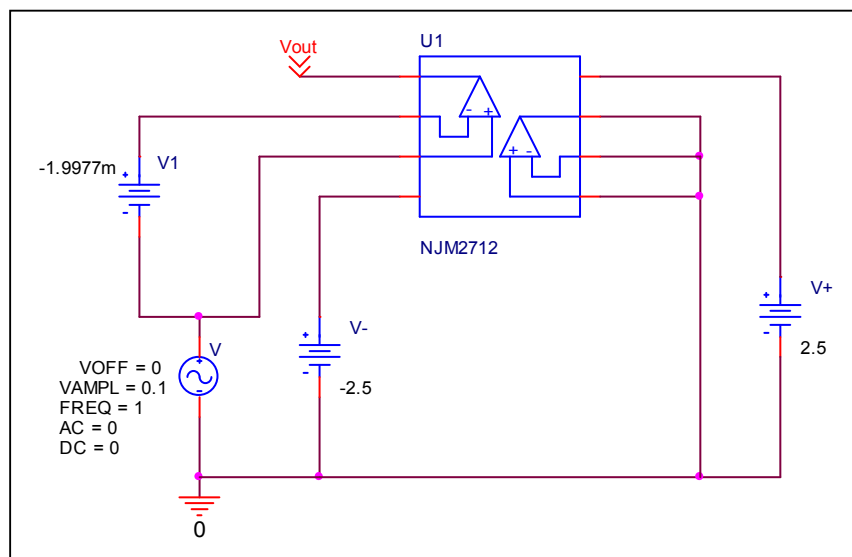
CMRR=20*LOG(5708.868/(1.1879 /0.2)) = 59.656 dB

Comparison table

	Measurement	Simulation	%Error
CMRR(dB)	60	59.656	-0.573

Remark Output Voltage Swing

Before

Rload
10K

Vout

U21

V1

0Vdc

NJM2712

V-

-2.5Vdc

V+

2.5Vdc

0

0

After

Rload
1K

Vout

U1

V1

0Vdc

NJM2712

V-

-2.5Vdc

V+

2.5Vdc

0

0
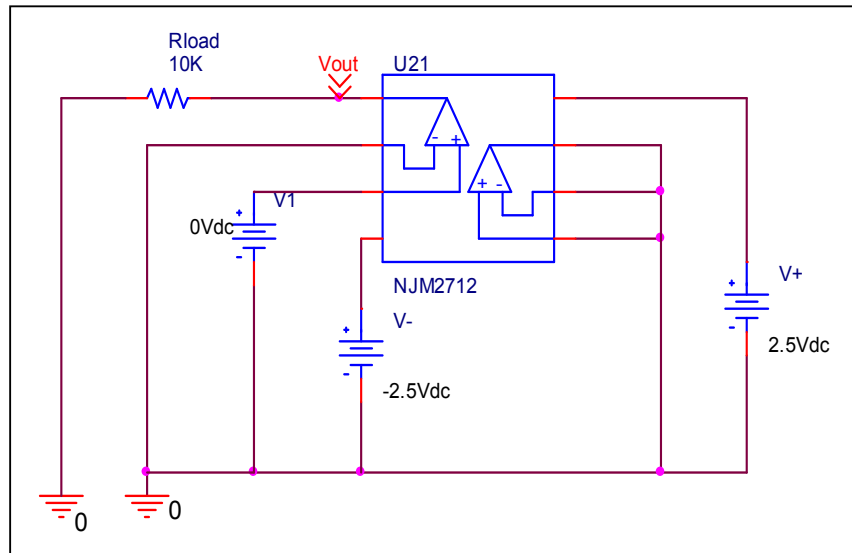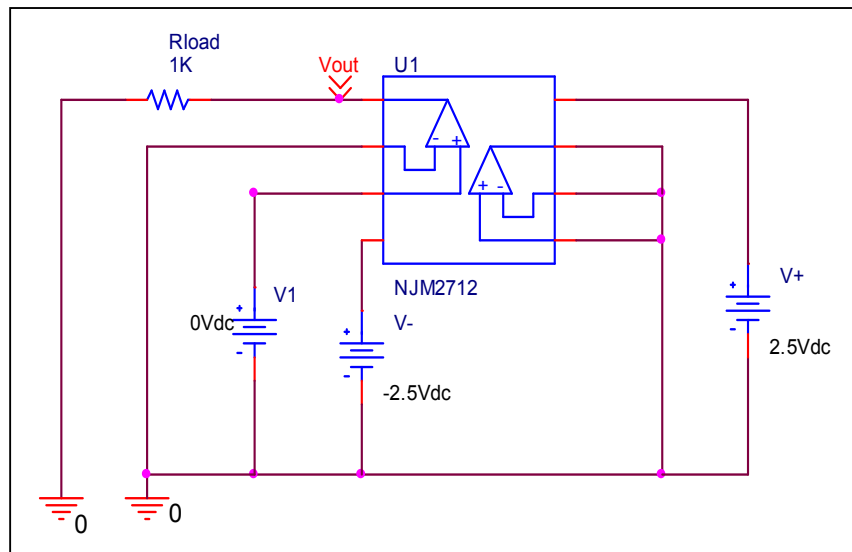
Remark Input Offset Voltage

Before
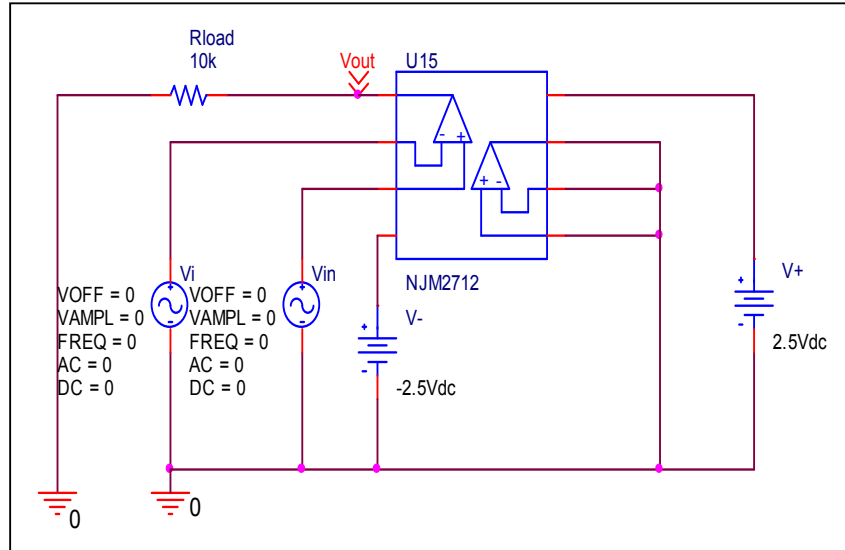
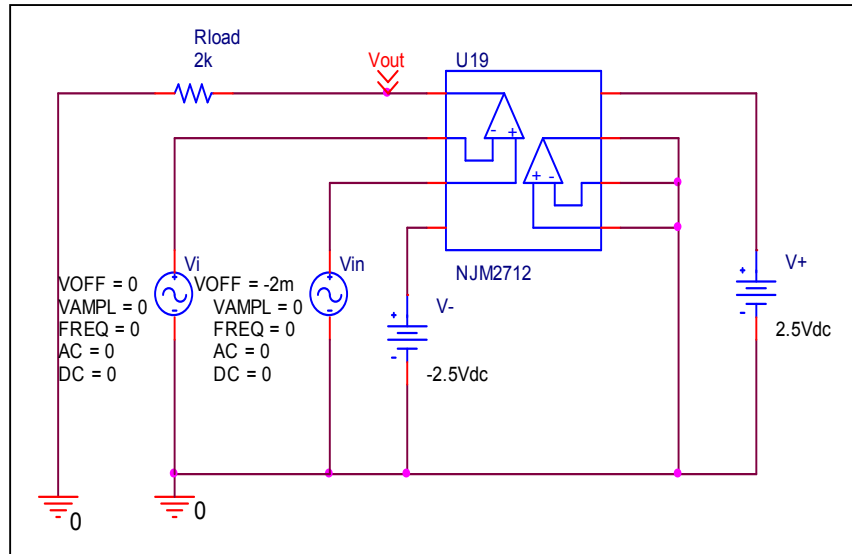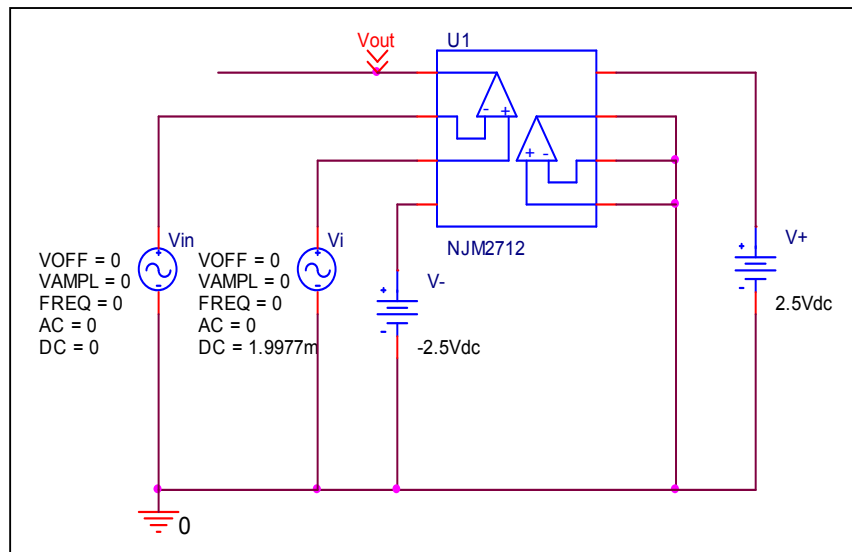
After
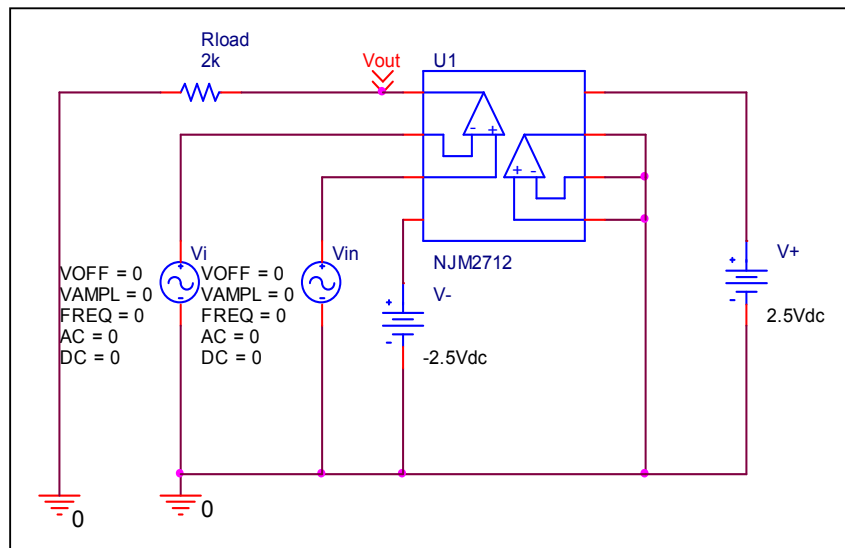
Remark Slew Rate

Before
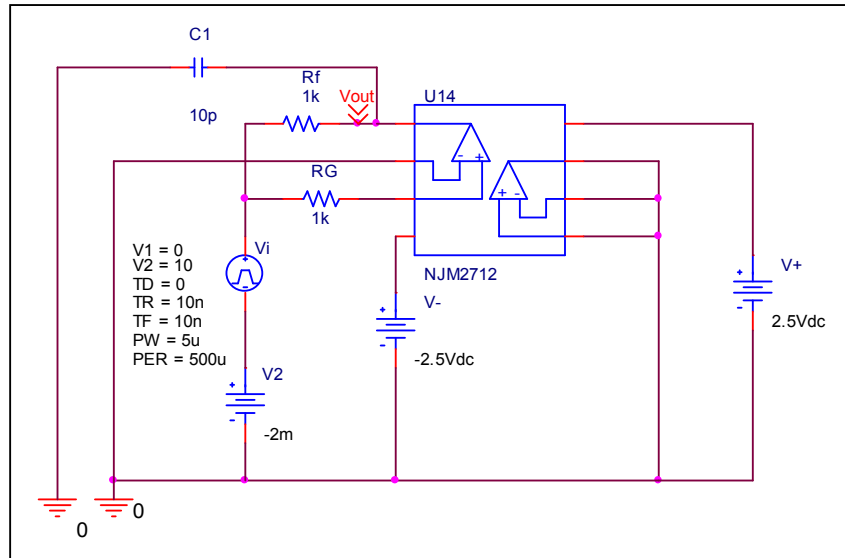
After
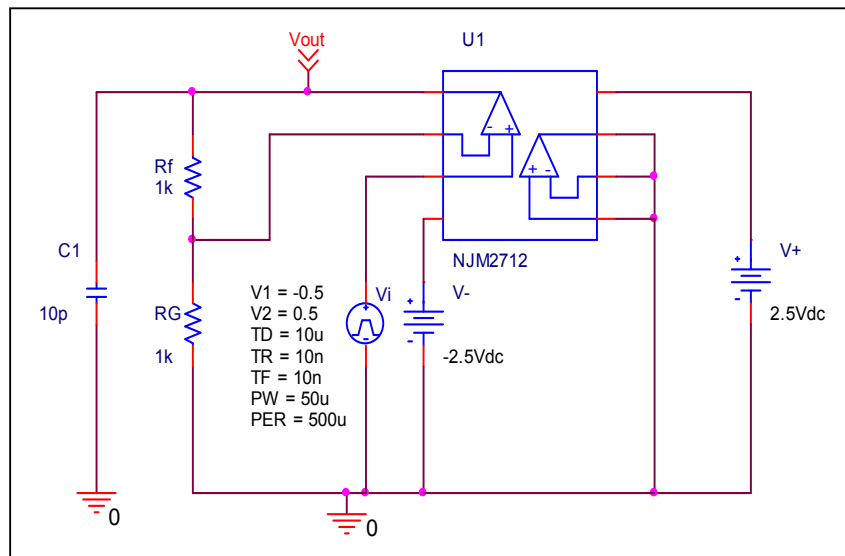
Remark Input current

Before

After

Remark Open Loop Voltage Gain
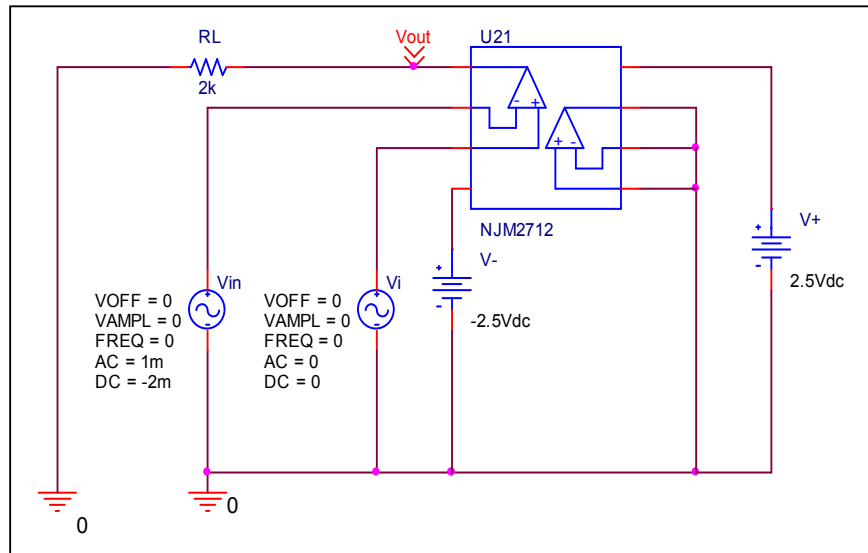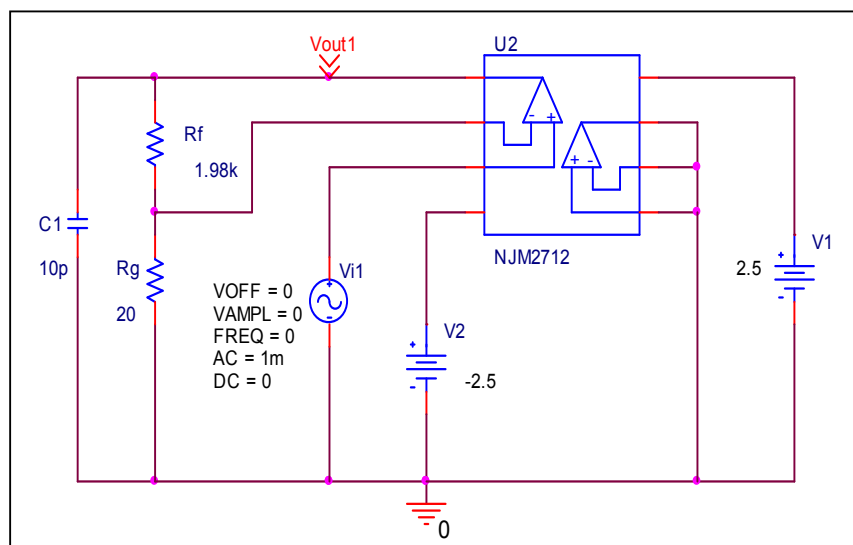
Before
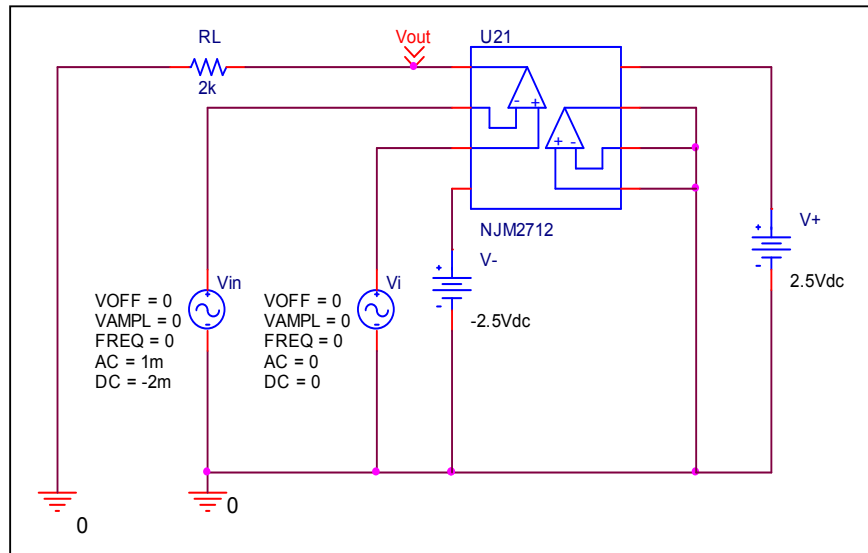
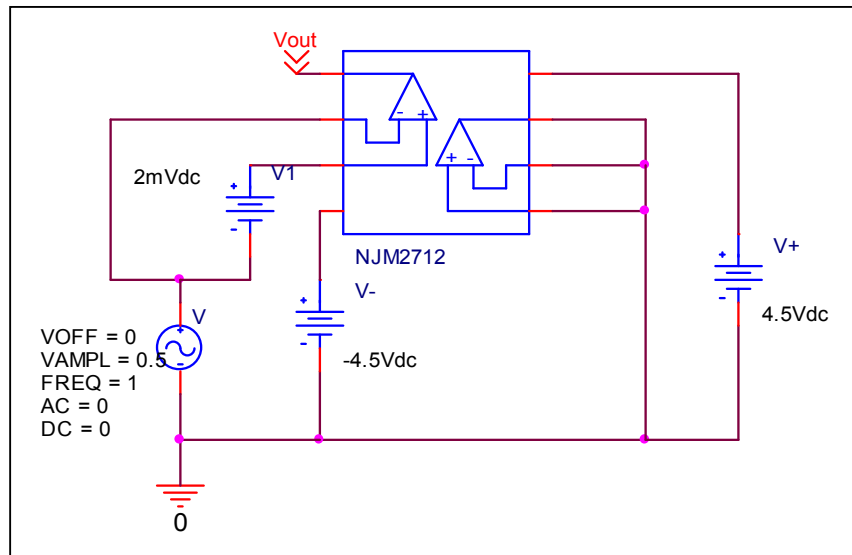
After
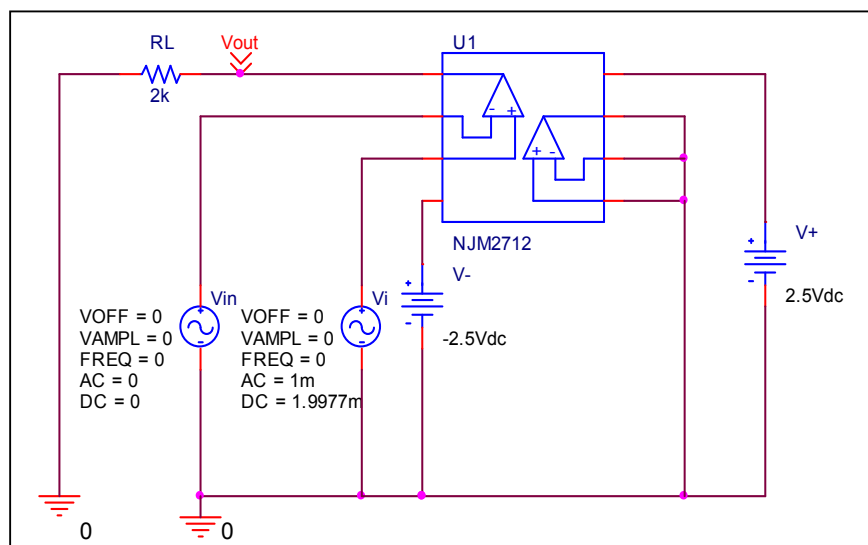
Remark Unity Gain Bandwidth

Before

After

Remark Common-Mode Rejection Voltage gain

Before

Vout

2mVdc

V1

NJM2712

V-

V+

-4.5Vdc

4.5Vdc

VOFF = 0
VAMPL = 0.5
FREQ = 1
AC = 0
DC = 0

V

0

After

Vout

U1

-1.9977m

V1

NJM2712

V-

V+

-2.5

2.5

VOFF = 0
VAMPL = 0.1
FREQ = 1
AC = 0
DC = 0

V

0