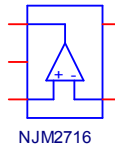# Device Modeling Report

COMPONENTS: OPERATIONAL AMPLIFIER
PART NUMBER: NJM2716
MANUFACTURER: NEW JAPAN RADIO CO., LTD.

Bee Technologies Inc.
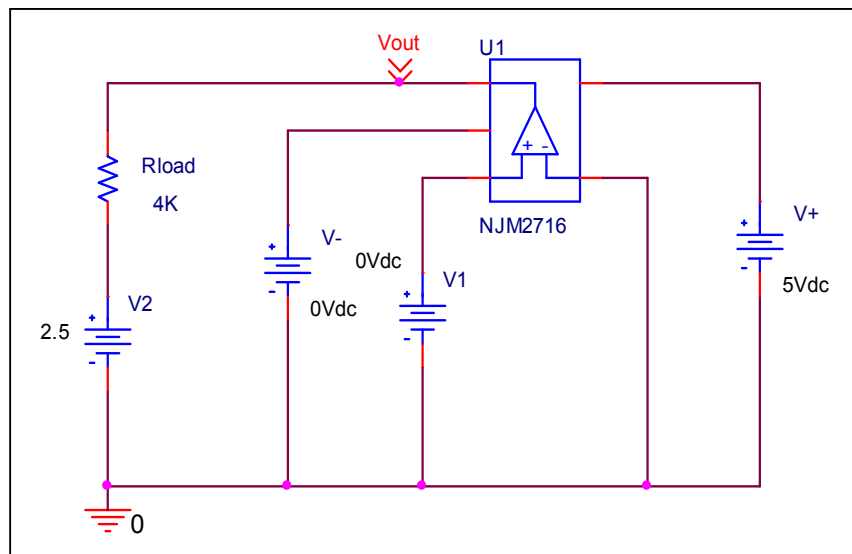
Spice Model

NJM2716

```
*$
*PART NUMBER: NJM2716
*MANUFACTURER: NEW JAPAN RADIO
*OPAMP
*All Rights Reserved Copyright (c) Bee Technologies Inc. 2007
.subckt njm2716 OUT GND IN+ IN- V+
X_U1 IN+ IN- V+ GND OUT njm2716_ME
.ends njm2716
.subckt NJM2716_ME 1 2 3 4 5
  c1   11 12 8.6603E-12
  c2    6  7 4.1450E-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 78.000E3 -1E3 1E3 78E3 -78E3
  ga    6  0 11 12 18.182E-3
  gcm   0  6 10 99 290.00E-9
  iee   3 10 dc 152.00E-6
  hlim 90  0 vlim 1K
  q1   11  2 13 qx1
  q2   12  1 14 qx2
  r2    6  9 100.00E3
  rc1   4 11 65
  rc2   4 12 65
  re1  13 10 58
  re2  14 10 58
  ree  10 99 1.3158E6
  ro1   8  5 50
  ro2   7 99 25
  rp    3  4 125.47
  vb    9  0 dc 0
  vc    3 53 dc 1.0880
  ve   54  4 dc .8885
  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=67.024)
.model qx2 PNP(Is=838.5000E-18 Bf=85.324)
.ends
*$
```
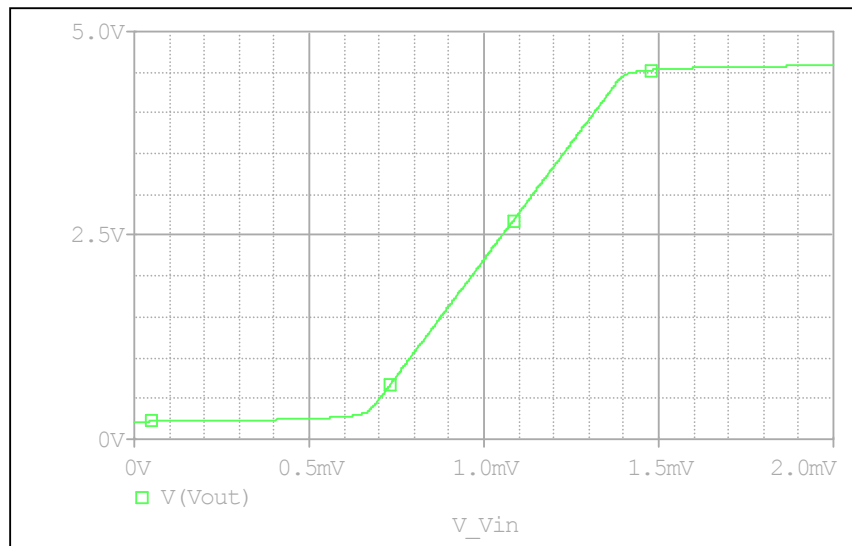
Output Voltage Swing
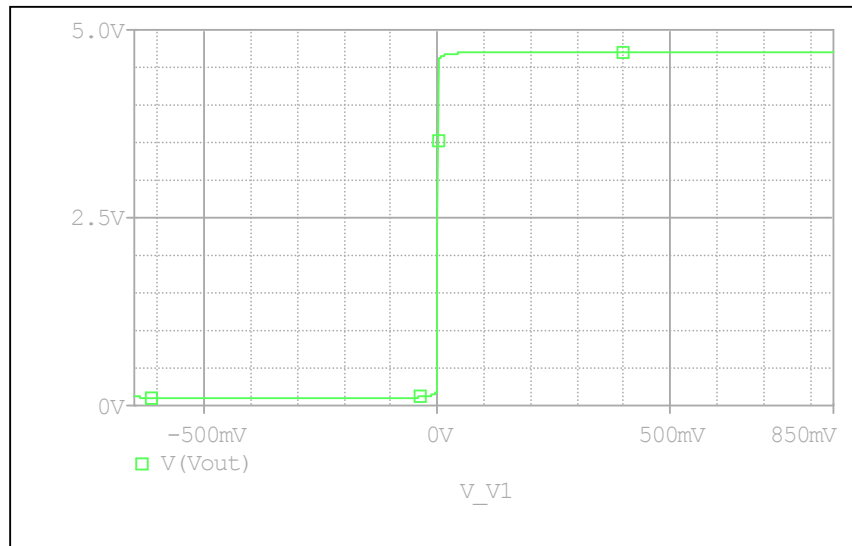
Evaluation circuit

Comparison table

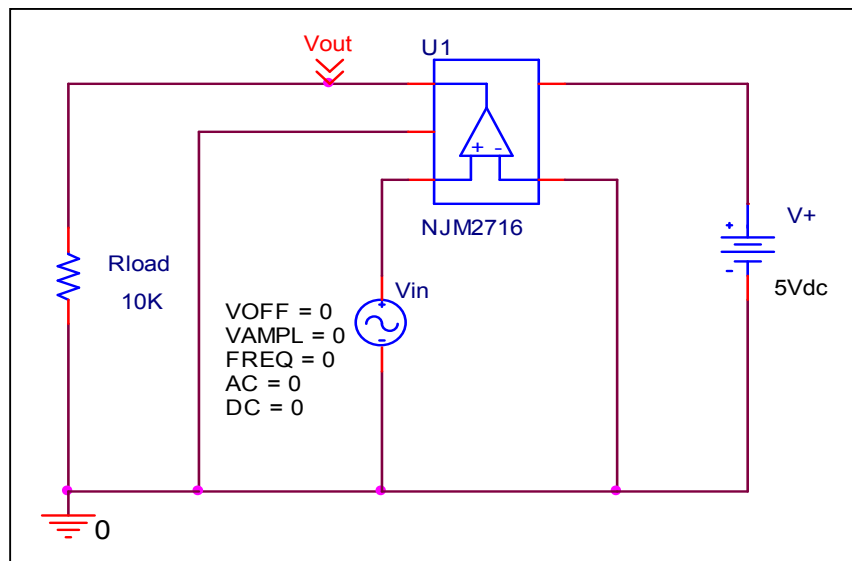| Output Voltage Swing	Measurement	Simulation	%Error
+Vout (V)	4.7	4.7004	0.009
-Vout (mV)	100	100.151	0.151

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Input Offset Voltage

	Measurement	Simulation	%Error
Vos (mV)	1	1.0345	3.45

Slew Rate
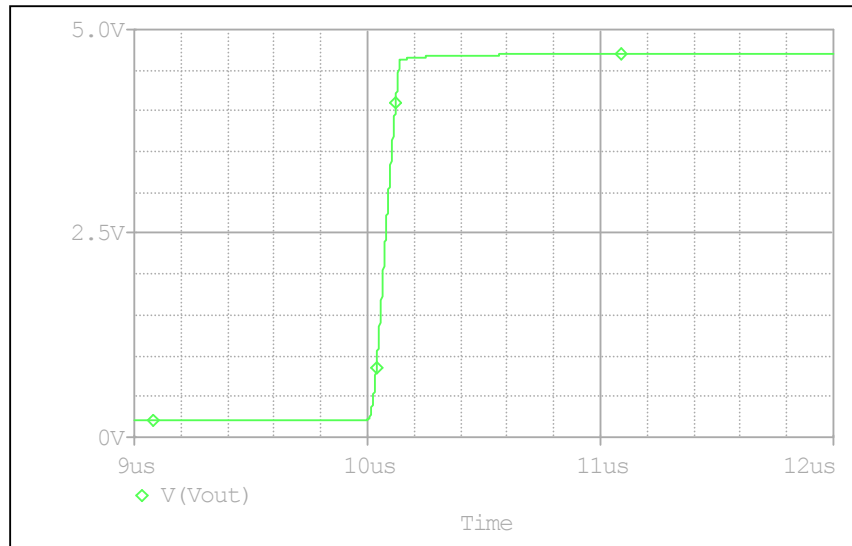
	Measurement	Simulation	%Error
Slew Rate(v/us)	40	38.023	-4.942

Input current
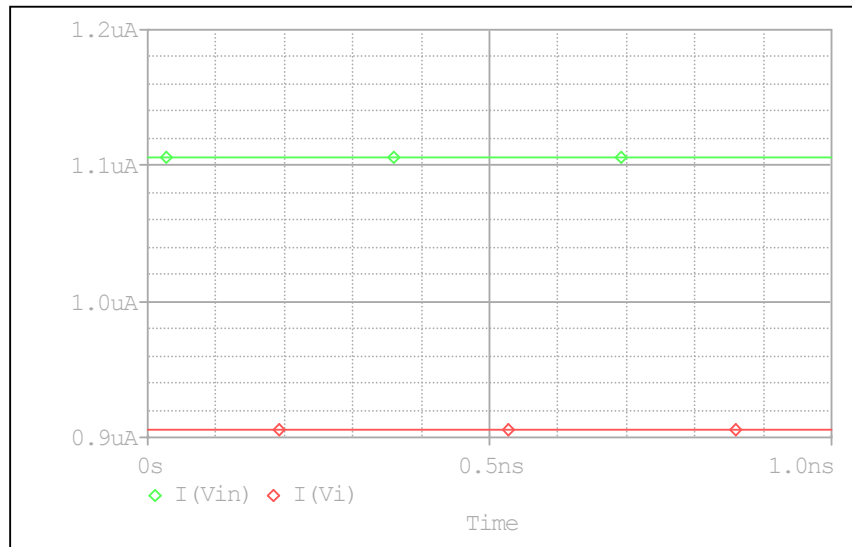
Evaluation circuit

Comparison table

	Measurement	Simulation	%Error
Ib (uA)	1	1.0058	0.580
Ibos (uA)	0.2	0.201	0.500

Open Loop Voltage Gain vs. Frequency

Simulation result
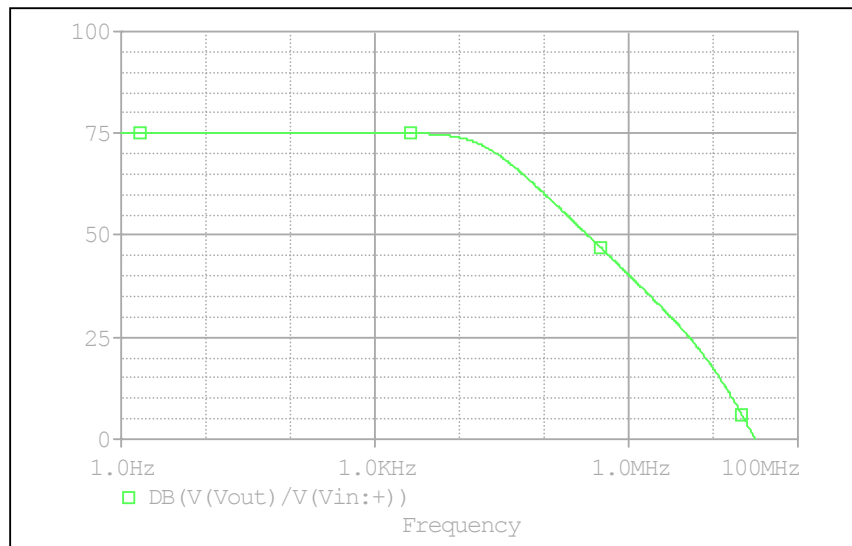
Evaluation circuit
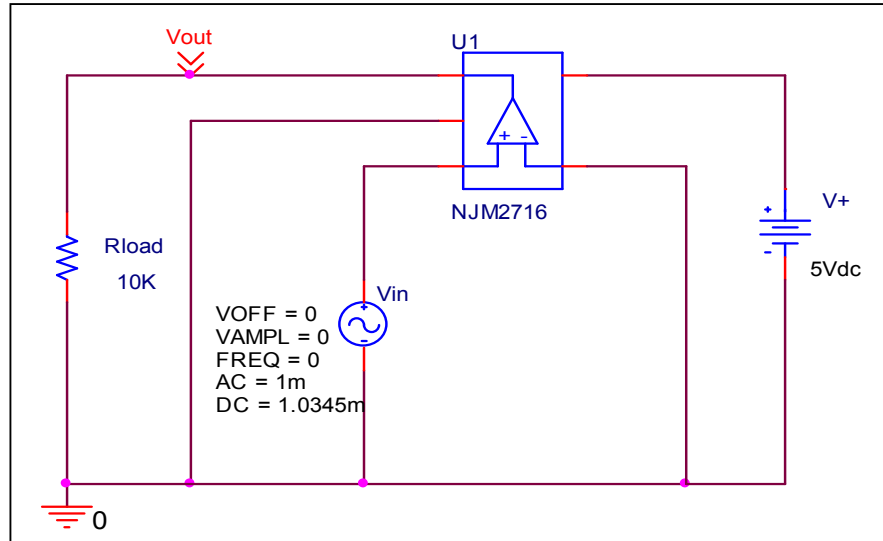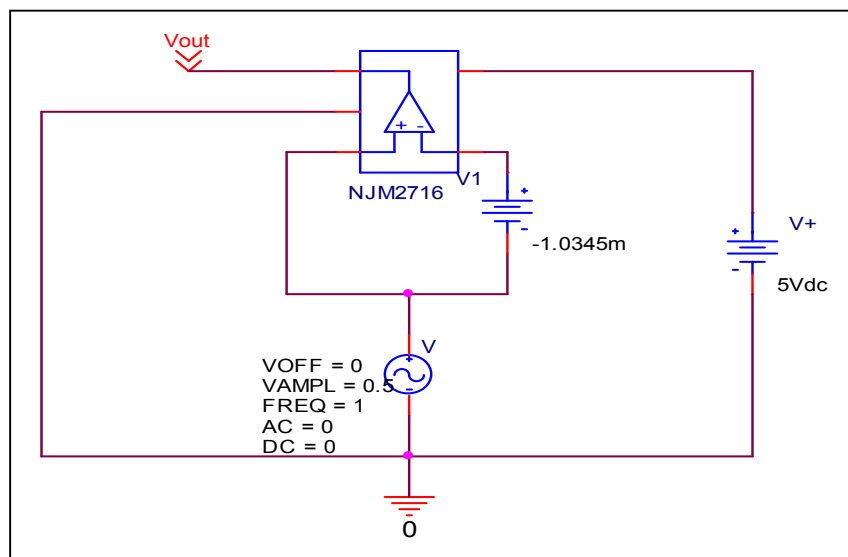

Comparison table

	Measurement	Simulation	%Error
f-0dB(MHz)	30.000	31.499	4.997
Av-dc(dB)	75.000	75.135	0.180

Common- Mode Rejection Voltage gain
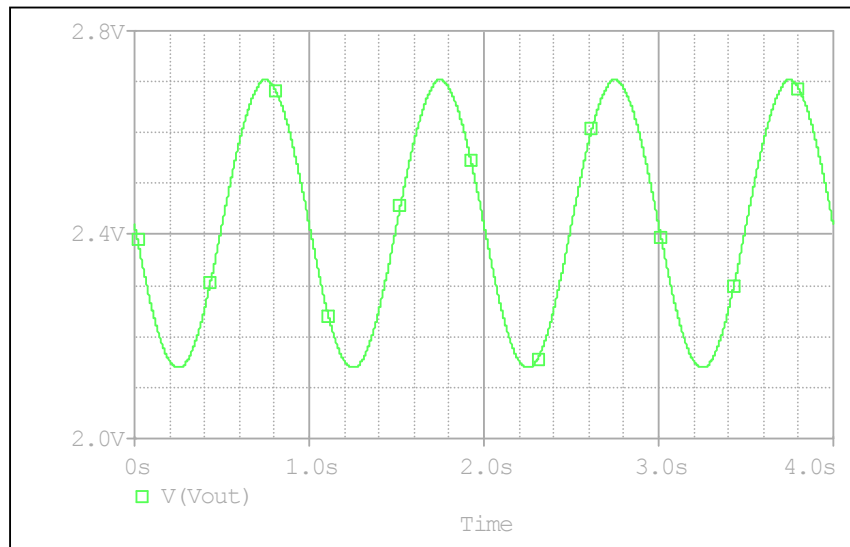
Evaluation circuit

CMRR=20*LOG(5711.497/(0.565734)) = 80.084 dB

Comparison table

	Measurement	Simulation	%Error
CMRR(dB)	80	80.084	0.105

Remark Output Voltage Swing

Before

Vout

U25

Rload
20K

V1
0Vdc

NJM2716

V+
5Vdc

0

After

Vout

U1

Rload
4K

V-
0Vdc

V2
2.5

V1
0Vdc

NJM2716

V+
5Vdc

0
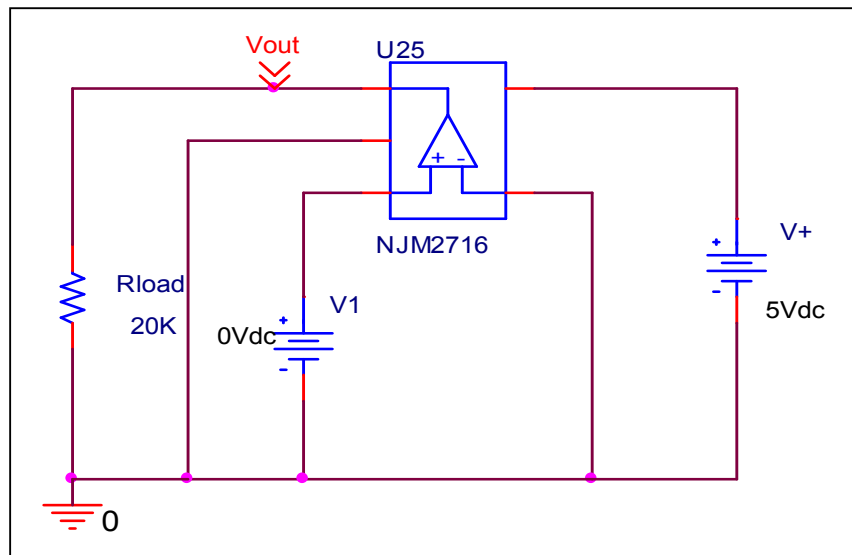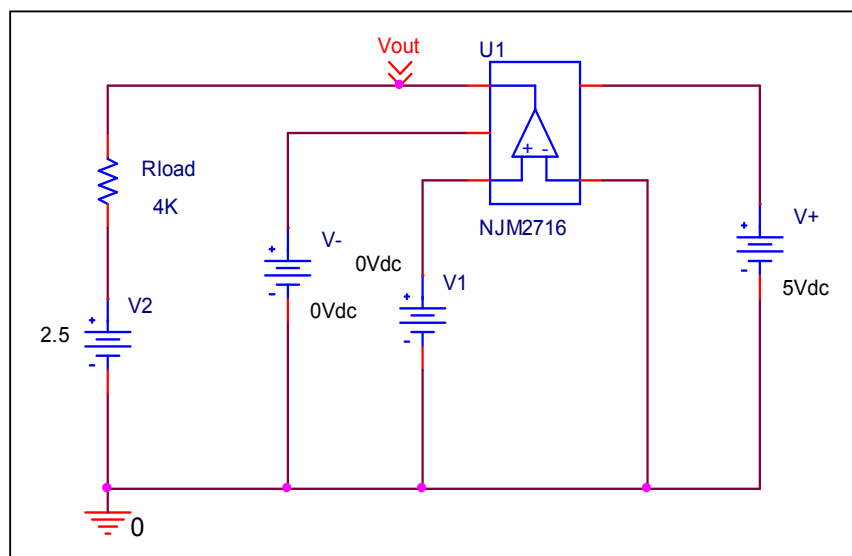
Remark Input Offset Voltage

Before

Vout
U25

Rload
20K

VOFF = 0
VAMPL = 0
FREQ = 0
AC = 0
DC = 0

Vin

NJM2716

V+

5Vdc

0

After

Vout
U1

Rload
10K

VOFF = 0
VAMPL = 0
FREQ = 0
AC = 0
DC = 0

Vin

NJM2716

V+

5Vdc

0

Remark Slew Rate

Before

Vout U25

V1 = 0
V2 = 5
TD = 0
TR = 10n
TF = 10n
PW = 50u
PER = 500u

Rload
20K

Vi NJM2716

V2

-1m

V+

5Vdc

0

After

Vout U1

NJM2716

V1 = 0
V2 = 4
TD = 10u
TR = 10n
TF = 10n
PW = 50u
PER = 500u

Vi

V+

5Vdc

0
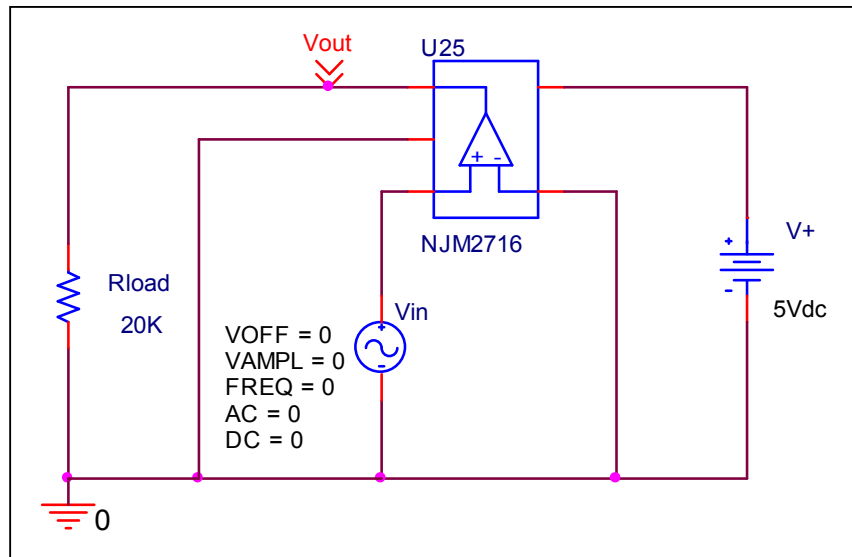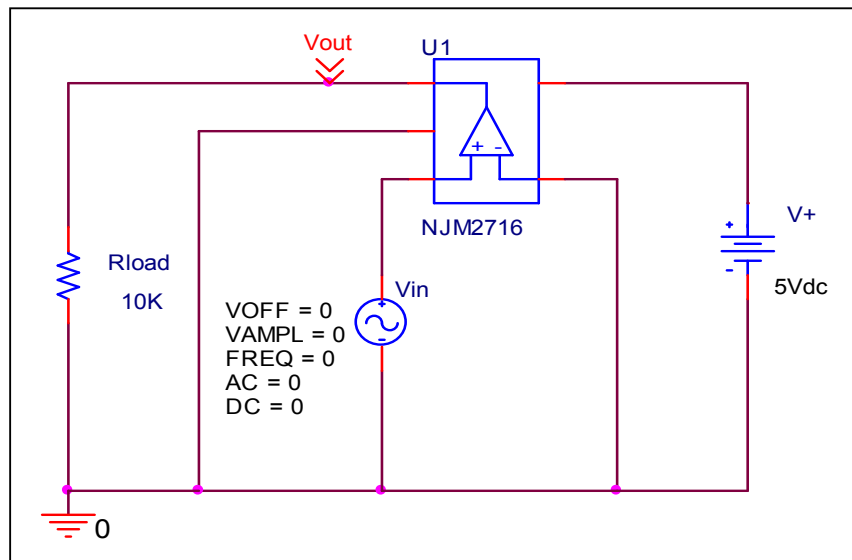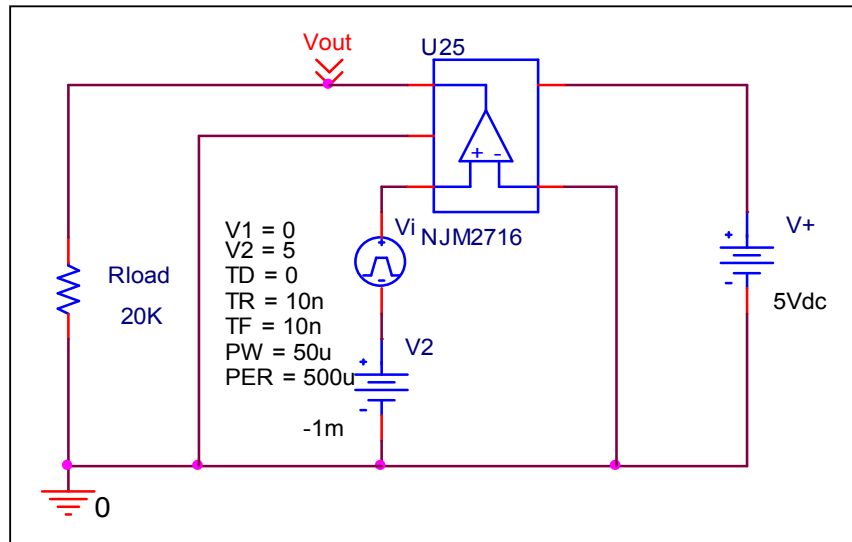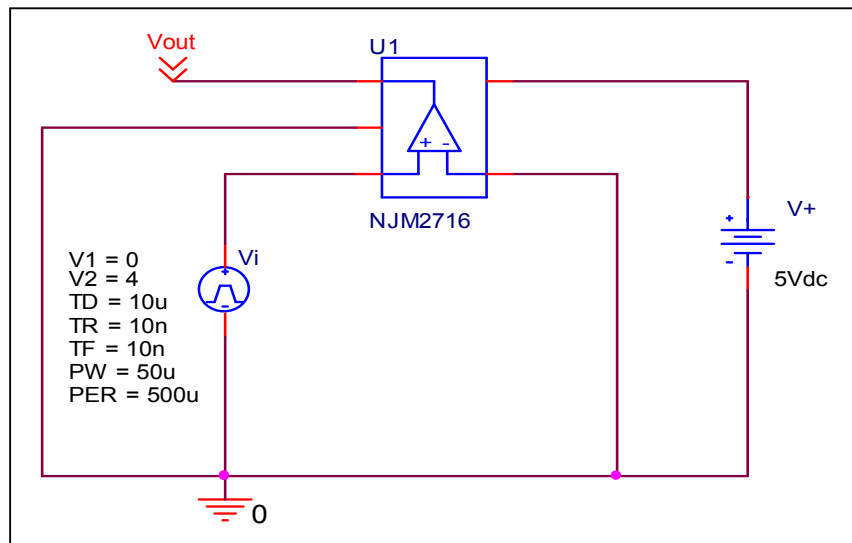
Remark Input current

Before

Vout

U25

Rload
20K

NJM2716

Vin
VOFF = -1m
VAMPL = 0
FREQ = 0
AC = 0
DC = 0

Vi
VOFF = 0
VAMPL = 0
FREQ = 0
AC = 0
DC = 0

V+
5Vdc

0

After

Vout

U1

NJM2716

Vi
VOFF = 0
VAMPL = 0
FREQ = 0
AC = 0
DC = 1.0345m

Vin
VOFF = 0
VAMPL = 0
FREQ = 0
AC = 0
DC = 0

V+
5Vdc

0
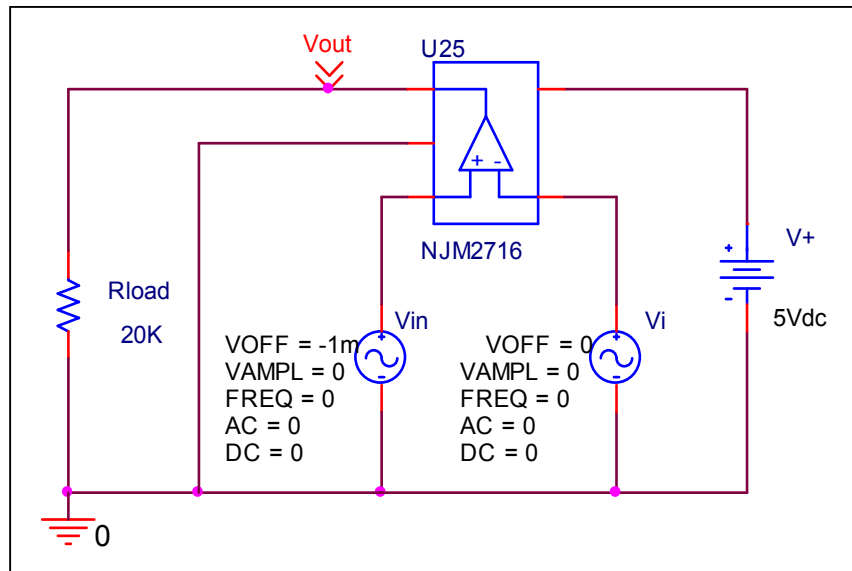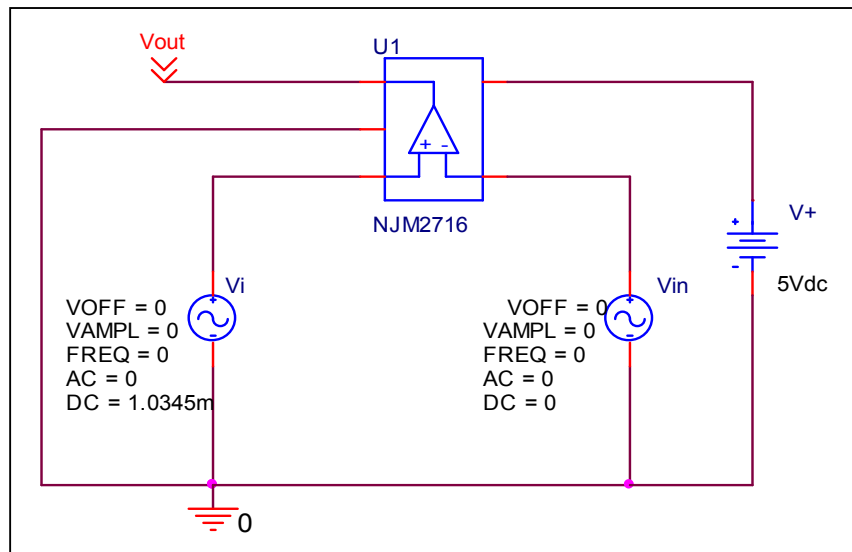
Remark Open Loop Voltage Gain vs. Frequency

Before

Vout U25

Rload

20K

Vi

VOFF = 0
VAMPL = 0
FREQ = 0
AC = 0
DC = 0

NJM2716

Vin

VOFF = 0
VAMPL = 0
FREQ = 0
AC = 1m
DC = -1m

V+

5Vdc

0

After

Vout U1

Rload

10K

NJM2716

Vin

VOFF = 0
VAMPL = 0
FREQ = 0
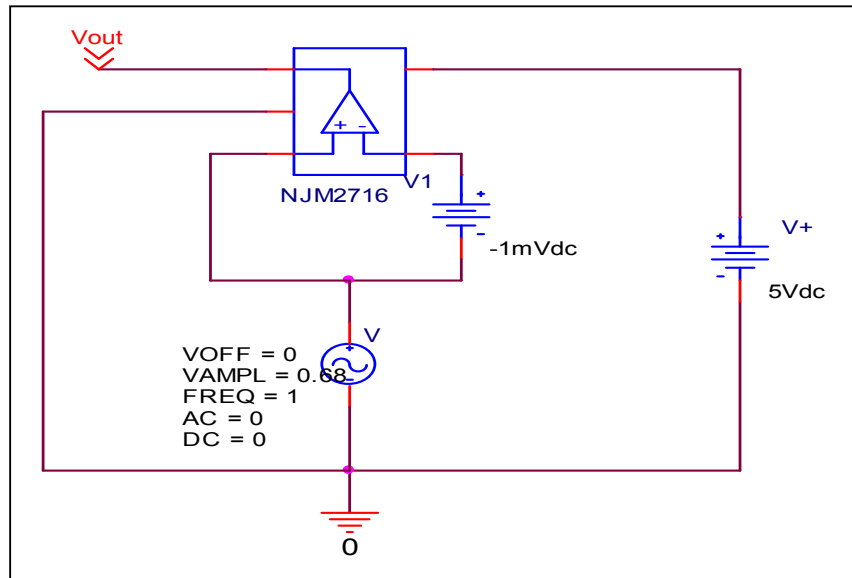AC = 1m
DC = 1.0345m

V+

5Vdc

0
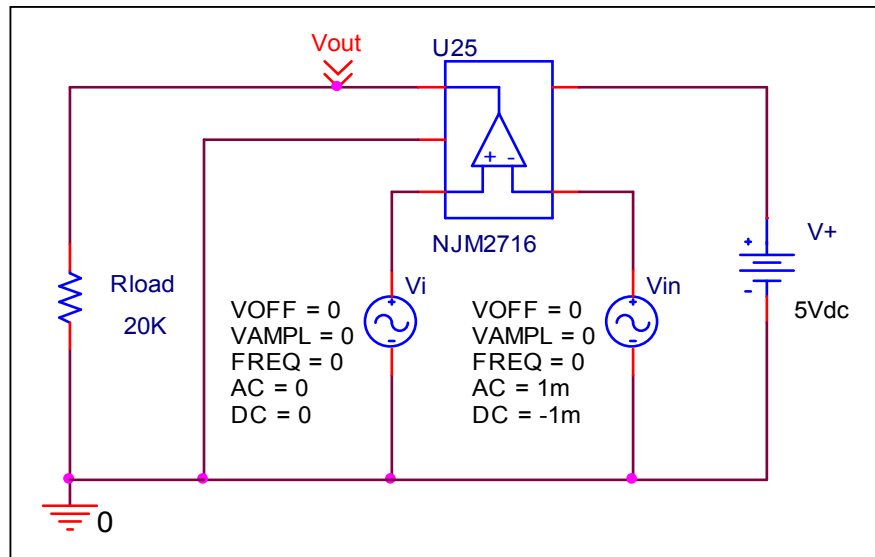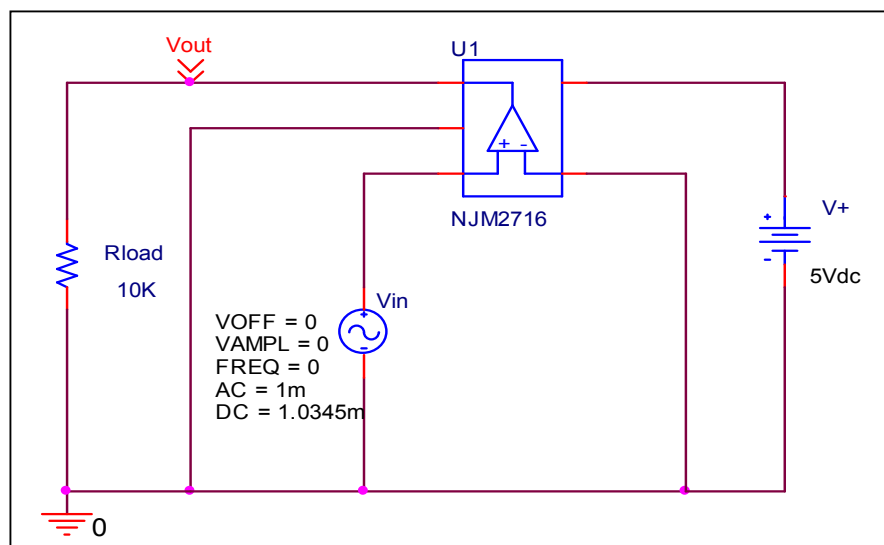
Remark Common-Mode Rejection Voltage gain

Before

Vout

V1

NJM2716

-1mVdc

V+

5Vdc

V

VOFF = 0
VAMPL = 0.68
FREQ = 1
AC = 0
DC = 0

0

After

Vout

U1

NJM2716

V+

5Vdc

Rload

10K

Vin

VOFF = 0
VAMPL = 0
FREQ = 0
AC = 1m
DC = 1.0345m

0