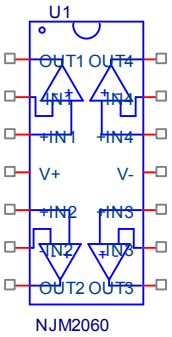
Device Modeling Report

COMPONENTS:MOSFET: OPERATIONAL AMPLIFIER
PART NUMBER:NJM2060
MANUFACTURER: NEW JAPAN RADIO CO.,LTD

Bee Technologies Inc.

SPice Model




```
*$
* PART NUMBER:NJM2060
* MANUFACTURER: NEW JAPAN RADIO
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.Subckt NJM2060 OUT1 -IN1 +IN1 V+ +IN2 -IN2 OUT2 OUT3 -IN3 +IN3 V-
+ +IN4 -IN4 OUT4
X_U1     +IN1 -IN1 V+ V- OUT1 NJM2060_SUB
X_U2     +IN2 -IN2 V+ V- OUT2 NJM2060_SUB
X_U3     +IN3 -IN3 V+ V- OUT3 NJM2060_SUB
X_U4     +IN4 -IN4 V+ V- OUT4 NJM2060_SUB
.ends  NJM2060
.subckt NJM2060_SUB  1 2 3 4 5
  c1   11 12 8.6603E-12
  c2    6  7 30.000E-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 1.9100E6 -1E3 1E3 1E6 -1E6
  ga    6  0 11 12 2.1781E-3
  gcm   0  6 10 99 66.404E-9
  iee   3 10 dc 120.68E-6
  hlim 90  0 vlim 1K
  q1   11  2 13 qx1
  q2   12  1 14 qx2
  r2    6  9 100.00E3
  rc1   4 11 459.12
  rc2   4 12 459.12
  re1  13 10 30.178
  re2  14 10 30.178
  ree  10 99 1.6573E6
  ro1   8  5 50
  ro2   7 99 25
  rp    3  4 1.2924E3
  vb    9  0 dc 0
  vc    3 53 dc 4.3545
  ve   54  4 dc 4.3555
  vlim  7  8 dc 0
```
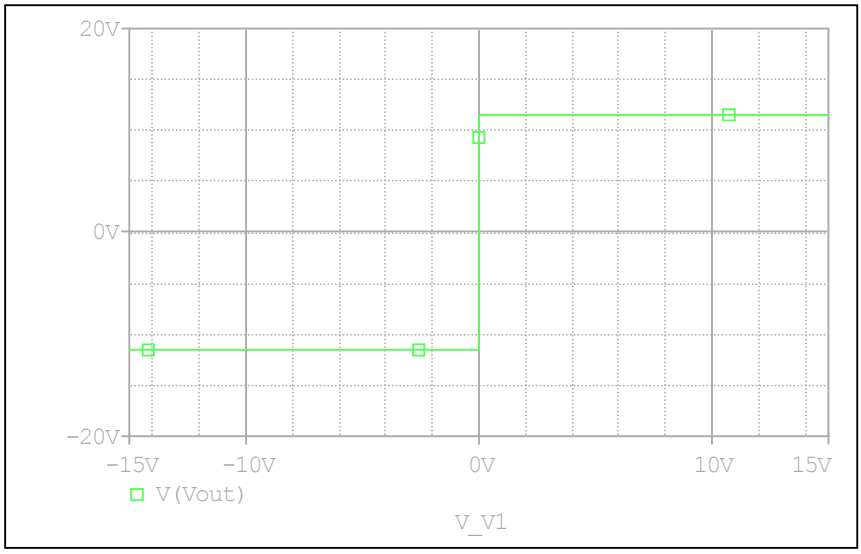
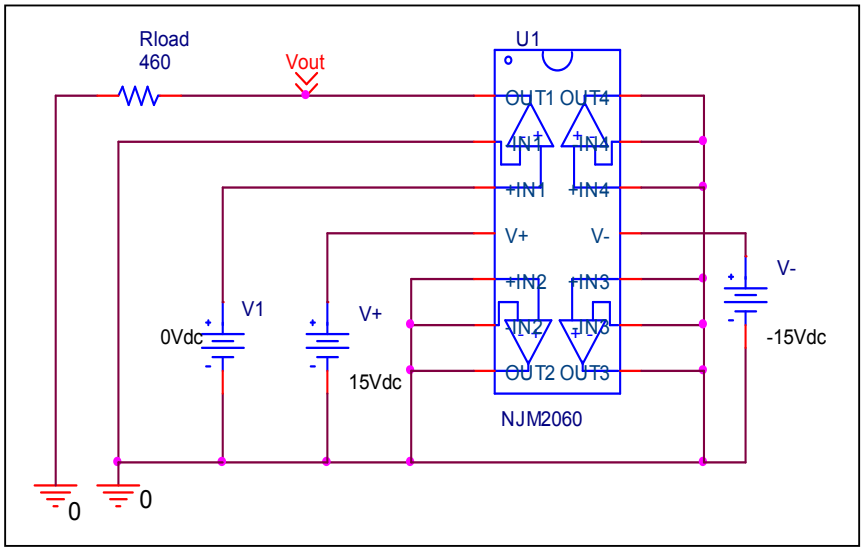

```
  vlp  91  0 dc 200
  vln   0 92 dc 200
.model dx D(Is=800.00E-18)
.model dy D(Is=800.00E-18 Rs=1m Cjo=10p)
.model qx1 PNP(Is=800.00E-18 Bf=1.4004E3)
.model qx2 PNP(Is=814.9854E-18 Bf=1.6149E3)
.ends
*$
```

Output Voltage Swing

Simulation result



Evaluation circuit

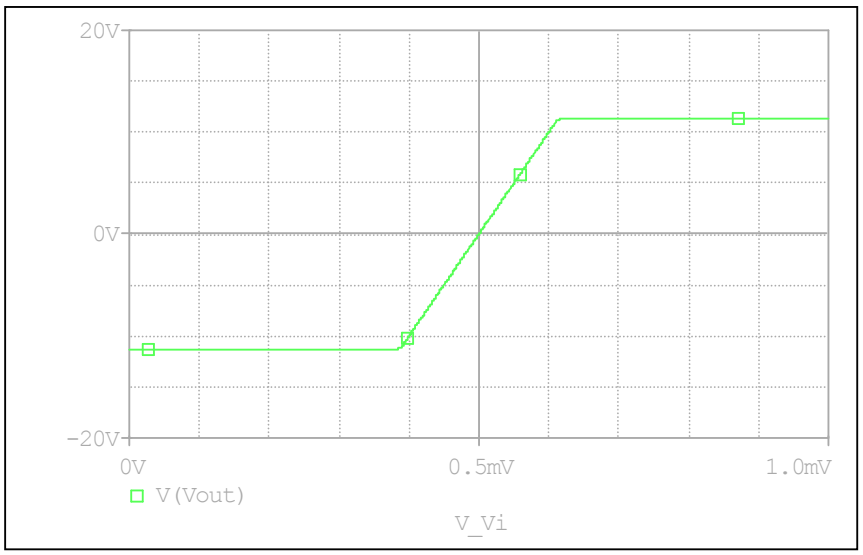


Comparison table Io = 25 mA

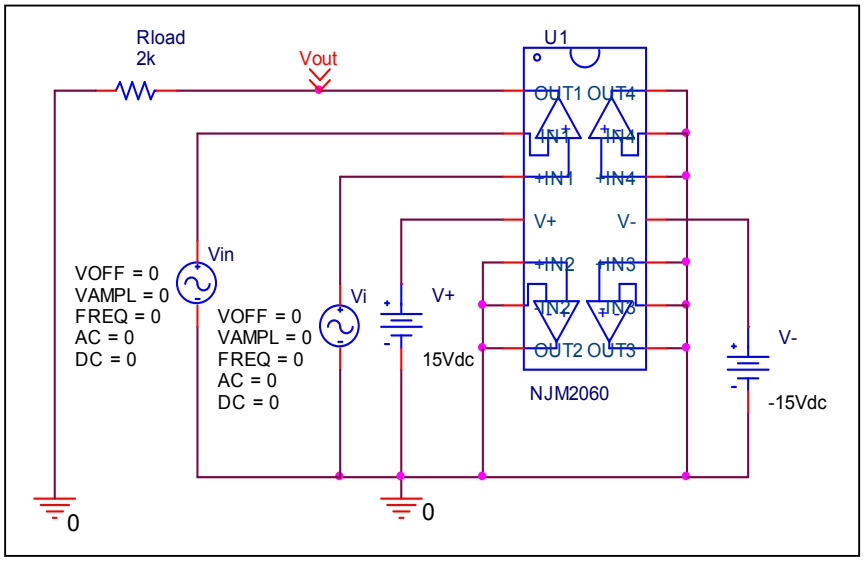
Output Voltage Swing	Measurement	Simulation	%Error
+Vout(V)	+11.5	+11.500	0
-Vout(V)	-11.5	-11.499	-0.009

Input Offset Voltage

Simulation result



Evaluation circuit

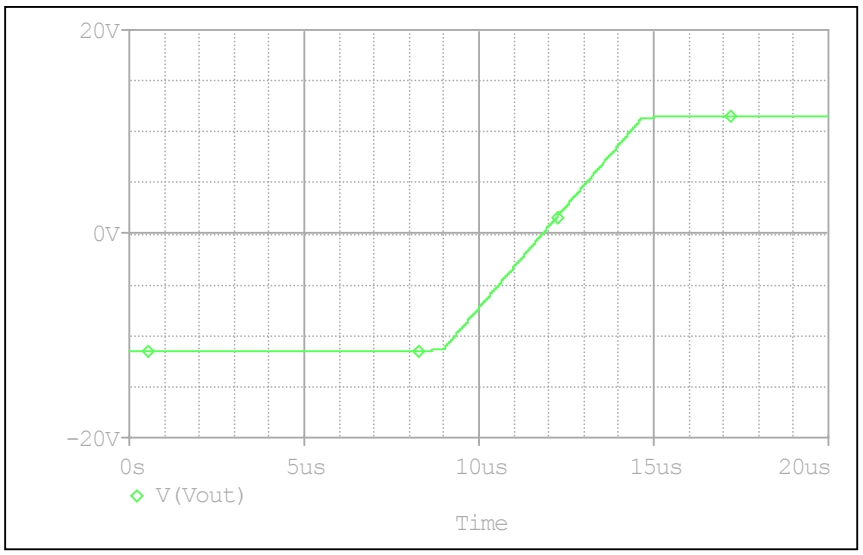


Comparison table

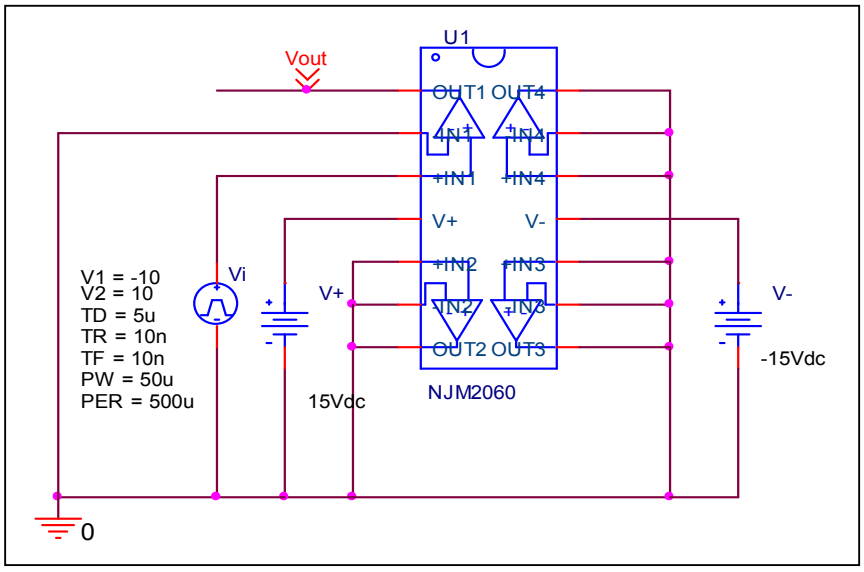
	Measurement	Simulation	%Error
Vos (mV)	0.5	0.5	0

Slew Rate

Simulation result



Evaluation circuit

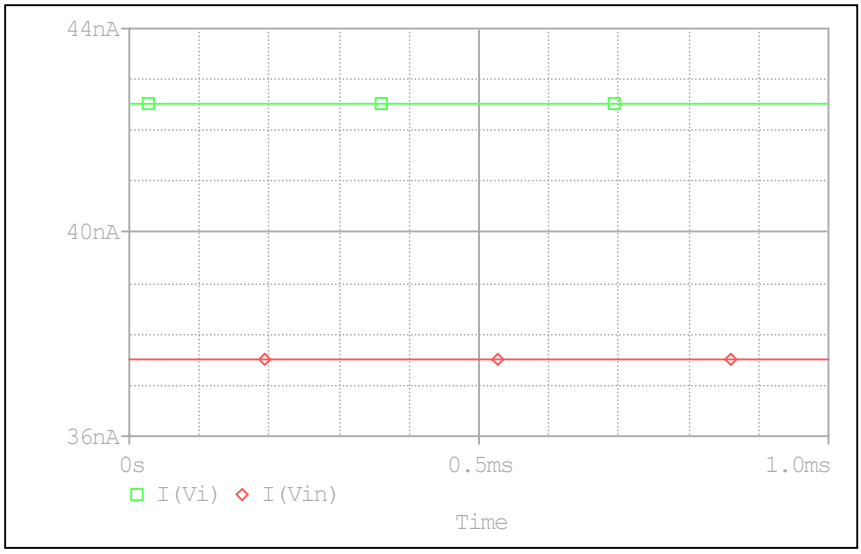


Comparison table

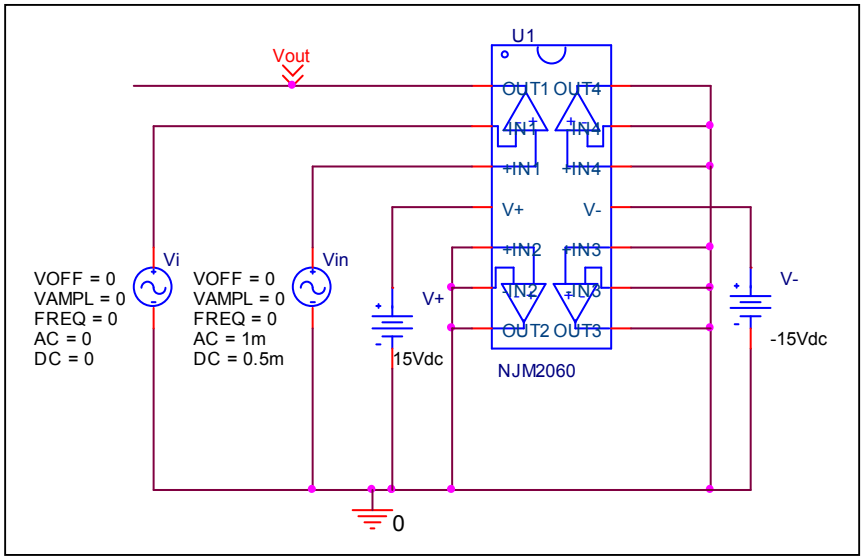
	Measurement	Simulation	%Error
Slew Rate(v/us)	4	3.996	-0.1

Input current

Simulation result



Evaluation circuit

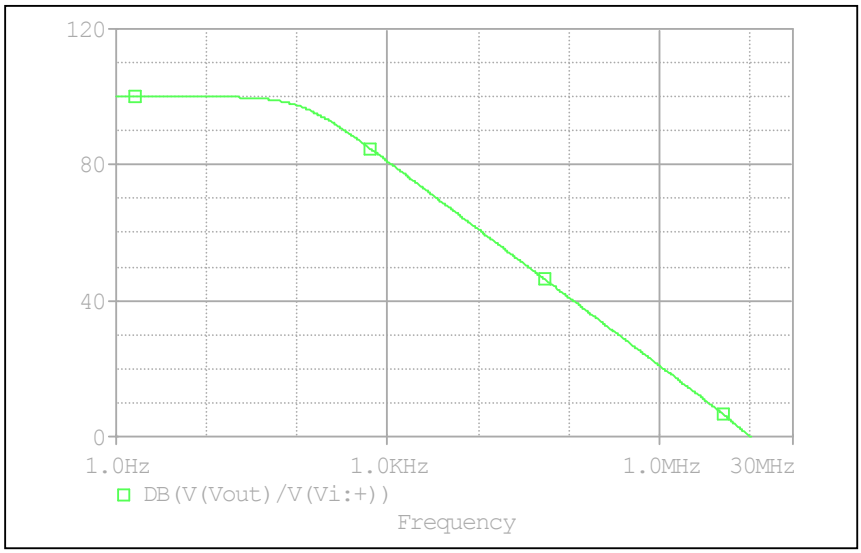


Comparison table

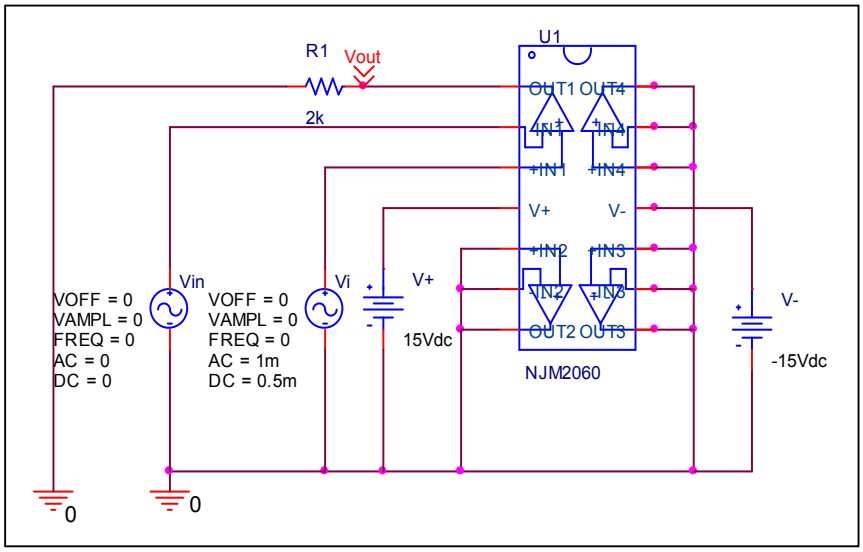
	Measurement	Simulation	%Error
Ib (nA)	40	40.029	0.073
Ibos (nA)	5	5.0057	0.114

Open Loop Voltage Gain vs. Frequency

Simulation result



Evaluation circuit

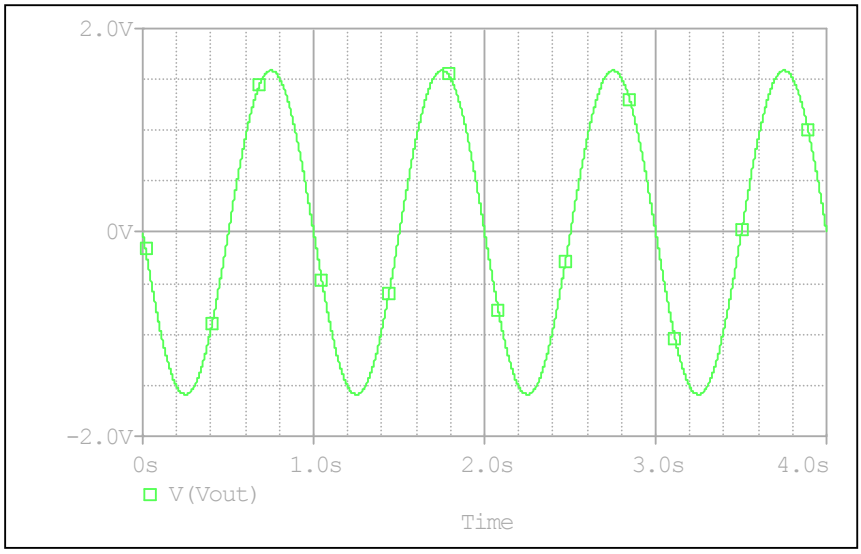


Comparison table

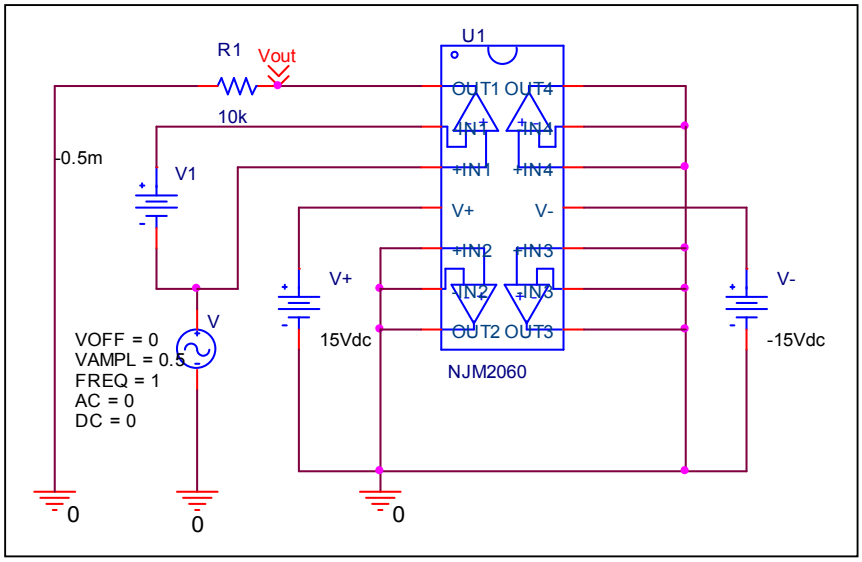
	Measurement	Simulation	%Error
f-0dB(MHz)	10	10.21	2.100
Av-dc(dB)	100	99.994	-0.006

Common-Mode Rejection Voltage gain

Simulation result



Evaluation circuit



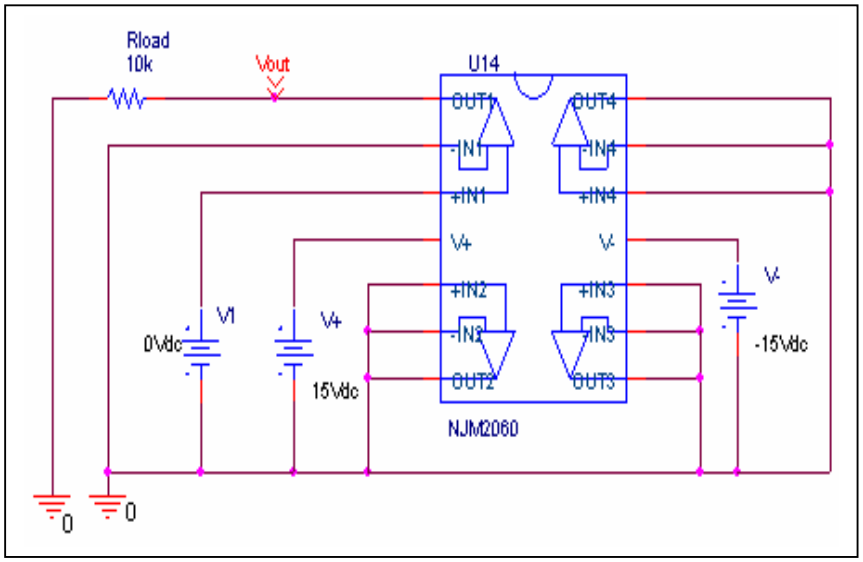
CMRR=20*LOG(99930.946/3.1555) = 90.012 dB

Comparison table

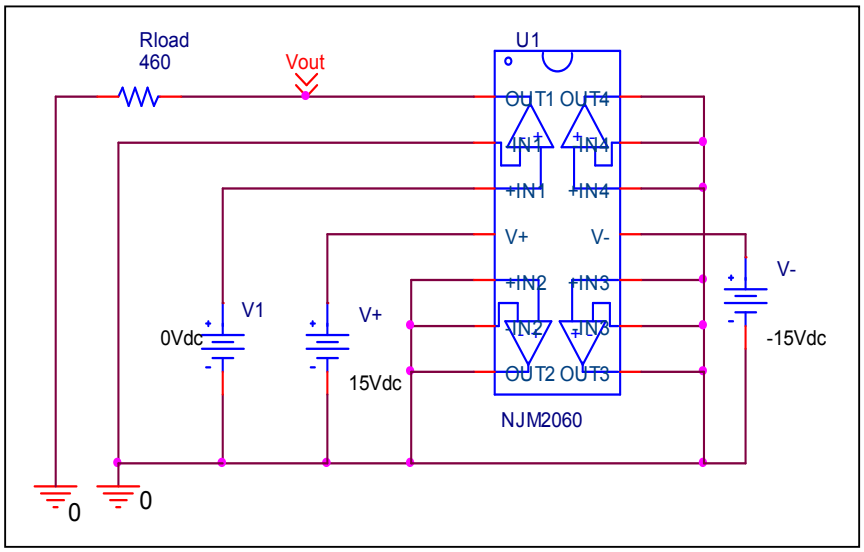
	Measurement	Simulation	%Error
CMRR(dB)	90	90.012	-0.06

Remark Output Voltage Swing

Before

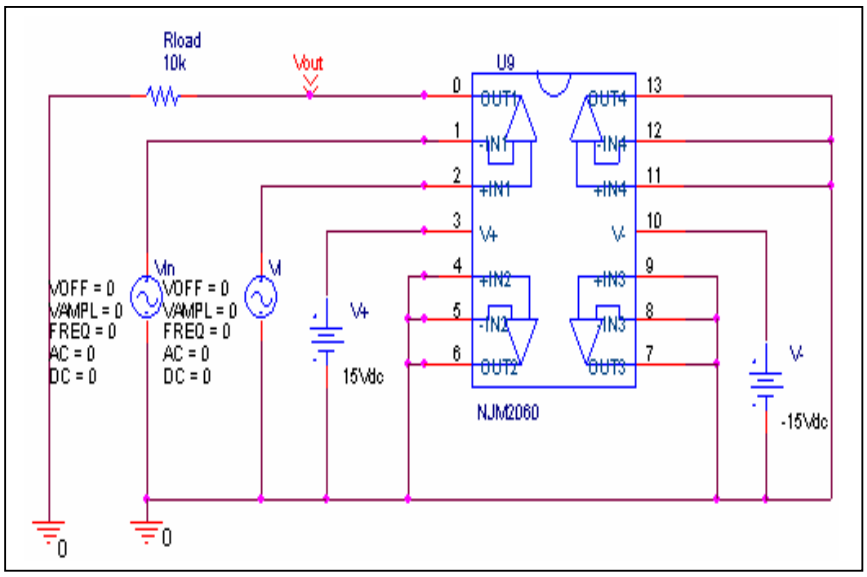


After

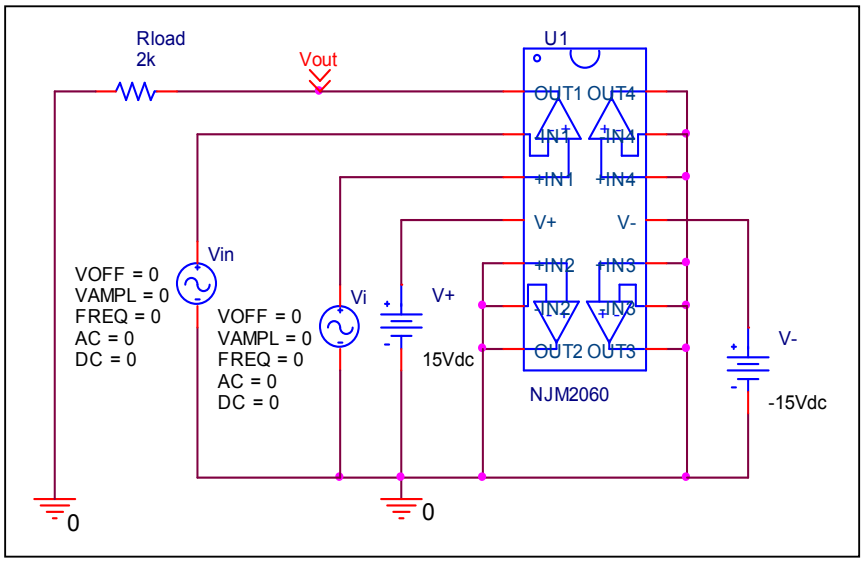


Remark Input Offset Voltage

Before

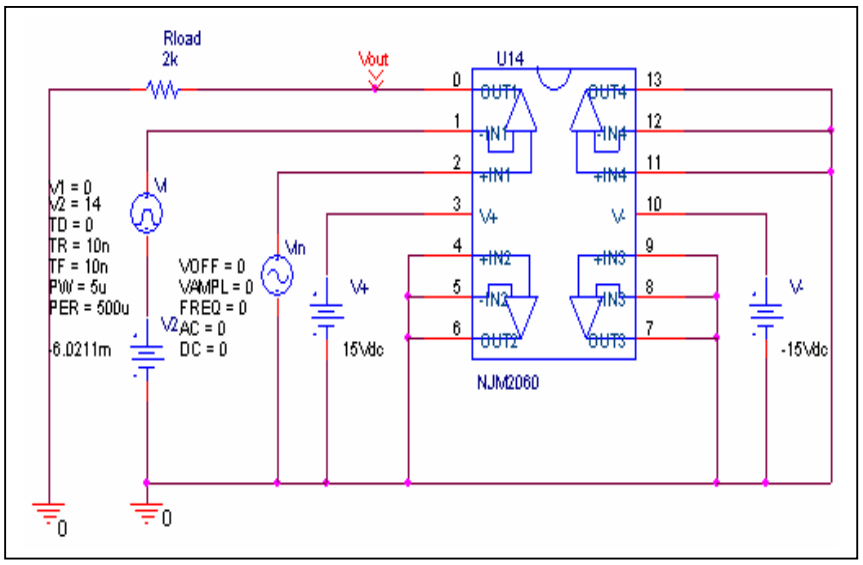


After

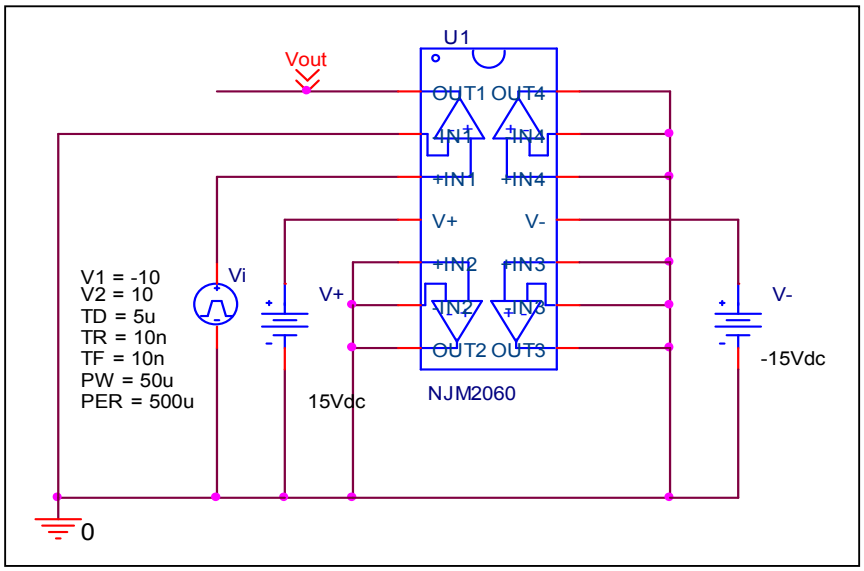


Remark Slew Rate

Before

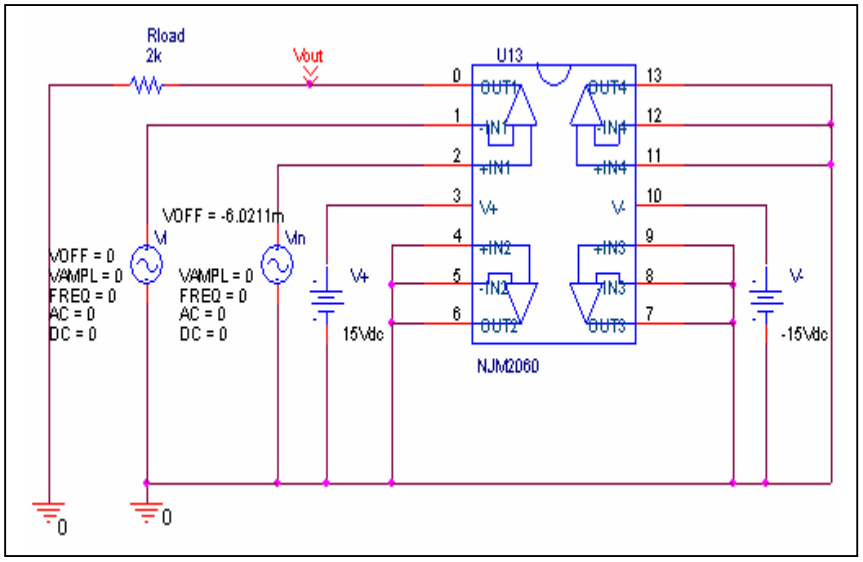


After

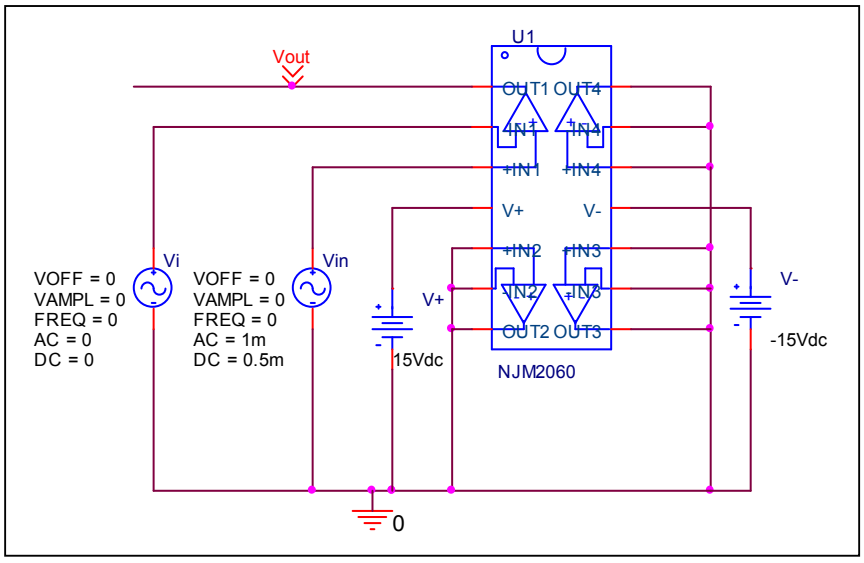


Remark Input current

Before

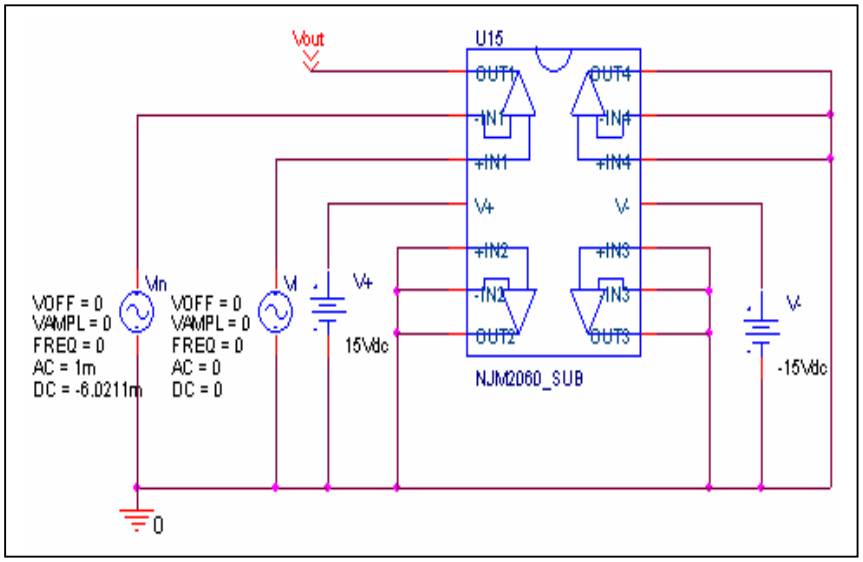


After

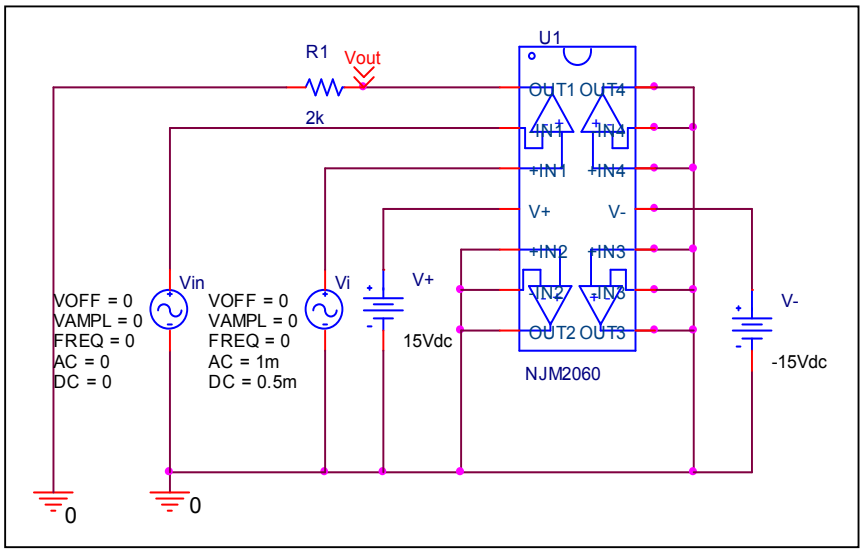


Remark Open Loop Voltage Gain vs. Frequency

Before

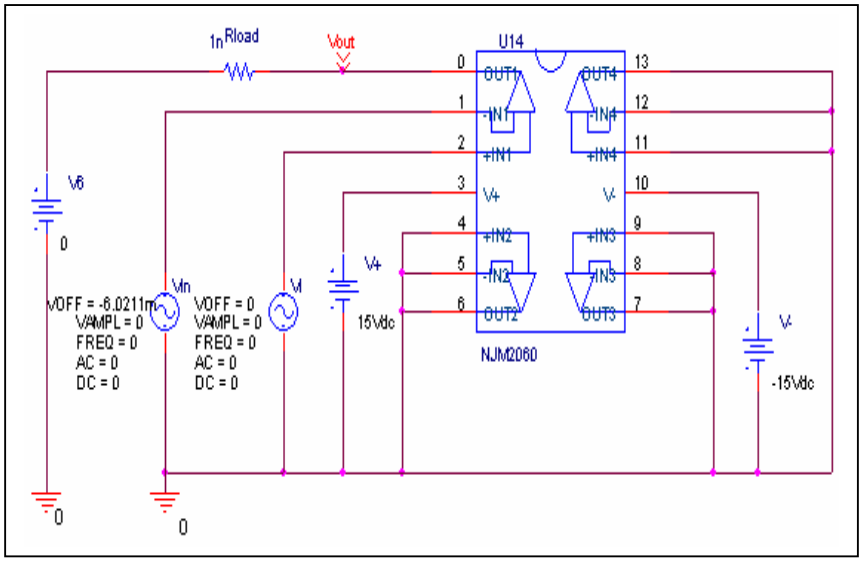


After



Remark Common-Mode Rejection Voltage gain

Before



After