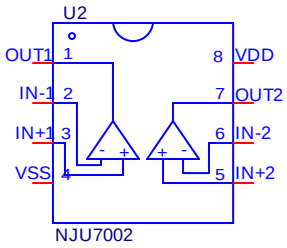
Device Modeling Report

COMPONENTS : OPERATIONAL AMPLIFIER (CMOS)
PART NUMBER : NJU7002
MANUFACTURER : NEW JAPAN RADIO

Bee Technologies Inc.

SPICE MODEL

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*PART NUMBER: NJU7002
*MANUFACTURER: NEW JAPAN RADIO
*CMOS OPAMP
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.SUBCKT nju7002 IN-1 IN+1 IN-2 IN+2 VDD VSS OUT1 OUT2
X_U1 IN-1 IN+1 VDD VSS OUT1 nju7002_s
X_U2 IN-2 IN+2 VDD VSS OUT2 nju7002_s
.ENDS nju7002
.SUBCKT nju7002_s     IN- IN+ VDD VSS OUT
M1              2 IN- 3 VDD MbreakPD3
M2              2 IN+ 4 VDD MbreakPD2
M3              VDD 1 2 VDD MbreakPD
M4              VDD 1 5 VDD MbreakPD
M5              VDD 1 6 VDD MbreakPD
M6              VDD 1 1 VDD MbreakPD
M7              5 5 VSS VSS MbreakND    W=3.2m      L=6u
M8              5 4 VSS VSS MbreakND3
M9              3 3 IN1 VSS MbreakND1
M10             4 3 IN2 VSS MbreakND1
M11             1 6 11 11 MbreakND        W=9m      L=6u
M12             6 6 VSS VSS MbreakND3
M13             7 5 VSS VSS MbreakND1
M14             VDD 7 7 VDD MbreakPD
M15             VDD 7 OUT VDD MbreakPD1
M16             OUT 4 VSS VSS MbreakND2
C1              OUT 7 15p
C2              OUT 1 10p
Cout            OUT IN- 70p
R1              11 VSS    1.522k
R2              IN1 VSS 2.0k
R3              IN2 VSS    3.93k
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```
I1              0 IN-    0.505p
I2              0 IN+    1.5p
X_U1              VSS 3 DbreakZ
X_U2              VSS 4 DbreakZ
.model MbreakND NMOS (LEVEL=3 VTO=0.9 RS=10.000E-3 RD=10.000E-3
+ RDS=1.0000E6 TOX=2.0000E-6 CGSO=4.000E-12 CGDO=1.000E-12
+ CBD=1.000E-12 RG=5 RB=1.0000E-3 KP=10E-6)
.model MbreakND1 NMOS (LEVEL=3 L=6u W=0.5 VTO=1 RS=10.000E-3
+ RD=10.000E-3 RDS=1.0000E6 TOX=2.0000E-6
+ CGSO=3.00E-12 CGDO=1.000E-12 CBD=1.000E-12
+ RG=5 RB=1.0000E-3 KP=10E-6)
.model MbreakND2 NMOS (LEVEL=3 L=6u W=0.483m VTO=0.9
+ RS=10.000E-3 RD=10.000E-3 RDS=1.0000E6 TOX=2.0000E-6
+ CGSO=4.000E-12 CGDO=1.00E-12 CBD=1.000E-12
+ RG=5 RB=1.0000E-3 KP=10E-6)
.model MbreakND3 NMOS (LEVEL=3 L=6u    W=3.2m    VTO=0.9
+ RS=10.000E-3 RD=10.000E-3 RDS=1.0000E6 TOX=2.0000E-6
+ CGSO=5.000E-7 CGDO=1.000E-13 CBD=10.000E-6
+ RG=5 RB=1.0000E-3 KP=10E-6)
.model MbreakPD PMOS (LEVEL=3 L=6u W=0.023 VTO=-1 RS=10.000E-3
+ RD=10.000E-3 RDS=1.0000E6 TOX=2.0000E-6 CGSO=4.000E-12
+ CGDO=1.000E-12 CBD=1.000E-12 RG=5 RB=1.0000E-3 KP=1E-6)
.MODEL MbreakPD1 PMOS (LEVEL=3 L=6u W=0.0056 VTO=-0.9
+ RS=10.000E-3 RD=10.000E-3 RDS=1.00E6 TOX=2.0000E-6
+ CGSO=4.000E-12 CGDO=1.000E-12 CBD=1.000E-12
+ RG=5 RB=1.0000E-3 KP=1E-6)
.MODEL MbreakPD2 PMOS (LEVEL=3 L=6u W=0.13 VTO=-1.5
+ RS=10.000E-3 RD=10.00E-3 RDS=1.00E6 TOX=2.0000E-6
+ CGSO=4.000E-12 CGDO=1.000E-12 CBD=1.00E-12
+ RG=5 RB=1.0000E-3 KP=1E-6)
.MODEL MbreakPD3 PMOS (LEVEL=3 L=6u W=0.14 VTO=-1.5
+ RS=10.000E-3 RD=10.00E-3 RDS=1.E6 TOX=2.0000E-6
+ CGSO=4.000E-12 CGDO=1.000E-12 CBD=1.00E-12
+ RG=5 RB=1.0000E-3 KP=1E-6)
.ENDS nju7002_s
```

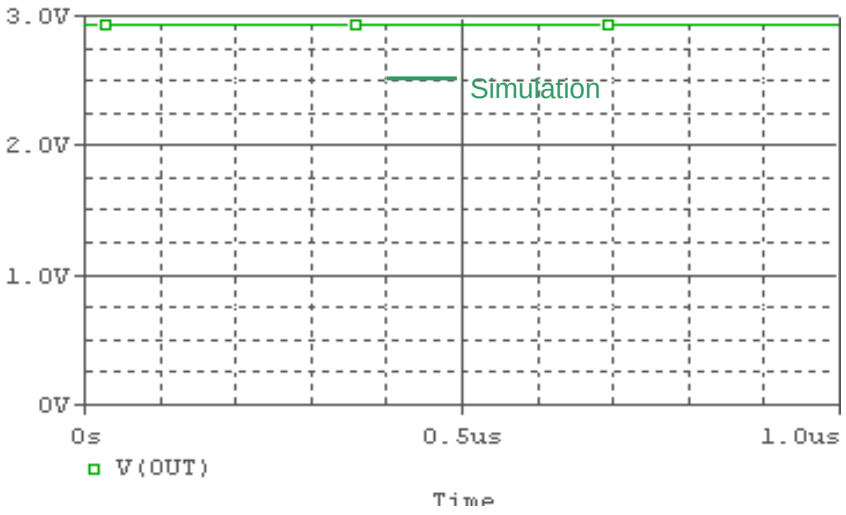
```
.SUBCKT DbreakZ    A K
D1 A K DF
DZ A2 A DR
VZ K A2 1
.MODEL DF D
.MODEL DR D
.ENDS DbreakZ
*$
```

MOSFET MODEL

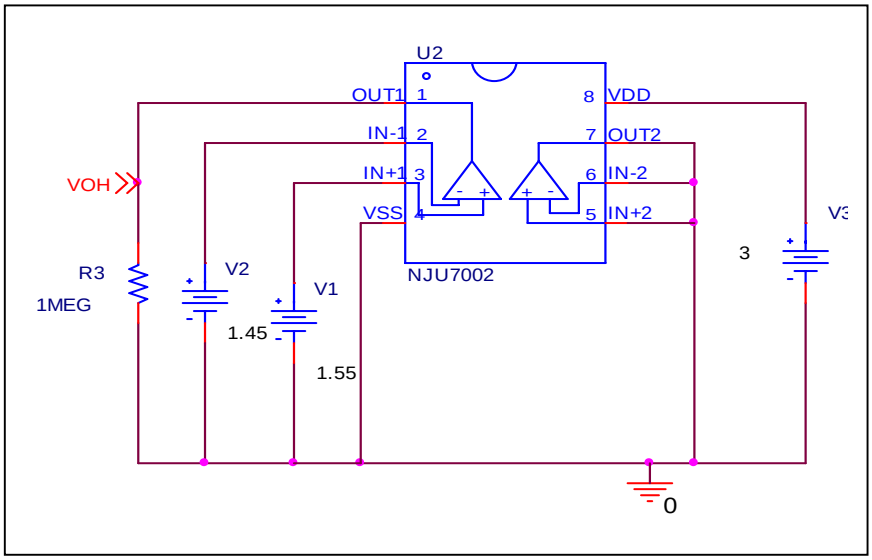
Pspice model parameter	Model description
LEVEL	
L	Channel Length
W	Channel Width
KP	Transconductance
RS	Source Ohmic Resistance
RD	Ohmic Drain Resistance
VTO	Zero-bias Threshold Voltage
RDS	Drain-Source Shunt Resistance
TOX	Gate Oxide Thickness
CGSO	Zero-bias Gate-Source Capacitance
CGDO	Zero-bias Gate-Drain Capacitance
CBD	Zero-bias Bulk-Drain Junction Capacitance
MJ	Bulk Junction Grading Coefficient
PB	Bulk Junction Potential
FC	Bulk Junction Forward-bias Capacitance Coefficient
RG	Gate Ohmic Resistance
IS	Bulk Junction Saturation Current
N	Bulk Junction Emission Coefficient
RB	Bulk Series Resistance
PHI	Surface Inversion Potential
GAMMA	Body-effect Parameter
DELTA	Width effect on Threshold Voltage
ETA	Static Feedback on Threshold Voltage
THETA	Modility Modulation
KAPPA	Saturation Field Factor
VMAX	Maximum Drift Velocity of Carriers
XJ	Metallurgical Junction Depth
UO	Surface Mobility

Output Voltage Swing

Simulation result



Evaluation Circuit

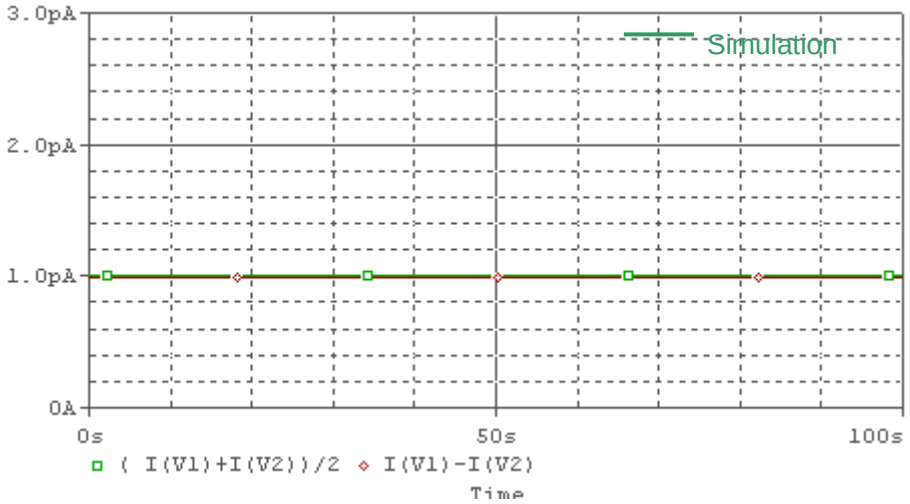


Compasion Table

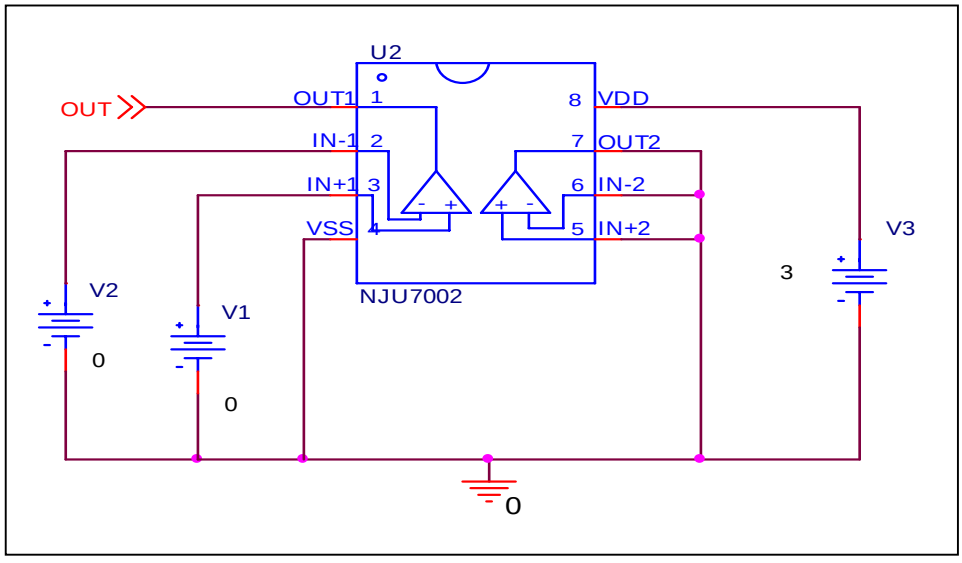
	Measurement	Simulation	%Error
V_{OM} (V)	2.940	2.939	-0.034

Input Current

Simulation result



Evaluation Circuit

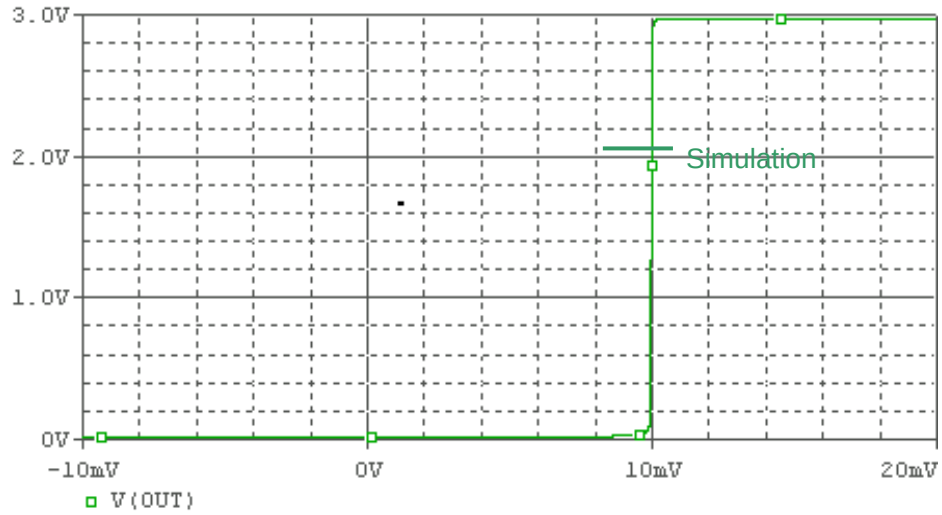


Compasion Table

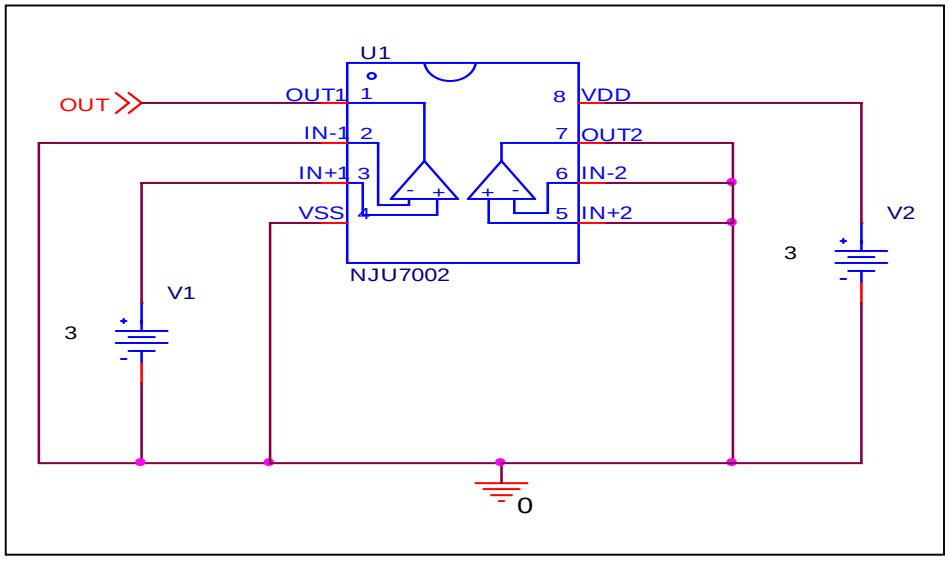
	Measurement	Simulation	% Error
I_b (pA)	1.000	1.002	0.200
I_{os} (pA)	1.000	0.995	-0.500

Input Offset Voltage

Simulation result



Evaluation Circuit

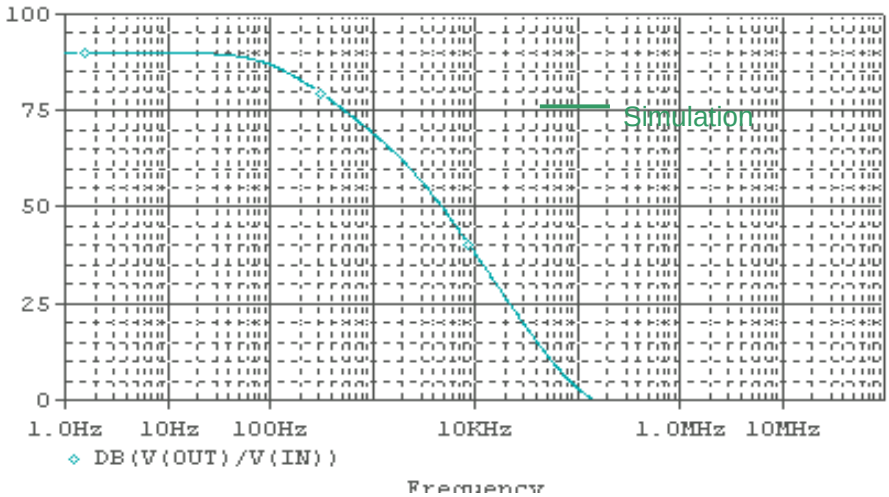


Compasion Table

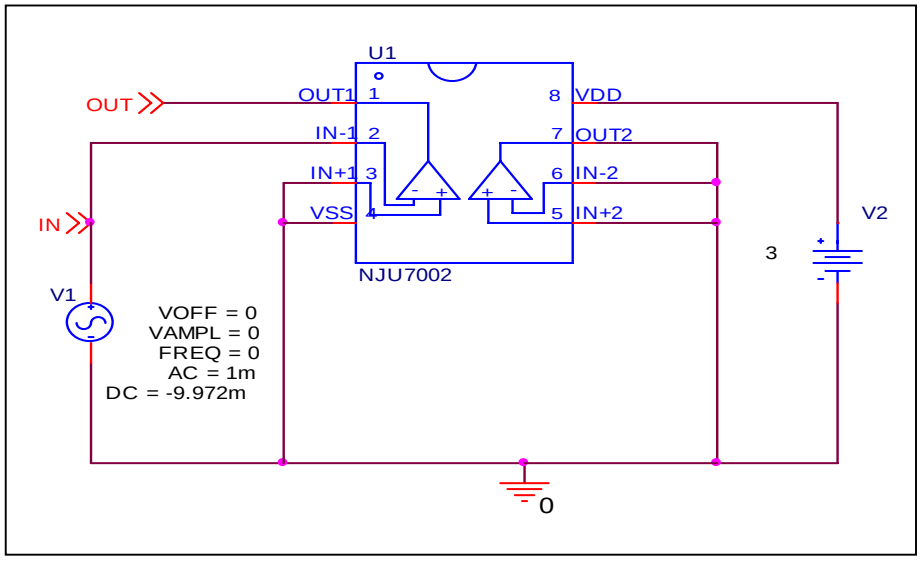
	Measurement	Simulation	%Error
V_{OS} (mV)	10.000	9.972	-0.280

Open loop Voltage Gain

Simulation result



Evaluation Circuit

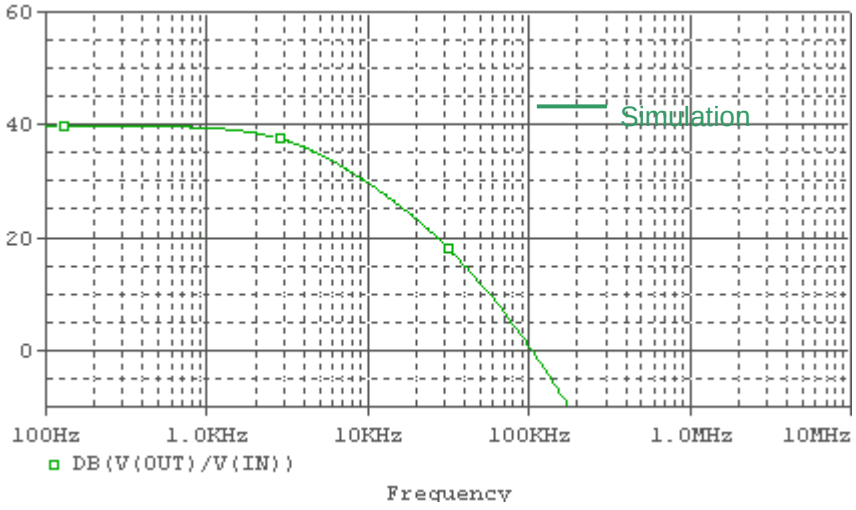


Compasion Table

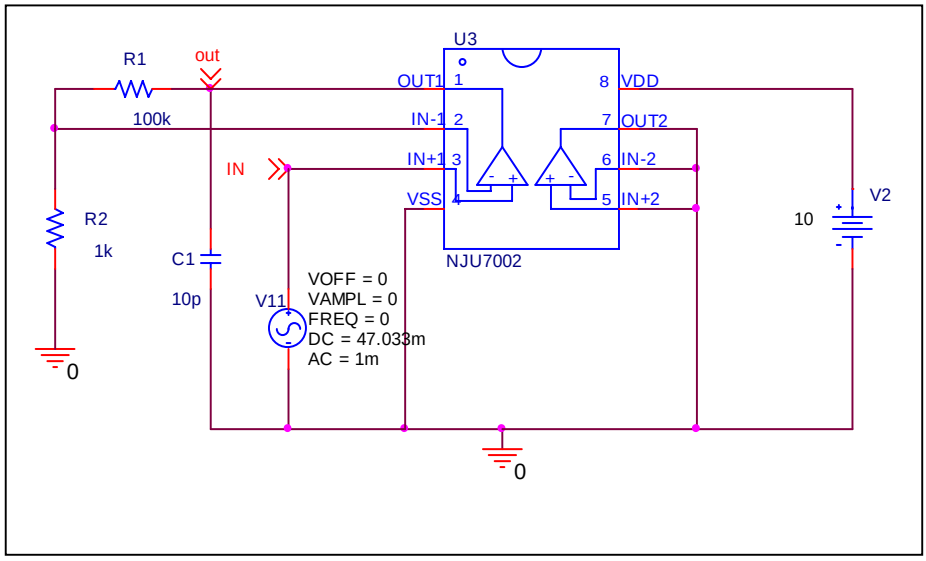
	Measurement	Simulation	%Error
Av (dB)	90.000	90.000	0

Unity Gain Frequency

Simulation result



Evaluation Circuit

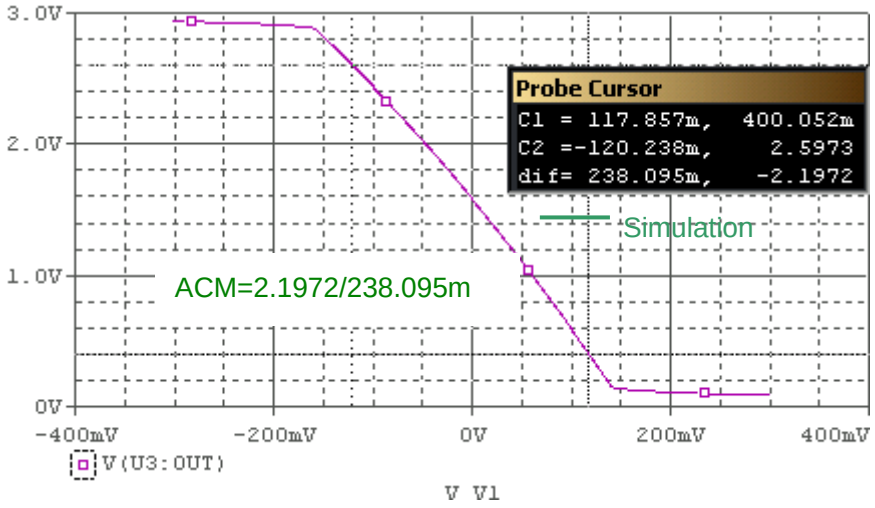


Compasion Table

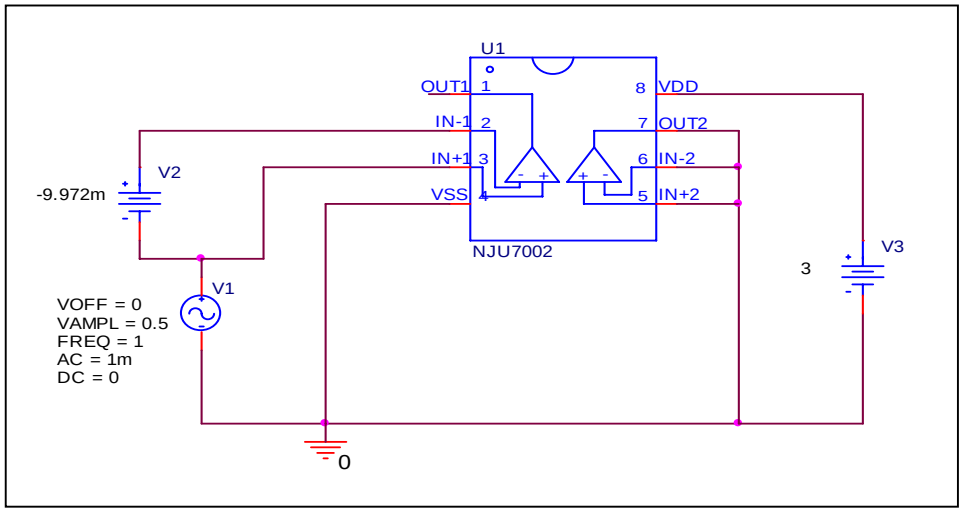
A_V=40dB,C_L=10pF	Measurement	Simulation	%Error
Ft(MHz)	0.100	0.099	-1.000

Common-Mode Rejection Ratio

Simulation result



Evaluation Circuit



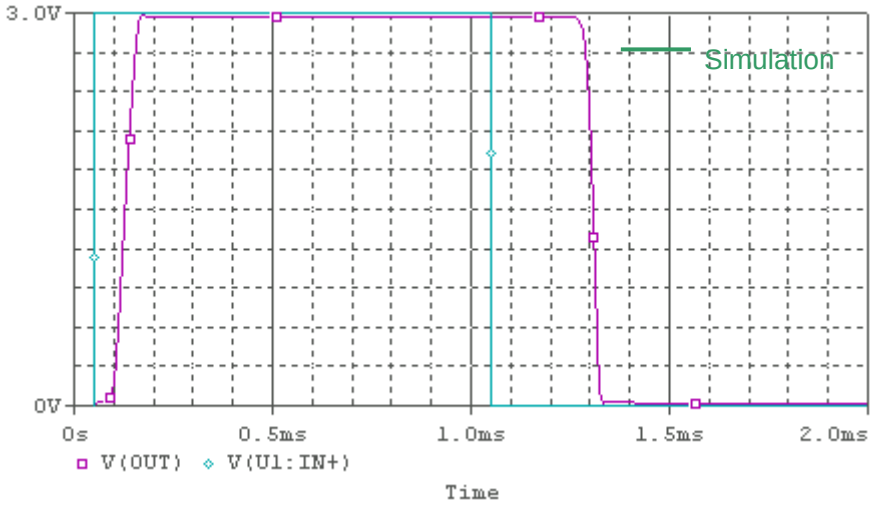
CMRR = AV/ACM

Compasion Table

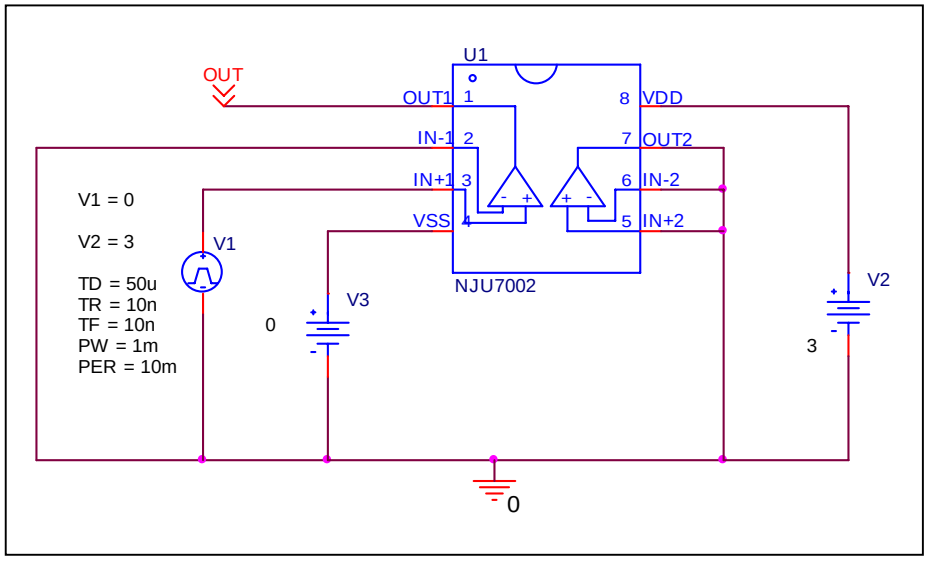
	Measurement	Simulation	%Error
CMRR (dB)	70.000	70.680	0.975

Slew Rate

Simulation result



Evaluation Circuit



	Measurement	Simulation	% Error
SR (V/us)	0.050	0.051	2.000