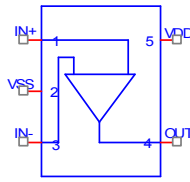# Device Modeling Report

COMPONENTS : OPERATIONAL AMPLIFIER (CMOS)
PART NUMBER : NJU7092A
MANUFACTURER : NEW JAPAN RADIO

Bee Technologies Inc.

Spice Model


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*$
*PART NUMBER: NJU7092A
*MANUFACTURER: NEW JAPAN RADIO
*CMOS OPAMP
*All Rights Reserved Copyright (c) Bee Technologies Inc. 2005
.SUBCKT nju7092a     IN+ VSS IN- OUT VDD
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=3.2m     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 IN-   26p
C2          1 2 100p
R1          11 VSS   1.522k
R2          IN1 VSS 2.0k
R3          IN2 VSS   2.423k
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=0.165 VTO=1 RS=10.000E-3
+ RD=10.000E-3 RDS=1.0000E6 TOX=2.0000E-6 CGSO=1.00E-12
+ CGDO=5.000E-12 CBD=5.000E-12 RG=5 RB=1.0000E-3 KP=10E-6)
.model MbreakND2 NMOS (LEVEL=3 L=6u W=0.732m 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=1.000E-12
+ CGDO=1.000E-12 CBD=1.000E-12 RG=5 RB=1.0000E-3 KP=10E-6)
.model MbreakPD PMOS (LEVEL=3 L=6u W=0.23 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=0.0334 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=0.001 VTO=-1.4
+ RS=10.000E-3 RD=10.00E-3 RDS=1.025e6 TOX=2.0000E-6 CGSO=1.000E-9
+ 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=0.0010787 VTO=-1.4
+ RS=10.000E-3 RD=10.00E-3 RDS=1.00E6 TOX=2.0000E-6
+ CGSO=2.000E-8 CGDO=1.000E-12 CBD=1.00E-12 RG=5
+ RB=1.0000E-3 KP=1E-6)
.ENDS nju7092a
.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

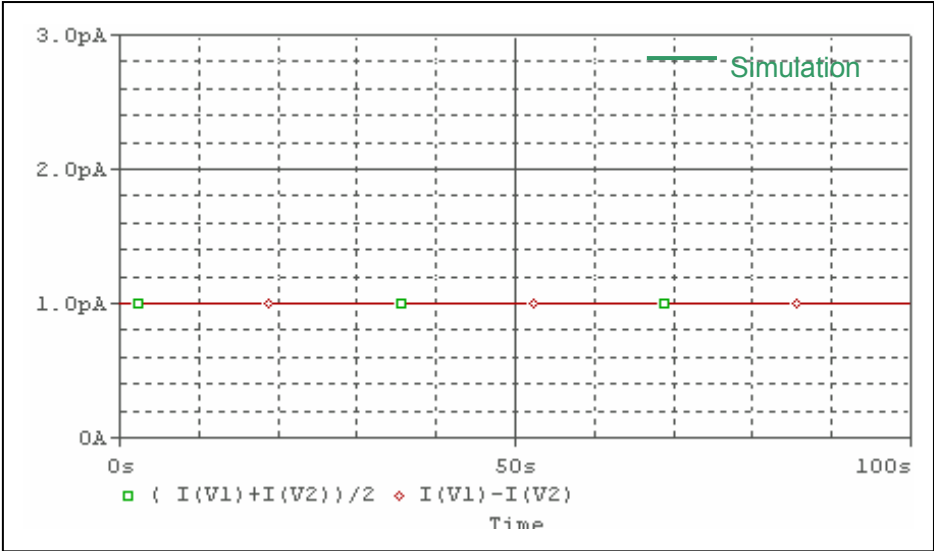# Output Voltage Swing
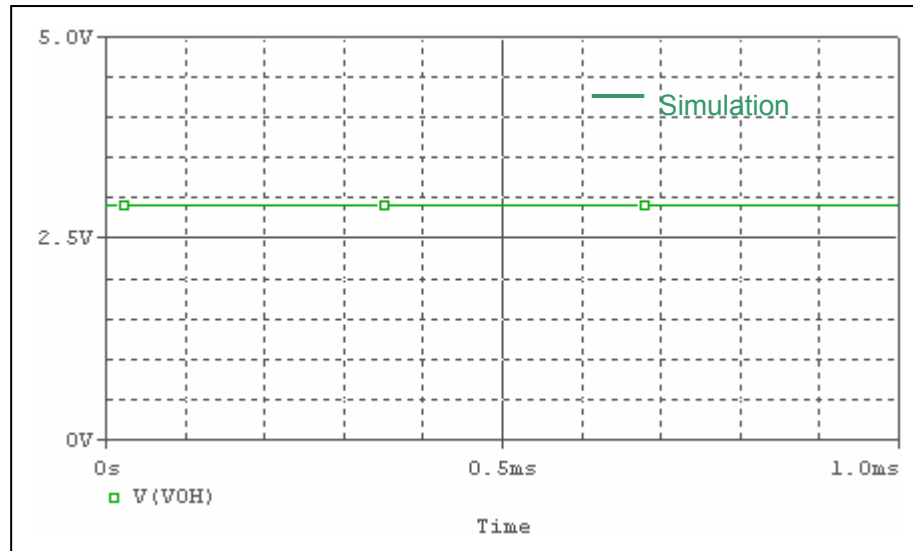
Evaluation Circuit
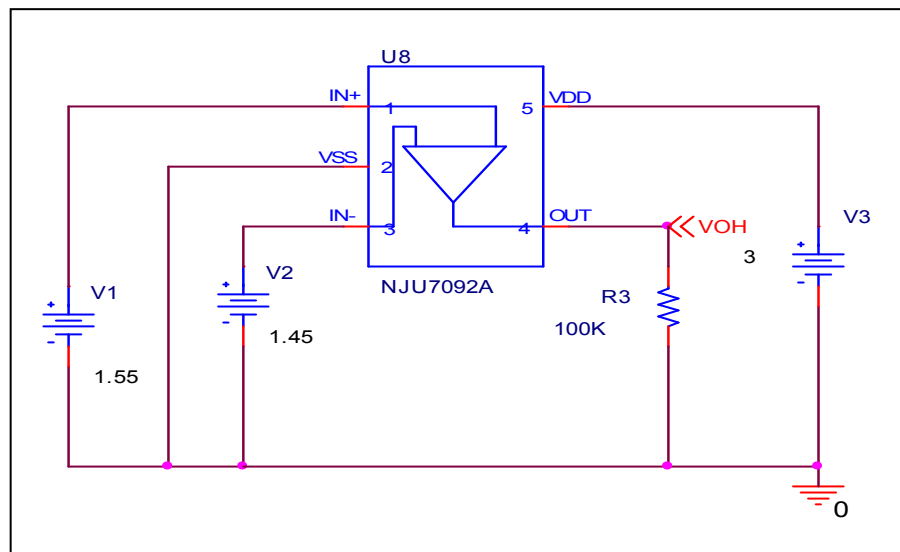
VIN+ = (VDD/2) + 0.05,   VIN- = (VDD/2) - 0.05

Comparison Table

	Measurement	Simulation	%Error
V_{OM} (V)	2.9	2.9	0

Input Current
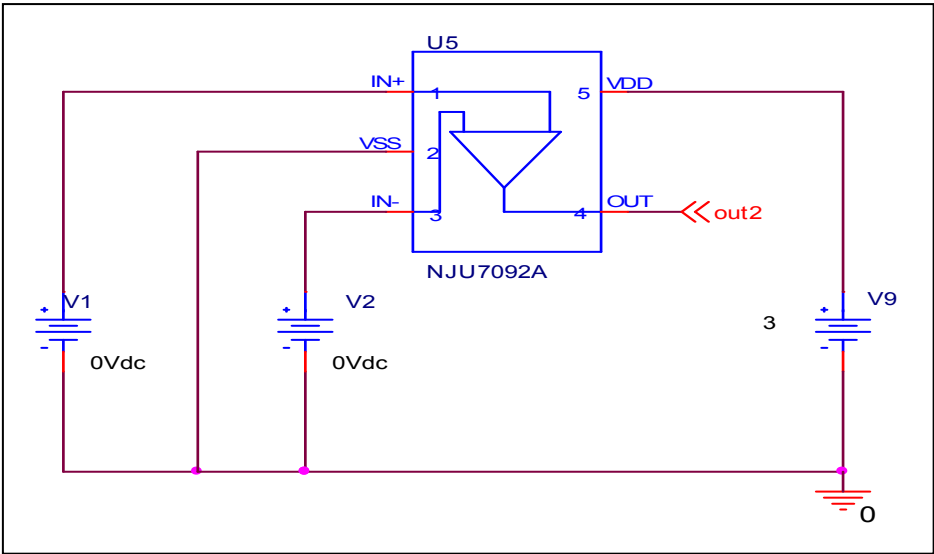
	Measurement	Simulation	% Error
I_b (pA)	1	1.002	0.2
I_{OS} (pA)	1	0.994	-0.4

Input Offset Voltage

Simulation result
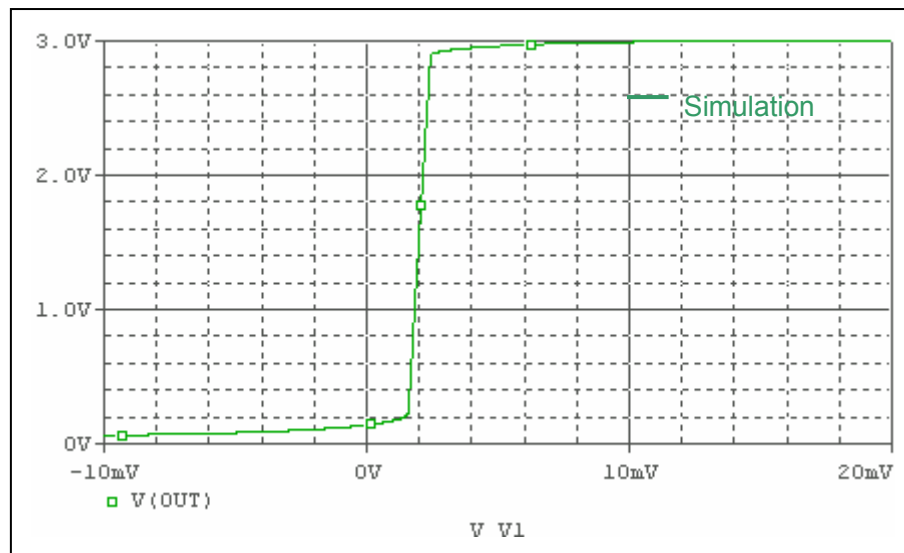
Evaluation Circuit
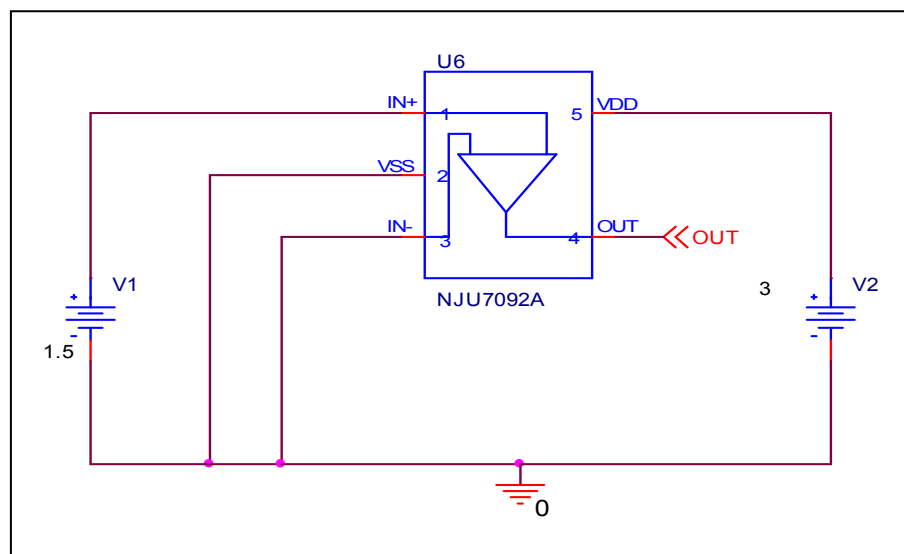
Comparison Table

	Measurement	Simulation	%Error
V$_{OS}$ (mV)	2	1.994	-0.3

Open loop Voltage Gain
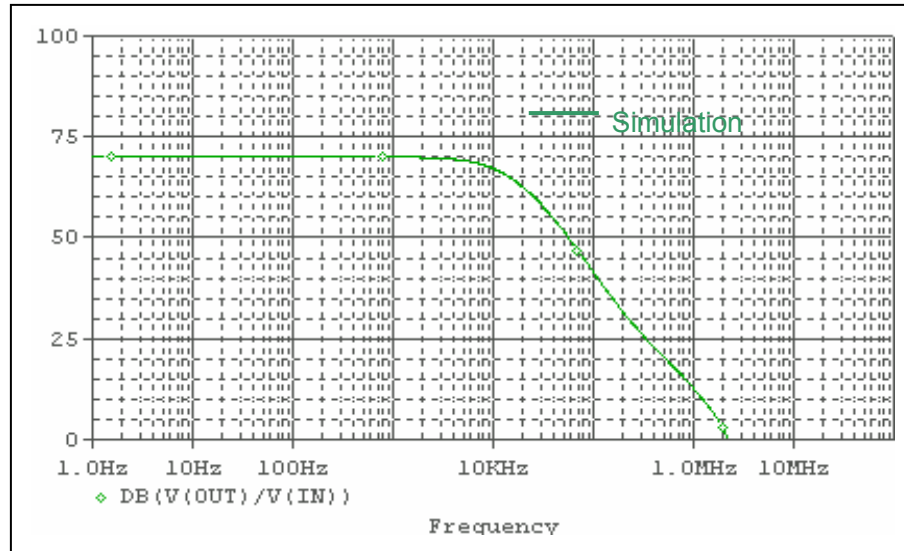
Evaluation Circuit
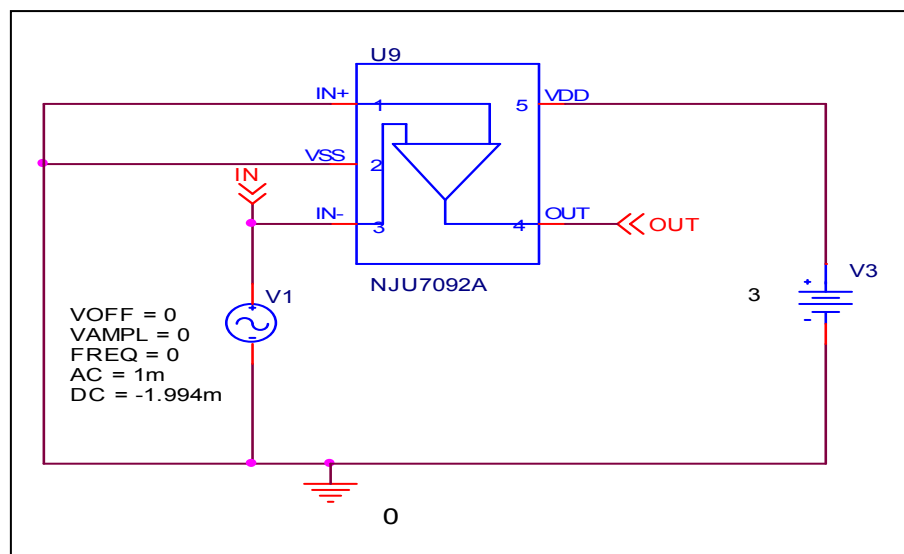
Comparison Table

	Measurement	Simulation	%Error
Av (dB)	70	70.032	0.045

Unity Gain Frequency

Simulation result
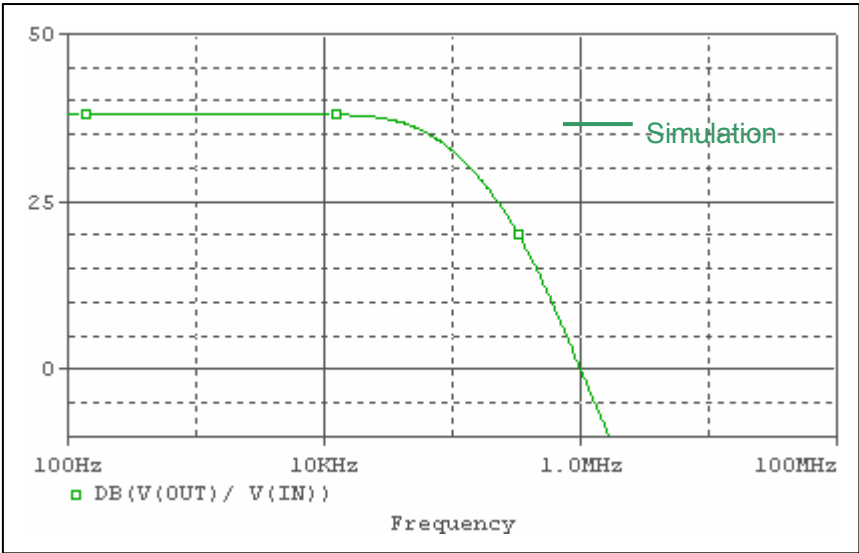
Evaluation Circuit
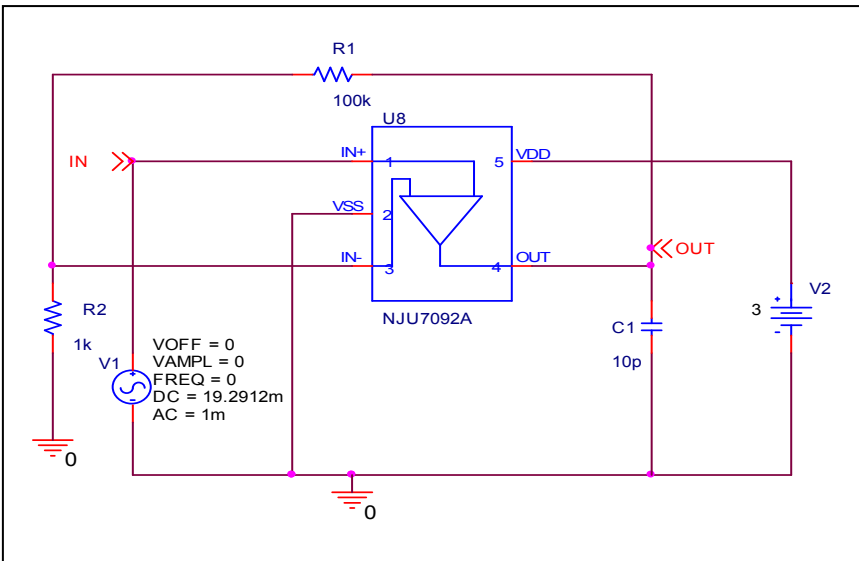
Comparison Table

A_V=40dB,C_L=10pF	Measurement	Simulation	%Error
Ft(MHz)	1	1	0

Common-Mode Rejection Ratio

Simulation result

ACM=500.068m/281.333m
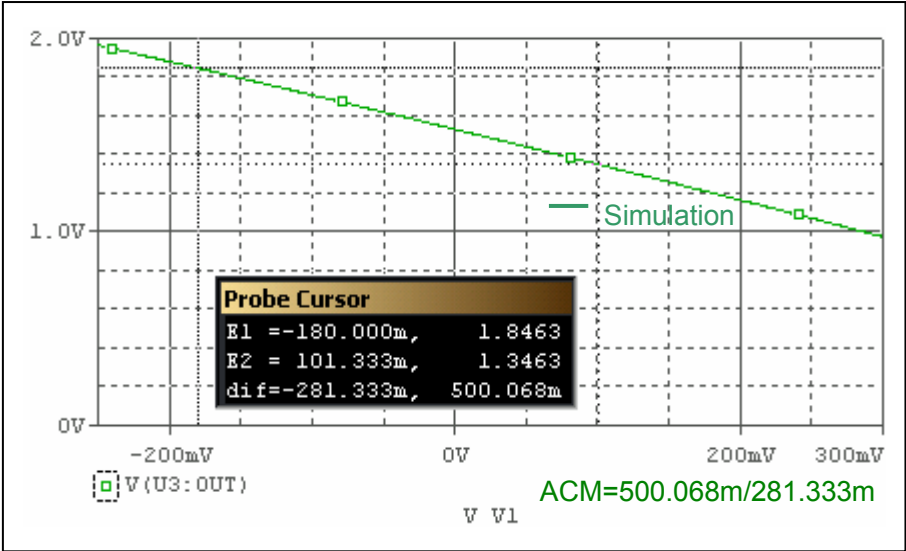
Evaluation Circuit
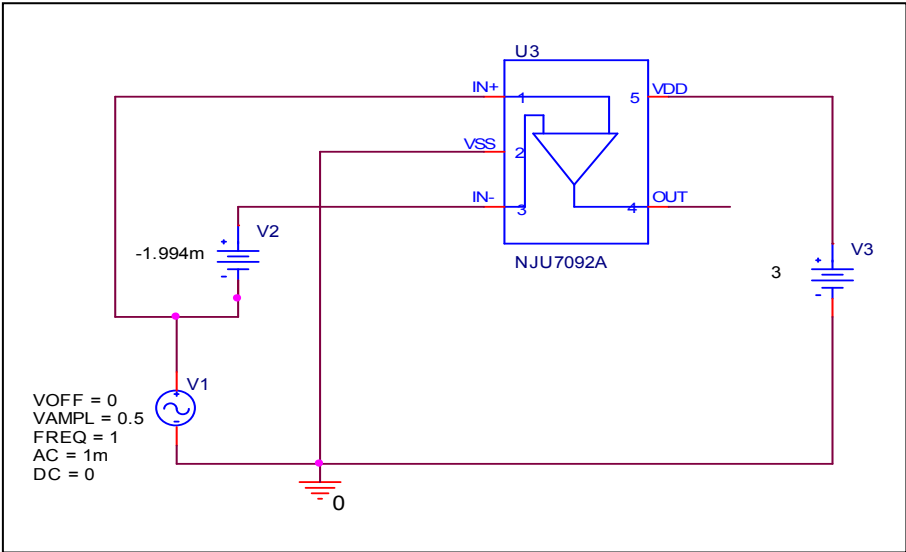
CMRR   = AV/ACM

Comparison Table

	Measurement	Simulation	%Error
CMRR (dB)	65	65.038	0.058

Slew Rate

Simulation result

Evaluation Circuit


```
V1 = 0
V2 = 3
TD = 50u
TR = 10n
TF = 10n
PW = 1m
PER = 10m
```

U5

IN+ 1   5 VDD

VSS 2

IN- 3   4 OUT   OUT

NJU7092A

V1

3   V13

0
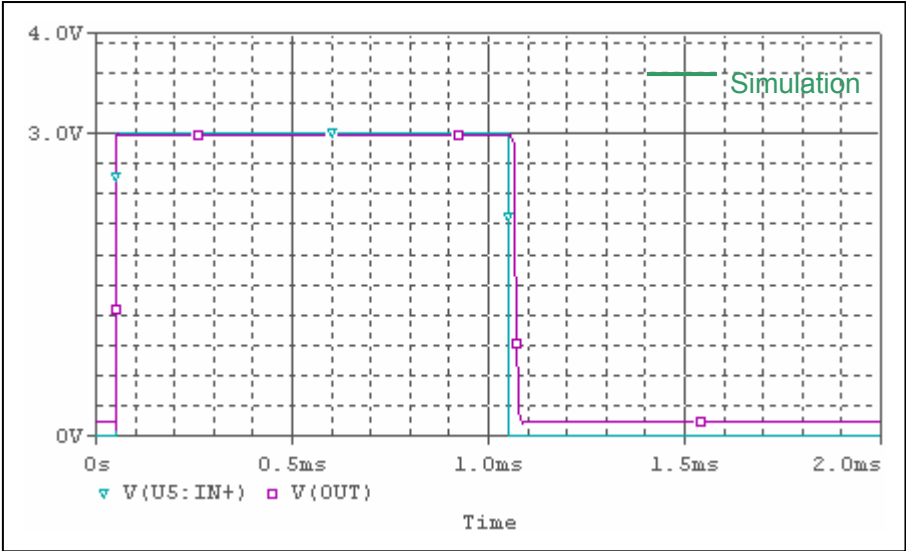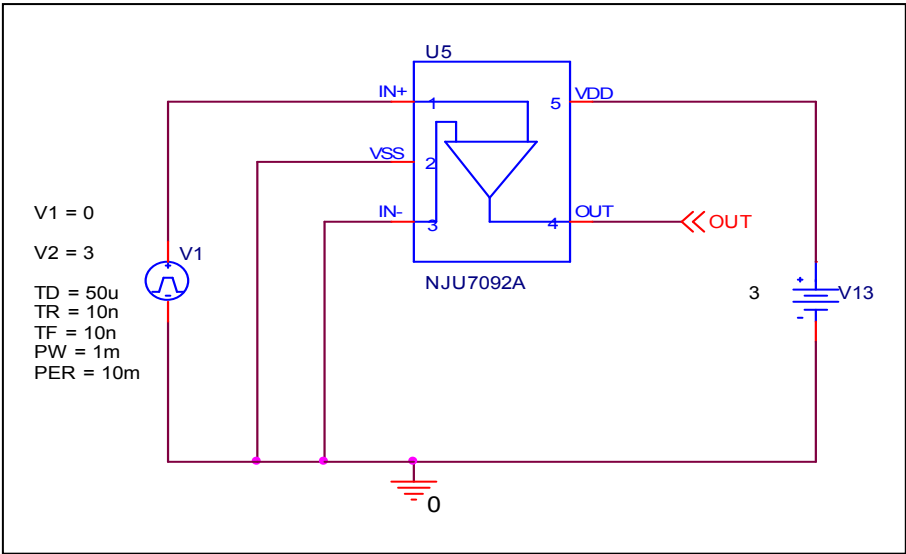
Comparison Table

	Measurement	Simulation	% Error
SR (V/us)	1	1.04	4