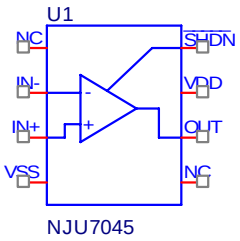
Device Modeling Report

COMPONENTS : OPERATIONAL AMPLIFIER (CMOS)
PART NUMBER : NJU7045
MANUFACTURER : NEW JAPAN RADIO
REMARK : OPERATIONAL AMPLIFIER (CMOS) WITH SHUTDOWN

Bee Technologies Inc.

Spice Model

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*PART NUMBER: NJU7045
*MANUFACTURER: NEW JAPAN RADIO
*CMOS OPAMP WITH SHUTDOWN
*All Rights Reserved Copyright (c) Bee Technologies Inc. 2006
.SUBCKT NJU7045     IN- IN+ VSS OUT VDD SHDN
ESH1                REF 0 VALUE
+ { IF(V(SHDN1)>V(VDD)*0.299,V(VDD)*0.305,V(VDD)*0.7) }
RSH1                EO SHDN1    100
CSH1                SHDN1 0    10p
RSH2                REF 0    1G
ESH2                EO 0 VALUE { IF(V(SHDN)>V(REF),V(VDD)*0.7,0) }
M1      4    IN+ 3 3 PIX L=6E-6 W=25E-6
M2      6    7 3 3 PIX L=6E-6 W=22.8E-6
RC1    4 VSS 4.833E3
RC2    6 VSS 4.833E3
C1      4    6 2E-12
I1    VDD    8 50u
M3    10    IN+ 12 12 NIX L=6E-6 W=25E-6
M4    11    7 12 12 NIX L=6E-6 W=25E-6
RC3 10 VDD 4.833E3
RC4 11 VDD 4.833E3
C2    10 11 2E-12
I2    13 VSS 50u
EOS    7    IN- POLY(3) (21,98) (73,98) (61,0) 1E-3 0.05 0.05 1
IOS1    IN+ 98 1.5E-12
IOS2    IN- 98 1.5E-12
V1    VDD    9 0.9
D1      3    9 DX
V2    14 VSS 0.9
D2    14 12 DX
S1      3    8 82 98 SOPEN
S2    VDD    8 98 82 SCLOSE
S3    12 13 82 98 SOPEN
S4    13 VSS 98 82 SCLOSE
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ECM1 20 98 POLY(2) (IN+,98) (IN-,98) 0 .5 .5
RCM1 20 21 700000
CCM1 20 21 100e-12
RCM2 21 98 14.3k
RPS1 70    0 1E6
RPS2 71    0 1E6
CPS1 VDD 70 1E-5
CPS2 VSS 71 1E-5
EPSY 98 72 POLY(2) (70,0) (0,71) 0 1 1
RPS3 72 73 1.59E6
CPS3 72 73 500E-12
RPS4 73 98 80
EREF 98    0 POLY(2) (VDD,0) (VSS,0) 0 .5 .5
GSY    VDD VSS POLY(1) (VDD,VSS) 20E-6 10E-7
E1 81 98 (SHDN1,VSS) 1
R1 81 82 1E3
C3 82 98 0.98E-9
VN1 60 0 0
RN1 60 0 16.45E-3
HN    61 0 VN1 30
RN2 61 0 1
G2    98 30 POLY(2) (4,6) (10,11) 0 145u 145u
R2    30 98 5.066E6
CF    OUT 30 24E-12
S5    30 98 98 82 SCLOSE
D3    30 31 DX
D4    32 30 DX
V3    VDD 31 1.37
V4    32 VSS 1.37
M5    OUT 46 VDD VDD POX L=1.5E-6 W=435u
M6    OUT 47 VSS VSS NOX L=1.5E-6 W=435u
EG1 VDD 48 POLY(1) (98,30) 0.78925 1
EG2 49 VSS POLY(1) (30,98) 0.78925 1
RG1 48 46 10E3
RG2 49 47 10E3
S6    46 VDD 98 82 SCLOSE
S7    47 VSS 98 82 SCLOSE
ROUT OUT 0 12.5MEG
COUT OUT 10 5000F
.model nix nmos (vto=0.75 kp=205.5u rd=1 rs=1 rg=1 rb=1
+ cgso=4e-9 cgdo=4e-9 cgbo=3.667e-6 cbs=10.5e-5 cbd=9.5e-7)
.model nox nmos (vto=0.75 kp=195u rd=.5 rs=.5 rg=1 rb=1
+ cgso=66.667e-12 cgdo=66.667e-12 cgbo=125e-9
```

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+ cbs=2.34e-13 cbd=2.34e-13)
.model pix pmos (vto=-0.75 kp=205.5u rd=1 rs=1 rg=1 rb=1
+ cgso=4e-9 cgdo=4e-9 cgbo=76.667e-8 cbs=2.34e-12 cbd=20.534e-12)
.model pox pmos (vto=-0.75 kp=195u rd=.5 rs=.5 rg=1 rb=1
+ cgso=76.667e-9 cgdo=130.667e-10 cgbo=125e-9
+ cbs=2.34e-13 cbd=2.34e-13)
.MODEL SOPEN VSWITCH(VON=2.4,VOFF=0.8,RON=10,ROFF=1E9)
.MODEL SCLOSE VSWITCH(VON=-0.8,VOFF=-2.4,RON=10,ROFF=1E9)
.MODEL DX D(IS=1E-12)
.ENDS
*$
```
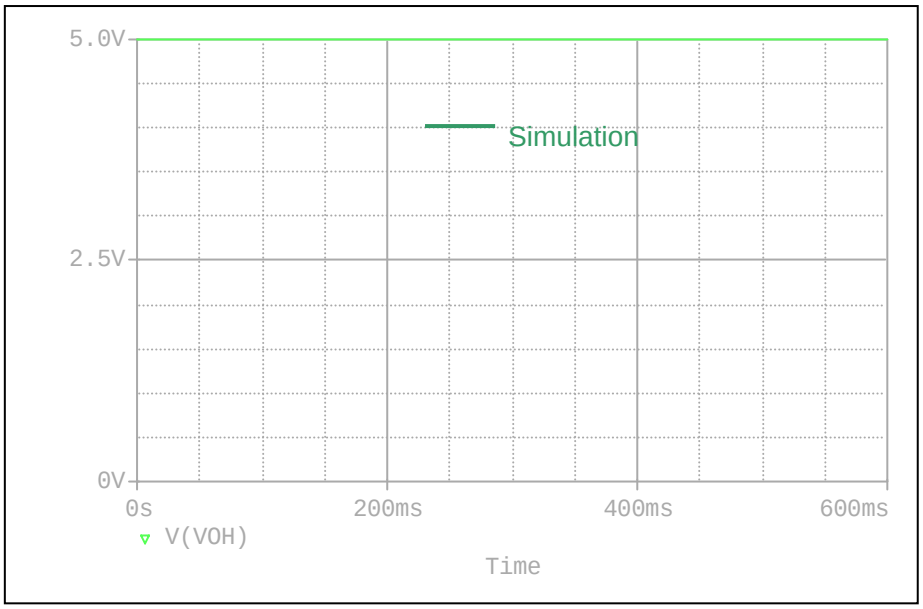

MOSFET MODEL

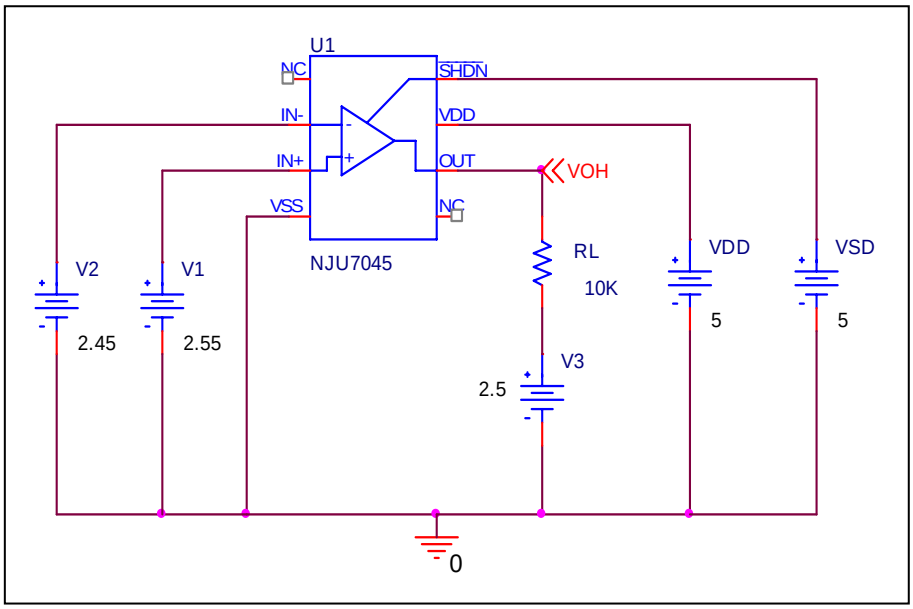
Pspice model parameter	Model description
LEVEL	
L	Channel Length
W	Channel Width
KP	Transconductance
RS	Source Ohmic Resistance
RD	Ohmic Drain Resistance
VTO	Zero-bias Threshold Voltage
RDS	Drain-Source Shunt Resistance
TOX	Gate Oxide Thickness
CGSO	Zero-bias Gate-Source Capacitance
CGDO	Zero-bias Gate-Drain 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 (V_{OH1})

Simulation result



Evaluation Circuit

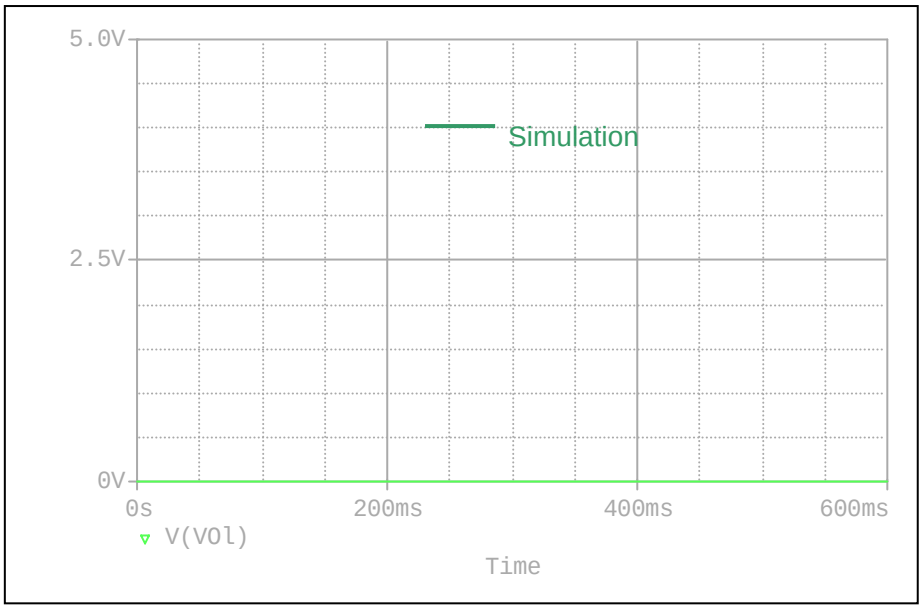


Comparison Table

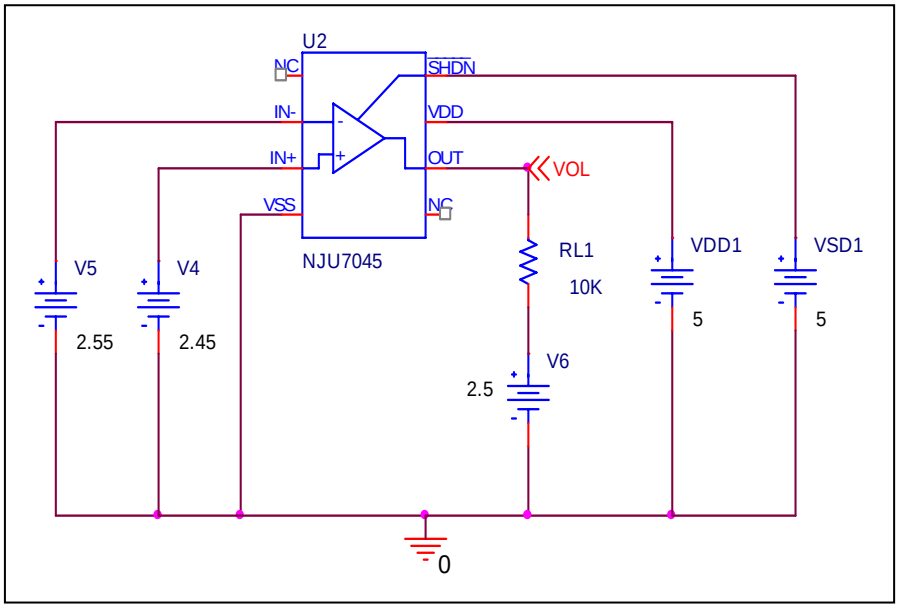
R_L=10 kΩ to 2.5 V	Measurement	Simulation	%Error
$V_{OH1\ (min)}$ (V)	4.95	4.9970	-

Output Voltage Swing (V_{OL1})

Simulation result



Evaluation Circuit

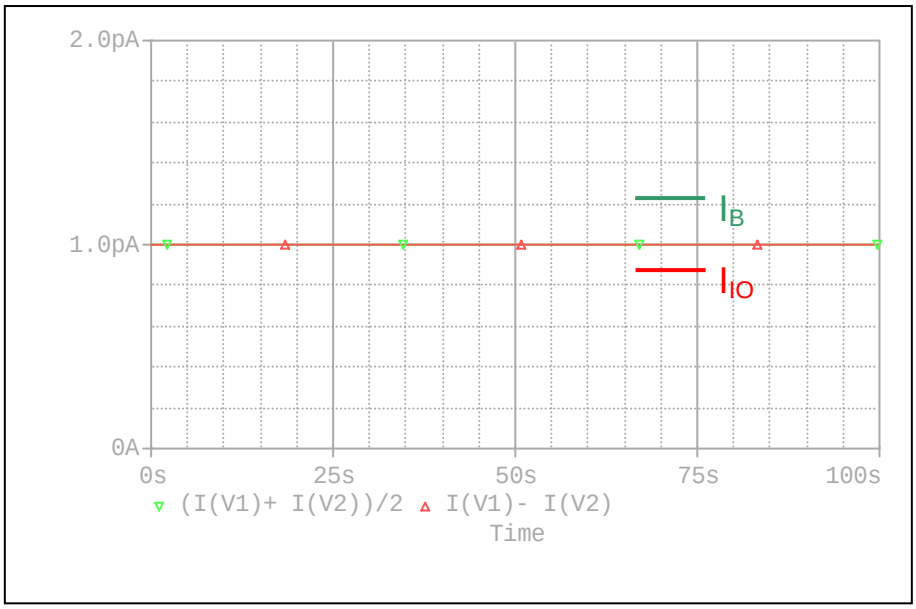


Comparison Table

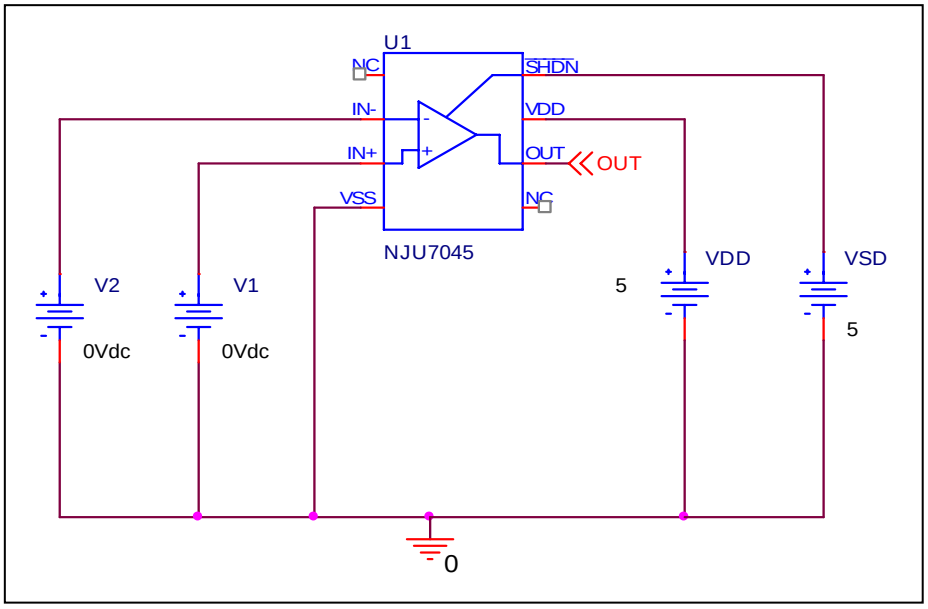
R_L=10 kΩ to 2.5 V	Measurement	Simulation	%Error
$V_{OL1\ (MAX)}$ (mV)	50	2.9879	-

Input Current

Simulation result



Evaluation Circuit

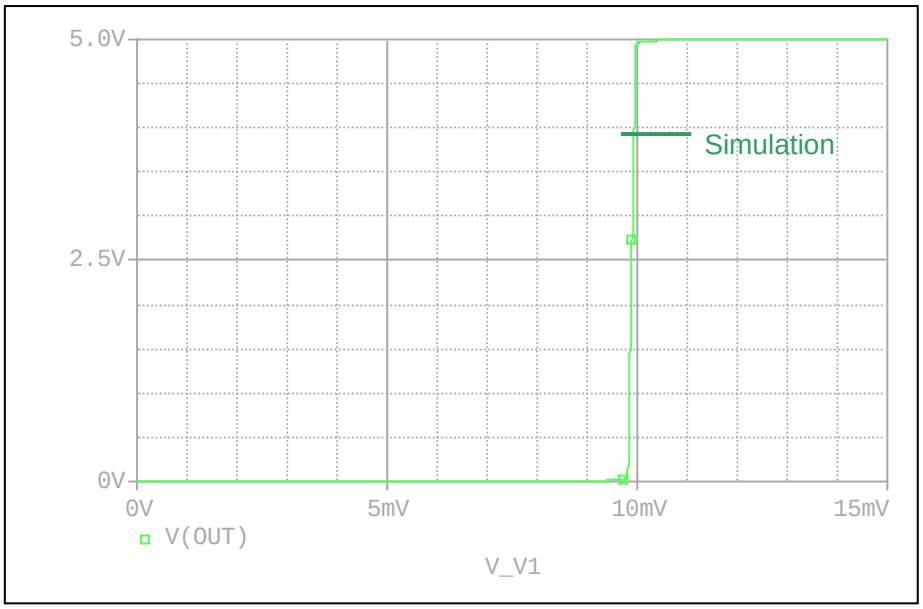


Comparison Table

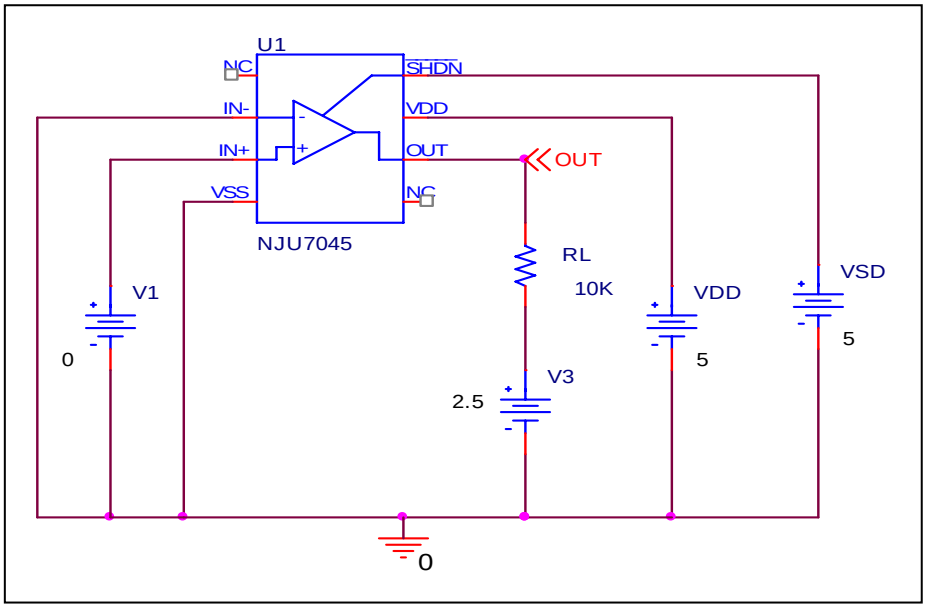
	Measurement	Simulation	% Error
I_b (pA)	1	1	0
I_{IO} (pA)	1	1	0

Input Offset Voltage

Simulation result



Evaluation Circuit

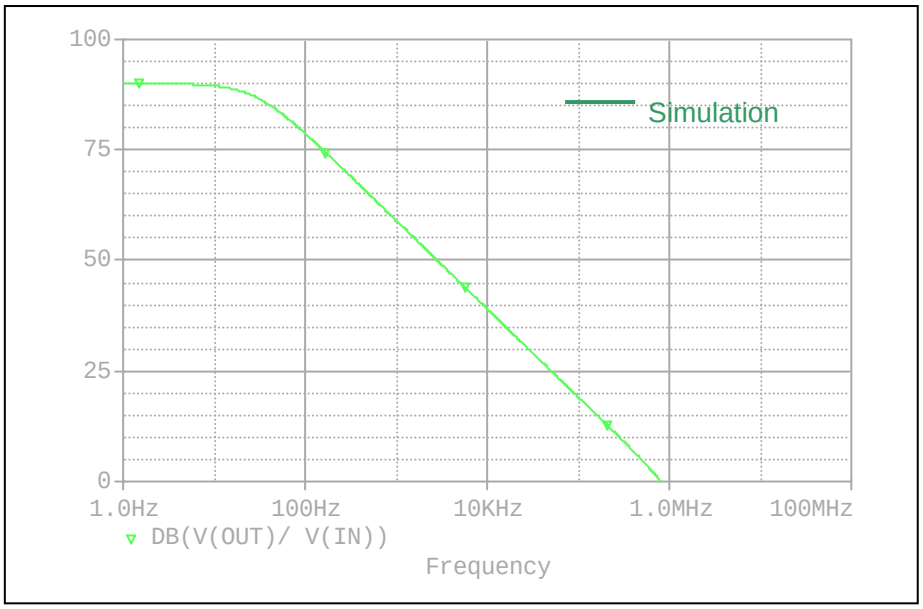


Comparison Table

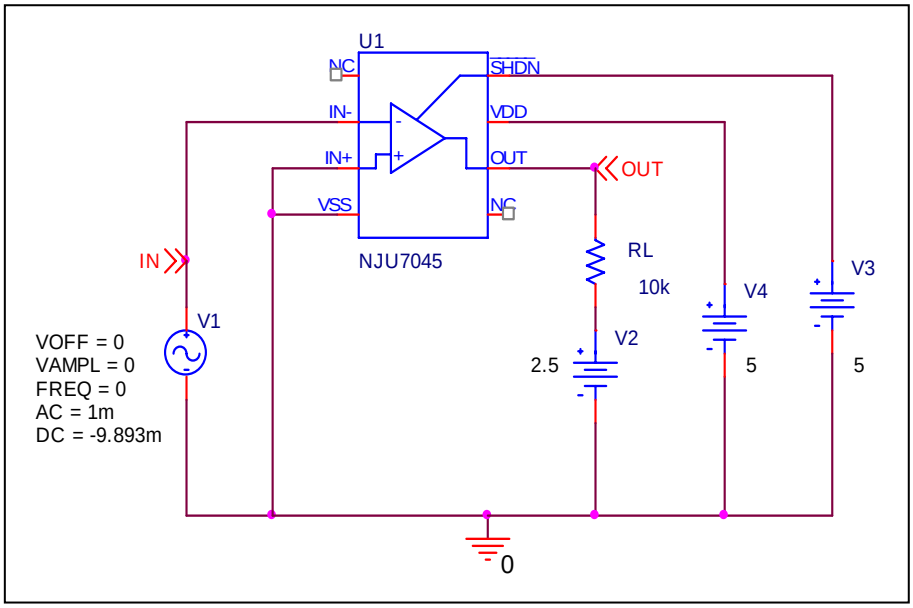
	Measurement	Simulation	%Error
V_{os} (mV)	10	9.893	-1.07

Open loop Voltage Gain

Simulation result



Evaluation Circuit

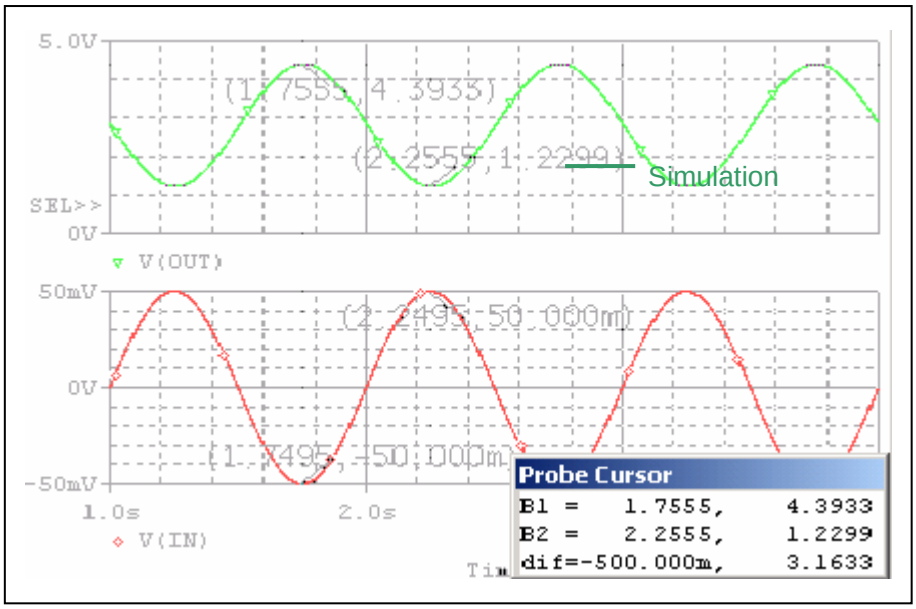


Comparison Table

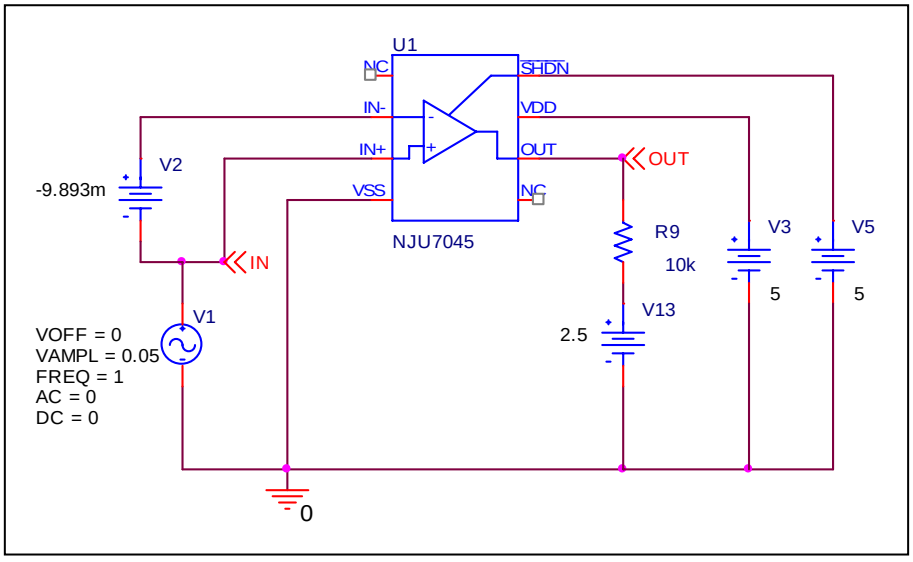
	Measurement	Simulation	%Error
AV(dB)	90	89.993	-0.008
F0-db (MHz)	0.8	0.800354	0.044

Common-Mode Rejection Ratio

Simulation result



Evaluation Circuit



CMRR = AV/ACM

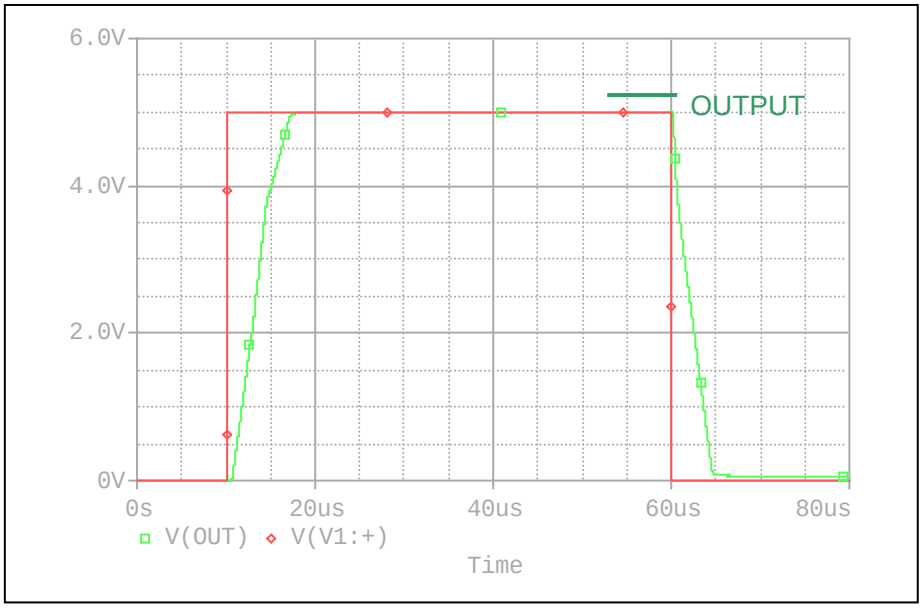
= 20* LOG(31597/(3.1633/0.1))

Comparison Table

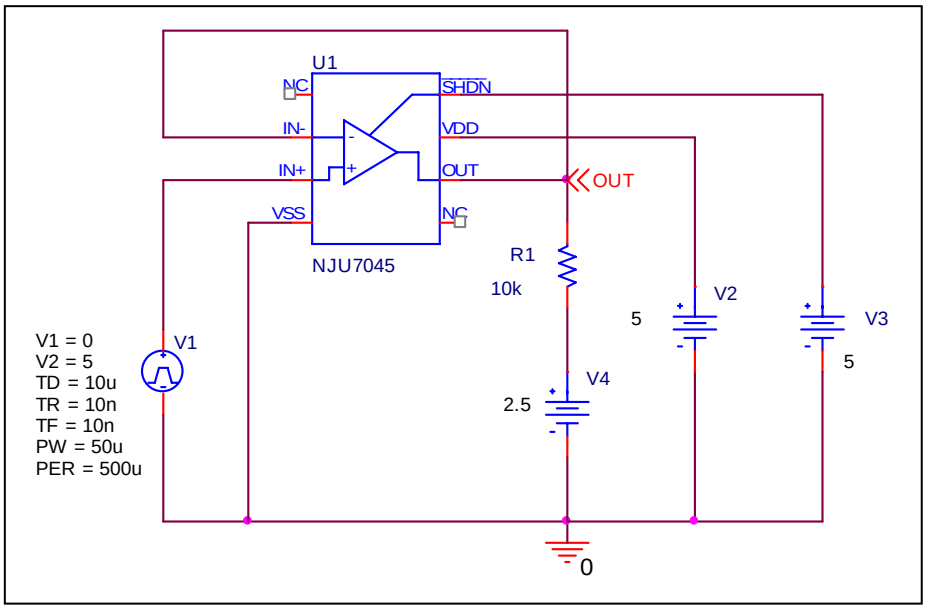
	Measurement	Simulation	%Error
CMRR (dB)	60	59.99	-0.017

Slew Rate

Simulation result



Evaluation Circuit

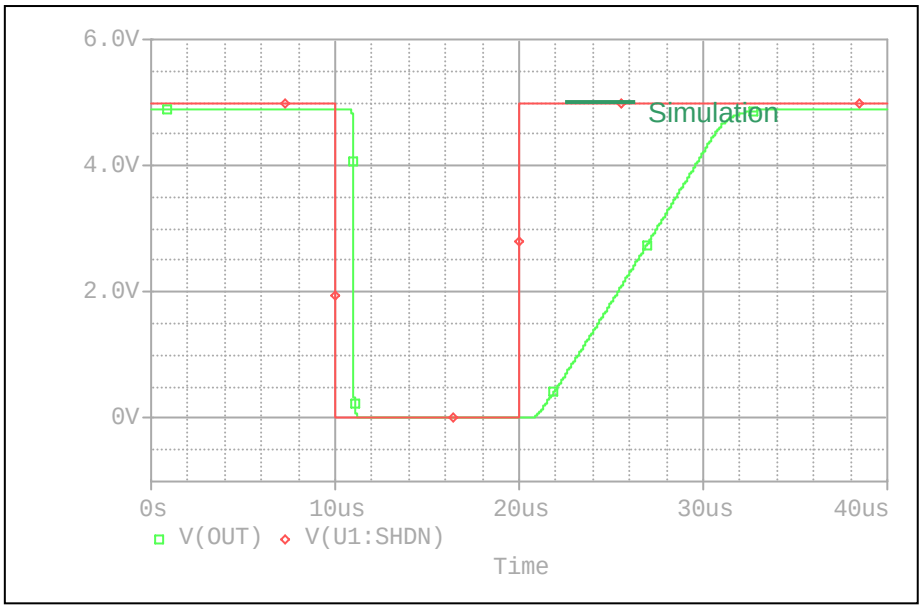


Comparison Table

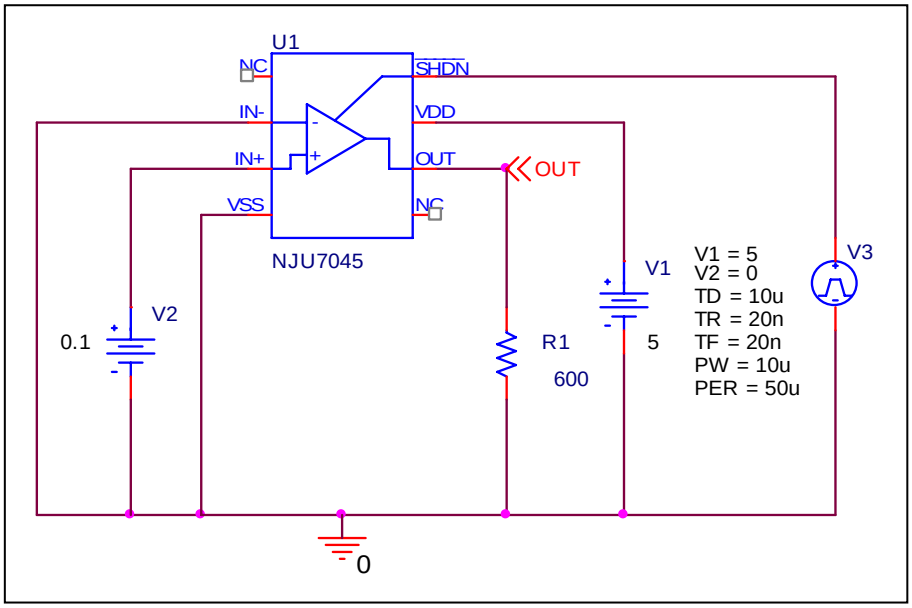
	Measurement	Simulation	%Error
SR (V/us)	0.8	0.798	-0.25

T_{OFF}/T_{ON} TIME

Simulation result



Evaluation Circuit

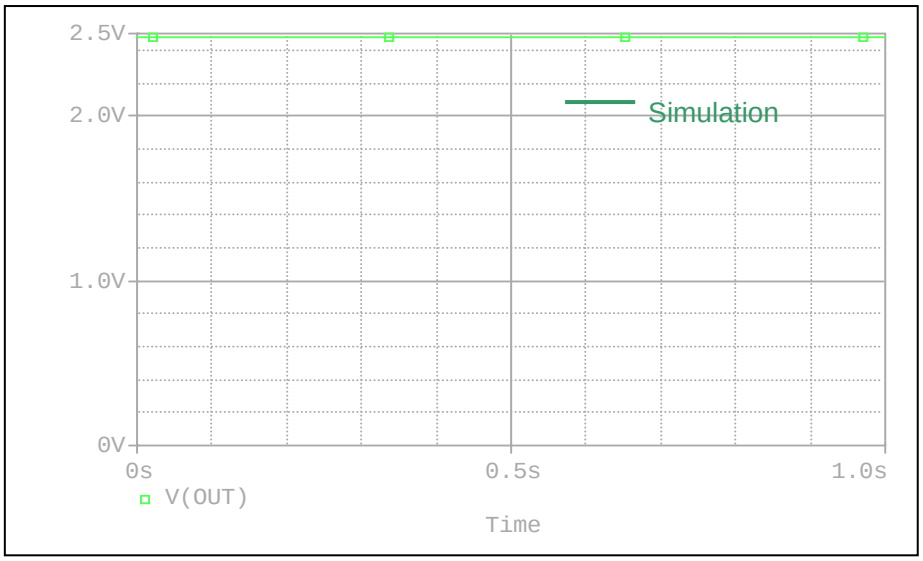


Comparison Table

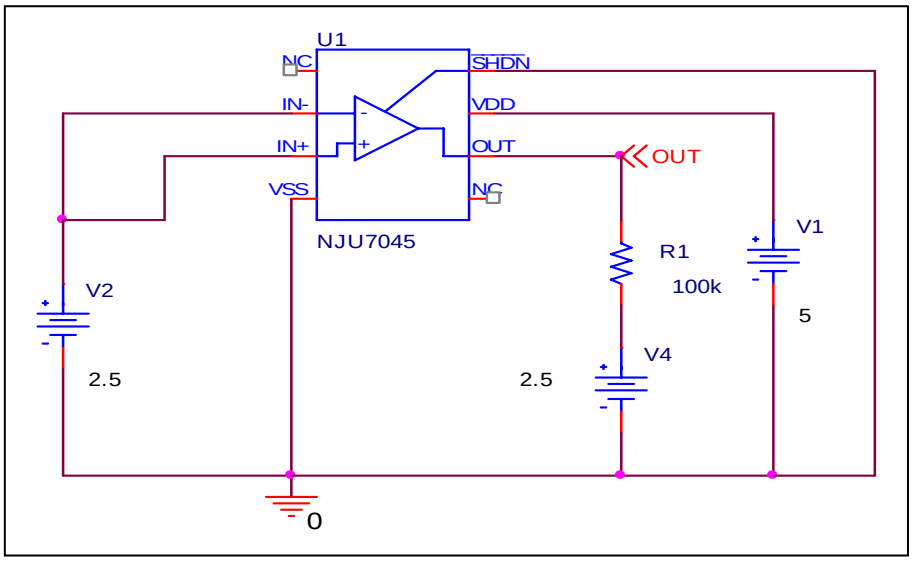
	Measurement	Simulation	%Error
T_{OFF} (us)	1	1.0159	1.590
T_{ON} (us)	10	10.172	1.720

Leak Current

Simulation result



Evaluation Circuit

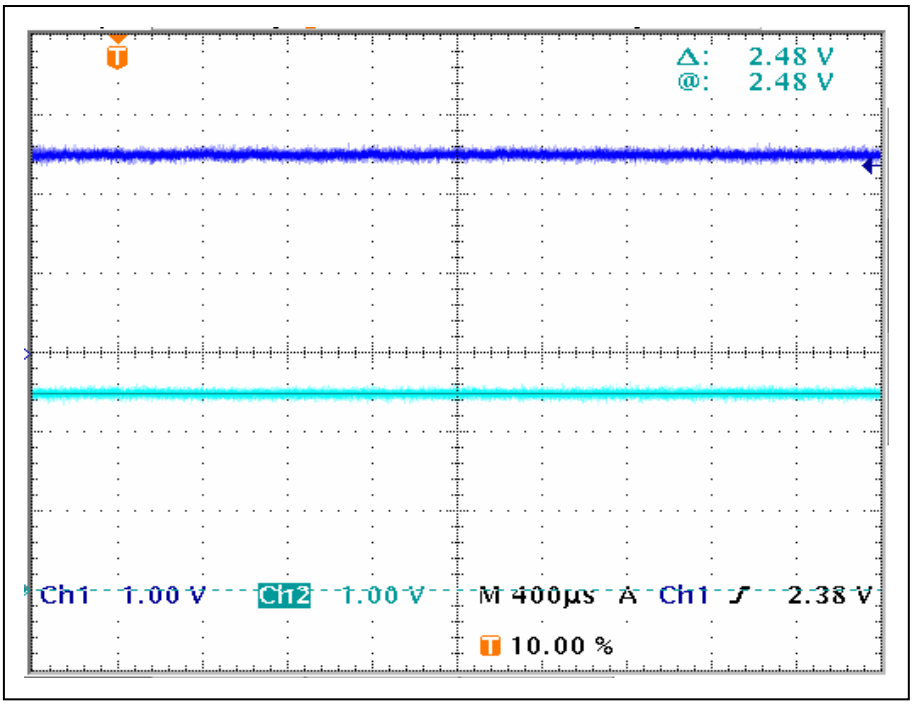


$$I_{LEAK} = \frac{V_{OUT} - 1/2V_{DD}}{R_L} = \frac{2.4802 - 2.5}{100K}$$

Comparison Table

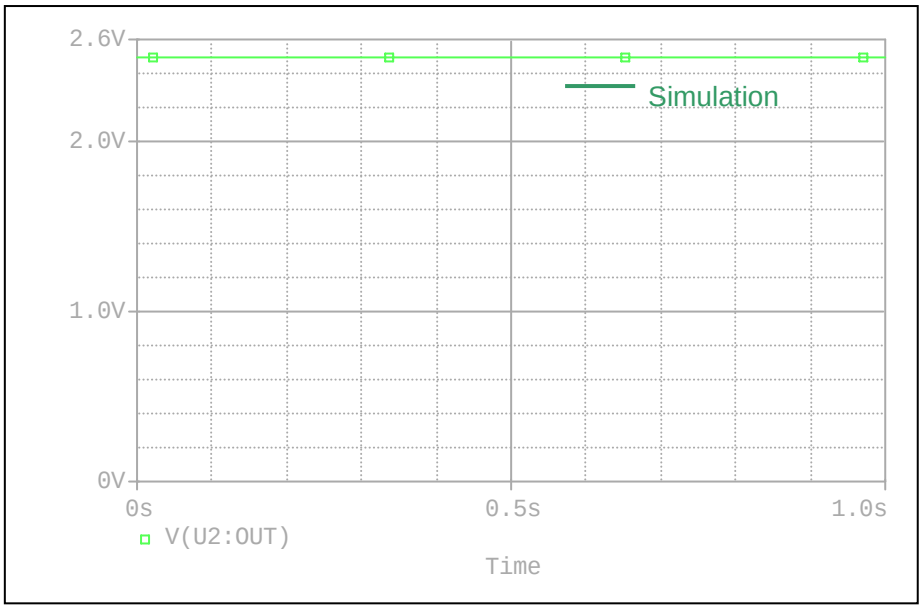
	Measurement	Simulation	%Error
$I_{LEAK\ (MAX)}$ (uA)	± 3	-0.2	-

Reference

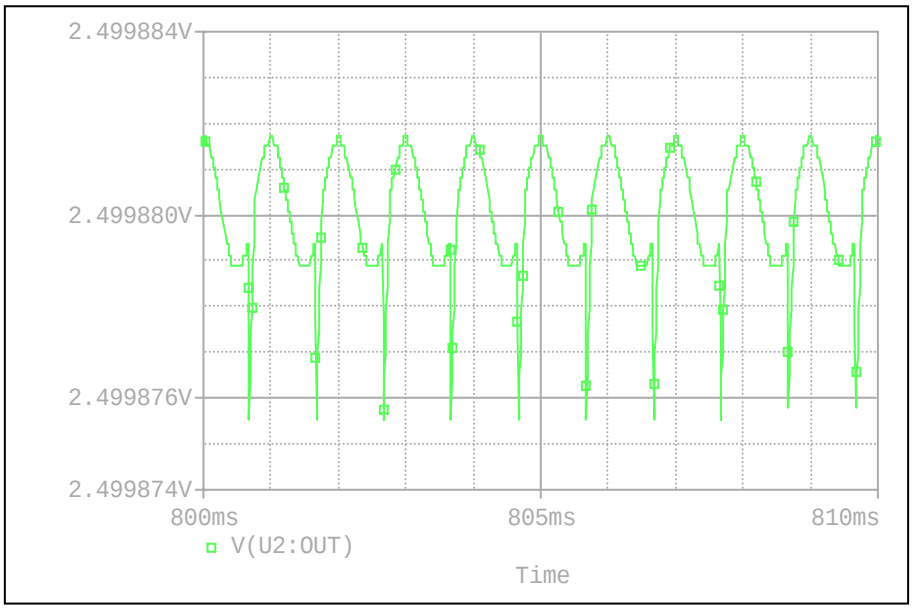


Mute Level

Simulation result



Simulation result zoom up



Calculation Mute Level

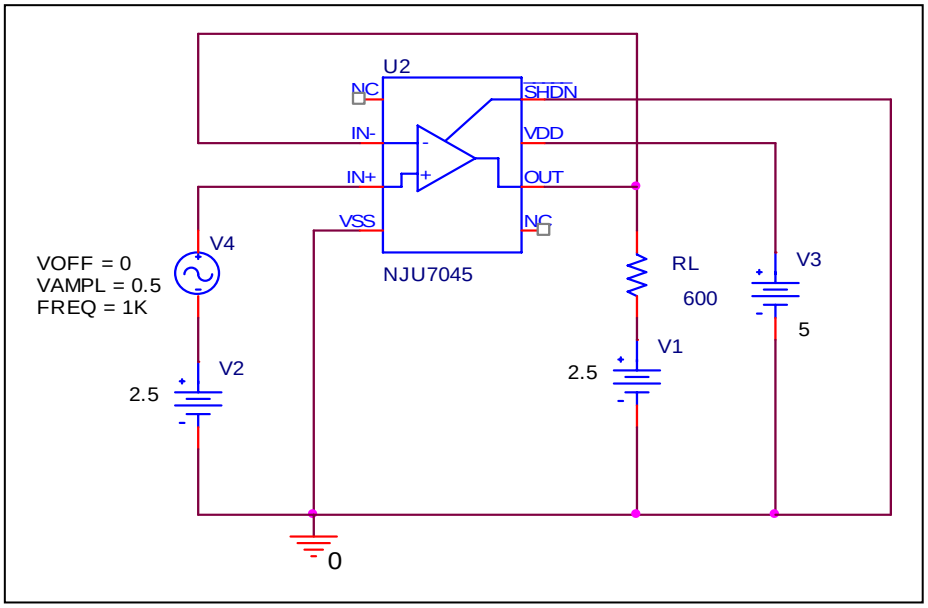
Mute Level = V_{OUT} / V_{IN}

= 20* LOG(6.1989u / 1)

Comparison Table

V_{IN}=1V_{PP},f=1kHz	Measurement	Simulation	%Error
MUTE	-100	-104.153	4.153

Evaluation Circuit



Reference