

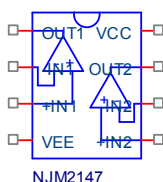
# Device Modeling Report

COMPONENTS:MOSFET: OPERATIONAL AMPLIFIER  
PART NUMBER:NJM2147  
MANUFACTURER: NEW JAPAN RADIO CO.,LTD



**Bee Technologies Inc.**

## SPice Model



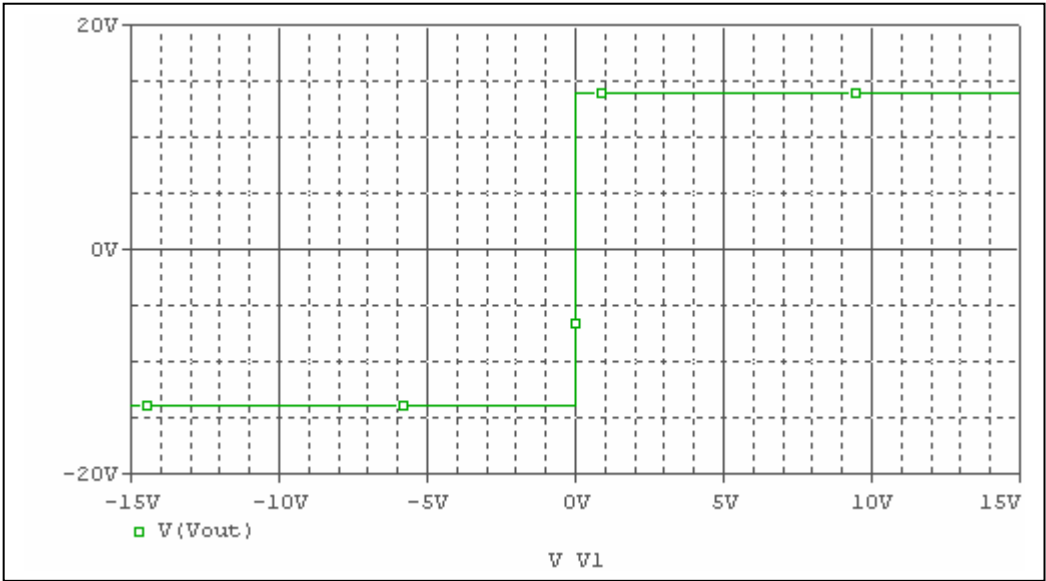
```

*$
* PART NUMBER:NJM2147
* MANUFACTURER: NEW JAPAN RADIO
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.Subckt NJM2147 OUT1 -IN1 +IN1 VEE +IN2 -IN2 OUT2 VCC
X_U1  +IN1 -IN1 VCC VEE OUT1 NJM2147_SUB
X_U2  +IN2 -IN2 VCC VEE OUT2 NJM2147_SUB
.ends  NJM2147
*$
.subckt NJM2147_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 4.8459E6 -1E3 1E3 4E6 -4E6
ga  6 0 11 12 207.35E-6
gcm 0 6 10 99 6.5569E-9
iee 3 10 dc 15.030E-6
hlim 90 0 vlim 1K
q1  11 2 13 qx1
q2  12 1 14 qx2
r2  6 9 100.00E3
rc1 4 11 4.8229E3
rc2 4 12 4.8229E3
re1 13 10 1.3716E3
re2 14 10 1.3716E3
ree 10 99 13.307E6
ro1 8 5 50
ro2 7 99 25
rp  3 4 1.8016E3
vb  9 0 dc 0
vc  3 53 dc 1.7668
ve  54 4 dc 1.7668
vlim 7 8 dc 0
vlp 91 0 dc 5.5000
vln 0 92 dc 5.5000
.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=483.87)
.model qx2 PNP(Is=970.6100E-18 Bf=517.24)
.ends
*$

```

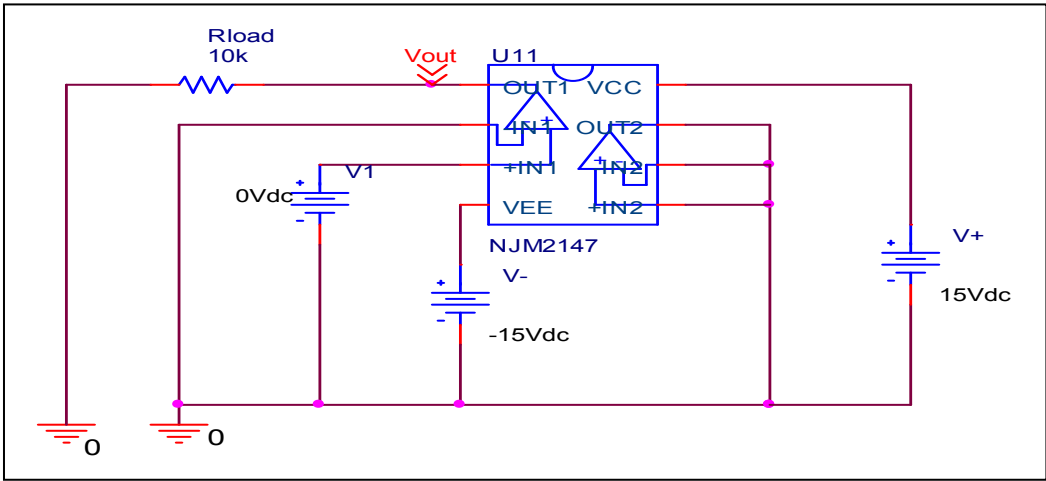
# Output Voltage Swing, +Vout and -Vout

## Simulation result



These simulation results are compared with  $\pm V_{out}$

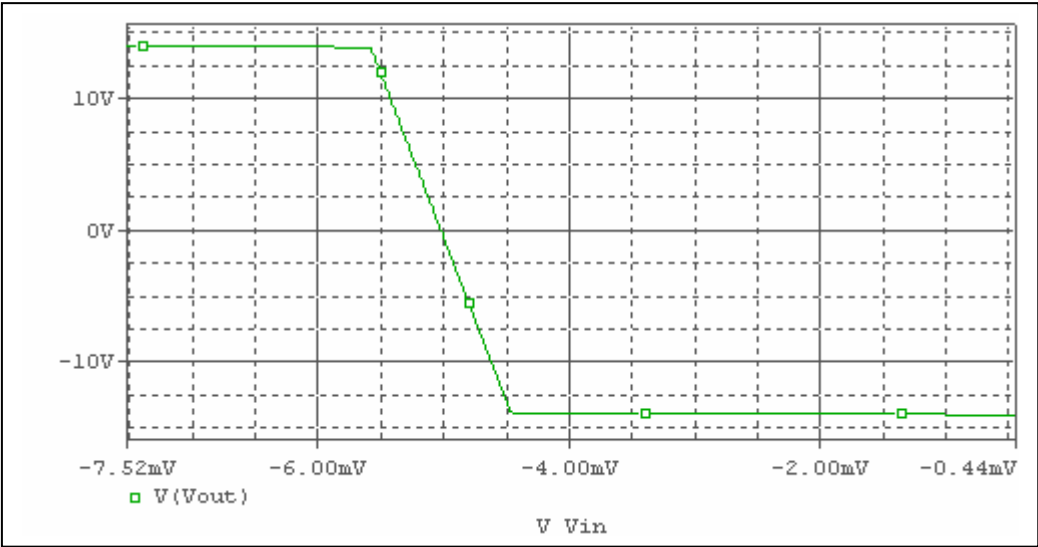
## Evaluation circuit



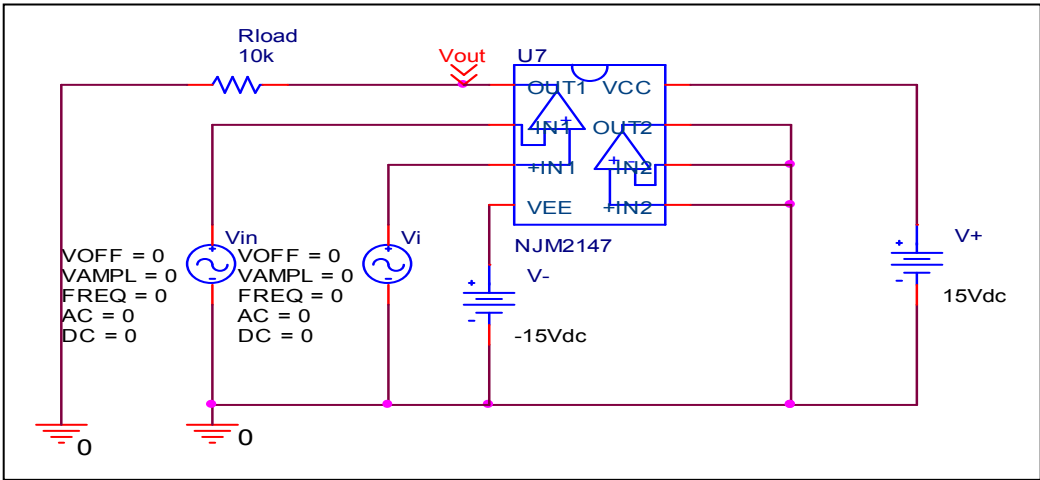
Output Voltage Swing	Data sheet	Simulation	%Error
+Vout(V)	+14	+13.994	0.042
-Vout(V)	-14	-13.994	0.042

# Input Offset Voltage

## Simulation result



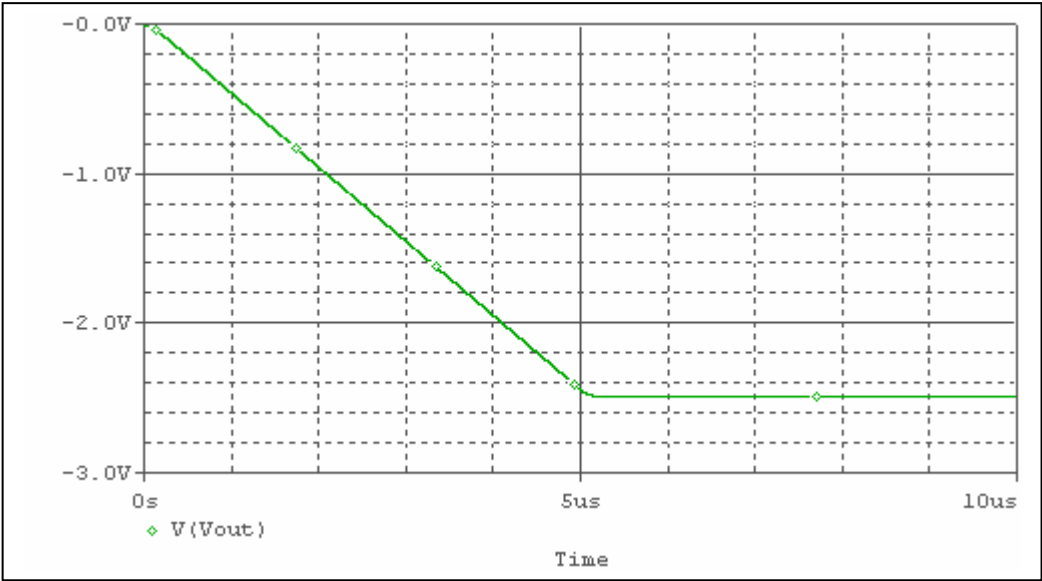
## Evaluation circuit



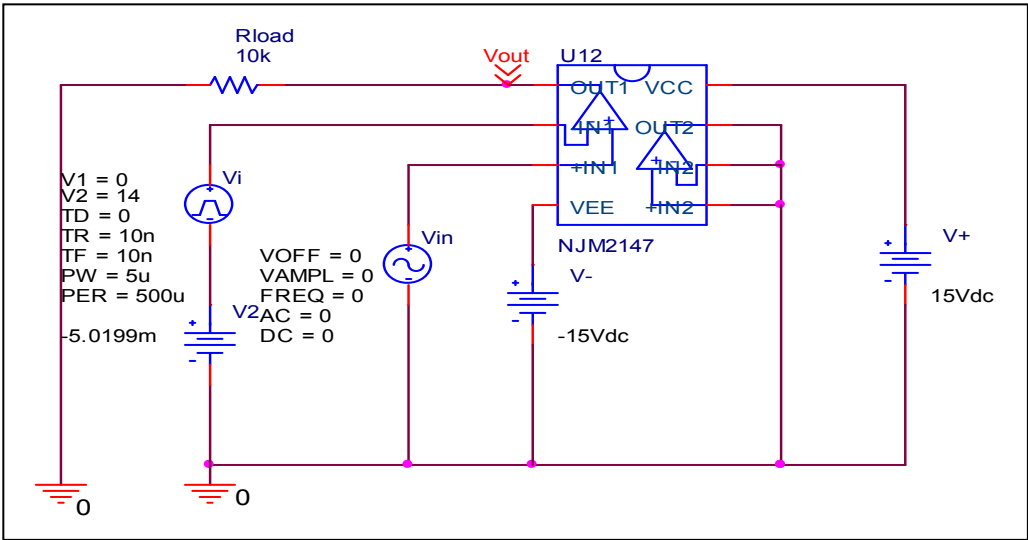
Vos	Measurement		Simulation		Error	
	5	mV	5.0199	mV	0.398	%

# Slew Rate, +SR, -SR

## Simulation result



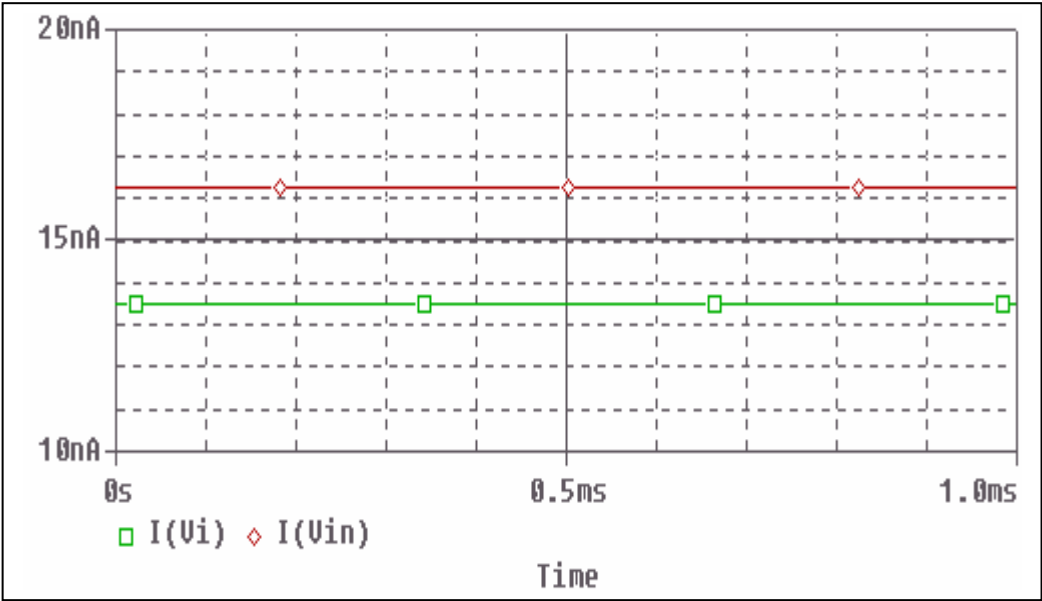
## Evaluation circuit



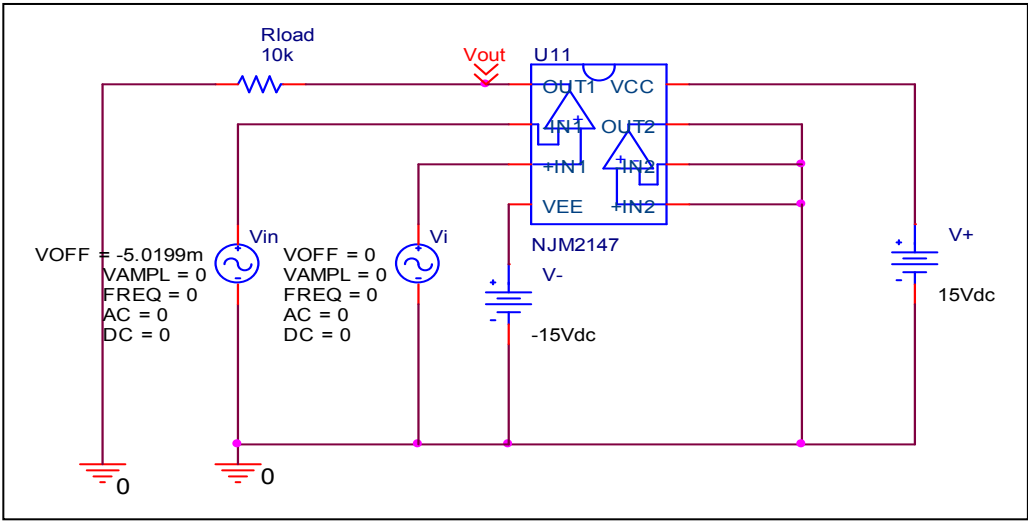
Slew Rate(v/us)	Data sheet	Simulation	%Error
	0.5V/us	0.499V/us	0.2

# Input current Ib, Ibos

## Simulation result



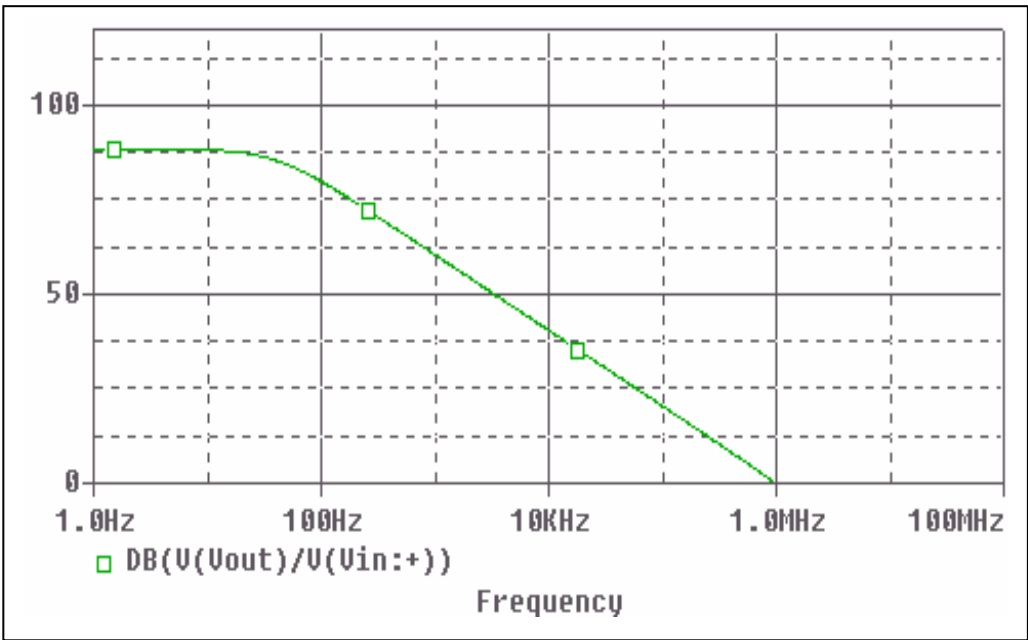
## Evaluation circuit



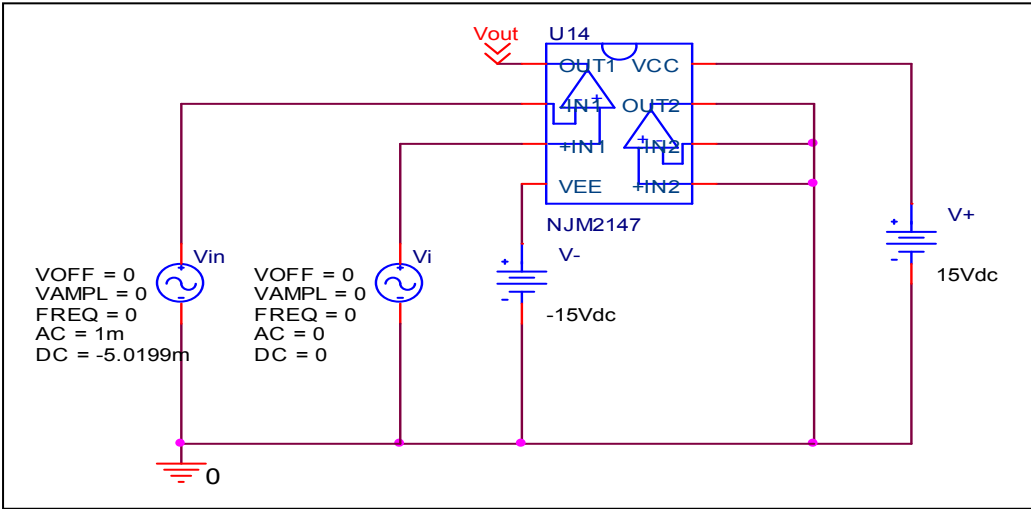
	Data sheet	Simulation	%Error
Ib(nA)	15	14.4	4
Ibos(nA)	80(Max)	2.76	-

# Open Loop Voltage Gain vs. Frequency , Av-dc, f-0dB

Simulation result



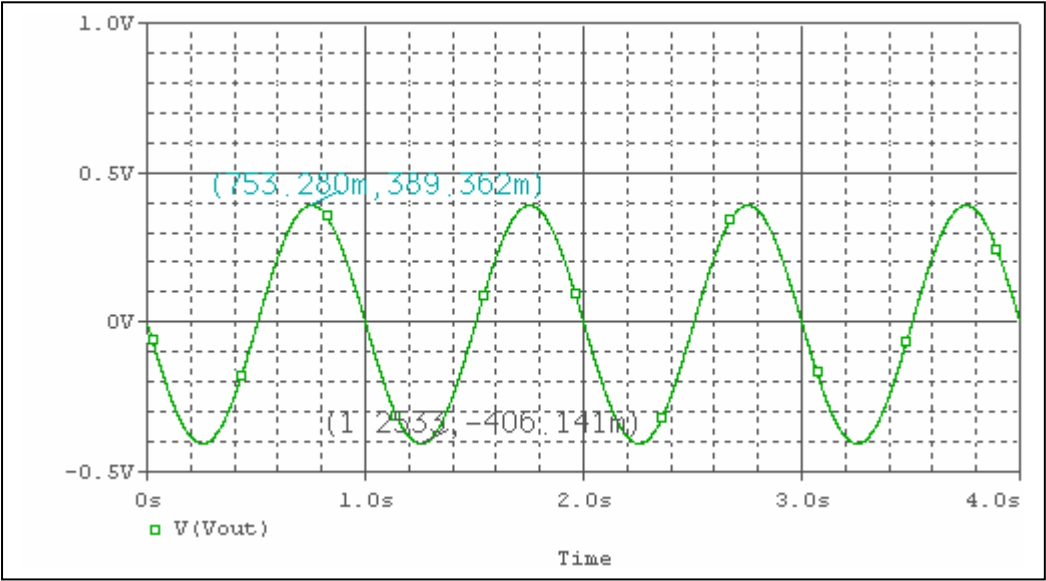
Evaluation circuit



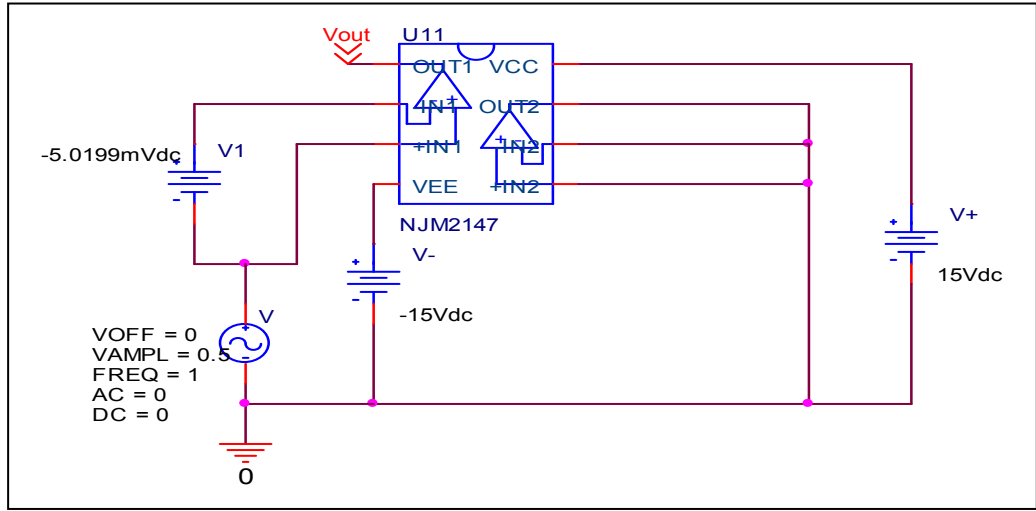
	Data sheet	Simulation	%Error
f-0dB(MHz)	1	0.964	3.6
Av-dc	88	88.3	0.34

# Common-Mode Rejection Voltage gain

## Simulation result



## Evaluation circuit



Common mode gain=0.795504/1

Common Mode Reject Ratio=26001/0.795504=326849 = 90 dB

CMRR(dB)	Data sheet	Simulation	%Error
	90	90.2867	0.3186