微电子专业基础实验作业

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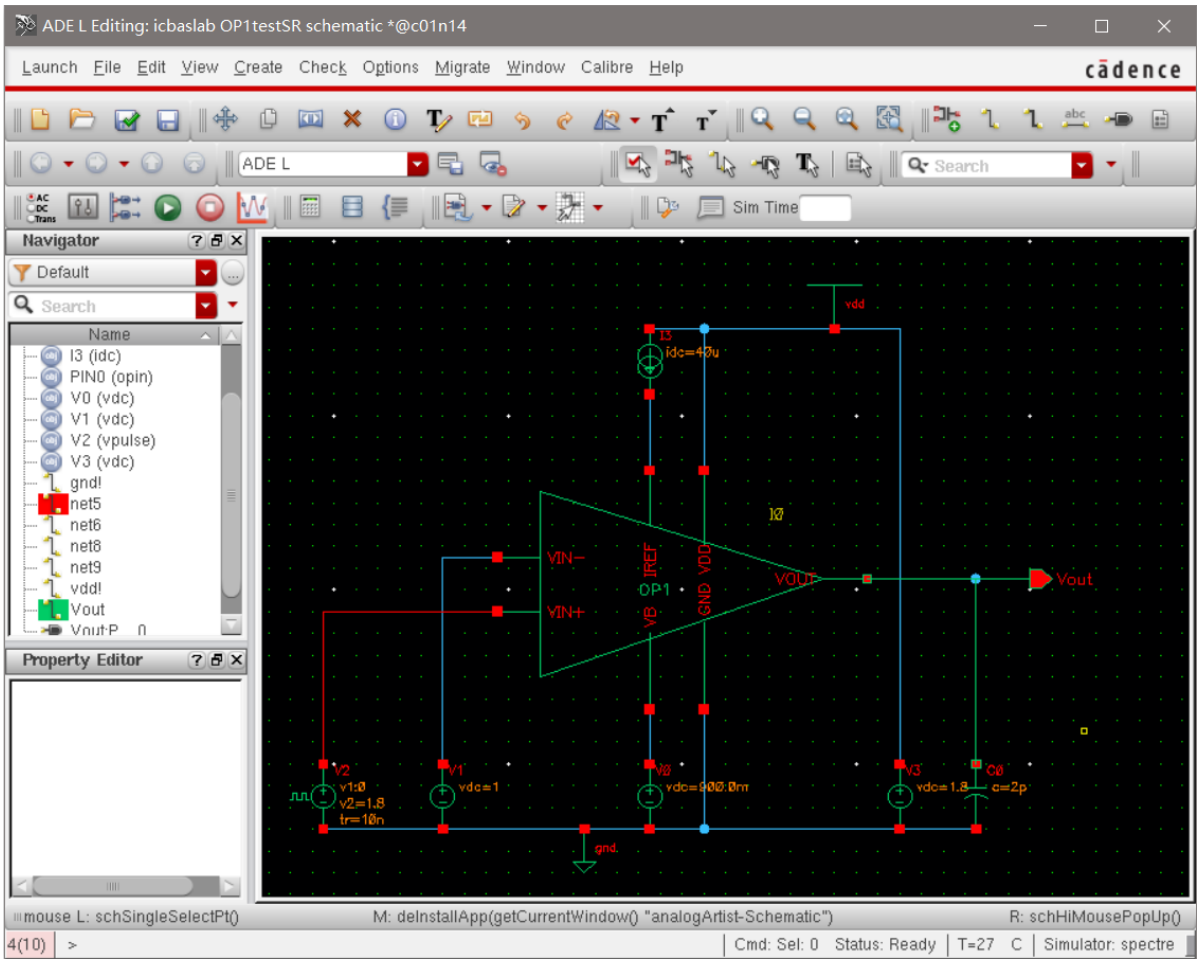
模拟部分

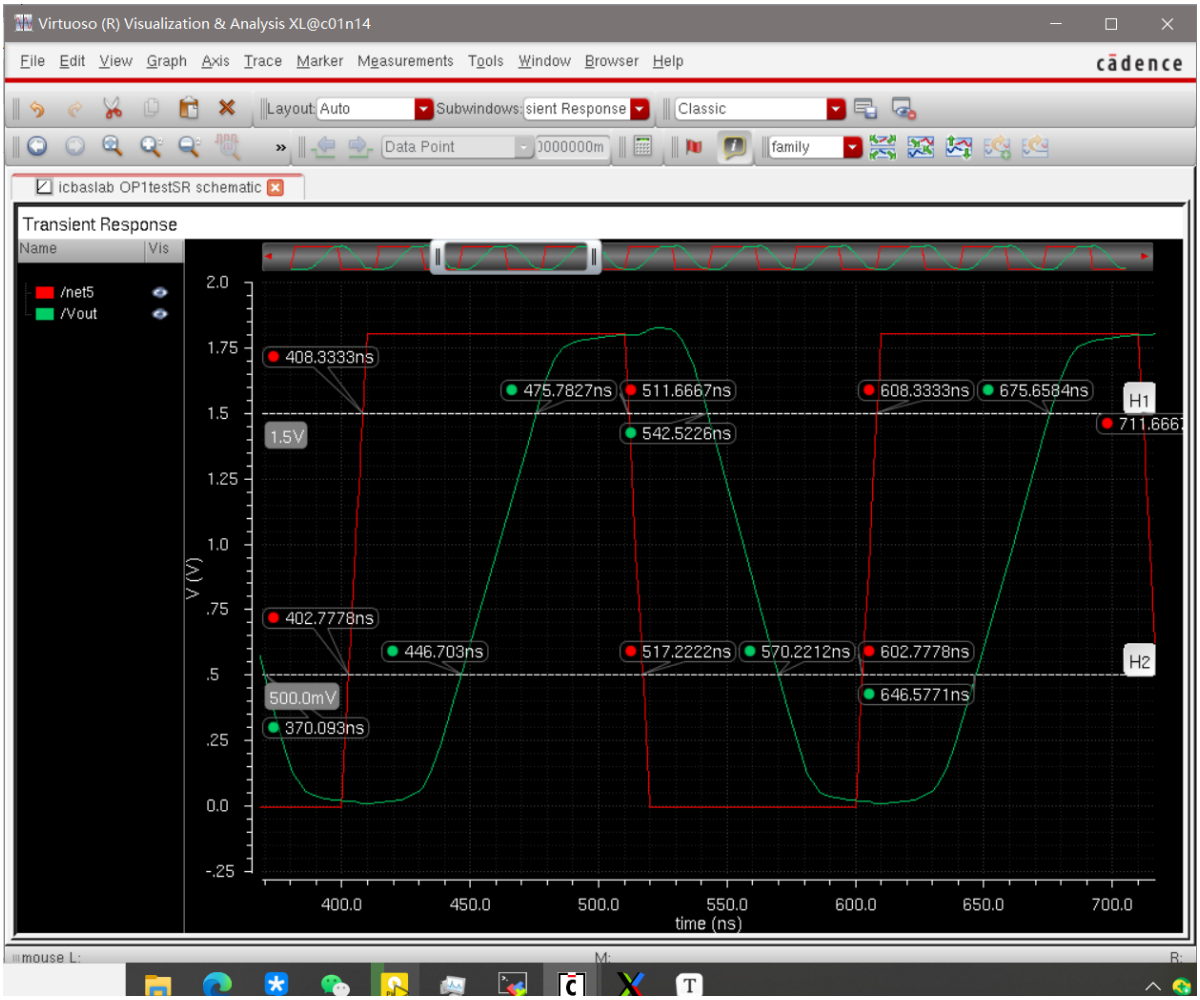
实验6

转换速率

仿真原理图



波形图



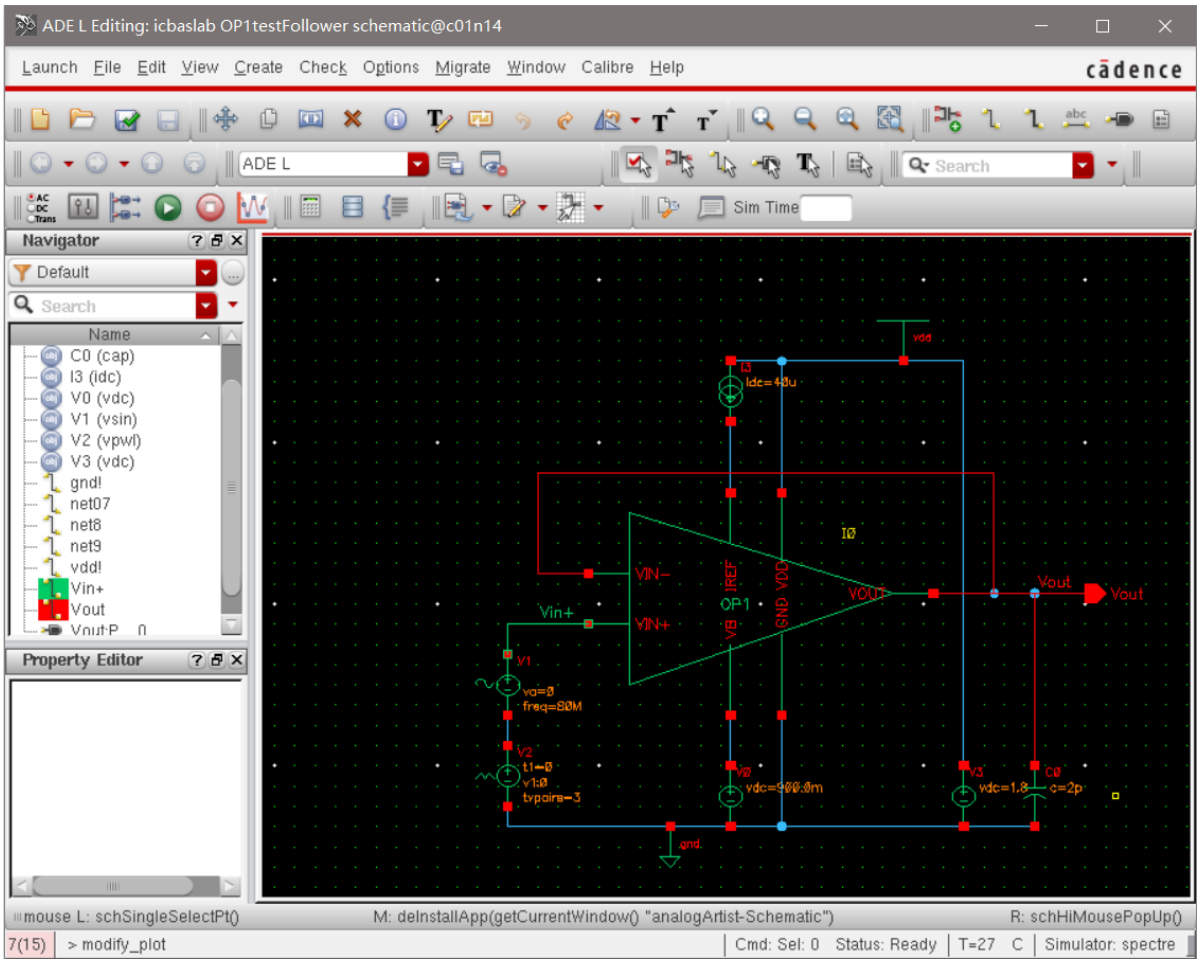
转换速率

$$s = \frac{dV}{dt} = \frac{1.5V - 0.5V}{475.7827ns - 446.703ns} = 34.39MV/s$$

$$BW = \frac{s}{11.3} = 3.04MHz$$

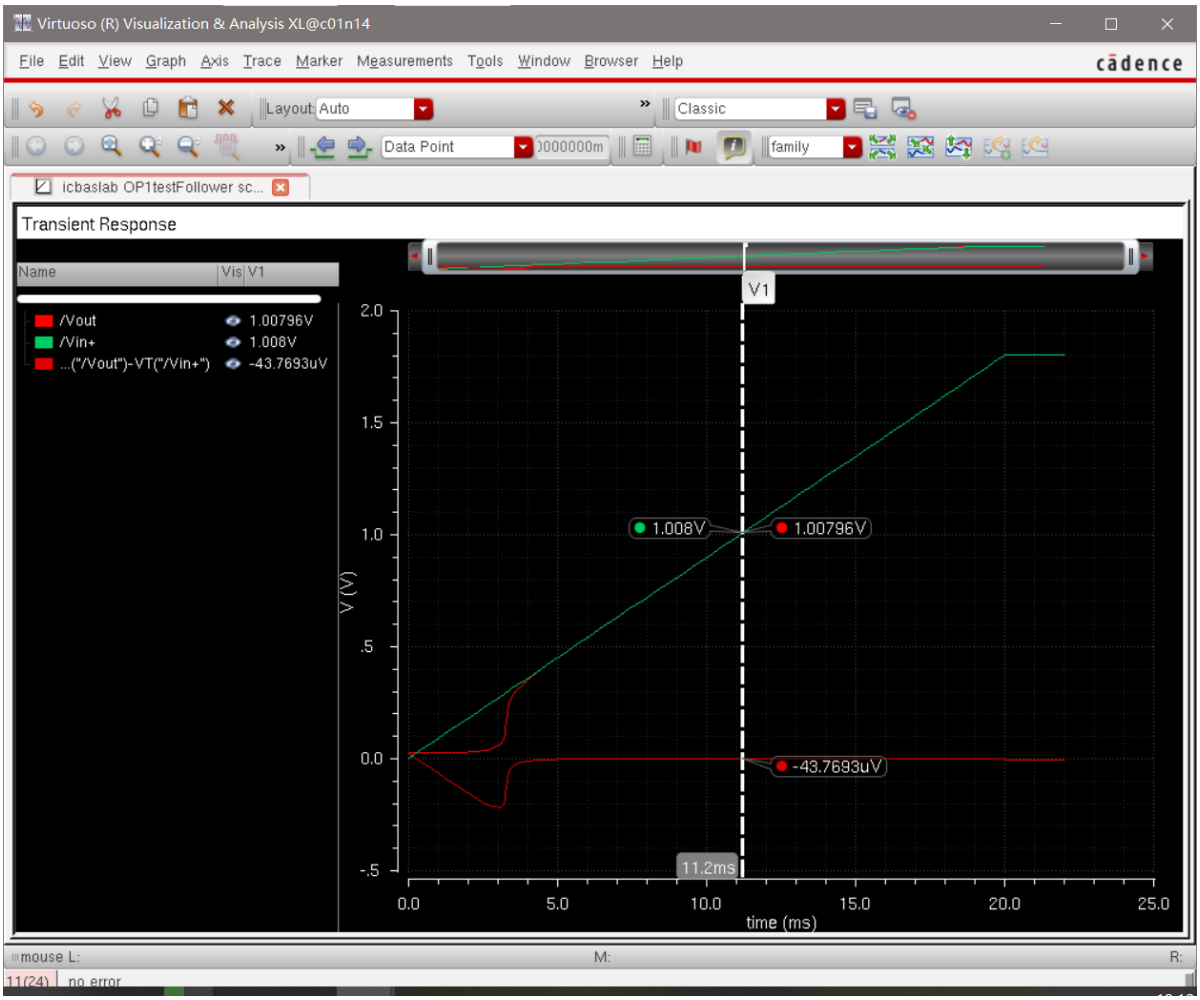
电压跟随器

仿真原理图

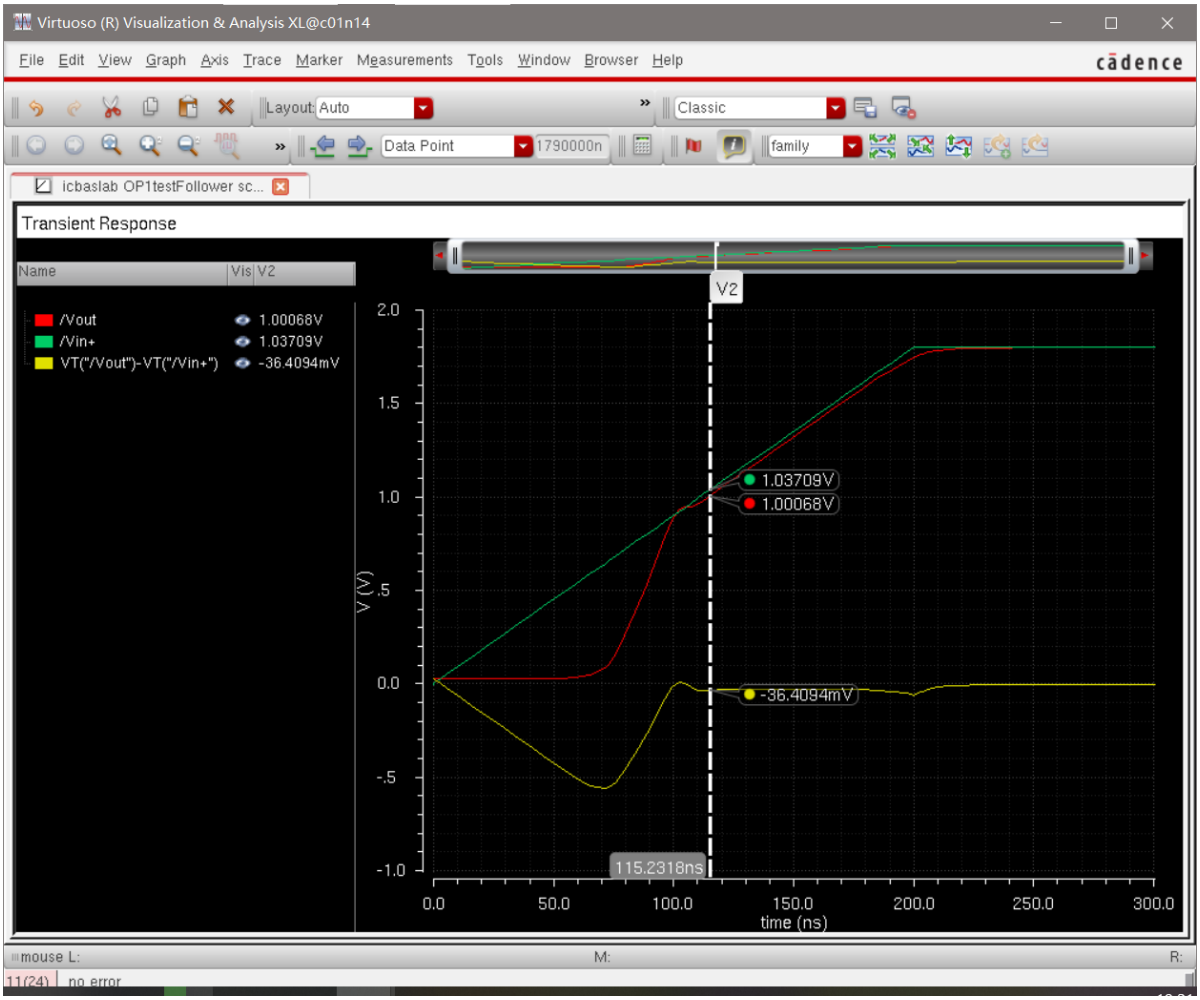


瞬态仿真

8Hz的信号跟随：



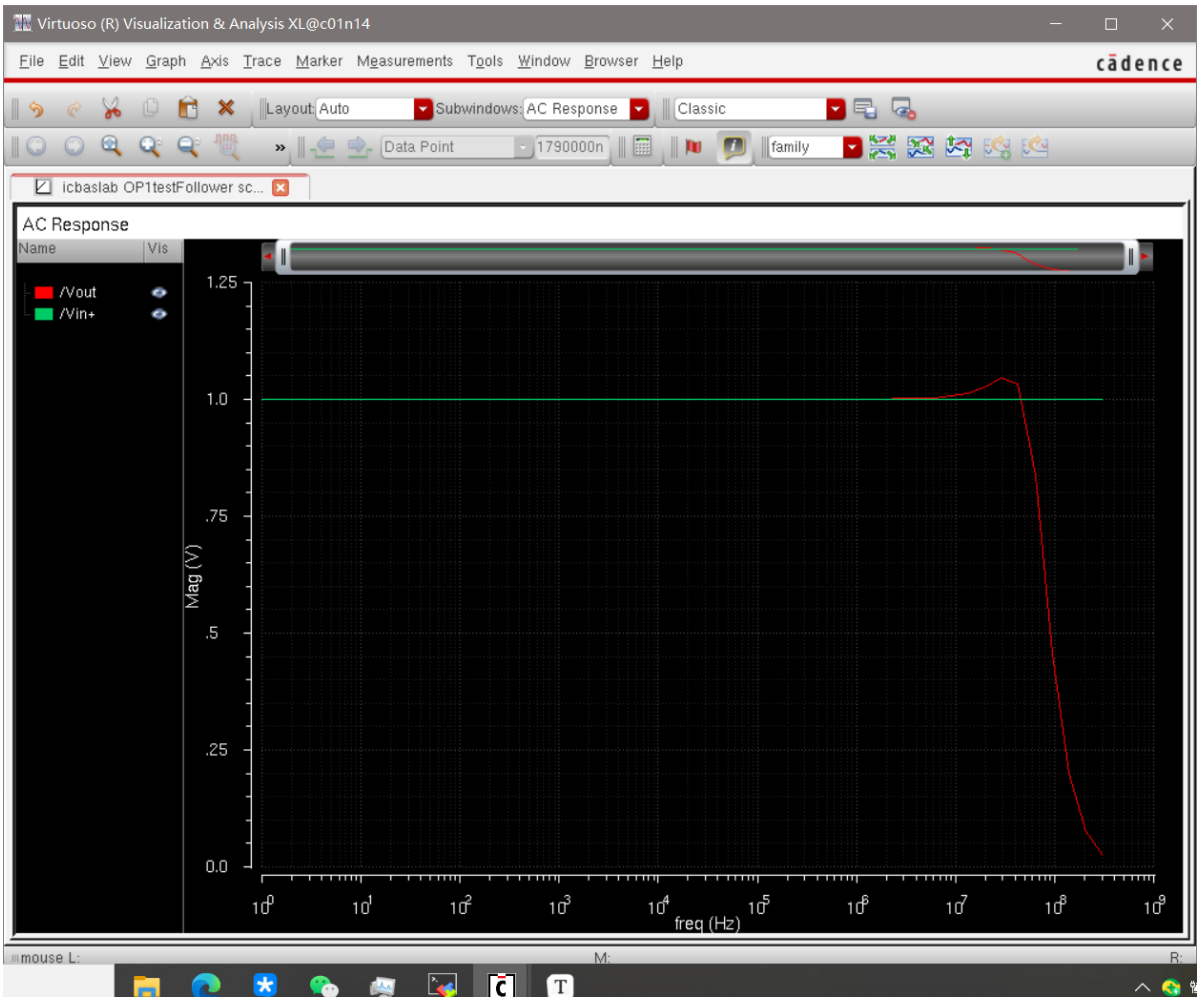
800kHz的信号跟随：



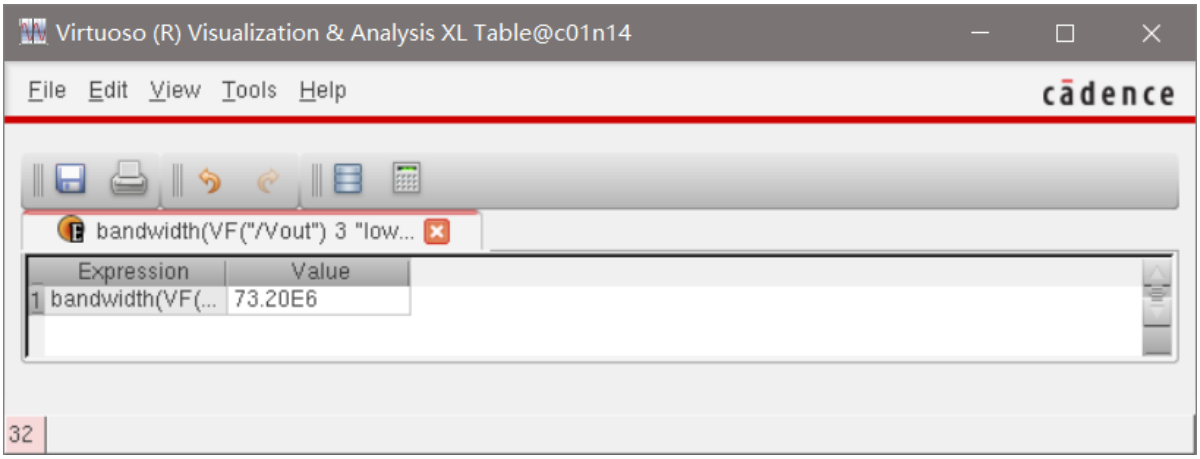
高频情况下的电压跟随能力变差，符合预期

ac仿真

波形图：



3dB带宽：

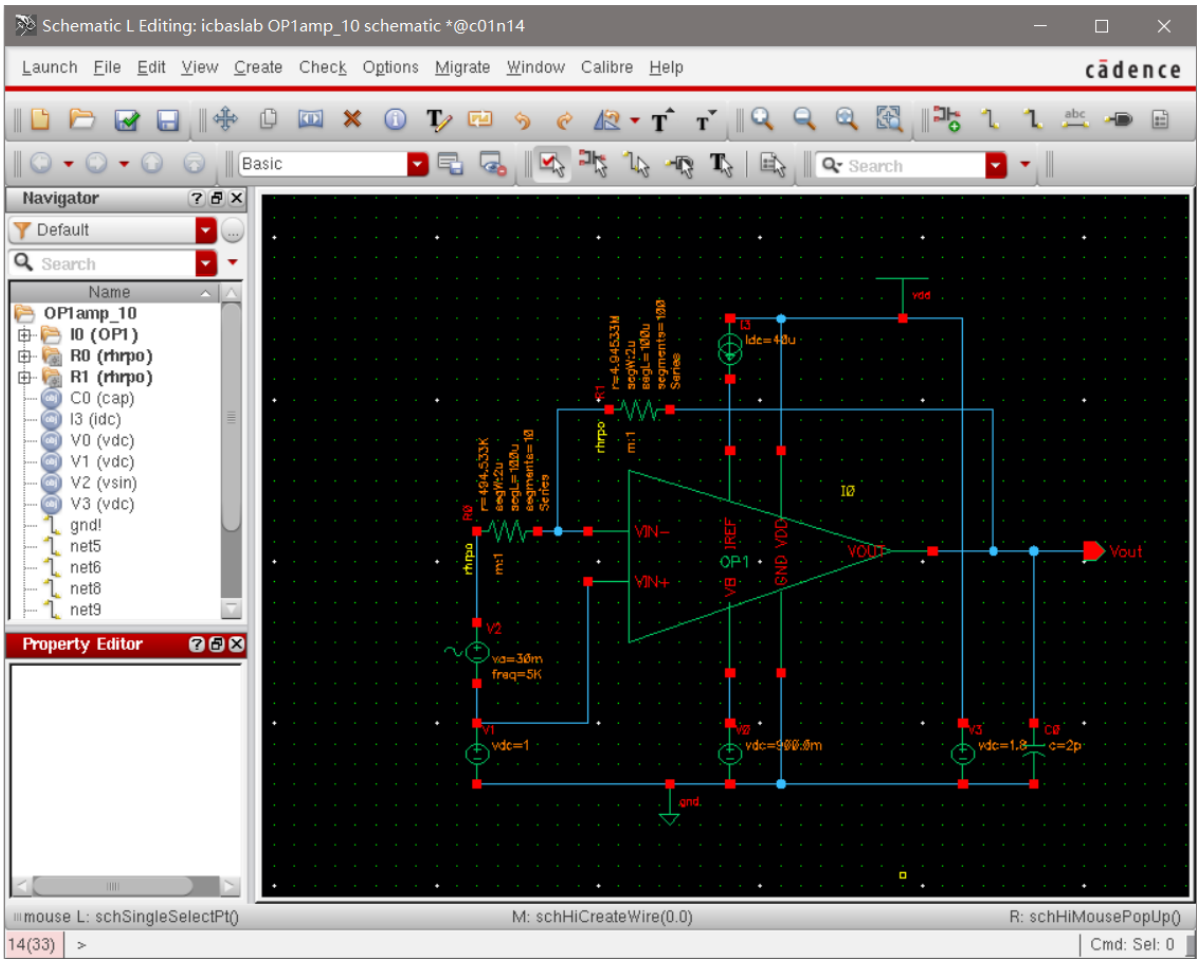


电压跟随器的 3dB 带宽比开环运放 OP 的单位增益带宽大，为什么?

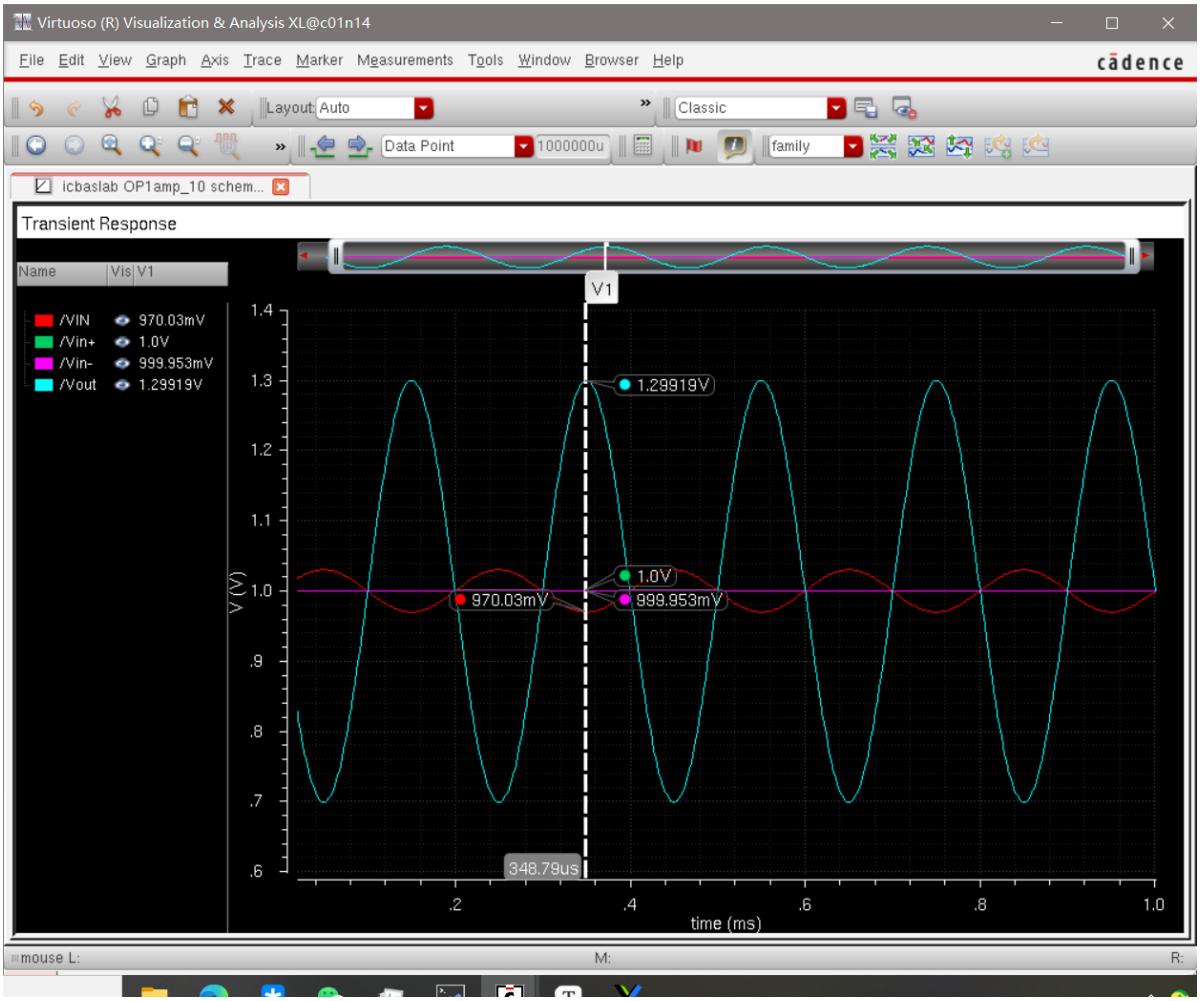
因为反馈的增益带宽积GBW不变，而反馈减小了增益，所以提高了带宽。

反向放大器

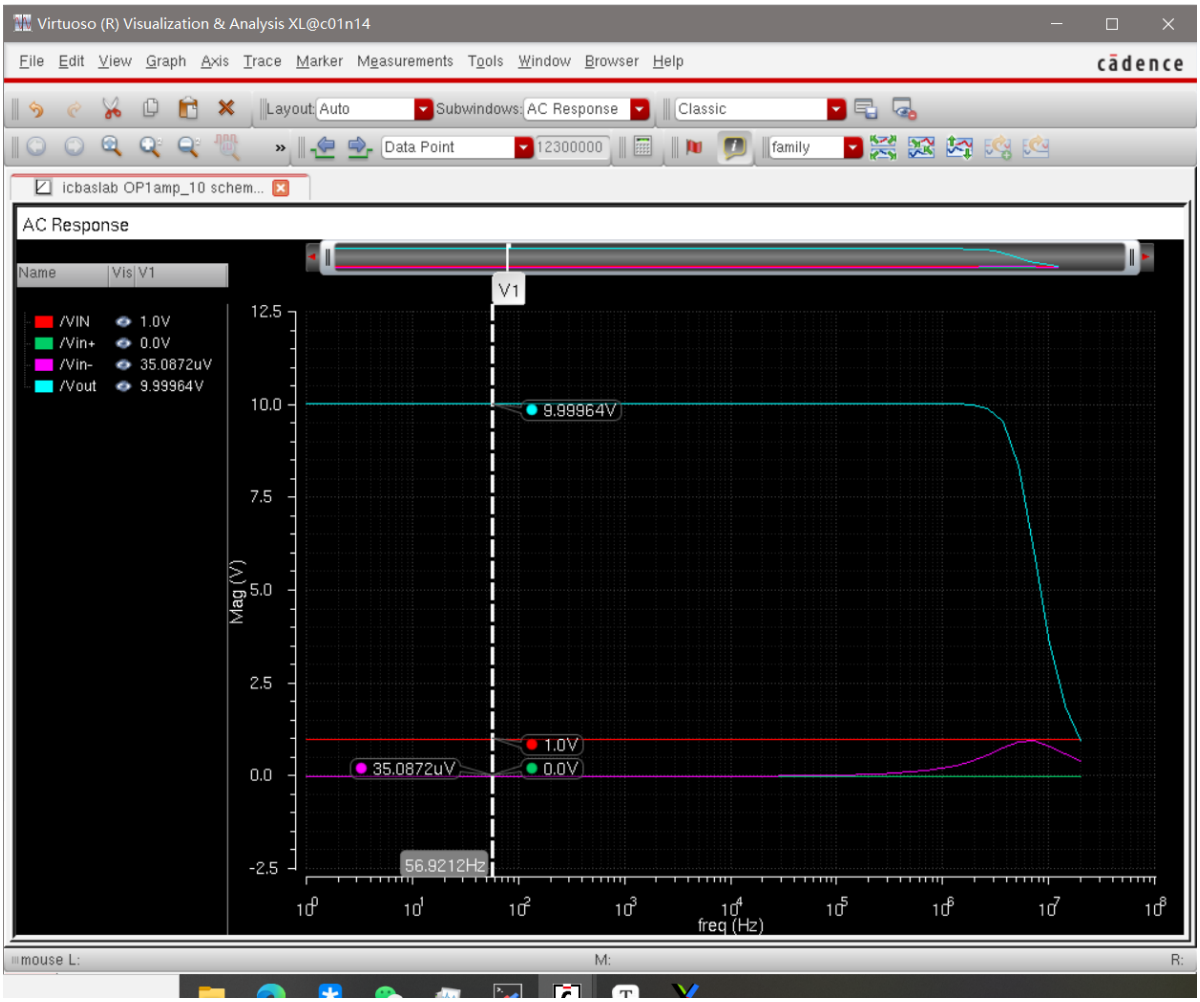
仿真原理图


Schematic L Editing: icbaslab OP1amp_10 schematic *@c01n14
Launch File Edit View Create Check Options Migrate Window Calibre Help
cadence
Navigator
Default
Search
Name
OP1amp_10
I0 (OP1)
R0 (rhrpo)
R1 (rhrpo)
C0 (cap)
I3 (idc)
V0 (vdc)
V1 (vdc)
V2 (vsin)
V3 (vdc)
gnd!
net5
net6
net8
net9
Property Editor
VIN-
VIN+
VOUT
OP1
IREF
GND VDD
Vout
vdd
gnd
mouse L: schSingleSelectPt()
M: schHiCreateWire(0.0)
R: schHiMousePopUp()
14(33)
Cmd: Sel: 0

瞬态仿真

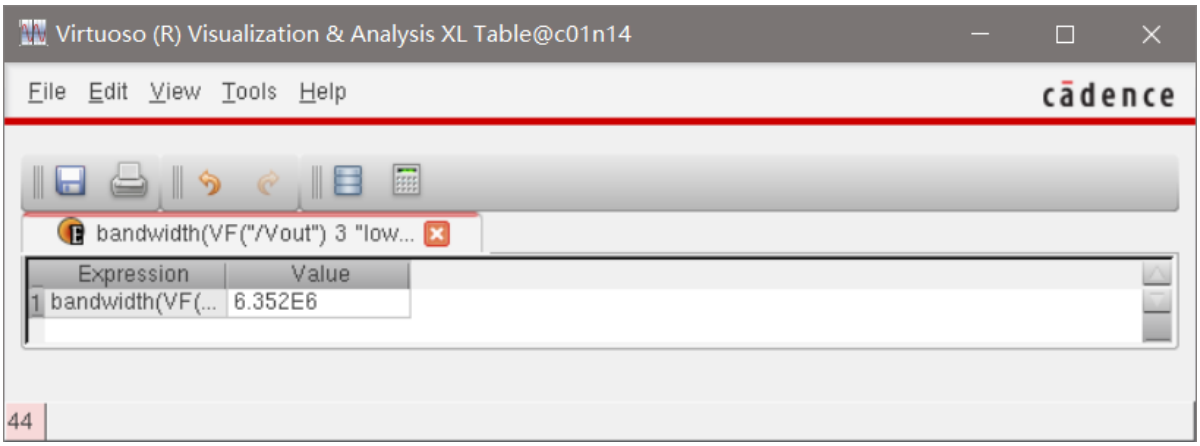

Virtuoso (R) Visualization & Analysis XL@c01n14
File Edit View Graph Axis Trace Marker Measurements Tools Window Browser Help
cadence
Transient Response
Name Vis V1
/VIN 970.03mV
/Vin+ 1.0V
/Vin- 999.953mV
/Vout 1.29919V
V1
1.29919V
1.0V
970.03mV
999.953mV
348.79us
time (ms)
mouse L:
M:
R:

ac仿真

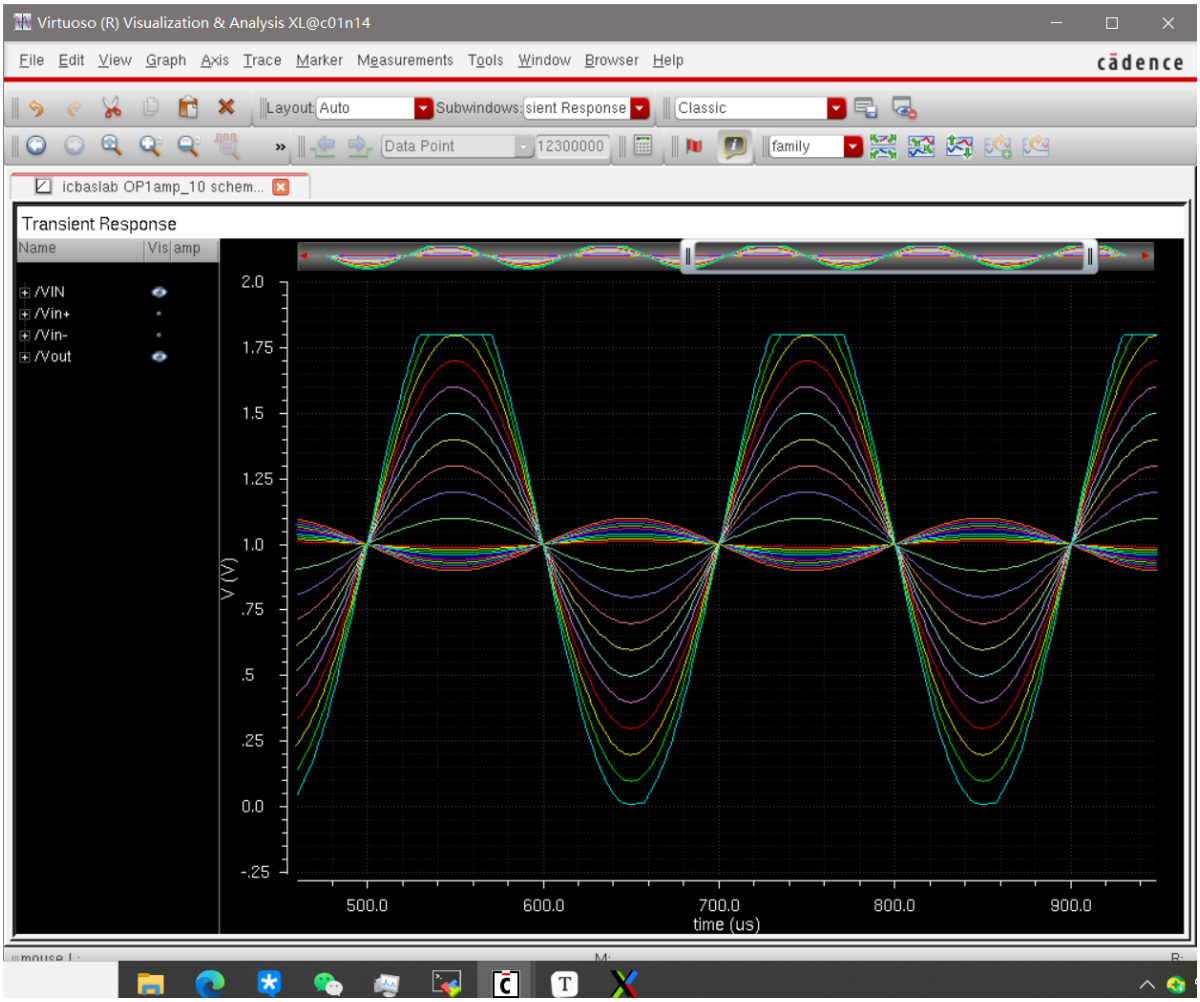


低频增益$A_{v0} = 9.99964$

3dB带宽：



输入输出范围

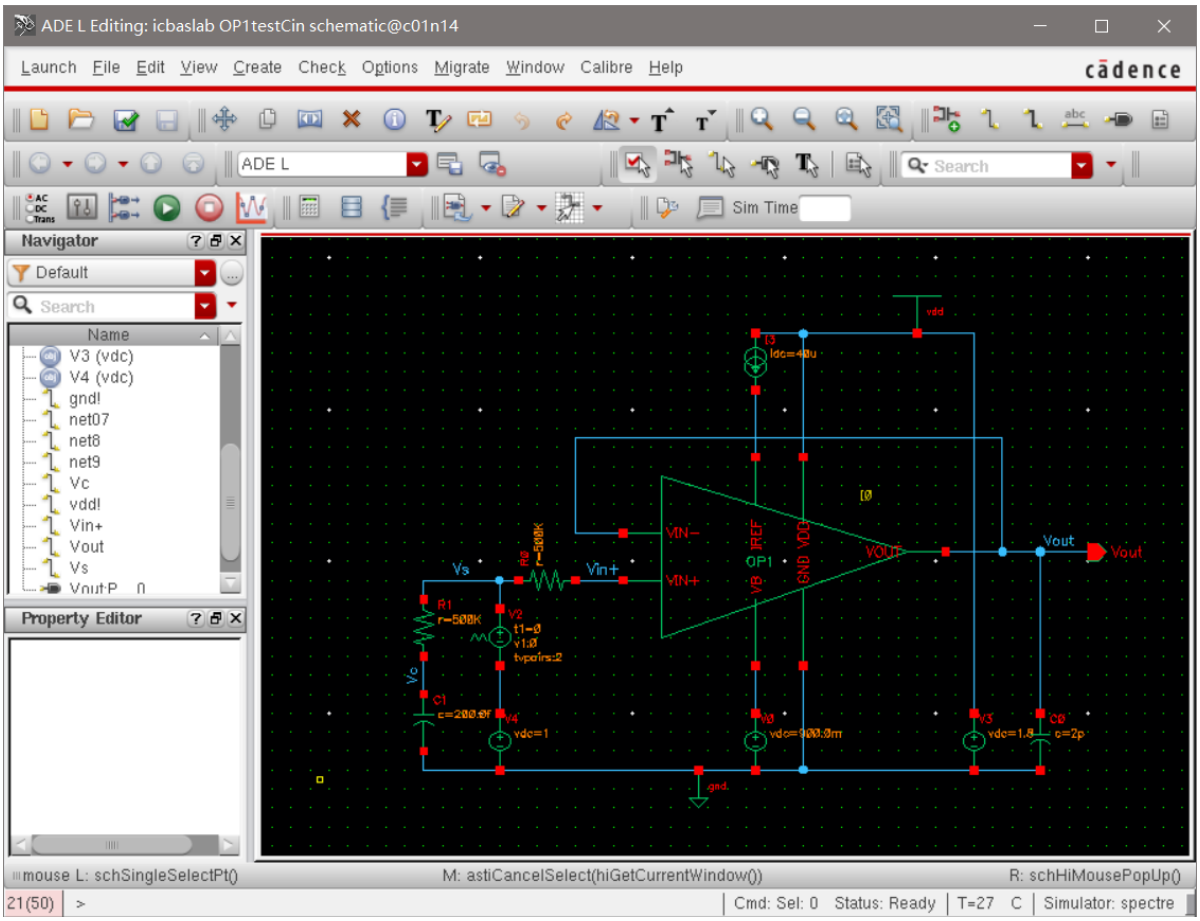


输入范围：0~80mV

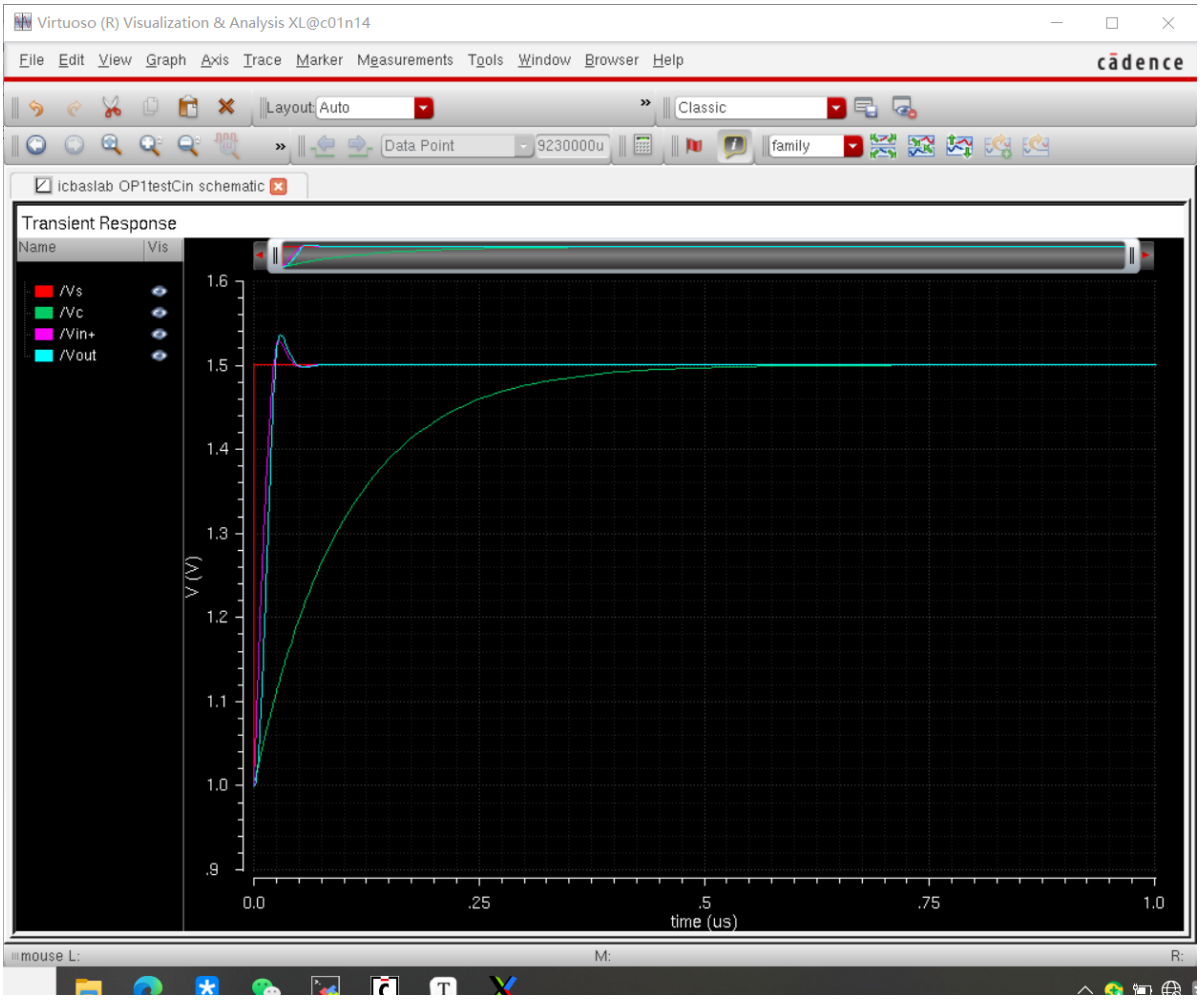
输出范围：0.793V

输入电容

仿真原理图



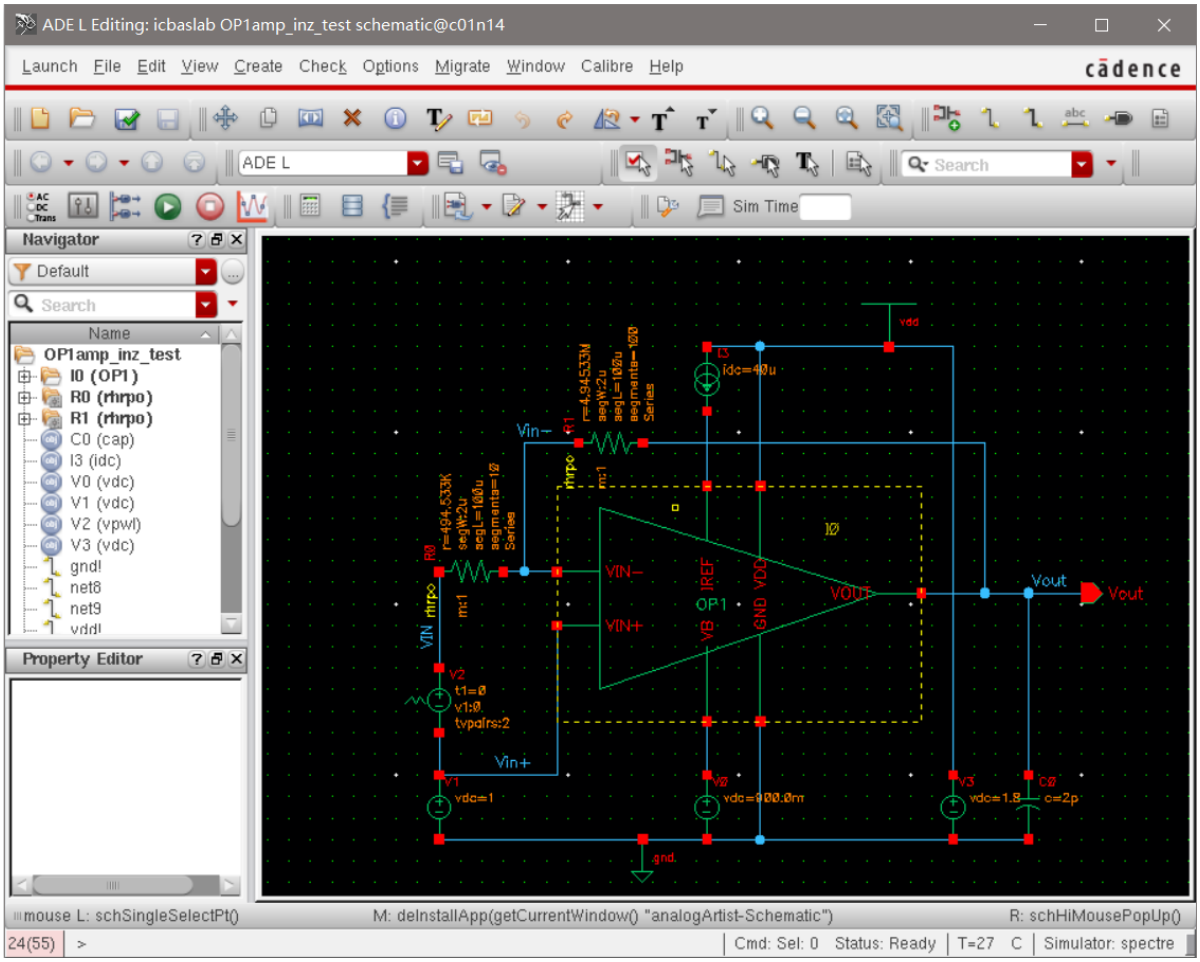
波形图



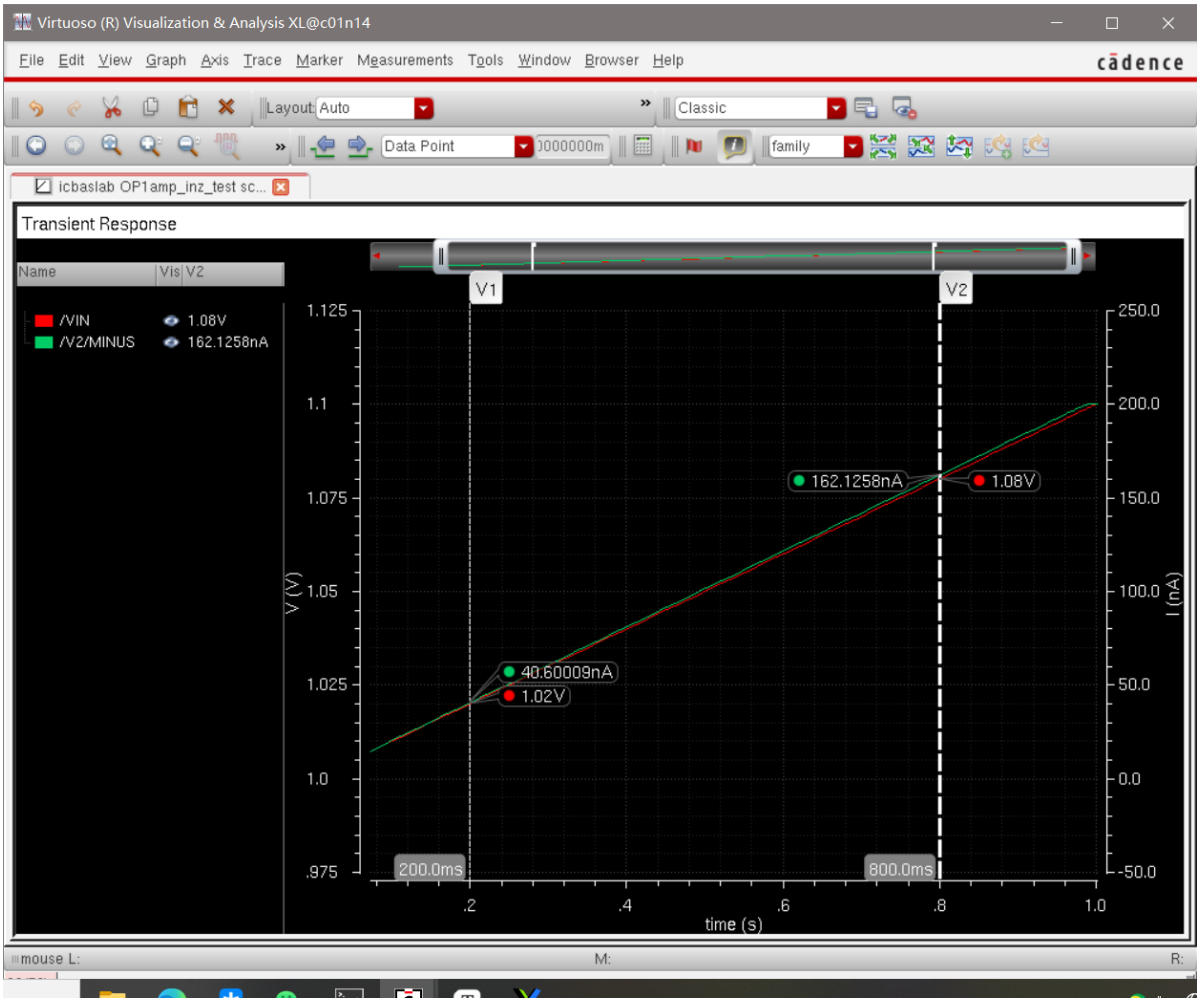
Vc比其它曲线上升的慢，所以输入电容小于0.2pF

输入阻抗

仿真原理图


ADE L Editing: icbaslab OP1amp_inz_test schematic@c01n14
Launch File Edit View Create Check Options Migrate Window Calibre Help
cadence
ADE L
Search
Sim Time
Navigator
Default
Search
Name
OP1amp_inz_test
I0 (OP1)
R0 (rhrpo)
R1 (rhrpo)
C0 (cap)
I3 (idc)
V0 (vdc)
V1 (vdc)
V2 (vpwl)
V3 (vdc)
gnd!
net8
net9
vdd!
Property Editor
vdd
idc=40u
Vin−
Vin+
VIN−
VIN+
VOUT
OP1
IREF
VB
GND
VDD
Vout
vdc=1
vdc=900.0m
vdc=1.8
c=2p
gnd
mouse L: schSingleSelectPt()
M: deInstallApp(getCurrentWindow() "analogArtist-Schematic")
R: schHiMousePopUp()
24(55)
Cmd: Sel: 0
Status: Ready
T=27 C
Simulator: spectre

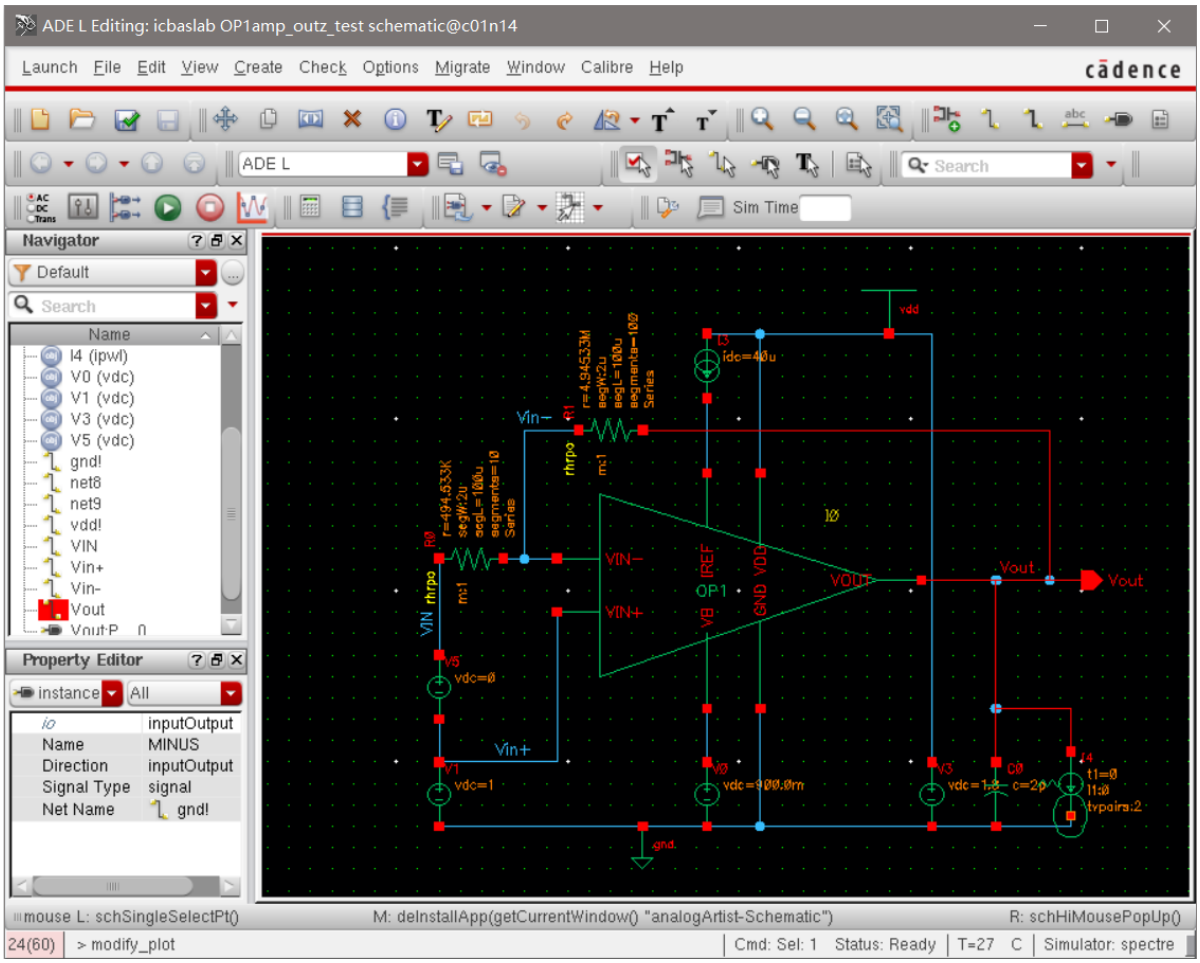
波形图



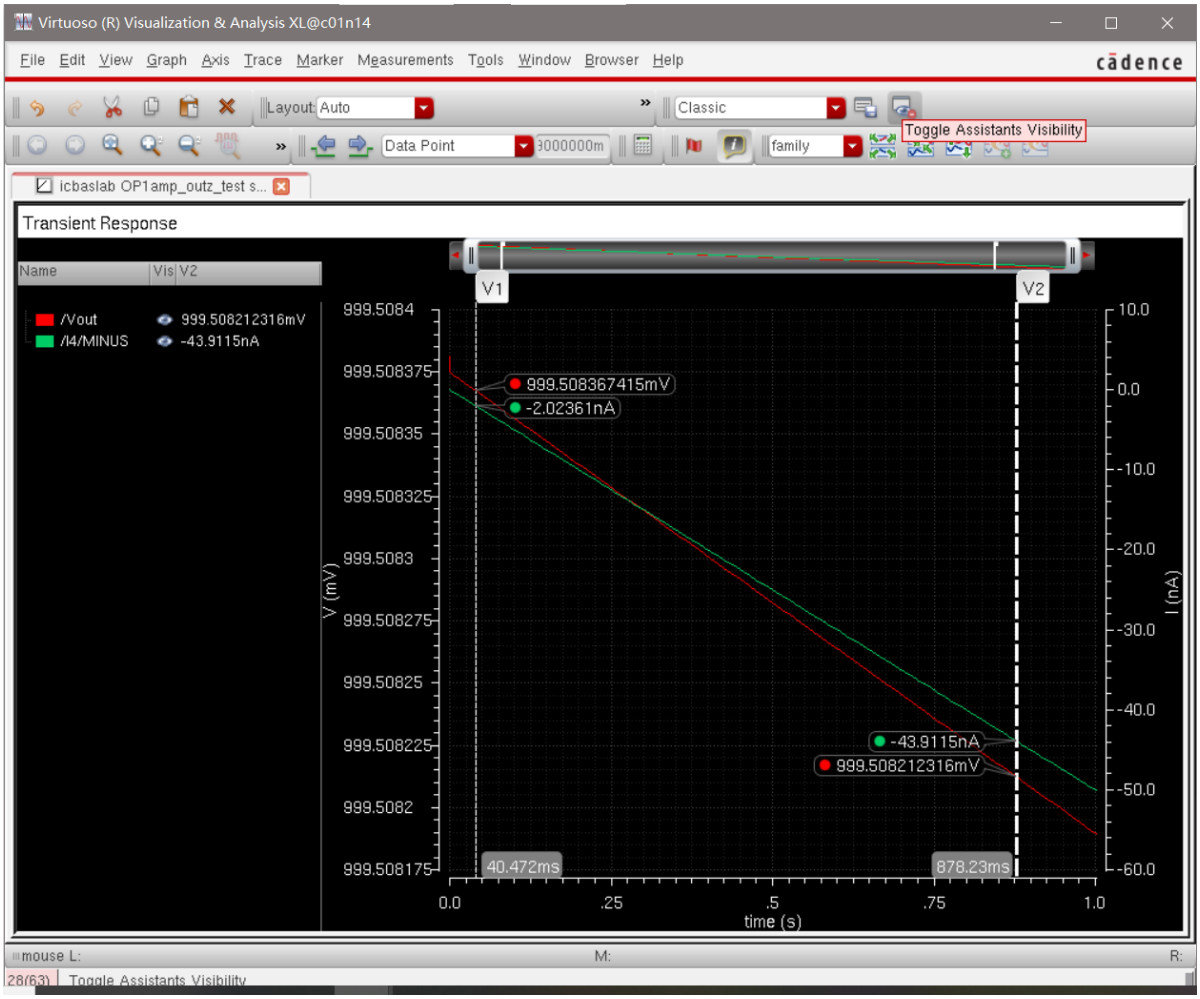
$$R_{in} = \frac{1.08V - 1.02V}{162.1258nA - 40.60009nA} = 493.72k\Omega$$

输出阻抗

仿真原理图


ADE L Editing: icbaslab OP1amp_outz_test schematic@c01n14
Launch File Edit View Create Check Options Migrate Window Calibre Help
cadence
ADE L
Search
Sim Time
Navigator
Default
Search
Name
I4 (ipwl)
V0 (vdc)
V1 (vdc)
V3 (vdc)
V5 (vdc)
gnd!
net8
net9
vdd!
VIN
Vin+
Vin-
Vout
Property Editor
instance
All
io inputOutput
Name MINUS
Direction inputOutput
Signal Type signal
Net Name gnd!
Vin-
Vin+
VIN-
VIN+
OP1
IREF
VDD
GND
VOUT
Vout
mouse L: schSingleSelectPt()
M: deInstallApp(getCurrentWindow() "analogArtist-Schematic")
R: schHiMousePopUp()
24(60)
> modify_plot
Cmd: Sel: 1
Status: Ready
T=27 C
Simulator: spectre

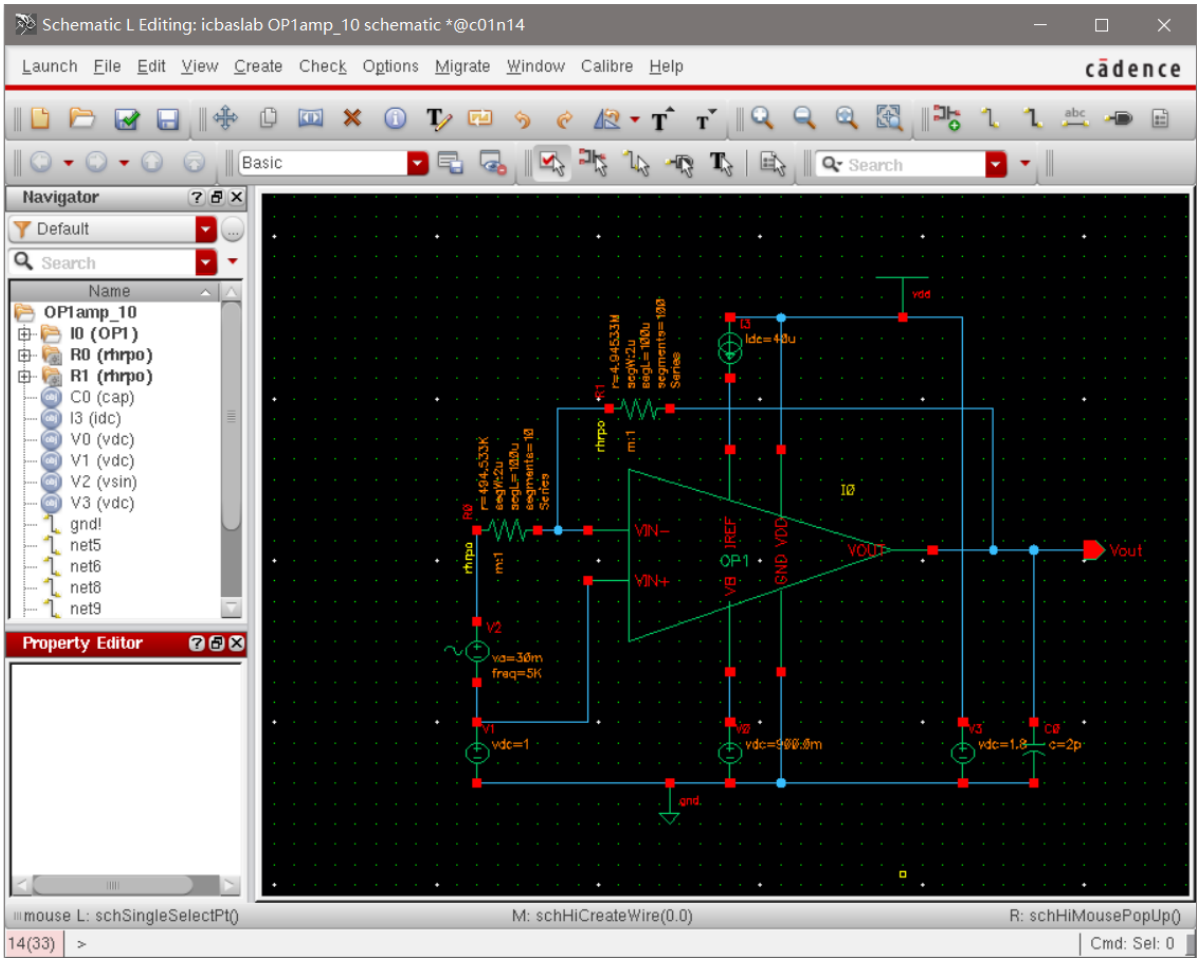
波形图


Virtuoso (R) Visualization & Analysis XL@c01n14
File Edit View Graph Axis Trace Marker Measurements Tools Window Browser Help
cadence
Layout Auto
Classic
Toggle Assistants Visibility
Data Point
family
icbaslab OP1amp_outz_test s...
Transient Response
Name
Vis
V2
/Vout
999.508212316mV
/I4/MINUS
-43.9115nA
V1
V2
999.508367415mV
-2.02361nA
-43.9115nA
999.508212316mV
40.472ms
878.23ms
V (mV)
I (nA)
time (s)
mouse L:
M:
R:
Toggle Assistants Visibility

$$R_{out} = \frac{999.508367415mV - 999.508212316mV}{43.9115nA - 2.02361nA} = 3.702\Omega$$

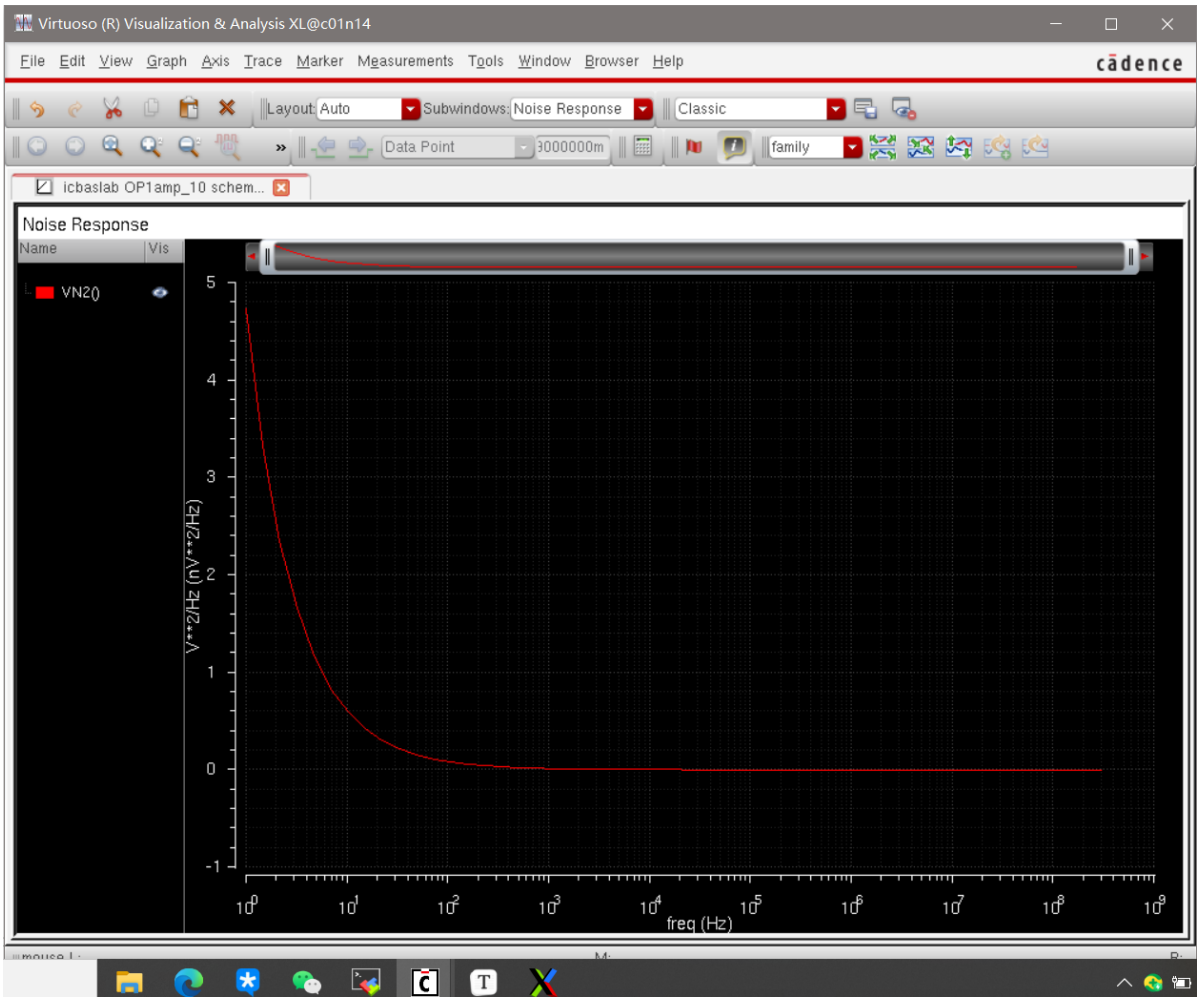
输入等效噪声电压功率谱

仿真原理图

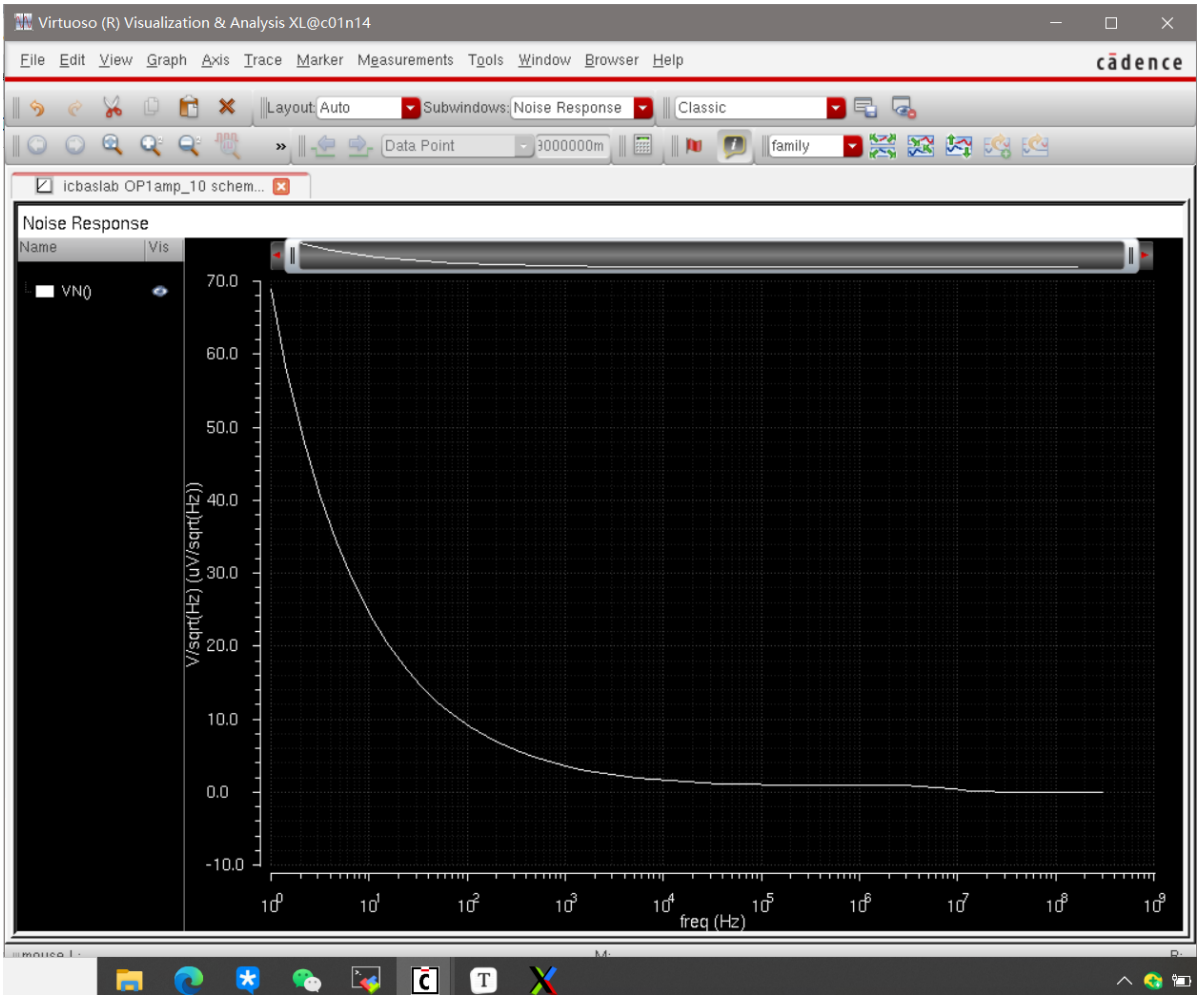


功率谱

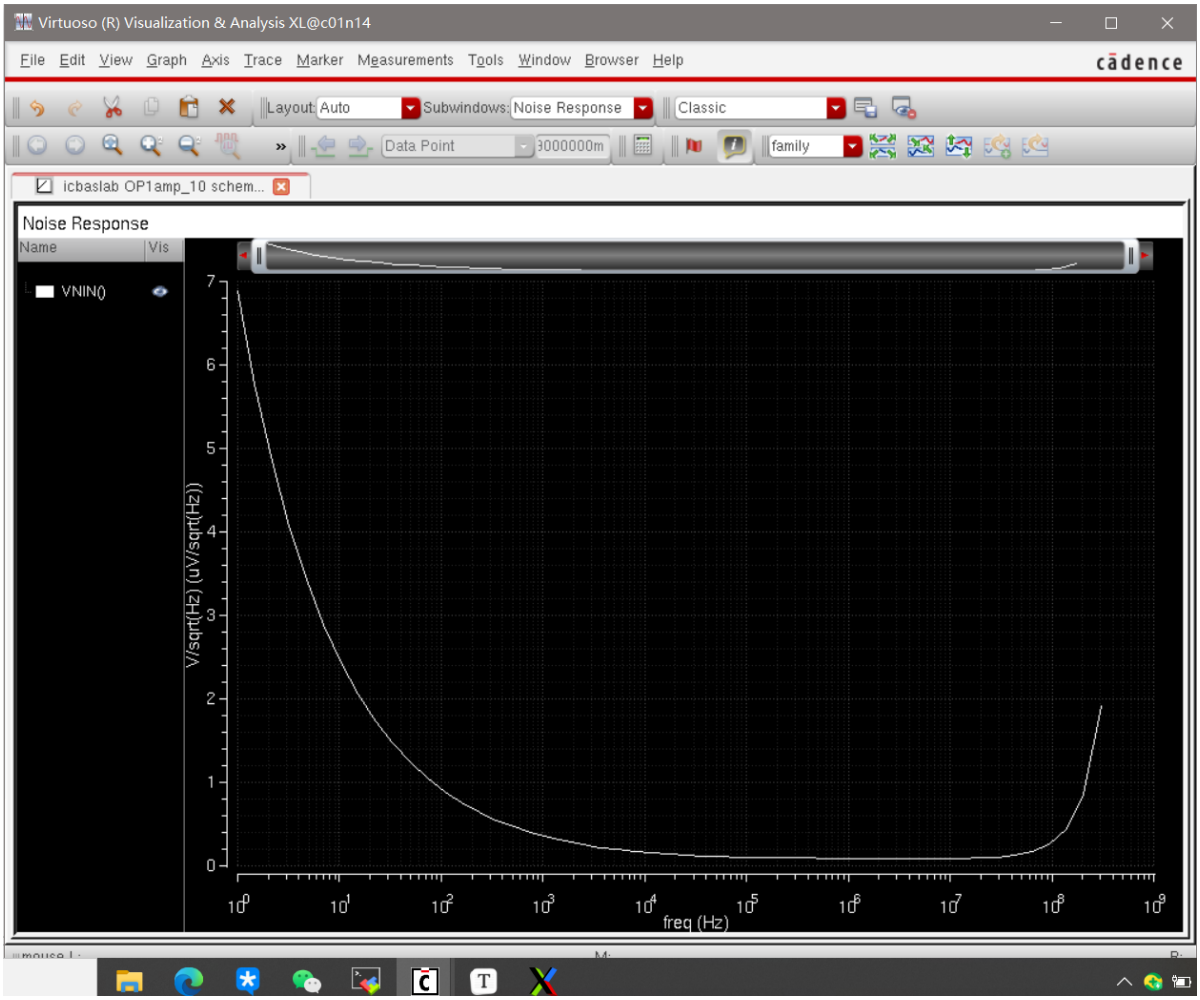
输出噪声电压“功率”谱 VN2()：


Virtuoso (R) Visualization & Analysis XL@c01n14
File Edit View Graph Axis Trace Marker Measurements Tools Window Browser Help
cadence
Layout: Auto
Subwindows: Noise Response
Classic
Data Point
family
icbaslab OP1amp_10 schem...
Noise Response
Name
Vis
VN2()
V**2/Hz (nV**2/Hz)
freq (Hz)

等效输出噪声电压谱


Virtuoso (R) Visualization & Analysis XL@c01n14
File Edit View Graph Axis Trace Marker Measurements Tools Window Browser Help
cadence
Layout: Auto
Subwindows: Noise Response
Classic
Data Point
family
icbaslab OP1amp_10 schem...
Noise Response
Name
Vis
VN()
V/sqrt(Hz) (uV/sqrt(Hz))
freq (Hz)

等效输入噪声电压谱：



等效输入噪声电压有效值：