Low Noise Preamplifier and Our Blue Print

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Project requirements

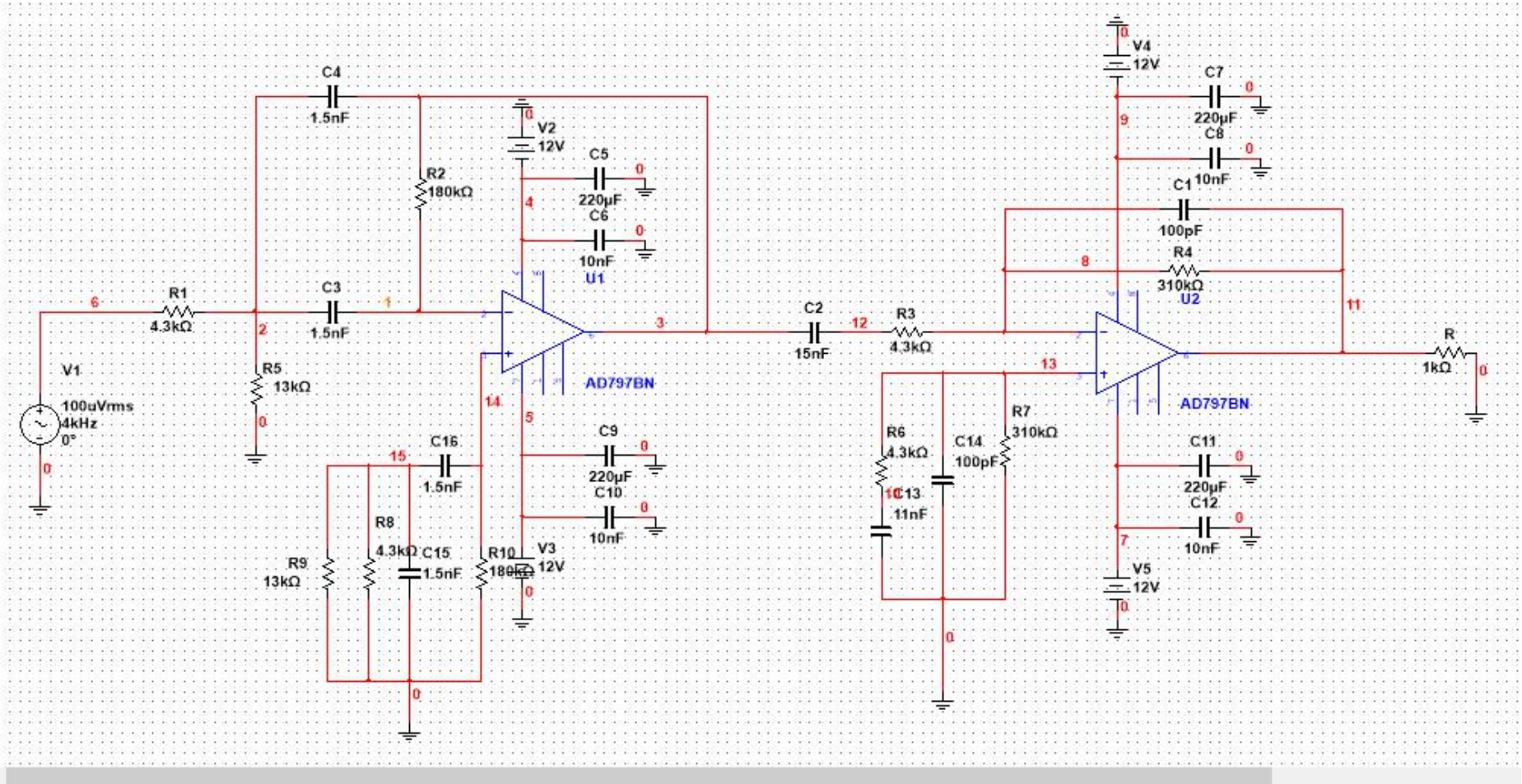
- Voltage Gain Av≥100
  - Plan 1：Av=1500
  - Plan 2： Av=2000
- Band width BW=1k Hz
- Central frequency f=4k Hz
- low noise RTI≤5 μ v

Selection of component

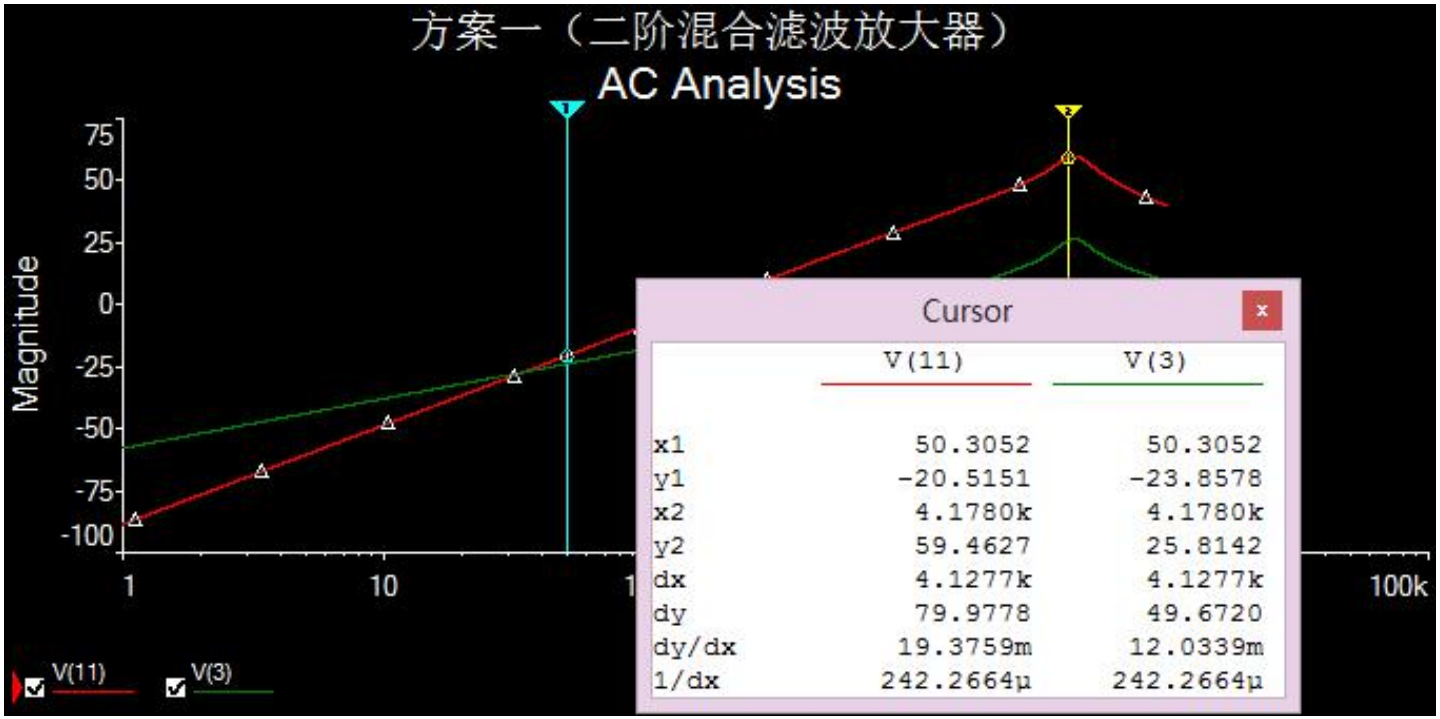
Arrangement

Amplifiler and filter

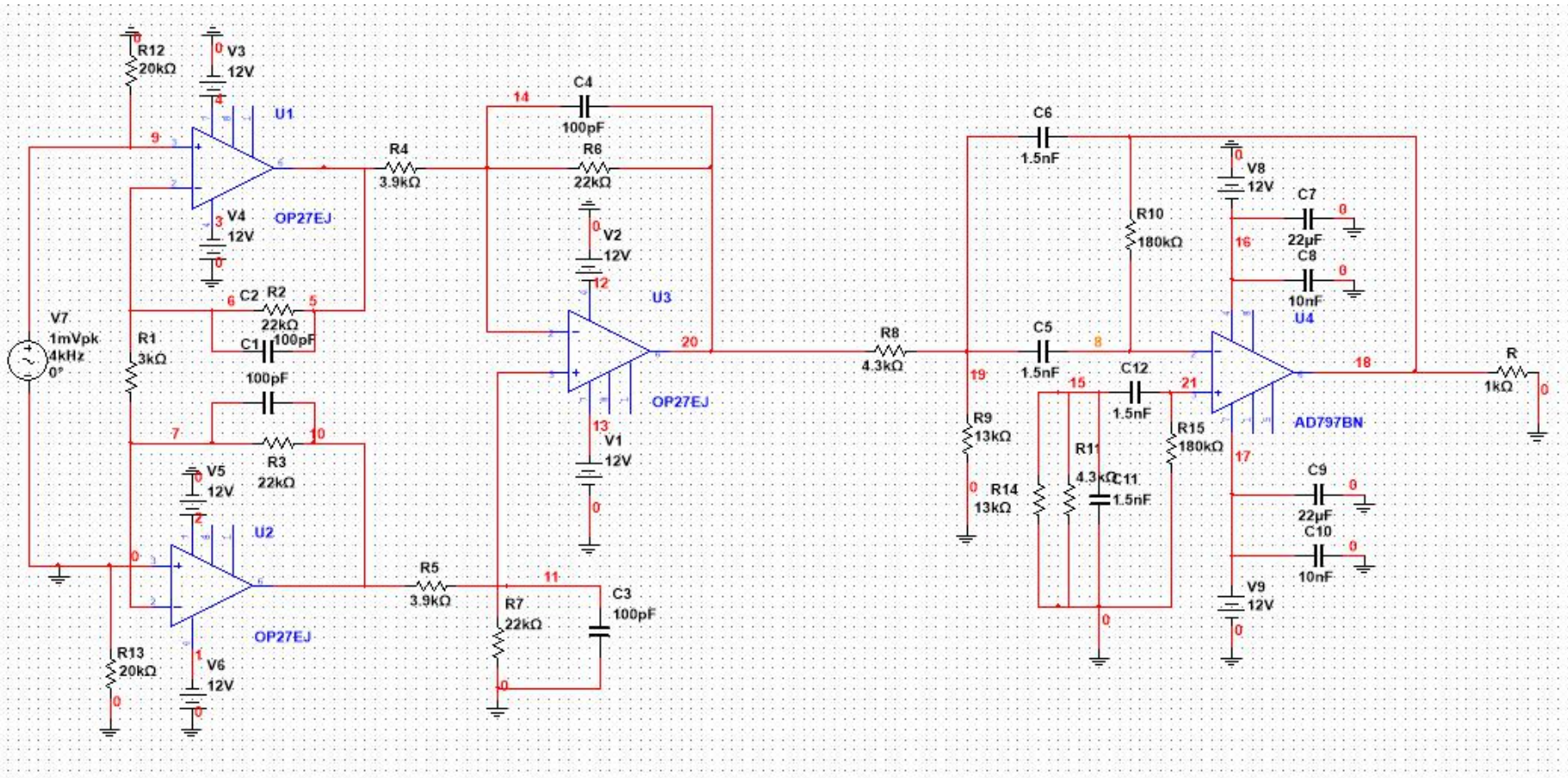
Plan 1


V1
100uVrms
4kHz
0°
R1
4.3kΩ
R5
13kΩ
C4
1.5nF
C3
1.5nF
R2
180kΩ
V2
12V
C5
220µF
C6
10nF
U1
AD797BN
C16
1.5nF
R8
4.3kΩ
C15
1.5nF
R9
13kΩ
R10
180kΩ
V3
12V
C9
220µF
C10
10nF
C2
15nF
R3
4.3kΩ
V4
12V
C7
220µF
C8
10nF
C1
100pF
R4
310kΩ
U2
AD797BN
R6
4.3kΩ
C13
11nF
C14
100pF
R7
310kΩ
C11
220µF
C12
10nF
V5
12V
R
1kΩ

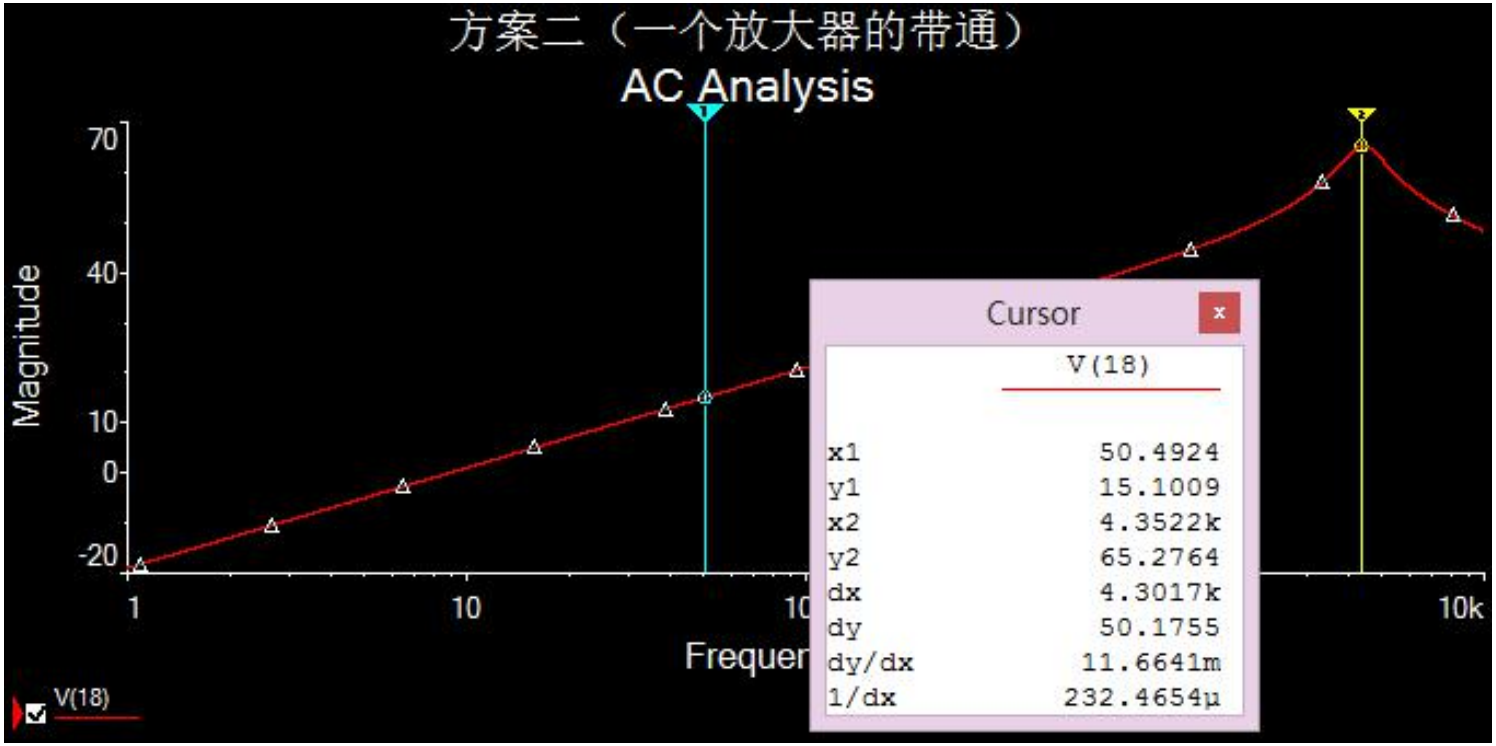
Plan 1


方案一（二阶混合滤波放大器）
AC Analysis
Magnitude
75
50
25
0
-25
-50
-75
-100
1
10
100k
V(11)
V(3)
Cursor
V(11)
V(3)
x1 50.3052 50.3052
y1 -20.5151 -23.8578
x2 4.1780k 4.1780k
y2 59.4627 25.8142
dx 4.1277k 4.1277k
dy 79.9778 49.6720
dy/dx 19.3759m 12.0339m
1/dx 242.2664µ 242.2664µ

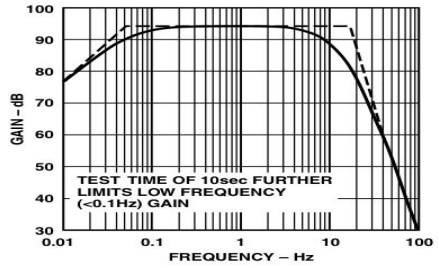
Plan 2


R12
20kΩ
V3
12V
U1
C4
100pF
R4
3.9kΩ
R6
22kΩ
C6
1.5nF
V8
12V
C7
22µF
R10
180kΩ
V4
12V
OP27EJ
V2
12V
U3
C2
R2
22kΩ
C1
100pF
V7
1mVpk
4kHz
0°
R1
3kΩ
100pF
R8
4.3kΩ
C5
1.5nF
C8
10nF
U4
R
1kΩ
OP27EJ
V1
12V
C12
1.5nF
R3
22kΩ
R9
13kΩ
R15
180kΩ
AD797BN
V5
12V
U2
R11
4.3kΩ
C11
1.5nF
R14
13kΩ
C9
22µF
C10
10nF
R5
3.9kΩ
R7
22kΩ
C3
100pF
V9
12V
R13
20kΩ
V6
12V
OP27EJ

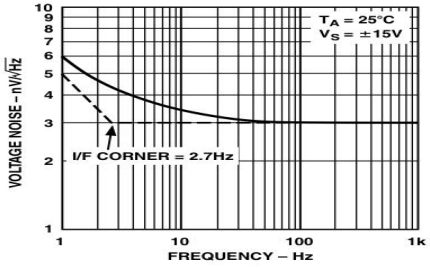
Plan 2


方案二（一个放大器的带通）
AC Analysis
Magnitude
70
40
10
0
-20
1
10
10k
Frequen
V(18)
Cursor
V(18)
x1 50.4924
y1 15.1009
x2 4.3522k
y2 65.2764
dx 4.3017k
dy 50.1755
dy/dx 11.6641m
1/dx 232.4654µ

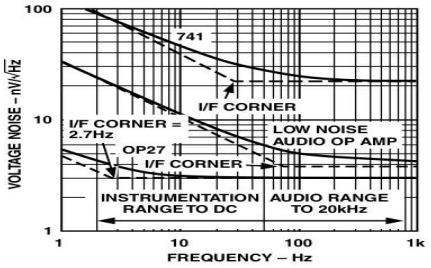
OP27—Typical Performance Characteristics



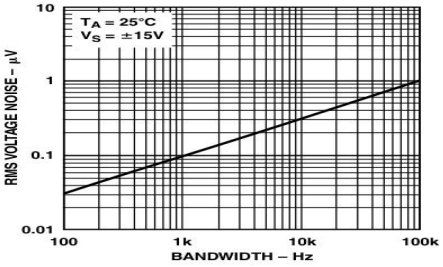
TPC 1. 0.1 Hz to 10 Hz$_{p-p}$ Noise Tester Frequency Response



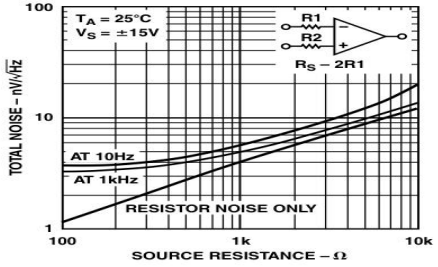
TPC 2. Voltage Noise Density vs. Frequency



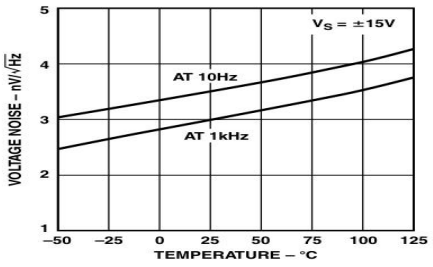
TPC 3. A Comparison of Op Amp Voltage Noise Spectra



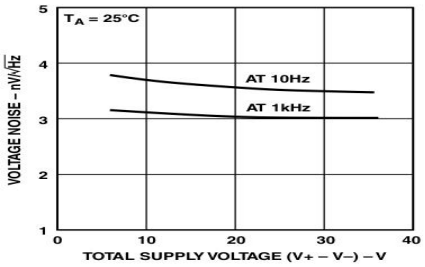
TPC 4. Input Wideband Voltage Noise vs. Bandwidth (0.1 Hz to Frequency Indicated)



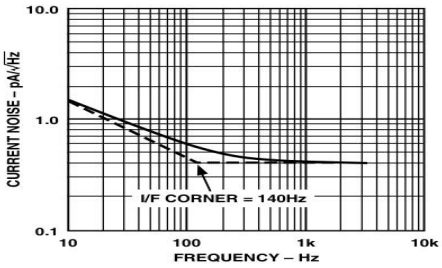
TPC 5. Total Noise vs. Sourced Resistance



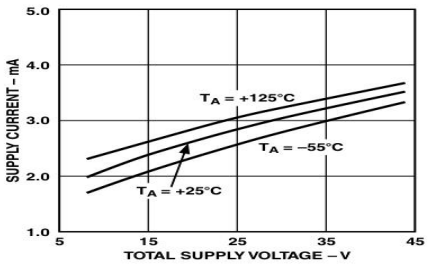
TPC 6. Voltage Noise Density vs. Temperature



TPC 7. Voltage Noise Density vs. Supply Voltage



TPC 8. Current Noise Density vs. Frequency



TPC 9. Supply Current vs. Supply Voltage

Noise analysis plan 1

Req=1.468kΩ

BW=1kHz

BWn=1.57kHz

enf =1.2× √ ln(1.57kHz/0.1Hz)nV=3.7nV

enBB= e_{nBB} **× √ BWn=3× √ 1570=118.8nV**

en-v= √ enf^2+ enBB^2=118.9nV

en-i=Req×einBB× √ BWn=17.5nV

en-R= √ 4KTReqBWn=0.195uV

en-RTL= √ en-v^2+ en-i^2+enR^2=0.230uV

仪表放大器噪声

由于仪表放大器主要用于放大微小精密信号，因此，有必要了解所有相关噪声源的效应。仪表放大器模型如下面图1所示。

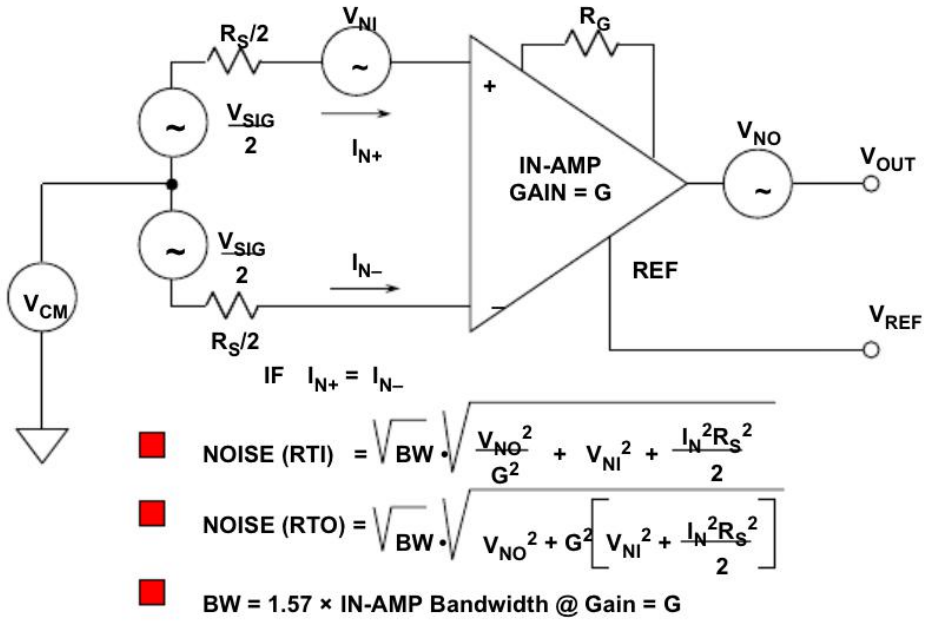


图1：仪表放大器噪声模型

Noise analysis plan 2

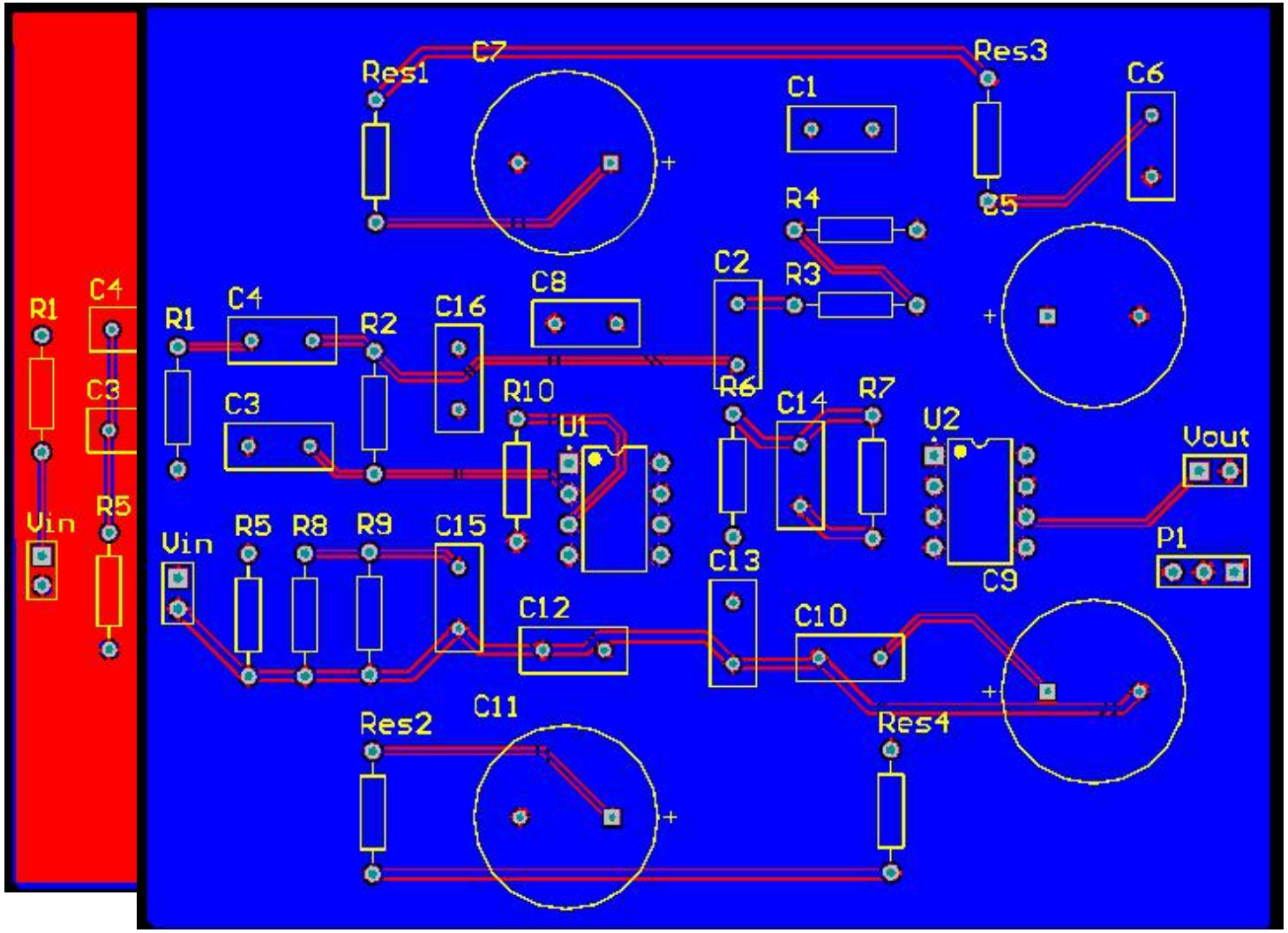
RTI1= $\sqrt{\mathrm{BWn}} \times \sqrt{\frac{\mathrm{V_n^2}}{\mathrm{G^2}} + V_n^2 + \frac{I_\mathrm{n}^2 R^2}{2}}$ =914.39nv

（BW=5kHz BWn=6.1kHz）

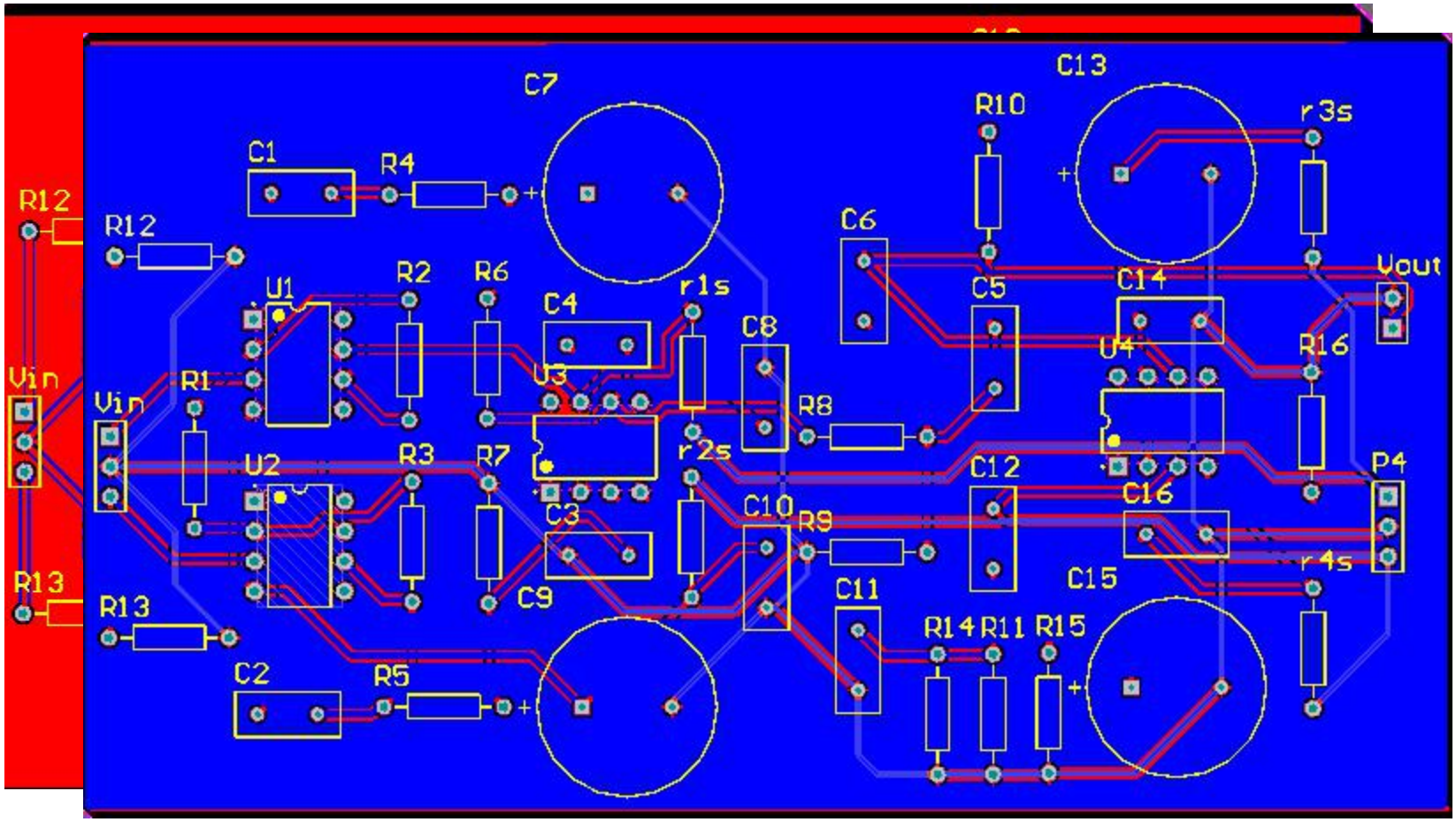
RTI2=0.308uV/11=28nv

RTI=0.915uv

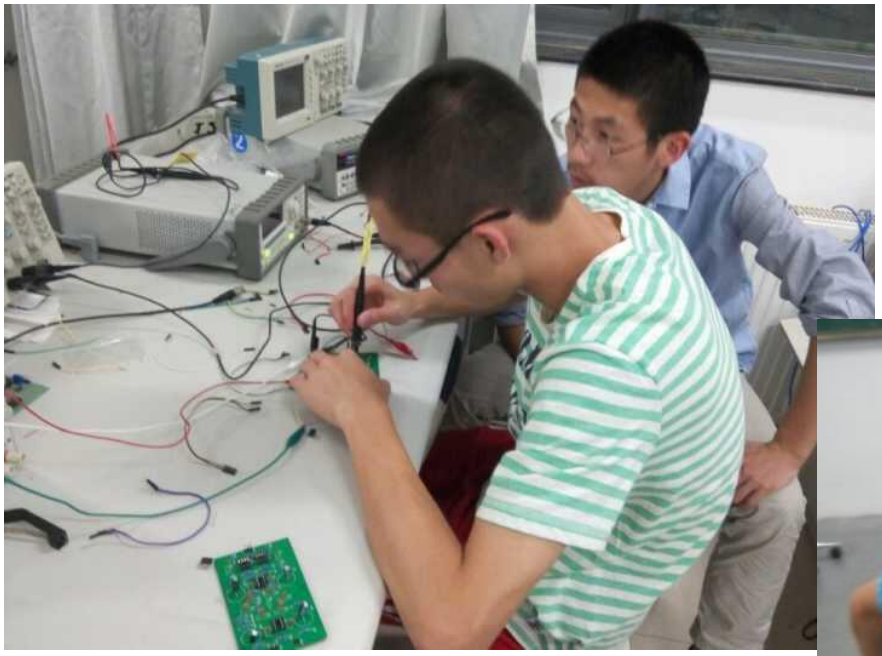
PCB of Plan 1

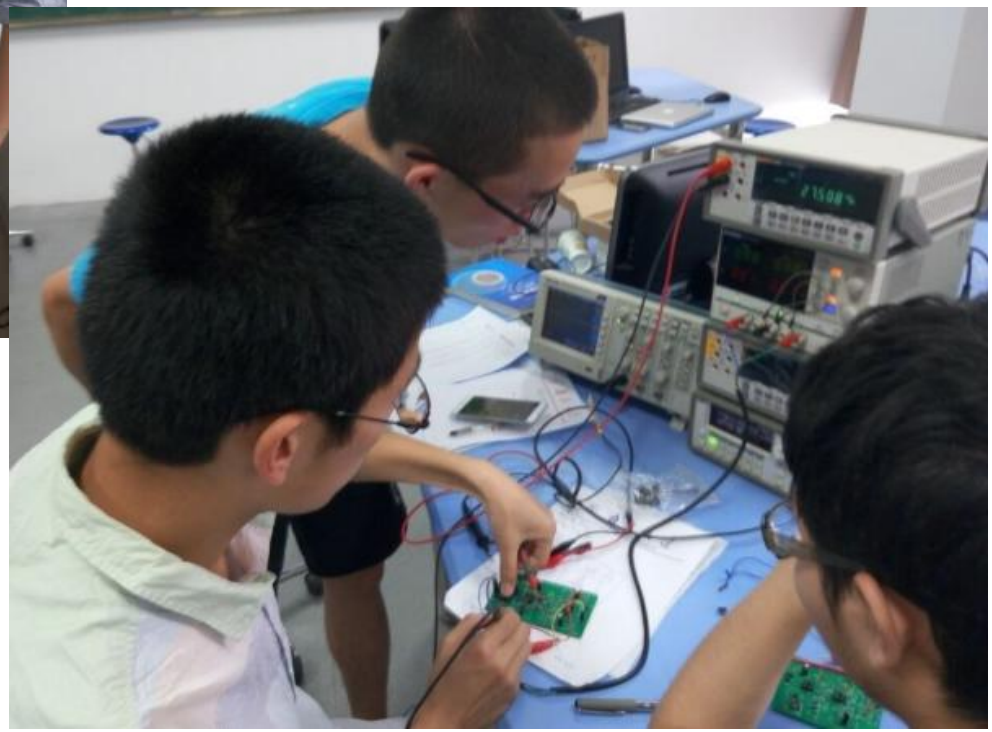

C7
Res1
Res3
C6
C1
C5
R4
R3
C2
C8
C16
R2
C4
R1
C3
R10
U1
R6
C14
R7
U2
Vout
P1
C9
C13
C10
C12
C11
Res2
Res4
Vin
R5
R8
R9
C15

PCB of Plan 2

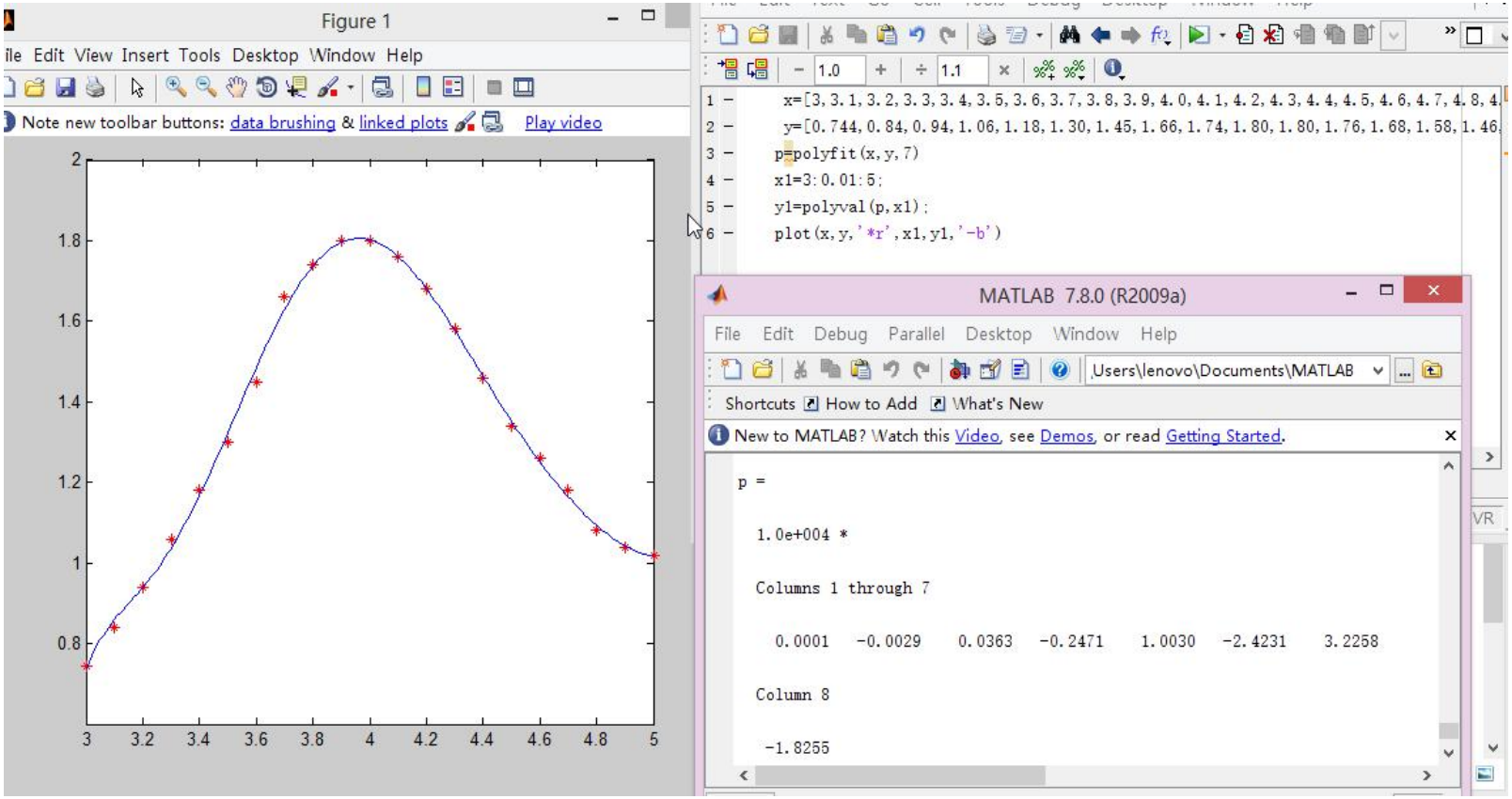

C7
C1
R4
R12
R12
U1
R2
R6
C4
r1s
C8
C6
R10
C13
r3s
C5
C14
Vout
U4
R16
Vin
Vin
R1
U3
R8
U2
R3
R7
r2s
C12
P4
C16
C3
C10
R9
C9
r4s
C15
R13
R13
C11
R14
R11
R15
C2
R5

Process

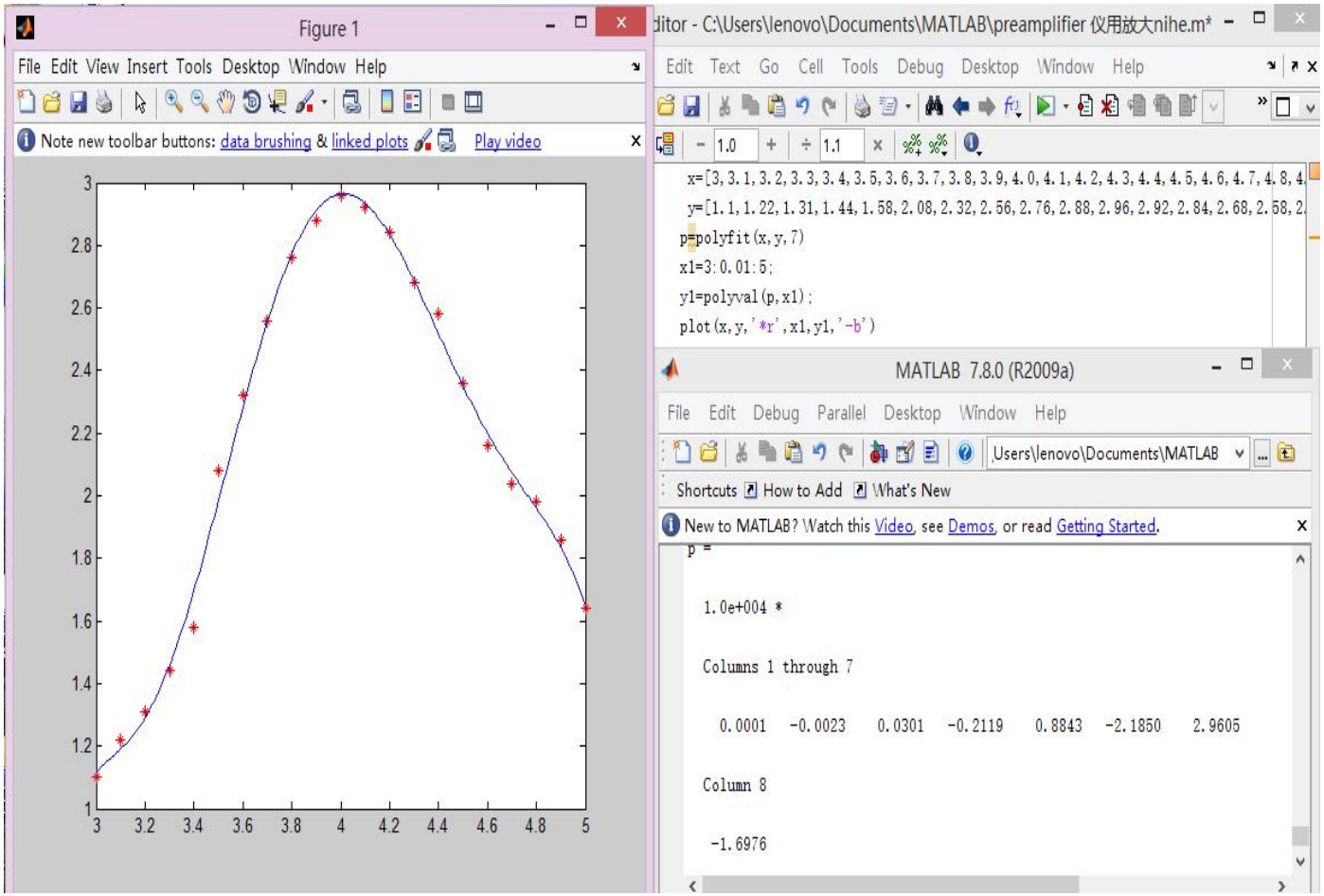




Analysis of plan 1



Analysis of plan 2



Analysis

Plan 1 f_0=4.0kHz （3.4kHz-4.6kHz）
A=1670
$V_{\text{i-noise}}$ =62.6uv

plan2 f_0=4.0kHz （3.5kHz-4.7kHz）
A=2040
$V_{\text{i-noise}}$ =7.68uv

Thank you