Demystifying Noise – KWIK Labs

Ed Mullins, Principal Applications Engineer

Low-Frequency Noise Demo

Agenda

0.1 Hz to 10 Hz Demo

- In this demo we are going to estimate-simulate-measure the 0.1 Hz to 10 Hz noise for three different amplifiers:
  - LT1782 – a low power opamp
  - ADA4077 – a low noise opamp
  - ADA4522 – a low noise, zero-drift opamp
- **Estimate noise from the data sheet** information
- Perform a **noise simulation** with LTSpice
- Use the ADALM2000 + demo board and **measure the noise**
- **Compare** our measured results to our estimated results
- We will use the Network Analyzer feature of the ADALM2000 to measure the actual filter response from 1 Hz to 100 Hz

Signal Chain Designer Demo

- **Simulate** the circuit on Signal Chain Designer + Filter Wizard and compare the results

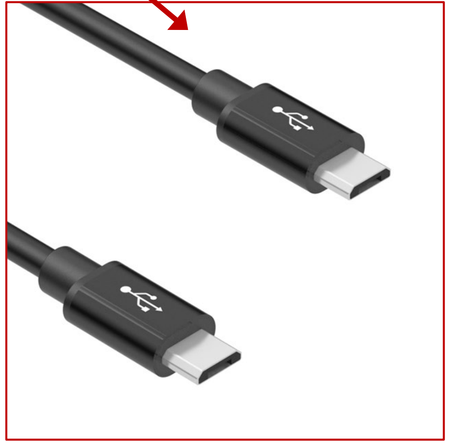
Hardware for the Demo

- **Laptop**
- **[ADALM2000]**
- **Cables**
  - ADALM2000 comes with a USB-Micro male to USB-A male *cable*.
  - If using ADALM2000 *cable* in kit need your own USB-Micro male to USB-A female connection for most modern PCs.
  - Or use your own USB-Micro male to USB-Micro male cable for most modern PCs.
- **Noise Demo Board & one jumper**

Has This

Need This

Or This



Software for the Demo

- Scopy
  - Download and Install Software for Scope, Power Supplies, etc. control of ADALM2000
  - For Windows download & install: *Installer for latest release (Windows 64/32-bit)*

analogdevicesinc / **scopy** Public

scopy-v1.4.1-Windows-setup.exe

- Libm2k
  - Download and Install C++ Library for interface to ADALM2000

Go to the latest release page and download the package that fits your system.

analogdevicesinc / **libm2k** Public

libm2k-0.8.0-Windows-setup.exe

- Low Frequency Noise KWIK Lecture + Lab
  - Download Config Files:

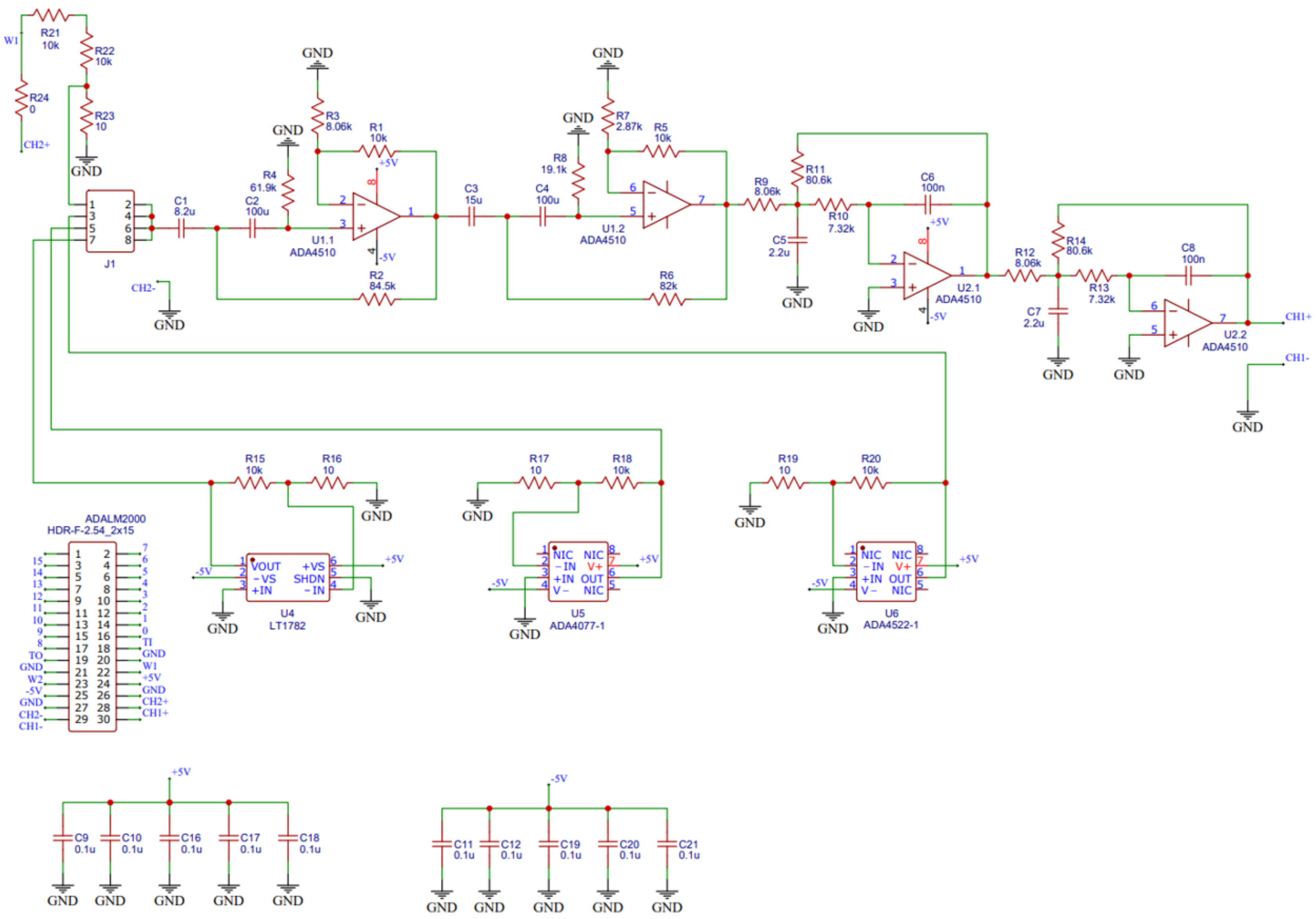
ADALM2000 Configuration Files

Configuration files for the ADALM2000 can be found at demystifying_noise_adalm2000_config_files.zip

The Setup

+ You!

0.1 Hz to 10 Hz Demo Board Schematic



0.1 Hz to 10 Hz Demo Board Explanation

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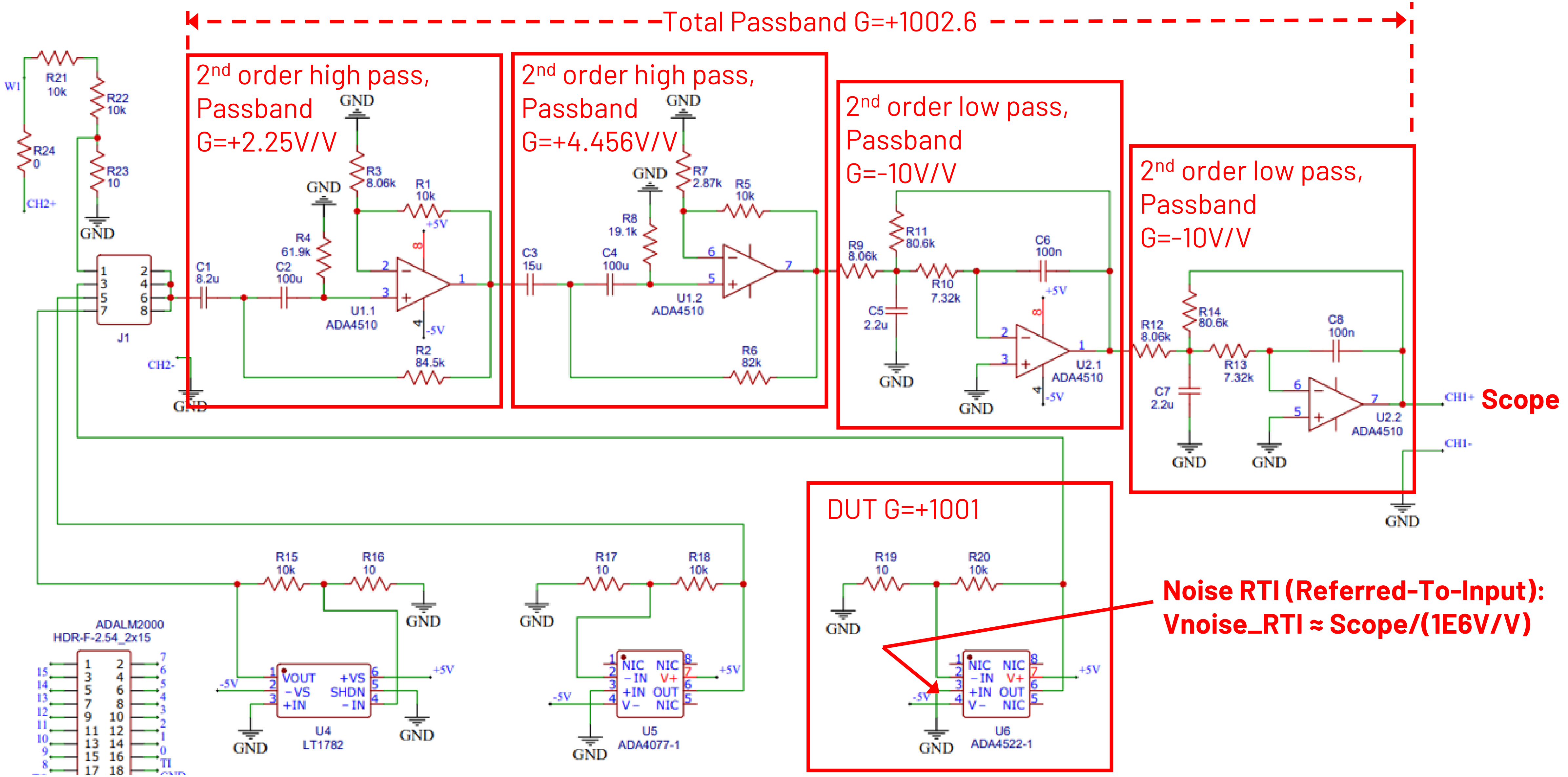

ADA4510: Precision, 40 V, Low Input Bias, Low Noise, CMOS Op Amp

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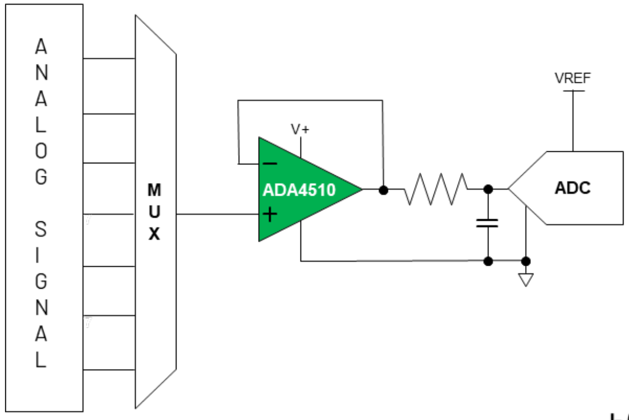
Key Features:

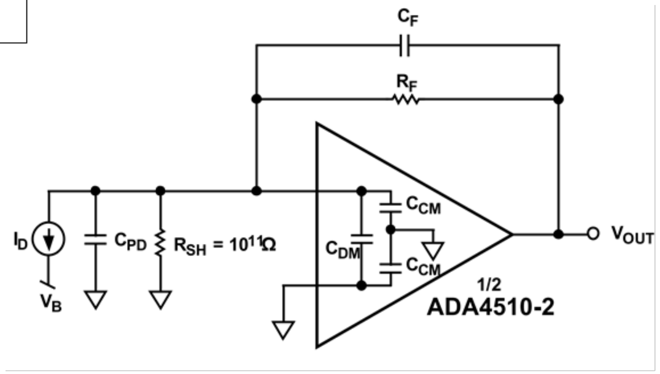
- Low Offset Voltage: **±5µV** typ., **±20µV** max
- Low Offset Voltage Drift: **0.5µV/°C** max
- Low Noise: **5nV/√Hz** @ 1kHz and **1.0µVp-p** typ. from 0.1 to 10Hz
- Wide GBW: **10.4MHz** typ.
- Fast Slew Rate: **19V/µs** typ.
- Low Input Bias Current: **10pA** max
- Heavy Capacitive Load Drive Capability: 1nF
- Integrated EMI Filter

Key Applications:

- Mux-Compatible
- Precision Instrumentation
- Data acquisition systems
- Multipole filters



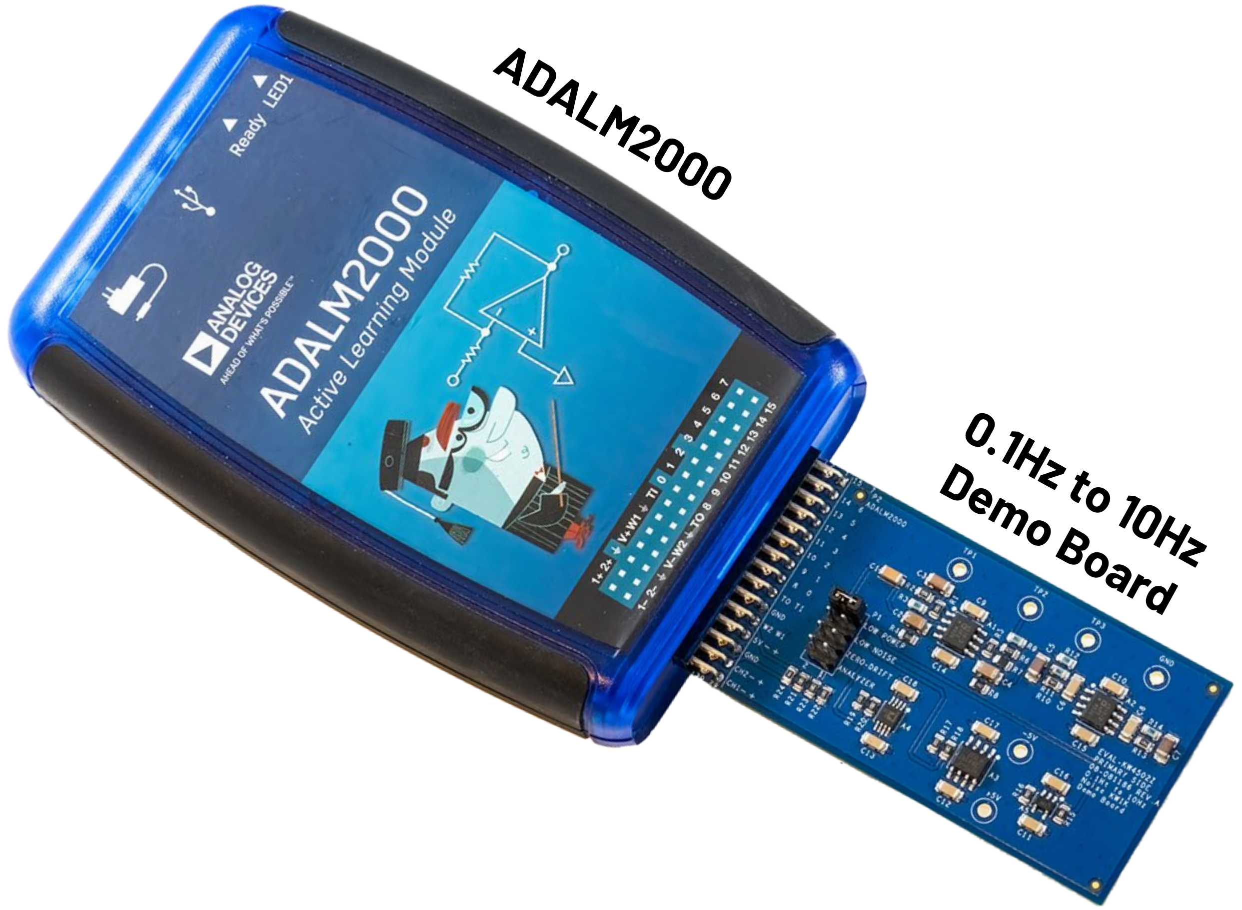
Multiplexed Data Acquisition System



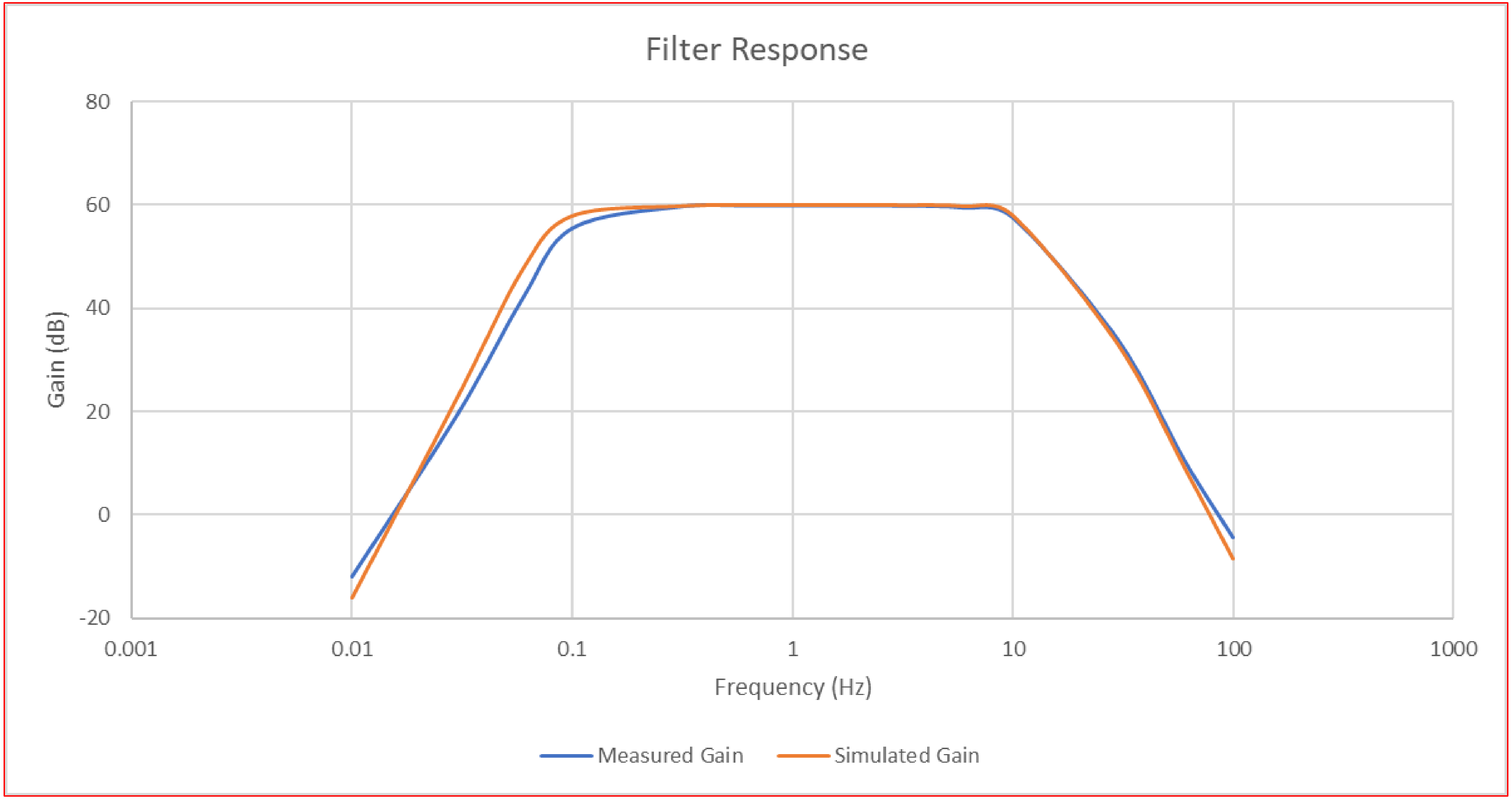
Photodiode TIA Circuit

	ADA4510	Competitor
Offset Voltage (Max)	20 µV	25 µV
1/f Noise	1.0 µVp-p	1.3 µVp-p
Voltage Noise Density	5 nV/√Hz	5.5 nV/√Hz

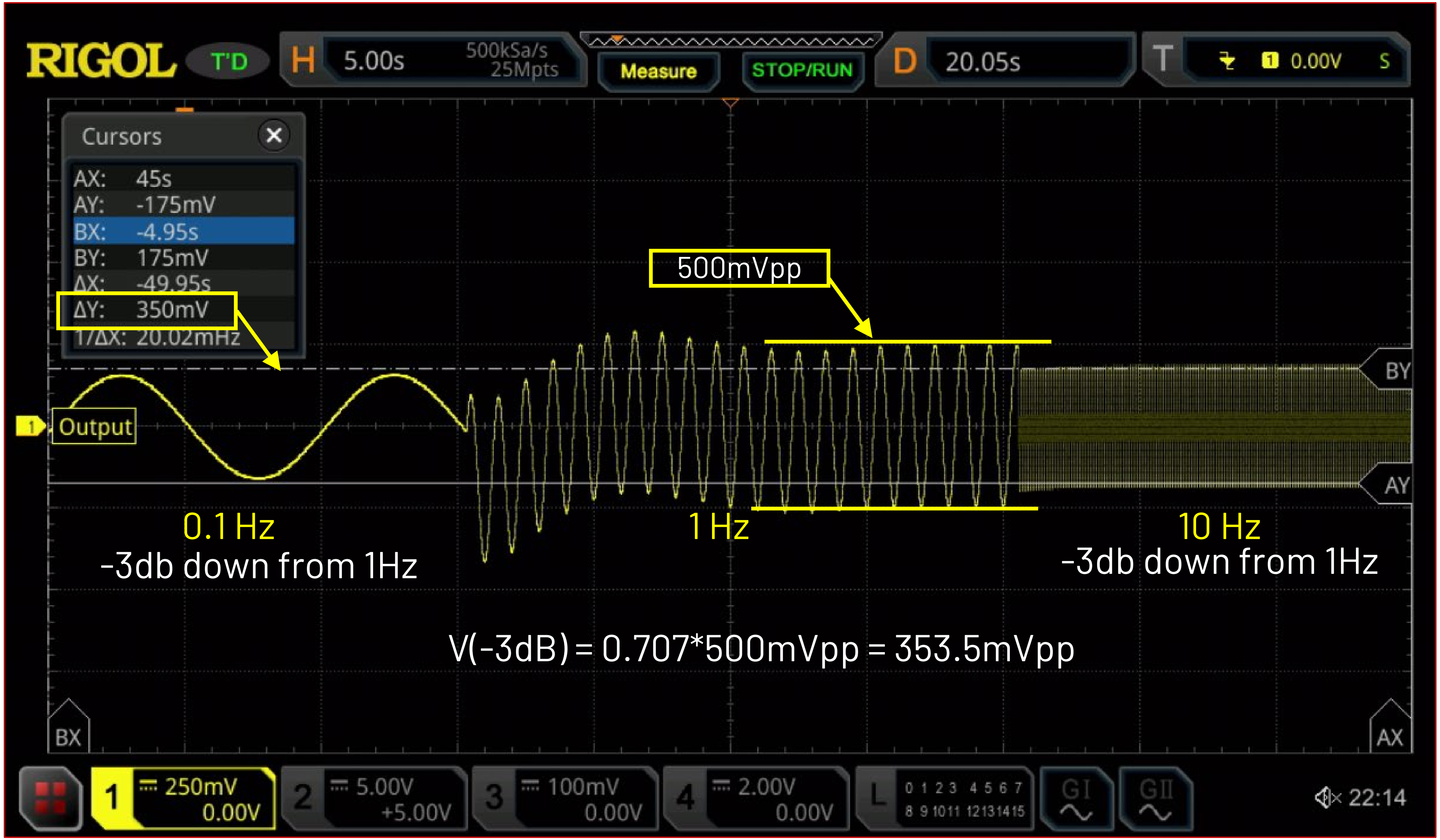
0.1 Hz to 10 Hz Demo Board



0.1 Hz to 10 Hz Demo Board Verification Results



0.1 Hz to 10 Hz Demo Board Verification Results



0.1 Hz to 10 Hz Demo

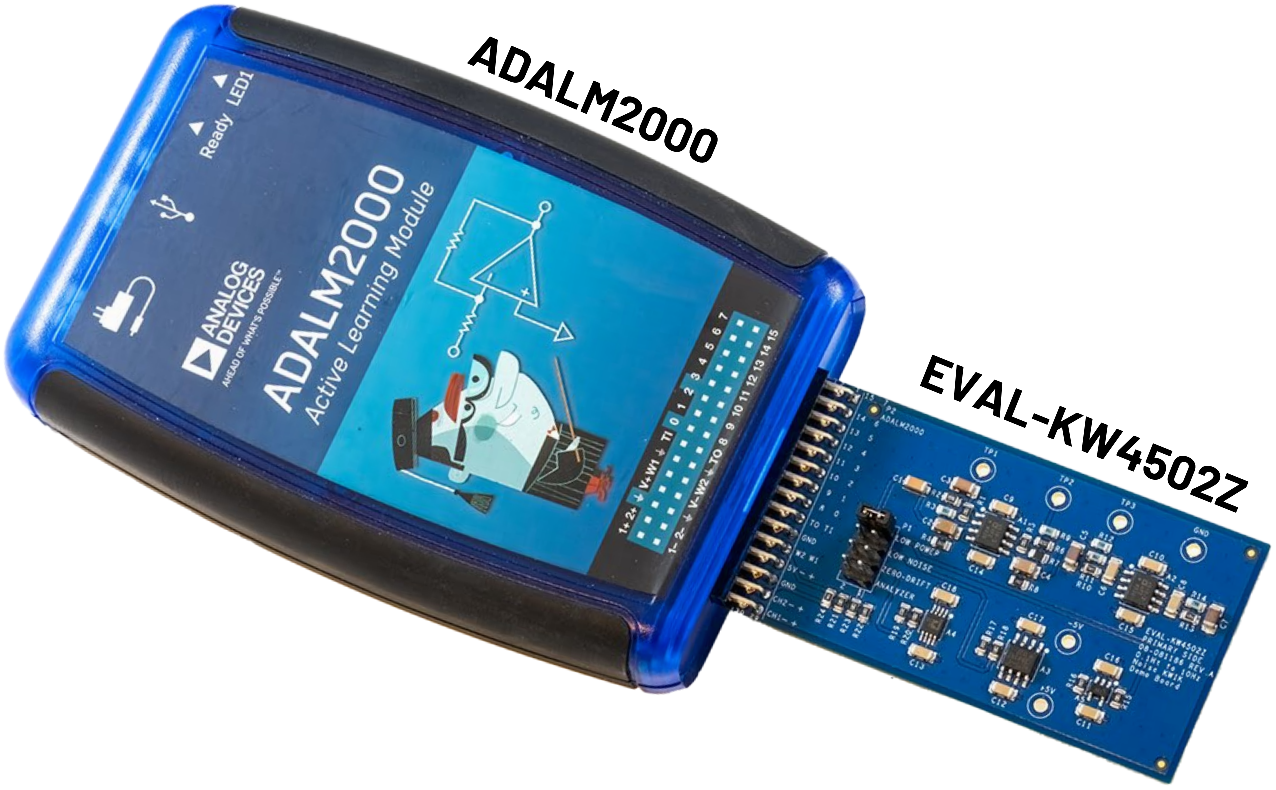
- In this demo we are going to estimate the 0.1 Hz to 10 Hz noise for three different amplifiers
  - LT1782 – a low power opamp
  - ADA4077 – a low noise, bipolar opamp
  - ADA4522 – a low noise, zero-drift opamp
- We will compare the estimate to the data sheet information
- We will use the ADALM2000 + demo board and measure the noise
- We will compare our measured results to our estimated results
- We will use the Network Analyzer feature of the ADALM2000 to measure the filter response from 1 Hz to 100 Hz

0.1 Hz to 10 Hz Noise KWIK LAB Step-by-Step Guide

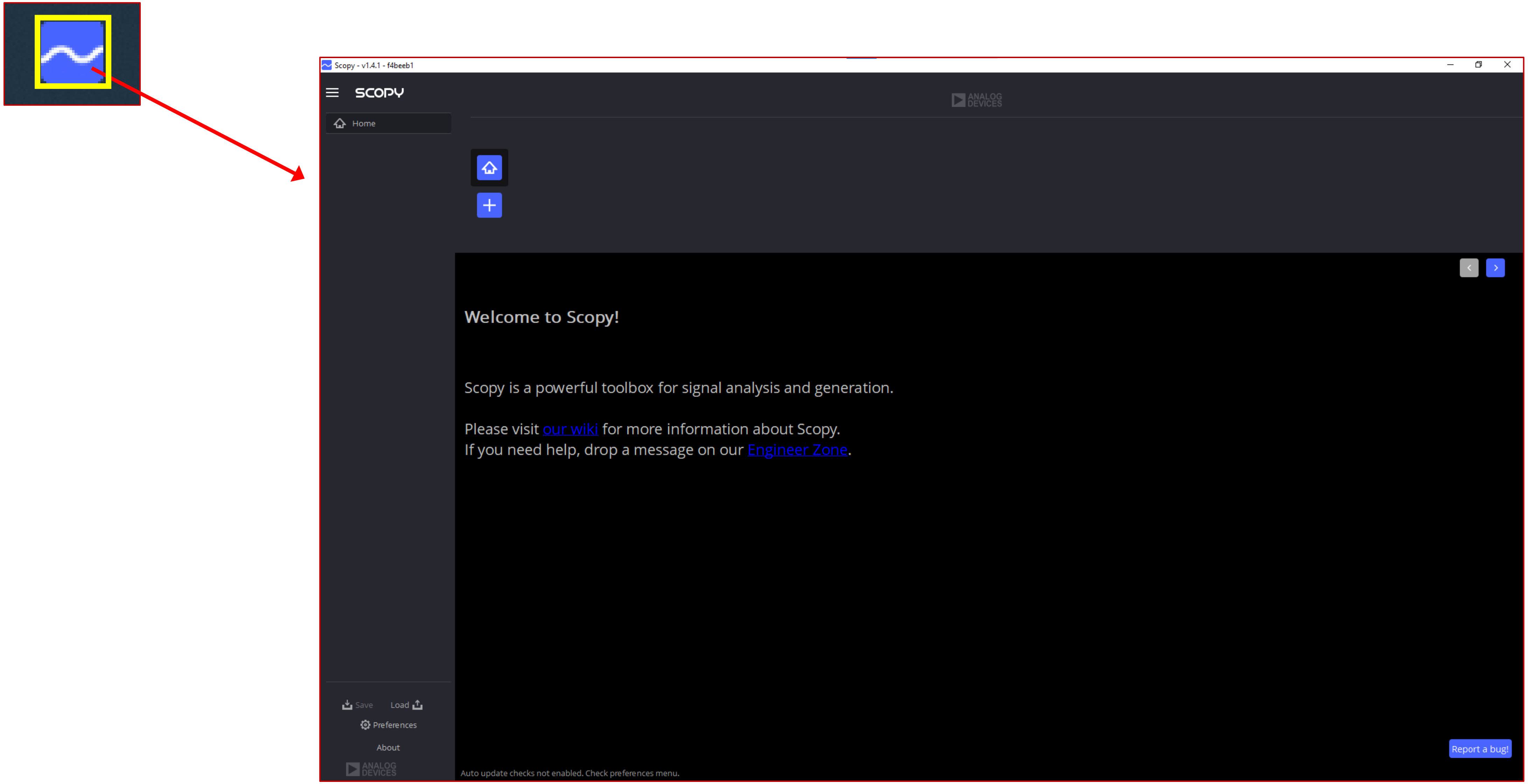
Physically Connect PCB to ADALM2k

Using EVAL-KW4502Z:

- ✓ Carefully align pins and insert firmly.
- ✓ Note PCB connector is not keyed, and PCB must be connected as shown!
- ✓ ADALM2000 should be powered off when connecting or disconnecting the PCB.

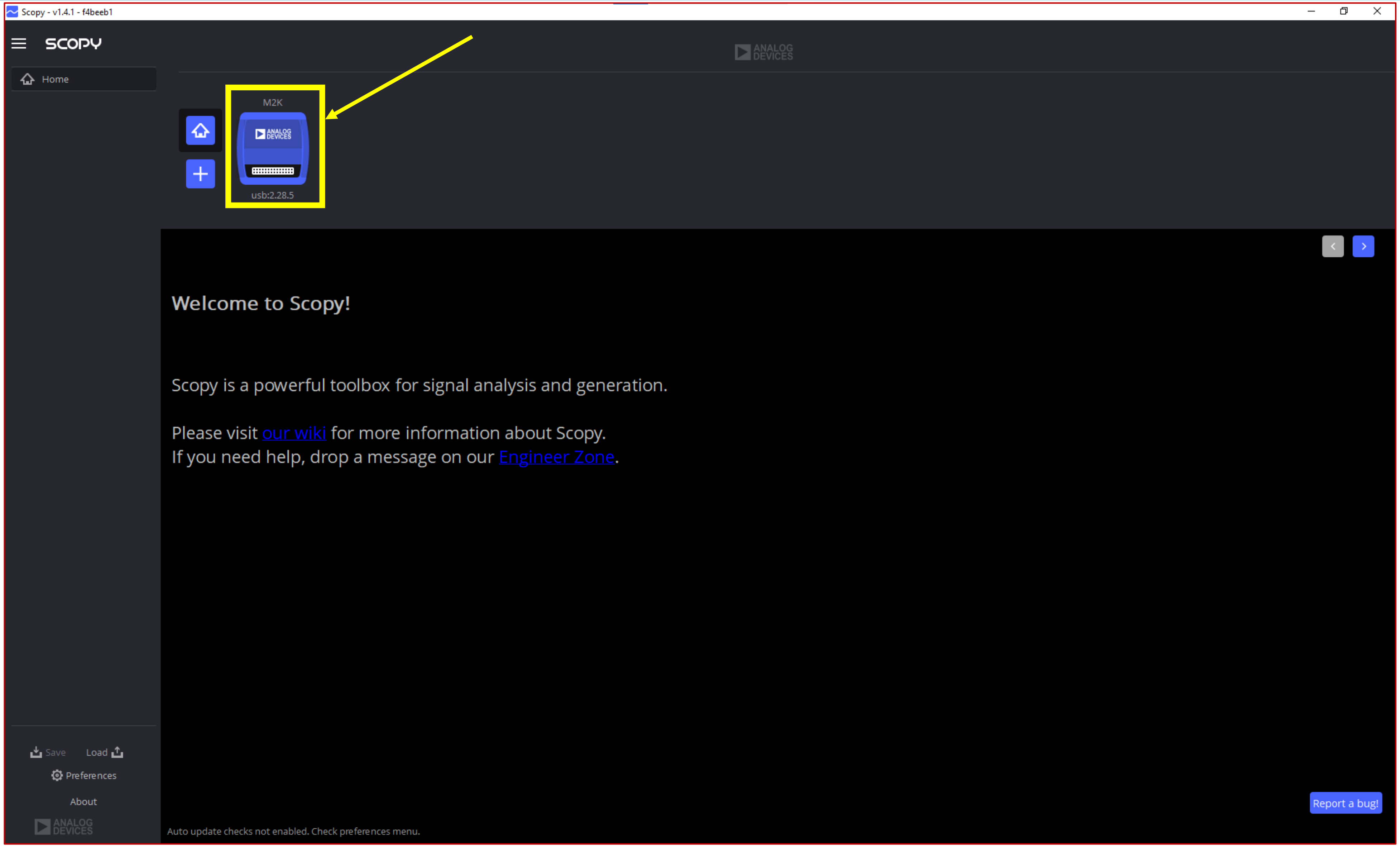


Launch the Scopy Software

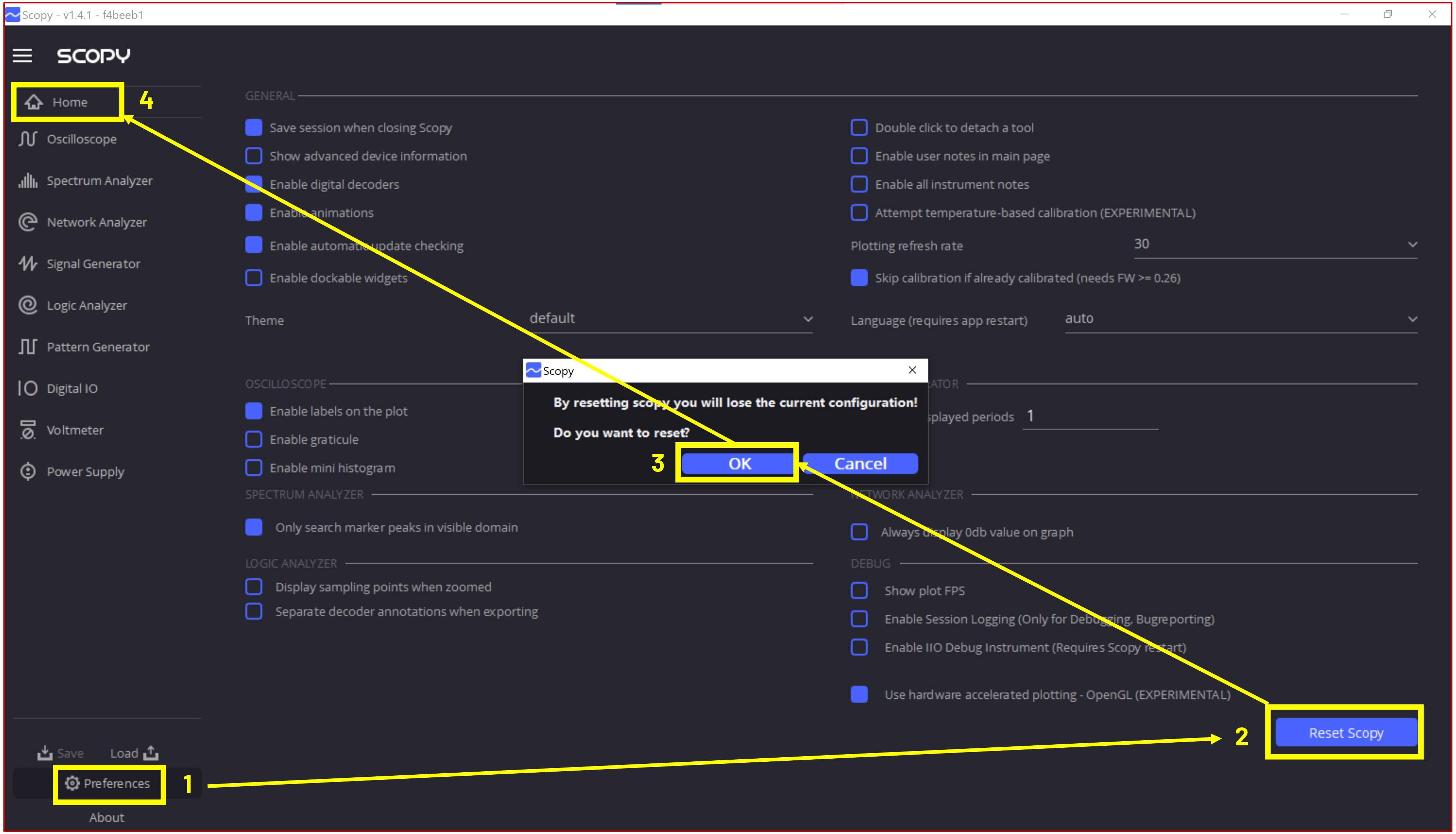


Physically Connect the ADALM2k to the Laptop

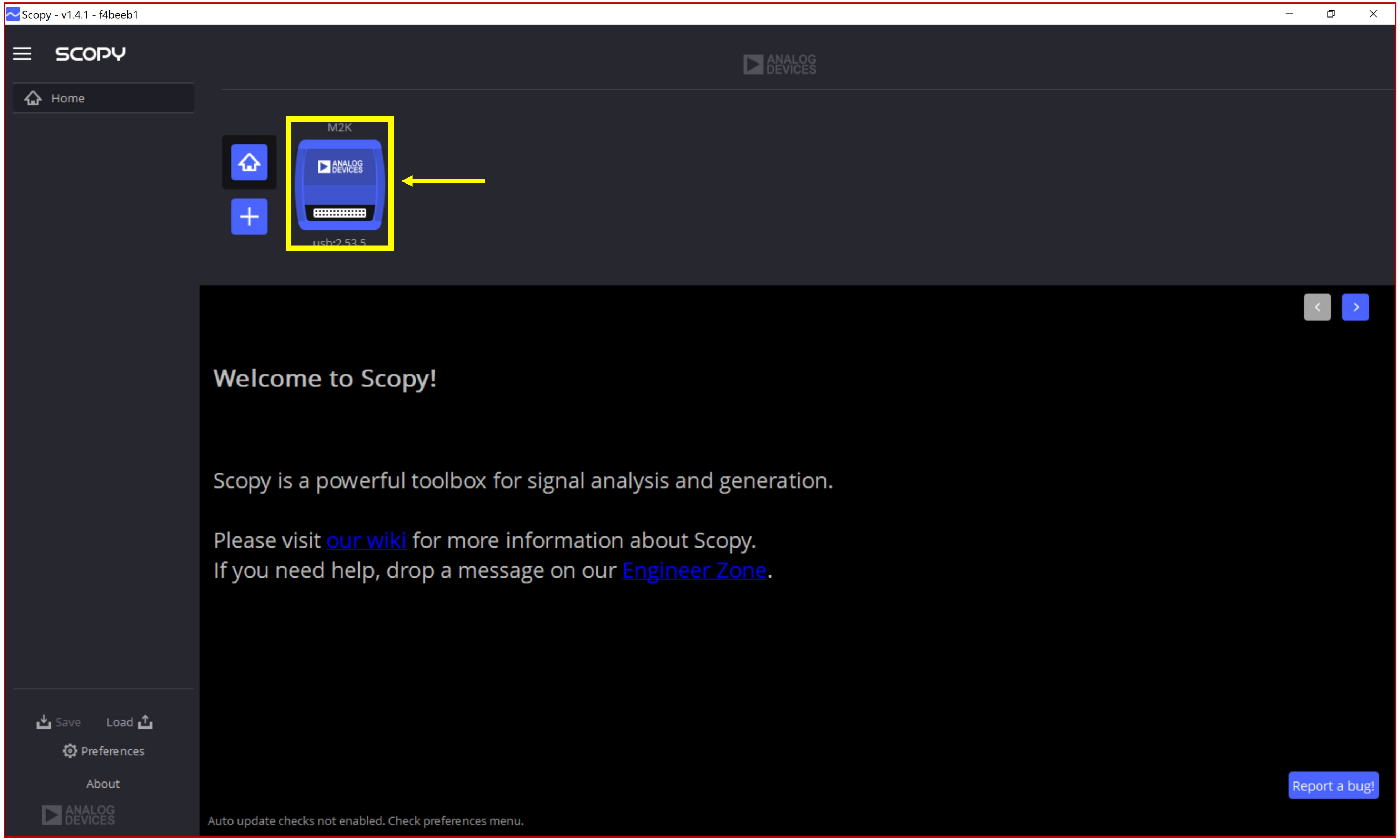
Click on the "M2K" Icon



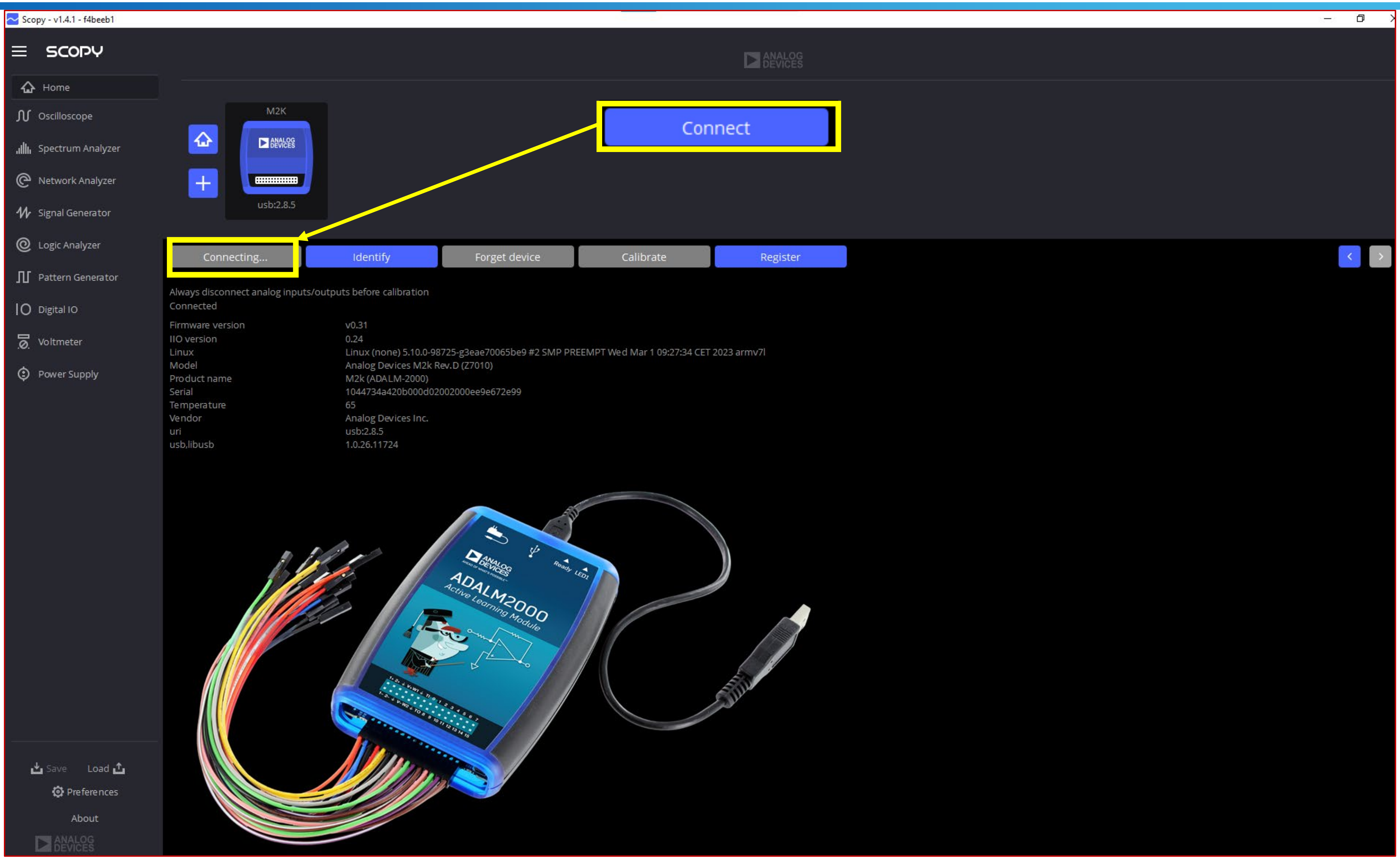
Reset Scopy to Factory Defaults...1,2,3



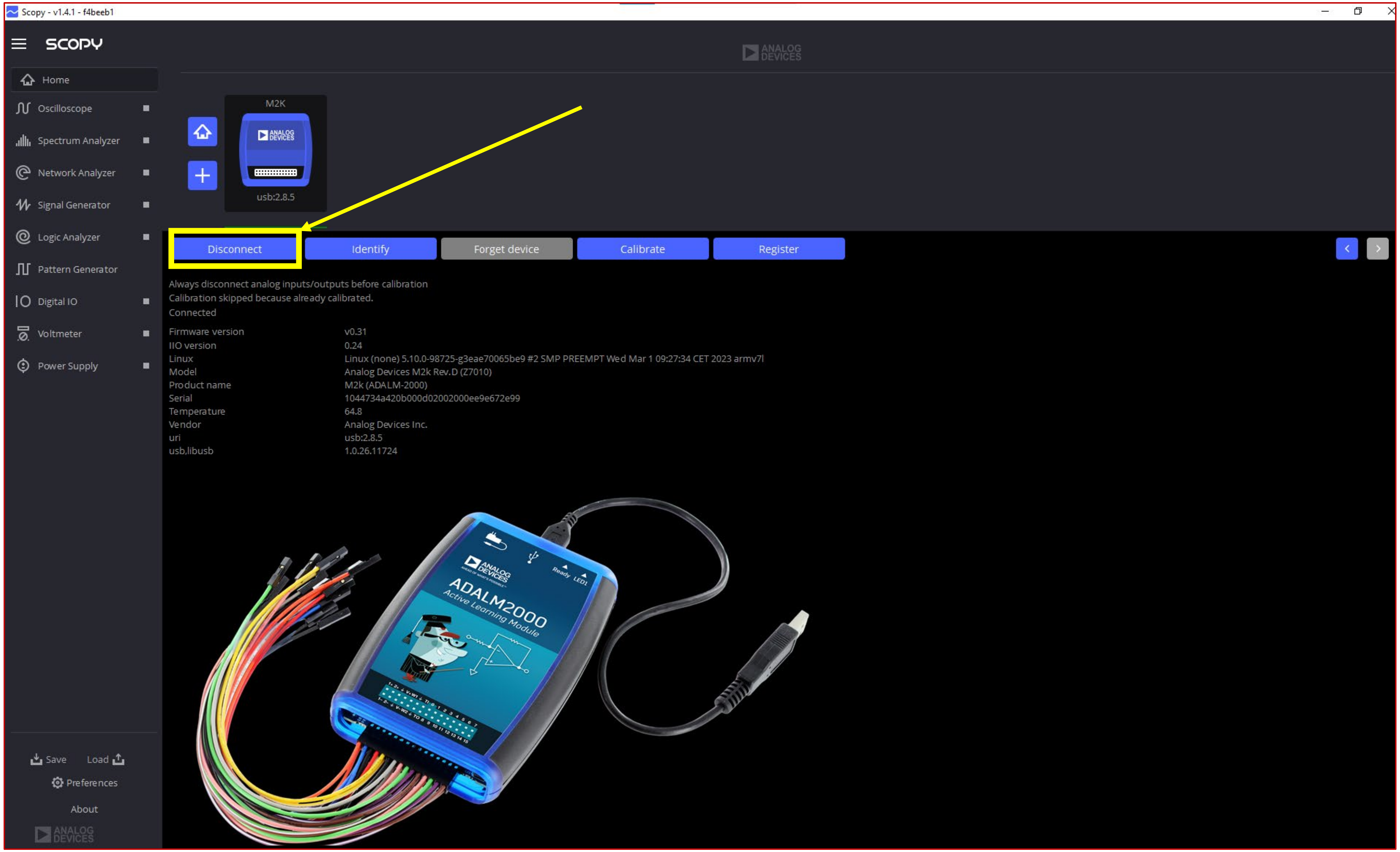
Click "M2K" Icon!



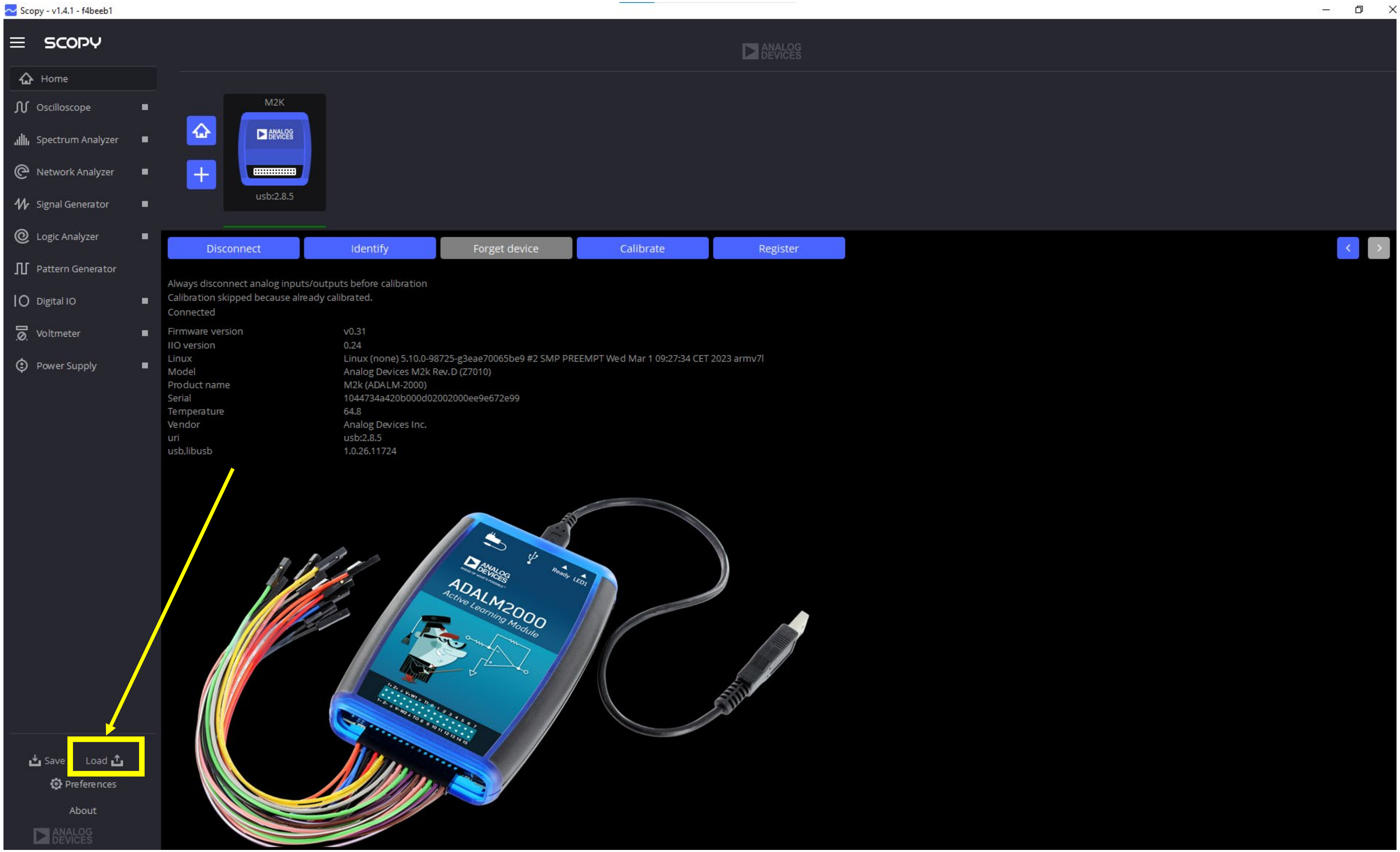
Click “Connect” & ADALM2k will Begin Connecting



Successful Connection Looks Like This



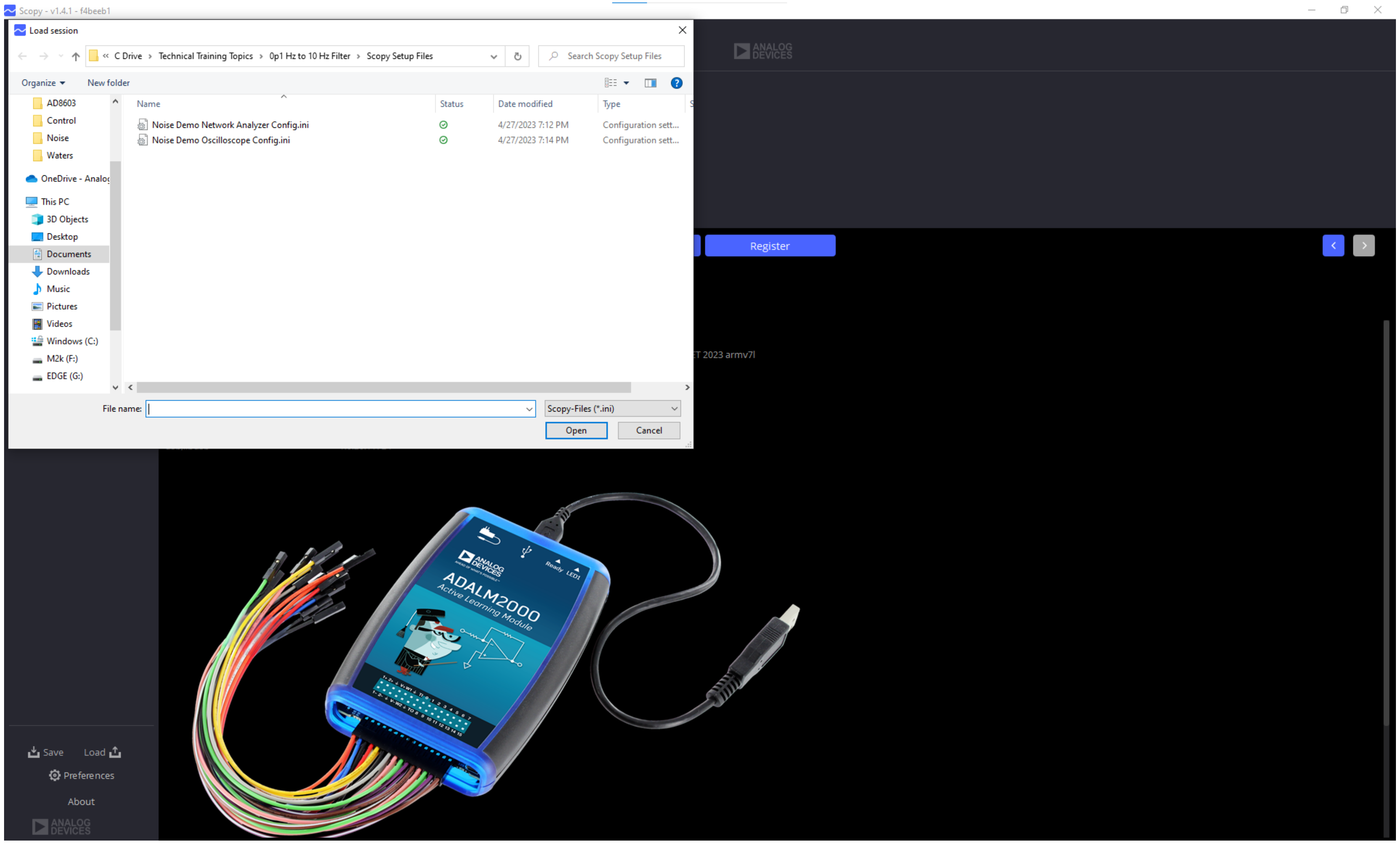
Load the Config Files



Navigate to the Config File Location

Scopy ini

Noise Demo Oscilloscope Config.ini



After Loading the Config.ini File

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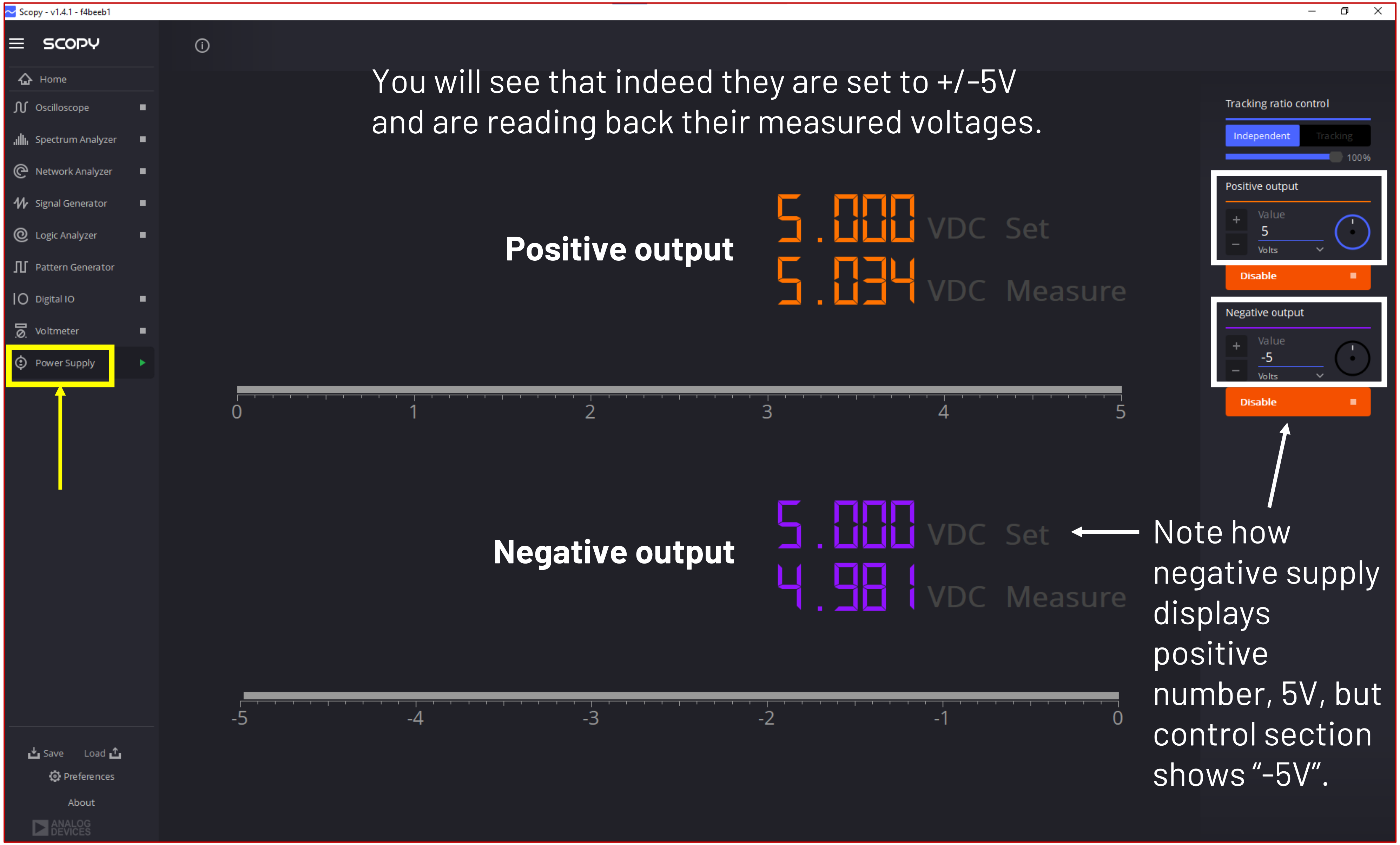
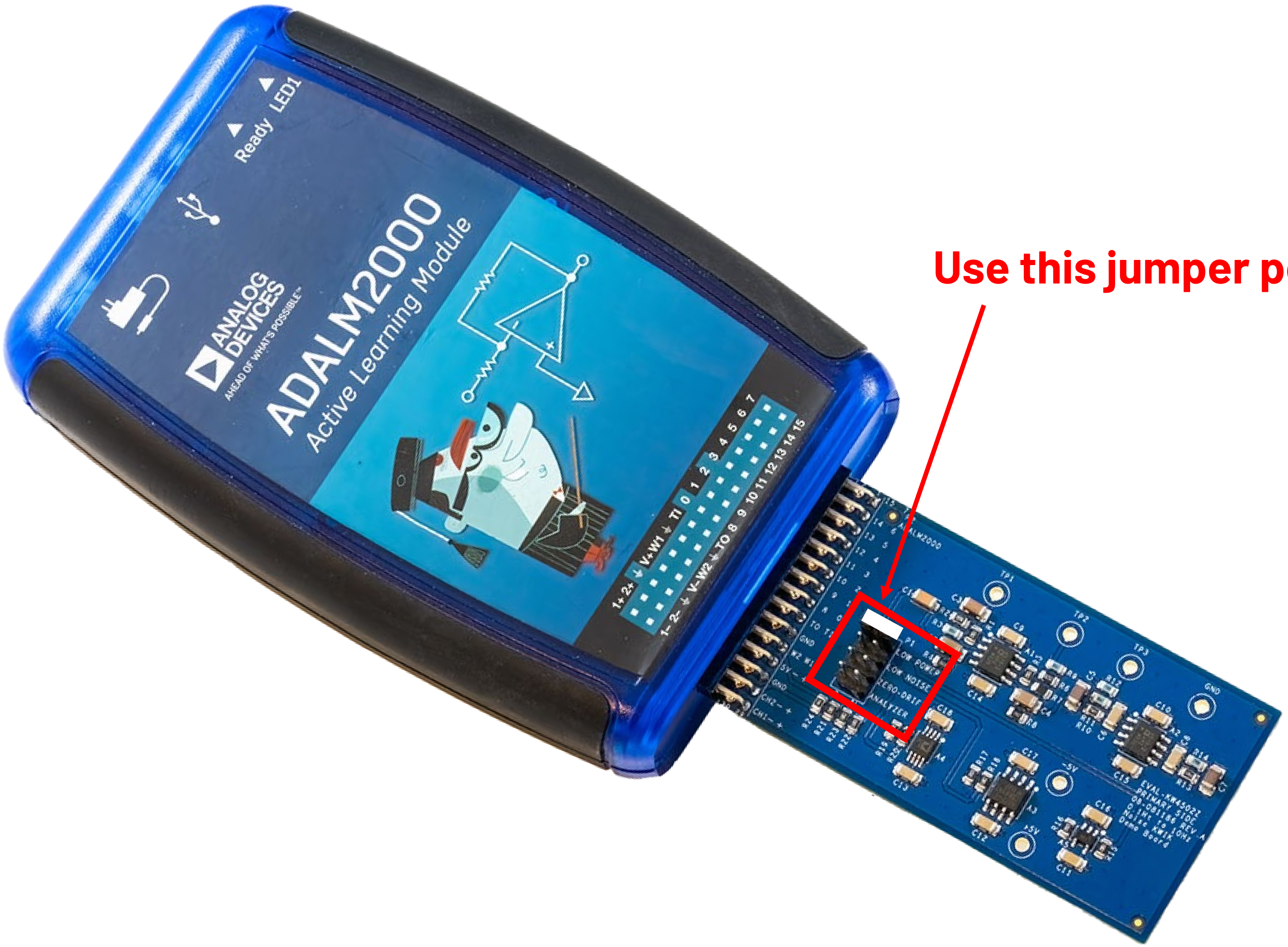
If You Click on the Power Supply ***Label*** *only*



You will see that indeed they are set to +/-5V and are reading back their measured voltages.

Note how negative supply displays positive number, 5V, but control section shows “-5V”.

Set the Jumper to “Low Power”



Select “Oscilloscope” Label & click Green “Run” Button

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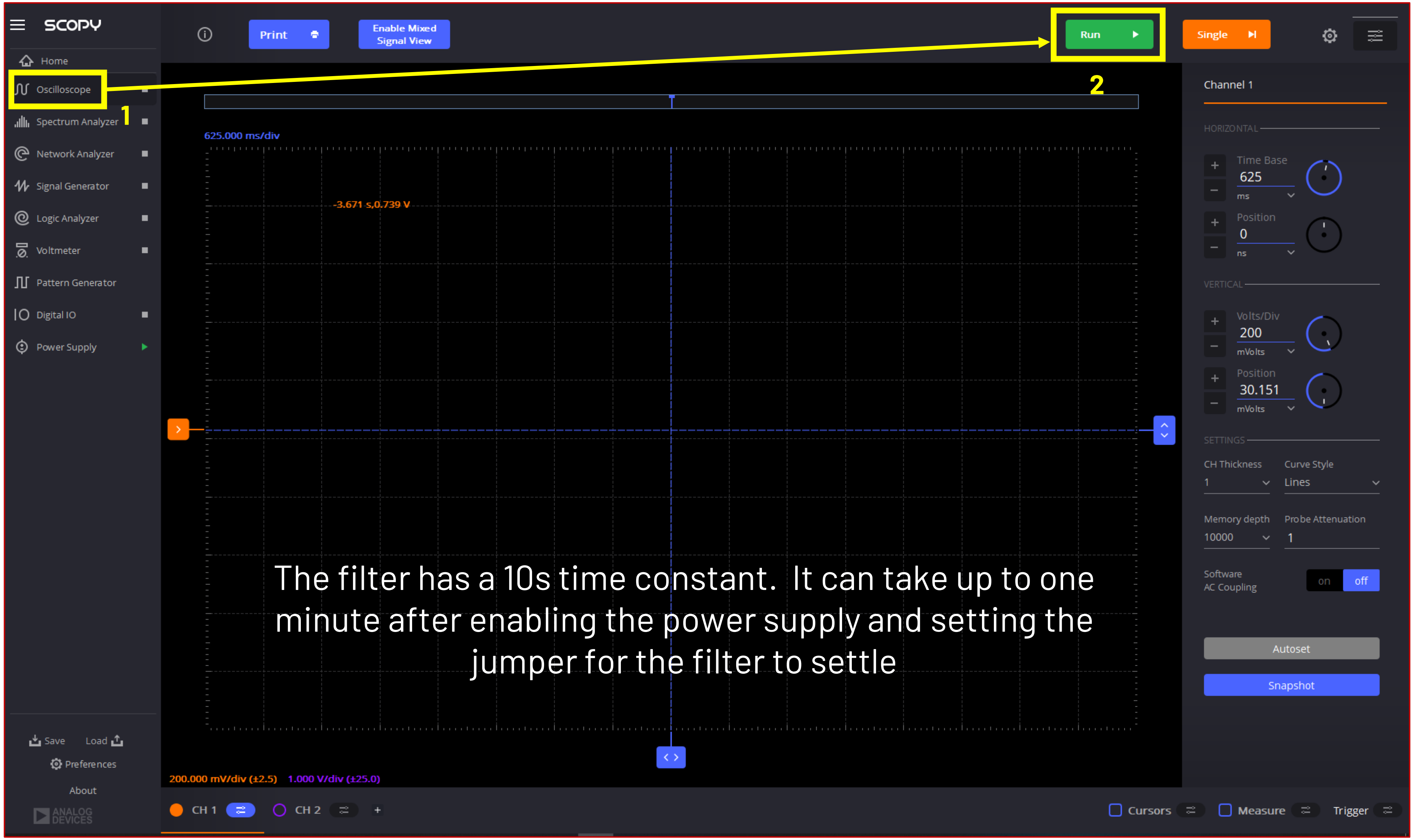

Let’s Estimate the 1/f Noise for the LT1782

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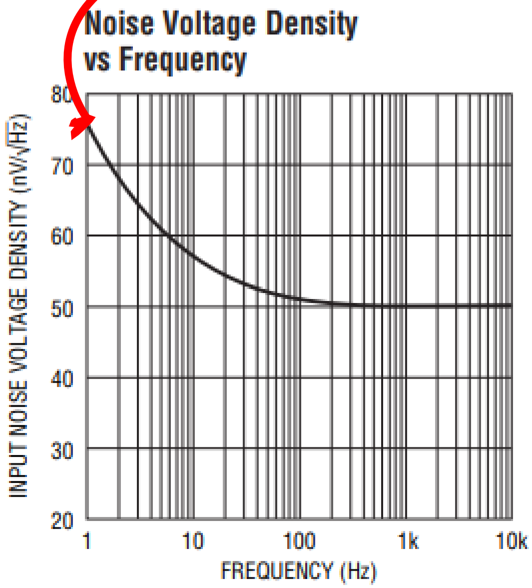
While the filter is settling, let’s take a minute to estimate the low frequency noise:



From the data sheet curve, we can estimate the 1Hz 1/f noise at 75nV/SQRT-Hz.

We will integrate from 0.1 Hz to 10 Hz.

Calculation:

$$V_{\frac{1}{f}} = 6.6 \times \boxed{e_{1Hz} \times \sqrt{\ln\left(\frac{f_{HIGH}}{f_{LOW}}\right)}} = 6.6 \times 75e^{-9} \times \sqrt{\ln\left(\frac{10}{0.1}\right)} = 1.06\mu V_{PP}$$

Vrms to Vpp

Vrms

Noise Spectral Density @1Hz

Let's Compare our Estimate to the LT1782 Datasheet

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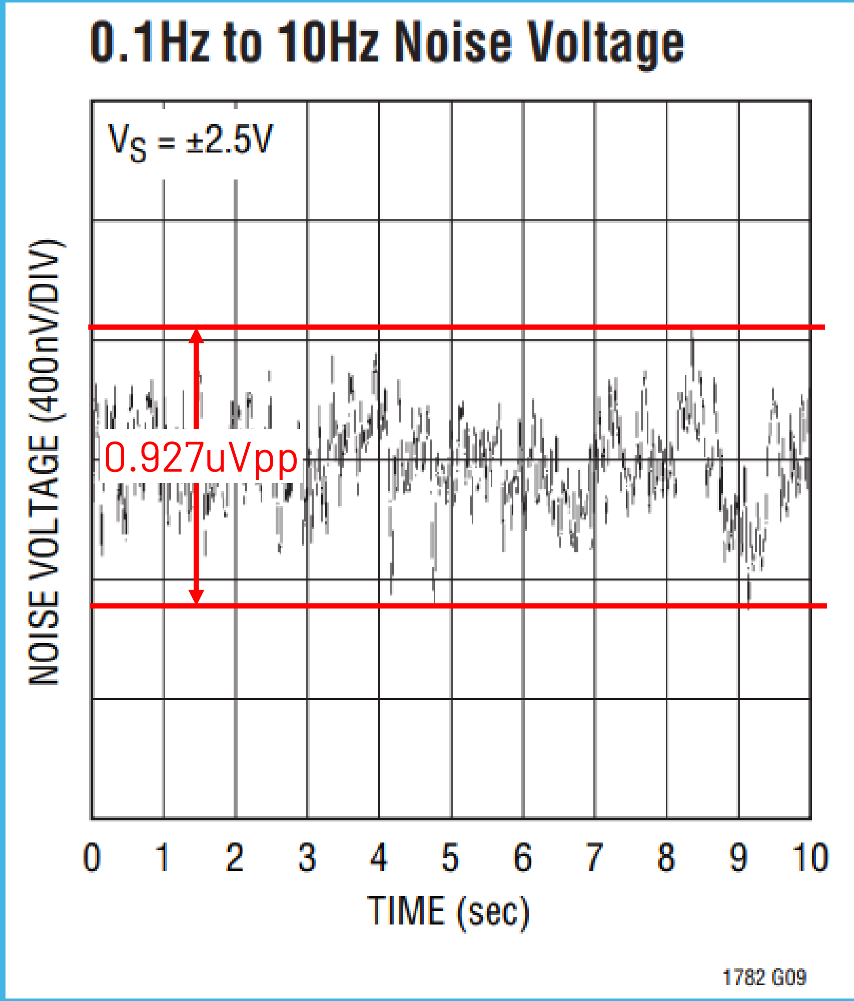
Data Sheet:

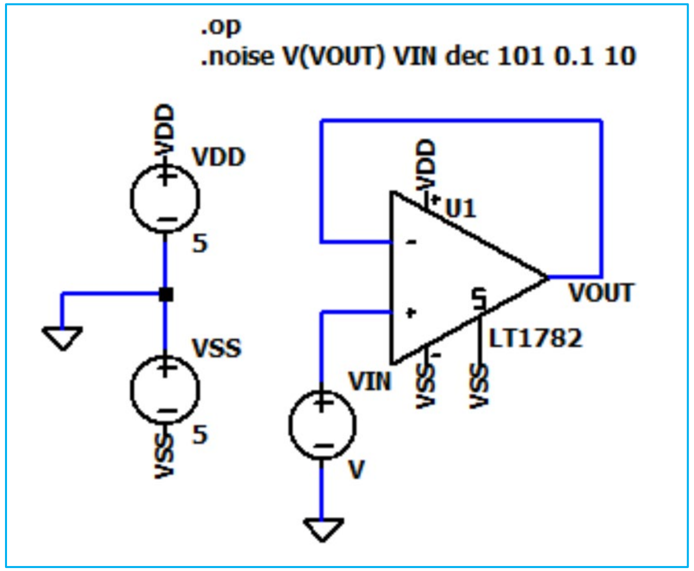
PARAMETER	CONDITIONS	LT1782C/LT1782I MIN	TYP	MAX	UNITS
Input Noise Voltage	0.1Hz to 10Hz		1		µVP-P

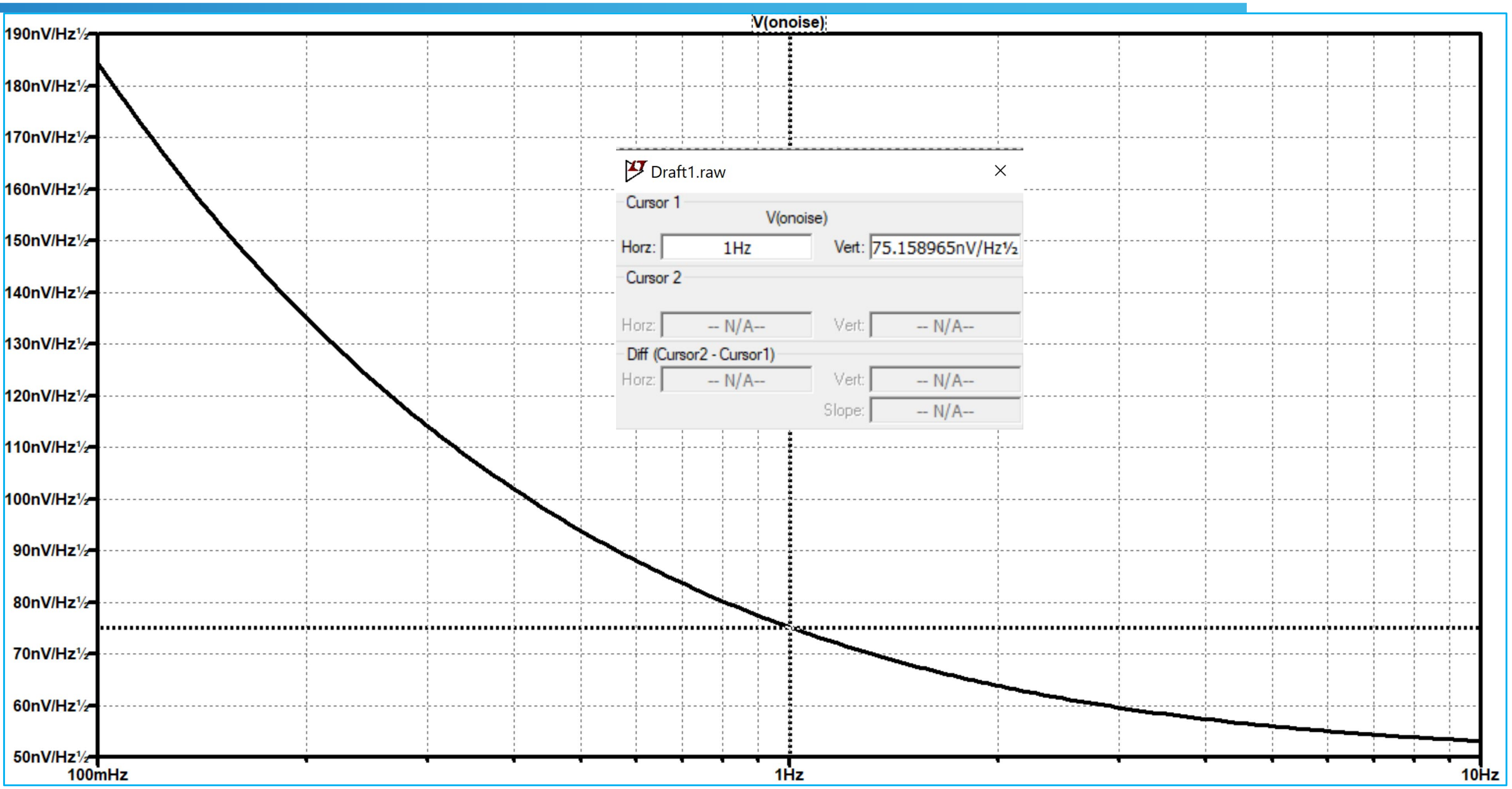


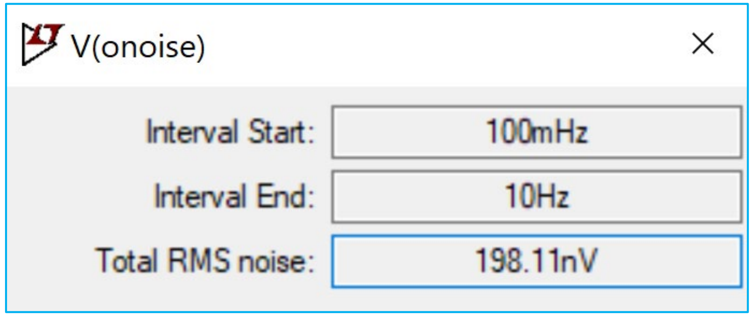
Estimate:

$$V_{\frac{1}{f}} = 6.6\times e_{1Hz}\times\sqrt{\ln\left(\frac{f_{HIGH}}{f_{LOW}}\right)} = 6.6\times 75e^{-9}\times\sqrt{\ln\left(\frac{10}{0.1}\right)} = \boxed{1.06\mu V_{PP}}$$

LT1782 Noise Analysis in LTspice







Vnoise_pp = 198.11nVrms * 6.6 = 1.3uVpp

Enable Measurements

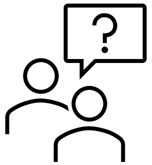
Typical Result for the Low Power Device

The Low Power device, LT1782, Vnoise_RTI = 1.356/1E6 = 1.356uVpp

Comparison LT1782 Noise

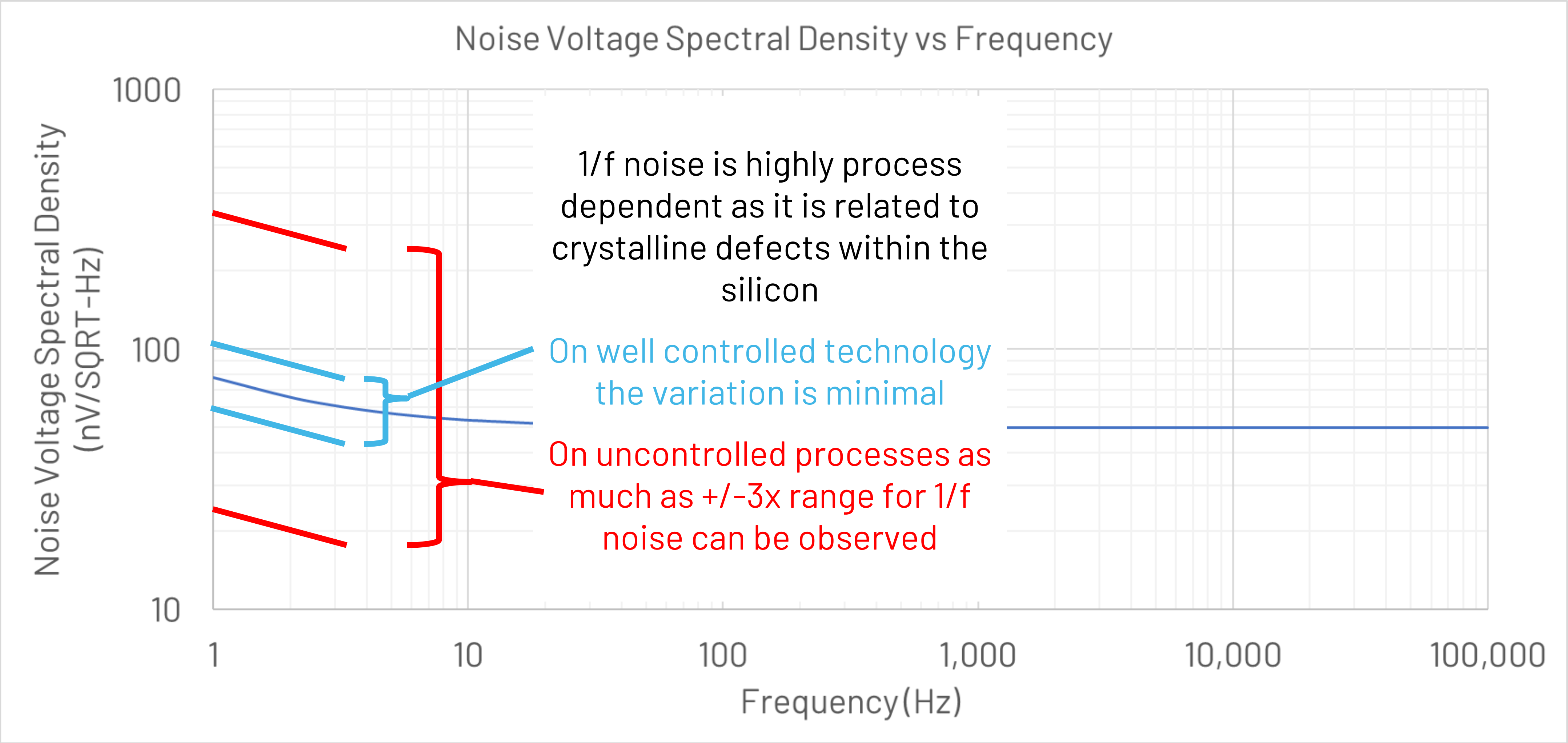
	Datasheet	Hand Calculation	LTspice	ADALM2000 Measure
$V_{noise\ pp\ RTI}$	1µVpp	1.06µVpp	1.3µVpp	1.356µVpp
$V_{noise\ RMS\ RTI}$	n.a.	161nVrms	198nVrms	227nVrms

Conclusion:
Datasheet is a bit optimistic for this particular device.
Hand Calculations match the data sheet closely.
LTSpice model matches the measured result.

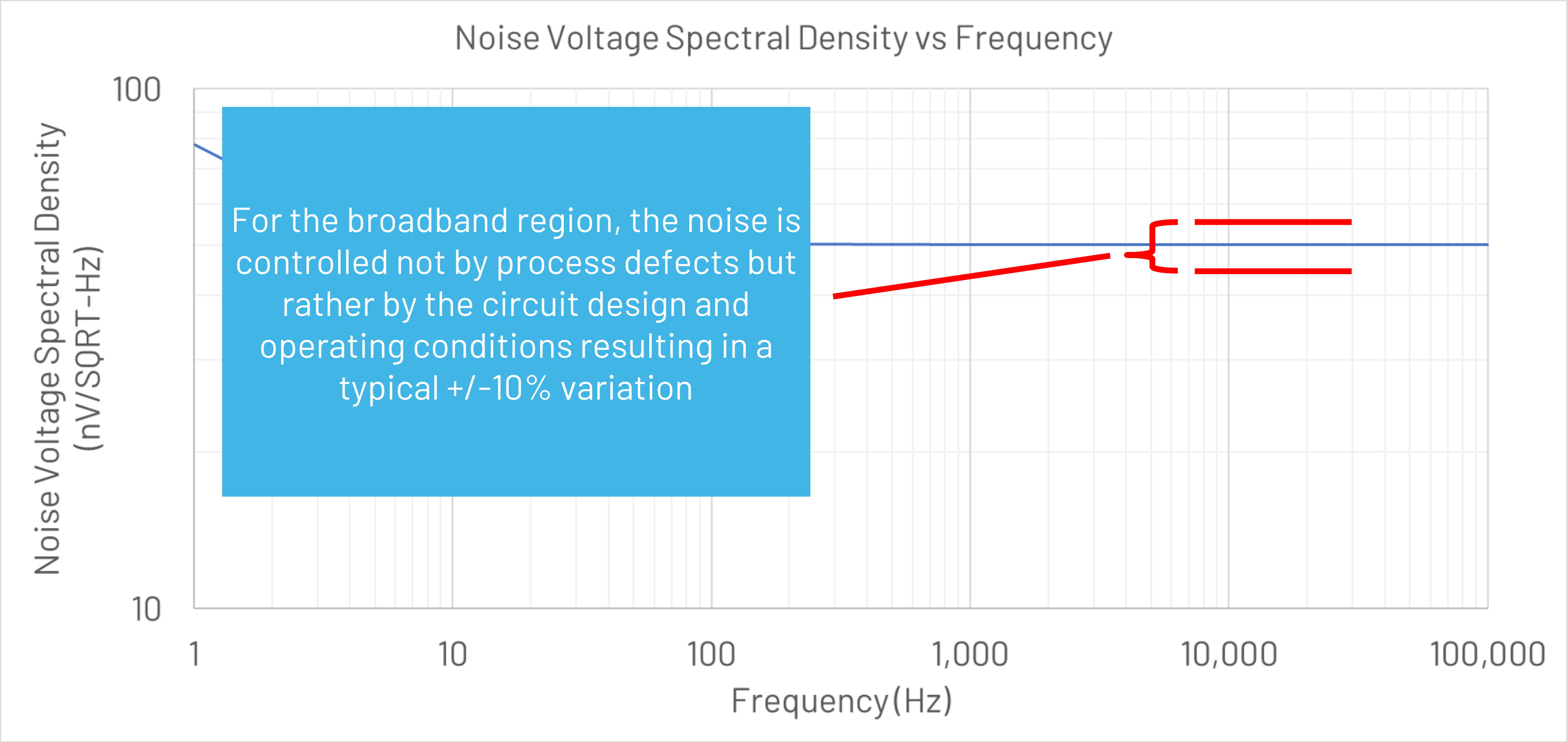


What reasons might the data sheet be more optimistic than our measured results?

What to Expect if Only a Typical Value is Given?

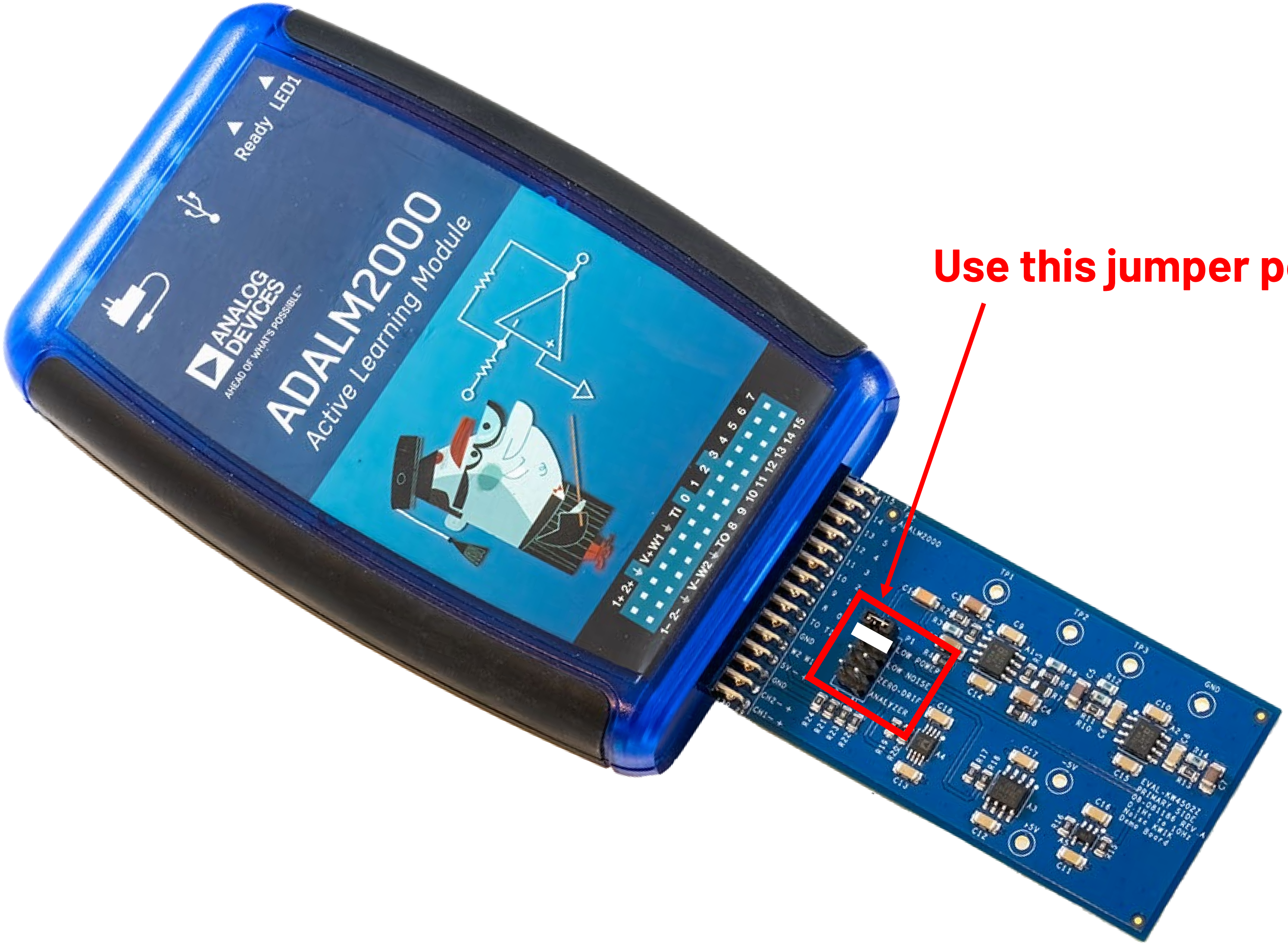


What to Expect if Only a Typical Value is Given?



Source:
Art Kay, Operational Amplifier Noise Techniques and Tips for Analyzing and Reducing Noise, Boston, Newnes/Elsevier, 2012

Set the Jumper to "Low Noise"



Use this jumper position

Let’s Estimate the 1/f Noise for the ADA4077

While the filter is settling, let’s take a minute to estimate the low frequency noise

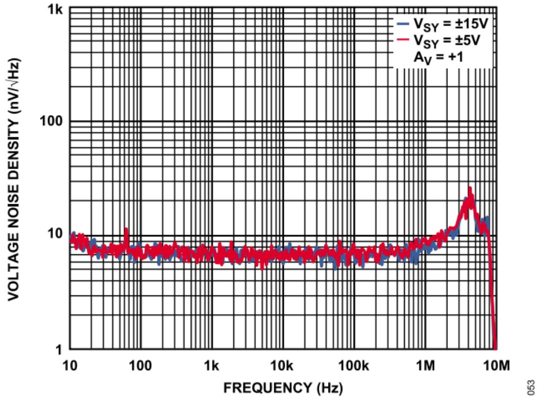


Figure 58. Voltage Noise Density vs. Frequency, V_{SY} = ±5 V and V_{SY} = ±15 V

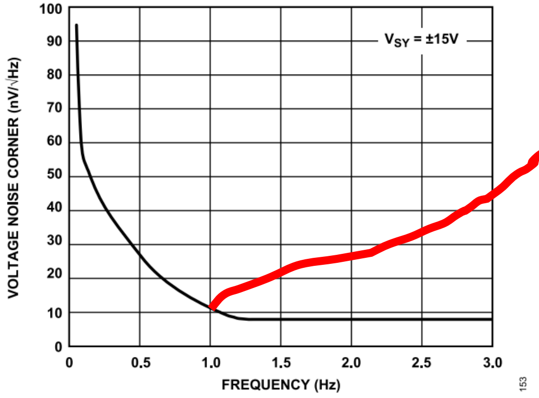


Figure 61. Voltage Noise Corner vs. Frequency, V_{SY} = ±15 V and V_{SY} = ±5 V

From the data sheet curve, we can estimate the 1Hz 1/f noise at 13nV/SQRT-Hz.

We will integrate from 0.1 Hz to 10 Hz.

Calculation:

$$V_{\frac{1}{f}} = \underbrace{6.6}_{\text{Vrms to Vpp}} \times \underbrace{e_{1Hz}}_{\text{Noise Spectral Density @1Hz}} \times \underbrace{\boxed{\sqrt{\ln\left(\frac{f_{HIGH}}{f_{LOW}}\right)}}}_{\text{Vrms}} = 6.6 \times 13e^{-9} \times \sqrt{\ln\left(\frac{10}{0.1}\right)} = 0.18\mu V_{PP}$$

Let’s Compare our Estimate to the ADA4077 Datasheet

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Data Sheet:

NOISE PERFORMANCE				
Voltage Noise	e_n p-p	0.1 Hz to 10 Hz	0.25	μV p-p
Voltage Noise Density	e_n	f = 1 Hz	13	nV/√Hz

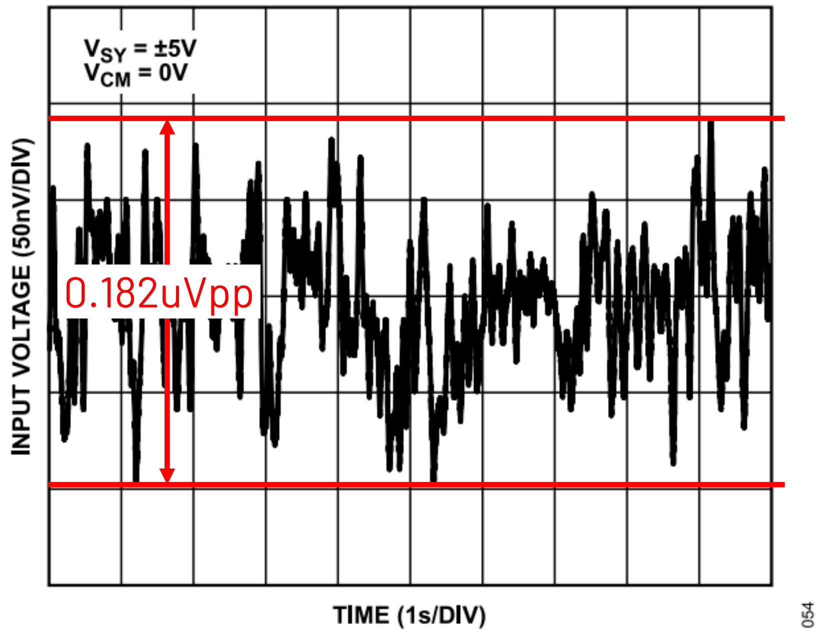
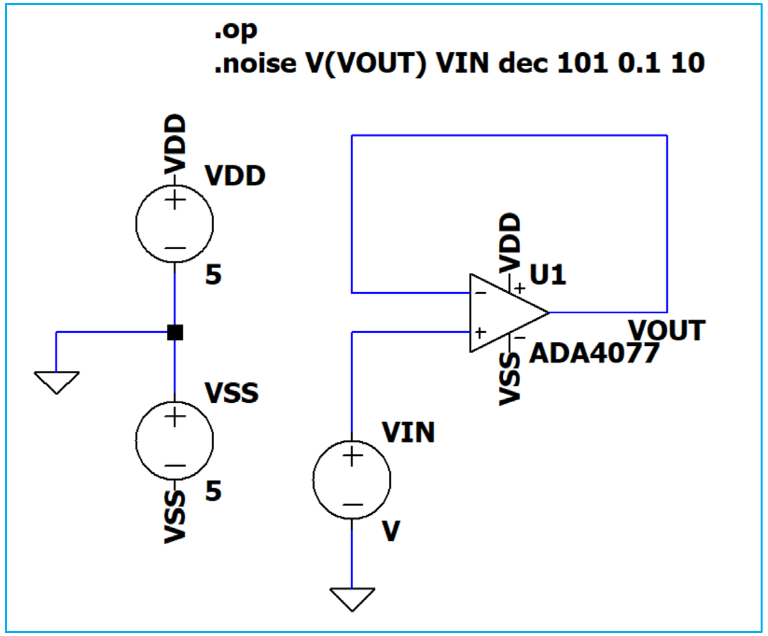


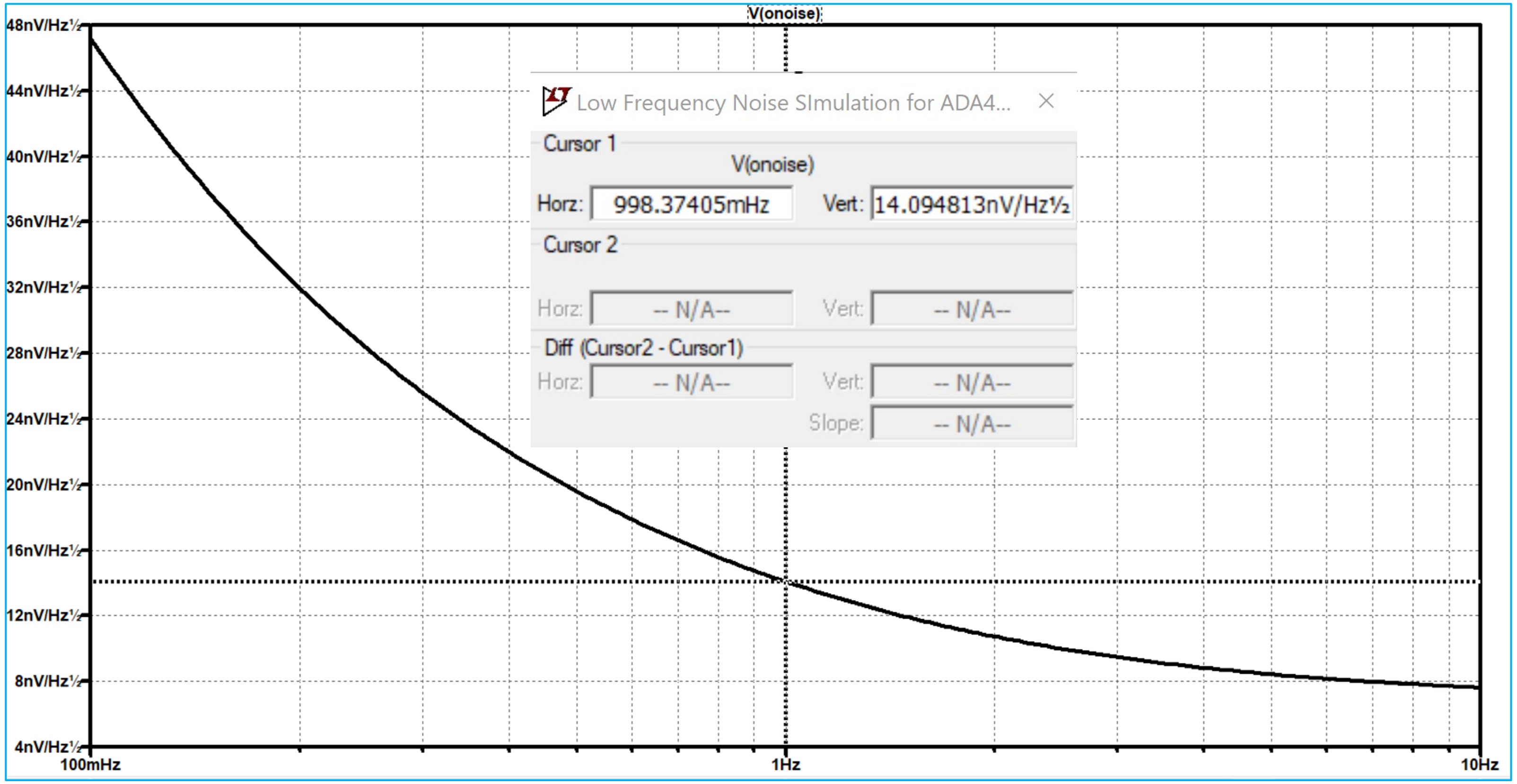
Figure 60. 0.1 Hz to 10 Hz Noise, V_{SY} = ±5 V

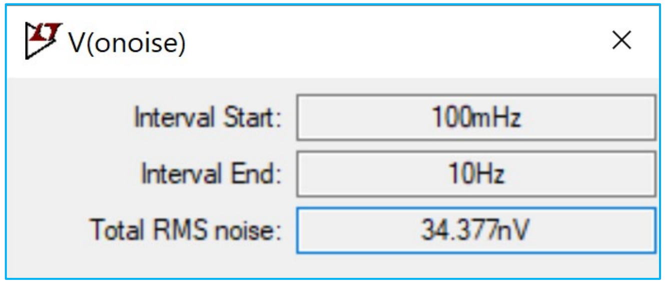
Estimate:

$$V_{\frac{1}{f}} = 6.6 \times e_{1Hz} \times \sqrt{\ln\left(\frac{f_{HIGH}}{f_{LOW}}\right)} = 6.6 \times 13e^{-9} \times \sqrt{\ln\left(\frac{10}{0.1}\right)} = \boxed{0.18\mu V_{PP}}$$

ADA4077 Noise Analysis in LTspice



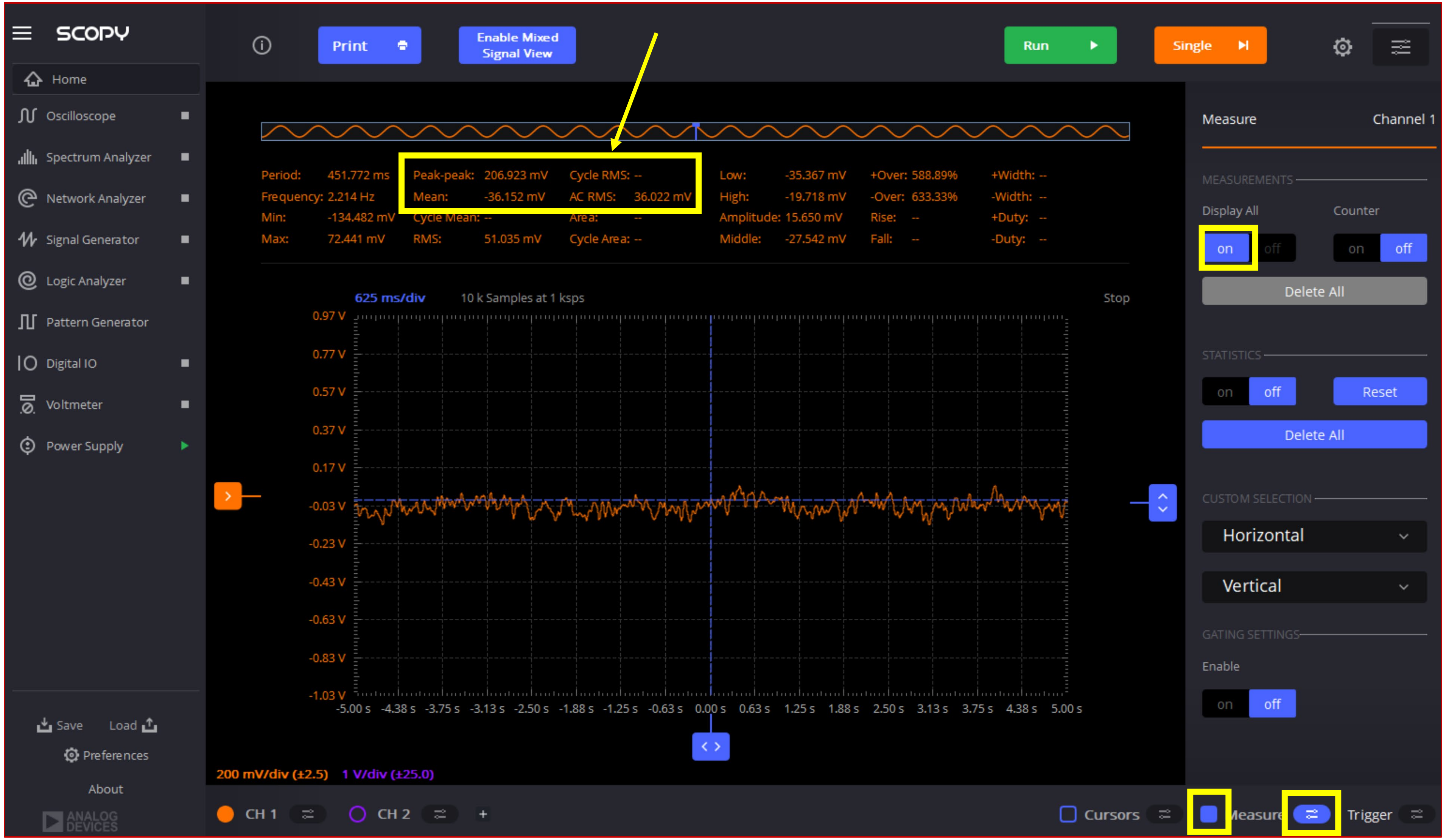




Vnoise_pp = 34.377nVrms * 6.6 = 227nVpp

Typical Result for the Low Noise Device

The Low Noise device, ADA4077, Vnoise_RTI = 206.9mVpp/1E6 = 0.207uVpp



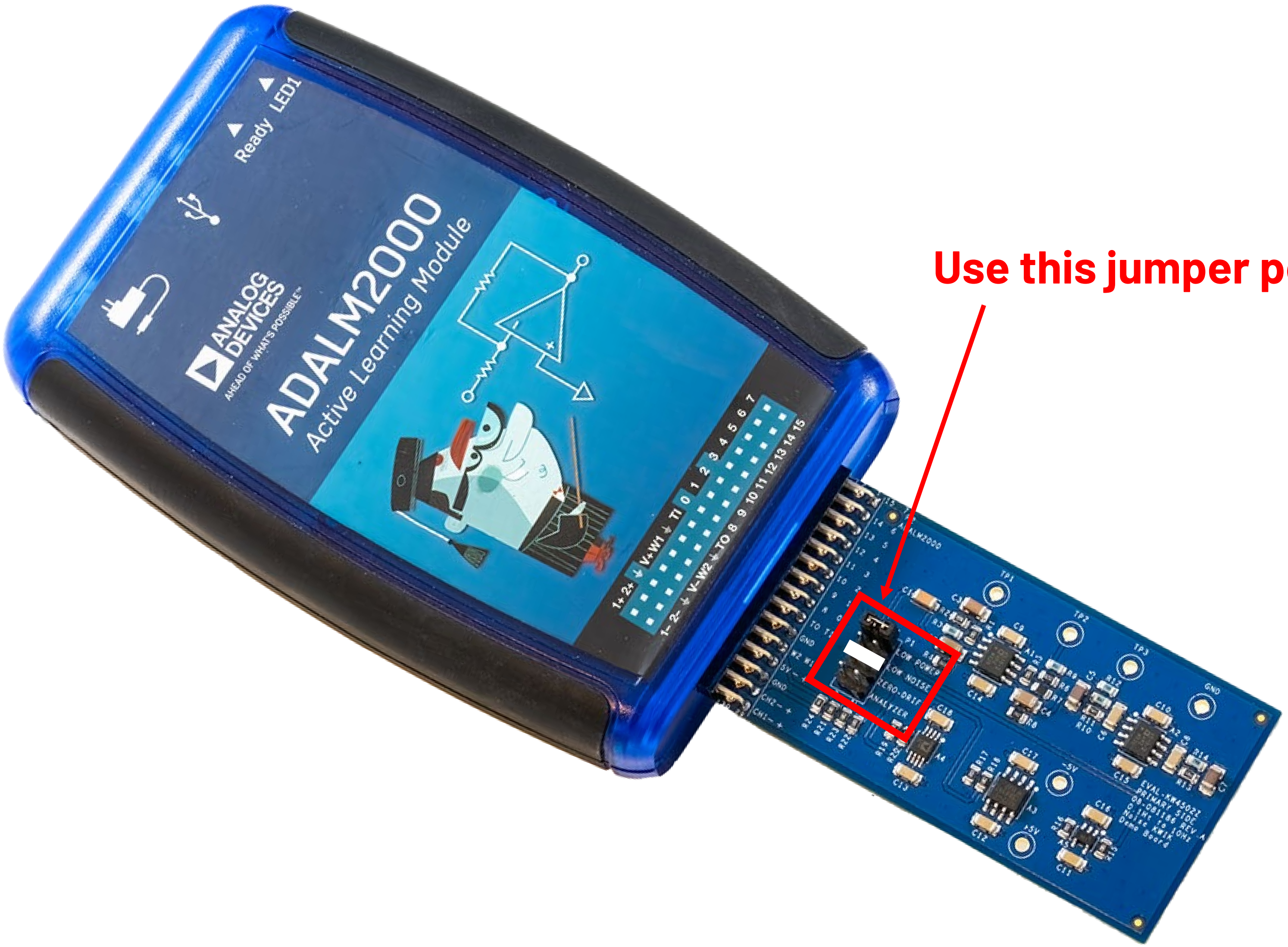
Comparison ADA4077 Noise

	Datasheet	Hand Calculation	LTspice	ADALM2000 Measured
$V_{noise\ pp\ RTI}$	0.25µVpp	0.18µVpp	0.227µVpp	0.207uVpp
$V_{noise\ RMS\ RTI}$	n.a.	27nVrms	34nVrms	36nVrms

Conclusion:

Datasheet, Hand Calculations, LTSpice and Measured Results closely match.

Set the Jumper to “Zero-Drift”



Use this jumper position

Let’s Estimate the 1/f Noise for the ADA4522

While the filter is settling, let’s take a minute to estimate the low frequency noise

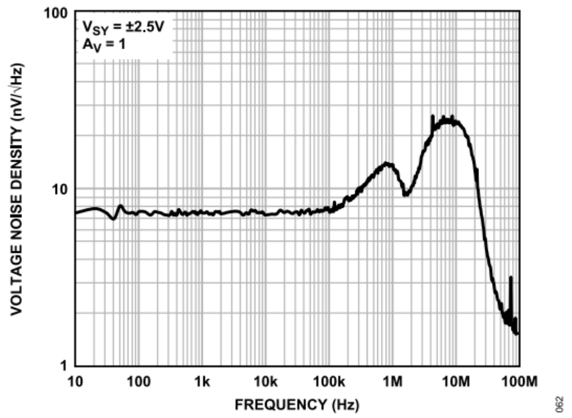


Figure 60. Voltage Noise Density vs. Frequency, V_{SY} = ±2.5 V

Because the ADA4522 is a Zero-Drift device, it has no 1/f noise, so we must calculate the broadband noise from 0.1 Hz to 10 Hz using 5.8nV/SQRT-Hz.

We will use a noise bandwidth of 10 Hz.

Calculation:

$$V_n = \underbrace{6.6\times}_{\text{Vrms to Vpp}} \underbrace{\boxed{NSD\sqrt{Noisebandwidth}}}_{\text{Vrms}} = 6.6\times\underbrace{5.8e^{-9}}_{\text{Broadband Noise Spectral}}\sqrt{10} = 0.12\mu V_{PP}$$

Let's Compare our Estimate to the ADA4522 Datasheet

Data Sheet:

NOISE PERFORMANCE				
Total Harmonic Distortion Plus Noise	THD + N	A_V = 1, f = 1 kHz, V_{IN} = 6 V rms		
BW = 80 kHz			0.0005	%
BW = 500 kHz			0.004	%
Peak-to-Peak Voltage Noise	$e_{N\ p\text{-}p}$	A_V = 100, f = 0.1 Hz to 10 Hz	117	nV p-p
Voltage Noise Density	e_N	A_V = 100, f = 1 kHz	5.8	nV/√Hz
Peak-to-Peak Current Noise	$i_{N\ p\text{-}p}$	A_V = 100, f = 0.1 Hz to 10 Hz	16	pA p-p
Current Noise Density	i_N	A_V = 100, f = 1 kHz	0.8	pA/√Hz

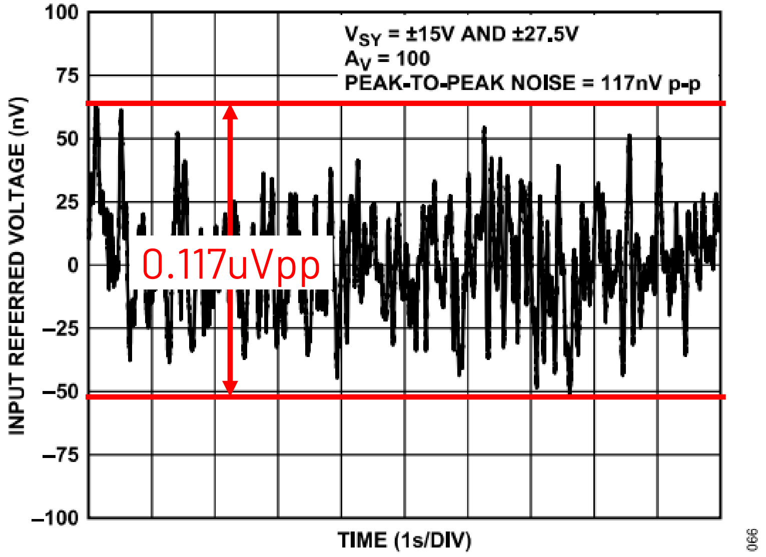


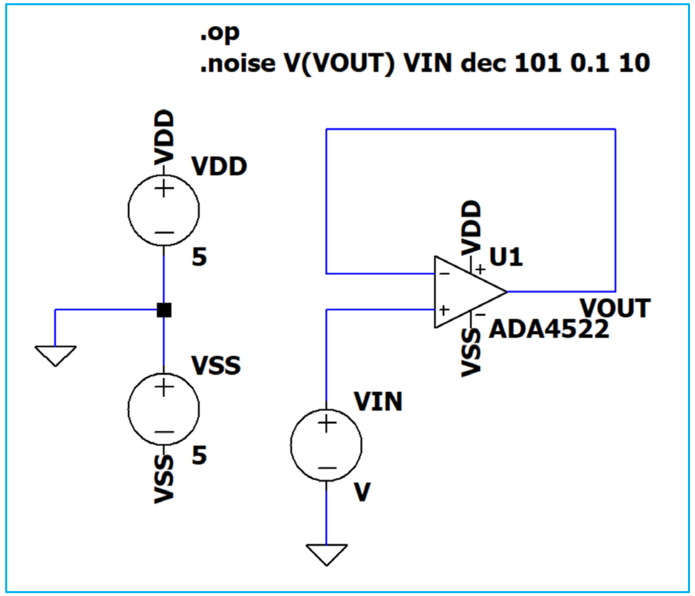
Figure 64. 0.1 Hz to 10 Hz Noise

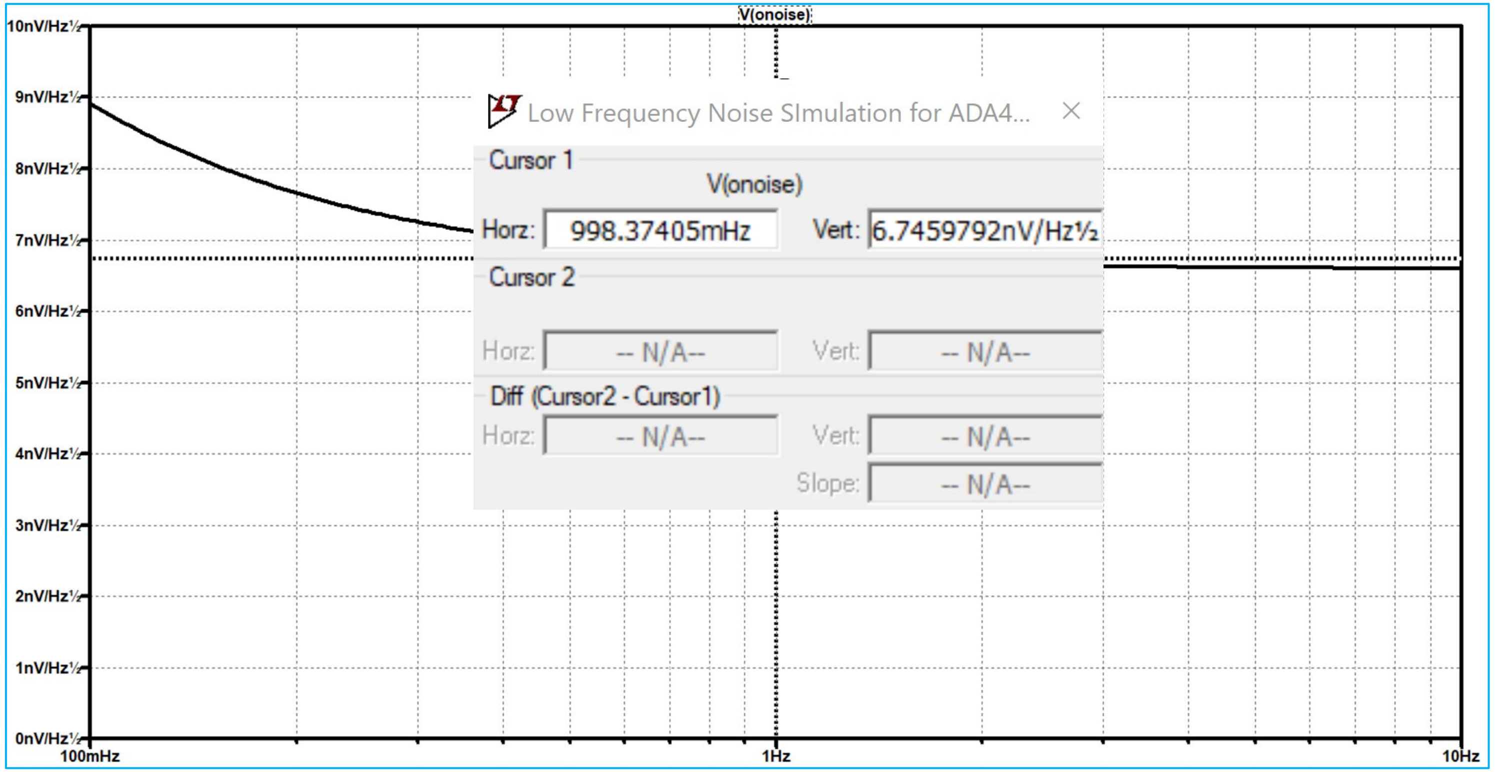
Estimate:

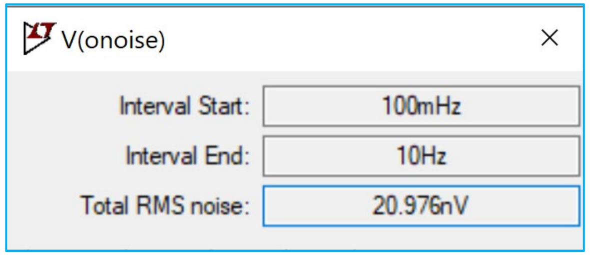
$$V_n = 6.6 \times NSD\sqrt{Noisebandwidth} = 6.6 \times 5.8e^{-9}\sqrt{10} = \boxed{0.12\mu V_{PP}}$$

ADA4522 Noise Analysis in LTspice

1782noise.asc







Vnoise_pp = 20.976nVrms * 6.6 = 138nVpp

Typical Result for the Zero-Drift Device

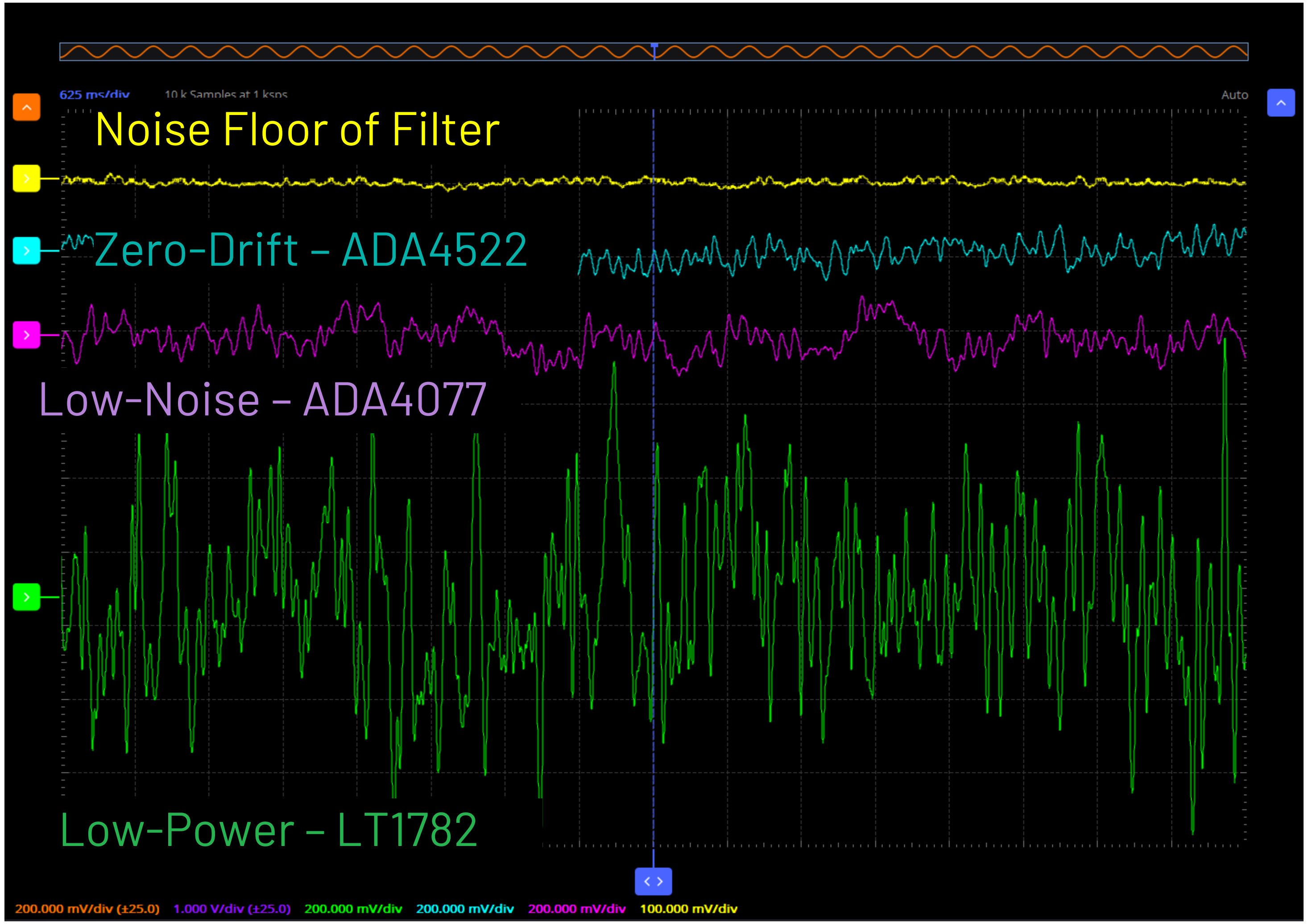
The Zero-Drift device, ADA4522, Vnoise_RTI = 127mVpp/1E6 = 127nVpp

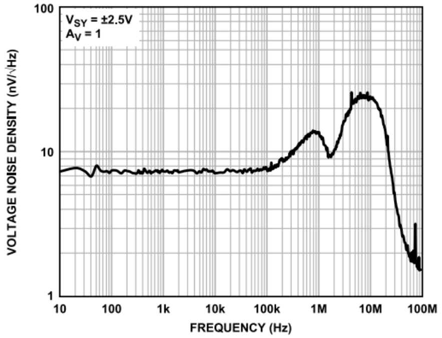
Comparison ADA4522 Noise

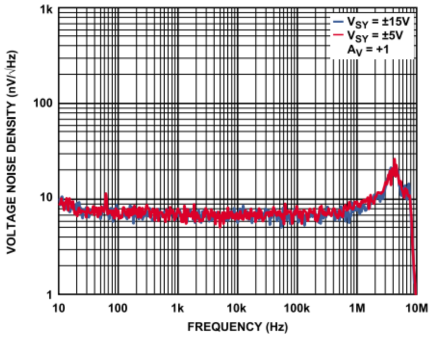
	Datasheet	Hand Calc,	LTspice	ADALM2000 Meas.
$V_{noise\ pp\ RTI}$	0.117µVpp	0.12µVpp	0.138µVpp	0.127µVpp
$V_{noise\ RMS\ RTI}$	n.a.	18nVrms	21nVrms	21nVrms

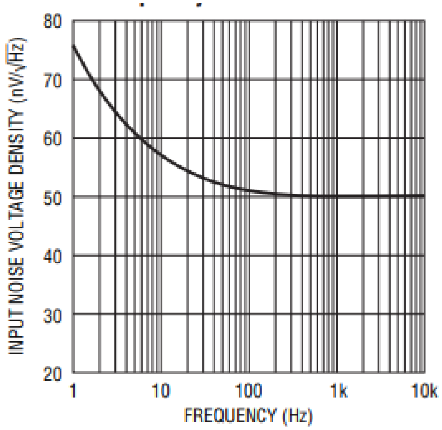
Conclusion:
Datasheet, Hand Calculations, LTSpice and Measured Results closely match.

Results Summary

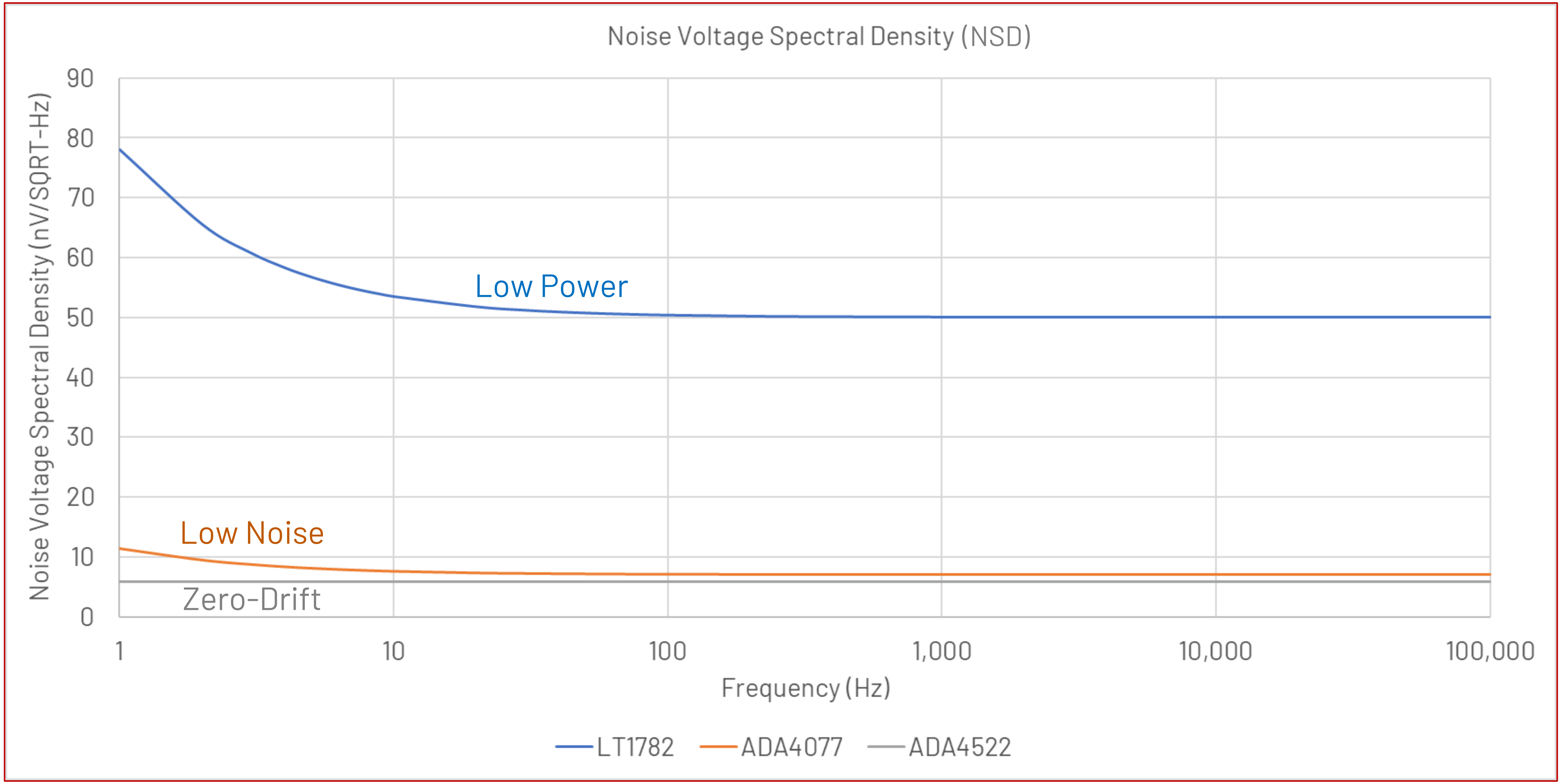






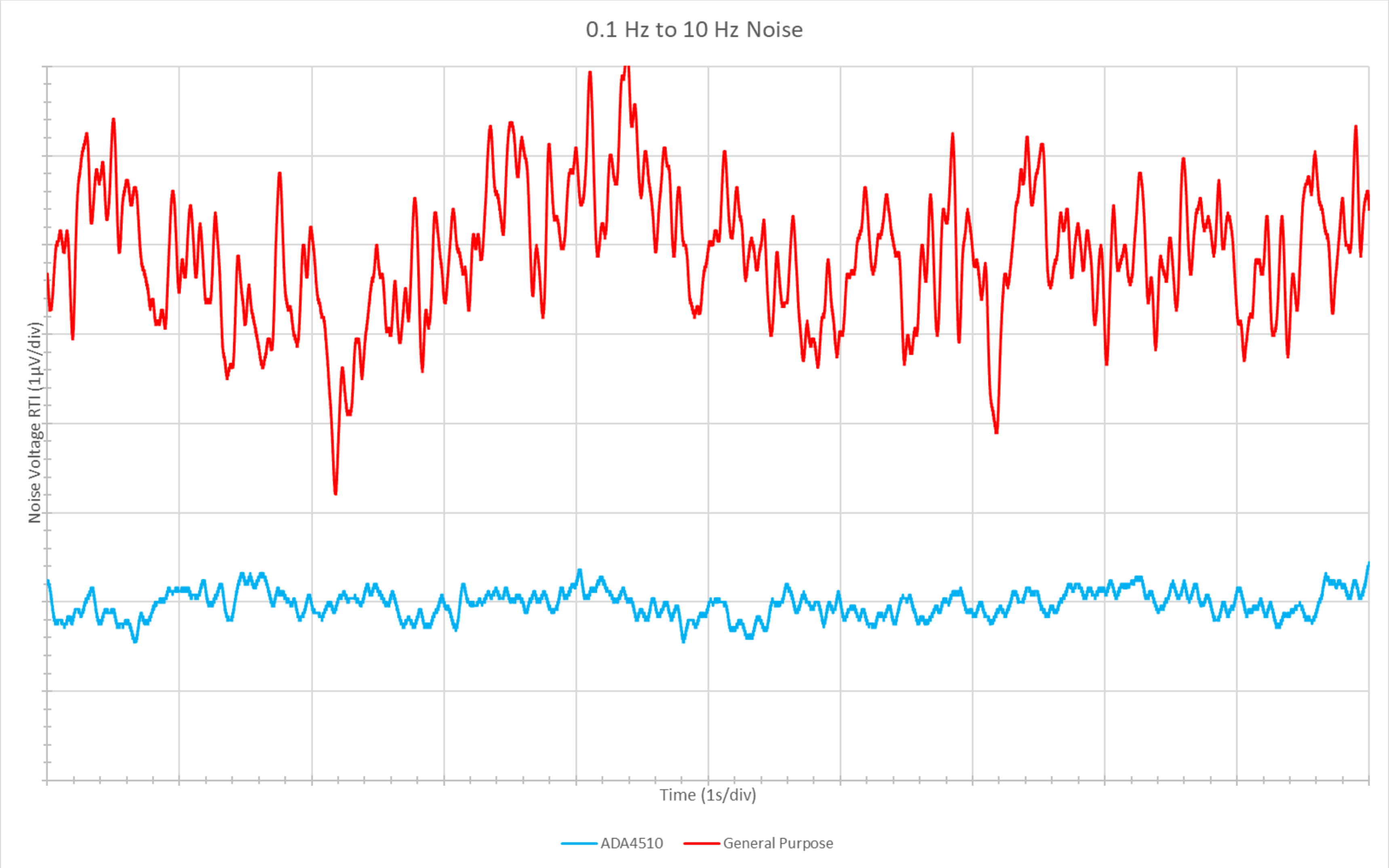


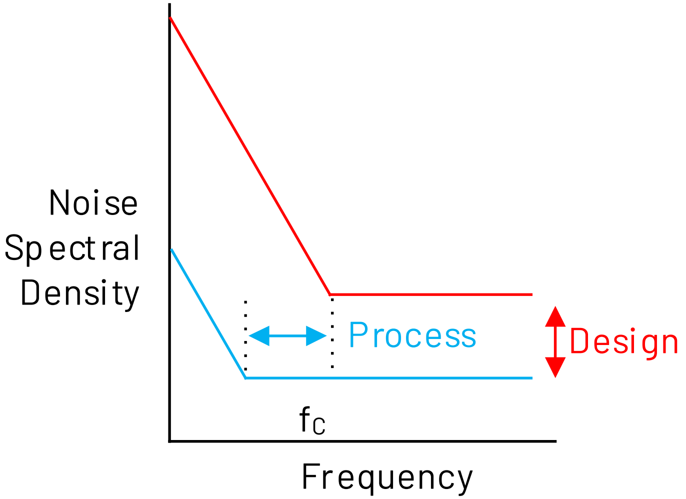
Recap - NSD for all three Opamps Included in this Demo

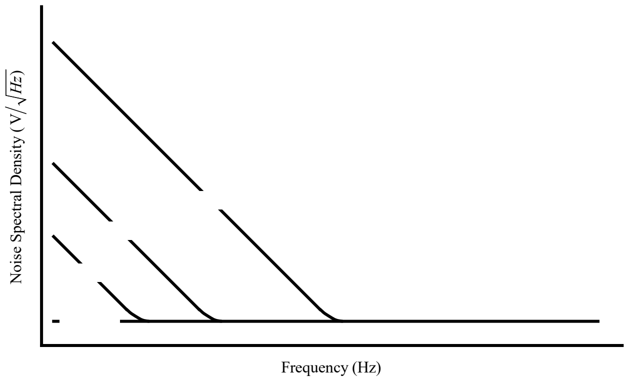


Recap - Low Frequency Noise Comparison

Low Noise Technology vs Standard Technology







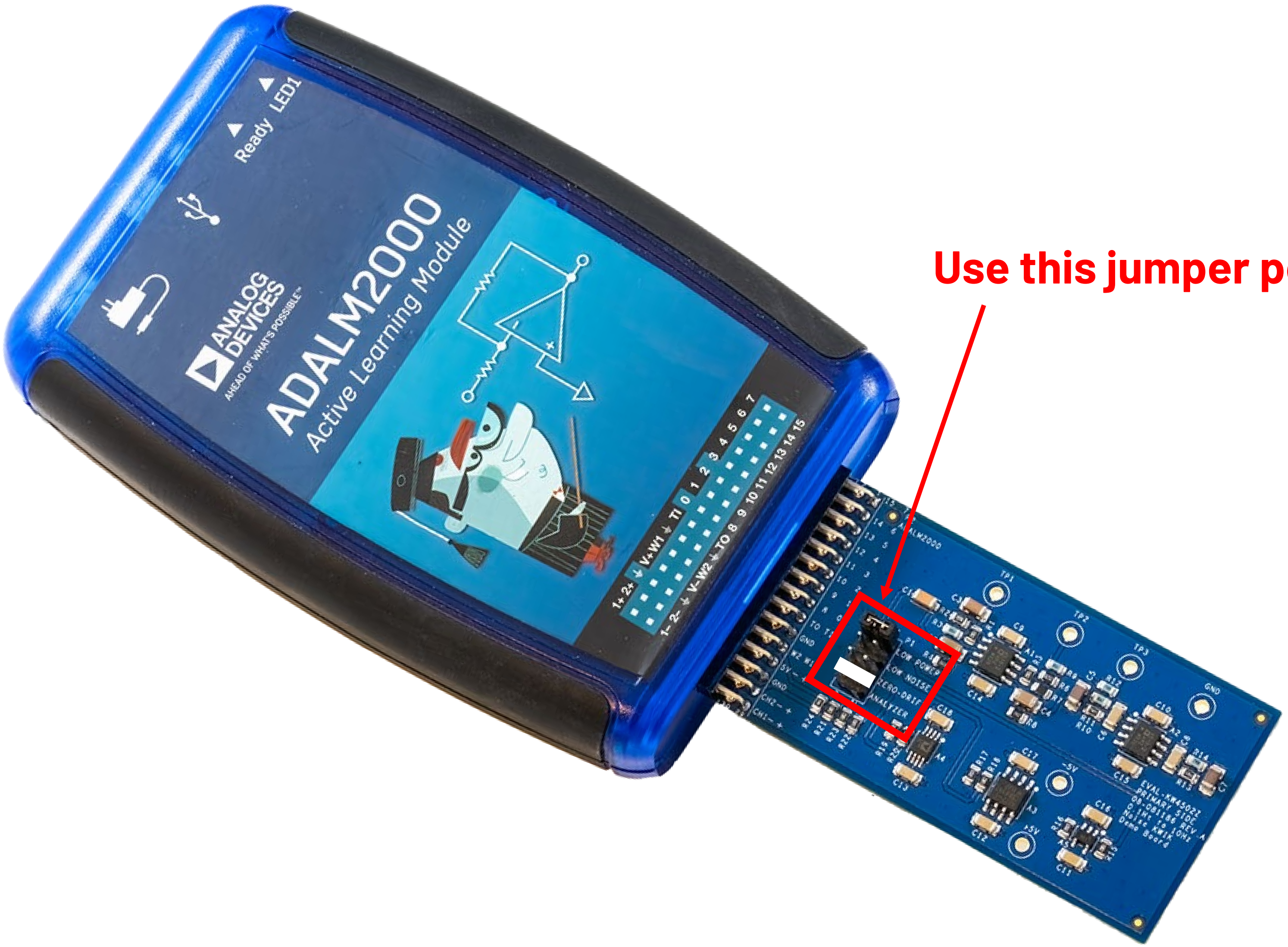
Op Amp Process vs Noise and other Key Specs

- ***Bipolar Amplifiers***: Lowest Broadband Noise, Lowest 1/f corner frequency.
- ***JFET Amplifiers***: Next to lowest 1/f corner frequency, ultra low input bias currents, high slew rates.
- ***CMOS Amplifiers***: Highest 1/f corner frequency, low power, low input bias currents.
- ***Zero-Drift Amplifiers***: CMOS technology, eliminates the 1/f noise by switching techniques, excellent performance in very low frequency applications, higher distortion than their non-Zero Drift counterparts, chopping noise and can have intermodulation effects with the input signal, as well as the ADC sample rate. Analog Devices offers the lowest noise Zero-Drift amplifiers in the market.

Let’s use the Network Analyzer Feature of the ADALM2000 to Measure the Filter Response

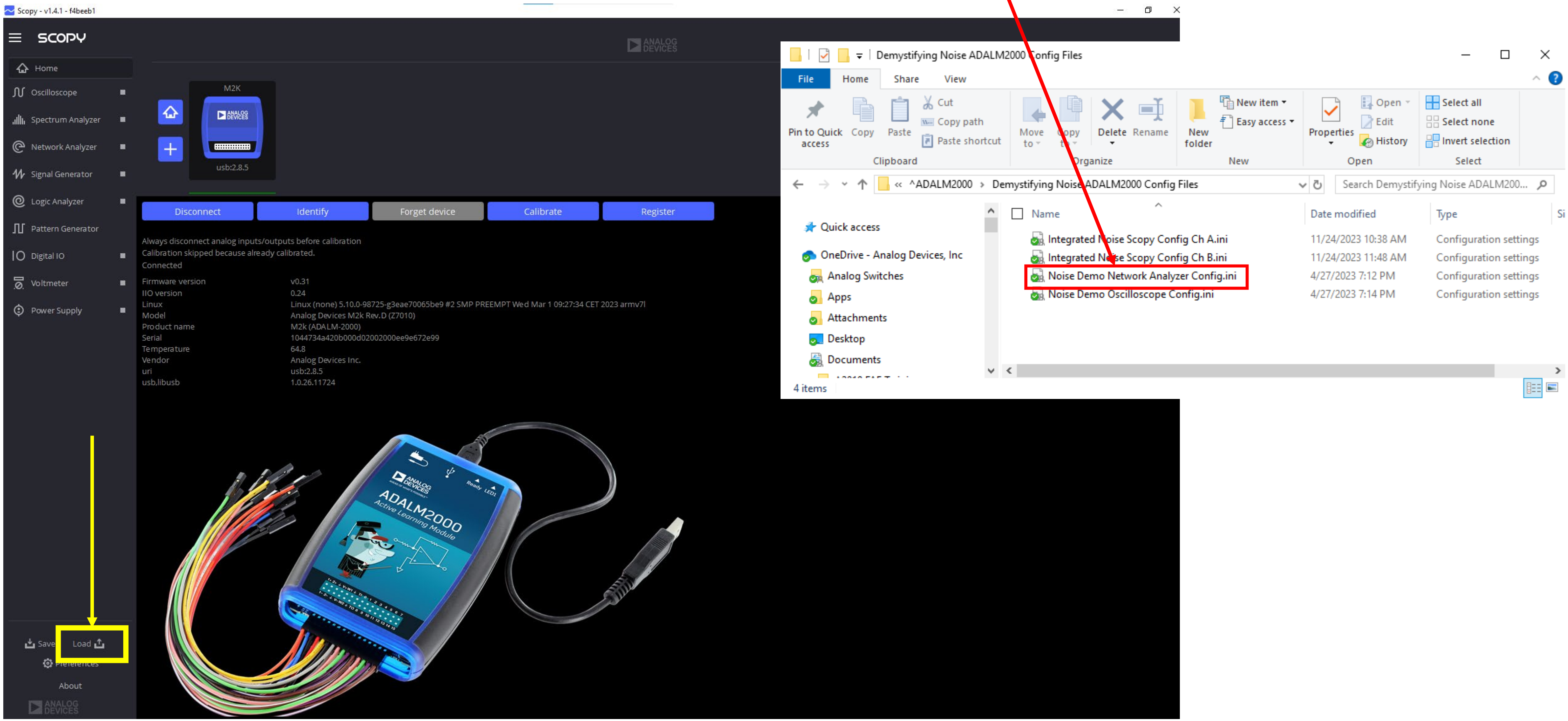
Set the Jumper to "Network Analyzer"

Use this jumper position



Load the Config Files

Noise Demo Network Analyzer Config.ini



The Network Analyzer Panel is Opened and Configured

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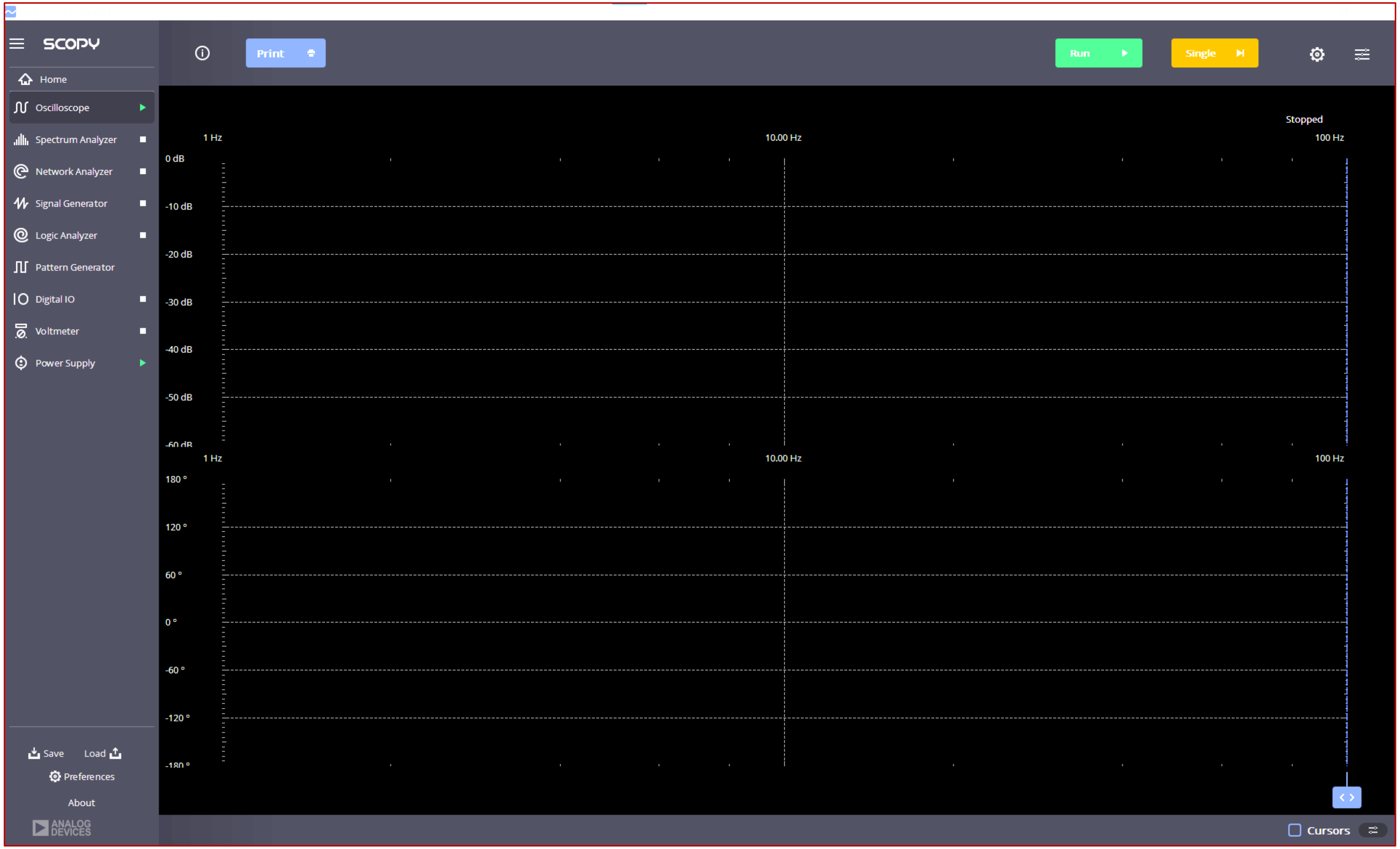

Click Here to see the Relevant Settings

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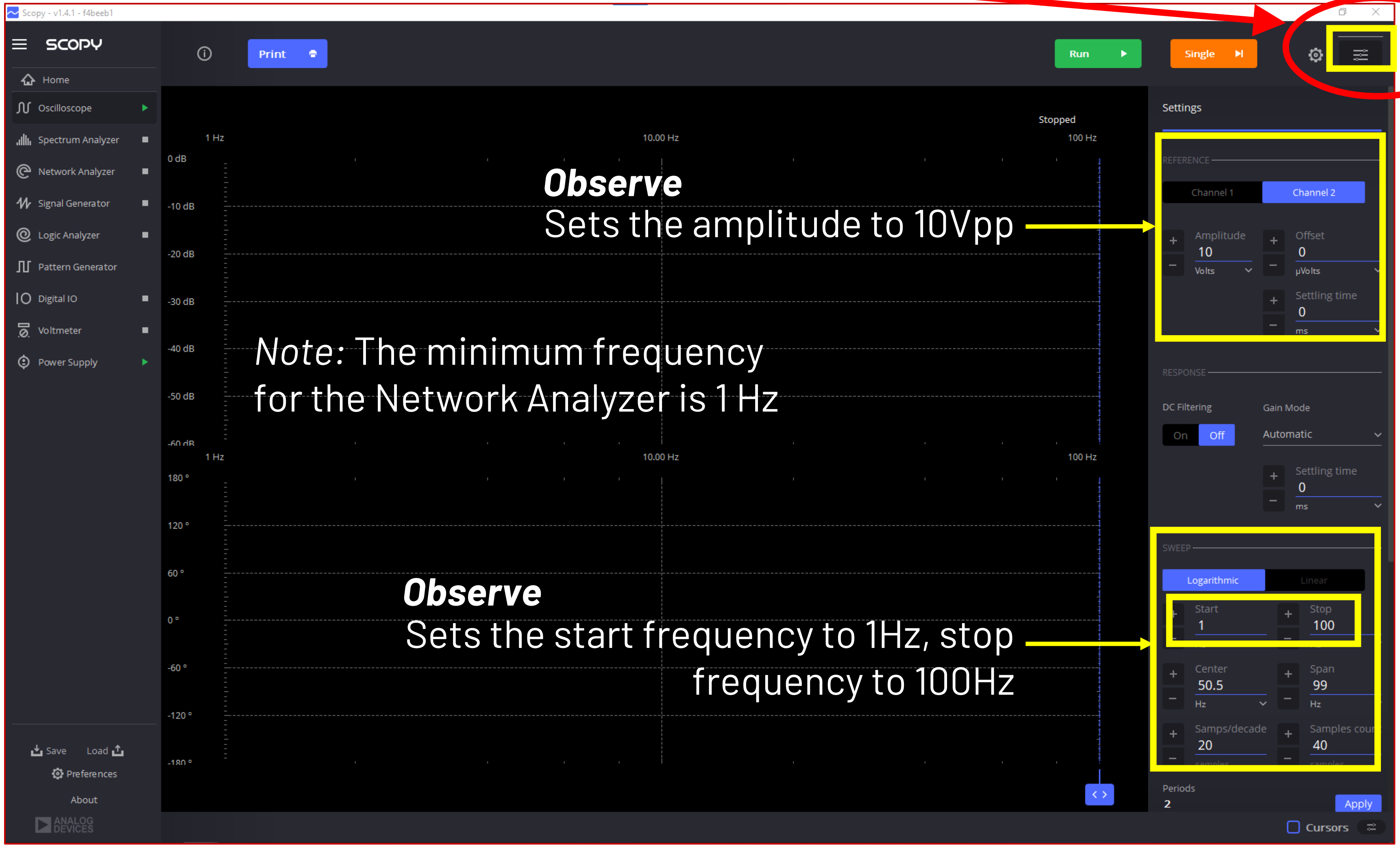
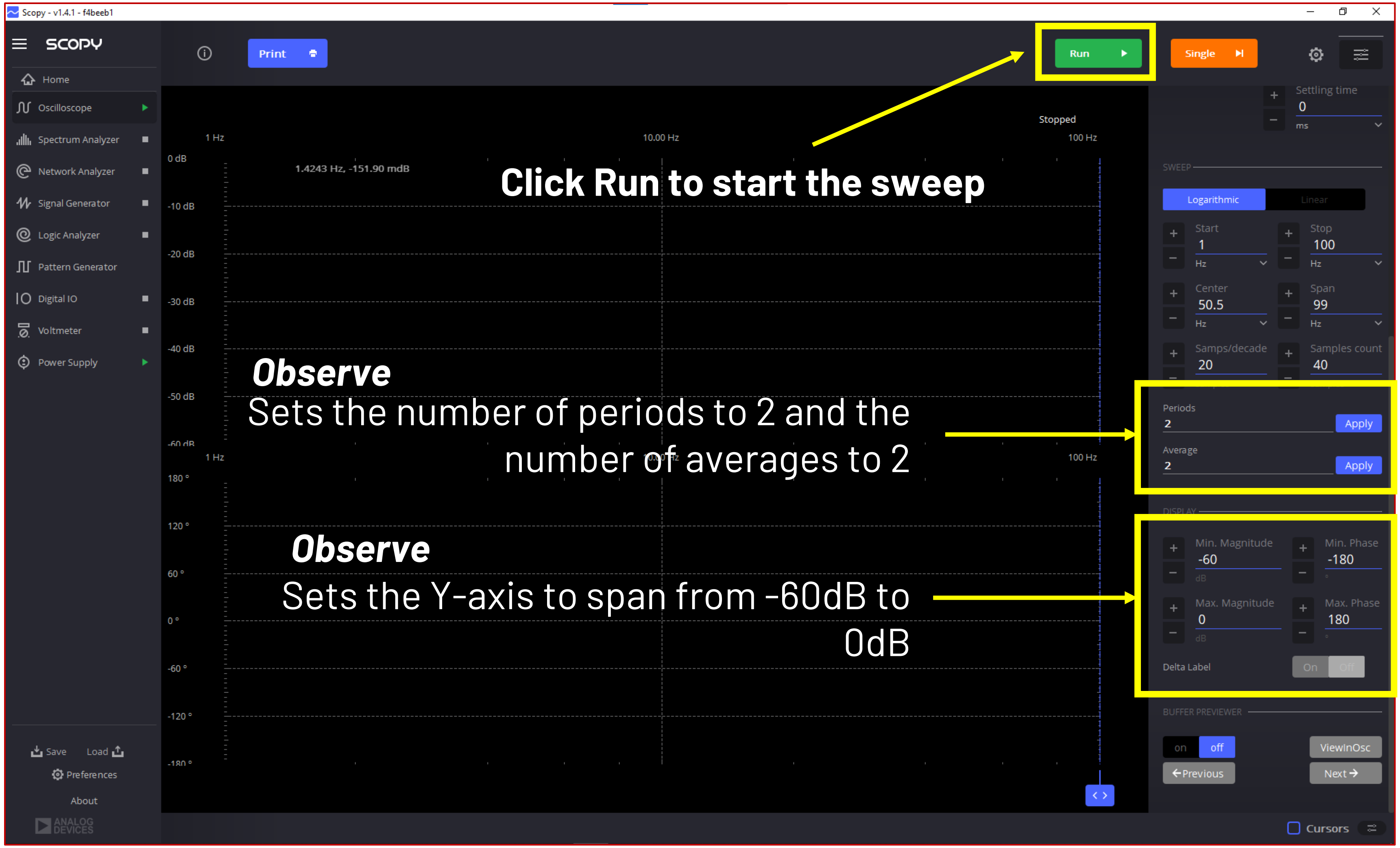


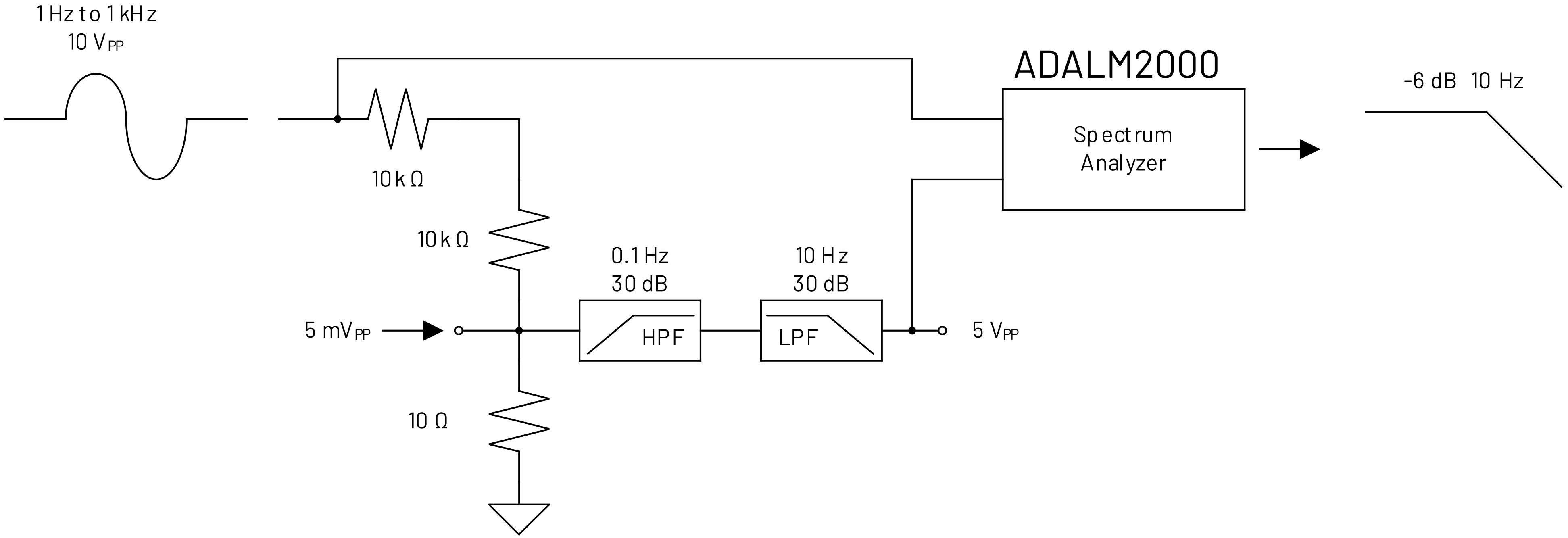
Scroll down on right side if "Sweep" settings are not shown.

Scroll Down to See Additional Config Settings



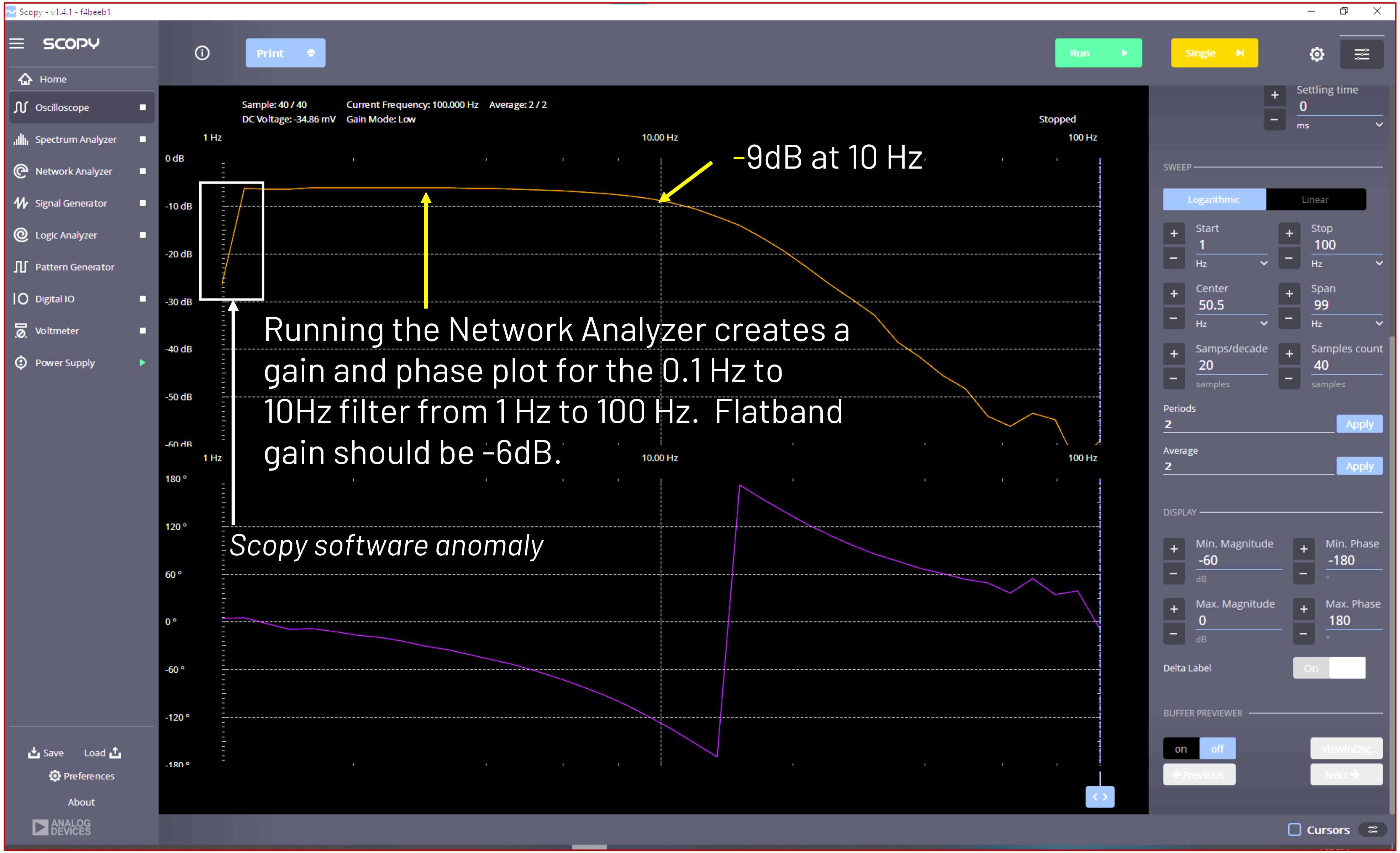
Scroll down on right side if "Sweep" settings are not shown.

What Do We Expect to See?



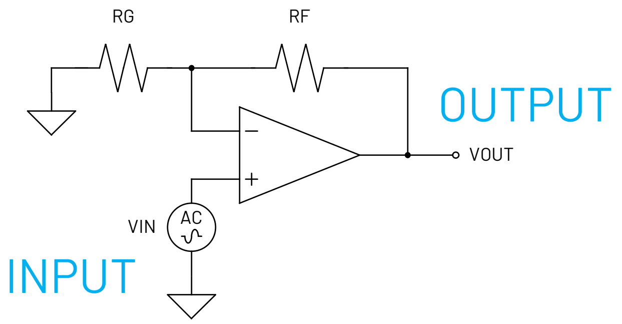
We are applying a 10 V_{PP} sinewave at the input, dividing it by 2000, multiplying by 60dB (1000) and measuring the ratio ➔ -6 dB

Typical Result for the Network Analyzer Demo

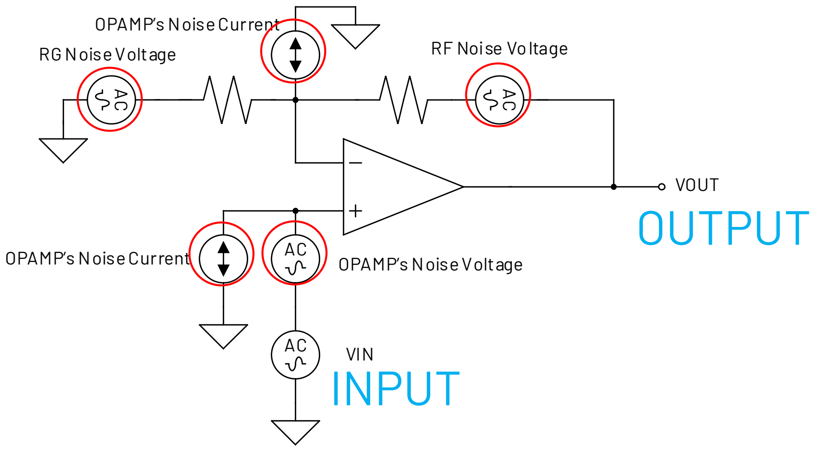


Total Integrated Noise KWIK Lab Step-by-Step Guide

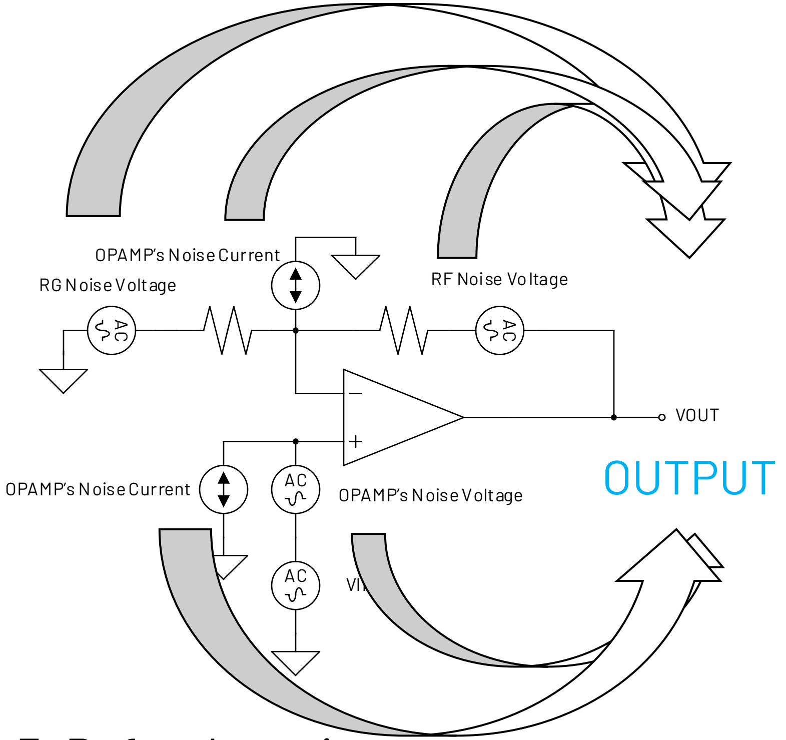
Estimate the Noise



1. Start with your circuit



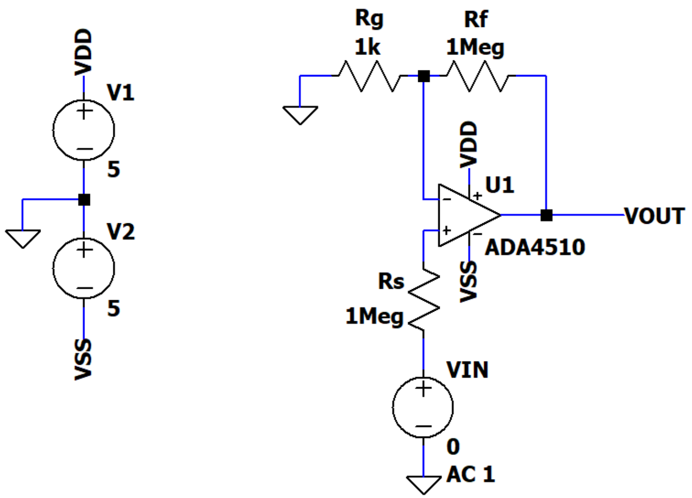
2. Add the noise sources



3. Refer the noise sources to the output

Noise Bandwidth and Noise Sources

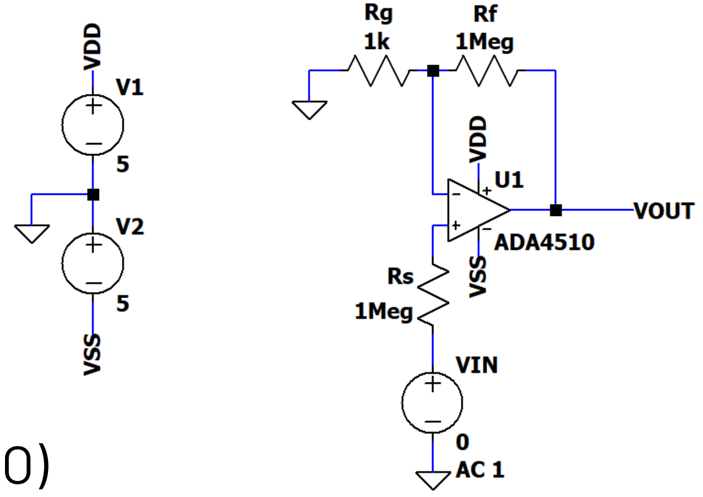
- Identify the noise Bandwidth
  - ADA4510 configured in G = 1001
    - Small-signal bandwidth = 10.4Mhz/1001 = 10.4kHz
    - Noise bandwidth = 10.4Khz * 1.57 = 16.3kHz



- Identify each noise source:
  - Rg = 1k ➔4nV/SQRT-Hz
  - Rf = 1M➔127nV/SQRT-Hz
  - Rs = 1M➔127nV/SQRT-Hz
  - ADA4510 ➔Vn = 5nV/SQRT-Hz (@16.3kHz)
  - ADA4510 ➔ In- = 200fA/SQRT-Hz (@16.3kHz)
  - ADA4510 ➔ In+ = 200fA/SQRT-Hz (@16.3kHz)

Refer to the Output

- Refer each Noise Source to the Output:
  - Rg = 1k ➔ 4nV/SQRT-Hz*1000 = 4µV/SQRT-Hz (RTO)
  - Rf = 1M ➔ 127nV/SQRT-Hz*1 = 127nV/SQRT-Hz (RTO)
  - Rs = 1M ➔ 127nV/SQRT-Hz*1001 = 127µV/SQRT-Hz (RTO)
  - ADA4510 ➔ Vn = 5nV/SQRT-Hz (@16.3kHz)*1001 = 5µV/SQRT-Hz (RTO)
  - ADA4510 ➔ In- = 200fA/SQRT-Hz (@16.3kHz) *1M= 200nV/SQRT-Hz (RTO)
  - ADA4510 ➔ In+ = 200fA/SQRT-Hz (@16.3kHz)*1M*1001 = 200µV/SQRT-Hz (RTO)



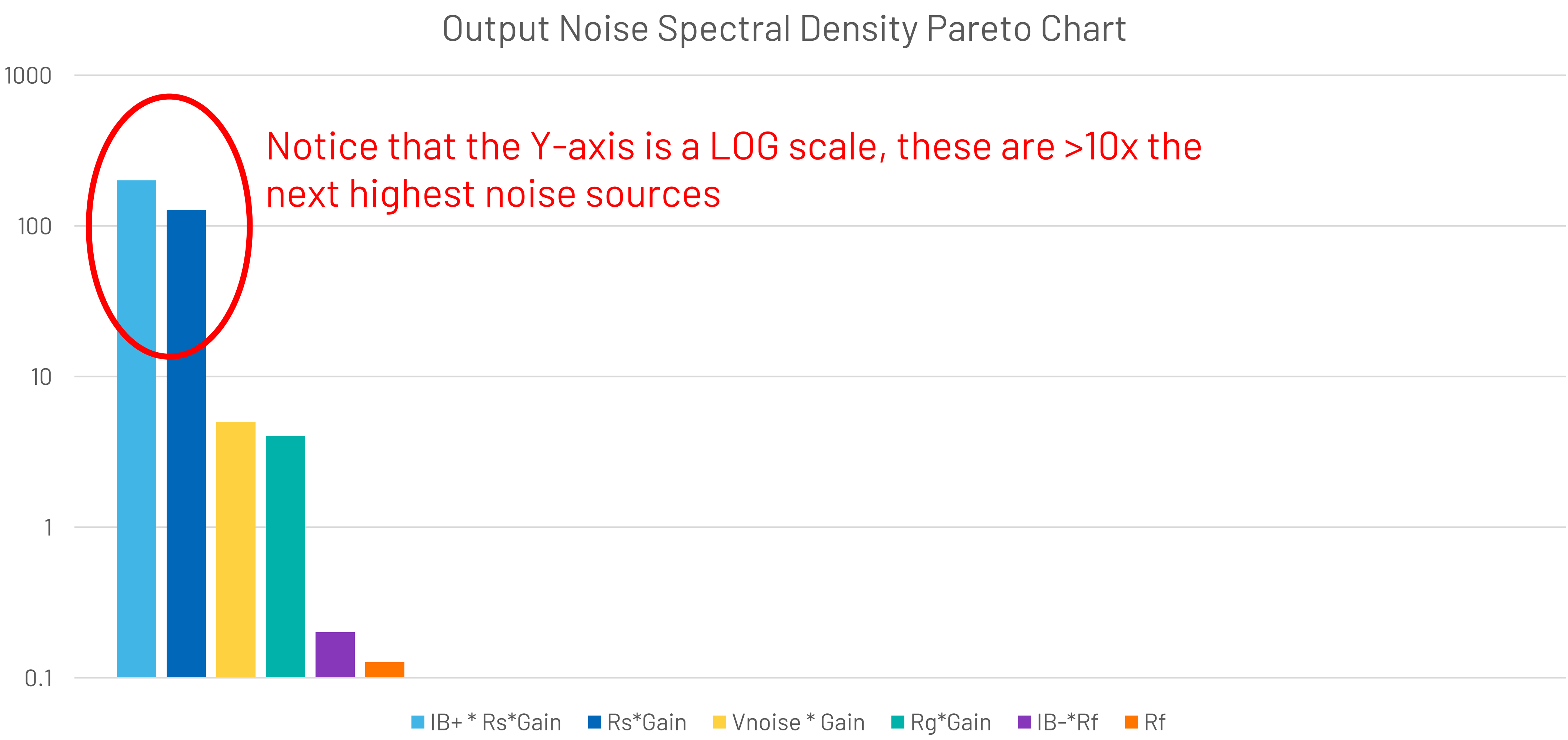
<u>Sum the NSD at the output:</u>

$$V_{OUT_{NSD@16.3kHz}} = \sqrt{\left(4\mu V/\sqrt{Hz}\right)^2 + \left(127nV/\sqrt{Hz}\right)^2 + \left(127\mu/\sqrt{Hz}V\right)^2 + \left(5\mu V/\sqrt{Hz}\right)^2 + \left(200nV/\sqrt{Hz}\right)^2 + \left(200\mu V/\sqrt{Hz}\right)^2} = 237\mu V/\sqrt{Hz}$$

<u>Estimate the Total Noise:</u>

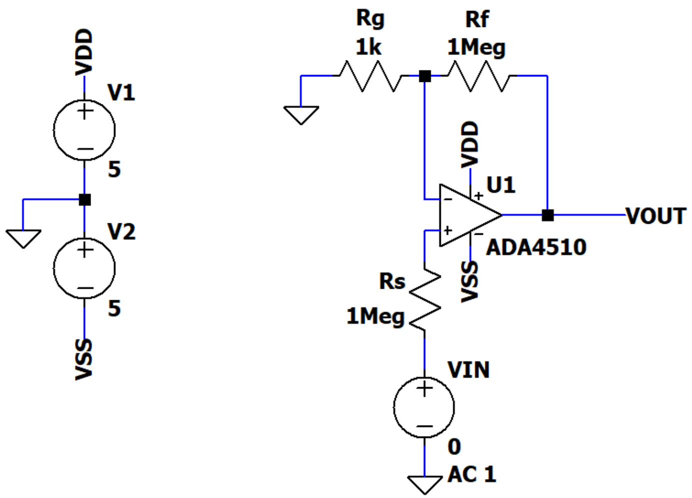
$$V_{OUT_{TOTALNOISEV_{PP}}} = 6.6 \times 237\mu V/\sqrt{Hz} \times \sqrt{16.3kHz} = 200mV_{PP}$$

Identify Dominant Noise Sources



Simulating Noise in LTSpice

- Add the .noise command as a SPICE directive with the listed arguments:
  - Output: The **node** where you want to examine the ***output referred noise***
  - Input: The **source** where you want to examine the ***input referred noise***
  - Type of sweep: octave, decade, linear or list
  - Number of points: per octave, per decade, etc
  - Start Frequency: Lowest frequency in the sweep in Hz
  - Stop Frequency: Highest frequency in the sweep in Hz

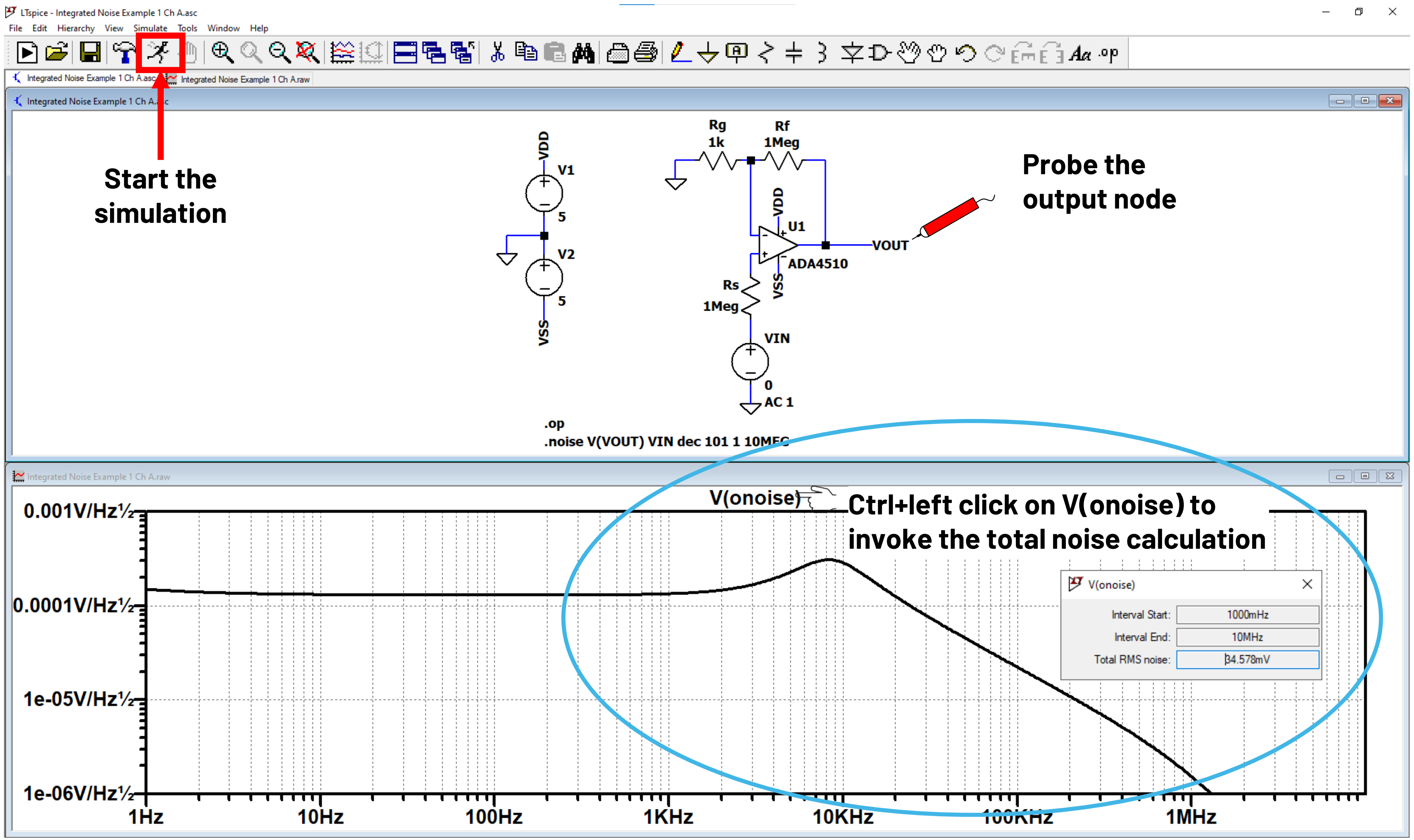


SPICE directive | Input source | Points/dec

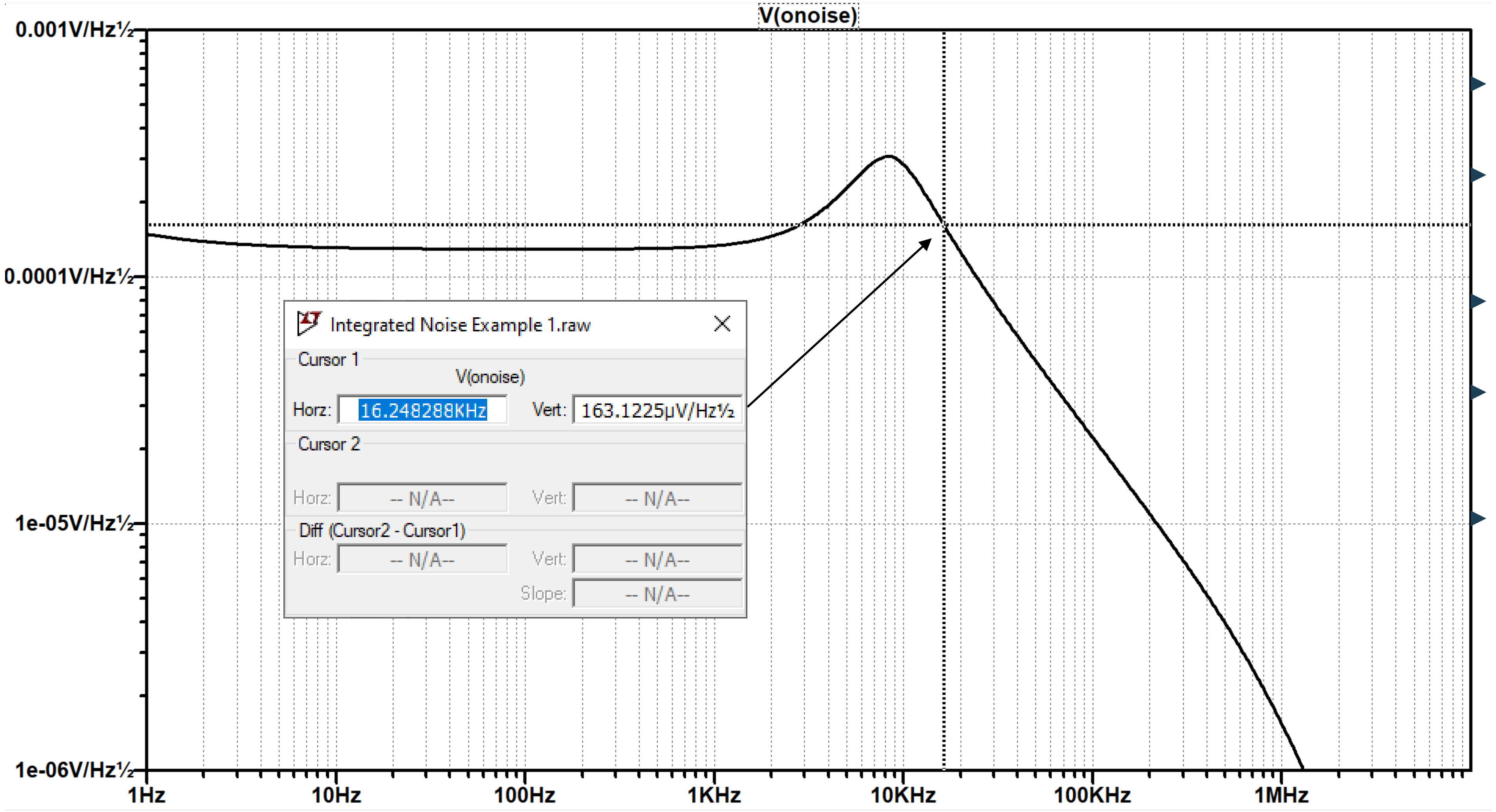
.noise V(VOUT) VIN dec 101 1 10MEG

Output node | Decade sweep | Start frequency Stop frequency

Simulating Noise in LTSpice

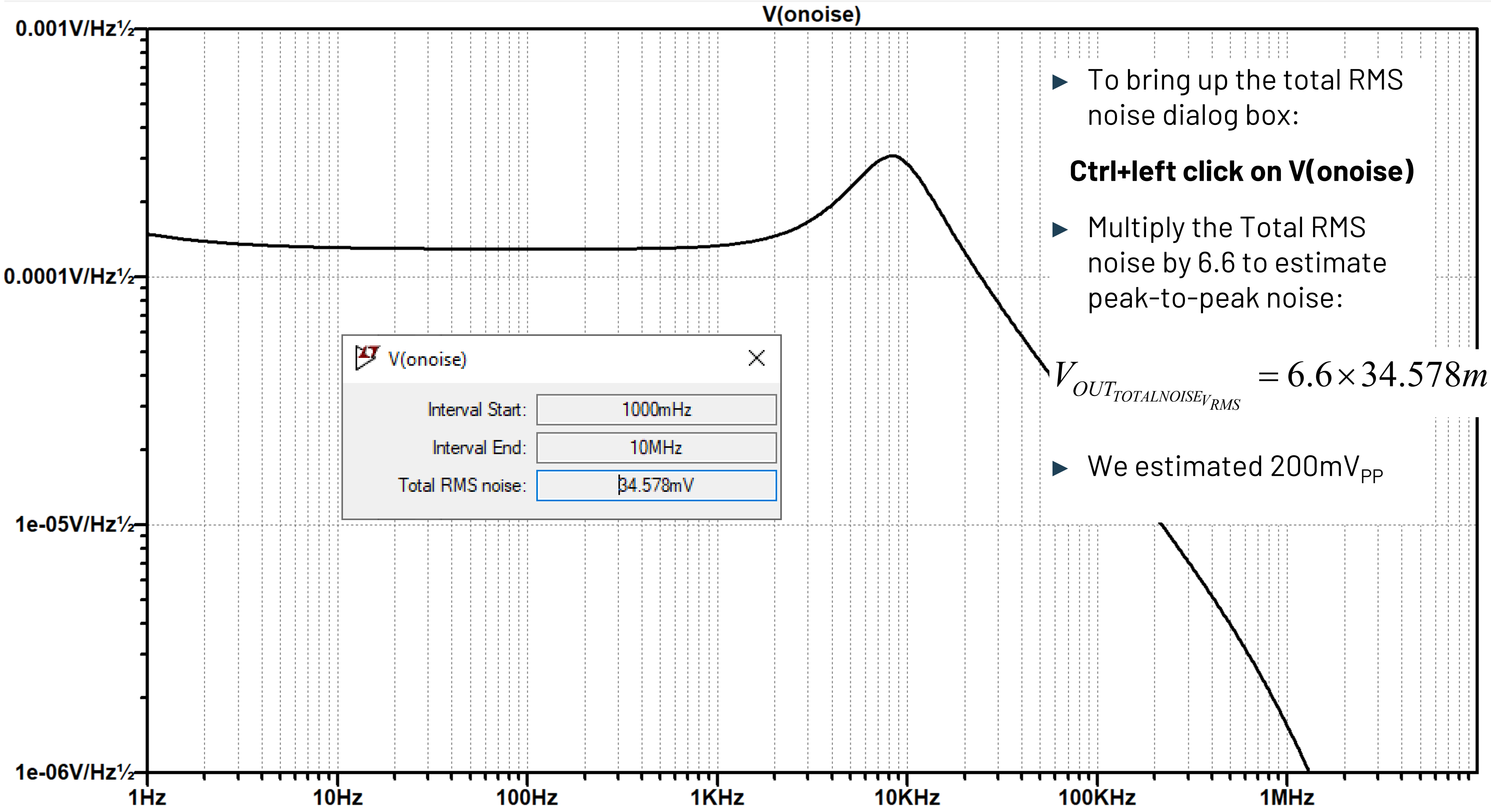


Output Referred Noise Spectral Density



- Place the cursor at the noise bandwidth of 16.3kHz
- We estimated 237 µV/√Hz at the noise bandwidth of 16.3 kHz
- This is slightly past the -3dB point
- Calculating ~3dB down from our estimate we would expect 167 µV/√Hz
- The simulation shows 163 µV/√Hz

Total Noise



- To bring up the total RMS noise dialog box:

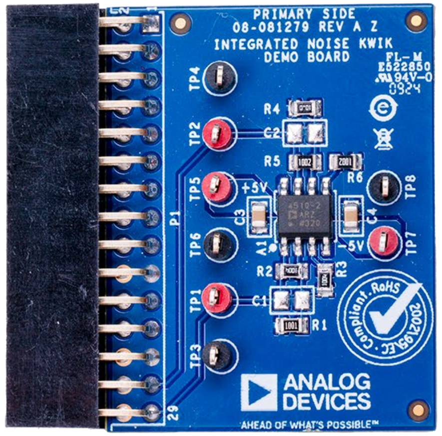
Ctrl+left click on V(onoise)

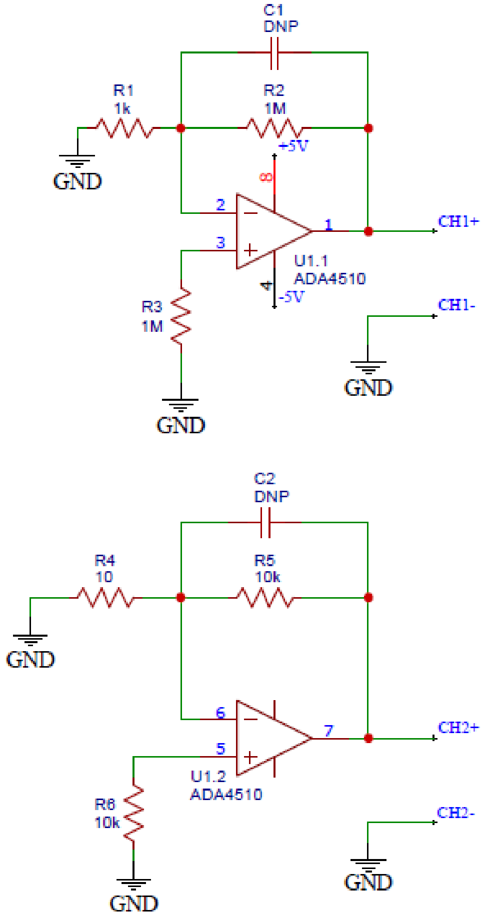
- Multiply the Total RMS noise by 6.6 to estimate peak-to-peak noise:

$$V_{OUT_{TOTALNOISE_{V_{RMS}}}} = 6.6 \times 34.578mV = 228mV_{PP}$$

- We estimated $200mV_{PP}$

Integrated Noise Demo Board Schematic





Physically Connect PCB to ADALM2k

ADALM2000

EVAL-KW4501Z

Using EVAL-KW4501Z

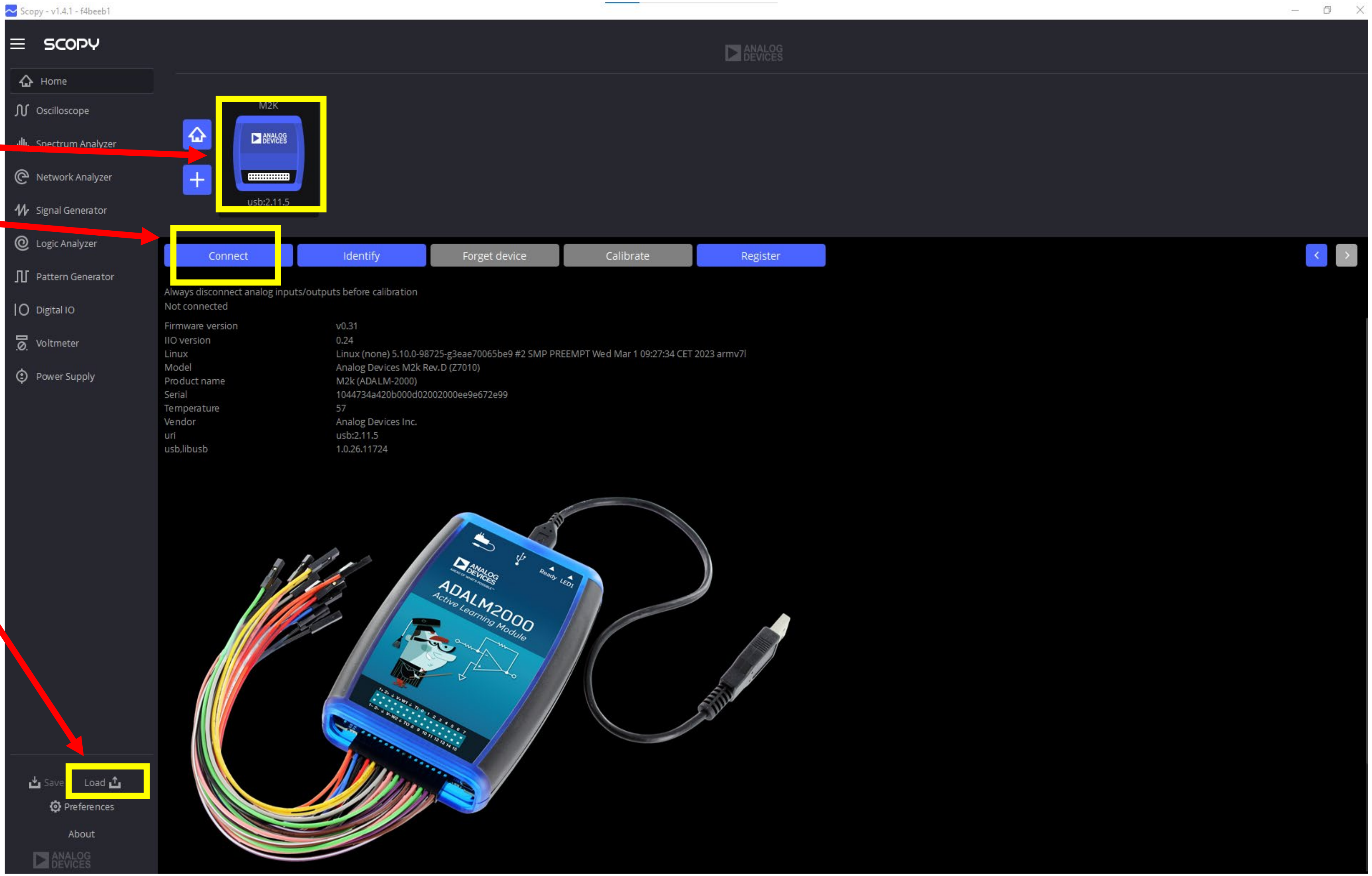
Carefully align pins and insert firmly

ADALM2000 should be powered off when connecting or disconnecting the PCB

Launch Scopy and Load Config File

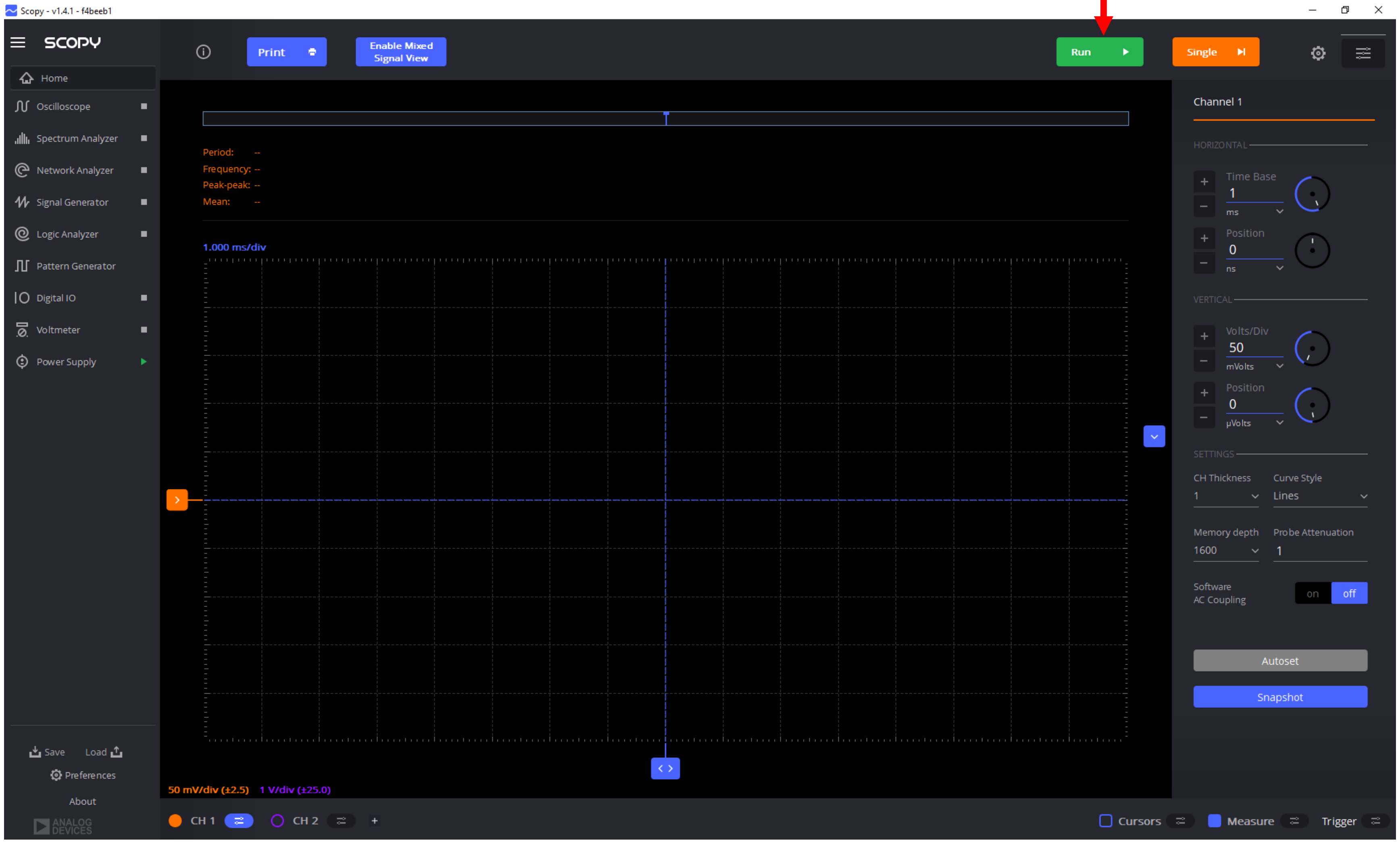
- Connect the ADALM2000 to your laptop and launch Scopy
- Click on the M2K icon
- Click connect
- Once connected click on load and load the file named:

"**Integrated Noise Scopy Config Ch A.ini**"



Let’s Have a Look at the Total Noise

- Click “Run” to start the oscilloscope



Review the Result…is it about what you expected?

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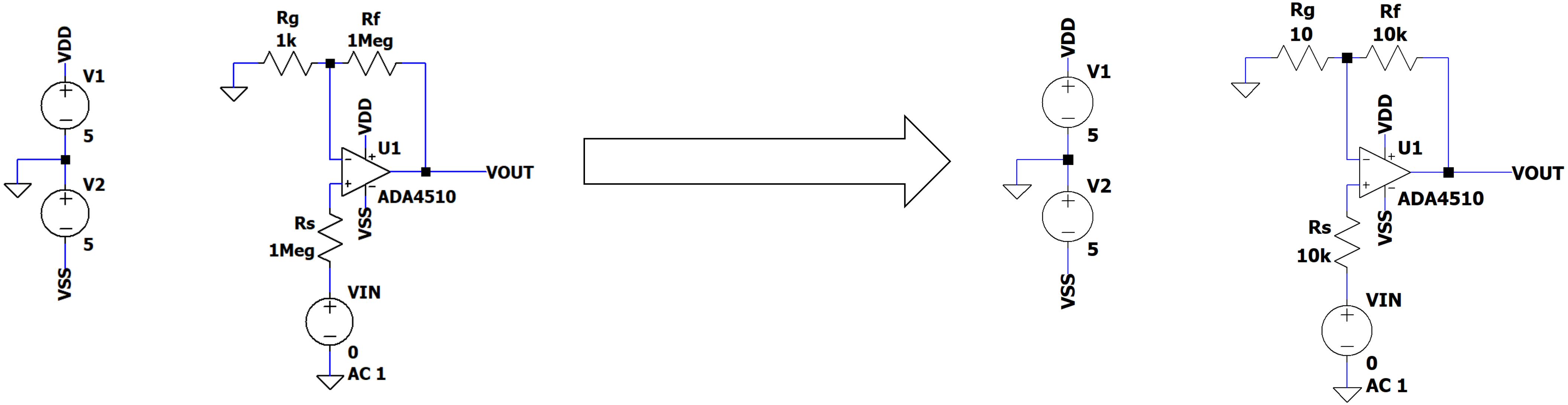
- You can click the stop button and look at the peak-to-peak measurement
- Try running and stopping a few times…you will notice some variation in the result…this is the nature of noise
- *If your result seems too high, you might be picking up external noise (the circuit has very high impedances and is in a high gain) try moving the board or rotating it to reduce any external interference* ☺

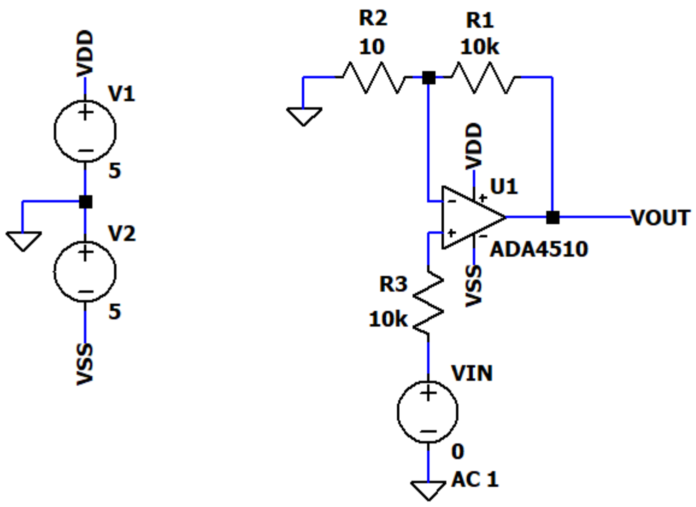
Reducing the Noise

- In the previous example we saw that the dominant sources of noise were the IB+ noise current multiplied by the source impedance multiplied by the gain and the voltage noise of the source resistance multiplied by the gain
- Let’s reduce all the impedance values by 100, keeping the same gain, but with less noise contribution from IB+ and Rs



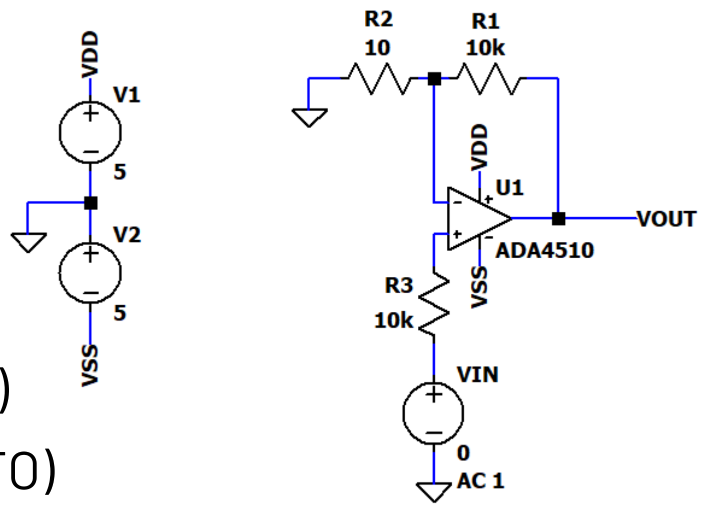
Example for a Simple Non-Inverting Amplifier

- Identify the noise Bandwidth
  - ADA4510 configured in G = 1001
    - Small-signal bandwidth = 10.4Mhz/1001 = 10.4kHz
    - Noise bandwidth = 10.4Khz * 1.57 = 16.3kHz
- Identify each noise source:
  - Rg = 10 ➔0.4nV/SQRT-Hz
  - Rf = 10k➔12.7nV/SQRT-Hz
  - Rs = 1k➔12.7nV/SQRT-Hz
  - ADA4510 ➔Vn = 5nV/SQRT-Hz (@16.3kHz)
  - ADA4510 ➔ In- = 200fA/SQRT-Hz (@16.3kHz)
  - ADA4510 ➔ In+ = 200fA/SQRT-Hz (@16.3kHz)



Example for a Simple Non-Inverting Amplifier

- Refer each Noise Source to the Output:
  - Rg = 10 ➔0.4nV/SQRT-Hz*1000 = 0.4µV/SQRT-Hz (RTO)
  - Rf = 10k➔12.7nV/SQRT-Hz*1 = 12.7nV/SQRT-Hz (RTO)
  - Rs = 10k➔12.7nV/SQRT-Hz*1001 = 12.7µV/SQRT-Hz (RTO)
  - ADA4510 ➔Vn = 5nV/SQRT-Hz (@16.3kHz)*1001 = 5µV/SQRT-Hz (RTO)
  - ADA4510 ➔ In- = 200fA/SQRT-Hz (@16.3kHz) *10k= 2nV/SQRT-Hz (RTO)
  - ADA4510 ➔ In+ = 200fA/SQRT-Hz (@16.3kHz)*10k*1001 = 2µV/SQRT-Hz (RTO)



Sum the NSD at the output:

$$V_{OUT_{NSD@16.3kHz}} = \sqrt{\left(0.4\mu V/\sqrt{Hz}\right)^2 + \left(12.7nV/\sqrt{Hz}\right)^2 + \left(12.7\mu/\sqrt{Hz}V\right)^2 + \left(5\mu V/\sqrt{Hz}\right)^2 + \left(2nV/\sqrt{Hz}\right)^2 + \left(2\mu V/\sqrt{Hz}\right)^2} = 14\mu V/\sqrt{Hz}$$

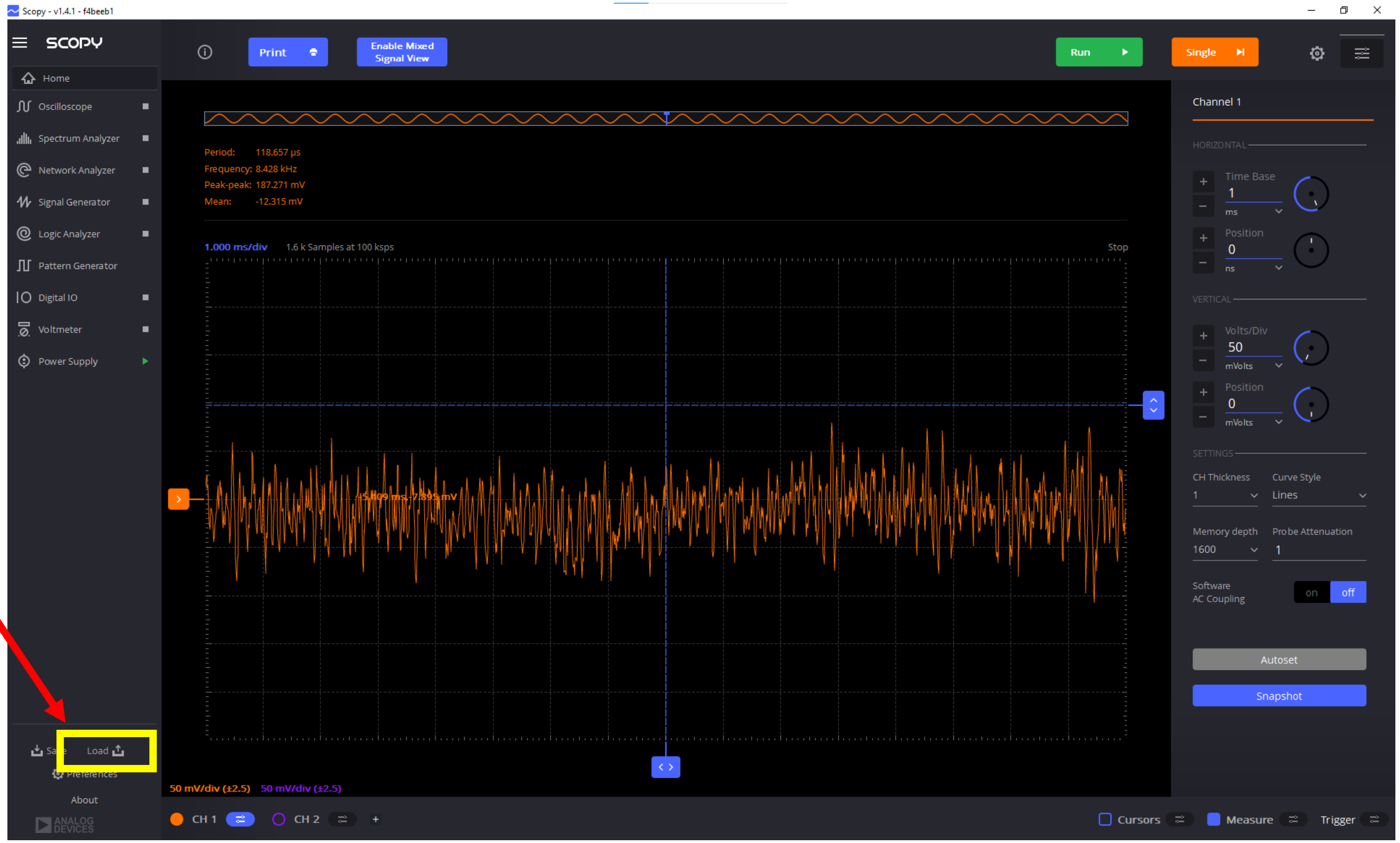
Estimate the Total Noise:

$$V_{OUT_{TOTALNOISE_{V_{PP}}}} = 6.6 \times 14\mu V/\sqrt{Hz} \times \sqrt{16.3kHz} = 12mV_{PP}$$

Load Config File

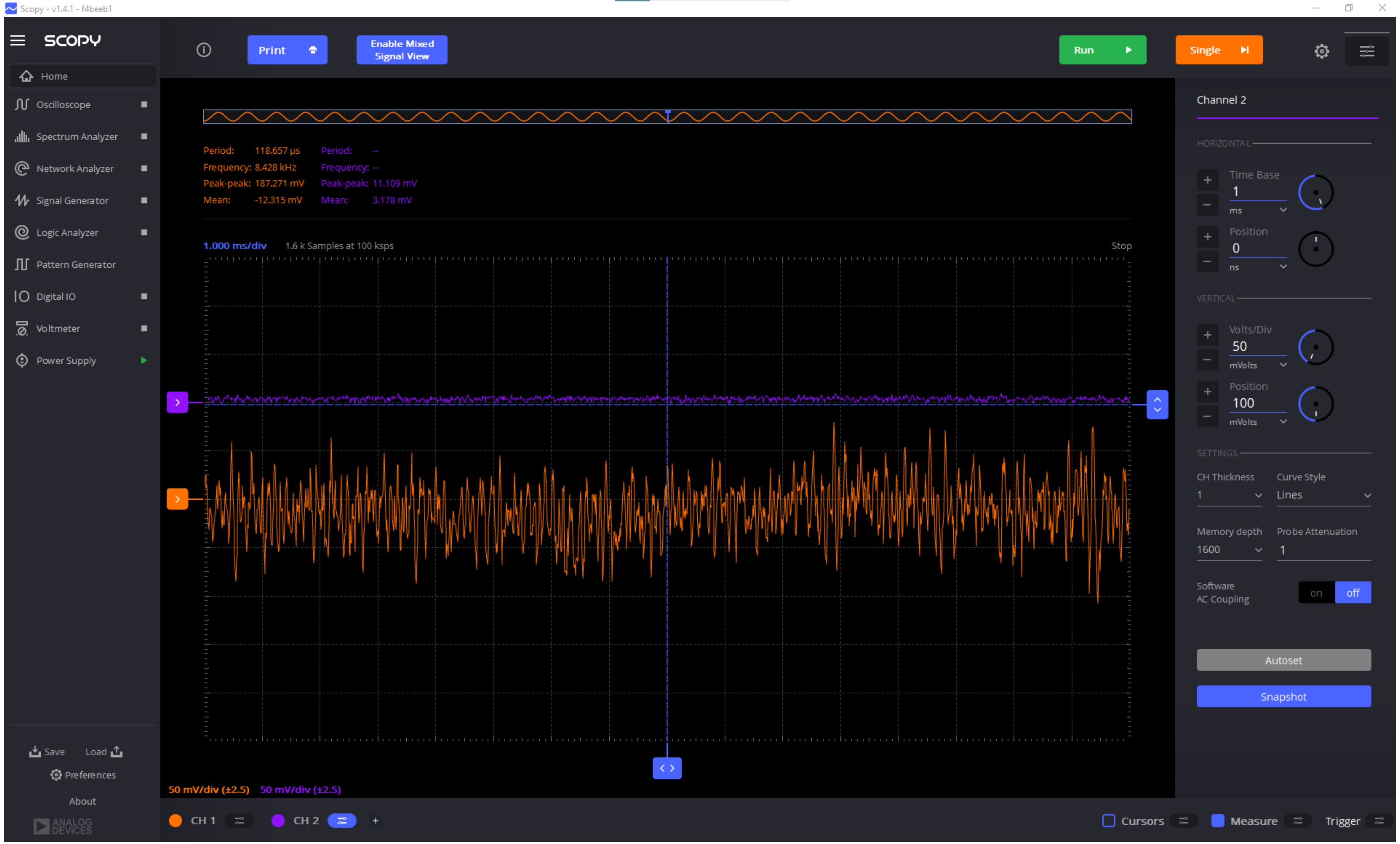
- Load the file named:

"Integrated Noise Scopy Config Ch B.ini"



Let’s Have a Look at the Total Noise

- Click “Run” to start the oscilloscope

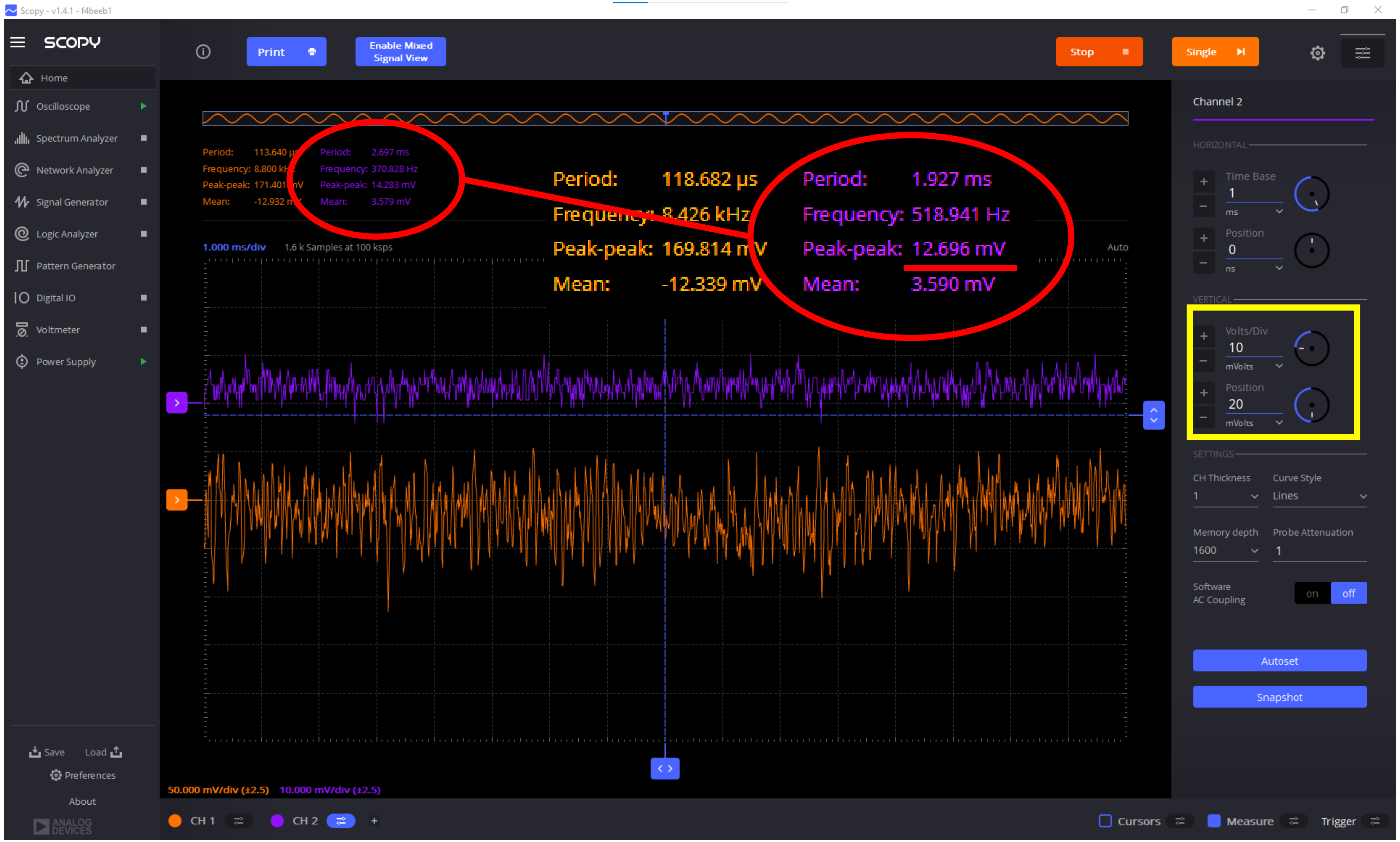


- Click “Run” to start the oscilloscope

- Notice both Ch1 and Ch2 are on the same scale
- You see how much the noise is reduced

Let's Zoom In and Measure

- Click "Run" to start the oscilloscope



- Change Ch 2 to 10mV/Div
- Change Ch2 Position to 20mV
- Measure the peak-to-peak noise

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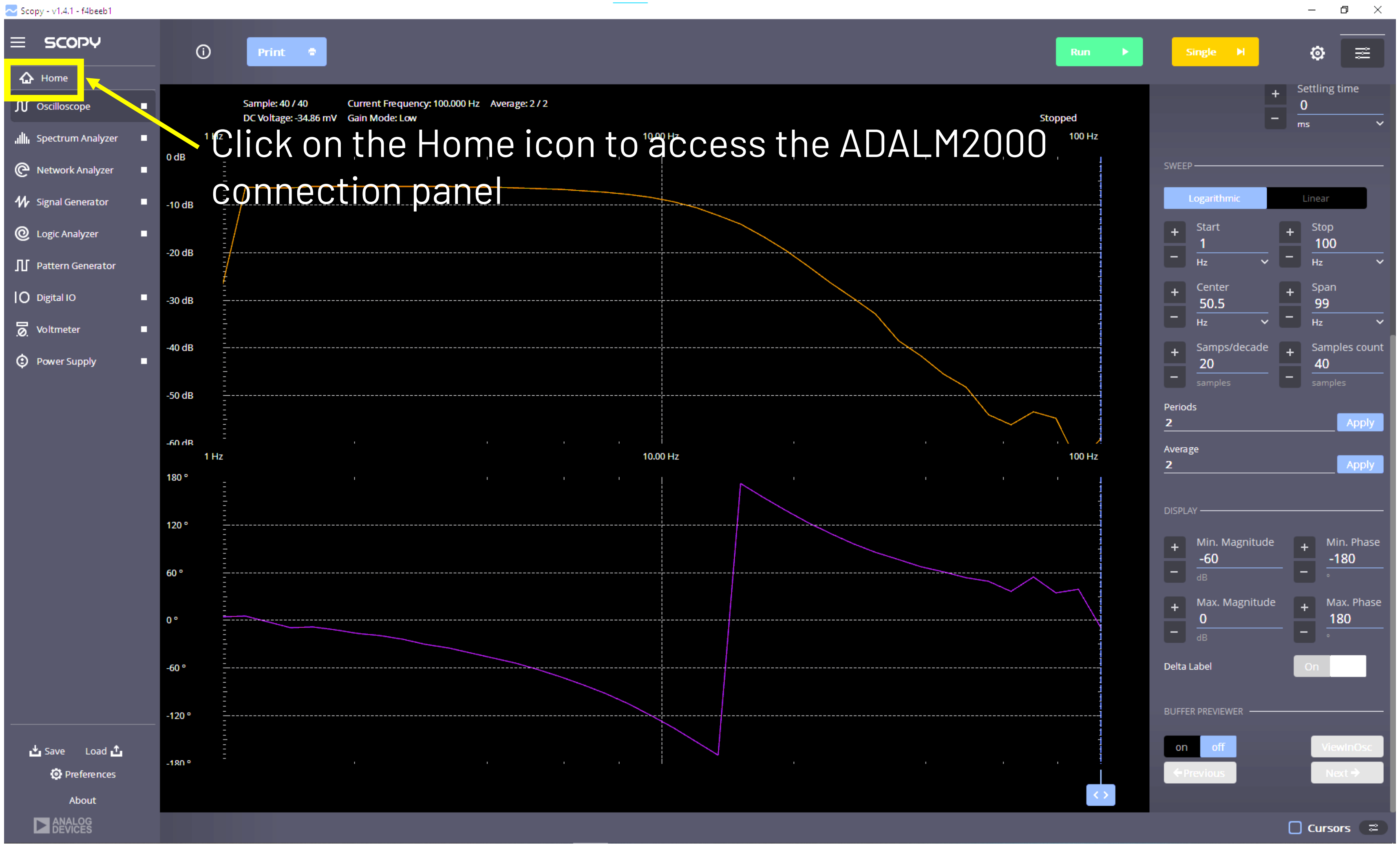
Shutting Down

Shutting Down

Click on the green triangle icon next to the Power Supply label…it will turn into a grey box. It is now safe to disconnect the PCB from the ADALM2000

Shutting Down



Click on the Disconnect Button

You may first need to click on this icon if the option to disconnect does not automatically appear

Click on the Disconnect button. It is now safe to disconnect the ADALM2000 from your laptop

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Thank You!