

1. Introduction

This software allows you to collect data from the PicoScope 5000 series by customizing channel settings, voltage ranges, sampling rates, and duration. The collected data is stored in NumPy (.npy) format for easy analysis.

2. Hardware Connection

4) 1Connect the power cable to the PicoScope device.

4) 2Use the provided USB cable to connect the PicoScope device to your PC. (Refer to Figure 1)



Figure 1 Hardware Connection

4) 3Connect the probes to the channel ports on the front of the PicoScope. (Refer to Figure 2)



Figure 2 Oscilloscope Probe

4) 4Connect the electrodes you want to measure to the ends of the probes.

3. Software Execution

✂ Ensure sufficient hard drive space before running the software.

3.1 Running the Executable

- 1) Before running the program, visit <https://www.picotech.com/downloads>. Select your PicoScope model (5444D MSO) and download the PicoSDK that matches your PC's operating system (32-bit or 64-bit). (Refer to Figure 3)

Product series	PicoScope 5000 Series	PicoScope 5444D MSO	Software				
PicoScope 2000 Series >	PicoScope 5242D MSO >	Software >	Resource	Architecture	Release	Size	Released
PicoScope 3000D Series >	PicoScope 5243D >	Manuals & brochures >	Windows:				
PicoScope 3000E Series >	PicoScope 5243D MSO >		PicoScope 7.1.29 (64-bit)	x64	Stable <i>*Recommended</i>	235 MB	Jun 13 2024
PicoScope 4000 Series >	PicoScope 5244D >		Picoscope 7.1.32 Early Access	x64	Early Access	235 MB	Jul 02 2024
PicoScope 5000 Series >	PicoScope 5244D MSO >		PicoLog 6.2.9		Stable	103 MB	Feb 21 2024
PicoScope 6000 Series >	PicoScope 5442D >		PicoSDK 10.7.26 (32-bit)	x86	Stable	117 MB	Mar 08 2024
PicoScope 9000 Series >	PicoScope 5442D MSO >		PicoSDK 10.7.26 (64-bit)	x64	Stable	121 MB	Mar 08 2024
PicoLog Data Loggers >	PicoScope 5443D >						
PicoSource >	PicoScope 5443D MSO >						
PicoVNA >	PicoScope 5444D >						
Discontinued products >	PicoScope 5444D MSO >						

Figure 3 PicoSDK download

- 2) Run the downloaded PicoSDK installation file to install PicoSDK. (Install with default settings)
- 3) After installation, run PicoProbe.exe. (If you encounter execution errors, refer to [3.2 Running via CMD]) ***The loading process may take a while.**

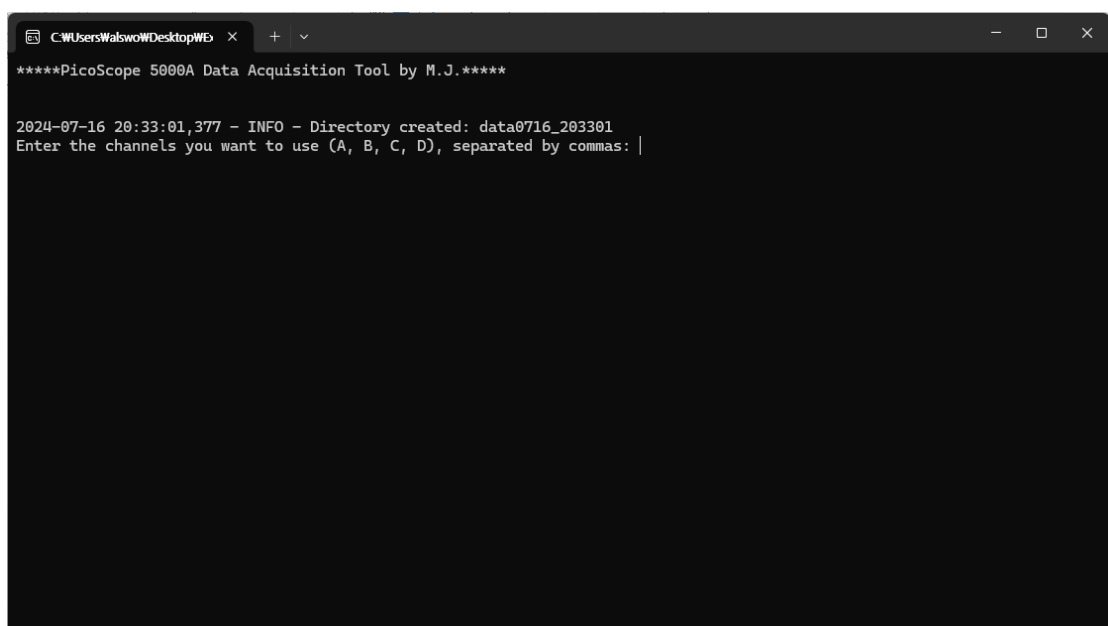


Figure 4 PicoProbe.exe

- 4) After execution, proceed to [4. Software Initial Setup] to use the software.

3.2 Running via CMD

※ If you encounter errors with the executable file or need to modify the code, you can run the program using the following method

- 1) Before execution, install modules and check versions (development version). (We recommend setting up an Anaconda virtual environment)

Python 3.7.1

Numpy 1.21.5

Pandas 1.3.5

Picosdk 1.1 (Refer to **[3.1 Running the Executable]** for PicoSDK download)

- 2) Press Windows+R, and when the Run window appears, type 'cmd' to open the Command Prompt.

(For Anaconda users, open the Anaconda Prompt instead)

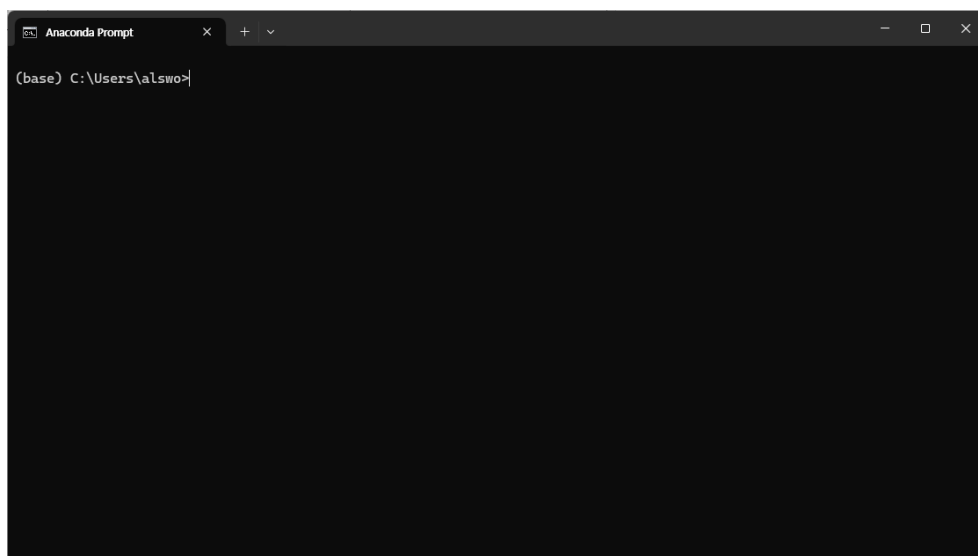


Figure 5 Anaconda Prompt

- 3) In the Command Prompt, navigate to the folder containing the PicoProbe.py file. (Example: cd example)

※ You can simply copy and paste the folder path from File Explorer for easy navigation. (Refer to Figure 6) Command: cd C:\Users\alswo\Desktop\Example



Figure 6 Directory Path

Alternatively, you can use the commands 'cd Desktop' followed by 'cd Example' to achieve the same result.

- 4) Enter 'python PicoProbe.py' to run the file.

```
(picoscope) C:\Users\alswo\Desktop\Example>python PicoProbe.py
*****PicoScope 5000A Data Acquisition Tool by M.J.*****

2024-07-16 20:52:33,850 - INFO - Directory created: data0716_205233
Enter the channels you want to use (A, B, C, D), separated by commas: |
```

Figure 7 Python file execution

- 5) After execution, proceed to **[4.Software Initial Setup]** to use the software.

4. Software Initial Setup

When running PicoProbe.py, a folder for data storage is automatically created in the same directory as the file, named based on the execution time. After this, you'll proceed with settings such as channel selection. (Refer to Figure 7)

1) Channel Selection

Available channels are A, B, C, and D. Connect the probes and input the channels you wish to use. Separate multiple channels with commas (.). The selection is not case-sensitive. (Example: A,B or A,c,D)

2) Voltage Range Selection

You can set the voltage range for each selected channel. Choose one of the following options for each channel:

(10mV, 20mV, 50mV, 100mV, 200mV, 500mV, 1V, 2V, 5V, 10V, 20V) Default: 2V

****Include units when inputting, case-sensitive**

3) Sampling Rate Setting [Refer to 7. Warnings & Errors for recommendations]

Set the sampling rate, which is the frequency at which samples are measured. The unit is ns (nanoseconds). Be cautious not to set it too low as it may cause overflow. ****Input numbers only**

4) Resolution Setting

Enter either 8 or 12. This value represents the data resolution. Choosing 12-bit will result in larger file sizes but provide higher resolution data. ****Input numbers only**

5) Duration Setting

Set the program's execution time. Enter either 'time' or 'manual'.

- If you enter 'time', input the measurement duration in seconds. For example, entering 10 will run the measurement for 10 seconds. ****Input numbers only**

- If you enter 'manual', the measurement will continue until you manually stop it. You can terminate the measurement by pressing Ctrl+C.

```
2024-07-15 21:03:54,611 - INFO - Directory created: data0715_210354
Enter the channels you want to use (A, B, C, D), separated by commas: A,c,D

Voltage range options: 10mV, 20mV, 50mV, 100mV, 200mV, 500mV, 1V, 2V, 5V, 10V, 20V
Enter voltage range for channel A: 2V

Voltage range options: 10mV, 20mV, 50mV, 100mV, 200mV, 500mV, 1V, 2V, 5V, 10V, 20V
Enter voltage range for channel C: 5V

Voltage range options: 10mV, 20mV, 50mV, 100mV, 200mV, 500mV, 1V, 2V, 5V, 10V, 20V
Enter voltage range for channel D: 2V
Enter sampling rate (in ns): 200
Enter resolution (8 or 12 bit): 12
Enter 'time' for specific duration or 'manual' for manual termination: time
Enter duration in seconds: 10
```

Figure 8 Initial Settings Example

5. Data Measurement

Measurement begins immediately after completing [4. Software Initial Setup].

1) The program outputs logs of device connection and measurement settings based on your inputs. (Refer to Figure 9)

```
2024-07-15 21:39:10,687 - INFO - Device opened successfully
2024-07-15 21:39:10,687 - INFO - Channels A, C, D set up successfully
2024-07-15 21:39:10,688 - INFO - Buffers set successfully
2024-07-15 21:39:10,806 - INFO - Streaming started with sample interval: 208 ns
```

Figure 9 Initial log

2) During execution, the number of samples being saved to each channel is displayed in real-time. This allows you to monitor the measurement progress.

```
2024-07-15 21:39:12,942 - INFO - Put in Queue 10092544
2024-07-15 21:39:13,197 - INFO - Processing data batch 0
2024-07-15 21:39:13,216 - INFO - Data 0 saved for channel A, Sample #: 10092544
2024-07-15 21:39:13,232 - INFO - Data 0 saved for channel C, Sample #: 10092544
2024-07-15 21:39:13,250 - INFO - Data 0 saved for channel D, Sample #: 10092544
```

Figure 10 Data Saving log

3) The data is saved in channel-specific folders within the main folder created when the program was run (e.g., data0715_210354).

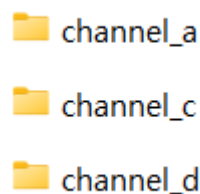


Figure 11 Data Files

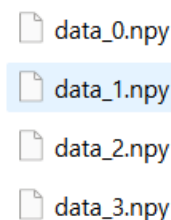


Figure 12 Channel Folders

4) Upon termination, the program outputs a closing log including measurement duration and data folder location.

```
2024-07-15 21:39:20,839 - INFO - Specified duration of 10 seconds reached. Stopping data collection.
2024-07-15 21:39:20,839 - INFO - Data collection stopped.
2024-07-15 21:39:20,849 - INFO - Process time: 10.043707370758057 seconds
2024-07-15 21:39:20,858 - INFO - Save data worker finished
2024-07-15 21:39:20,899 - INFO - Files saved to data0715_210354
2024-07-15 21:39:20,985 - INFO - Device closed
2024-07-15 21:39:20,985 - INFO - Data saved and program terminated
```

Figure 13 Termination log

5) The saved data is raw ADC (Analog-to-Digital Converter) data from the PicoScope without any processing. The data type is numpy.int16.

6. 데이터 분석

6.1 Data Graphs

- 1) Run Data_Plot.py to view the data graphs. (This file requires matplotlib and numpy to be installed)
- 2) Enter the path to your data. If you're checking a single data set (Figure 14), enter one path. To check the connection point between two data sets (Figure 15), enter two paths separated by a comma (,).

※ When checking connected graphs, input consecutive data sets

```
(picoscope) C:\Users\alswo\Desktop\Example>python data_plot.py
Enter the path(s) to your .npv file(s), separated by comma if two files: C:\Users\alswo\Desktop\Example\dist\data0716_215214\channel_a\data_5.npv|
```

Figure 14 Single Data plot Path input

```
(picoscope) C:\Users\alswo\Desktop\Example>python data_plot.py
Enter the path(s) to your .npv file(s), separated by comma if two files: C:\Users\alswo\Desktop\Example\dist\data0716_215214\channel_a\data_5.npv, C:\Users\alswo\Desktop\Example\dist\data0716_215214\channel_a\data_6.npv|
```

Figure 15 Multiple Data plot Path input

- 3) Enter the voltage range and sampling rate used when measuring the data. **Input numbers only

```
Enter the voltage range (in Volts): 2
Enter the sampling interval (in ns): 48
```

Figure 16 Voltage range & Sampling Interval input

- 4) The graph will be displayed.

6.2 Loading Data

If you need to load the data for analysis other than graphing, you can use `np.load(file_path)` to load the data.

7. Warnings & Errors

This software may experience frequent errors as error handling is not perfect.

If an error occurs, it's generally recommended to restart the program and reconnect the PicoScope.

Queue Capacity Warning ※ This may occur frequently.

- Warning message: "Queue is filling up" or "Queue is critically full"

- Solution:

a) The data saving speed is not keeping up with the data collection speed.

b) Lower the sampling rate or reduce the number of selected channels.

c) The minimum sampling rates that did not cause this error during testing are as follows:

(1Ch.: 48ns / 2Ch.: 80ns / 3Ch.: 112ns / 4Ch. 160ns)

※ These sampling rates may vary depending on hardware and execution environment.

Initial Setting Input Error

- Warning message: "Invalid ... input"

- Solution:

a) Review the instructions for each setting and input again.

1) Device Connection Error

- Error message: "Error opening device" or "Device not found"

- Solution:

a) Check if the PicoScope is properly connected to the computer

b) Disconnect and reconnect the USB cable

c) Try a different USB port

d) Verify that the PicoScope driver is correctly installed

2) Power-related Error

- Error message: "Power source issue" or "Insufficient power"

- Solution:

a) Ensure the PicoScope is receiving sufficient power

b) If using a power adapter, check if it's properly connected

3) Channel Setup Error

- Error message: "Error setting up channel"
- Solution:
 - a) Verify that the selected channel is supported by the PicoScope
 - b) Check if the voltage range setting is correct
 - c) Restart the program and try setting up the channel again

4) Buffer Setup Error

- Error message: "Error setting up buffer"
- Solution:
 - a) Check available memory on the computer
 - b) Restart the program and try again
 - c) Reduce buffer size (requires code modification)

5) Data Collection Error

- Error message: "Error in main_loop" or "Error in data collection"
- Solution:
 - a) Check if the connection to the PicoScope is stable
 - b) Verify that the selected sampling rate is within the PicoScope's performance range
 - c) Restart the program and try again

6) Data Saving Error

- Error message: "Error in save_data_worker"
- Solution:
 - a) Check if you have write permissions for the output folder
 - b) Ensure sufficient disk space
 - c) Verify that the output path doesn't contain invalid characters

7) Process Termination Error

- Warning message: "Save process did not terminate gracefully"
- Solution:
 - a) The program may have been forcibly terminated. Check for data loss

8. Code Modification and References

PicoProbe.py and Data_Plot.py can be downloaded from the following link:

https://github.com/MinjaeKim7280/Picoscope_data_acquisition

For code modifications and error resolution, please refer to the comments included in the code, as well as Picotech's user guide and programmer's guide.