Author: Zach Philip
Date: June 2025
Property of Whisper Aero

Documentation and Instructions for Pak Interface Program (Python)

Purpose:

This program was designed to create an interface to the C program provided by MBBM so that Python packages could be applied to the data. A Python interface allows for easy, flexible, and reliable modification of the data. The main.py file reads in the binary data from the input file, processes it using the desired function in my_function.py and writes it to the output file.

The program makes the following assumptions:

1. nz = 1
2. n_data_arrays = 1
3. n_data_sets = 1

Each of these limitations can easily be accounted for by slight manipulation of the python files. The c code should not need to be edited.

User Instructions:

1: Installs (Required)

Python:

Ensure the latest version of Python is installed. If not, download here and follow these instructions (for Windows).

1. Click download and run the installer once it's downloaded.
2. On the first screen, check the box that says: “Add Python to PATH.”
3. Click “Install Now” and follow the prompts.
4. After installation, verify it worked by opening a terminal window and typing:
   ```
   Python --version
   ```
5. You should see something like: Python 3.13.0
6. Then, verify pip is installed properly by running
   ```
   pip --version
   ```
7. You should see something like: pip 24.0 from < your directory >

VS Code Extension:

This guide assumes that VS Code is properly installed and configured. Be sure the Python extension by Microsoft is installed. Do this by navigating to extensions on the left tool bar (4 square blocks) and typing in “Python.”

C Code: Not Required

Author: Zach Philip
Date: June 2025
Property of Whisper Aero

If you're not looking to use the C code (most use cases), skip to step 2.

The instructions below allow a user to edit, run, and compile the C code provided by MBBM. If the DLL ever needs to be changed, instructions below will explain how to do it. As of June 2025, the DLL is working properly and grants all desired functionality to the Python user. Note: the C files have been slightly edited by Zach Philip.

These instructions will give a rough outline of what to download and install to use the C code. More specific instructions, if errors occur, can be found online.

Zip File:

The zip file with C code includes the rw files and the main.c file. There is also a provided sin_wave.pak52 file to use as an example input.

VS Code extensions:

Install C/C++ by Microsoft, found under extensions on left tool bar.

C Compiler:

MinGW-w64: Download it here.

During the install, follow these instructions:

1. During install: Architecture: x86_64
2. Threads: posix
3. Exception: seh
4. Build revision: latest
5. Add the bin directory to your system PATH:
   Example: C:\Program Files\mingw-w64\x86_64-posix-seh\mingw64\bin
6. Open a new terminal and check:
   ```
   gcc –version
   ```
7. Confirm output looks something like:
   ```
   gcc (x86_64-posix-seh, Built by MinGW-W64 project) 13.2.0
   Copyright (C) 2023 Free Software Foundation, Inc.
   This is free software; see the source for copying conditions.
   There is NO warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR
   PURPOSE.
   ```

Running The Code:

Once the compiler and extensions are set up in VS code, the code can be run. First, the user must compile the code into an executable that can be run. Do this by running the following command into the terminal:

```
gcc main.c rw_data.c -o main
```

Author: Zach Philip
Date: June 2025
Property of Whisper Aero

This will create an executable and place it into your working directory. Any errors are likely due to directories, so make sure you run this command from your working directory. Note: if you want to run in debug mode, add "-g" in front of main.c and you can step through the program.

Once the main.exe file is made, run the code using a launch.json file. Here is an example launch.json file:

```
{
  "version": "0.2.0",
  "configurations": [
    {
      "name": "Debug main.exe",
      "type": "cppdbg",
      "request": "launch",
      "program": " ", // Path to and including your main.exe
      "args": ["input.bin", "output.bin"], // ifile and ofile
      "stopAtEntry": false,
      "cwd": " ", // Working directory one level higher than executable
      "environment": [],
      "externalConsole": true,
      "MIMode": "gdb",
      "miDebuggerPath": "C:/msys64/ucrt64/bin/gdb.exe", // may be different on user system
      "setupCommands": [
        {
          "description": "Enable pretty-printing",
          "text": "-enable-pretty-printing",
          "ignoreFailures": true
        }
      ]
    }
  ]
}
```

Be sure to edit the file with the correct directories and file names. Then use the run button to execute the main.c. Check that it worked by verifying your input file matches your output file. Do this by opening the files in the "Hex Editor." Get there by clicking the file, clicking "Open Anyway" and selecting "Hex Editor."

Creating a DLL:

A DLL allows the python code to access the C functions. To create one, go to the rw_data.h file and uncomment the statements commented out by Zach Philip. Then type the following command into the command line to create the DLL:

```
gcc -shared -o pak_lib.dll rw_data.c
```

The DLL should be created, and you can copy it over to your working directory in Python. Keep the DLL in the same directory as main.py.

2: Edit Files

The user should only edit main.py and my_function.py.

In main.py, there is only one place to edit (if no additional arguments are needed). Comments are in place to guide the user.

The user must call their processing function that is written in my_function.py. Assign the variable "filtered_data" to the return value of your processing function. This variable is of type NumPy array. The user must ensure they're passing the proper parameters and returning the proper data type. If any data array is not being filtered, assign the data array to the corresponding filtered_data variable.

In my_function.py, there are up to two places to edit. Comments are in place to guide the user.

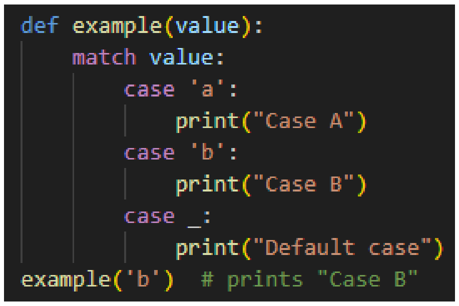
In my_function.py the user must define and implement their scaling function, paying close attention to parameters and return type. An example using the Gaussian filter is provided. Note: user will likely have to add additional import statements based on what packages they're using.

Input files:

Ensure the input file is in the supporting_files directory. The input file should be in the PAK binary format. Its name should not contain spaces or non-ASCII characters. If the input file is in a different directory, be sure to specify the path when running the program from the command line.

Arguments:

If additional arguments are needed, see the comments for where to add and process them. For newer versions of Python, match-case statements are recommended for processing, but if-else statements also work. Here is an example of how to use match-case:



```
def example(value):
    match value:
        case 'a':
            print("Case A")
        case 'b':
            print("Case B")
        case _:
            print("Default case")
example('b')  # prints "Case B"
```

Imports:

All third-party libraries are documented in requirements.txt. These imports include only NumPy and SciPy. Other imports are in the standard Python library or are local modules and do not need to be installed separately. After the user has Python installed, run the following command in the terminal from the project folder to install all packages from the requirements.txt file:

```
pip install -r requirements.txt
```

If the user needs to install additional packages for their my_function.py function, use the following command:

```
pip install <package_name>
```

3: Using the Python code

Running the code:

The user can run the code from the terminal or from the text editor's built-in run button. From the terminal, navigate to your project root folder and use the following command to run the main.py file (assuming Python version 3):

```
python main.py <ifile_directory>/<file_name> <ofile_name.bin>
```

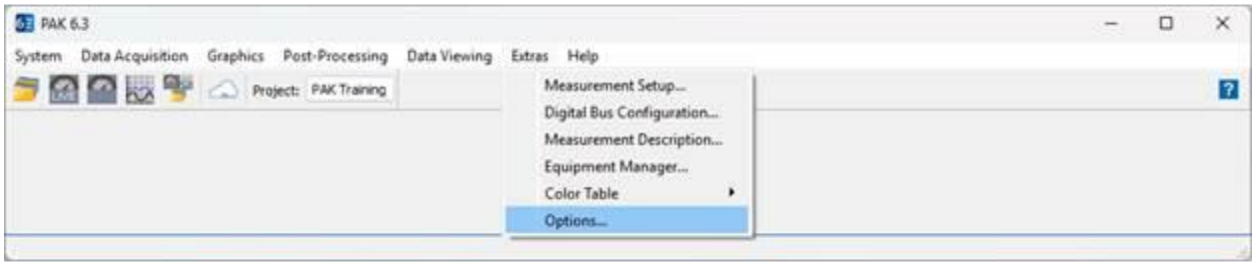
For example, for the original file setup,

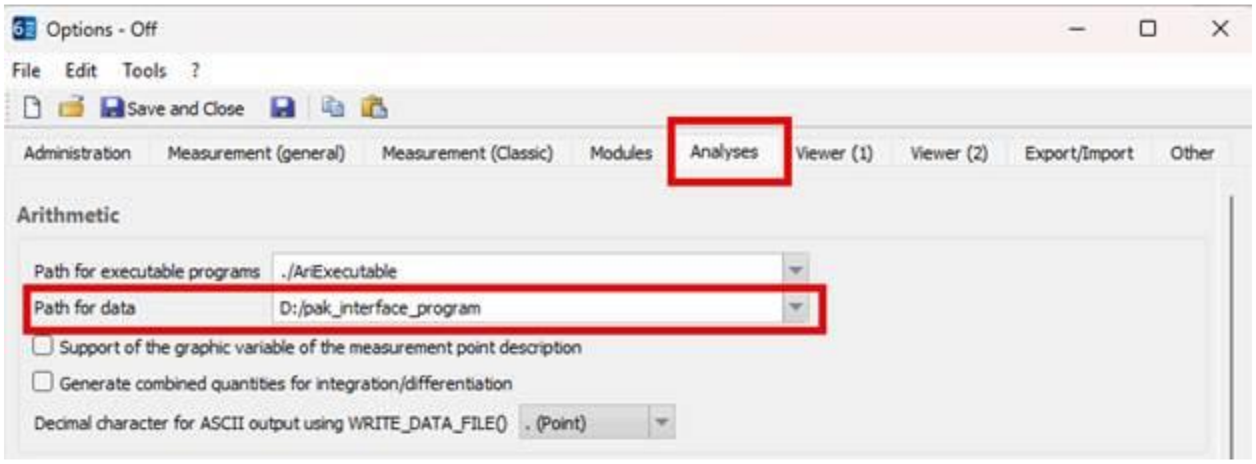
```
python main.py supporting_files/sin_wave.pak52 ofile.bin
```

4: Configure PAK

It's best to set the path for where the Python script is located. This will allow the script name and the PAK binary files to use relative paths. (NB: Any file names passed to Python via the command line still require absolute paths.)

Author: Zach Philip
Date: June 2025
Property of Whisper Aero



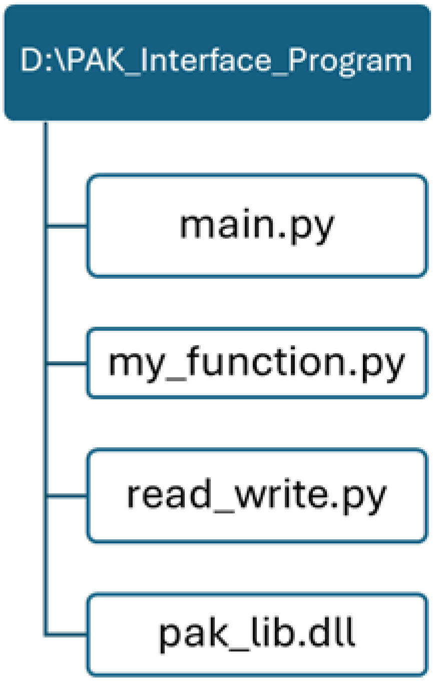


Arithmetic

Path for executable programs ./AriExecutable
Path for data D:/pak_interface_program
☐ Support of the graphic variable of the measurement point description
☐ Generate combined quantities for integration/differentiation
Decimal character for ASCII output using WRITE_DATA_FILE() . (Point)

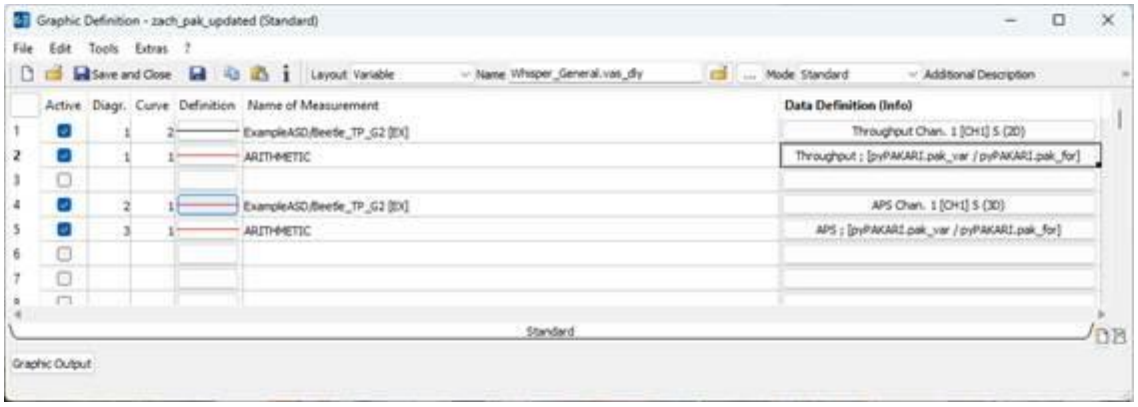
Example Python Directory Setup

Author: Zach Philip
Date: June 2025
Property of Whisper Aero



Using the PAK – Python Interface

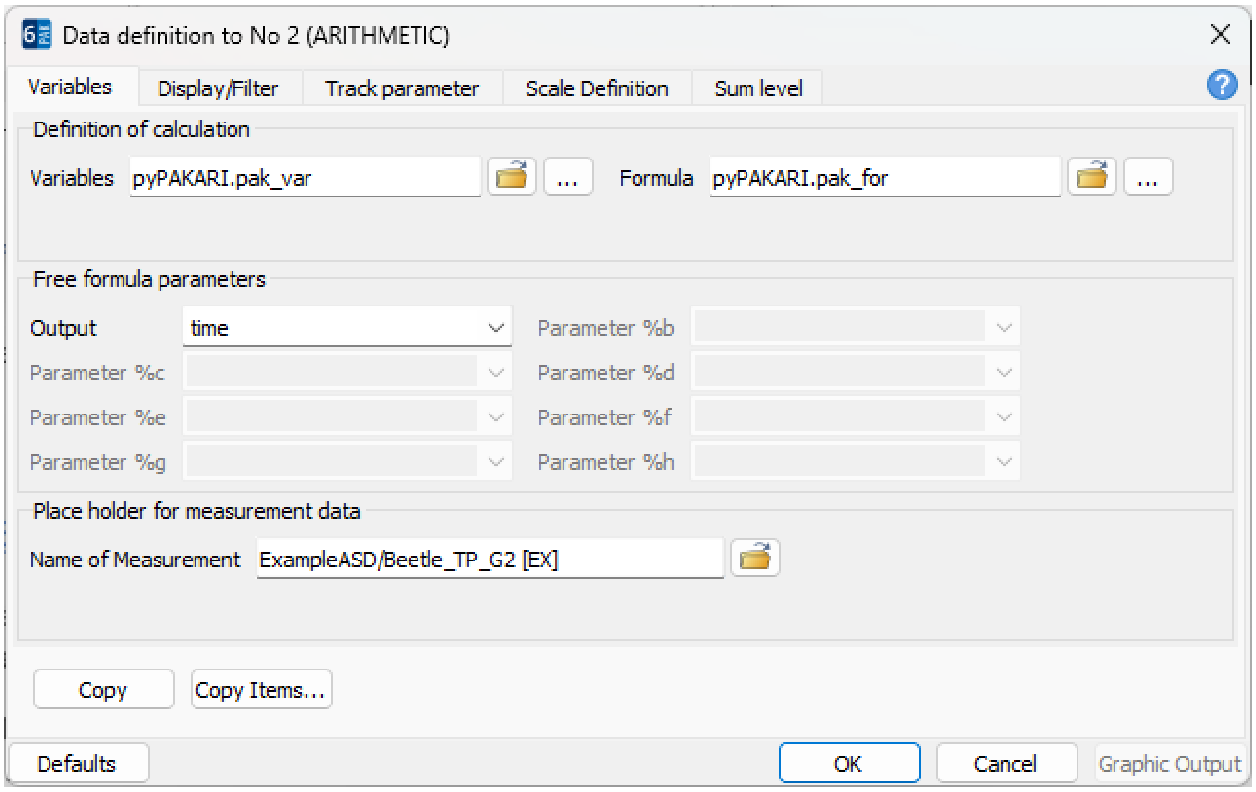
1. Create a graph definition containing an arithmetic definition



Layout: Variable Name: Whisper_General.vas_dly Mode: Standard Additional Description

	Active	Diagr.	Curve	Definition	Name of Measurement	Data Definition (Info)
1	✓	1	2	—	ExampleASD/Beetle_TP_G2 [EX]	Throughput Chan. 1 [CH1] S (20)
2	✓	1	1	—	ARITHMETIC	Throughput ; [pyPAKARI.pak_var / pyPAKARI.pak_for]
3	☐					
4	✓	2	1	—	ExampleASD/Beetle_TP_G2 [EX]	APS Chan. 1 [CH1] S (30)
5	✓	3	1	—	ARITHMETIC	APS ; [pyPAKARI.pak_var / pyPAKARI.pak_for]
6	☐					
7	☐					
8	☐					

2. Define the ARI variables and function



Data definition to No 2 (ARITHMETIC)

Definition of calculation

Variables: pyPAKARI.pak_var
Formula: pyPAKARI.pak_for

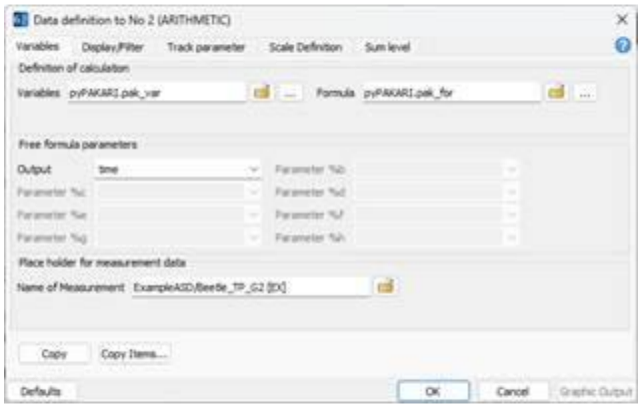
Free formula parameters

Output: time

Parameter %b, Parameter %c, Parameter %d, Parameter %e, Parameter %f, Parameter %g, Parameter %h

Place holder for measurement data

Name of Measurement: ExampleASD/Beetle_TP_G2 [EX]



Data definition to No 2 (ARITHMETIC)

Definition of calculation

Variables: pyPAKARI.pak_var
Formula: pyPAKARI.pak_for

Free formula parameters

Output: time

Place holder for measurement data

Name of Measurement: ExampleASD/Beetle_TP_G2 [EX]

3. Create an ARI with the following Process flow
    a. Use ARI function *WRITE_52DATA_FILE* to create binary data file
    b. Call Python script with ARI function *CALL_EXE*
    c. Use ARI function *READ_52DATA_FILE* to read the processed data file into PAK
4. To work with the example Python script and ARI graphic definition, please copy the included tables into your PAK tables.
5. Example ARI Script

Author: Zach Philip
Date: June 2025
Property of Whisper Aero

```
# Arithmetic to demonstrate PAK interaction with Python #
# Created : June 25, 2024 John Huff
# General note: For relative paths to work, the Main PAK --> Extras -->
Options --> Analysis --> Path for data must be set

# Input variables :
# PARAM 1 - The PAK binary data file with a 2-D value (i.e. x & y). This
will be the input file for the Python script
# PARAM 2 - The PAK binary data file that is generated by the Python
script
# PARAM # - Additional parameters can be passed to the script. This will
require the addition of handling code in the Python script

# Write out binary arithmetic file for the Python script. The name is not
restricted.
output = WRITE_52DATA_FILE(signal, "signal.bin", BIN, NEW_FILE, "")

# Call the Python script. This example uses main.py
# The example CALL_EXE will allow you to capture the STDOUT error while
you debug your script.
# exe =
CALL_EXE("C:\Users\john.huff\AppData\Local\Programs\Python\Python313\pytho
n.exe D:\pak_interface_program\main.py 2>
D:\pak_interface_program\log.txt")

# Call the Python script. Note that the "IN" argument can be a relative
path but the "PARAM" statements require an absolute path
# The first argument should be the path to your Python installation
exe =
CALL_EXE("C:\Users\john.huff\AppData\Local\Programs\Python\Python313\pytho
n.exe",IN,"main.py",PARAM,"D:\PAK_Interface_Program\signal.bin",PARAM,"D:\
PAK_Interface_Program\filtered_data.bin")

# Read in the binary arithmetic file process by Python
# Note that you must tell PAK what kind of data you are returning. In this
example:
# dt or Data Type is throughput
# yQuant1 or Y axis unit is Sound Pressure
# xQunat1 or X axis unit is Time.
#
# It is also possible to give the data a position name using the SET_PARAM
function as shown
input = SET_PARAM(READ_52DATA_FILE("filtered_data.bin", 'Throughput',
'Sound Pressure', 'Time'),POS,"Python Data")

time = input
```

```
# It is also possible to have PAK further process the data once it is read
in.
# Here the autopower spectra is being calculated from the throughput.
freq = APS_ANLY(input,16384,HANN,AVG_NONE,1,0,MIN,0.25)

# By using a variable it is possible to choose what result to display.
# In this case it is either the modified time history or the autopower
spectra
RESULT = %a
```