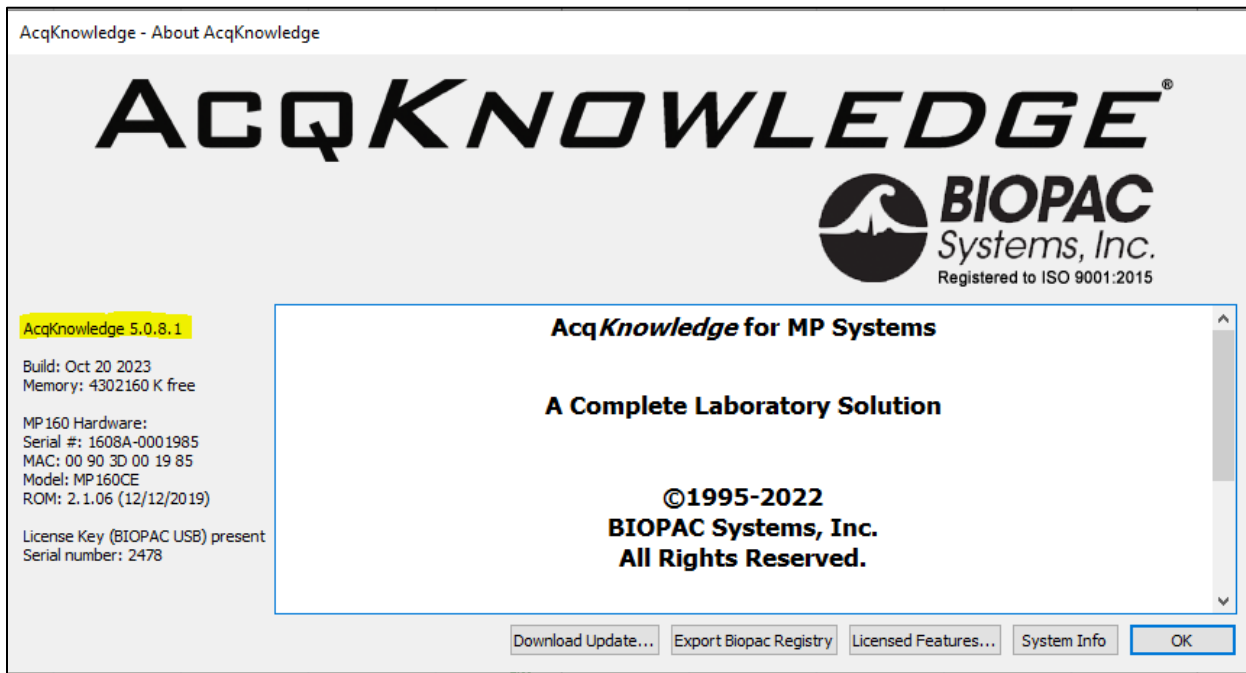


Application Note 298: *Getting Started with Workflow*

Checking Requirements

Workflow requires AcqKnowledge 5.0.7 or higher with a Biopac Basic Scripting license. To check the version of the software and the license status of your key, go to the Help menu in AcqKnowledge, and select “About AcqKnowledge.”

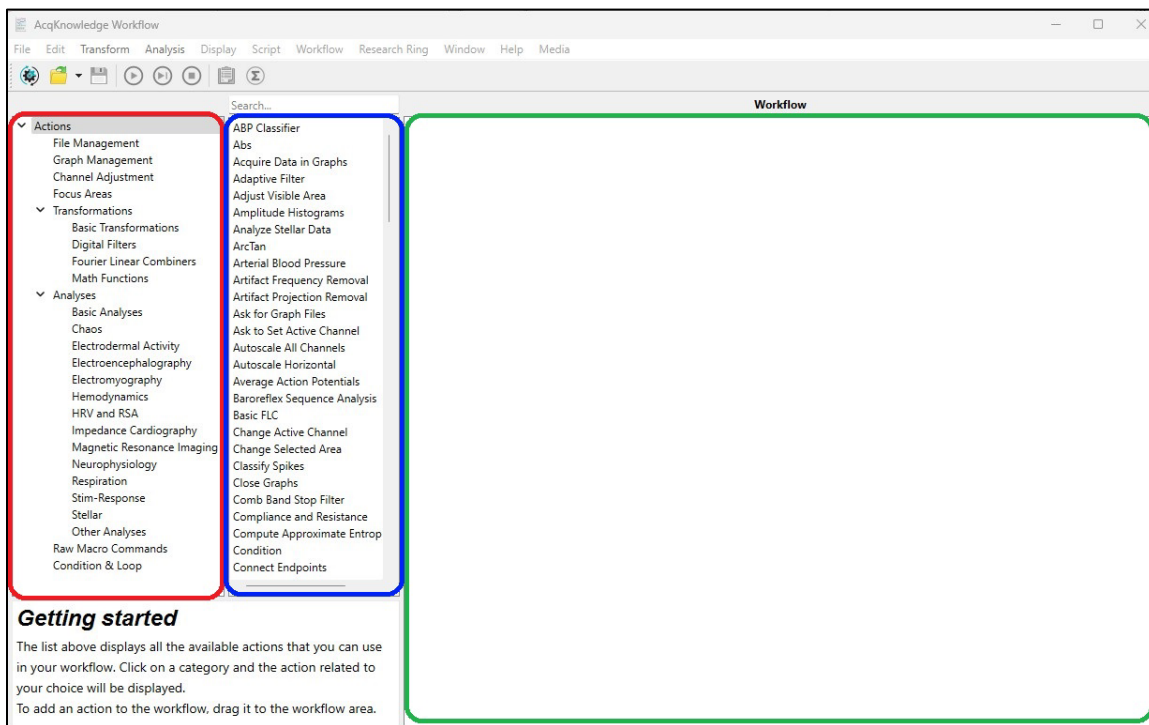


The version of the software will be displayed on the left side of the window. Click “Licensed Features...” to check the license status. If the key is authorized for Workflow, a window should open with “BIOPAC Basic” as one of the licensed features.

Note: For the purposes of this guide, “Workflow” (with a capital “W”) refers to the AcqKnowledge licensed feature, while “workflow” (with a lowercase “w”) refers to the individual routines created within the feature.

Getting Started with Workflow

To create a workflow, first go to the Workflow dropdown menu in *AcqKnowledge*, and select “Workflow Editor.” It will open the following window:



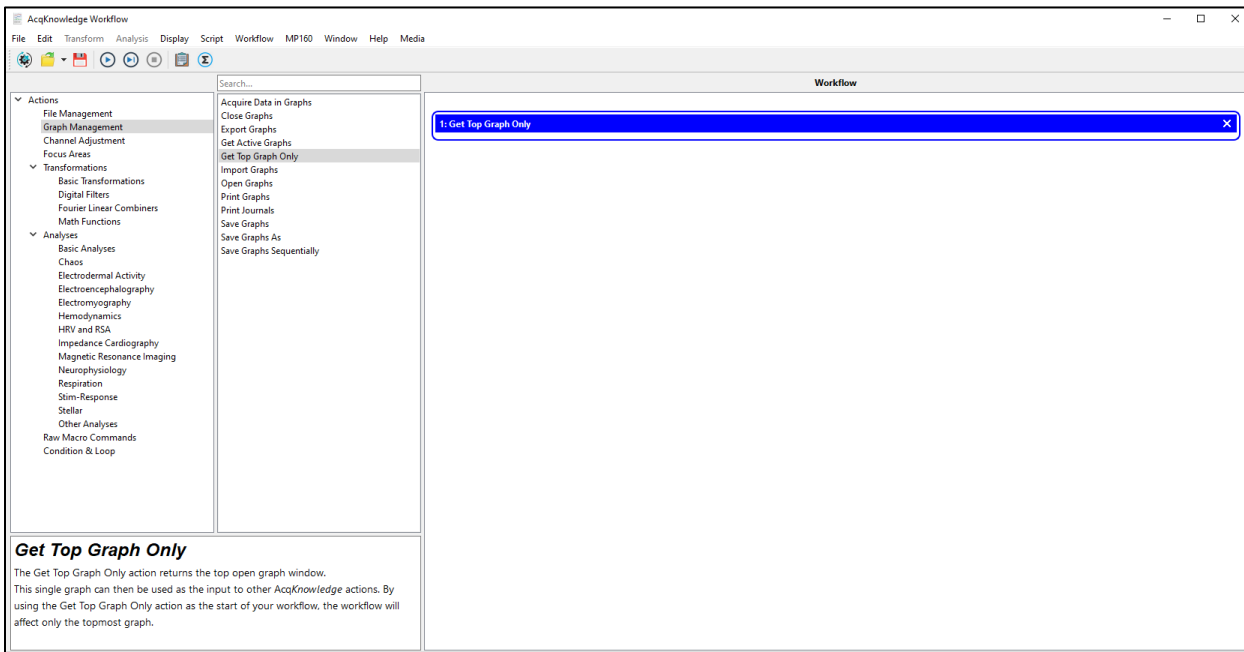
The area outlined in red is the **category list**. The area outlined in blue is the **actions list**. Finally, the area outlined in green is the **workflow area**. When “Actions” itself is highlighted, all possible actions will be listed in the **actions list**. If one of the categories under “Actions” is highlighted, only the actions associated with that **category** will be listed. The search bar above the **actions list** will only search the actions that are currently listed.




Click the folder to open an existing workflow. A workflow can only be saved when at least one action has been placed in the **workflow area**. A workflow will be saved as an .awf file and can only be opened in *AcqKnowledge*. This file can be opened separately from any graph or template.

Selecting The Graph

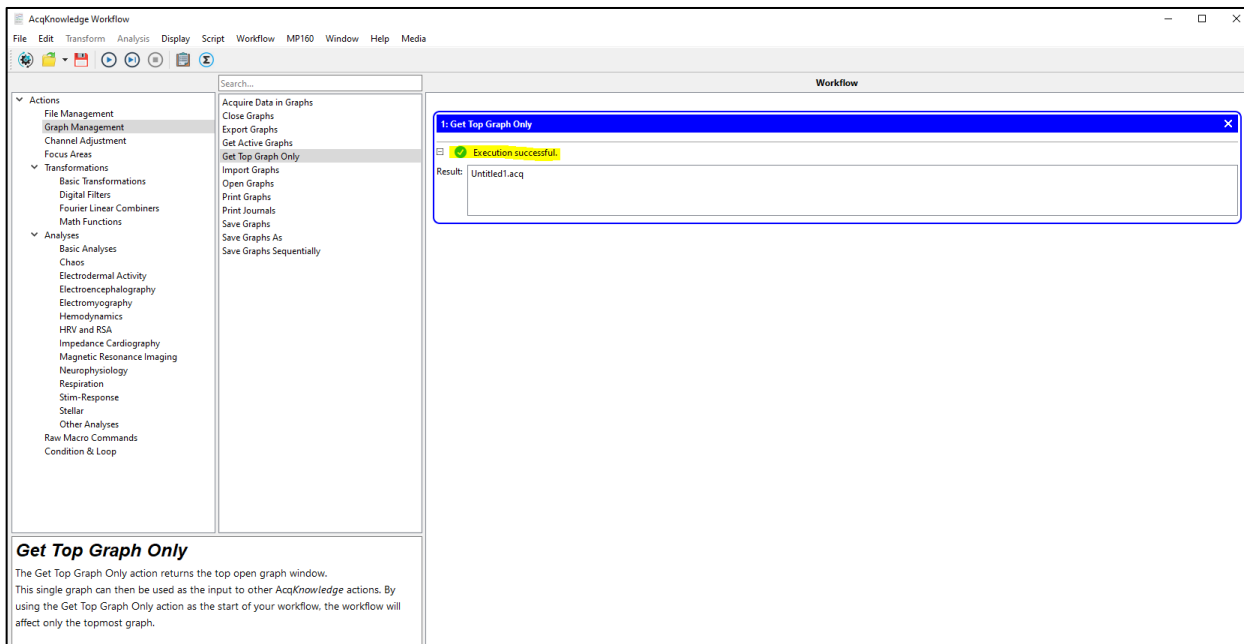
Every workflow begins by selecting the target graph upon which the workflow will operate. This can either be a graph that is currently open, or one saved somewhere on the computer. Multiple graphs can also be chosen.



If the desired graph is already opened (and no other graphs are currently open) the following will be displayed:



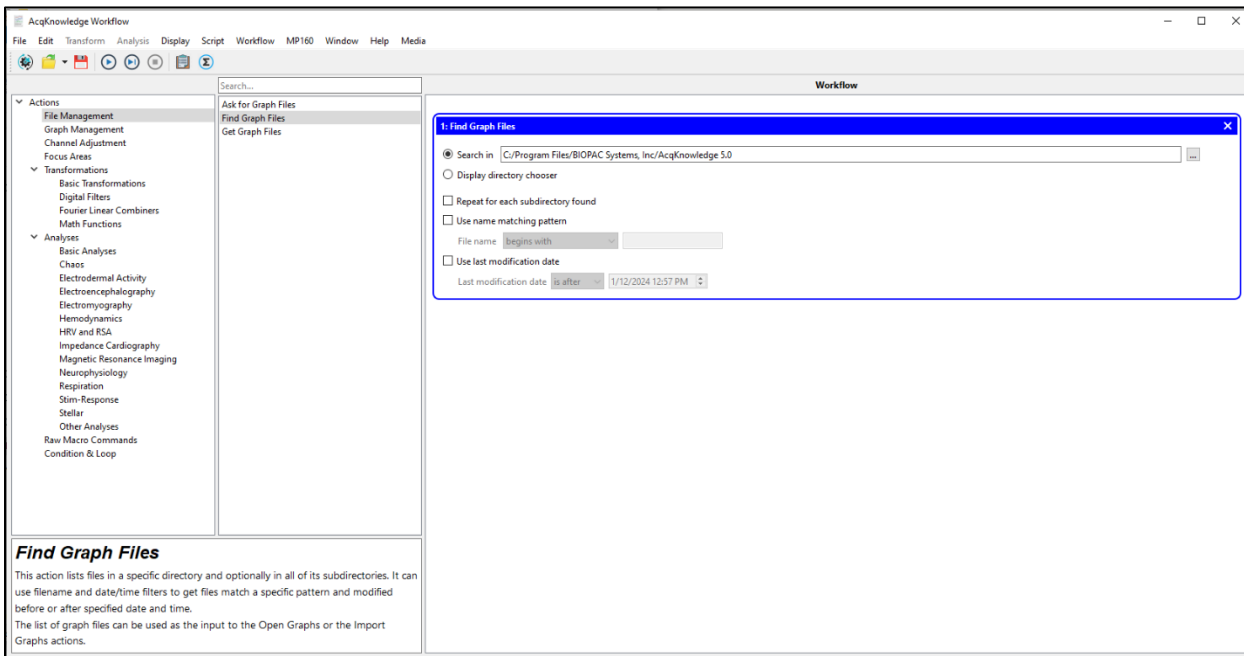
Go to Graph Management → Get Top Graph Only and drag that option to the workflow area. Users should test each action within Workflow as they build them. To do this, press the play button  next to the save button . The button to the right of the play button  allows users to proceed through the workflow sequentially action-by-action, starting with the first action, rather than running through the entire workflow.

Pressing either button should result in the following:



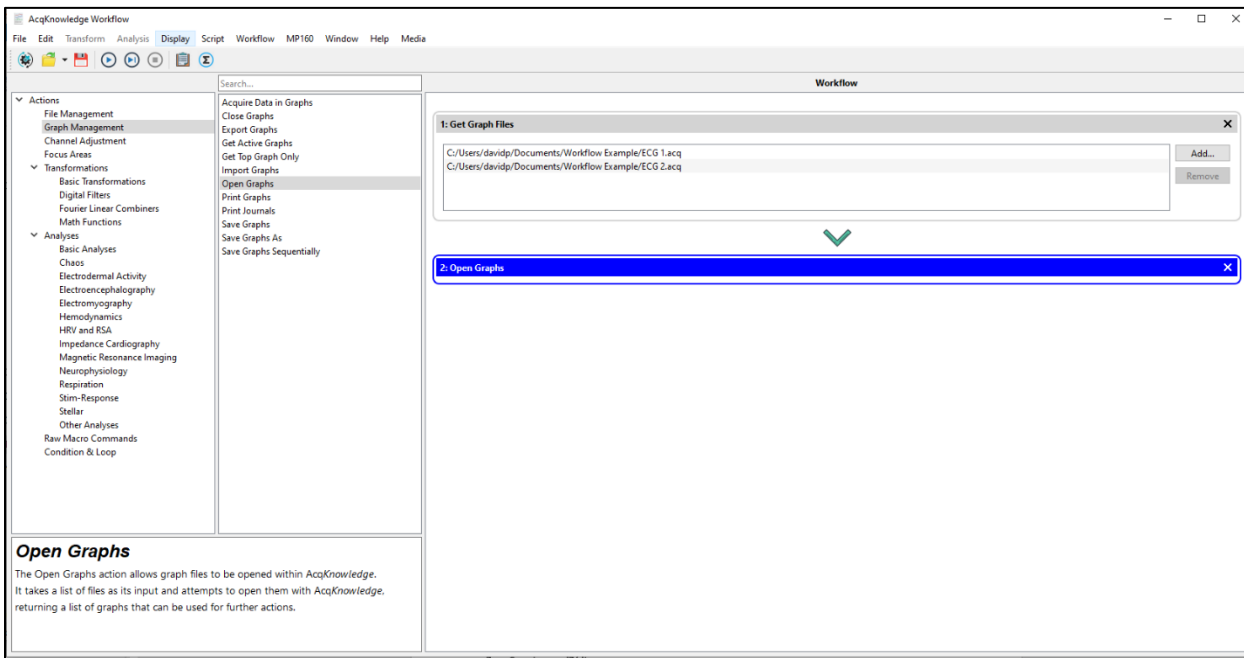
Click the highlighted plus button  . The result will be the name of the graph that was found. This should be the graph that is currently open.

If the desired graph is not currently open, there are two ways to open it. Graph files can be found at runtime with “Find Graph Files,” located under “File Management,” as shown below:

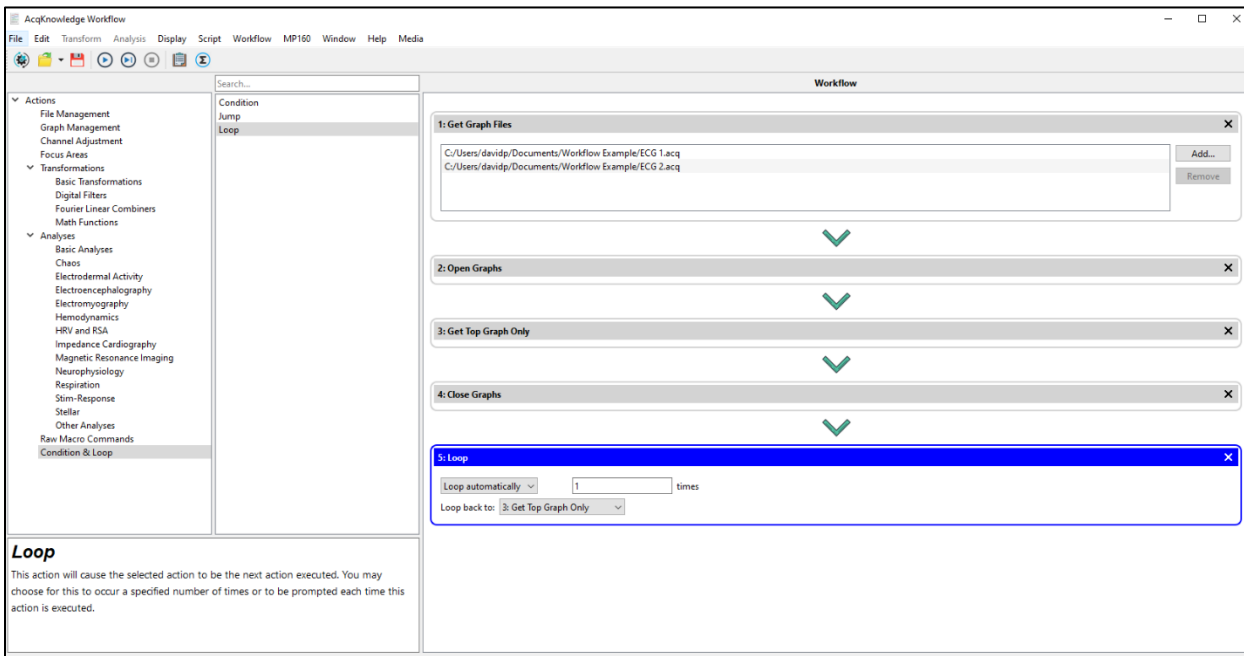


A directory containing the desired graph files must be specified. Otherwise, “Get Graph Files,” also located under “File Management,” can be used to manually specify which files should be used.

The next step once the files have been specified is to open the files. This can be done with “Open Graphs” under “Graph Management,” as follows:



Multiple files can be processed in succession. To do this, open all the desired graphs to be processed and then select a single graph. After all actions have been performed on the selected graph, the graph will close and the next graph will be selected. Next, add “Get Top Graph Only” to the workflow and then add “Close Graphs.” Finally, to instruct the workflow to loop back to “Get Top Graph Only,” add the “Loop” action, located under “Condition & Loop,” as shown below:

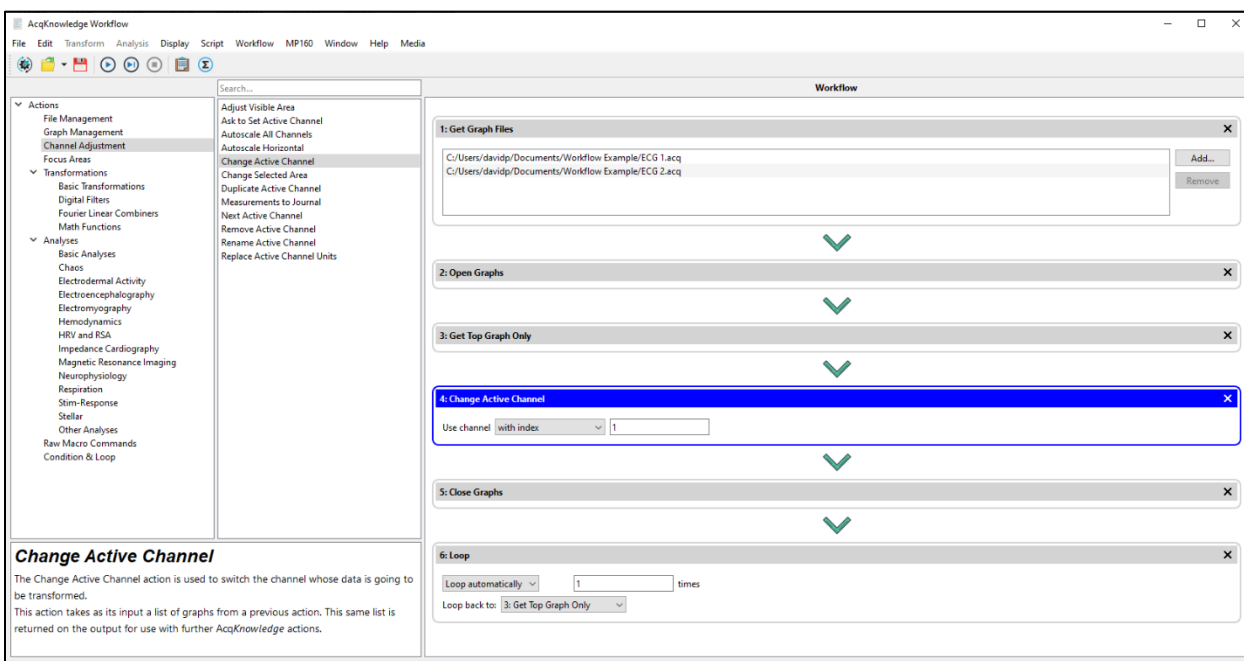


Note that in a full workflow, there will likely be other actions after step 3 and before 4 in the example above. This workflow opens the graphs, selects one, closes it, selects the next one, and closes that one.

“Loop” can be configured to automatically loop a set number of times. If the number of graphs is known, n , the number entered here should be $n-1$. “Loop” can also be configured to prompt the user after every iteration before continuing.

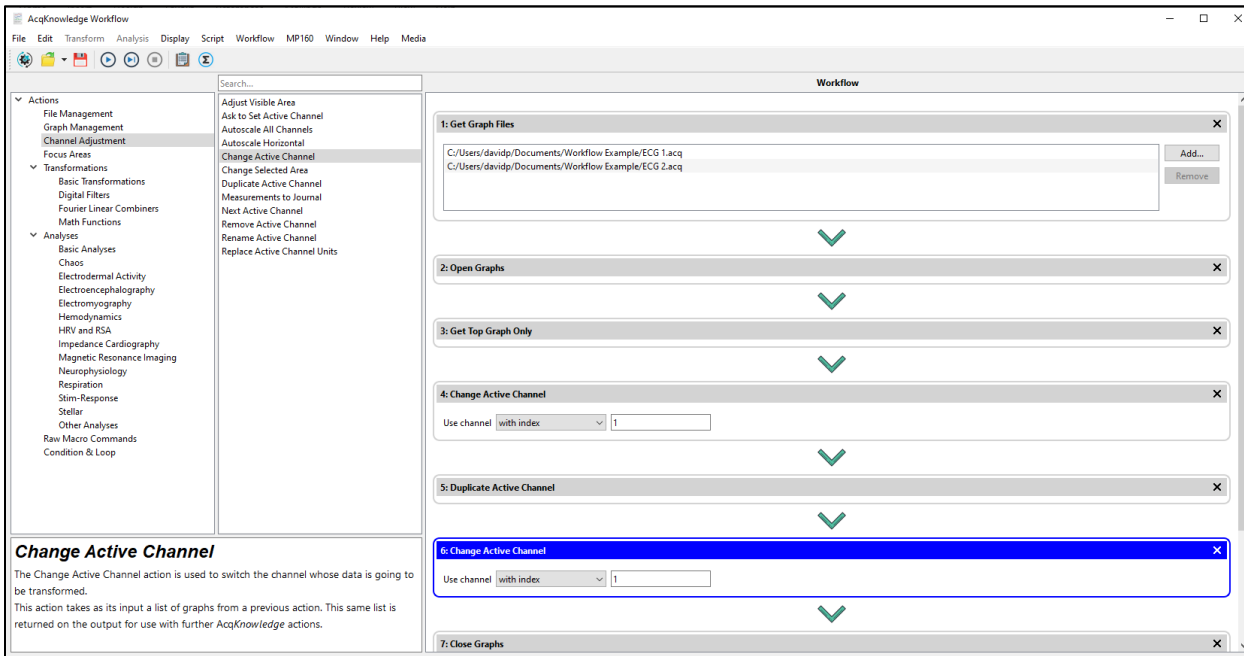
Performing Actions on Graphs

Once the graphs are opened, actions can be performed on them. In this example, some ECG data will be filtered and classified with QRS peaks. The logical order of operations would be to filter the data first. Before doing that, the ECG data must be selected. This can be done with Channel Adjustment → Change Active Channel:

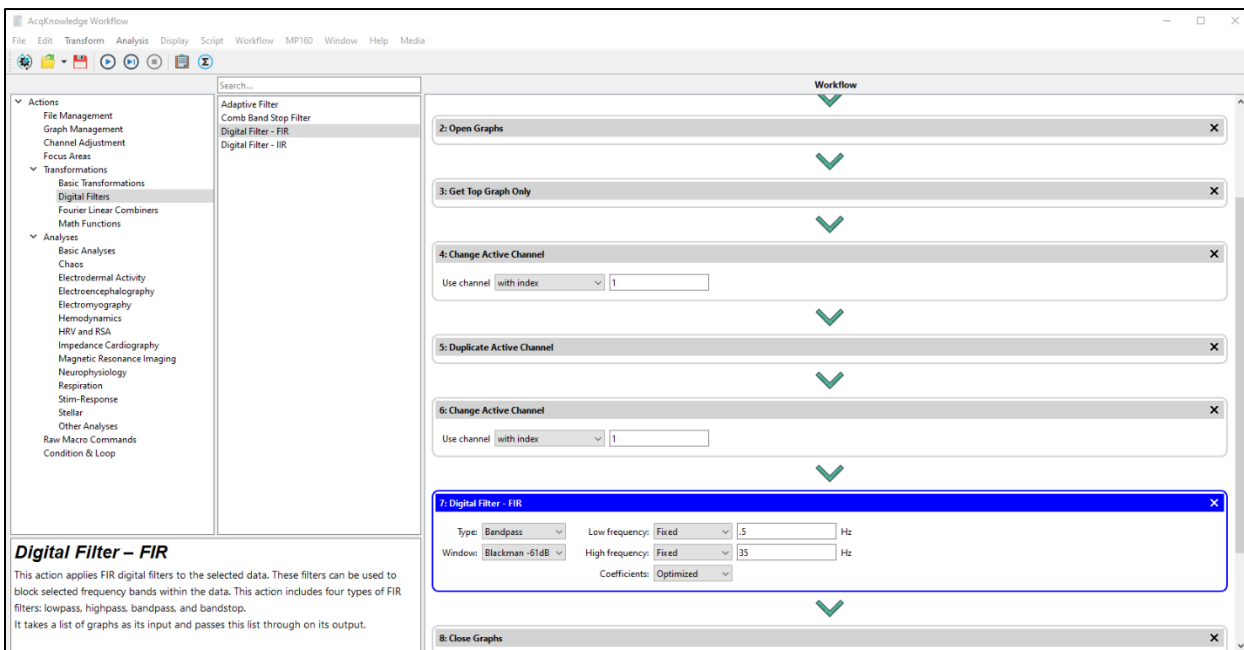


Note that this action was placed in between the “Get Top Graph Only” and “Close Graphs” actions. The numbers were automatically updated when this was placed. The channel index (1) was chosen to reflect the channel index of the ECG data.

To add a filter to data, users should duplicate their channel so that they will always have a copy of the original raw data. Users can do this by using the “Duplicate Active Channel” action, located under “Channel Adjustment.” This creates a new duplicate channel of ECG data, **containing the same name as the user’s original ECG channel**. The active channel is now automatically set to the newly created duplicated channel. This means that to continue working upon your original ECG channel, we must set the active channel back to channel 1 using another “Change Active Channel” action.



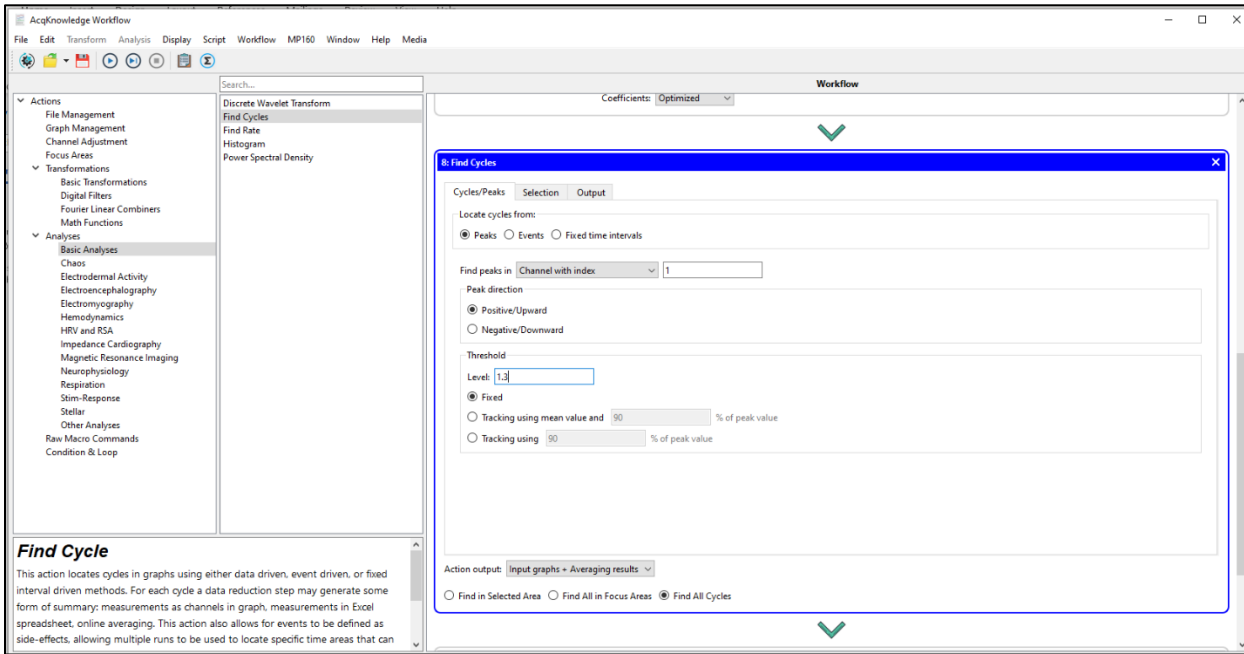
Next, to use a 0.5-35 Hz bandpass filter on the data, the action “Digital Filter – FIR,” located under “Transformations” and “Digital Filters” can be used, as follows:



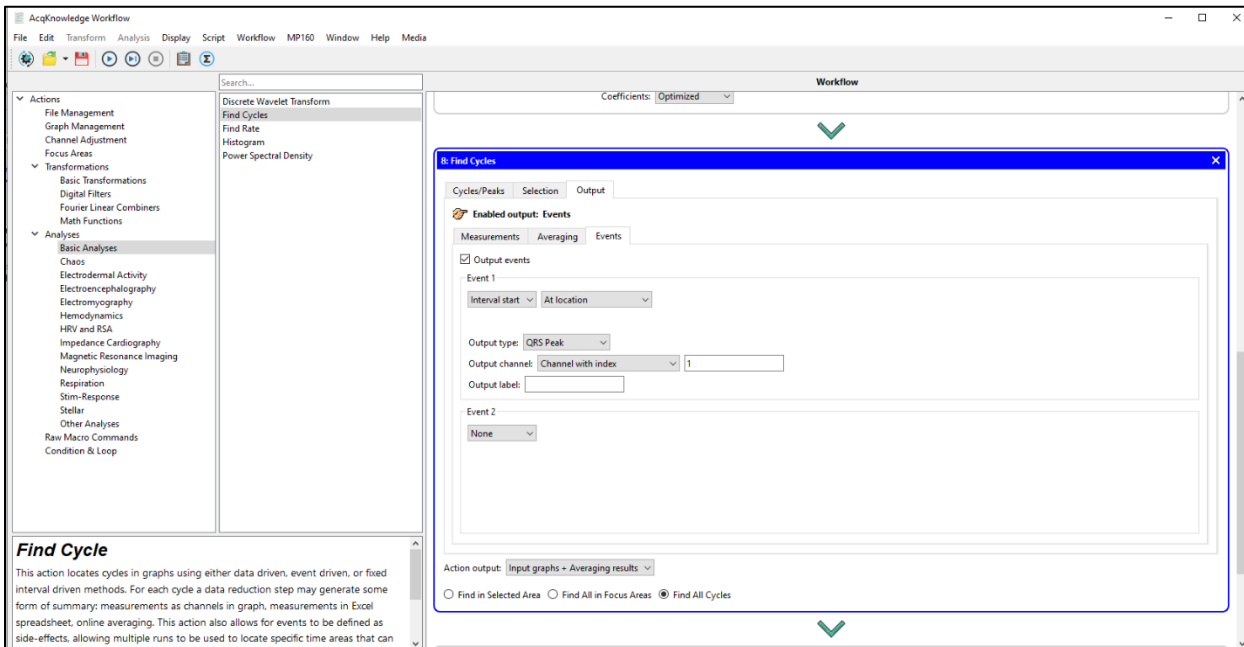
The filter settings can be modified through the settings in the workflow panel.

The next step is to mark the ECG data with the Find Cycles algorithm. For more on the Find Cycles tool please see [this series of videos](#).

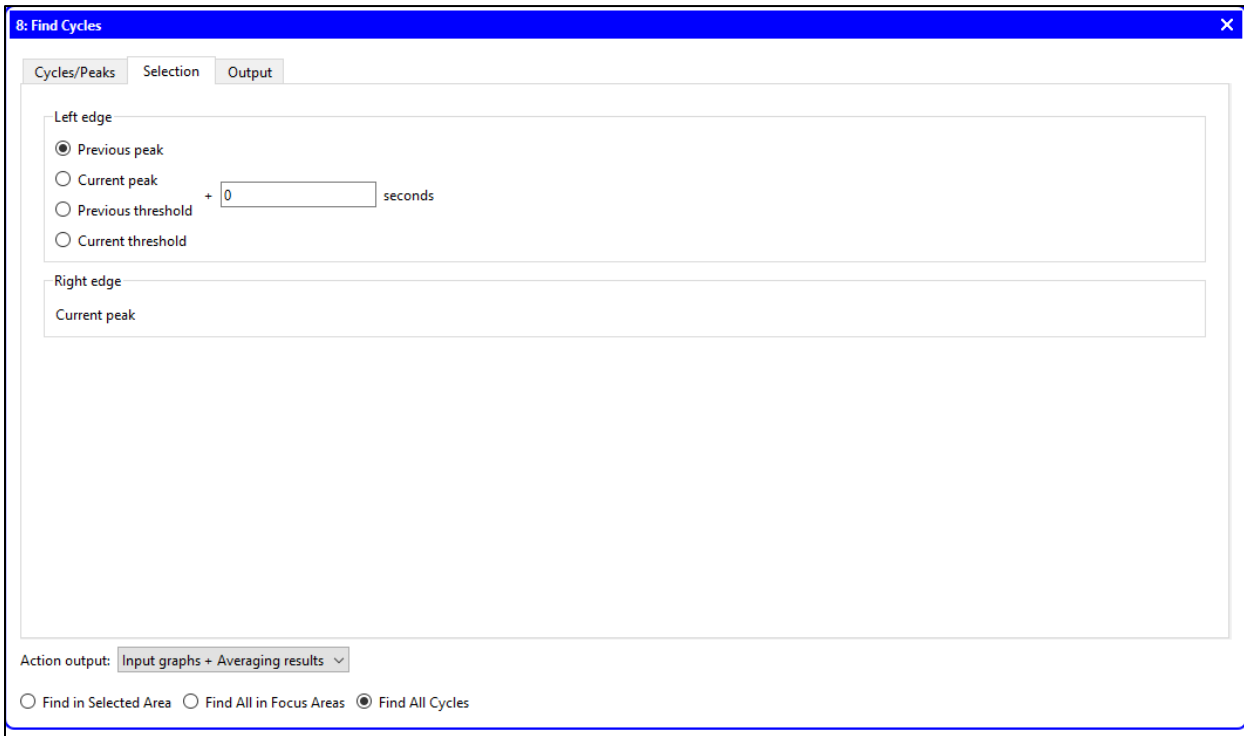
In Workflow, the “Find Cycles” action is under the “Analyses” and “Basic Analyses” category. Below, “Find Cycles” settings have been set to look for positive/upward peaks on channel 1, the ECG channel, with a threshold height of at least 1.3 mV:



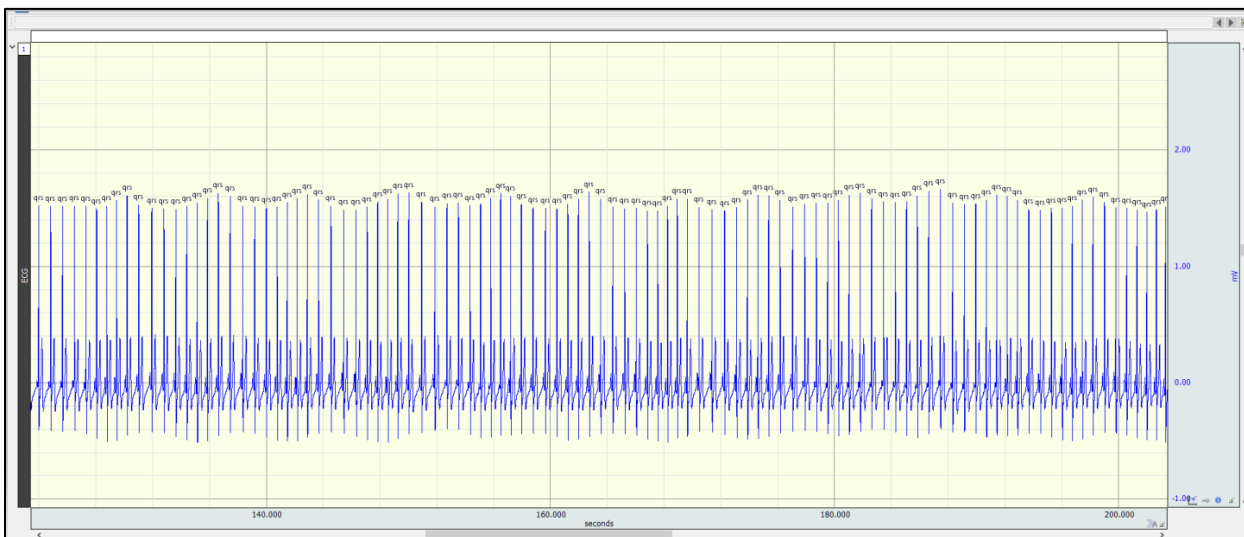
Note that “Find peaks in” has a dropdown menu that can specify an active channel or a channel with a certain name, as opposed to being hard coded for a specific index. Under the “Output” tab, select “Events,” choose to Output “Events,” with the following options:



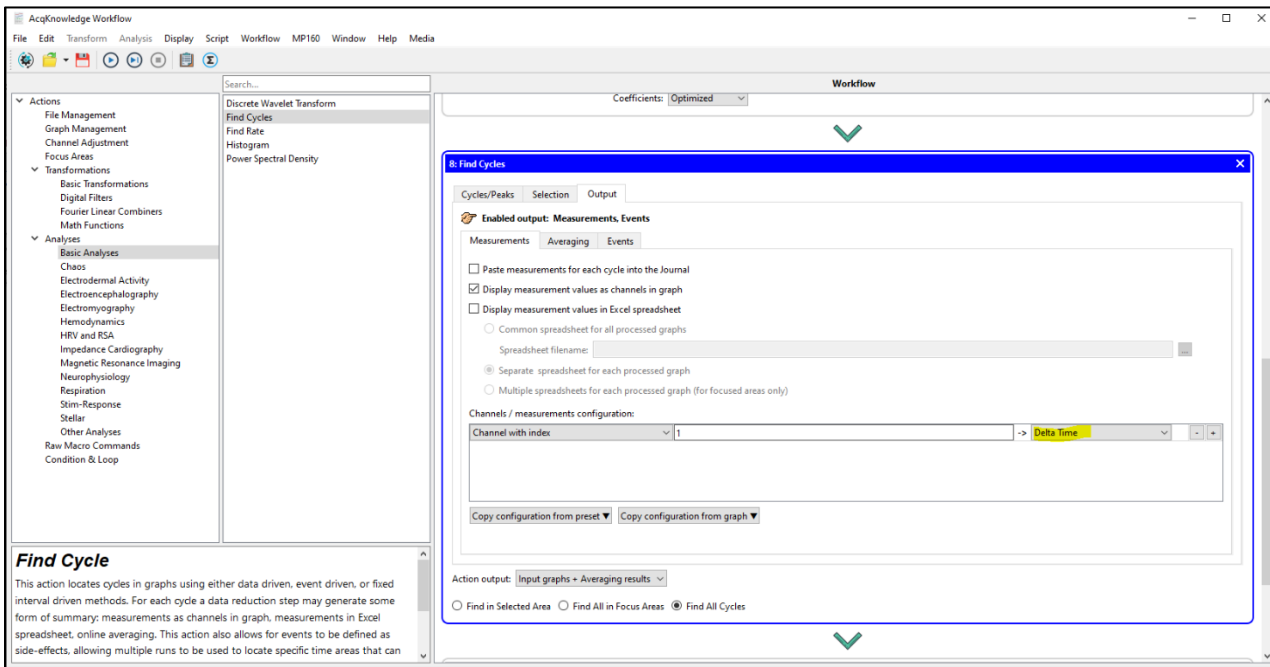
Note that there is another tab in the Find Cycle element, “Selection.” The default settings of these are already set properly, so no change is required here:



The “QRS Peak” event type for “Output type” can be found under “Hemodynamic”→ECG Complexes. Testing this should result in the R peaks in the ECG data being properly marked:



If one wished to also obtain a channel that displays the time between each R peak, that can be done in the same "Find Cycles" action. Under the “Output” tab, select “Measurements” and choose the following options:

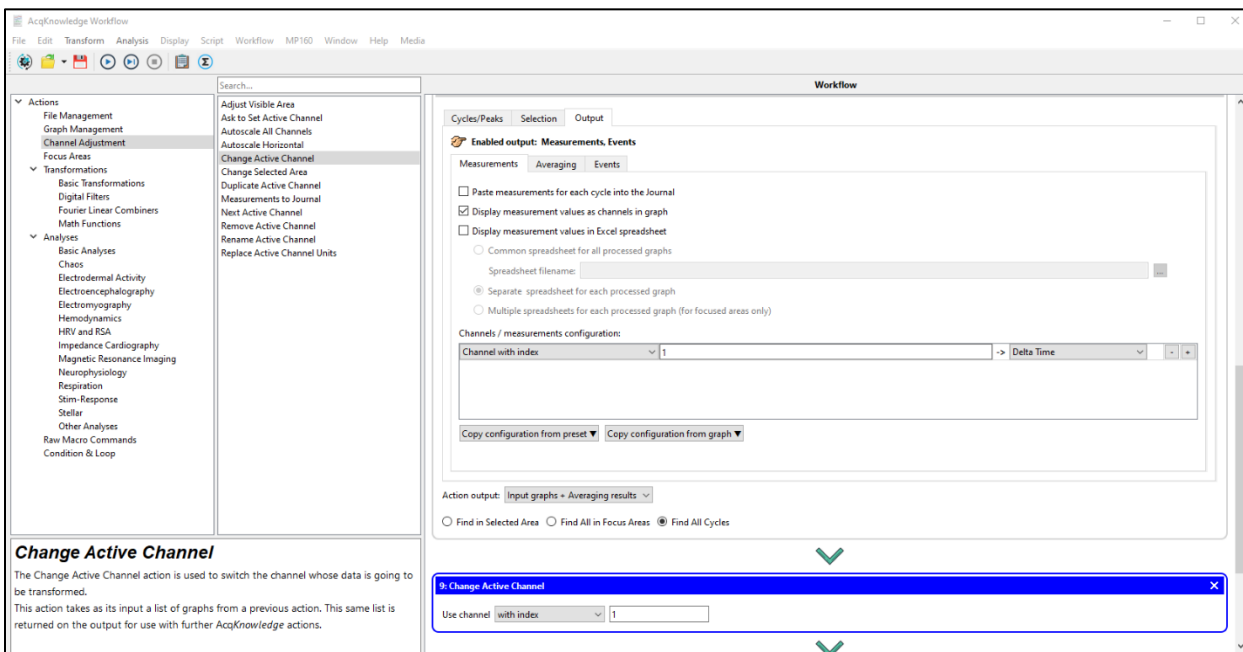


This will create a rate channel in the units of seconds. Choose “Frequency” for Hz, or “BPM” for BPM.

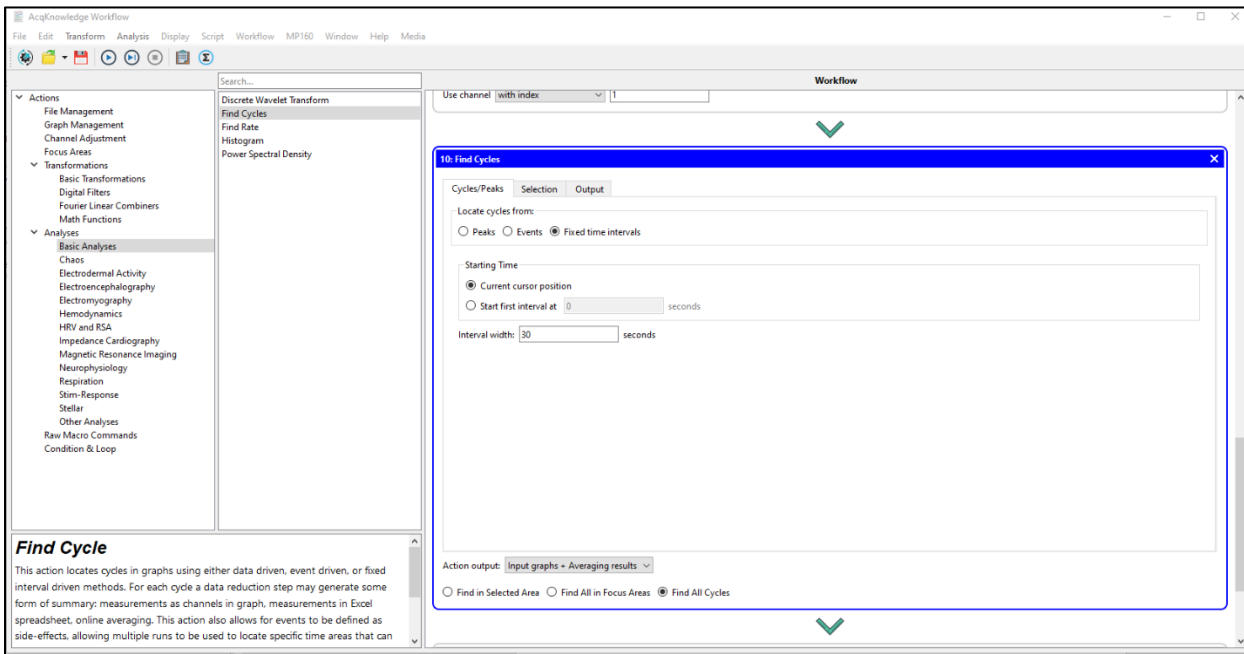
Extracting Measurements from the Graph

Users can choose to get the average value of this rate channel for a repeating arbitrary time interval throughout the graph.

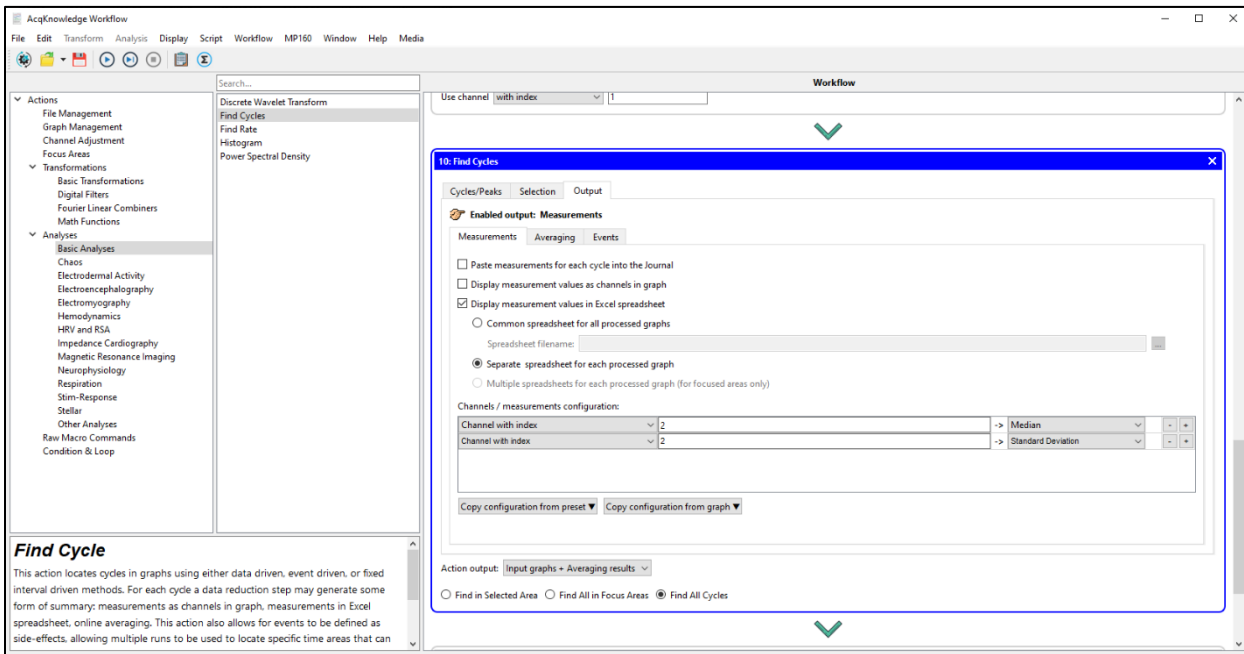
First, place a “Change Active Channel” action below the “Find Cycles” action. The active channel should be set to the new channel that is created by the previous “Find Cycles” action, as shown below:



Next, one can place another “Find Cycles” action underneath this. In this case, in the “Cycles/Peaks” tab, choose the “Fixed Time Intervals” option, instead of “Peaks”:

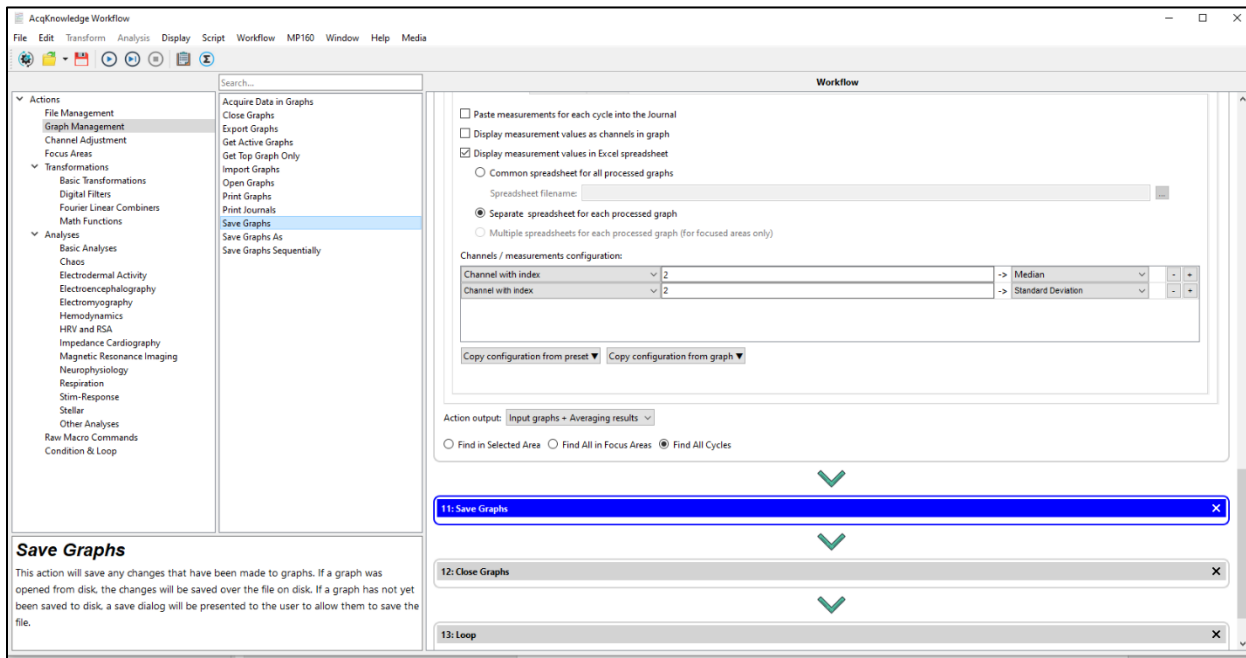


The “Interval width” should be set to the desired duration of the interval, from whence data are to be extracted. In this example this is set to 30 seconds. Under the “Output” tab, choose to output “Measurements” as channels in the graph, in an Excel spreadsheet, or both:




In this case, one may output these measurements directly to Excel. We have chosen two measurements, Median and Standard Deviation. Use the + or - buttons to the right of the measurements to add or remove measurements. Ensure that the correct channel is selected.

If there is nothing else that needs to be done with the graph, save the graph before closing. This can be done by selecting “Graph Management” → “Save Graphs,” as follows:



As always, it is important to not work on the only copy of your graph. Using automated analyses makes this especially important.

Note that the “Close Graphs” and “Loop” actions are still present from earlier.

Now save the workflow by clicking the save icon .

This is a small sample of what can be done with Workflow. The simplest way to design a workflow is to first do the analysis manually, write down the steps required, and then translate this into a workflow, matching specific actions to each step.