

TECH NOTE #025:: Signal Analysis using QuantumX and catmanAP

Version: 2020-06-24

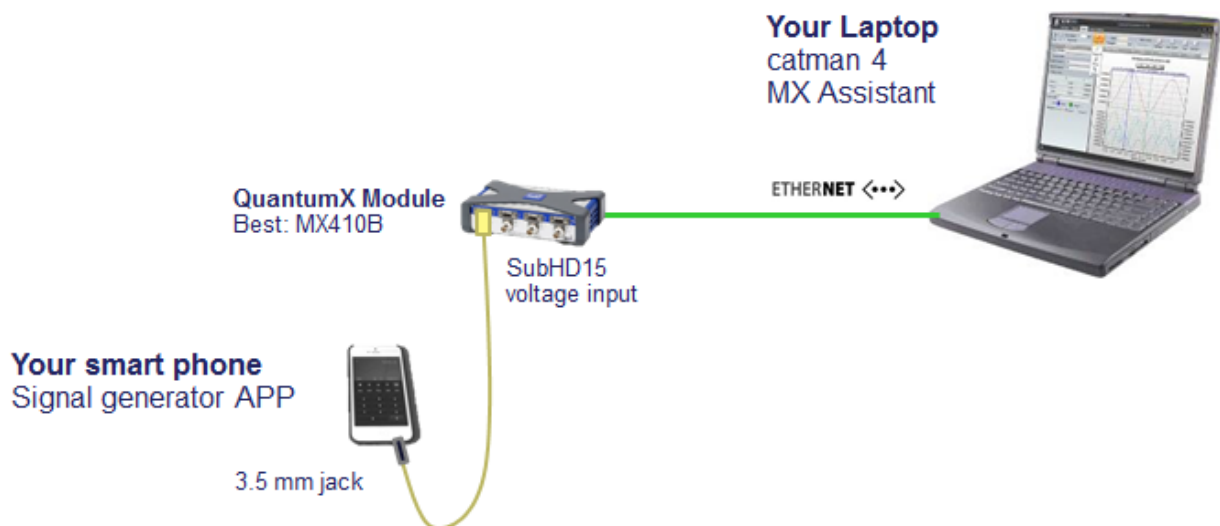
Status: public

Abstract

This hands-on workshop gets you familiar with some basics in signal analysis working with QuantumX data acquisition module and catman software. Main aspects are active data analysis and modification, report generation and offline demonstration. This shall help you in getting more familiar with the tool set, its functionality and performance.

Preparation

We will work only with one single PC tethered module. The only input is a signal generator running on a smart phone, connected via 3.5 mm head phone jacks to voltage input pins of the SubHD15 connector on the QuantumX unit. In best case you use a MX410B supporting data rates of 100 kS/sec per channel or a MX840B with 40 kS/sec per channel.



Workshop Tasks

1. Online Analysis
 - Set a 500 Hz sine signal on your signal generator app
 - Visualize the signal in time and frequency domain (standard FFT, 2D spectrum)
 - Acquire data for 10 sec and store it in binary format
 - Then set a 500 Hz rectangular signal
 - Visualize the signal in time and analyse the harmonics in frequency domain (standard FFT, 2D spectrum)
 - Acquire data for 10 sec and store it in binary format
2. Post-process Analysis and Report Generation
 - Switch to "Analysis Mode" and load / merge the two BIN files
 - Do a frequency analysis of the overall file
 - Cut out in total 4 harmonic periods (2 sine and 2 rectangular) and store this section as wave file (CATWFM)
 - Do a statistical analysis with min, max, mean, ...

- Generate an overall test report in Microsoft Word and describe the overall result of the test
3. Offline demo
- Restart catman without a DAQ module and start a “offline demo project”
 - Open the signal generator, replay your wave file in an endless loop, visualize, analyse, ...

Solution Guide

As in live it's always best to think about the tasks and the way to solve it by yourself and without any tool.

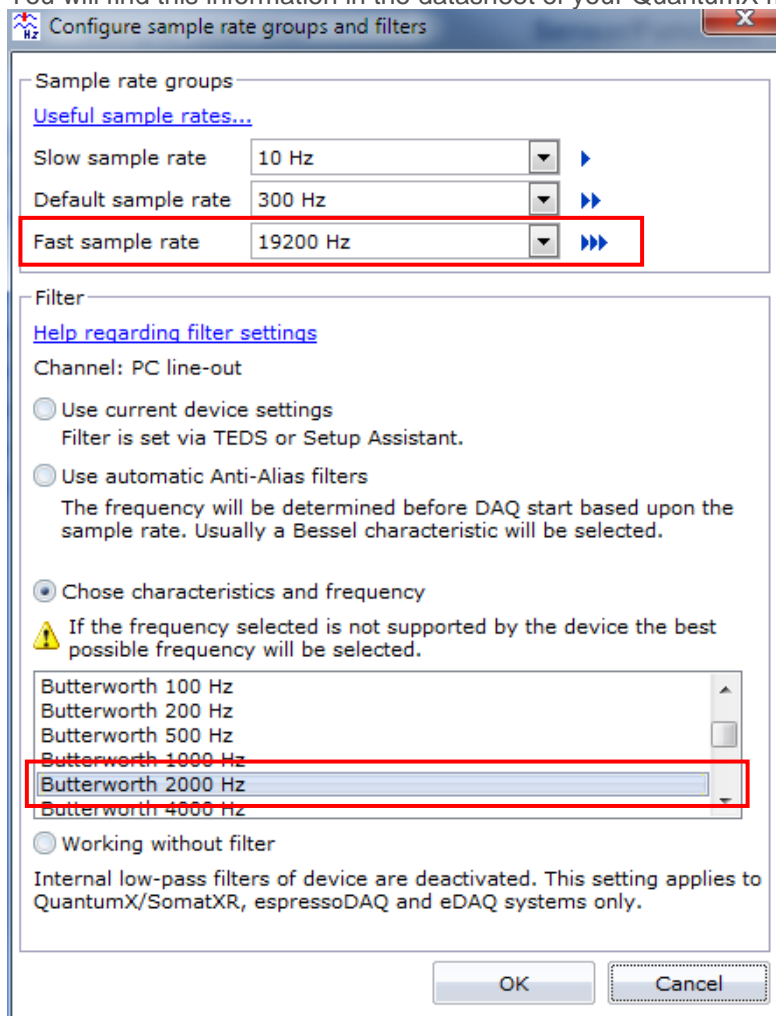
Nevertheless, in the following pages you will find one possible solution solving the different tasks.

1. Preparing the ground

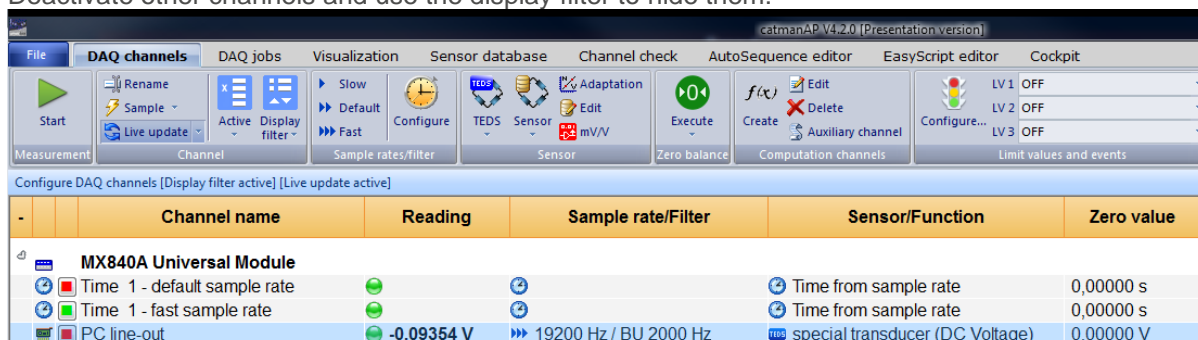
Now start catmanEasy, create a new DAQ project, select the instrument you want to work with and connect to it.

For signal analysis, please take the maximum data rate for all channels and work with the highest filter you get.

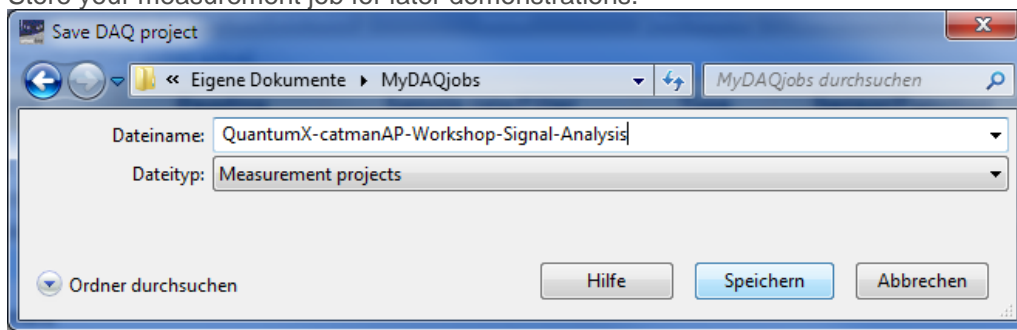
You will find this information in the datasheet of your QuantumX module.



Deactivate other channels and use the display filter to hide them:

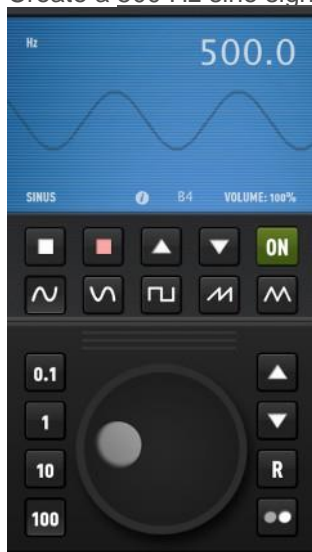


Store your measurement job for later demonstrations.

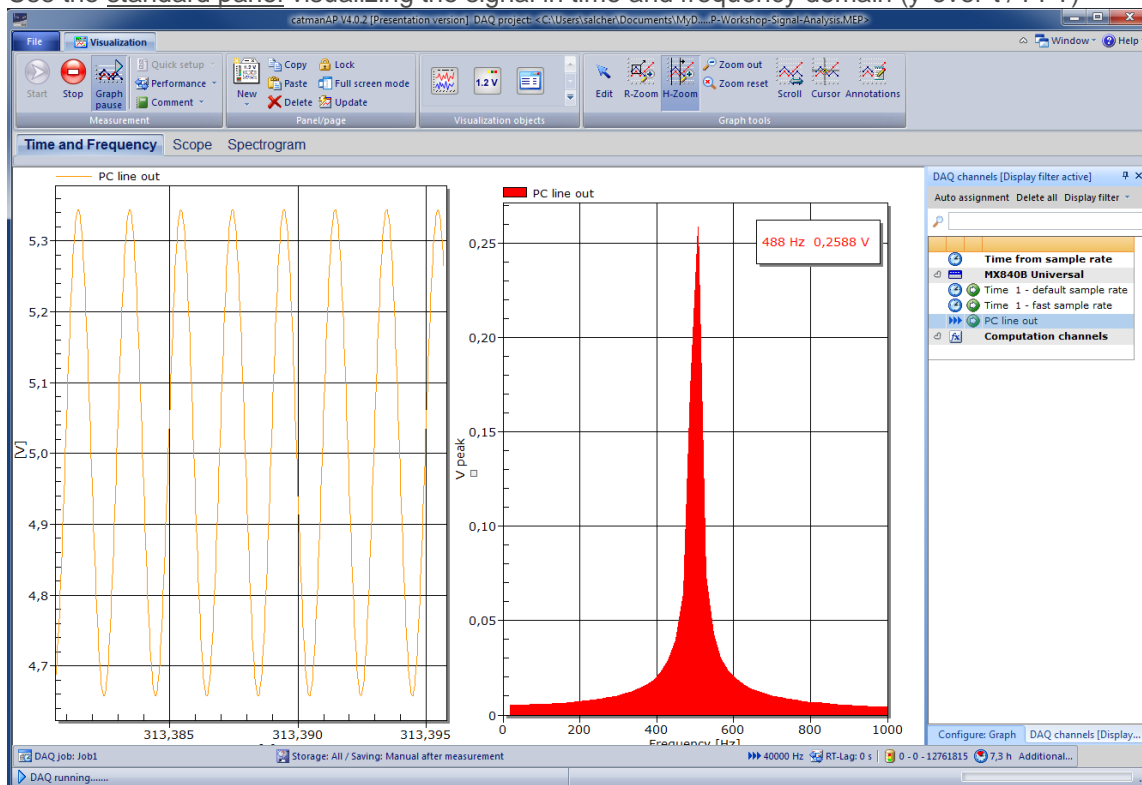


2. Online Analysis

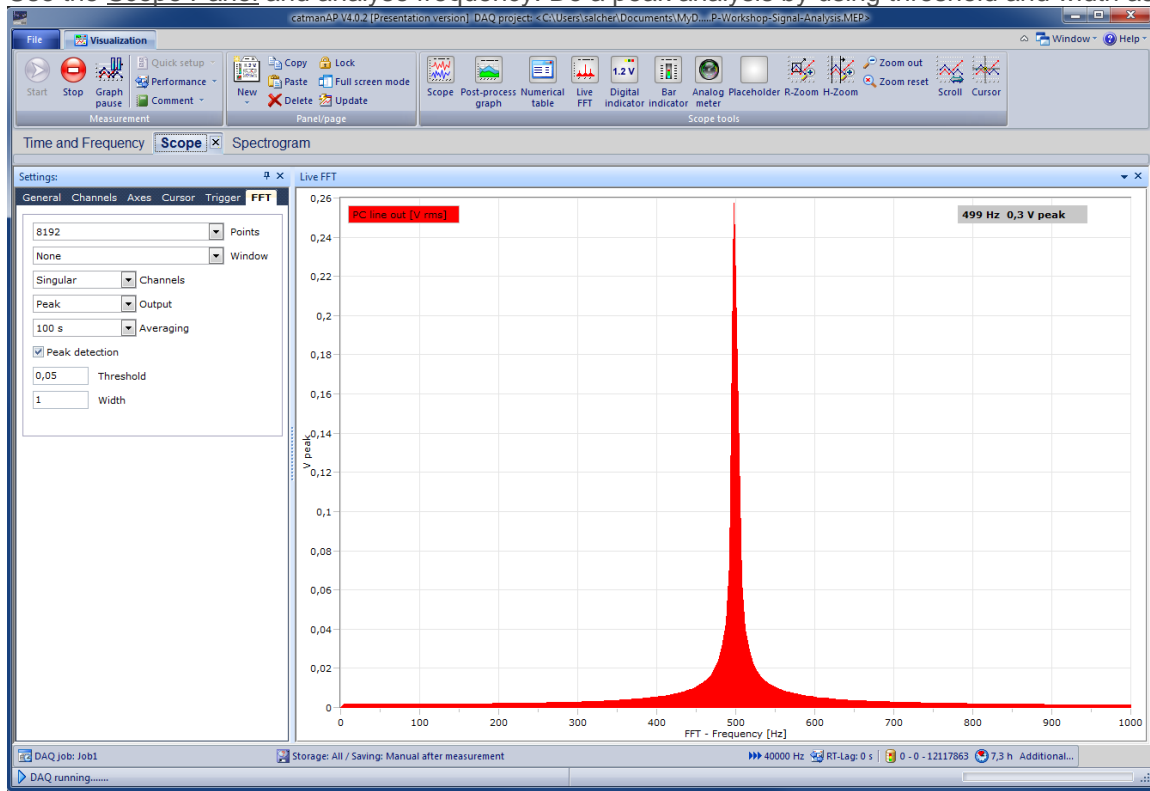
Create a 500 Hz sine signal on your signal generator app



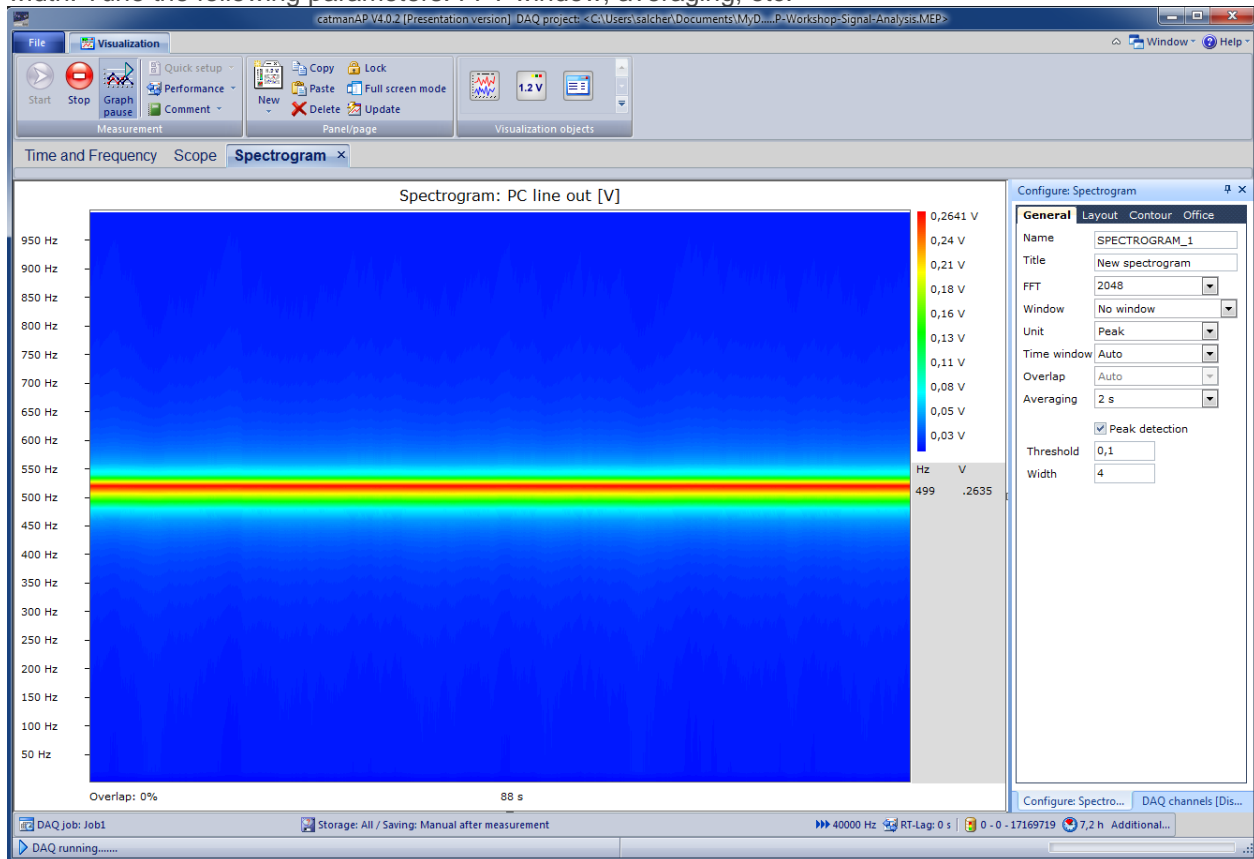
Use the standard panel visualizing the signal in time and frequency domain (y-over-t / FFT)



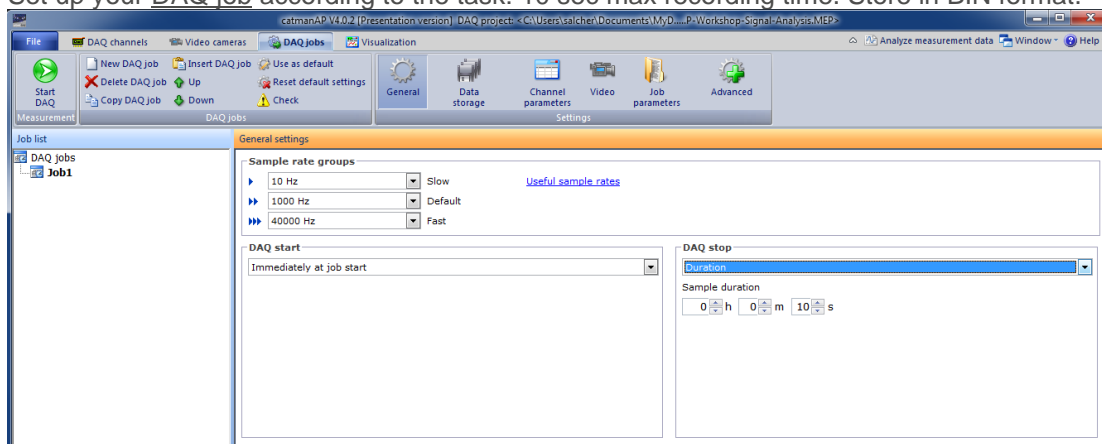
Use the Scope Panel and analyse frequency. Do a peak analysis by using threshold and width as parameters.



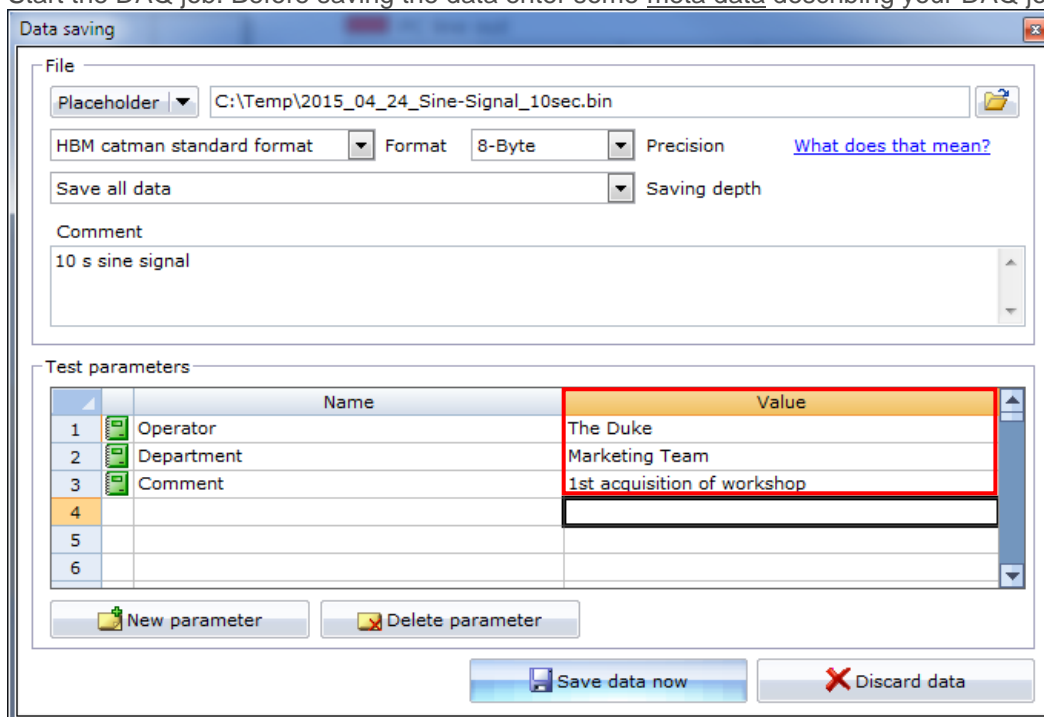
Use a new standard panel and the object frequency spectrogram. Do a peak analysis by using threshold and width. Tune the following parameters: FFT window, averaging, etc.



Set up your DAQ job according to the task: 10 sec max recording time. Store in BIN format.



Start the DAQ job. Before saving the data enter some meta data describing your DAQ job.

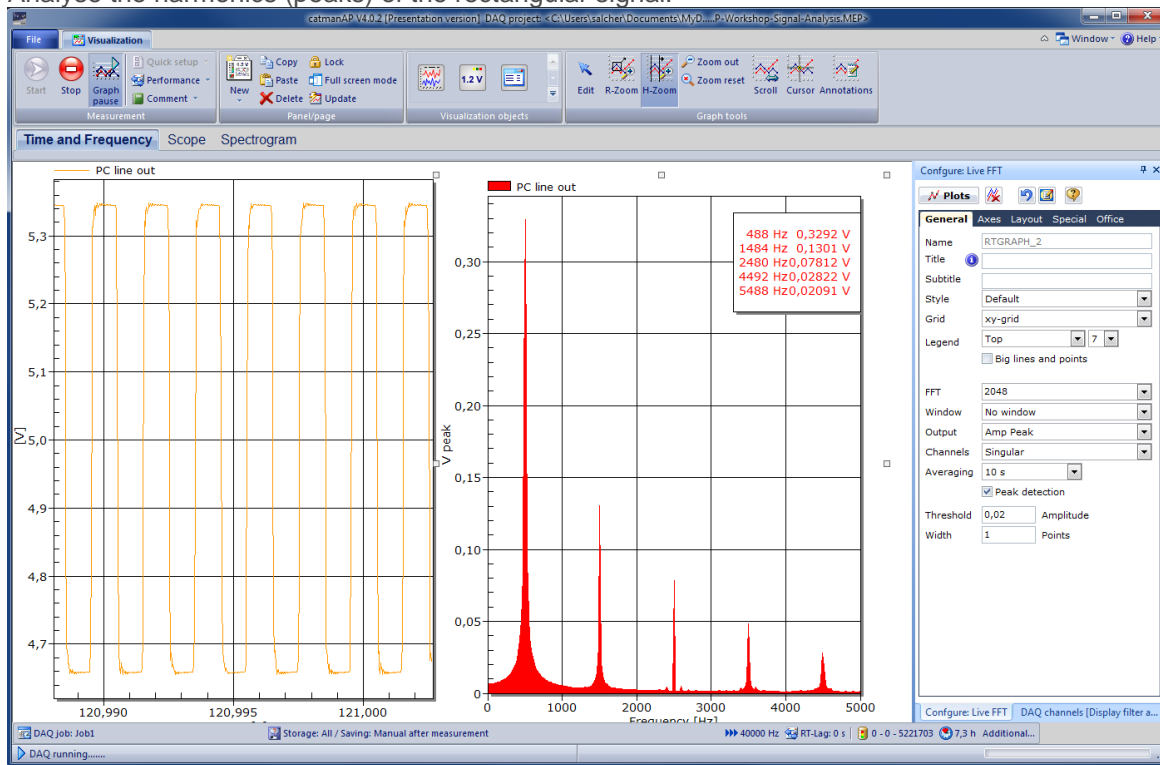


Create a 500 Hz rectangular signal on your signal generator app



Use the created standard panel visualizing the signal in time and frequency domain (y-over-t / FFT)

Analyse the harmonics (peaks) of the rectangular signal.



Again, acquire data for 10 sec and store it in BIN format

The 'Data saving' dialog box shows the following configuration:

- File: Placeholder
- Format: HBM catman standard format
- Format: 8-Byte
- Precision: [What does that mean?](#)
- Save all data:
- Saving depth:
- Comment:

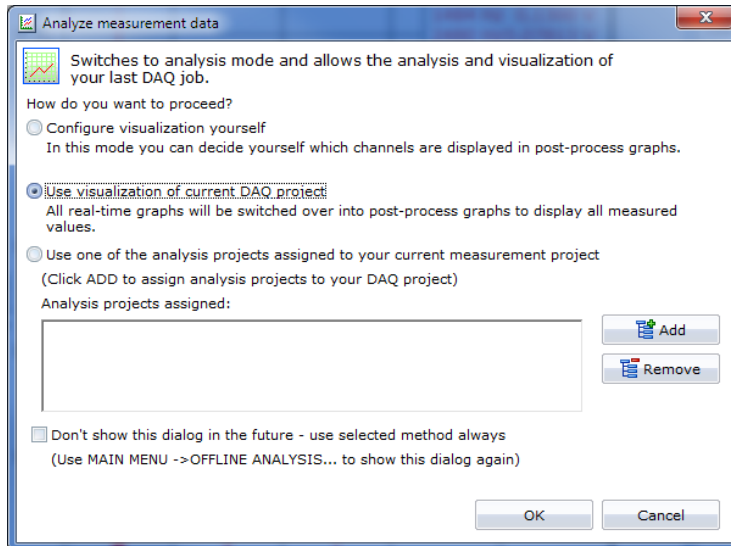
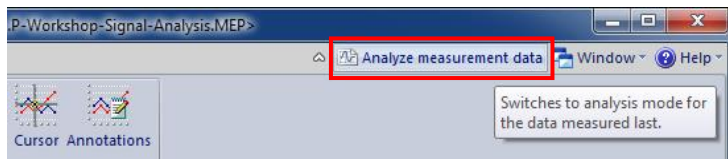
Test parameters table:

	Name	Value
1	Operator	The Duke
2	Department	Marketing Team
3	Comment	2nd acquisition of workshop
4		
5		
6		

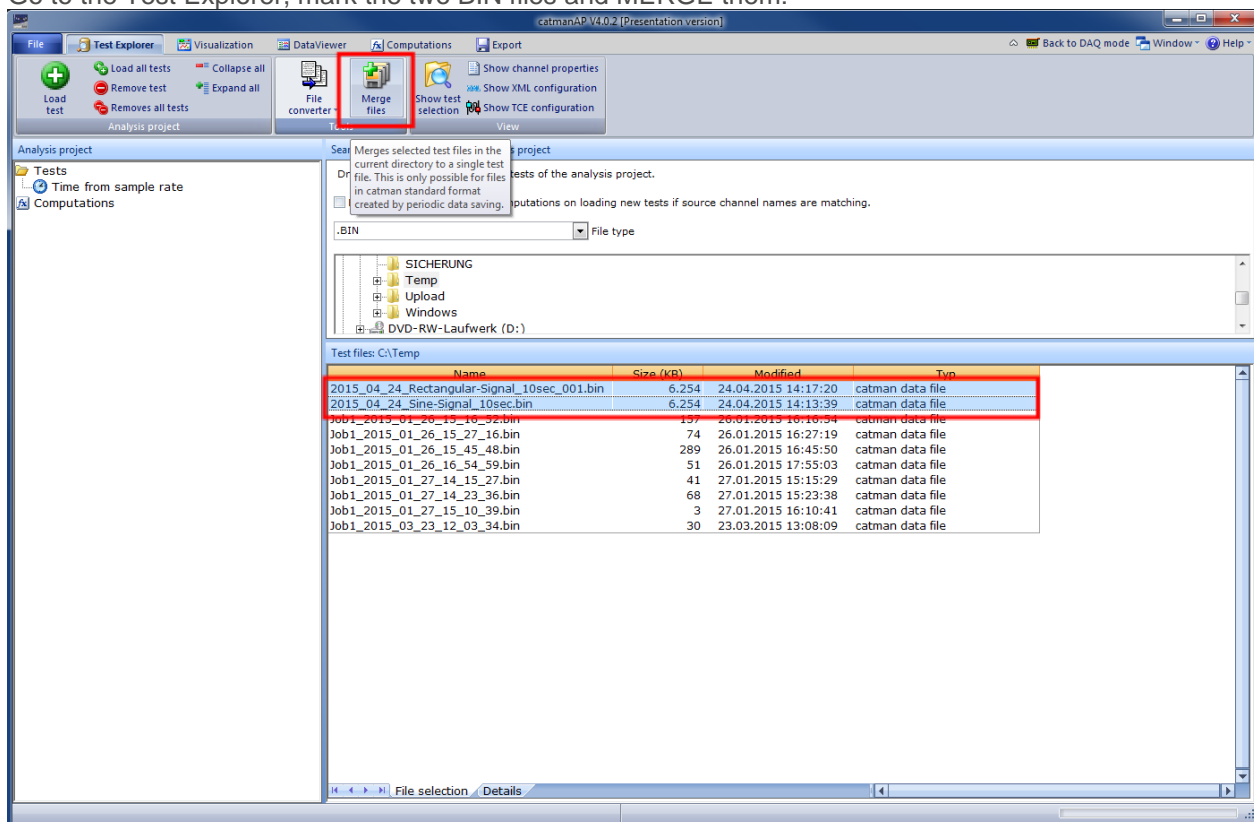
Buttons:

3. Post-process or Offline Data Analysis

Now analyse your measurement data.



Go to the Test Explorer, mark the two BIN files and MERGE them:

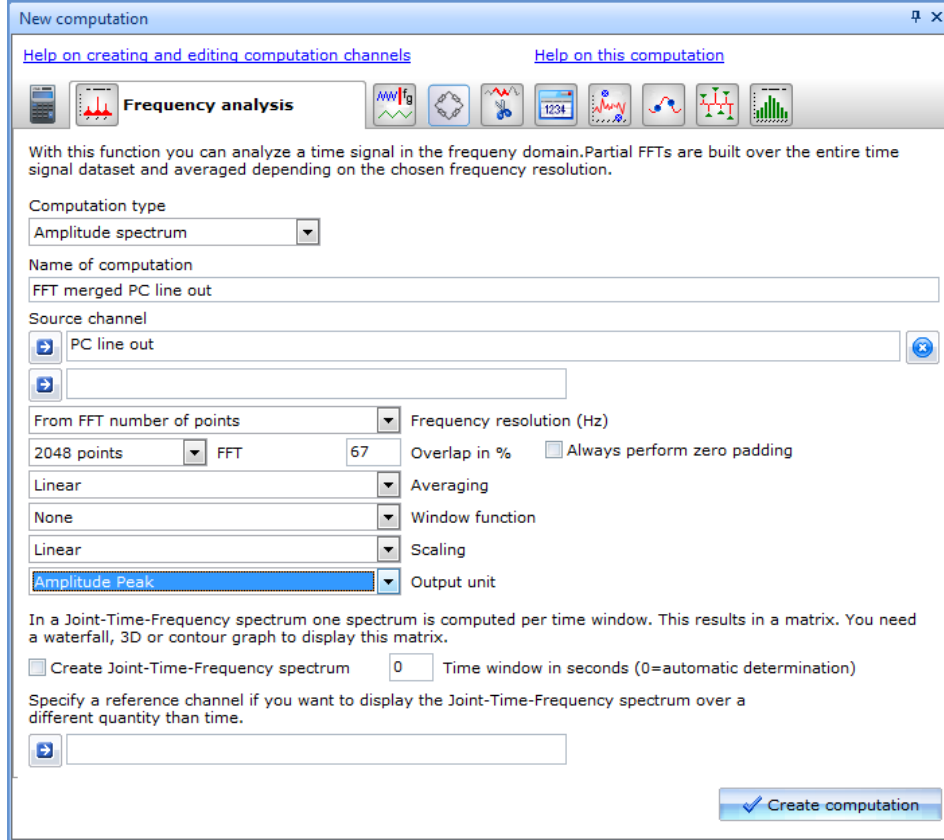


Load the merged file to your “Test Setup” on the left side by drag and drop.

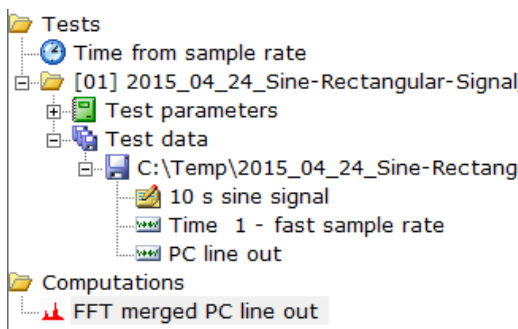
2015_04_24_Sine-Signal_10sec.bin	6.254	24.04.2015 14:13:39	catman data file
2015_04_24_Rectangular-Signal_10sec_001.bin	6.254	24.04.2015 14:17:20	catman data file
2015_04_24_Sine-Rectangular-Signal_20sec_Merge.BIN	12.504	24.04.2015 14:27:06	catman data file

Analyse frequency of this artificial overall file by setting up a new computation channel.

→ “Visualization tab” → create “new computation” → “Frequency analysis” and parameterize accordingly.

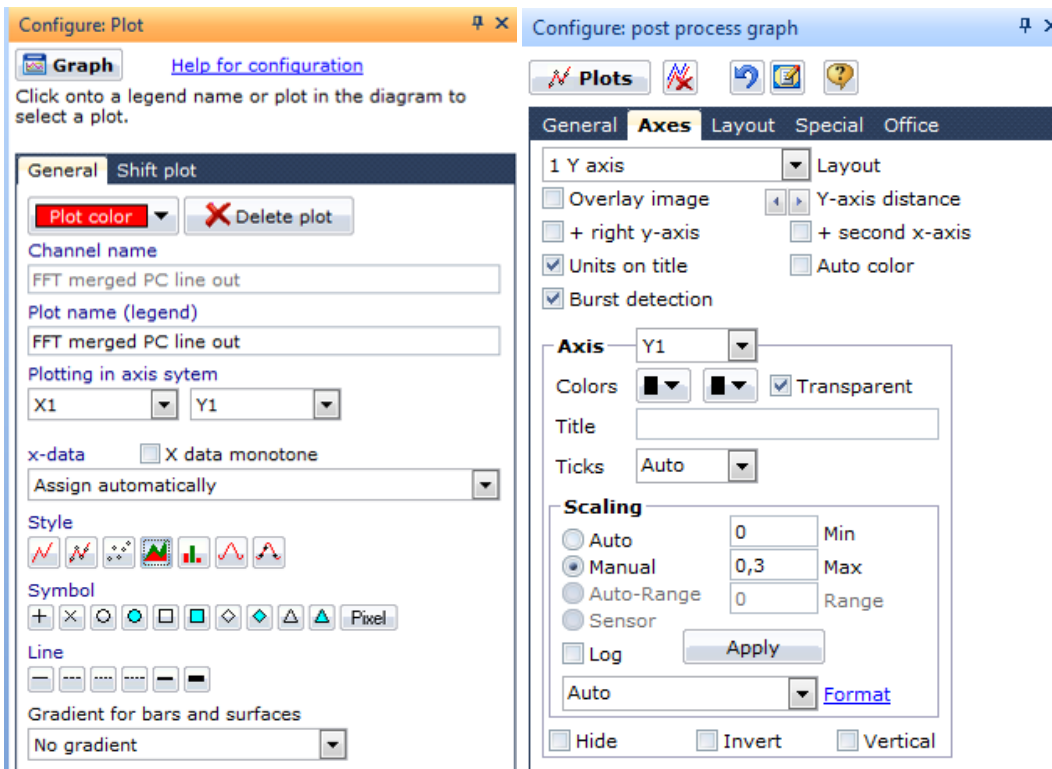


Drag and drop the created FFT to the panel:

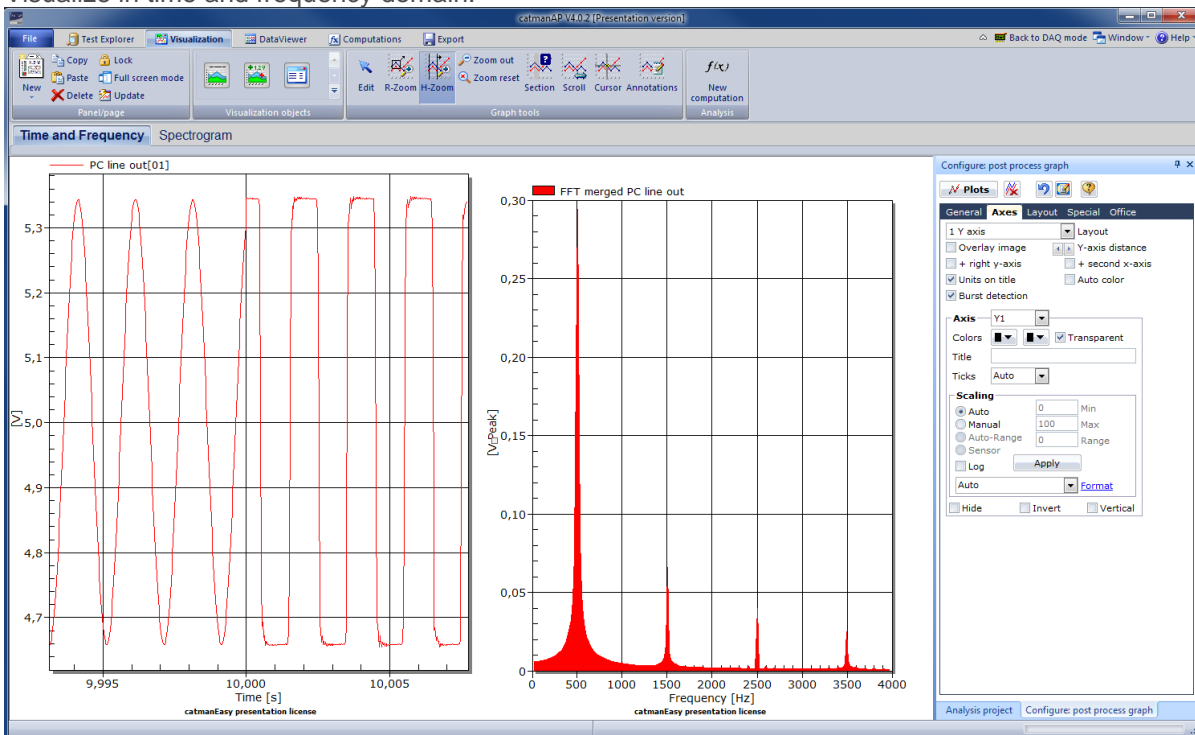


Parameterize the graph in color, layout and axis.

graph in color, layout and axis.



Visualize in time and frequency domain.



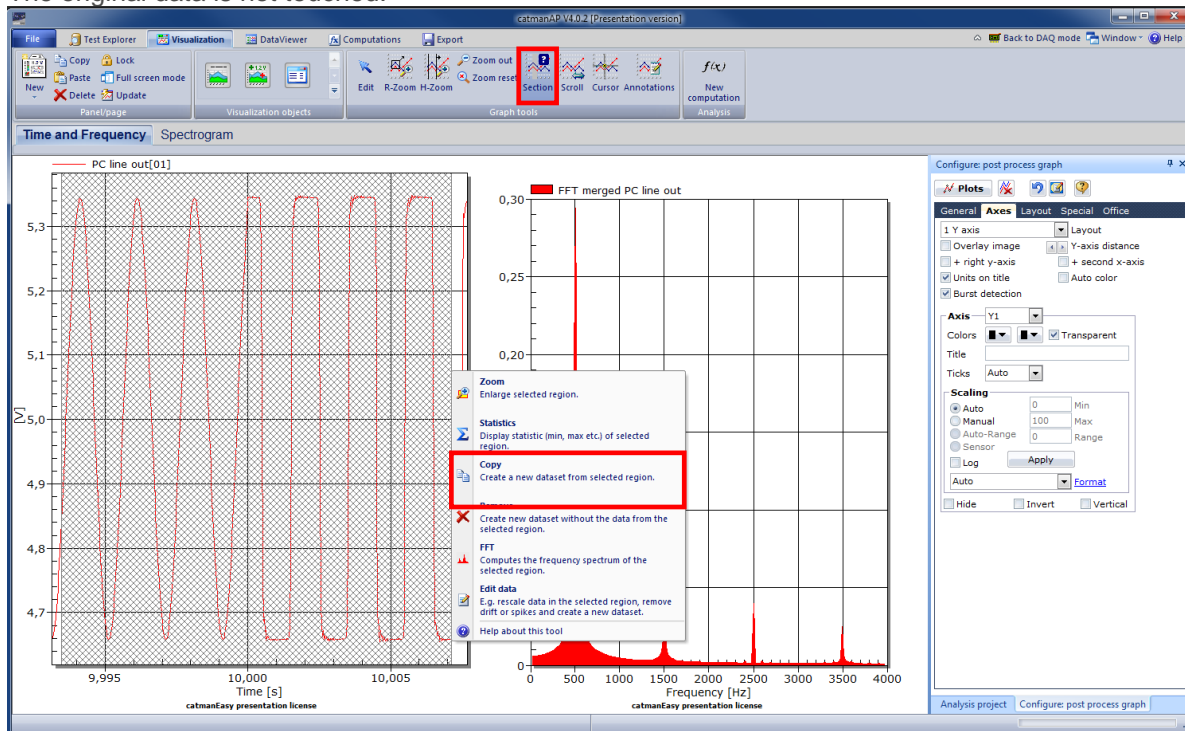
Cut out a certain section:

- Target 2 sine and 2 rectangular waves

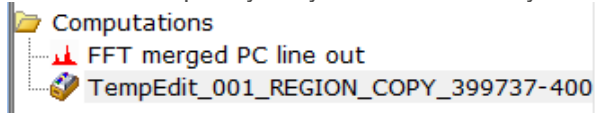
and store this section as wave file (CATWFM)

How?

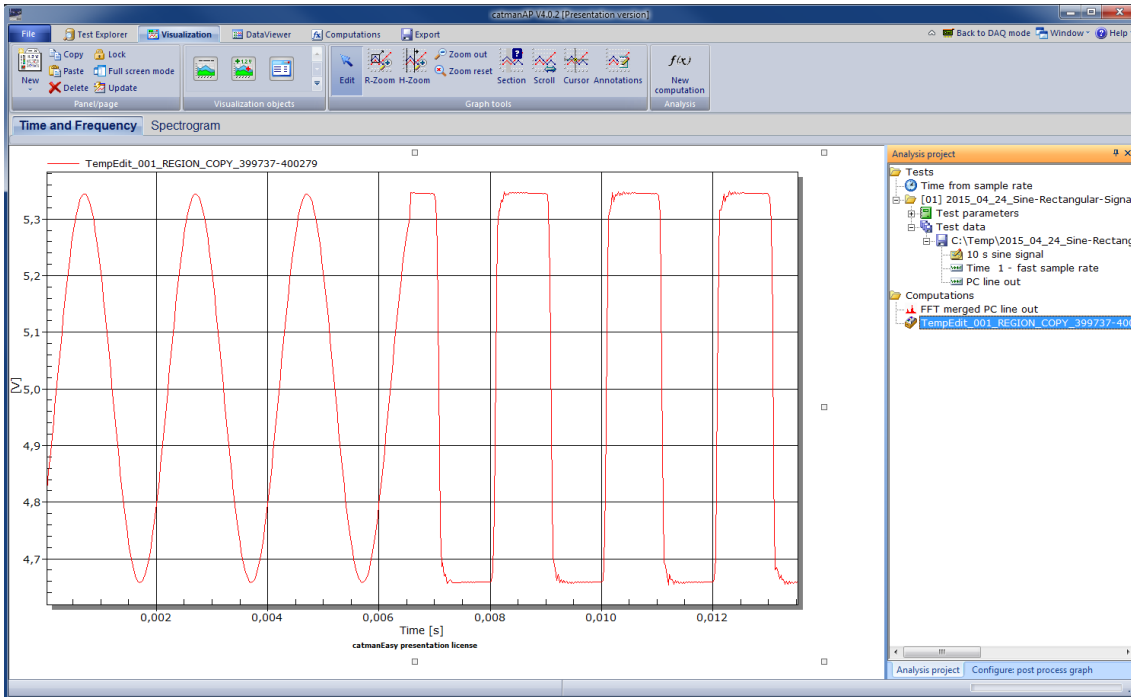
Use the Section tool. Zoom into the graph, Remove the overlapping sections, Copy the result as an own file. The original data is not touched.



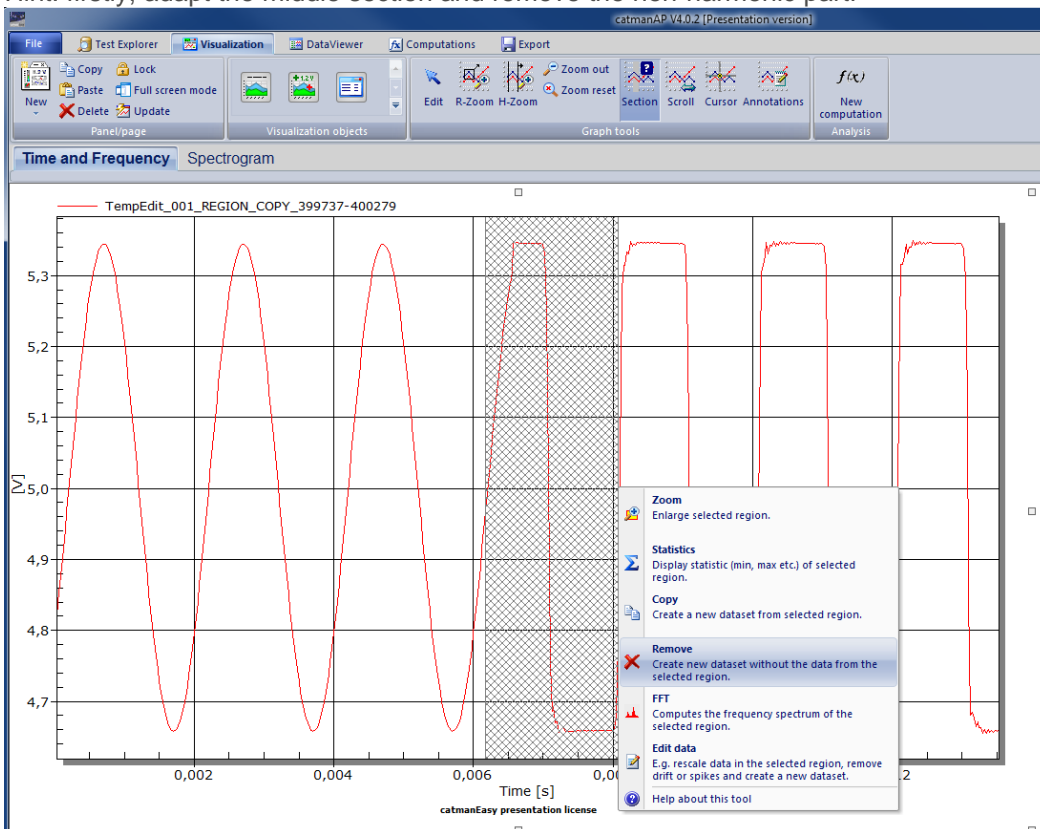
Result is a temporary file you can individually name.

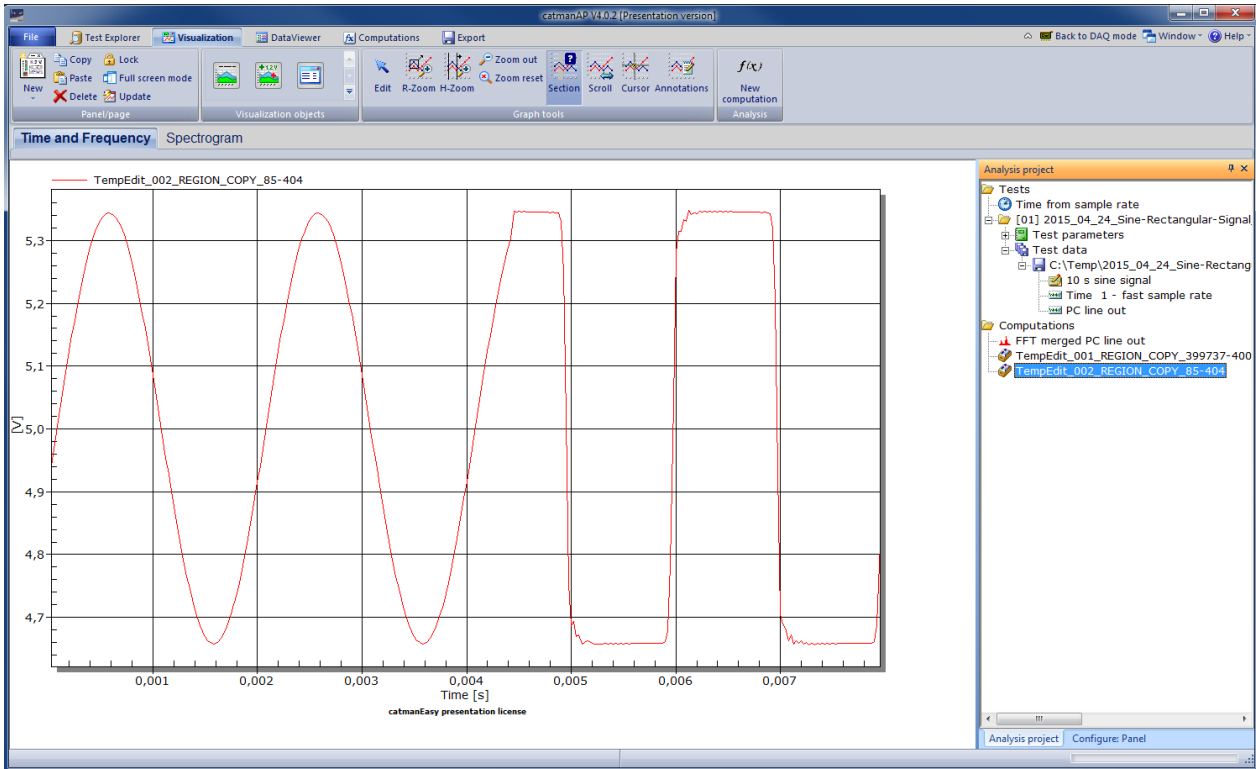


Now drag and drop this file section to a graph again.



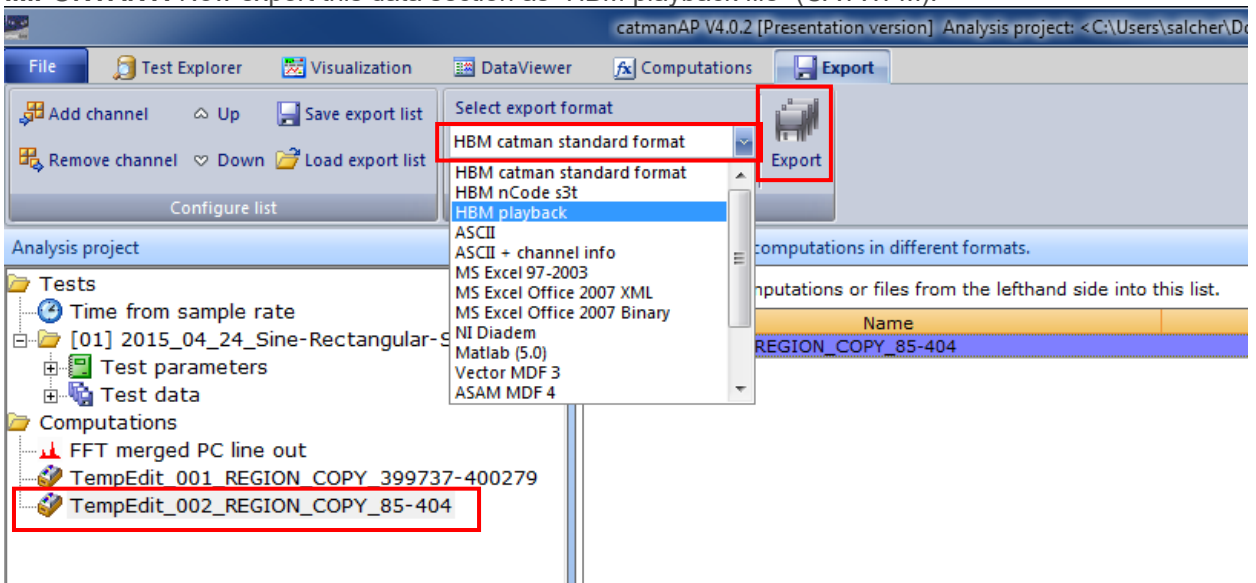
Work again with the section tool if necessary.
 Hint: firstly, adapt the middle section and remove the non-harmonic part!





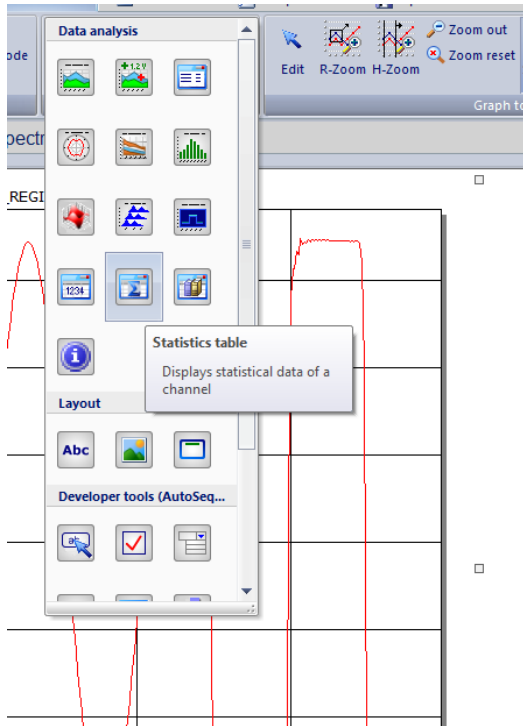
Result: exactly two sine and two rectangular signals.

IMPORTANT: Now export this data section as “HBM playback file” (CATWFM).

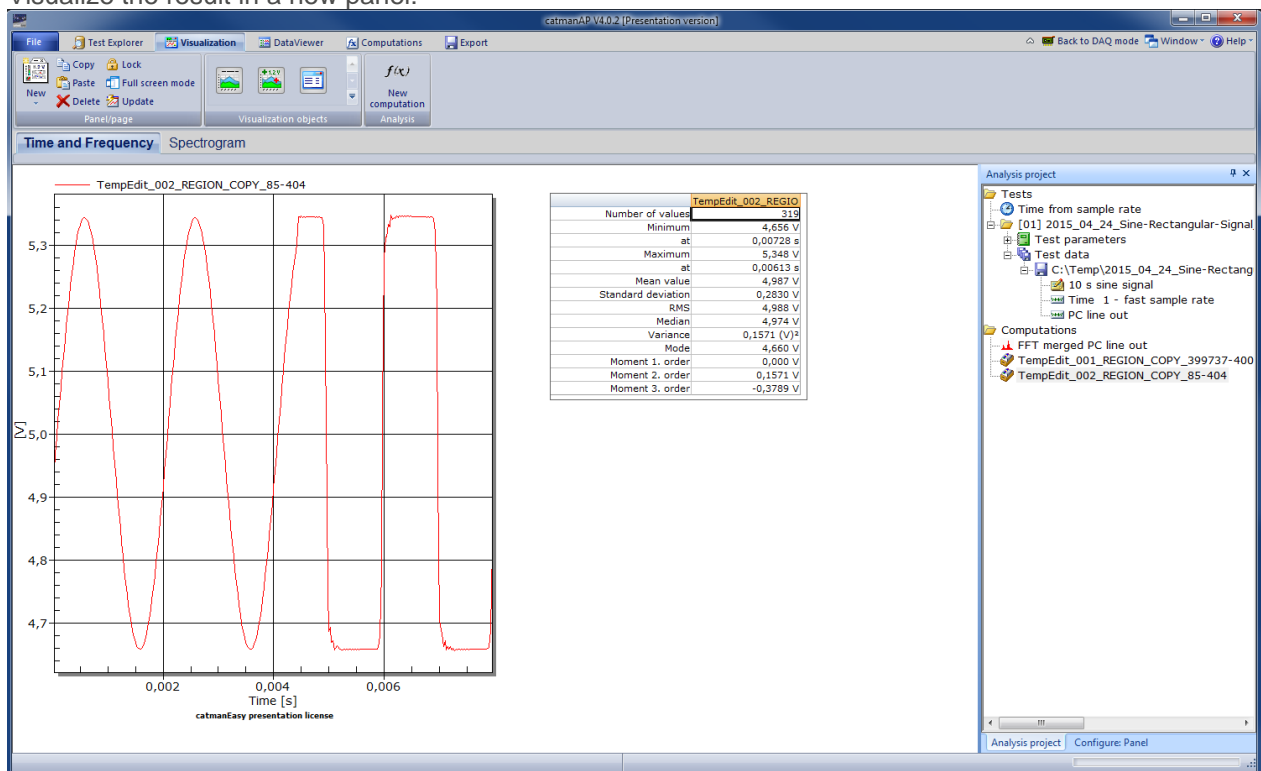


Set up a statistical analysis with min, max, mean, ...

This can be done by using the “Statistics table”:



Visualize the result in a new panel:



Side Topic: Post-process Computation



Beside the “manual analysis and editing” of data there is a bunch of pre-defined computations available in the catman package EasyMath making post-processing easier than ever:

- Formula editor you can cross calculate signals with each other
 - Including fixed formulas: Statistical analysis (min, max, mean), linearization table, removing offset
- Frequency analysis (see screenshot below)
- Filter box
 - Sliding mean
 - Savitzky-Golay smoothing
 - Mean over time window
 - RMS value over time window
 - Low-, high-, band- and band-rejection filters in Butterworth, Chebyshev and elliptic characteristics
 - Low-pass filter with Bessel characteristic
 - Sound pressure filter in dBA
- Strain gage rosette calculation
- Curve Operations
 - Form plot function cuts out the specified section of a channel. Alternatively, you can also use the Section functions or the cursor functions.
 - Shift plot function moves all values of a channel in the positive or negative direction, for example to compensate a time delay (propagation time) of various filter characteristics.
 - Outlier elimination in case the signal level exceeds a certain value (threshold)
- Interpolation
 - converting to other sample rates (higher or lower) or x-y recalculation allowing an easier comparison of several data sets of the same test
 - Accurate PEAK detection using interpolation algorithm
- Class Counting
 - Rainflow (FromTo, RangeMean) counts the frequency of occurrence of certain amplitude values subdivided into sections, the so-called classes used for material fatigue tests.
 - Time-At-Level (TAL) counts how long a signal is located in a certain amplitude range, the so-called classes and shown in a so-called histogram.
 - Span Pairs counts the frequency of occurrence of certain amplitudes.
 - Joint-Time-at-Level (2-dim) counts how long a signal is located in a certain amplitude range considering also the amplitude range of a second reference channel, for example for monitoring torque towards rotational speed.

4. Test report generation

Test engineers often need to report their analysis results in a convenient way. In most of the cases Microsoft Word or EXCEL is used as this simply installed on many computers.

At the end of this chapter you will find more details about reporting itself.

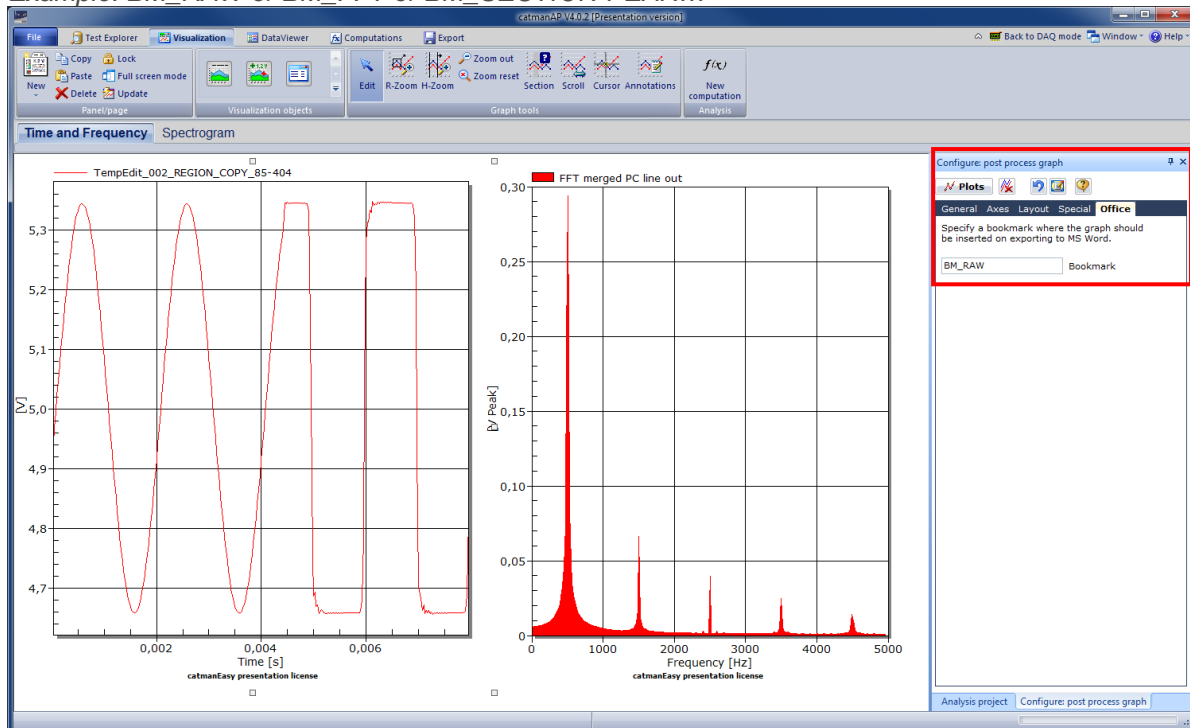
What do we offer speeding up that process?

Bookmarks.

Highlight the graph you want to automatically transfer into your Test Report Template in Microsoft Word format.

Go to “Office” tab of each graph and set a bookmark name.

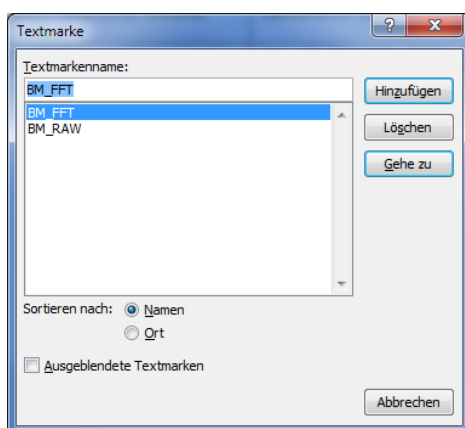
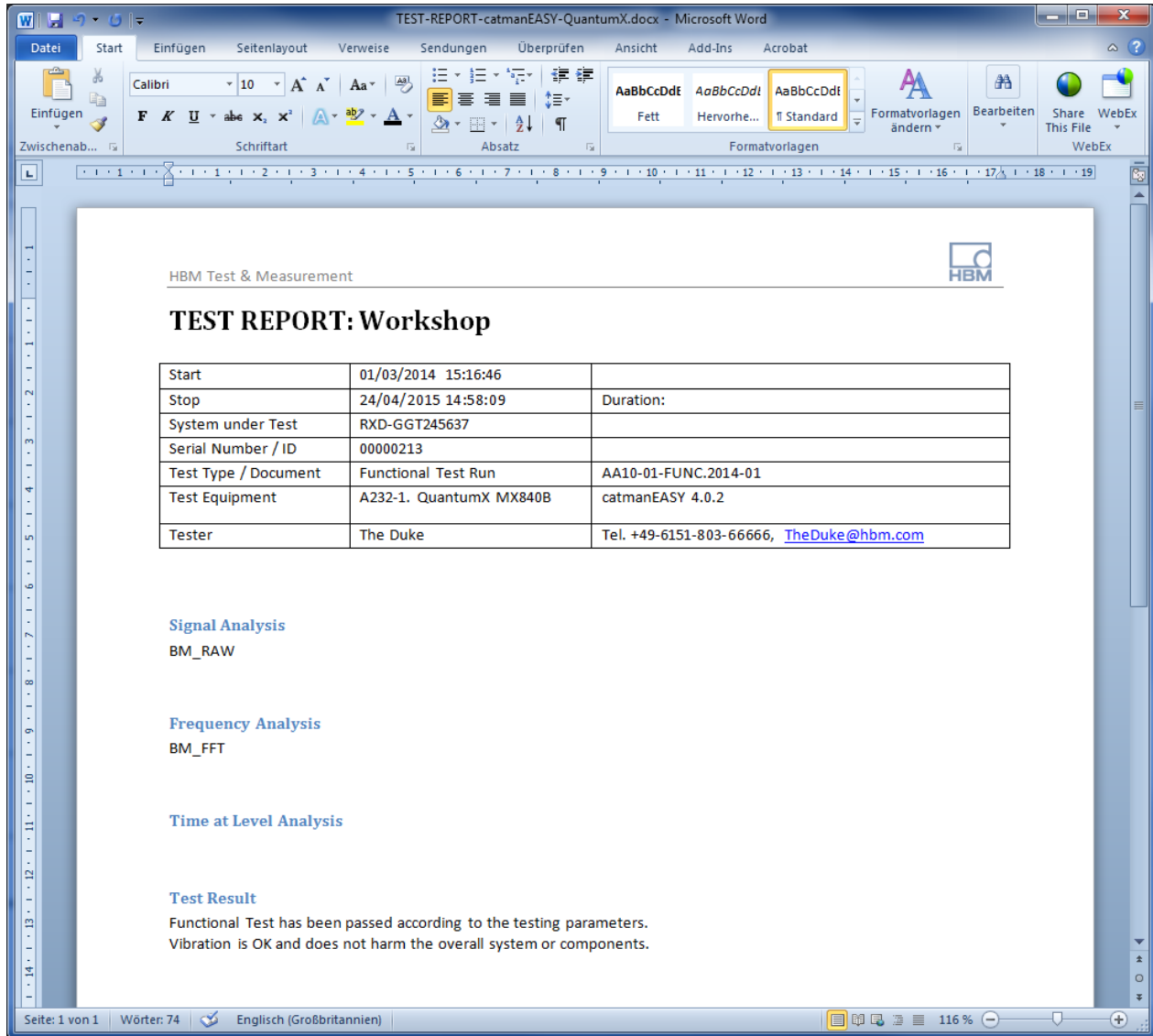
Example: BM_RAW or BM_FFT or BM_SECTION-PEAK...



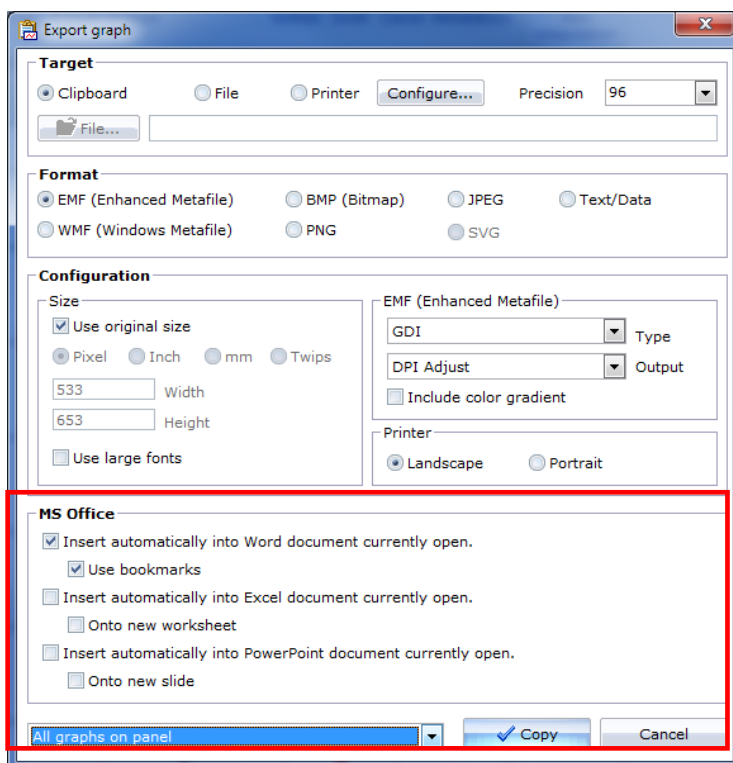
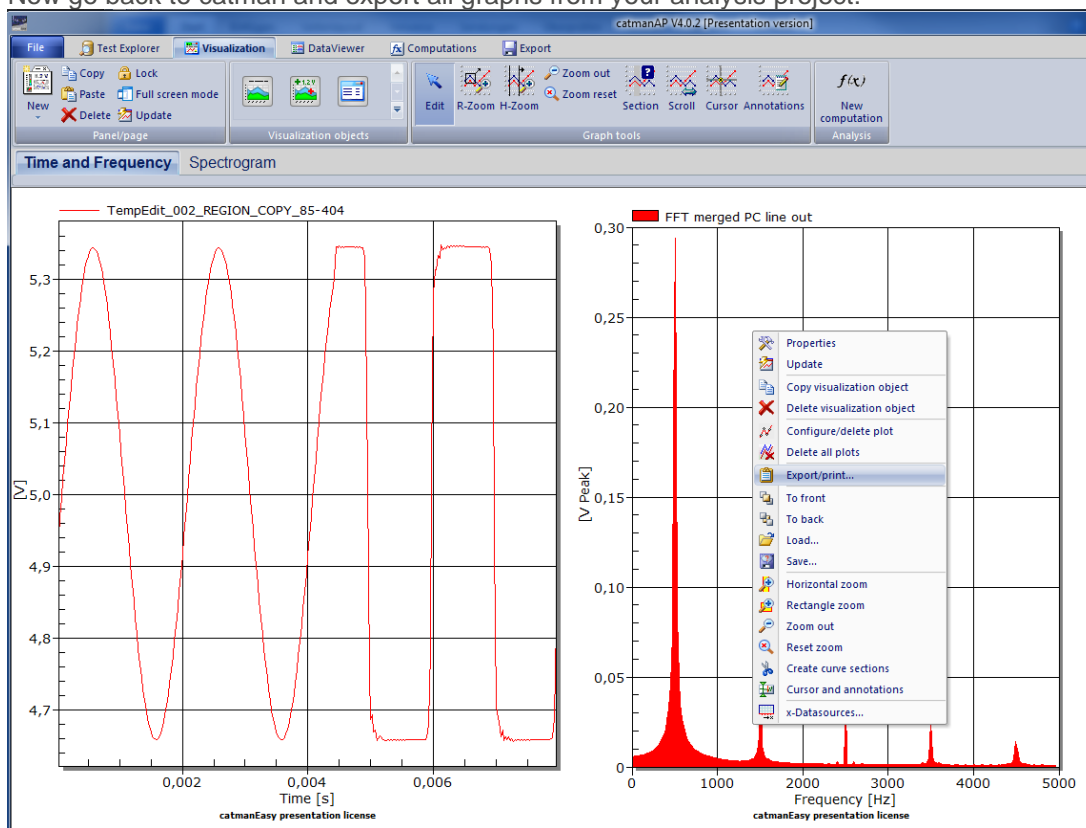
Now open your Test Report template in Microsoft Word and integrate the bookmarks in a place you want to automatically copy the graphs to.

Go to the specific place → Insert tab → insert Bookmark → enter name. Done.

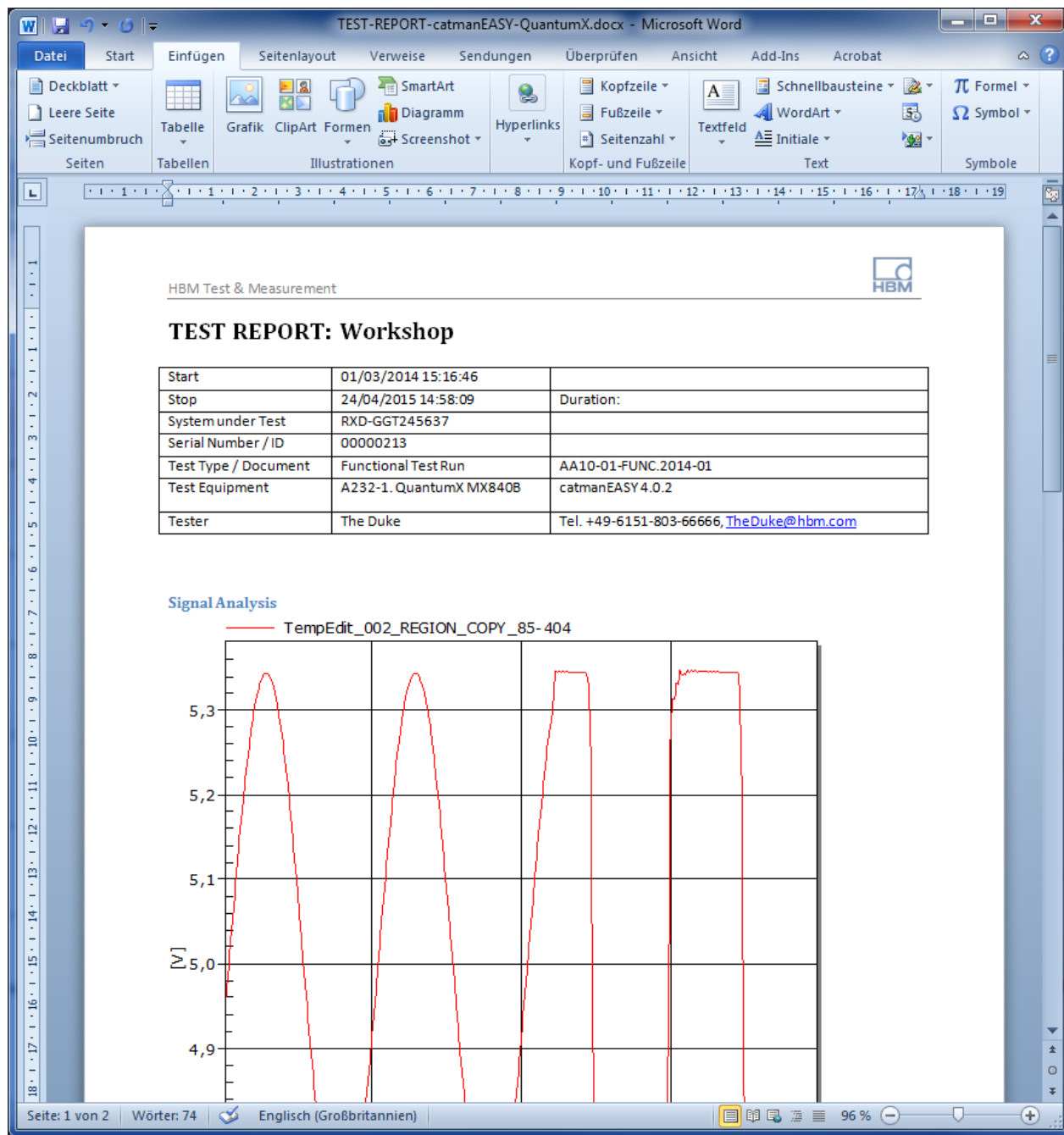
We recommend to also entering the bookmarks name into the text itself. Modifications are quicker in the future.



Now go back to catman and export all graphs from your analysis project:



Result is that all objects are copied into your test report. For recurring tests with a pre-defined analysis project and a pre-defined test report this is a quick solution.



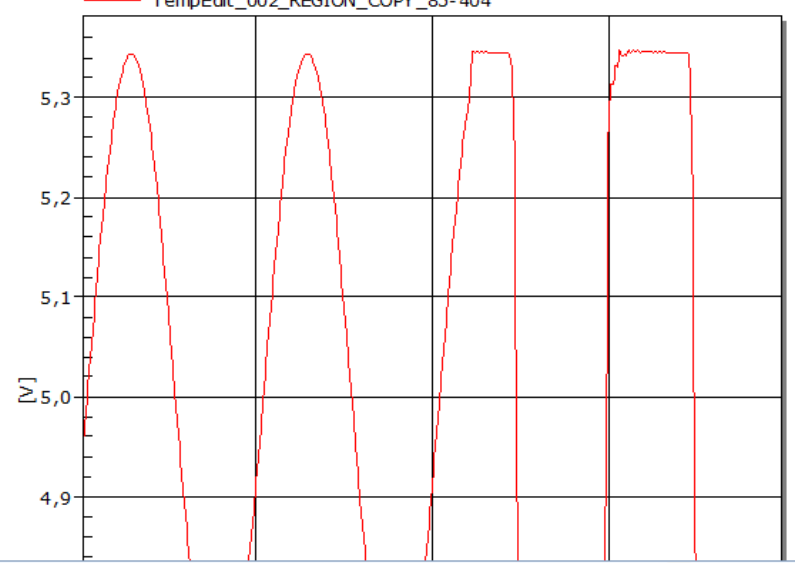
HBM Test & Measurement

TEST REPORT: Workshop

Start	01/03/2014 15:16:46	
Stop	24/04/2015 14:58:09	Duration:
System under Test	RXD-GGT245637	
Serial Number / ID	00000213	
Test Type / Document	Functional Test Run	AA10-01-FUNC.2014-01
Test Equipment	A232-1. QuantumX MX840B	catmanEASY 4.0.2
Tester	The Duke	Tel. +49-6151-803-66666, TheDuke@hbm.com

Signal Analysis

TempEdit_002_REGION_COPY_85-404



Seite: 1 von 2 Wörter: 74 Englisch (Großbritannien) 96 %

Now save your analysis project for upcoming projects.

Side Topic – Why Test Reports?

Now we all don't like writing long test reports but it is helpful in case you need to do a similar tests in the future and some documentation might help making life easier and reproducible for others. The prime objective of such a document is to explain various details and activities about the testing performed in your project and therefore of great value for the respective stakeholders like the mechanical engineering department, senior management, client or others. Assume that if the client who sits in a remote location need to understand the results and status about a testing project which has been performed for some months, A Test Report will solve this purpose. Most of the companies are ISO9001 certified and thus documentation is essential anyhow.

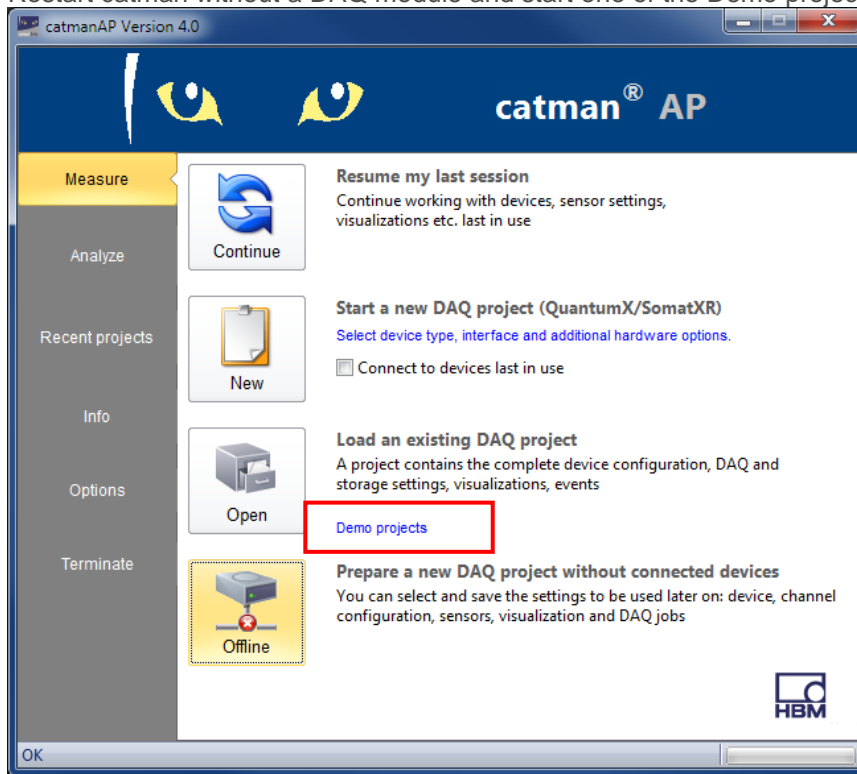
A typical Test Report template should therefore contain:

- Purpose of the document
 - Example: This document explains the various activities performed as part of Testing of system part XYZ.
- Testing Scope (in and out, Items not tested)
 - Pictures (test object itself, measurement spots, equipment, environment, ...)
 - Example: The following functions have been in Scope.... Performance Testing was out of scope...
- Metrics if you have any, i.e. amount of items to improve... or numbers of tests you do (passed / failed)
- Types of testing
 - In-field Load Data Acquisition and Analysis
 - Functional Test
 - System Integration Test
 - System Test
 - Regression Testing
- Test Environment & Tools
 - Describe the equipment you work with, i.e. QuantumX module, serial number, type and firmware, but also PC operating system and software
 - The acquired data will host all META data you entered before in catman, like name of tester, identification of the system under test (i.e. serial number), weather conditions, date, type of test, etc.
 - Sensor META data (from sensor data base or TEDS) will be stored in the acquired data as well
- Lessons Learned and way to improve
- Recommendations / Best Practices / Conclusion/Sign Off

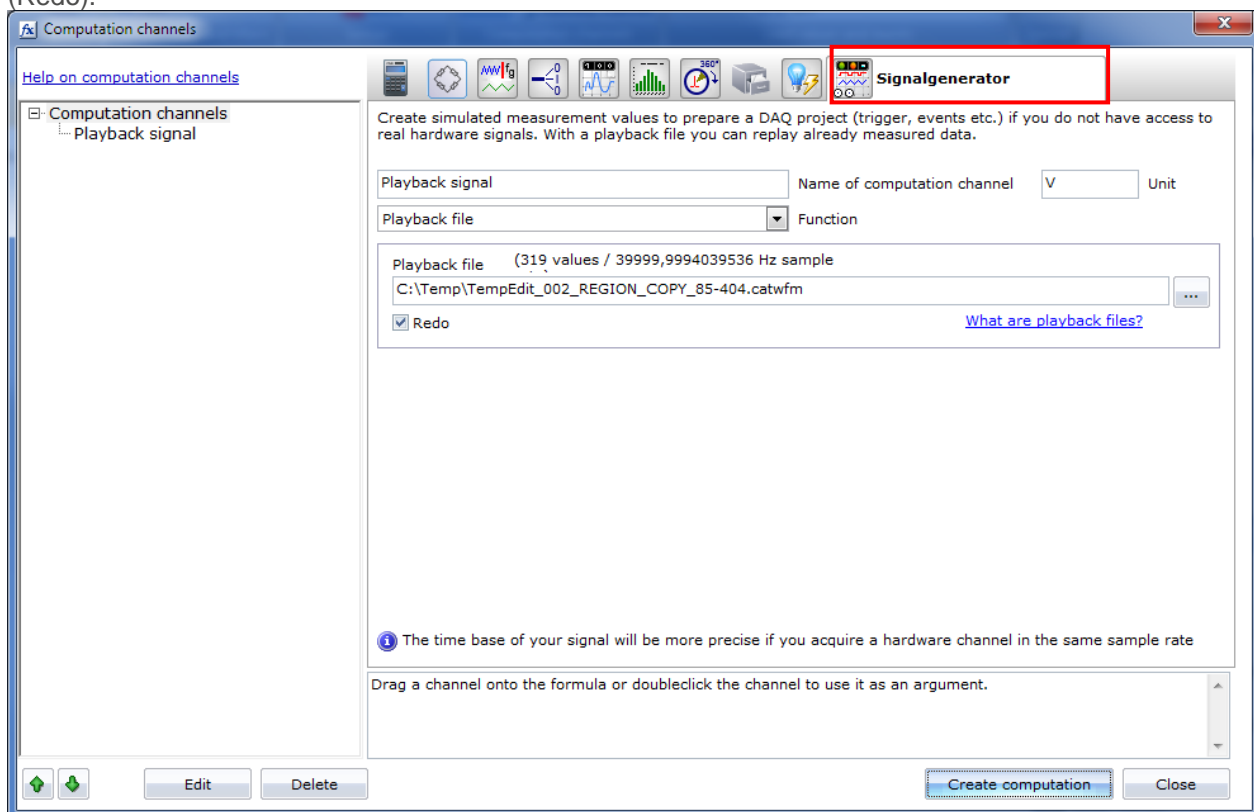
Please think about it, a repetitive task done manually every time is time consuming. Tasks can be automated by using the same analysis project and test report templates. You can further on automate testing by creating and using scripts running over your data, which saves time and resources.

5. Offline presentation

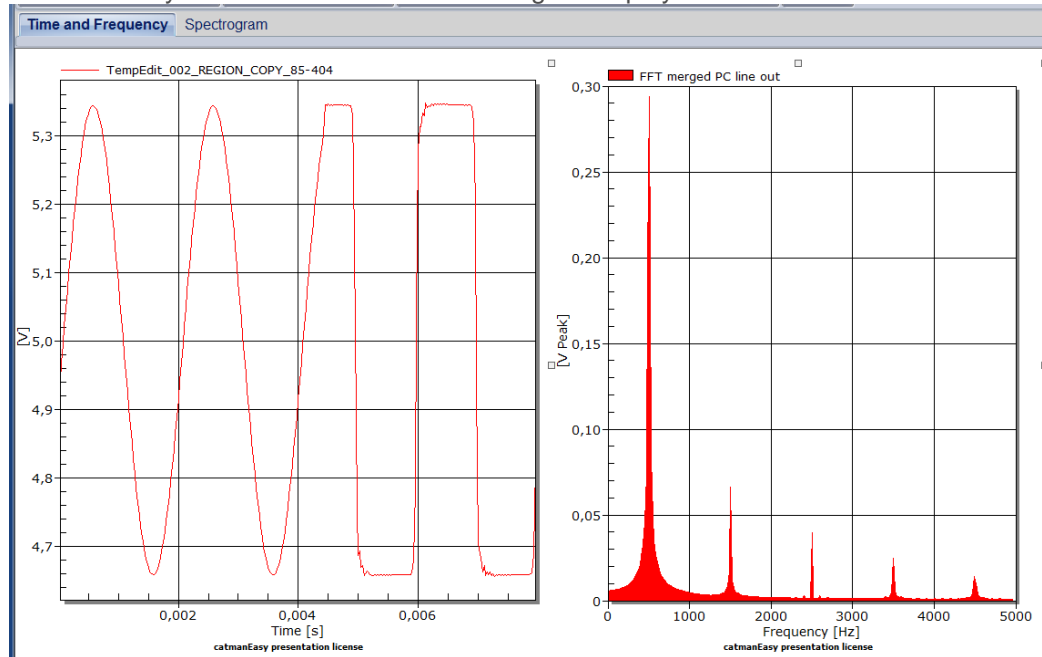
Restart catman without a DAQ module and start one of the Demo projects



Open the “Signal Generator” tab and parameterize it by loading the file you exported before (CATWFM) and which shall be replayed now. Create the new computation signal which can be replayed in an endless loop (Redo).



Now drag and drop the new Computation channel to a graph and start data acquisition. You are now able to demonstrate your data without a device using it in replay mode.

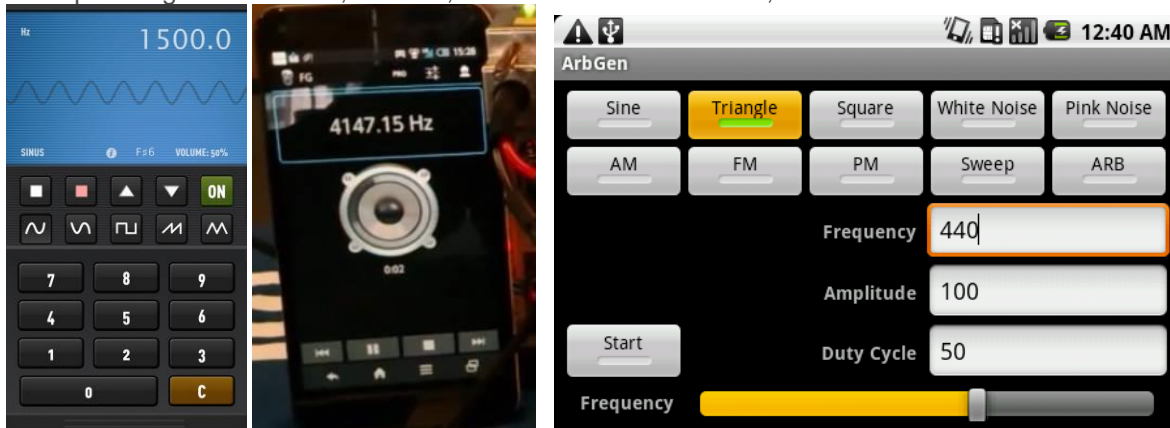


Done. Thanks for your patience. I hope you feel more comfortable with your tool now. Please let us know your comments/questions/thoughts...

Preparation

Please download and install a “[signal or function generator app](#)” for your smartphone.

Examples: Signal Generator, ArbGen, Audio Function Generator, FuncGen



Now you have your own demo tool for signal analysis.

Typical features are:

Wave form: Sine, cosine, square, triangle / sawtooth, white noise

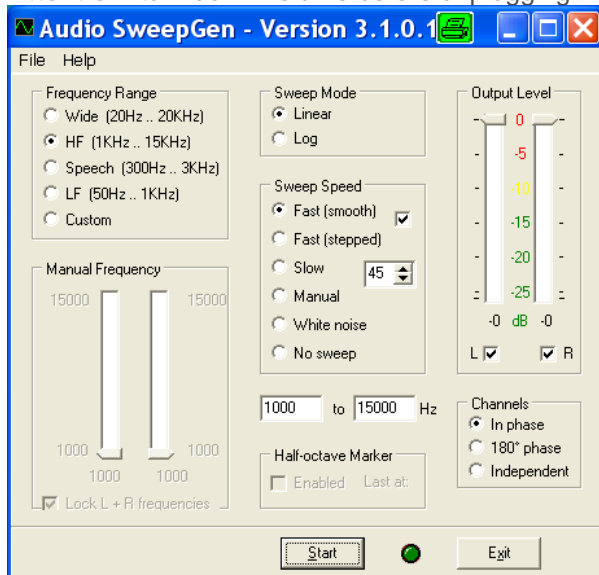
Parameterization: Direct frequency input or dial wheel (sweep)

Frequency range: 20 ... 20000 Hz

In case you don't have a smart phone or tablet available you can use the PC software [SweepGen](#) and generate any signal with the sound card of your notebook. SweepGen is a freeware-tool you can download from the internet.

Tip: plug in the 3.5 mm jack and tune the sound volume of your smart phone, tablet or PC to the max.

Attention: turn down volume before unplugging!



-- end

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