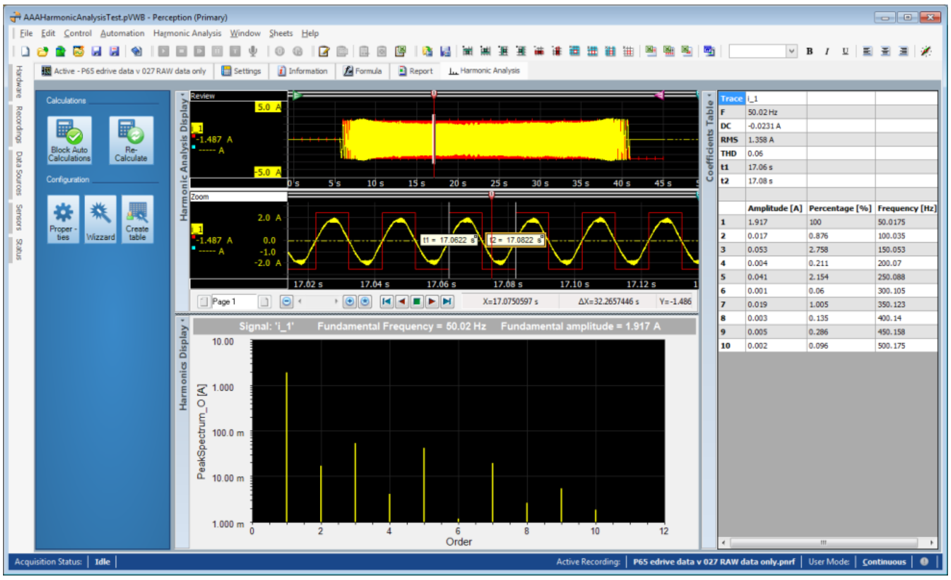
Genesis HIGH SPEED

User manual

English



Perception CSI Extension
Harmonic Analysis Sheet

HBM

A4192_04_E00_00

Document version 4.0 – June 2020

For Harmonic Analysis version 3.6.20155
For Perception 6.60 or higher

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1 Introduction

Welcome to the **Harmonic Analysis Sheet** software manual. This document describes how to use this software application.
The purpose of the software is to calculate the amplitude of the harmonic components of a periodic signal using the Fourier series. A special user interface is created to make this possible.
The application is based on the Perception Custom Software Interface (CSI).
This manual assumes you understand your Genesis HighSpeed Test and Measurement equipment, software and basic acquisition terminology. You may like to use the Perception User Manual as a reference.

2 Scope

This Perception software extension enables the use of Harmonic Analysis Sheet with any GEN DAQ hardware.
Via the new software the operator can do the following things:

- Calculate a variable number of harmonics over a selected period of time.
- Period of time is selected by the active cursor and may use a cycle detect signal to find the correct start and end times.
- Show the harmonics graphically in a special display
- Show the numerical values of the harmonics in a table
- Calculate the Total Harmonic Distortion (THD)
- All used and calculated values are available as data sources. Therefore they can be used throughout Perception for displaying, reporting or special additional user calculations.
- Various wizards will help you to set up your configuration. One of the wizards is the table configuration wizard, via this wizard you can interactively configure a new or existing user table with results from the Harmonic analysis calculations.
- Harmonic Analysis can be controlled from Perception automation

3 Getting Started

3.1 Installation

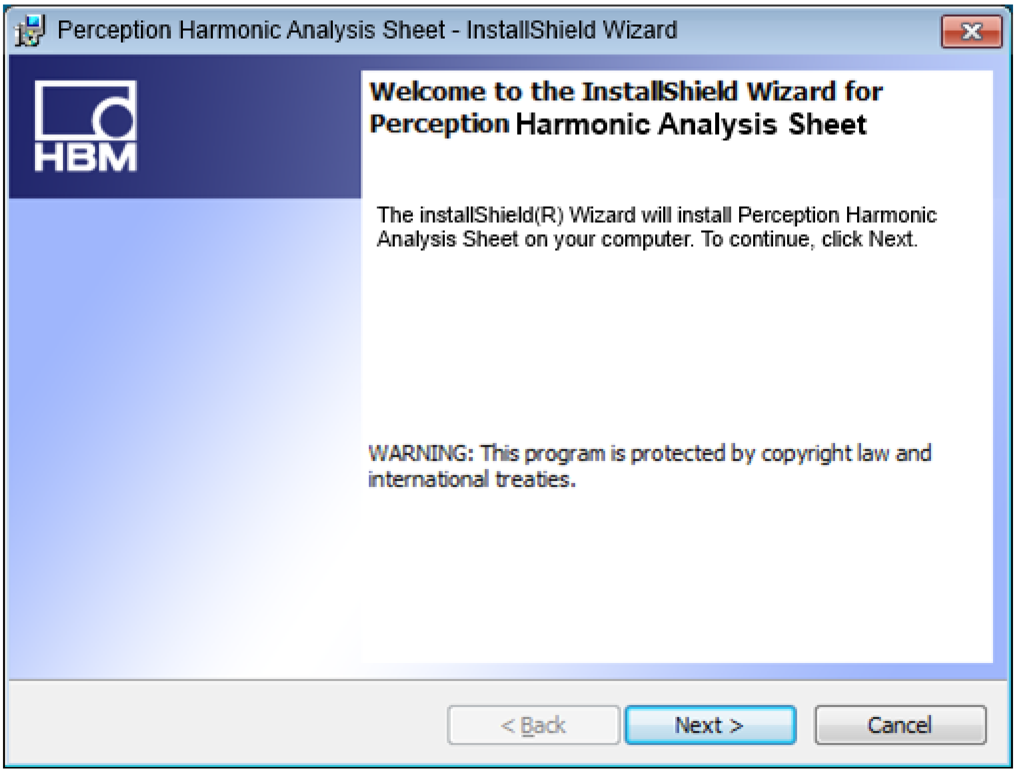
The Harmonic Analysis Sheet software is included with documentation.

The software can be installed via an install file. The name of the install file contains the version number and looks like:

Perception CSI Harmonic Analysis Sheet 64 bit 3.6.20145.msi

Installing procedure:

- Run the msi install file:



- Click **Next** and follow the on-screen instructions to complete the installation. When the process is complete, a message tells you that the option is installed. Click **Finish**.

Now the software and manual should be installed on your PC.
The Harmonic Analysis Sheet software is **not** a stand-alone program which can be started from the Windows Start menu! It is an integrated part of the Perception software program. Once you start Perception you will see an extra sheet called: **Harmonic Analysis Sheet**

The manual has also been installed on your PC. It is a PDF file which can be opened via the windows HBM menu.

If you cannot open this pdf file, then you may have to install the Acrobat® Reader® which can be found on the installation CD.
The manual is also available on the CD, you can read it before installing the software; to do this you just have to click **User Manual Harmonic Analysis Sheet** (See previous shown installation screen).

3.2 Requirements

Harmonic Analysis Sheet software operates on any PC where Perception is running.

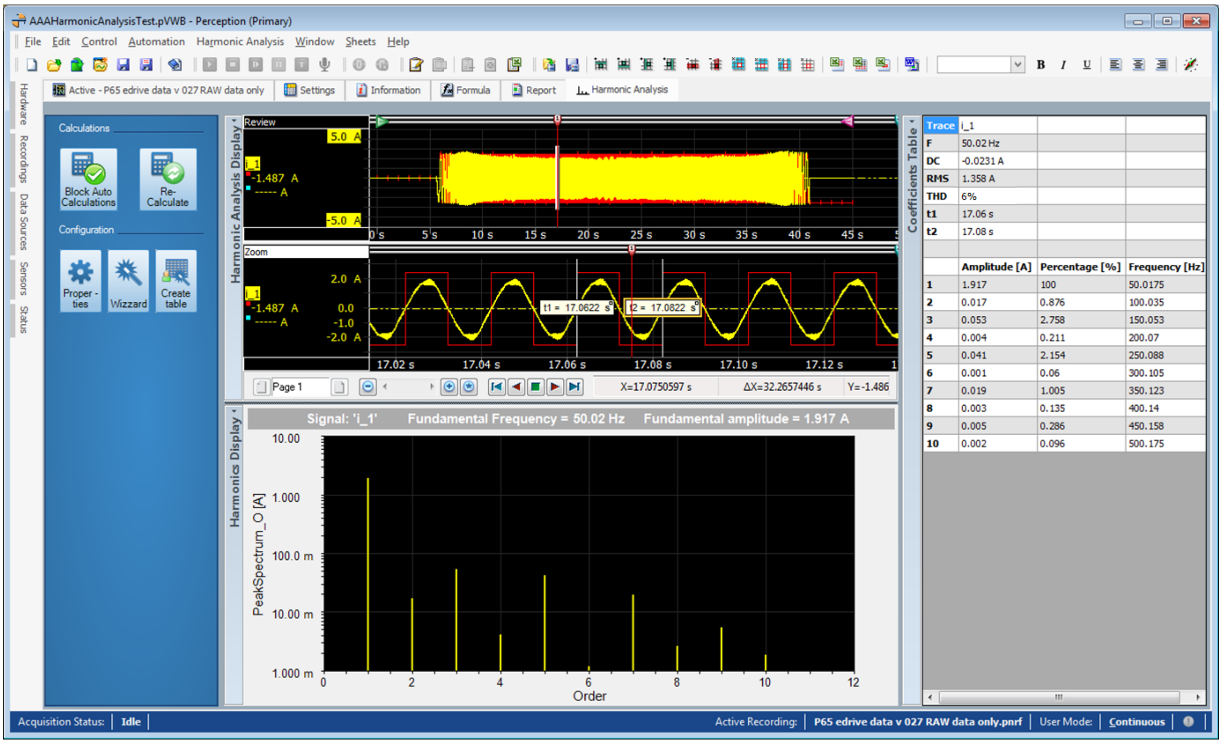
The Harmonic Analysis Sheet application can only be used when the HASP® USB key CSI option has been enabled. You can check it has been enabled by going to the Help About dialog and click **More…**. The “More About Perception” dialog shows which options are enabled.

The CSI option icon looks like: 

4 Harmonic Analysis Sheet

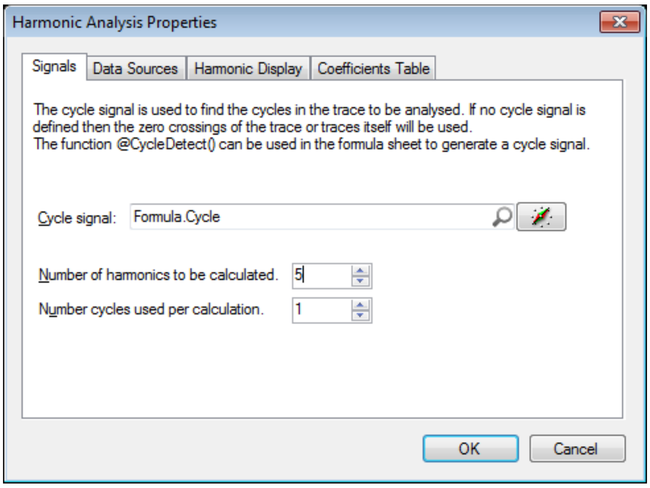
4.1 General

The Harmonic Analysis sheet contains a Menu Panel, a standard Perception display, a standard Perception User table and a special display for showing the spectral components.

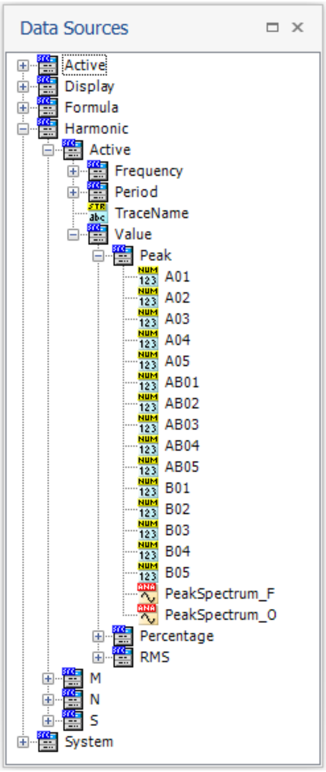


Before the calculations can be done the following things have to be prepared:

- The periodic signal of interest should be the active trace in the **Harmonic Analysis Display**.
- Optionaly a cycle detect signal can be defined, if not then the zero crossings of the signal itself will be used to find the correct cycle(s)
- The number of harmonics to be calculated has to be entered.
- The number of cycles used per calculation has to be entered.



- The cursor position and the cycle detect signal are used to find the correct cycle to be used for the calculations.
- The calculations can be done automatically after moving the cursor or can be done by pressing a special Re-Calculate button. The calculations will only be done automatically after cursor movement when you have not blocked the auto calculation via the **Block Auto Calculation** button.
- The results of the calculations are available as Perception Data Sources.

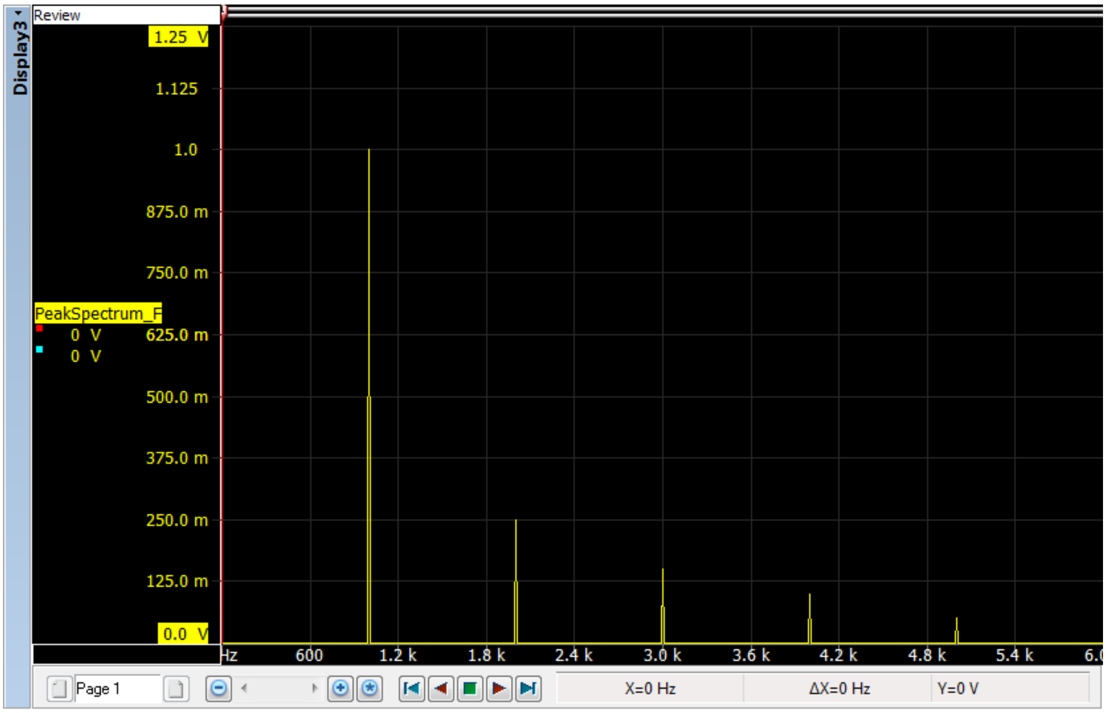


These data sources can be used by a Perception User table:

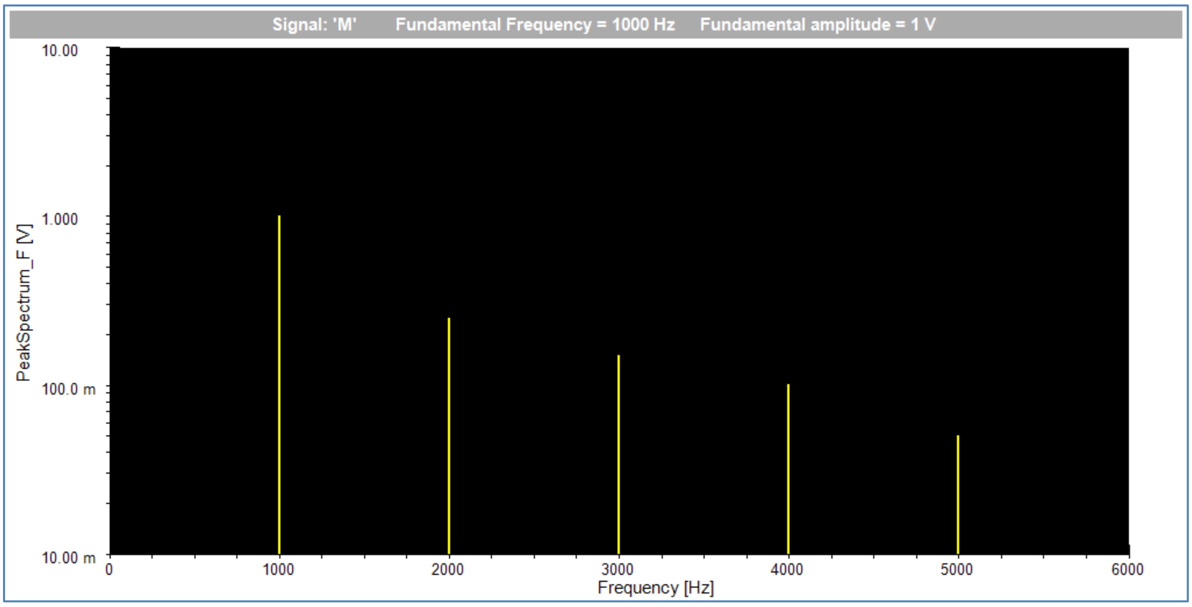
Coefficients Table

Trace	i_1	
F	51.25 Hz	
DC	-0.0273 A	
RMS	1.314 A	
THD	0.066	
t1	22.51 s	
t2	22.53 s	
	Amplitude [A]	Frequency [Hz]
1	1.854	51.25
2	0.01	102.5
3	0.068	153.8
4	0.006	205
5	0.049	256.3

The Spectrum waveform data source can be shown in a regular Perception display:



But can also be displayed in the special spectrum display at the Harmonic analysis sheet:



4.2 Calculations

The Harmonic Analysis Sheet will calculate the various spectral components based on the Fourier series.
The calculations are based on the following formulas:

$$f(t) = \mathrm{DC} + \sum_{k=1}^{\infty}\left(A_k \cos\left(\frac{2\pi kt}{T}\right) + B_k \sin\left(\frac{2\pi kt}{T}\right)\right)$$

$$T = t_2 - t_1$$

$$DC = \frac{2}{T}\int_{t_1}^{t_2} f(t)dt$$

$$A_k = \frac{2}{T}\int_{t_1}^{t_2} f(t)\ \cos\left(\frac{2\pi kt}{T}\right)dt$$

$$B_k = \frac{2}{T}\int_{t_1}^{t_2} f(t)\ \sin\left(\frac{2\pi kt}{T}\right)dt$$

$$AB_k = \sqrt{{A_k}^2 + {B_k}^2}$$

$$\varphi_k = \mathrm{acos}(\frac{A_k}{AB_k})$$

The Total Harmonic Distortion (**THD**) uses the RMS of the function during the selected cycle ($Urms$) together with the RMS of the fundamental ($Urmsfund$). The fundamental is the same as the first harmonic.

$$THD = \frac{\sqrt{Urms^2 - Urmsfund^2}}{Urmsfund} \times 100\%$$

$$Urmsfund = \frac{AB_1}{\sqrt{2}}$$

$$THD = \frac{\sqrt{Urms^2 - 0.5\ {AB_1}^2}}{\frac{AB_1}{\sqrt{2}}} \times 100\%$$

The Total Harmonic Current distortion (**THC**) uses the RMS of the first n harmonics (excluding the fundamental with n=1), adds them up geometrically and puts the result in relation to the RMS of the fundamental. The fundamental is the same as the first harmonic.

$$THC = \frac{\sqrt{\sum_{h=2}^{n} I_h^2}}{Irmsfund} \times 100\%$$

Where:

- I_h = The RMS of the h^{th} harmonic.
- *Irmsfund* = The RMS of the fundamental

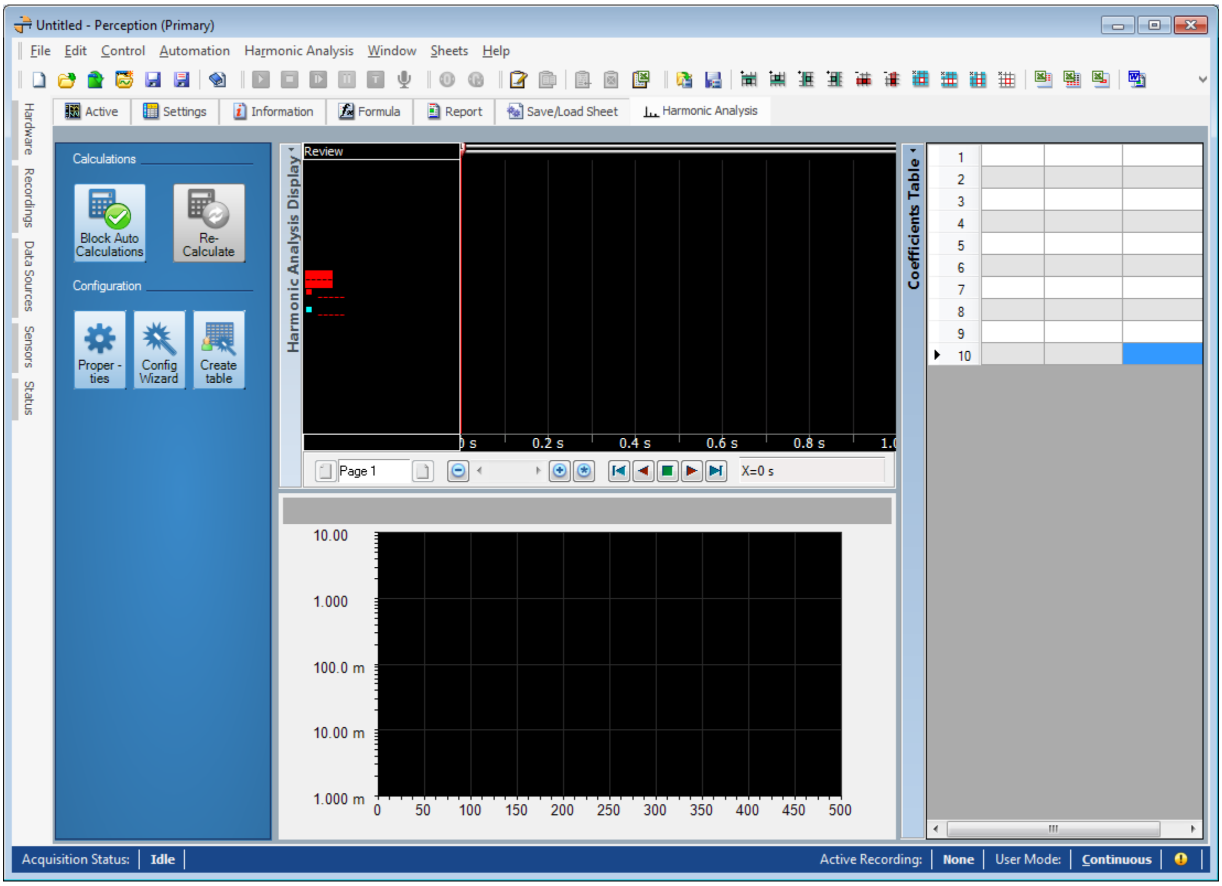
Formula is listed on page 28 of the **EN 61400-21:20008**(D) paper

This THC calculation is done according to **EN 61400-21:2008** Wind turbines – Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines.
The **EN 61400-21:2008** defines this calculation to be done on the current and up to the 50th harmonics.

So in order to be compliant the user must add one or more current channels of interest to the **Harmonic Analysis Display** which resides at the **Harmonics Analysis sheet** and set the number of harmonics to be calculated to 50.

4.3 How to get started

When you have installed the Harmonic Analysis Sheet and then start Perception you will see the following rather empty screen:



Before you can continue you need to have at least one periodic signal which will be used for the analysis. This signal can come from a recording you just have recorded, or by opening an existing recording.

So the initial steps you have to do when you start from scratch are:

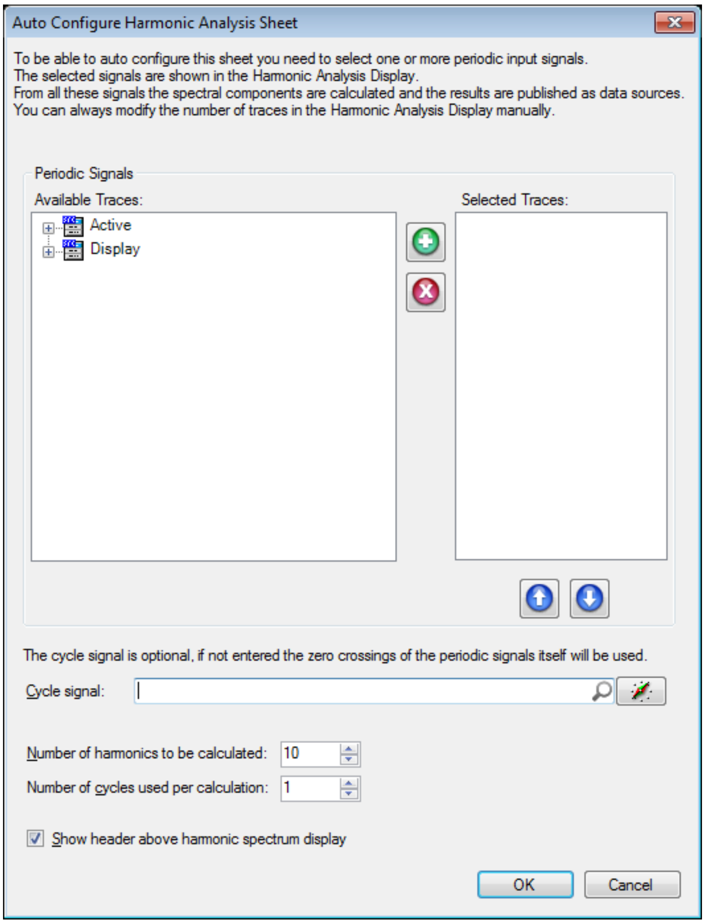
- Open an existing recording or record a new one.
- We recommend you to use the formula database function **@CycleDetect**() for creating a cycle detect signal, see also chapter with example about the usage of the CycleDetect() function; This step is optional and can be skipped, then the zero crossings of the periodic signal itself will be used to determine the cycles. However often the results are better when using the **@CycleDetect()** function because it contains special logic to handle noisy signals.

Num	Name	Formula
1	Cycles	@CycleDetect(Active.Group1.Recorder_A.i_1)

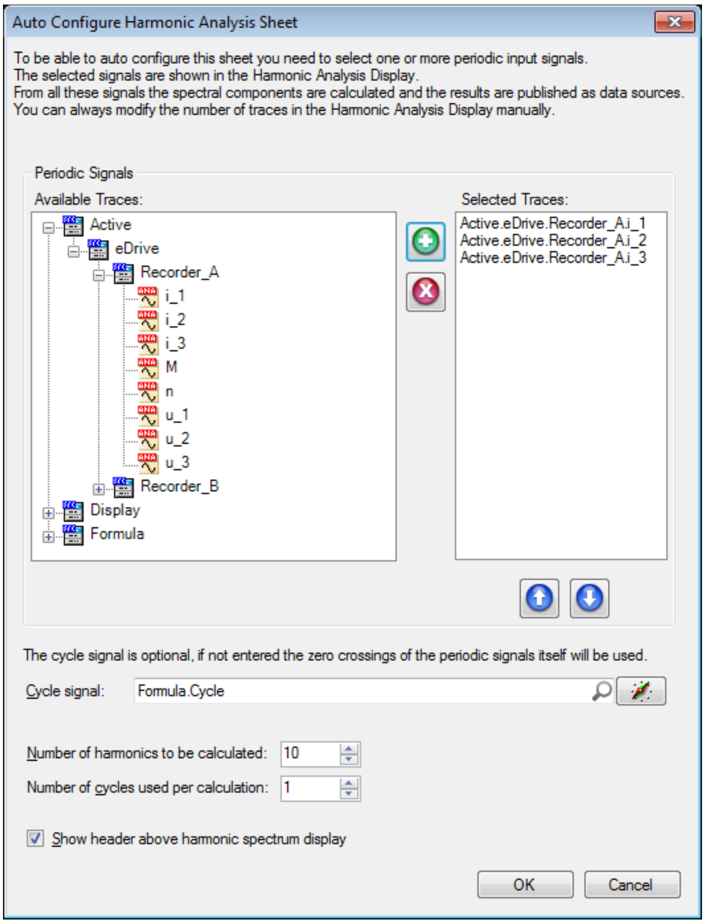
- Press the **Config Wizard** button 

to initially configuring your Harmonic Analysis application.

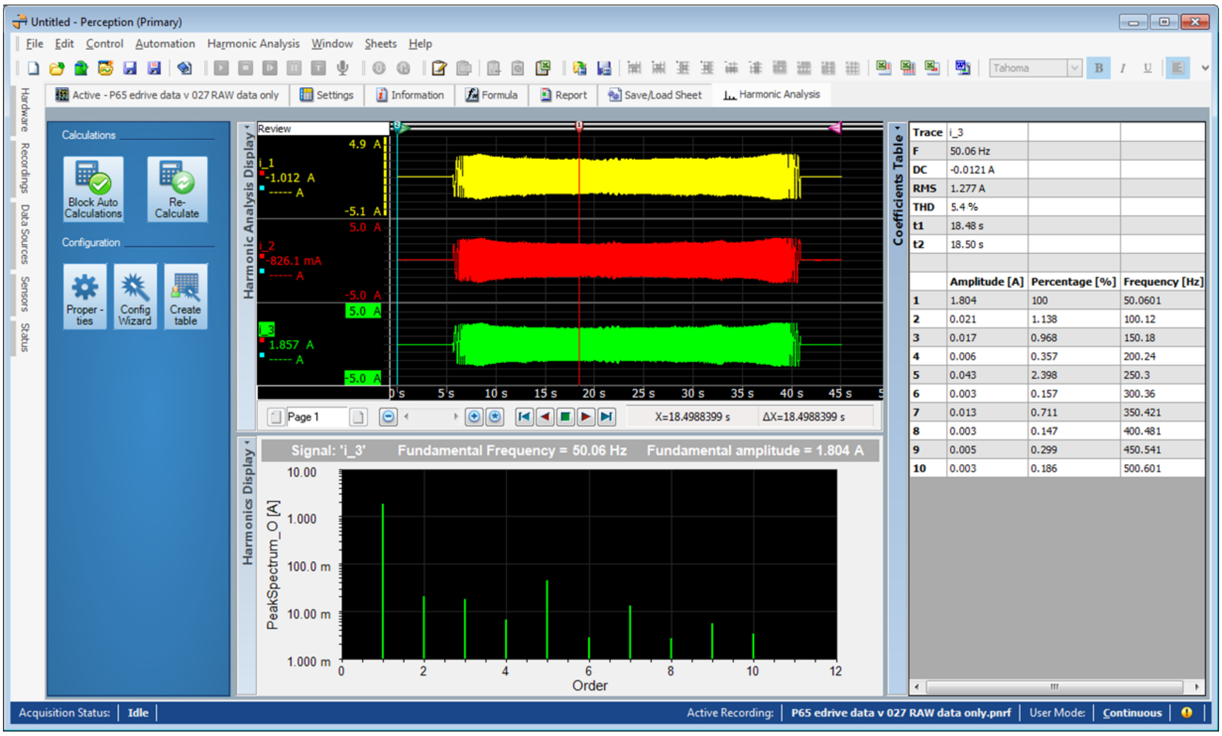
- The following dialog will be shown:



- Now select the Periodic signal(s) you want to use for the calculations.
- Enter optionally the cycle signal, this is the signal which will be used to find the correct period (t_1 and t_2 in the formulas above) around the location of the first cursor. See information (**@CycleDetect()**) above.
- Enter the number of harmonics you want to be calculated
- Enter the number of cycles used per calculation.
- Your dialog can now look like:



- Press the OK button and the system will configure the Harmonic Analysis sheet and will also do the calculations.
- The result can look like:

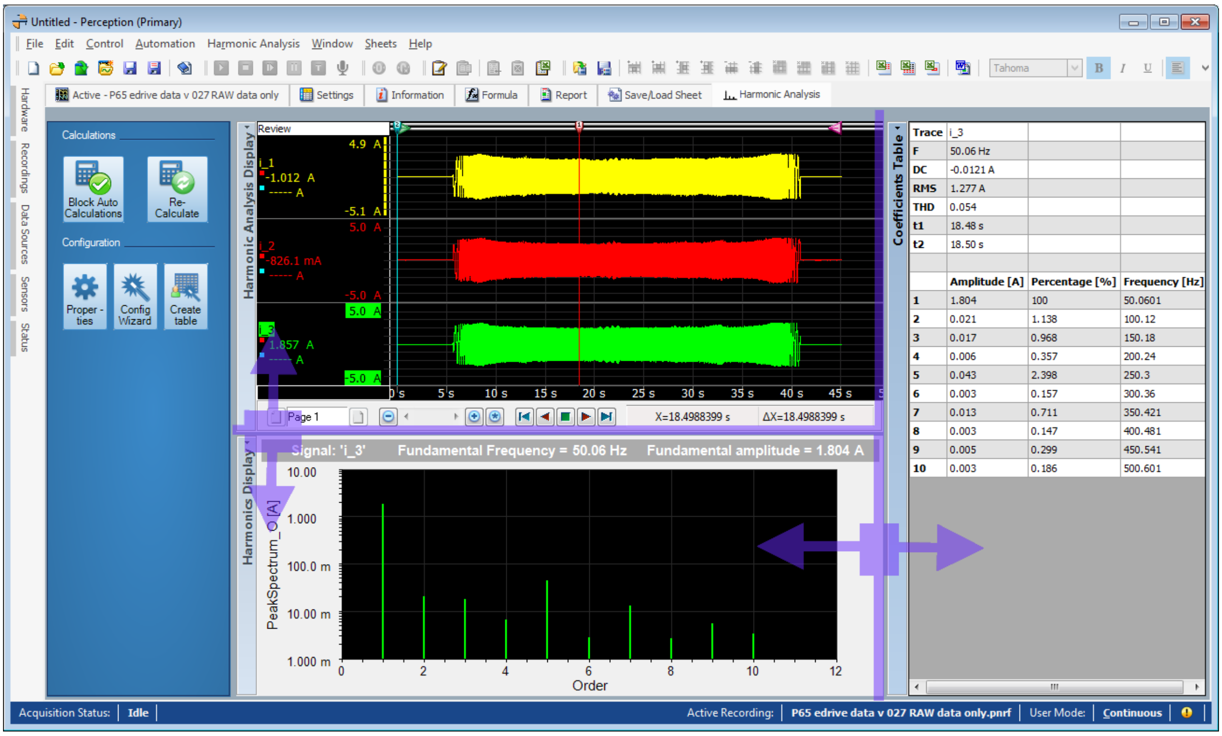


- You are now ready, after you moved cursor 1 the calculations will automatically be started again, using a new period.
- If you like the configuration you can save this into a virtual workbench and reuse it later again.

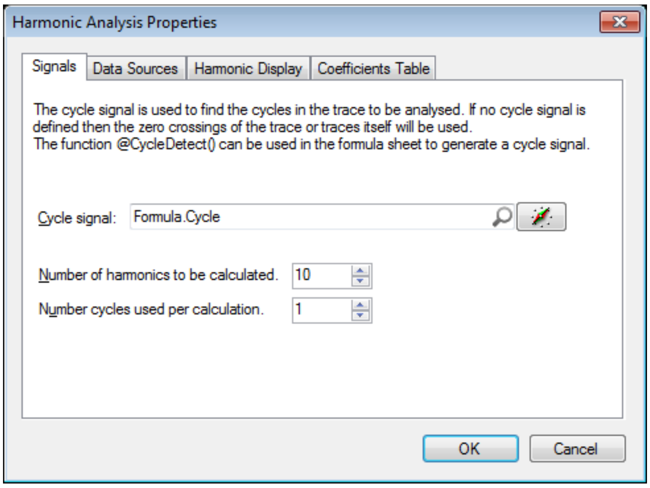
4.4 Modify an existing configuration

If the default configuration is not what you want, you can modify it.

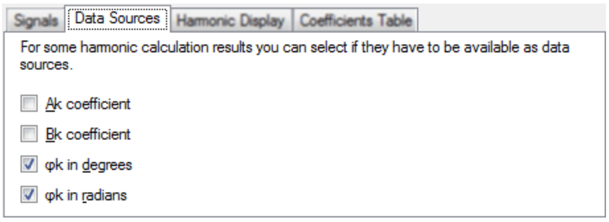
- You can always add more traces to the Harmonic Analysis Display. The calculations are always done on all the traces in the display; if the active trace is the cycle signal then the program automatically will change the active trace to another trace. The cycle signal is the signal as defined via the Harmonic Analysis Properties dialog.
  The program assumes that the cycle signal can be used for all the traces you add to the Harmonic Analysis Display.
- Use the vertical or horizontal splitters to resize the displays or coefficients table.



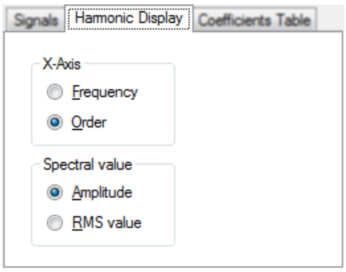
- Press the **Properties** button  to modify various properties.
- The Harmonic Analysis Properties dialog has four different tabs:
  - Signals Tab
    You can change:
    - The cycle signal
    - The number of harmonics to be calculated
    - The number of cycles per calculation



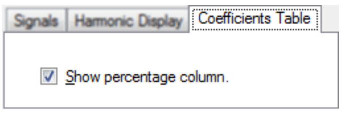
- Data Sources
  For some of the harmonic calculation results it is optional weather or not you want them to be available as data sources. These are:
  $A_k, B_k \text{ and } \varphi_k \text{ (in radians or degrees)}$



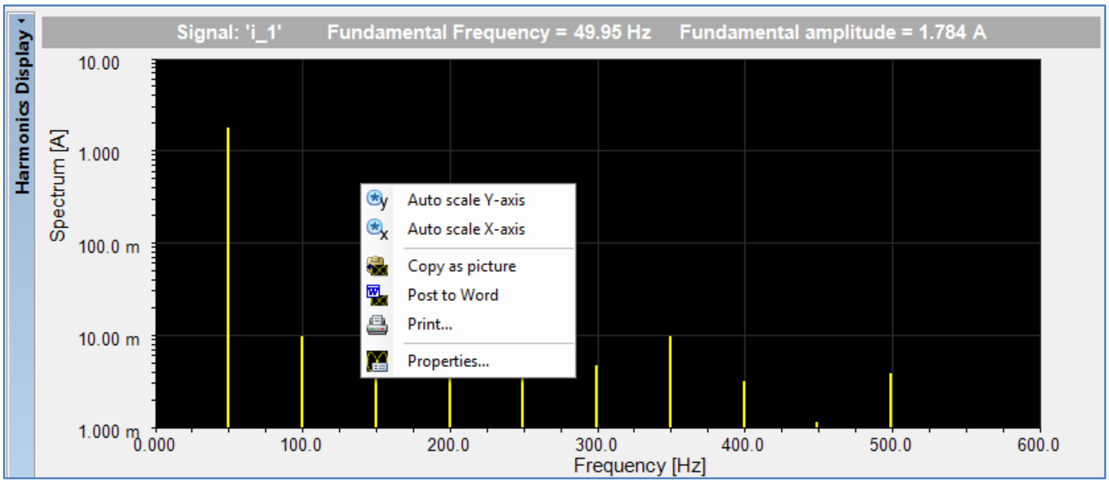
- Harmonic Display
  The X-axis of the Harmonic display can either be set to Frequency or Order.
  The spectral values can be the peak amplitude or the RMS of the amplitude



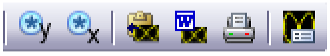
- Coefficients Table
  The coefficients table can show a percentage column, the 1st harmonic or fundamental frequency is set to 100% the other spectral components are related in percentage to this value.



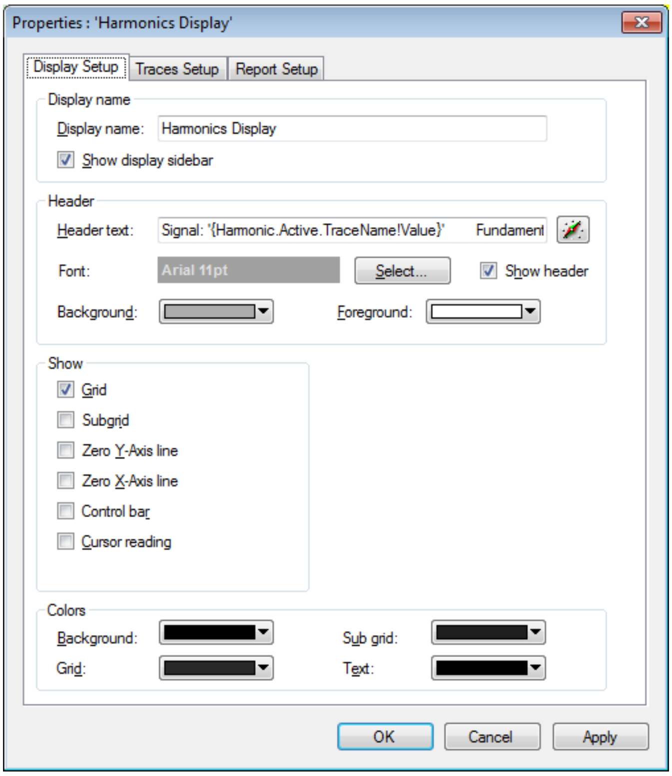
- Use right mouse click on the displays to change the setup or properties. For the **Harmonic Analysis Display** you can use the Perception user manual to see what possibilities there are, however the spectral display called **Harmonics Display** works differently because it is not a standard Perception display.



- You can also use the toolbar buttons; they only appear when the spectral harmonic display is selected.



- Via the properties menu you can modify the Spectral display, most properties are self-explaining and most of the time the default settings will be OK.



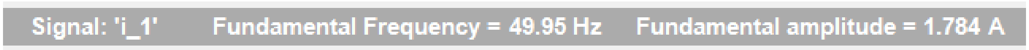
Some properties which might be interesting are:

- Header text

  You can modify the header text above the **Harmonics Display**; you can use data sources to create a dynamic header. If you have used the **Configure Wizard** you see the following header definition text:

Signal: '{Harmonic.Active.TraceName!Value}'   Fundamental Frequency = {Harmonic.Active.F01!Value,####.!Units}   Fundamental amplitude = {Harmonic.Active.Value.RMS.AB01!Value,####.!Units}

This results in the following header:



It is also possible to switch off the header.

- Report Setup settings

  Those settings will be used when you want to use this display at a Perception report. For more information see chapter reporting.

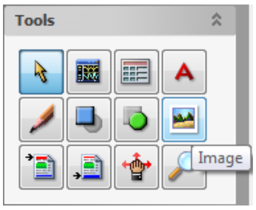
- You can modify the **Coefficient Table**; this table is a standard Perception user table, information on how to modify this can be found in the standard Perception user manual.

4.5 Reporting

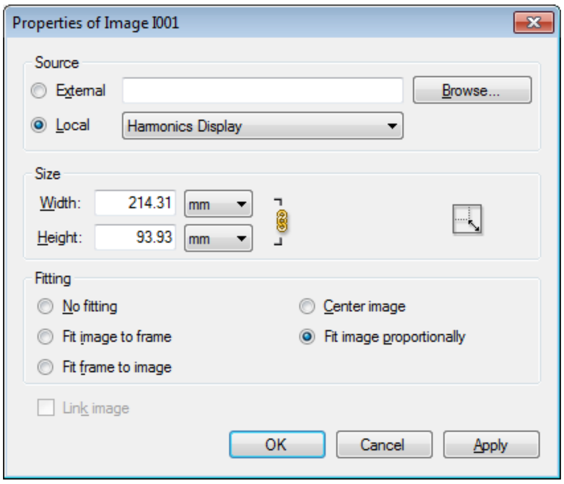
The Harmonic Analysis sheet contains three main components, two displays and a table; all those components can be used by the report sheet to create nice reports. Read the Perception user manual to see how the standard Perception display and user table can be used by the report sheet.
The spectral **Harmonics Display** however is not a standard Perception display and therefore it works different when you want to have this display at your report. You should use the report **Image** component and use the **Harmonics Display** as the local source.

Steps for using the spectral **Harmonics Display** at a Perception report:

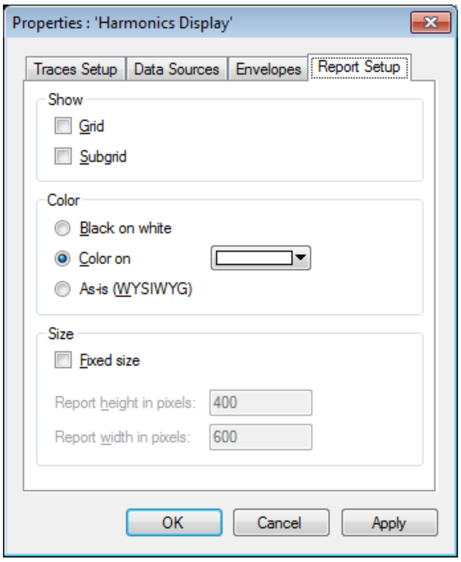
- Before you start make sure the layout of your display is OK for you
- Go to the report sheet
- Select the Image in the Tools panel and drop it on the report



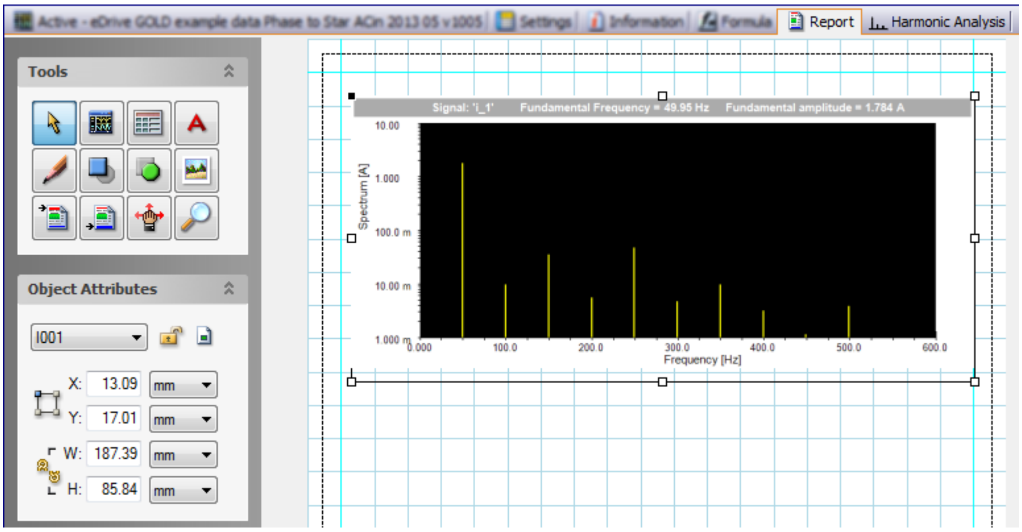
- Select the **Harmonics Display** as the local source



- Preferred setting for fitting is: *Fit image proportionally* however you can use a different setting as well. The best choice also depends on the harmonic display **Report Setup** settings.

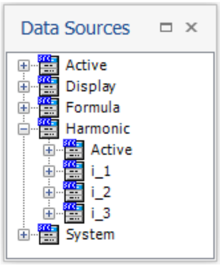


- You just can experiment and find out what you like the most.
- An example of a report:



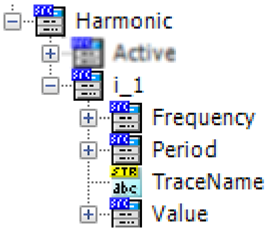
4.6 Harmonic Analysis Data Sources

After the calculations have been done the various results are available as data sources. Per trace (as shown in the **Harmonic Analysis Display**) there will be a sub tree in the main entry called **Harmonic**. There is also always a sub tree called **Active**. This **Active** tree is a copy of one of the *trace* trees, and is controlled by the Harmonic Analysis Display. The results of the harmonic calculations of the **active trace** in the **Harmonic Analysis Display** are also available in the **Harmonic**.**Active** tree in the data sources. By doing this the **Coefficients Table** and the spectral **Harmonics Display** will be automatically updated when another trace is selected in the time display. Both these components are linked to this *active* data source tree.



In the picture above you can see that there are three results of three traces called **i_1**, **i_2** and **i_3**
Next to this you can see the **Active** tree.

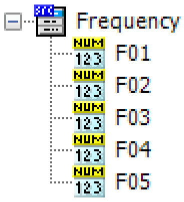
All these trees have the same structure.



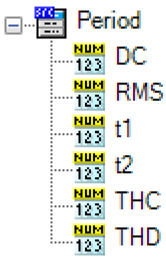
Each sub tree has a **TraceName** field; this is the name of the trace used for the calculations.

The sub trees are:

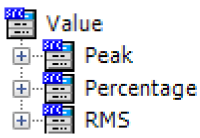
- **Frequency**
  F01 to **F05** are the harmonic frequencies, where **F01** is the fundamental frequency
  The number of frequencies depends on the selected number of harmonics to be calculated; in this example this was set to 5



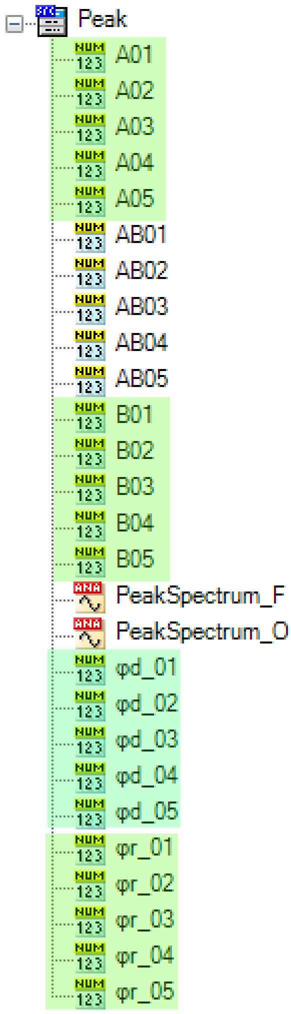
- **Period**
  The period contains:
  - **DC** is the DC component
  - **RMS** the RMS value of the selected cycle
  - $\mathbf{t_1}$ the begin of the cycle
  - $\mathbf{t_2}$ the end of the cycle
  - **THD** the Total Harmonic Distortion of the selected cycle
  - **THC** the Total Harmonic Current Distortion of the selected cycle



- **Value**
  This section contains information on the various harmonic coefficients:
  - **Peak**: The values are related to the signal Peak amplitude value,
  - **Percentage**: The values are related to the fundamental frequency
  - **RMS**: The values are related to the RMS value of the signal



The **Peak** tree looks like:



In this example the number of harmonics is 5; the various data sources have the following meaning:

- **A01** to **A05** are A_k where k = 1 to 5 in the formula below.
- **B01** to **B05** are B_k where k = 1 to 5 in the formula below.

$$f(t) = \mathrm{DC} + \sum_{k=1}^{\infty}\left(A_k \cos\left(\frac{2\pi kt}{T}\right) + B_k \sin\left(\frac{2\pi kt}{T}\right)\right)$$

- **AB01** to **AB05** are AB_k where k = 1 to 5 in the formula below.

$$AB_k = \sqrt{{A_k}^2 + {B_k}^2}$$

- ***φ*d_01** to ***φ*d_05** are φ_k in degrees where k = 1 to 5 in the formula below
- ***φ*r_01** to ***φ*r_05** are φ_k in radians where k = 1 to 5 in the formula below

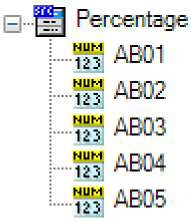
$$\varphi_k = \mathrm{acos}\left(\frac{A_k}{AB_k}\right)$$

- **PeakSpectrum_F** is a waveform data source constructed from the spectral components the y-axis are the values AB01, AB02, etc... the x-axis is the frequency in Hz.

- **PeakSpectrum_O** is a waveform data source constructed from the spectral components the y-axis are the values AB01, AB02, etc... the x-axis is the order of the harmonic.

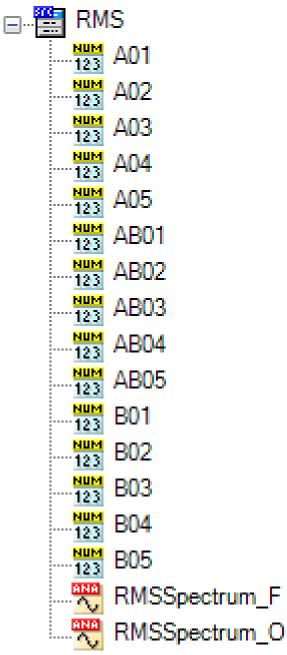
Remark: *The green marked data sources are optional; they can be disabled via the properties dialog!*

The **Percentage** tree looks like:



The harmonic values are now expressed in percentage, where AB01 is set to 100%, the other values are related to this value.

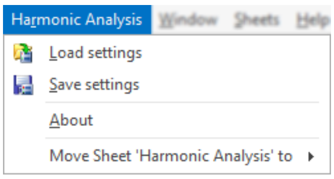
The **RMS** tree looks like:



All the variables have the same meaning as the described for the Peak tree, except that now the values are RMS (= Peak values divided by √2).

4.7 Harmonic Analysis Menus and Toolbars

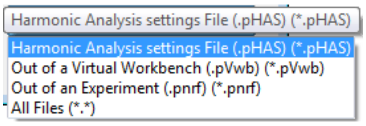
The Harmonic Analysis sheet comes with the following menu and toolbar



The menu items or toolbar buttons have the following functionality:

-  Load settings

The configuration of the Harmonic Analysis sheet can be saved to and loaded from a Harmonic Analysis Settings file (*.**pHAS**). This mechanism is the same as for example the formula sheet where the configuration can also be saved and loaded from a *.pFormulas file. Via the Load settings menu you can however also load the Harmonic Analysis configuration from an existing **Virtual Workbench** or an existing **Experiment**.



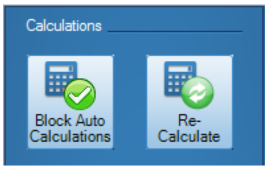
-  Save setting
  Saving the existing configuration into a separate Harmonic Analysis Settings file (*.**pHAS**).

4.8 Persistency

The setup of the Harmonic Analysis Sheet is saved just like other setup settings of Perception into a virtual workbench file (pVWB) or recording file (pNRF). If you reopen a recording file or virtual workbench file, the Harmonic Analysis sheet will be set the same as at the moment of saving.

4.9 When does re-calculation happen

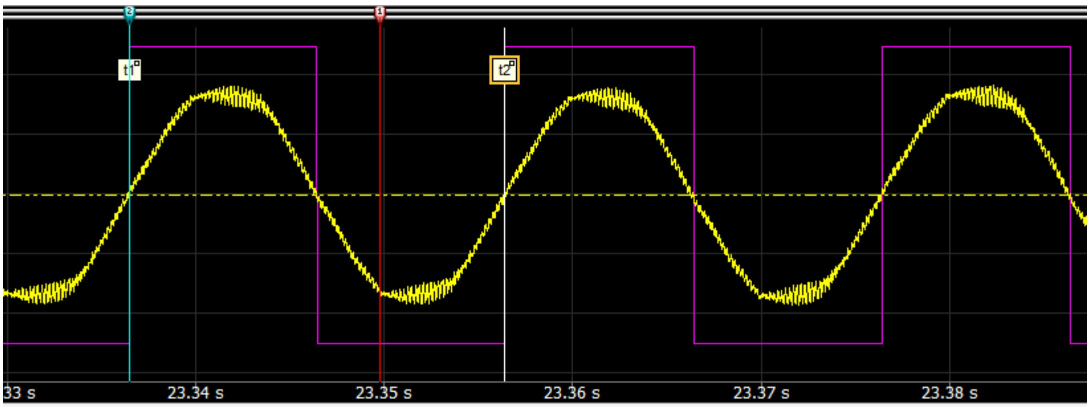
In the menu there are two buttons related to the Harmonic Analysis calculations:



The first button is used to block or unblock the automatic recalculation of the Harmonics when moving the 1st cursor. If the recalculations are blocked the button looks like:

The Re-Calculate button can be used to force a re-calculation.

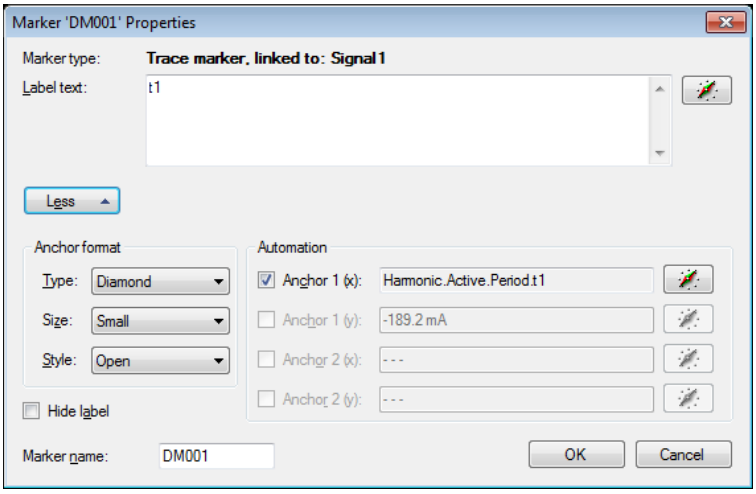
The picture below shows the cycle signal (purple) and the periodic signal to be analyzed (yellow). The time markers t_1 and t_2 show the used cycle. When moving the cursor outside the current cycle a re-calculation will happen; this happens of course when the **Block Auto Calculations** is enabled.



4.10 Use time markers to show selected cycle

In the picture above you see two time markers which indicate the start and end of the used cycle. We will describe here how you can do this.

- Make sure you have done a calculation and all information is available as data sources
- Add a time marker. You can do this by right mouse click at cursor 2 or use the toolbar button
- Change the properties of the time marker as follows:



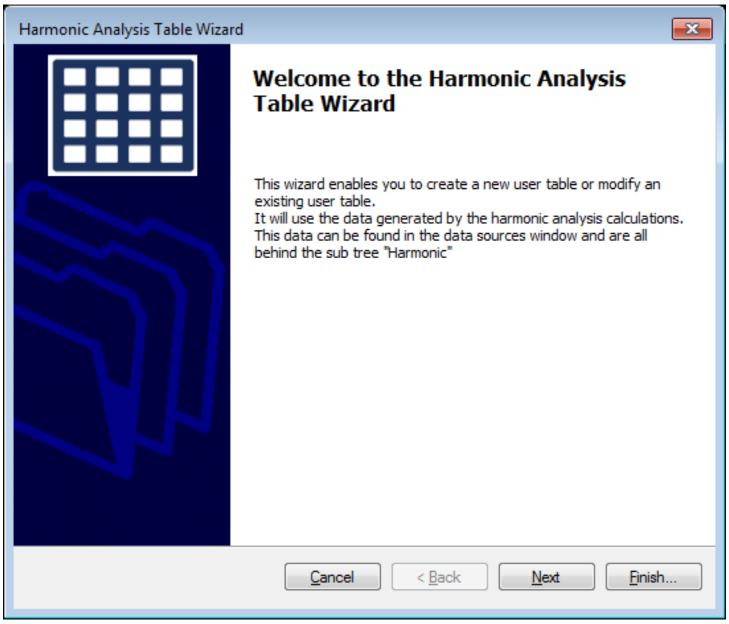
- Create a second time marker and now use as *label text* **t2** and set the *Anchor 1(x)* to **Harmonic.Active.Period.t2**
- If you now move the cursor you will see the time markers are automatically repositioned to the correct start and end of the used cycle.

4.11 Table creation Wizard

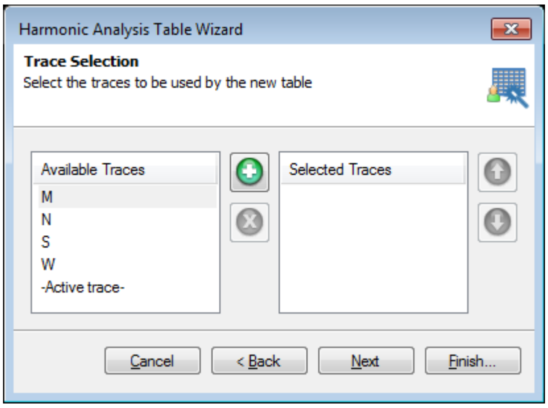
The table creation wizard can be used to create new or modify existing user tables. This wizard uses the data sources as created by the harmonic analysis calculations. You can interactively setup a table layout.

The wizard can be started via the **Create table** 

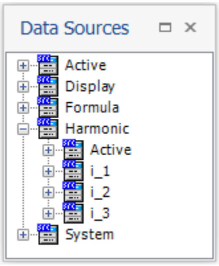
button at the menu panel of the Harmonic Analysis sheet.



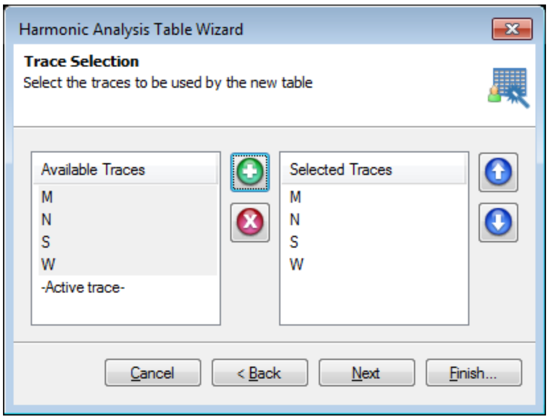
The next page looks like:



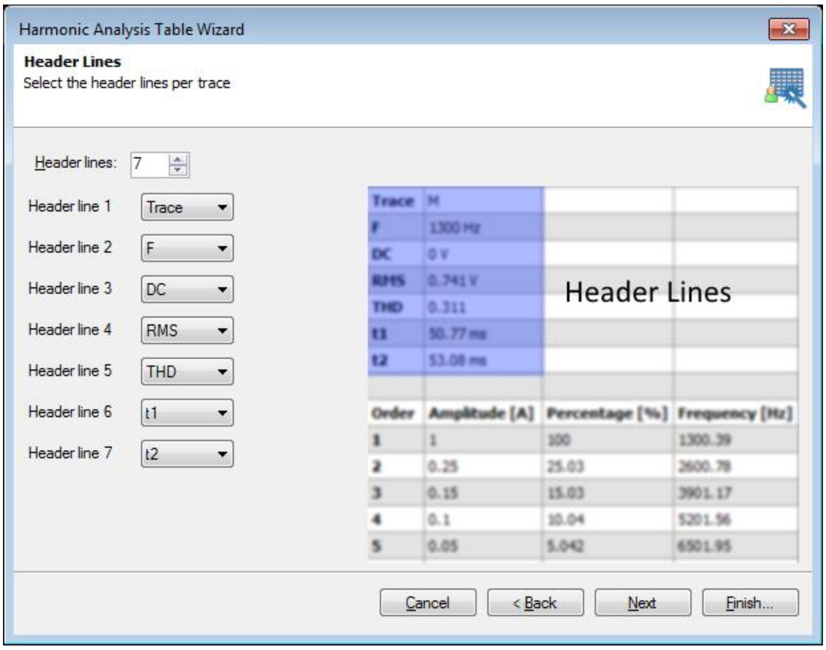
At the left you see the names of the traces as they are available in the **Harmonic Analysis Display**. However there is one extra item called **-Active trace-**, you should select this if you want to use the calculated results from the **Harmonic.Active** tree.



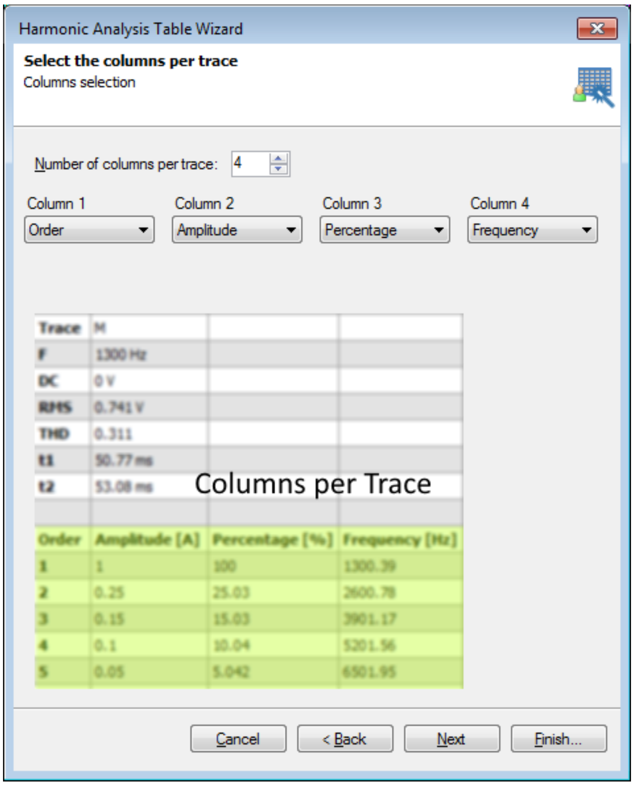
Select the traces from which you want to use the calculated results. In the picture below M, N, S and W are selected.



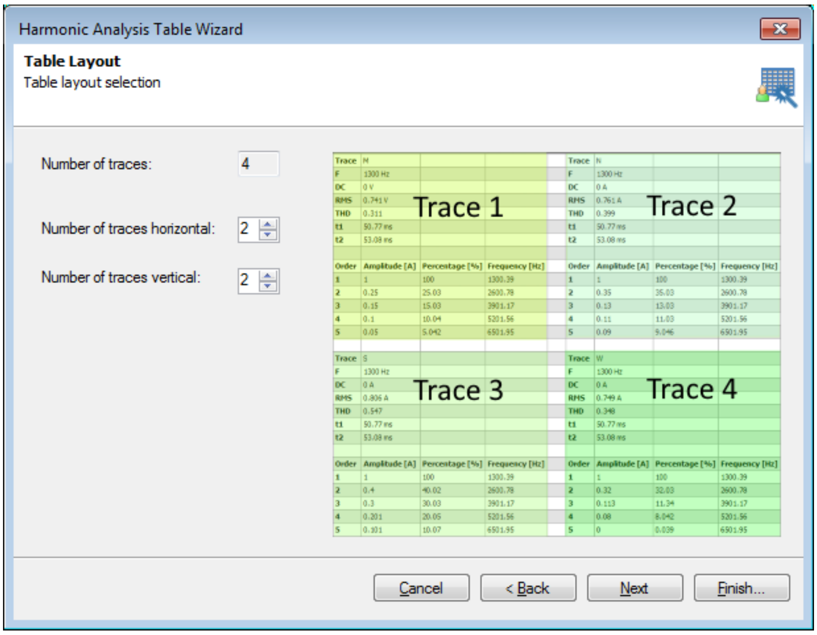
The next wizard page shows the Header Lines selection. Via this page you can select which Header Lines per trace should be shown in the user table.



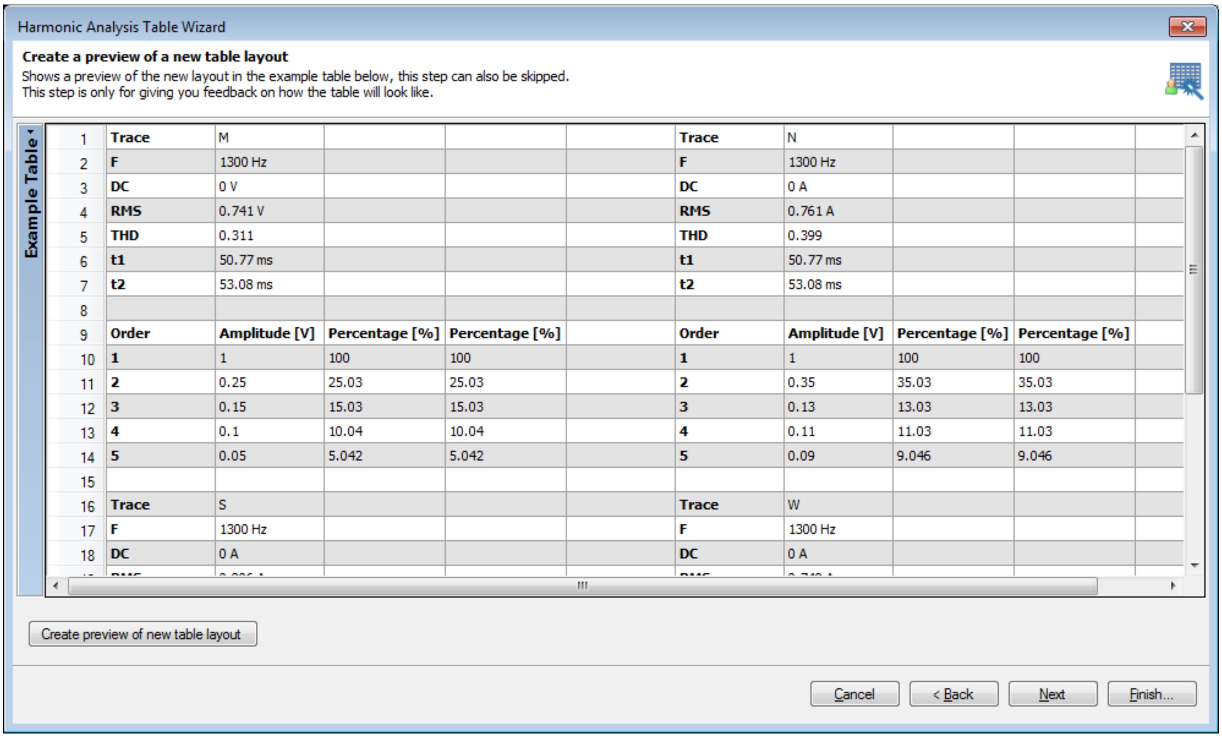
The next wizard page you can select the columns definition. Per calculated order there will be a row added into the user table. Via this page you define which fields should be shown per order results line.



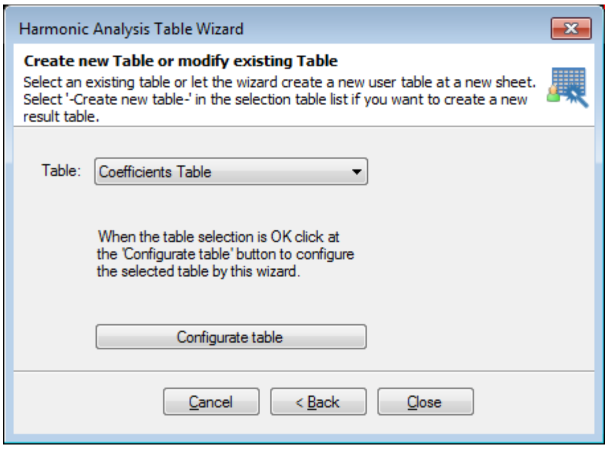
The next wizard page is used to define how the trace blocks should be layouted in the targeted user table. In the example below we have chosen for two trace blocks horizontal and also two blocks vertical.



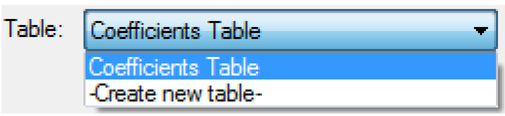
The next wizard page is used to see how the table will look like with the so far selected settings. This step is only for convenience and can also be skipped. If the layout is not what you expected you can go back and change the selections.



When you are pleased with the layout you can select an existing or create a new table and configure this table with your new configuration.



The table selection entry shows all existing user sheets plus a **-Create new table-** selection. When you select this then a new user sheet will be created and a new user table will be added to this new user sheet.



If you have done the correct table selection press the **Configurate table** button to actualy configure the selected table.

Remark: If you configure an existing table the old content will be deleted completely and will be overridden by new data.

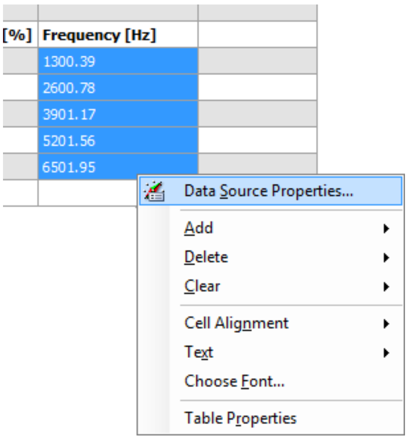
If the Wizard does not excactly produce the content as what you want; you can always manualy change the user table.

For example if you do not like the formatting of the **Frequency** column in the table below.

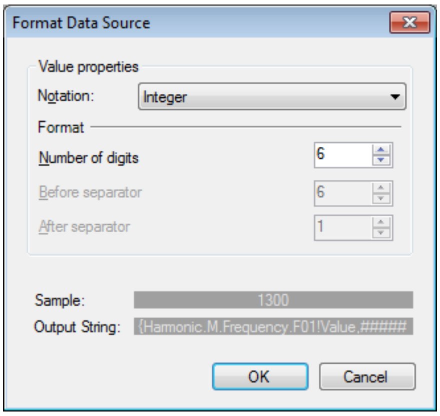
Harmonic Results Table

1	Trace	M		
2	F	1300 Hz		
3	DC	0 V		
4	RMS	0.741 V		
5	THD	0.311		
6	t1	50.77 ms		
7	t2	53.08 ms		
8				
9	Order	Amplitude [V]	Percentage [%]	Frequency [Hz]
10	1	1	100	1300.39
11	2	0.25	25.03	2600.78
12	3	0.15	15.03	3901.17
13	4	0.1	10.04	5201.56
14	5	0.05	5.042	6501.95

Select all the frequency cells you want to reformat:



Select the 1st menu option called **Data Source Properties…**, this will show the **Format Data Source** dialog. Now you can select the formatting of your choice.



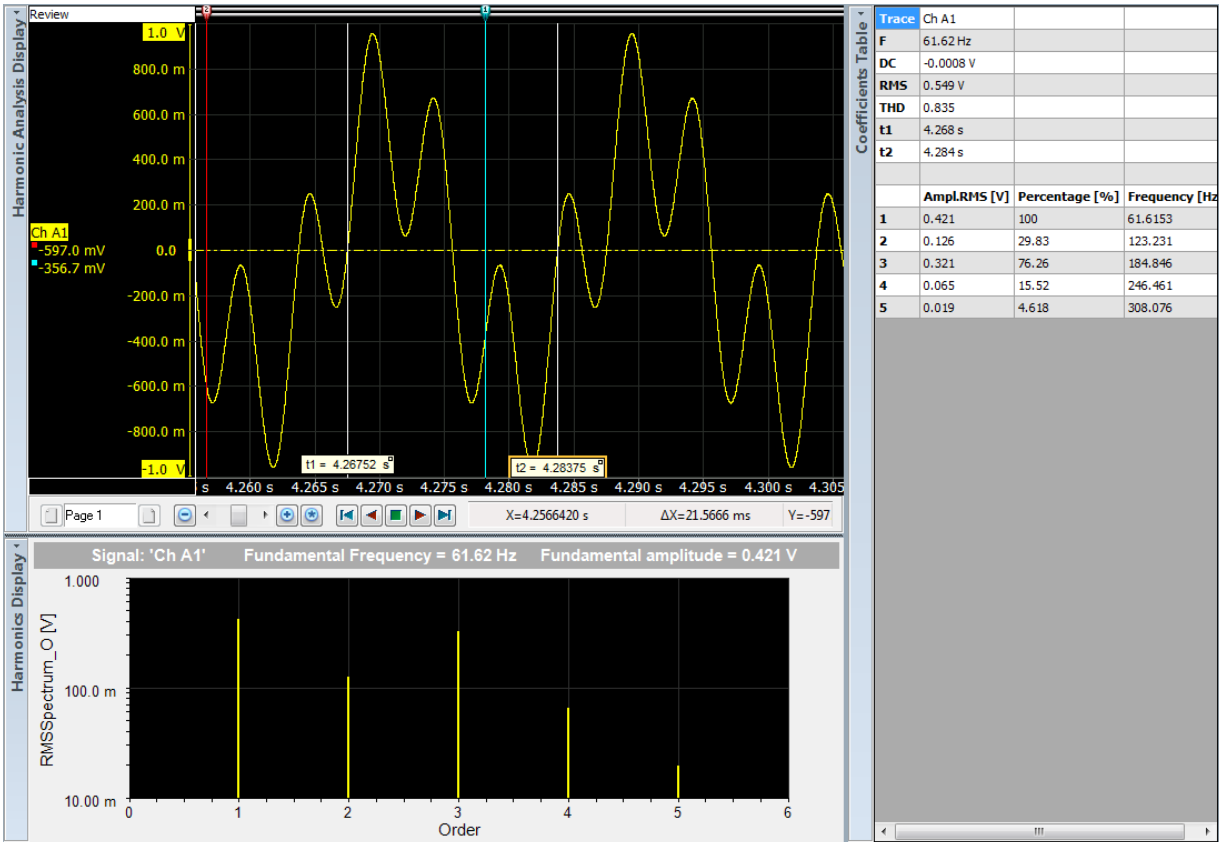
This will result in the following Frequency column:

Frequency [Hz]
1300
2601
3901
5202
6502

4.12 Example on how to use the @CycleDetect() function

For better results we recommend to use the standard function called **@CycleDetect()**; The calculations might be faster and more accurate. Information on how the **@CycleDetect()** function works can be found in the Perception documentation. This chapter only shows you how this function can help you to get better results in doing the harmonic analysis calculations.
It is very important to find the correct cycles when doing the harmonic analysis calculations, the **@CycleDetect()** function is specially built for finding the correct cycles. It contains special argorithms to make it perform better for noisy signals. One of the input parameters of this function is the **Hysteresis** input parameter. The example below shows you what this can bring to you.

We have created a signal which is the addition of a 50Hz and a 200Hz sine signals, the amplitude of the 50Hz is 555mV and the 200Hz is 444mV.
If we do the harmonic analysis without using a cycle detect signal we see the following results:

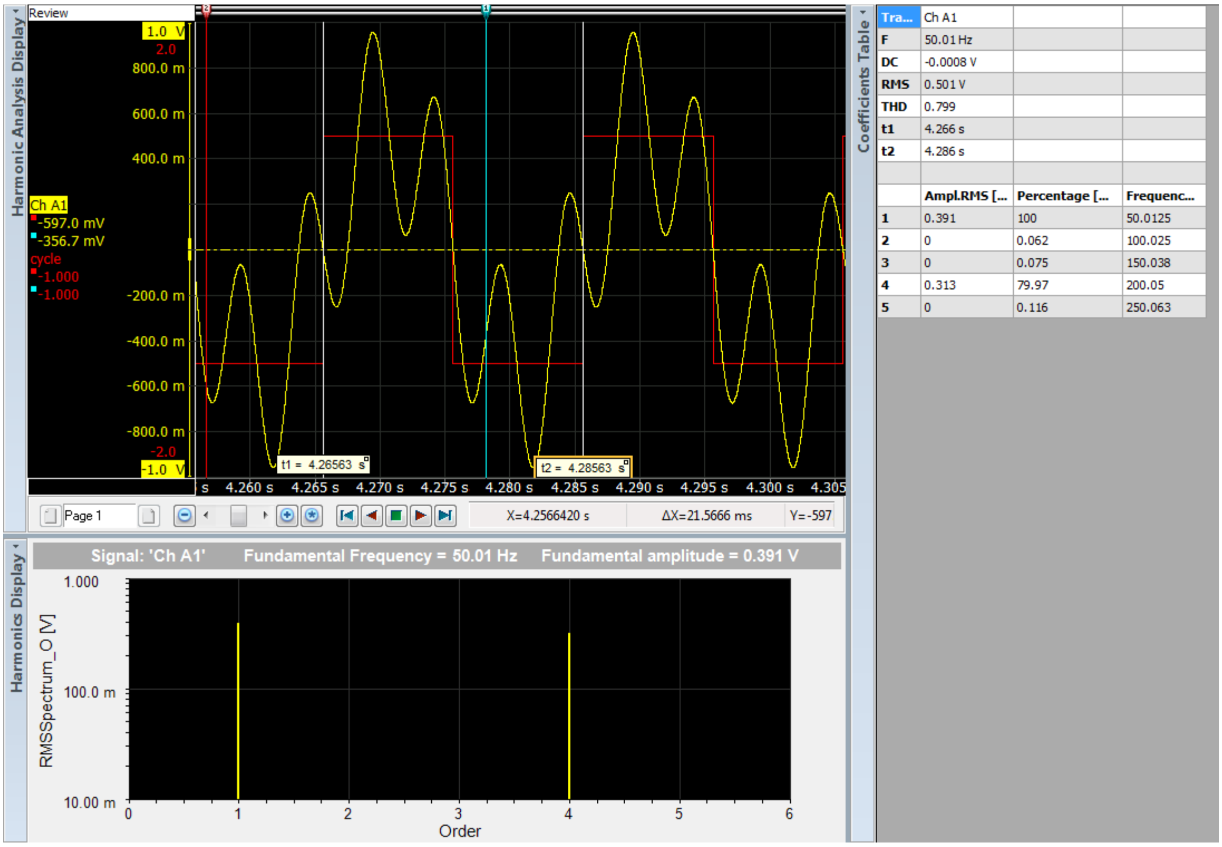


The frequency of 61Hz is not correct, you can see from the picture that t1 and t2 are the found zero crossings which were used.

If we now however use the **@CycleDetect()** function as shown below, we get better results.

Num	Name	Formula	Units
1	cycle	@CycleDetect(Active.Group1.Recorder_A.Ch_A1; 0; 300m)	

The detection Level is set to 0V and the Hysteresis is set to 300mV.
The cycle signal is the red signal below. You can see that the calculated results are now correct because t1 and t2 are better.



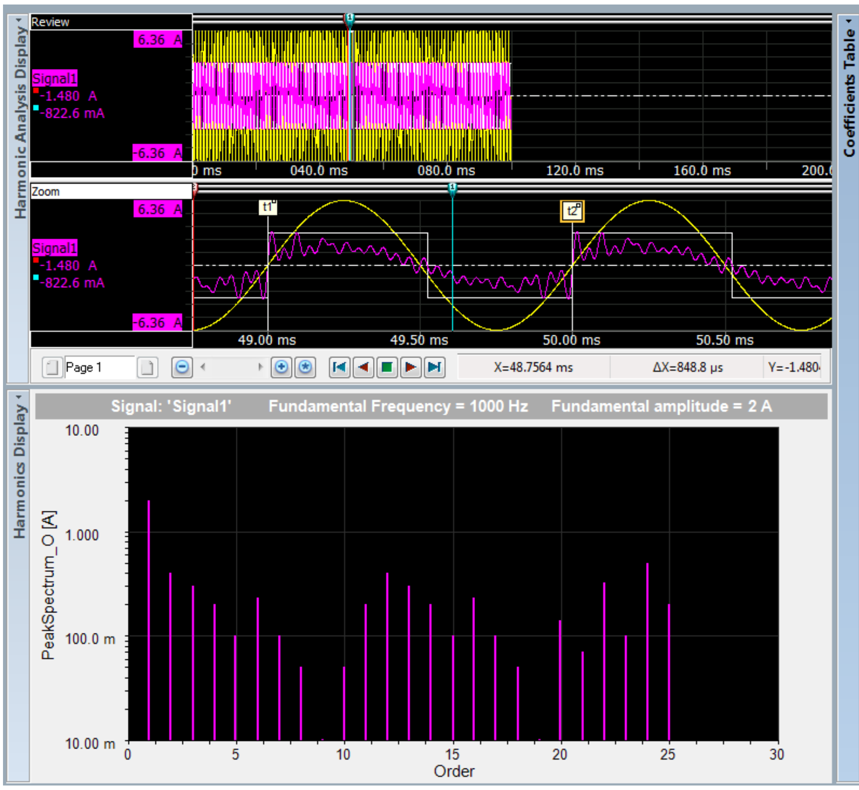
The CycleDetect signal has also a parameter called **SuppressTime**, you can use this when you already know the main frequency to be expected, you then calculate the minimum required duration of half a cycle and use this value as the SuppresTime.

4.13 Example using the formula sheet for creating test signals

To understand the working of the harmonic analysis calculations it might be helpful to generate some test signals using the formula sheet. The function **@SineWave()** can be used for this. The picture below shows an example of a simulated periodic signal by adding various sine waves with different frequencies and different amplitudes.

Num	Name	Formula	Units
1	S1	2*@SineWave(1M;100k;1k)	A
2	S2	0.4*@SineWave(1M;100k;2k)	A
3	S3	0.3*@SineWave(1M;100k;3k)	A
4	S4	0.2*@SineWave(1M;100k;4k)	A
5	S5	0.1*@SineWave(1M;100k;5k)	A
6	S6	0.23*@SineWave(1M;100k;6k)	A
7	S7	0.1*@SineWave(1M;100k;7k)	A
8	S8	0.05*@SineWave(1M;100k;8k)	A
9	S9	0.01*@SineWave(1M;100k;9k)	A
10	S10	0.05*@SineWave(1M;100k;10k)	A
11	S11	0.2*@SineWave(1M;100k;11k)	A
12	S12	0.4*@SineWave(1M;100k;12k)	A
13	S13	0.3*@SineWave(1M;100k;13k)	A
14	S14	0.2*@SineWave(1M;100k;14k)	A
15	S15	0.1*@SineWave(1M;100k;15k)	A
16	S16	0.23*@SineWave(1M;100k;16k)	A
17	S17	0.1*@SineWave(1M;100k;17k)	A
18	S18	0.05*@SineWave(1M;100k;18k)	A
19	S19	0.01*@SineWave(1M;100k;19k)	A
20	S20	0.14*@SineWave(1M; 100k; 20k)	A
21	S21	0.07*@SineWave(1M; 100k; 21k)	A
22	S22	0.32*@SineWave(1M; 100k; 22k)	A
23	S23	0.1*@SineWave(1M; 100k; 23k)	A
24	S24	0.5*@SineWave(1M; 100k; 24k)	A
25	S25	0.2*@SineWave(1M; 100k; 25k)	A
26			
27			
28	Signal1	S1 + S2 + S3 + S4 +S5 + S6 + S7+S8 + S9 + S10+S11 + S12 + S13 + S14 +S15 + S16 + S17+S18 + S19 + S20+S21 + S22 + S23 + S24 +S25	A
29			
30	Cycle	@CycleDetect(Signal1; 0; 0.5; 0.25/1k)	

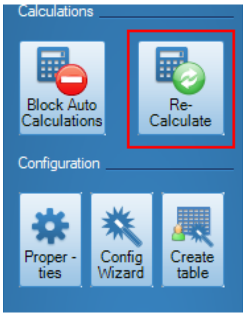
You now can use the signal **Formula.Signal1** in the Harmonic Analysis sheet, for the cycle detection the formula **Formuls.Cycle** is used. The results are shown below. You now can check if the calculated amplitudes are simular to the amplitudes as entered in the formulas.



Trace	Signal1		
F	1000		
DC	-0.0004 A		
RMS	1.611 A		
THD	0.545		
t1	49.00 ms		
t2	50.00 ms		
	Amplitude [A]	Percentage [%]	Frequency [Hz]
1	2	100	1000
2	0.4	20	2000
3	0.3	15	3000
4	0.2	10	4000
5	0.1	5.001	5000
6	0.23	11.5	6000
7	0.1	5.002	7000
8	0.05	2.502	8000
9	0.01	0.504	9000
10	0.05	2.503	10000
11	0.2	10	11000
12	0.4	20	12000
13	0.3	15	13000
14	0.2	10	14000
15	0.1	5.004	15000
16	0.23	11.5	16000
17	0.1	5.004	17000
18	0.05	2.505	18000
19	0.01	0.506	19000
20	0.14	7.005	20000
21	0.07	3.505	21000
22	0.32	16.01	22000
23	0.1	5.006	23000
24	0.5	25.01	24000
25	0.2	10.01	25000

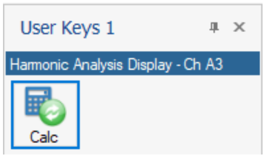
5 Harmonic Analysis User key and automation

A recalculate of the harmonic analysis sheet can be requested via a user key action. This action is doing exactly the same as the Re-Calculate button in the harmonic analysis sheet:

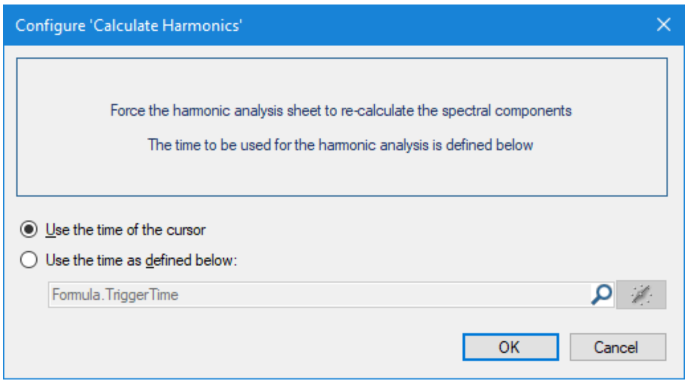


The user key is called **Calculate Harmonics** and can be found in the **Harmonic Analysis** category. The main purpose of the user key action is to use it via the Perception automation. This gives the possibility to calculate the harmonics for each sweep during a recording. For motor analysis (eDrive) this is often done for a so-called set-point, in a set-point the speed and torque are set to wanted values and the voltages and currents are then measured. The automation can then use the **Calculate Harmonics** user key action to force to calculate the spectral components and use the Perception logging functionality to log the calculated values. This will be done automatically during a recoding.

User key example:



The Calculate Harmonics action can be configured using the following dialog:



You can either use the time of cursor 1 in the Harmonic Analysis display or a pre-defined time position. This time position can be a fixed time or you can use a dynamic data source. As an example you can use your own formula to define the time to be used. For example **Formula.TriggerTime** where:

Num	Name	Formula
1	TriggerTime	@TriggerTime(Active.Group1.Recorder_A.Ch_A1; Display.Display.ActiveSweep.Index)

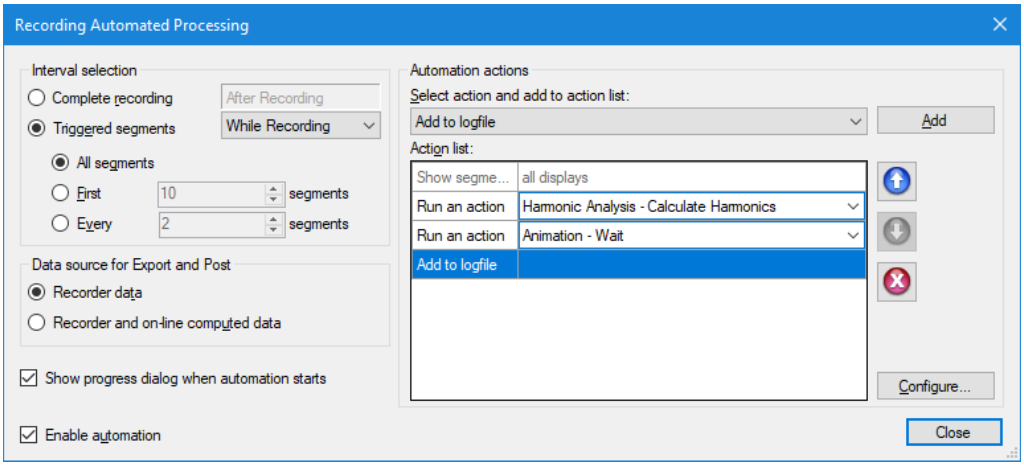
In this example the active sweep of the display with name "Display" is used.

In the following text it will be explained how to use this user-key action from within the Perception automation. The automation will force the harmonic analysis calculations for each sweep and logs the harmonic analysis results into an xml file which can be viewed in Microsoft Excel.

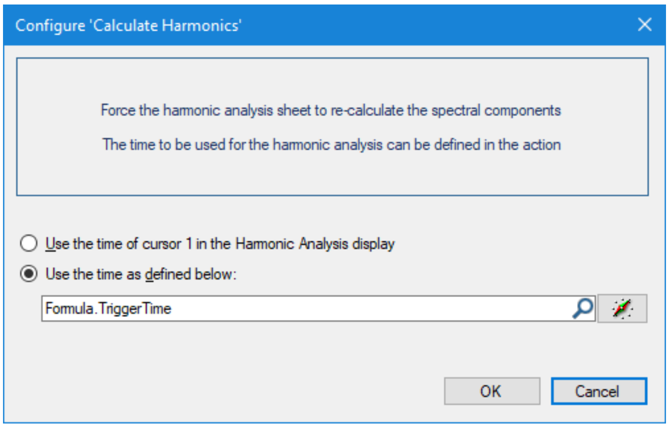
Make sure you have a setup for a multi sweep recording with some pre-trigger set.

Open the Recording Automated Processing dialog and add the three actions to the action list:

1. Run an Action: *Harmonic Analysis* – **Calculate Harmonics**
2. Run an Action: *Animation* - **Wait**
3. **Add to logfile**

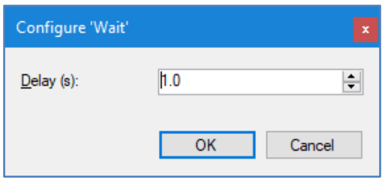


1. Set the following configuration to the **Calculate Harmonics** action:

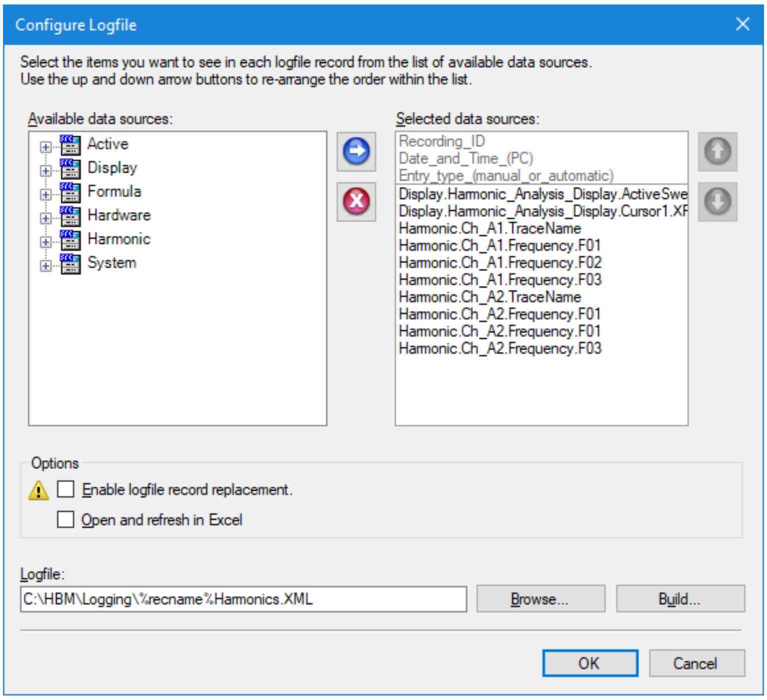


See above for the definition of **Formula.TriggerTime**

2. A **Wait** action has been added because it takes some time for doing the Harmonic calculations. How long depends on several things the most important are the performance of the used PC, the number of channels used, the number of harmonics to be calculated and the used sample rate. You should experiment how much time this cost and according to this set the correct delay time.



3. An example of a logfile configuration can look like:



But it is up to you what you want to log.

An example of a created log file:

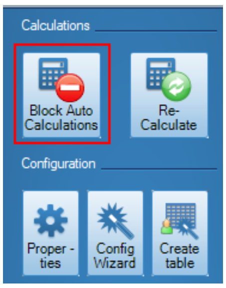
```
<LogFile>
  <Log />
  <Log>
    <Recording_ID>Recording004</Recording_ID>
    <Date_and_Time>2020-06-02T13:34:25</Date_and_Time>
    <Entry_type>Automatic</Entry_type>
    <Display.Harmonic_Analysis_Display.ActiveSweep.Index>1
    </Display.Harmonic_Analysis_Display.ActiveSweep.Index>
    <Display.Harmonic_Analysis_Display.Cursor1.XPosition>7.2306516817610067
    </Display.Harmonic_Analysis_Display.Cursor1.XPosition>
    <Display.Harmonic_Analysis_Display.Cursor1.XPosition_Units>s
    </Display.Harmonic_Analysis_Display.Cursor1.XPosition_Units>
    <Harmonic.Ch_A1.TraceName>Ch A1</Harmonic.Ch_A1.TraceName>
    <Harmonic.Ch_A1.Frequency.F01>99.992887442762125</Harmonic.Ch_A1.Frequency.F01>
    <Harmonic.Ch_A1.Frequency.F01_Units>Hz</Harmonic.Ch_A1.Frequency.F01_Units>
    <Harmonic.Ch_A1.Frequency.F02>199.98577488552425</Harmonic.Ch_A1.Frequency.F02>
    <Harmonic.Ch_A1.Frequency.F02_Units>Hz</Harmonic.Ch_A1.Frequency.F02_Units>
    <Harmonic.Ch_A1.Frequency.F03>299.97866232828636</Harmonic.Ch_A1.Frequency.F03>
    <Harmonic.Ch_A1.Frequency.F03_Units>Hz</Harmonic.Ch_A1.Frequency.F03_Units>
    <Harmonic.Ch_A2.TraceName>Ch A2</Harmonic.Ch_A2.TraceName>
    <Harmonic.Ch_A2.Frequency.F01>239.68502315177622</Harmonic.Ch_A2.Frequency.F01>
    <Harmonic.Ch_A2.Frequency.F01_Units>Hz</Harmonic.Ch_A2.Frequency.F01_Units>
    <Harmonic.Ch_A2.Frequency.F03>719.05506945532863</Harmonic.Ch_A2.Frequency.F03>
    <Harmonic.Ch_A2.Frequency.F03_Units>Hz</Harmonic.Ch_A2.Frequency.F03_Units>
  </Log>
  <Log>
    <Recording_ID>Recording004</Recording_ID>
    <Date_and_Time>2020-06-02T13:34:33</Date_and_Time>
    <Entry_type>Automatic</Entry_type>
    <Display.Harmonic_Analysis_Display.ActiveSweep.Index>2
    </Display.Harmonic_Analysis_Display.ActiveSweep.Index>
    <Display.Harmonic_Analysis_Display.Cursor1.XPosition>15.304100731761006
    </Display.Harmonic_Analysis_Display.Cursor1.XPosition>
    <Display.Harmonic_Analysis_Display.Cursor1.XPosition_Units>s
    </Display.Harmonic_Analysis_Display.Cursor1.XPosition_Units>
    <Harmonic.Ch_A1.TraceName>Ch A1</Harmonic.Ch_A1.TraceName>
    <Harmonic.Ch_A1.Frequency.F01>99.993366115115137</Harmonic.Ch_A1.Frequency.F01>
    <Harmonic.Ch_A1.Frequency.F01_Units>Hz</Harmonic.Ch_A1.Frequency.F01_Units>
    <Harmonic.Ch_A1.Frequency.F02>199.98673223023027</Harmonic.Ch_A1.Frequency.F02>
    <Harmonic.Ch_A1.Frequency.F02_Units>Hz</Harmonic.Ch_A1.Frequency.F02_Units>
    <Harmonic.Ch_A1.Frequency.F03>299.98009834534543</Harmonic.Ch_A1.Frequency.F03>
    <Harmonic.Ch_A1.Frequency.F03_Units>Hz</Harmonic.Ch_A1.Frequency.F03_Units>
    <Harmonic.Ch_A2.TraceName>Ch A2</Harmonic.Ch_A2.TraceName>
    <Harmonic.Ch_A2.Frequency.F01>242.51572625891265</Harmonic.Ch_A2.Frequency.F01>
    <Harmonic.Ch_A2.Frequency.F01_Units>Hz</Harmonic.Ch_A2.Frequency.F01_Units>
    <Harmonic.Ch_A2.Frequency.F03>727.547178776738</Harmonic.Ch_A2.Frequency.F03>
    <Harmonic.Ch_A2.Frequency.F03_Units>Hz</Harmonic.Ch_A2.Frequency.F03_Units>
  </Log>
  <Log>
    <Recording_ID>Recording004</Recording_ID>
    <Date_and_Time>2020-06-02T13:34:42</Date_and_Time>
    <Entry_type>Automatic</Entry_type>
    <Display.Harmonic_Analysis_Display.ActiveSweep.Index>3
```


Or if you open this XML file in Excel:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Recording_ID	Date_and_Time	Entry_type	D	Display.Harn		Harn	Harmonic.Cl	H	Harmoni	H	Harmonic.C	I	Harm	Harmonic.C	H	Harmonic.Ch_	Harr
2	Recording004	02-06-20 13:34	Automatic	1	7.230651682	s	Ch A1	99.99288744	Hz	199.985775	Hz	299.9786623	Hz	Ch A2	239.6850232	Hz	719.0550695	Hz
3	Recording004	02-06-20 13:34	Automatic	2	15.30410073	s	Ch A1	99.99336612	Hz	199.986732	Hz	299.9800983	Hz	Ch A2	242.5157263	Hz	727.5471788	Hz
4	Recording004	02-06-20 13:34	Automatic	3	24.31627588	s	Ch A1	99.97393347	Hz	199.947867	Hz	299.9218004	Hz	Ch A2	219.8617032	Hz	659.5851095	Hz
5	Recording004	02-06-20 13:34	Automatic	4	31.54941218	s	Ch A1	99.97255655	Hz	199.945113	Hz	299.9176697	Hz	Ch A2	1191.872491	Hz	3575.617472	Hz

Now everything has been configured and you can test the configuration. To test this it is recommended to use manual triggering, this way you can better see what is happening.

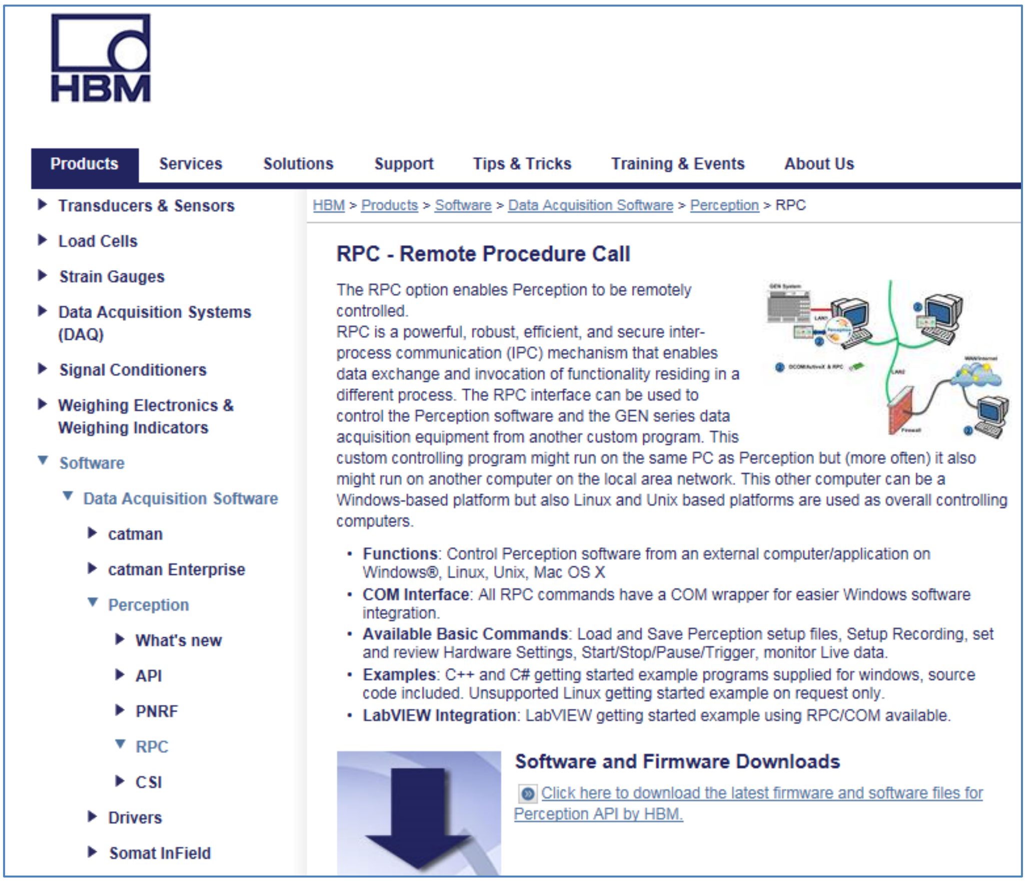
It is also recommended to block the auto calculations of the harmonic analysis sheet to prevent possible unwanted recalculations.



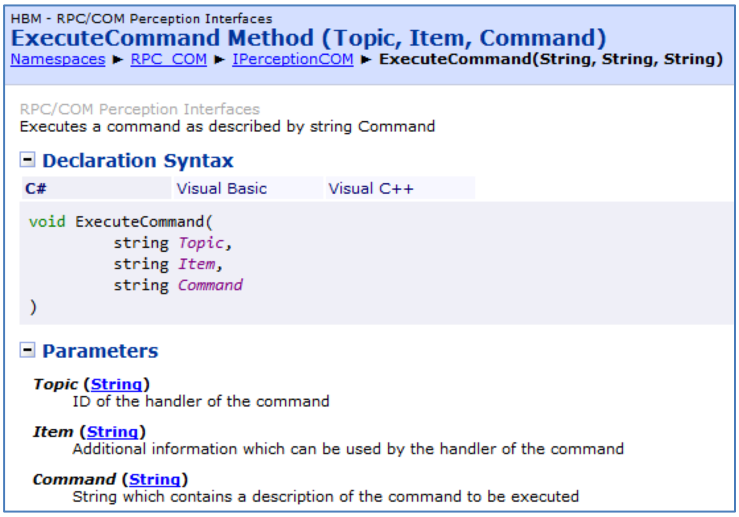
6 Harmonic Analysis RPC calls

This section describes the Harmonic Analysis RPC calls. These calls are only interesting for when you want to initiate the Harmonic Analysis calculations from within your own software program; for example from your own LabVIEW program. You can do the harmonic analysis calculations at a time specified by you; when the calculations are ready you can read the results into your own program.

For more information on RPC and Perception we will recommend to get the appropriate information from the HBM web site section Products – Software – Perception – RPC.



The RPC Harmonic Analysis Sheet implementation is using the general RPC function **ExecuteCommand**():



There are a number of Harmonic Analysis Sheet related RPC calls:

- RPC call to check if the calculations are still busy
- RPC call to force a recalculation
- RPC call to do a calculation at a specified time.
- RPC call to get all trace names used by the calculations
- RPC calls to get and set the number of harmonics to be calculated
- RPC calls to get set the number of cycles used per calculation

Note: You can only use RPC when the Remote API key item has been enabled! This item is a cost option and can be ordered at HBM.

You can check if the option has been enabled by looking in the Perception main menu: *Help – About Perception – More..* dialog.

Remote API: control Perception using the SOAP interface or using RPC calls.

6.1 RPC IsCalculating Call

This RPC call is used to check if the Harmonic Analysis sheet is still busy with calculating the various harmonics. It is recommended to check this “**IsCalculating**” flag before you start a new calculation or change some settings.
Below you see how you can create your own function to check if the calculations are still busy.

```
private bool IsCalculating()
{
    string strBusy;
    m_Perception.ExecuteRequest("HarmonicAnalysis", string.Empty,
                                "IsCalculating", out strBusy);
    int nBusy = 0;
    if (int.TryParse(strBusy, out nBusy))
    {
        if (nBusy != 0)
            return true;
    }
    return false;
}
```

In the above example you see that the **ExecuteRequest** function returns a string called strBusy. This string contains an integer value, where 0 means that *IsCalculating* is false and all other values mean that *IsCalculating* is true.

6.2 RPC Recalculate Call

The recalculate command acts the same as what happens when the Re-**Calculate** button is pressed. The Harmonic Analysis Sheet will do a recalculating using the current cursor 1 position.
The call looks like:

```
m_Perception.ExecuteCommand("HarmonicAnalysis", string.Empty, "DoReCalculate()");
```

Where:

```
private PerceptionCOM m_Perception = new PerceptionCOM();
```

Before you do this call, make sure that you are connected to Perception!

```
m_Perception.SetServerAddress("localhost");
m_Perception.ConnectToServer();
```

6.3 RPC Calculate at specified time Call

This call is used when you want to force a recalculation at specified time.
The call looks like:

```
m_Perception.ExecuteCommand("HarmonicAnalysis", string.Empty,
                            "DoCalculateAtTime(0.02)");
```

The specified time in this example is 0.02 = 200ms.

Attention: Use the correct decimal symbol! If you are not sure which decimal symbol you should use then check the Windows **Region and Language** settings.

6.4 RPC call to get all trace names as used by the calculations

Via this call you get a list of all trace names used by the harmonic analysis calculations.

```
string strTraceNames = String.Empty;
m_Perception.ExecuteRequest("HarmonicAnalysis", string.Empty, "GetTraceNames", out
strTraceNames);
```

strTraceNames contains a semicolumn separated list of trace names.

6.5 RPC call to get the number of calculated harmonics

You can use this call to get the number of calculated harmonics.

```
string strHarmonics;
m_Perception.ExecuteRequest("HarmonicAnalysis", string.Empty,
                            "GetNumberOfHarmonics", out strHarmonics);
```

strHarmonics is a string containing the number of harmonics.

6.6 RPC call to set the number of harmonics to be calculated

You can use this call to set the number harmonics to be calculated.
The example below sets the number of harmonics to 10.

```
m_Perception.ExecuteCommand("HarmonicAnalysis", string.Empty,
                            "SetNumberOfHarmonics(10)");
```

6.7 RPC call to get the number of cycles used by the harmonic analysis calculations

You can use this call to get the number of cycles used by the harmonic analysis

```
string strNumberOfUsedCycles;
m_Perception.ExecuteRequest("HarmonicAnalysis", string.Empty,
                            "GetNumberOfUsedCycles", out strNumberOfUsedCycles);
```

strNumberOfUsedCycles is a string containing the number of used cycles per calculation.

6.8 RPC call to set the number of cycles used by the harmonic analysis calculations

You can use this call to set the number of cycles used per calculation.
The example below sets the number of harmonics to 2.

```
m_Perception.ExecuteCommand("HarmonicAnalysis", string.Empty,
```

```
"GetNumberOfUsedCycles(2)");
```

6.9 Getting the Harmonic analysis calculated results

As you can read above all calculated results are available as data sources; see chapter "**Harmonic Analysis Data Sources**".
Via the RPC commands DSGetNumericalValue, DSGetUnits and DSGetStringValue you can read them from Perception.

HBM - RPC/COM Perception Interfaces

DSGetNumericalValue Method (DataSrcPath, Value, TimeOfUpdate)

Namespaces ► RPC_COM ► IPerceptionCOM ► **DSGetNumericalValue(String, Double, Double)**

RPC/COM Perception Interfaces
Get numerical value of the specified datasource

Declaration Syntax

C#	Visual Basic	Visual C++

```
void DSGetNumericalValue(
        string DataSrcPath,
        out double Value,
        out double TimeOfUpdate
)
```

Parameters

DataSrcPath **(String)**
Path/identifier of the data source

Value **(Double)**
Numerical value of the data source

TimeOfUpdate **(Double)**
Time since start recording that value was updated in case of hardware data sources

HBM - RPC/COM Perception Interfaces

DSGetStringValue Method (DataSrcPath, Result)

Namespaces ► RPC_COM ► IPerceptionCOM ► **DSGetStringValue(String, String)**

RPC/COM Perception Interfaces
Get the string value of the specified data source

Declaration Syntax

C#	Visual Basic	Visual C++

```
void DSGetStringValue(
        string DataSrcPath,
        out string Result
)
```

Parameters

DataSrcPath **(String)**
Path/identifier of the data source

Result **(String)**
String value of the data source

HBM - RPC/COM Perception Interfaces

DSGetUnits Method (DataSrcPath, XUnit, YUnit)

Namespaces ► RPC_COM ► IPerceptionCOM ► **DSGetUnits(String, String, String)**

RPC/COM Perception Interfaces
Get the horizontal and vertical units of the data source

Declaration Syntax

C#	Visual Basic	Visual C++

```
void DSGetUnits(
        string DataSrcPath,
        out string XUnit,
        out string YUnit
)
```

Parameters

DataSrcPath **(String)**
Path/identifier of the data source

XUnit **(String)**
The horizontal unit string

YUnit **(String)**
The vertical unit string

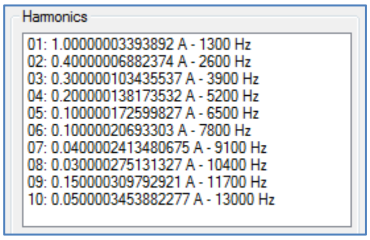
The code below shows how the peak values of the harmonics and corresponding frequencies can be read:

```
for (int i = 1; i <= nHarmonics; i++)
{
     strDSPathName = string.Format("Harmonic.Active.Value.Peak.AB{0:00}", i);
     m_Perception.DSGetNumericalValue(strDSPathName, out dHarmonicValue,
                                      out TimeOfUpdate);
     m_Perception.DSGetUnits(strDSPathName, out XUnit, out YUnit);

     strDSPathName = string.Format("Harmonic.Active.Frequency.F{0:00}", i);
     m_Perception.DSGetNumericalValue(strDSPathName, out dFrequency,
                                      out TimeOfUpdate);

     listBox1.Items.Add(string.Format("{0:00}: {1} {2} - {3} Hz",
                            i, dHarmonicValue, YUnit, (int)dFrequency));
}
```

The output of this code can look like:



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