

Using channel calculation

The **Calculation Project** allows you to perform not only statistical evaluations, but also channel-related operations, such as automated post-processing of analysis results. It is possible to define individual calculation rules for each channel (e.g., level adaptation or adaptation of the constant component) as well as cross-channel operations (e.g., first channel + second channel). Furthermore, new channels can be created via various mathematical functions (e.g., sin, log). This Application Note explains how to work with channel calculation¹ by means of some examples.

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Channel calculation with a Calculation Project

A new **Calculation Project** is opened via **START -> New -> Calculation Project**. This project has a similar structure as a Pool project, but has only three Pools (see figure 1).

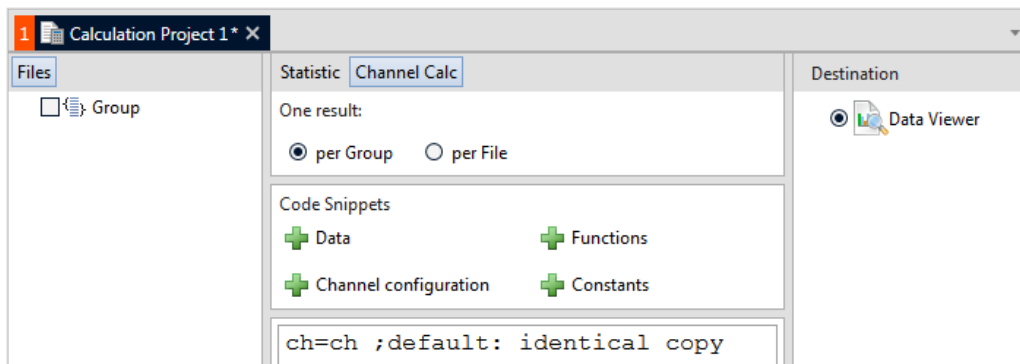


Figure 1: Calculation Project with channel calculation

In the Source Pool on the left, you can add input signals (time domain signals or saved analysis results) via the **Add files** command in the context menu of the **Group** item. Alternatively, you can drag and drop the desired files directly from the HEAD Navigator onto the item. The Function Pool in the middle contains two tabs: **Statistic** and **ChannelCalc**². The examples in this Application Note refer to the **ChannelCalc** tab. In the Destination Pool on the right, you specify the format in which the new data are to be saved, or you enable the representation of the results in a **Data Viewer**. Various export formats are available, e.g., HDF, ATFX or UFF.

¹ The descriptions in this Application Note refer to version 8.2. The general procedures also apply to other versions. However, the scope of functionality and the user interface may differ.

² The **ChannelCalc** tab is only available if your software license includes the ArtemiS SUITE Calculation Module (ASM 27).

In the lower part of the Function Pool, you can enter the calculation rules in the form of a text script³. A newly created Calculation Project always contains the formula `ch=ch`, which simply copies all input channels to the output channels. The appended description `;default: identical copy` is a comment, the beginning of which is marked by the semicolon. To create or edit the script, you can either enter the desired commands directly in the text field, or you can insert predefined **Code Snippets** at the current cursor position by clicking on a corresponding  icon.

In the script editor field, output data are written to the left of the equal sign, whereas the calculation rules based on the input data are written on the right side. With the abbreviation `ch` or `ch[]`, all channels of a signal can be referenced. Using an index, e.g., `ch[1]`, allows a specific channel to be selected for the calculation.

If an output channel appears more than once on the left side, only the last assignment is valid. Iterations are not possible, as the formulae on the right side always refer to the original input signals.

Thus the following calculation script

```
ch[2]=ch[1]+ch[2]
ch[2]=ch[2]
```

only causes the second input channel to be copied to the second output channel. The summation of channels 1 and 2 in the first line is performed, too, but is then overwritten by the statement in the second line, because the formulae on the right side always refer to the (unaltered) original input data.

The calculation rules can contain basic arithmetic operations as well as more complex operations, such as sine or logarithm. A list of all supported operations can be found in the Help System of ArtemiS SUITE in the section "Channel Calculation".

Another thing you specify in the middle Pool is how the input files of a group are to be combined. The default setting in a newly created Calculation Project is **One result per Group**, which turns each group in the Source Pool into a single result with the number of channels of the respective input files. This requires all files within a group in the Source Pool to have the same channel structure. Different groups in the Source Pool can have different channel structures without causing an error message. If you select the option **One result per File**, the channels of each individual file are calculated with each other.

In order to combine data from several sound files, the prefix `d[]` must be used before the channel specification (e.g., `ch[2]=d[1].ch[2]` to refer to the second channel of the first data set).

Once you have entered the complete script, you can perform the calculation. You can also save the Calculation Project in the HCal format, so it can be re-used for future calculations.

Another possibility to open and use a Calculation Project is available in the Destination Pool of a Pool Project. After adding a Calculation Project to the Destination Pool of the Pool Project, you can use the Properties window of this element to specify whether the calculation results of the project are to be added to the Source Pool of a new or previously configured and saved Calculation Project.

When using an existing Calculation Project, a click on the abacus button in ArtemiS SUITE starts the calculations for the active elements of the Pool Project (e.g., filtering and analysis), after which the results are handed over to the Source Pool of the Calculation Project. Another click on the abacus button runs the specified script of the Calculation Project, and the final result is exported to a new file, for example.

The following examples demonstrate the wide range of possible applications.

³ The **ChannelCalc** tab provides access to the complete range of functions of the Statistic Pool element **Channel Calc** from ArtemiS Classic. Scripts created in ArtemiS Classic are fully compatible and can be transferred into ArtemiS SUITE via copy and paste.

Application example 1

Task: The levels of all channels of a time domain signal are to be reduced by 10 dB.

Configuration of the Calculation Project: Open a new Calculation Project, select the option **One result per File** and add the time domain signals whose levels you want to reduce to the Source Pool. Then edit the script in the Function Pool. The first line defines the constant `amplification_dB` and sets it to -10 (see figure 2).

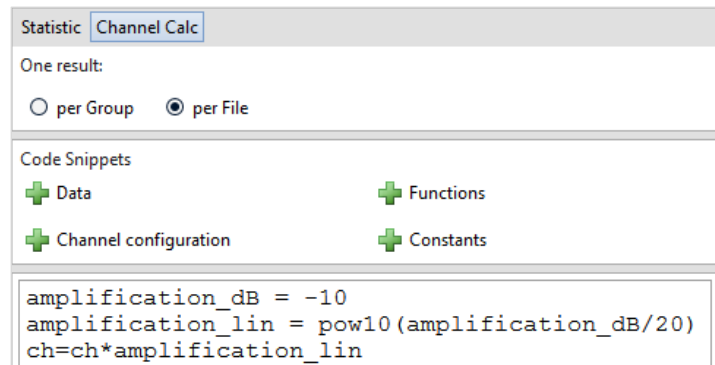


Figure 2: Script for application example 1

In the next line, this dB value is converted to a linear sound pressure level value: `amplification_lin=pow10(amplification_dB/20)`. This conversion is necessary because the subsequent calculation formula is applied to time domain signals saved as linear level values (in Pascal). The calculation formula `ch=ch*amplification_lin` multiplies all input channels with the linear constant. The multiplication with the linear value is equivalent to the subtraction of the level value in dB. To save the change permanently, an HDF export must be selected as the target in the Destination Pool. This configuration creates a new file with the new, reduced signal levels.

Application: With this little script, you can quickly and easily adapt the levels of multiple time domain signals. This is necessary, for example, if a calibration error was made prior to a recording.

Application example 2

Task: The results of a level analysis of all channels of a mark are to be referred to the first channel of the mark.

Configuration of the Calculation Project: With the statement $ch=ch/ch[1]$, all active channels of a mark are divided by the first channel. This calculation can be applied to the results of a level analysis in a Pool Project if, besides the input signal and the level analysis, a Calculation Project is active in the Destination Pool. Upon a click on the abacus button, ArtemiS SUITE first calculates the level analysis and then hands over the analysis results to the Source Pool of the Calculation Project. In the document, you must enter the statement $ch=ch/ch[1]$ and select the setting **One result per File** (see figure 3). Another click on the abacus button applies the script to the analysis results.

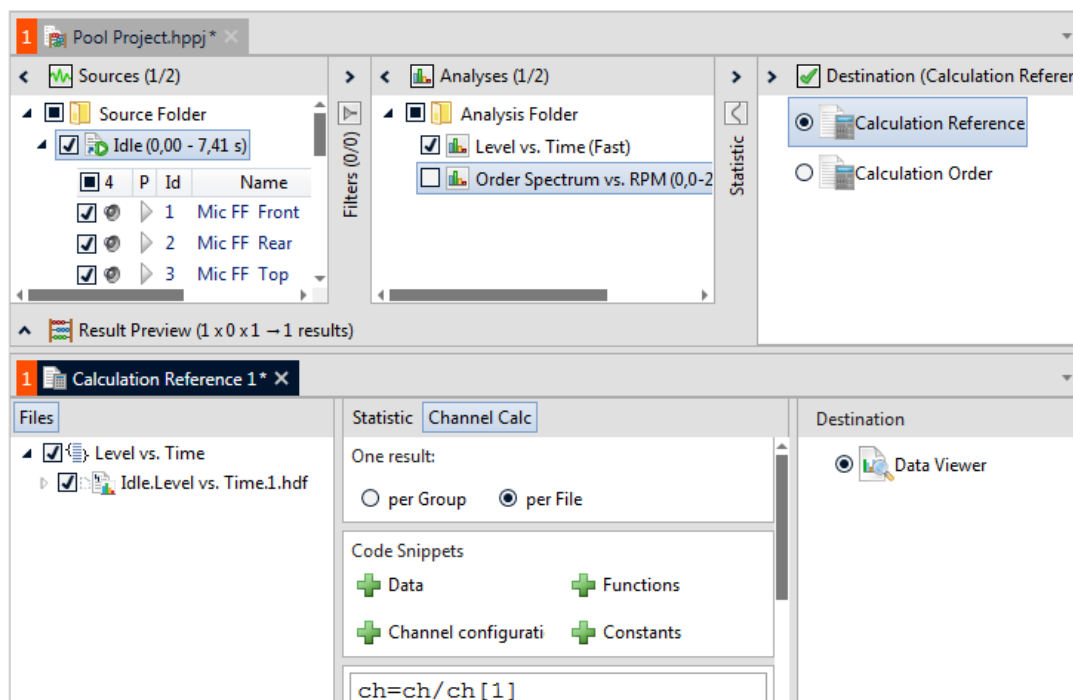


Figure 3: Project and script for application example 2

All files contain linear quantities with the corresponding measurement units. The calculation always refers to these linear quantities and their units. This is the case even if the analysis results are displayed in dB in the result window. In this example, where the **Level vs. Time** analysis is used, the calculation rules therefore do not refer to the level values in dB, but to the sound pressure values in Pascal.

Furthermore, the division not only affects the numeric values, but also their measurement units. Therefore, the result of the example script presented here is dimensionless, i.e., it does not have a unit. In the result window, this dimensionless quantity is displayed in dB. Since the quotient of the Pascal values is equivalent to the difference in dB, the Calculation Project shown in figure 3 delivers the difference between channel n and channel 1 in dB.

Tip: If you want to repeat the calculation in the future, you can save the Calculation Project with the formula described above. Then open the Properties window of the calculation element in the Destination Pool and change the configuration so that instead of creating a new Calculation Project, the saved document with the desired script is opened. A click on the abacus button then causes the analysis results to be added directly to the Source Pool of the saved Calculation Project. That way, all you need to do is click the abacus button a second time to complete the calculation.

Application example 3

Task: The percentage of the sixth and eighth engine order in relation to the total level is to be determined using a Calculation Project.

Configuration of the Calculation Project: First the levels of the sixth and eighth order as well as the total level need to be determined. To do so, use the **Order Spectrum vs. RPM** analysis in a Pool Project. In the Properties window of the analysis enable the function **Cut** with the **Cut Values 0, 6 and 8** (see figure 4).

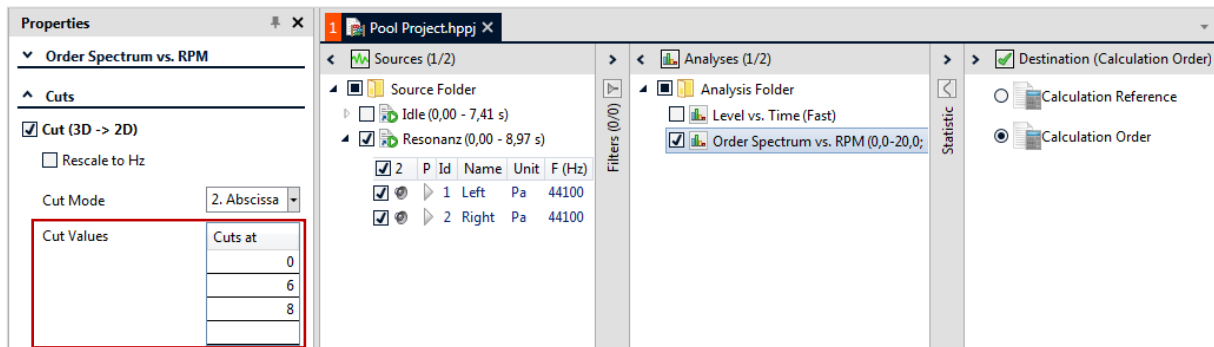


Figure 4: Pool project and Properties window of the **Order Spectrum vs. RPM** analysis for calculating the total level and the order levels

The value **0** determines the total level, whereas **6** and **8** calculate the levels of the sixth and the eighth order (**Important:** for the zeroth order cut to be calculated, it must be included in the **Spectral Range [order]** of the analysis settings).

In the Destination Pool of the Pool Project, a Calculation Project is specified as the target. Upon a click of the abacus button, the total level and the level curves of the sixth and the eighth order are added to the Source Pool of the Calculation Project.

Figure 5 shows the complete script for the channel calculation in the Calculation Project. The first section

$$ch = \sqrt{(\sqrt{d[2].ch} + \sqrt{d[3].ch})} * 100 / d[1].ch$$

calculates the percentage of the sixth and the eighth order in relation to the total level. By means of a multiplication of this term with the expression `Unit("%")` the unit % is added. Moreover, by using the command

```
ch="channel name; abbreviation of channel name; channel title"
```

a new channel name is specified. Adapted to this application example the precise command for the left channel is `ch[1]="Left;L;(6thOrder + 8thOrder)/Overall"`, which changes the channel name of the first channel to **Left**, the abbreviation is **L**, and the channel title is **(6thOrder+8thOrder)/Overall**.

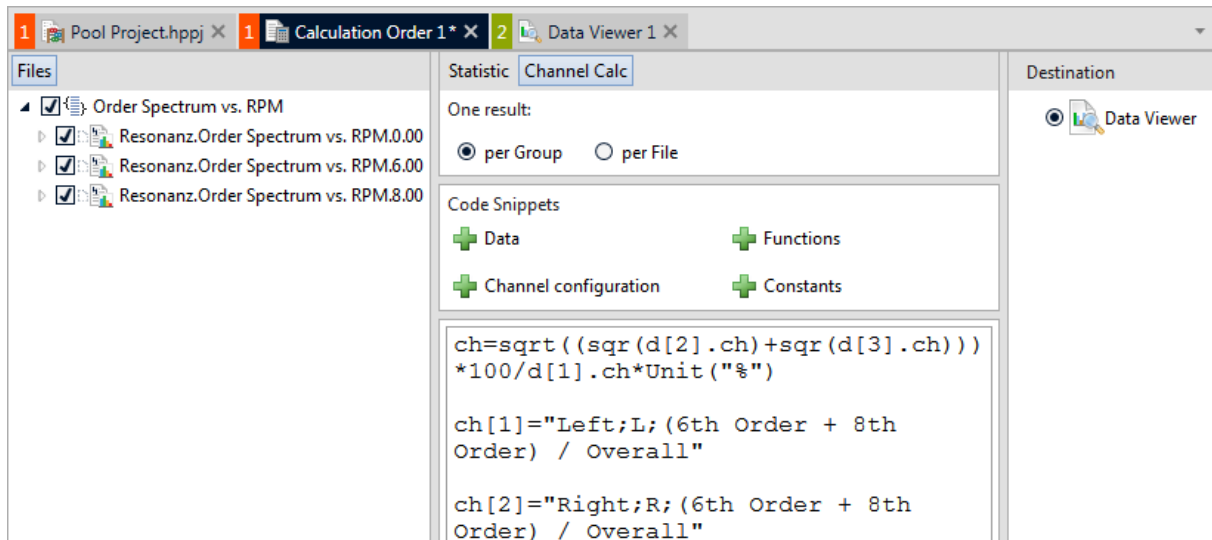


Figure 5: Script for application example 3

In order to combine the results of the three files, the setting **One result per Group** must be used.

Figure 6 shows an example calculated with the procedure described above.

The part of an engine coast-down examined here contains a resonance that is particularly prominent in the sixth and the eighth order. This is represented very well by the percentage of these orders in relation to the total level. When passing through the resonance, the percentage of the sixth and the eighth order increases to almost 80 % of the total level.

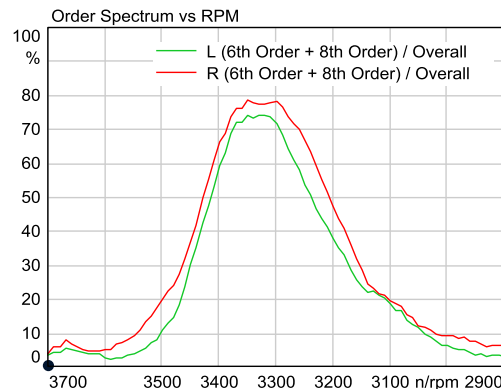


Figure 6: Percentage of the 6th and 8th order in relation to the total noise level

Important: In order for the result to be displayed correctly in % rather than **dB(100%)**, the axis in the Data Viewer must be switched from **dB** to **Lin** (right-click on the Y axis, see figure 7).

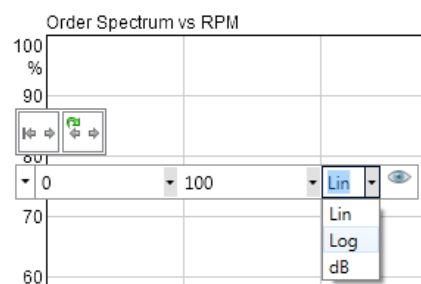


Figure 7: Switching the Y axis from **dB** to **Lin** scale

A summary of the script syntax and the available functions can be found in the Help System of ArtemiS SUITE under the keyword “Channel Calc”.

Notes

For the applications presented in this Application Note, you need the following ArtemiS SUITE modules: **ASM 00** ArtemiS SUITE Basic Framework (code 5000), **ASM 01** ArtemiS SUITE Basic Analysis Module (code 5001) and **ASM 27** Calculation Module (code 5027). Some export formats like UFF require **ASM 23** Advanced Import & Export Module (code 5023).

Do you have any questions or comments?
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We look forward to your feedback!