

Single value calculation in ArtemiS SUITE¹

In a number of application cases, it can be useful to consolidate your analysis results into a single value. For example, you might want to turn a time-dependent signal level curve into a meaningful, single level value. Such single value results then allow you to perform a ranking of different examined sound signals. Furthermore, version 7.0 or later of ArtemiS SUITE also allows you to check your single value results against certain limit values, providing a simple means of quality control for your signals.

Single value results can be displayed in a diagram, a table, or a report. A direct export to an Excel² spreadsheet is possible, too. This Application Note first introduces the various possibilities to calculate single value results, which are available in a Pool Project. The last section provides you with an overview of how you can use these functions in an Automation Project.

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Calculating single value results

Single value results from 1D analyses

ArtemiS SUITE offers you a number of dedicated single value analyses, also referred to as 1D analyses, the results of which are not curves, but only the averaged single value results for the entire time-domain signal. To add a single value analysis to the Analysis Pool of your Pool Project, select **Insert -> Single Values**. You can choose between 1D analyses for calculating the level, the loudness, the sharpness or the vibration dose of a signal.

The 1D analysis **Level** calculates the root mean square (RMS) value of the signal level. For airborne sound signals, this value is also referred to as the equivalent continuous sound level (L_{eq}). The result of this analysis equals the root mean square of the 2D analysis **Level vs. Time**, as long as the same frequency weighting for both analyses as well as a suitable time weighting for the 2D analysis were selected.

To determine the loudness single value with the 1D analysis **Loudness**, first the averaged third-octave spectrum of the input signal is determined. From this spectrum, the loudness is then calculated according to the specifications defined in the Properties window of the analysis. In some cases, the result of the 1D loudness analysis can differ significantly from the average value³ of the 2D analysis **Loudness vs. Time**, even if the same properties for both analyses were selected. For the 2D analysis,

¹ The descriptions in this Application Note refer to version 9.2. The general procedures also apply to other versions. However, the scope of functionality and the user interface may differ.

² Excel is a registered trademark of Microsoft Corporation.

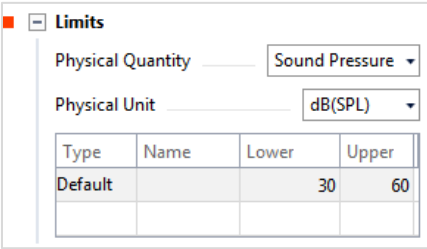
³ With the default setting of the **Loudness vs. Time** analysis, the N5 value is calculated rather than the mean value. Particularly for non-stationary signals, the N5 value is significantly higher than the mean value.

first the loudness curve against time is calculated, which is averaged subsequently. Due to the different time at which the averaging takes place, the results can be different particularly in case of non-stationary signals.

To determine the sharpness single value with the 1D analysis **Sharpness**, first the averaged third-octave spectrum of the input signal is determined, too. The sharpness value is then calculated from this spectrum according to the specifications defined in the Properties window of the analysis. In some cases, the result of the 1D sharpness analysis can differ significantly from the average value of the 2D analysis **Sharpness vs. Time**, even if the same properties for both analyses were selected. For the 2D analysis, first the sharpness curve against time is calculated, which is averaged subsequently. Due to the different time at which the averaging takes place, the results can be different particularly in case of non-stationary signals.

The **Vibration Dose Value** analysis calculates a single value that describes the influence of mechanical vibrations on the human body. The analysis requires at least one structure-borne sound channel in the input data, otherwise an error message will be displayed in the Event Viewer. More information about the properties of this analysis can be found in the Help System of ArtemiS SUITE.

In the **Limits** area of the Properties window of each 1D analysis, you can specify individual upper/lower limit values to be checked against after the analysis. First, click on the  icon. This opens the **Physical Quantity** selection field, where the quantity matching the analysis is preselected automatically. In the **Physical Unit** field, you can specify a measurement unit matching the physical quantity for your limit values, e.g., the unit **Pa** or **dB(SPL)** for the sound pressure level in the 1D analysis **Level** (see figure 1).



Type	Name	Lower	Upper
Default		30	60

Figure 1: Specifying limit values for the 1D analysis **Level**

In the table below these fields, you can enter the limits for the single value results. After double-clicking into the first line, you can edit the values for the **Lower** and **Upper** limits, whereby it is not required to specify both limits. You can also enter a custom name for your limits in the **Name** column. The results of 1D analyses can be displayed in table form (see sections “Output in a Single Values Table” and “Output to Excel format”) and in Single Values Diagrams (see section “Output in a Single Values Diagram”).

Single value results from 2D analyses

In 2D analyses, you can enable the calculation of single value results in the Properties window of the respective analysis, in the tab **Single Values** (see figure 2).

Figure 2: Configuration of single values calculation in the Properties of a 2D analysis

The following parameters can be configured in the Properties:

- **Only single values as Result:** If this option is enabled, only the single values selected in this section will be delivered as results. As with a 1D analysis, the analysis results can then only be output in table form or to Single Values Diagrams.
- **Abscissa Range:** Via these two entry fields, you can specify the range of abscissa values the calculation is to be based on. Data outside this range is not taken into account. However, this does only affect the statistical single values. Analysis-specific single values delivered through the activation of the **Default** option always base on the entire data set.

Default: With this option, you can calculate the single value that is defined as common for the particular analysis and that has also been output in ArtemiS Classic. If you hover the mouse pointer above the option, the tooltip shows which single value is actually being calculated. For some analyses, the default single value is the so-called analysis-specific single value. This value cannot be calculated by the following statistical algorithms. For the calculation of this single value, the entire data set is always used, i.e., limits defined in the **Abscissa Range** have no effect.

For some analyses (e.g., auto correlation), no default single value has been defined, hence the **Default** option is deactivated and grayed out then.

For other analyses, the default single value represents the actual result of the particular analysis (e.g., reverberation time or harmonic distortion). In these cases, the **Default** option is grayed out and cannot be deactivated.

- **Min:** determines the minimum value.
- **Max:** determines the maximum value.
- **Percentile:** Selecting this option opens a table, where you can enter the desired percentile values (between 1 and 99). The calculation of the percentile values is a statistical evaluation, which examines the value distribution of the analysis results. If you enter "10" in the table, ArtemiS SUITE will display the value that is exceeded by 10 % of the analysis results, etc. Example: in case of a time-dependent analysis, the 5 % percentile value is the value that is exceeded during 5 % of the total time period that is analyzed.
- **Advanced:** Clicking on the plus sign next to **Advanced** displays additional options, which allow you to expressly choose and further specify the calculation of the average and/or the sum (e.g., arithmetic mean or root mean square).

- Limits:** In this section, you can specify limit values (thresholds) for each of the single values you selected. After a click on the  icon the selection box **Physical Quantity** appears, in which the quantity matching the analysis is preselected automatically. In the selection box **Physical Unit**, you can define a unit matching the physical quantity for your limits. Afterwards, you can specify the desired limit values in the table displayed below these fields. Double-click on a row to edit the values. In each row, you can select one of the active single values as the **Type** and enter a custom description in the **Name** column. You can specify the allowed range of values for this single value by entering an **Upper** and a **Lower** limit, or only one of them if you do not need the other.

If you have selected multiple analyses for your Pool Project, you can configure their single value results jointly. However, you cannot define percentiles or limit values for multiple selections. These must be specified separately for each analysis.

Single value results from 3D analyses

You can also extract single value results from 3D analyses. This is done by cutting two-dimensional curves out of the 3D diagram, which are then summarized into a single value.

First, ensure that the **Cut (3D -> 2D)** option in the first tab of the Properties window of the 3D analysis is active and that the correct cut values are entered in the table. Once you have enabled the analysis cuts, you will see an additional tab in the Properties window titled **Single Values**. In this section, you can now configure the calculation of the single values from the 2D cuts, including limit values, as described in the previous section.

Figure 3 shows a part of the Properties window of the analysis **Order Spectrum vs. RPM** with the cut option enabled.

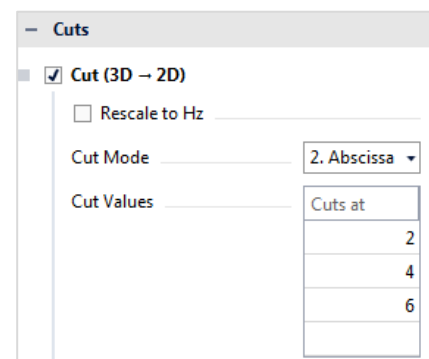


Figure 3: Properties of the analysis **Order Spectrum vs. RPM** with enabled cut option

Display of single value results

A Pool Project in ArtemiS SUITE offers several options how you can output and display your calculated single value results. According to the needs of your application case, you can display the single values, e.g., in the legend of a diagram in addition to the curve, you can output them as a table, or display them in a special Single Values Diagram. It is also possible to export them directly to an Excel spreadsheet.

Displaying single values in the legend or title of a diagram

After enabling the desired single value results in the Properties window of the analysis, you can display them in addition to the curve in a diagram of a Data Viewer, Mark Analyzer, or Report.

To do so, open the Properties window of the diagram and select the desired single value as a text block after a click on the **+** button (tab **Diagram Defaults** -> section **Show Title** or **Show Legend** -> selection box **Pattern**).

You can define this element prior to the calculation for a Mark Analyzer or a Data Viewer by defining the desired single value in the Properties window of the Destination Pool item. However, you can also configure the display after the calculation in the Properties window of the active diagram(s). Figure 4 shows an example of the Properties of a Data Viewer, for which the display of single value results has been specified in the legend.

For a newly inserted Data Viewer or Mark Analyzer item, the display of single value results in the legend is enabled by default.

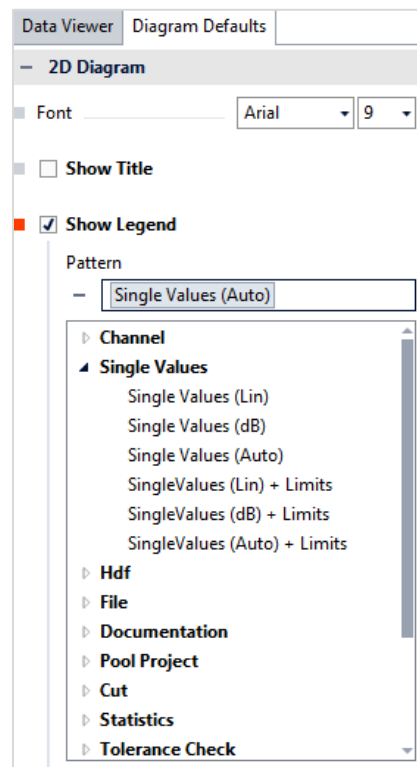


Figure 4: Adding single values to the legend in the Properties of a Data Viewer

Selecting **Single Values (Lin)** causes the single value results to be displayed as linear quantities, **Single Values (dB)** displays them as dB values, and selecting **Single Values (Auto)** causes only single value results of level quantities (e.g., **Level vs. Time**) to be displayed in dB, whereas other quantities, such as psychoacoustic or energy quantities, are displayed as linear values. Furthermore, you can configure the display of limit checks, e.g., **Single Values (Auto) + Limits**.

Figure 5 shows an example of a diagram with single values in the legend (sum level $L(A)$, maximum level $Max(A)$). After the maximum value, ArtemiS SUITE automatically displays the abscissa value where the maximum level is reached.

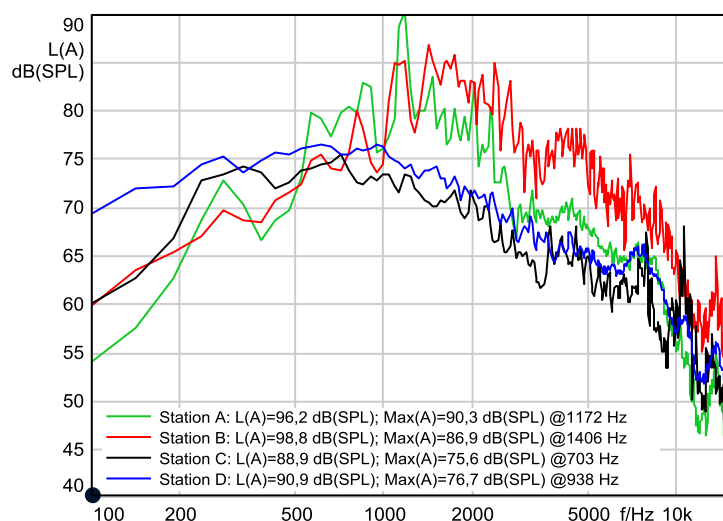


Figure 5: Diagram with single values in the legend

Output in a Single Values Table

The Destination Pool item **Single Values Table** allows you to output your single value results in tabular form. This is particularly useful for displaying the single value results of multiple signals and multiple analyses in a clearly arranged, comparable form. In the Properties window, you can specify which columns are to be displayed in which order. Via the  button, you can add columns, or you can remove them via the  button. Use the arrow buttons  and  to change the order.

You can specify the columns and their order prior to the calculation in the Properties window of the Destination Pool item, but also after the calculation in the Properties window of an already existing Single Values Table.

Since a calculated Single Values Table already contains values, its Properties contain more elements than those of the Destination Pool item (see figure 6). The additional elements represent the calculated single value results, e.g., **Default** and **Max**. For the display of some of these elements, you can select not only the options **visible** ☒ and **invisible** ☐, but also **short** ☒. In the short form, a reduced number of columns is displayed.

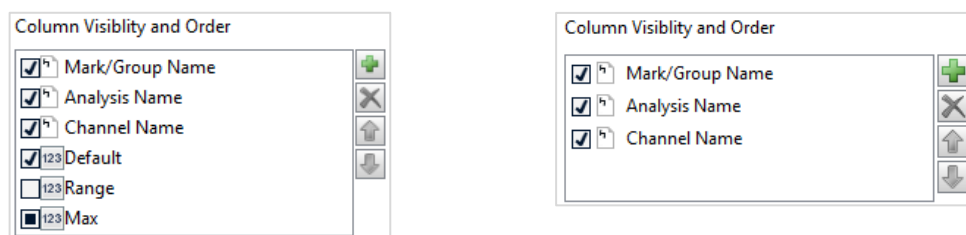


Figure 6: Properties of a calculated Single Values Table and of the Destination Pool item

You can change the sorting of a table by clicking on a column header. For example, clicking on **Analysis Name** sorts the values alphabetically by their analysis names. To sort a table by multiple criteria, click on another column header while keeping the CTRL key pressed.

Besides displaying a Single Values Table as a separate document in the user interface of ArtemiS SUITE, you can also include it in a report, e.g., in addition to the diagrams. After opening a report, click on the  button to insert a table at the desired position in your report. When the table is selected in the report, you can configure its appearance in the Properties window (**Content** tab -> section **Single Values Table**) in the same way as described above. In the Properties window you can also configure the data binding in the **Data Binding** tab, which specifies the analysis results of which the single values are to be displayed.

Display in a Single Values Diagram

If you select a report as your output destination, you can also have the single value results displayed as a bar graph diagram. After opening a report, click on the  icon to insert a diagram at the desired position in your report. After selecting the table in the report, you can select the data sources on the **Data Binding** tab in the Properties window. On the **Content** tab in the **Routing & Aggregation** section, you can specify the display options, e.g., the subdivision into categories. Information about the various options to route and aggregate your data can be found in the Help System of ArtemiS SUITE.

Figure 7 shows an example of a report with a 2D diagram and a Single Values Diagram (sum level $L(A)$, maximum level $Max(A)$).

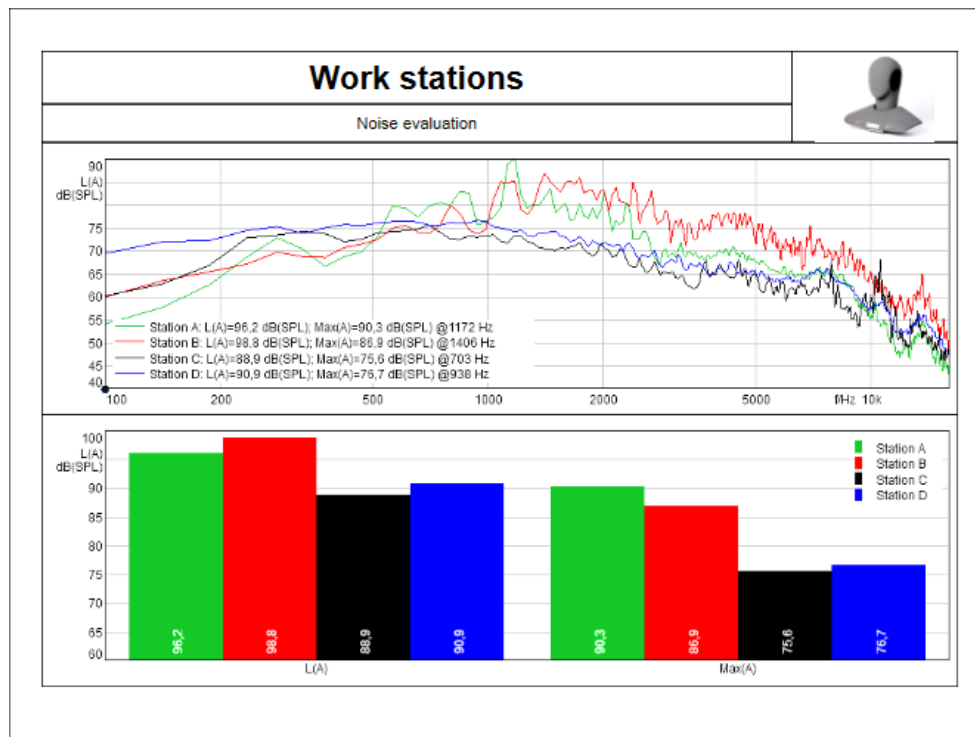


Figure 7: Report with a Single Values Diagram

Output to Excel format

In the Destination Pool of a Pool Project, you can select **Insert -> Other Files -> Excel Single Values** in order to export your single value results directly as an Excel spreadsheet⁴, e.g., for further processing in Excel.

The Properties of this item are similar to those of a Data Viewer. Unlike the Data Viewer, where the analysis results can be distributed across multiple diagrams, here you can distribute the single value across multiple spreadsheet pages, columns, and rows (see figure 8).

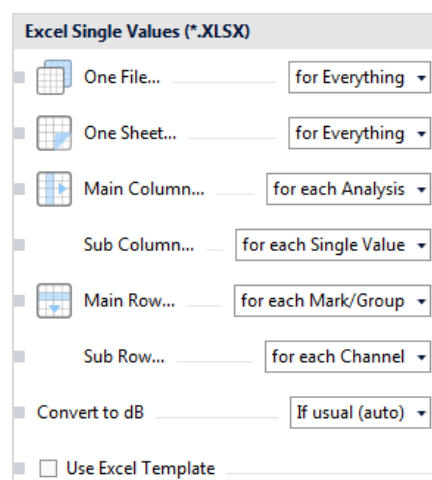


Figure 8: A section of the Properties of the **Excel Single Values** item

For example, if you have calculated single value results for multiple marks and several analyses at the same time, you can write all of them to a single file (**One File for Everything**). In this case, an individual

⁴ This function does not require Excel to be installed on your computer.

spreadsheet page (sheet) is created for each mark, on which the results of the individual analyses are distributed across several columns (**One Sheet for each Mark/Group** and **Main Column for each Analysis**).

With the **Convert to dB** option, you can specify whether the single values are displayed as dB values or linear quantities. Furthermore, you can use an existing Excel file as a template (**Use Excel Template**). A detailed description of the configuration options offered in the Properties can be found in the Help System of ArtemiS SUITE.

Single value calculation in an Automation Project or Standardized Test Project

Various single value result calculations and output formats are also available for analyses performed in an Automation Project.

Single value calculation as an element in processing sequences

Via **Insert Sequence -> Insert Process -> Single Values**, you can select the 1D analyses introduced at the beginning of this Application Note for your automated calculations. The calculation takes place as described in the first chapter. As in a Pool Project, the results of 1D analyses can be output in table form or in Single Values Diagrams.

To calculate single value results from 2D analyses, first insert the desired 2D analysis, e.g., **FFT (average)**, into your processing sequence. Directly after the analysis, insert the single value calculation via **Insert Process -> Single Values -> Single Values**. The Properties of this process are the same as described in the chapter “Single value results from 2D-analyses”, allowing you to configure the desired single value calculation and to specify limit values for these single value results. The results of the single value calculation from 2D analyses can be output in diagrams and in table form.

For 3D analyses, you need the following three processes successively in a processing sequence: 3D analysis, **Cut 2D from 3D**, and **Single Values from 2D**. With these three processes, ArtemiS SUITE first calculates the 3D analysis, then extracts 2D cuts from it at the position specified in the Properties of the **Cut 2D from 3D** process, and the **Single Values from 2D** process reduces them to a single value result.

Figure 9 shows an example of such a processing sequence (3D analysis: **Order Spectrum vs RPM**; **Cut 2D from 3D**: cut at the second order; **Single Values from 2D**: calculation of the mean value; the **Mark by time** process is required to specify the RPM channel for the order calculation).

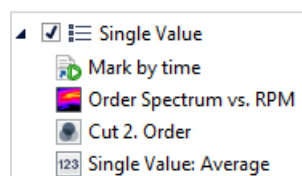


Figure 9: Processing sequence for calculating a single value result from the **Order Spectrum vs. RPM** analysis

Output and display of the single value results

Several options are available in the Automation Project for the output of the single value results: the results can be displayed, e.g., in the legend of a diagram in addition to the curve or they can be output as a Single Values Table, or a Single Values Diagram.

To display the single value results in the legend or title of a diagram, add a Data Viewer or a report item to the Destination Pool of your Automation Project and configure its appearance as described in the chapter “Displaying single values in a legend or title of a diagram”.

To display all calculated single value results in one table, insert a **Single Values Table** item into the Destination Pool of your Automation Project. The configuration works as described in the chapter

“Output in table form”. Of course, you can also include such a Single Values Table in a report via an Automation Project using a suitably configured report template.

In order to display the single value results in a Single Values Diagram, you need to select a report element as the destination, then configure the display options as described in the section “Display in a Single Values Diagram” above.

For representing single values by means of a Standardized Test Project, you need to generate a report template showing the single values in the format you require. The results can be output in the report within the diagrams, e.g., in the legend, in a Single Values Diagram, or in a Single Values Table.

Using single values from documentation entries

The function **Single Value from Documentation** is available, e.g., in the Analysis Pool of a Pool Project. This function allows documentation entries, which return a numerical value, to be selected and, e.g., represented in a report. For a correct representation please note that only numerical values, which had been entered in a number field, can be output as single value. Dates or numbers, which had been entered in a text field, cannot be processed by this function. The requested documentation entry is selected in the Properties window of the function. More information, e.g., which documentation entries are provided, can be found in the Help System of ArtemiS SUITE.

Notes

For calculating single values by means of a Pool Project, you need the following ArtemiS SUITE modules **ASM 00** Basic Framework (code 5000), **ASM 01** Basic Analysis Module (code 5001), and **ASM 02** Basic Report Module (code 5002). If you want to calculate single values by means of an Automation Project or a Standardized Test Project, you may need other modules. Your HEAD acoustics representative will gladly provide you with further information.

Do you have questions or suggestions?
Contact the author at imke.hauswirth@head-acoustics.de.
We look forward to your feedback!