

# Ai Function

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## Contents

Ai Function .....	5
Description of Ai function .....	5
How to Ai function. ....	5
Step 1).....	5
Step 2).....	5
Step 3).....	5
Step 4).....	5
How to make tolerance limits. ....	6
Make References with a known golden unit. ....	7
Make references with some known good units. ....	8
Make references with many units and select manual statistical data to make limits. ....	9
Make references with many units and auto select statistical data to make limits. ....	11
Ai-mode to auto learns and modifies references on the fly in run-mode. ....	13
Example .....	15



## **Ai Function**

### **Description of Ai function**

The Ai function enable the system to automatic modify the upper and lower limits in run-mode when activated. The Ai algorithm is a self-learning to auto optimize the upper and lower limits. The size of the envelope is not changed. Example if the envelope between the upper and lower limit is +/- 3 db will be the same on all measuring point when the Ai function is active. With other word the upper and lower are floating.

Some actions must be taken before the Ai function can be activated.

First the upper and lower limits must be generated for a setup.

Second the system for a setup have to learned up to a certain level to able to enable the Ai algorithm.

When the setups have enough data to work with the Ai function must be activated in Edit reference-mode before it can be used in Run-mode.

In Run-mode only approved test will be part of the data calculation used by the Ai function.

The Ai function works in single mode and with system multiplex mode.

In chain mode it is only the first test in the chain the Ai function is active if enabled.

### **How to Ai function.**

#### **Step 1)**

Make references with many units as described below under step d) and e)

#### **Step 2)**

Activate the Ai function in Edit Reference-mode

#### **Step 3)**

Use Ai function in Run-mode. Only approved test use data to Ai function.

#### **Step 4)**

How to check change of the limits after N processed test data.

## How to make tolerance limits.

When testing loudspeakers you need to know what you are testing against.

Normally you test against some reference parameters.

The concept used for all models produced by K & K International the references tested against is upper (maximal) and lower (minimal) limits or upper limits only.

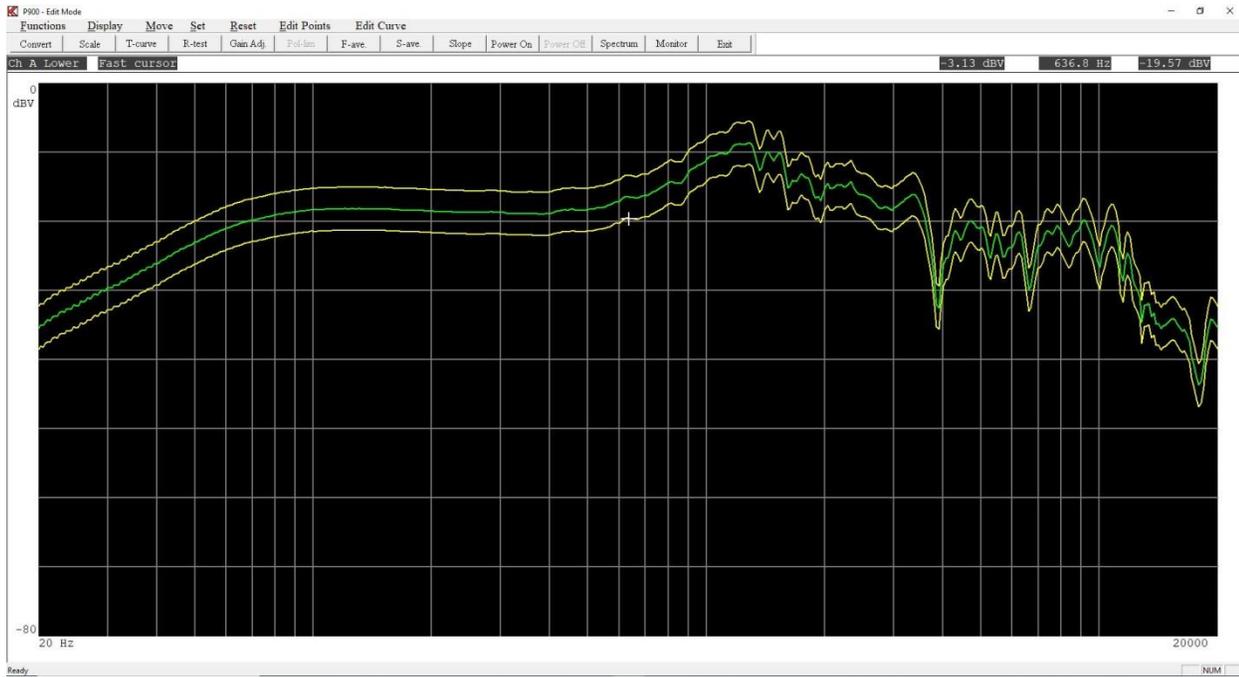
On the following descriptions are explained how to make those limits.

- a) Make references with a known golden unit.
- b) Make references with some known good units.
- c) Make references with many units and select manual statistical data to make limits.
- d) Make references with many units and auto select statistical data to make limits.
- e) Ai-mode to auto learns and modifies references on the fly in run-mode.

The following examples show the differences between the different ways to make limits and not how to setup the different tests. It is recommending look in the user manual for actual test system.

## Make References with a known golden unit.

To make test limits with a well-known good speaker, a golden unit it is very easy and simple. After the desired test parameters are selected as start and end frequency, output voltage, test time, input channels and gain and setup of filters if need a measurement is done. Include all data and then edit the limits.



In the following example only frequency curve limits are used. The limits are moved  $\pm 3.1$ db. Normally higher tolerances are given at the lower and higher frequency due to wider deviations.

Benefit: Very simple to make.

Disadvantage: No guarantee that the golden unit is representative for a wider number of units.

Test for units: Few number of units.

References: One.

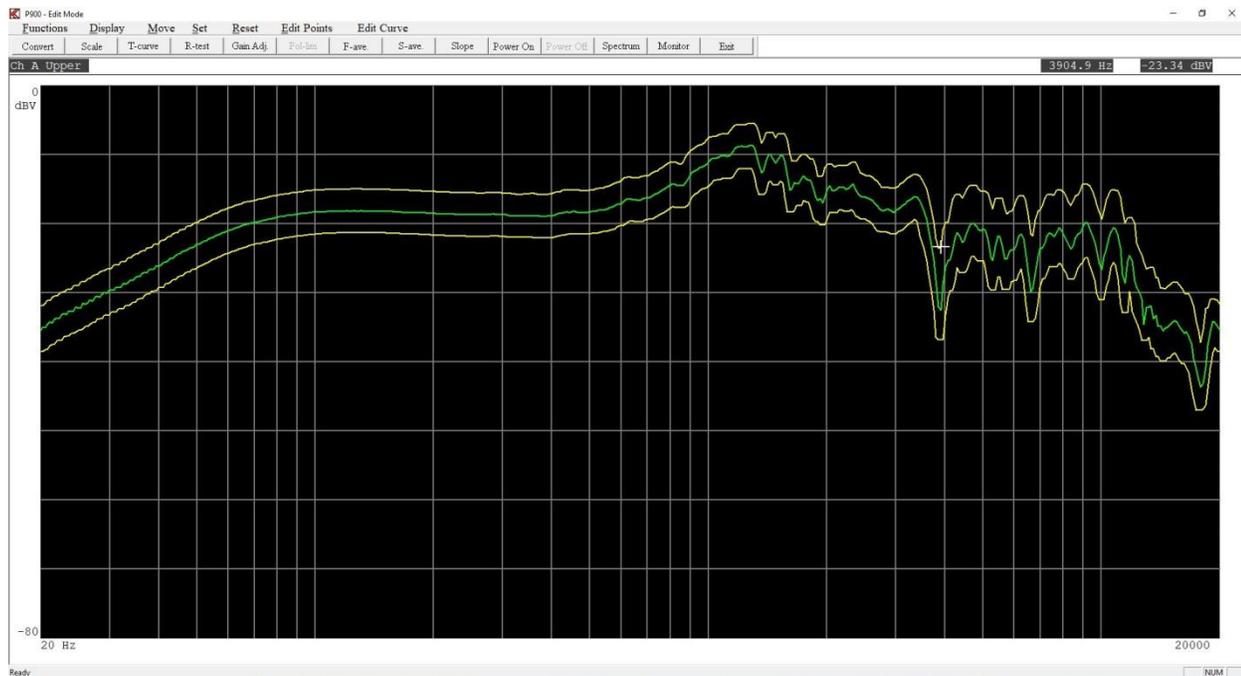
## Make references with some known good units.

To make test limits with some well-known good speakers.

After the desired test parameters are selected as start and end frequency, output voltage, test time, input channels and gain and setup of filters if need a measurement is done.

Include all data and then edit the limits. Repeat this with a number of good units.

Every time an “include” is done the upper and lower limits are grown if the measured data are outside the present limits before an “include”. On this way the limits give a better tolerance for a wider population of number of tested units.



In the following example only frequency curve limits are used. The limits are moved +/-2 db. Here are used 10 good units. The difference from only use 1 unit and now using 10 units see in this case at frequency higher than 4000 Hz.

Benefit: Very simple to make. Give a better representation for a number of units.

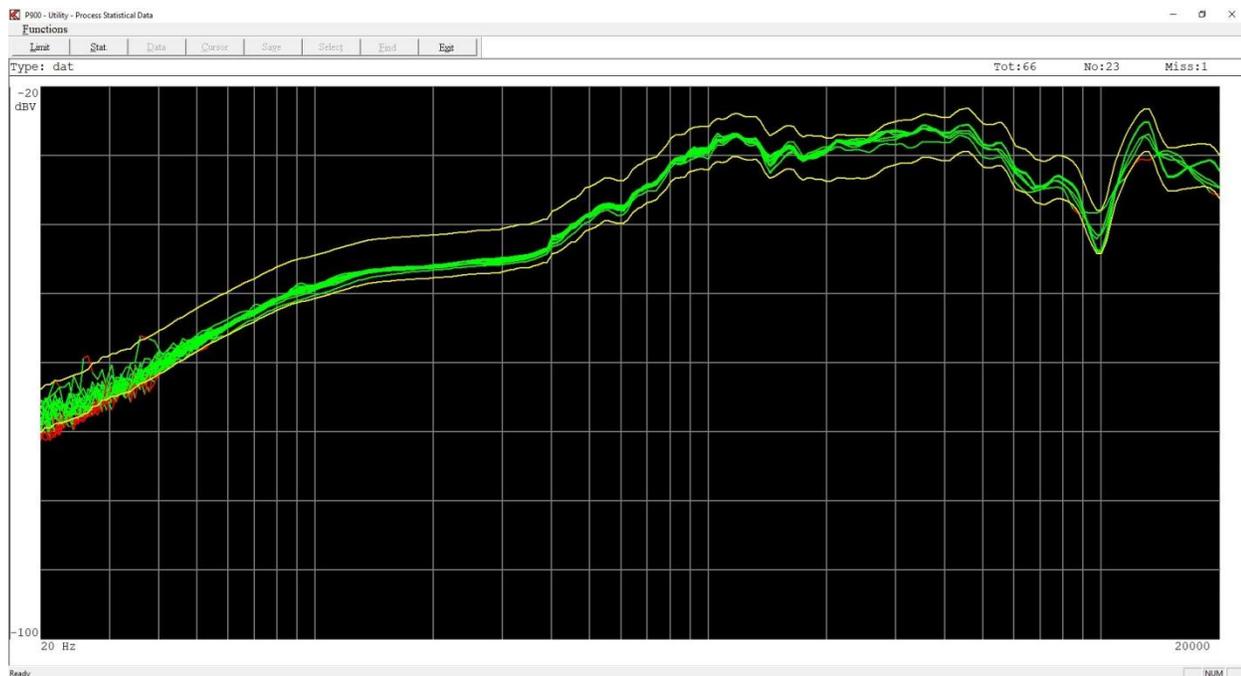
Disadvantage: No guarantee that the good units give representation for a large number of units.

Test for units: A wider number of units.

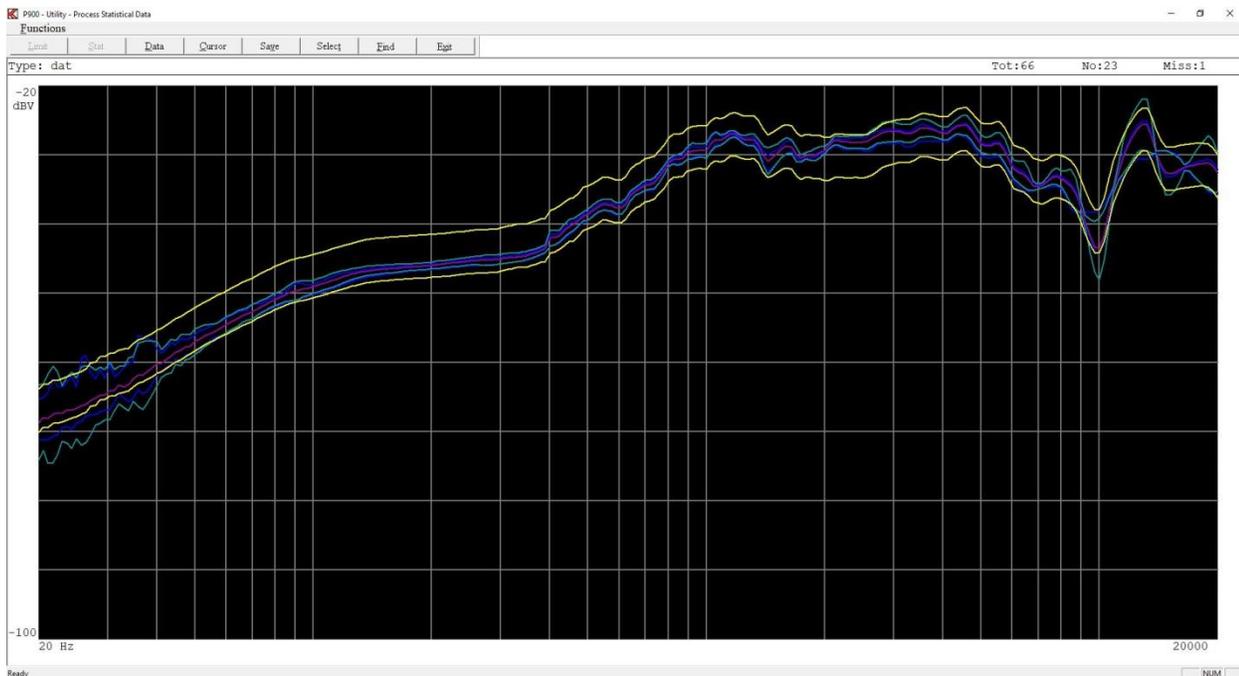
References: Few units as 5 to 25 good units.

## Make references with many units and select manual statistical data to make limits.

A better way to make test limits is to collect a number of stored measured data for analyze. To this make a complete setup for a wanted speaker. When a setup is complete and all test parameters are done you are ready to run test in run-mode. You have made test limits as described above. Now collect all measured data both approved and rejected to a4mstat.dat file (default name). To do this enables the function in global-setup. When several measurements are done and data is collected and stored use the utility function “Process Statistical Data”.



In this example above show only the frequency curve data processed in manual mode. Number of collected measurement is in this case 23 out of 66 measurements. This show that the current limits could be fitted better to the measured data.



The same data is now processed. Displayed are the upper and lower limits, the average of collected and selected data and in this case  $\pm 3$  Standard deviations ( $\sigma$ ). With benefit the upper and lower limits could be modified. I would use  $\pm 3$  sigma and add a limit example  $\pm 1$  db to this.

Benefit: Give a good representation for a many number of units.

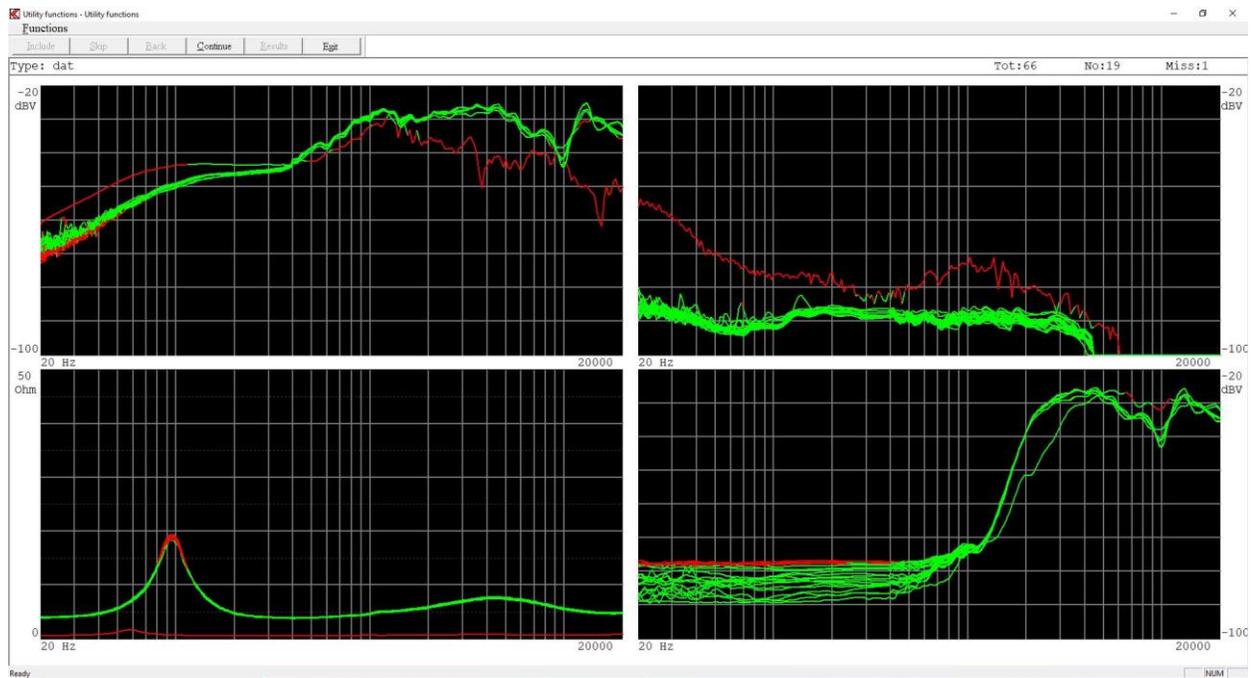
Disadvantage: No guarantee that this gives representation a large number of units in different batch.  
It takes time to manual process the collected data.

Test for units: A wide number of units.

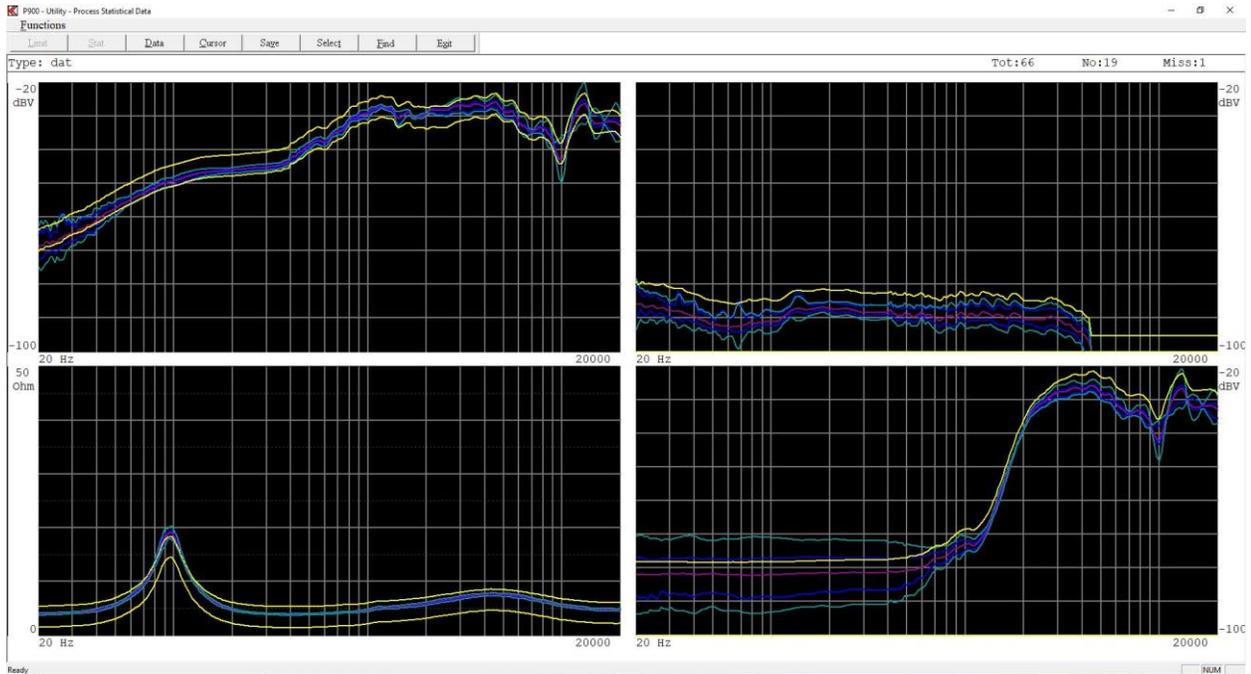
References: Units as 25 to 100 of accepted good units.

## Make references with many units and auto select statistical data to make limits.

As to “Process Statistical Data” in manual mode the data can be processed on auto mode. The auto mode is a “pseudo learning mode” where a large number of data can be processed. This mode a suppress function is very powerfully. To get a more correct population of data as both rejected and approved data however not direct very bad measurements this suppress function are used. Simply it take the current limits and add a new limit (the suppress values) to data before the processing are excluded in the collecting of data.



In this example a suppress function is used for all 4 channels. There are collected 19 measurements of 66 stored measurements.



The data is now processed for all channels. Improvements of limits are recommended for all channels. The stored data used are the same used in manual and auto mode.

**Benefit:** Fast to use. Give a good representation for a large number of units.

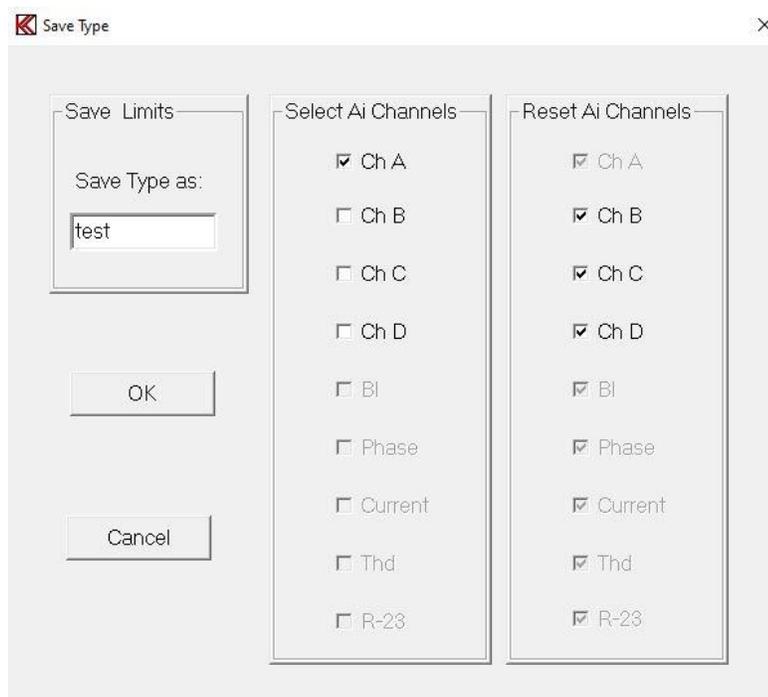
**Disadvantage:** No guarantee that this gives representation a large number of units in different batch unless data are collected from different batch.

**Test for units:** A large number of units.

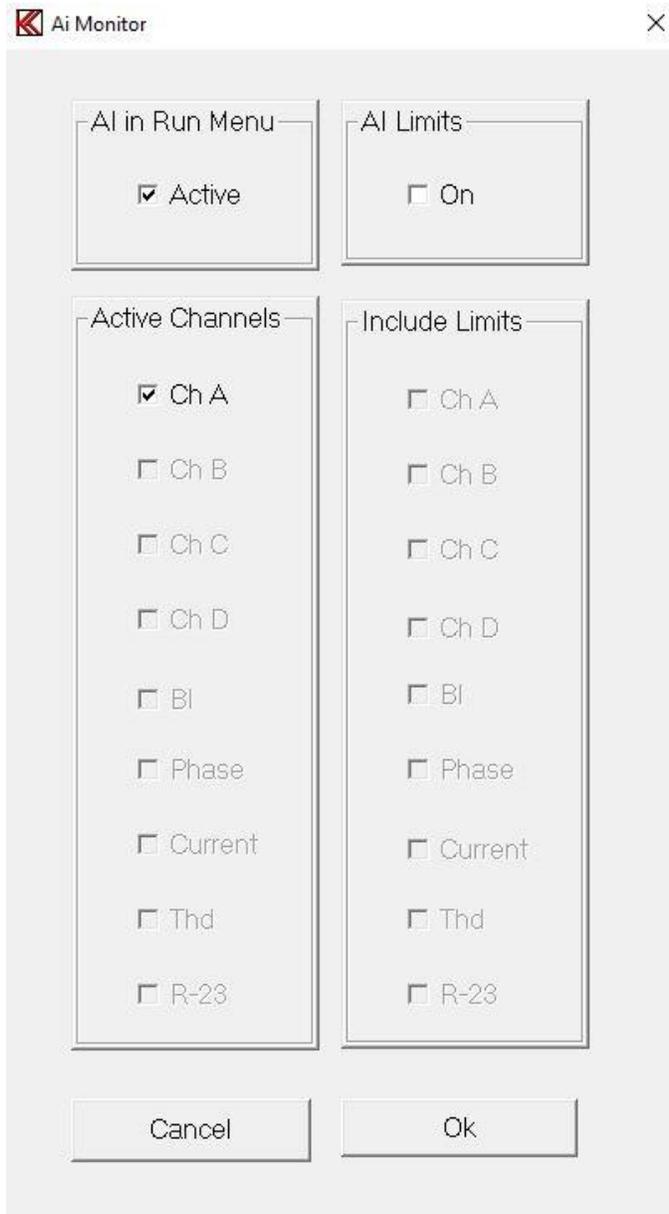
**References:** Units as 25 and > 10000 of accepted units.

## Ai-mode to auto learns and modifies references on the fly in run-mode.

A step further can the system auto learn the entire population of measured data on the fly. First accepted measurement higher than 50 units must be processed by the utility “Process Statistical Data”. Typical this is done in the auto-mode. In Ai-mode the system learns for every measurement in run-mode where the averages of the population have to be placed. The upper and lower limits are them auto moved under the auto learning, however not the gap between upper and lower limits. Then saving the processed limits you got following.



In this case all tests were processed, due to highlighted under Reset Ai Channels. We do only want to select Channel A. The selected Ai channels are prepared to use / select for later auto learning. Before the auto learning can be activated the references for the selected channels must be selected as above. When this is done the channels must be selected in edit-mode the Ai-mode activated. It is allowed to select all channels as picture above and later only select one of them in edit-mode. If the channels are not selected when save data in utility the reference in Ai-mode are missing.



Now next time a measurement is made in run-mode the auto learning is done. If auto learning is not wanted click the Ai in Run mode off. It is possible to see the difference of the references in auto learning and the reference mode before learning in the edit-mode.

The save measured data set in global setup can be OFF or ON this do not interfere the learning mode.

**Benefit:** Fast to use. Give a good representation for very large number of units.

**Disadvantage:** The auto-learn function do move limits by machine learning. It is needed to check that the machine take over test result by mistake (run away case).

**Test for units:** A very large number of units.

**References:** Minimum units as 50 and up.

## Example

Following example displayed in figure 1 have used the utility process statistical data function to process stored data generated in run-mode. An auto collection of data has been used to filter faulty measurement. Used data are 70 out of 75 measurements.

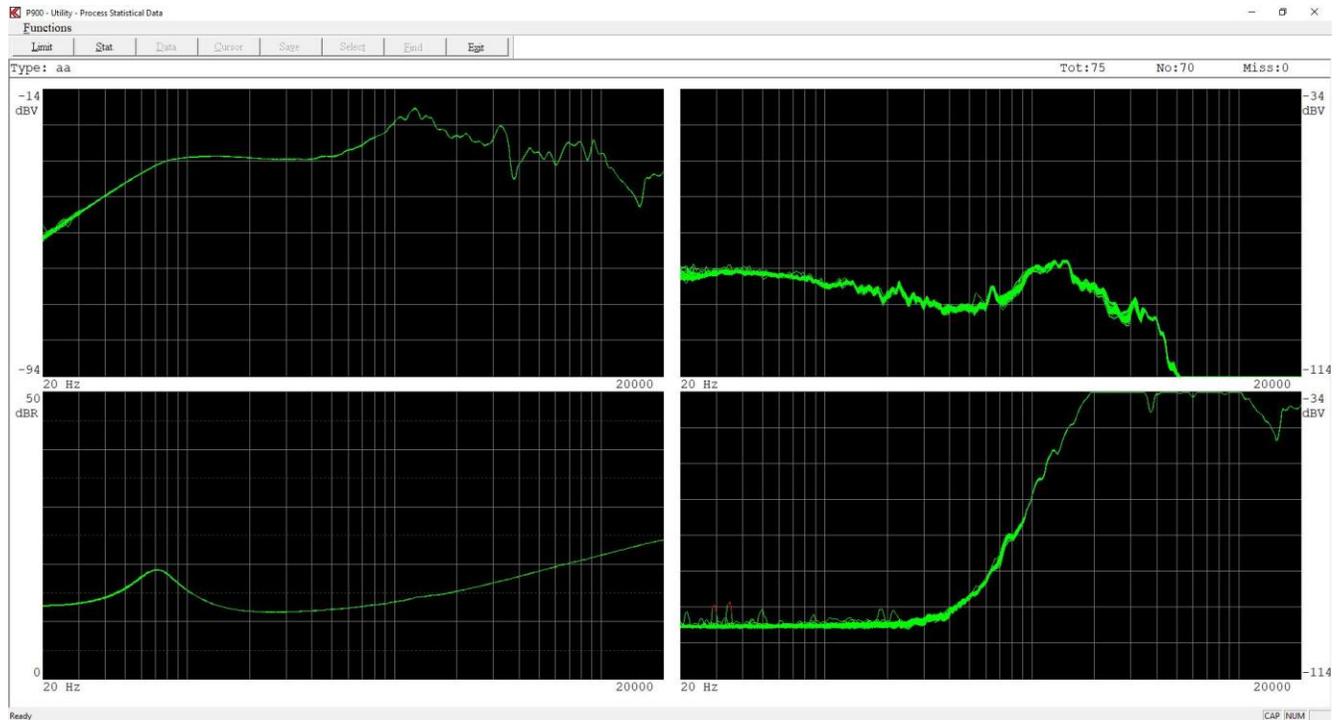


Figure 1: Collected 70 measurements to further processing.

Figure 2 show the same data calculated in Stat menu. The average curves are used to generate +/- standard deviations. At the same time the average curve(s) are used for the base data to the Ai-function.

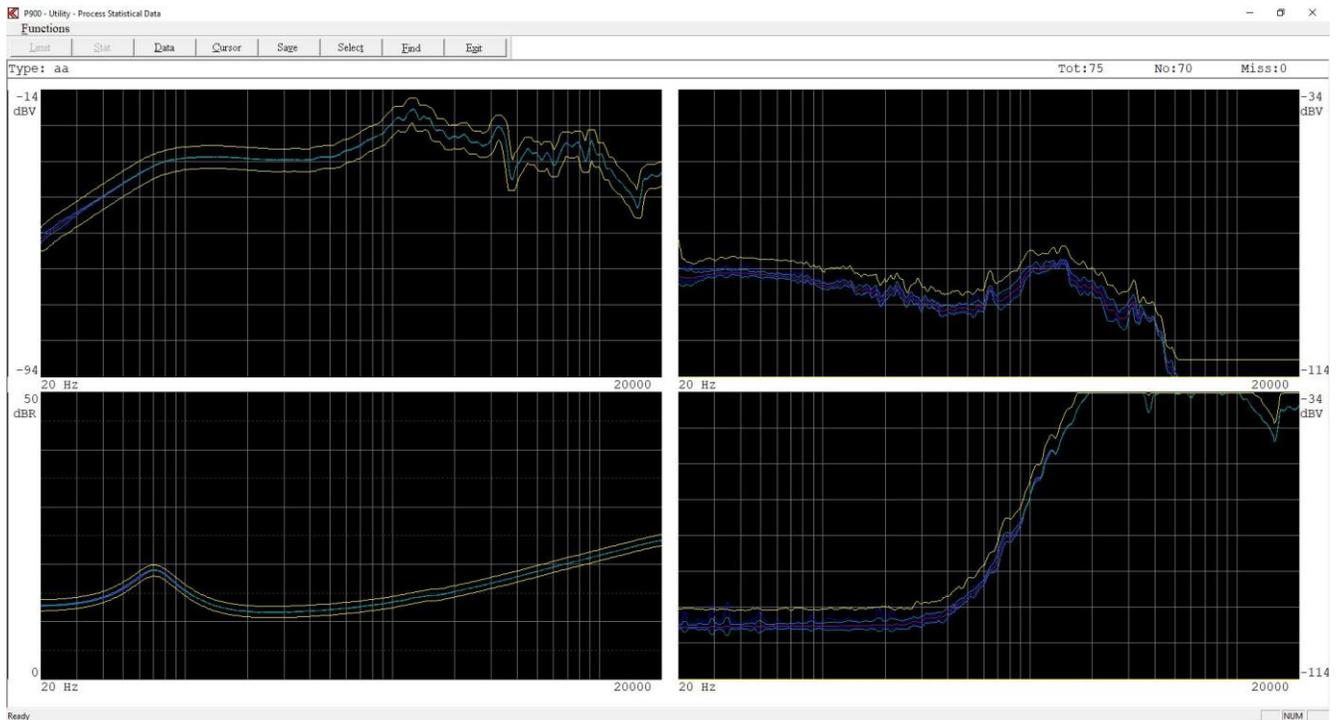


Figure 2: The upper & lower limits, the Average and +/- standard deviation curves.

When saving the type a selection of wanted data to use for the Ai function can be selected.

Figure 3 show that the Cannel A is selected. Note on “Select Ai Channels” all processed data can be selected. Not stored data and processed data are grayed. All Ai data are reset as default. However it is possible to example only reset selected Ai channel and keep the other channels to use for the Ai function.

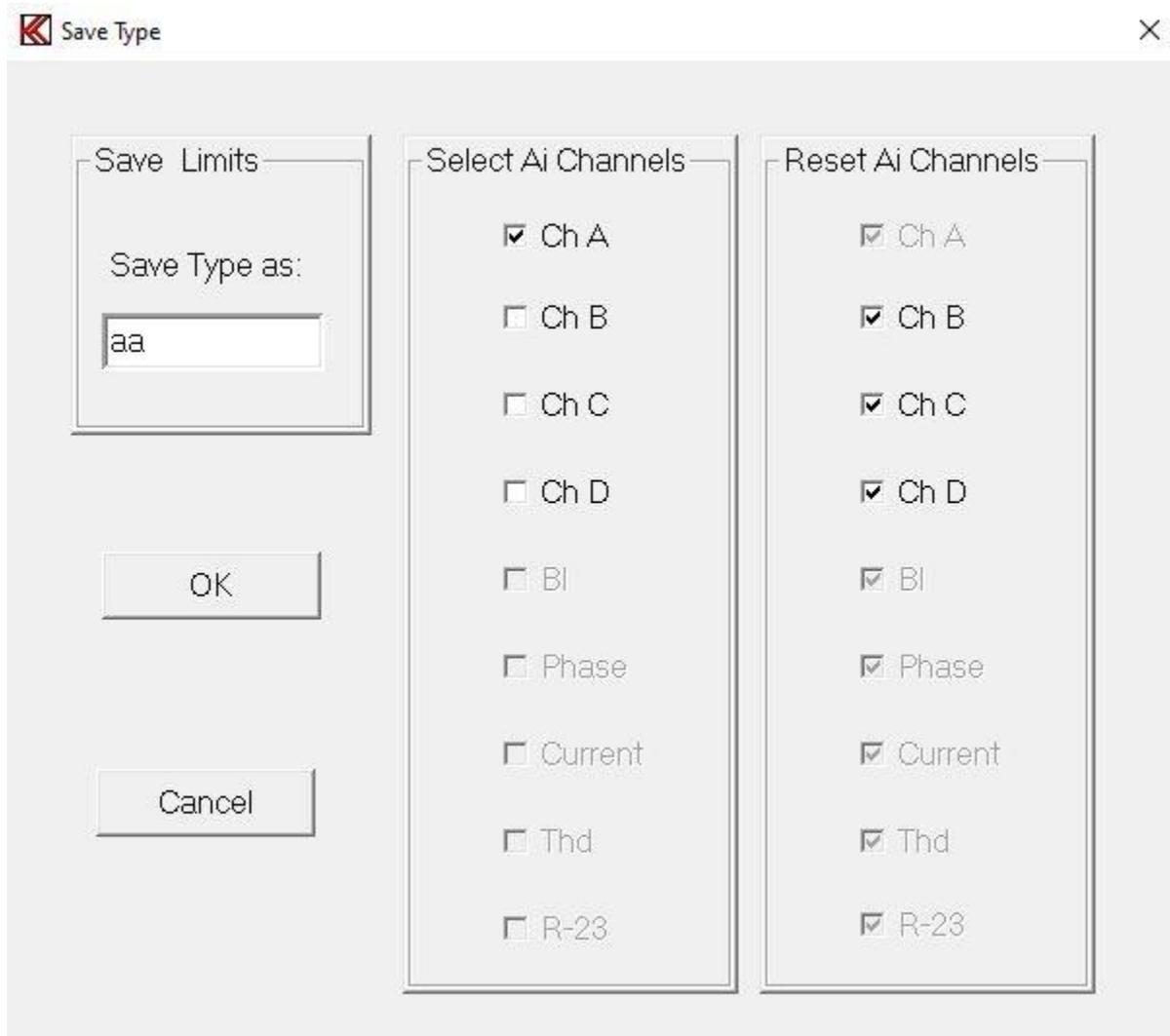


Figure 3: Channel A is selected to be used for Ai function for type “aa”.

To activate the Ai function on run mode it must be activated in edit reference mode. Figure 4 show that the channel A is activated to be used in rub-mode. Note remember to save the setup before the changes is activated. Be aware that all listed test can be included in the Ai function due all listed test function have their own limits.

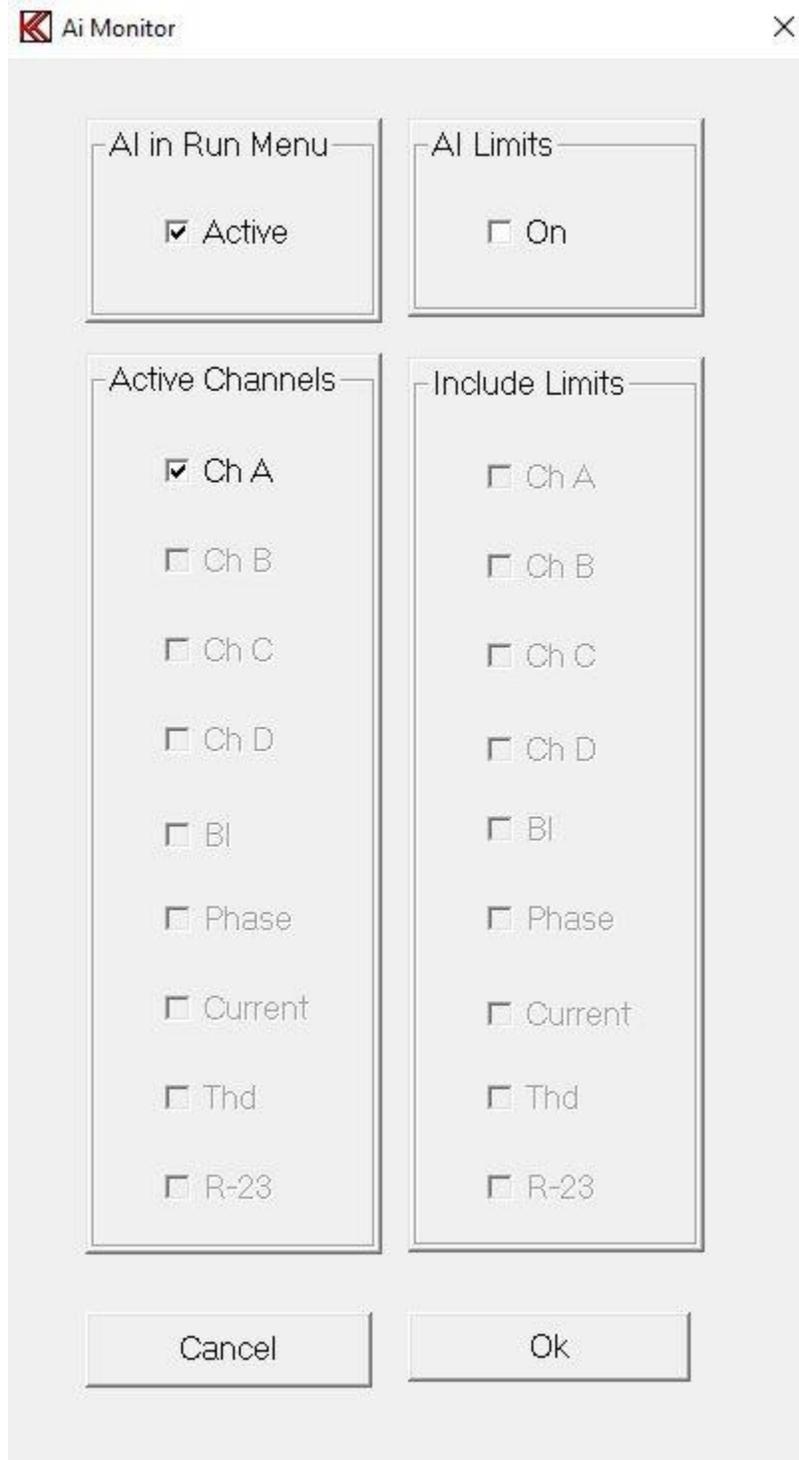


Figure 4: In edit Reference-mode the Ai function for Channel A is activated in the Ai Monitor.

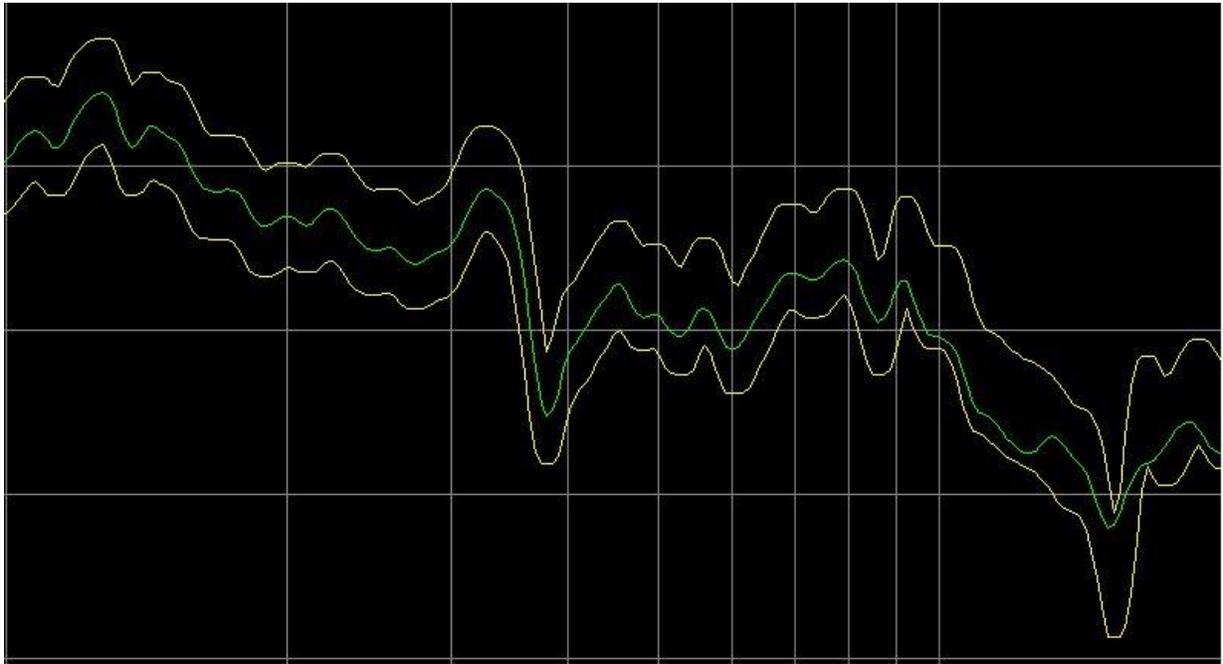


Figure 5: Frequency response from 1000 – 20000 Hz Ai limits off

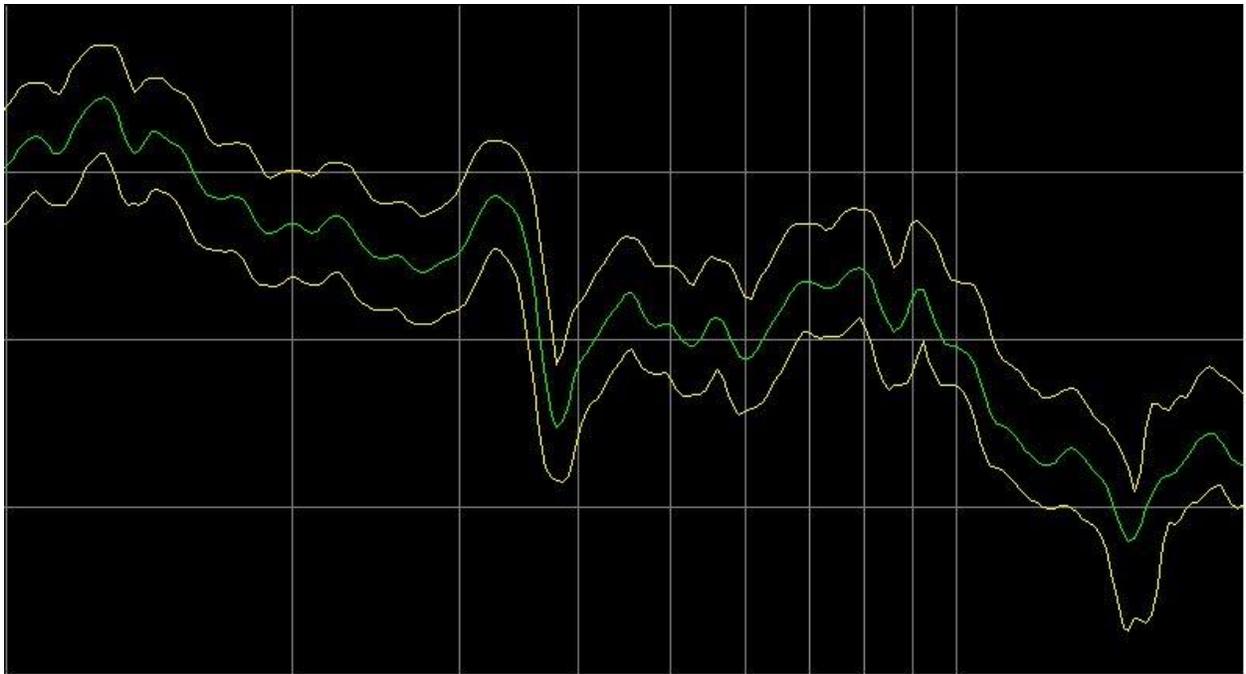


Figure 6: Frequency response from 1000 – 20000 Hz Ai limits on

In reference - mode the display show the upper and lower limits with before the Ai function have made changes. Figure 5 show a part of frequency response from 1000 to 20000 Hz. The sweep was from 20 to 20000 Hz. To simulate the Ai function the same speaker was used however the speaker has been mowed the position in a fixture due do bad mounting. Due to this movement changes at the high end of the frequency response changes.

To see the changes done by the Ai function set the Ai limits flag on. Figure show the new limits generated by the Ai function used in Run-mode. By toggle the Ai limits flag on / off it is easy to see the changes.

It is possible to include – replace the Upper and lower limits with the Ai limits. If so flag the channel in “Include limits”. When leave the setup remember so save the setup.

Another possibility is to go to utility and process the data and save the processed data for Ai function.

Note it is the user to check the Ai function that work within an accepted range. The check is needed in some periods to avoid a run-away of limits.