QC – Match Speaker Tool (MSP) **S15**

Version 3.2

FEATURES

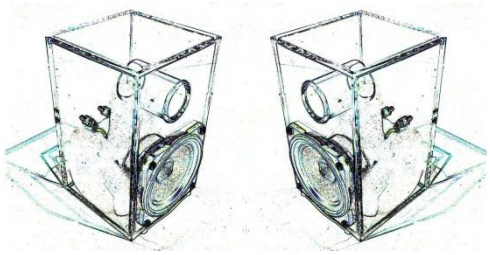
- Automatic scan of QC result databases
- Display matched pairs in a graph
- User adjustable algorithms
- Pool management of potential and matched candidates
- Stand-alone application
- No measurement hardware required
- Report of matched speaker pairs

BENEFITS

- Find best matching pairs from a pool of speakers
- Organizes the pool of matching candidates
- Improves the quality of production by individual selection
- Allows different grades of matching
- Applications: high end systems, headphones

Match Speaker Tool (MSP) will analyze a pool of speakers measured with the Klippel QC-System and match pairs with the least deviation in either sound pressure or impedance curve. It suggests which speakers are a good match, e.g. for stereo boxes or high end headphones, and helps you organizing the pool if you add or remove speakers.

Match Speaker Tool is a good example for post processing software developed using the Klippel Automation Interface.



Article Number:	4000-220

CONTENTS:

Klippel GmbH
Mendelssohnallee 30
01309 Dresden, Germany

www.klippel.de
info@klippel.de

TEL: +49-351-251 35 35
FAX: +49-351-251 34 31

Description

Requirements

The following components are required:

- QC Software (version 2.0 or higher) or free Klippel dB-Lab software (version 202 or higher)
- PC with MS Windows XP or higher
- USB port + Hardware Key (Dongle)
- License

Components

The following components are part of the QC Match Speaker Tool:

- Special Software Setup
- Software License
- Hardware Dongle

Theory

Required input data

Databases of measured speakers from a pool (e.g. a production batch) are required.

The matching algorithm is based on the calculation of the deviation of the selected property (frequency response or impedance magnitude) between all possible pairs of speakers in a pool.

The pool is defined by the available databases in a certain folder. Note that all results must have identical measurement conditions (at least the frequency axis of the results must be identical[1]).

Logarithmic Scaling

The matching algorithm can be used for either Impedance or SPL (Frequency Response) Curves. The SPL curves are in dB while the Impedance curves are in Ohm.

Internally the match speaker algorithm works with dB thus the Impedance curves are converted to log scale before starting the main calculations.

$x_i(f)$ [Ohm]

$m_i(f) = 10 \cdot \log_{10}(x_i(f))$ [dB]

Weighting

If a weight curve is used, it is normalized and applied to all curves.

$$weightCurve_{\text{normalized}} = \frac{weightCurve}{\max(weightCurve)}$$

$$measuredCurve_{\text{weighted}} = measuredCurve \cdot weightCurve$$

$$y_i(f) = m_i(f) \cdot w_i(f)$$

Using a weight curve allows to reduce the importance of the deviation in a certain frequency range. This means that the calculated deviation does not represent the actual deviation between the curves but has rather informative character.

[1] It is possible to compare measurement results with different x-axis settings. See Chapter "Run Match Speakers in dBLab".

Calculation

The most important part is the calculation of the deviation between two curves.

The distance d is defined as

$$d_{i,k}(f) = \left| y_i(f) - y_k(f) \right| .$$

The deviation of a pair *i,k* is defined by the cost function

$$D_{ik} = \sqrt[c]{\frac{\sum_{f=f\,\min}^{f\,\max} d(f)^c}{a}} .$$

Where *a* is the number of discrete points of curve d in the range between fmin and fmax.

The parameter c, and the selected frequency range defined by fmin and fmax can be defined using the Match Speaker User Interface.

The parameter c depends on the selected “compare by” parameter in the Match Speaker Tool. It is possible to choose between following settings:

- *Mean deviation* (c = 1)
- *Root mean square deviation* (c = 2)
- *Maximum deviation* (c = infinite)

How the options affect the comparison between the curves:

- *Mean deviation* - all points of the curves are taken into account equally. (City block distance)
- *Root mean square deviation* - all points of the curves are taken into account but smaller deviations between the curves are less important than bigger ones. (Euclidian distance)
- *Maximum deviation* - only the point of maximum deviation (where the distance between the curves is the largest) is taken into account

dB to % Conversion

After the matching algorithm is finished deviation values are converted to % **for Impedance curves** to make it easier to interpret the results.

$$P_{ik} = (1 - 10^{-D_{ik}}) \cdot 100\%$$

Symbols

x … value of an impedance curve
m … value of a measurement result (log impedance or frequency response)
w … value of the weight curve
y … value of a weighted curve
d … distance between two values
D,P deviation between two curves
a … number of frequency points in a curve
f … discrete frequencies
c … exponent
i,k index of the result in the pool

Best matching Pairs Algorithm

Best matching pairs algorithm searches for the minimal deviation between all available candidates.

	If this pair was found, it will be removed from the pool. Then the next best fit among the remaining candidates will be searched and so on. In this case the best match will be found. However, for the very last speakers the deviation may be relatively high since the pool size becomes very small at the end. Pairs which deviate more than the ***max. deviation*** parameter are not matched. **Use this mode** if not all speakers of the pool must be matched. If you have a continuous production, keep the pool number more or less constant and take off the best matched pair(s).
Max. Number of Pairs Algorithm	*Max. number of pairs* will find as many pairs as possible under the condition that the characteristics of two speakers deviate not more than the ***max. deviation*** parameter. **Use this mode** if quantity is more important than quality. (Quality can still be assured by setting ***max. deviation*** to a relatively small value.)
Output	
Graphics	Each calculated pair could be visualized as a graph.
List of matches	A sorted table is shown with the database names of the pair and the deviation in percent.
Output report	The list of matches can be exported as a plain text file with the format: Pair ID | database name 1 | database name 2 | deviation in % or dB.
Limits	
Max. Number of test objects	No restrictions, but large pools (>500 objects) may take longer time. Recommended number of objects is max. 500.
Curves to match	• Frequency Response (vs. frequency) • Impedance (Magnitude vs. frequency) Objects must be measured with identical settings (identical frequency axis).
Input Data Format	Klippel QC database (binary format) only.[2]

[2] It is possible to import data from a text file to load results extracted with the *db extract* or measured with third-party software . See Chapter "Run Match Speakers in dBLab".

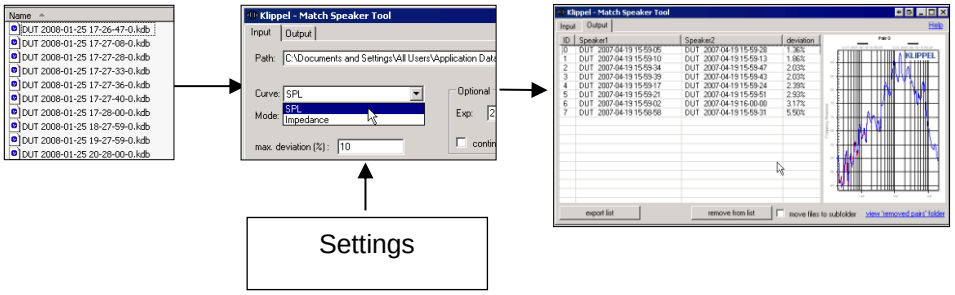
Applications

Matching drivers for headphones

A straightforward application is to match headphone drivers. Left and right reproduction should be as similar as possible.

How it works:

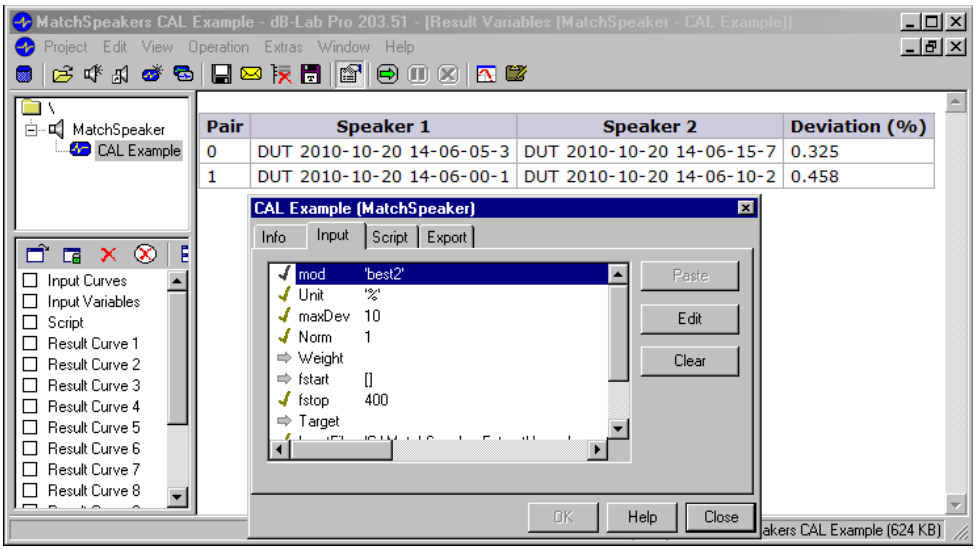
Pool of databases | Match Speaker Tool | Result List of Matches



Advanced Options

Run Match Speakers in dBLab

The match speaker algorithm can be used without the graphical user interface of the "Match Speaker Tool" but in a CAL Module of the dBLab Software instead. This offers additional possibilities to use the algorithm.



An example database is installed with the Match Speaker Tool.

It can be found under: "C:\Documents and Settings\All Users\Application Data\Klippel\MatchSpeaker\CAL Example".

Setup

Parameters:

mod	Represents "Find:" • best1 – old do not use • best2 - Best matching Pairs Algorithm • max - Max. Number of Pairs Algorithm
Unit	• for curves in dB use 'dB' • for curves with absolute Units (e.g. Ohm) use '%'
maxDev	Maximum deviation
Norm	Represents parameter c in the formulas above. • 1 – mean • 2 – rms • >= 3 - max (automatically set to infinity)
Weight	Weight curve
fstart / fstop	Use to select a certain frequency range

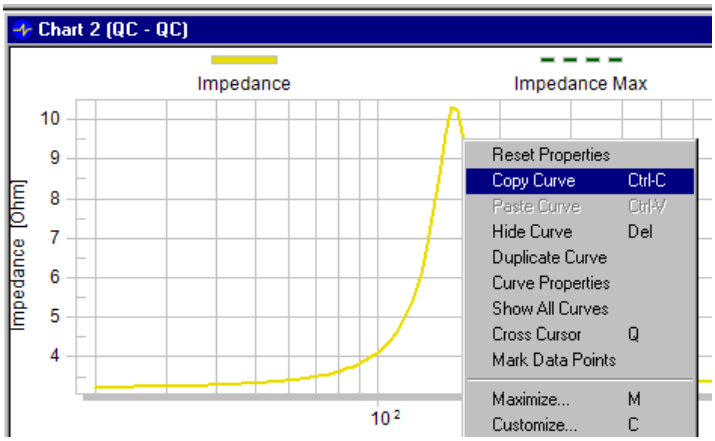
Data Import

There are two options to import measured data to the CAL module.

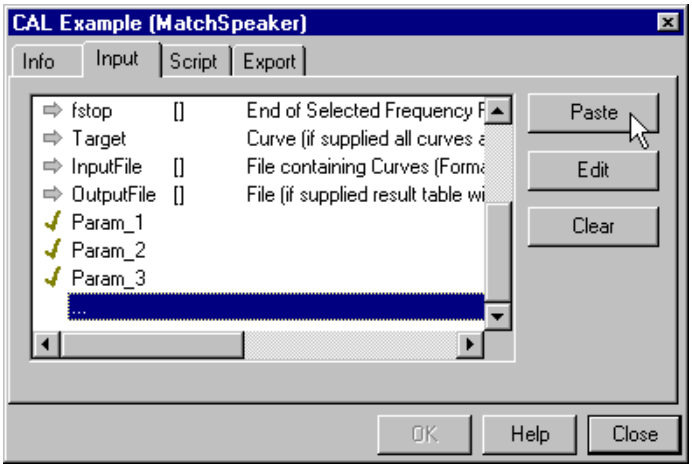
1. Copy and Paste

(This is only suitable for a small number of curves)

Select any curve from a Chart in dBLab and copy it.

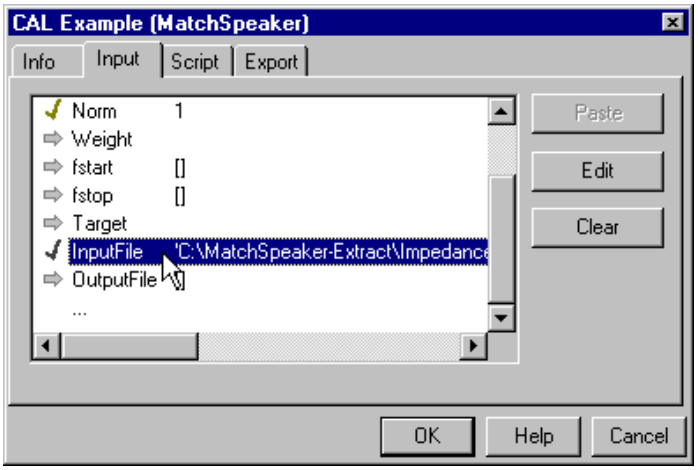


Paste the curve as a "free parameter" to the CAL operation. Simply select "…" from the parameter list and click on "Paste", as shown in the image.



2. Text file Import

Instead of importing all curves individually it is possible to import one text file containing data of multiple curves. To select a file insert the files path to the parameter "InputFile".



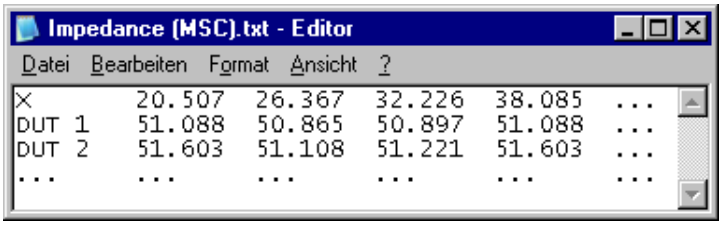
The file needs to be formatted like this:

First row: X-axis

Each following row represents the y vector of one curve.

The first column must contain the name of the curve (or DUT respectively). The name of the first row is "X".

The columns must be separated by tabulator.



This text file import offers the possibility to load all kinds of curves even measured with third-party software to be loaded and compared with the matching algorithm.

Klippel QC database files (*.kdb or *.kdbx) can easily be converted into this format by *db extract*.

A preconfigured settings file for the *db extract* is located under: "C:\Documents and Settings\All Users\Application Data\Klippel\MatchSpeaker\CAL Example\extract_databases.kxdbsettings".

- Double click the settings file
- Drag and drop the databases (or folder containing the databases) on the "Select Database Files" tab
- Switch to the "Run!" tab and click the "Run!" button
- The extracted files will be stored under: "C:\MatchSpeaker-Extract"

Data Export	The matching results can be exported to excel compatible tab separated text file by supplying a path to the "OutputFile" parameter. (The folder must exist)
Compare to target curve	Using this CAL Module it is possible to compare multiple curves to one target curve. If the parameter "Target" contains a curve all other supplied curves are compared to this curve. The result table will show the deviation from the target. (No search for pairs takes place.)

Compare Curves with different X-axis	This is possible by activating the interpolation in *db extract*. Go to the "Export Format" tab and set the "X Axis Export" option to "Interpolated". (please refer to the *db extract* Manual)

updated June 29, 2016

Klippel GmbH
Mendelssohnallee 30
01309 Dresden, Germany

www.klippel.de
info@klippel.de

TEL: +49-351-251 35 35
FAX: +49-351-251 34 31