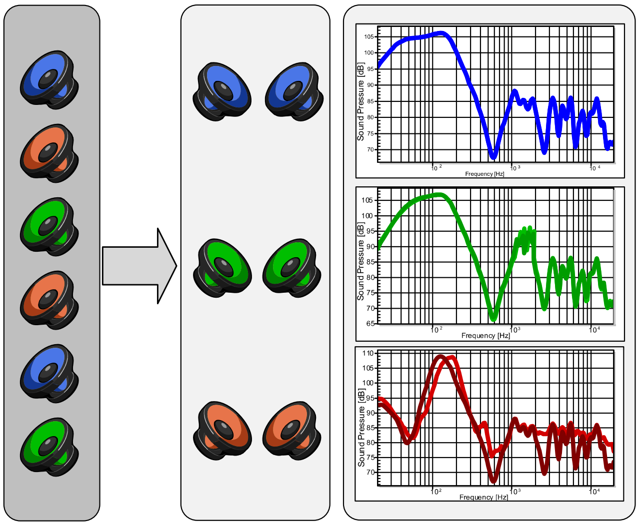
QC – Match Speaker Tool (MSP) S15

Version 3.6 (Document Revision 1.8)

FEATURES	BENEFITS
• 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	• Find best matching pairs from a pool of speakers or two independent pools (e.g. left pool vs. right pool) • Organizes the pool of matching candidates • Improves the quality of production by individual selection • Allows different grades of matching • Applications: high end systems, headphones

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



Article Number:	4000-220

CONTENT:

1 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 7 or higher • USB port + Klippel license dongle (*Rockey*) • MSP license
Components	The following components are part of the QC Match Speaker Tool: • MSP software setup • MSP software license • USB license dongle

2 Theory

Input Data	Databases of measured speakers from one (e.g. a production batch) or two pools (e.g. left and right pool with pool ID in serial number) 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.)

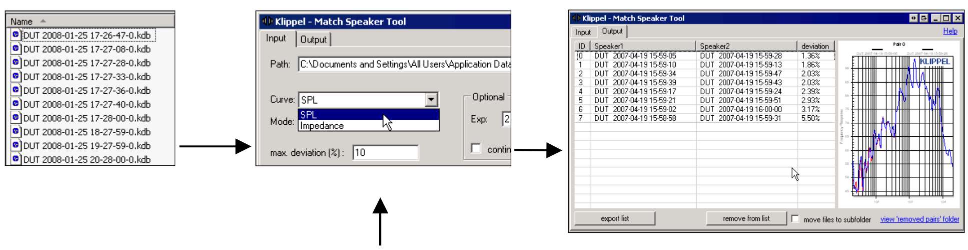
3 Output

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.

4 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 (.kdb or .kdbx format) only.[2] In case Pool IDs are used too match pairs from two different pools, a unique pool token should be used within the serial number (file name) of the input databases

5 Applications

Matching Drivers for Headphones	A straight-forward application is to match headphone drivers. Left and right level and tonal balance should be as similar as possible. How it works: **Pool of databases** **Match Speaker Tool** **Result List of Matches**  **Settings**

[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".

Find explanations for symbols at:

http://www.klippel.de/know-how/literature.html

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