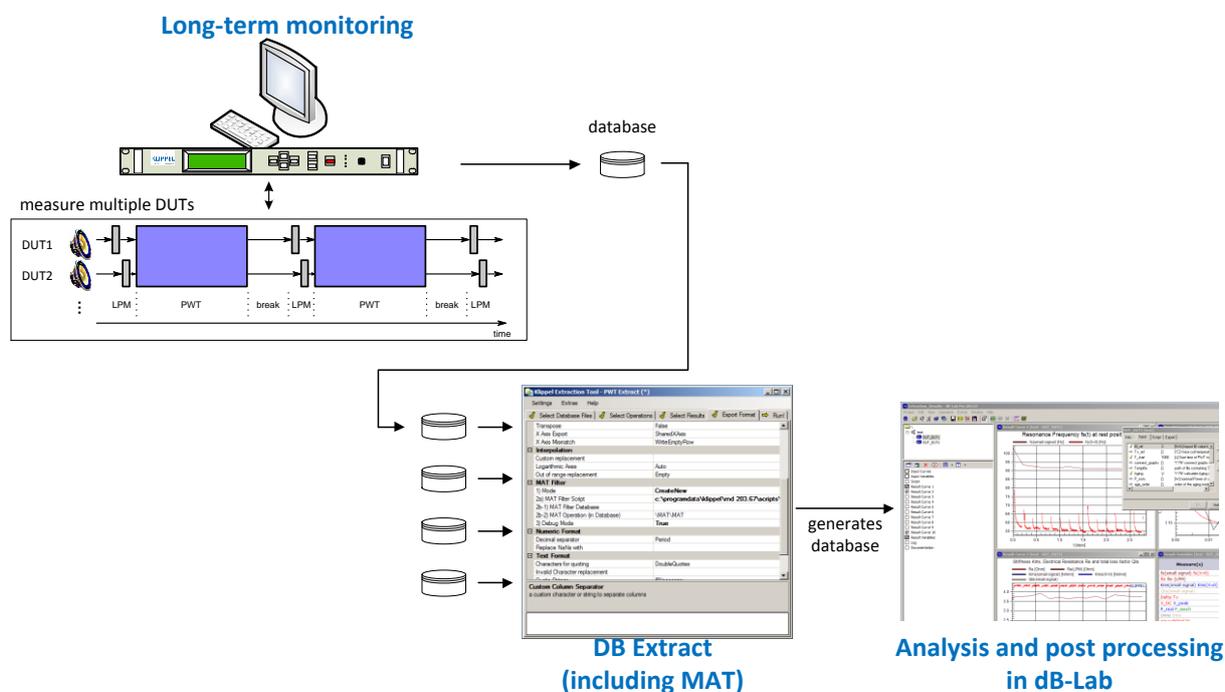


Long-term monitoring tests are used to observe the loudspeaker parameter variation over a long measurement time (from hours to month) while using a natural audio stimulus (e.g. music) or an artificial test signal (e.g. noise). This can be done by either *on-line testing* in the large signal domain using the normal power test stimulus or by *intermittent testing* interrupting the power test and performing separate small signal measurements. Any form of long-term monitoring requires multiple measurements where the results (tables, curves) are stored in multiple operations and databases.

The tool *DB Extract* collects measurement results distributed in multiple operations in one or more databases using a unique identifier assigned to each device under test (DUT) and performs post processing and a proper visualization of the data. The capability of a *Scilab* script may be used to calculate the voice coil temperature considering the ambience and the starting condition, variation of the resonance frequency, stability of the voice coil rest position and many other small and large signal parameters. Long-term monitoring with *DB extract* is for example the ideal basis for studying aging of the mechanical suspension.



CONTENTS:

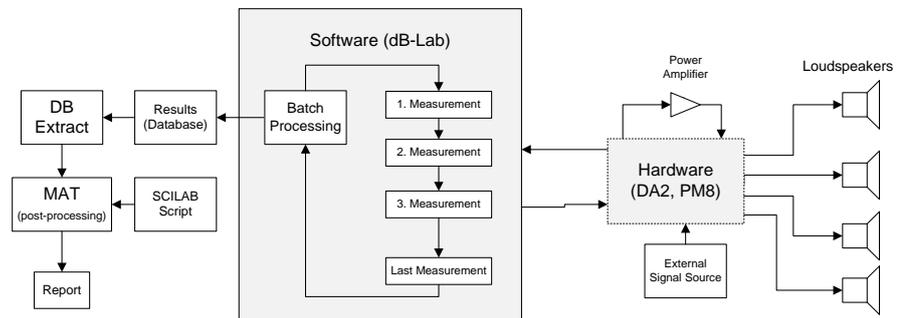
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Overview

Objectives

- Power test (PWT) using any external stimulus (music) or internally generated test signals (noise, sweeps, two-tones)
- On-line measurement (PWT) of loudspeaker parameters and state variables (voice coil temperature, displacement, electrical signals at the terminals) in the large signal domain
- Intermittent testing to determine the small signal T/S parameters (e.g. resonance frequency) using an optimal multi-tone stimulus
- Extraction and collection of the measurement results of multiple measurement operations stored in one or more databases
- Post-processing to visualize and enhance the important information (e.g. derived parameters)
- Report generation based on an HTML-template

Components



Hardware:

- Distortion Analyzer DA2 (limited to 2 speakers) or Power Monitor PM8 (monitoring 8 speakers) are required as measurement platform with four-wired speaker cables
- Power Amplifier(s) capable for driving the loudspeakers in the large signal domain with SPEAKON amplifier cable
- External signal source (e.g. CD-Player) is optional with XLR cable

Software

- dB-Lab software version 204 or higher supporting batch processing of multiple measurement operations
- Power Test Module (PWT) to perform long term testing with internal or external signal
- Linear Parameter Measurement (LPM) to measure T/S parameters in the small signal domain
- *DB-Extract* to extract results of multiple operations stored in one or more databases
- MAT module to perform post-processing of the accumulated data

Measurements in dB-Lab

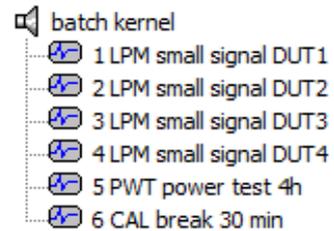
Start Up

The following software is required to run long-term monitoring tests on your PC:

- Install the Klippel R&D analysis software on your computer (204 or higher)
- Install the MAT/CAL script *pause.klpack* to generate recovery breaks between the measurements

Batch processing

On-line monitoring can easily be realized by using the feature *Batch Processing* provided by *dB-Lab* frame software. All operations (e.g. LPM, PWT, CAL) assigned to the object (e.g. batch kernel) are processed sequentially in a loop. After completing the last measurement, the results are copied into a specified subfolder before starting the next loop.



The example batch comprises four Linear Parameter Measurements (LPM), providing the T/S parameters of each of the four speakers tested. Those measurements use a small multi-tone stimulus and are a part of the intermittent testing.

The Power Test (PWT) operation performs on-line monitoring in the large signal domain using an internal or external signal (e.g. music).

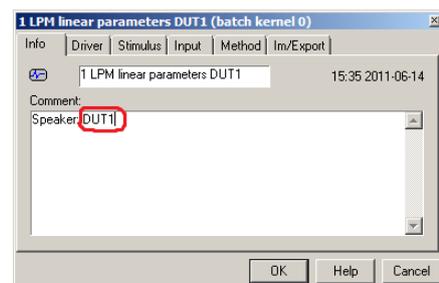
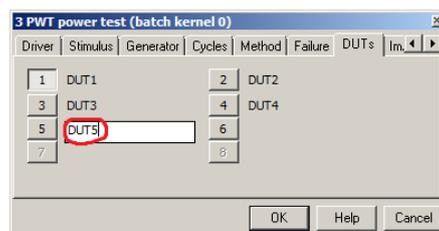
The Calculator Module (CAL) provides a break to ensure that the voice coil temperature of all speakers is in steady-state to ensure proper measurement of the T/S parameters in the following LPM operations.

To include an individual break, generate a default CAL operation and select the script 'Klippel\Basics\pause.klb' in property page *Script*. You may specify the desired time delay in minutes in property page *Input*.

Alternatively, the same effect can be achieved by using a MAT operation with a similar setup.

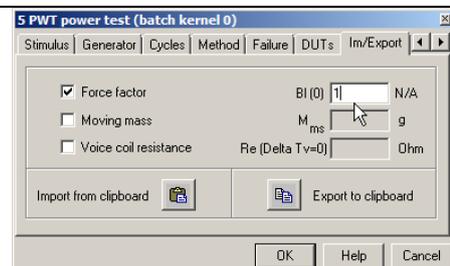
Multiple DUTs

When measuring multiple DUTs at the same time, it is necessary to provide an identifier for each DUT in the LPM or the PWT, e.g. 'DUT1', 'DUT2', ... or the serial number. This DUTname can be specified on property page *DUTs* in the PWT and in the *Comment* field of the LPM.



Import force factor

For a correct estimation of the mechanical parameters it is necessary to import a force factor to the measurements, otherwise no curves of the stiffness or the displacement will be available in the PWT. This value can be set for now to 1 in property page *Im/Export*, all values of BI will be corrected later with a reference value set in the MAT module.



Data Extraction

Motivation

Tests like an intermittent test consist of several independent measurements. The result data is hence stored in separate operations. This complicates a direct analysis of trends during the long-term test. For an easy interpretation of the results, it is necessary to extract and accumulate the results of these operations to display the data in common curves.

This Application Note just illustrates the settings which are specific for the extraction of long-term measurement data using the PWT_Extract script. For more general information about all settings, please refer to AN 43 or the *DB Extract* manual. An example of how to extract a typical database of an intermittent test is presented in the following.

Start Up

For the extraction and accumulation of long-term monitoring results the following additional software is required:

- Install *DB Extract* on your computer (1.13 or higher)
- Execute the file *PWT_Extract.klpack* to install all necessary MAT filter scripts for the extraction

Select database files

How to do it: Start *DB Extract* and create a new settings file by selecting *Settings* → *New* or load the provided standard settings file 'PWT_Extract.kxdbsettings'. Add the database(s) containing the data to be extracted in the tab 'Select Database Files'.

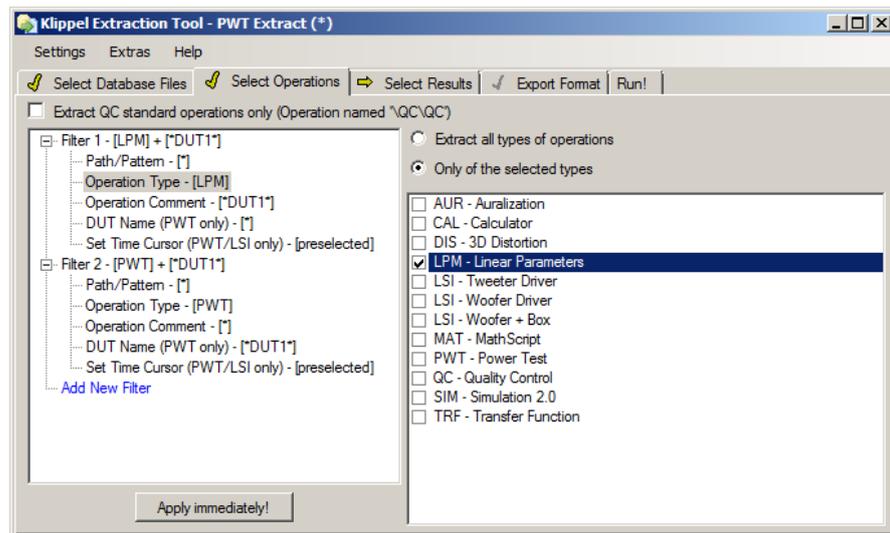
Select operations

DB Extract can only extract the data of one DUT at a time. Therefore it is necessary to specify the data of the DUT to be extracted before the extraction process.

How to do it: Go to the next tab page *Select Operations* and uncheck the checkbox 'Extract QC standard operations only'. To select one DUT which is specified in both the LPM and the PWT as described above, two filters are needed.

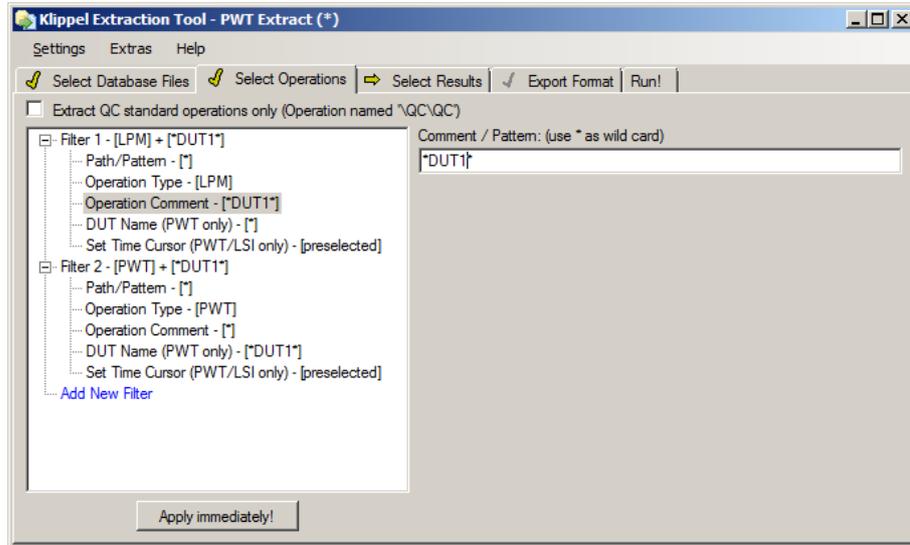
In *Filter 1* select the Operation Type LPM (and/or LSI if desired) as illustrated in the figure below.

Repeat this step for *Filter 2*, but select PWT Power Test as Operation Type for this filter.



Select DUTs

The identifier of the DUT should be saved in the comment field of each operation, hence, it needs to be entered in *Operation Comment* in *Filter 1*. If additional information is written in the comment field, the identifier should be enclosed by asterisk symbols (*).

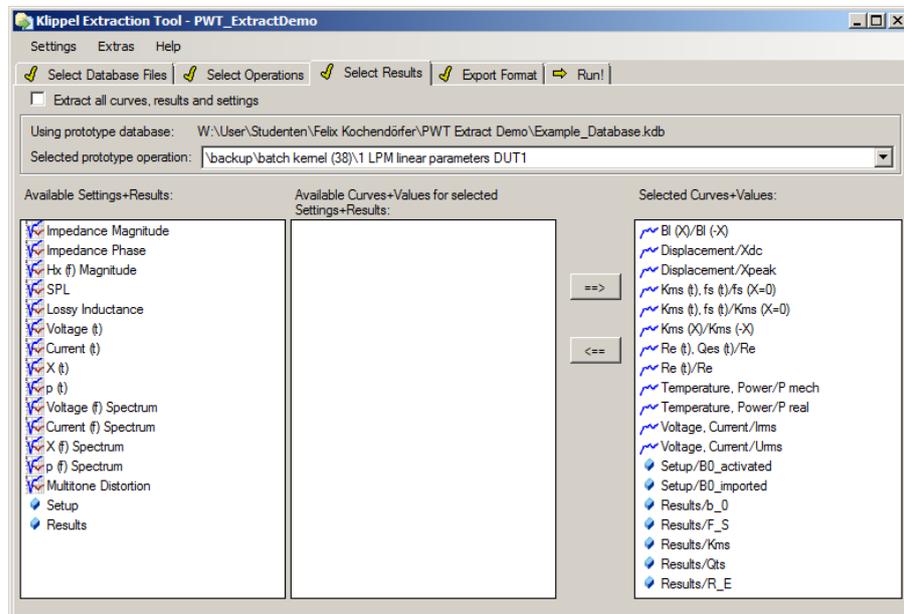


This step shall be repeated for the second filter specifying the PWT. However, the identifier shall be written in the field *DUT Name* here.

Select results

Besides the curves and the measurement results, several additional parameters are required for the extraction. For this reason we recommend to select all parameters as shown in the example settings file 'PWT_Extract.kxdbsettings'. This will ensure that all available parameters and curves will be extracted and presented in the resulting database.

The figure below shows the maximum number of parameters which will be used for the extraction. If not required or available, single parameters may be removed from that list. Other parameters than those presented here will however not be considered.



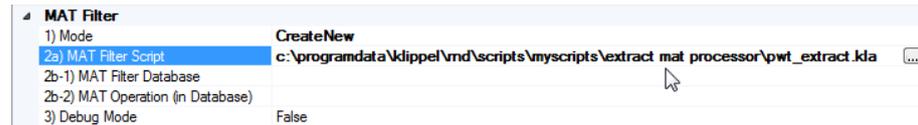
Export format

The Export Format tab offers a lot of options, hence only the most important will be explained in the following. In order to avoid overwriting of previously extracted data, it is recommended to specify a new Target Folder for the extraction results.

The extraction procedure presented here requires a special MAT Filter which can be selected in two ways:

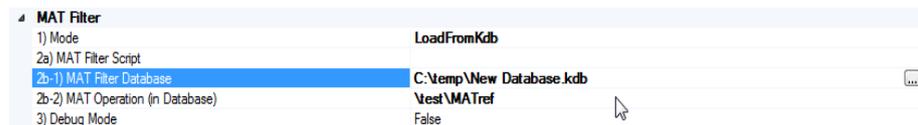
The first option is to select the MAT processing script directly. With this setup, no special options for the post processing can be selected beforehand. The script will run with the default settings, but the post processing can be started again later.

Select CreateNew as MAT Filter Mode and specify the path of the script 'PWT_Extract.kla' in point 2a) MAT Filter Script. The location of the script depends on the used operating system.



If you already have a dB-Lab database with a MAT operation of this script (e.g. from a previous extraction), it is also possible to reuse the settings made to this operation in the post processing of the next extraction process.

The Mode of the MAT Filter needs therefore be set to LoadFromKdb and the path of the database shall be specified in 2b-1). Additionally the path of the MAT operation is required as well since the database may contain several operations.



Run the Extraction

If all parameters are setup properly (please refer to the example settings 'PWT_Extract.kxdbsettings') the extraction should start immediately after clicking Run! in the next tab. However, the whole extraction process may take some time dependent on the size of the database(s) to be extracted.

At the end of the export, dB-Lab will be opened automatically with the MAT operation containing the result data.

Extracted Results

If available in the results of the PWT, LSI or LPM measurement, following parameters will be extracted and displayed in common curves in the MAT operation:

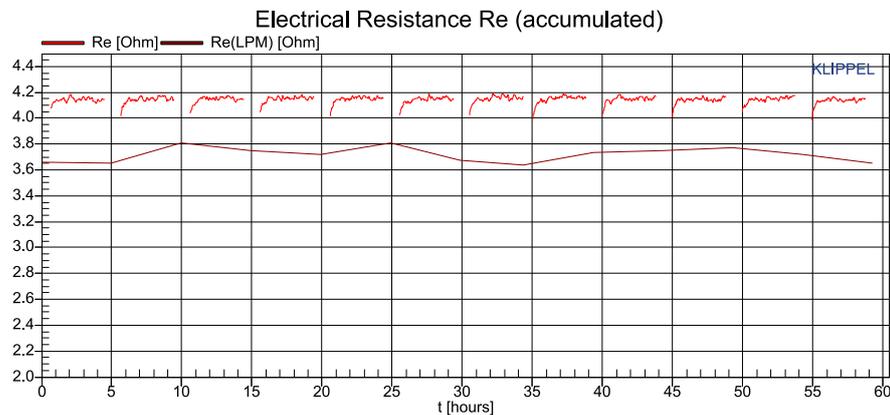
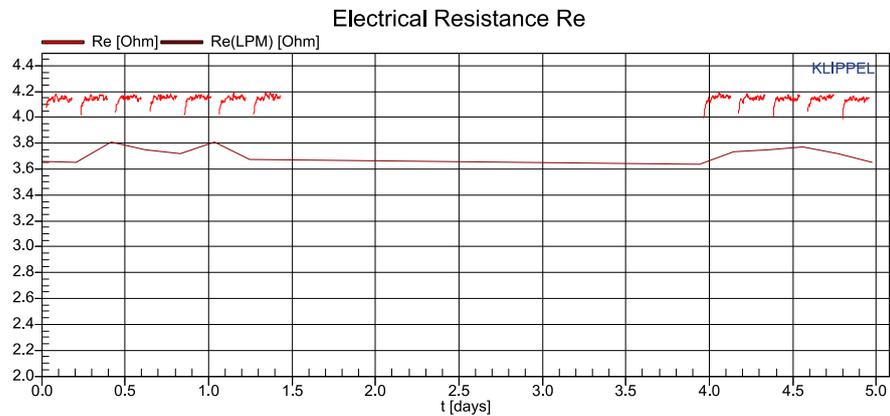
- Resonance frequency f_s
- Electrical Resistance R_e , Voice Coil Temperature ΔT_v
- Mechanical Stiffness K_{ms}
- total loss factor Q_{TS} (LPM only)
- Electrical and mechanical Power P_{real} , P_{mech} (PWT, LSI only)
- Voltage U_{rms} , Current I_{rms} (PWT, LSI only)
- Displacements X_{peak} , X_{dc} (PWT, LSI only)
- Displacement limits $X_{max}@Bl=82\%$, $X_{max}@C_{ms}=75\%$ (PWT, LSI only)

Small signal and large signal parameters (e.g. K_{ms} , f_s) will be displayed in different graphs in the same window. The relative voice coil temperature will be referred to the temperature of the very first measurement in the database.

Result Curves

The results as specified before are presented in different Result Curves. A list of the available curves is shown in the *Result Variables* window.

Some curves are presented in different time formats: real-time and accumulated time. The only difference between both formats is that accumulated curves do not contain breaks longer than one hour between the measurements. They are removed for a better overview of the data. (see example below)



Post-processing

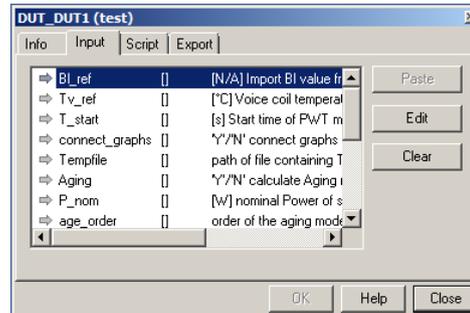
MAT

The Mathematical processing module (MAT) uses a Scilab script to perform additional post-processing of the accumulated data.

This is very convenient to compare the voice coil resistance measured in separate PWT and to calculate the voice coil temperature in degree Celsius as an absolute value. The relative value provided by the PWT is the increase of the voice coil temperature referred to the initial temperature of the voice coil when the power test is started.

Additional Settings

In property page Input of the MAT module it is possible to set some additional parameters for post processing which will be considered in the next run of the script:



BI_ref: For an estimation of the mechanical parameters the value of the force factor BI needs to be known, since measurements with a laser or microphone are not convenient for a long-term power test. The value of BI should be constant during all tests for one speaker, however it can be setup differently in the different operations. To ensure a consistent force factor value and to be able to correct the force factor used for the calculation of the mechanical parameters, the parameter *BI_ref* needs to be specified. The default value of this reference force factor is 1 N/A.

Tv_ref: The voice coil temperature is calculated using the relative variation of the the voice coil resistance. Since the resistance at a defined temperature is unknown, the voice coil temperature can normally just be displayed as a relative variation (ΔT_v) compared to the first measurement. In order to obtain absolute values of T_v it is possible to import the temperature (in °C) of the first measurement in the database.

alpha_Re: It is possible to specify the temperature coefficient of the voice coil temperature manually. The default value is 0.0039 1/K, which is valid for both copper and aluminum voice coils.

T_start: Every Power Test (PWT) has an initialization mode before the start of the main measurement. The measures during this initial identification are obtained at different levels and are eventually not useful for the analysis. The parameter *T_start* allows to select the start time of the main measurement. All data obtained before will be neglected in the result curve.

connect_graphs: The curves of several PWT operations are separated in order to distinguish easily between the different measurements. You may unselect this option by entering 'N' (no). This way all graph of the same measure will be connected.

Tempfile: The complete path of the logfile containing additional climate information can be entered here as a string. The file needs to have the format as specified below, but can also contain just three columns, if no humidity data is available.

Aging: It can be selected whether the aging model and the corresponding parameters will be calculated. Options are 'Y' (yes) or 'N' (no). If 'N' is selected (default), the post processing will skip this estimation which will save some post processing time.

P_nom: This value is just used as additional information for the aging model. By entering the nominal power of the speaker, the value T_{90} will be displayed. This represents the time, after which the stiffness has been reduced already by more than 90% of the total shift, when the driver is excited with the nominal power. This illustrates how long the speaker needs to be burned-in to reach stable conditions.

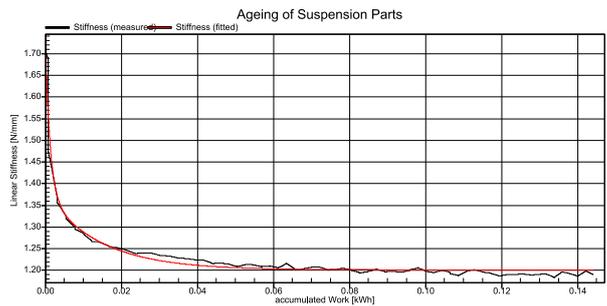
age_order: For a better least square fitting, you may choose the order of the nonlinear curve for approximation. Default value is 2, but you may also select an order of 3, which however does not provide the complete results. See below for further information.

Aging Model

The MAT module is a perfect tool for investigating the aging of the mechanical suspension and to fit an aging model to the accumulated mechanical stiffness K_{ms} and power P_{mech} . The aging parameters calculated by the Scilab script of the model will be displayed and additional aging parameters will be extracted. For more information about the model and the parameters see [3]. The decrease of the stiffness as a function of the mechanical work can be described by the following equation with the order N :

$$\Delta K_{ms}(W_m) = \sum_{i=1}^N C_i (1 - e^{-W_m/w_i})$$

The Result Curve 10 will display the decrease of the stiffness as a function of the mechanical work applied to the speaker. The measured data will be used for a nonlinear least square approximation, the result of this approximation is displayed in the same curve. Additional parameters such as the work constants $W_{s,90}$, $W_{s,50}$ which indicate the burn-in behavior of the stiffness or the total expected stiffness shift $K_{ms,\infty}$. More information about these parameters can be found in [3].



Model Parameters			
C_1	.3581878 N/mm	W_1	.0012688 kWh
C_2	.1756835 N/mm	W_2	.0144147 kWh

Derived Parameters			
K_{∞}	1.2008193 N/mm	V_B	30.776168 %
W_{50}	.0015792 kWh	V_f	10.127654 %
W_{90}	.0172115 kWh	R_b	67.092542 %
T_{90}	13.597138 h		
$P_{m,mean}$.4648777 W		

Fitting Precision	
LSq_{error}	.0644216 N/mm
$grad_{end}$.0522924 N/mm kWh ⁻¹
$deltaK$	-.0096986 N/mm
A_{end}	99.998506 %

Import of external climate data

The MAT processing script allows to import climate measurements from an external source. The results need to be stored in a log file specifying date and time of the measurement. It is possible to import the temperature only or temperature and relative humidity together. The data needs to be tab-separated and provided in a defined format as presented in the example:

Date	Time	Temperature	Humidity
12.06.2011	12:00:00	22.5	35.6
12.06.2011	12:05:12	21.2	36.8
12.06.2011	12:10:24	20.9	40.2
12.06.2011	12:15:36	23.1	39.4

More Information

- Related Application** [1] AN 43 – Data extraction and post processing
Notes /Specifications [2] S6 – Power Test (PWT)
 [3] Felix Kochendörfer – Long-term monitoring of loudspeaker systems in automotive applications. Thesis of Diploma, Dresden University of Technology

updated Monday, October 08, 2012



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