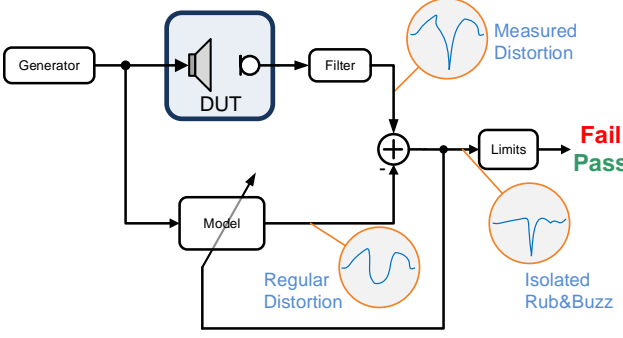


FEATURES	BENEFITS
<ul style="list-style-type: none"> <li>• Extension of regular Rub&amp;Buzz detection method for highest sensitivity</li> <li>• Active compensation of regular distortion</li> <li>• Applicable to                             <ul style="list-style-type: none"> <li>○ Repetitive Distortion (<i>Rub &amp; Buzz</i>)</li> <li>○ Impulsive Distortion (loose particles)</li> </ul> </li> <li>• Ultra-fast testing at physical limit</li> <li>• Automatic limit calculation</li> <li>• User definable Fail classification</li> </ul>	<ul style="list-style-type: none"> <li>• Reliable detection of extremely small defect symptoms</li> <li>• More sensitive than human ear testing</li> <li>• Online loudspeaker diagnostics</li> <li>• Ensures high consistency of production</li> </ul>
 <p>The diagram illustrates the signal processing flow. A Generator provides input to both the DUT and a Model. The DUT's output is filtered, and the Model's output is subtracted from this filtered signal at a summing junction. The resulting signal is then compared against a set of Limits to determine if the unit is a 'Fail' or 'Pass'. Three waveforms are shown: 'Measured Distortion' (top), 'Regular Distortion' (middle), and 'Isolated Rub&amp;Buzz' (bottom).</p>	<p>Some defects in loudspeakers such as loose particles in the gap produce random symptoms, which may be not audible during end-of-line testing. Other defects like voice coil rubbing become worse after some time and may be detected when the transducer is mounted in the car audio system or in any other final application. In order to avoid shipping defective units, irregularities should be detected in manufacturing even if they are inaudible for a human tester.</p>
<p>The Meta-Hearing add-on reveals symptoms of loudspeaker defects, which are masked by the distortion found in good devices. This patent protected technology learns the regular distortion of “good” units by adaptive modeling and uses this knowledge to compensate it in the measured response of new units. This provides up to 20 dB more sensitivity to detect potential problems and reliability issues as early as possible.</p>	

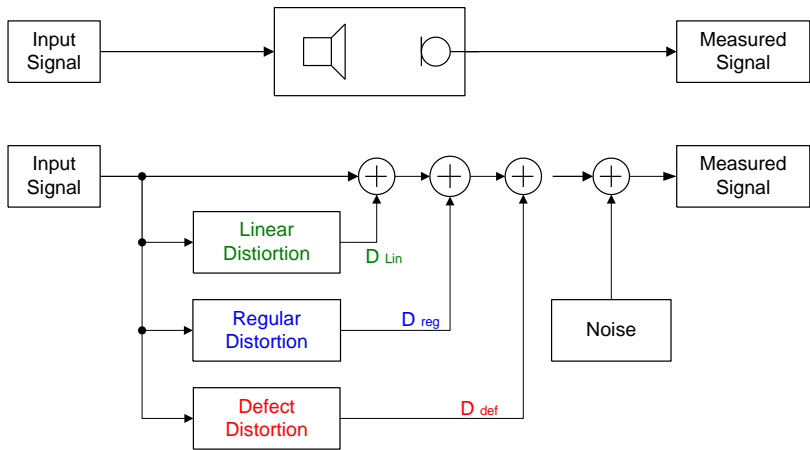
## CONTENT

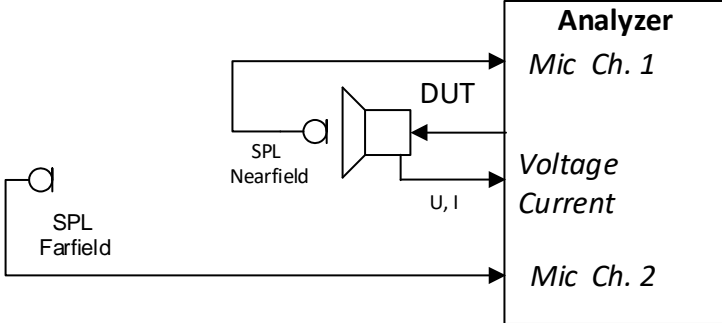
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## 1 Overview

<b>Philosophy</b>	The <b>Rub&amp;Buzz Meta Hearing Technology</b> was developed to separate defects from inherent regular distortion of all drivers and audio systems.
<b>Requirements</b>	<ul style="list-style-type: none"> <li>• Klippel QC Standard Version</li> <li>• 1 Microphone, (2 Microphones for Noise Immunity Add-On)</li> <li>• Power amplifier for passive operation</li> <li>• Fixture for driver and microphone (not supplied by KLIPPEL)</li> </ul> <p>See also specification <i>C3 - QC End of Line Test System</i>.</p> <p>The Meta Hearing Add-On provides considerably more sensitivity for Rub&amp;Buzz detection. It is an extension of the existing Rub&amp;Buzz measure included in the QC standard version.</p>

## 2 Meta Hearing – Superior Rub & Buzz Detection

<b>Background</b>	<p>The response of a DUT (Device under Test) to an input signal can be modeled by the superposition of several distortion components:</p>  <p><b>Linear distortion</b> describe the deviation from unity response, which is the linear, wanted behavior of a loudspeaker (frequency response).</p> <p><b>Regular distortion</b> describe the response of determined-by-design nonlinear behavior (e.g. 2<sup>nd</sup>, 3<sup>rd</sup> order harmonics due to motor or compliance nonlinearity).</p> <p><b>Defect distortion</b> (often called Rub&amp;Buzz) are all unwanted signal components due to production failures, material problems or even design errors (wires hitting the cone). Usually these defects are short-term phenomenon such as clicks, rubbing at a certain excursion or loose particles.</p> <p>Noise is also an unwanted signal but not related to the driver. The influence of the noise from the ambience should be reliably separated from the distortion components (see separate specification <i>S21-Production Noise Immunity</i>).</p>
<b>Standard Method for Rub &amp; Buzz Defect Distortion</b>	Defects have in most cases very low energy and are usually concentrated at one time instant. They can be detected in time domain analysis best, since frequency domain (neglecting phase information) smears these effects over the whole measurement interval. Using time domain analysis, even shortest defects can be detected.

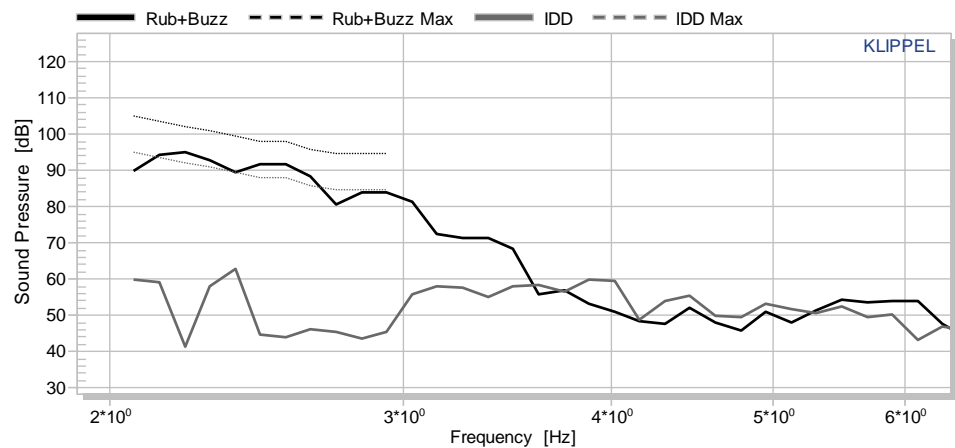
	<p>The defect distortion is separated from regular distortion and the fundamental using a tracking high-pass filter with variable cut-off frequency.</p> <p>This is an effective measure to detect Rub&amp;Buzz defects. However, these measures do not only reveal the defect but are still contaminated with higher-order regular distortion (which are also found on good units) and noise. Testing even smaller defects which are masked by regular distortion the Meta-Hearing-Technology shall be applied (see below).</p>
<p><b>Isolated Defect Distortion (IDD)</b></p>	<p>The <b>Meta Hearing technology</b> (patented in DE 102 14 407, CN 1449136, US) is used to suppress the regular distortion (from motor, or suspension) inherent in the defect distortion and to isolate the distortion (IDD) caused by the loudspeaker defect.</p> <p>This technology is based on a loudspeaker model, which has to be identified by a learning procedure applied to a good unit (e.g. golden unit). The continuous learning procedure provides also a compensation for parameter shifts during production. Thus, loudspeaker with smallest defects (stray units) are detected reliably.</p> <p>These defects may be masked by regular distortion and inaudible for a human tester (Meta-Hearing technology). However, inaudible effects may provide valuable indications for loose particle detection or other defects, which become worse in the final application. The active compensation of the regular distortion provides additional headroom between a good and a defect unit. Limits are easier to define.</p>
<p><b>Production Noise Immunity</b></p>	<p><b>Ambient noise</b> from production may impair the detection of rub&amp; buzz defects for a human or automated tester. Shielding of the test unit by a test box or measurement cabin may help. However, an additional microphone measuring the noise in the far field (1 m distance) is used to predict the <b>Noise</b> level in the near field and to separate the defects from ambient noise disturbances. In case of an external noise disturbance the measurement can be repeated automatically. See also Specification S21 - Production Noise Immunity.</p> 
<p><b>Interpretation</b></p>	<p>The defect distortion (Rub&amp;Buzz), isolated defect distortion (IDD) as well as the production noise level are transparent measures which can be easily compared with the fundamental and THD of the SPL on an absolute scale.</p> <p>Having all criteria related to SPL in one single window allows comparing different defects regarding their occurrence in frequency and interaction.</p>

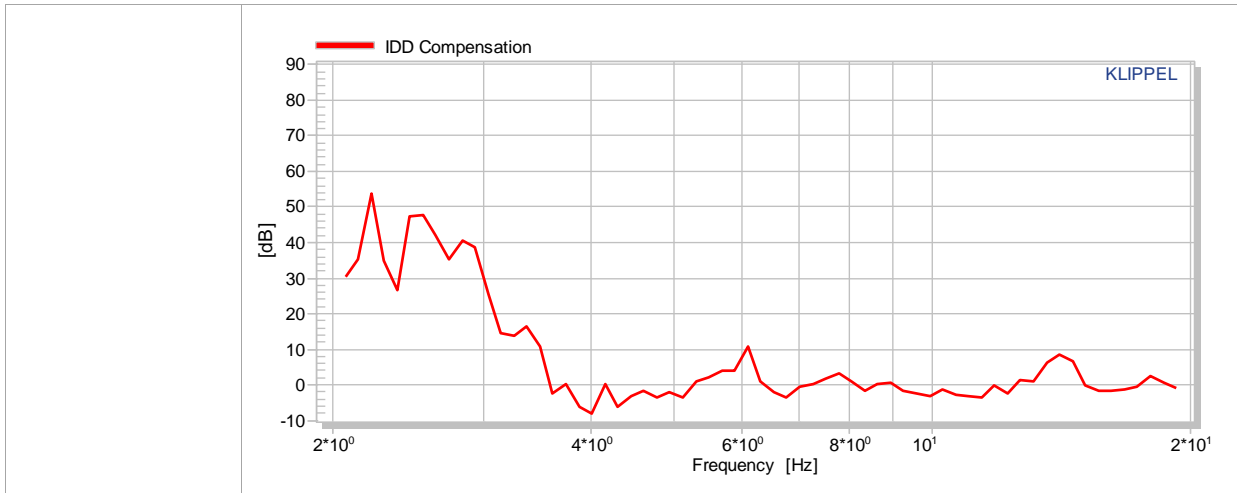
### 3 Input Parameters (Setup)

<b>Activation</b>	The Meta Hearing Module is activated by installing <ul style="list-style-type: none"> <li>• A valid license and</li> <li>• Task <i>Property Page</i> section <i>Processing set RBz – Meta Hearing</i> to ‘on’</li> </ul>
<b>Setup Parameters</b>	The Meta Hearing Add-On uses no dedicated setup parameter. The Rub&Buzz setup parameters are also used for IDD (High-pass, Type).
<b>Display IDD measure and limits</b>	IDD measure and limit are displayed in <i>Frequency Response</i> window only, if the IDD limit is exceeded in the current test. However, the curves can be displayed using the context graphics menu of the chart.  Note: IDD exists only, if limits exist, if MHT module is activated (see above) and if at least 2 DUTs were tested with PASS verdict. This is required to initialize the model of defect distortion.

### 4 Results

<b>Isolated Defect Distortion (IDD)</b>	IDD measure and limit are displayed in <i>Frequency Response</i> window only, if the IDD limit is exceeded in the current test. However, the curves can be displayed using the context graphics menu of the chart.  Note: IDD exists only, if limits exist, if MHT module is activated (see above) and if at least 2 DUTs were tested with PASS verdict. This is required to initialize the model of defect distortion.
<b>Compensation</b>	In <i>Auxiliary</i> window the achieved compensation is shown. This is the difference between the conventional (standard) Rub&Buzz measure and the compensated IDD measure.





## 5 Limits

<p><b>Dynamic Limit</b></p>	<p>The limit of IDD (Isolated Defect Distortion, see above) is calculated automatically from the preceding tests. At the beginning of testing (after log-in) 2 passed tests are required to initialize the IDD check and to learn a Rub&amp;Buzz model of the currently used DUT. Each passed test updates this limit with information of the currently measured DUT, thus the limit is not static but depends on the reproducibility of Rub&amp;Buzz information.</p>
<p><b>Limit Parameters and Verdict Handling</b></p>	<p>There are two options for the verdict if the meta hearing results violates the limit: <b>Warning</b> or <b>Fail</b>. It can be selected on <i>Property Page - Limits</i>, section <i>Rub&amp;Buzz</i>. Warning may be useful for manually operated lines, where a test can easily be repeated.</p> <p>FAIL should be used in automatic lines for low cost products, where stray unit detected by MHT module are rejected.</p> <p>There are no dedicated parameters for IDD limit. The same parameters used for Rub&amp;Buzz are also used to calculate the IDD limit. See also the manual for more details.</p>
<p><b>Display Limits</b></p>	<p>See above “Display IDD measures”.</p>

## 6 Applications

<p><b>Transducer Production Line</b></p>	<p>Right after production EOL the units are extremely similar. Not only the linear properties but only the nonlinear properties (voice coil position, suspension properties) are almost identical. This makes the Meta Hearing Technology ideal for using. Any reproducible high order harmonic distortion can be effectively compensated. Thus, the sensitivity of defect detection is enhanced even below the hearing threshold.</p>
<p><b>(Sub) Woofer</b></p>	<p>Especially woofers with a large linear range should be tested with Meta Hearing. The reason is the sudden drop of Bl, if the voice coil is moving out of the gap at high level. This causes high harmonic distortion, even 20-50<sup>th</sup> order are not unusual. To keep sufficient energy for the defect detection, those high order harmonic distortion can be compensated and hence the sensitivity for smallest defects can be enhanced.</p>

## 7 Patents

Germany	P10214407
USA	7,221,167
China	03108708.6

Find explanations for symbols at:

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

Last updated: January 28, 2020

