R&D SYSTEM USER'S GUIDE 分析仪系统用户指南

Large Signal Identification 大信号辨识

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LSI-Tutorial LSI 指南

What is the goal of this tutorial?

指南的目的是什么?

This tutorial makes you familiar with the Large Signal Identification module.

该指南将引导您熟悉 Large Signal Identification (大信号辨识) 模块。

Since this measurement goes far beyond the well-known Thiele-Small Parameters, valuable information can be gained by analyzing the driver at high displacements.

由于除已知的 Thiele-Small 参数以外，该测量满足更多的需求，因此宝贵的信息可通过在位移较大处分析扬声器单体得到。

The tutorial is divided into three parts:

该指南分为三个部分。

Part one will examine existing results of the example database, that comes together with the software.

部分一将检验例样数据库中软件自带的已有结果。

Part 2 will guide you through your first measurement, which runs almost automatically.

部分二将带领您完成几乎是自动运行的首次测量。

Part 3 gives valuable background information on customizing the measurement according to your needs.

部分三将按照您的需求，给出与定制测量相关的有价值的背景信息。

Part 1: Viewing Results

部分一: 查看结果

What happens at high displacements?

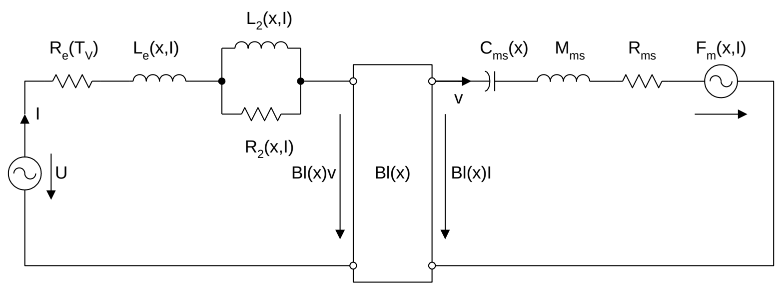
在位移较大处发生了什么？

At higher amplitudes loudspeakers produce substantial distortion in the output signal generated by nonlinearities inherent in the transducer. The LSI allows to identify these nonlinearities and relate them to physical mechanisms, particular design, material properties and assembling techniques of the transducer.

在振幅较大处，扬声器在输出信号上产生了由电动换能器固有的非线性特性生成的大量失真。LSI 允许辨识这些非线性特性并把它们与电声换能器的物理机制，详细设计，材料性能和装配技术联系起来。

The model used to describe the large signal behavior is closely related to the small signal model:

用于描述大信号行为的模型与小信号模型是密切相关的:



The main nonlinearities can be described by the variation of inductance, force factor, and compliance over displacement. The LSI can identify additional nonlinearities (not all shown here), and the thermal behavior of a transducer. You find a more detailed discussion in the reference, and additional material on our web site.

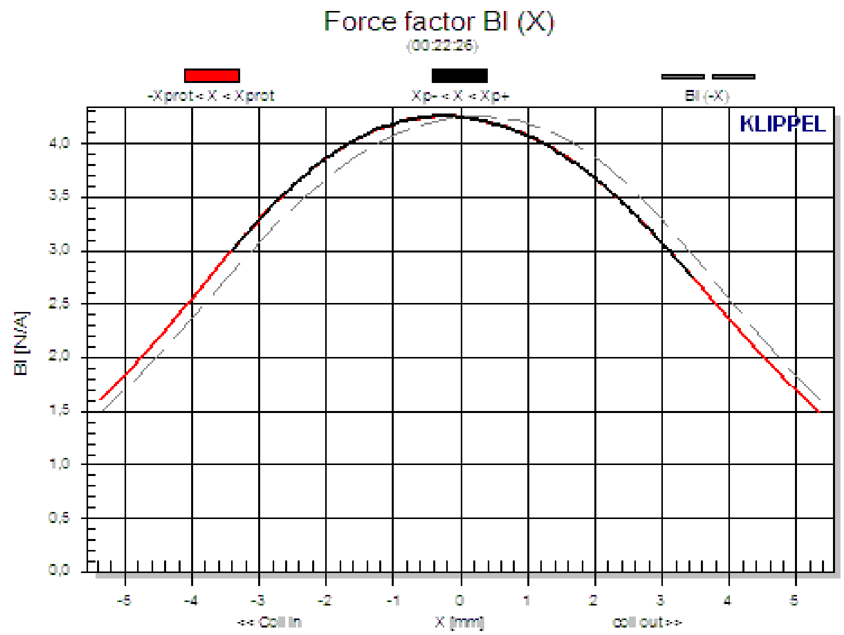
主要的非线性特性通过位移方向上的电感，力因数和顺性的变化来进行描述。LSI 可辨识电动换能器额外的非线性特性 (没有全部显示在此) 和热性能。您可以在 reference 中找到更多的细节讨论，并在我们的网站上查看到补充资料。

Force factor Bl(x)

力因数

From the example database, open the *Multimedia Woofer* and double-click the *LSI woofer* operation to display the most important windows (see dB-Lab Tutorial for more information).

从例样数据库中打开 *Multimedia Woofer* ，并双击 *LSI woofer* 操作以显示最重要的窗口 (更多信息请参见 dB-Lab Tutorial)。



The electrodynamic coupling factor, also called Bl-product or force factor *Bl(x)*, is defined by the integral of the magnetic flux density *B* over voice coil length *l*, and translates current into force.

电动耦合系数，也可称作 Bl-product 或力因数 *Bl(x)*，定义为磁束密度 *B* 沿着音圈长度方向 *l* 的积分值，并可将电流转换为力。

In traditional modeling this parameter is assumed to be constant. The force factor *Bl(0)* at the rest position corresponds with the *Bl*-product used in linear modeling.

在传统的模型中，该参数假定为接近恒定。静止位置的力因数 *Bl(0)* 与使用在线性模型中的 *Bl*-product 一致。

The red curve displays Bl over the entire displacement range covered during the measurement. You see the typical decay of Bl when the voice coil moves out of the gap.

红色曲线显示了测量期间覆盖整个位移范围的 Bl。您可以看见当音圈移出磁隙后，Bl 的典型衰减。

At the end of the measurement, the black curve shows the confidential range (interval where the voice coil displacement in this range occurred 99% of the measurement time). During the measurement, the black curve shows the current working range.

在测量的尾声，黑色曲线显示了保密范围(在该范围内音圈位移随测量时间出现机率大约为 99%的区间范围)。测量期间，黑色曲线显示了电流的工作范围。

The dashed curve displays Bl(x) mirrored at the rest position of the voice coil – this way, asymmetries can be quickly identified.

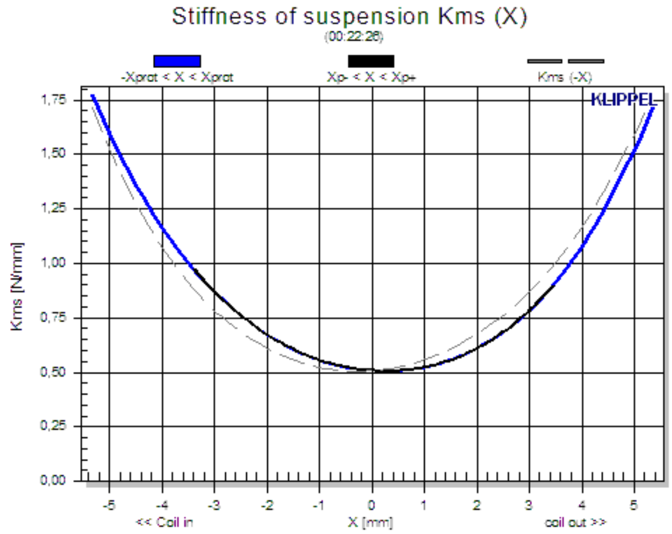
虚线显示了音圈静止位置 Bl(x) 的镜像特性曲线。这样，可迅速地识别出 Bl(x)非线性特征的不对称性。

Since a laser was connected during the measurement, a "coil in / coil out" marker is displayed on the bottom left / bottom right.

由于测量期间连接了激光，"coil in / coil out" 标记显示在 bottom left / bottom right (左下角/右下角)。

Stiffness $K_{ms}(x)$

劲度 $K_{ms}(x)$

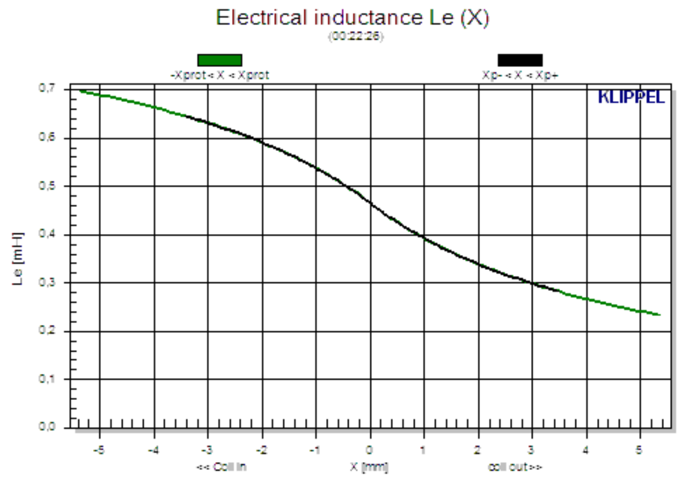


The stiffness $K_{MS}(x)$ describes the mechanical properties of the suspension. It's inverse, the compliance $C_{MS}(x)$, is also available as result window.

劲度 $K_{MS}(x)$ 描述了悬挂系统的力学特征。它的逆，也就是顺性 $C_{MS}(x)$，也可作为结果窗口。

Inductance L_e (x)

电感 L_e (x)



The electrical properties of the voice coil is described by the inductance $L_e(x)$, the DC resistance $R_e(T_v)$, and the parainductance $L_2(x)$ and $R_2(x)$, describing the effect of eddy currents in the conductive parts close to the voice coil.

音圈的电学特征通过电感 $L_e(x)$，直流电阻 $R_e(T_v)$ 和次电感 $L_2(x)$和电阻 $R_2(x)$ 来进行描述，其显示了靠近音圈位置在导电部件中的电涡流的效应。

The inductance L_e (x) of most drivers has a strong asymmetric characteristic. If the voice coil moves towards the back plate the inductance usually increases since the magnetic field generated by the current in the voice coil has a lower magnetic resistance due to the shorter air path.

大多数扬声器单体的电感 L_e (x) 具有强大的不对称性特性。如果音圈朝导磁下板方向移动，电感通常会增加，这是因为由于过短的气道，音圈中的电流产生的磁场具有小的磁电阻的缘故。

Viewing Results of LSI Pro

查看 LSI Pro 结果

The LSI module comes in two different versions: Lite and Pro.

LSI 模块有 2 种不同的版本: Lite 和 Pro。

The Pro version offers a much more detailed result, together with the ability to go back in time to review the adaptive identification process, and how parameters change over time.

Pro 版本提供了更详细的结果显示，且具有随时返回能力以回顾自适应辨识过程，并告知怎样随时间改变参数。

Existing results from LSI Pro can be viewed with the Demo-Version of dB-Lab. However, an LSI Pro license is needed to acquire results with extended Pro functionality.

LSI Pro 中的已有结果可通过 dB-Lab 的 Demo-Version 查看。然而，LSI Pro 许可则需与扩展的 Pro 功能一起进行结果采集。

Additional results

额外的结果

Click the ✕ **Close All Windows** button in the result window list, then double-click the *LSI – Large Signal Identification (Pro)* operation in the project window. This opens the defaut windows for the operation - the major nonlinearities, plus the *Temperature, Power* result window (P, T over time).

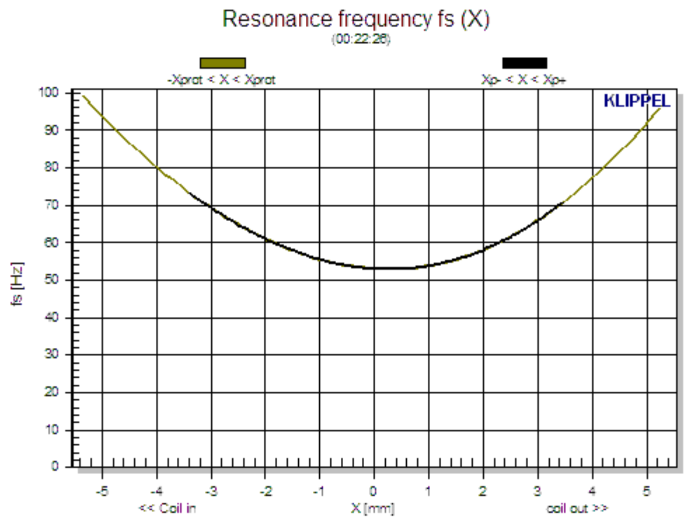
在结果窗口列表中按 **Close All Windows** 键，然后在项目窗口中双击 *LSI – Large Signal Identification (Pro)* 操作。这就打开了操作的默认窗口 - 主要的非线性特性，加上 *Temperature* (温度)，*Power* (功率)结果窗口(随时间变化的 P,T)。

You see that the result window list in the lower left has more results available than the LSI Standard measurement.

您可以看见，左下角的结果窗口列表比 LSI Standard 测量具有更多的可用结果。

Open the f_S(x) Result window:

打开 f_S(x)结果窗口:



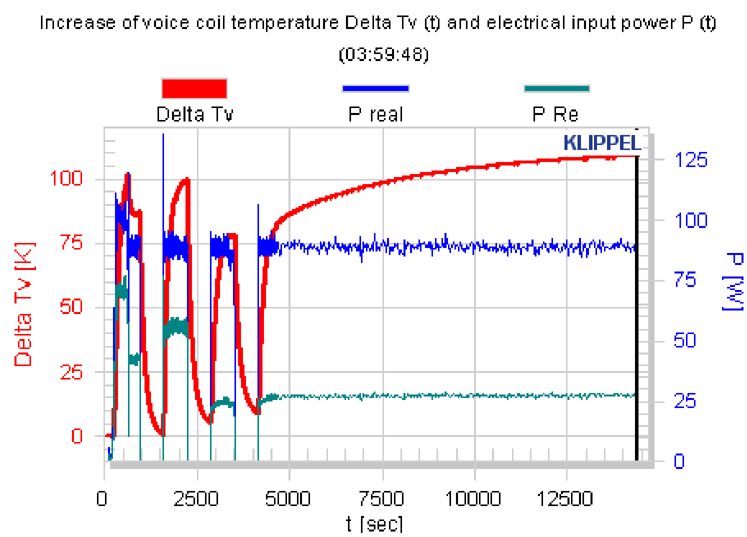
You see the increase of the resonance frequency due to increased stiffness at higher displacements.

您可以看见，在高位移处由于增加的劲度而增加的谐振频率。

For details of the additional results available, please refer to the reference, or the specifications available from www.klippel.de

对可用的额外结果的细节，请参阅 reference 或 www.klippel.de 中的说明。

Viewing the History
查看历史纪录



This result window shows the increase of the voice coil temperature ΔT_V and the electric input power *P(t)* versus measurement time, and different powers related to the thermal model.

结果窗口显示了音圈温度ΔT_V和电输入功率 *P(t)* 相对于测量时间的增长，以及与热模型相关的不同功率。

You also see a bold black “time cursor” to the far right. You can drag it with the mouse, or click into the chart and move it with the Cursor left/right keys while holding down Ctrl.

您同样可以看见最右边的粗体黑字“time cursor” (时间光标)。您可以用鼠标拖住它，或点击进入图标，并同时按住 Ctrl 键，用 Cursor (光标) 左/右键移动它。

When you move the time cursor around you see the other windows change their display to reflect the state of the driver at the selected time. This allows you to review the identification process, and the changes of parameters over time with increasing amplitude.

当您移动周围的时间光标，您看见其他的窗口改变它们的显示以反映出选定时间点上的扬声器单体状态。这允许您回顾辨识过程和随增加的位移基于时间上的参数的变化。

The time cursor is available in all windows where *x*-axis denotes measurement time.

时间光标适用于所有 x 轴表示测量时间的窗口。

Nonlinear Parameter, Displacement Limits 非线性参数，位移门限

Open the *Nonlinear Parameters* result window. It contains a table with important nonlinear parameters, such as the polynomial coefficients for the Bl(x), L_E(x) and C_{MS}(x) curves, and the displacement limits.

打开 *Nonlinear Parameters* (非线性参数) 结果窗口。它包含了带重要非线性参数的表格，如 Bl(x), L_E(x)和 C_{MS}(x)曲线的多项式系数以及位移门限。

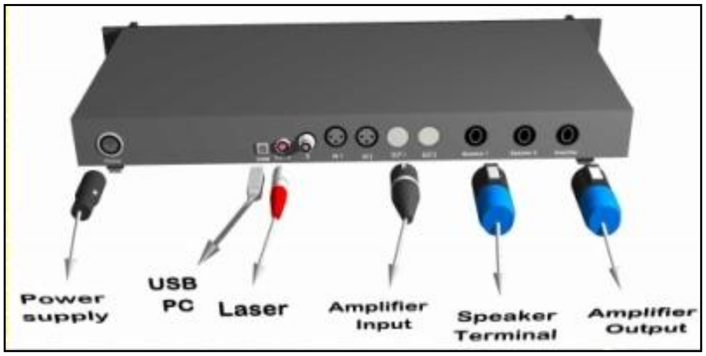
Parameters like these can be exported to the clipboard on the Im/Export property page.

诸如此类的参数可导出到 Im/Export 属性页的剪贴板上。

Part 2: Do your first Measurement 部分 2: 执行您的首次测量

Setting up the Hardware

设置硬件



Note: Relevant connectors are at the back side of the device (except USB).

注: 相关的连接器都在设备的背面 (USB 除外)。

1. Connect the Distortion Analyzer with the power supply delivered by Klippel.
   连接失真分析仪与 Klippel 自带的电源线。

2. Connect OUTPUT 1 (XLR, symmetric signal) to the input of your power amplifier. This cable is not distributed by Klippel since there are to many Amplifier input connectors available on the market. Please use you own specific cable.
   连接 OUTPUT 1 (XLR, symmetric signal 对称信号) 到功放的输入端。由于市面上有很多的功放输入连接器可用，因此该线不由 Klippel 配备，请使用您自己具体的接线。

3. Connect the Amplifier output to the Speakon connector AMPLIFIER of the Distortion Analyzer.
   连接功放输出端到失真分析仪的 Speakon 接头 AMPLIFIER。

4. Mount the driver in the driver stand or in a baffle.
   在扬声器立架或挡板上安装扬声器单体。

5. Connect Speakon connector SPEAKER 1 to the terminals of the driver or loudspeaker. Use the SPEAKER cable (having a Speakon at one end, and clips at the other) coming with the system.
   连接 Speakon 接头 SPEAKER 1 到扬声器或音箱的端口。使用系统自带的 SPEAKER 线 (一头带 Speakon，另一头带夹钳)。

6. A Laser Displacement Sensor can be connected to the LASER input to enable the identification of the mechanical parameters.
   激光位移传感器可连接到 LASER 输入端，以允许力学参数的辨识。

7. Connect the PC to the USB port.
   连接 PC 机至 USB 端口。

Note: The LSI uses a protection system that adapts well to a wide range of drivers. Before using a very small driver with a low impedance, please see "Protection Parameters" in Tutorial 3 or the Reference for adjusting protection limits and small signal gain.

注: LSI 使用一适应于广泛的扬声器单体的保护系统。使用带低阻抗且非常小的扬声器单体前，请参见指南第 3 部分的"Protection Parameters" (保护参数) 或 Reference (参照)，获取有关调整保护门限和小信号增益的相关信息。

Safety Information: The LSI can be used for destructive testing to determine the maximal limits (power, temperature, voltage, displacement) which are permissable for the drive unit. The user is responsible to comply with safety requirements. Note that overload of the driver may cause a fire hazard.

安全信息: LSI 可使用于无损检测，以测定扬声器单元允许的最大门限 (功率，温度，电压，位移)。用户有责任遵守安全规定。注意扬声器单体的过载可能导致火灾的危险。

Using a Laser
使用激光

CAUTION LASER RADIATION !

小心激光辐射！

Avoid direct or indirect (e.g. reflection) exposure of human eyes to beam !

避免人眼到光束的直接或间接 (如反射) 接触！

See section *Using a laser sensor* in the *hardware* manual for basic information about laser measurements.

参见 *hardware/ Using a laser sensor* 中有关激光测量的基础信息。

1. Connect the laser head via the laser controller to the connector LASER at the rear side of the hardware unit.
   经激光控制器连接激光头到位于硬件单元背面的接口 LASER。

2. Make a dot of white ink (correction fluid) on the diaphragm and adjust the Laser to this point.
   在膜片上标记一白点(涂改液) 并调整激光到该点位置。

3. Ensure that the rest position of the diaphragm is in the middle of the lasers working range.
   确保膜片的静止位置在激光工作范围的中间位置。

Starting from dB-Lab
从 dB-Lab 开始

To become familiar with the LSI-module you should start the measurement by using dB-Lab. In dB-Lab, create a new object with an LSI operation. (More information can be found in the dB-Lab Tutorial and reference):

要想更熟悉 LSI 模块，您应该通过使用 dB-Lab 开始进行测量。在 dB-Lab 中，创建带 LSI 操作的新对象。(更多信息可在 dB-Lab Tutorial 和 reference 中找到):

In dB-Lab Pro, click Create/Open Project select a folder to work in, and click OK. Then click New Object.

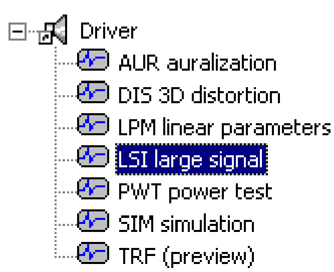
在 dB-Lab Pro 中，点击 Create/Open Project (创建/开启项目)，选择一文件夹进行工作，并点击 OK。再点击 New Object (新对象)。

In dB-Lab Lite, click Open Object, in the browse dialog, click *New*... to create a new object, open the new object.

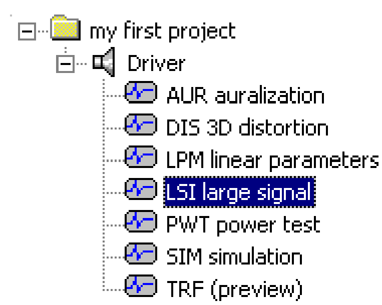
在 dB-Lab Lite 中，点击 Open Object (打开对象)，在浏览对话框中，点击 *New*...来创建新对象，并打开新对象。

Note: LSI is available in three different versions (Woofer, Woofer+Box, Tweeter). You can follow this tutorial with any of these as long as you have a licence. For more information, see "LSI Versions" in the Reference

注: LSI 适用于 3 种不同的版本(Woofer, Woofer+Box, Tweeter)。只要有许可，您可以遵循该教程选择使用任何一种版本。更多的信息，请参见 Reference/"LSI Versions"。



project window in dB-Lab Lite
dB-Lab Lite 中的项目窗口



project window in dB-Lab Pro
dB-Lab Pro 中的项目窗口

1. In the project window, select the LSI operation.
   在项目窗口中，选择 LSI 操作。

2. Double click on the LSI operation, to open a default set of result windows. Since no data was acquired yet, the charts are empty.
   双击 LSI 操作以打开结果窗口的默认设置。由于还没有采集数据，因此图表是空的。

3. Make sure the Hardware Unit is set up correctly and connected to the PC using the USB cable.
   确保硬件单元已正确设置并使用 USB 线将其连接到 PC 机上。

4. Verify that the settings on the "protection" property page are appropriate for your driver

核实"protection"属性页中的设定适用于您的扬声器单体。

WARNING: Wrong settings can damage your driver. See "*PROTECTION Page*" in the reference section for more information. **Be especially careful with tweeter and telecommunications drivers**

警告: 错误的设定会损坏您的扬声器单体。更多信息请参见 reference/"*PROTECTION Page*"。**请特别注意高音扬声器和通讯用扬声器。**

5. Click Run to start the measurement.
   按 Run 键，开始测量。

The measurement will check the amplifier, and then automatically find the working range based on the default protection parameters. For more information on the protection limits, see Tutorial 3, "Customizing the measurement". For more information on the individual steps of the LSI, see "Modes of Operation" in the LSI reference.

测量将检查功放，接着自动地找到基于默认的保护参数的工作范围。更多有关保护门限的信息，请参见指南第 3 部分的"Customizing the measurement" (定制测量)。更多有关 LSI 单个步骤的信息，请参见 LSI reference/"Modes of Operation" (LSI 参照/操作模式)。

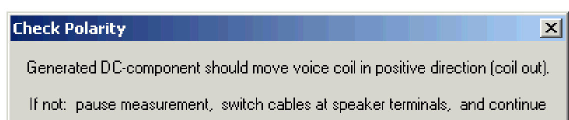
Polarity
极性

Near the beginning of the test, you should verify the polarity of the driver is correct. We recommend that positive displacement represents an outward movement of the voice coil.

测试开始前，您应核实扬声器单体的极性是否正确。我们建议，正位移代表音圈的向外运动。

A DC component is generated in step 2 of the measurement, and the following message is displayed:

类直流成分由测量的步骤 2 产生，以下信息将显示:



Verify that the DC signal moves the voice coil outwards. If not,

核实直流信号向外移动音圈。如果不是，

- Pause the measurement 暂停测量
- Change polarity (switch speaker clamps) 交换极性 (交换扬声器夹钳)
- Continue the measurement 继续测量

If a laser is connected, "coil out" and "coil in" will also be displayed in the respective result windows. Note that this information relies on correct polarity of the laser calibration.

如果激光已连接，"coil out"和"coil in"将在各自的结果窗口中显示。注意，这些信息依赖于激光校准的正确的极性。

Pause Measurement

暂停测量

The measurement can be paused at any time by clicking the Pause button in dB-Lab. To continue, click Pause again.

测量可随时通过在 dB-Lab 中按 Pause 键暂停。要继续，再按 Pause 键。

You can also select STOP from the Processing Unit menu to pause the measurement, and select CONTINUE to proceed.

您同样可从 Processing Unit 菜单中选择 STOP 来暂停测量，选择 CONTINUE 继续测量。

Finish Measurement

完成测量

The measurement can be finished once it reaches the Final Mode (displayed both on the hardware Unit display, and in the **State result window**). By default the measurement continues to run so you can monitor long-term effects.

一旦到达最终模式 (都显示在 hardware Unit display 和 **State result window** 中)，测量完成。默认情况下，测量继续运行，因此您可监测后继效应。

Note: The *Cancel Operation* button changes to Save/Finish when the most important data is available.

注: 当最重要的数据可用时，按钮 *Cancel Operation* 将转变为 Save/Finish。

To save all data, the measurement should be finished from dB-Lab. If you finish the measurement at the processor unit the stored measurement data will be lost.

要保存所有数据，测量应从 dB-Lab 中完成。如果您在处理器单元中完成测量，已存储的测量数据可能会丢失。

Click the Save/Finish button, and choose "Finish Measurement" from the Finish dialog.

按 Save/Finish 键，并从完成对话框中选择"Finish Measurement" (完成测量)。

Part 3: Customizing the measurement

部分 3: 定制测量

Modify the Protection Parameters

修改保护参数

The LSI determines the maximum working range automatically, it uses protection parameters that are adaptive to a wide range of drivers. The default setting is safe for most drivers with 40 Hz < *fs* < 150 Hz, but may be overly protective especially for large ones. For very small drivers (like headphone drivers) you might need to lower the small signal gain, and/or use more restrictive settings.

LSI 自动地测定最大工作范围，它使用适应于广泛的扬声器单体的保护参数。默认设定对大部分谐振频率在 40 赫兹到 150 赫兹之间 (40 Hz < *fs* < 150 Hz) 的扬声器单体是安全的，但也可能过于保护，特别是对较大的扬声器单体。对非常小的扬声器单体(像耳机)，您应该调低小信号增益，并/或使用更具有限制性的设定。

1. Select the LSI operation in the project window.
   在项目窗口中选择 LSI 操作。

2. Click View Properties, and select the *Protection* page, where you can change the protection settings
   点击 View Properties，选择 *Protection* 页面，您可在该页面中改变保护设定。

3. Available Protection Parameters are:
   适用的保护参数有:

- Increase of temperature 温度的增加
- decay of Bl and Cms Bl 和 Cms 的衰减
- input power (real) 输入功率 (真实的)

Note: Smaller values for Bl_{lim} and C_{lim} mean more aggressive measurement.

注: 更小的 Bl_{lim} 和 C_{lim} 值意味着更多的测量。

If you change the protection parameters while a measurement is running, the operation will go back into the Enlargement Mode to adjust the working range based on the new settings.

如果您在测量运行中改变保护参数，操作将返回到 Enlargement Mode (增强模式) 来调整基于新设定的保护参数的工作范围。

Import parameters from LPM

从 LPM 中导入参数

The Large Signal Identification uses only electrical information (current and voltage) at the speaker's terminals to measure the elements of the pure electrical equivalent circuit and the shape of the nonlinear curve for force factor (*Bl*-product), Compliance C_{MS} and Stiffness K_{MS} as relative quantities, e.g.:

大信号辨识在扬声器端口仅使用电气信息 (电流和电压) 来测量纯电气等效电路的元素并且将力因数 (*Bl*-product)，顺性 C_{MS} 和劲度 K_{MS} 非线性曲线的波形作为相对量，例如:

$$C_{MSrel}(x_{rel}) = C_{MSrel}\left(\frac{x}{x_{prot}}\right) = \frac{C_{MS}(x)}{C_{MS}(0)}$$

where x_{prot} is the allowed limit of the displacement detected by the automatic gain adjustment. Thus the relative compliance $C_{MSrel}(x_{rel})$ is displayed in the range $-1 < x_{rel} < 1$. At the rest position holds $C_{MSrel}(x=0)=1$.

x_{prot} 是由自动增益调节检测到的位移的允许门限。因此相对顺性 $C_{MSrel}(x_{rel})$ 显示在范围 $-1 < x_{rel} < 1$ 之间。在静止位置 $C_{MSrel}(x=0)=1$。

The absolute identification of the mechanical parameters (e.g. C_{MS} in N/mm) can easily be accomplished by importing at least one known parameter value (*Bl(0)* or M_{MS}):

1. Open the **IMPORT** property page.
2. Provide the parameter *Bl* and M_{ms} , e.g. from the Linear Parameter Measurement Module (LPM).
   The clipboard may be used for the transfer.
   Open **PP Import/Export** in LPM and press **Export** button
   Open **PP Import** in LSI, press **Import** button

力学参数的绝对辨识可简单地通过导入至少一个已知参数值来完成 (*Bl(0)* 或 M_{MS}):

1. 打开 **IMPORT** 属性页。
2. 提供参数 *Bl* 和 M_{ms}，例如，从线性参数测量模块 (LPM)。
   剪贴板可用于传递参数。
   在 LPM 中打开 **PP Import/Export**，按 **Export** 键。
   在 LSI 中打开 **PP Import**，按 **Import** 键。

Note: You can identify the absolute values also by using a laser. However, importing a mechanical parameter is more accurate and robust, as the Linear Parameter Measurement (LPM) is more immune against measurement noise, vibration of the laser stand at high amplitudes and detects certain malfunctions of the laser (like limiting) automatically.

注: 您也可以使用激光来辨识绝对值。然而，导入力学参数将更准确和鲁棒，因为线性参数测量(LPM)相对于测量噪声，在较高振幅处激光立架的振动更具免疫性并可以自动地检测激光 (诸如门限) 的某些故障。

Defining the end of the measurement

定义测量尾声

By default, the LSI continues to run after identifying the nonlinear parameters, so you can assess long-term variations of the parameters.

默认设置下，LSI 在辨识完非线性参数后继续运行，因此您可评估参数的后继振动。

For a predefined end of the measurement, you may specify the mode of operation in the property page **Condition** where the system is supposed to pause:

1. Open property page **Condition**
2. Select **Thermal Mode** in drop down list **Finish task after**.
3. Restart the measurement

4. After completing the Thermal Mode the measurement will be paused and the message "Task finished" will be displayed.
5. You may finish the measurement by clicking **Finish/Save** or continue by releasing the Pause button.

对于测量的预处理尾声，您可在属性页 **Condition** 中指定操作的模式，该处系统假定为暂停:

1. 打开属性页 **Condition**。
2. 在下拉式列表 **Finish task after** 中选择 **Thermal Mode**。
3. 重新启动测量。
4. 在 Thermal Mode (热模式) 完成后，测量暂停，显示消息"Task finished" (任务完成) 。
5. 您可点击 **Finish/Save** 来完成测量或释放按键 Pause 来继续测量。

Speeding up the measurement

加速测量

The **Condition** page provides ways to expedite the measurement:

- If you are not interested in the thermal parameters, you may select the **Nonlinear Mode** in the property page **Condition** in the **Finish After..** drop-down list.
- If you know that the motor has a equal-length configuration of voice coil length and gap height generating a early decay of the *Bl* product you may shorten the convergence time in the Nonlinear Mode on the **Condition** property page to 1 or 2 minutes without loosing accuracy.

页面 **Condition** 中提供了加快测量的途径:

- 如果您对热学参数不感兴趣，您可在下拉式列表 **Finish After..** 中的属性页 **Condition** 中选择 **Nonlinear Mode**。
- 如果您知道驱动器具有等长的音圈长度配置，并且磁隙高度产生了 *Bl* product 的早期衰减，您可在不丢失准确性的情况下，在非线性模式中的属性页 **Condition** 中将收敛时间缩短至 1 到 2 分钟。

Modify test noise

修改测试噪声

The property **Generator** allows modifying the properties of the noise used as excitation signal.

属性页 **Generator** 中允许修改用作于激励信号的噪声的特性。

The automatic setting optimizes the signal towards best identification of the mechanical parameters, by putting all energy around the resonance frequency for high displacements and relatively low heating. For improved detection of thermal parameters and inductance characteristic, you should select a larger bandwidth.

自动设置通过对大位移和相对低热围绕谐振频率放置所有能量来优化信号以实现最佳的力学参数辨识。对于热学参数和电感特征的改善检测，您应该选择一较大的带宽。

How to get the best performance

如何获得最佳性能

Although the measurement runs almost automatically the setup parameters accessible on the property pages may be used to optimize performance.

虽然测试几乎自动运行，但在属性页上的设置参数可用于优化性能。

Import Bl(x=0)

导入 Bl(x=0)

Although the mechanical parameters may be provided in absolute terms by using a laser head we recommend to import the Bl(x=0) via the property page **IM/EXPORT**. The module Linear Parameter Measurement is dedicated for providing the force factor Bl at the rest position x=0 and for measuring the moving mass. After performing an LPM open the property page **IM/EXPORT** and press the export button. Select the new LSI and open the property page **IM/EXPORT** and press button Import from Clipboard. The Bl(x=0) may be imported at any time (before or after the measurement). Available data will always calibrated automatically.

虽然通过使用激光头，力学参数可以以绝对值形式给出，但我们建议您经属性页 **IM/EXPORT** 来导入 Bl(x=0)。线性参数测量模块致力于在静止位置 x=0 处提供力因数 Bl 以及测量振动空气质量。执行 LPM 后，打开属性页 **IM/EXPORT**，按 export (导出) 键。选择新的 LSI 操作并打开属性页 **IM/EXPORT**，在剪贴板中按 Import (导入) 键。可随时导入 Bl(x=0) (在测量前或测量后)。可用数据总是进行自动校准。

Optimal Noise Bandwidth

优化噪声带宽

During the parameter measurement the internal model is fitted to the transducer by minimizing the error E_i between estimated and measured current. Typically the error E_i will become below 20 % for most drivers at the end of the Nonlinear Mode. Transducers having a high value of inductance or a non-regular frequency response will cause a higher fitting error which will degrade the accuracy of the measurement. However, by adjusting the spectral properties of the used noise signal this effect can be substantially reduced. Here some guidelines to use optimal setup parameters on the property page **GENERATOR**:

- For woofers use pink noise signal and a cut-off frequency of the low pass $f_{low} \approx 20\ f_s$ where f_s is the resonance frequency of the driver.
- For tweeters use white noise and the maximal cut-off frequency $f_{low}= 3\ f_s$.
- Set the cut-off frequency of the high-pass $f_{high} < 0.25\ f_s$ to provide sufficient excitation below resonance.

参数测量期间，内模通过将估计的与实测的电流之间的误差 E_i 最小化来与电动换能器进行拟合。通常，对于大部分扬声器单体来说，在非线性模式尾声，误差 E_i 将低于 20 %。带高电感值或不规则频率响应的电动换能器将引起可降低测量准确性的较大的拟合误差。然而，通过调整被用噪声信号的频谱特性，该影响可显著减少。在属性页 **GENERATOR** 上有一些使用最佳设置参数的指导信息:

- 对于低音扬声器，使用粉红噪声信号，低通截至频率 $f_{low} \approx 20\ f_s$，f_s 是扬声器单体的谐振频率。
- 对于高音扬声器，使用白噪声信号，最大低通截至频率 $f_{low}= 3\ f_s$。
- 设置高通截至频率 $f_{high} < 0.25\ f_s$ 以提供低于谐振的足够大的激励级。

Optimal Working Range

最佳工作范围

The adaptive identification determines parameters giving the best fitting over the working range $–X_p < X < X_p$ where the probability of the occurrence of the coil is more than 99%. This range is about 20% smaller than the peak displacement X_{prot} allowed by the protection system.

自适应辨识将测定音圈出现概率超过 99%的工作范围$–X_p < X < X_p$ 内，给出最佳拟合的参数。该范围比由保护系统允许的峰值位移 X_{prot} 大约小 20%。

For this reason, we recommend to adjust the protection parameters in such a way to measure the curves up to X_{prot} which is 20% higher than the peak displacement required for further analysis and system design.

基于该原因，为了更进一步的分析以及系统设计，我们建议来如此调整保护参数，测量曲线直到比要求的峰值位移还要高 20%的 X_{prot} 处。

Small Signal Amplitude Level

小信号振幅级

The LSI measurement procedure starts in the small signal domain defined by the parameter G_{small} and the gain of the external power amplifier. The starting amplitude is not very critical in most cases. However, if the level is very low the measurement will be cancelled by an exception error saying that the gain of the amplifier is too small. Contrary, if the gain is too high then the nonlinearities and the heating of the driver will produce some bias in the estimation of the small signal parameters and increase of the voice coil temperature. After the measurement please check the increase of the gain during enlargement mode is within the limits $12 < G_{large} < 26$ dB.

LSI 测量程序开始于由参数 G_{small} 和外接功放的增益定义的小信号域。大部分情况下，初始振幅不是很关键。然而，如果振幅级太低，测量将由一显示为功放的增益太小的致命错误取消。相反，如果增益太高，那么扬声器单体的非线性特性和热度将在小信号参数的评估和音圈温度的增加上产生一些偏离。测量完成后，请查看 enlargement mode (增强模式) 期间的增益增加是否在门限 $12 < G_{large} < 26$ dB 内。

How to measure tweeters and mini-loudspeakers

如何测量高音扬声器和微型扬声器

Some tweeters and special loudspeakers intended for telecommunication have no regular suspension (such as a spider) giving mechanical protection of the voice coil. Here the maximal peak displacement Xmax can not be detected automatically by monitoring the variation in Bl(x) and Kms(x) as performed successfully for woofers. To protect your driver use the maximal input power P_{lim} to find the limits of the allowed working range. Note you may change the value P_{lim} during the measurement (and the system returns into the Enlargement Mode).

一些高音扬声器和扩展的用于通讯的特殊扬声器具有不规则的给与音圈机械保护的悬挂系统(比如像定心支片)。此时，最大峰值位移 Xmax 不能自动地通过监测 Bl(x)和 Kms(x)的变化而检测出 (对于低音扬声器该方法可行)。要保护您的扬声器单体，请使用最大输入功率 P_{lim} 来找出允许的工作范围的门限。注意，您可以在测试期间改变 P_{lim} 值 (系统将返回到 Enlargement Mode (增强模式))。

It is recommended to use an appropriate laser sensor during the LSI measurement which measures the peak, bottom and mean displacement directly and shows the orientation of the x-axis (coil in and coil out position).
Those result can be compared with the predicted displacement (based on current and voltage monitoring) in the result window **Displacement**. The predicted displacement describes the dynamic generation of a dc component due to asymmetries in the driver nonlinearities (such as Bl(x), $K_{ms}(x)$, …) but can not reflect a shift of the rest position caused by other causes such as gravity (changing from vertical to horizontal driver position), visco-elastic behavior of the suspension and static air pressure generated by heating of the air sealed below the diaphragm. The shift of the rest position during the LSI measurement is also displayed in the nonlinear parameter windows Bl(x), $K_{ms}(x)$, $L_e(x)$.

建议在 LSI 测量期间使用合适的可直接测量位移峰值，位移谷值和位移平均值以及显示 x 轴方向性的激光传感器(音圈进和出的位置)。那些测量结

果可在结果窗口 **Displacement** 中与预测的位移 (基于电流和电压的监测) 进行比较。预测的位移描述了由于扬声器单体非线性特性的不对称性 (比如 Bl(x)，K_{ms}(x)的不对称性) 产生的类直流成分的动态生成，但是不能反映出由其它诸如悬挂系统的重力 (从扬声器单体垂直位置到水平位置的改变) 和粘弹性行为以及由膜片下密封空气的热度产生的空气静压所引起的静止位置的偏移。LSI 测量期间，静止位置的偏移同样显示在非线性参数窗口 Bl(x)，K_{ms}(x) 和 L_e(x)中。