KCS-ID Manual

KLIPPEL

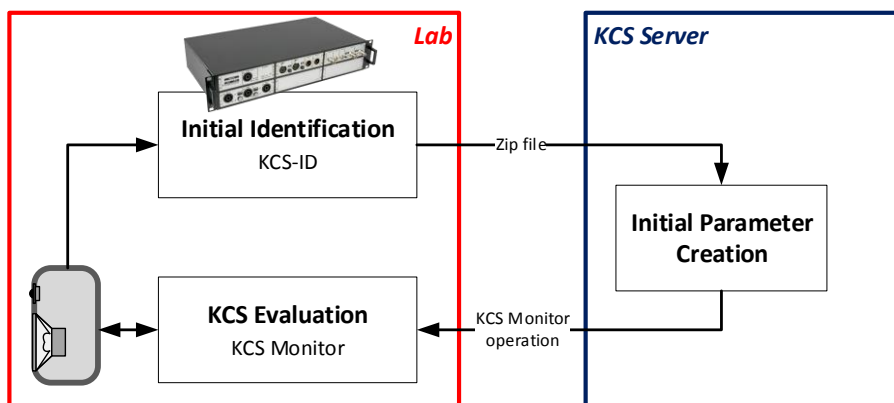Klippel GmbH

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1.1   Introduction

The *KCS-ID Parameter Identification* is a measurement module which is required for creating initial speaker parameters for the *KLIPPEL Controlled Sound Technology (KCS)*. *KCS-ID* uses a multi-tone stimulus to excite a loudspeaker and measures electrical voltage, current and optionally laser and microphone signals. After the measurement, the signals recorded by KCS-ID are sent to the *KCS Server* which automatically creates initial KCS data comprising linear and nonlinear speaker parameters for the particular KCS hardware platform. This initial data set is stored in a *KCS Monitor* operation and can be downloaded from the server. The *KCS Monitor* operation can connect to any supported KCS hardware platform and a KCS control session can be started.

This manual gives step-by-step instructions on how to create the initial data:

1. Hardware Setup

2. Performing a measurement

3. Creating initial data

1.2 System Requirements

The following hardware is required for running KCS-ID:

- KLIPPEL Analyzer 3 (KA3)

- Power amplifier or KLIPPEL AMP Card

It is highly recommended to use

- Microphone

- Triangulation Laser

The following software is required for running KCS-ID:

- An installation of *KLIPPEL dB-Lab* of version >= 212.30

- KCS-ID license

Internet access is required for creating initial parameters on the KCS Server.
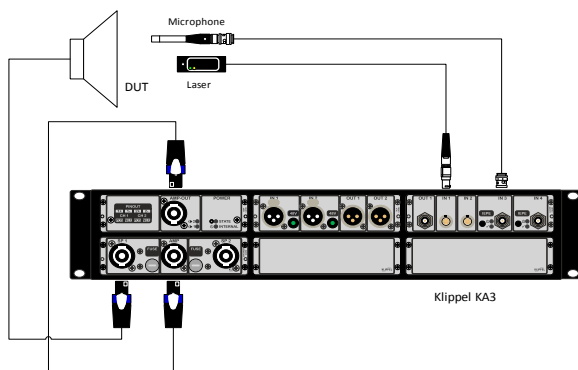
1.3   Hardware Setup

1.3.1   Hardware Connection

The hardware setups on the *KLIPPEL KA3* comprising one *Speaker Card*, one *Laser CARD*, one *XLR Card* and an optional *AMP Card* is illustrated in the figures underneath. For more information about the hardware, please see *Manual Hardware*.
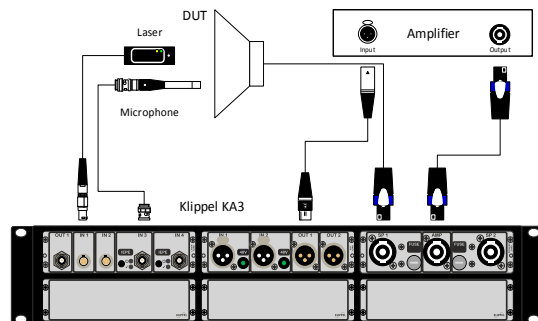
Laser and microphone sensors are not necessarily required for operating *KCS-ID* and *KCS Monitor*. However, these sensors are highly recommended for determining the voice coil's peak displacement automatically and for getting a comprehensive set of diagnostics information.

The microphone should be placed in the near-field of the device under test to achieve a high signal-to-noise ratio. A microphone calibration is not necessary as a relative measurement comprises all relevant information required by KCS-ID. Make sure that IEPE/phantom power is switched on using the buttons next to the microphone input on the KA3's front panel.

If a transducer with multiple voice coils shall be used, please see section 1.6.

Hardware connection on KA3 with AMP Card   *Hardware connection on KA3 without AMP Card*

Attention: <u>Keep the polarity consistent</u>. It is crucial that the speaker is connected with the same polarity to the KA3 as later on the KCS target hardware platform.

1.3.2   Hardware Setup - Routing

In the dB-Lab software's tool bar, open *Extras → KA3 → KA3 Signal Configuration* to setup the routing. Set the correct output channel (AMP if an *AMP card* is used or XLR if an external amplifier is used) and input channels for the optional external sensors.
If not done already, calibrate your laser using the *LC KA Laser Calibration* module accessible in the *dB-Lab's tool bar → Extras → KA3 → Laser Calibration* (more information in *Hardware Manual* [Hardware]).

Note: The current sense (Low/High Sense) is set automatically by the KCS-ID operation and does not have to be changed for the KCS-ID measurement.

KA3 Signal Configuration

1.4   Performing Measurements

1.4.1   Basic Measurement Setup

Open a database by pressing 🟦 *Select Database* in the dB-Lab software. Create ⚙ a new *KCS-ID* operation, open its *Properties* by right-clicking on the operation and set up the measurement as follows. It is assumed that the hardware is set up as described in the previous section and laser sensor and microphone are connected to the KA3.

1. Select the **Speaker System Type** (*free air*, *sealed box* or *vented box*/*passive radiator*) and the **Target Bandwidth** (fullrange, woofer/midrange or subwoofer).
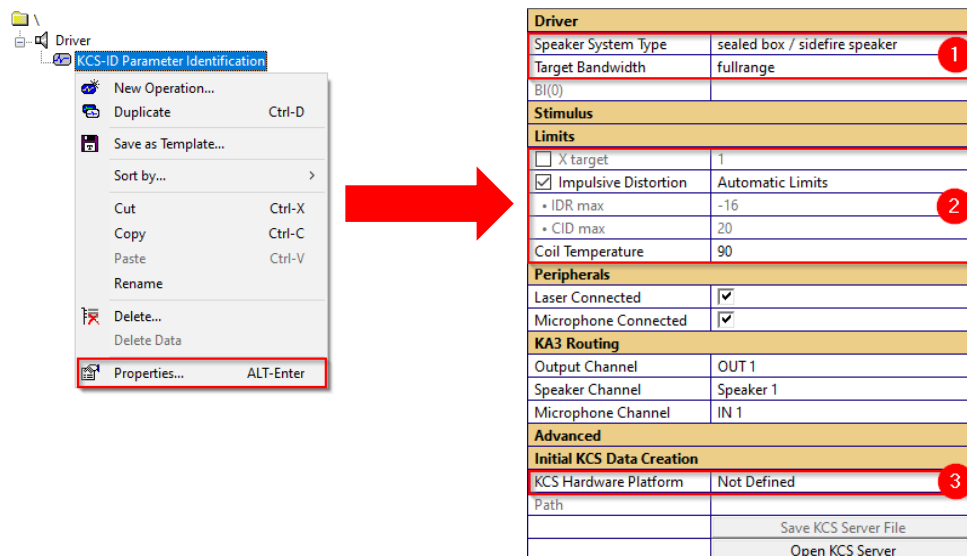
Note: The KCS-ID measurement has to be performed in an enclosure of similar specification (same volume and same passive radiator/port properties) like used in the KCS on-line mode.

2. Select **Limit Parameters**. It is recommended to never switch off the **Impulsive Distortion** limit which indicates excessive impulsive distortion (*Rub&Buzz*). If the target displacement X_{target} is known, it should be specified here as limit parameter. See the next section for more detailed information about the limit parameters.

3. Select the hardware platform the initial data shall be created for. **Only KA3**: Also, the **Target amplifier** (*AMP card* or *External amp*) has to be specified. If *External amp* is selected, the same amplifier with the same gain settings on which the KCS-ID measurement is performed has to be used as amplifier for running KCS.

   This step can also be done after the measurement.

Note (KA3 target platform only): It is highly recommended to use the AMP card for KCS evaluation if its voltage and power capabilities are sufficient for the particular speaker, because DC coupling is not supported on external amplifiers. The AMP card can provide a peak voltage of approx. 20 V and can handle a minimum load of 2 Ω (see specification [H6 Amplifier Card])

Note: Bl(0) can only be imported if no laser is used (switch off *Laser Connected* in the *Peripherals* category). If a laser is used (which is highly recommended), Bl(0) is identified accurately on the KCS Server.

Property page of KCS-ID module

1.4.2   Additional Options

Stimulus

The **Stimulus** settings are set to *Automatic* by default. You can select a higher **Start Voltage** if you use a big speaker and want to accelerate the ENLARGEMENT MODE. In some cases, the **Level** might be set to *Manual* to fine-tune X_{max} (see 1.6.2).

Peripherals

Select whether laser/microphone sensors are used in this measurement. It is recommended to use both, however sometimes the laser might not have access to the transducer's membrane and cannot be used. Note that a microphone calibration is not required for this measurement.

Advanced

Save Intermediate Results saves the results of each measurement block into a new KCS Monitor operation. It is not recommended to activate this option. However, KLIPPEL support might require this data in case of problems.

1.4.3   Limit Parameters

In the ENLARGEMENT MODE, the excitation voltage is incrementally increased until the first limit parameter is reached or exceeded. Following limit parameters are available:

1. **X target** - Maximum absolute peak voice coil excursion that shall be used in the target application. If a laser is used, the peak displacement value is measured by a laser sensor. If no laser is used, it is calculated by a linear speaker model and a Bl(X=0) import which e.g. can

be taken from the driver's datasheet. Note that in this case, the displacement value can differ significantly from the real voice coil excursion as it depends on a manual Bl(X=0) import and only uses a linear speaker model. See 1.6 for further information about X_{target} and X_{max}

2. **Impulsive Distortion -** Impulsive distortion is identified by exploiting out-of-band distortion in the sound pressure signal. Two parameters indicating excessive impulsive distortion/Rub&Buzz issues are used: The IDR_{MT} (*Impulsive Distortion Ratio* according to IEC 60268-21 for multi-tone stimuli) limit is the ratio between peak higher order distortion and mean SPL. To be sensitive to very audible short impulsive distortion peaks with low energy (such as beating wires), the crest factor CID_{MT} of the out-of-band distortion is calculated. High IDR_{MT} or CID_{MT} values indicate that the speaker is working above its safe working range.

   The impulsive distortion metrics IDR_{MT} and CID_{MT} are calculated similarly like the *IDR* or *CID* values for sinusoidal excitation (see *TRF Transfer Function* module). However, the crest factor of the multi-tone is much higher than that of the sinusoidal tone, which is one reason why the multi-tone impulsive distortion limits are much lower than their counterparts for sinusoidal excitation. **It is not recommended to change the default impulsive distortion limits.**

Note: The IDR is very susceptible for impulsive distortion (e.g. voice coil rubbing) and not so much for air flow noises which exhibit less impulsive characteristics.

   Coil Temperature – Maximum allowed relative voice coil temperature increase. If this limit is exceeded, the measurement is immediately stopped. The measurement of the coil temperature is done by measuring its DC resistance The reference temperature is measured in the LINEAR MODE.

Note: Voice coils do not heat up homogenously. Usually, the hottest place is at the rims, while it is colder in the gap. KCS-ID measures the average temperature, hence allow some margin to the maximum absolute maximum temperature rating of the voice coil.

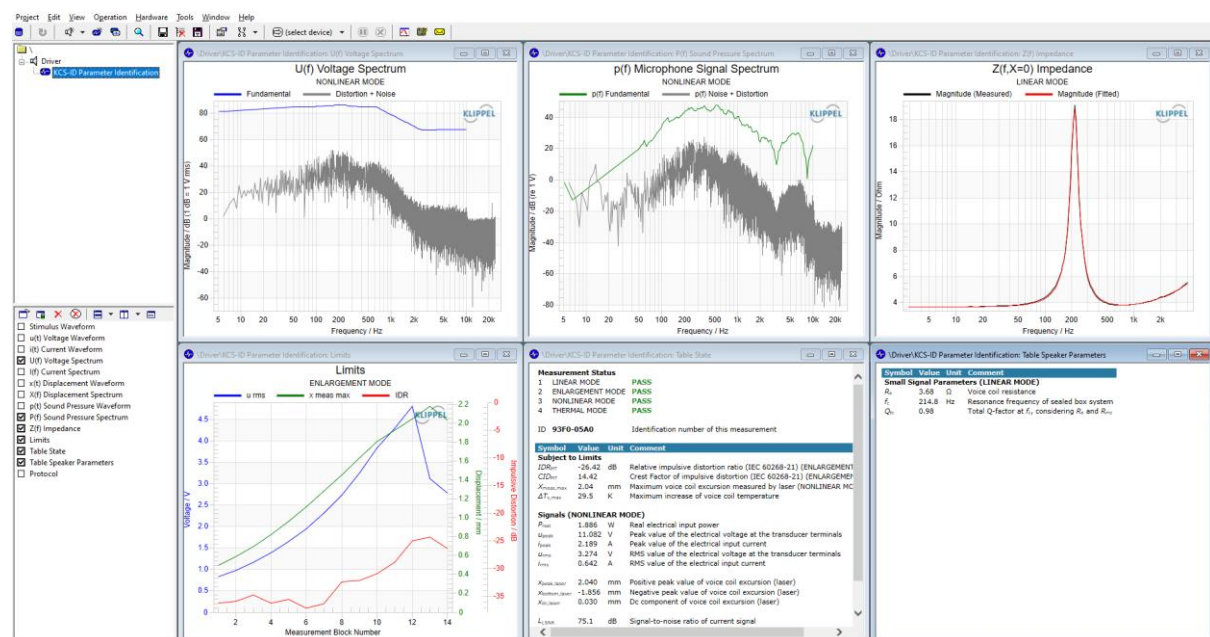# 1.4.4 Running and Interpreting Measurements

Press the *Run* button to perform a measurement.

Now multiple measurement steps are performed consecutively:

1. ***LINEAR MODE:*** Small signal parameters are identified and optimum settings for the NONLINEAR MODE are determined.

2. ***ENLARGEMENT MODE:*** The excitation level is incrementally increased to approach the voice coil's peak displacement x_{max}. This mode is finished when any of the limit parameters are reached.

3. ***NONLINEAR MODE:*** This measurement excites the speaker so that the peak voice coil displacement corresponds approximately to its working range x_{max} in the final application.

4. ***THERMAL MODE:*** If the voice coil heating was not sufficient in the NONLINEAR MODE, another measurement of the voice coil heating characteristic is performed before measuring the cooling curve.

Attention: Always wear ear protection since very high sound pressure levels may occur during the measurements.

Overview of default windows of finished KCS-ID operation

If the measurement has successfully finished, the measurement status overview in the *State* table displays a **PASS** after all measurement modes and an 8-character identification number. Initial KCS data can now be created based on this measurement. If the measurement has not finished successfully, check the *Speaker Parameters* window for any warning messages and follow its instructions.

Measurement Status

1	LINEAR MODE	**PASS**
2	ENLARGEMENT MODE	**PASS**
3	NONLINEAR MODE	**PASS**
4	THERMAL MODE	**PASS**

ID **93F0-05A0**   Identification number of this measurement

Symbol	Value	Unit	Comment
Subject to Limits			
IDR_{MT}	-26.42	dB	Relative impulsive distortion ratio (IEC 60268-21) (ENLARGEMENT MODE)
CID_{MT}	14.42		Crest Factor of impulsive distortion (IEC 60268-21) (ENLARGEMENT MODE)
$X_{meas,max}$	2.04	mm	Maximum voice coil excursion measured by laser (NONLINEAR MODE)
$\Delta T_{v,max}$	29.5	K	Maximum increase of voice coil temperature
Signals (NONLINEAR MODE)			
P_{real}	1.886	W	Real electrical input power
u_{peak}	11.082	V	Peak value of the electrical voltage at the transducer terminals
i_{peak}	2.189	A	Peak value of the electrical input current
u_{rms}	3.274	V	RMS value of the electrical voltage at the transducer terminals
i_{rms}	0.642	A	RMS value of the electrical input current
$x_{peak,laser}$	2.040	mm	Positive peak value of voice coil excursion (laser)
$x_{bottom,laser}$	-1.856	mm	Negative peak value of voice coil excursion (laser)
$x_{dc,laser}$	0.030	mm	Dc component of voice coil excursion (laser)
$L_{i,SNR}$	75.1	dB	Signal-to-noise ratio of current signal
$L_{u,SNR}$	67.3	dB	Signal-to-noise ratio of voltage signal
$L_{x,SNR}$	66.1	dB	Signal-to-noise ratio of laser signal
$L_{p,SNR}$	60.6	dB	Signal-to-noise ratio of microphone signal

State Window of successfully finished KCS-ID operation

1.5 Creating Initial Data

Initial KCS Data Creation	
KCS Hardware Platform	Nuvoton NAU83G20
Path	D:\E58F-5EF8.zip
	Save KCS Server File
	Open KCS Server

Property Page of KCS-ID operation – Export for Initial Data Creation

The *KCS-ID* measurement data has to be sent to the *KCS Server* so that initial data can be created for your specific hardware platform. Save the *zip* file on your hard drive. Now press *Open KCS Server* which opens KCS Server website *www.klippel-hub.de*.

After logging-in, the zip file can be uploaded. Based on this data, the KCS Server creates a full initial data set for operating KCS comprising linear and nonlinear speaker parameters, calibration values and more. After the processing is finished, a *KCS Monitor* operation is created and can be downloaded.

Now you are ready to start KCS on-line processing. See the *Manual KCS Monitor [KCS3].* Before evaluating KCS it is highly recommended to see *Tutorial 4* (Alignment, Equalization) and *5* (Protection, Limiter) of *[KCS3]* which describe steps how to achieve best audio performance.

Note: The hardware platform can be selected after the KCS-ID measurement has finished. If initial data for different target platforms shall be created, it is not necessary to perform another KCS-ID measurement.

FILE EXCHANGES

Upload file [Browse...] No file selected.   [Upload]

Status	Uploaded File	Responses	Messages
✔	7685-A178.zip uploaded on 2020-02-17 13:36:49 UTC	7685-A178.kdbx made available on 2020-02-17 13:37:41 UTC	OK
✔	D3AF-FEF6.zip uploaded on 2020-02-13 09:45:37 UTC	D3AF-FEF6.kdbx made available on 2020-02-13 09:46:39 UTC	OK
✔	9C9C-08DA.zip uploaded on 2020-02-04 13:02:03 UTC	9C9C-08DA.kdbx made available on 2020-02-04 13:03:06 UTC	OK

KCS Server – Uploading Data and List of File Exchanges

Note: Request a KCS-Server account by sending an email to *kcs-support@klippel.de.* Note that this login is not connected to the *Download Manager* log-in on *www.klippel.de/dm*.

1.6 X_{max} and X_{target}

1.6.1 Why is X_{max} not equal to X_{target}?

A maximum voice coil displacement X_{max} is automatically detected in the KCS-ID and on the KCS Server. X_{max} is the voice coil excursion which shall never be exceeded during KCS on-line operation. The determination of X_{max} is based on the KCS-ID limit parameters

- **X_{target}**

- ***Impulsive distortion***

If one of these limits is reached in the ENLARGEMENT MODE, the corresponding voltage is used to perform the NONLINEAR MODE measurement which is the basis for nonlinear parameter identification.

It can happen that the resulting X_{max} which the KCS Server determines is lower than the X_{target}, even if it was reached in the KCS-ID measurement. This can have multiple reasons:
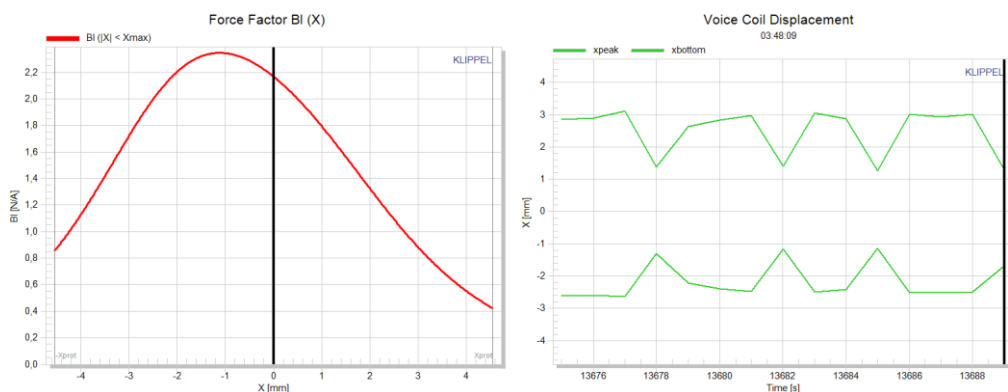
No Laser in KCS-ID

> If no laser is used in in the KCS-ID measurement, the peak excursion is estimated based on a **linear speaker model** using a manual $Bl(0)$ import. However, a linear model cannot describe a real speaker with good accuracy. Based on the degree of nonlinearity of the speaker, the peak excursion estimation can be quite significantly lower than in reality. Hence when the speaker's **nonlinear parameters** are identified on the KCS Server, the resulting excursion might be lower than the estimated one of the KCS-ID.

Asymmetric Voice Coil Excursion

> Electrodynamic transducers are nonlinear systems. Based on the particular design, some nonlinearities might exhibit a significant asymmetry which can cause an asymmetric peak excursion. This means that for instance the positive peak displacement is higher than the absolute peak value on the negative side (see curves below).

> If the voice coil is never reaching a certain excursion range during the KCS-ID measurement, the parameter identification system running on the KCS Server cannot identify the speaker parameters in this range reliably. In addition it is not known whether impulsive distortion occurs if the voice coil would be driven to this excursion range during KCS on-line operation with other signals.

> Hence the KCS Server determines a safe and conservative X_{max} value, whereas the peak excursion displayed in the KCS-ID is an absolute peak value.

Nonlinear Parameters can cause asymmetric peak excursion in the KCS-ID measurement

Significant Voice Coil Heating during KCS-ID

> If the voice coil heated up significantly during the NONLINEAR MODE, excursion can decrease during the measurement due to an increasing voice coil resistance. Hence the peak excursion was overestimated in the shorter ENLARGEMENT MODE measurement.

1.6.2   How to achieve a higher Xmax?

If you are sure that the transducer can handle a higher X_{max} than the KCS Server determined, you can repeat the KCS-ID measurement with higher excitation voltage. The easiest way to do that is

1. Open the KCS-ID operation which lead to an insufficient X_{max} and copy the operation.

2. In the KCS-ID *Properties* (category *Stimulus)*, change the **Level** from *Automatic* to *Manual*

Stimulus	
Level	Manual
• Voltage	2.43686

3. Increase the level depending on how much you want to increase the X_{max} compared to the previous measurement.
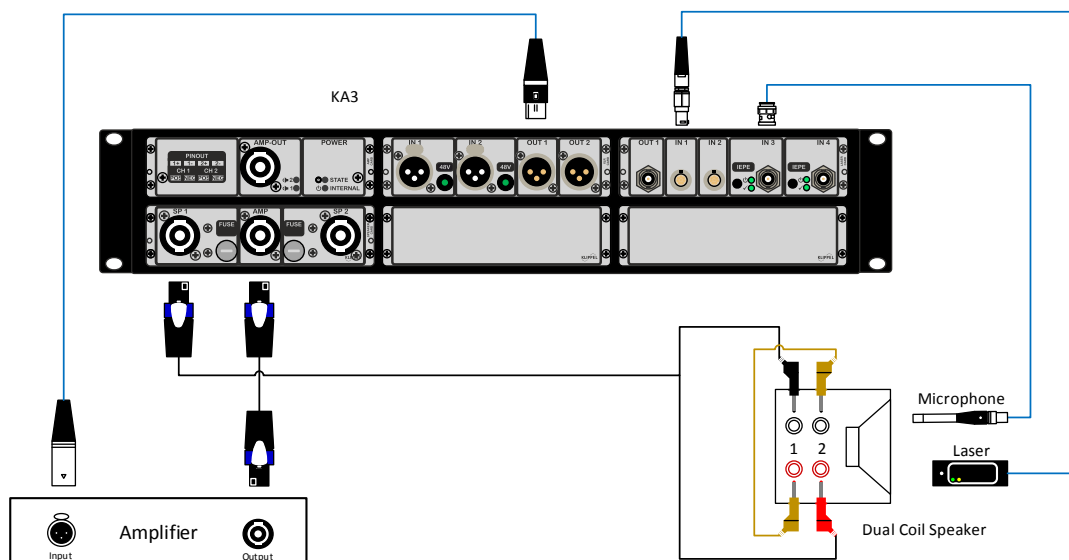
Stimulus	
Level	Manual
• Voltage	4

4. Repeat the measurement and create initial data with higher X_{max} using the KCS Server again.

1.7 Transducers with multiple voice coils

Initial KCS data can also be created for transducers with multiple voice coils, each driven by a separate amplifier channel.

Note: KCS only supports multi coil configurations if all coils show identical small and large signal properties. Please contact Klippel if you are unsure if your transducer is suited.

Hardware connection for double voice coil speakers

To create the data, you need to run the KCS-ID operation with the voice coils connected in series as shown above for a dual voice coil speaker.

Note: Due to the series connection, the peak voltage demands of KCS-ID for the amplifier will rise according to the number of voice coils. Make sure that your amplifier can deliver the required peak voltage.

1.8 Troubleshooting

1.8.1 KCS-ID messages

Amplifier Headroom exceeded

The KA3's amplifier can provide approx. 19…22 V peak (depending connected DC resistance). The error message pops up if more voltage is required to reach a certain limit or the excitation voltage is set manually to a level exceeding the amplifier's capability. Note that the multi-tone stimulus has a crest factor of approx. 3. Hence, the maximum possible voltage is 6…7 V RMS when the internal AMP card is used.

You can use an external amplifier that can provide more voltage to drive the transducer to its limits or to reach a higher excitation voltage.

If 6…7 V RMS are sufficient because the target amplifier used in the KCS online mode cannot deliver more voltage anyway, you can set the level manually to approx. 6 V RMS in the KCS-ID's property page's category *Stimulus.*

Stimulus	
Level	Manual
• Voltage	6

High voice coil position change detected

This message indicates that between LINEAR MODE and NONLINEAR MODE either
- the voice coil was shifted significantly due to very asymmetric nonlinear behavior of the transducer or
- the distance between laser sensor and transducer membrane position has changed

Note that the rest position of the NONLINEAR MODE is used as reference rest position used in the KCS on-line mode. The voice coil stabilization feature will shift the voice coil to this reference rest position.

Check correct Speaker System Type setting

KCS-ID performs a small signal speaker parameter identification in the LINEAR MODE. If it detects that e.g. the number of distinct impedance magnitude peaks does not correspond to the specified Speaker System Type (e.g. sealed or vented enclosure), this message appears. Note that in rare cases, the warning might trigger even if the correct speaker type is set. In this case you do not have to do anything.

1.8.2 KCS Server messages

The KCS Server website might display warnings and information after a KCS-ID file has been uploaded. See explanations of selected info and error messages below.
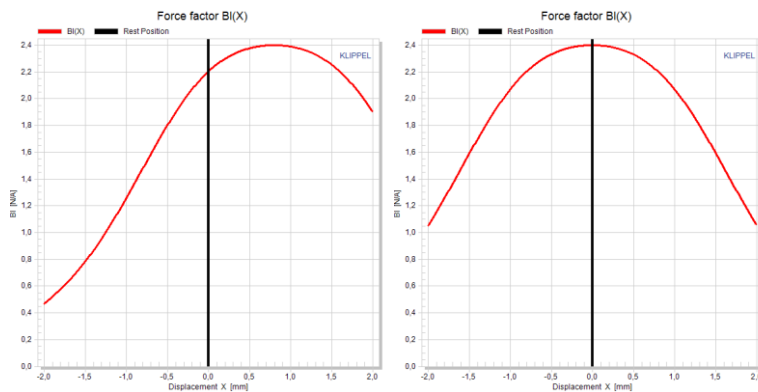
Info/Warning Messages

Low both-sided Bl(x) decay. Detection of the voice coil rest position and stabilization might not work optimally.

For identifying the voice coil rest position, KCS evaluates the nonlinear distortion found in the measured current signal caused by the nonlinear Bl(x) speaker characteristic. If the Bl(x) curve is too linear, not enough distortion is created to perform an identification of the rest position. In this case also an active shifting of the voice coil position using a DC voltage (*Stabilization*) is not possible.

Note that KCS will work anyway, but higher safety margins for the maximum allowed excursion are required, leading to less acoustical output at low frequencies.

For KCS it is highly recommended to use a speaker with a higher decay of the Bl(x) curve (usually a decay to 50…75% relative to Bl(x=0). The higher Bl(x) decay leads to higher efficiency and sensitivity and the added nonlinear distortion caused by the more nonlinear Bl(x) is compensated by KCS. In addition, the KCS stabilization allows to exploit the working range of the speaker optimally.

Bl(x) offset > 25%. Use a transducer with centered voice coil offset for maximizing efficiency.

If the voice coil offset is very high compared to the peak displacement (left picture), sensitivity and efficiency drop. For best performance it is recommended to use a transducer with a centered voice coil (right picture).

Xmax had to be reduced. It could not be realized on both positive and negative side of the identified Bl(x) curve.
See 1.6.

Xmax was reduced due to exceeded IDR limit.
X_{target} could not be reached because the impulsive distortion limit (*IDR Limit*) was hit at excursions smaller than X_{target}. Either the transducer cannot be used up to the specified peak excursion without producing excessive distortion or the IDR Limit was set too conservatively.

Laser Position has changed by more than 20% of maximum measured excursion during KCS-ID measurement.
See 1.8.1 (*High voice coil position change detected*).

Amplifier Gain is not sufficient to reach desired Xmax. Xmax has been reduced.
The gain of the specified target amplifier is not sufficient to drive the speaker to the X_{max} determined in the KCS-ID. X_{max} was reduced.

Error Messages

High Linear Identification error/High Nonlinear Identification error
Speaker parameters could not be identified with sufficient accuracy. Check if the *Speaker Type* was set correctly in the KCS-ID. If it was, contact *kcs-support@klippel.de*.

Bl(x) variation too high. Reduce limits or excitation level.
If Bl(x) decays to a value smaller than 0.25*Bl(x=0) at either positive or negative displacements, highest accuracy of the nonlinear parameters cannot be ensured under all circumstances. In addition, a disproportionate high peak voltage is required in KCS on-line mode for linearization. Reduce limits in the KCS-ID or reduce the voltage manually.

Kms(x) variation too high. Reduce limits or excitation level.
If $C_{ms}(x)=1/K_{ms}(x)$ decays to a value smaller than $0.25*C_{ms}(x=0)$ at either positive or negative displacements, highest accuracy of the nonlinear parameters cannot be ensured under all circumstances. In addition, a disproportionate high peak voltage is required in KCS on-line mode for linearization. Reduce limits in the KCS-ID or reduce the voltage manually.

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