Klippel Endurance Test (KET) S16

Software Module of the KLIPPEL ANALYZER SYSTEM (Document Revision 1.08)

PRELIMINARY PRODUCT INFORMATION – BETA VERSION

FEATURES

- Dedicated solution for long-term, power and accelerated life tests
- Any transducer: woofers, micro-speakers, headphones
- Passive Audio Systems
- Reveals destruction process in detail
- User-defined failure limits
- Monitors up to 32 DUTs simultaneously
- Internal and external stimuli
- Stimulus shaping/filtering
- Voltage Control at amplifier output
- Voltage stepping, ON/OFF Cycling
- Monitors data of user-defined, external sensors (e.g., temperature & humidity)
- Control of peripheral devices (e.g., heating chambers)

Klippel Endurance Test (KET) Solution provides a simple-to-use, cost-efficient soft- and hardware solution to run multi-channel long-term, power and accelerated life tests for typical quality assurance (QA) applications such as validation checks or type approvals.

Test signals can be defined flexibly using predefined stimuli as well as arbitrary wave files. Level stepping and cycling is available for any signals. Each DUT is monitored individually. Failures can be automatically detected by checking against user-defined limits. Open and short circuits are detected by general limits; thus, a destroyed device is detected immediately. A “Death Report” reveals details of monitored states at the highest available rate for a limited time just before the failure was detected.

The solution is Windows®-PC based and includes a power amplifier, control and analysis software as well as an easy interface to connect external sensors and control peripheral devices such as heating chambers. 32 DUTs can be measured using one PC. Even a higher channel number up to max. 64 channels, depending on PC performance and Dante® Interfaces, is possible (see references). Each DUT test can be individually started, muted and terminated. Each DUT can have its own test signal and configuration. The current test status of all DUTs can be visualized in a dashboard. Status information can be easily accessed via any browser device in the network. Dante® technology is used for streaming data via (wired) network connection.

Article Number:	1000-720, 1000-721

CONTENT

Abbreviations

KET	Klippel Endurance Test
DUT	Device under test
V/I	voltage / current
Hi-Z	High impedance
tbd	to be defined (in a later document revision)

1 Overview

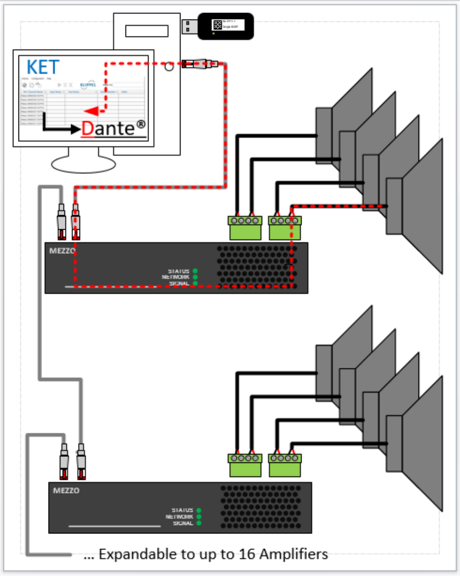
1.1 Principle

General Setup

KET is a multichannel test system for monitoring long-term tests.

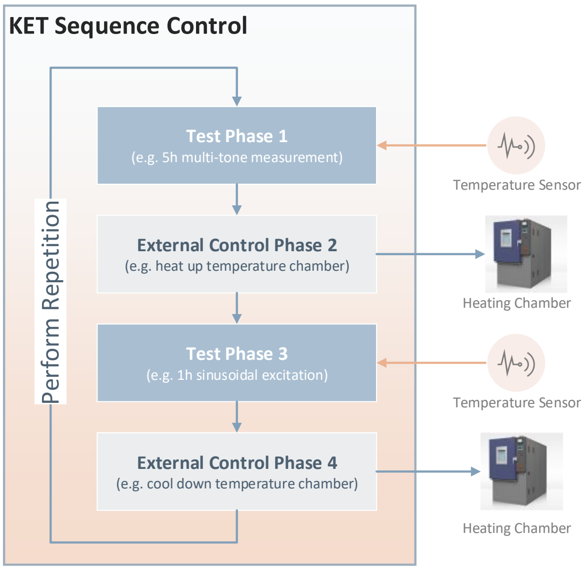
A dashboard controls and monitors each device under test (DUT). Each DUT can be tested independently with a user-defined test sequence and stimulus. Thus, any DUT may have its own test signal. Also, parallel testing of DUTs (batch testing) having the same test signal is available.

A test sequence consists of one or more test phases (e.g., for different stimuli). A cost-efficient smart amplifier with U/I sensing provides detailed data for each DUT and test step. The KET software provides a detailed analysis of DUT properties over time.

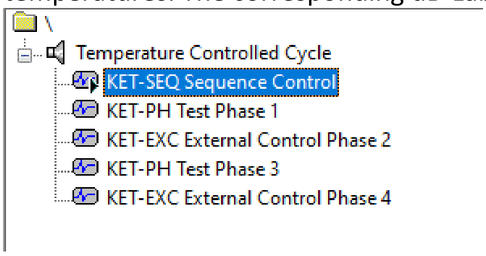


Test Sequence

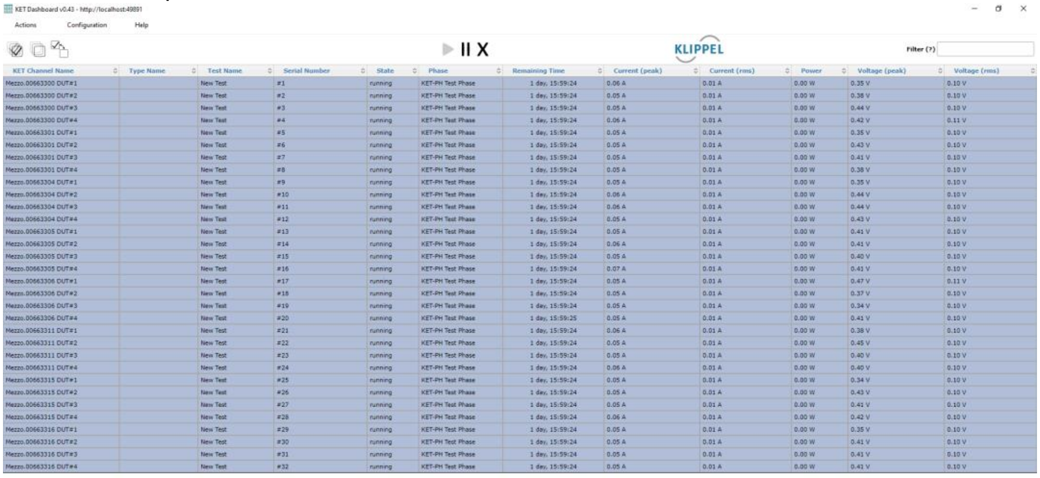
KET test phases are managed by a special operation "KET Sequence Control". It performs KET phase operations (e.g., for measurement or external control) in a user-defined sequence and controls hardware setup, and looping configuration.



In this example, 4 test phases are configured for a typical stress test at different temperatures. The corresponding dB-Lab object reflects this sequence:



KET-Dashboard	Multiple KET channels are managed by the KET Dashboard. It provides an overview of all test channels (status, results), test creation and execution as well as error handling. See the Examples section for more information.



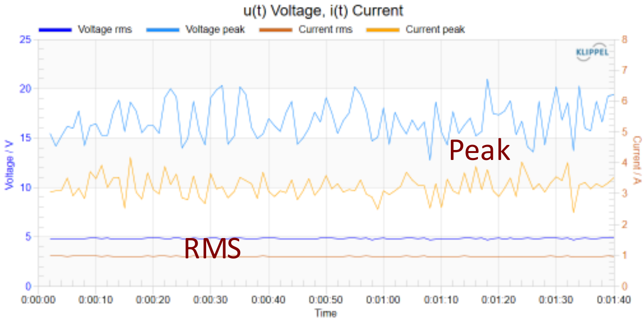
1.2 Results

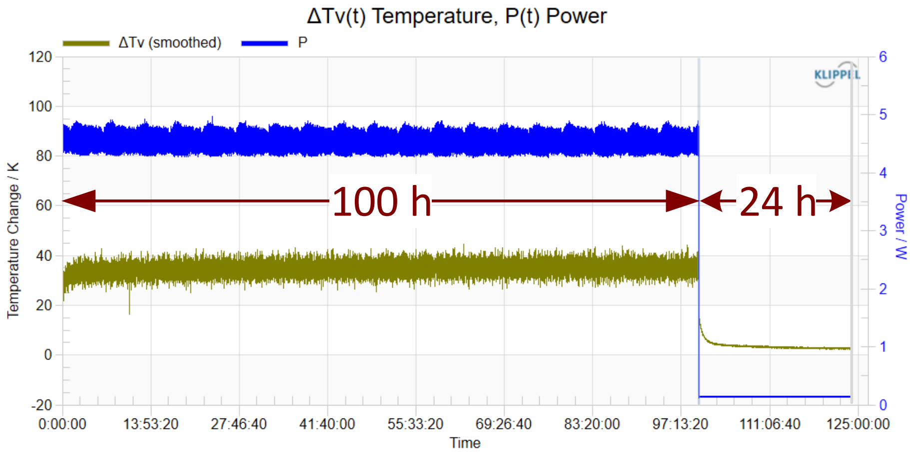
	Result Charts can be configured for providing the time course of rms and peak values for: • Voltage, Current, Power, Input resistance, Temperature • External sensors (e.g., temperature sensors in heating chambers) A high-resolution death report provides details during the destruction of a DUT.

2 Examples

2.1 Woofer continuous 100h test according to IEC 60268-21 (cl 17.1; 18.1) Rated maximum input value; Rated maximum sound pressure

Continuous testing	The simplest test is continuous playback of test stimuli for a defined duration. Monitoring power, temperature, voltage and current reveal steady state performance for given environmental conditions. Thermal equilibrium may take hours to settle, especially for larger woofers. For mass production, a statistical investigation of the fault rate may be required regularly. KET eases this process considerably using multi-channel tests and template-based setups applied to a given number of DUTs. This setup is available as template in dB-Lab and dashboard: `KET Rated maximum sound-pressure level; IEC 60268-21`
Voltage and Current	Power amplifiers used for KET are voltage driven, thus, the actual voltage at amplifier output can be monitored and compared with the specified level in setup.

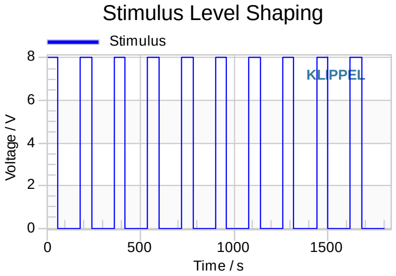
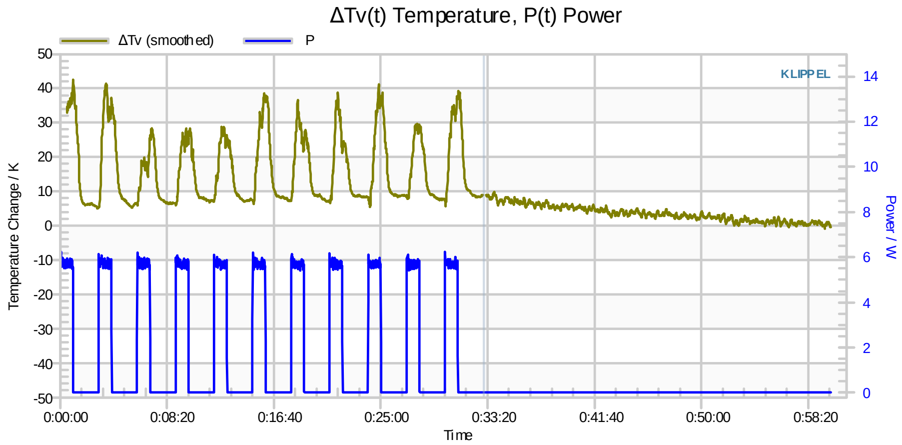
<table>
<tr><td></td><td>

Current and voltage are provided as rms and as peak values. Potential clipping or power compression can be checked in the chart *Device Compression / Limiter*.</td></tr>
<tr><td>Voice Coil Resistance</td><td>The electrical resistance R_e of the voice coil increases with the instantaneous voice coil temperature. A sudden increase indicates a loose connection or a broken coil. A sudden decrease may be caused by a shortcut of the windings in the gap. Open circuit and shortcut conditions are automatically detected and abort the running test.</td></tr>
<tr><td>Temperature Input Power</td><td>

The voice coil temperature is closely related to the real input power supplied to the transducer. Note the dual Y axis in the chart. Both state variables plotted versus measurement time give important information for defining admissible maximal input power. For a continuous playback test the steady state temperature for the given level can be assessed.</td></tr>
</table>

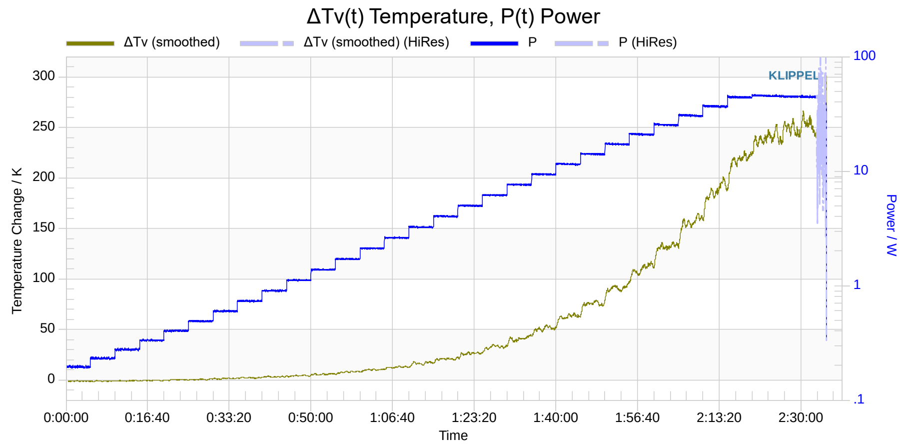
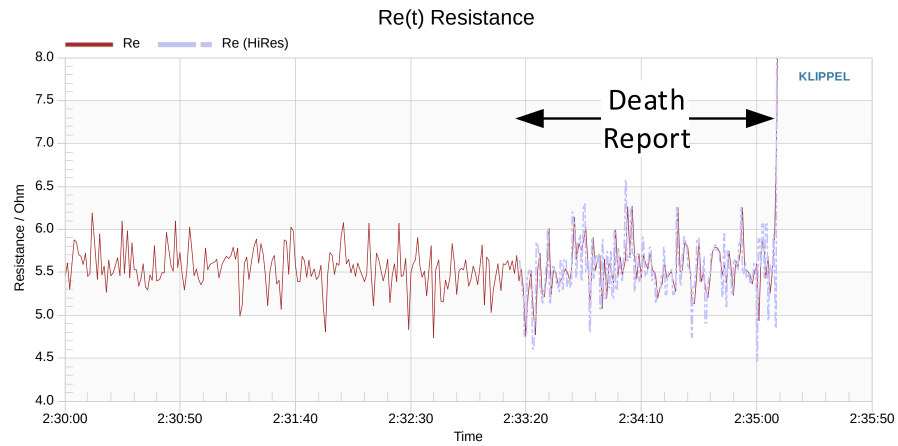
2.2 Midrange cycling 30 minutes test according to IEC 60268-21 (cl 18.4) Long-term maximum sound pressure level

<table>
<tr><td>Accelerated Stress Test</td><td>Special profiles of excitation level and/or environmental conditions are used to accelerate the life cycle of a transducer. Fast changes in conditions stress the DUT and simulate a typical load scenario of product life in a much shorter time. One typical test (which is also used to determine the long-term maximum sound pressure level according to IEC 60268-21 cl. 18.4) is alternating high level with resting (cooling down).
KET provides many options to alternate or step up/down the level for any kind of stimulus. Templates provide predefined setups according to international standards for easy setup and use.
This setup is available as template in dB-Lab and dashboard:
<code>KET Long term maximum sound-pressure level; IEC 60268-21</code></td></tr>
</table>

Voltage Cycling	This test consists of 10 loops of a heating phase of 60 seconds at a maximum power level, followed by 120 seconds cooling phase with low or no input power. Arbitrary level profiles are supported in KET. 
Temperature, Input Power	 Note the dual Y axis in the chart. After the cooling phase, the voice coil temperature quickly heats up, increasing the input resistance of the DUT and therefore reducing the input power within the On-phase. A maximum temperature of 40 K on top of the starting temperature (in the example 25°C, which was measured using an external USB temperature sensor in parallel to the test). The maximum (average) voice coil temperature was therefore about 65° C.

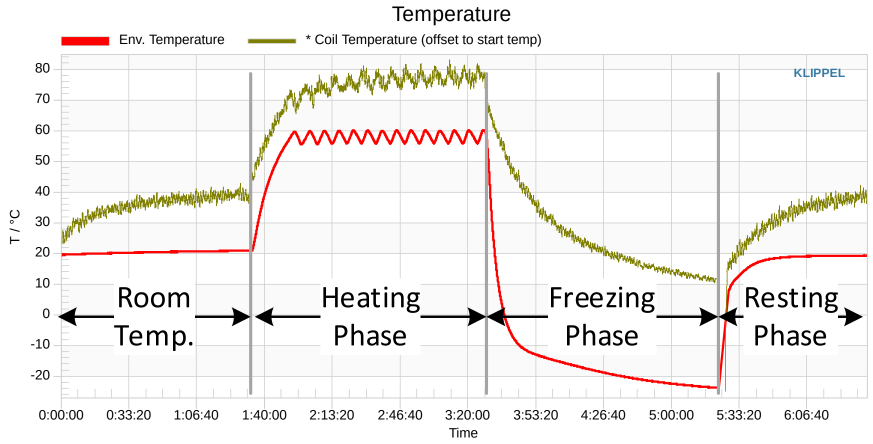
2.3 Woofer destructive testing

Destructive Testing	Most devices undergo thorough testing within their specified limits, but it's important to also test their maximum capabilities. Klippel Endurance Testing (KET) is a useful tool for determining the highest allowable power and coil temperature. The test automatically stops if the device is damaged or exceeds individual power, current, or temperature limits. The final 100 seconds of the test provide detailed information about the device's behavior during this crucial phase. This setup is available as template in dB-Lab and dashboard: `KET Destructive Testing`

Temperature, Input Power	 In this example, the test level is increased every 5 minutes by 1 dB steps up to a maximum test level of 25V / 45 W. Note the logarithmic y-axis for power. The device under test, a small automotive woofer that is specified with a 12V max rms level, withstands more than twice that specified level for about 5 minutes. The coil temperature at the breakdown was measured at about 250°C. Note, that the coil temperature is averaged over the coil, usually the outer parts of the coil are less cooled and may be considerably hotter than the inner parts.
Death report	 A death report provides high-resolution data just before a detected failure. A ring buffer of 100 seconds length stores results at the highest available rate, here about 200ms. This may reveal the root causes for a malfunction. In this example, the coil suddenly broke and the resistance jumped up quickly causing an open circuit failure.

2.4 Thermal stress tests

Monitoring of External Data	External sensors, such as temperature or humidity sensors, can provide sensor data to KET. A software interface (KET-Store) accepts data and meta information to be monitored in KET software. A ready-to-use python or VBS script can be provided for the USB temperature and humidity sensor (Art.-Nr. 2800-011), which is available from Klippel.
Heating Chamber Control	Heating chambers can be controlled by the External Control Phase, which allows starting external, user-defined scripts (e.g., batch files, python scripts). External sensor data can be monitored during the control phase. Note, that KET measurements are not available during the control phase.

Temperature Profile Test	 A temperature sensor (red) measures the environmental temperature in a climate chamber while the voice coil temperature is plotted in brown. The test consists of 4 phases at room temperature, a heating phase, a freezing phase, and a resting phase, about 90 minutes each. Here the environmental heat and cold add additional thermal stress to the voice coil and the DUT, resulting in high coil temperature even at moderate excitation levels. In this example, the external temperature sensor is automatically queried using an open API for any kind of sensor and included in result charts. Thus, other conditions using almost any digital sensor can be monitored and integrated into KET. Moreover, a software interface is available to control climate chambers or other instruments of torture for DUTs for automatic long-term tests with specific test profiles. As always after endurance testing, compliance with expected behaviour shall be verified. Note that room temperature offset (20°C) was added to the measured coil temperature increase allowing comparison on an absolute scale.

3 Requirements

3.1 Hardware

PC	Standard PC running the software, not included in KET-solution, See PC-Requirements on Klippel Website for details.
Power Amplifiers	The power amplifiers (*Powersoft Mezzo* or *Unica* series), are part of the KET solution.
	 This picture illustrates a typical 16-channel KET hardware rack equipped with 4 Mezzo 4-channel power amplifiers and one optional Ket Mezzo Patch-Bay.

	 This picture illustrates a typical 16-channel KET hardware rack equipped with 2 Unica 8-channel power amplifiers and one optional KET Unica Patch-Bay. See TN16 - KET - KLIPPEL Endurance Testing HW setup for more wiring and setup information.
Network / Audio Distribution	Ethernet port for Dante® network, controlled by PC running Klippel KET software. A shared network is possible as long as audio streaming is reliable. For higher channel setups, a separate network is recommended.
Dongle	License USB key for PC running Klippel KET software, included in KET-solution
	No dedicated test hardware (Klippel Analyzer) is required.
Optional Sensors	Data of external sensors (e.g., a temperature sensor in a climate chamber) can be imported and displayed in the KET software. A software interface as well as example scripts are provided.

3.2 Software

dB-Lab	Klippel Frame Software executing tests, included in KET-solution
Dante® Interface	A virtual or physical Dante® compatible soundcard is required. A license for the DVS (Dante® Virtual Soundcard) is included in the KET package by request.
KET Dashboard	Overview and control of all running tests, included in KET-solution
License	A software license enables the operation of a defined number of channels that can be operated in parallel.

4 Limitations

4.1 Devices under Test (DUTs)

Any electro-mechanical transducer (with electrical input)

- Bare transducer (Pro Audio, HiFi, Automotive, Micro-speaker, Headphones, TV speaker…)
- Audio systems with external power amplifier (passive)
- 70 or 100 V installation speaker or systems

Electrical networks

- Cross-Over circuits

Parameter	Symbol	Min	Typ	Max	Unit
Voice coil resistance (DC):	R_e	2	2 - 8	∞ (Hi-Z), e.g., a capacitor in series with a tweeter	Ω
Resonance frequency*:	f_0	10		10 k	Hz

* Pilot tone must be set up properly to avoid interference by back-induced voltage

4.2 Power Amplifier

Supported power amplifier (see Appendix for technical data):

- Mezzo Series by Powersoft
- Unica Series by Powersoft

4.3 Acoustical

None, a sound-shielded power test room is recommended. Be aware of fire hazards.

5 Setup

<table>
<tr><td>Number of DUTs</td><td colspan="5">• Restricted by license and available amplifier channels
• 32 DUTs per PC DVS (Dante® Virtual Soundcard)</td></tr>
<tr><td>Stimulus</td><td>Level Profile</td><td>Frequency (Range)</td><td>Crest Factor / dB</td><td>Cycling (On/Off)</td><td>Stepping</td></tr>
<tr><td>Wave File</td><td>Yes</td><td>-</td><td>-</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Pink Noise</td><td>Yes</td><td>Yes</td><td>6 - 18</td><td>Yes</td><td>Yes</td></tr>
<tr><td>White Noise</td><td>Yes</td><td>Yes</td><td>6 - 18</td><td>Yes</td><td>Yes</td></tr>
<tr><td>IEC Noise</td><td>Yes</td><td>Yes</td><td>(fixed)</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Multi-Tones</td><td>Yes</td><td>Yes</td><td>6 - 18</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Single Tone</td><td>fixed</td><td>fixed</td><td>3, fixed</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Two Tones</td><td>Yes</td><td>fixed</td><td>(fixed)</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Sine Chirp</td><td>Yes</td><td>Yes</td><td>3, fixed</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Cycling</td><td colspan="5">The stimulus may be switched on and off during the power test to simulate variations in the voice coil temperature and the mechanical load. The user may define the cycles or the time scheme.</td></tr>
<tr><td>Stepping</td><td colspan="5">The voltage U(t) at the terminals may be set to a user-defined RMS value. This value may be constant during the measurement or increased automatically (lin/log/user-defined).
Note: For user-defined wave files, the digital RMS value of the test signal must be provided (in dBFS) to use this feature.</td></tr>
<tr><td>Wave File</td><td colspan="5">The supported sample rates of wave files depend on the Dante® system sample rate (by default 48 kHz). Any sample rate lower or equal to the system sample rate are supported. Down sampling is not supported due to possible loss of information. In this case a manual down sampling is required (e.g., by Audacity® tool).</td></tr>
<tr><td>KET Channel</td><td colspan="5">KET channels can be defined by the user globally. Connected devices are auto-detected. A KET channel comprises:
• Name
• Dante audio channel for stimulus distribution to the power amplifier
• IP address of power amplifier for data access</td></tr>
<tr><td>Analysis</td><td colspan="5">• Recorded states (e.g., current, voltage, power, R_e, temperature)
• Failure limit for voltage, current, power, temperature
• Imported measurement data vs. time (e.g., environmental sensor data)
• Death report (High-speed sampling before limit violation or malfunction)</td></tr>
</table>

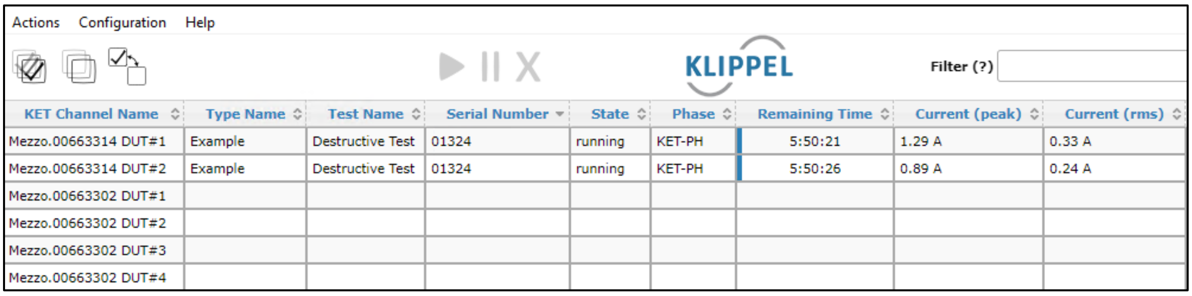
5.1 Analysis Setup Parameters

Parameter	Symbol	Min	Typ	Max	Unit
Frequency of pilot tone to measure resistance	f_{PT}	2	2	22 k	Hz
Regular update interval	t_{upd}	1			s
Death report update interval	t_{death}		0.2		s
Death report duration	T_{death}		60		s
Material of voice coil	• Copper (α = 0.0038 K^{-1}) • Aluminum (α = 0.0039 K^{-1}) • User-defined				
Initial Resistance	• Measured at the start of the test (1st phase only), if resistance or temperature are requested.				
Failure Limits					
Voltage (Max)	U_{Lim}	0	10	(depends on amplifier capabilities)	V
Current (Max)	I_{Lim}	0	1		A
Power (Min, Max)	P_{Lim}	0	10		W
delta Temperature* (Max)	ΔT_{Lim}		300	1000	K
Min resistance ref. to initial state	$R_{e,Min}$	20	50	80	%
Max resistance ref. to initial state	$R_{e,Max}$	120	300	500	%
Short circuit detection	$R_{e,Short}$		20		%

*Temperature calculated based on R_e variation considering specified voice coil material.

6 Results

6.1 Dashboard



KET Channel Name	Type Name	Test Name	Serial Number	State	Phase	Remaining Time	Current (peak)	Current (rms)
Mezzo.00663314 DUT#1	Example	Destructive Test	01324	running	KET-PH	5:50:21	1.29 A	0.33 A
Mezzo.00663314 DUT#2	Example	Destructive Test	01324	running	KET-PH	5:50:26	0.89 A	0.24 A
Mezzo.00663302 DUT#1								
Mezzo.00663302 DUT#2								
Mezzo.00663302 DUT#3								
Mezzo.00663302 DUT#4								

The **Dashboard** is a control panel for managing multiple KET tests. It uses a table-like layout to give an overview about all tests (running, stopped or paused) and is the hub tool for creating new tests. Every row represents one test object operated at one KET channel, which can be labelled by the user.

The *Dashboard* manages routing setup and the measurement process, as well as linking to a detailed data history (in dB-Lab).

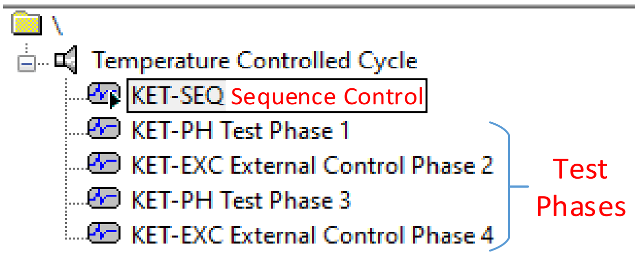
The current state and a comprehensive list of information is updated in real-time for any DUT. Tests can be easily created using KET-test templates and assigned to available channels.

A read-only *Dashboard* is available from any connected PC in the network and allows remote monitoring.

Visualization	• KET channel, Type Name, Test Name • State (running/stopped, alive/dead) • Active test phase • Time elapsed/remaining • Selected states (e.g., U_{rms}, U_{peak}, P_{rms}, T) • Link to KLIPPEL test database (history, charts, setup)
Control	• Start • Finish / Abort • Pause
Replacing DUTs	KET supports measurements of different loudspeaker types started and finished with arbitrary start times. DUTs may be replaced without affecting other running measurements. This means that every running test is independent and can be started and stopped at any time.

6.2 Test Organization

Test Result Storage	Test results are stored in a Klippel database and can be viewed using dB-Lab. Reports and test templates (Klippel standard features) can be used. Due to parallel testing, it is strongly recommended to use one database for each DUT. Measurements of the same DUT can be stored in one database.
Test Phases	Each endurance test consists of one or more *Test Phases* (steps in a test sequence) that are independently defined as **KET Test Phase** operations. Test phases can be used to • apply different stimuli to a DUT, • separate results for different environmental conditions (e.g., temperature),

	• break-in DUTs without storing results, • recover DUTs to recover from stress and much more. For each test phase, the user can define which states are to be monitored. Those states are displayed versus time in charts and provide a full data history. Test phases can be stored as and created by operation templates. Test phases are stored as operations in a dB-Lab database.
Test Sequence **KET Sequence Control**	 One or multiple **Test Phases** are defined as a *Test Sequence.* A test sequence is defined by any KET phase operations in one dB-Lab object and its position (top-down). The test sequence is managed by a **KET Sequence Control** operation. A KET Sequence Control operation manages a full endurance test consisting of one or multiple test phases. The complete test sequence can be stored as an **Object** template to be used in the KET Dashboard to create new tests.
Results	Any result shown in the dashboard is also available as a time course chart in the KET Sequence Control operation. Available results are rms and peak values of: • Voltage • Current • Power (apparent power; $P = i_{rms} \cdot u_{rms}$) • Input resistance • Temperature • External sensors (e.g., temperature sensors in heating chambers), and user-defined scripting are required.
Regular Sampling	During the Endurance Test selected states are sampled periodically and stored at an interval of 1 second.
Failure Detection	Several failure types of the driver will be detected automatically. The user also may specify a permissible variation of the selected states. A detected failure stops the complete test sequence and activates the Death Report feature. Generic failure types are Open Circuit (Hi-Z) and Short Circuit conditions.
Death Report	In addition to the regular sampling of 1 second all selected results are monitored internally at a higher rate and stored for a specified time (ring buffer). In case of a malfunction, this data of the particular DUT is added to the regularly sampled data. This allows a detailed analysis of the time just before a limit was violated or a failure was detected. Thus, valuable information for finding the root cause of a failure is available.

6.3 Temperature Measurement

Principle	The voice coil temperature is derived from the measured input resistance at a fixed frequency (pilot tone). Accuracy and noise depend on the used acquisition hardware.

	Note that the coil temperature is not constant in all windings but depends on position due to convection and heat transfer [1][2]. The measured coil temperature is an average over all windings.
Reference Resistance	Resistance $R_{ref} = R_e(t_0)$ at starting time $t = t_0$, which is assumed to represent the "cold" state of DUT
Increase of Voice Coil Temperature	The increase of the voice coil temperature during the test is expressed in Kelvin: $$\Delta T_v(t) = \frac{1}{\alpha}\left(\frac{R_e(\Delta T_v(t)+T_v(t_0))}{R_e(T_v(t_0))}-1\right) \approx \frac{1}{\alpha}\left(\frac{Z_e(f_p,\Delta T_v(t)+T_v(t_0))}{Z_e(f_p,T_v(t_0))}-1\right)$$ It is calculated by using the cold resistance as a reference and the thermal conductivity coefficient α for the selected voice coil material. Copper ($\alpha = 0.0038\ K^{-1}$), aluminium ($\alpha = 0.0039\ K^{-1}$) or user-defined coefficients are available.
Pilot tone	The measurement of voice coil temperature is based on assessing the electrical input impedance at a specified frequency. This method requires voltage and current monitoring. The DC resistance measured at the loudspeaker terminals is the most accurate way of estimating the voice coil temperature but requires a DC-coupled amplifier. However, using a low-frequency tone is more convenient than a DC stimulus because an AC signal can pass the high-pass of the power amplifier. Loudspeaker systems, active or passive crossovers may require a pilot tone at higher frequencies. Temperature monitoring is always active when enabled, even when the test signal is off or very low to assess the cooling process. For more details on setting up the pilot tone and optimizing temperature monitoring, see the KET user manual.
Temperature Speed / Averaging	The time constants affecting the temperature measurement are also adjustable during measurement. The resolution can be set using the parameter *Temperature Speed* on the property page *Measures/ Limit: ΔTv Voice Coil Temperature:* The mode **Slow** is recommended for • monitoring of slow thermal changes (woofer, subwoofer) • resonance frequencies below 50 Hz • higher input resistance (headphones) > 8 Ω • low test levels < 5 V • too high-temperature variation in Medium or High Mode • temperature results are integrated over 30 s The mode **Medium** is recommended for applications with • too high-temperature variation in High Mode • temperature results are integrated over 5 s • resonance frequencies > 50 Hz The mode **High** is recommended for applications with • monitoring of fast thermal transients (tweeter, micro speaker) • dedicated noise stimulus for thermal testing • higher test levels >5 V and higher test current > 1 A • resonance frequencies > 100 Hz • there is no additional integration implemented

7 Feature Comparison

Feature	Klippel Endurance Test (KET)	Power Test (PWT) – Deprecated
Max. Num DUTs	32 (64)	8 (using Power Monitor 8) 2 (using Distortion Analyzer)
Signals	Voltage / Current No Displacement	Voltage / Current (PM8) + Displacement (1 DUT only, DA2)
Sample Rate	Up to 192 kHz (depends on Amp)	48 kHz
Sources	Internal (predefined stimuli)	
	External audio signal	
	Any wave-file (PC playback), length restricted	Bypass Mode (Analog input) (Monitoring any amplifier output)
	Any stimulus generated by MTON	-
Stimuli (internal)	• Pink Noise • White Noise • IEC / EIA • Multi-tone • Two-tone • Chirp	• Pink Noise • White Noise • IEC / EIA • Two-tone • Chirp
Voltage Control	For any internal stimuli. For Wave-Files: • By digital RMS value • User defined	For internal and external sources. Not available for Bypass mode
Voltage Stepping	Linear, Exponential, User defined	Linear, Exponential
Intermittent Excitation	Yes	Yes
Stimulus Crest Factor	User-defined (6 – 18 dB)	User-defined (6 – 18 dB)
Filter for stimulus	6/12/24/48/∞ dB	6/12 dB
Sampling Interval	1s (0.2s for 100s death report)	1s for 1 DUT (Minimum, used for death report) 8s for 8 DUTs (Minimum)
States	U / I / P / R / T X (optional, multi-channel)	U / I / P / R / T / X (1 channel only)
Nonlinear Identification	No (planned in future)	PWT-Pro only
Pilot Tone	Yes (for internal and wave files)	Yes (for internal, and external)
Failure Criteria	I / R_e / P / T	R_e (T)

8 Appendix: Compatible Amplifier Specification

Supported Amplifiers (recommended types are bold):

Mezzo series: 322AD, **324AD**, 602AD, **604AD**

Unica 8M series (8-channel models): 1K8, **2K8**, 4K8, **8K8**

Unica 4L series (4-channel models): 5K4, 9K4, 12K4, **16K4**

Mezzo and Unica amplifiers are configured during the installation and setup process. There is no need to modify amplifier settings except if special customer needs require it. Armonia+® software provided by Powersoft may be used to change the standard setup. Note that Klippel Support may provide help for standard settings only.

8.1 Mezzo series V/I Measurement (any model)

Parameter	Symbol	Min	Typ	Max	Unit
V/I Frequency Range @ ±1 dB	f_{Ana}	20		20 k	%
Voltage Accuracy @ 1kHz	E_{Volt}		5		%
Current Accuracy @ 1kHz	E_{Curr}		5		%
Pilot tone frequency for Re and Temperature monitoring	f_{pilot}	2	2	22 k	Hz

8.2 Mezzo series general specification (any model)

Parameter	Symbol	Min	Typ	Max	Unit
Output Frequency Range ±0.5 dB @ 8 ohm	f_{Out}	20		20k	Hz
Maximum peak voltage	U_{peak}			142	V
Maximum output current	I_{peak}			15.6	A
Output Crosstalk @ 1kHz	L_{cross}		-60		dB
Signal Noise Ratio	L_{SNR}	100		102	dB(A)
Power supply	V	100		240 VAC @ 50-60 Hz	V

8.3 Unica series V/I Measurement (any model)

Parameter	Symbol	Min	Typ	Max	Unit
V/I Frequency Range @ ±1 dB	f_{Ana}	20		20 k	%
Voltage Accuracy @ 1kHz	E_{Volt}		5		%
Current Accuracy @ 1kHz	E_{Curr}		5		%
Pilot tone frequency for Re and Temperature monitoring	f_{pilot}	2	2	22 k	Hz

8.4 Unica series general specification (any model)

Output Frequency Range +0 dB / -1 dB @ 8 ohm	f_{Out}	20		20k	Hz
Output Crosstalk @ 20 Hz - 1kHz @ 20 kHz	L_{cross}		-80 -60		dB dB
Signal Noise Ratio	L_{SNR}	116		120	dB(A)
Power supply	V	100		240 VAC @ 50-60 Hz	V

8.5 Mezzo & Unica series maximum ratings

Specified values are defined by Powersoft. They are listed here for convenience. Please check the detailed specifications at https://www.powersoft.com.

Power ratings are **commercial ratings** dedicated to typical use cases (music). Consider the test results in the chapters below for KET application. U_P and I_P are the absolute maximum ratings.

			MEZZO 604AD		UNICA 2K8		UNICA 8K8		UNICA 16K4	
channel used in parallel			4	1	8	1	8	1	4	1
	2 Ω	**P_{nom}**	150 W	-	250 W	500 W	1000 W	1000 W	4000 W	4500 W
	4 Ω	**P_{nom}**	150 W	400 W	250 W	500 W	1000 W	2000 W	4000 W	5200 W
	8 Ω	**P_{nom}**	150 W	600 W	250 W	500 W	1000 W	1500 W	2500 W	2700 W
		U_P	142 V		160 V		160 V		220 V	
		I_P	16 A		30 A		48 A		80 A	

8.6 Mezzo & Unica evaluation results under steady-state conditions

Test Signal: Pink Noise with IEC 60268 program simulating shaping

High-pass filter: 20 Hz, 6 dB/octave Low-pass filter: 20 kHz, 6 dB/octave

Crest Factor: ≈ 4 (lin) / 12 dB @ the DUT

Duty cycle: continuous test signal

Voltage stepping: 1 Vrms stepping up every minute

channel used in parallel			4	1	8	1	8	1	4	1
			MEZZO 604AD		UNICA 2K8		UNICA 8K8		UNICA 16K4	
LOAD RESISTOR	2 Ω	U_{RMS}	7 V	9 V	7 V	12 V	15 V	21 V	20 V	30 V
		I_{RMS}	3 A	4 A	3 A	6 A	7 A	10 A	10 A	13 A
		P_{real}	**23 W**	**38 W**	**24 W**	**70 W**	**100 W**	**200 W**	**200 W**	**400 W**
		U_P	27 V	36 V	28 V	49 V	60 V	84 V	90 V	110 V
		I_P	13 A	16 A	13 A	23 A	28 A	39 A	38 A	60 A
	4 Ω	U_{RMS}	10 V	17 V	10 V	20 V	22 V	29 V	30 V	50 V
		I_{RMS}	2 A	4 A	3 A	5 A	5 A	7 A	7 A	12 A
		P_{real}	**24 W**	**72 W**	**25 W**	**100 W**	**110 W**	**200 W**	**220 W**	**600 W**
		U_P	39 V	67 V	41 V	80 V	88 V	115 V	110 V	170 V
		I_P	10 A	16 A	10 A	19 A	21 A	28 A	28 A	43 A
	8 Ω	U_{RMS}	14 V	25 V	15 V	28 V	29 V	40 V	40 V	50 V
		I_{RMS}	2 A	3 A	2 A	4 A	4 A	5 A	5 A	6 A
		P_{real}	**25 W**	**79 W**	**26 W**	**100 W**	**105 W**	**200 W**	**200 W**	**300 W**
		U_P	54 V	98 V	59 V	111 V	114 V	156 V	150 V	170 V
		I_P	7 A	12 A	7 A	14 A	14 A	19 A	20 A	22 A

8.7 Mezzo & Unica evaluation results under cycled test conditions

Test Signal: Pink Noise with IEC 60268 program simulating shaping

High-pass filter: 20 Hz, 6 dB/octave Low-pass filter: 20 kHz, 6 dB/octave

Crest Factor: ≈ 4 @ the DUT (12 dB)

Duty cycle: 3s ON (Excitation) & 12s OFF (Cooling Phase)

Voltage stepping: 1 Vrms stepping up every ON/OFF cycle

channel used in parallel			4	1	8	1	8	1	4	1
			MEZZO 604AD		**UNICA 2K8**		**UNICA 8K8**		**UNICA 16K4**	
LOAD RESISTOR	2 Ω	U_{RMS}	9 V	9 V	12 V	13 V	23 V	26 V	38 V	38 V
		I_{RMS}	4 A	4 A	6 A	6 A	11 A	12 A	18 A	18 A
		P_{real}	**40 W**	**40 W**	**75 W**	**80 W**	**250 W**	**320 W**	**700 W**	**700 W**
		U_P	35 V	35 V	49 V	51 V	92 V	103 V	177 V	177 V
		I_P	16 A	16 A	20 A	24 A	43 A	48 A	71 A	71 A
	4 Ω	U_{RMS}	16 V	16 V	16 V	24 V	32 V	32 V	49 V	51 V
		I_{RMS}	4 A	4 A	4 A	6 A	8 A	8 A	12 A	13 A
		P_{real}	**66 W**	**66 W**	**66 W**	**140 W**	**250 W**	**250 W**	**600 W**	**660 W**
		U_P	63 V	63 V	65 V	96 V	130 V	130 V	183 V	192 V
		I_P	16 A	16 A	17 A	23 A	31 A	31 A	46 A	48 A
	8 Ω	U_{RMS}	21 V	33 V	22 V	38 V	40 V	40 V	40 V	41 V
		I_{RMS}	3 A	4 A	3 A	5 A	5 A	5 A	5 A	5 A
		P_{real}	**60 W**	**140 W**	**60 W**	**180 W**	**200 W**	**200 W**	**200 W**	**215 W**
		U_P	82 V	130 V	91 V	152 V	156 V	146 V	169 V	171 V
		I_P	10 A	16 A	11 A	19 A	20 A	20 A	21 A	22 A

Color scale: Headroom indication by color intensity

From grey to blue: U_P with maximum headroom -> U_P maximum rating

From grey to red: I_P with maximum headroom -> I_P maximum ratings

Used for tables in the above chapters:

- Mezzo & Unica series maximum ratings
- Mezzo & Unica evaluation results under steady-state conditions
- Mezzo & Unica evaluation results under cycled test conditions

Explanation:

As KET measurement stimuli will typically be defined by their rms-voltage supplied to the DUT, we have evaluated the Mezzo and Unica amplifiers with one of the typically used KET test signals, the IEC 68268 program simulating full band noise signal. Comparison tables are presented for different conditions.

The tables above should help select the right amplifier type. Real power numbers measured with artificial and often static test signals are typically much lower than the commercial rating. The commercial rating assumes typical music stimuli, and an ideal nominal transducer impedance, see chapter Mezzo & Unica series maximum ratings.

All results in chapter Mezzo & Unica evaluation results under steady-state conditions and Mezzo & Unica evaluation results under cycled test conditions are measured by Klippel using high-power load resistors. All P_{real} power values are the measured real power levels dissipated at the load resistors into heat. Values represent the last step before the amplifier starts limiting. Values reached at a fixed load resistor could typically be exceeded by real transducers presenting a frequency-dependent impedance to the amplifier.

Depending on the properties of the DUT, the nominal power P_{nom} (commercial ratings) is typically much higher than real power P_{real}.

The listed U_{RMS} and P_{real} values could be interpreted as a worst-case scenario for a dense, broadband noise signal. A signal having a high crest factor is very challenging for the amplifiers. In such cases, the power is limited by U_P and I_P. The color scale helps to identify the limiting criteria indicating the remaining headroom.

The reached values could be influenced by:

- DUT: Re of the cold transducer, impedance (f), temperature increase during measurement
- Test signal: type, bandwidth, density, crest factor
- Duty cycle, duration, number of channels used in parallel, ambient temperature

Safety:

The Powersoft amplifiers are equipped with powerful limiting and self-protection features. Any overload situation or critical state will be detected and the control circuit reacts to protect the amplifier. In addition, the DUT can be protected from overload situations by the built-in user-definable limiters. The Armonia+® software from Powersoft is required for this.

9 References

9.1 Related Modules	Power Testing (PWT) Multi-Tone Measurement (MTON) Tone Burst Measurement (TBM)
9.2 Manuals	KET Manual
9.3 Website	https://www.klippel.de/products/klippel-endurance-test.html
9.4 Application / Tech Notes	TN16 - KET - KLIPPEL Endurance Testing HW setup
9.5 Literature	[1] W. Klippel, “Nonlinear Modeling of the Heat Transfer in Loudspeakers,” J. of Audio Eng. Soc. 52, Volume 1, 2004 January. [2] Henricksen, “Heat Transfer Mechanisms in Loudspeakers: Analysis, Measurement and Design,” J. of Audio Eng. Soc., Volume 35, No. 10, 1987 October.
9.6 Audinate / Dante® Resources	Hardware Dante® Interfaces: https://www.audinate.com/products/manufacturer-products/dante-pcie-card
9.7 Standards	CEA-CEB19, CEA-2006-A, CEA-2019 IEC 60268-5, IEC 60268-7, IEC 60268-21, IEC 60268-22, IEC 62458, IEC WD 63034 BS EN 54-24 AES2

Find explanations for symbols at:
http://www.klippel.de/know-how/literature.html
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