ELIS4

User's guide

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1 General

The introductory chapter informs you about the basic safety information, product return and recycling, the use of this manual, the scope of delivery and other information.

1.1 Basic safety information

Please observe the product liability exclusion (ETAS disclaimer) and the following safety information in order to prevent impairments to health or damage to the equipment.

1.1.1 Intended use

The ETAS GmbH accepts no liability for damage that has resulted from improper handling and from noncompliance with the safety precautions.

1.1.2 Identification of safety information

The safety information contained in this handbook is marked with the general danger symbol shown below:

The safety information shown below is used with it. It indicates the most important information. Please read this information carefully.

WARNING!

Identifies a possible danger with medium risk, which could result in death or (severe) bodily injury if it is not avoided.

Caution!

Identifies a danger with low risk that could result in slight or moderate bodily injuries or property damage if it is not avoided.

1.1.3 Requirements of the technical state of the product

The following requirements are put in place for safe operation:

- During installation and before operation, heed the instructions for Ambient conditions.

1.2 Product return and recycling

The European Union (EU) has enacted the Directive on Waste Electrical and Electronic Equipment (WEEE) in order to ensure the establishment of systems for collection, handling and further processing of electronics waste. This ensures that the equipment is recycled in a manner that conserves resources and poses no hazard to the health of humans and to the environment.

Figure 1: WEEE symbol

The WEEE symbol on the product or its packaging indicates that the product may not be disposed of together with the residual waste. The user is obligated to collect the waste equipment and to make it available to the WEEE return system for further processing. The WEEE directive relates to all ETAS equipment, but not to external cables or batteries. Additional information about the recycling program of ETAS GmbH can be obtained from the ETAS sales and service branch offices (see chapter 9).

1.3 About this manual

The commissioning and the technical data of the module ELIS4 are described in this manual.

1.3.1 Organization

The manual consists of eight chapters and an index.

- Chapter 1: "Introduction"

  The "Introduction" chapter (this chapter) informs you about the basic safety information, product return and recycling, the use of this manual, the scope of delivery and other information.

- Chapter 2: "Measuring System for Liquid Impact Sensor“

  The chapter "Measuring System for Liquid Impact Sensor" gives you an overview of ELIS4 and informs you about the housing, serial number, connections and LEDs.

- • Chapter 3: "Commissioning"

  The chapter "Commissioning" includes general installation recommendations, a description of the connection and assembly possibilities, application examples and information about cabling and configuration.

- • Chapter 4: "Handling of Problems"

  The chapter "Handling Problems" gives some information about what you can do when problems arise with the ELIS4 that are not specific to an individual software or hardware product.

- • Chapter 5: "Technical Data"

  The "Technical Data" chapter describes the satisfied standards and norms, the ambient conditions, mechanical data, system requirements for the ELIS4, electrical data and the terminal assignment.

- • Chapter 6: "Cables and Accessories"

  The "Cables and Accessories" chapter includes an overview of the available cables and the accessories.

- • Chapter 7: "Ordering Information"

  The "Ordering Information" chapter includes the ordering information for the available cables and the accessories.

The concluding chapter "ETAS Contacts" gives you information about the international ETAS sales and service branch offices.

1.4 Package contents

Please check before the initial commissioning of your ELIS4 to see whether the device was delivered with all required parts and cables. Additional cables and adapter can be purchased separately from ETAS. A list of the available accessories and the order description are included in the chapter "7 Cables and accessories".

1.5 General installation recommendations

The "Commissioning" chapter includes the general installation recommendations and a description of the connection and assembly possibilities.

1.5.1 Assembly environment and components for the attachment

CAUTION!

Damage or destruction of the module possible.
The modules are only permitted for assembly and operation on components or at locations that ensure adherence to the technical data of the modules during their operation (see chapter 9 on page 119).

1.5.2 Equipotential bonding in the vehicle and assembly of the modules

WARNING!

Equipotential bonding in the vehicle possible through the shielding of the Ethernet connection cable of the modules!
Mount the modules only on components having the same electrical potential or isolate the modules of the components.

1.6 Assembly and blocking

1.6.1 Secure the module to a support system

The ELiS4 has a rugged metal housing with nonskid plastic feet. The unit can easily be screwed onto a carrier system for installation in a vehicle or the lab.

The screw thread for attaching your device is already contained in the housing and is easily accessible.

To fasten the ELiS4 housing:

- Remove the plastic feet from the bottom of the module by pushing a minus screwdriver between the housing bottom and the plastic foot. Lifting off the plastic foot using the screwdriver as a lever.

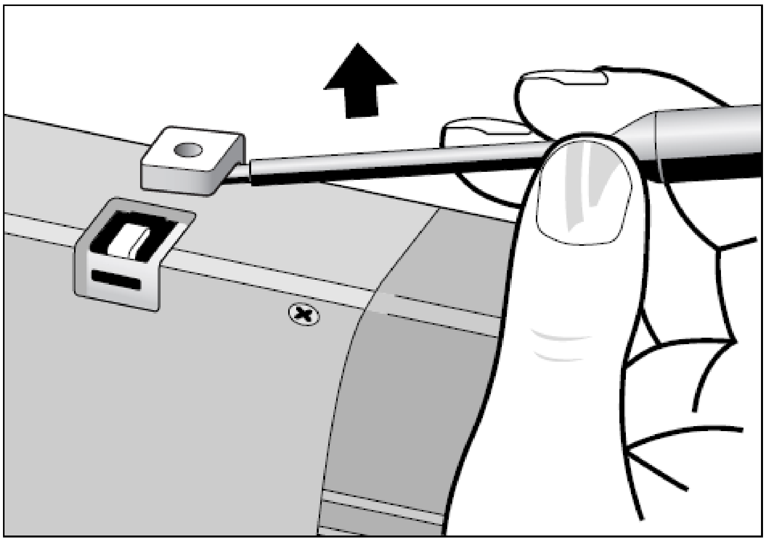

Fig. 2: Levering Off the Plastic Foot

- A threaded hole will become visible under the plastic foot.

  The threads for fastening the module are located both on the bottom of the ELiS4 housing.

Note

*Use **excluding** M3 cylinder screws and fastening the module onto your carrier system with a max. torque of 0.8 Nm. The max. length of engagement into the tapped blind hole of housing is 3 mm.*

CAUTION!

The electronic can be damaged or destroyed!
Do not rework the threaded hole.

1.6.2 Mechanically connect multiple modules

As ETAS system housing was used, the ELiS4 can also be connected to modules of the ETAS compact line (ES59x, ES6xx, ES91x) providing certain conditions are adhered to. These can be combined easily using the T-Brackets provided to form larger blocks.

To connect modules mechanically:

- Remove the four plastic feet from the bottom of the ELiS4 so a further module can be attached.

  This makes the assembly slits for the T Brackets accessible.

  You can attach a further module under the
- Remove the four plastic feet on the relevant side of the second module.
- Turn the seals of the T-Brackets so they are at a right angle to the longitudinal axis of the brackets and click two brackets into the assembly slits on one long side of the first module.
- Click the second module into the two T-Brackets.

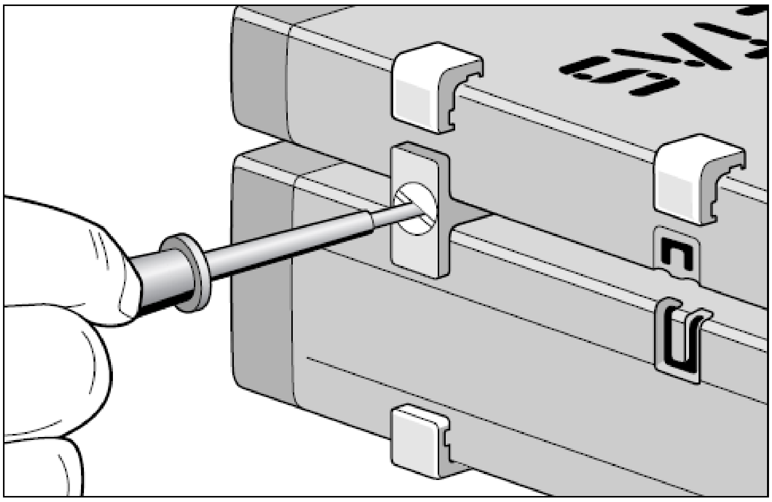

Fig. 3: Connecting the ELiS4 to Another Module

- Quarter-turn the seals of the T-Brackets. This locks the connection of the two modules.
- Click the other two T-Brackets into the assembly slits on the opposite long side of the device and lock these brackets too.
- If you would like to stack further modules, repeat this procedure with the next module.

2 Measuring system liquid impact sensor

The measuring system has the purpose of determining the water load, for example, in the exhaust gas system on a time-resolved basis. With the Liquid Impact Sensor, this is easier to carry out than with systems that were previously used.

Note

The sensors are as an application aid/measuring device not designed for permanent use and therefore not for a long service life (service life depending on the thermal stress).
Warranty is 6 months.

2.1 Components of the measuring system

The measuring system essentially consists of a sensor (EGS-LI) and a control electronics unit (ELIS4). Suitable software (e.g. INCA) and a CAN interface are also required for the measured data recording.

The following components are used for the construction of the system:

- Liquid Impact Sensor EGS-LI (AS_LIS.1; F-00K-107-365)
  - Sealing ring for probes to align the sensor (Bosch TTNo.: 1250280002)
- Electronics ELIS4 (AS_ELIS4.1; F-00K-107-364)
  - Sensor wiring harness AS_CBL300.1-3 (F-00K-107-366)
  - CAN connection cable AS_CBCX300.1-0m3 (F-00K-107-596)
  - CAN terminating resistor with 120 Ω (CBCX131.1-0; F-00K-103-786)
  - Cable for power supply CBP120-2 (F-00K-102-584)
- Optional: cable for external trigger input AS_CBAV190.50.1-2 (F-00K-107-597)
- *Power supply 9...30 VDC (nom. 13 VDC), max. 5 A per ELIS4
- *Measured data recording system with CAN interface (e.g. INCA)

*These components are only necessary once per vehicle

2.2 Operating principle of the measurement system

The measuring principle is based on the measurement of temperature curves and an energy balance on a heat-modulated ceramic sensor element. As shown in Figure 4, the sensor consists of a heater centered within the sensor element and two temperature measurement meanders (TM) resting on the two outer surfaces. The sensor element is installed within a housing similarly to the lambda sensor.

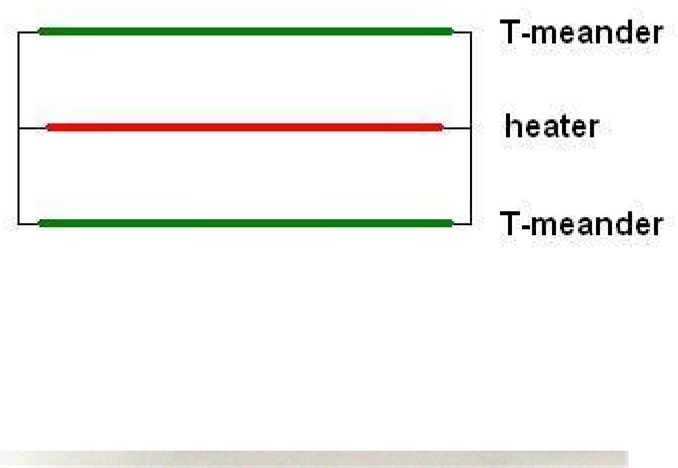

Figure 4: Structure of sensor element and EGS-LI sensor

The ELIS4 control electronics unit is used to measure the resistances of the two TMs and convert them via individually parameterized temperature characteristics into temperatures. These two temperature values are used with a 1:1 weighting as a control input signal for the heat output controller. This component regulates the heat output according to the deviation from the set temperature (standard setting: 200 °C) that exists by changing the ON-time of the heater current in the form of a pulse-width modulation.

If a drop hits the sensor element, the following occurs: the cold drop extracts energy from the sensor element. This causes the temperature of the TM involved to drop sharply from the controlled 200°C by a certain value. The heat control circuit detects this temperature drop and accordingly increases the heat output in order to regulate the temperature back to 200°C. When drops hit, typical signal curves result from this that can be detected via the steep flanks both in the temperature signal as well as in the heat output signal. If the exhaust temperature, and thus also the sensor temperature, exceeds 200°C, the heat output signal is no longer utilizable. The detection and evaluation then occurs exclusively via the two temperature signals. The following typical signal curves are produced by this response:

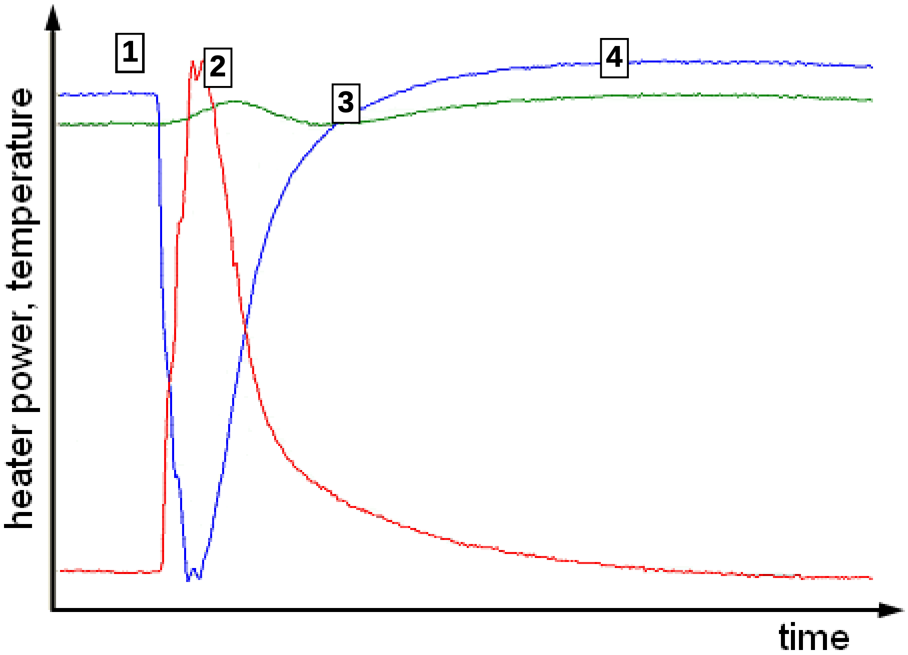

Figure 5: Typical signal curve ELIS4 at 200°C sensor temperature

At (1) a drop hits the primary side (blue) of the sensor element and creates a cooling effect. The heat controller reacts and increases the heat output (red) until the temperature drop is compensated. The increased input of heat results in a slight temperature increase excess (2) with small drops on the secondary side (green) that was not hit. With larger drops, the temperature drop is detectable even on the secondary side that was not hit. As soon as the drop has evaporated (3), the temperature stabilizes back to the original level and the heat output is likewise regulated back accordingly.

The temperature difference between the primary and secondary side (4) is not an actual temperature difference but, rather, a computer effect. This occurs due to the production-related deviations of the R(T) characteristic and the associated deviations from the saved calculation characteristic. The difference, depending on the sensor, is generally within the range 0.4...6 K.

Note

The sensors are not designed to get drops of water over 300 ° C – this leads to thermal stress and can thus lead to the destruction of the sensors.
In typical vehicle applications usually no drops occur at these temperatures.

2.3 Installation of the measurement system in the vehicle

2.3.1 Selection of the installation positions for the Liquid Impact Sensor

The installation positions for the EGS-LI must be selected corresponding to the intended purpose. In this context, note that the EGS-LI must always be installed in the same installation angle and geometric position as is specified by the installation situation to be studied. Therefore, the EGS-LI must not be moved around the circumference of the pipe or be mounted slightly upstream or downstream, for example, to examine a particular installation position. This can cause incorrect measured results. The influence of the exhaust gas flow on the distribution of the drainage water over the pipe cross-section is to be noted when choosing the installation position, especially with pipe bends and the like.

When the EGS-LI is installed, it also needs to be noted that it is not shadowed by other EGS-LIs, lambda probes, thermal elements or the like unless this were the case in the original installation position. A shadowing of the EGS-LI may likewise distort the results.

Furthermore, it is to be noted that because of the maximum permissible bus load a maximum of ten ELIS4s can be operated jointly on a CAN bus. Otherwise, there may be an overload of the CAN bus and, thus, transmission errors in the measured value recording. It is recommended, moreover, that the ELIS4 always be placed on a separate CAN bus. The link to an available CAN bus (e.g. vehicle Can bus) can lead to address conflicts with other existing devices.

2.3.2 Installation of the sensors

The sensor elements are protected by a protective bracket against damage to the ceramics due, for example, to impacts. Nevertheless, the ceramics can still be damaged by sharp edges or points, thereby rendering the sensor unusable. Therefore, proceed with the utmost caution when installing or removing the sensors. It is recommended that the sensor first be screwed in by hand and then tightened and aligned using a suitable tool.

Note

Therefore, proceed with the upmost caution while handling, storing and shipping the sensors. Always put the protective cap onto the sensor when it is not installed in an exhaust pipe to avoid mechanical damage. Take care that the sensor gets not dropped or gets hits. Excessive vibrations must be prevented.

The sensors can detect drops hitting over the entire sensor element. In order to achieve the highest possible hit probability, the sensors must be aligned perpendicular with the wide side against the exhaust flow. In order to determine whether the drops are hitting on the front or rear side, the sensor must always be aligned with the primary side against the exhaust flow. To do this, the primary side is marked with a center punch on the hexagon head (see **Figure6**). This also needs to be heeded for installation positions in pipe bends and similar installation points.

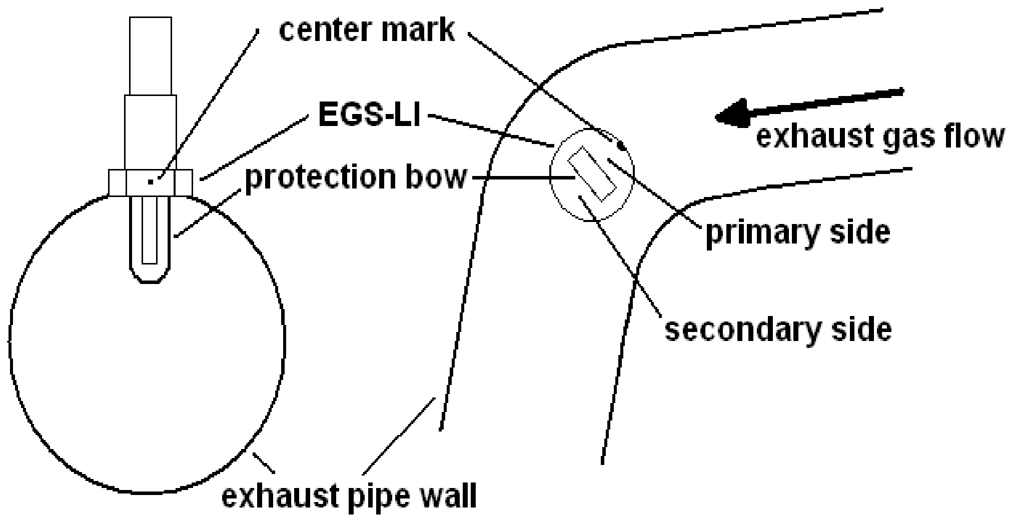

Figure6: Alignment of sensor in the exhaust gas system

During installation of the sensor, a new sealing ring (RB-TTNr. 1250280002) must always be used. This makes it possible to screw down the sensor another 360° past the original tight fit and thereby align it in whatever way desired. More than one sealing ring is not allowed, because the EGS-LI is pulled out of the flow.

In order to minimize the danger of electrical interference in the supply lines, the wiring harnesses are to be arranged with supply lines twisted in pairs. A total of approx. 5 meters are available for laying the supply lines (2 m sensor, 3 m electronics). When laying the supply lines, always make sure that the lines are laid far from moving vehicle parts, such as fans or axle components as well as from parts like the exhaust gas system.

Moreover, the supply lines must not be routed in the vicinity of electrical components with high voltage or current, such as piezoelectric injectors or switching relay. The plugs are sealed against sprayed water. However, in particular for measurements while driving, it is recommended to install the plug in a manner protected from sprayed water in order to increase the service life of the measuring technology, especially when many plugging cycles are expected. Ideally, the plug connection is placed in the interior area, which should be possible in most cases because of the available cable lengths.

WARNING!

The roadworthiness of the vehicle needs to be ensured for measurements outside of test benches.

2.4 Structure of the measuring system

The measurement system is to be set up and connected according to the following diagram:

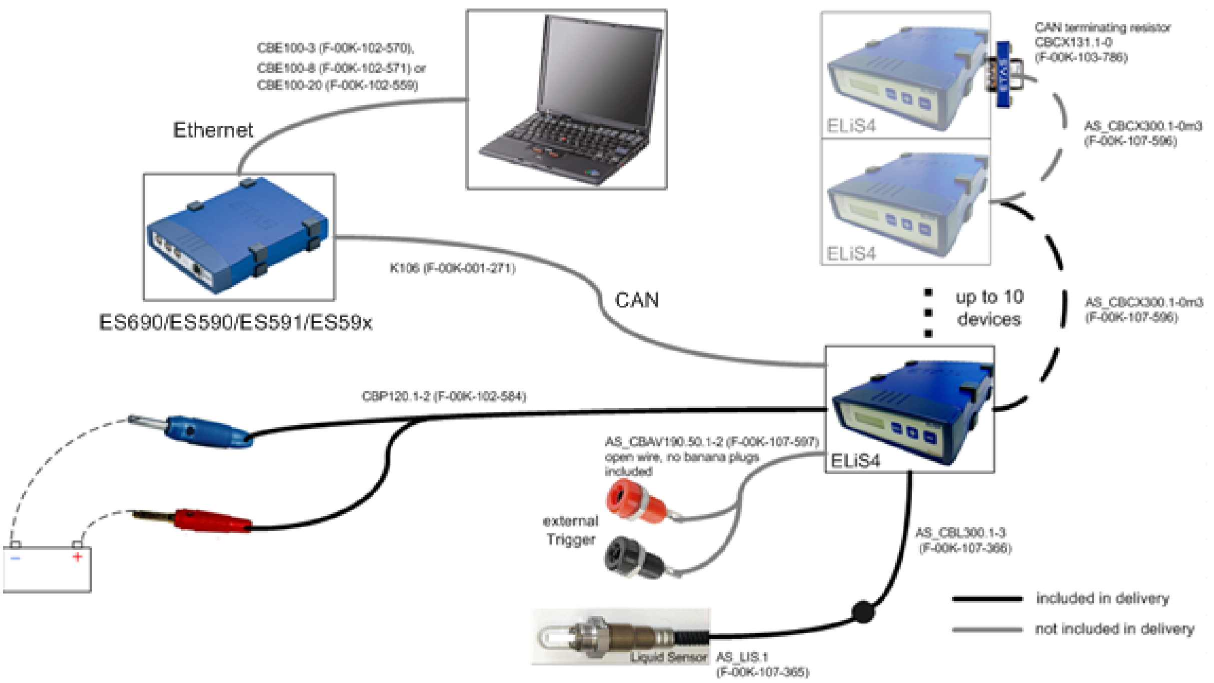

Figure 7: Measuring setup and connection diagram for vehicle measurements.

With the voltage supply make sure that it is at least 10V under all conditions. If, for example, this is not the case during an engine start, the service voltage of the ELIS4 can dip and thereby reset it, which would be expressed in an interruption of the measured value detection. In the ideal case, a separate voltage supply is to be prepared. During operation in the vehicle, use of a second battery or of a series capacitor is recommended for bypassing the voltage dip. Whether the power supply during a starting operation is sufficient to operate the ELIS4, must therefore be checked in advance in the individual case.

The measured signals are sent in a CAN message every 5 ms via the CAN bus. The measured data recording used must therefore operate with a scan rate of 200 Hz. This is also important for the later evaluation, because otherwise the time intervals between two measured values change and thus the mathematical thresholds for the drop detection are no longer correct. Furthermore, the measured data recording should provide a graphic output of the measured signals. This makes it possible to recognize drop characteristics already during the measurement and simplifies the detection of problems. It is recommended that the measured data recording be performed with INCA.

2.5 Signals of the ELIS4

The measuring system supplies a total of three signals, which can be used for the detection of drops and for the determination of drop volume. These are the heat output (P_h) and the temperatures (T_{prim}, T_{sec}) of the two temperature measurement meanders (TM) on the sensor element. The individual signals and the basic mode of functioning of the measuring principle are described in section 2.2. These signals must be recorded accordingly in order to ensure the offline evaluation of the water load.

Generally, still other signals are provided by the ELIS4, which, although they can be recorded, are not relevant for the determination of the drop volume. Shown in **Table 1**, all available signals and their necessity for the evaluation of the measurements.

Signal-Name*	***Description***	***Unit***	***Transmission rate***	***Message****	***Necessity for evaluation***
Tprim_iiii	Temperature on the primary TM	°C	200 Hz	0x18C1iiii	Necessary
Tsec_iiii	Temperature on the secondary TM	°C	200 Hz	0x18C1iiii	Necessary
Ph_iiii	Effective heat output of the heater	W	200 Hz	0x18C1iiii	Necessary
ED_iiii	ON-time of the heater PWM for each heating cycle	‰	100 Hz	0x18C1iiii	Not necessary
I_heat_iiii	Maximum heating current with an active heater	x	50 Hz	0x18C1iiii	Not necessary
Ubatt_iiii	Power supply	V	50 Hz	0x18C1iiii	Not necessary
MUX_iiii	Multiplexer for ED, Ih, Ubatt	-	200 Hz	0x18C1iiii	Not necessary
Tprim_alpha_iiii	Characteristic line slope for the temperature characteristic of the primary TM	E-6	0.05 Hz	0x18C2iiii	Not necessary**
Tprim_beta_iiii	Characteristic line curve for the temperature characteristic of the primary TM	E-9	0.05 Hz	0x18C2iiii	Not necessary**
Tprim_Rc_iiii	Resistance of the primary TM with calibration temperature (generally at 20°C)	Ω	0.05 Hz	0x18C2iiii	Not necessary**
Tsec_alpha_iiii	Characteristic line slope for the temperature characteristic of the secondary TM	E-6	0.05 Hz	0x18C3iiii	Not necessary**
Tsec_beta_iiii	Characteristic curve for the temperature characteristic of the secondary TM	E-9	0.05 Hz	0x18C3iiii	Not necessary**
Tsec_Rc_iiii	Resistance of the secondary TM with calibration temperature (generally at 20°C)	Ω	0.05 Hz	0x18C3iiii	Not necessary**

Table 1: ELIS4 Measurement signals

*(iiii corresponds to the last 4 places of the serial numbers of the ELIS4)

** These signals are used only for subsequent control whether the configuration of the sensors were performed correctly. The necessity of recording the signals must therefore be decided in the individual case.

2.6 CAN data format

The ELIS4 transmits and receives data via high-speed CAN (500 kBaud) with a 29-bit Extended Identifier. The aforementioned signals are transmitted in three CAN messages.

The measuring signals are transmitted in a message every 5 ms, while the two messages are transmitted with the control values of the calibration only on an alternating basis every 10 s.

The message of the measured signals is built up as follows:

Message address: 0x18C1iiii (iiii corresponds to the last 4 places of the serial numbers of the ELIS4)

Length of the data frame: 8 bytes

Data format: Intel (LSB first)

Bit range	***0-16***	***17-33***	***34-49***	***50-59 / 50-61 / 50-61***	***62-63***
Bit length	17	17	16	10 / 12 / 12 (multiplexed)	2
Signal name	T_{prim}	T_{sec}	P_h	ED / I_{heat} / U_{batt} (multiplexed)	MUX
Type	Unsigned	Unsigned	Unsigned	Unsigned	Unsigned
Factor	0.01	0.01	0.001	0.1 / 0.002 / 0.01	1
Offset	-50	-50	0	0	0

Table 2: Structure of CAN data frames 0x18C1iiii

0	*ED*
1	I_heat
2	Ubatt

Table 3: Multiplexer assignment

The multiplexer series is 0 – 1 – 0 – 2. As a result a transmission of the ED results every 10 ms and for I_heat and U_{batt} every 20 ms.

Bit range	***0-15***	***16-31***	***32-47***
Bit length	16	16	16
Signal name	Rc_{prim}	α_{prim}	β_{prim}
Type	Unsigned	Signed	Signed
Factor	0.1	1	1
Offset	0	0	0

Table 4: Structure of CAN data frames 0x18C2iiii

Bit range	***0-15***	***16-31***	***32-47***
Bit length	16	16	16
Signal name	Rc_{sec}	α_{sec}	β_{sec}
Type	Unsigned	Signed	Signed
Factor	0.1	1	1
Offset	0	0	0

Table 5: Structure of CAN data frames 0x18C2iiii

2.6.1 Produce the CANdb file

With the ELIS CANdb generator (available in the download area http://www.etas.com/en/products/download_center.php?entrylist=16073)

a CANdb file can be created and can then be read in with INCA. In order to create such a file, only the number of ELIS devices used as well as their serial numbers need be entered in the CAN dB Generator (see **Figure 8**).

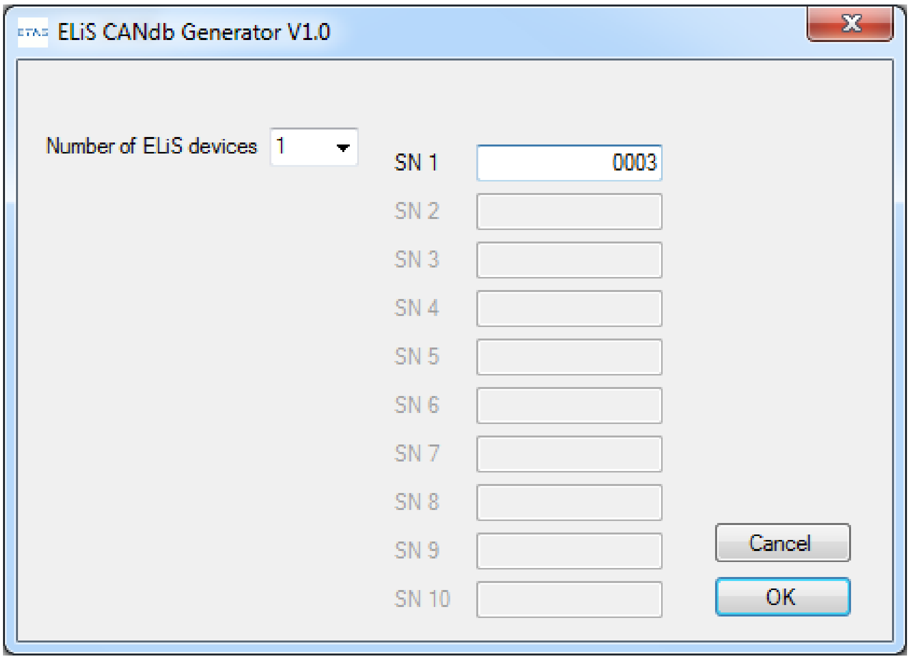

Figure 8: ELIS CANdb Generator

2.7 Recording of the measured data in INCA

2.8 Preparation of the vehicle for data recording

In order to use all of the functions later and thereby reduce the manual expenditure of time in the evaluation, vehicle data should also be recorded in the measurement.

Should it not be possible to read data from the engine control unit, the measurements can be performed using the EGS-LI even without these measured variables. However in this case, the drop events can be applied exclusively over the measuring time. A correlation with other measured values can in this case only be performed manually.

With the parallel recording of EGS-LI data and control unit data, a time-synchronous data recording should be followed in order to prevent errors in the correlation of drop events to operating states or points in time.

2.9 Configuration of the data recording

The general operation of INCA or else another data recording is covered in the applicable documentation. Included below is just the information on how the configuration and illustration of the INCA experiment for measurements have proven effective with the Liquid Impact Sensor. Such an experiment is shown as example in **Figure 9**.

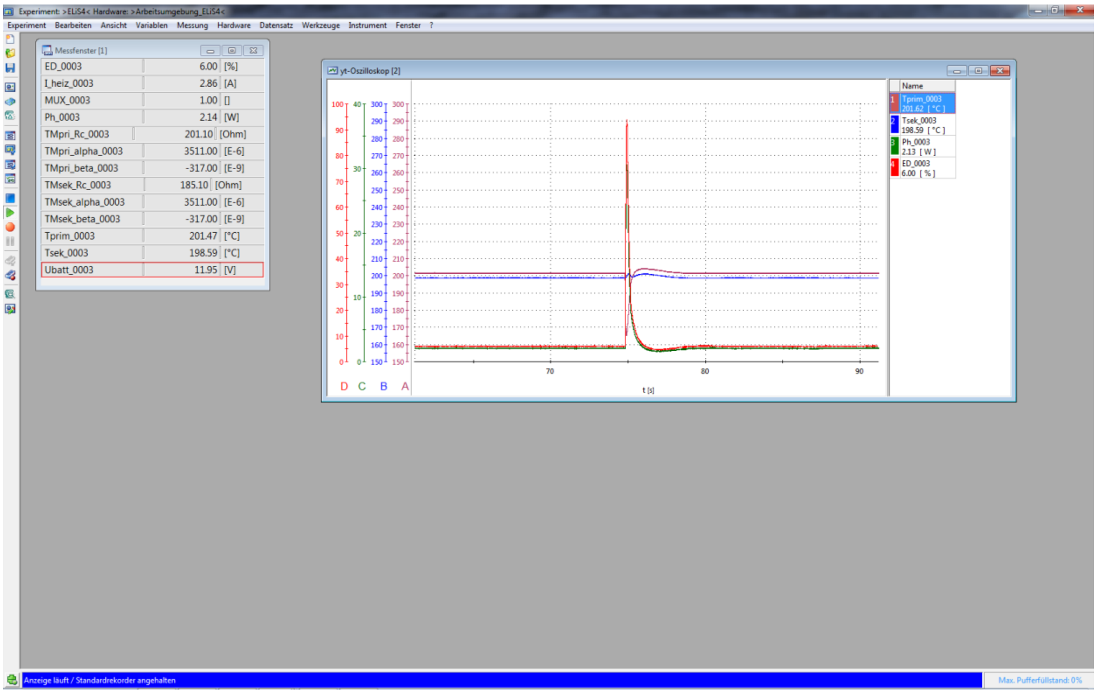

Figure 9: Recording of the measurement with INCA

In order to ensure a smooth execution of the measurements and to receive an initial impression about the water load even during the measurement, the following signals are shown:

- EGS-LI temperatures (graphic output)
- EGS-LI heat outputs (graphic output)
- Engine runtime (table)
- Engine speed (table or else graphic output)
- Dew point end bits (table)
- Engine temperature (table)
- Oil temperature (table)

For the graphic output of the EGS-LI signals, a length of the X-axis of 30 s is recommended. The Y-axis should be set for the heat output of 0...40 watts and for the temperature of 150...300 °C (after Cat) or 150...700 °C (before Cat).

2.10 Data evaluation

Starting in 2012, an evaluation tool will be offered for the off-line evaluation of the raw data.

3 Commissioning

3.1 Operation of ELIS4

The ELIS4 has 4 LEDs, in order to give important information about the current operating state.

LED	***Description***
UB	*ELIS4 is connected to the supply voltage*
ER	*ELIS4 has detected an error*
H	*ELIS4 heats the EGS-LI, to get it to operating temperature*
RG	*ELIS4 performs a regeneration of the EGS-LI*

Table 6: LEDs of the ELIS4

3.2 Starting the ELIS4

The ELIS4 starts automatically as soon as the required supply voltage is applied. If a sensor is connected, the electronics immediately go into the "Running" state. This means that the sensor is immediately heated to the set temperature, and the measuring system is ready for operation, depending on ambient conditions, within 4 to 8 seconds.

If no sensor is recognized or if another error is detected, the ELIS4 goes into fault mode and the corresponding LED lights up.

The operating state can be changed both by menu as well as by sending a CAN message to the ELIS4. There are essentially five operating states:

Operating state	***Description***
Idle	*ELIS4 is ready to operate in Standby mode*
Running	*ELIS4 regulates the sensor temperature and transmits signals via CAN*
Reset	*ELIS4 can be restarted after an error*
Regeneration	*ELIS4 regenerates the sensor at 800°C and transmits signals via CAN*
Error	*ELIS4 has detected an error, is in Standby mode and awaits an input*

Table 7: Operating states of the ELIS4

3.3 Functions and settings of ELIS4

The settings of the ELIS4, can be adjusted or activated via the menu. It is possible to browse through the menu structure for setting the parameters and make changes to the parameters in the following sequence:

Menu item	***Description***	***Range of values***	***Default value***
M01 App state	*Reading the TEDS values* Manual reset	*+ TEDS* *- Reset*	*-*
M02 Regeneration	*Start of the regeneration*		*-*
M03 Start delay	*Delay after applying the voltage in order to switch from Idle to Run*	*0..600 s*	*0 (no delay)*
M04 max Run Time	*Time after which the switch is made from Run to Idle.*	*0..60 min*	*0 (no shutdown)*
M05 Sensor temp.	*Set temperature of the sensor*	*0..800 °C*	*200 °C*
*M06 TM-P Tc**	*Calibration of the primary TM*	*+-32768 °C*	*20 °C*
*M07 TM-P-Rc**	*Resistance of the primary TM at calibration temperature*	*0...65535 Ohm*	*is read from TEDS chip*
*M08 TM-P α**	*Characteristic line slope for the temperature curve of the primary TM*	*+-32768E-6*	*is read from TEDS chip*
*M09 TM-P β**	*Characteristic line curve for the temperature curve of the primary TM*	*+-32768E-9*	*is read from TEDS chip*
*M10 TM-S Tc**	*Calibration temperature for R0 of the secondary TM*	*+-32768 °C*	*20 °C*
*M11 TM-S-Rc**	*Resistance of the secondary TM at calibration temperature*	*0...65535 Ohm*	*is read from TEDS chip*
*M12 TM-S α**	*Characteristic line slope for the temperature curve of the secondary TM*	*+-32768E-6*	*is read from TEDS chip*
*M13 TM-S β**	*Characteristic line curve for the temperature curve of the secondary TM*	*+-32768E-9*	*is read from TEDS chip*
M14 ELIS SN/Vers	*Serial number and FW version of the ELIS*		
M15 LiS SN/Vers	*Serial number and version of the EGS-LI*		
*M16 Master-IP***	*IP address of the M-Box, if connected*		*Not connected: 0.0.0.0*

Table 8: Operating parameters of the ELIS4

*If a sensor is connected with TEDS, this is indicated by "TEDS" and a lock in the display. The corresponding values then cannot be changed.

**Only relevant for BOSCH internal use.

By pressing the "-" key, the ELIS4 can be set directly in the Idle operating state.

By pressing the "+" key, the ELIS4 can be set directly in the Run operating state.

3.4 Calibration values for the sensors

The ELIS4 measures the temperature-dependent resistance of the two TMs of the EGS-LI. These resistances are subject to a variance dictated by production. For this reason the sensor-specific values are stored in a Transducer Electronic Data Sheet (TEDS) in the sensor cable. These values are read in when the unit is switched on or manually via M01.

The measured heat output is at an ambient temperature of 20 °C and quiet air in the range from 1.5 to 2.5 W. At a higher ambient temperature, this value is reduced, while at lower temperatures it increases.

3.5 Regeneration of the sensor

In particular with vehicles that in operation emit significant amounts of particles, such as diesel engines or direct fuel injectors, this may involve deposits on the EGS-LI. In the low amounts, these deposits do not have any influence on the measurement. However, with increased deposits, the detection can be negatively affected by reduced wetting behavior of the condensate.

For this reason, it is necessary to regenerate the sensors from the first measurement and after each measurement that is performed. With a regeneration, the sensor is heated for 40 s to 800 °C. This causes the organic deposits on the sensor to burn off so that it is ready for operation again.

To start the regeneration, the "Menu" key is pressed twice, so that "Regeneration" is shown in the display. Now, the regeneration is started by pressing the "+" key. The display switches back into the overview, and the course of the regeneration can be tracked on the basis of the displayed temperature. The regeneration lasts approximately one minute and can be interrupted before this time lapses by just pressing the "-" key. As soon as the sensor temperature has reached the set temperature (200 °C) again, the measurement is continued.

Caution!

After the regeneration, it may occur that the heating output requirement is reduced. When the heat input is increased, this is in the area surrounding the sensor, whereupon the thermal losses at the surrounding area are less. Because this also has an effect on the occurrence of condensate, the regeneration must never be performed directly before a measurement, rather, always after that or at least 30 minutes before a measurement. In this way, the near environment cools back down to the level of the overall vehicle environment.

Alternatively to the menu, the regeneration can also be started via the external trigger or via a corresponding CAN message. This has the advantage that the regeneration can be automated, for example, during operation on the test bench. The CAN message for starting the regeneration is described in the 3.6 Activation of the ELIS4 via the CAN bus section; the regeneration via external trigger is discussed below.

The ELIS4 has an input on the back side for the connection of the external trigger (see 0). In order to activate the trigger, the two pins 1 and 2 must be short-circuited for just > 30 ms. This can be realized, for example, via a separately controlled relay. The regeneration mode then proceeds fully automatically. The starting of the regeneration via the external trigger is possible only as long as the device is in Run Mode.

Caution!

In the regeneration, make sure that it is not carried out during the condensation phase or other phases with possible water loading. This could damage the sensor if it is hit by a drop during the regeneration.

Note

Before using the sensor for new projects, ensure that any deposits on the sensing element are removed from the sensing element by using regeneration mode. After performing the regeneration, the sensing element should be plain white in the detection area of the heater meander. In case of chemical non-organic debris, regeneration might not be able to successfully clean the sensor. In such cases the sensitivity of the sensor might be influenced. If any deposits remain on the surface of the sensing element after regeneration, the sensor should be replaced.

3.6 Activation of the ELIS4 via the CAN bus

The ELIS4 can also be activated via the CAN bus. This status message is transmitted with a 29-bit Extended Identifier.

Message address: 0x0A36iiii (iiii corresponds to the last 4 places of the serial numbers of the ELIS4)

Length of the data frame: 1 byte

Data format: Intel (LSB first)

Significance of the byte values:

Byte value (decimal)	***Program status***
0	Idle
4	Regeneration
7	Run

Table 9: Activation via CAN

3.7 Start Delay and max Run Time

Specifically for tests on the test bench and in endurance runs, the possibility exists with the ELIS4 to set a Start Delay and a maximum Run Time.

The Start Delay causes the ELIS4 not to switch into the "Running" state immediately after the application of the power supply but instead to remain for a certain time in the "Idle" state before it then switches independently into the "Running" state. The adjustable time here is 0...600 s, where 0 s corresponds to the immediate start after application of the power supply.

The max. Run Time is used to reset the ELIS4 from the "Running" state to the "Idle" state after the lapse of a definable time. This could be required, for example, if the sensors are to be installed in a vehicle for a longer time but after a drying out of the exhaust gas system no more measurement and heating of the sensor is to occur. The adjustable time for this amounts to 0...60 min, where 0 min corresponds to a continuous measuring operation until the power supply is interrupted. In principle, it is recommended that the sensors always be heated with the engine running in order to prevent persistent deposits on the cold sensor element at cold installation positions.

4 Regular functional test of the EGS-LI

When using the EGS-LI for pure cold start examinations, no aging of the sensor could be detected until now. Particularly in endurance test vehicles and if a sensor is used over several years, it must be assumed that especially the heater of the EGS-LI is subject to a certain degree of aging which could impact the performance.

4.1 Process routine of the functional test

For this reason, it is recommended to test the EGS-LI once a year with regular application usage or every 400 h in continuous usage to ensure the faultless function of the sensor. This function test can also be conducted with the sensor installed in the vehicle, as long as the engine is switched off and the environment of the sensor is at room temperature. A sufficient voltage supply must be ensured since particularly voltages and currents that are too low can negatively impact the power input and thereby distort the measuring result.

The following process routine must be executed:

1) Connect sensor to ELIS4
2) Connect ELIS4 to signal recording
3) Configure recording of T_{prim}, T_{sec}, Ph and ED and start recording
4) ELIS4 voltage supply with 13.0 V / 5 A max.
5) Switch on ELIS4 and EGS-LI
6) As soon as the operating temperature reaches 200 °C, continue to run for approx. 10 s
7) Start regeneration and wait until it is finished
8) Switch off ELIS4 and exit data recording

The signal curves should ideally be displayed graphically to analyze the test. The following values can now be included in the assessment of the functional performance of the sensor:

At switch-on of ELIS4 and operation at 200 °C:

	New values	Maximum values
Time until 200 °C is reached	3...8 s	10 s
Power consumption at 200 °C	1.8...2.4 W	3 W

Table 10: Values during heating of ELIS4

With regeneration of sensor:

	New values	Maximum values
Time until sensor is heated up from 200 °C to 800 °C	5...50 s	50 s
Power consumption at 800 °C (in swiveled-in state)	10...20 W	25 W
Switch-on time of heater at 800 °C (in swiveled-in state)	55...95 %	95 %

Table 11: Values during regeneration of the sensor

If no data recording is available at any time, the test may also be conducted using a stop watch and reading the ELIS4 display. All relevant measurement variables are shown on the display in the RUNNING state.

Figure 10 shows examples of the signal curves during the regeneration for a new sensor (blue) and an aged sensor (red/orange).

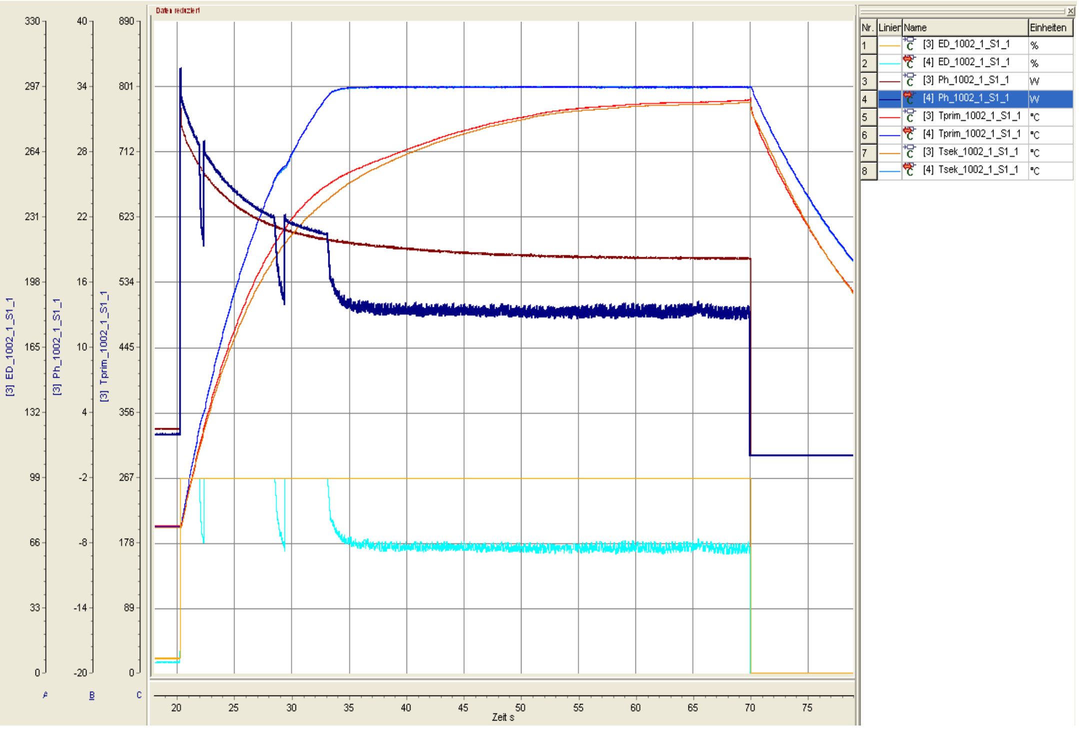

Figure 10: Signal curve during regeneration for function test

In particular, if the regeneration temperature of 800 °C is no longer reached or only very late and with long switch-on time of the heater, then the performance of the heater is limited. This creates the risk that the EGS-LI can no longer respond quickly enough to cooling through droplets or exhaust-gas flow, thereby distorting the measurement signal. In addition, it is no longer ensured that the sensor is completely cleared from soot deposits during a regeneration.

In this case, the sensor must be replaced. In case of doubt, a complete calibration with functional test can be performed in the lab. For this purpose, the sensor must be returned to ETAS.

5 Troubleshooting problems

This chapter gives some information of what you can do when problems arise with the ELIS4 and in general that are not specific to an individual software or hardware product.

5.1 Automatic fault diagnosis of the ELIS4

The ELIS4 offers a simple fault diagnosis during the initialization and in ongoing operation. This includes the checks of the heating circuit and the T-meander measuring circuits for open and short circuits. Moreover, the applied supply voltage is monitored and a warning is issued when there is an undervoltage or overvoltage. Furthermore, in the initialization the difference of the two measured temperatures is check for plausibility. If the two measured values deviate from each other too sharply, a faulty calibration or a sensor defect is assumed, and the ELIS4 does not start.

All detected errors will be displayed via the red error LED "Er“. Most errors will cause a resetting of the ELIS4 into the "Idle" state. Into the "Idle" state fault a corresponding message with the exact identification of the error appears on the display.

In **Table 12:** Error messages, the possible error messages are listed and solution possibilities are shown.

Fault message in the display	***Possible cause***	***Correction of the error***
TM shrt	T-meander defective	Replace sensor
	Supply line or sensor damaged	Check plug connections, replace supply line
	Initialization error	Restart ELIS4
TM fault	T-meander defective	Replace sensor
	Supply line broken	Check plug connections, replace supply line
	Initialization error	Restart ELIS4
Htr fault	Heater defective	Replace sensor
	Supply line broken	Check plug connections, replace supply line
	Initialization error	Restart ELIS4
HtrShrt	Short circuit in the heater circuit	Replace sensor
	Supply line or sensor damaged	Check plug connections, replace supply line
	Initialization error	Restart ELIS4
TM_diff	Measured temperatures of the two TMs deviate significantly from each other	Check set resistance values (Rc) in ELIS4 and if necessary adjust them or have the sensor recalibrated
	T-meander defective	Replace sensor
Ubatt low	Supply voltage too low	Check supply voltage and increase if necessary
Ubatt high	Supply voltage too high	Check supply voltage and reduce

		if necessary

Table 12: Error messages

5.2 Problems with the ELIS4

In the following table, some possible problems are listed with a solution approach.

Error pattern	***Possible cause***	***Possible solutions***
Display indication changes very slowly	Ambient temperature too low	-Allow ELIS4 to warm up for a few minutes -Go through the menu only step by step because display time needs to adapt
No display indication	Ambient temperature too low	Allow the ELIS4 to warm up for a few minutes or check it again at room temperature
	Display defective	Replace ELIS4
Heat output deviates significantly from set value	-Resistance value Rc incorrectly set	-Adapt resistance values Rc, measure in the event of doubts
	Ambient temperature around sensor element deviates sharply from 20°C	Normal behavior with dropping ambient temperature increases heat output and vice-versa
CAN signal is not received	-CAN terminating resistor missing	-Install CAN terminating resistor 120 Ω
	incorrect CAN db	Compare ID of the ELIS4 with CAN db and adapt CAN db as required
	CAN cable defective	Replace cable
	Other errors in the measured value determination	Check settings and adjust as required

Table 13: Error patterns

6 Technical data

This chapter describes the satisfied standards and norms, the ambient conditions, mechanical data, system requirements for the ELIS4, electrical data and the terminal assignment.

6.1 General data

6.1.1 Ambient conditions

Operating temperature -20°C to +70°C	
Storage temperature range (module without packaging)	*-40°C to +85°C*
Installation height	*max. 5000 m*
Protection type	*IP30*

Table 14: Ambient conditions

6.1.2 Mechanical data

Dimensions (H x B x T)	*55 mm x 127 mm x 160 mm*
Weight approx. 0.8 kg	

Table 15: Mechanical Data

6.2 Electrical data

6.2.1 Power supply

Operating voltage	*9V to 30 VDC*
Current consumption	*type 300 mA at 14.4 V* *Max. 5 A.*

Table 16: Power supply

6.3 Terminal assignment

Note

All connections are shown with a view of the interfaces of the ELIS4.

All shields are at housing potential

6.3.1 Power supply interface (9..30V)

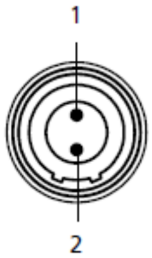

Figure11: Power supply interface (9..30V)

Pin	Signal	Description
1	UBATT+	Power supply, plus
2	Ground	Ground

Table 17: Terminal assignment of the power supply interface

6.3.2 Sensor interface

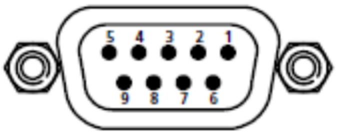

Figure12: Sensor interface (DSub9 female)

Pin	Signal	Description
1	TMprim_p	Primary temperature measurement meander, plus
2	TMsec_p	Secondary temperature measurement meander, plus
3	TEDS	Connection for the cable coding via TEDS
4	Heater_n	Heater voltage, minus
5	Heater_p	Heater voltage, plus
6	TMprim_n	Primary temperature measurement meander, minus
7	TMsec_n	Secondary temperature measurement meander, minus
8	Heater_n	Heater voltage, minus
9	Heater_p	Heater voltage, plus

Table 18: Terminal assignment of the sensor interface

Trigger interface

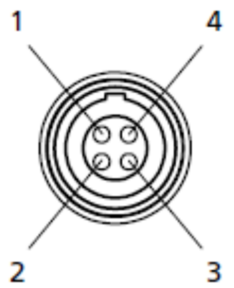

Figure13: Trigger interface

Pin	Signal	Description
1	UBatSave_p	Supply voltage, plus (behind fuse!)
2	Start_in	Trigger input (regeneration)
3	Gen_IO	Reserved, please do not connect
4	UBatSave_n	Supply voltage, minus

Table 19: Terminal assignment of the trigger interface

In order to start the regeneration, pin 1 (UBatSave_p) must be connected to pin 2 (Start_in) for a few seconds.

6.3.3 CAN interface

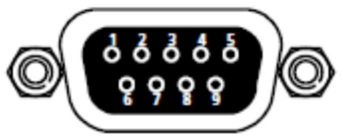

Figure14: CAN interface (Dsub9 male)

Pin	Signal	Description
1	TXOUT	Reserved, please do not connect
2	CAN-L	CAN bus, low
3	GND	Ground
4	RXIN	Reserved, please do not connect
5	CASE	Housing
6	GND	Ground
7	CAN-H	CAN bus, high
8	n.c.	--
9	n.c.	--

Table 20: Terminal assignment of the CAN interface

7 Cables and accessories

Cable for external trigger input AS_CBAV190.50.1-2 (F-00K-107-597)

Color	Signal	Description
Red	UBatSave_p	Supply voltage, plus (behind fuse!)
Brown	Start_in	Trigger input
Orange	Gen_IO	Reserved, please do not connect
Black	UBatSave_n	Supply voltage, minus

Table 21: Lead colors of the cable for external trigger

8 Ordering information

8.1 ELIS4 scope of supply

Order name	Short name	Order number
ELIS4 Liquid Impact Sensor Module	AS_ELIS4.1	F-00K-107-364
Sensor wiring harness	AS_CBL300.1-3	F-00K-107-366
CAN connection cable	AS_CBCX300.1-0m3	F-00K-107-596
CAN terminating resistor 120Ω	CBCX131.1-0	F-00K-103-786
Voltage supply cable	CBP120-2	F-00K-102-584

Table 22: ELIS4 scope of supply

8.2 Liquid Impact Sensor EGS-LI scope of delivery

Order name	Short name	Order number
Liquid Impact Sensor EGS-LI	AS_LIS.1	F-00K-107-365
Sealing ring for probes	--	1250280002

Table 23: EGS-LI scope of supply

9 ETAS contact information

ETAS Main Office

ETAS GmbH		
Borsigstraße 24	Phone:	+49 711 89661-0
70469 Stuttgart	Fax:	+49 711 89661-106
Germany	WWW:	www.etas.com

ETAS regional companies and technical support

Information about your local sales and local technical support and the product hotlines is available on the Internet:

ETAS Regional companies	WWW:	www.etas.com/en/contact.php
ETAS Technical Support	WWW:	www.etas.com/en/hotlines.php

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