ETAS

DRIVING EMBEDDED EXCELLENCE

ETAS ES630.1/ES635.1 Lambda Module (1-CH) ETAS ES631.1/ES636.1 Lambda Module (2-CH)

User Guide

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ES63x - User Guide R08 EN - 10.2021

Contents

1 About this Document

1.1 Classification of Safety Messages

The safety messages used here warn of dangers that can lead to personal injury or damage to property:

DANGER

indicates a hazardous situation with a high risk of death or serious injury if not avoided.

WARNING

indicates a hazardous situation of medium risk, which could result in death or serious injury if not avoided.

CAUTION

indicates a hazardous situation of low risk, which may result in minor or moderate injury if not avoided.

NOTICE

indicates a situation, which may result in damage to property if not avoided.

1.2 Presentation of Instructions

The target to be achieved is defined in the heading. The necessary steps for his are in a step-by-step guide:

Target definition

1. Step 1
2. Step 2
3. Step 3

> Result

1.3 Presentation of Supporting Information

NOTE

Contains additional supporting information.

2 Basic Safety Notices

This chapter contains information about the following topics:

2.1 General Safety Information

Please observe the Product Safety Notices ("ETAS Safety Notice") and the following safety notices to avoid health issues or damage to the device.

NOTE

Carefully read the documentation (Product Safety Advice and this User's Guide) that belongs to the product prior to the startup.

ETAS GmbH does not assume any liability for damages resulting from improper handling, unintended use or non-observance of the safety precautions.

2.2 Requirements for Users and Duties for Operators

The product may be assembled, operated and maintained only if you have the necessary qualification and experience for this product. Improper use or use by a user without sufficient qualification can lead to damages or injuries to one's health or damages to property.
The assembler of the system is responsible for the safety of any system incorporating the equipment.

General Safety at Work

The existing regulations for safety at work and accident prevention must be followed. All applicable regulations and statutes regarding operation must be strictly followed when using this product.

2.3 Intended Use

Application Area of the Product

This product was developed and approved for applications in the automotive sector. The module is suitable for use in interiors, in the passenger cell or in the trunk of vehicles. The module is not suitable for installation in the engine compartment and similar environments. For use in other application areas, please contact your ETAS contact partner.

Requirements for the Technical State of the Product

The product is designed in accordance with state-of-the-art technology and recognized safety rules. The product may be operated only in a technically flawless condition and according to the intended purpose and with regard to safety

and dangers as stated in the respective product documentation. If the product is not used according to its intended purpose, the protection of the product may be impaired.

Requirements for Operation

- Use the product only according to the specifications in the corresponding User's Guide. With any deviating operation, the product safety is no longer ensured.
- Observe the requirements on the ambient conditions.
- Do not use the product in a wet or damp environment.
- Do not use the product in potentially explosive atmospheres.

Electrical Safety and Power Supply

- Observe the regulations applicable at the operating location concerning electrical safety as well as the laws and regulations concerning work safety!
- Connect only current circuits with safety extra-low voltage in accordance with EN 61140 (degree of protection III) to the connections of the module.
- Ensure that the connection and setting values are being followed (see the information in the chapter "Technical data").
- Do not apply any voltages to the connections of the module that do not correspond to the specifications of the respective connection.

Power Supply

- The power supply for the product must be safely disconnected from the supply voltage. For example, use a car battery or a suitable lab power supply.
- Use only lab power supplies with double protection to the supply network (with double insulation/reinforced insulation (DI/ RI)).
- The lab power supply must be approved for an operating altitude of 5000 m and for an ambient temperature of up to 70 °C.
- In regular operation of the modules as well as very long standby operation, a discharge of the vehicle battery is possible.

Connection to the Power Supply

- The power cable must not be connected directly to the vehicle battery or lab power supply, but via a fuse of up to 20 A.
- Route the power cable in such a way that it is protected against abrasion, damages, deformation and kinking. Do not place any objects on the power cord!
- Ensure that the connections of the lab power supply, the power supply at the module and the vehicle battery are easily accessible!

DANGER

Dangerous electrical voltage!

Connect the power cable only with a suitable vehicle battery or with a suitable lab power supply! The connection to power outlets is not allowed!

To prevent an inadvertent insertion in power outlets, ETAS recommends to equip the power cables with safety banana plugs in areas with power outlets.

Disconnecting from the Power Supply

The module does not have an operating voltage switch. The module can be de-energized as follows:

- Disconnecting the module from the lab power supply
  - Separating device is the lab plug of the power cable or
  - Separating device is the plug of the power cable at the connection of the module
- Disconnecting the module from the vehicle battery
  - Separating device is the lab plug of the power cable or
  - Separating device is the plug of the power cable at the connection of the module
- Disconnecting the vehicle battery.

Approved Cables

- Use exclusively ETAS cables at the connections of the module!
- Adhere to the maximum permissible cable lengths!
- Do not use any damaged cables! Cables may be repaired only by ETAS!
- Never apply force to insert a plug into a socket. Ensure that there is no contamination in and on the connection, that the plug fits the socket, and that you correctly aligned the plugs with the connection.

Requirements for the Location

- Position the module or the module stack on a smooth, level and solid underground.
- The module or the module stack must always be securely fastened.

Fixing the Modules on a Carrier System

- When selecting the carrier system, observe the static and dynamic forces that could be created by the module or the module stack on the carrier system.

Requirements on the Ventilation

- Keep the module away from heat sources and protect it against direct exposure to the sun.
- The free space above and behind the module must be selected so that sufficient air circulation is ensured.

Assembling (Interconnecting) the Modules

- Prior to assembling (interconnecting) or separating a module stack, the modules must be disconnected from the supply voltage or they have to be in the standby operating mode.

Transport

- Stack and connect the modules only at the location of the startup!
- Do not transport the modules at the cable of the module or any other cables.

Maintenance

The product is maintenance-free.

Repair

If an ETAS hardware product should require a repair, return the product to ETAS.

Cleaning the Module Housing

- Use a dry or lightly moistened, soft, lint-free cloth for cleaning the module housing.
- Do not user any sprays, solvents or abrasive cleaners which could damage the housing.
- Ensure that no moisture enters the housing. Never spray cleaning agents directly onto the module.

Ambient Conditions

The housing and the connectors of the module as well as the plug connectors of the cables meet the degree of protection IP40.

Opening the m´Module

CAUTION

Damage to the module and loss of properties based on IP40!

Do not open or change the module housing!
Work on the module housing may only be performed by ETAS.

Potential equalization

CAUTION

Potential equalization in the vehicle is possible via the shield of the connecting cables of the modules!

Install the modules only at locations with the same electrical potential or isolate the modules from the installation location.

Cabling

For detailed information about cabling, see the User's Guide of the module.

Notices about Specific Components

CAUTION

Risk of burns!

The lambda sensor is very hot during operating and some time after operation.

During operation the lambda sensor at the module, a supply voltage is required for the sensor heater. Since the sensor heater is not supplied with current by the module, this supply voltage must be provided separately at the sensor cable.

CAUTION

Damage of the lambda sensor when operated without sensor heater!

The lambda sensor must be supplied with current at all times when it is being operated and as soon as it is exposed to the exhaust gases of a combustion process. The regulated heating voltage is provided at the sensor connection if the sensor cable is connected with a separate voltage supply and connected to the module and if the signal for switching on the heater is present at the sensor cable.

CAUTION

Operate the lambda sensors only on modules with up to date firmware!

Prior to the start-up, update the firmware of the module with the current service software HSP to avoid damage of the lambda sensor!

NOTE

Operate the lambda sensors only with the original sensor plugs to be able to determine valid measurement data.

NOTE

The Bosch lambda sensor LSU ADV-D must be calibrated with the lambda module prior to use.

3 Hardware Description

This chapter contains information on the following topics:

3.1 Lambda Modules

The Lambda Modules ES630.1, ES631.1, ES635.1 and ES636.1 are part of the family of ES600 modules for use in the lab and in the vehicle. They are universal precision lambda measuring instruments that, in connection with lambda sensors, enable emission measuring for SI, diesel and gas engines.

Fig. 3-1 ES636.1 Lambda Module

The lambda modules ES630.1/ES635.1 (one channel) and ES631.1/ES636.1 (two channel) scan the pump current, and then determine the oxygen content in the exhaust gas, as well as the values and reciprocals of the variable lambda and the air-fuel ratio. The conversions can be based on distinctive application-specific characteristics which can be downloaded to the module.

	ES630.1	ES631.1	ES635.1	ES636.1
Measurement Channels	1	2	1	2
External Pressure Sensor Port	-	-	1	2

The algorithm used by the ES63x modules for controlling the pump current can be adapted to suit specific sensors.

The ES63x modules supply and control the sensor heater. To protect the lambda sensor, the sensor heater's operation may be allowed to continue beyond the point at which the measuring units within the modules have been shut off. Similarly, the heater can be powered up independently of the measure-

ment function by an external signal (typically “Engine On”). The lambda modules monitor both the sensor temperature and internal resistance while supplying relevant output data.

Thanks to a TEDS code inside the sensor or wiring connection, the modules recognize the sensor type, preventing improper sensor operation. The modules automatically detect sensor and wiring defects.

All ES63x modules are capable of measuring the atmospheric pressure by means of an integrated sensor. To the modules ES635.1 and ES636.1, an external pressure sensor can be connected in addition. With this external sensor, pressure changes within the exhaust or air system can be measured. Influences of atmospheric and exhaust pressure changes on the lambda measurement can automatically be compensated by the lambda modules.
Independently of lambda measuring, pressure signals are available for further analyses. As an example, on the basis of an air pressure measurement, the height profile of a test drive can be recorded. By means of the external sensor, the pressure in the turbo charger can be measured.

Using an Ethernet connection, the ES63x lambda modules can be directly linked to a PC running suitable measuring software, or interfaced with miscellaneous ETAS compact hardware devices.

All modules feature an RS-232 interface and support the SMB protocol. In the event that an LA4 lambda meter in an existing measurement hardware configuration must be changed out, it can be easily replaced by an ES63x module.

3.1.1 Measure Values

The ES63x modules use fuel- and sensor-specific curves to calculate the oxygen content, the lambda value λ and the air/fuel ratio, A/F. The lambda sensor is installed in the exhaust system. This makes it possible to determine the following parameters:

- Lambda λ
- Air/fuel ratio, A/F
- Oxygen content O_2
- Fuel/air ratio, F/A
- 1 / lambda λ
- Pump current of the lambda sensor I_p
- Internal resistance of the lambda sensor R_i
- Heater voltage U_h
- Heater current I_h
- Nernst voltage U_{nernst}
- Pump voltage U_{pump}
- Sensor temperature T
- Ambient pressure p_{amb}
- External pressure p_{exh} (ES635.1 and ES636.1)
- Filling level of reservoir Fr (only applicable to the LSU5.1)
- State/ operational state of the sensor Sta

3.1.2 Features

- Display for configuring and displaying the measure values
- Configurable linearized analog output
- Automatic sensor type detection
- Automatic sensor error detection
- Automatic wiring error detection
- Sensor heating even when module powered off
- Simultaneous determination of different measure values with one lambda sensor
- External pressure measurement for automatic compensation of the pressure dependence of the lambda sensor pump current (ES635.1 and ES636.1)
- Communication with the PC via an XCP-based protocol that is compatible with the existing ETAS Ethernet topology. The concept fulfils the following requirements:
  - High bandwidth to be able to acquire measure values with high resolution and high sampling rates,
  - Low transfer times for applications in function development,
  - Exact synchronization with other measurement systems possible,
  - Simple application based on the Ethernet integration in INCA, no complicated setting of bus parameters,
  - Simple to integrate in measurement and calibration tools manufactured by third-party suppliers due to the use of XCP as application protocol.
- Communication with the PC via SMB
- Designed for use both in the development environment and as a stand-alone device.
- Module suitable for use in automotive applications; suitable for use in the development environment and in the vehicle on test drives:
  - Not sensitive to acceleration or mechanical damage,
  - Not sensitive to extreme environmental conditions (temperature, dampness, EMC) and
  - Very low temperature coefficients contribute to the reduction in the number of measurement errors.
- Part of the ETAS Tool Suite
- Stand-alone operation with Daisy Chain Configuration Tool from ES6xx-_DRV_SW

For the complete technical data of the ES63x, refer to the chapter “Technical Data” on page 95.

3.2 Housing

Housing with ports on the rear of the device is used for the ES63x. The sturdy metal housing has nonskid plastic feet. It can be easily screwed onto a carrier system for installation in a car or in the lab. The housings of this device family can also quickly and easily be connected to one another (see the section 5.1 on page 41). The ES63x module is specifically designed to be installed in the passenger cell.

3.2.1 Front of Device

Fig. 3-2 Front of Devices

Display and Keys

The ES63x module has a display for displaying the measure values as well as 6 keys for configuration and operation.

The current function of the function keys **F1**, **F2**, **F3** and **F4** is displayed in the bottom line of the display.

The two keys **-** / ¯ to the right of the display enable the user to select what is displayed and also to move around the display. For a detailed description of the key functions, refer to chapter 6 on page 56.

LEDs

On the front of the module, there are two LEDs: **ER** and **ON**. They indicate the operational states of the module (refer to chapter 13.1 on page 163).

Serial Number

The serial number is on the front of the module.

3.2.2 Rear of Device

All ports are on the rear of the ES63x Lambda Module (see Fig. 3-3 on page 20 and Fig. 3-4 on page 21).

The Lemo and Souriau connectors used are reverse-polarity protected due to coding. They are installed in accordance with the protection class IP40.

Rear of the ES630.1 and the ES631.1Module

Fig. 3-3 Rear of the ES630.1 (top) and of the ES631.1 module (bottom)

Port		Meaning
IN	Daisy-Chain In	Input; Ethernet connection to the previous module or to the PC, module power supply
OUT	Daisy-Chain Out	Output; Ethernet connection and power supply of the subsequent module
SERVICE	SMB; Service	Serial measure bus (SMB)
CH1 (measurement channel 1)	VOUT	Analog voltage output
	LAMBDA	Sensor cable port
CH2 (measurement channel 2) [1)]	VOUT	Analog voltage output
	LAMBDA	Sensor cable port

[1)]: ES631.1 only

Rear of the ES635.1 and the ES636.1Module

Fig. 3-4 Rear of the ES635.1 (top) and of the ES636.1 (bottom) module

Port		Meaning
IN	Daisy-Chain In	Input; Ethernet connection to the previous module or to the PC, module power supply
OUT	Daisy-Chain Out	Output; Ethernet connection and power supply of the subsequent module
SERVICE	SMB; Service	Serial measure bus (SMB)
CH1 (measurement channel 1)	VOUT	Analog voltage output
	LAMBDA	Sensor cable port
CH2 (measurement channel 2) [1)]	VOUT	Analog voltage output
	LAMBDA	Sensor cable port
	EPS	External pressure sensor port

[1)]: ES636.1 only

“LAMBDA” Port

A lambda sensor can be connected to the 22-pin Souriau jack using a sensor cable. Every measurement channel is assigned a 22-pin Souriau jack. A lambda sensor can be connected to each one with sensor cables.

The sensor cables (see section 11.5 on page 125) are equipped with a connector for the external supply voltage of the sensor heating as well as an input for controlling the heating. The sensor cables CBAL410.1, CBAL4105.1, CBAL451.1, CBAL4515.1, CBAL463.1, CBAL4635.1,CBAL468.1 and 4685.1 also have a port for analog output signals.

“VOUT” Port

The analog output signal is made available at the BNC jack. The analog output voltage can be assigned to a measure value and its output parameters configured. Every measurement channel is assigned a BNC jack at which the analog output signal of the measurement channel is provided. The analog output voltage can be assigned to a measure value and its output parameters configured.

Daisy Chain Ports (“IN”, “OUT”)

Every module has an explicit input socket (“IN”) as well as an explicit output socket (“OUT”). The modules are connected to each other in a chain structure. For this purpose, the output socket of one module and the input socket of the next module are connected with a cable or a connector. This type of cabling is referred to as daisy-chain topology.

The Ethernet data line and the supply voltage are routed through the daisy chain ports of the module:

- “IN” (input)
- “OUT” (output)

The PC, the ES600 network module, the ES910 or the Drive Recorder ES720 are connected at the “IN” port (input). The “OUT” port (output) is connected with the following ES63x or with a module of the ES400 line or remains free on the last module of the chain.

NOTE

If ES63x modules are operated in an SMB bus (“SERVICE” port), each of these ES63x modules must be connected to the power supply at the “IN” port.

“EPS” Port (ES635.1 and ES636.1)

An external pressure sensor can be connected to the 4-pin Lemo socket “EPS” to compensate for the influence of exhaust gas pressure on the lambda sensor curve during measurements in exhaust systems.

“SERVICE” Port

At the “Service” port, the ES63x module can be connected to an SMB bus using an adapter and integrated in test setups like the Lambda Meter LA4.

3.3 Block Diagram

The electronic of the module provides all signals necessary for operating a lambda sensor in one measurement channel (ES630.1 and ES635.1) or in two identical measurement channels (ES631.1 and ES636.1). A microprocessor system with two Ethernet interfaces processes the acquired values of the measurement channel respectively of the both measurement channels. In addition, a value can be issued at the galvanically isolated analog output of the measurement channel.

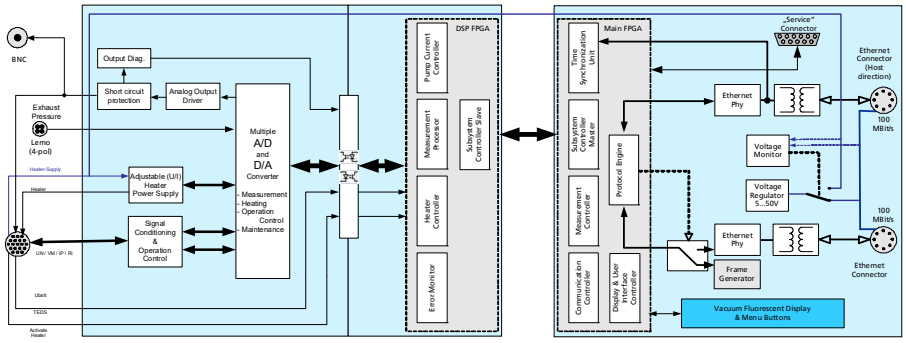

Fig. 3-5 Block Diagram (one Measurement Channel)

The electronics control the heating of the sensor(s) to guarantee the correct operating temperature. The internal resistance of the sensor element is used as the measure for its temperature. By controlling the pump current, a constant voltage is set at the Nernst concentration cell. The lambda value can be calculated from the pump current measured.

3.4 Measurement Channel

A measurement channel consists of the function groups input stage, signal processing with filter, heater control, cable identification and a galvanically isolated analog output.

3.4.1 Signal Processing and Filters

Measuring Pump Current

When the pump current is measured, the amplified signal of the pump current controller is filtered with a Bessel 2nd order low-pass with 1 kHz cutoff frequency. An A/D converter digitizes this pump current signal with a sampling rate of up to 2 kHz. Sampling takes place synchronously with other devices of the ES400/ES63x family. A digital Bessel 2nd order low-pass which can be disabled and adjusted is used to further smooth the pump current signal.

The microprocessor software calculates the values for lambda, oxygen content and the air/fuel ratio from the pump current.

Measuring Internal Resistance

When the internal resistance is measured, the signal is filtered by a Bessel 2nd order low-pass with a cutoff frequency of 50 Hz. The subsequent A/D converter digitizes the signal with a sampling rate of up to 20 Hz. A digital Bessel 2nd order low-pass which can be disabled and adjusted is used to further smooth the signal that feeds a digital controller that controls sensor heating.

Depending on the sensor temperature, the R_i measuring unit supplies a voltage which, once filtered and digitized, is used as the actual value for controlling the heating temperature of the sensor.

3.4.2 Pressure Compensation

The partial pressure of the oxygen influences the pump current measure signal provided by lambda sensors. Changes in pressure of the gas mixture surrounding the sensor in the exhaust duct therefore change the pump current measured and thus all calculated variables such as lambda, oxygen content and air/fuel ratio.

Compensation of the Ambient Pressure

The ES63x.1 has an internal sensor for measuring ambient pressure that can be used to compensate the lambda sensor signal or as a barometric altitude sensor. The ambient pressure determined can be output by the module.

Pressure Compensation in Open Exhaust Systems

The ambient pressure depends on the altitude above sea level in which the lambda sensor is used. If there is no (mechanical) obstruction for the exhaust gas in the exhaust system and the lambda sensor is mounted close to the end of the exhaust pipe, the exhaust gas pressure at the lambda sensor is about the same as the ambient pressure. The lambda sensor signal is sufficiently exact. Apart from ambient pressure compensation, no further pressure compensation is necessary.

Pressure Compensation in Complex Exhaust Systems (ES635.1 and ES636.1)

If there are obstructions for the exhaust gas in the exhaust system, such as turbochargers, particle filters, catalytic converters or valves, the exhaust gas pressure inside the exhaust system can be much higher than the ambient pressure. If the lambda sensor is mounted in this section of the exhaust system, the exhaust gas pressure influences the lambda sensor signal and is thus detrimental to measurement accuracy. Instead of the compensation of ambient pressure, the influence of exhaust gas pressure on the pump current must be compensated.

To compensate for the dependence between exhaust gas pressure and the pump current of the lambda sensor, the pressure of the exhaust gas flow is measured with an additional pressure sensor mounted close to the lambda

sensor in the exhaust system. The pressure sensor is connected to the exhaust system using a customized adapter (a pipe/tube construction) for the purposes of thermal isolation.

NOTE

ETAS does not supply the components for thermal isolation of the pressure sensor.

The ES63x uses the signal of the pressure sensor connected to the “EPS” port to calculate a corrected pump current signal in accordance with the compensation curves of the lambda sensor manufacturer.

This procedure of exhaust pressure compensation (EPC) of the ES63x completely compensates for the influence of static and slow-changing exhaust gas pressures on the lambda measurement.

Changes of the exhaust gas pressure in static operation of the engine or on a change of operating point (acceleration, using the gas pedal) are compensated. The influence of pressure fluctuations on the lambda sensor, caused by the combustion process and the opening of the exhaust valves, cannot be compensated with this procedure.

3.4.3 Heater Control

To operate the sensor at a target temperature, the current sensor internal resistance is permanently compared to its desired value and the effective heating performance updated.

This control circuit can be operated independently of the digital part of the ES63x and can therefore guarantee an operational sensor even when the module is switched off.

3.4.4 Analog Output "VOUT"

The ES635.1 also has a connector "VOUT" for analog output signals for each measurement channel. The analog output of the ES635.1 is galvanically separated, protected against shorts and overload (see section 10.10.8 on page 105).

3.5 Sensor Identification (TEDS)

The connected sensor must be identified to coordinate the operating parameters of the ES63x with the connected sensor and rule out faulty operation.

3.5.1 Sensor Cable with Cable Identification (TEDS)

The ETAS sensor cables for the Bosch Lambda Sensors LSU 4.2, LSU 4.9and LSU 5.2 as well as for the NTK Lambda Sensors ZFAS-D, ZFAS-U2 and ZFAS-U3 contain an active component (TEDS) for cable identification and thus the connected lambda sensor.

3.5.2 Lambda Sensor with Sensor Identification (TEDS)

The Bosch Lambda Sensors LSU ADV-G (Code A7), LSU ADV-D (Code 1) and LSU 5.1 contain an active component (TEDS) in its cable for identifying the connected lambda sensor. For the sensors LSU ADV-D and LSU 5.1 the TEDS also holds the last calibration data.

3.6 Sensor Cable

The sensor cables are equipped with a connector for the heating voltage of the sensor as well as with a control line for the sensor heating. Sensor cables are available both with and without an analog output jack.

3.7 Data Transfer via Ethernet

For data transfer, the ES63x and ES400 modules use a 100 Mbit/s Ethernet network connection in duplex operation. The data transfer can be adapted flexibly to suit the test setup and the measurement task.

NOTE

The complete Ethernet bandwidth is available for both measure data and control variables.
Calibration procedures can take place in a Rapid Prototyping application without delay with measure data being acquired at the same time.

3.7.1 Communication Protocols

The universal ASAM measure and calibration protocol XCP is used for serial communication. On the Ethernet transport and network layer, the UDP/IP protocol is used (see Fig. 3-6 on page 27).

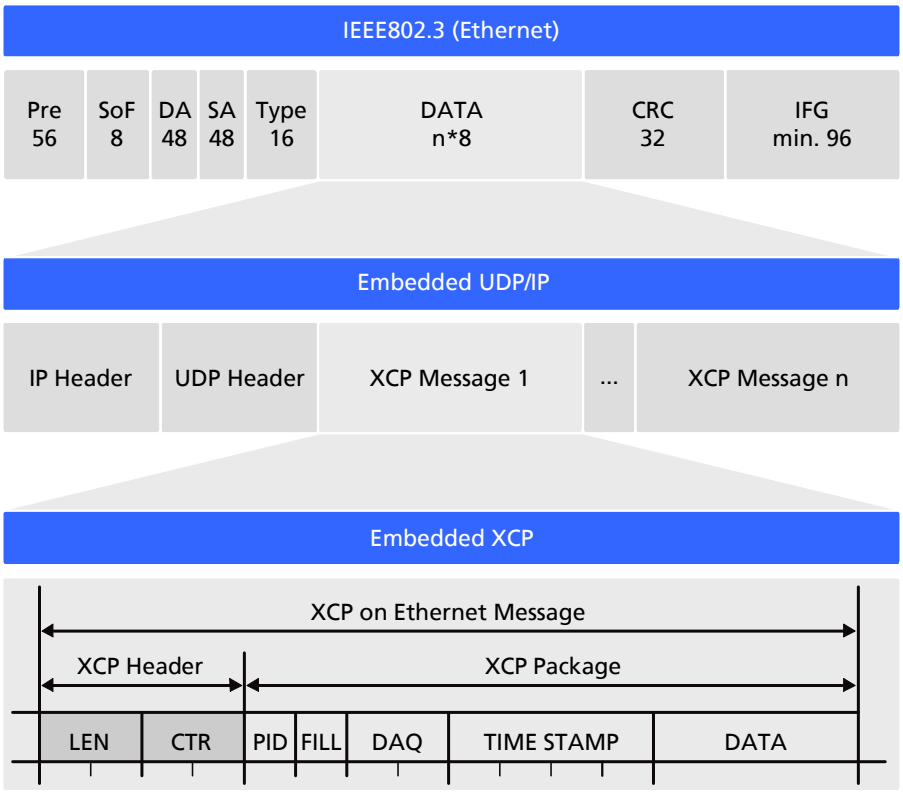

Fig. 3-6 Message Format “XCP on UDP” (Schematic)

Within the XCP protocol, the modules transfer, among other things, module ID, time stamp and measure and/or stimulation data in an extremely precise and predictable time pattern. The communication protocol used for the ES400 family and the ES63x family avoids repeated transfer of protocol data that takes place, for example, in handshake-based systems. This makes a high bandwidth available for reference data.

Using the UDP/IP standard for data transfer makes it possible to connect the ES400 modules or the ES63x modules directly to a PC, a router or a switch. In XCP communication, the PC has the master function.

No real-time requirements are made. Data acquisition on a PC, which generally does not have to fulfill high real-time requirements, can thus be connected directly to a module chain. With a real-time-capable master, such as, for example, a Rapid Prototyping system, lots of different kinds of I/O signal can be accessed with extremely short cycle times.

NOTE

The communication protocol used by the ES63x makes it possible for other suppliers to use the communication protocol for their own, non-ETAS applications once the modules have been configured with the “Daisy Chain Configuration Tool from ES6xx_DRV_SW”.

3.7.2 Realization

Time Slice Procedure

The ES400 modules in the daisy chain transfer the data to the master using a 100 MBit/s Ethernet connection time-controlled, i.e. without being prompted. The PC assumes the function of the master. In the network, the ES400 modules respond like a single Ethernet device with one MAC address.

All ES400 and ES63x modules have a generator which is only activated in the last module of each chain after the test setup has been connected to the PC. The frequency of the generator or the period duration of the time slices generated can be set in the application program. It corresponds to the measuring frequency of the measurement channel with the highest acquisition rate in the chain.

A binary counter linked to the generator periodically counts the time slices generated (value range: 2^{16} = 65536). The last module in the chain sends the relevant number of time slices in the IP header. The Ethernet frames are transferred from module to module within the chain.

Each module in the chain receives bandwidth to transfer its measure data in freely selectable time slices assigned within the period of the binary counter. The module uses the number of the time slice to determine whether it can insert an XCP message with its measure data into the current time slice.

The fastest module, which determines the period duration of the time slices generated, transfers data in every time slice. An Ethernet frame then contains at least one XCP-on-Ethernet data package. The length of the Ethernet frame transferred inside a time slice increases with the number of modules which can insert their data into this time slice.

The numbering of the time slices ensures, for example, that two modules which work with half the sampling rate of the generator never attach their data to the same Ethernet frame. One module uses only the odd frame numbers and the other only the even ones. This mechanism also ensures for certain that the assigned frames do not exceed the length of a time slice.

The measure data is automatically distributed to the frames so that the available bandwidth is used perfectly.

The time slice procedure makes both measurements of fast signals and the acquisition of a large number of channels with a low sampling rate possible.

If a few fast signals and lots of slow ones are acquired in a chain, the slow signals can be transferred in time multiplex procedure.

NOTE

Due to data transfer by Ethernet, there are virtually no limitations in terms of the number of modules in a module chain even with fast sampling rates.

Clock Generator for Synchronizing Modules

The clock generator for the synchronization of the modules is either the first module in an ES400 chain, the first module in an ES63x chain or the network module ES600. In both cases, the measure data is synchronized with a toler-

ance of one microsecond. Using an ES600 network module, several ES400/ES63x chains can be synchronized with each other or with the modules of the ES600 series. The ES400/ES63x and ES600 modules add the relevant time stamp to the Ethernet data package for every measure value. The exact assignment in terms of time of the measure data of the ES400/ES63x and ES600 modules used resulting from this makes precise analysis of the correlations of measure signals possible.

Synchronizing the ES63x and INCA Signal Processing

Data transfer does not require synchronization of the local timebases of the ES400/ES63x modules. The time stamps are still synchronized by the ES400/ES63x system to be able to correlate measure data and sampling times of different modules in terms of time after data transfer. A precise time and drift synchronization takes place in the ES400/ES63x modules via a hardware connection.

No bandwidth is required for this, unlike time synchronization in acc. with IEEE1588 (Precision Time Protocol). The modules add the time stamp to the Ethernet data package for every measure date.

The combination of time stamp synchronization, full duplex and time slice procedure results in a very high reference data rate of the ES400 measure modules.

3.7.3 Examples

Example 1

Fig. 3-7 on page 30 shows an example of an application with three concatenated ES400/ES63x modules with the same acquisition rates. The transfer scheme for this configuration is shown in Fig. 3-8 on page 30.

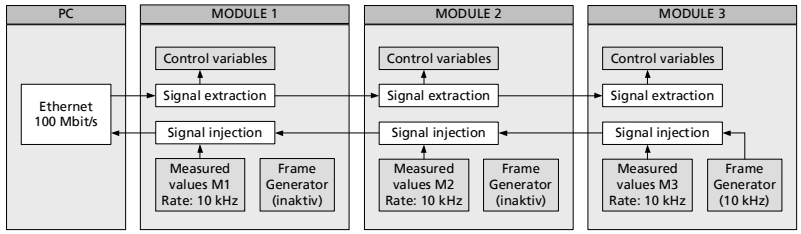

Fig. 3-7 Time-Multiplex Data Transfer Between an ES400/ES63x Module Chain and a PC

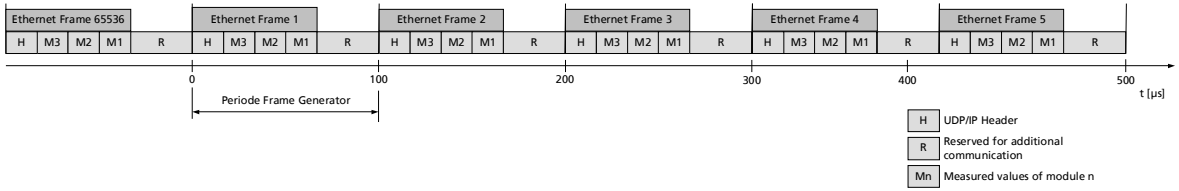

Fig. 3-8 Transfer Scheme for Example 1 (Simplified, Not True to Scale)

In this example, the third module periodically generates 2^{16} (65536) time slices each 100 microseconds long. Modules 1, 2 and 3 acquire measure values with the same rate of 10 kHz each. Module 1, Module 2 and Module 3 link their measure values to each time slice (see Fig. 3-8 on page 30).

Independently of this, control variables can be transferred at the same time from the PC to the modules.

Example 2

Fig. 3-9 on page 31 shows an example in which three modules with different acquisition rates are linked to each other. The transfer scheme for this configuration is shown in Fig. 3-10 on page 31.

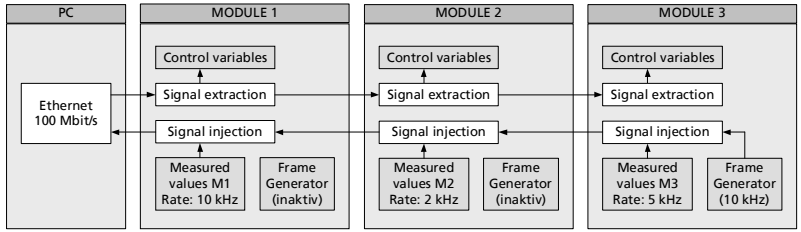

Fig. 3-9 Time-Multiplex Data Transfer Between an ES400/ES63x Module Chain and a PC

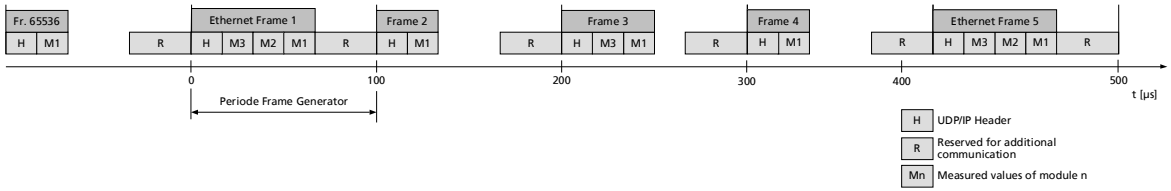

Fig. 3-10 Transfer Scheme for Example 2 (Simplified, Not True to Scale)

In this example, the third module periodically generates 2^{16} (65536) time slices (Ethernet frames) each 100 microseconds long. The modules 1, 2 and 3 acquire measure values at a rate of 10 kHz, 2 kHz and 5 kHz. Module 1 links its measure values to each Ethernet frame, module 2 to every fifth Ethernet frame and module 3 to every second Ethernet frame (bottom figure).

Independently of this, control variables can be transferred at the same time from the PC to the modules.

3.8 Data Transfer via SMB

At the “SERVICE” port, the ES63x can be connected directly to an SMB bus using the serial interface (V24) and integrated in test setups like the Lambda Meter LA4.

Every measurement channel of a module is assigned its own SMB address (see section 7.6.3 on page 72). The ES63x module thus requires two SMB addresses (one SMB address each for measurement channel CH1 and measurement channel CH2) and can be addressed in the test setup like two LA4 modules.

SMB addresses must not be assigned twice over within the bus.

Up to 16 measuring modules can be connected to the serial interface of a PC using the serial measuring bus. The transfer rate is 38,400 bauds using the format 1 start bit, 8 data bits, 1 stop bit, and no parity.

Communication is always initiated by the PC. Every message contains the address of the measuring module and the command code. All the measuring modules check this request, i.e. each module decodes it and compares the address part with the module address set in its memory. Only the module addressed processes the message. The others ignore the message. Command processing is defined specific to the module.

3.8.1 Request PC ⇒ ES63x

Each message is 1 byte long. It consists of the address part for the module intended and a command part of 4 bits for the module-specific command code.

Every module address (0 to 15) must be unique.

3.8.2 Response ES63x ⇒ PC

The information sent by the module contains no information on its format or standardization. On request, only 1 byte is sent to the PC.

The PC must always request the HIGH byte first and then the associated LOW byte. The LOW byte is only valid after the HIGH byte has been requested.

3.8.3 Code Table of SMB

When the PC is queried using defined codes, the ES63x sends information with a max. 1 byte (see section 10.10.4 on page 102).

3.9 Power Supply

The ES63x module and the lambda sensor are powered via separate power supply connectors.

NOTE

The module and the lambda sensor must be connected to the supply voltage for measuring and for the firmware update of the ES63x.

NOTE

The ES63x must be physically disconnected from all supply voltages so the module is not supplied with power.

3.9.1 Supply Voltage of the ES63x Modules

In every module, DC/DC converters guarantee the operation of the ES63x modules (depending on the supply voltage and ambient temperature, see the section “Power Supply” on page 103).

3.9.2 Power Supply to ES63x Modules linked by Ethernet

In the simplest application case, the modules are linked directly to the daisy-chain ports “IN” and “OUT”. They are connected to the supply voltage via the previous module all the way.

Additional Supply of the ES63x Modules via a Y Boost Cable

If the supply voltage (at the input) of a module is too low because of the current consumption of the previous modules, multiple feeding of the supply voltage can guarantee this and the following modules sufficient supply voltage in longer module chains.

In this application case, you have to split the module chain. Swap the existing connection cable between the two modules for a Y boost cable for additional, direct feeding of the supply voltage. The module chain is now closed again and the power supply of the following modules guaranteed.

The special design of the Y boost cable avoids reverse feeding into the front parts of the module chain and thus arising potential differences.

When is it necessary to use a Y boost cable?

An exact calculation of the current consumption of a module chain is only possible if numerous variables are known:

- supply voltage of the first module at the input
- minimum supply voltage at the last module of the chain
- number and type of the modules
- cable length
- cable type
- ambient temperature

The necessary minimum voltage for supplying power to the system must be determined individually for each test setup.

NOTE

Please contact ETAS to discuss your particular ES63x configurations.

Example 1:

For module chains which are equipped exclusively with ES63x modules, ETAS recommends the use of Y boost cables if the length of the module chain is longer than 10 modules.

Example 2:

With a minimum voltage of 7.7 V , no additional feeding is necessary with a Y cable if the module chain consists of the following modules:

- nine ES420 modules
- four ES63x modules
- one ES441 module

NOTE

The examples apply at an ambient temperature of 70 °C.

3.9.3 Power Supply to ES63x Modules linked by SMB

If ES63x modules are operated in an SMB bus (“SERVICE” port), each of these ES63x modules must be connected to the power supply at the “IN” port.

3.9.4 Supply Voltage of the Lambda Sensor

The lambda sensor requires a supply voltage to operate the heating. When several ES63x modules are used, each lambda sensor must be powered separately.

NOTE

Depending on the operating mode, the sensor can continue to be heated regardless of whether power is supplied to the module (see section 4.4 on page 39).

4 Functional Description

This chapter contains information on the following topics:

4.1 Broadband Lambda Sensors

The Bosch lambda sensor LSU 5.1 is a planar single-cell limiting current sensor, the Bosch lambda sensors LSU 4.2, LSU 4.9, LSU 5.2, LSU ADV, and the NTK lambda sensor ZFAS-U2 and ZFAS-U3 are planar two-cell, limiting current sensors.

The LSU 4.2 compares the oxygen content of the exhaust gas with the ambient air. All other broadband lambda probes compare the oxygen content of the exhaust gas with their integrated oxygen reservoir.

The single-cell probe LSU 5.1 is particularly suitable for use in the lean environment.

As the above-mentioned two-cell sensors consist of a combination of a Nernst concentration cell (sensor cell) and a pump cell transporting oxygen ions, they can carry out precise measurements not only in the stoichiometric point at $\lambda = 1$, but also in the lean and rich ranges.

With the exception of the LSU ADV-D, all sensors are calibrated individually at the factory.

The operational state of the lambda sensor is characterized by the following parameters:

- R_i (internal resistance of the lambda sensor)
- I_p (pump current of the lambda sensor)

For the proper use of Bosch lambda probes, the lambda probe-specific Bosch Technical Customer Documents (TCD) must be taken into account. The TCDs cannot be obtained from ETAS and are available from Bosch under the following document numbers:

Lambda Sensor	Product number	Technical Customer Documentation	Issue date
LSU4.2	0-258-007-151	Y 258 K01 010-000e	27.05.2003
LSU4.9	0-258-017-025	Y 258 K01 029-000 Issue 5	14.05.2020
LSU ADV G	0-258-027-010	Y 258 K01 024-000 Issue 4	28.05.2020
LSU ADV D	0-281-004-211	Y 258 K01 043-000 Issue 5	28.05.2020
LSU5.1	0-281-004-439	Y 258 K01 120-000 Issue 4	04.05.2020
LSU5.2	0-258-037-022	Y 258 K01 068-000 Issue 5	28.05.2020

NOTE

In this product the heater, temperature and lambda characteristics for the above mentioned Bosch lambda probes are pre-installed. The characteristic curves according to the measured values and specifications of the above mentioned TCD (Technical Customer Document) from Bosch.
The characteristic curves were determined with a synthetic gas mixture specified in the TCD and under the conditions specified there. When used in gasoline or diesel applications, the corresponding notes in the Bosch TCD must be considered.

NOTE

User-defined characteristics can be managed with the Daisy-Chain Config-Tool as a standalone version or as part of INCA. An HSP-Update only loads the current default characteristics onto the module.

NOTE

The electrical measurement accuracy is specified in this user guide for room temperature and over the operating temperature range. Thus, the measuring accuracy of the ES63x is factors higher than that of the lambda probe. Therefore, the measuring accuracy of the measuring chain consisting of the lambda sensor and ES63x measuring device can be specified with sufficient accuracy with the measuring accuracy of the lambda sensor. Values for this are stored in the corresponding lambda sensor TKU.

4.2 Operating Modes of the Measurement System

The measurement system consisting of ES63x and lambda sensor can be in the following operating modes:

- Operational state “Normal” or
- Operational state Standby" (measurement switched off).

NOTE

The ES63x must be physically disconnected from all supply voltages so the module is not supplied with power.

4.2.1 Operational State “Normal”

In the operational state “Normal”, the ES63x is operated alone or in connection with other modules of the ES400/ES63x family. The module must be supplied with operating voltage at the “IN” input in this operational state. The display is only activated in the operational state “Normal”

.

NOTE

Measure values are only available in the operational state “Normal”.

4.2.2 Operational State "Standby" (measurement switched off)

The measurement channel or channels of the module and the display are disabled, the digital components are activated. The lambda sensor can be further heated and operated if necessary (see section 4.4 on page 39).

4.3 Measure Values

4.3.1 Overview

The measure values of the ES63x Lambda Module can be output at various interfaces (individually for each measurement channel of the ES631.1/ ES636.1 module):

- in the display of the module,
- in the calibration software on the PC
- as a message at the SMB “SERVICE” port
- as an analog voltage value at the module’s “VOUT” analog output
- as an analog voltage value when using sensor cables with an additional analog output (see section 11.5 on page 125)

	Output of the Measure Values in/to		
Measure Value	Display and calibration software	Analog output "VOUT"	SMB "SERVICE" port
Lambda λ	Yes	Yes	Yes
Air/fuel ratio, A/F	Yes	Yes	Yes
Oxygen content O_2	Yes	Yes	Yes
Fuel/air ratio, F/A	Yes	Yes	No
1 / lambda λ	Yes	Yes	No
Pump current of the lambda sensor I_p	Yes	Yes	Yes
Internal resistance of the lambda sensor R_i	Yes	Yes	Yes
Heater voltage U_h	Yes	Yes	No
Heater current I_h	Yes	Yes	No
Nernst voltage U_{nernst}	Yes	Yes	No

	Output of the Measure Values in/to		
Pump voltage U_{pump}	Yes	Yes	No
Sensor temperature T	Yes	Yes	No
Ambient pressure p_{amb}	Yes	Yes	No
External pressure p_{exh} (ES635.1 and ES636.1 only)	Yes	Yes	No
Filling level of reservoir (LSU 5.1 only) Fr	Yes	Yes	No
State Sta	Yes	No	No

4.3.2 Output in the Calibration Software or on the Display

All measure values are available simultaneously and can be configured in the calibration software. The measure values of the internal pressure sensor (ambient pressure p_{amb}) and the external pressure sensor (external pressure p_{exh}) can be either acquired or displayed.

4.3.3 Output at the Analog Output

Measure Values

All measure values the ES63x sends to the PC via XCP can be output as an analog voltage value at the analog output of the module and when using sensor cables with an additional analog output at the BNC jack of the sensor cable (see section 11.5 on page 125).

The BNC jack VOUT of the measurement channel on the rear of the module and the BNC jack of the sensor cable are connected in parallel.

In the calibration software or at the module, you can select one each of the measure values for output at the analog output of the ES63x.

Output Voltage

Dimensional equations apply for the output voltage at the analog output of the ES63x according to the measure value output (see section 10.10.8 on page 105).

In the operational state “Standby”, no output voltage is available at the analog output.

4.3.4 SMB-Output at the “SERVICE” Port

At the “SERVICE” port, the ES63x can be connected to an SMB bus using an adapter and integrated in test setups like the Lambda Meter LA4. The function scope of the module is limited to the function scope of the Lambda Meter.

NOTE

In this operating mode of the module, the ambient pressure compensation can be activated, but the measured pressure values cannot be output. Measuring with an extesrnal pressure sensor is not possible.

4.4 Sensor Heating

The heater of the probe can be switched on independently of the voltage supply at the "IN" connection of the module, since the voltage supply of the heater control is provided via the "Sensor" connection.

NOTE

The operating modes of the sensor heating described below only apply when the module is connected to a power supply. The lambda sensor is always heated when the ES63x is “On”!

4.4.1 Operating Modes

Depending on the measuring tasks and where the lambda sensor is installed, the sensor may have to be operated (heated) independently from the actual measuring. The following settings are available for this purpose in the calibration software:

- “External Signal”

  The setting “External Signal” is selected if the lambda sensor of the ES63x is installed in the exhaust system of a vehicle and the sensor heating is to be operated independently of measuring by being controlled with an external signal (e.g. terminal 15).

- “On”

  This setting is selected when no cooling of the sensor is required for a specific set of measurements as the delay between measurements would otherwise be too long.

  This setting can, for example, avoid the lambda sensor cooling off in start-stop tests with the control of the heater control via terminal 15.

- “Off”

  “Off” is selected when the sensor only has to be ready for use when the measurement system (sensor, ES63x and calibration software) is active. An example of an application for this setting is working on the test bench.

4.4.2 Heater Control

The heater control of the ES63x is adapted to the selected lambda sensor. The heater curve ensures a short warm-up phase and minimum thermal load of the sensor. The heating curve controls the effective heating voltage of the probe until the working temperature of the probe is reached.

The state of the heater control (enabled/disabled) depends on the following components:

- the operational state of the ES63x (“On”, “Standby”), determined by the supply voltage at the “IN” port
- a heater control parameter selected in the calibration software
- an external voltage to operate the heater control
- the supply voltage at the "Sensor" connection of the module

Possible states of heater control:

Supply Voltage	**Control of the Sensor Heating via**		**Supply Voltage**	**Heater Control**
"IN" Port	**Parameter in the Calibration Software** [1)]	**External Signal** [2)]	**Sensor**	State
On	x	x	In target range	Enabled
Off	Off	x	x	Disabled
Off	On	x	In target range	Enabled
Off	External signal	On	In target range	Enabled
Off	External signal	Off/ open	x	Disabled
x	x	x	Outside target range	Disabled

1): Master function for the control of the heater control
2): External signal:
Threshold value on: min. +9 V, threshold value off: max. +6 V
x: No influence on heater control

5 Getting Started

This chapter contains information on the following topics:

5.1 General Installation Recommendations

5.1.1 Assembly Environment and Components for Attaching the Module

CAUTION

The module can be damaged or destroyed.
The modules are only admissible for assembly and operation on components or in locations which guarantee adherence to the technical data of the modules during operation (see chapter 10 on page 95).

5.1.2 Potential Equalization in the Vehicle and Module Assembly

CAUTION

Potential equalization possible in the vehicle via the shield of the Ethernet connecting cables of the modules!
Only assemble the modules on components with the same electric potential or isolate the modules from the components.

5.1.3 Fastening the Module onto a Carrier System

The ES63x module has a robust metal housing equipped with non-slip plastic feet. The module can easily be screwed onto a support system for fastening in the vehicle or lab. The screw threads for fastening the module are already in the housing and easily accessible.

Fastening the housing of the Lambda Module:

1. Remove the plastic feet on the underside of the module. To do so, push the blunt screwdriver between bottom of housing and plastic foot.
2. Pry off the plastic foot.

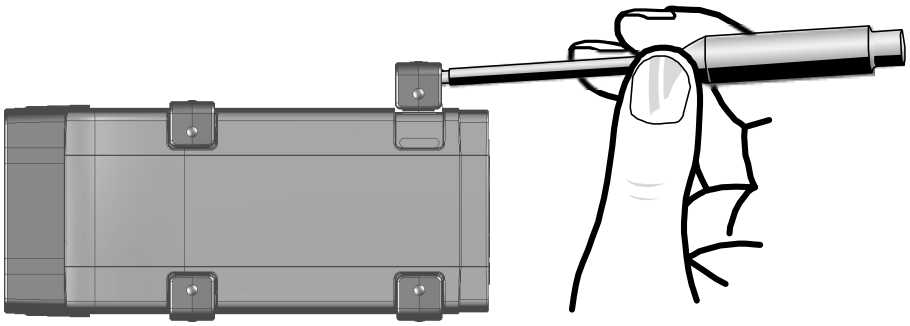

Fig. 5-1 Prying off the plastic foot

3. A screw thread becomes visible under the plastic foot. The threads for fastening the module are located on the underside of the housing.

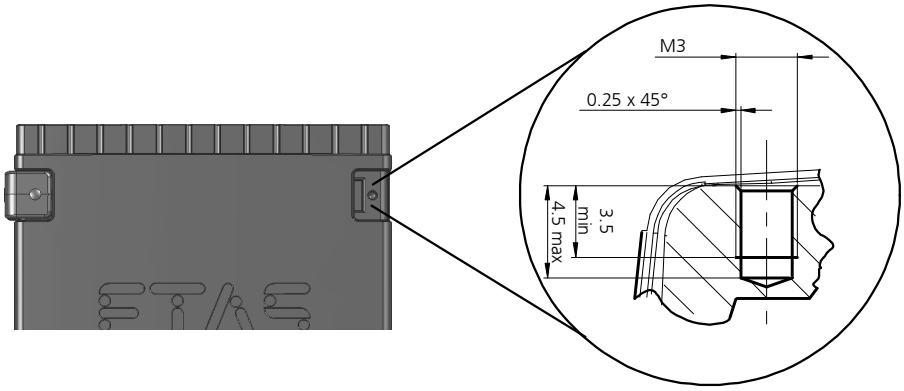

Fig. 5-2 Threaded blind hole

CAUTION

Damage or destruction of the electronics is possible.
Do not rework the existing threaded hole.

NOTE

Screw the module onto your carrier system using **exclusively** M3 fillister head screws and a max. torque of 0.8 Nm.
The maximum screw-in depth in the threaded blind hole of the housing is 3 mm (see Fig. 5-2 on page 42).

5.1.4 Connecting several Modules Mechanically

Because of the use of ETAS system enclosures, the Lambda Module can also be combined with modules of the ETAS compact series (ES59x, ES6xx, ES910). They can simply be combined into larger blocks by using the supplied T-connectors.

An additional module of the ETAS compact series can be fastened underneath the Lambda Module. to do so, remove the four respective plastic feet at the corresponding device sides and install the supplied T-connectors in their place.

Connecting several modules mechanically:

1. Remove the four plastic feet on the underside of the module to be able to fasten another module.

   This exposes the installation openings for the T-connectors.

   You can fasten an additional module underneath the Lambda Module.
2. Remove the four plastic feet on the corresponding side of the second module.
3. Turn the fasteners of the T-connectors transverse to the longitudinal axis of the connectors
4. Click two connectors into the installation openings at one longitudinal side of the first module.
5. Click the second module into the two T-connectors.

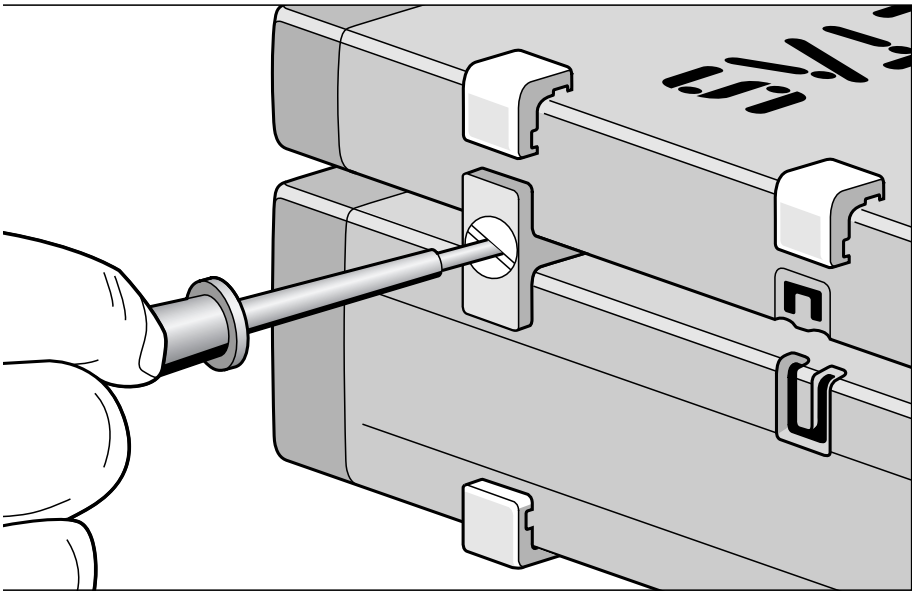

Fig. 5-3 Connecting the Lambda Module with another module

6. Turn the fasteners of the T-connector by one-quarter turn. This locks the connection of the two modules.
7. Click the two additional T-connectors into the installation openings on the opposite longitudinal side of the device
8. Also lock those connectors.
9. If you want to stack additional modules and fasten them on top of each other, repeat the process with the next module.

5.2 Installing the Lambda Sensor

NOTE

For more details on the Bosch lambda sensors, consult

- "Bosch: Technical Customer Information on the LSU 4.2“ (Y 258 K01 005-000e)
- "Bosch: Technical Customer Information on the LSU 4.9“ (Y 258 K01 008-000)
- "Bosch: Technical Customer Information on the LSU ADV-G“ (Y 258 K01 024-000)
- "Bosch: Technical Customer Information on the LSU 5.1“ (Y 258 K01 047)
- "Bosch: Technical Customer Information on the LSU 5.2" (Y 258 K01 068e)

The following general guidelines apply when installing the LSU lambda sensor:

- Make sure that you install the sensor in exhaust pipes at a point at which the exhaust gas composition is representative and remains within the prescribed temperature limits.

  The following maximum values are valid for the lambda sensors:

Sensor	Max. Gas Temperature	Max. Temperature at the hexagonal screw
LSU 4.2	850 °C	570 °C
LSU 4.9	930 °C	570 °C
LSU ADV-D	930 °C	650 °C
LSU ADV-G	930 °C	650 °C
LSU 5.1	930 °C	650 °C
LSU 5.2	980 °C	650 °C

  Cold exhaust gas at a high flow velocity can lead to the operating temperature of the sensor cell varying, depending on the operating voltage. This may result in measurement errors.

  Hot exhaust gas at temperatures above the controlled ceramic temperature may cause the operating temperature of the sensor cell to rise. This also may result in measurement errors.

- The active sensor ceramic is heated up quickly by the internal heater. The place of installation should be selected to ensure that the amount of condensate penetrating from the exhaust gas system is minimal in order to avoid ceramic breakages.

  The point of installation and position of the sensor should fulfill the following requirements:

  – Install the sensor as near the engine as possible. Maintain the minimum distance from the combustion chamber of 15 cm.
  – Ensure rapid warm-up of the exhaust pipes just upstream of the sensor installation point.

– As far as possible, ensure the exhaust pipes are on a downward stretch to avoid the accumulation of condensate upstream of the sensor installation point (no recesses, projections, cutting edges).

- The angle of installation should be inclined at least 10° to the horizontal (tip of the sensor pointing downwards).

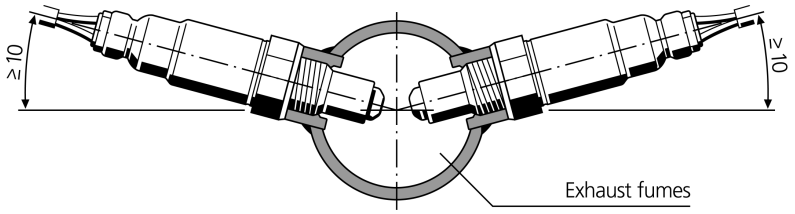

Fig. 5-4 Angle of Installation

This prevents condensate or fuel from accumulating between the sensor housing and the sensor ceramic during the cold-start phase.

- Install using special grease on screw thread (e.g. Bosch lambda sensor assembly paste, item number 1 987 123 020).
- Tightening torque: 50 Nm to 60 Nm, the material and strength of the thread have to be chosen accordingly.
- Avoid inadmissible heating of the sensor cable gland, particularly after the engine has been switched off.
- Do not use any cleaning or greasy liquids or vaporizing substances on the sensor connection.

To install the lambda sensor

NOTE

When installing the lambda sensor, please observe the installation guidelines in section 5.2 on page 44.

1. Choose a position on the exhaust pipe for the lambda sensor which is at least 15 cm from the combustion chamber. Otherwise the sensor could suffer heat damage.

2. Before the sensor is installed, weld a threaded boss in the exhaust manifold.

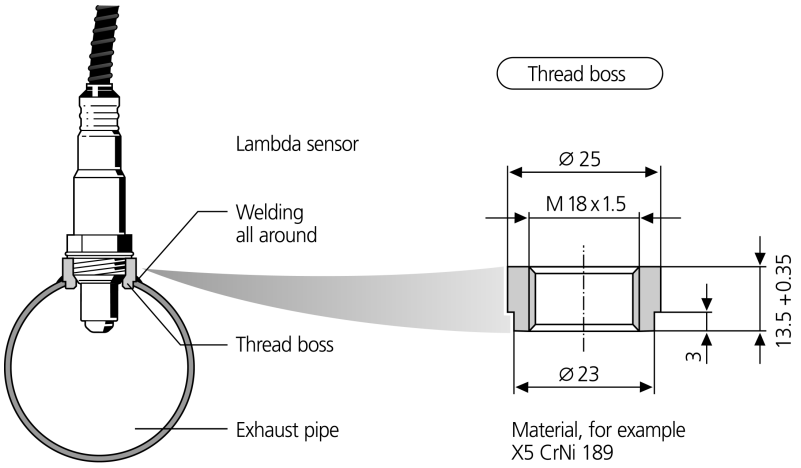

Fig. 5-5 Installation of the Lambda Sensor

3. When installing the LSU lambda sensor, ensure you use ultra-high heat-resistant lubricant (cf. Page 45). Spread it round the threaded boss of the lambda sensor.

   This avoids difficulties when removing the sensor later.
4. At least half the tip of the lambda sensor should extend into the exhaust pipe to obtain accurate mixture measurements.
5. Connect the module to the power supply.

NOTE

Incorrect use can result in the lambda sensor being damaged or aging prematurely.
The LSU lambda sensor must always be connected to the module (heater control active) when exposed to engine exhaust gases.
Use operating modes “On” or “External Signal” of the heater control (see section 4.4.1 on page 39).

5.3 Assembling the Pressure Sensor

5.3.1 Place of Installation

The pressure sensor whose measure values the ES635.1/ ES636.1 module uses to compensate for the dependence between exhaust gas pressure and pump current of the lambda sensor must be mounted near the lambda sensor in the exhaust system.

CAUTION

The pressure sensor can be damaged or destroyed.
The pressure sensor is only admissible for assembly and operation on components or in locations which guarantee adherence to the technical data of the pressure sensor during operation (see section 10.10.12 on page 108).

5.3.2 Thermal Isolation

So as not to exceed the maximum operating temperature of the pressure sensor in test setups with high exhaust gas temperatures, the pressure sensor must not be mounted directly on the exhaust system but only when thermally isolated from the exhaust system.

Suggestion for Thermal Isolation

The pressure sensor is connected with the exhaust system using a customized pipe/tube construction for the purposes of thermal isolation (see the symbolic representation of the test setup in Fig. 5-6 on page 47).

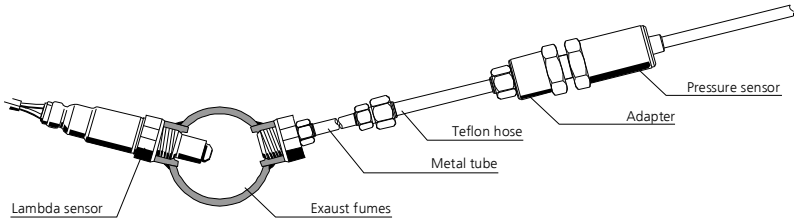

Fig. 5-6 Thermally Isolated Assembly of the Pressure Sensor

The pipe mounted between the exhaust system and the Teflon tube cools the exhaust gas led to the pressure sensor by emitting heat to the environment via its surface, depending on the test setup.

In addition, the Teflon tube attached to the pipe of the test setup prevents temperature compensation by direct heat conduction from the metallic pipe to the pressure sensor housing and thus an exceeding of the operating temperature of the pressure sensor.

The exhaust gas pressure pending at the pressure sensor corresponds to the exhaust gas pressure in the exhaust system because no additional pressure compensation of the exhaust gas is possible via the test setup. This is why the internal diameter of the tube/pipe construction is insignificant for measuring pressure. You only have to take mechanical requirements such as the connecting thread of the pressure sensor into consideration when dimensioning this construction.

Components for the Test Setup

The components necessary for the test setup for connecting the pressure sensor with the exhaust system must be designed, and the parts selected and ordered by the customer. They are not part of the delivery scope or accessories of the module and are not supplied by ETAS.

NOTE

ETAS does not supply the components for thermal isolation of the pressure sensor.

Suggestion for Components

The SS-8M0-7-4 tube fitting and the SS-8M5-6M tubing insert from the company Swagelok can be used to make a suitable test setup. These act as a connecting piece between the thread of the pressure sensor and the pipe/tube construction attached to the exhaust duct.

5.3.3 Connecting with the Module

The pressure sensor has a permanent cable with a Lemo connector for the connection with the ES635.1/ ES636.1 module's "EPS" port. In the case of larger distances between the pressure sensor and the module, the pressure sensor cable can be extended using the CBAX100 cable.

5.4 Applications

5.4.1 ES63x Modules with ES4xx/ES600/ES720/ES910 and INCA

With INCA, signals can be acquired from the vehicle bus and ECUs calibrated parallel to the acquisition of sensor measure data.

In addition to the laptop, the drive recorder ES720 or the Rapid Prototyping Module ES910 can be used to read the ES400 modules data. The ES400 modules are installed in the vehicle or on the test stand.

ES63x Modules with ES600 Measurement Modules and INCA

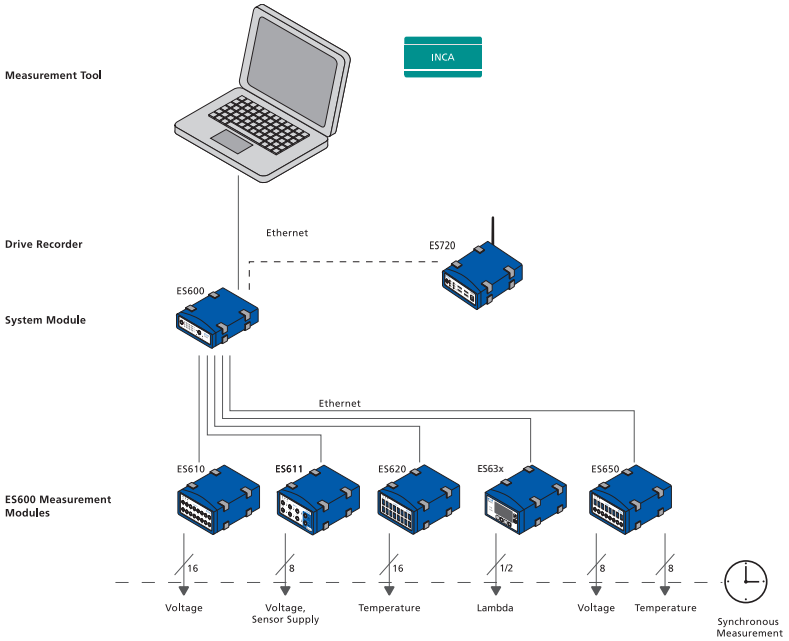

Fig. 5-7 Application with ES63x Modules, ES600 Measurement Modules and INCA

Parallel to one or several ES400 chains, you can use the network module ES600 to connect further ETAS modules to INCA. With the network module ES600, the ES400 modules can be synchronized in terms of time with measure modules of the ES600 series based on the same mechanism.

ES63x Modules with ES4xx/ES720/ES910 and INCA

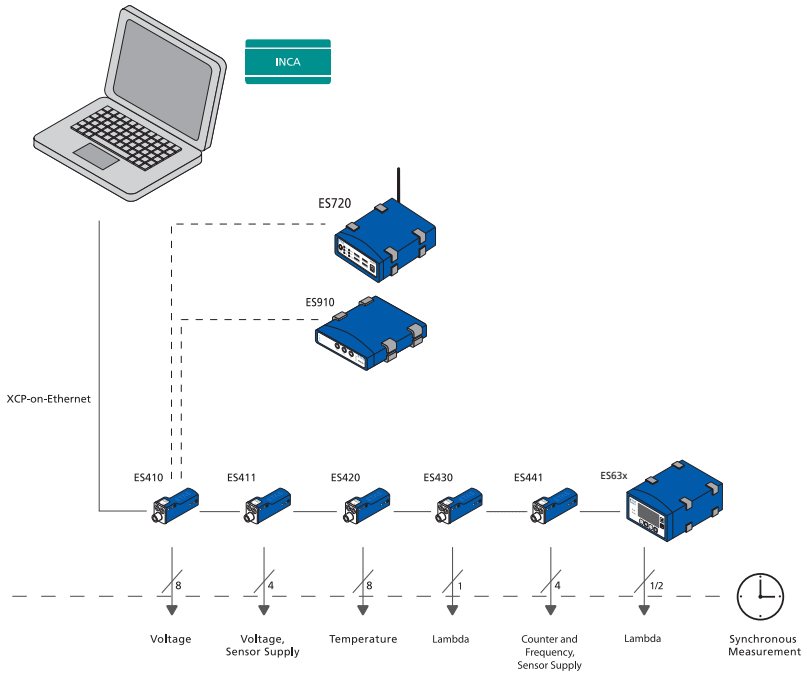

Fig. 5-8 Application with ES63x Modules, ES4xx/ES720/ES910 and INCA

With INCA, signals can be acquired from the vehicle bus and ECUs calibrated parallel to the acquisition of sensor measure data by ECU and bus interface.

XCP-on-Ethernet makes it possible to integrate software tools or devices from other suppliers.

5.4.2 ES63x Modules with ES4xx/ES720/ES910 and INTECRIO

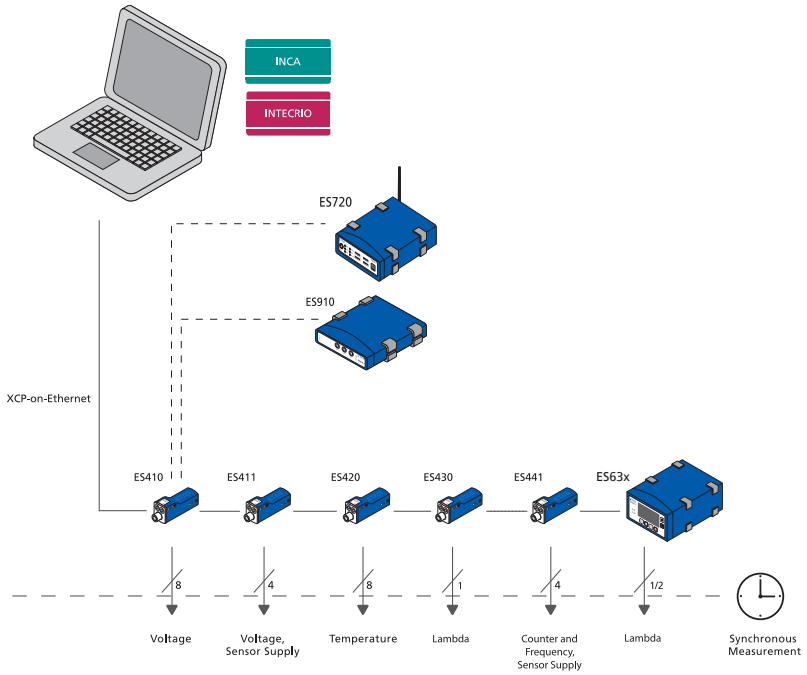

Fig. 5-9 Application with ES63x Modules, ES4xx/ES720/ES910 and INTECRIO

You can use the ES910 module to connect one ES400 chain to INTECRIO. Fig. 5-9 on page 50 shows an example of operating one ES400 module chain with the ES910 module. As an alternative to the ES910, the drive recorder ES720 can be used to acquire ES400 measure data.

5.5 Wiring

The ports may be wired in any order. Special connecting cables are available and can be ordered separately. An overview is contained in the chapter “Accessories” on page 158.

5.5.1 Power Supply to ES63x Modules linked by Ethernet

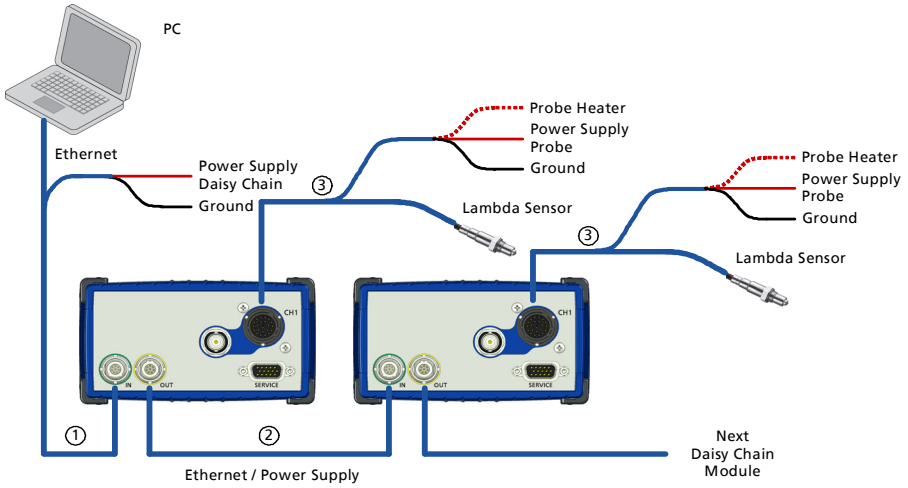

Fig. 5-10 Power Supply to ES63x Modules linked by Ethernet

Cable in Fig. 5-10	Function	Short name
1	Ethernet PC and Power Supply Cable (PC, power supply, ES63x module)	CBEP410 / CBEP4105, CBEP415 / CBEP4155
2	Ethernet Chain Connection Cable (ES63x/ES4xx chain)	CBE430, CBE431
3	Lambda Sensor Cable	CBAL410 / CBAL4105, CBAL451 / CBAL4515, CBAL452 / CBAL4525, CBAL463 / CBAL4635, CBAL468 / CBAL4685, CBAL472 / CBAL4725

5.5.2 Power Supply to ES63x Modules linked by SMB

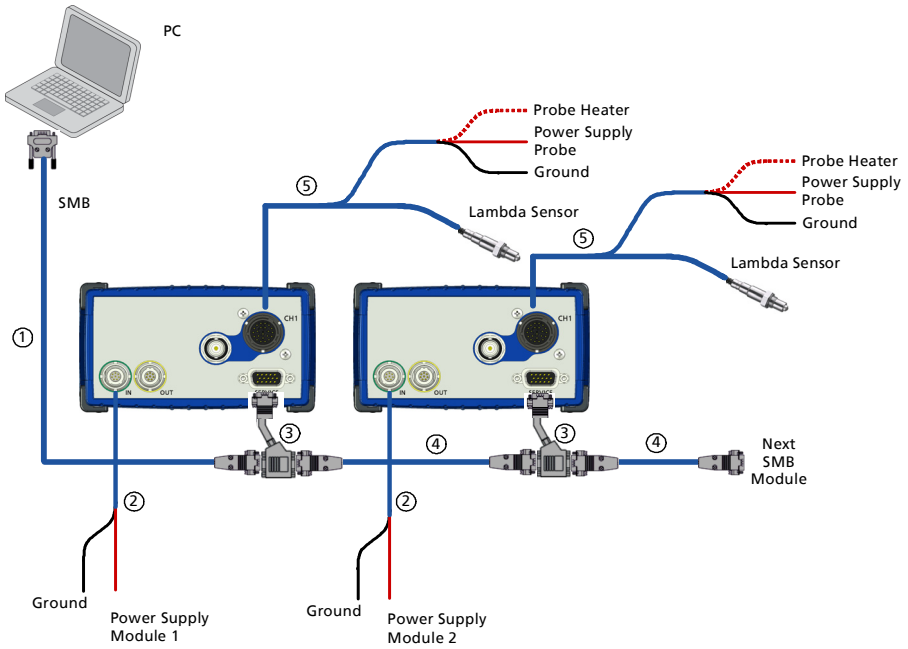

Fig. 5-11 Power Supply to ES63x Modules linked by SMB

Cable in Fig. 5-11	Function	Short name
1	SMB - PC Connection Cable	K38
2	Power Supply Cable (ES63x module)	CBP630 / CBP6305
3	SMB Connection Y-Cable	CBAS100
4	SMB Connection Cable	K40
5	Lambda Sensor Cable	CBAL410 / CBAL4105, CBAL451 / CBAL4515, CBAL452 / CBAL4525, CBAL463 / CBAL4635, CBAL468 / CBAL4685, CBAL472 / CBAL4725

NOTE

If ES63x modules are operated in an SMB bus (“SERVICE” port), each of these ES63x modules must be connected to the power supply at the “IN” port.

5.5.3 Daisy Chain Ports (“IN”, “OUT”)

Wiring goes from the first module towards the end of the module chain.

To wire the first module with the following module

1. Connect an Ethernet cable to the “OUT” port of the first module.
2. Connect the Ethernet cable to the “IN” port of the next module.
3. Continue to wire or connect further modules as described above.

To wire the first module with the PC and the power supply

1. Connect the combined Ethernet and power supply cable to the “IN” port of the ES63x.
2. Connect the RJ-45 connector to the free Ethernet interface port of your PC.
3. Connect the supply voltage connector of the combined Ethernet and power supply cable to the desired power supply.

   Note the color coding of the connectors.

To wire the module chain with additional current feeding

1. End the module chain after the last module whose power supply is still guaranteed in the entire operational range.
2. Connect the combined Ethernet and power supply cable to the “OUT” port of the last ES63x module of the chain towards the PC.
3. Connect the combined Ethernet and power supply cable to the “IN” port of the ES63x of the next module towards the end of the chain.
4. Connect the supply voltage connector of the combined Ethernet and power supply cable to the desired power supply.

   Note the color coding of the connectors.

5.5.4 “LAMBDA” Port

You can use different cables to connect the lambda sensors to the module.

NOTE

Refer to the detailed information on the sensor cables in section 11.5 on page 125.

To wire the ES63x with the sensor

1. If there is a protective cap at the “Sensor” port, remove it.
2. Connect the sensor cable to the “Sensor” port of the ES63x.
3. Connect the sensor to the sensor plug of the sensor cable.

To wire the control of the heater control

1. Pull the cable end out of the shrinkage tube of the sensor cable.
2. Connect the end of the cable to a suitable signal (e.g. terminal 15).

To wire the analog output of the ES63x (only special sensor cables)

1. Connect the BNC jack of the sensor cable to a data acquisition system, e.g. the analog input of the test stand.

To wire the sensor with the supply voltage

1. Connect the supply voltage connector of the sensor cable to a suitable power supply for the sensor.

   Note the color coding of the connectors.

5.5.5 “VOUT” Port

To wire the “Analog” port of the ES63x

1. Connect the “VOUT” port of the ES63x (BNC jack) to a data acquisition system, e.g. the analog input of the test stand.

5.6 Tool Integration

The ES63x modules can be selected and configured in the calibration software and support the open protocol XCP-on-Ethernet. This enables easy integration of the modules into other measure software.

The measure system can be connected directly to the PC’s Ethernet port. No additional devices or interface converters are necessary.

5.7 Configuration

5.7.1 Configuring the Lambda Module

The configuration of the Lambda Module is performed via the GUI of the calibration software or directly on the module. The configuration of the measurement channel is saved either in the calibration software or in the individual ES400/ES63x modules. In the first case, you can prepare settings for specific measure tasks, e.g. in the lab. The second case is of interest to users who share a test carrier with a corresponding ES400/ES63x test setup. In this way, several users can call up the saved configuration directly from the modules.

NOTE

If necessary, Lambda Module can be configured directly at the module without using calibration software (see chapter 6 on page 56).

5.7.2 Configuring the Lambda Sensor

The ES63x and the lambda sensors supported are designed to be operated together.

CAUTION

Operate the lambda sensors only on modules with up to date firmware!
Prior to the start-up, update the firmware of the module with the current service software HSP to avoid damage of the lambda sensor!

5.7.3 Calibrating the Lambda Sensor LSU ADV-D

NOTE

The Bosch lambda sensor LSU ADV-D must be calibrated with the lambda module prior to use.

The calibration values for the lambda sensors LSU 5.1 and LSU ADV are stored in TEDS. The TEDS is mounted in the plug of the sensor.

5.8 Calibration

A calibration service for this product is available. Calibrate this product on a regular basis to ensure reliable accuracy of the measured values.

NOTICE

ETAS recommends a calibration interval of 12 months.

The seal of approval on the product shows the date of the last calibration. In the calibration certificate you will find information on the measurement accuracy.

Please contact your local ETAS representative for information on obtaining the calibration service (see chapter “Contact Information” on page 190). For information on ordering the calibration service, refer to chapter “Calibration” on page 161.

6 Configuration at the Module

The “Configuration at the module” chapter describes the keys, display and configuration of the ES63x directly at the module and contains information on the following topics:

6.1 Configuration in the Calibration Software and at the Module

The ES63x module can be configured for the measuring task in the calibration software or directly at the module. This manual describes configuration at the module.

With the function keys **F1**, **F2**, **F3** and **F4** under the display and the two keys ↑ / ↓ to the right of the display, it is possible to configure the ES63x directly at the module using menu items in a menu structure (see section 6.4 on page 62).

6.1.1 Function Keys

The function keys **F1**, **F2**, **F3** and **F4** under the display are intended for different functions in the menus. The relevant current function of a function key is displayed in the bottom line of the display.

Display	Key Function
MENU	In the operating mode “Measuring”, calls up the top level of the menu for configuration.
CH1/2	Assigns a measurement channel (CH1 or CH2) to the selected area of the display. The signal type displayed remains unchanged when the measurement channel to be displayed is changed.
ERR	Calls up the display of text information when an error occurs. Use the keys to the right of the display to scroll through very long error texts.
SIG	Fast selection of the signals for display in the selected display area.
SHOW	Display of the selected sensor configuration.
SET	Activates the selected sensor configuration.
DI1/2	Selection of the top or bottom area of the display.
ESC	Exiting a menu / a menu level without changing the selection.
OK	Exiting a menu / a menu level accepting the change to the selection.
CAL	Calls up directly the menu to measure the sensor curve (menu 4|3|3|2; see Page 80) for calibration on air

6.1.2 Keys

The two keys ↑ / ↓ on the right-hand side of the display can be used to select menu items, change the value of settable parameters or scroll long texts (e.g. error texts) in the display.

6.2 Display

The module display is used differently in the operating modes “Measuring” and “Configuration”. The representation of the measure values in the display can be configured by the user.

6.2.1 Displaying in the Operating Mode “Measuring”

Display Layout

Fig. 6-1 Areas of the Display

Area in Fig. 6-1	Function
1	Status display: measurement channel 1 (CH1) / measurement channel 2 (CH2), error display
2, 4	Display symbol / abbreviation of the signal type (measure value)
3	Status display: measurement channel 1 (CH1) / measurement channel 2 (CH2)
4	Signal type (measure value)
5	Error display / indication of oxygen reservoir fill level (LSU 5.1 only) / indication of IPC (LSU 4.9, LSU 5.1and LSU 5.2 only) or indication of breathe (LSU 5.1 only)
6	Display area 1
7	Display area 2
8	Display of the current function of the function keys

In the operating mode “Measuring”, the display of the ES63x module is divided into four areas that are used for the following displays:

- Upper area (one line): status display
- Central area: display of the measure values (divided into display area 1 and display area 2)
- Lower area (one line): display of the current function of the function keys

Representation of the Measure Values in the Display

The two central areas for displaying the measure values are identical in terms of function. The measure values are displayed as follows in the upper and lower areas of the display:

- Symbol / abbreviation of the signal type
- Measure value
- Unit of the measure value (if available)

In addition to the measure value, the measurement channels are also labeled in the upper and lower areas of the ES631.1/ ES636.1 display:

- CH1: assignment of the display to measurement channel 1
- CH2: assignment of the display to measurement channel 2

Adjusting the Display of Information in the Display

In the operating mode “Measuring”, a total of two measure values or signal types can be displayed simultaneously in the two display halves. The user can configure the display of measure values or signal types and assign the different displays to the two display halves. In the upper and lower area of the display, you can choose to display:

- Measure values of different signal types of the measurement channel
- Measure values of identical signal types of the measurement channel

Using the ES631.1/ ES636.1 module you can additionally choose to display:

- Measure values of different signal types of different measurement channels
- Measure values of identical signal types of different measurement channels

The display of the measure values can be hidden in one display half or both display halves. The division of the display into the areas described and the assignment to the signal types and measurement channels remains.

Displaying Measure Errors

Any errors that occur are displayed flashing in the top right corner in the upper or lower area of the display.

If, in modules with two measurement channels, two different signals of a measurement channel are assigned to the upper and lower areas of the display, only errors of the channel shown are displayed. Errors of the hidden second measurement channel are not shown.

Other information can be displayed in the top right corner in the upper or lower area of the display:

- Ri ↓ : Ri too low
- Ri ↑ : Ri too high
- error
- fill level of oxygen reservoir (LSU 5.1 only)
- IPC (LSU 4.9, LSU 5.1 and LSU 5.2 only)
- breathe (LSU 5.1 only)

NOTE

General errors and channel-specific errors are shown as messages in the display (see chapter 13.2 on page 163).

Selecting the Display Area

During measurement, the upper or lower display area can be selected using the ↑ / ↓ keys to show a signal type in this display area.

Selecting the Displayed Signal Type During Measuring

Once the upper or lower display area has been selected, the signal type shown in the display can be changed during measuring.

Parameters and settings cannot be changed during measuring. That is only possible in the operating mode “Configuration”.

Use the function key **SIG** to call up the menu for selecting the parameters that can be represented in the display. Menu items are selected using the two keys to the right of the display.

6.2.2 Displaying in the Operating Mode “Configuration”

Display Layout

In the operating mode “Configuration”, the display of the ES63x module is divided into three areas that are used for the following displays:

- Upper area (one line): status display
- Central area (maximum of 5 lines): display of the settings and parameters of the current menu
- Lower area (one line): display of the current function of the function keys

Labeling in the Display

The current line number and the total number of entries in the activated menu are displayed on the right in the status bar for better orientation.

If the activated menu contains more menu items than can be displayed simultaneously under one another in the display, additional arrows are shown on the right in the display. The direction they point in is the scroll direction for calling further menu items of the menu.

The text of the current menu is displayed inverted before being selected.

Selected configurations or settings are displayed with a triangle on the left in the line.

Selecting the Display Area

In the operating mode “Configuration”, the upper or lower display area can be selected using the ↑ / ↓ keys to display a menu or its parameters in this display area.

6.3 Calling Menus and Submenus

6.3.1 Switching to the Operating Mode “Configuration”

To switch to the operating mode “Configuration”

1. Press the function key **MENU**.

   The main menu is displayed.

   You can select the following menus:

No. Menu	Name of Menu	Use
1	sensor presets	Select lambda sensor curve
2	analog out	Configure analog output „VOUT“
3	signal on display	Select display
4	channel	Configure pressure compensation, configure settings of the operating mode “Advanced”
5	other	Configure other settings, switch to the operating mode “Advanced” and back

Tab. 6-1 Main Menus of the Lambda Meter ES63x

6.3.2 Selecting a Menu Item

To select a menu item

1. Within the menu displayed select
   - a menu item above the menu item currently highlighted using the ↑ key

   or

   - select a menu item below the menu item currently highlighted using the ↓ key
2. Confirm your selection with the function key **OK**.

6.3.3 Changing Numerical Parameter Values of a Menu Item

To change numerical parameter values of a menu item

1. Within the menu structure, select a parameter that can be modified.
2. Modify the displayed numerical value of the parameter with the ↑ or ↓ key within the admissible value range.
3. Confirm your selection with the function key **OK**.
4. Press the function key **ESC**.

   The menu level above is displayed.

6.3.4 Exiting a Menu Item / Menu Level

Exiting a Menu Item / Menu Level without Changing the Selection

You can exit the menu level shown without accepting changes to the settings of this menu level.

To switch menu level without changing the selection

1. Press the function key **ESC**.

   The menu level above is displayed.

Exiting a Menu Item / Menu Level and Changing the Selection

You can exit the menu level shown and accept changes to the settings of this menu level.

To switch menu level and change the selection

1. Confirm your selection by pressing the function key **OK**.
2. Press the function key **ESC**.

   The menu level above is displayed.

6.3.5 Switching Between “Standard” and “Advanced”

To switch to the operating mode “Advanced”

1. Select “other” in the main menu.
2. Confirm your selection by pressing **OK**.
3. Select “dev. mode”.
4. Confirm your selection by pressing the function key **OK**.
5. Press the function key **OK** (several times) until “advanced” is shown in the display.

   “advanced” is confirmed.
6. Press the function key **ESC**.

   The menu level above is displayed.

To exit the operating mode “Advanced”

1. Select “other” in the main menu.
2. Confirm your selection by pressing **OK**.
3. Select “dev. mode”.
4. Confirm your selection by pressing **OK**.
5. Press the function key **OK** (several times) until “standard” is shown in the display.

   “standard” is confirmed.
6. Press the function key **ESC**.

   The menu level above is displayed.

6.3.6 Switching to the Operating Mode “Measuring”

To switch to the operating mode “Measuring”

1. Press the function key **ESC** (several times) until the measurement values are displayed.

6.3.7 Displaying the Error Text

1. An invalid measure value is shown in the display.
2. Press the function key **ERR**.
   An error text is shown in the display.
3. Press the function key **ESC** to exit the error display in the display.

6.4 Configuration Menu

6.4.1 Operating Modes

You can switch between “Standard” and “Advanced” (see chapter 6.3.5 on page 61).

"Standard" Operating Mode

The ES63x modules are prepared for measurements with typical lambda sensors the “Standard” operating mode.

NOTE

The chapter 7 on page 63 describes how to set the operating parameters of your ES63x in “Standard” operating mode.

"Advanced" Operating Mode

The “Advanced” operating mode is an extension of the “Standard” operating mode and provides additional menus. In the "Advanced" operating mode many operation parameters of the lambda sensor can be modified and displayed.

CAUTION

Setting wrong parameters in the "Advanced" operating mode may destroy the lambda sensor!

NOTE

The chapter 8 on page 74 describes how to set the operating parameters of your ES63x in “Advanced” operating mode.

6.4.2 Operating Modes and Measurement Channels

The menu structure of both measurement channels of the module ES631.1 and the menu structure of both measurement channels of the module ES636.1 is identical.

6.4.3 Adjustable Parameters

The "Adjustable Parameters" chapter on Page 176 gives an overview about the limits and defaults of adjustable parameters.

7 Setting the Parameters (“Standard” Operating Mode)

This section describes how to set the operating parameters of your ES63x in “Standard” operating mode.

The menu items are described in the same order as they appear in the main menu.

For a graphical representation of the ES63x configuration menu of the operating mode "Standard" see chapter 15 on page 189.

7.1 [Menu 1]: sensor presets: Display of the Configurations of the Lambda Sensor

In the **sensor presets** menu, you can display the configuration of the ES63x for the lambda sensors.

To display the configurations for the lambda sensors

1. Press the **MENU** key to call up the main menu.
2. Select the **sensor presets** menu with the ↑ / ↓ keys.
3. Confirm with **OK**.

> **NOTE**
>
> Only those configurations defined in the channel → sensor detection menu are displayed.

4. Select a lambda sensor using the ↑ / ↓ keys.
5. Press the **SHOW** key to call up the lambda sensor configuration.
6. Press the **-** / ¯ keys to display further configuration parameters.

The following parameters are displayed.

Parameter	Meaning
Name	Name of the sensor configuration
Lambda	Lambda line
Heater	Heater line
Temp	Sensor temperature line
Rinom	Nominal internal resistance of the sensor
tpref0	Warm-up time without pump current
tpref+	Warm-up time with increased reference pump current
Ipref	Pump current reference
Ipref+	Increased pump current during tpref+

7.2 [Menu 2]: analog out: Output Voltage at the Analog Output

The output voltage at the analog output „VOUT“ of the Lambda Meter can be parameterized freely depending on the selected measure value. With the **analog out** menu, you can configure the analog output for your measuring tasks perfectly independently of the display.

The factors offset (deviation), gain (multiplier) and filter can be set for this purpose. These settings are saved separately for each measure value and can thus be used again at any time. You can assign the following measure values separate offset, gain and filter settings:

Symbol	Signal
λ	Lambda value
A/F	Air/fuel ratio
O2	Oxygen content
F/A	Fuel/air ratio
1/λ	1/lambda value
Ip	Pump current
Ri	Internal resistance of the sensor
Uh	Heater voltage
Ih	Heater current
Unernst	Nernst voltage
Upump	Pump voltage
T	Temperature
pamb	Ambient pressure
pex	Pressure, external sensor (ES635.1 and ES636.1 only)
Fr	Oxygen reservoir fill level (for LSU 5.1 only)

The settable values and value ranges of the settings can be found in section 14.2 on page 177.

Sample Calculations

Examples of parameterization of the analog output voltage are listed in the section 9.3 on page 91.

7.3 [Menu 3]: signal on display

In the menu **signal on display**, you can select a measure value to be displayed in the area of the display of the ES63x previously defined. You can select the following measure values to be displayed:

Symbol	Signal
λ	Lambda value
A/F	Air/fuel ratio
O2	Oxygen content
F/A	Fuel/air ratio
1/λ	1/lambda value
Ip	Pump current
Ri	Internal resistance of the sensor
Uh	Heater voltage
Ih	Heater current
Unernst	Nernst voltage
Upump	Pump voltage
T	Temperature
Pamb	Ambient pressure
pex	Pressure, external sensor (ES635.1 and ES636.1 only)
Fr	Oxygen reservoir fill level (for LSU 5.1 only)
Sta	State/ operational state of the sensor
OFF	Display off (ES631.1/ ES636.1: CH1/ CH2 separately)

7.4 [Menu 4|1]: channel / pressure comp.: Automatic Pressure Compensation

In the menu **channel** → **pressure comp.**, you can activate and deactivate the automatic pressure compensation of the ES63x.

To select automatic pressure compensation

1. Press the **MENU** key to call up the main menu.
2. Select the **channel** menu from the main menu using the ↑ / ↓ keys .
3. Confirm with **OK**.
4. Press the **OK** key several times to activate or deactivate automatic pressure compensation.

   The following settings are available:

PAMB	Pressure compensation on (internal sensor)
PEXH	Pressure compensation on (external sensor; ES635.1 and ES636.1 only)
OFF	Pressure compensation off

   The setting last selected and displayed is activated.
5. Exit the menu with **ESC**.

If pressure compensation is activated, the ambient pressure or the external pressure is measured by the module and taken into consideration in the calculation of the lambda value. When pressure compensation is deactivated (off), a default value of 1013 hPa is used in the calculation of the lambda value.

7.5 [Menu 4|2]: channel / sensor detection

In the menu **channel** → **sensor detection** , you can enable and disable lambda sensor detection.

The following parameters are available:

Parameter	Meaning
off	Lambda sensor detection disabled
on	Lambda sensor detection enabled
userdef. defaults	Lambda sensor detection enabled

7.5.1 Sensor Detection: off

Lambda sensor detection is disabled. You can assign any configuration to the lambda sensor.

If a lambda sensor supported by the module is connected with the corresponding ETAS sensor cable, **no** configuration is automatically assigned for the sensor.

NOTE

The lambda sensor configuration must be set before the sensor is connected.

7.5.2 Sensor Detection: on

Automatic lambda sensor detection is enabled.

If a lambda sensor supported by the module is connected with the appropriate cable, and the current configuration does not match the sensor type, the configuration is set back to the defaults for that sensor.

You can then only select a configuration that corresponds to the type of connected sensor.

7.5.3 Sensor Detection: userdef. defaults

Automatic lambda sensor detection is enabled.

In the calibration software, exactly one configuration must have been assigned to each sensor type. If a lambda sensor supported by the module is connected with the corresponding ETAS sensor cable, this configuration of the lambda sensor is activated.

There are no other configurations for this sensor type.

7.6 [Menu 5]: other

7.6.1 [Menu 5|1]: other / display

[Menu 5|1|1]: other / display / filter: Setting the Software Filter

In the menu **other** → **display** → **filter**, you can configure signal evaluation for the display output channel to be the same for all measure values (e.g. λ, O_2, AF Ratio).

Select “SLOW” or “FAST” as filter value. The filter value “SLOW” results in a highly smoothed measure result indicating the measurement average. When using the filter value “FAST”, any peaks which occur during measuring can be seen.

Generally, the high filter value is set for the display to avoid extreme fluctuations in the display.

To set the software filter

1. Press the **MENU** key to call up the main menu.
2. Select the menu **filter** from the **display** menu.
3. Confirm with **OK**.
4. The activated filter setting is displayed.
5. Press **OK** key several times to select a filter setting.

   The following settings are available:

   SLOW
   FAST

   The setting last selected and displayed is activated. The filter is configured for all measure values on the display.
6. Exit the menu with **ESC**.

[Menu 5|1|2]: other / display / resolution: Display Resolution

In the menu **other** → **display** → **resolution**, you set the number of decimal places for the measure data display.

To determine display resolution

1. Press the **MENU** key to call up the main menu.
2. Select the menu **resolution** from the **display** menu.
3. Confirm with **OK**.
4. Press the **OK** key several times to select a display resolution.
   The following values are available:

COARSE	Low display resolution
FINE	High display resolution

5. Confirm with **OK**.
   The display resolution is set accordingly.
6. Exit the menu with **ESC**.

For an overview of the display resolution of the measure values (number of decimal places), refer to section 14.5.1 on page 184.

7.6.2 [Menu 5|2]: other / smb

[Menu 5|2|1]: Other / smb / modul address: SMB Module Address (ES630.1 and ES635.1)

In the menu **other** → **smb** → **modul address**, you set the SMB module address of the ES630.1/ ES635.1. An individual module address must be assigned to each device when several SMB modules are connected.

The admissible value range for SMB module addresses is 0…15.

[Menu 5|2|2]: Other / smb / filter (ES630.1 and ES635.1)

With the function **other** → **smb** → **filter**, you can assign a filter value to the following measure values to smooth the measure result:

Symbol	Signal
λ	Lambda value
A/F	Air/fuel ratio
O2	Oxygen content
Ip	Pump current
Ri	Internal resistance of the sensor

The settable values and value ranges of the parameters can be found in section 14.5.2 on page 185.

[Menu 5|2|1]: other / smb / CH1 address: SMB Module Address (ES631.1 and ES636.1)

In the menu **other → smb → CH1 address**, you set the SMB module address of the measurement channel 1 (CH1) of the ES631.1/ ES636.1. An individual module address must be assigned to each measurement channel of each module when several SMB modules are connected.

The admissible value range for SMB module addresses is 0…15.

[Menu 5|2|2]: other / smb / CH1 filter (ES631.1 and ES636.1)

With the function **other → smb → CH1 filter**, you can assign the measurement channel 1 (CH1) a filter value to the following measure values to smooth the measure result:

Symbol	Signal
λ	Lambda value
A/F	Air/fuel ratio
O2	Oxygen content
Ip	Pump current
Ri	Internal resistance of the sensor

The settable values and value ranges of the parameters can be found in section 14.5.2 on page 185.

[Menu 5|2|3]: other / smb / CH2 address: SMB Module Address (ES631.1 and ES636.1)

In the menu **other → smb → CH1 address**, you set the SMB module address of the measurement channel 2 (CH2) of theES631.1/ ES636.1. An individual module address must be assigned to each measurement channel of each module when several SMB modules are connected.

The admissible value range for SMB module addresses is 0…15.

[Menu 5|2|4]: other / smb / CH2 filter (ES631.1 and ES636.1)

With the function **other → smb → CH2 filter**, you can assign the measurement channel 2 (CH2) a filter value to the following measure values to smooth the measure result:

Symbol	Signal
λ	Lambda value
A/F	Air/fuel ratio
O2	Oxygen content
Ip	Pump current
Ri	Internal resistance of the sensor

The settable values and value ranges of the parameters can be found in section 14.5.2 on page 185.

7.6.3 [Menu 5|3]: other / dev. mode: Operating Modes

In the menu **other** → **dev. mode**, you can choose between the opreating modes “Standard” and “Advanced” of the ES63x. The operating mode “Advanced” is an extension of the operating mode “Standard” and provides additional menus and functions.

To select the operating mode

1. Press the **MENU** key to call up the main menu.
2. Select the **dev. mode** menu from the **other** menu.
3. Confirm with **OK**.
4. The activated operating mode is displayed.
5. Press the **OK** key several times to select an operating mode.
   The following settings are available:

   STANDARD
   ADVANCED

   The setting last selected and displayed is activated.
6. Exit the menu with **ESC**.

7.6.4 [Menu 5|4]: other / factory init: Default Configuration

In the menu **other** → **factory init** , you can reset the settings of the module to their default configuration if the factory default configurations of the module have been changed.

The default configuration of the module with the device-specific default values to which the parameters are reset is listed in the overview of all menu parameters in chapter 14 on page 176.

NOTE

The same device-specific default values apply for the ES63x and for the ES63x-4.9.

Resetting to the Default Configuration

The default configuration is reset when you confirm the selection **reset to default**; confirming the selection **cancel** enables you to exit the menu without any changes.

NOTE

The following settings are **not** reset if they have been changed by the user:
- lambda line
- heater line
- temperature line

7.6.5 [Menu 5|5]: other / version: Displaying Firmware Version and Serial Numbers

With the menu **other** → **version**, information on the firmware and the serial numbers is displayed simultaneously.

8 Setting the Parameters (“Advanced” Operating Mode)

This section describes how to set the operating parameters of your ES63x in the operating mode “Advanced”.

The menu items are described in the same order as they appear in the main menu.

For a graphical representation of the ES63x configuration menu of the operating mode "Advanced" see chapter 15 on page 189.

8.1 [Menu 1]: sensor presets: Assigning a Configuration for the Lambda Sensor

In the **sensor presets** menu, you can display or assign the configuration of the ES63x for the lambda sensors.

To assign the configurations for the lambda sensors

1. Press the **MENU** key to call up the main menu.
2. Select the **sensor presets** menu with the ↑ / ↓ keys.
3. Confirm with **OK**.

> **NOTE**
>
> Only those configurations defined in the channel → sensor detection menu can be assigned.

4. Select a lambda sensor configuration using the ↑ / ↓ keys.
5. Press the **SET** key to call up the lambda sensor configuration.
6. The selected lambda sensor configuration is activated.

In the **sensor presets** menu of the connected lambda sensor, you can display or assign a saved configuration.

The following configurations are available:

- 4.2-80
- 4.2/4.7
- 4.9
- ADV
- ADV-D
- ZFAS-U2
- ZFAS-U2-D

- 5.1
- 4.2-80-old
- 4.2/4.7-old
- ZFAS-U3
- 5.2
- 4.2-80 analytic
- 4.2/4.7 analytic
- 4.9-300 analytic
- ADV analytic
- ADV-D analytic
- 5.1 analytic
- 4.2-80-old analytic
- 4.2/4.7-old analytic
- 5.2 analytic

If the user has defined additional configurations, these are also displayed.

8.2 [Menu 4|3]: channel / mode λ: Determining the Calculation Process

Use **channel** → **mode** λ to switch between the various calculation processes in the Lambda Meter. You can then optimize your Lambda Meter to the place of installation, the age of your lambda sensor and the ambient conditions.

This function can best be used in the following applications:

- use of different fuels
  (O/C and H/C ratios)
- use under extreme ambient conditions
  (pressure, humidity, temperature)
- precise measurements in the lean range
- compensating for tolerances in the λ sensor

Besides the static calculation process, which is based on a curve, the current version also includes a dynamic process, the *analytical calculation*, which flexibly adapts to changing ambient conditions.

In the dynamic calculation process, a curve is also used. It is re-adapted each time the ambient and sensor parameters are specified. This permits direct, local adaptation without the need for lengthy measurements on the test stand.

The greater flexibility of the analytical calculation is achieved with minimum trade-offs in measuring accuracy. We advise as before the use of static curves to achieve high measuring accuracy.

The user cannot see the curve for analytical calculation. Settings in the analytical calculation have no impact on default curves.

The following sections will describe in detail the various options for selecting the static and dynamic calculation processes.

8.2.1 [Menu 4|3|1] : channel / mode λ / line: Selecting a Lambda Line

With the menu **channel** → **mode** λ → **line**, you can use a lambda line available in the Lambda Meter memory as the basis of calculation for measuring. Selecting a line results in the Lambda Meter being switched to static calculation mode.

The names of all lines loaded in the memory of the ES63x are available. The lambda line selected is used to calculate the measure result.

Parameter	Meaning
ANALYTIC	calculated lambda line
ETAS DEF	lambda line for the sensor LSU 4.2-4.7-100
-5%	lambda line for the sensor LSU 4.2-80
4.9-300	lambda line for the sensor LSU 4.9-300
ADV	lambda line for the sensor LSU ADV
ADV-D	lambda line for the sensor LSU ADV-D
ZFAS-U2	lambda line for the sensor ZFAS-U2
ZFAS-U2-D	lambda line for the sensor ZFAS-U2-D
5.1-120	lambda line for the sensor LSU 5.1-120
ZFAS-U3	lambda line for the sensor ZFAS-U3
5.2	lambda line for the sensor LSU 5.2

NOTE

Ensure that the settings for internal resistance and pumped reference also apply to the sensor used (cf. section 5.7.2 on page 55).

8.2.2 [Menu 4|3|2] : channel / mode λ / analytic: Adapting Fuel and Environment

The **channel** → **mode** λ → **analytic** submenu contains a dynamic function to match the calculation process. It takes into account various climatic conditions as well as the use of various fuel mixtures.

The analytical calculation process rematches the curve used after you have set all the parameters.

[Menu 4|3|2|1]: channel / mode λ / analytic / fuel: Fuel Composition

channel → **mode** λ → **analytic** → **fuel** helps you to set a number of parameters which characterize the fuel mixture used. When you calculate the lambda value according to Brettschneider, you can compensate for the H/C ratio of various fuel types.

Many countries also use fuels that contain various amounts and strengths of alcohol. Now you can compensate for the characteristic O/C ratio and the water proportion in the calculation. You will find sample calculations at the end of this section.

As a further characteristic of the fuel, you can set the stoichiometric air/fuel ratio. This becomes a fixed value in the calculation.

All the other changes in the fuel mixture influence the calculation of the lambda value and the air/fuel ratio.

The following parameters are available:

Parameter	Meaning	Unit
H/C	Ratio of hydrogen/carbon	mol/mol
O/C	Ratio of oxygen/carbon	mol/mol
H2O	Water proportion	mmol/mol
AFSt.	Stoichiometric ratio	kg/kg

The measure units, default values and value ranges listed in section 14.4.4 on page 181 apply for fuel composition.

Examples of fuel composition are calculated in section 9.4.1 on page 93.

[Menu 4|3|2|2]: channel / mode λ / analytic / climatic conditions: Climatic Conditions

Use **channel** → **mode** λ → **analytic** → **climatic conditions** to set another group of parameters. They will act as the basis for the analytical calculation of the lambda value, the environmental conditions.

Among climatic conditions, air pressure has a major impact on the measuring accuracy of the lambda sensor. Since the sensor doesn't actually measure the oxygen content in the exhaust gas but the partial oxygen pressure, deviations will arise rapidly, especially during altitude tests.

When the pressure compensation function is activated, deviations due to ambient pressure can be compensated with the measure values of the module’s internal pressure sensor or with the measure values of an external pressure sensor (see section 3.4.2 on page 24).

In addition, relative humidity has an impact on measuring accuracy in the lean range, although to a lesser extent. Similarly, air temperature is also included in the calculation of absolute relative humidity.

All other changes in the environmental conditions have an impact on the calculation of the lambda value and the air/fuel ratio. Ambient pressure has an indirect impact through the oxygen content measurement.

The following parameters are available for setting the climatic conditions:

Parameter	Meaning
humidity	Relative humidity
air temp	Air temperature

The measure units, default values and value ranges listed in section 14.4.4 on page 181 apply for the climatic conditions.

8.2.3 [Menu 4|3|3]: channel / mode λ / advanced: Adapting Combustion and Sensor

In submenu **channel** → **mode** λ → **advanced**, you can carry out a dynamic adaptation of the calculation process for measuring mode.

Due to the high theoretical requirements linked to the use of this calculation method, it should only be used by advanced users who have the necessary basic knowledge for making settings in this field.

In this section, you can set parameters that describe the hydrogen residues in the exhaust gas, the deviation of the sensor used and the special water-gas equilibrium of the combustion engine.

The individual factors are compensated when the curve is calculated. The Lambda Meter can then be used for high-precision measurements which take even the slightest deviations into account.

You can enter directly the sensor curve as a measurement result. You can also use the Lambda Meter to measure a sensor. In both cases, you must have the necessary resources (reference gas).

Hydrogen residue in the exhaust gas and the water-gas equilibrium temperature can be determined by making measurements. You can then enter your measuring results in the Lambda Meter.

The hydrogen residues from combustion, the special sensor sensitivity and the water-gas equilibrium temperature all impact on the lambda value calculation and the air/fuel ratio. Changes mainly have a direct, but sometimes indirect, effect on the measurement of the oxygen content.

The water-gas equilibrium temperature only has an impact in the rich range of the measuring result. In the range λ=1, it is as negligible as in the lean range.

[Menu 4|3|3|1]: channel / mode λ / advanced / H2 shift: Hydrogen Shift

channel → **mode** λ → **advanced** → **H2 shift** lets you set the sensor's hydrogen shift. It is used as a basis for performing the analytical calculation of the lambda value.

The hydrogen shift occurs due to hydrogen residue in the exhaust gas. Such residue can be found even in complete combustion. Due to its physical process, the LSU sensor has a hydrogen cross-sensitivity.

Hydrogen residue in the exhaust gas can therefore lead to measuring result deviations. Ideally, the sensor's zero current is λ=1 if the sensor deviation is neglected. In reality, a higher lambda value must be assumed for the zero current (the default is 1.009). An exhaust gas analysis is required to determine the lambda value.

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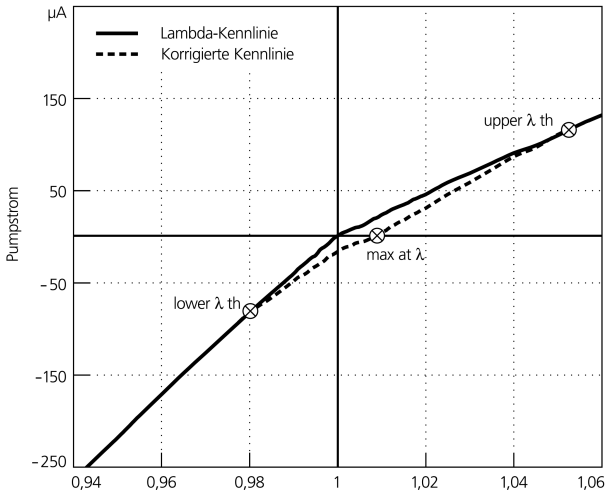


Fig. 8-1 How to Correct Hydrogen Shift

To calculate the hydrogen shift, an upper limit, a lower limit, and a mean deviation are used. The lower limit (lower λ th) is situated in the rich range and denotes the point from which the real values deviate from the ideal values. The upper limit (upper λ th) is situated in the lean range and denotes the point at which the real values are identical with the ideal values. The mean deviation (avg λ th) is the point at which the sensor supplies no signal.

To correct hydrogen shift, adapt the curve by changing the interval defined by the upper and lower limits. The mean deviation acts as the parameter for interpolating the actual lambda value.

The following parameters are available for setting the hydrogen shift:

Parameter	Meaning
lower λ th	Lower limit H_2 shift
λ at Ip=0	Mean H_2 shift
upper λ th	Upper limit H_2 shift

The settable values and value ranges of the parameters can be found in section 14.4.5 on page 181.

[Menu 4|3|3|2]: channel / mode λ / advanced / sensor calibration: Setting Sensor Characteristics

Use **channel** → **mode** λ → **advanced** → **sensor calibration** → **input** to set the sensor curve. It is used as the basis for the analytical calculation of the lambda value.

The sensor curve is sensed separately mainly as an age-linked deviation of the individual measuring accuracy of the sensor in the rich and lean ranges. In both cases, you can use measurements in reference gas to determine the correction factor by which the sensor signal is multiplied in each range.

In addition, the zero current deviation of each sensor can be corrected to compensate for individual features. The actual pump current of the sensor is measured in pure nitrogen. The value set here is included as a deviation in the lambda value calculation.

This section describes how to enter your measuring results for the sensor curve by hand. You can also measure your sensor using the Lambda Meter and accept the measuring results directly as correction factors. You'll find more information about this in the next section.

The following parameters are available for setting the sensor characteristics:

Parameter	Meaning
lean scale	Sensor deviation, lean
rich scale	Sensor deviation, rich
zero offset	Sensor deviation, zero current

The settable values and value ranges of the parameters can be found in section 14.4.5 on page 181.

[Menu 4|3|3|2]: channel / mode λ / advanced / sensor calibration: Measuring Sensor Characteristics

Use **channel** → **mode** λ → **advanced** → **sensor calibration** → **ref. gas** to measure the sensor curve. It acts as the basis for the analytical calculation of the lambda value.

The parameters used are the correction factors described in the previous section: deviation in lean and rich ranges, and sensor zero current deviation.

The sensor sensitivity in the lean range can be determined using the ambient air or a different oxygen mixture. The ambient air has an assumed oxygen content of 20.95 % and can be adjusted on a case-by-case basis. The actual value depends on temperature and relative air humidity. You will find calculation examples at the end of this section.

The sensor sensitivity in the rich range can be determined from known reference gases where the CO and H_2 concentrations in each case are available as input parameters to determine the reference gas.

The zero current compensation must take place in pure nitrogen. This requires a nitrogen content of 99.999 %.

When you use nitrogen and a reference gas for the rich range, you should always use a washing bottle. The volumetric flow should be 2 l/min.

The test results are automatically taken over as correction factors in the analytical calculation of the lambda value. You need not enter them again manually.

Due to the measured values, the Lambda Meter automatically detects whether the reference gas used is suitable for adjusting the sensor. If you use an unsuitable gas, an error message will appear.

Refer to the chapter “Measuring the Sensor Curve” on page 87 for a detailed description of the setup for measuring the sensor curve. When measuring, please make sure you observe the hazard warnings for working with toxic and combustible gases.

To measure the sensor characteristics in the lean range

1. Select the menu item **ref. gas** if necessary using the ↑ / ↓ keys.
2. Activate the submenu using **OK**.

   The parameter last set is displayed.
3. Select the menu item **lean ref** if necessary using the ↑ / ↓ keys.
4. Confirm with **OK**.

   The current oxygen content for the reference gas is displayed (in %).
5. Use the ↑ / ↓ keys to set the value required.
6. Confirm again using **OK** to start measuring.

   The deviation factor for the lean range is measured and briefly shown in the display.

To measure the sensor characteristics in the rich range

1. Select the menu item **ref. gas** if necessary using the ↑ / ↓ keys.
2. Activate the submenu using **OK**.

   The parameter last set is displayed.
3. Select the menu item **rich ref** if necessary using the ↑ / ↓ keys.
4. Confirm with **OK**.

   The current carbon monoxide content for the reference gas is displayed (in %).
5. Use the ↑ / ↓ keys to set the value required.
6. Confirm with **OK**.

   The current hydrogen content for the reference gas is displayed (in %).
7. Use the ↑ / ↓ keys to set the value required.
8. Confirm again using **OK** to start measuring.

   The deviation factor for the rich range is measured and briefly shown in the display.

The procedure in the rich range only differs in the composition of the reference gas. When compensating in the rich range, enter both the CO concentration and the H_2 concentration.

To simplify operating the device, the sensor curve for the lean range is always adopted automatically in the rich range when a new value is set for **lean scale**.

If you want to enter a separate correction value for the rich range, make sure you observe the operating sequence: always set the value for **lean scale** *first* and *then* the value for **rich scale**.

No input is required for zero current compensation since the gas composition is a fixed figure.

Calculation example: Oxygen content

An ideal oxygen content of 20.95 % is assumed. In the next example, the ambient temperature is specified as 23° C and relative humidity as 50 %.

At 23° C, the saturation vapor pressure of air is 3 %, the absolute humidity is about 3 % * 50 % = 1.5 %.

Since oxygen can only occur in air that is actually present, the actual oxygen content is calculated as follows:

20.95 % * (1 - 0.015) = 20.64 %

Fig. 8-2 illustrates the relationship between temperature and the saturation vapor pressure of ambient air.

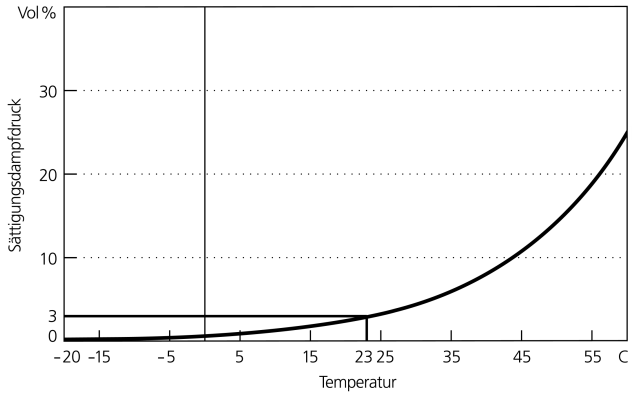


Fig. 8-2 Saturation Vapor Pressure of Dry Air

[Menu 4|3|3|3]: channel / mode λ / advanced / TDET: Water-Gas Equilibrium Temperature

Use **channel** → **mode** λ → **advanced** → **TDET** to enter the water-gas equilibrium temperature, TDET, which is used as the basis for the analytical calculation of the lambda value.

When the water-gas equilibrium is fully set, this value is 1212 °C. Deviations from this temperature impact on accuracy in the rich range.

The relationship between the water-gas equilibrium temperature, TDET, and the customary factor k_p found in the literature is explained in the equation below.

$$k_p = 10^{\left(1,93 - \frac{2040}{TDET + 273}\right)}$$

The settable values and value ranges of the parameters can be found in section 14.4.5 on page 181.

[Menu 4|3|3|4]: channel / mode λ / advanced / IPC:

In case of longer operation of some sensors in lean environment, inaccuracy caused by fatigue can occur. This sensors can to be regenerated by operating with inverse pump current (PUK).

The operating mode is also called Inverse Pump Current Cycle (IPC).

NOTE

Only the lambda sensors LSU4.9, LSU5.1and LSU 5.2 can be used in inverse pump current operating mode.

In the Auto IPC mode (automatic inverse pump current mode) the module evaluates characteristic parameters for the fatigue of the sensor, and regenerates the sensor automatically, if necessary.

Use **channel** → **mode** λ → **advanced** → **IPC** → **Auto IPC** to enable or disable the Auto IPC mode.

To select automatic inverse pump current mode

1. Press the **MENU** key to call up the main menu.
2. Select the **channel** → **mode l** → **advanced** → **IPC** → **Auto IPC** menu from the main menu using the ↑ / ↓ and **OK** keys.
3. Press the **OK** key several times to activate or deactivate automatic inverse pump current mode.

   The following settings are available:

On	Automatic inverse pump current mode on
Off	Automatic inverse pump current mode off

   The setting last selected and displayed is activated.
4. Exit the menu with **ESC**.

Use **channel** → **mode** λ → **advanced** → **IPC** → **Start IPC cycle** to start an single IPC cycle.

To start a single inverse pump current cycle

1. Press the **MENU** key to call up the main menu.
2. Select the **channel** → **mode l** → **advanced** → **IPC** → **Start IPC cycle** menu from the main menu using the ↑ / ↓ and **OK** keys.
3. Press the **OK** key to start a inverse pump current cycle.
4. Exit the menu with **ESC**.

[Menu 4|3|3|4]: channel / mode λ / advanced / Breathe:

Unlike other sensors, which are comparing the exhaust gas oxygen ratio to the ambient air, LSU 5.1 compares it to an integrated oxygen reservoir. In case of longer operation of the LSU 5.1 in rich environment, inaccuracy caused by fatigue can occur. This sensors can to be regenerated by refilling the oxygen reservoir by a so called breathe cycle.

NOTE

Only the lambda sensor LSU 5.1 can be used in this operation mode.

In the Auto Breathe mode the module evaluates characteristic parameters for the fatigue of the sensor, and refill its integrated oxygen reservoir automatically, if necessary.

Use **channel** → **mode** λ → **advanced** → **Breathe** → **Auto Breathe** to enable or disable the auto breathe mode.

To select automatic breathe cycle

1. Press the **MENU** key to call up the main menu.
2. Select the **channel** → **mode l** → **advanced** → **Breathe** → **Auto Breathe** menu from the main menu using the ↑ / ↓ and **OK** keys.
3. Press the **OK** key several times to activate or deactivate automatic breathe cycle to refill the oxygen reservoir.

   The following settings are available:

On	Automatic breathe cycle on
Off	Automatic breathe cycle off

   The setting last selected and displayed is activated.
4. Exit the menu with **ESC**.

Use **channel** → **mode** λ → **advanced** → **Breathe** → **Start breathe cycle** to start an single breathe cycle.

If the estimated fill level of the integrated oxygen reservoir is relatively high, them the request to start a breathe cycle will be ignored.

To start a single breathe cycle

1. Press the **MENU** key to call up the main menu.
2. Select the **channel** → **mode l** → **advanced** → **Breathe** → **Start breathe cycle** menu from the main menu using the ↑ / ↓ and **OK** keys.
3. Press the **OK** key to start a single breathe cycle to refill the oxygen reservoir.
4. Exit the menu with **ESC**.

8.3 [Menu 4|4]: channel / heater line

In the menu **channel** → **heater line** , you can select different heater lines to adapt the heater control perfectly to your application. The lambda sensor is heated in accordance with this line.

The following heater lines can be selected:

Parameter	Meaning
ETAS DEF	Heater line for the sensors LSU 4.2-80 and LSU 4.2-4.7-100
HtUp-300	Heater line for the sensor LSU 4.9-300
ADV	Heater line for the sensor LSU ADV
ZFAS-U2/D	Heater line for the sensors ZFAS-U2 and ZFAS-D
HtUp-5.1	Heater line for the sensor LSU 5.1

Parameter	Meaning
HtUp-4.2	Heater line for the sensors LSU 4.2-80 and LSU 4.2-4.7-100
ZFAS-U3	Heater line for the sensor ZFAS-U3
HtUp-5.2	Heater line for the sensor LSU 5.2

If the user has defined additional heater lines, these are also displayed.

The heater lines that can be set are listed in section 14.4.6 on page 183.

8.4 [Menu 4|5]: channel / temperature line

In the menu **channel → temperature line** , you can select different temperature lines. This line determines the correlation between the measured internal resistance and the temperature of the lambda sensor.

Without a valid temperature line, the temperature of the lambda sensor cannot be measured and the measure value “Temperature” is set to an invalid value.

The following temperature lines can be selected:

Parameter	Meaning
T-4.2-100	Temperature line for the sensor LSU 4.2-4.7-100
T-4.2-80	Temperature line for the sensor LSU 4.2-80
T-4.9-300	Temperature line for the sensor LSU 4.9-300
T-ADV	Temperature line for the sensor LSU ADV
T-ADV-D	Temperature line for the sensor LSU ADV-D
T-ZFAS-U2/D	Temperature line for the sensors ZFAS-U2 and ZFAS-D
T-5.1-120	Temperature line for the sensor LSU 5.1
T-ZFAS-U3	Temperature line for the sensor ZFAS-U3
T-5.2	Temperature line for the sensor LSU 5.2

If the user has defined additional temperature lines, these are also displayed.

The temperature lines that can be set are listed in section 14.4.7 on page 183.

8.5 [Menu 4|6]: channel / operating parameters

If you are operating your Lambda Meter with a lambda sensor whose settings are not saved in the default configuration of the ES63x, you can set nominal values for your lambda sensor in the menu **channel → operating parameters**. You can adjust its parameters when lambda sensor detection is disabled.

The following parameters can be adapted:

Parameter	Meaning
Ri,nom	Nominal internal resistance of the sensor
k rich	Coefficient for pressure dependence of pump current at lambda < 1
k lean	Coefficient for pressure dependence of pump current at lambda > 1
Ip,ref	Current intensity for pumped reference of the lambda sensor

Ip,ref+	Increased pump current during tpref+
tp,ref0	Warm-up time without pump current
tp,ref+	Warm-up time with increased reference pump current

The settable values and value ranges of the parameters can be found in section 14.4.8 on page 184. ´

NOTE

Ensure that the settings for pumped reference and lambda line also apply to the sensor used (cf. section 5.7.2 on page 55).

NOTE

Ensure that the settings for internal resistance and lambda line also apply to the sensor used (cf. section 5.7.2 on page 55).

9 Instructions and Sample Calculations

This chapter contains information on the following topics:

9.1 Measuring the Sensor Curve

You can carry out high-precision measurements in which the precise sensor curve is included in the lambda value calculation. First the characteristic of the connected sensor is saved in the Lambda Meter.

If you know the sensor curve, you can enter it directly in the Lambda Module. You can also use the Lambda Meter as a measuring instrument to measure the sensor curve and then accept the determined values to continue work.

Chapter 8.2.3 on page 78 describes the work steps for measuring the sensor curve. This chapter contains a description of the test setup for measuring individual values.

Normally, single-point adjustment is sufficient for the sensor in the lean range to achieve high measuring accuracy when measuring the sensor curve. To compensate for minor tolerances, you can carry out additional adjustment for the rich range and zero current.

A basic setup is required for the measurements where all three measuring points are identical:

- ES63x Lambda Module
- power supply cable
- power supply
- Lambda sensor
- sensor cable
- fitting through which the measuring gas flows, with M18 * 1.5 thread for the sensor
- connecting tubes

In addition to this basic setup, other setups are required depending on the measuring point. They are listed and illustrated below in the description of test setups for each of the measuring points.

When you measure the sensor curve, your readings are automatically taken over as correction factors for the analytical calculation of the lambda value. The measured values are shown on the display.

Each sensor requires its own adjustment parameters. For this reason, you should carry out a recalibration each time the lambda sensor is changed.

The sections below describe the setup for measuring the sensor curve at each of the measuring points. The basic setup described above is used for all measuring points.

9.1.1 Sensor Curve in the Lean Range: lean scale

The sensor curve in the lean range can be determined by using ambient air or a reference gas.

The sensor curve for the lean range is automatically take over for the rich range if a new value is set for **lean scale**. If you want to enter a separate correction value for the rich range, make sure you observe the operating sequence: always set the value for **lean scale** *first* and then the value for **rich scale**.

Lean Range: Measuring the Ambient Air

In this process, a compressor pumps the ambient air through the fitting. You require a compressor as additional equipment for the basic setup.

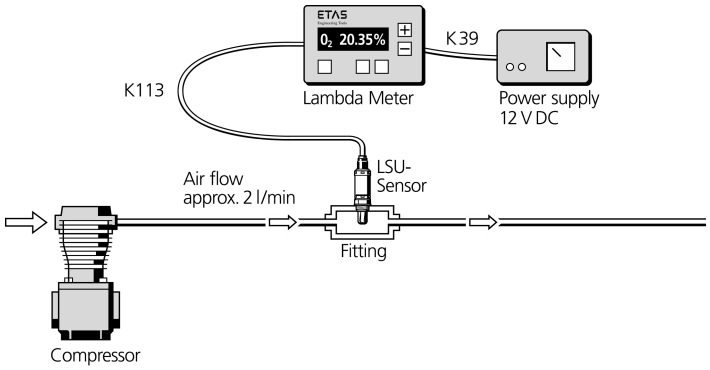


Fig. 9-1 Setup for measuring ambient air

After you select the right menu item on the Lambda Meter, adjust the current concentration of O_2 in the ambient air by pressing the ↑ / ↓ keys.

Lean Range: Measuring with Reference Gas

In this process, reference gas passes through the fitting. We recommend a concentration of 8.29% O_2 in N_2 for the lean range. You require a gas bottle and pressure reducing valve as additional equipment for the basic setup.

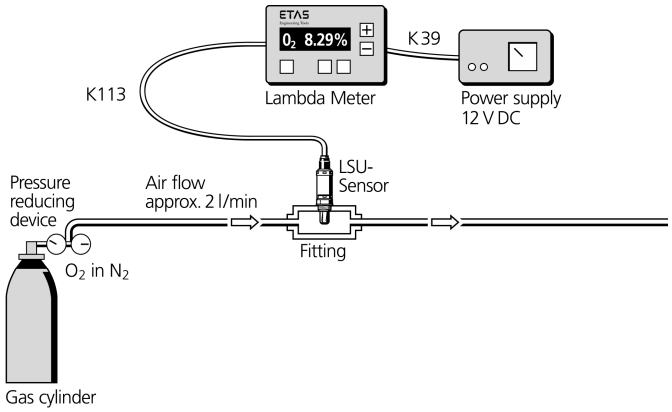
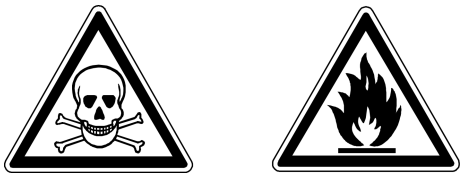


Fig. 9-2 Setup for measuring reference gas

After you select the right menu item on the Lambda Meter, adjust the current concentration of O_2 by pressing the ↑ / ↓ keys.

9.1.2 Sensor Curve in Rich Range: rich scale

To measure the sensor curve in the rich range, a reference gas is pumped through the fitting via a washing bottle. We recommend a gas mixture of 4.1% CO and 3.2% H_2 in N_2.



NOTE

CO gas is a highly combustible gas that is poisonous if inhaled.
Make sure the rooms where you are working are sufficiently ventilated or work under an extractor hood. Do not smoke when handling CO gas. Breathing apparatus not requiring ambient air should be kept at hand in case of an emergency.

The following equipment is required in addition to the basic setup:

- gas bottle with pressure reducer and washing bottle
- extractor hood and
- breathing apparatus not requiring ambient air in case of emergency.

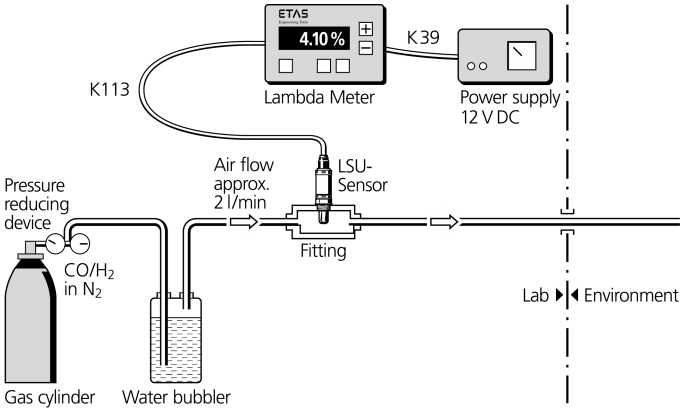


Fig. 9-3 Setup for measuring CO gas

After you select the right menu item on the Lambda Meter, adjust the current concentration of CO in the reference gas by pressing the ↑ / ↓ keys. Then adjust the concentration of H_2 in the reference gas in the same way.

9.1.3 Sensor Curve in Zero Current Range: zero offset

To measure the sensor curve in the zero current range, a reference gas passes through a washing bottle and the fitting. We recommend pure nitrogen at a concentration of min. 99.999%. In addition to the basic setup, you also require a gas bottle, pressure reducer and washing bottle.

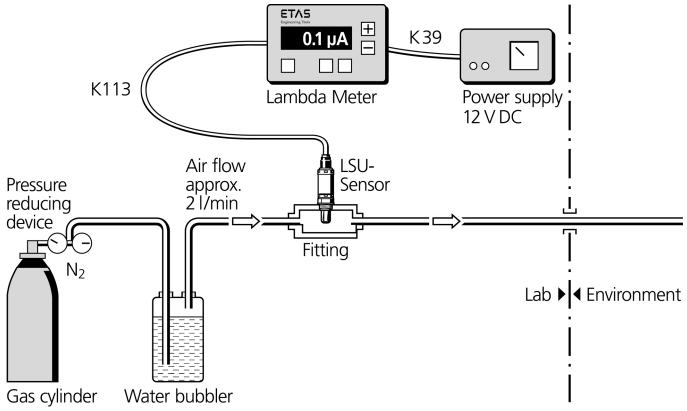


Fig. 9-4 Setup for measuring zero current range

After you select the right menu item on the Lambda Meter, the zero current is detected and saved automatically.

9.2 Calibrate to Air

A semi-automatic calibration of the sensor / ES630.1ES631.1Lambda Module system can be carried out in the calibration software.

Applications:

- Compensation of tolerances of the lambda sensor
- Compensation of aging effects of the lambda sensor (can still be used in spite of a weaker signal)
- Determination of whether a sensor deviates from the desired values

Normal ambient air is used as air reference. To be able to execute a correct calibration in extreme atmospheric pressure or temperature conditions, a different value from the default value of 20.9% can be entered as desired oxygen value.

NOTE

The correction factor determined is sensor-specific and is stored in the module. If a different lambda sensor is connected, the correction factor has to be reset and a new system calibration executed. On calibration, the factors are also stored in TEDS for LSU ADV-D and LSU 5.1, and are reloaded from TEDS to the module when the sensor is connected (i.e. the system does not need recalibration if the sensor was previously correctly calibrated).

To calibrate the system to air

1. Ensure that the sensor is operated in air or that any residual exhaust gas has been blown out, e.g. using compressed air.
2. If the exact concentration of oxygen is not known, use the default value 20.9%.
3. Switch on the supply voltage of the Lambda Module and the sensor.
4. Check that all parameters for activating heater control are fulfilled (see section 4.4.2 on page 39).
5. Check in the diagnostics section of the calibration software whether “Ri” is marked in green.

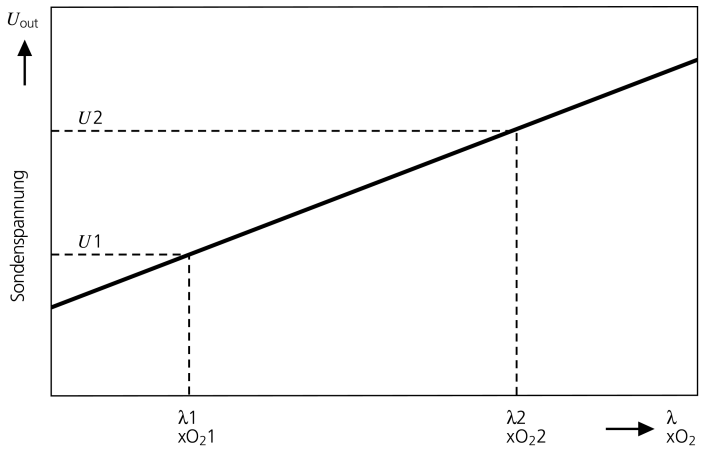
   The sensor is sufficiently heated. TheLambda Module / sensor system is ready for operation.

9.3 Parameterizing the Analog Output Voltage

9.3.1 Calculating the Offset and Gain Parameters

General straight line equation: Uout:

$$U\text{out} = offset + gain \times \lambda$$



$$gain = \frac{U_2 - U_1}{\lambda_2 - \lambda_1}, \quad offset = U_1 - \lambda_1 gain = U_2 - \lambda_2 gain$$

9.3.2 Examples of Offset and Gain

Default Setting

When λ = 1, analog output voltage should be 1 V; when λ = 10, the analog output should supply 10 V → U_1 = 1 V, λ_1 = 1 and U_2 = 10 V, λ_2 = 10. The following values therefore result for the parameters:

$$gain = \frac{10\,V - 1\,V}{10\lambda - 1\lambda} = 1\,V/\lambda$$

$$offset = 1\,V - 1\lambda(1\,V/\lambda) = 0\,V$$

Checking the Sensor Installation Point

At a sensor resistance R_i of 110 Ω, the output voltage should be 6 V; at an R_i of 90 Ω it should be 4 V:

$$gain = \frac{6\,V - 4\,V}{110\,\Omega - 90\,\Omega} = 0,1\frac{V}{\Omega}$$

$$offset = 4\,V - 90\,\Omega \cdot \left(0,1\frac{V}{\Omega}\right) = -5\,V$$

High-Resolution Measurement of About λ = 3

The minimum output voltage (0 V) will set itself at λ = 2; at λ = 4, the output voltage will be 10 V:

$$gain = \frac{10\,V - 0\,V}{4\lambda - 2\lambda} = 5\,V/\lambda$$

$$offset = 0\,V - 2\lambda(5\,V/\lambda) = -10\,V$$

Measuring the Oxygen Concentration up to Air

Let's assume that xO_2 = 0 % produces an output voltage of 0 V; when xO_2 = 20.9 %, the output voltage will be 10 V:

$$gain = \frac{10\,V - 0\,V}{20,9\%O_2 - 0\%O_2} = 0,478\,V/\%O_2$$

$$offset = 0\,V - 0\%O_2(0,478\,V/\%O_2) = 0\,V$$

Measuring the Air/Fuel Ratio in the Stoichiometric Range

When the air/fuel ratio (A/F) = 12, the output voltage should be 0 V. When A/F = 24, the analog output voltage should be 10 V. The equation below illustrates this concept:

$$gain = \frac{10\,V - 0\,V}{24\,AF - 12\,AF} = 0,833\,mV/AF$$

$$offset = 0\,V - 12\,AF(0,833\,mV/AF) = -10\,V$$

NOTE

If the minimum or maximum output voltage is exceeded when offset or gain is selected incorrectly, then 0 V or 10 V is output.

9.4 Sample Calculations

9.4.1 Fuel Composition

Fuel Composition (Diesel)

The example below illustrates how to calculate the composition of diesel fuel. The specified parameters are:

- the composition of the fuel by weight at 86 C : 13 H : 1 others (sulfur, etc.)
- the molecular weights of each element, carbon at 12.011 and hydrogen at 1.008

This first results in the calculation of the fuel mixture as follows:

- (86 / 12.011) = 7.160 [mol/weight%] C
- (13 / 1,008) = 12.897 [mol/weight%] H
- and an undefined value for the remaining components

The simplified H/C ratio is therefore

(12.897/7.160) = 1.80 [mol/mol] H/C

The deviation from the value for the H/C ratio in diesel fuel of 2.0 known from the previous example is due to neglecting the remaining components.

Fuel Composition (Fuel Containing Butanol)

The example below illustrates how to calculate a fuel mixture with a butanol content of 25%. The specified parameters are:

- the composition of the fuel by weight at 72 C_8H_{18} (octane) : 25 C_4H_9OH (butanol) : 3 H_2O (water)
- the molecular weights of each element, oxygen at 16.000, carbon at 12.011 and hydrogen at 1.008

In the first step, the parameters for pure butanol are calculated:

- the molecular weight is (4 * 12.011) + (10 * 1.008) + (1 * 16) = 74.124
- the weight by volume of C is (4 * 12.011) / 74.124 = 64.8 %
- the weight by volume of H is (10 * 1.008) / 74.124 = 13.6 %
- the weight by volume of O is (1 * 16.000) / 74.124 = 21.6 %

Since the fuel only contains 25 % butanol, the actual relationships for the butanol components can be calculated by simple multiplication:

- the weight by volume of C is 64.8 % * 25 % = 16.2 %
- the weight by volume of H is 13.6 % * 25 % = 3.4 %
- the weight by volume of O is 21.6 % * 25 % = 5.4 %

Using the same process, you can calculate the relationships for the components of water and octane. For water, the following values are obtained:

- the molecular weight is (2 * 1.008) + (1 * 16.000) = 18.016
- the weight by volume of H is (2 * 1.008) / 18.016 = 11.2 %
- the weight by volume of O is (1 * 16.000) / 18.016 = 88.8 %

Here, too, you can multiply by 3% to calculate the actual relationships in the specified fuel:

- the weight by volume of H is 11.2 % * 3 % = 0.34 %
- the weight by volume of O is 88.8 % * 3 % = 2.66 %

For pure octane, the results are the following weight relationships:

- the molecular weight is (8 * 12.011) + (18 * 1.008) = 114.232
- the weight by volume of C is (8 * 12.011) / 114.232 = 84.1 %
- the weight by volume of H is (18 * 1.008) / 114.232 = 15.9 %

The distinctive numbers for octane components (72 %) are calculated as follows:

- the weight by volume of C is 84.1 % * 72 % = 60.55 %
- the weight by volume of H is 15.9 % * 72 % = 11.45 %

From the relationships for the various components, you can calculate the ratio for the specified fuel by addition.

	C	H	O
Butanol	16.20 %	3.40 %	5.40 %
Water	0.00 %	0.34 %	2.66 %
Octane	60.55 %	11.45 %	0.00 %
Total	**76.75 %**	**15.19 %**	**8.06 %**

Using these values, you can now calculate all the necessary parameters:

- the H/C ratio is (15.19 / 1.008) / (76.75 / 12.011) = 2.36
- the O/C ratio is (8.06 / 16.000) / (76.75 / 12.011) = 0.08
- the water component is (3.00 / 18.016) / (76.75 / 12.011) = 0.03 (equivalent to an input value of 30 mmol/molC)

10 Technical Data

This chapter contains information on the following topics:

10.1 General Data

10.1.1 Product labeling

The following symbols are used for product labeling:

Symbol	Description
	Prior to operating the product, be sure to read the user's guide!
	Labeling of the daisy chain port„IN“ (input)
	Labeling of the daisy chain port„OUT“ (output)
SN: 1234567	Serial number (seven-digit)
Vx.y.z	Hardware version of the product
F 00K 123 456	Ordering number of the product, see chapter 12.1 on page 154
7-29V ⎓	Operating voltage range (DC)
P_{max} = xy W	Power consumption, max.
	Labeling for WEEE, see chapter 10.6 on page 98
	Marking for CE conformity (Chapter 10.3 on page 98)

Symbol	Description
	Marking for UKCA conformity (Chapter 10.4 on page 98)
	Marking for KCC conformity (Chapter 10.5 on page 98)
	Labeling for RoHS (China), see chapter on page 97

10.1.2 Standards and Norms

The module adheres to the following standards and norms:

Norm	Test
EN 61326	Electrical equipment for measurement, control and laboratory use - EMC requirements
EN 61000-6-2	Immunity (industrial environments)
EN 61000-6-4	Emission standard (industrial environments)

The module is designed only for use in industrial environments in accordance with EN 61000-6-4. When using the module outside of industrial environments avoid possible radio disturbances by additional shielding measures!

WARNING

This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

CAUTION

Loss of features as defined by IP40!

Do not open or change the module!

Work on the module must only be carried out by specialist, qualified personnel.

10.1.3 Environmental Conditions

Operating temperature range	-40 °C to +70 °C/ -40 °F to +158 °F
Storage temperature range (module without packaging)	-40 °C to +85 °C / -40 °F to +185 °F
Relative humidity (non-condensing)	0 to 95%
Implementation altitude	max. 5000 m/ 16400 ft
Protection class	IP40
Degree of pollution	2

NOTE

The module is suited for use in interiors, in the passenger compartment or in the luggage compartment of vehicles.

10.1.4 Maintenance the Product

Do not open or change the module! Works on the module housing may be executed only by qualified technical personnel. Send defect modules to ETAS.

10.1.5 Cleaning the product

We recommend to clean the product with a dry cloth.

10.1.6 Mechanical Data

Dimensions (H x W x D)	73 mm x 128 mm x 174 mm / 2.9 in x 5 in x 6.8 in
Weight	905 g / 2.0 lb
Weight	1055 g / 2.33 lb
Weight	ES630.1: 905 g / 2.0 lb
	ES631.1: 1055 g / 2.33 lb
	ES635.1: 920 g / 2.03 lb
	ES636.1: 1085 g / 2.39 lb

10.2 RoHS Conformity

European Union

The EU Directive 2002/95/EU limits the use of certain dangerous materials for electrical and electronic devices (RoHS conformity).

ETAS confirms that the product corresponds to this directive which is applicable in the European Union.

China

ETAS confirms that the product meets the product-specific applicable guidelines of the China RoHS (Management Methods for Controlling Pollution Caused by Electronic Information Products Regulation) applicable in China with the China RoHS marking affixed to the product or its packaging.

10.3 CE conformity

With the CE mark attached to the product or its packaging, ETAS confirms that the product corresponds to the product-specific, applicable directives of the European Union.

The CE Declaration of Conformity for the product is available upon request.

10.4 UKCA conformity

With the UKCA mark attached to the product or its packaging, ETAS confirms that the product corresponds to the product-specific, applicable standards and directives of Great Britain.

The UKCA declaration of conformity for the product is available on request.

10.5 KCC conformity

With the KC mark attached to the product and its packaging, ETAS confirms that the product has been registered in accordance with the product-specific KCC guidelines of the Republic of Korea.

10.6 Taking the Product Back and Recycling

The European Union has passed a directive called Waste Electrical and Electronic Equipment, or WEEE for short, to ensure that systems are setup throughout the EU for the collection, treating and recycling of electronic waste.

This ensures that the devices are recycled in a resource-saving way representing no danger to health or the environment.

Fig. 10-1 WEEE Symbol

The WEEE symbol (see Fig. 10-1 on page 98) on the product or its packaging shows that the product must not be disposed of as residual garbage.

The user is obliged to collect the old devices separately and return them to the WEEE take-back system for recycling.

The WEEE directive concerns all ETAS devices but not external cables or batteries.

For more information on the ETAS GmbH Recycling Program, contact the ETAS sales and service locations (see chapter 16 on page 190).

10.7 Declarable Substances

European Union

Some products from ETAS GmbH (e.g. modules, boards, cables) use components with substances that are subject to declaration in accordance with the REACH regulation (EU) no.1907/2006.
Detailed information is located in the ETAS download center in the customer information "REACH Declaration" (www.etas.com/Reach). This information is continuously being updated.

10.8 Use of Open Source software

The product uses Open Source Software (OSS). This software is installed in the product at the time of delivery and does not have to be installed or updated by the user. Reference shall be made to the use of the software in order to fulfill OSS licensing terms. Additional information is available in the document "OSS Attributions List" at the ETAS website www.etas.com.

10.9 System Requirements

10.9.1 Hardware

Operation of the module requires a power supply voltage of 7 V to 29 V DC.

PC with one Ethernet interface

A PC with one open Ethernet interface (1 Gbit/s or 100 Mbit/s, full duplex) with RJ-45 connection is required. Ethernet interfaces that are implemented with an additional network card in the PC must feature a 32-bit data bus.

Requirement to ensure successful initialization of the module

NOTE

It is imperative you disable the function which automatically switches to power-saving mode on your PC network adapter when there is no data traffic on the Ethernet interface!

To deactivate the power saving mode

Choose in System Control Center / Device Manager / Network Adapter the used network adapter by double-click. Deactivate the "Allow the computer to turn off this device to save power" option in the "Power Management" register. Confirm your configuration.

The manufacturers of network adapter have different names for this function.

Example:

- “Link down Power saving”
- "Allow the computer to turn off this device to save power."

10.9.2 Supported Applications and Software Requirements

CAUTION

Operate the lambda sensors only at modules with up to date firmware!
Before you start-up, update the firmware of the module with the current service software HSP to avoid damage of the lambda sensor!

To configure the ES63x module and for control and data acquisition, you need software in the following versions or higher:

Sensor	INCA + INCA Add-On ES63x Daisy Chain Configuration	Daisy Chain Configuration Tool	INTECRIO + INCA Add-On ES63x Daisy Chain + HSP
LSU 4.2	7.0 + 1.3.3	1.3.3	3.2 + 1.3.3 + 9.8.0
LSU 4.9	7.0 + 1.3.3	1.3.3	3.2 + 1.3.3 + 9.8.0
LSU ADV	7.0 + 1.3.3	1.3.3	3.2 + 1.3.3 + 9.8.0
LSU 5.1	7.1.4 + 1.4.3	1.4.3	4.4.0 + 1.4.3 + 10.5.0
LSU 5.2	7.2.8 + 7.2.8	7.2.8	4.6.3 + 7.2.8 + 10.8.0
ZFAS-U2	7.0 + 1.3.3	1.3.3	3.2 + 1.3.3 + 9.8.0
ZFAS-U3	7.2.8 + 7.2.8	7.2.8	4.6.3 + 7.2.8 + 10.8.0

10.10 Electrical Data

10.10.1 Measurement Category

The module is designed for measuring category CAT I.

10.10.2 Measurement Accuracy

NOTE

ETAS guarantees measurement accuracy of the module for one year. Please use our calibration service (see section 5.8 on page 55)!

NOTE

Unless otherwise specified, all data applies at 25 °C.

10.10.3 Host Interface (Ethernet)

Socket	100Base-T Ethernet; 100 Mbit/s, Full Duplex necessary
	PC Card 32 bit
Protocol	XCP on UDP/IP
IP address	Dynamic via INCA, INTECRIO or in stand-alone operation with ES63x Daisy Chain Configuration Tool from ES6xx_DRV_SW (Default: 192.168.40.44)

NOTE

To ensure successful initialization of the network card of your PC, refer to chapter 10.9.1 on page 99.

10.10.4 Host Interface (RS232)

Protocol

Protocol	SMB

When the PC is requested by the following codes, the ES63x module sends a maximum of 1 byte containing the following information:

Code	Description	Value Range and Algorithm
0	Reserved, exit from test mode	
1	Module sends λ value in 8-bit notation	0.744 ≤ λ ≤ 1.746 $\lambda = \frac{Byte + 186}{250}$
2	Module sends high byte of λ value in 16-bit notation	0.7 ≤ λ ≤ 32.767 $\lambda = \frac{(HighByte \cdot 256) + LowByte}{1000}$
3	Module sends low byte of λ value in 16-bit notation	
4	Module sends high byte of Ri value in 16-bit notation	0.0 ≤ R_i ≤ 500.0 Ω $R_i = \frac{(HighByte \cdot 256) + LowByte}{10}$
5	Module sends low byte of R_i value in 16-bit notation	
6	Module sends high byte of O_2 value in 16-bit notation	0.0 ≤ O_2 ≤ 24.41 % $O_2 = \frac{(HighByte \cdot 256) + LowByte}{10}$
7	Module sends low byte of O_2 value in 16-bit notation	
8	Module sends high byte of A/F value in 16-bit notation	10.29 ≤ A/F ≤ 327.67 $A/F = \frac{(HighByte \cdot 256) + LowByte}{100}$
9	Module sends low byte of A/F value in 16 bit notation	
ch	Module sends high byte of I_P value (16 bit)	−3 mA ≤ I_P ≤ 3 mA $I_p = \frac{(HighByte \cdot 256) + LowByte}{10}$
dh	Module sends low byte of I_P value (16 bit)	
fh	Reserved, switch to test mode	

10.10.5 Power Supply

ES63x Module

Operating voltage	7 V to 29 V DC
Power consumption (normal mode, room temperature, without sensor heating)	ES630.1: typ. < 6.5 W at 13.5 V, max.10 W
	ES631.1: typ. < 7.5 W at 13.5 V, max. 13 W
	ES635.1: typ. < 7 W at 13.5 V, max.11 W
	ES636.1: typ. < 8.5 W at 13.5 V, max. 14 W
Power consumption (normal mode, room temperature, with sensor heating)	ES630.1: typ. < 15.5 W at 13.5 V (incl. 9 W rated heater power sensor)
	ES631.1: typ. < 25.5 W at 13.5 V (incl. 18 W rated heater power sensor)
	ES635.1: typ. < 16 W at 13.5 V (incl. 9 W rated heater power sensor)
	ES636.1: typ. < 26.5 W at 13.5 V (incl. 18 W rated heater power sensor)
Power consumption (standby [display off], room temperature, with sensor heating)	ES635.1: typ. < 13 W at 13.5 V (incl. 9 W rated heater power sensor)
	ES636.1: typ. < 23 W at 13.5 V (incl. 18 W rated heater power sensor)
Reverse polarity protection, Overload protection	with cable CBEP410, CBEP415, CBEP420, CBEP425, CBEP430 or with safety cable CBEP4105, CBEP4155, CBEP4205, CBEP4255, CBEP4305
Overvoltage category (AC mains supply)	II

Daisy Chain Port "OUT"

Output current [1)]	max. 1.25 A

[1)]: for additional daisy chained modules

10.10.6 Display

Type	Grafical, 128 x 64 pixel

10.10.7 Signal Processing

Features

A/D converter		16-bit high speed (for I_P and U_n)
Samplng rate[1)]	λ, $1/\lambda$, A/F, F/A, O_2, I_P, U_n, U_p, p_{exh}	0.5 to 2000 samples/s
	R_i, T, I_h, U_h	0.5 to 20 samples/s
	p_{amb}	1 sample/s
Hardware filter		Measurement I_P: Bessel 2th order low-pass, cutoff frequency 1 kHz (-3 dB)
		Measurement R_i: Bessel 2th order low-pass, cutoff frequency 50 Hz (-3 dB)
Digital filter		IIR filter, Bessel 2th order low-pass, cutoff frequency adjustable (0.5 Hz to 10 Hz), can be disabled

[1)] with ETAS application software

Characteristics Analog Input

Parameter	Min	Max
Pump current analog input resolution	-	100 nA
Pump current range	-10 mA	10 mA
DC accuracy of pump current (values in the specified lambda measurement range)	-	+/-(1 µA + |Ip| * 0.1%)
Pump current drift vs. temperature (-40 °C to +70 °C)	-	+/-(0.15 µA + |Ip| * 0.01%)/K
Sensor resistance measurement resolution	-	0.1 Ω
Sensor resistance measurement range	0	2000 Ω
Sensor resistance measurement accuracy	-	+/-(0.4 Ω + R_i * 0.1%)
Sensor resistance drift vs. temperature (-40 °C to +70 °C)	-	+/-0.008%/K

Measure Values and Measurement Ranges

All measure values are available simultaneously at the module (display) and in the calibration software.

Symbol	Measure Value	Min	Max	Invalid Value	Unit
l	Lambda	0.6	33.0	-0.01	-
A/F	Air to fuel ratio	8.5	327.67	-0.1	-
O_2	O2 concentration	0.0	25.0	-0.1	%
F/A	Fuel to air ratio	0.004	0.12	-0.001	-
1/λ	Reciprocal Lambda	0.06	1.67	-0.001	-
I_p	Pump current	-10.0	10.0	-15.0	mA
R_i	Sensor resistance	0.0	2000.0	-1.0	Ω
U_h	Heater voltage	0.0	18.0	-1.0	V
I_h	Heater current	0.0	5.0	-1.0	A
U_n	Nernst voltage	0.0	900.0	-10.0	mV
U_p	Pump voltage	-4000.0	4000.0	-10000.0	mV
T	Sensor temperature	500.0	1500.0	-1000	°C
p_a	Ambient pressure	600.0	1150	-1.0	hPa
p_{ex}	Pressure from external pressure sensor (ES635.1 and ES636.1 only)	500.0	5000.0	-1.0	hPa
Fr	Oxygen reservoir fill level (for LSU 5.1 only)	0	100	-1	%
Sta	State/ operational state of the sensor	0	2	-1	-

10.10.8 Analog Output "VOUT"

An analog voltage is output at the “VOUT” output of the ES63x module and at the BNC jack of sensor cables CBAL410.1, CBAL4105.1, CBAL451.1, CBAL4515.1, CBAL463.1, CBAL4635.1, CBAL468.1 and CBAL4685.1.

The course of this voltage corresponds to any measure signal that was selected and parameterized at the module or in the calibration software.

Features

No. of output channels	1 (ES630.1 and ES635.1)
	2 (ES631.1 and ES636.1)
Output impedance	0 Ohm virtual
Ground potential	Galvanically isolated from the power supply and the sensor measurement channel(s)
Overvoltage protection	±28 V (analog output to external overvoltage)
D/A converter	16-bit D/A converter
Diagnostics	Detection of short and overload

Characteristics

Output voltage	0 V to 10 V
Output current	-10 mA to 10 mA
Accuracy of analog output voltage (measured at high impedance input)	max. +/-(1 mV + V_{out} * 0.1%)
Voltage drift over -40 °C to +70 °C (refering to RT)	max. +/-(25 µV + V_{out} * 0.0025%)/K

Measurement Ranges

The measurement ranges on the module (display) and at the analog output "VOUT" are identically.

Scaling the Measurement Value

At the analog output the dependencies from output voltage described in chapter 14.2 on page 177 are valid.

10.10.9 EXTEN - External Signal

The state of the sensor heater control can be controlled with the EXTEN signal if the signal was selected in the calibration software and if the ES63x module is off or on standby.

The control possibilities of the states of the sensor heater control is shown in section 4.4.2 on page 39 dargestellt.

Symbol	Parameter	Min	Max	Unit
V_{ON_th}	Threshold value EXTEN - On	-	9	V
V_{OFF_th}	Threshold value EXTEN - Off	6	-	V

10.10.10 Sensor Port

Channels	1, galvanically isolated from the power supply (ES630.1 and ES635.1)
	2, galvanically isolated from the power supply (ES631.1 and ES636.1)
Power supply	9 V to 28 V
Power consumption (standby, sensor in still air, room temperature)	Typ. 9 W
Power consumption (standby, sensor in still air, room temperature)	Typ. 9 W (per measurement channel)
Overvoltage protection	28 V
Supported sensor types	Robert Bosch LSU 4.2, LSU 4.9, LSU 5.1, LSU 5.2, LSU ADV-G
	NTK ZFAS-U2, ZFAS-U3
Sensor detection	Automatic detection via the sensor cable
Sensor connector	On cable CBAL410 / CBAL4105: RB130fl, Code 1
	On cable CBAL451 / CBAL4515 and CBAL452 / CBAL4525: RB150, Code 1
	On cable CBAL463 / CBAL4635: Trapezoid plug, Code A7
	On cable CBAL468 / CBAL4685: RB150, Code 2
	On cable CBAL472 / CBAL4725: RB150, Code 1 NTK

NOTE

NTK ZFAS-U2 lambda oxygen sensors are not provided by ETAS.

10.10.11 Pressure Sensor Port "EPS"

Feature

Pressure sensor supply voltage	12 V
Pressure sensor output current	max. 30 mA
A/D converter	12 Bit A/D converter, 1.6 mbar resolution

10.10.12 Pressure Sensor PS63

Characteristics

Parameter	Min	Max	Unit
Pressure range	0	75	psi
	0	5.17	bar
Proof pressure	-	15.5	bar
Burst pressure	-	51.7	bar
Operating temperature range	-40	105	°C
	-40	221	°F

Mechanical Data

Length of the harness	1 m
Thread	1/4-18 NPT
Wrench size	22 mm

Test Setup: Suggestion for Components

Female Connector

Manufacturer	Swagelok Company
Ordering name	SS-8MO-7-4
Description	SS Swagelok Tube Fitting, Female Connector, 8 mm Tube OD x 1/4 in. Female NPT

Tubing Insert

Manufacturer	Swagelok Company
Ordering name	SS-8M5-6M
Description	Stainless Steel Tubing Insert, 8 mm OD x 6 mm ID

NOTE

ETAS does not supply the components for thermal isolation of the pressure sensor.

10.11 Pin Assignment

> **NOTE**
>
> All connectors are shown with a view of the front of the ES63x module. All shields are at case potential.

10.11.1 “IN” Connector

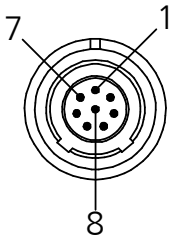


Fig. 10-2 „IN“ Connecor

Pin	Signal	Meaning
1	UBatt	Operating voltage
2	Ground	Ground
3	RX-	Received data, minus
4	TX-	Send data, minus
5	RX+	Received data, plus
6	Ground	Ground
7	UBatt	Operating voltage
8	TX+	Send data, plus

10.11.2 “OUT” Connector

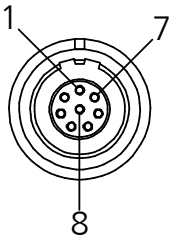


Fig. 10-3 „OUT“ Connector

Pin	Signal	Meaning
1	UBatt	Operating voltage
2	UBatt	Operating voltage
3	Ground	Ground
4	RX+	Received data, plus
5	TX-	Send data, minus
6	RX-	Received data, minus
7	Ground	Ground
8	TX+	Send data, plus

10.11.3 “Sensor” Connector

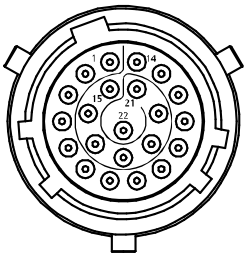


Fig. 10-4 „Sensor“ Connector

Pin	Signal	Meaning
1	U_{Batt+}	Supply voltage (plus)
2	U_{Batt+}	Supply voltage (plus)
3	U_{Heat+}	Sensor heating (plus)
4	U_{Heat+}	Sensor heating (plus)
5	U_{Heat-}	Sensor heating (minus)
6	U_{Heat-}	Sensor heating (minus)
7	U_{Batt-}	Supply voltage (ground)
8	U_{Batt-}	Supply voltage (ground)
9	Analog-	Analog output (ground)
10	RE+	Nernst voltage
11	IP	Pump current
12	RT	Trim resistance
13	IPN	Virtual ground
14	H_EXTEN	Enable sensor heating
15	U_{Batt+}	Supply voltage (plus)
16	U_{Heat+}	Sensor heating (plus)
17	U_{Heat-}	Sensor heating (minus)
18	U_{Batt-}	Supply voltage (ground)
19	Analog+	Analog output (plus)
20	TEDS-	TEDS-
21	TEDS+	TEDS+
22	n.b.	Not assigned

NOTE

Analog ground (Analog -) and supply voltage ground (U_{Batt-}) are galvanically separated from one another.s

10.11.4 „Analog“ Connector

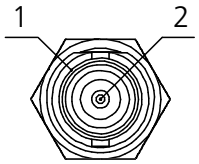


Fig. 10-5 „Analog“ Connector

Pin	Signal	Meaning
1 (outside)	Ground	Analog output (ground)
2 (inside)	Analog+	Analog output (plus)

10.11.5 „EPS“ Connector (ES635.1 and ES636.1)

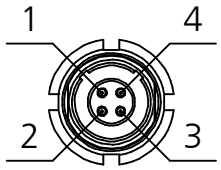


Fig. 10-6 „EPS“ Connector

Pin	Signal	Meaning
1	Signal +	Pressure sensor signal
2	VCC	Pressure sensor supply voltage
3	GND	Ground
4	GND	Ground

10.11.6 „SERVICE“ Connector

At the “SERVICE” port, the ES63x module can be connected to an SMB bus using an adapter and integrated in test setups like the Lambda Meter LA4.

11 Cables and Accessories

This chapter contains information on the following topics:

The “Cables and Accessories” chapter contains an overview of the available cables and accessories.

NOTE

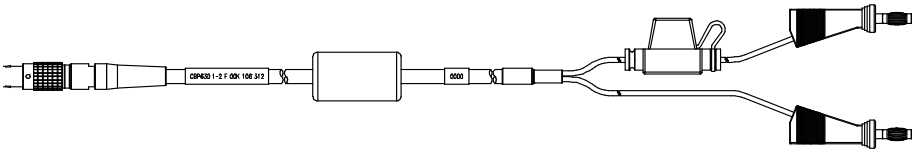
Only use ETAS cables at the interfaces of the module. Adhere to the maximum cable lengths!

11.1 Power Supply Cable

DANGER

Dangerous electrical voltage!
Connect the power cable only with a suitable vehicle battery or with a suitable lab power supply! The connection to power outlets is not allowed!
To prevent an inadvertent insertion in power outlets, ETAS recommends to equip the power cables with safety banana plugs CBP6305 in areas with power outlets.

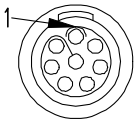
11.1.1 Cable CBP630



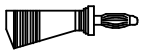
Side A Side B

Fig. 11-1 CBP630-2 Cable

Side A



Side B



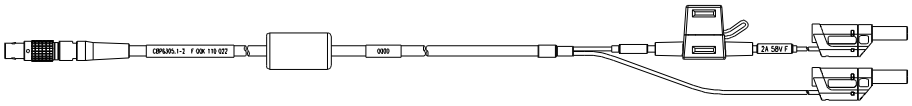
Pin	Signal	Plug	Signal
1, 7	UBATT	Red	UBATT
2, 6	Ground	Black	Ground
3, 4, 5, 6	n. c.		

The CBP630-2 C cable is used to power the ES63x module in standalone mode.

The cable is in harness „UBATT“ equipped with a fuse (7,5 A, type 997 07.5).

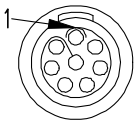
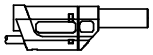
Product	Length	Order Number
CBP630-2	2 m	F 00K 106 312

11.1.2 Cable CBP6305



Side A Side B

Fig. 11-2 CBP6305-2 Cable

Side A		Side B	
			
Pin	**Signal**	**Plug**	**Signal**
1, 7	UBATT	Red	UBATT
2, 6	Ground	Black	Ground
3, 4, 5, 6	n. c.		

The CBP6305-2 C cable is used to power the ES63x module in standalone mode.

The cable is in harness „UBATT“ equipped with a fuse (7,5 A, type 997 07.5).

Product	Length	Order Number
CBP6305-2	2 m	F 00K 110 022

11.2 Combined Ethernet and Power Supply Cable

This chapter contains information on the following cables:

11.2.1 Overview

DANGER

Dangerous electrical voltage!
Connect the power cable only with a suitable vehicle battery or with a suitable lab power supply! The connection to power outlets is not allowed!
To prevent an inadvertent insertion in power outlets, ETAS recommends to equip the combined ethernet and power supply cables with safety banana plugs in areas with power outlets.

You can use combined ethernet and power supply cables with standard banana plugs or with safety banana plugs:

Cables with standard banana plugs	Cables with safety banana plugs
CBEP410.1	CBEP4105.1
CBEP415.1	CBEP4155.1
CBEP420.1	CBEP4205.1
CBEP425.1	CBEP4255.1
CBEP430.1	CBEP4305.1

11.2.2 CBEP410.1 Cable

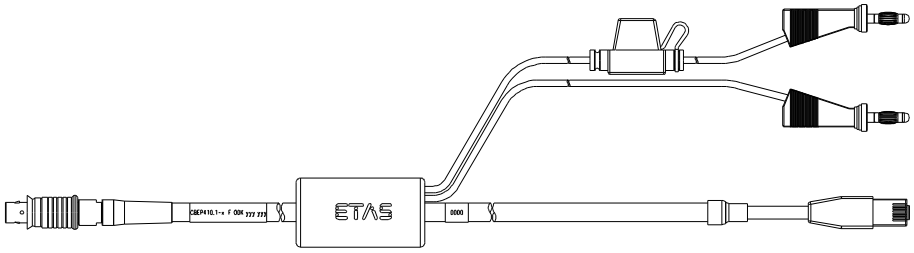


Fig. 11-3 CBEP410.1 Cable

Connection of an ES4xx/ES63x/ES93x module to PC and power supply (stand-alone operation). Supply battery in the vicinity of the module.

Not compatible with ES610, ES611, ES620 and ES650. For connecting this modules use CBEP120 cable.

Cable includes reverse-polarity, load-dump protection and replaceable standard fuse (MINI flat automotive fuse, quick-response, 3 A, 58 V).

Robust, waterproof and dust-proof (IP67).

Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBEP410.1-3	3 m	F 00K 104 927

11.2.3 CBEP4105.1 Cable

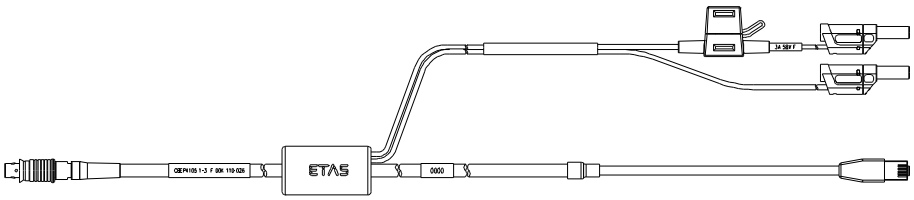


Fig. 11-4 CBEP4105.1 Cable

Connection of an ES4xx/ES63x/ES93x module to PC and power supply (stand-alone operation). Supply battery in the vicinity of the module.

Not compatible with ES610, ES611, ES620 and ES650. For connecting this modules use CBEP120 cable.

Cable includes reverse-polarity, load-dump protection and replaceable standard fuse (MINI flat automotive fuse, quick-response, 3 A, 58 V).

Robust, waterproof and dust-proof (IP67).

Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBEP4105.1-3	3 m	F 00K 110 026

11.2.4 CBEP415.1 Cable

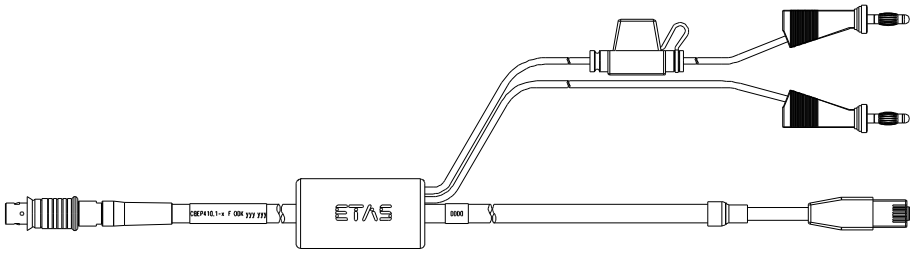


Fig. 11-5 CBEP415.1 Cable

Connection of an ES4xx/ES63x/ES93x module to PC and power supply (stand-alone operation). Supply battery at the other end (i.e. in the trunk).

Not compatible with ES610, ES611, ES620 and ES650. For connecting this modules use CBEP120 cable.

Cable includes reverse-polarity, load-dump protection and replaceable standard fuse (MINI flat automotive fuse, quick-response, 3 A, 58 V).

Robust, waterproof and dust-proof (IP67).

Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBEP415.1-5	5 m	F 00K 105 680

11.2.5 CBEP4155.1 Cable

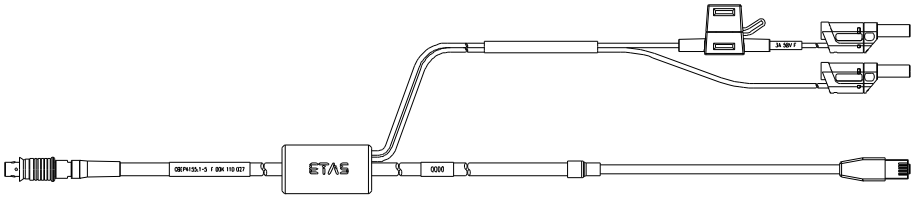


Fig. 11-6 CBEP4155.1 Cable

Connection of an ES4xx/ES63x/ES93x module to PC and power supply (stand-alone operation). Supply battery at the other end (i.e. in the trunk).

Not compatible with ES610, ES611, ES620 and ES650. For connecting this modules use CBEP120 cable.

Cable includes reverse-polarity, load-dump protection and replaceable standard fuse (MINI flat automotive fuse, quick-response, 3 A, 58 V).

Robust, waterproof and dust-proof (IP67).

Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBEP4155.1-5	5 m	F 00K 110 027

11.2.6 CBEP420.1 Cable

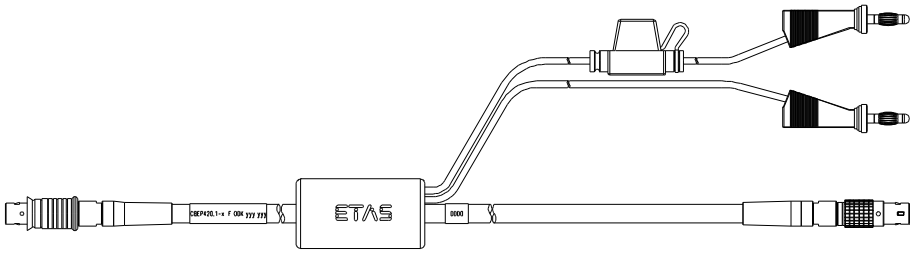


Fig. 11-7 CBEP420.1 Cable

Ethernet and voltage supply connection of an ES4xx/ES63x/ES93x measurement module with an ES600 network module or ES592/ES593-D/ES595 interface module (if the current consumption of the connected ES4xx/ES63x chain exceeds 2.5 A), an ES1135 simulation/system controller card or an ES720 Drive Recorder.

Not compatible with ES610, ES611, ES620 and ES650. For connecting this modules use CBEP120 cable.

Cable includes reverse-polarity, load-dump protection and replaceable standard fuse (MINI flat automotive fuse, quick-response, 3 A, 58 V).

Robust, waterproof and dust-proof (IP67).

Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBEP420.1-3	3 m	F 00K 105 292

11.2.7 CBEP4205.1 Cable

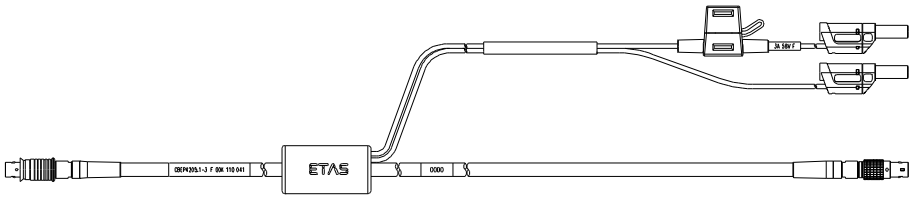


Fig. 11-8 CBEP4205.1 Cable

Ethernet and voltage supply connection of an ES4xx/ES63x/ES93x measurement module with an ES600 network module or ES592/ES593-D/ES595 interface module (if the current consumption of the connected ES4xx/ES63x chain exceeds 2.5 A), an ES1135 simulation/system controller card or an ES720 Drive Recorder.

Not compatible with ES610, ES611, ES620 and ES650. For connecting this modules use CBEP120 cable.

Cable includes reverse-polarity, load-dump protection and replaceable standard fuse (MINI flat automotive fuse, quick-response, 3 A, 58 V).

Robust, waterproof and dust-proof (IP67).

Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBEP4205.1-3	3 m	F 00K 110 041

11.2.8 CBEP425.1 Cable

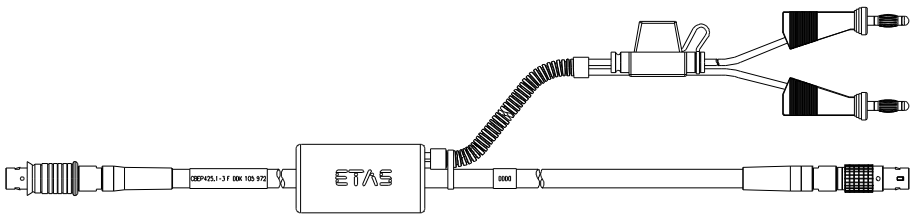


Fig. 11-9 CBEP425.1 Cable

Ethernet and voltage supply connection of an ES4xx/ES63x/ES93x measurement module with an ES600 network module or ES592/ES593-D/ES595 interface module (if the current consumption of the connected ES4xx/ES63x/ES93x chain exceeds 2.5 A), an ES1135 simulation/system controller card or an ES720 Drive Recorder.

Cable includes reverse-polarity, load-dump protection and replaceable standard fuse (MINI flat automotive fuse, quick-response, 3 A, 58 V).

Robust, waterproof and dust-proof (IP67).

Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBEP425.1-3	3 m	F 00K 105 972

11.2.9 CBEP4255.1 Cable

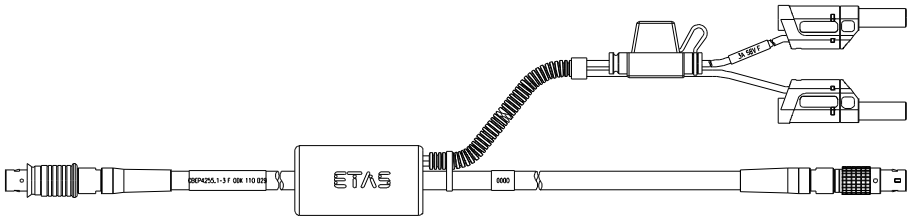


Fig. 11-10 CBEP4255.1 Cable

Ethernet and voltage supply connection of an ES4xx/ES63x/ES93x measurement module with an ES600 network module or ES592/ES593-D/ES595 interface module (if the current consumption of the connected ES4xx/ES63x/ES93x chain exceeds 2.5 A), an ES1135 simulation/system controller card or an ES720 Drive Recorder.

Cable includes reverse-polarity, load-dump protection and replaceable standard fuse (MINI flat automotive fuse, quick-response, 3 A, 58 V).

Robust, waterproof and dust-proof (IP67).

Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBEP4255.1-3	3 m	F 00K 110 029

11.2.10 CBEP430.1 Cable

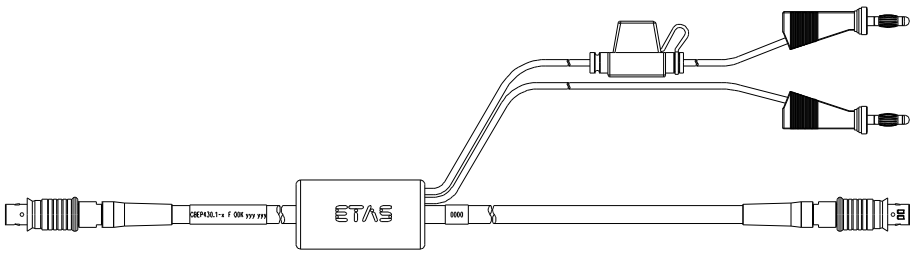


Fig. 11-11 CBEP430.1 Cable

To chain ES4xx/ES63x/ES93x modules and connect an ES4xx/ES63x/ES93x chain to an ES910.3 Rapid Prototyping module. Additional connection to the power supply to compensate for voltage losses in long chains.

Not compatible with ES59x, ES6xx, ES11xx. For connecting this modules use CBE130 or CBE140 cable.

Cable includes reverse-polarity, load-dump protection and replaceable standard fuse (MINI flat automotive fuse, quick-response, 3 A, 58 V).

Robust, waterproof and dust-proof (IP67).

Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBEP430.1-0m5	0.5 m	F 00K 104 928

11.2.11 CBEP4305.1 Cable

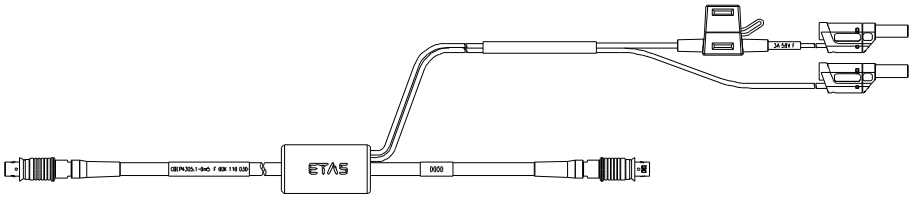


Fig. 11-12 CBEP4305.1 Cable

To chain ES4xx/ES63x/ES93x modules and connect an ES4xx/ES63x/ES93x chain to an ES910.3 Rapid Prototyping module. Additional connection to the power supply to compensate for voltage losses in long chains.

Not compatible with ES59x, ES6xx, ES11xx. For connecting this modules use CBE130 or CBE140 cable.

Cable includes reverse-polarity, load-dump protection and replaceable standard fuse (MINI flat automotive fuse, quick-response, 3 A, 58 V).

Robust, waterproof and dust-proof (IP67).

Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBEP4305.1-0m5	0.5 m	F 00K 110 030

11.3 Ethernet Cable

This chapter contains information on the following cables:

11.3.1 CBE400.2 Cable

Fig. 11-13 CBE400.2 Cable

Ethernet and voltage supply connection of an ES4xx/ES63x/ES93x measuring module at an ES600 network module or at an ES592/ES593-D/ES595 interface module.

Cable includes reverse-polarity, load-dump protection and replaceable standard fuse (MINI flat automotive fuse, quick-response, 3 A, 58 V).

Robust, waterproof and dust-proof (IP67).

Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBE400.2-3	3 m	F 00K 104 920

11.3.2 CBE401.1 Cable

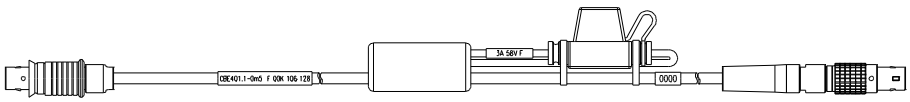


Fig. 11-14 CBE401.1 Cable

Highly flexible Ethernet and voltage supply connection of an ES4xx/ES63x/ES93x measuring module at an ES600 network module or at an ES592/ES593-D/ES595 interface module.

Cable includes reverse-polarity, load-dump protection and replaceable standard fuse (MINI flat automotive fuse, quick-response, 3 A, 58 V).

Robust, waterproof and dust-proof (IP67).

Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBE401.1-0m5	0.5 m	F 00K 106 128

11.3.3 CBE430.1 Cable

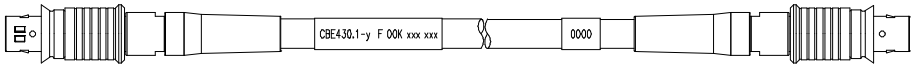


Fig. 11-15 CBE430.1 Cable

Cable for chaining ES4xx/ES63x/ES93x modules. Not compatible with ES59x, ES6xx, ES11xx. For connecting this modules use CBE130 or CBE140 cable.

Robust, waterproof and dust-proof (IP67).

Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBE430.1-0m45	0.45 m	F 00K 104 923

11.3.4 CBE431.1 Cable

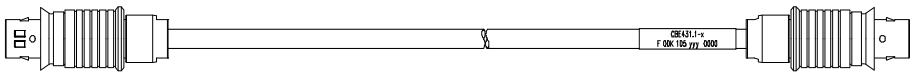


Fig. 11-16 CBE431.1 Cable

Highly flexible cable for chaining successive ES4xx/ES63x/ES93x modules.

Not compatible with ES59x, ES6xx, ES11xx. For connecting this modules use CBE130 or CBE140 cable.

Robust, waterproof and dust-proof (IP67).

Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBE431.1-0m14	0.14 m	F 00K 105 676
CBE431.1-0m30	0.30 m	F 00K 105 685

11.3.5 CBEX400.1 Cable

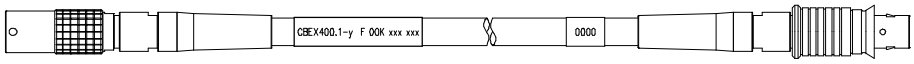


Fig. 11-17 CBEX400.1 Cable

Ethernet extension cable to increase the length of ES4xx/ES63x/ES93x Ethernet cables. Can also be used to connect ES4xx via PC, ES600 or ES1135 alternatively while keeping cable installation through bulkhead.

Robust, waterproof and dust-proof (IP67).

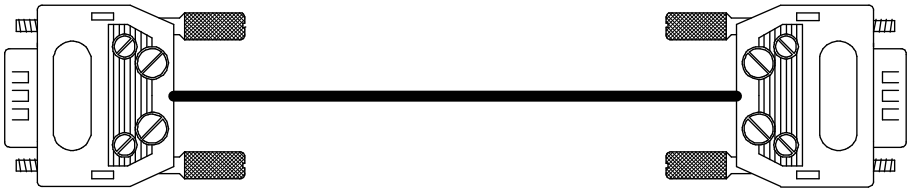
Temperature rated for: -40 °C to +125 °C/ -40 °F to +257 °F

Product	Length	Order number
CBEX400.1-3	3 m	F 00K 105 294

11.4 SMB Cable

This chapter contains information on the following cables:

11.4.1 K38 Cable

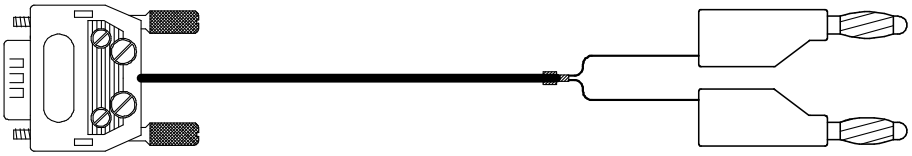


Side A Side B

Fig. 11-18 K38 Cable

Product	Length	Order Number
K38	2 m	Y 261 A24 342

11.4.2 K39 Cable



Side A Side B

Fig. 11-19 K39 Cable

Product	Length	Order Number
K39	2 m	Y 261 A24 343

11.4.3 K40 Cable

Side A Side B

Fig. 11-20 K40 Cable

Product	Length	Order Number
K40	0,3 m	Y 261 A24 344

11.4.4 CBAS100 Cable

Fig. 11-21 CBAS100 Cable

Product	Length	Order Number
CBAS100-0m3	0,3 m	F 00K 106 313

11.5 Sensor Cables

This chapter contains information on the following topics:

11.5.1 Lambda Sensors and associated Cables

DANGER

Dangerous electrical voltage!
Connect the power cable only with a suitable vehicle battery or with a suitable lab power supply! The connection to power outlets is not allowed!
To prevent an inadvertent insertion in power outlets, ETAS recommends to equip the sensor cables with safety banana plugs in areas with power outlets.

To connect the lambda sensors to the module you can use sensor cables with standard banana plugs or with safety banana plugs:

Sensor cables with standard banana plugs

Cable	Lambda Sensor						
	LSU 4.2	LSU 4.9	LSU 5.1	LSU 5.2	LSU ADV	ZFAS-U2	ZFAS-U3
CBAL410.1	X	-	-		-	-	-
CBAL451.1	-	X	-		-	-	-
CBAL452.1	-	X	-		-	-	-
CBAL463.1	-	-	X	-	X	-	-
CBAL468.1	-	-	-	X	-	-	-
CBAL472.1	-	-	-		-	X	X

Sensor cables with safety banana plugs

Cable	Lambda Sensor						
	LSU 4.2	LSU 4.9	LSU 5.1	LSU 5.2	LSU ADV	ZFAS-U2	ZFAS-U3
CBAL4105.1	X	-	-		-	-	-
CBAL4515.1	-	X	-		-	-	-
CBAL4525.1	-	X	-		-	-	-
CBAL4635.1	-	-	X	-	X	-	-
CBAL4685.1	-	-	-	X	-	-	-
CBAL4725.1	-	-	-		-	X	X

11.5.2 CBAL410.1 Cable

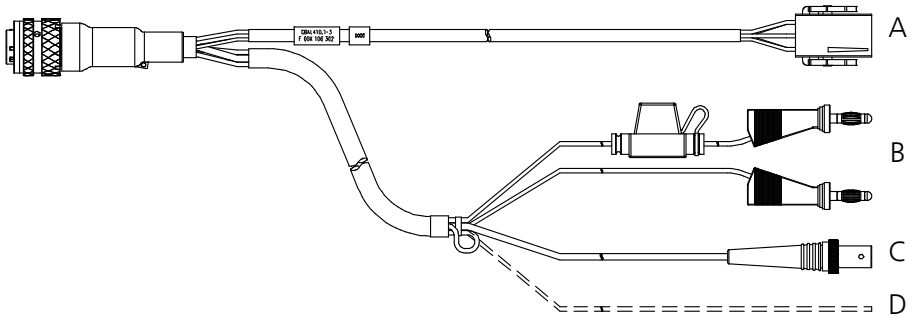


Fig. 11-22 CBAL410.1 Cable

Usage

Cable for Bosch Lambda Sensors LSU4.2 and LSU4.7 (Code 1)

Cable Plugs

Plug Fig. 11-22	Comment
A	RB130fl plug (Code 1) for the lambda sensor
B	MC lamella connector for the external supply of the sensor heating (with inverse-polarity protection, overvoltage protection and current limitation)
	Red connector = plus, black connector = minus
C	BNC socket for analog output signals
D	Input for powering on the heating for the sensor heating when the module is on “Standby” Sensor heating on: +9 V to +28 V
	On delivery, the end of the cable is fixed as a loop in the shrinkage tube of the sensor cable. This must be pulled out to use the cable.

RB130fl Plug (Connector A in Fig. 11-22)

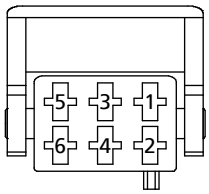


Fig. 11-23 RB130fl Sensor Plug (Code 1)

Pin	Signal	Meaning
1	RE+	Nernst voltage
2	RT	Trim resistance
3	H+	Heater U_{Batt}
4	H-	Heater minus
5	IPN	Virtual ground
6	IP	Pump current

BNC Socket (Connector C in Fig. 11-22)

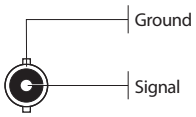


Fig. 11-24 BNC Socket for Analog Output Signals

Detecting the Lambda Sensor

NOTE

The TEDS to detect the lambda sensor is located in the sensor cable.

Fuse

Cable includes replaceable standard fuse (MINI flat automotive fuse, quick-response, 5 A, 58 V).

Ordering Information

Product	Length	Order Number
CBAL410.1-3	3 m	F 00K 106 302

11.5.3 CBAL4105.1 Cable

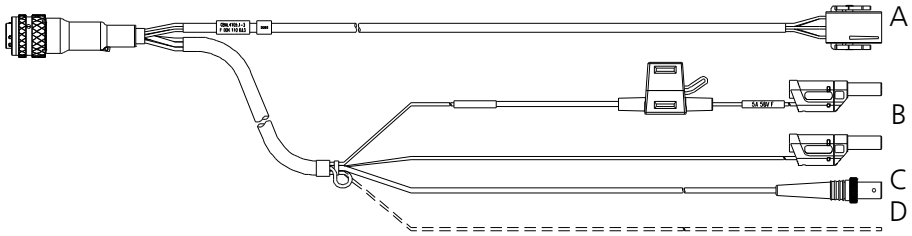


Fig. 11-25 CBAL4105.1 Cable

Usage

Cable for Bosch Lambda Sensors LSU4.2 and LSU4.7 (Code 1)

Cable Plugs

Plug Fig. 11-22	Comment
A	RB130fl plug (Code 1) for the lambda sensor
B	MC lamella connector for the external supply of the sensor heating (with inverse-polarity protection, overvoltage protection and current limitation)
	Red connector = plus, black connector = minus
C	BNC socket for analog output signals
D	Input for powering on the heating for the sensor heating when the module is on “Standby” Sensor heating on: +9 V to +28 V
	On delivery, the end of the cable is fixed as a loop in the shrinkage tube of the sensor cable. This must be pulled out to use the cable.

RB130fl Plug (Connector A in Fig. 11-22)

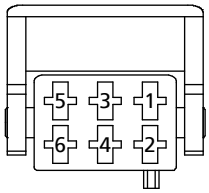


Fig. 11-26 RB130fl Sensor Plug (Code 1)

Pin	Signal	Meaning
1	RE+	Nernst voltage
2	RT	Trim resistance
3	H+	Heater U_{Batt}
4	H-	Heater minus
5	IPN	Virtual ground
6	IP	Pump current

BNC Socket (Connector C in Fig. 11-22)

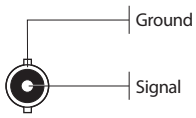


Fig. 11-27 BNC Socket for Analog Output Signals

Detecting the Lambda Sensor

NOTE

The TEDS to detect the lambda sensor is located in the sensor cable.

Fuse

Cable includes replaceable standard fuse (MINI flat automotive fuse, quick-response, 5 A, 58 V).

Ordering Information

Product	Length	Order Number
CBAL4105.1-3	3 m	F 00K 110 033

11.5.4 CBAL451.1 Cable

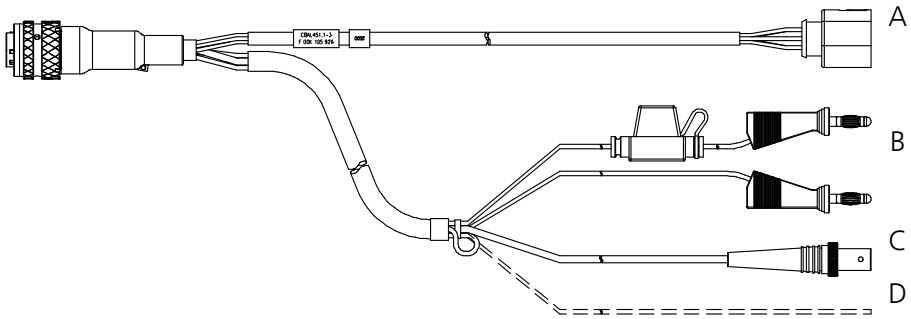


Fig. 11-28 CBAL451.1 Cable

Usage

Cable for Bosch Lambda Sensor LSU4.9 (Code 1)

Cable Plugs

Plug Fig. 11-28	Comment
A	RB150 plug (Code 1) for the lambda sensor
B	MC lamella connector for the external supply of the sensor heating (with inverse-polarity protection, overvoltage protection and current limitation)
	Red connector = plus, black connector = minus
C	BNC socket for analog output signals
D	Input for powering on the heating for the sensor heating when the module is on “Standby” Sensor heating on: +9 V to +28 V
	On delivery, the end of the cable is fixed as a loop in the shrinkage tube of the sensor cable. This must be pulled out to use the cable.

RB150 Plug (Connector A in Fig. 11-28)

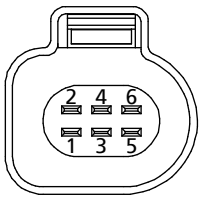


Fig. 11-29 RB150 Sensor Plug (Code 1)

Pin	Signal	Meaning
1	IP	Pump current
2	IPN	Virtual ground
3	H-	Heater minus
4	H+	Heater U_{Batt}
5	RT	Trim resistance
6	RE+	Nernst voltage

BNC Socket (Connector C in Fig. 11-28)

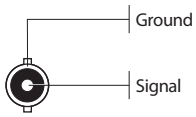


Fig. 11-30 BNC Socket for Analog Output Signals

Detecting the Lambda Sensor

NOTE

The TEDS to detect the lambda sensor is located in the sensor cable.

Fuse

Cable includes replaceable standard fuse (MINI flat automotive fuse, quick-response, 5 A, 58 V).

Ordering Information

Product	Length	Order Number
CBAL451.1-3	3 m	F 00K 105 926

11.5.5 CBAL4515.1 Cable

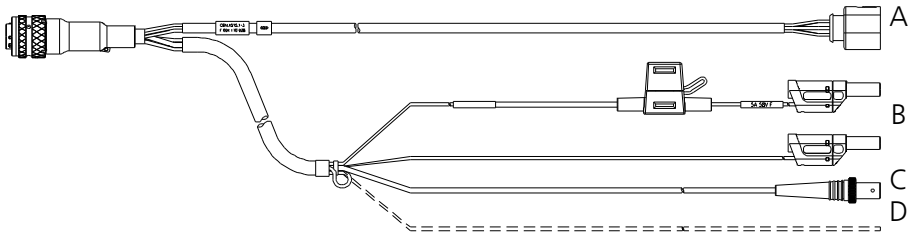


Fig. 11-31 CBAL4515.1 Cable

Usage

Cable for Bosch Lambda Sensor LSU4.9 (Code 1)

Cable Plugs

Plug Fig. 11-28	Comment
A	RB150 plug (Code 1) for the lambda sensor
B	MC lamella connector for the external supply of the sensor heating (with inverse-polarity protection, overvoltage protection and current limitation)
	Red connector = plus, black connector = minus
C	BNC socket for analog output signals
D	Input for powering on the heating for the sensor heating when the module is on “Standby” Sensor heating on: +9 V to +28 V
	On delivery, the end of the cable is fixed as a loop in the shrinkage tube of the sensor cable. This must be pulled out to use the cable.

RB150 Plug (Connector A in Fig. 11-28)

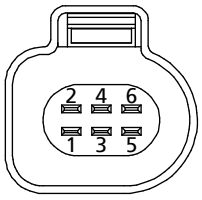


Fig. 11-32 RB150 Sensor Plug (Code 1)

Pin	Signal	Meaning
1	IP	Pump current
2	IPN	Virtual ground
3	H-	Heater minus
4	H+	Heater U_{Batt}
5	RT	Trim resistance
6	RE+	Nernst voltage

BNC Socket (Connector C in Fig. 11-28)

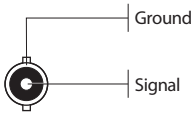


Fig. 11-33 BNC Socket for Analog Output Signals

Detecting the Lambda Sensor

NOTE

The TEDS to detect the lambda sensor is located in the sensor cable.

Fuse

Cable includes replaceable standard fuse (MINI flat automotive fuse, quick-response, 5 A, 58 V).

Ordering Information

Product	Length	Order Number
CBAL4515.1-3	3 m	F 00K 110 038

11.5.6 CBAL452.1 Cable

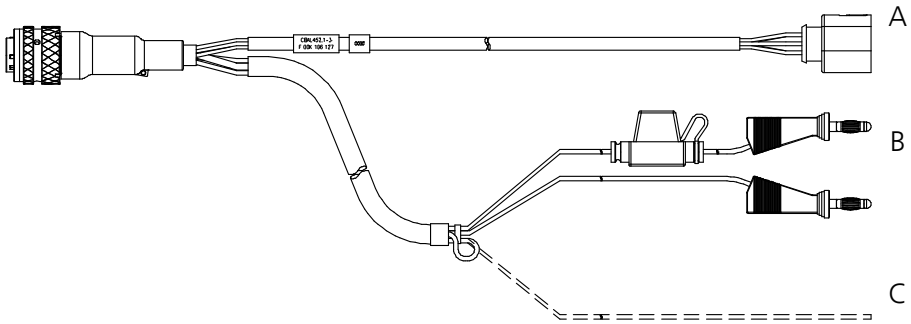


Fig. 11-34 CBAL452.1 Cable

Usage

Cable for Bosch Lambda Sensor LSU4.9 (Code 1)

Cable Plugs

Plug Fig. 11-34	Comment
A	RB150 plug (Code 1) for the lambda sensor
B	MC lamella connector for the external supply of the sensor heating (with inverse-polarity protection, overvoltage protection and current limitation)
	Red connector = plus, black connector = minus
C	Input for powering on the heating for the sensor heating when the module is on “Standby” Sensor heating on: +9 V to +28 V
	On delivery, the end of the cable is fixed as a loop in the shrinkage tube of the sensor cable. This must be pulled out to use the cable.

RB150 Plug (Connector A in Fig. 11-34)

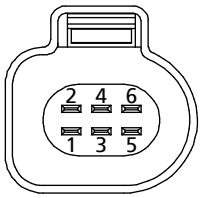


Fig. 11-35 RB150 Sensor Plug (Code 1)

Pin	Signal	Meaning
1	IP	Pump current
2	IPN	Virtual ground
3	H-	Heater minus
4	H+	Heater U_{Batt}
5	RT	Trim resistance
6	RE+	Nernst voltage

Detecting the Lambda Sensor

NOTE

The TEDS to detect the lambda sensor is located in the sensor cable.

Fuse

Cable includes replaceable standard fuse (MINI flat automotive fuse, quick-response, 5 A, 58 V).

Ordering Information

Product	Length	Order Number
CBAL452.1-3	3 m	F 00K 106 127

11.5.7 CBAL4525.1 Cable

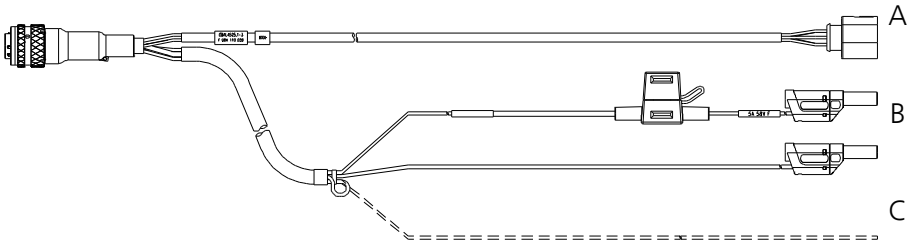


Fig. 11-36 CBAL4525.1 Cable

Usage

Cable for Bosch Lambda Sensor LSU4.9 (Code 1)

Cable Plugs

Plug Fig. 11-34	Comment
A	RB150 plug (Code 1) for the lambda sensor
B	MC lamella connector for the external supply of the sensor heating (with inverse-polarity protection, overvoltage protection and current limitation)
	Red connector = plus, black connector = minus
C	Input for powering on the heating for the sensor heating when the module is on “Standby” Sensor heating on: +9 V to +28 V
	On delivery, the end of the cable is fixed as a loop in the shrinkage tube of the sensor cable. This must be pulled out to use the cable.

RB150 Plug (Connector A in Fig. 11-34)

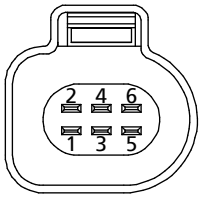


Fig. 11-37 RB150 Sensor Plug (Code 1)

Pin	Signal	Meaning
1	IP	Pump current
2	IPN	Virtual ground
3	H-	Heater minus
4	H+	Heater U_{Batt}
5	RT	Trim resistance
6	RE+	Nernst voltage

Detecting the Lambda Sensor

NOTE

The TEDS to detect the lambda sensor is located in the sensor cable.

Fuse

Cable includes replaceable standard fuse (MINI flat automotive fuse, quick-response, 5 A, 58 V).

Ordering Information

Product	Length	Order Number
CBAL4525.1-3	3 m	F 00K 110 039

11.5.8 CBAL463.1 Cable

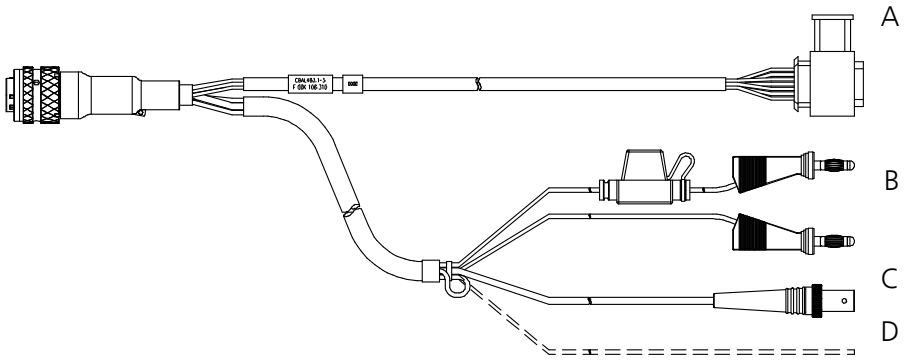


Fig. 11-38 CBAL463.1 Cable

Usage

Cable for Bosch Lambda Sensor LSU 5.1 and LSU ADV-G (Code A7)

Cable Plugs

Plug Fig. 11-38	Comment
A	Trapezoid plug (Code A7) for the lambda sensor
B	MC lamella connector for the external supply of the sensor heating (with inverse-polarity protection, overvoltage protection and current limitation)
	Red connector = plus, black connector = minus
C	BNC socket for analog output signals
D	Input for powering on the heating for the sensor heating when the module is on “Standby” Sensor heating on: +9 V to +28 V
	On delivery, the end of the cable is fixed as a loop in the shrinkage tube of the sensor cable. This must be pulled out to use the cable.

Trapezoid Plug (Connector A in Fig. 11-38)

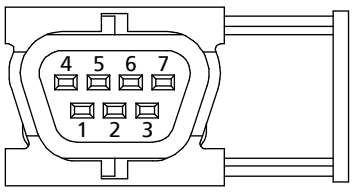


Fig. 11-39 Trapezoid Plug (Code A7)

Pin	Signal	Meaning
1	IP	Pump current
2	IPN	Virtual ground
3	H-	Heater minus
4	H+	Heater U_{Batt}
5	TEDS+	TEDS+
6	RE+	Nernst voltage
7	TEDS-	TEDS-

BNC Socket (Connector C in Fig. 11-38)

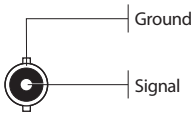


Fig. 11-40 BNC Socket for Analog Output Signals

Detecting the Lambda Sensor

NOTE

The TEDS to detect the lambda sensor is located in the sensor cable.

Fuse

Cable includes replaceable standard fuse (MINI flat automotive fuse, quick-response, 5 A, 58 V).

Ordering Information

Product	Length	Order Number
CBAL463.1-3	3 m	F 00K 106 310

11.5.9 CBAL4635.1 Cable

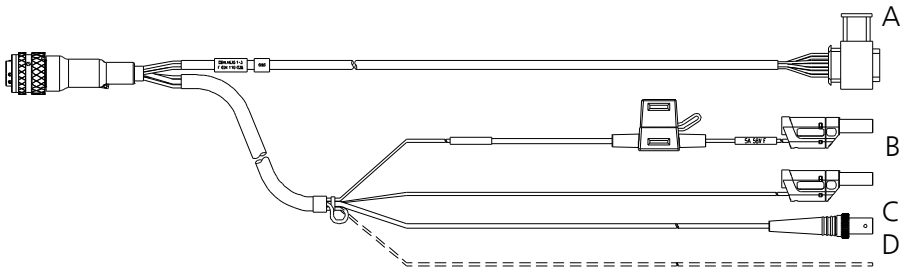


Fig. 11-41 CBAL4635.1 Cable

Usage

Cable for Bosch Lambda Sensor LSU 5.1 and LSU ADV-G (Code A7)

Cable Plugs

Plug Fig. 11-38	Comment
A	Trapezoid plug (Code A7) for the lambda sensor
B	MC lamella connector for the external supply of the sensor heating (with inverse-polarity protection, overvoltage protection and current limitation)
	Red connector = plus, black connector = minus
C	BNC socket for analog output signals
D	Input for powering on the heating for the sensor heating when the module is on “Standby” Sensor heating on: +9 V to +28 V
	On delivery, the end of the cable is fixed as a loop in the shrinkage tube of the sensor cable. This must be pulled out to use the cable.

Trapezoid Plug (Connector A in Fig. 11-38)

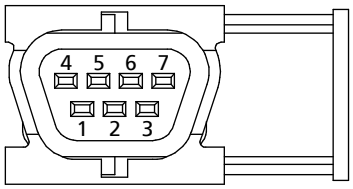


Fig. 11-42 Trapezoid Plug (Code A7)

Pin	Signal	Meaning
1	IP	Pump current
2	IPN	Virtual ground
3	H-	Heater minus
4	H+	Heater U_{Batt}
5	TEDS+	TEDS+
6	RE+	Nernst voltage
7	TEDS-	TEDS-

BNC Socket (Connector C in Fig. 11-38)

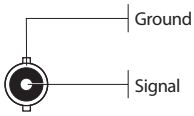


Fig. 11-43 BNC Socket for Analog Output Signals

Detecting the Lambda Sensor

NOTE

The TEDS to detect the lambda sensor is located in the sensor cable.

Fuse

Cable includes replaceable standard fuse (MINI flat automotive fuse, quick-response, 5 A, 58 V).

Ordering Information

Product	Length	Order Number
CBAL4635.1-3	3 m	F 00K 110 035

11.5.10 CBAL468.1 Cable

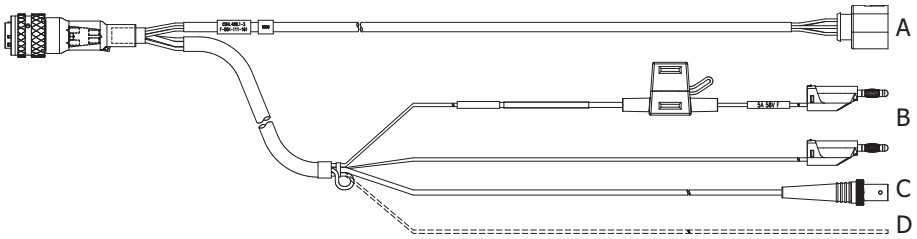


Fig. 11-44 CBAL468.1 Cable

Usage

Cable for Bosch Lamdba Sensor LSU 5.2 (Code 2)

Cable Plugs

Plug in Fig. 11-44	Comment
A	RB150 plug (Code 1) for the lambda sensor
B	Schützinger lamella connector for the external supply of the sensor heating (with inverse-polarity protection, overvoltage protection and current limitation)
	Red connector = plus, black connector = minus
C	BNC socket for analog output signals
	Input for powering on the heating for the sensor heating when the module is on “Standby” Sensor heating on: +9 V to +28 V
D	On delivery, the end of the cable is fixed as a loop in the shrinkage tube of the sensor cable. This must be pulled out to use the cable.
	Red connector = plus, black connector = minus

RB150 Plug (Connector A in Fig. 11-44)

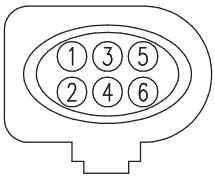


Fig. 11-45 RB150 Sensor Plug (Code 2)

Pin	Signal	Meaning
1	IP	Pump current
2	IPN	Virtual ground
3	H-	Heater minus
4	H+	Heater U_{Batt}
5	Ip_cal	Pump current trimming resistor
6	RE+	Nernst voltage

BNC Socket (Connector C in Fig. 11-44)

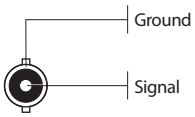


Fig. 11-46 BNC Socket for Analog Output Signals

Detecting the Lambda Sensor

NOTE

The TEDS to detect the lambda sensor is located in the sensor cable.

Fuse

Cable includes replaceable standard fuse (MINI flat automotive fuse, quick-response, 5 A, 58 V).

Ordering Information

Product	Length	Order Number
CBAL468.1-3	3 m	F 00K 111 161

11.5.11 CBAL4685.1 Cable

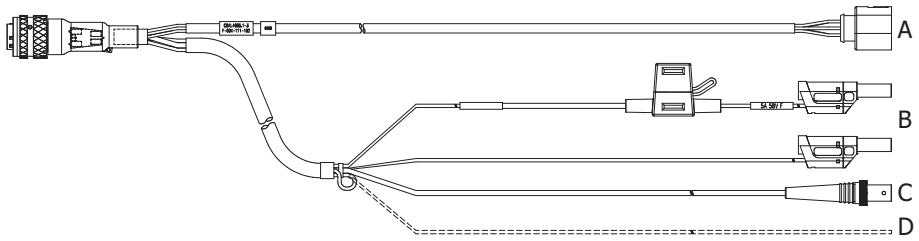


Fig. 11-47 CBAL4685.1 Cable

Usage

Cable for Bosch Lamdba Sensor LSU 5.2 (Code 2)

Cable Plugs

Plug in Fig. 11-47	Comment
A	RB150 plug (Code 1) for the lambda sensor
B	Schützinger lamella connector for the external supply of the sensor heating (with inverse-polarity protection, overvoltage protection and current limitation)
	Red connector = plus, black connector = minus
C	BNC socket for analog output signals
	Input for powering on the heating for the sensor heating when the module is on “Standby” Sensor heating on: +9 V to +28 V
D	On delivery, the end of the cable is fixed as a loop in the shrinkage tube of the sensor cable. This must be pulled out to use the cable.
	Red connector = plus, black connector = minus

RB150 Plug (Connector A in Fig. 11-47)

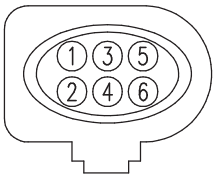


Fig. 11-48 RB150 Sensor Plug (Code 2)

Pin	Signal	Meaning
1	IP	Pump current
2	IPN	Virtual ground
3	H-	Heater minus
4	H+	Heater U_{Batt}
5	Ip_cal	Pump current trimming resistor
6	RE+	Nernst voltage

BNC Socket (Connector C in Fig. 11-47)

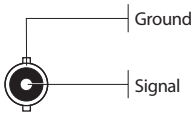


Fig. 11-49 BNC Socket for Analog Output Signals

Detecting the Lambda Sensor

NOTE

The TEDS to detect the lambda sensor is located in the sensor cable.

Fuse

Cable includes replaceable standard fuse (MINI flat automotive fuse, quick-response, 5 A, 58 V).

Ordering Information

Product	Length	Order Number
CBAL4685.1-3	3 m	F 00K 111 162

11.5.12 CBAL472.1 Cable

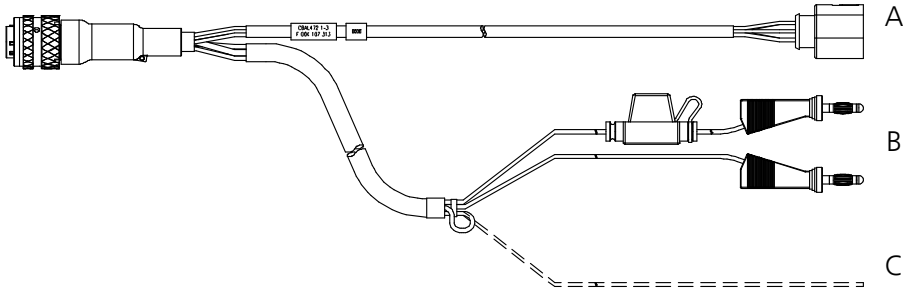


Fig. 11-50 CBAL472.1 Cable

Usage

Cable for NTK Lambda Sensor NTK ZFAS-U2

Cable Plugs

Plug Fig. 11-50	Comment
A	RB150 plug (Code 1 NTK) for the lambda sensor
B	MC lamella connector for the external supply of the sensor heating (with inverse-polarity protection, overvoltage protection and current limitation)
	Red connector = plus, black connector = minus
C	Input for powering on the heating for the sensor heating when the module is on “Standby” Sensor heating on: +9 V to +28 V
	On delivery, the end of the cable is fixed as a loop in the shrinkage tube of the sensor cable. This must be pulled out to use the cable.

RB150 Plug (Connector A in Fig. 11-50)

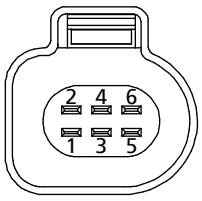


Fig. 11-51 RB150 Sensor Plug (Code 1 NTK)

Pin	Signal	Meaning
1	RT	Trim resistance
2	IP	Pump current
3	H-	Heater minus
4	RE+	Nernst voltage
5	H+	Heater U_{Batt}
6	IPN	Virtual ground

Detecting the Lambda Sensor

NOTE

The TEDS to detect the lambda sensor is located in the sensor cable.

Fuse

Cable includes replaceable standard fuse (MINI flat automotive fuse, quick-response, 5 A, 58 V).

Ordering Information

Product	Length	Order Number
CBAL472.1-3	3 m	F 00K 107 313

11.5.13 CBAL4725.1 Cable

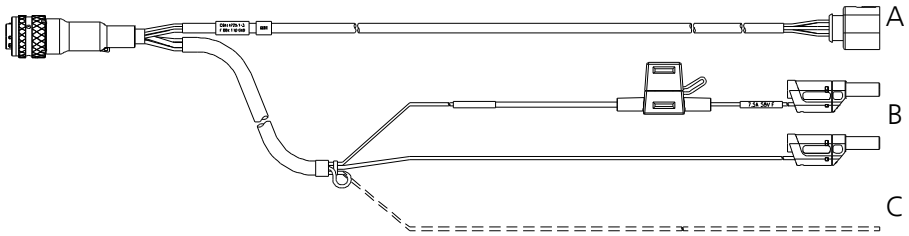


Fig. 11-52 CBAL4725.1 Cable

Usage

Cable for NTK Lambda Sensor NTK ZFAS-U2

Cable Plugs

Plug Fig. 11-50	Comment
A	RB150 plug (Code 1 NTK) for the lambda sensor
B	MC lamella connector for the external supply of the sensor heating (with inverse-polarity protection, overvoltage protection and current limitation)
	Red connector = plus, black connector = minus
C	Input for powering on the heating for the sensor heating when the module is on “Standby” Sensor heating on: +9 V to +28 V
	On delivery, the end of the cable is fixed as a loop in the shrinkage tube of the sensor cable. This must be pulled out to use the cable.

RB150 Plug (Connector A in Fig. 11-50)

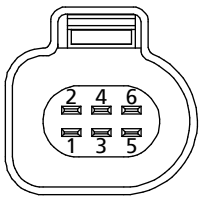


Fig. 11-53 RB150 Sensor Plug (Code 1 NTK)

Pin	Signal	Meaning
1	RT	Trim resistance
2	IP	Pump current
3	H-	Heater minus
4	RE+	Nernst voltage
5	H+	Heater U_{Batt}
6	IPN	Virtual ground

Detecting the Lambda Sensor

NOTE

The TEDS to detect the lambda sensor is located in the sensor cable.

Fuse

Cable includes replaceable standard fuse (MINI flat automotive fuse, quick-response, 5 A, 58 V).

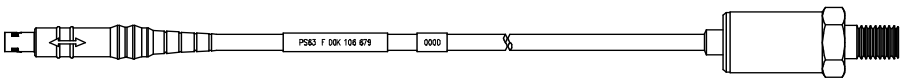
Ordering Information

Product	Length	Order Number
CBAL4525.1-3	3 m	F 00K 110 040

11.6 Pressure Sensor and Accessories

This chapter contains information on the following accessories::

11.6.1 Pressure Sensor



Side A Side B

Fig. 11-54 Pressure Sensor PS63

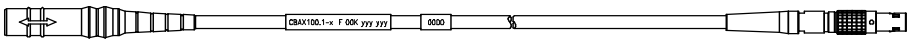
Application

External pressure sensor for ES635.1 and ES636.1.

Ordering Information

Product	Length	Order Number
Pressure Sensor PS63	1 m	F 00K 106 679

11.6.2 CBAX100.1 Cable



Side A Side B

Fig. 11-55 CBAX100.1 Cable

Application

Extension cable for external pressure sensor PS63

Ordering Information

Product	Length	Order Number
CBAX100.1-3	3 m	F 00K 106 680

11.7 Protective Caps

This chapter contains information on the following accessories:

The connections "IN" and "OUT" of the module can be protected with different protective caps according to the operating conditions.

Protective Caps supplied

The "IN" and "OUT" ports of the module are covered with simple dust and transport caps on delivery. These caps are only suitable for the limited temperature range of -40 °C to +70 °C

NOTE

The protective caps supplied are in no way a replacement for or viable alternative to the caps CAP_LEMO_1 and CAP_LEMO_1B_LC.

11.7.1 Cap CAP_LEMO_1B

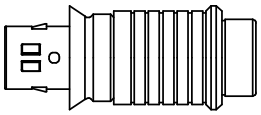


Fig. 11-56 Cap CAP_LEMO_1B

The cap CAP_LEMO_1B protects the connection "IN" or "OUT" against dirt according to IP67.

Product	Order number
CAP_LEMO_1B	F 00K 105 298

11.7.2 Cap CAP_LEMO_1B_LC

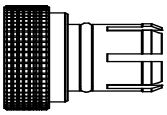


Fig. 11-57 Cap CAP_LEMO_1B_LC

The cap CAP_LEMO_1B_LC protects the connection "IN" or "OUT" in an inexpensive way against dirt.

Product	Order number
CAP_LEMO_1B_LC	F 00K 105 683

11.7.3 Cap CAP_SOURIAU_8STA

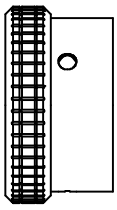


Fig. 11-58 Cap CAP_SOURIAU_8STA

The cap CAP_SOURIAU_8STA protects the "Sensor" port against water and dirt.

Product	Order number
CAP_SOURIAU_8STA	F 00K 105 303

12 Ordering Information

This chapter contains information on the following topics

:

NOTE

Cables are not part of the scope of supplies of the module and must be ordered separately (see chapter 12.3 on page 158).

NOTE

If you require customized cables, please contact your ETAS contact partner or sales.de@etas.com.

12.1 Lambda Module

Order Name	Short Name	Order Number
ES630.1 Lambda Module (1-CH)	ES630.1	F 00K 106 296
Package Contents		
ES630.1 Lambda Module (1-CH), CDROM ES6xx_DRV_SW_CD (driver and tools for ES6xx Daisy Chain Modules Family)		
ES631.1 Lambda Module (2-CH)	ES631.1	F 00K 106 297
Package Contents		
ES631.1 Lambda Module (2-CH), CDROM ES6xx_DRV_SW_CD (driver and tools for ES6xx Daisy Chain Modules Family)		
ES635.1 Lambda Module (1-CH)	ES635.1	F 00K 106 675
Package Contents		
ES635.1 Lambda Module (1-CH), CDROM ES6xx_DRV_SW_CD (driver and tools for ES6xx Daisy Chain Modules Family)		
ES636.1 Lambda Module (2-CH)	ES636.1	F 00K 106 676
Package Contents		
ES636.1 Lambda Module (2-CH), CDROM ES6xx_DRV_SW_CD (driver and tools for ES6xx Daisy Chain Modules Family)		

12.2 Lambda Module Sets

12.2.1 ES630.1 Sets

Set including Lambda Sensor LSU 4.9

Order Name	Short Name	Order Number
ES630.1 Lambda Module (1-CH) including LSU4.9	ES630.1-4.9	F 00K 106 294
Package Contents		
ES630.1 Lambda Module (1-CH), Lambda Sensor LSU 4.9 (SR4, RB150 Code1, 300 Ohm), Lambda Sensor Cable CBAL452.1-3, CDROM ES6xx_DRV_SW_CD (driver and tools for ES6xx Daisy Chain Modules Family)		

Set including Lambda Sensor LSU ADV-G

Order Name	Short Name	Order Number
ES630.1 Lambda Module (1-CH) including LSU ADV-G	ES630.1-ADV-G	F 00K 106 983
Package Contents		
ES630.1 Lambda Module (1-CH), Lambda Sensor LSU ADV-G (Trapezoid plug, Code A7, 300 Ohm), Lambda Sensor Cable CBAL463.1-3, CDROM ES6xx_DRV_SW_CD (driver and tools for ES6xx Daisy Chain Modules Family)		

12.2.2 ES631.1 Sets

Set including Lambda Sensor LSU 4.9

Order Name	Short Name	Order Number
ES631.1 Lambda Module (2-CH) including LSU4.9	ES631.1-4.9	F 00K 106 295
Package Contents		
ES631.1 Lambda Module (2-CH), 2 x Lambda Sensor LSU 4.9 (SR4, RB150 Code1, 300 Ohm), 2 x Lambda Sensor Cable CBAL452.1-3, CDROM ES6xx_DRV_SW_CD (driver and tools for ES6xx Daisy Chain Modules Family)		

Set including Lambda Sensor LSU ADV-G

Order Name	Short Name	Order Number
ES631.1 Lambda Module (2-CH) including LSU ADV-G	ES631.1-ADV-G	F 00K 106 984
Package Contents		
ES631.1 Lambda Module (2-CH), 2 x Lambda Sensor LSU ADV-G (Trapezoid plug, Code A7, 300 Ohm), 2 x Lambda Sensor Cable CBAL463.1-3, CDROM ES6xx_DRV_SW_CD (driver and tools for ES6xx Daisy Chain Modules Family)		

12.2.3 ES635.1 Sets

Set including Lambda Sensor LSU 4.9

Order Name	Short Name	Order Number
ES635.1 Lambda Module (1-CH) including LSU4.9	ES635.1-4.9	F 00K 106 673
Package Contents		
ES635.1 Lambda Module (1-CH), Lambda Sensor LSU 4.9 (SR4, RB150 Code1, 300 Ohm), Lambda Sensor Cable CBAL452.1-3, Pressure Sensor PS63, CDROM ES6xx_DRV_SW_CD (driver and tools for ES6xx Daisy Chain Modules Family)		

Set including Lambda Sensor LSU ADV-G

Order Name	Short Name	Order Number
ES635.1 Lambda Module (1-CH) including LSU ADV-G	ES635.1-ADV-G	F 00K 106 677
Package Contents		
ES635.1 Lambda Module (1-CH), Lambda Sensor LSU ADV-G (Trapezoid plug, Code A7, 300 Ohm), Lambda Sensor Cable CBAL463.1-3, Pressure Sensor PS63, CDROM ES6xx_DRV_SW_CD (driver and tools for ES6xx Daisy Chain Modules Family)		

12.2.4 ES636.1 Sets

Set including Lambda Sensor LSU 4.9

Order Name	Short Name	Order Number
ES636.1 Lambda Module (2-CH) including LSU4.9	ES636.1-4.9	F 00K 106 674
Package Contents		
ES636.1 Lambda Module (2-CH), 2 x Lambda Sensor LSU 4.9 (SR4, RB150 Code1, 300 Ohm), 2 x Lambda Sensor Cable CBAL452.1-3, 2 x Pressure Sensor PS63, CDROM ES6xx_DRV_SW_CD (driver and tools for ES6xx Daisy Chain Modules Family)		

Set including Lambda Sensor LSU ADV-G

Order Name	Short Name	Order Number
ES636.1 Lambda Module (2-CH) including LSU ADV-G	ES636.1-ADV-G	F 00K 106 678
Package Contents		
ES636.1 Lambda Module (2-CH), 2 x Lambda Sensor LSU ADV-G (Trapezoid plug, Code A7, 300 Ohm), 2 x Lambda Sensor Cable CBAL463.1-3, 2 x Pressure Sensor PS63, CDROM ES6xx_DRV_SW_CD (driver and tools for ES6xx Daisy Chain Modules Family)		

12.3 Accessories

12.3.1 Sensor Cables

Order Name	Short Name	Order Number
Lambda Sensor Cable LSU 4.2 and LSU 4.7, Souriau 8ST12-35 - RB130fl - Banana - BNC (22mc-6fc+2mc+2mc), 3 m	CBAL410.1-3	F 00K 106 302
Lambda Sensor Cable LSU 4.2 and LSU 4.7, Souriau 8ST12-35 - RB130fl - Safety Banana - BNC (22mc-6fc+2mc+2mc), 3 m	CBAL4105.1-3	F 00K 110 033
Lambda Sensor Cable LSU 4.9, Souriau 8ST12-35 - RB150 (Code 1) - Banana - BNC (22mc-6fc+2mc+2mc), 3 m	CBAL451.1-3	F 00K 105 926
Lambda Sensor Cable LSU 4.9, Souriau 8ST12-35 - RB150 (Code 1) - Safety Banana - BNC (22mc-6fc+2mc+2mc), 3 m	CBAL4515.1-3	F 00K 110 038
Lambda Sensor Cable LSU 4.9, Souriau 8ST12-35 - RB150 (Code 1) - Banana (22mc-6fc+2mc), 3 m	CBAL452.1-3	F 00K 106 127
Lambda Sensor Cable LSU 4.9, Souriau 8ST12-35 - RB150 (Code 1) - Safety Banana (22mc-6fc+2mc), 3 m	CBAL4525.1-3	F 00K 110 039
Lambda Sensor Cable LSU ADV, Souriau 8ST12-35 - Trapezoid plug - Banana - BNC (22mc-7fc+2mc+2mc), 3 m	CBAL463.1-3	F 00K 106 310
Lambda Sensor Cable LSU ADV, Souriau 8ST12-35 - Trapezoid plug - Safety Banana - BNC (22mc-7fc+2mc+2mc), 3 m	CBAL4635.1-3	F 00K 110 035
Lambda Sensor Cable LSU5.2, Souriau 8ST12-35 - RB150 plug, Code 2 - Banana - BNC (22mc-7fc+2mc+2mc), 3m	CBAL468.1-3	F 00K 111 161
Lambda Sensor Cable LSU5.2, Souriau 8ST12-35 - RB150 plug, Code 2 - Safety Banana - BNC (22mc-7fc+2mc+2mc), 3m	CBAL4685.1-3	F 00K 111 162
Lambda Sensor Cable ZFAS-U2, Souriau 8ST12-35 – RB150 (Code 1) – Banana (22mc-6fc+2mc), 3m	CBAL472.1-3	F 00K 107 313
Lambda Sensor Cable ZFAS-U2, Souriau 8ST12-35 – RB150 (Code 1) – Safety Banana (22mc-6fc+2mc), 3m	CBAL4725.1-3	F 00K 110 040

12.3.2 Pressure Sensor Cable

Order Name	Short Name	Order Number
Extension Cable for Pressure Sensor PS63, 3 m	CBAX100.1-3	F 00K 106 680

12.3.3 Ethernet Cables

Order name	Short name	Order number
Ethernet Chain Connection Cable, Lemo 1B FGF - Lemo 1B FGL (8mc-8fc), 3 m	CBE400.2-3	F 00K 104 920
Ethernet Chain Connection Cable, Highly Flexible, Lemo 1B FGF - Lemo 1B FGL (8mc-8fc), 0.5 m	CBE401.1-0m5	F 00K 106 128
Ethernet Chain Connection Cable, Lemo 1B FGA - Lemo 1B FGL (8mc-8fc), 0m45	CBE430.1-0m45	F 00K 104 923
Ethernet Chain Connection Cable, Highly Flexible, Lemo 1B FGA - Lemo 1B FGL (8mc-8fc, 0m14)	CBE431.1-0m14	F 00K 105 676
Ethernet Chain Connection Cable, Highly Flexible, Lemo 1B FGA - Lemo 1B FGL (8mc-8fc, 0m30)	CBE431.1-0m30	F 00K 105 685
Ethernet Extension Cable, Lemo 1B PHL - Lemo 1B FGL (8mc-8fc), 3 m	CBEX400.1-3	F 00K 105 294

12.3.4 Power Supply Cable

Order Name	Short Name	Order Number
Power Supply Cable, Lemo 1B FGL - Banana (8mc-2mc), 2 m	CBP630-2	F 00K 106 312
Power Supply Cable, Lemo 1B FGL - Safety Banana (8mc-2mc), 2 m	CBP6305-2	F 00K 110 022

12.3.5 Combined Ethernet and Power Supply Cables

Order name	Short name	Order number
Ethernet PC Connection and Power Supply Cable, Lemo 1B FGL - RJ45 - Banana (8fc-8mc-2mc), 3 m	CBEP410.1-3	F 00K 104 927
Ethernet PC Connection and Power Supply Cable, Lemo 1B FGL - RJ45 - Safety Banana (8fc-8mc-2mc), 3 m	CBEP4105.1-3	F 00K 110 026
Ethernet PC Connection and Power Supply Cable, Power Feeder close to PC, Lemo 1B FGL - RJ45 - Banana (8fc-8mc-2mc), 5 m	CBEP415.1-5	F 00K 105 680
Ethernet PC Connection and Power Supply Cable, Power Feeder close to PC, Lemo 1B FGL - RJ45 - Safety Banana (8fc-8mc-2mc), 5 m	CBEP4155.1-5	F 00K 110 027
Ethernet Connection and Power Supply Cable, Lemo 1B FGF - Lemo 1B FGL - Banana (8mc-8fc-2mc), 3 m	CBEP420.1-3	F 00K 105 292
Ethernet Connection and Power Supply Cable, Lemo 1B FGF - Lemo 1B FGL - Safety Banana (8mc-8fc-2mc), 3 m	CBEP4205.1-3	F 00K 110 041
Ethernet Connection and Power Supply Cable, Power Feeder close to Interface Module, Lemo 1B FGF - Lemo 1B FGL - Banana (8mc-8fc-2mc), 3 m	CBEP425.1-3	F 00K 105 972
Ethernet Connection and Power Supply Cable, Power Feeder close to Interface Module, Lemo 1B FGF - Lemo 1B FGL - Safety Banana (8mc-8fc-2mc), 3 m	CBEP4255.1-3	F 00K 110 029
Ethernet Chain Connection and Power Supply Cable, Lemo 1B FGL - Lemo 1B FGA - Banana (8fc-8mc-2mc), 0m5	CBEP430.1-0m5	F 00K 104 928
Ethernet Chain Connection and Power Supply Cable, Lemo 1B FGL - Lemo 1B FGA - Safety Banana (8fc-8mc-2mc), 0m5	CBEP4305.1-0m5	F 00K 110 030

12.3.6 SMB Cable

Order Name	Short Name	Order Number
SMB Connection Y-Cable, DSUB - DSUB - DSUB (15fc-9mc-9mc), 0m3	CBAS100-0m3	F 00K 106 313
SMB PC Connection Cable, DSUB - DSUB (9mc-9fc), 2 m	K38	Y 261 A24 342
Power Supply Cable, DSUB - Banana (9mc-2mc), 2 m	K39	Y 261 A24 343
SMB Connection Cable, DSUB - DSUB (9mc-9mc), 0m3	K40	Y 261 A24 344

12.3.7 Lambda Sensor

Order Name	Short Name	Order Number
Bosch Lambda sensor LSU 4.2 for Lambda Meter with universal connector, 1 m	LSUS_42	0 258 007 151
Lambda sensor LSU 4.9, SR4, RB150 Code1, 300 Ohms, 1 m	LSUS_49	0 258 017 025
Lambda Sensor LSU 5.1 for Diesel Engines, Protection Tube d6.9, Trapezoid plug Code A7, 120 Ohm, 1 m / 3.3 ft	LSU_51	F 00K 109 445
Lambda Sensor LSU 5.2, RB150 Code 2, 307 Ohm, 1m / 3.3 ft	LSU_52	0 258 037 022
Lambda Sensor LSU ADV-G for Gasoline Engines, Protection Tube TP3, Trapezoid plug, Code A7, 300 Ohm, 1 m / 3.3 ft	LSU_ADV_G	F 00K 106 409

12.3.8 Pressure Sensor

Order Name	Short Name	Order Number
Pressure Sensor PS63	PS63	F 00K 106 679

12.3.9 Protective caps

Order name	Short name	Order number
Cap to protect open LEMO 1B sockets against dirt	CAP_LEMO_1B	F 00K 105 298
Cap to protect open LEMO 1B sockets against dirt, cost effective	CAP_LEMO_1B_LC	F 00K 105 683
Cap to protect unused Souriau sockets against dirt and water	CAP_SOURI-AU_8STA	F 00K 105 303

12.3.10 Calibration

NOTE

ETAS recommends a calibration interval of 12 months.

12.3.10.1 Factory calibration

Factory calibration service

- Verification of measurement accuracy
- Issue a standard-compliant calibration certificate

Order name	Short name	Order number
Calibration service for ES630	C_ES630	F-00K-112-742
Calibration service for ES631	C_ES631	F-00K-112-743
Calibration service for ES635	C_ES635	F-00K-112-744
Calibration service for ES636	C_ES636	F-00K-112-745

Adjustment service

- Verification of measurement accuracy
- Adjustment of the measuring accuracy to the smallest possible deviation
- Issue standard-compliant calibration certificates for "pre-adjustment" and "post-adjustment"

Order name	Short name	Order number
Adjustment service for ES630	A_ES630	F-00K-106-412
Adjustment service for ES631	A_ES631	F-00K-106-413
Adjustment service for ES635	A_ES635	F-00K-106-683
Adjustment service for ES636	A_ES636	F-00K-106-684

12.3.10.2 Accredited calibration

Accredited calibration service according to ISO/IEC 17025

- Verification of measurement accuracy by accredited calibration laboratory[1]
- Issue an internationally recognized ISO/IEC 17025 calibration certificate.[2]

Order name	Short name	Order number
DAkkS calibration service for ES630	DAkkS_C_ES630	F-00K-112-784
DAkkS calibration service for ES631	DAkkS_C_ES631	F-00K-112-785
DAkkS calibration service for ES635	DAkkS_C_ES635	F-00K-112-786
DAkkS calibration service for ES636	DAkkS_C_ES636	F-00K-112-787

Accredited adjustment service according to ISO/IEC 17025

- Verification of measurement accuracy by accredited calibration laboratory[1]
- Adjustment of the measuring accuracy to the smallest possible deviation
- Issue of internationally recognized, ISO/IEC 17025 compliant calibration certificates for "pre-adjustment" and "post-adjustment"[2]

Order name	Short name	Order number
DAkkS adjustment service for ES630	DAkkS_A_ES630	F-00K-112-439
DAkkS adjustment service for ES631	DAkkS_A_ES631	F-00K-112-440
DAkkS adjustment service for ES635	DAkkS_A_ES635	F-00K-112-465
DAkkS adjustment service for ES636	DAkkS_A_ES636	F-00K-112-466

1. Accreditation by Deutsche Akkreditierungsstelle (DAkkS)
2. Supervision of the calibration certificate by DAkkS

13 Appendix A: Error Messages and Solution of Problems

This chapter contains information on the following topics:

13.1 Error LEDs

Please observe the LEDs (see the section “LEDs” on page 19) which provides information to be able to judge the operational state of the ES63x module as well as troubleshooting measures.

LED ER	LED ON	Operational State	Note
Off	Off	Module off	No power supply, power supply defective
Off	Green	Normal	Module on, no errors
Red	Off	Hardware error	Internal error, display of error on the display when heater supplied with power
Red	Green	LED test	For a short time during module initialization
Red	Green	Error	Detailed display of error in display
Red, flashing	Green	Update process	Firmware update

13.2 Error Messages on the Display

If the module detects an error, you can display the error type by pressing the ERR function key. Use the following error list to try to solve the problem.

13.2.1 “IP-Protection error”

The module detected an internal error when checking the hardware.

Please send the module to ETAS for repair.

13.2.2 “Inconsistent hardware found”

The module detected an internal error when the hardware was checked during booting.

Please send the module to ETAS for repair.

13.2.3 “Analog board error”

The module has detected an internal error.

Update the firmware of the module (again) with an up-to-date HSP version. Start a booting procedure by powering the module off and then on again.

If the error continues to be displayed, send the module to ETAS for repair.

13.2.4 “Rescue software variant loaded”

A rescue version of the software was loaded instead of the valid module software. Possible causes are hardware errors or a defective firmware update of the module with HSP.

Update the firmware of the module (again) with an up-to-date HSP version. If the error continues to be displayed, send the module to ETAS for repair.

13.2.5 “Calibration defaults”

The device must be calibrated by ETAS. If you use the module without having it calibrated, the accuracy of measurement cannot be guaranteed.

Please send the module to ETAS to be calibrated.

13.2.6 “Missing sensor heater current”

The supply voltage necessary for the sensor is available at the module’s “LAMBDA” port.

Either the sensor cable is defective or the sensor has been removed. Check the sensor, the sensor cable, the sensor plug and use a different sensor as an independent test.

If the error continues to be displayed, send the module to ETAS for repair.

13.2.7 “No sensor power or sensor power low”

If the supply voltage necessary for the sensor is too low at the module’s “LAMBDA” port, this error is briefly (one to two seconds) shown during the warm-up phase of the sensor if high currents have been allowed for the heater line (warm-up line) or for the heater parameters. This brief error display has no significance.

If this error is displayed for longer than one to two seconds during the warm-up phase of the sensor, the supply voltage necessary for the sensor is either not available at the module’s “LAMBDA” port or is too low, there is no sensor cable connected to the module or the connected sensor is not suitable for the configuration selected.

13.2.8 “Probe short circuit”

The heater current exceeds its limit during heating.

Check the sensor and the sensor cable. Check whether a configuration defined by the user is being used with invalid parameters.

13.2.9 “Analog out failed”

The voltage at the “VOUT” port cannot be parameterized. Check whether the load at the output is too high or the output is short-circuited.

NOTE

No error is displayed if the calculated output voltage is outside the area defined by offset and gain.

13.2.10 “Lambda line missing”

A lambda line is required to calculate the lambda value from the pump current. If this line was not loaded, measuring is not possible. The available lines can be found in the menu [4|3|1]: Channel / Mode Lambda / Line.

Load this line into the module with the calibration software or select another configuration with another line.

13.2.11 “Heater line missing”

A heater line is required to heat the sensor. If this line was not loaded, measuring is not possible.

The available lines can be found in the menu [4|4]: Channel / Heater Line

Load this line into the module with the calibration software or select another configuration with another line.

13.2.12 “Temperature line missing”

A temperature line is required to calculate the temperature. If this line was not loaded for the current configuration, measuring is not possible.

Load this line into the module with the calibration software or select another configuration with another line.

13.2.13 “Un too low”

The Nernst voltage is outside the expected range (too low).

Check the sensor and the sensor cable. Check whether a configuration defined by the user is being used with invalid parameters.

13.2.14 “Un too high”

The Nernst voltage is outside the expected range (too high).

Check the sensor and the sensor cable. Check whether a configuration defined by the user is being used with invalid parameters.

13.2.15 “Sensortype mismatch”

If sensor detection is activated and the type of connected sensor and the sensor type of the current configuration are not the same, the module always tries to load the available configuration that corresponds to that of the connected sensor type.

If sensor detection is set to “on”, the preset factory configuration cannot be loaded. If sensor detection is set to “userdef. Defaults”, the configuration assigned in the software cannot be loaded.

Please send the module to ETAS for repair.

13.2.16 "Excessive heatup time"

The operating temperature of the sensor was not reached within the time duration defined by the heatup line.

Check the sensor, the sensor cable, the sensor plug and use a different sensor as an independent test.

This error requires the sensor to be powered off then on (or unplugged then reconnected) before operation will restart.

If the error continues to be displayed, send the module to ETAS for repair.

13.2.17 "Excessive Ri change"

The operation temperature of the sensor is suddenly outside the expected range.

Check the sensor and the sensor cable.

This error requires the sensor to be powered off then on (or unplugged then reconnected) before operation will restart.

13.2.18 "Sensor cell open circuit" (LSU 5.1 only)

The connection to the lambda sensor is interrupted.

Check the sensor, the sensor cable, the sensor plug and use a different sensor as an independent test.

This error requires the sensor to be powered off then on (or unplugged then reconnected) before operation will restart.

13.3 Problems with the ES63x Module

The following table lists some of the possible problems with a remedy.

If you have any further questions, please contact our Customer Support (see chapter “Contact Information” on page 190).

Problem	Diagnostic Questions	Possible Solutions
The application program cannot find any ES63x modules.	Did you configure the network card correctly?	Check that the function for automatic change to energy saving mode on your PC Card has been disabled [1)]. Disable this function.
		INCA, Config Tool and HSP operation: Check that your network card has been configured in accordance with section 13.4 on page 170.
		Stand-alone operation: Check that the IP address used belongs to your IP subnetwork and has been entered in the A2L file.
	Did you install the application software required?	Check that the application software installed on your PC corresponds to the requirements listed in section 10.9.2 on page 100.
	Power supply	Check that your power supply and test setup correspond to the requirements listed in section 3.9 on page 32.
	Is the hardware connected to the PC?	Check that the wiring is undamaged.
	Are the modules in the module chain connected correctly?	Check that the wiring is undamaged.

Problem	Diagnostic Questions	Possible Solutions
Measurement does not start.	Are you being prompted to carry out an update in the INCA-Monitorlog or in the Config-Tool?	Update the modules.
	Is there no data from the module?	Check that your power supply and test setup correspond to the requirements listed in section 3.9 on page 32.
		Check that the wiring of the hardware to the PC is correct/intact.
		Check that the modules in the module chain are connected correctly.
	You are using the ES6xx Configuration Tool and the module is supplying no data?	Check whether the position of one or more modules in the chain has changed.
		Check that you are not using an incorrect A2L file.
		Check whether you have loaded the measure configuration to the module chain.
		Check that you have not assigned the same IP address to two module chains.
	Is the module supplying usable data?	Check that the sensor is connected correctly.
Data is lost during data transfer.	Are you using WLAN in your test setup?	WLAN is not permissible within this ETAS network. Wire your test setup (ETAS modules and their connection to the PC) with ETAS cables only.
	Are you using the correct type of network card in your laptop?	Check whether you are using a PCMCIA network card in your laptop. PCMCIA cards with an 8- or 16-bit data bus are not suitable. Only use PCMCIA cards with a 32-bit data bus, mini-PCI or ExpressCards.

Problem	Diagnostic Questions	Possible Solutions
Other	Is the sensor supply voltage connected?	Check whether the sensor supply voltage is connected and the supply voltage switched on.
		If the LED continues to show red, send the module to ETAS for repair.
	Is the fuse in the sensor cable intact?	Check the fuse in the sensor cable.
		If the LED continues to show red, send the module to ETAS for repair.
	Have you just carried out an update?	INCA users: Power on the module and then power it off again. Config-Tool users: Power on the module and then power it off again. Reload the measure configuration.
		Use an up-to-date HSP version for the update.
		If the LED continues to show red, send the module to ETAS for repair.
The firmware of one or more modules cannot be updated.	Is the module to be updated in a module chain?	Update the firmware of these ES63x modules separately.

[1)]: The manufacturers of PC Cards have different names for this function.
Example: “Link down Power saving”

13.4 General Problems and Solutions

13.4.1 Network Adapter cannot be selected via Network Manager

Cause: APIPA is disabled

The alternative mechanism for IP addressing (APIPA) is usually enabled on all Windows 7, 8.1 and 10 systems. Network security policies, however, may request the APIPA mechanism to be disabled. In this case, you cannot use a network adapter which is configured for DHCP to access ETAS hardware. The ETAS Network Manager displays a warning message.

The APIPA mechanism can be enabled by editing the Windows registry. This is permitted only to users who have administrator privileges. It should be done only in coordination with your network administrator.

To enable the APIPA mechanism:

1. Open the Registry Editor:
   - Windows 7, 8.1:
     1.1 Click on the Windows symbol.
     1.2 Enter `regedit` in the entry field.
     1.3 Push <ENTER>.
   - Windows 10:
     1.1 Rightclick on the Windows symbol.
     1.2 Click on **Search**.
     1.3 Enter `regedit` in the entry field.
     1.4 Push <ENTER>.

   The registry editor is displayed.
2. Open the folder `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\Tcpic\Parameters\`
3. Click **Edit** → **Find** to search for the key `IPAutoconfigurationEnabled`.

If you cannot find any instances of the registry key mentioned, the APIPA mechanism has not been disabled on your system, i.e. there is no need to enable it. Otherwise proceed with the following steps.

4. Set the value of the key `IPAutoconfigurationEnabled` to `1` to enable the APIPA mechanism.

   You may find several instances of this key in the Windows registry which either apply to the TCP/IP service in general or to a specific network adapter. You only need to change the value for the corresponding network adapter.
5. Close the registry editor.
6. Restart your workstation in order to make your changes take effect.

13.4.2 Search for Ethernet Hardware fails

Cause: Personal Firewall blocks Communication

For a detailed description on problems caused by personal firewalls and possible solutions see “Personal Firewall blocks Communication” on page 173.

Cause: Client Software for Remote Access blocks Communication

PCs or notebooks which are used outside the ETAS hardware network sometimes use a client software for remote access which might block communication to the ETAS hardware. This can have the following causes:

- A firewall which is blocking Ethernet messages is being used (see „Cause: Personal Firewall blocks Communication“ on page171)
- By mistake, the VPN client software used for tunneling filters messages. As an example, Cisco VPN clients with versions before V4.0.x in some cases erroneously filtered certain UDP broadcasts.

  If this might be the case, please update the software of your VPN client.

Cause: ETAS Hardware hangs

Occasionally the ETAS hardware might hang. In this case switch the hardware off, then switch it on again to re-initialize it.

Cause: Network Adapter temporarily has no IP Address

Whenever you switch from a DHCP company LAN to the ETAS hardware network, it takes at least 60 seconds until ETAS hardware can be found. This is caused by the operating system’s switching from the DHCP protocol to APIPA, which is being used by the ETAS hardware.

Cause: ETAS Hardware had been connected to another Logical Network

If you use more than one PC or notebook for accessing the same ETAS hardware, the network adapters used must be configured to use the same logical network. If this is not possible, it is necessary to switch the ETAS hardware off and on again between different sessions (repowering).

Cause: Device driver for network card not in operation

It is possible that the device driver of a network card is not running. In this case you will have to deactivate and then reactivate the network card.

Deactivating and reactivating the network card:

1. Open the Control Panel:
   - Windows 7, 10:
     1.1 Click on the Windows symbol.
     1.2 Click on **Control Panel**.
   - Windows 8.1:
     1.1 Click on the Windows symbol.
     1.2 Enter `Control Panel` in the entry field.
     1.3 Push <ENTER>.

2. Click on **Network and Sharing Center**.
3. Click on **Change adapter settings**.
4. Right click on the used network adapter.
5. Select **Deactivate** in the context menu.
6. In order to reactivate the network adapter right click on it again.
7. Select **Activate**.

Cause: Laptop power management deactivates the network card

The power management of a laptop computer can deactivate the network card. Therefore you should turn off power monitoring on the laptop.

To switch off power monitoring on the laptop:

1. Open the Control Panel:
   - Windows 7, 10:
     1.1 Click on the Windows symbol.
     1.2 Click on **Control Panel**.
   - Windows 8.1:
     1.1 Click on the Windows symbol.
     1.2 Enter `Control Panel` in the entry field.
     1.3 Push <ENTER>.
2. Click on **Device Manager**.
3. In the Device Manager open the tree structure of the entry **Network Adapter**.
4. Right click on the used network adapter.
5. Select **Properties** in the context menu.
6. Switch off energy monitoring as follows:
   i. Select the **Energy Management** tab.
   ii. Deactivate the Computer can switch off device to save energy option.
7. Select the **Extended** tab.
8. If the property **Autosense** is included, deactivate it.
9. Click **OK** to apply the settings.

Cause: Automatic disruption of network connection

It is possible after a certain period of time without data traffic that the network card automatically interrupts the Ethernet connection. This can be prevented by setting the registry key `autodisconnect`.

To set the registry key **autodisconnect**:

1. Open the Registry Editor:
   - Windows 7, 8.1:
     1.1 Click on the Windows symbol.
     1.2 Enter `regedit` in the entry field.
     1.3 Push <ENTER>.
   - Windows 10:
     1.1 Rightclick on the Windows symbol.
     1.2 Click on **Search**.
     1.3 Enter `regedit` in the entry field.
     1.4 Push <ENTER>.
2. Select under `HKEY_LOCAL_MACHINE\SYSTEM\ControlSet001\Services\lanmanserver\parameters` the Registry Key `autodisconnect`.
3. Change its value to `0xffffffff`.

Cause: Ethernet card is not compatible with the ETAS hardware

It is possible that the Ethernet card that is used in your notebook or PC is not compatible with the ETAS hardware in your network.

To allow best possible operation of ETAS devices together with a PC or notebook, you will find under the following link a list of Ethernet cards that have been successfully used during system tests:

https://www.etas.com/en/products/faq.php

13.4.3 Personal Firewall blocks Communication

Cause: Permissions given through the firewall block ETAS hardware

Personal firewalls may interfere with access to ETAS Ethernet hardware. The automatic search for hardware typically cannot find any Ethernet hardware at all, although the configuration parameters are correct.

Certain actions in ETAS products may lead to some trouble if the firewall is not properly parameterized, e.g. upon opening an experiment in ASCET or searching for hardware from within INCA or HSP.

If a firewall is blocking communication to ETAS hardware, you must either disable the firewall software while working with ETAS software, or the firewall must be configured to give the following permissions:

- Outgoing limited IP broadcasts via UDP (destination address 255.255.255.255) for destination port 18001
- Incoming limited IP broadcasts via UDP (destination IP 255.255.255.255, originating from source IP 0.0.0.0) for destination port 18001
- Directed IP broadcasts via UDP to the network configured for the ETAS application, destination port 18001

- Outgoing IP unicasts via UDP to any IP in network configured for the ETAS application, destination ports 69, 18001, 18017 or 49152 to 50175
- Incoming IP unicasts via UDP originating from any IP in the network configured for the ETAS application, source ports 69, 18001, 18017 or 49152 to 50175

> **NOTE**
>
> The ports that have to be used in concrete use cases depend on the hardware used. For more precise information on the port numbers that can be used please refer to your hardware documentation.

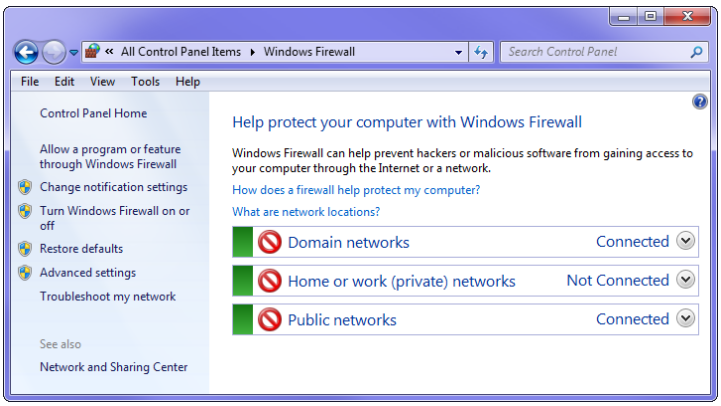
Windows 7, 8.1 and 10 come with a built-in personal firewall. On many other systems it is very common to have personal firewall software from third party vendors, such as Symantec, McAffee or BlackIce installed. The proceedings in configuring the ports might differ for each personal firewall software used. Therefore please refer to the user documentation of your personal firewall software for further details.

As an example for a firewall configuration, you will find below a description on how to configure the widely used Windows firewall if the hardware access is prohibited under Windows.

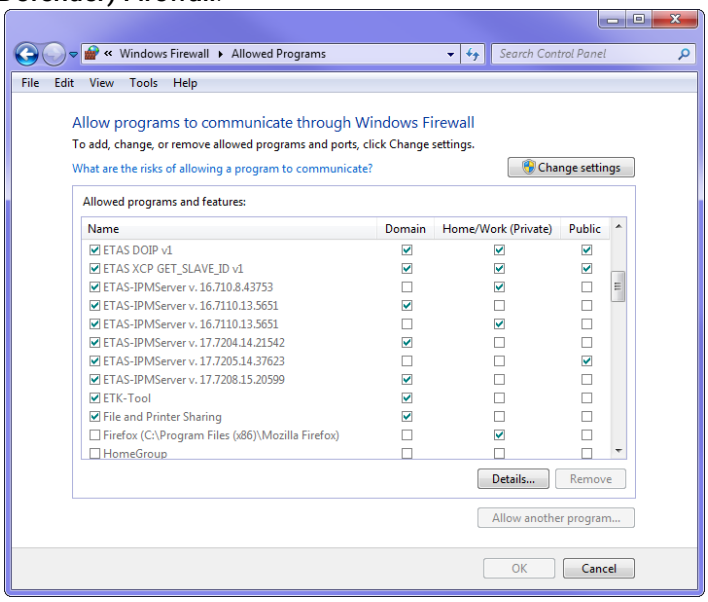
Solution for Windows Firewall, Users with Administrator Privileges

To unblock ETAS products in the firewall control:

1. Open the Control Panel:
   - Windows 7, 10:
     1.1 Click on the Windows symbol.
     1.2 Click on **Control Panel**.
   - Windows 8.1:
     1.1 Click on the Windows symbol.
     1.2 Enter `Control Panel` in the entry field.
     1.3 Push <ENTER>.
2. Click on **Windows Firewall** (Win 7, 8.1) or **Windows Defender Firewall** (Win 10).



3. Click on **Allow a program / app or feature through Windows (Defender) Firewall**.



   This window lists the exceptions that are not blocked by the firewall.

4. Click on **Change settings**.
5. Check the boxes to enable the respective program for the corresponding network.
6. Ensure that the ETAS products and services to be used are correctly configured exceptions.
7. Klick on **OK**.
8. Close the **Windows Firewall**.

   The firewall no longer blocks the ETAS product. The setting is retained after a restart of the PC.

Solution for Windows Firewall, Users without Administrator Privileges

This section addresses users with restricted privileges, e.g., no system changes, write restrictions, local login.

Working with an ETAS software product requires "Write" and "Modify" privileges within the `ETAS`, `ETASData`, and ETAS temporary directories. Otherwise, an error message opens if the product is started, and a database is opened. In that case, no correct operation of the ETAS product is possible because the database file and some `*.ini` files are modified during operation.

The ETAS software has to be installed by an administrator anyway. It is recommended that the administrator assures that the ETAS program/processes are added to the list of the Windows XP firewall exceptions, and selected in that list, after the installation.

14 Appendix B: Adjustable Parameters

The "Adjustable Parameters" chapter gives an overview about the limits and defaults of adjustable parameters.

This chapter contains information on the following topics:

14.1 [Menu 1]: „sensor presets“

The following configurations are available:

- 4.2-80
- 4.2/4.7
- 4.9
- ADV
- ADV-D
- ZFAS-U2
- ZFAS-U2-D
- 5.1
- 4.2-80-old
- 4.2/4.7-old
- ZFAS-U3
- 5.2
- 4.2-80 analytic
- 4.2/4.7 analytic
- 4.9-300 analytic
- ADV analytic
- ADV-D analytic
- 5.1 analytic
- 4.2-80-old analytic
- 4.2/4.7-old analytic
- 5.2 analytic

If the user has defined additional configurations, these are also displayed.

14.2 [Menu 2]: „analog out“

The output voltage at the analog output "VOUT" of the ES63x can be parameterized freely depending on the selected measure value. You can assign the following measure values separate offset, gain and filter settings:

14.2.1 [Menu 2|1]: Signal "Lambda"

Signal	Min	Max	Default	Unit
Offset	-200	9.7	0.0	V
Gain	0.5	10.0	1.0	V/ Lambda
Filter	OFF, 0.5 , 1.0, 2.0, 5.0, 10.0, 20.0, 50.0, 100.0, 200.0, 500.0		OFF	Hz

14.2.2 [Menu 2|2]: Signal "Air/Fuel"

Signal	Min	Max	Default	Unit
Offset	-250	9.840	0.0	V
Gain	0.02	1.0	0.05	V
Filter	OFF, 0.5 , 1.0, 2.0, 5.0, 10.0, 20.0, 50.0, 100.0, 200.0, 500.0		OFF	Hz

14.2.3 [Menu 2|3]: Signal "O2"

Signal	Min	Max	Default	Unit
Offset	-125	10.0	0.0	V
Gain	0.2	5.0	0.4	V/%
Filter	OFF, 0.5 , 1.0, 2.0, 5.0, 10.0, 20.0, 50.0, 100.0, 200.0, 500.0		OFF	Hz

14.2.4 [Menu 2|4]: Signal "Fuel/Air"

Signal	Min	Max	Default	Unit
Offset	-125	9.92	0.0	V
Gain	20.0	1000.0	50.0	V
Filter	OFF, 0.5 , 1.0, 2.0, 5.0, 10.0, 20.0, 50.0, 100.0, 200.0, 500.0		OFF	Hz

14.2.5 [Menu 2|5]: Signal "1 / Lambda"

Signal	Min	Max	Default	Unit
Offset	-80	9.9	0.0	V
Gain	2.0	50.0	5.0	V* Lambda
Filter	OFF, 0.5 , 1.0, 2.0, 5.0, 10.0, 20.0, 50.0, 100.0, 200.0, 500.0		OFF	Hz

14.2.6 [Menu 2|6]: Signal "Ip"

Signal	Min	Max	Default	Unit
Offset	-100.0	110.0	5.0	V
Gain	0.2	10.0	0.5	V/mA
Filter	OFF, 0.5 , 1.0, 2.0, 5.0, 10.0, 20.0, 50.0, 100.0, 200.0, 500.0		OFF	Hz

14.2.7 [Menu 2|7]: Signal "Ri"

Signal	Min	Max	Default	Unit
Offset	-1000.0	10.0	0.0	V
Gain	0.002	0.5	0.005	V/Ohm
Filter	OFF, 0.5 , 1.0, 2.0, 5.0, 10.0		OFF	Hz

14.2.8 [Menu 2|8] : Signal "Uh"

Signal	Min	Max	Default	Unit
Offset	-90.0	10.0	0.0	V
Gain	0.2	5.0	0.5	V/V
Filter	OFF, 0.5 , 1.0, 2.0, 5.0, 10.0		OFF	Hz

14.2.9 [Menu 2|9]: Signal "Ih"

Signal	Min	Max	Default	Unit
Offset	-200.0	10.0	0.0	V
Gain	1.0	20.0	2.0	V/A
Filter	OFF, 0.5 , 1.0, 2.0, 5.0, 10.0		OFF	Hz

14.2.10 [Menu 2|10]: Signal "Unernst"

Signal	Min	Max	Default	Unit
Offset	-1000.0	10.0	0.0	V
Gain	5.0	1000.0	10.0	V/V
Filter	OFF, 0.5 , 1.0, 2.0, 5.0, 10.0, 20.0, 50.0, 100.0, 200.0, 500.0		OFF	Hz

14.2.11 [Menu 2|11]: Signal "Upump"

Signal	Min	Max	Default	Unit
Offset	-80.0	90.0	5.0	V
Gain	0.5	20.0	1.0	V/V
Filter	OFF, 0.5 , 1.0, 2.0, 5.0, 10.0, 20.0, 50.0, 100.0, 200.0, 500.0		OFF	Hz

14.2.12 [Menu 2|12]: Signal "T"

Signal	Min	Max	Default	Unit
Offset	-100.0	8.0	-5.0	V
Gain	0.005	0.1	0.01	V/°C
Filter	OFF, 0.5 , 1.0, 2.0, 5.0, 10.0		OFF	Hz

14.2.13 [Menu 2|13]: Signal "pamb"

Signal	Min	Max	Default	Unit
Offset	-115.0	7.0	-5.0	V
Gain	0.005	0.1	0.01	V/hPa
Filter	OFF		OFF	Hz

14.2.14 [Menu 2|14]: Signal "pex" (ES635.1 and ES636.1 only)

Signal	Min	Max	Default	Unit
Offset	-250.0	10.0	0.0	V
Gain	0.001	0.05	0.002	V/hPa
Filter	OFF, 0.5 , 1.0, 2.0, 5.0, 10.0, 20.0, 50.0, 100.0, 200.0, 500.0		OFF	Hz

14.3 [Menu 3]: „signal on display“

Symbol	Signal
l	Lambda
A/F	Air to fuel ratio
O2	O2 concentration
F/A	Fuel to air ratio
1/l	Reciprocal Lambda
Ip	Pump current
Ri	Sensor resistance
Uh	Heater voltage
Ih	Heater current
Un	Nernst voltage
Up	Pump voltage
T	Sensor temperature
pa	Ambient pressure
pex	Pressure from external pressure sensor (ES635.1 and ES636.1 only)
Fr	Filling level of reservoir (only applicable to the LSU5.1)
Sta	State/ operational state of the sensor
OFF	Display off (ES631.1/ ES636.1: CH1/ CH2 separately)

14.4 [Menu 4]: „channel“

14.4.1 [Menu 4|1]: pressure compensation

Parameter	Standard	Meaning	Unit
PAMB	-	Pressure compensation on (internal pressure sensor)	-
PEXH	-	Pressure compensation on (external pressure sensor, ES635.1 and ES636.1 only)	-
OFF	1013	Pressure compensation off (Default)	hPa

14.4.2 [Menu 4|2]: channel / sensor detection

Parameter	Meaning
off	No sensor detection
factory defaults	Sensor detection on
userdef.defaults	Sensor detection on

14.4.3 [Menu 4|3|1]: channel / mode λ / line

You can select one of the following lambda lines:

Parameter	Meaning
ANALYTIC	calculated lambda line
ETAS DEF	lambda line for the sensor LSU 4.2-4.7-100
-5%	lambda line for the sensor LSU 4.2-80
4.9-300	lambda line for the sensor LSU 4.9-300
ADV	lambda line for the sensor LSU ADV
ADV-D	lambda line for the sensor LSU ADV-D
ZFAS-U2	lambda line for the sensor ZFAS-U2
ZFAS-U2-D	lambda line for the sensor ZFAS-U2-D
5.1-120	lambda line for the sensor LSU 5.1-120
ZFAS-U3	lambda line for the sensor ZFAS-U3
5.2	lambda line for the sensor LSU 5.2

14.4.4 [Menu 4|3|2]: channel / mode λ / analytic

[Menu 4|3|2|1]: fuel

Parameter	Min	Max	Default	Meaning	Unit
H/C	1.0	4.0	1.850	Ratio of hydrogen/carbon	mol/mol
O/C	0.0	1.0	0.0	Ratio of oxygen/carbon	mol/mol
H2O	0.0	100.0	0.0	Water proportion	mmol/mol
AFSt.	6.0	20.0	14.7	Stoichiometric ratio	kg/kg

[Menu 4|3|2|2]: climatic conditions

Parameter	Min	Max	Default	Meaning	Unit
Humidity	0.0	100.0	40.0	Relative humidity	%
Air Temp.	-20.0	70.0	23.0	Air temperature	°C

14.4.5 [Menu 4|3|3]: channel / mode λ / advanced

[Menu 4|3|3|1]: H2-Shift

Parameter	Min	Max	Default	Meaning	Unit
lower l th	0.9	0.98	0.98	Lower limit H2 shift	-
l at Ip=0	1.0	1.1019	1.009	Mean H2 shift	-
upper l th	1.02	1.1	1.05	Upper limit H2 shift	-

[Menu 4|3|3|2]: LSU calibration

The module can be calibrated to the characteristic of a connected sensor by different methods:

- manual input (submenu "Input")
- calibration by measuring in a lean or in a rich gas as well as in a reference gas (submenu "Ref. gas / lean ref.", "Ref. gas / rich ref." and "Ref. gas / zero ref."; for detailled information refer to chapter 8.2.3 on page 78).

[Menu 4|3|3|2|1]: Input

The user can enter correction values for the lean and for the rich range as well as for the zero current deviation.

Parameter	Min	Max	Default	Meaning	Unit
lean scale	0.8	1.2	1.0	Sensor deviation, lean	-
rich scale	0.8	1.2	1.0	Sensor deviation, rich	-
zero offset	-50	50	0.0	Sensor deviation, zero current	µA

[Menu 4|3|3|2|2]: Ref. gas

[Menu 4|3|3|2|2|1]: Ref. gas / lean ref.

The sensor is located in a lean gas whose oxygen concentration is known. After the user has entered the concentration of the reference gas the module determines the correction factor „lean scale“ (sensor deviation, lean) and saves it.

The value of the parameter „rich scale“ is set to the value of the parameter „lean scale“.

Parameter	Min	Max	Default	Meaning	Unit
O2	5.0	25.0	20.9	O2 content of the reference gas	%

[Menu 4|3|3|2|2|2]: Ref. gas / rich ref.

The sensor is located in a rich gas whose carbon monoxide and hydrogen content is known. After the user has entered the concentration of the reference gas the module determines the correction factor „rich scale“ (sensor deviation, rich) and saves it.

NOTE

If **rich ref.** and **lean ref.** are both calibrated with corresponding gases, the **lean ref.** has to be calibrated at first.

Parameter	Min	Max	Default	Meaning	Unit
CO	0.0	12.0	4.1	Carbon monoxide content	%
H2	0.0	12.0	3.2	Hydrogen content	%

[Menu 4|3|3|2|2|3]: Ref. gas / zero ref.

The sensor is located in a reference gas. The module determines automatically the correction factor „zero offset“ (sensor deviation, zero current) and saves it.

[Menu 4|3|3|2|3]: Reset values

The values of the parameters „lean scale“ (sensor deviation, lean), „rich scale“ (sensor deviation, rich) and „zero offset“ (sensor deviation, zero current) are set to defaults values.

[Menu 4|3|3|3]: TDET

Parameter	Min	Max	Default	Meaning	Unit
TDET	200.0	2000.0	1212.0	Water gas equilibrium temperature	°C

14.4.6 [Menu 4|4]: channel / heater line

Parameter	Meaning
ETAS DEF	Heater line for the sensors LSU 4.2-80 and LSU 4.2-4.7-100
HtUp-300	Heater line for the sensor LSU 4.9-300
ADV	Heater line for the sensor LSU ADV
ZFAS-U2/D	Heater line for the sensors ZFAS-U2 and ZFAS-D
HtUp-5.1	Heater line for the sensor LSU 5.1
HtUp-4.2	Heater line for the sensors LSU 4.2-80 and LSU 4.2-4.7-100
ZFAS-U3	Heater line for the sensor ZFAS-U3
HtUp-5.2	Heater line for the sensor LSU 5.2

14.4.7 [Menu 4|5]: channel / temperature line

Parameter	Meaning
T-4.2-100	Temperature line for the sensor LSU 4.2-4.7-100
T-4.2-80	Temperature line for the sensor LSU 4.2-80
T-4.9-300	Temperature line for the sensor LSU 4.9-300
T-ADV	Temperature line for the sensor LSU ADV
T-ADV-D	Temperature line for the sensor LSU ADV-D
T-ZFAS-U2/D	Temperature line for the sensors ZFAS-U2 and ZFAS-D
T-5.1-120	Temperature line for the sensor LSU 5.1
T-ZFAS-U3	Temperature line for the sensor ZFAS-U3
T-5.2	Temperature line for the sensor LSU 5.2

14.4.8 [Menu 4|6]: channel / operating parameters

Parameter	Min	Max	Meaning	Unit
Rinom	0	1000	Nominal internal resistance of the sensor	Ohm
k rich	100	2000	Coefficient for pressure dependence of pump current at lambda < 1	hPa
k lean	200	2000	Coefficient for pressure dependence of pump current at lambda > 1	hPa
Ipref	0	100	Current intensity for pumped reference of the lambda sensor	µA
Ipref+	0	200	Increased pump current during tpref+	µA
tpref0	0	10000	Warm-up time without pump current	ms
tpref+	0	10000	Warm-up time with increased reference pump current	ms

The default values for each sensor:

Parameter	Unit	LSU4.2-80	LSU4.2-4.7-100	LSU4.9-300	LSU5.1	LSU 5.2	LSUADV-G	LSUADV-D	ZFAS-U2 ZFAS-D	ZFAS-U3
Rinom	Ohm	80	100	300	120	307	300	240	75	155
krich	hPa	240	240	350	340	370	1050	1050	1363	953
klean	hPa	490	490	430	340	370	1150	1150	1363	1124
Ipref	µA	0	0	20	0	20	20	20	20	20
Ipref+	µA	0	0	0	0	0	0	0	0	0
tpref0	ms	0	0	0	0	0	0	0	0	0
tpref+	ms	0	0	0	0	0	0	0	0	0

14.5 [Menu 5]: other

14.5.1 [Menu 5|1]: display

[Menu 5|1|1]: filter

With the parameters "SLOW" and "FAST" you can configure signal evaluation for the display output channel to be the same for all measure values

Parameter	Cutoff frequency
SLOW	0.2 Hz
FAST	2.0 Hz

[Menu 5|1|2]: resolution

With the parameters "COARSE" and "FINE" you set the number of decimal places for the measure data display.

Symbol	Signal	Decimal places	
		COARSE	FINE
l	Lambda	3	4
A/F	Air to fuel ratio	1	2
O2	O2 concentration	1	2
F/A	Fuel to air ratio	4	5
1/l	Reciprocal Lambda	3	4
Ip	Pump current	3	4
Ri	Sensor resistance	0	1
Uh	Heater voltage	1	2
Ih	Heater current	2	3
Un	Nernst voltage	0	1
Up	Pump voltage	0	1
T	Sensor temperature	0	0
pa	Ambient pressure	0	0
pex	Pressure from external pressure sensor (ES635.1 and ES636.1 only)	0	0
Fr	Filling level of reservoir (only applicable to the LSU 5.1)	1	0
Sta	State/ operational state of the sensor	-	-

14.5.2 [Menu 5|2]: SMB

[Menu 5|2|1]: Address

The admissible value range for SMB module addresses is 0…15.

[Menu 5|2|2]: Filter

You can assign a filter value to the following measure values to smooth the measure result:

Signal	Possible Values	Default	Unit
Lambda	OFF, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000	20	ms
Ri	OFF, 100, 200, 500, 1000, 2000	OFF	ms
O2	OFF, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000	20	ms
A/F	OFF, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000	20	ms
Ip	50, 100, 200, 500, 1000, 2000	10	ms

Signal	Meaning	Min	Max	Invalid Value	Unit
Lambda Byte	Lambda	0.74	1.76	0.74	-
Lambda Word	Lambda	0.7	32.767	0.0	-
Air/Fuel Word	Air to fuel ratio	10.29	327.67	0.0	-
O2 word	O2 concentration	0.0	24.41	0.0	%
Ip Word	Pump current	-3.0	3.0	0.0	mA
Ri word	Sensor resistance	0.0	500.0	0.0	Ohms

[Menu 5|2|1]: Address (ES630.1 and ES635.1)

The admissible value range for SMB module addresses is 0…15.

[Menu 5|2|2]: filter (ES630.1 and ES635.1)

You can assign a filter value to the following measure values to smooth the measure result:

Signal	Possible Values	Default	Unit
Lambda	OFF, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000	20	ms
Ri	OFF, 100, 200, 500, 1000, 2000	OFF	ms
O2	OFF, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000	20	ms
A/F	OFF, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000	20	ms
Ip	50, 100, 200, 500, 1000, 2000	10	ms

Signal	Meaning	Min	Max	Invalid Value	Unit
Lambda Byte	Lambda	0.74	1.76	0.74	-
Lambda Word	Lambda	0.7	32.767	0.0	-
Air/Fuel Word	Air to fuel ratio	10.29	327.67	0.0	-
O2 word	O2 concentration	0.0	24.41	0.0	%
Ip Word	Pump current	-3.0	3.0	0.0	mA
Ri word	Sensor resistance	0.0	500.0	0.0	Ohms

[Menu 5|2|1]: CH1 address (ES631.1 and ES636.1)

An individual module address must be assigned to each measurement channel of each module when several SMB modules are connected.

The admissible value range for SMB module addresses is 0…15.

[Menu 5|2|2]: CH1 filter (ES631.1 and ES636.1)

You can assign a filter value to the following measure values to smooth the measure result:

Signal	Possible Values	Default	Unit
Lambda	OFF, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000	20	ms
Ri	OFF, 100, 200, 500, 1000, 2000	OFF	ms
O2	OFF, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000	20	ms
A/F	OFF, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000	20	ms
Ip	50, 100, 200, 500, 1000, 2000	10	ms

Signal	Meaning	Min	Max	Invalid Value	Unit
Lambda Byte	Lambda	0.74	1.76	0.74	-
Lambda Word	Lambda	0.7	32.767	0.0	-
Air/Fuel Word	Air to fuel ratio	10.29	327.67	0.0	-
O2 word	O2 concentration	0.0	24.41	0.0	%
Ip Word	Pump current	-3.0	3.0	0.0	mA
Ri word	Sensor resistance	0.0	500.0	0.0	Ohms

[Menu 5|2|3]: CH2 address (ES631.1 and ES636.1)

An individual module address must be assigned to each measurement channel of each module when several SMB modules are connected.

The admissible value range for SMB module addresses is 0…15.

[Menu 5|2|4]: CH2 filter (ES631.1 and ES636.1)

You can assign a filter value to the following measure values to smooth the measure result:

Signal	Possible Values	Default	Unit
Lambda	OFF, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000	20	ms
Ri	OFF, 100, 200, 500, 1000, 2000	OFF	ms
O2	OFF, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000	20	ms
A/F	OFF, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000	20	ms
Ip	50, 100, 200, 500, 1000, 2000	10	ms

Signal	Meaning	Min	Max	Invalid Value	Unit
Lambda Byte	Lambda	0.74	1.76	0.74	-
Lambda Word	Lambda	0.7	32.767	0.0	-
Air/Fuel Word	Air to fuel ratio	10.29	327.67	0.0	-

Signal	Meaning	Min	Max	Invalid Value	Unit
O2 word	O2 concentration	0.0	24.41	0.0	%
Ip Word	Pump current	-3.0	3.0	0.0	mA
Ri word	Sensor resistance	0.0	500.0	0.0	Ohms

14.5.3 [Menu 5|3]: device mode

You can choose between the opreating modes “Standard” and “Advanced” of the ES63x.

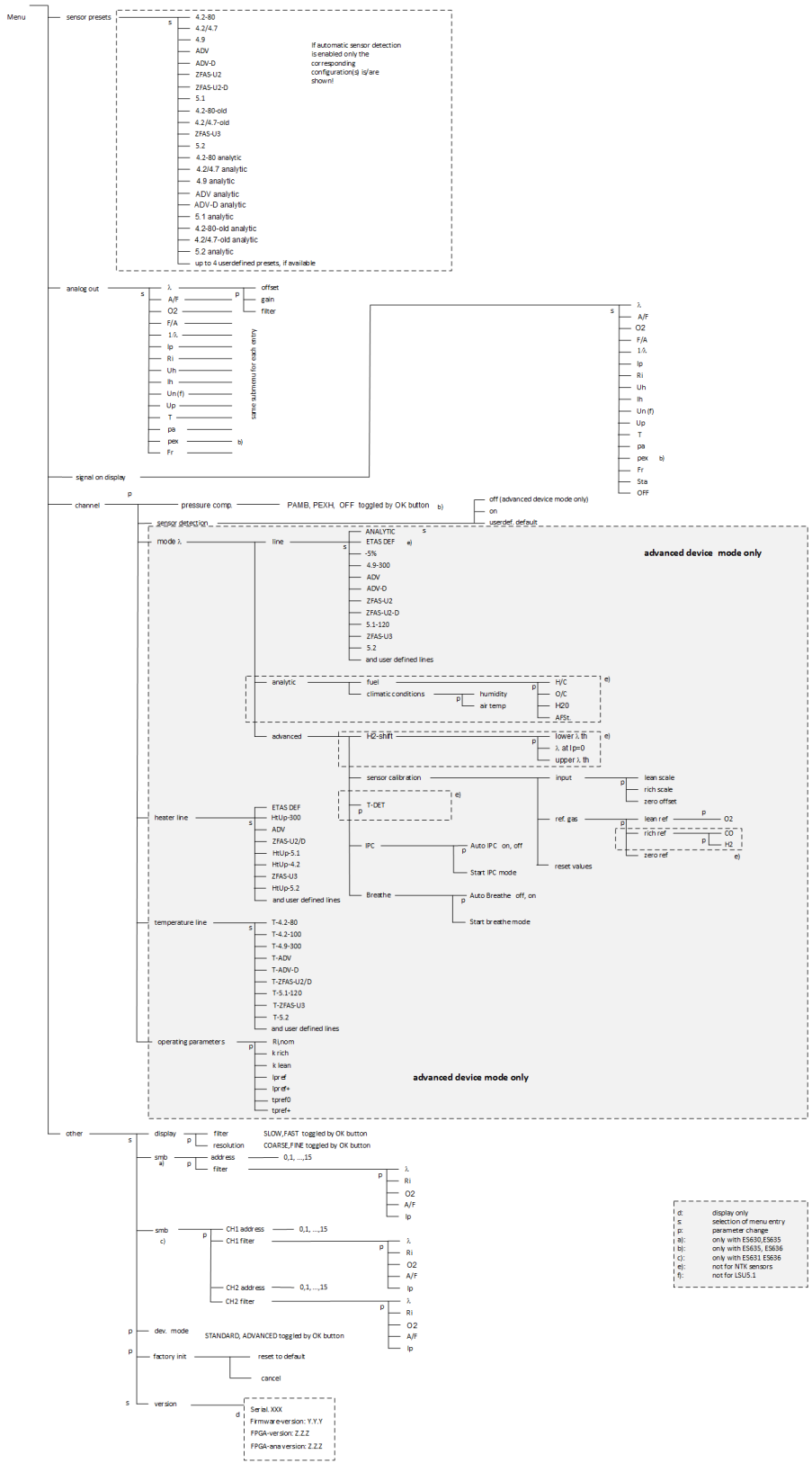
14.5.4 [Menu 5|4]: factory init

You can reset the settings of the module to their default configuration if the factory default configurations of the module have been changed.

14.5.5 [Menu 5|5] : version

Information on the firmware, the serial number,the IP address and the netmask is displayed simultaneously.

15 Appendix C: Configuration Menu



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