ETAS

DRIVING EMBEDDED EXCELLENCE

ETAS ES432.1 Lambda Module

Benutzerhandbuch

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ES432.1 - User Guide R08 EN - 04.2021

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 Typographical Conventions

Hardware

Bold	Menu commands, buttons, labels of the product
Italic	Emphasis on content and newly introduced terms

1.4 Presentation of Supporting Information

NOTE

Contains additional supporting information.

2 About this Manual

This chapter contains information about the following topics:

2.1 Scope of Supply

Prior to the initial commissioning of the module, please check whether the module was delivered with all required components and cables (see chapter 11.1 on page 122).

Additional cables and adapters can be obtained separately from ETAS. A list of available accessories and their order designation is located in chapter “Accessories” on page 122 of this manual or in the ETAS product catalog.

2.2 Additional Information

The configuration instructions for the module under INCA can be found in the corresponding software documentation.

3 Basic Safety Notices

This chapter contains information about the following topics:

3.1 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.

3.2 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. Incorrect operation or operation by users without sufficient qualification may lead to injuries or death or property damages.
The safety of systems that are using the product is the responsibility of the system integrator.

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.

3.3 Intended Use

Application area of the product

This product was developed and approved for applications in the automotive area. The module is suitable for use in interiors, in the passenger cell, in the trunk, in the engine compartment or in the exterior area of vehicles.
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 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 the compliance with the connection and adjustment values (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 exclusively lab power supplies with double protection to the supply system (with double insulation / with reinforced insulation (DI/ RI)).
- The lab power supply must be approved for an operating altitude of 5,000 m and for an ambient temperature of up to 120 °C.
- For normal operation of the modules as well as for very long standby operation, it is possible that the vehicle battery will be drained.

Connection to the power supply

- The power cable may not be connected directly to the vehicle battery or the lab power supply, but only via a suitable fuse.
- 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 cable!

- 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.

De-energizing the module

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

- Disconnecting the cables from the measurement inputs

and

- Disconnecting the module from the power supply
  - Switching off the lab power supply

  or
  - Disconnecting the module from the lab power supply

    Separating device is the lab plug of the power cable or the plug of the power cable at the connection of the module

  or
  - Disconnecting the module from the vehicle battery

    Separating device is the lab plug of the power cable or the plug of the power cable at the connection of the module

  or
  - Disconnecting the vehicle battery.

Cabling

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!

CAUTION

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.

CAUTION

Damage possible to connectors of the modules or the ES4xx_BRIDGE!
Fasten the two modules with screws to the stop inside the module without canting them.

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

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.

Requirements for the place of installation

- Place the module or the module block on a smooth, even and firm foundation.
- The module or module block must always be securely fastened.

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.

Fixing the module 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 block at the carrier system.

CAUTION

Damage or destruction of the module is possible.
The modules of series ES400 are approved only for installation and operation at components or locations that ensure compliance with the technical data of the modules, such as:

- the resistance to vibration of the modules (for example, install modules only on spring-loaded bodies, not on wheel suspensions or directly at the motor) and
- the temperature resistance of the modules (for example, do not install modules on the motor, turbocharger, exhaust manifold or their environments).

CAUTION

During the installation of the modules, observe the permissible temperature range of the cable ties being used!

Damage of the module and loss of properties acc. to IP67

CAUTION

Loss of Features as defined by IP67!
Water standing at the pressure balance element damages the membrane!
Please observe which way the module is pointing when installing vertically!

CAUTION

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

Transport

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

Maintenance

The product is maintenance-free.

Repair

If a repair of an ETAS hardware product should become necessary, send 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.

Notices about specific components

CAUTION

Risk of burns!
The lambda sensor is very hot during operating and some time after operation.

The module ES432.1 is a universal lambda measurement device which, together with lambda probes, allow emission measurements for gasoline, diesel and CNG engines.

During the operation at the module, the lambda probe requires a supply voltage for the probe heater. This supply voltage must be provided separately at the probe 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.

4 ES400 Product Family

This chapter contains information on the following topics:

4.1 Wiring Concepts in Test Vehicles

For the test phase, several hundred sensors must be installed in a test vehicle in various areas, e.g. in the engine compartment and in the floor area. The sensors, which are positioned all over the vehicle, then have to be connected to the measuring instruments of the test setup.

Today's standard solutions with their central setup of measuring instruments inside the vehicle require complex cabling to connect the widely distributed sensors with the measuring instruments. Numerous, usually long connection cables between the sensors and the measuring instruments, bundled together to form several fat wiring harnesses, require a highly modified splash wall of the test vehicle. This involves long setting-up times as well as high costs.

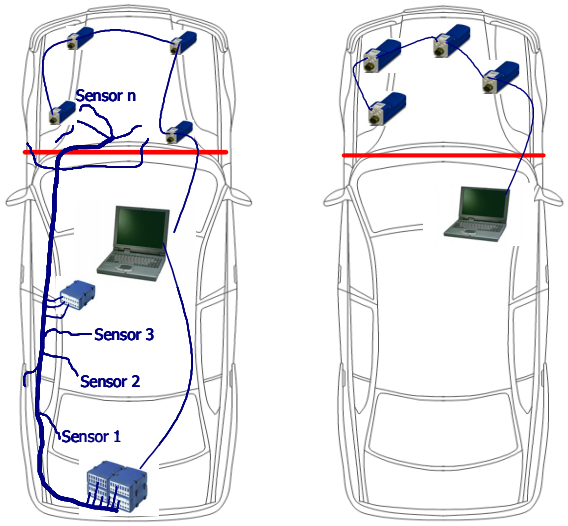


Fig. 4-1 Central and Decentral Sensor Cabling

With the ES400 modules, ETAS provides a decentral solution which considerably simplifies the test setup of the sensors.

The basic idea of this concept is to install the modules of the ES400 family as close as possible to the sensors, to concatenate the modules with each other and to connect just the first module of this chain with the laptop in the vehicle.

4.2 Features of the ES400 Line

4.2.1 Advantages of the Decentral Wiring Concept

- The compact ES400 modules can be mounted close to the sensors with short connection cables.
- The simple assembly and wiring principle (daisy chain topology) of the modules
  - requires only one common cable between the modules for power supply and data transfer
  - considerably reduces the setting-up times for tests
  - simplifies the maintenance and the extension of the test setup
- The only item in the vehicle is the laptop which is connected to the modules with just one cable.
- Test vehicles equipped with an ES400 measurement system can be used flexibly because the vehicles do not have to be modified for changed or new test tasks.

4.2.2 Further Features

This list provides an overview of the other features of the ES400 line in addition to decentral cabling:

- The ES400 modules have a very compact design.
- Each module has an LED for localizing the module.
- The Lambda Modules of the ES400 family use a XCP-based protocol which is compatible to the existing ETAS Ethernet topology.

  The concept fulfills the following requirements:
  - high bandwidth to be able to realize lots of channels with high resolutions (typical in measuring and calibration applications) with fast sampling rates
  - 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
  - support of all probes and pressure sensors used in the automotive industry
- Innovative, battery-saving power supply management
  - automatic power-saving feature (“Standby”)
  - “Wake Up” via the Ethernet interface
- Part of the ETAS Tool Suite
- Daisy Chain Configuration Tool (stand-alone operation)

- Modules suitable for use in automotive applications; suitable for use in the development environment and in the vehicle on test drives:
  - Housing, connectors and cables waterproof and dustproof in acc. with IP65 or IP67; designed for use in the engine compartment or the outside area of the vehicle
  - rugged to acceleration or mechanical damage
  - rugged to extreme environmental conditions (temperature, dampness, EMC)
  - very low temperature coefficients contribute to the reduction in the number of measurement errors

For the complete technical data of the ES432.1, refer to the chapter “Technical Data” on page 81.

4.3 Housing

A sturdy metal housing is used for the ES432.1; it has ports on the front of the device so it can fit into tight spaces. The ES432.1 is specifically designed to be installed in engine compartment, but also in the passenger cell.

The housings of the ES400 family can quickly and easily be connected to one another to create a measurement system (see section 7.2 on page 43). The modules can easily be screwed directly to a carrier system or attached to it using cable fasteners both in the vehicle and in the lab.

These simple and uncomplicated ways of attaching the modules make them flexible in terms of assembly. These methods of attachment can also be used in harsh environmental conditions (salt fog, dirt).

CAUTION

Loss of Features as defined by IP67!
Do not open or change the module housing!
Works on the module housing may be executed only by qualified technical personnel.

4.4 Ports

All ports of the ES400 measuring modules are on the front of the device (see Fig. 4-2 on page 20).

The LEMO and Souriau connectors used adhere to protection class IP67. All ports are reverse-polarity protected due to the exclusive use of coded LEMO or Souriau connectors.

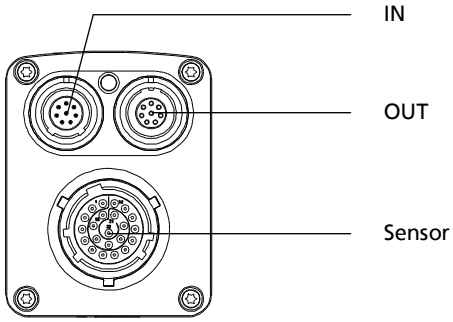


Fig. 4-2 Front

4.4.1 “Sensor” Port

The front of the ES432.1 features a 22-pin Souriau port to which four sensors can be connected using a adapter cable. An individual sensor power supply port is available for each sensor.

The use of a “cable tail” or “whip” solution with just one connector makes it possible to change the modules quickly within complex test setups.

4.4.2 Daisy Chain Ports (“IN”, “OUT”)

The modules are connected using a daisy chain topology. This means each module has an explicit input socket and an explicit output socket. The Ethernet data line and the supply voltage are routed through the daisy chain ports of the module:

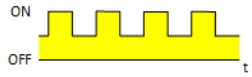
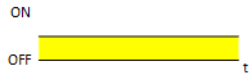
- “IN” (input)
- “OUT” (output)

The PC, the modules ES523, ES59x, ES600.2, ES891, ES910.3 or the Drive Recorder ES720 are connected at the “IN” port (input). The “OUT” port (output) is connected to the following module of the ES400 line or remains free on the last module of the chain.

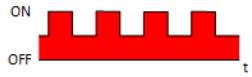
4.5 LED

Every module has an LED. It indicates the following states of the module:

4.5.1 Operational State

Display		State
	off	No power supply to the module
	yellow flashing 0,25 s on / 0,25 s reduced	Initialization of the module not yet complete - Further modules in a chain not initialized yet
	green illuminated semi bright	Normal
	yellow illuminated semi bright	At least one sensor supply voltage is activated.
	green flashing 0,1 s on / 1,9 s off	Standby No Ethernet connection established

4.5.2 Service State

Display		State
	red flashing 0,25 s on / 0,25 s reduced	Module identification
	red flashing 0,1 s on / 0,6 s off	Update of the firmware / HDC

4.5.3 Functional State

Display		State
	yellow-red flashing 0,5 s yellow reduced / 0,5 s red reduced	Warning Overload on a sensor supply voltage channel
	red illuminated fully bright	Error during self-test
	red illuminated semi bright	Internal error

NOTE

The general display of an error state with the LED of the ES432.1 is assigned uniquely to the special error categories in the calibration software (diagnostics).

5 Hardware Description

This chapter contains information on the following topics:

5.1 Features of the ES432.1

Fig. 5-1 ES432.1 Housing

The ES432.1 Lambda Module belongs to the family of ES400 modules. It is a robust and easy to use lambda measuring instrument which, in connection with the Robert Bosch broadband lambda sensor LSU4.9 and with the Robert Bosch broadband lambda sensor LSU ADV, enables inexpensive emission measuring for SI, diesel and gas engines.

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

- Lambda λ
- 1/Lambda 1/λ
- Oxygen content O_2
- Air/fuel ratio, A/F
- Fuel/air ratio, F/A

- Internal resistance of the lambda sensor R_i
- Pump current of the lambda sensor I_p

The Lambda Module ES432.1 is set to curves determined on test benches for operation with the lambda sensor LSU4.9 and the lambda sensor LSU ADV. The ES432.1 operating parameters for the connected sensor are selected automatically.

For the complete technical data of the ES432.1, refer to the chapter “Technical Data” on page 81.

5.2 Block Diagram

The ES432.1 is a module with electronics which provide all signals necessary for operating a broadband lambda sensor. A microprocessor system with two Ethernet interfaces processes the acquired values. In addition, a value can be issued at a galvanically isolated analog output.

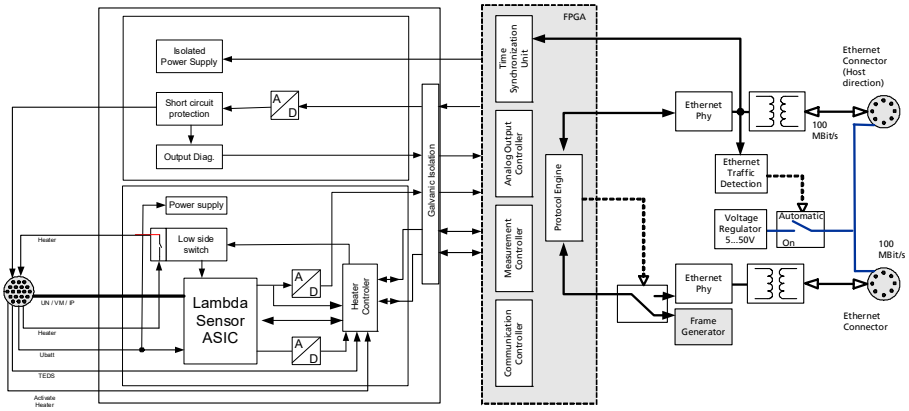


Fig. 5-2 Block Diagram

The electronics control the heating of the sensor 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.

5.3 Measurement Channel

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

5.3.1 Signal Processing and Filters

In pump current measuring, the amplified signal of the pump current controller is filtered with a Bessel 2nd order low-pass with 100 Hz cutoff frequency. An A/D converter digitizes this pump current signal with a sampling rate of 2 kHz. Sampling takes place synchronously with other devices of the ES400 family. A digital Bessel 4th 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.

The data is sent to the calibration software on the PC once acquired.

When measuring the internal resistance, the signal is filtered by a Bessel 2nd order low-pass with a cutoff frequency of 5 Hz. The subsequent A/D converter 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.

5.3.2 Heater Control

To operate the sensor at the nominal value of operating 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 ES432.1 and can therefore guarantee an operational sensor even when the module is switched off.

5.3.3 Analog Output

The ES432.1 also has a port for analog output signals which can be used with the sensor cables CBAL451.1, CBAL4515.1, CBAL463.1 and CBAL4635.1.

The analog output of the ES432.1 is galvanically separated, protected against shorts and overload (see section 9.10.4 on page 89).

5.4 Sensor Identification (TEDS)

The connected sensor must be identified which ensures that the operating parameters of the ES432.1 correspond to the connected sensor and that errors are impossible.

The sensor cables for the LSU4.9 contain an active component (TEDS) for cable identification and therefore the connected Bosch Lambda Sensor LSU4.9. The Bosch Lambda Sensor LSU ADV (Code A7) contains an own active component (TEDS) for sensor identification.

5.5 Sensor Cables

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 socket.

5.6 Data Transfer

For data transfer, the ES930.1 as well as the ES4xx and ES63x 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.

5.6.1 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. 5-3 on page 26).

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 modules avoids repeated transfer of protocol data, which takes place, for example, in handshake-based systems. This makes a high bandwidth available for reference data.

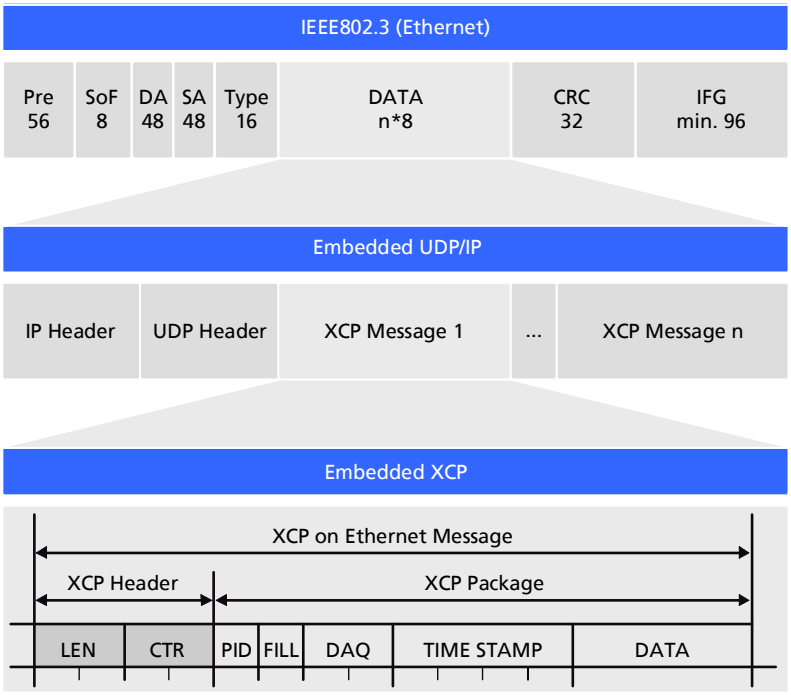


Fig. 5-3 Message Format “XCP on UDP” (Schematic)

Using the UDP/IP standard for data transfer makes it possible to connect the 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 fulfil high real-time requirements, can thus be connected directly to an ES400 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 ES400 family makes it possible for third-party suppliers to use the communication protocol for their own, non-ETAS applications once the modules have been configured with the „ES4xx Configuration Tool from ES4xx_DRV_SW“ .

5.6.2 Realization

Time Slice Procedure

The 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 modules respond like a single Ethernet device with one MAC address.

All daisy chained 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 module chain or the network module ES600. In both cases, the measure data is synchronized with a tolerance of one microsecond. Using an ES600 network module, several ES4xx/ES63x/ES93x chains can be synchronized with each other or with the modules of the ES600 series. The ES4xx/ES63x/ES93x 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 ES4xx/ES63x/ES93x and ES600 modules used resulting from this makes precise analysis of the correlations of measure signals possible.

Synchronizing the Modules and INCA Signal Processing

Data transfer does not require synchronization of the local timebases of the ES4xx/ES63x/ES93x modules. The time stamps are still synchronized by the 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 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 modules.

5.6.3 Examples

Example 1

Fig. 5-4 on page 29 shows an example of an application with three concatenated ES400 modules with the same acquisition rates. The transfer scheme for this configuration is shown in Fig. 5-5 on page 29.

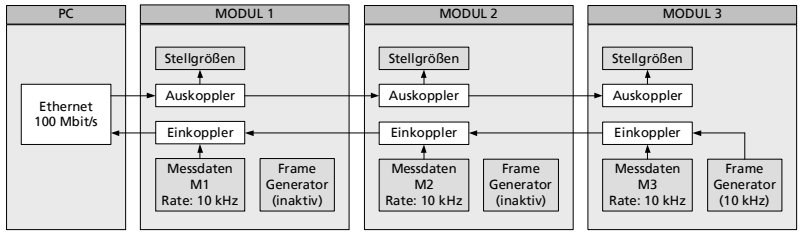


Fig. 5-4 Time-Multiplex Data Transfer Between an ES400 Module Chain and a PC

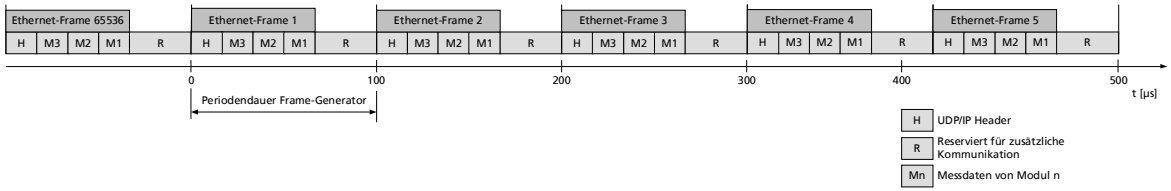


Fig. 5-5 Transfer Scheme for Example 1 (Simplified, Not True to Scale)

In this example, the third module periodically generates 2^{16} (65536) time slices each 100 microseconds long. Modules 1, 2 and 3 acquire measurements with the same rate of 10 kHz each. Module 1, Module 2 and Module 3 link their measurements to each time slice (see Fig. 5-5 on page 29).

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

Example 2

Fig. 5-6 on page 30 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. 5-7 on page 30.

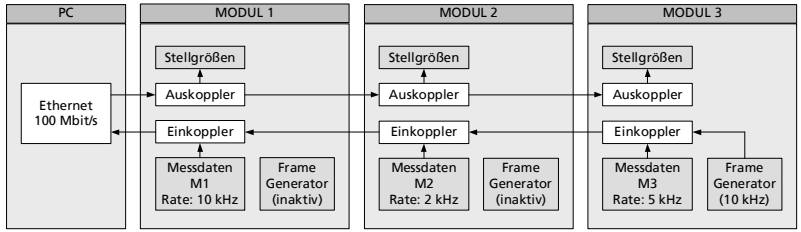


Fig. 5-6 Time-Multiplex Data Transfer Between an ES400 Module Chain and a PC

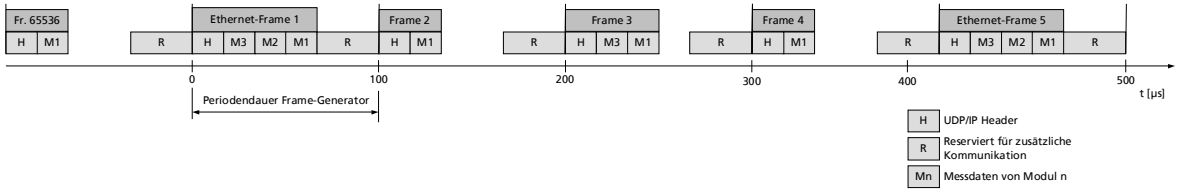


Fig. 5-7 Transfer Scheme for Example 2 (Simplified, Not True to Scale)

In this example, the third module periodically generates 2^{16} (65536) time slices (Ethernet frames) each 100 microseconds long. The ES400 modules 1, 2 and 3 acquire measurements at a rate of 10 kHz, 2 kHz and 5 kHz. Module 1 links its measurements 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.

5.7 Power Supply

5.7.1 Supply Voltage

DC/DC converters in every module guarantee both the operation as well as the launch of the ES400 modules with supply voltages between 5 V and 50 V DC over the entire temperature range.

With the power supply management of the ES432.1, you can use an automatic power-saving feature (“Standby”) as well as a “Wake Up” function via the Ethernet interface.

5.7.2 Supplying the ES400 Modules via the Connecting Line

In the simplest application case, the modules are directly linked to one another. They are connected to the supply voltage via the previous module all the way.

5.7.3 Additional Supply of the ES400 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
- consumption of sensor power supply of the connected sensors
- cable length
- cable type
- ambient temperature

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

NOTE

Please contact our local experts to discuss your particular ES432.1 configurations.

Example 1:

For module chains which are equipped exclusively with ES432.1 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 7.7V , no additional feeding is necessary with a Y cable if the module chain consists of the following modules:

- nine ES420 modules and
- four ES432.1 modules and
- one ES441 module

NOTE

All examples apply at 85 °C ambient temperature.

5.7.4 Supply Voltage of the Lambda Sensor

The lambda sensor requires a supply voltage to operate the heating. When several ES432.1 modules are used, each lambda sensor must be powered separately.

NOTE

Depending on the operating mode, the sensor can continue to be heated independently of whether power is supplied to the module (see section 6.7 on page 40).

5.8 Configuration

5.8.1 Configuring the ES432.1

The configuration of the ES432.1 is performed entirely via the GUI within INCA.

The configuration of the individual channels is saved either in INCA or in the individual ES400 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 test setup. In this way, several users can call up the saved configuration directly from the modules.

5.8.2 Configuring the Lambda Sensor

The ES432.1 and the lambda sensors LSU4.9 are designed to be operated together. No device-specific or sensor-specific settings have to be made.

5.9 Tool Integration

The ES400 modules can be selected and configured in INCA 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.

5.10 Firmware update

The firmware of the module can be updated by the user so that future versions of the module can also be used. The firmware update is done with the help of the service software "Hardware Service Pack" (HSP) from the connected PC.

NOTE

During a firmware update, neither the voltage supply nor the Ethernet connection may be interrupted!

5.11 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 127). For information on ordering the calibration service, refer to chapter “Calibration” on page 125.

6 Functional Description

This chapter contains information on the following topics:

6.1 Broadband Lambda Sensor LSU

The broadband lambda sensor is a planar two-cell, marginal current sensor. The combination of modular design and planar technology permits the integration of several functions.

As the LSU sensor consists of a combination of a Nernst concentration cell (sensor cell) and a pump cell transporting oxygen ions, it can carry out precise measurements not only in the stoichiometric point at $\lambda = 1$, but also in the lean and rich ranges. Each sensor is calibrated individually.

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

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

6.2 Operating Modes of the Measurement System

The measurement system consisting of ES432.1 and lambda sensor can either be in a “Normal” operating mode or on “Standby”.

In the operating mode “Normal”, the ES432.1 is operated alone or in connection with other modules of the ES400 family. The lambda sensor is connected to the ES432.1 using a CBAL45x cable. When using a cable with an additional analog output, a measure value is available additionally as an analog voltage signal at the BNC socket of the sensor cable (see section 6.3.2 on page 36).

No measure values are available when it is “Off” or on “Standby”. The lambda sensor can continue to be heated if necessary (see section 6.7 on page 40).

6.3 Measure Values

6.3.1 Output in the Calibration Software

You can acquire the following measure values in the calibration software with the ES432.1 Lambda Module:

- Lambda λ
- 1 / Lambda λ
- Air/fuel ratio, A/F
- Fuel/air ratio, F/A
- Oxygen content O_2
- Pump current of the lambda sensor I_p
- Internal resistance of the lambda sensor R_i

All measure values are available simultaneously and can be calibrated in the calibration software.

6.3.2 Output at the Analog Output

Measure Value

When using the sensor cable with an additional analog output individual measure values, which the ES432.1 sends to the PC via XCP, can be output as an analog voltage value at the analog output of the sensor cable. In the calibration software, you can select one each of the following measure values for output at the analog output of the ES432.1:

- Lambda λ
- 1 / Lambda λ
- Air/fuel ratio, A/F
- Fuel/air ratio, F/A
- Oxygen content O_2
- Pump current of the lambda sensor I_p

Output Voltage

Dimensional equations apply for the output voltage at the analog output of the ES432.1 according to the measure value output (see section 9.10.4 on page 89).

6.4 Measurement Channel Characteristics

The characteristics of the measurement channels can be configured for signal evaluation and the settings displayed in the calibration software.

6.4.1 IIR Filter Frequency

Select the cutoff frequency of the filter (in Hz) which is to be used to smooth the measure signal. A low cutoff frequency results in a highly smoothed measure result indicating the measurement average. With a high cutoff frequency, any peaks which occur during measuring can be seen.

NOTE

The filter setting selected in the calibration software is used for all measure values which are output (via XCP and via the analog output).

6.4.2 Range Min.

Specification of the lower limit of the selected measurement range.

6.4.3 Range Max.

Specification of the upper limit of the selected measurement range.

6.5 Module Characteristics

The operating parameters of the module can be displayed and also configured to an extent in the calibration software.

NOTE

Lots of parameters have been preset to ensure safe operation of the sensor and cannot be modified.

6.5.1 Analog Output

Selection of the measure value at the analog output (see section 6.3.2 on page 36).

6.5.2 Curve

Shows the name of the curve which the module uses to calculate lambda.

6.5.3 Heating

Selection of the operating mode of the heater control of the lambda sensor when only the lambda sensor is supplied with power or if the module is on “Standby” (see section 6.7.1 on page 40).

6.5.4 IP Ref

Shows the value of the reference pump current.

6.5.5 RI Nom

Shows the desired value of the sensor internal resistance which is used for heater control.

6.5.6 Correction Factor

Shows the linear correction factor for the pump current which is used to correct the starting values of older lambda sensors (see section 7.8 on page 70).

6.5.7 Heater Curve

Shows the name of the heater curve which the module uses when heating the lambda sensor.

6.6 Diagnostic Functions

The ES432.1 constantly checks that the lambda sensor is working correctly. Any deviations are shown via the LED. The operational state diagnosed is displayed in the calibration software.

6.6.1 Internal Sensor Resistance Ri

Shows whether the internal sensor resistance R_i deviates more than 10% above or below the desired temperature value 300 Ohm.

6.6.2 Lambda Control

Shows the operational state of the lambda control, any lack of supply voltage to the sensor or an internal defect in lambda control.

6.6.3 Sensor Type

Shows whether the ES432.1 is connected to the correct lambda sensor type (LSU4.9, LSU ADV). This is detected via the identification of the special cable (LSU4.9) or of the sensor (LSU ADV).

6.6.4 Sensor Supply

Shows whether the sensor supply voltage is within the range permissible for sensor heating. In the case of a value under the minimum input voltage defined, "lambda control" displays an error, as lambda control then does not work any more.

6.6.5 Lambda Sensor Short

Shows shorts of the cables and connectors involved in measuring which lead to incorrect measurements. Shorts of the sensor heater result in an overheated heater current and blow the fuse in the sensor cable. As a result, the “lambda control” error is displayed when this overcurrent problem occurs.

6.6.6 Internal Status

A status error has occurred when the programs and parameters were being checked. An update with HSP is necessary to return to a consistent basic state.

NOTE

If this error state cannot be recovered, send the module to ETAS for repair.

6.6.7 Plausibility Error

The “Power On” self-test has resulted in inconsistent measure values. The cause could also be a defective sensor, a defective cable or a sensor in an extreme operational state (a very cold sensor or an overheated sensor).

NOTE

If this error state cannot be recovered, send the module to ETAS for repair.

6.6.8 Calibration State of the Module

Display of the calibration state of the connected ES432.1.

NOTE

If “Not calibrated” is displayed in the calibration software, send the module to ETAS for repair.

6.6.9 External Signal

Shows the state of the external signal at the control cable for the sensor heater control.

6.7 Sensor Heating

The heating of the sensor can be powered on independently of the power supply of the module as the heater control is supplied with power via the sensor cable.

NOTE

The operating modes of the sensor heating described below only apply if the module is off or on “Standby”. When the ES432.1 is in operating mode "On", the lambda sensor is always heated!

6.7.1 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 ES432.1 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, ES432.1 and calibration software) is active. An example of an application for this setting is working on the test bench.

6.7.2 Heater Control

The heater control of the ES432.1 is adapted to the lambda sensors LSU4.9 and LSU ADV. The heater curve ensures a short warm-up phase and minimum thermal load of the sensor. The curve controls the relative heating performance of the sensor until the working temperature of 780° C has been reached.

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

- the operational state of the ES432.1 (“On”, “Off”, “Standby”),
- a heater control parameter selected in the calibration software,
- an external voltage for heater control as well as
- the supply voltage range of the sensor.

The control of the possible states of heater control is shown in the table.

Operational State	Control of the Sensor Heating via		Supply voltage	Heater Control
ES432.1	Parameter in the Calibration Software [1]	External Signal [2]	Sensor	State
On	x	x	In target range	Enabled
Off/Standby	Off	x	x	Disabled
Off/Standby	On	x	In target range	Enabled
Off/Standby	External signal	On	In target range	Enabled
Off/Standby	External signal	Off	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. +2 V
x: No influence on heater control

7 Getting Started

This chapter contains information on the following topics:

7.1 General Installation Recommendations

7.1.1 Assembly Environment and Components for Attaching the Module

CAUTION

The module can be damaged or destroyed.
The modules of the ES400 line 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 9 on page 81).

Adhere to the technical data of the modules for operation, such as

- the vibration resistance of the modules (only assemble modules on sprung masses, for example, and not on wheel suspensions or directly on the engine) and
- the temperature resistance of the modules (for example do not assemble modules on the engine, turbocharger, exhaust manifold or within their vicinity).

7.1.2 Potential Equalization in the Vehicle and Mounting the Modules

CAUTION

Potential equalization in the vehicle over the shield of the Ethernet connecting cables of modules may occur!
Mount the modules only to components with the same electrical potential or insulate the modules from the components.

7.1.3 Guarantee of Features as defined by IP67

CAUTION

Loss of Features as defined by IP67!
Water standing at the pressure balance element damages the membrane!
Please observe which way the module is pointing when installing vertically!

If installing the ES400 modules where water or other liquids could collect, install the modules so that the (black) pressure balance element on the back of the modules is not pointing upwards or that liquids can drain away.

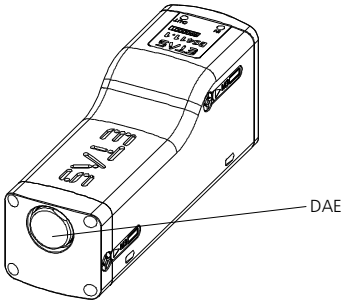


Fig. 7-1 Position of the Pressure Balance Element

Standing liquids or liquids which do not flow away from the pressure balance element can permanently damage the membrane. The module then loses the features defined by IP67.

7.2 Assembly

7.2.1 How to Connect and Attach ES400 Modules

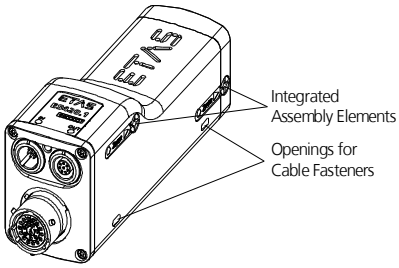


Fig. 7-2 How to Attach ES400 Modules

Integrated Assembly Elements

Every ES400 module has two integrated assembly elements to enable different assembly possibilities. If several modules are required in one location, they can be connected quickly, without any additional parts, using the integrated assembly elements to form a measuring instrument block (cascading). The two integrated assembly elements also make it possible to screw the modules directly onto other components (parts of the vehicle body, units).

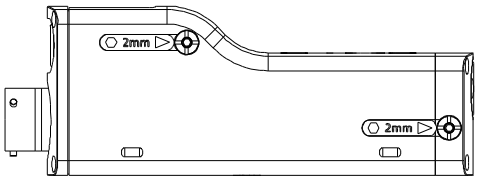


Fig. 7-3 Accessing the Integrated Assembly Elements

You can access and use the two integrated assembly elements of a module via the holes indicated (see Fig. 7-3 on page 44) on the right-hand side of the module.

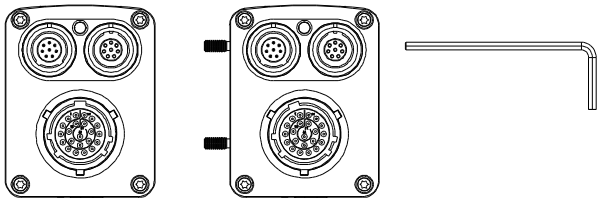


Fig. 7-4 Unscrewed Integrated Assembly Elements

Openings for Cable Fasteners

Every module base has two openings each on the right and left-hand side for attaching the modules to other components using cable fasteners.

Examples for mounting

Examples for mounting using the different possibilities to connect and attach ES400 modules are:

- Connect ES400 modules with the integrated assembly elements (cascading)
- Attaching ES400 modules with the integrated assembly elements:
  - on DIN rails with ES4xx angle brackets (left)
  - on other components
- Attaching ES400 modules with screws:
  - on DIN rails with ES4xx angle brackets (right)
  - on other components
- Attaching ES400 modules with cable fasteners:
  - on DIN rails with ES4xx angle brackets (left)
  - on DIN rails with ES4xx angle brackets (right)
  - on other components

7.2.2 Connecting Several ES400 Modules Mechanically

You can combine any ES400 modules with each other using the integrated assembly elements of the ES400 modules.

Here, you connect the ES400 modules using the integrated assembly elements.

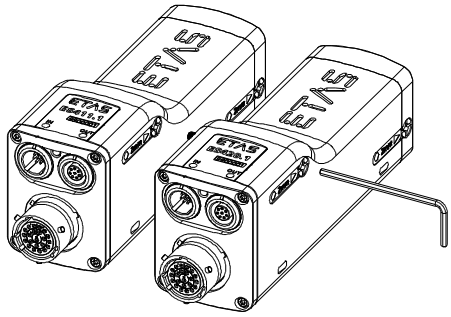


Fig. 7-5 Connecting ES400 Modules Using the Integrated Assembly Elements

Rules on Connecting the Modules

Observe the following rules when connecting the modules as required:

> **NOTE**
>
> The two integrated assembly elements can only be accessed from the right-hand side of the module and can only be turned using an Allen key.
> When connecting the modules, you must therefore always screw the module on the right to the module on its left.
> You can only successively screw additional modules, but not module blocks, onto the right-hand side of this module block.
> When creating module blocks, observe the defined order.

Preparing the Modules

To position the modules:

1. Position the modules to be connected in the required order.

   > **NOTE**
   >
   > Both modules' ports must point left.

2. Position the modules so that their fronts are in a line.
3. Hold the two modules together firmly on their outer sides.

Connecting the Modules

To connect several ES400 modules, you require a 2 mm Allen key (minimum length 20 mm).

To connect the modules:

1. Insert the Allen key into a hexagon socket on the right-hand side of the right-hand module.

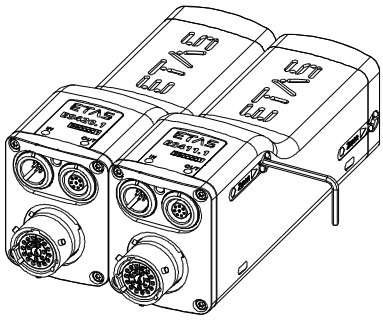


Fig. 7-6 Connected ES400 Modules

2. Screw the two modules by turning the Allen key clockwise as far as it will go within the module.

> **NOTE**
>
> Screw the two modules together without getting them off-thread!

   Both modules are now connected mechanically on one side.

3. Insert the Allen key into the other hexagon socket of the right-hand module.
4. Screw the two modules by turning the Allen key clockwise as far as it will go within the module.

> **NOTE**
>
> Screw the two modules together without getting them off-thread!

   Both modules are now completely connected mechanically.

Connecting to Other Modules

> **NOTE**
>
> You can only successively screw additional modules, but not module blocks, onto the right-hand side of this module.

To connect the ES400 module to other modules, you require a 2 mm Allen key (minimum length 20 mm).

To connect to other modules:

1. Assemble other modules in accordance with the procedure described in the section 7.2.2 on page 45.

7.2.3 Attaching ES400 Modules to Other Components Using the Integrated Assembly Elements

The integrated assembly elements of the ES400 modules can not only be used to connect modules to each other but also to connect them to other components.

Here, you connect the ES400 module to the component using the integrated assembly elements. Screwing the two together works in the same way as connecting several modules.

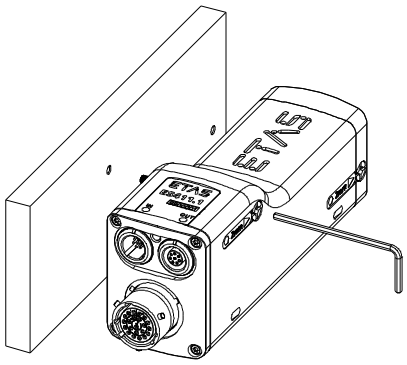


Fig. 7-7 Attaching a Module to Other Components with the Integrated Assembly Elements

Rules on Attaching the Modules to Other Components

Observe the following rules when connecting the modules as required to other components:

> **NOTE**
>
> The two integrated assembly elements can only be accessed from the right-hand side of the module and can only be turned using an Allen key.
> You therefore have to screw the module to the other component from the right.
> You can only successively screw additional modules, but not module blocks, onto the right-hand side of this module.

Preparing the Component

To cut the thread in the component:

1. Cut two M3 threads into the selected component.

   The threads should be cut 8 mm deep.

   > **NOTE**
   >
   > Use the drilling template (see Fig. 7-13 on page 57).

Connecting the Module to the Component

To connect the ES400 module to the component, you require a 2 mm Allen key (minimum length 20 mm).

To connect the module and the component:

1. Position the module to the right of the other component.
2. Align the integrated assembly elements of the module with the drill holes.
3. Insert the Allen key into a hexagon socket on the right-hand side of the module.
4. Screw the two parts together by turning the Allen key clockwise as far as it will go within the module.

   NOTE

   Screw the two parts together without getting them off-thread!

   Both parts are now connected mechanically on one side.
5. Insert the Allen key into the other hexagon socket of the module.
6. Screw the two parts together by turning the Allen key clockwise as far as it will go within the module.

   NOTE

   Screw the two parts together without getting them off-thread!

   Both parts are now completely connected mechanically.

Connecting to Other Modules

NOTE

You can only successively screw additional modules, but not module blocks, onto the right-hand side of this module.

To connect the ES400 module to other modules, you require a 2 mm Allen key (minimum length 20 mm).

To connect to other modules:

1. Assemble other modules in accordance with the procedure described in the section 7.2.2 on page 45.

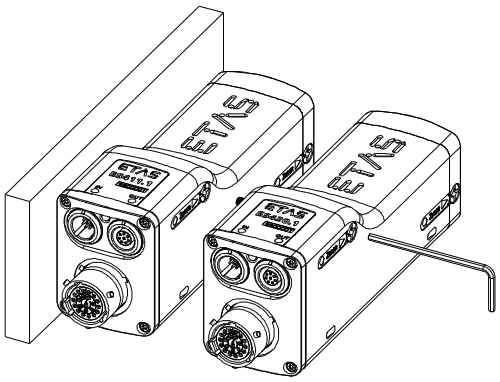


Fig. 7-8 Connecting to Other Modules

7.2.4 Attaching ES400 Modules on DIN Rails with the Integrated Assembly Elements

With the integrated assembly elements of the ES400 modules, you can not only connect the modules with each other, but also with DIN rails.

For this fastening variant, you connect the ES400 module with the DIN rail using an ES4xx angle bracket (left). The screw connection follows the principle of connecting several modules.

Fasten the ES400 modules on DIN rails with the integrated assembly elements using the following steps:

1. Connect the module with the ES4xx angle bracket (left).
2. Connect the module with additional modules (as required).
3. Connect the ES4xx angle bracket with the DIN rail.

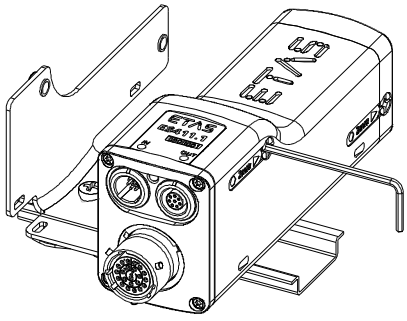


Fig. 7-9 Fastening to an ES4xx Angle Bracket (left) using the Integrated Assembly Elements

Rules on Connecting the Modules on the DIN Rails using the ES4xx Angle Bracket (left)

To be able to fasten the modules in the desired arrangement with the ES4xx angle bracket (left) on DIN rails, observe the following rules:

NOTE

The two integrated assembly elements are accessible only from the right side of the module and can be rotated with a hex key.
For this reason, the module must always be screwed onto the ES4xx angle bracket (left) from the right side.
Additional modules can only be screwed onto the right side of this module, but not any module blocks.

Connect the Module with the ES4xx Angle Bracket (left)

Connecting the ES400 module with the ES4xx angle bracket (left) requires a 2 mm hex key (minimum length 20 mm).

Connecting the module and the ES4xx Angle Bracket (left):

1. Position the module to the right of the ES4xx angle bracket (left).
2. Align the integrated assembly elements of the module with the bores.
3. Insert the hex key in a hexagon head on the right side of the module.
4. Screw the parts together by turning the hex key clockwise to the stop within the module.

   NOTE

   Screw the two parts together without canting the threads!

   Both parts are now mechanically connected on one side.
5. Insert the hex key in the other hexagon head of the module.
6. Screw the parts together by turning the hex key clockwise to the stop within the module.

   NOTE

   Screw the two parts together without canting the threads!

   Both parts are now completely connected mechanically.

Connecting with Additional Modules

NOTE

Additional modules can only be screwed onto the right side of this module, but not any module blocks.

Connecting the ES400 module with additional modules requires a 2-mm hex key (minimum length 20 mm).

Connecting with additional modules:

1. Connect additional modules according to the procedure described in chapter 7.2.2 on page 45.

Connecting the ES4xx Angle Bracket with the DIN Rail

Connecting the ES4xx Angle Bracket (left) with the DIN rail

1. Place the ES4xx angle bracket onto the DIN rail.
2. Insert the hooks of the ES4xx angle bracket into the upper part of the DIN rail.
3. Engage the ES4xx angle bracket in the DIN rail by pressing on the ES4xx angle bracket or the module.

   The module connected with the ES4xx angle bracket is fastened to the DIN rail.

7.2.5 Attaching ES400 Modules to Other Components with Screws

Here, you connect the ES400 module to the component using two additional M3 screws which are screwed into the drill holes of the component. The integrated assembly elements of the module are not used.

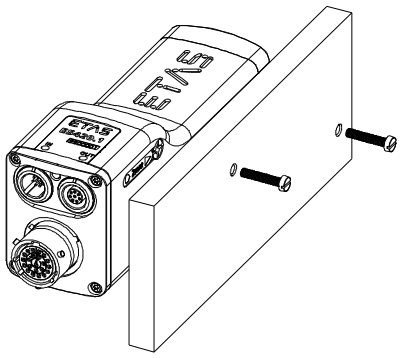


Fig. 7-10 Attaching to Other Components Using Additional Screws

Rules on Attaching the Modules to Other Components

Observe the following rules when connecting the modules as required to other components:

NOTE

The two integrated threaded holes in the module are only accessible from the right-hand side of the module.
You therefore have to screw the other component onto the module from the right.
Once the module is screwed to the other component, you cannot screw any further modules to this one.

Preparing the Component

NOTE

The pivot of the integrated assembly element can be screwed around 6 mm out of the module.

To drill the openings in the component:

1. Drill two holes in the selected component.

   NOTE

   Use the drilling template to prepare the component (see Fig. 7-13 on page 57).

Connecting the Module to the Component

To connect the ES400 module to the component, you need two screws M3 and a screwdriver.

To connect the module and the component:

1. Position the module to the right of the other component.
2. Align the threaded drill holes of the integrated assembly elements on the right-hand side of the module to the openings in the component.
3. Insert one screw into a hole in the component.
4. Screw the screw from the right-hand side of the component into the module.

   NOTE

   Screw the two parts together without getting them off-thread!

   Both parts are now connected mechanically on one side.
5. Insert the other screw into the other hole in the component.

6. Screw the screw from the right-hand side of the component into the module.

> **NOTE**
>
> Screw the two parts together without getting them off-thread!

Both parts are now completely connected mechanically.

Connecting to Other Modules

> **NOTE**
>
> If a module has been screwed to the other component, no other modules can be screwed to this module component connection.

You can attach several ES400 modules to the other component using the method described in this chapter if you first connect all modules to be installed with each other step by step (see section 7.2.2 on page 45). The module on the extreme right of the module block is connected to the other component like an individual module - using screws.

7.2.6 Attaching ES400 Modules on DIN Rails using Screws

With the integrated assembly elements of the ES400 modules, you can not only connect the modules with each other, but also with DIN rails.

For this fastening variant, you connect the ES400 module with the DIN rail using an ES4xx angle bracket (right) and two additional M3 screws inserted through their bores. The integrated assembly elements of the module are not used.

Fasten the ES400 modules on DIN rails with the integrated assembly elements using the following steps:

1. Connect the module with additional modules (as required).
2. Connect the module with the ES4xx angle bracket (right).
3. Connect the ES4xx angle bracket with the DIN rail.

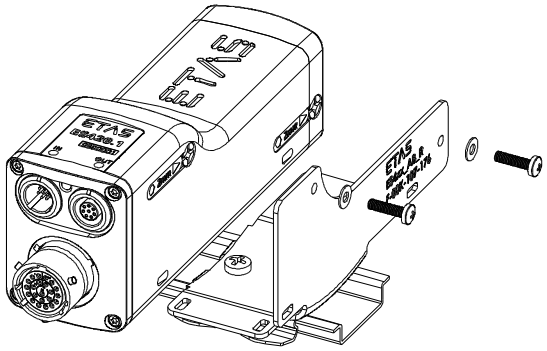


Fig. 7-11 Fastening on DIN Rails with Additional Screws

Rules on Connecting the Modules on the DIN Rails using the ES4xx Angle Bracket (right)

To be able to fasten the modules in the desired arrangement with the ES4xx angle bracket (right) on DIN rails, observe the following rules:

NOTE

The two integrated thread bores in the module for accepting the screws can be accessed only from the right side of the module.
For this reason, the ES4xx angle bracket (right) must always be screwed onto the module from the right side.
If the module is screwed onto the ES4xx angle bracket (right), no additional modules can any longer be screwed onto this module.

Preparing the Component

NOTE

The pin of the integrated assembly element can be screwed out of the module by approximately 6 mm.

Connecting the Module with the ES4xx Angle Bracket (right)

To connect the ES400 module with the ES4xx angle bracket (right) requires two M3 screws, two washers and a screwdriver.

Connecting the module and the ES4xx Angle Bracket (right):

1. Position the module to the left of the ES4xx angle bracket (right).
2. Align the thread bores of the integrated assembly elements on the right side of the module with the through bores of the ES4xx angle bracket (right).
3. Insert one screw through the bore of the ES4xx angle bracket (right).
4. Fasten the screw with the module from the right side of the ES4xx angle bracket.

   NOTE

   Screw the two parts together without canting the threads!

   Both parts are now mechanically connected on one side.
5. Insert the other screw through the other bore of the ES4xx angle bracket (right).

6. Fasten the screw with the module from the right side of the ES4xx angle bracket.

   NOTE

   Screw the two parts together without canting the threads!

   Both parts are now completely connected mechanically.

Connecting with Additional Modules

NOTE

If a module is screwed onto the other component, no additional modules can be screwed onto this module-component connection.

Several ES400 modules can be fastened to the other component with the connection type described in this chapter if you connect all modules to be attached first with each other step by step (see chapter 7.2.2 on page 45). The module which is the furthest to the right of the module block is subsequently connected with the ES4xx angle bracket (right) as a single module and fastened to the DIN rail using screws.

Connecting the ES4xx Angle Bracket with the DIN Rail

Connecting the ES4xx Angle Bracket (right) with the DIN rail

1. Place the ES4xx angle bracket onto the DIN rail.
2. Insert the hooks of the ES4xx angle bracket into the upper part of the DIN rail.
3. Engage the ES4xx angle bracket in the DIN rail by pressing on the ES4xx angle bracket or the module.

   The module connected with the ES4xx angle bracket is fastened to the DIN rail.

7.2.7 Attaching ES400 Modules to Other Components Using Cable Fasteners

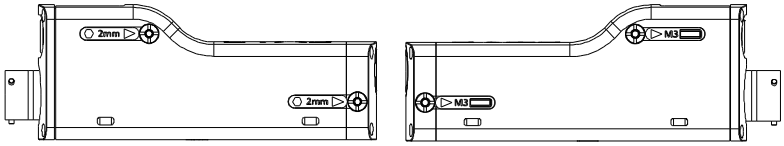


Fig. 7-12 Openings for Cable Fasteners in ES400 Modules

Every module base has openings for two cable fasteners each on the right- and left-hand side (see Fig. 7-12 on page 55). Just use cable fasteners to quickly attach the modules to other components in the test environment in the immediate proximity of the measuring points.

CAUTION

When assembling the modules, observe the admissible temperature range of the cable fasteners used!

Attaching ES400 Modules to Other Components Using Cable Fasteners

With this method of attachment, you connect the ES400 module or ES400 module blocks to the component using additional cable fasteners inserted through the openings of the modules. The integrated assembly elements of the module are not used.

Fastening ES400 Modules on DIN Rails using Cable Fasteners

For this fastening variant, the ES400 module or ES400 module blocks are connected with an ES4xx angle bracket (right) or with an ES4xx angle bracket (left) using additional cable fasteners inserted through the breakouts of the module. The integrated assembly elements of the module are not used.

The modules fastened to the ES4xx angle bracket are subsequently attached to the DIN rail.

Connecting the ES4xx Angle Bracket with the DIN rail

1. Place the ES4xx angle bracket onto the DIN rail.
2. Insert the hooks of the ES4xx angle bracket into the upper part of the DIN rail.
3. Engage the ES4xx angle bracket in the DIN rail by pressing on the ES4xx angle bracket or the module.

   The module connected with the ES4xx angle bracket is fastened to the DIN rail.

7.3 Drilling Template

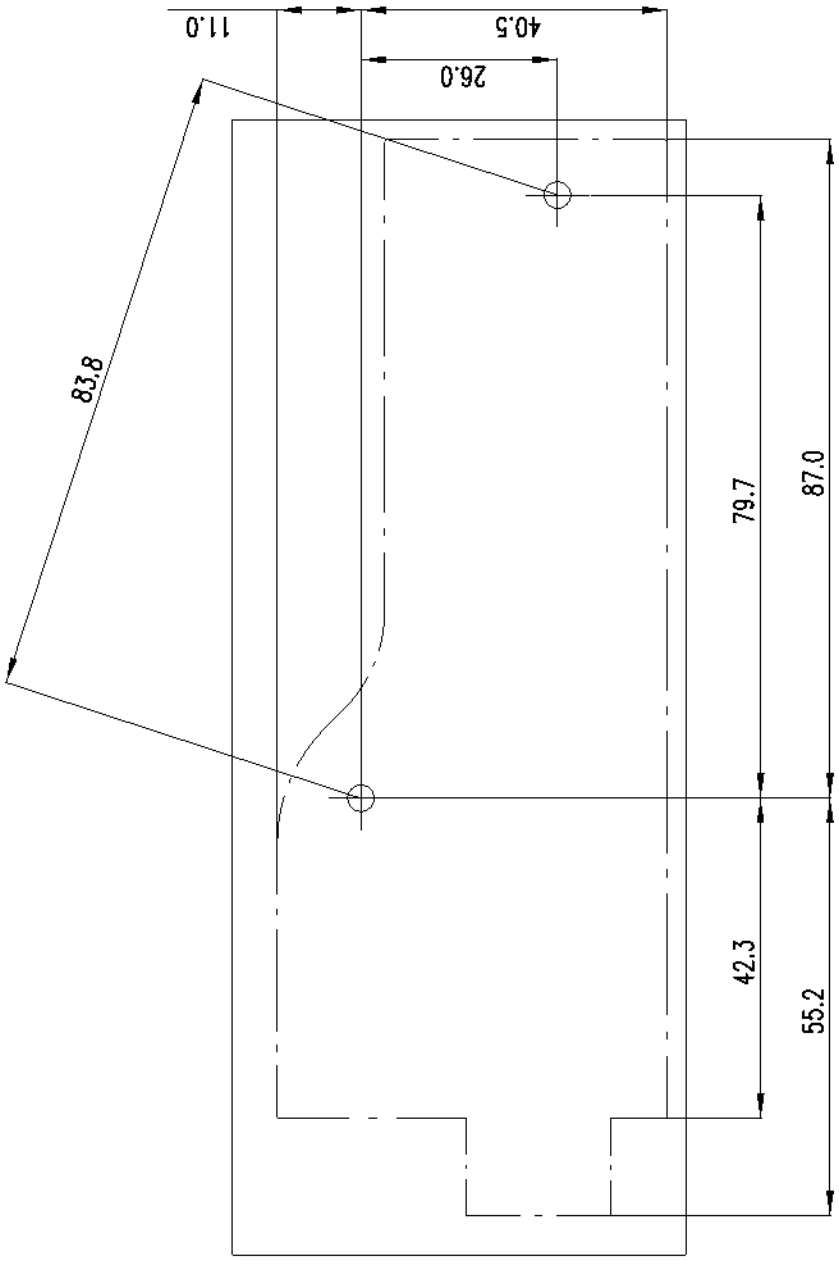


Fig. 7-13 Drilling Template

7.4 Installing the Lambda Sensor

NOTE

For more details on the lambda sensor LSU4.9, consult “Bosch: Technical Customer Information on the LSU4.9” (Y 258 K01 008-000e). For more details on the lambda sensor LSU ADV, consult “Bosch: Technical Customer Information on the LSU ADV” (Y 258 K01 024-000).

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 apply to the lambda sensors (which are not part of the delivery scope of the ES432.1):

Sensor	Max. Gas Temperatur	Max. Temperature at the hexagonal Srew
LSU4.9	930 °C	570 °C
LSU ADV	930 °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).

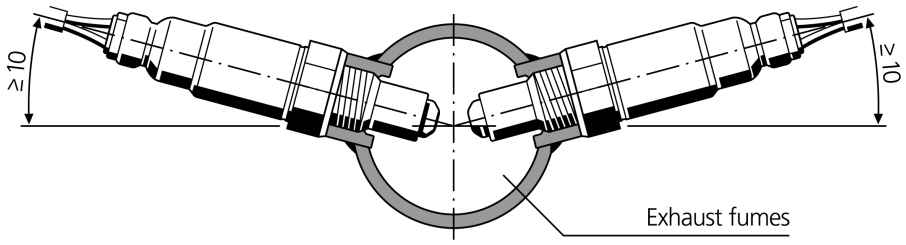


Fig. 7-14 Angle of Installation

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 LSU lambda sensor

NOTE

When installing the lambda sensor, please observe the installation guidelines in section 7.4 on page 58.

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.

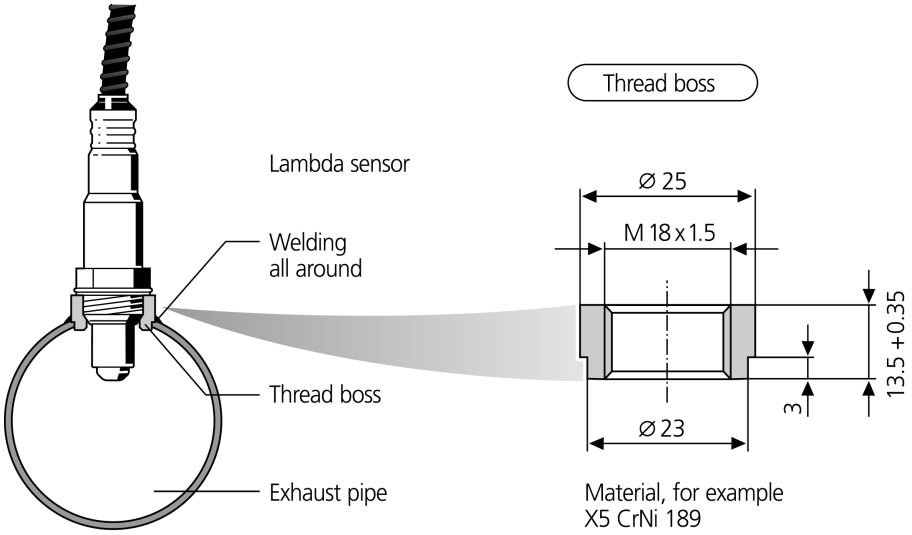


Fig. 7-15 Installation of the Lambda Sensor

3. When installing the LSU lambda sensor, ensure you use ultra-high heat-resistant lubricant (cf. Page 59). Spread it round the threaded boss of the LSU lambda sensor.

   This avoids difficulties when removing the sensor later.
4. At least half the tip of the LSU lambda sensor should extend into the exhaust pipe to obtain accurate mixture measurements.
5. Connect the ES432.1 to the power supply.

NOTICE

Incorrect use can result in the lambda sensor being damaged or aging prematurely.
The LSU lambda sensor must always be connected to the ES432.1 (heater control active) when exposed to engine exhaust gases.
Use operating modes “On” or “External Signal” of the heater control (see section 6.7.1 on page 40).

7.5 Applications

7.5.1 General

The modules ES4xx/ES63x/ES93x can be used for the following applications, individually or as part of a daisy chain module chain:

- Measuring and calibrating with INCA
- Rapid Prototyping with INTECRIO (with ES910.3 Prototyping Module or with RTPRO-PC).

Additional ECU and bus interface modules as well as measuring modules are networked with each other via Ethernet and connected with the daisy chain module chain.

The measuring setup can be supplemented with a drive recorder to record all of the data acquired by the connected modules. The drive recorder ES720.1 supports the simultaneous recording of different measurements (multi-recording). The data are stored in the ASAM standard format MDF (Measure Data Format). They can be conveniently evaluated using the Measure Data Analyzer MDA from ETAS and easily be compared with INCA reference measurements. The drive recorder ES720.1 can automatically transfer the recorded measure data encrypted and compressed via LAN, WLAN or wireless radio to customer-specific data servers.

7.5.2 ES432.1 with additional ETAS Modules (MC Application)

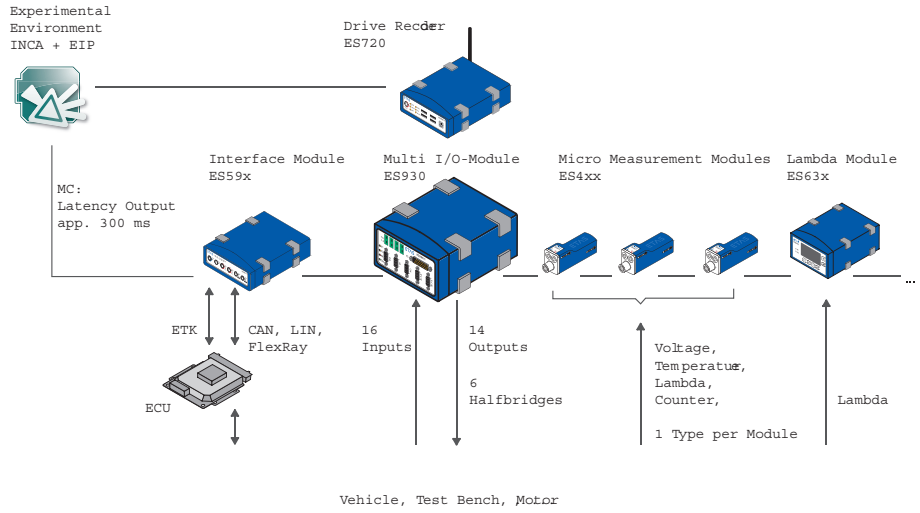


Fig. 7-16 ES432.1 with additional ETAS Modules for MC Applications

The ETAS Daisy Chain concept enables a simple network architecture since only the ES432.1 or the first module of the module chain is connected with the PC or with the "ETH" port of the ES59x.1.

Additional bus analysis functions on the CAN, LIN and FlexRay buses as well as (X)ETK bypass applications with measuring and calibrating can be made accessible with ES59x modules.

7.5.3 ES432.1 with additional ETAS Modules (Rapid Prototyping Application)

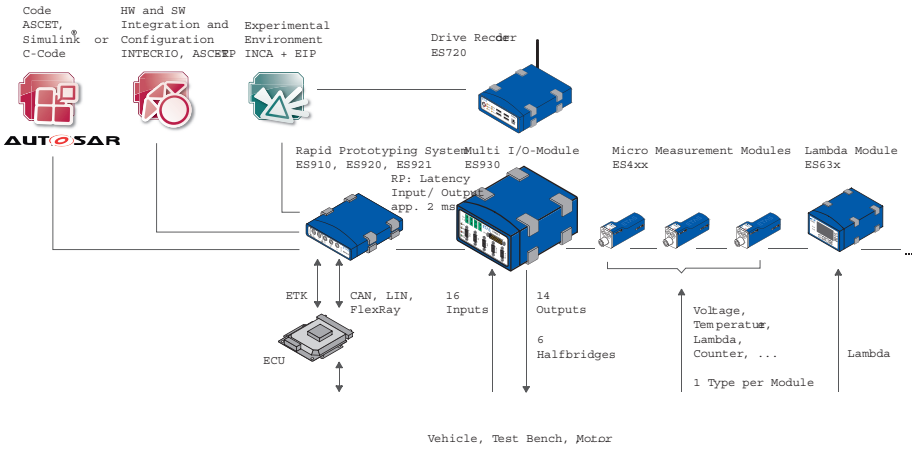


Fig. 7-17 ES432.1 with ES910.3 and additional ETAS Modules for Rapid Prototyping Applications

The concept of the ES4xx/ES63x/ES93x product family to install the modules as close as possible to the sensors, the chain the modules with each other, and to connect only the first module of this chain with the ES910.3 or the RTPRO-PC, enables a simple network architecture.

The combination of ES910.3 or PTPRO-PC with daisy chain modules can process information from sensors and control actuators in the Rapid Prototyping model.

From the Rapid Prototyping model, it is possible to access the connected modules whose signals are processed directly in the Rapid Prototyping model.

The ES910.3 or RTPRO-PC can access all customary ECU interfaces (ETK, XETK, CAN, LIN, FlexRay) and calculate the new control functions in the bypass.

Parallel to the bypass RP functionality, all control and diagnostics parameters as well as all measure signals of the connected ECU can be accessed with INCA. In addition, INCA/INCA-EIP offers access to all bypass and model sizes created in the ES910.3 Prototyping Module.

7.6 Wiring Examples

7.6.1 ES400 Modules with additional ETAS Modules (Measurement & Calibration)

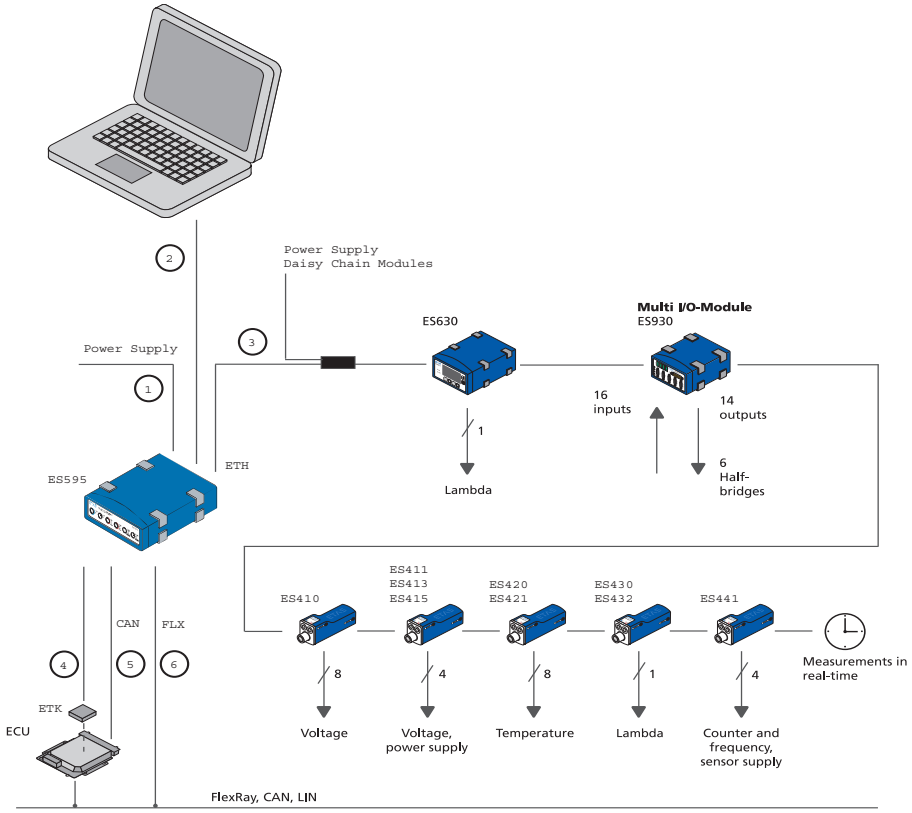


Fig. 7-18 ES400 Modules with add. ETAS Modules (Measurement & Calibration)

Cable in Fig. 7-18	Function	Order name
1	Power supply cable	CBP120, CBP1205
2	Host connection cable	CBE100
3	Power supply and Ethernet cable Daisy Chain modules	CBEP430, CBEP4305
4	ETK connection cable	CBM150
5, 6	CAN/LIN/FLX connection cable (CAN/LIN/FLX combined)	CBCFI100

7.6.2 ES400 Modules with additional ETAS Modules and Drive Recorder (Measurement and Calibration)

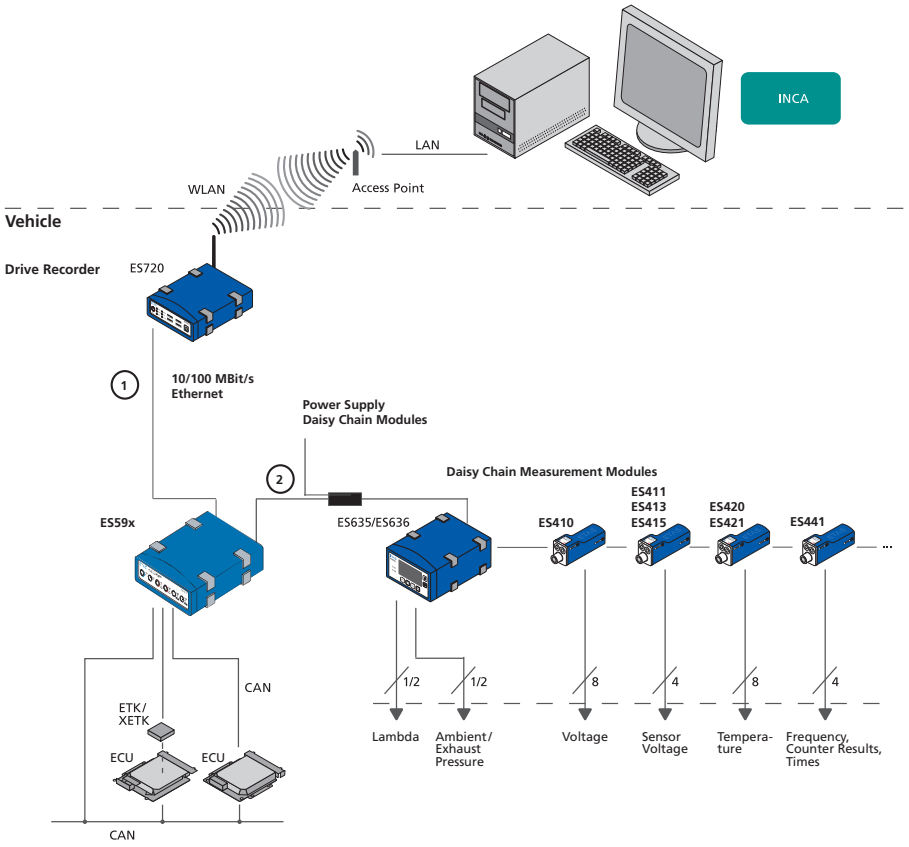


Fig. 7-19 ES400 Modules with additional ETAS Modules and Drive Recorder (Measurement and Calibration)

Cable in Fig. 7-19	Function	Order name
1	ES520-, ES59x-, ES6xx-, ES1120- or ES1135-Ethernet cable	CBE130, CBE140
2	Power supply and Ethernet cable Daisy Chain modules	CBEP430, CBEP4305

7.6.3 ES400 Modules with ES910.3 (Rapid Prototyping)

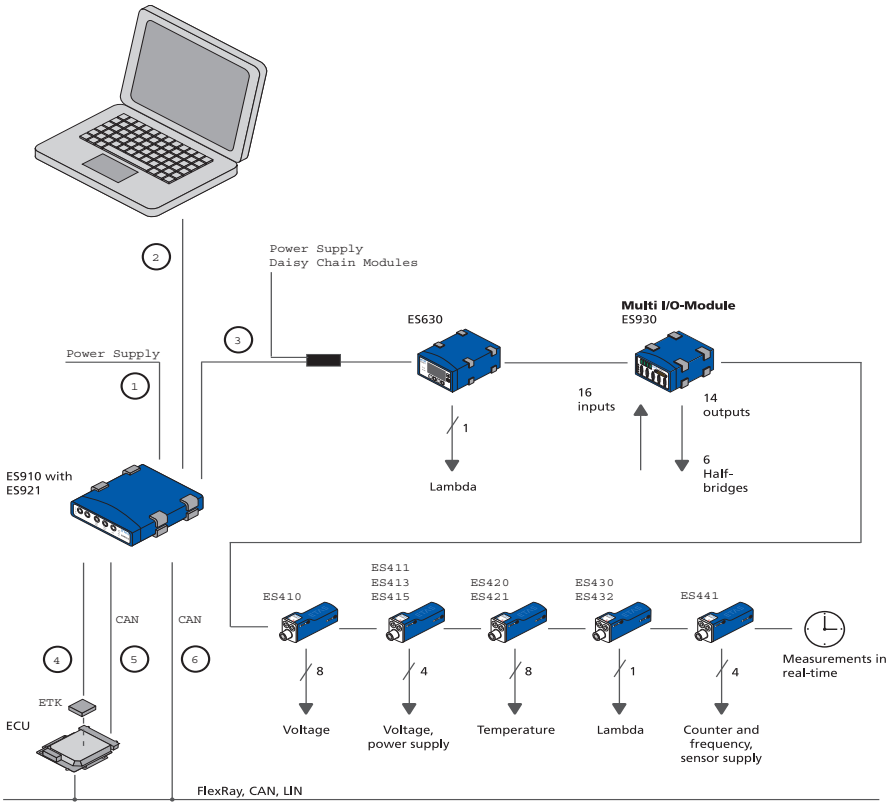


Fig. 7-20 ES400 Modules with ES910.3 (Rapid Prototyping)

Cable in Fig. 7-20	Function	Order name
1	Power supply cable	CBP120, CBP1205
2	PC connection cable	CBE200
3	Power supply and Ethernet cable Daisy Chain modules	CBEP430, CBEP4305
4	ETK connection cable	CBM150
5, 6	CAN/LIN/FLX connection cable (CAN/LIN/FLX combined) at ES910.3, at ES921.1	CBCFI100
	CAN connection cable (CAN only), at ES910.3, at ES921.1	CBAC130, CBAC140, CBAC150, CBCX130

7.6.4 ES400 Modules with ES910.3 and Drive Recorder (Rapid Prototyping)

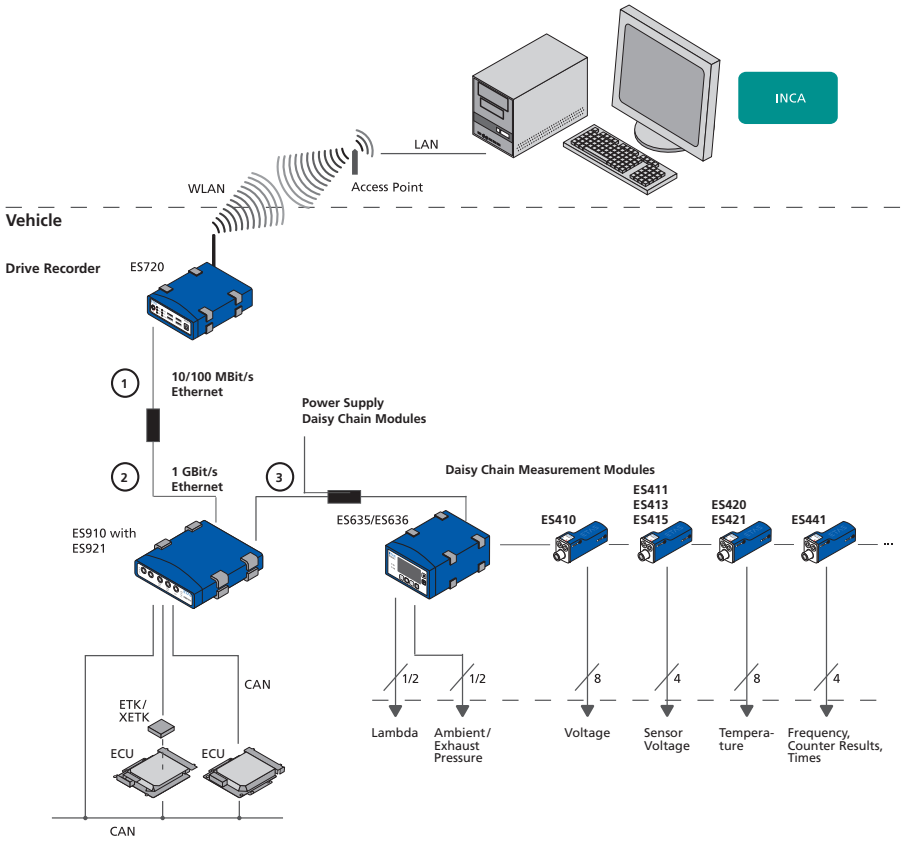


Fig. 7-21 ES400 Modules with ES910.3 and Drive Recorder (Rapid Prototyping)

Cable in Fig. 7-21	Function	Order name
1	Ethernet adapter cable (100 Mbit/s)	CBAE330 (connected to cable 2)
2	Ethernet connection cable(1 Gbit/s)	CBE230 (connected to cable 1)
3	Power supply and Ethernet cable Daisy Chain modules	CBEP430, CBEP4305

7.6.5 ES400 Modules with ETAS RTPRO-PC (Rapid Prototyping)

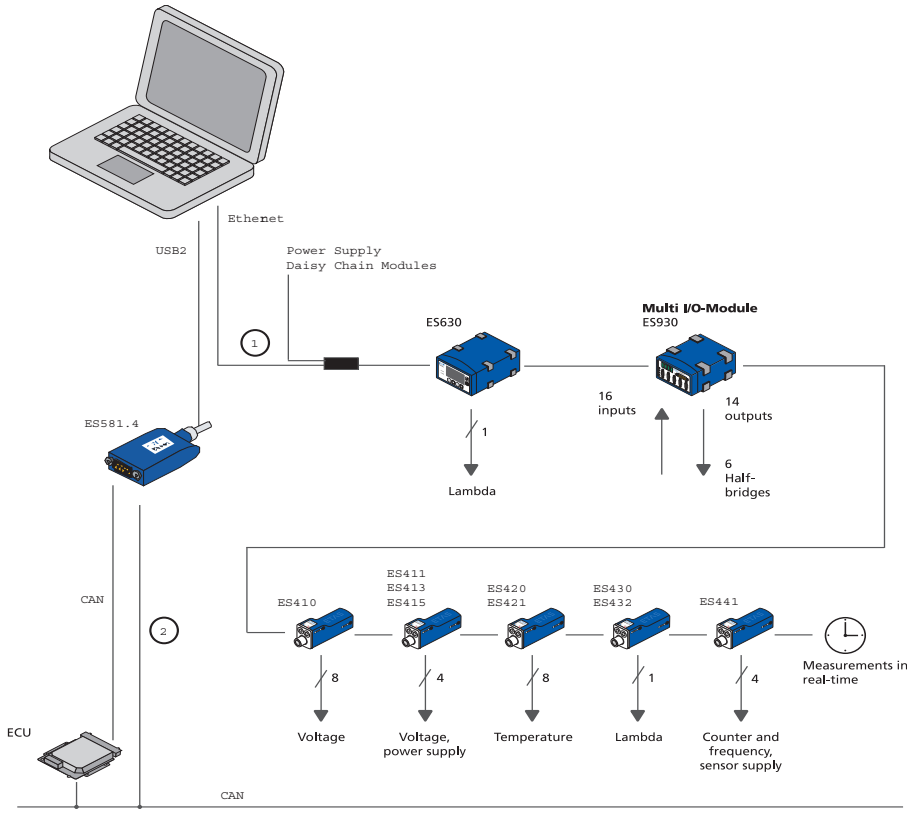


Fig. 7-22 ES400 Modules with ETAS RTPRO-PC (Rapid Prototyping)

Cable in Fig. 7-22	Function	Order name
1	Power supply and Ethernet cable PC and Daisy Chain modules	CBEP410, CBEP4105, CBEP415, CBEP4155
2	CAN and FlexRay Y-interface cable	CBCF100

7.7 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 “Cables and Accessories” on page 96.

7.7.1 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

or

- if two modules are connected mechanically, connect their adjacent “IN” and “OUT” ports to the ES4xx_BRIDGE.

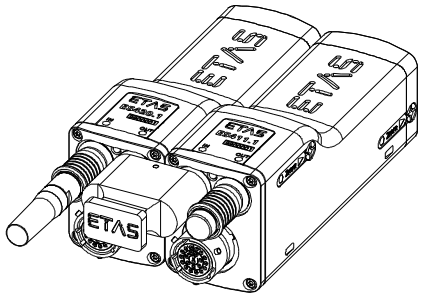


Fig. 7-23 ES432.1 with ES4xx_BRIDGE

CAUTION

The ports of the modules or the ES4xx_BRIDGE may be damaged!
Screw the two modules as far as they will go within the module without getting them off-thread.

3. Continue to wire or connect further modules as described above.

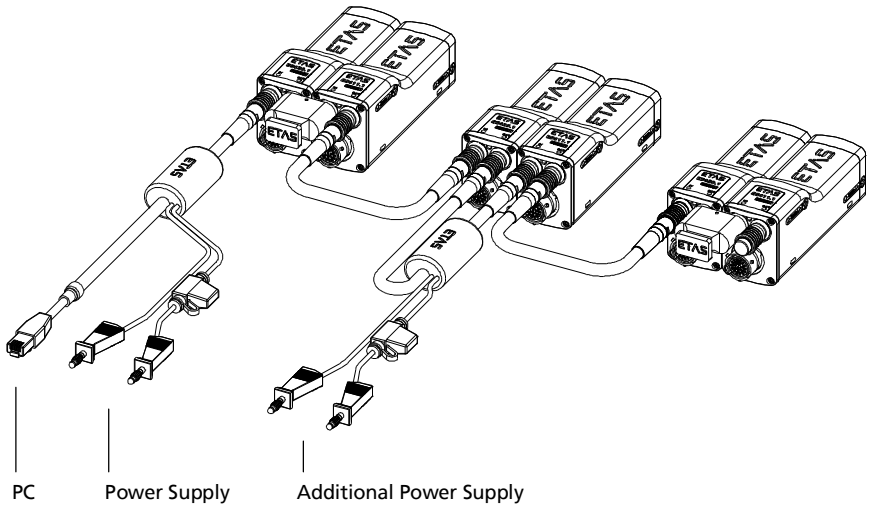
To wire the first module with the PC and the power supply

1. Connect the combined Ethernet and power supply cable to the “IN” port of the ES432.1.
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 ES432.1 module of the chain towards the PC.



3. Connect the combined Ethernet and power supply cable to the "IN" port of the ES432.1 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.

7.7.2 "Sensor" Port

Bosch Lambda Sensor LSU4.9 (Code 1)

You can use different cables to connect the Bosch lambda sensor LSU4.9 (Code 1) to the ES432.1:

- Sensor cable CBAL451.1/ CBAL4515.1, equipped as follows (with analog output):
  - RB150 plug (Code 1) for the lambda sensor
  - MC lamella connector for the supply of the sensor heating,
  - BNC socket for analog output signals and
  - input for an external signal for controlling the heater control when the ES432.1 is on standby.
- Sensor cable CBAL452.1/ CBAL4525.1, equipped as follows:
  - RB150 plug (Code 1) for the lambda sensor
  - MC lamella connector for the supply of the sensor heating and
  - input for an external signal for controlling the heater control when the ES432.1 is on standby.

Bosch Lambda Sensor LSU ADV (Code A7)

You can use the following cable to connect the Bosch lambda sensor LSU ADV (Code A7) to the ES432.1:

- Sensor cable CBAL463.1/ CBAL4635.1, equipped as follows (with analog output):
  - Trapezoid plug (Code A) for the lambda sensor
  - MC lamella connector for the supply of the sensor heating,
  - BNC socket for analog output signals and
  - input for an external signal for controlling the heater control when the ES432.1 is on standby.

On delivery, the end of the cable which is used as an input for powering on the sensor heating is fixed as a loop in the shrinkage tube of the sensor cable. This must be pulled out to use the cable.

To wire the ES432.1 with the sensors

1. If there is a protective cap at the “Sensor” port, remove it.
2. Connect the sensor cable to the “Sensor” port of the ES432.1.
3. Connect the LSU4.9 sensor to the RB150 plug (Code 1) 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 ES432.1 (only CBAL451.1, CBAL4515.1, CBAL463.1, CBAL4635.1)

1. Connect the BNC socket 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.

7.8 Calibrate to Air

A semi-automatic calibration of the sensor / ES432.1 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) and
- 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.

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 ES432.1 and the sensor.
4. Check that all parameters for activating heater control are fulfilled (see section 6.7.2 on page 40).
5. Check in the diagnostics section of the calibration software whether “Ri” is marked in green.

   The sensor is sufficiently heated. The ES432.1 / sensor system is ready for operation.

8 Troubleshooting

This chapter contains information on the following topics:

8.1 Error LEDs

Please observe the LED which provides information on the functions of the interfaces and the (see the section "LED" on page 21) to be able to judge the operational state of the as well as troubleshooting measures.

8.2 Problems with the

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 12 on page 127).

Problem	Diagnostic Questions	Possible Solutions
The application program cannot find any ES400 modules.	Are all modules' LEDs flashing green?	Check that the function for automatic change to energy saving mode on your PC Card has been disabled [1]. Disable this function.
	Did you configure the network card correctly?	INCA, Config Tool and HSP operation: Check that your network card has been configured in accordance with section 8.3 on page 75.
		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 9.9.2 on page 87.
	Power supply	Check that your power supply and test setup correspond to the requirements listed in section 5.7 on page 31.
	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 5.7 on page 31.
		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 ES4xx 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 Express-Cards.

Problem	Diagnostic Questions	Possible Solutions
The LED is showing red.	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.
	Is the connected sensor supported by the ?	Check whether a LSU4.9 or a LSU ADV is connected.
	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 ES400 modules separately.

1): The manufacturers of PC Cards have different names for this function.
Example: “Link down Power saving”

8.3 Problems and Solutions

8.3.1 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 `IPAutoconfiguratio-nEnabled` 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.

8.3.2 Search for Ethernet Hardware Fails

Cause: Personal Firewall blocks Communication

For a detailed description on problems caused by personal firewalls and possible solutions see chapter 8.3.3 on page 78.

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 page76)
- 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 energy management deactivates the network card

The energy management of a laptop computer can deactivate the network card. Therefore you should turn off energy monitoring on the laptop.

Switching off Energy Monitoring on 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`.

Setting 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`.

8.3.3 Personal Firewall Blocks Communication

Reason: Missing releases in the firewall block the 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.

Some actions in ETAS products can lead to problems if the firewall is not properly parameterized, e.g. when opening the experiment environment in ASCET or for the hardware search by 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 IP 255.255.255.255) for the destination port 17099 or 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 ports 17099 or 18001
- Outgoing IP unicasts via UDP to every IP address in the network configured for the ETAS application, destination ports 17099 to 18020
- Incoming IP unicasts via UDP originating from any IP address in the network configured for the ETAS application, originating ports 17099 to 18020, destination ports 17099 to 18020

- Outgoing TCP/IP connections to the network configured for the ETAS application, destination ports 18001 to 18020

> **NOTE**
>
> The ports to be used in a specific case depend on the hardware used. For more detailed information about the port numbers to be used, see the respective hardware documentation.

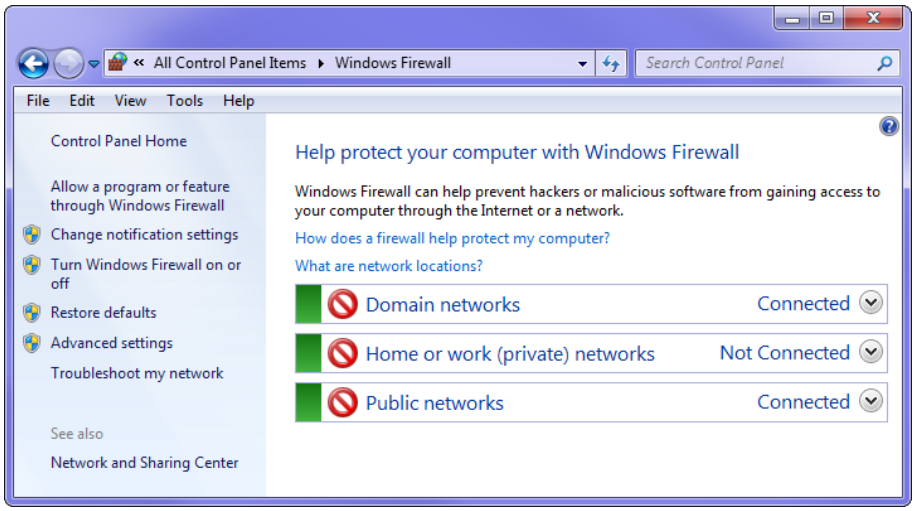
In Windows 7, 8.1 and 10, a Personal Firewall program is part of the scope of delivery and enabled by default. On many other systems, similar programs from independent providers can frequently be found, such as Symantec, McAfee or BlackIce. The procedure for the configuration of ports may differ in the various programs. More detailed information can be found in the user documentation of your firewall program.

Below is a sample description about how to configure the Windows firewall if the hardware access is being blocked.

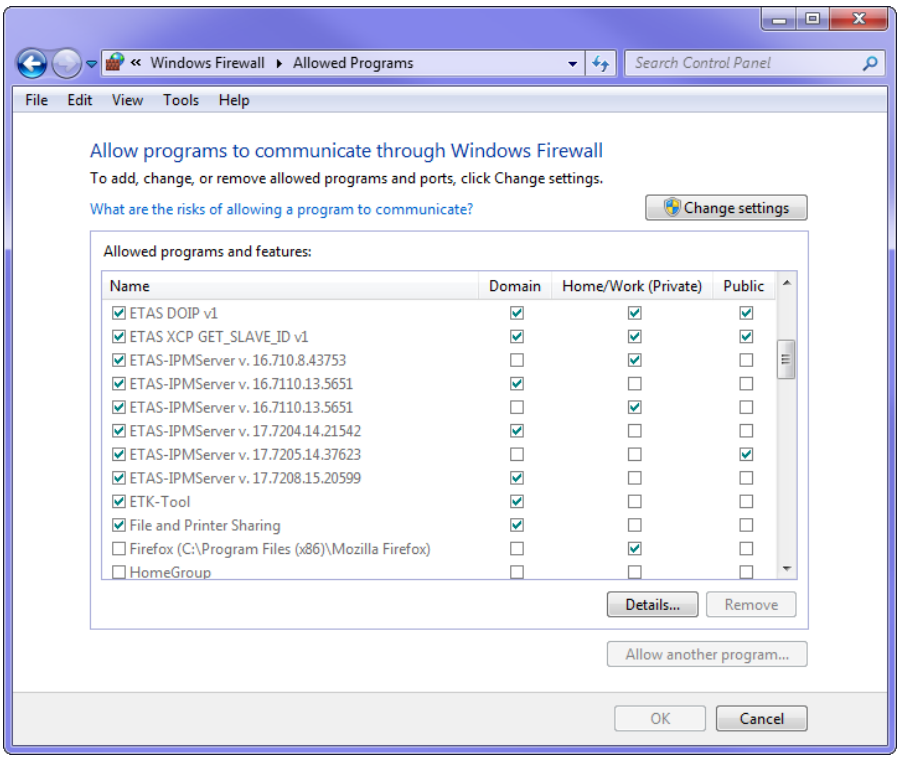
Solution for Windows Firewall, user with administrator rights

Enabling 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, user without administrator rights

This chapter is directed at users with restricted rights, e.g. no changes to the system, restricted write permissions, local login.

Working with an ETAS product requires the rights "Write" and "Modify" in the directories `ETAS`, `ETASData` and the temporary ETAS directories. Otherwise, an error message appears if the product is being started and a database is being opened. A correct operation of the product is not possible since the database file as well as various `*.ini` files are modified during the work.

The ETAS software must be installed by an administrator in any case. It is recommended that the administrator ensures that the ETAS product or the processes are added to the list of selected exceptions of the Windows Firewall after the installation.

9 Technical Data

This chapter contains information on the following topics:

9.1 General Data

This section contains details of the admissible environmental conditions as well as the mechanical data.

9.1.1 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; Ethernet connection to the upstream module or the PC, power supply of the module)
	Labeling of the daisy chain port„OUT" (output; Ethernet connection and power supply of the downstream module)
CH	Connection of sensor cable
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 11.2 on page 122
5-50V ⎓ Pmax=3W	Operating voltage range (DC), Power consumption
	Labeling for WEEE, see chapter 9.6 on page 85
	Marking for CE conformity (Chapter 9.3 on page 85)

Symbol	Description
	Marking for UKCA conformity (Chapter 9.4 on page 85)
	Marking for KCC conformity (Chapter 9.5 on page 85)
	Labeling for RoHS (China), see chapter 9.2.2 on page 85

9.1.2 Standards and Norms

The module adheres to the following standards and norms:

Norm	Test
DIN EN 60068-2-1	Premature fatigue cold test
DIN EN 60068-2-2	Premature fatigue heat test
DIN EN 60068-2-13	Negative pressure
DIN EN 60068-2-14 Na	Temperature shock
DIN EN 60068-2-14 Nb	Temperature change: Temperatures: Tu –40 °C / To +120 °C, number of cycles: 10, test specimens active
DIN EN 60068-2-56	Humidity storage
DIN EN 60068-30, Variant 1	Climate change
DIN EN 60068-2-64, ISO 16750-3	Vibration, Noise: 3 spatial axes, test duration 4 h, test specimens active
	The combination of cascaded modules was also verified
ISO 16750-3, Sec. 4.2.2.2	Mech. shock: 3 spatial axes, half sine, acceleration: 500 m/s², shock duration: 6 ms, shocks per direction and axis: 10, test specimens active
ISO 16750-3, Sec. 4.3	Drop test: 2 impacts each from a height of 1 m onto steel or concrete, test specimens passive
ISO 16750-4, Sec. 5.2	Phased temperature test

Norm	Test
ISO 16750-4, Sec. 5.4.2	Swirl water: air temperature: To +120 °C, cycle duration: 30 min, swirl length: 3 s, swirl quantity: approx. 3 l, temperature of the water swirl: +2 °C ± 2 °C, medium: water, mixed with 3% fine Arizona dust, No. of cycles: 100, test specimen active
ISO 16750-4, Sec. 5.5.1.; DIN EN 60068-2-52	Salt fog: intensity 5, test duration 16 d, test specimens passive
ISO 16750-5	Chemical resistance: identification A-W, test specimens passive
DIN 5596-1	Stone impact
IPX7	Protection class test: Protection class IP67
EN 61000-4-2	Interference immunity: ESD
EN 61000-4-3	Interference immunity: spurious irradiation
EN 61000-4-4: 2005	Interference immunity: burst [1)] Power supply: 2 kV (peak), 5/50 ns tr/th, 5 kHz repetition rate; I/O cables: 1 kV (peak), 5/50 ns tr/th, 5 kHz repetition rate
EN 61000-4-5: 2007	Interference immunity: surge [1)] 1 kV symmetrical, 1.2/50 (8/20) µs tr/th
EN 61000-4-6	Conducted disturbances immunity
DIN EN 55022 B	Emission: irradiation/radiated interfering voltage, class B [1)]

[1)]: The module must be powered by a direct current power supply or a battery with operation voltage. Between module and power supply unit cables with a maximal length of 30 m are permitted.

9.1.3 Environmental Conditions

Operating temperature range	Operating voltage 5 V to 50 V DC: -40 °C to +85 °C / -40 °F to +185 °F
	Operating voltage 6 V to 50 V DC: -40 °C to +120 °C / -40 °F to +248 °F
Storage temperature range (module without packaging)	-40 °C to +125 °C -40 °F to +257 °F
Implementation altitude	max. 5000 m / 16400 ft
Protection class	IP67

CAUTION

Loss of features as defined by IP67!
Do not open or change the module!
Work on the module must only be carried out by specialist, qualified personnel.

9.1.4 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.

9.1.5 Cleaning the Product

We recommend to clean the product with a dry cloth.

9.1.6 Mechanical Data

Dimensions (H x W x D)	51.5 mm x 40 mm x 142 mm / 37.5 mm x 40 mm x 129 mm
	2.0 in x 1.57 in x 5.59 in / 1.48 in x 1.57 in x 5.08 in
Weight	350 g / 0.77 lb

9.1.7 Modules in One Chain

Modules in chain	Max. 254 in one chain

9.2 RoHS Conformity

9.2.1 European Union

The EU Directive 2011/65/EU limits the use of certain dangerous materials for electric and electronic devices (RoHS conformity).

ETAS confirms that the product meets this directive applicable in the European Union.

9.2.2 China

ETAS confirms that the product meets the "China RoHS" (Management Methods for Controlling Pollution Caused by Electronic Information Products Regulation) guidelines applicable to the People's Republic of China with a China RoHS label attached to the product or its packaging.

9.3 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.

9.4 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.

9.5 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.

9.6 Product Return and Recycling

The European Union (EU) has issued the guideline on waste electric and electronic equipment (Waste Electrical and Electronic Equipment - WEEE) in order to ensure the institution of systems for collection, handling, and disposal of all electronic scrap.

This ensures that the devices are recycled in a resource-friendly way that does not represent any risk to personal health and the environment.

Fig. 9-1 WEEE symbol

The WEEE symbol (see Fig. 9-1 on page 85) on the product or its packaging identifies that the product may not be disposed of together with the remaining trash.

The user is obligated to separate the waste equipment and to provide it to the WEEE return system for reuse.

The WEEE Directive applies to all ETAS devices, but not to external cables or batteries.

Additional information about the recycling program of ETAS GmbH is available from the ETAS sales and service locations (see chapter 12 on page 127).

9.7 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.

9.8 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.

9.9 System Requirements

This section tells you what hardware and software is needed to operate your ES432.1 module.

9.9.1 Hardware

Power Supply

Operation of the modules requires a power supply voltage of 5 V to 50 V/ 6 V to 50 V DC.

PC with one Ethernet Interface

A PC with one open Ethernet interface (100 Mbit/s, full duplex) with RJ-45 connection is required.

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".

9.9.2 Software

To configure the ES432.1 and for control and data acquisition, you need software in the following versions:

- INCA V6.2.1 and higher with ES4xx INCA Add-On V1.1.7 and higher from ES4xx_DRV_SW

  or

- ES4xx Daisy-Chain Tool V1.1.7 and higher from ES4xx_DRV_SW (stand-alone operation)

  or

- INTECRIO V3.1.1 with ES4xx Daisy-Chain Tool V1.1.7 and higher from ES4xx_DRV_SW.

NOTE

Operating the ES432.1 with older versions of software is not possible.

9.10 Electrical Data

This chapter contains information on the following topics:

NOTE

ETAS guarantees measurement accuracy of the ES432.1 for one year. Please use our calibration service (see section 5.11 on page 33)!

NOTE

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

9.10.1 Host Interface

Socket	100Base-T Ethernet; 100 Mbit/s, Full Duplex necessary
	PC Card 32-bit
Protocol	XCP on UDP/IP
IP address	Dynamic via INCA or in stand-alone operation with ES4xx Configuration Tool from ES4xx-_DRV_SW (Default: 192.168.40.44)

NOTE

To ensure successful initialization of the network card of your PC, refer to chapter 9.9.1 on page 86.

9.10.2 Power Supply

Operating voltage	Temperature range -40 °C to +85 °C / -40 °F to +185 °F: 5 V to 50 V DC
	Temperature range -40 °C to +120 °C / -40 °F to +248 °F: 6 V to 50 V DC
Power consumption (normal mode, room temperature, without sensor heating)	Typ. 2 W at 12 V DC
Power consumption (standby, room temperature, without sensor heating)	Typ. 200 mW at 12 V DC
Polarity inversion protection, load dump protection [1)]	With CBEP410, CBEP4105, CBEP415, CBEP4155, CBEP420, CBEP4205, CBEP425, CBEP4255, CBEP430, CBEP4305 cable
Overvoltage category (AC mains supply)	II

[1)] : The module may be used only with central load dump protection.

9.10.3 Signal Processing

Features

Sampling rate of calibration software	0.5 to 2000 samples/s
Ri sampling rate	2 samples/s
Hardware input filter	Measurement I_P: Bessel 2nd order low-pass, cutoff frequency 100 Hz (-3 dB)
	Measurement R_i: Bessel 2nd order low-pass, cutoff frequency 5 Hz (-3 dB)
Digital filter	IIR filter, Bessel 4th order low-pass, cutoff frequency adjustable (1 Hz to 50 Hz), can be disabled

Measure Values and Measurement Ranges

All measure values are available simultaneously in the calibration software. They can be configured in the calibration software.

Measure Value	Min	Max	Unit
Lambda	0.6	16	-
1/Lambda	0.0625	1.67	-
Air/fuel ratio, A/F	8.5	200	-
Fuel/air ratio, F/A	0.005	0.118	-
Oxygen content O_2	0	25	%
Pump current lambda sensor Ip	-2.5	5	mA
Internal sensor resistance Ri	0	1950	Ohm

Characteristics of Measuring Pump Current

Symbol	Parameter	IIR Filter	Min	Max	Unit
I_{P_PP}	Ripple pump current (peak-to-peak), depending on filter selected; probe in nitrogen	Off	-	30	µA
		50 Hz	-	10	µA
		2 Hz	-	2.5	µA

9.10.4 Analog Output

At the BNC jack of the sensor cables CBAL451.1, CBAL4515.1, CBAL463.1 and CBAL4635.1 an analog output voltage of the measurement channel is provided.

The analog output voltage can be assigned to a measure value and its output parameters configured.

NOTE

The internal resistance R_i can only be output in the calibration software.

Features

No. of output channels	1
Range	0 V to 10 V
Signal types	Lambda, 1/Lambda, A/F, F/A, O2, IP, can be configured in the calibration software
Output impedance	0 Ohm virtual, short-circuit-proof against external voltages up to 28 V
Ground potential	Galvanically isolated output
Overvoltage protection	±50 V (analog output ground to power supply ground)
D/A converter	16-bit D/A converter (effective resolution: 1.2 mV)
Diagnostics	Detection of short and overload

Measurement Ranges

NOTE

At the analog output, lambda measure values of max. lambda=10 can be displayed; in the calibration software, lambda measure values of max. lambda=16 can be output.

Measure Value	Min	Min [V]	Max	Max [V]
Lambda λ	0.60	0.60	10.0	10.0
1 / Lambda λ	0.0625	0.3125	1.67	8.333
Air/fuel ratio, A/F	8.5	0.425	200	10.0
Fuel/air ratio, F/A	0.005	0.25	0.118	5.90
Oxygen content O_2 [%]	0.0	0.0	25.0	10.0
Pump current, lambda sensor I_P [mA]	-3.0	3.50	+6.0	8.00

Scaling the Measure Value

At the analog output of the ES432.1, the following dependencies on the output voltage apply for the measure value output:

Measure Value	Measure Value Scaling	Unit
Lambda λ	$\lambda = \frac{U_{out}}{1\ V}$	-
1 / Lambda λ	$\frac{1}{\lambda} = \frac{U_{out}}{5\ V}$	-
Air/fuel ratio, A/F	$\frac{A}{F} = \frac{U_{out}}{0.05\ V}$	-

Measure Value	Measure Value Scaling	Unit
Fuel/air ratio, F/A	$\frac{F}{A} = \frac{U_{out}}{50\ V}$	-
Oxygen content O_2	$O_2 = \frac{U_{out}}{0.4\ V}$	%
Pump current, lambda sensor I_P	$I_p = \frac{U_{out} - 5\ V}{0.5\ V}$	mA

9.10.5 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 ES432.1 is off or on standby.

The control possibilities of the states of the sensor heater control is shown in section 6.7.2 on page 40.

Symbol	Parameter	Min	Max	Unit
V_{ON_th}	Threshold value EXTEN - On	-	9	V
V_{OFF_th}	Threshold value EXTEN - Off	2	-	V

9.10.6 Sensor Port

Operating voltage	9 V to 16 V (heating powered off outside the range)
Power consumption (standby, sensor in still air, room temperature)	Typ. 8 W
Pumped reference	20 µA
Overvoltage protection	28 V
Supported sensor types	Robert Bosch LSU4.9, automatic detection via the sensor cable
	Robert Bosch LSU ADV, automatic detection via the sensor
Sensor connector	On cable CBAL451/ CBAL4515 or CBAL452/ CBAL4525: RB150, Code 1
	On cable CBAL463/ CBAL4635: Trapezoid plug, Code A7
Maximum input voltage (dry environment)	Input-to-input: 60 V DC / 30 V AC
	Input-to-ground of voltage supply or housing: 60 V DC / 30 V AC
Maximum Input voltage (wet environment)	Input-to-input: 35 V DC / 16 V AC
	Input-to-ground of voltage supply or housing: 35 V DC / 16 V AC

9.11 Pin Assignment

This chapter contains information on the following topics:

NOTE

All connectors are shown with a view of the front of the .
All shields are at case potential.

9.11.1 "IN" Connector

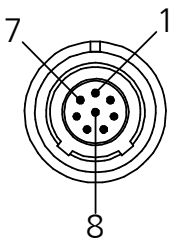


Fig. 9-2 "IN" Connector

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

9.11.2 “OUT” Connector

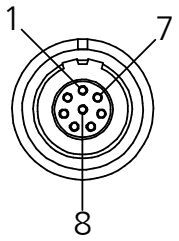


Fig. 9-3 “OUT” Connector

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

9.11.3 “Sensor” Connector

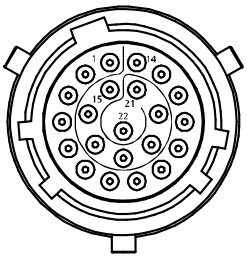


Fig. 9-4 “Sensor” Connector

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.
Sensor heating plus (U_{Heat+}) and supply voltage plus (U_{Batt+}) are connected internal.

10 Cables and Accessories

This chapter contains information on the following topics:

NOTE

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

10.1 Combined Ethernet and Power Supply Cable

This chapter contains information on the following cables:

10.1.1 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

10.1.2 CBEP410.1 Cable

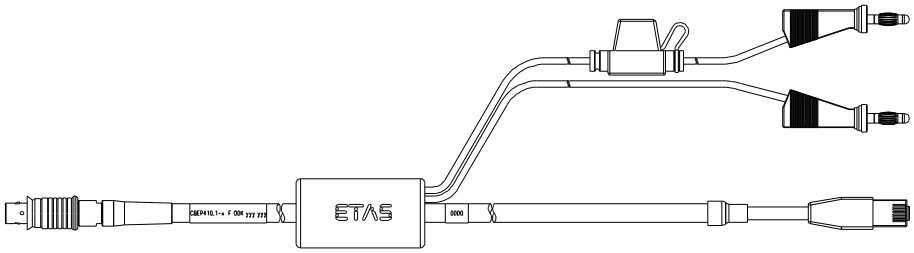


Fig. 10-1 CBEP410.1 Cable

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

10.1.3 CBEP4105.1 Cable

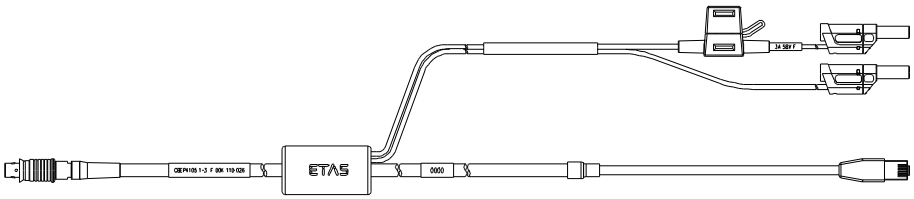


Fig. 10-2 CBEP4105.1 Cable

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

10.1.4 CBEP415.1 Cable

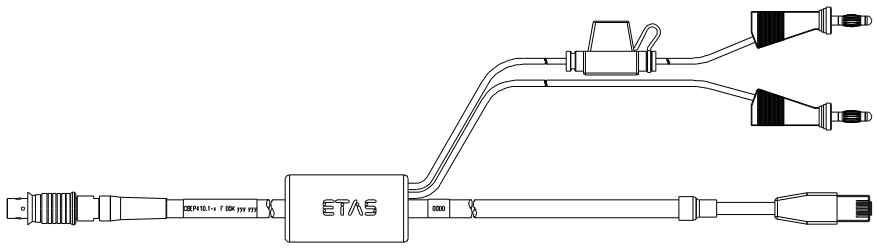


Fig. 10-3 CBEP415.1 Cable

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

10.1.5 CBEP4155.1 Cable

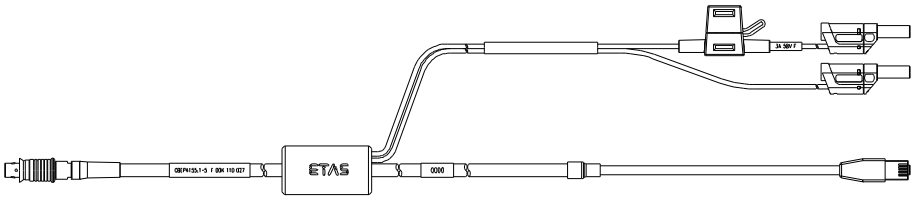


Fig. 10-4 CBEP4155.1 Cable

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

10.1.6 CBEP420.1 Cable

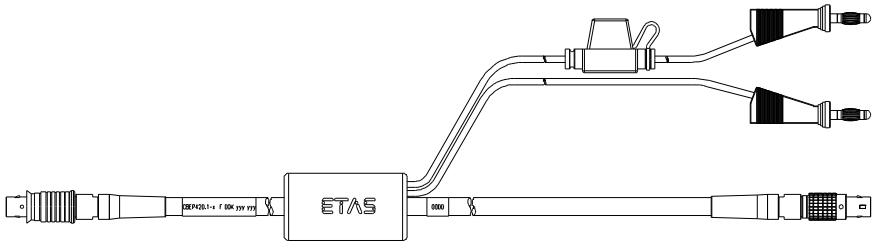


Fig. 10-5 CBEP420.1 Cable

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

10.1.7 CBEP4205.1 Cable

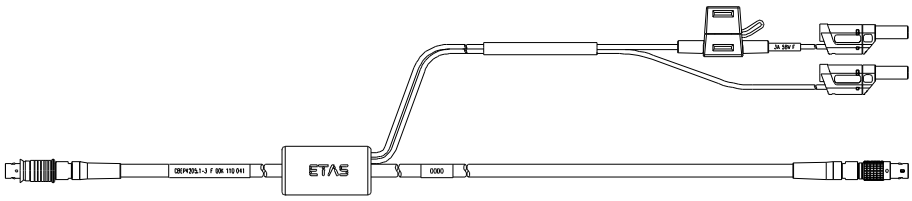


Fig. 10-6 CBEP4205.1 Cable

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

10.1.8 CBEP425.1 Cable

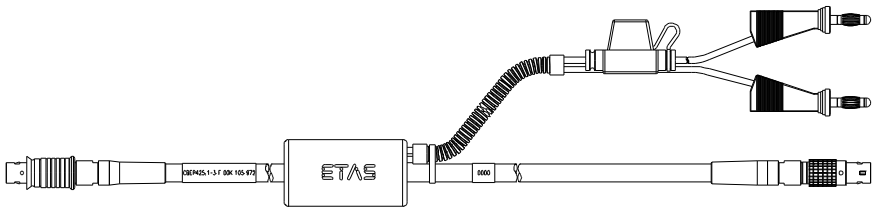


Fig. 10-7 CBEP425.1 Cable

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

10.1.9 CBEP4255.1 Cable

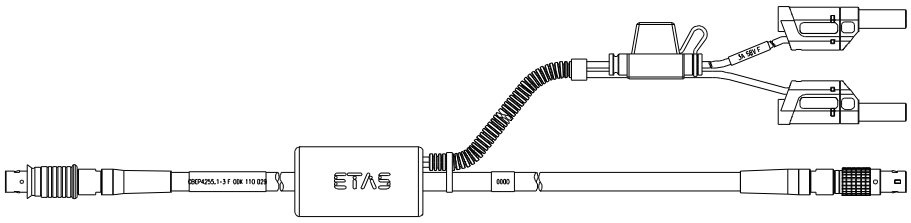


Fig. 10-8 CBEP4255.1 Cable

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

10.1.10 CBEP430.1 Cable

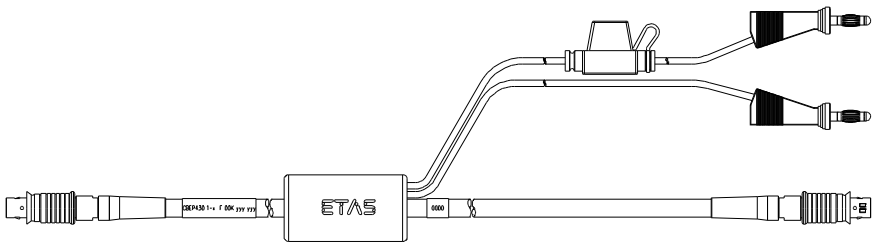


Fig. 10-9 CBEP430.1 Cable

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

10.1.11 CBEP4305.1 Cable

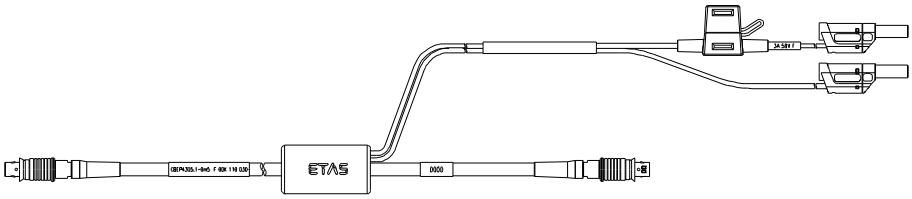


Fig. 10-10 CBEP4305.1 Cable

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

10.2 Ethernet Cable

This chapter contains information on the following cables:

10.2.1 CBE400.2 Cable

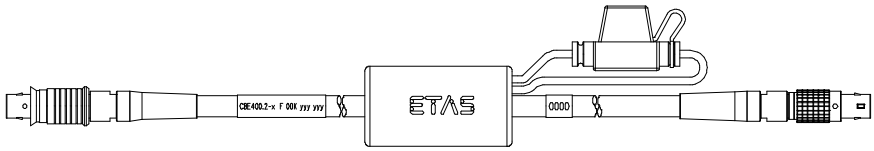


Fig. 10-11 CBE400.2 Cable

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

10.2.2 CBE401.1 Cable

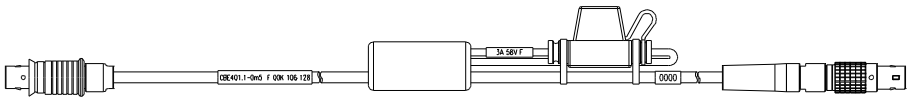


Fig. 10-12 CBE401.1 Cable

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

10.2.3 CBE430.1 Cable

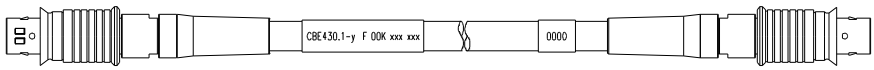


Fig. 10-13 CBE430.1 Cable

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

10.2.4 CBE431.1 Cable

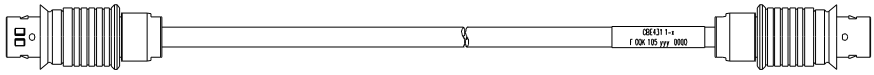


Fig. 10-14 CBE431.1 Cable

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

10.2.5 CBEX400.1 Cable

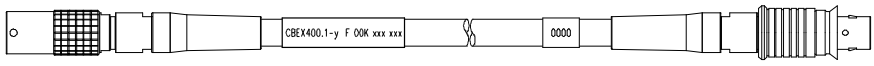


Fig. 10-15 CBEX400.1 Cable

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

10.2.6 ES4xx_BRIDGE

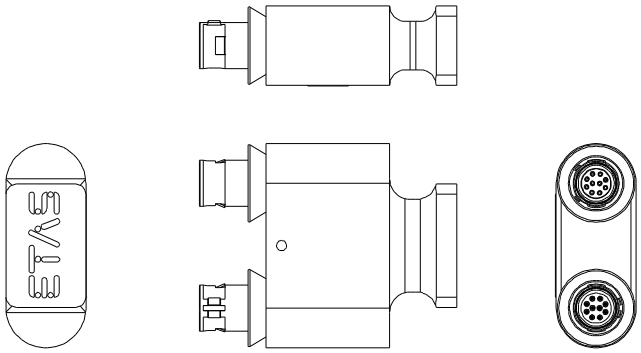


Fig. 10-16 ES4xx Bridge

Ethernet bridge connecting blocked ES400 modules. Facilitates very compact measurement setups. IP67 compliant.

Product	Order number
ES4xx_BRIDGE	F 00K 105 684

10.3 Cables for the connector "Sensor"

This chapter contains information on the following topics:

10.3.1 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 4.9	LSU ADV
CBAL451.1	X	-
CBAL452.1	X	-
CBAL463.1	-	X

Sensor cables with safety banana plugs

Cable	Lambda Sensor	
	LSU 4.9	LSU ADV
CBAL4515.1	X	-
CBAL4525.1	X	-
CBAL4635.1	-	X

10.3.2 CBAL451.1 Cable

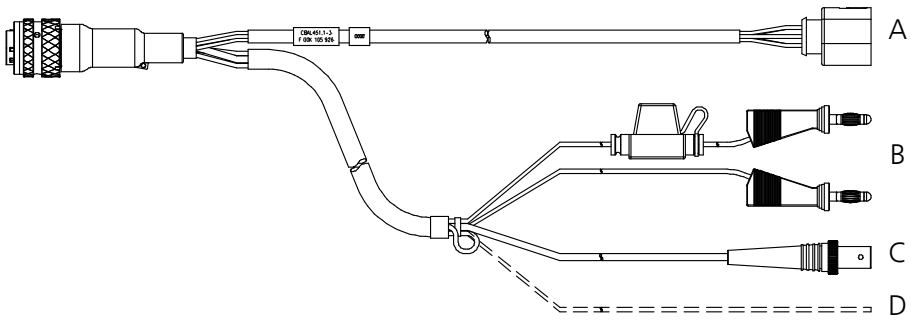


Fig. 10-17 CBAL451.1 Cable

Usage

Cable for Bosch Lambda Sensor LSU4.9 (Code 1)

Cable Plugs

Plug Fig. 10-17	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. 10-17)

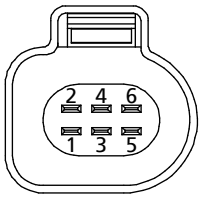


Fig. 10-18 RB150 Sensor Plug (Code 1)

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. 10-17

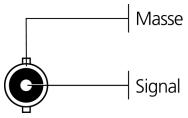


Fig. 10-19 BNC Socket for Analog Output Signals

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

10.3.3 CBAL4515.1 Cable

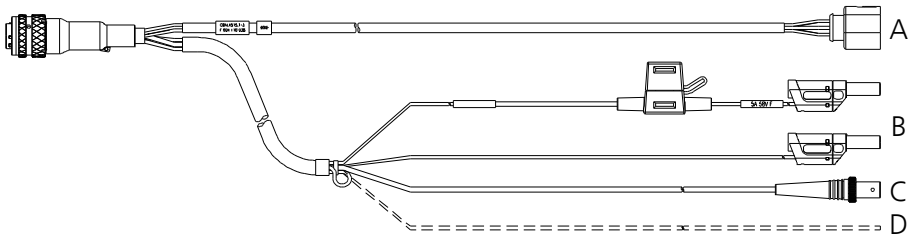


Fig. 10-20 CBAL4515.1 Cable

Usage

Cable for Bosch Lambda Sensor LSU4.9 (Code 1)

Cable Plugs

Plug Fig. 10-17	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. 10-17)

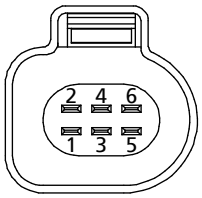


Fig. 10-21 RB150 Sensor Plug (Code 1)

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. 10-17)

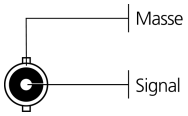


Fig. 10-22 BNC Socket for Analog Output Signals

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

10.3.4 CBAL452.1 Cable

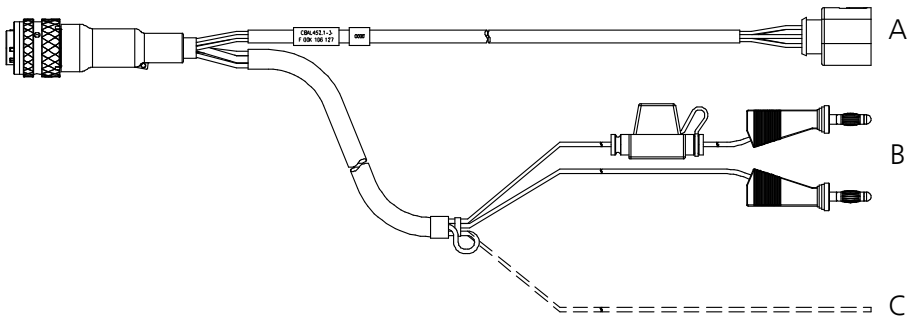


Fig. 10-23 CBAL452.1 Cable

Usage

Cable for Bosch Lambda Sensor LSU4.9 (Code 1)

Cable Plugs

Plug Fig. 10-23	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. 10-23)

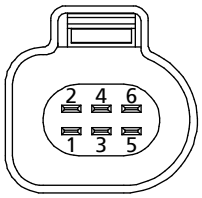


Fig. 10-24 RB150 Sensor Plug (Code 1)

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

10.3.5 CBAL4525.1 Cable

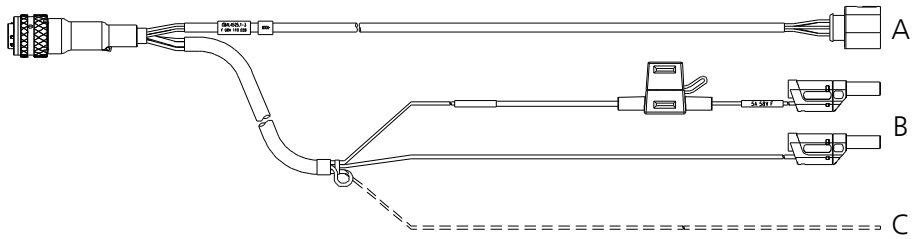


Fig. 10-25 CBAL4525.1 Cable

Usage

Cable for Bosch Lambda Sensor LSU4.9 (Code 1)

Cable Plugs

Plug Fig. 10-23	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. 10-23)

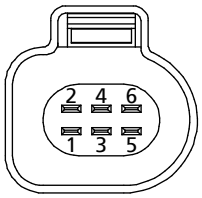


Fig. 10-26 RB150 Sensor Plug (Code 1)

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

10.3.6 CBAL463.1 Cable

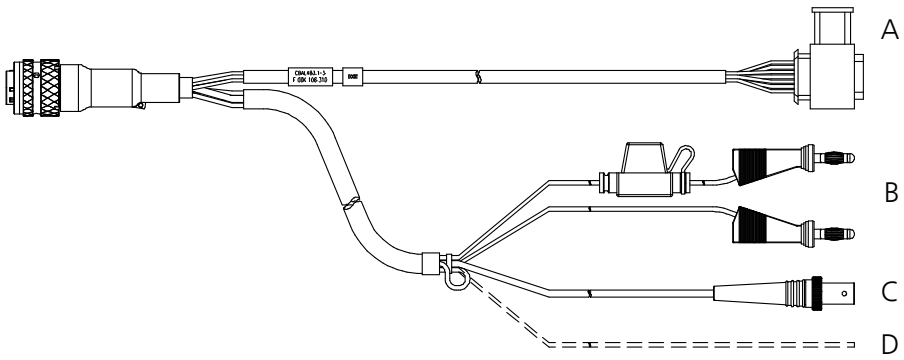


Fig. 10-27 CBAL463.1 Cable

Usage

Cable for Bosch Lambda Sensor LSU 5.1 and LSU ADV-G (Code A7)

Cable Plugs

Plug Fig. 10-27	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. 10-27)

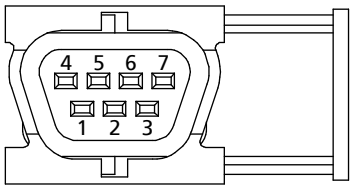


Fig. 10-28 Trapezoid Plug (Code A7)

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. 10-27)

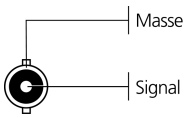


Fig. 10-29 BNC Socket for Analog Output Signals

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

10.3.7 CBAL4635.1 Cable

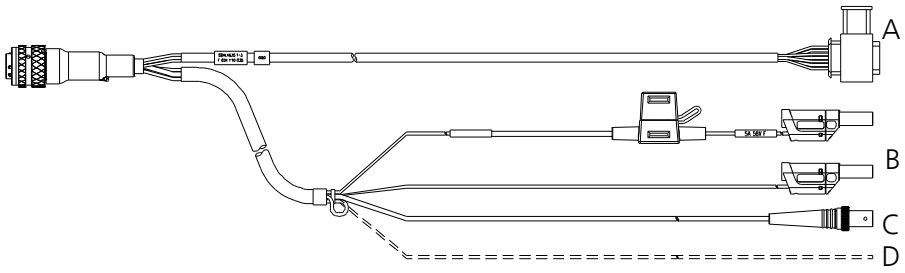


Fig. 10-30 CBAL4635.1 Cable

Usage

Cable for Bosch Lambda Sensor LSU 5.1 and LSU ADV-G (Code A7)

Cable Plugs

Plug Fig. 10-27	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. 10-27)

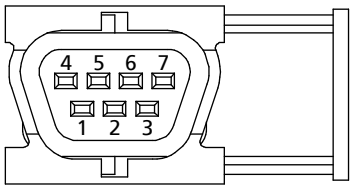


Fig. 10-31 Trapezoid Plug (Code A7)

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. 10-27)

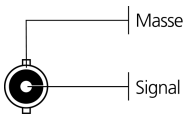


Fig. 10-32 BNC Socket for Analog Output Signals

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

10.4 Protective Caps

The connections "IN" and "OUT" of the ES432.1 can be protected with different protective caps according to the operating conditions.

10.4.1 Protective Caps supplied

The "IN" and "OUT" ports of the ES4xx 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.

10.4.2 Cap CAP_LEMO_1B

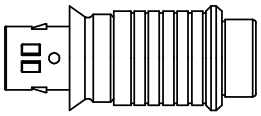


Fig. 10-33 Cap CAP_LEMO_1B

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

10.4.3 Cap CAP_LEMO_1B_LC

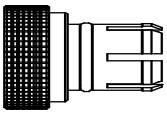


Fig. 10-34 Cap CAP_LEMO_1B_LC

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

10.4.4 Cap CAP_SOURIAU_8STA

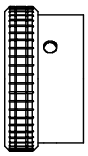


Fig. 10-35 Cap CAP_SOURIAU_8STA

The cap CAP_SOURIAU_8STA protects the "Sensor" port against water and dirt.

Product	Order number
CAP_SOURIAU_8STA	F 00K 105 303

10.5 Angle Brackets

10.5.1 Angle Bracket Left

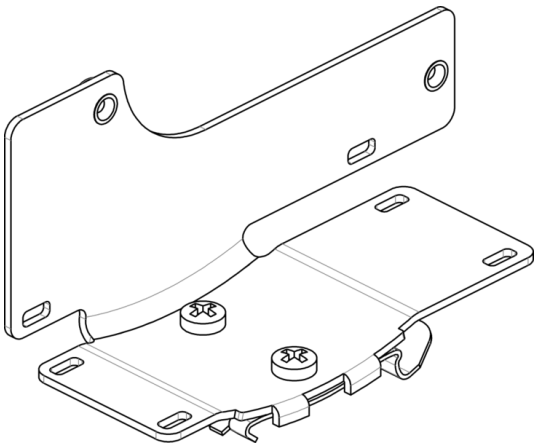


Fig. 10-36 Angle Bracket Left

Angle Bracket for mounting ES4xx modules to a DIN rail 35 x 7.5 (EN 60715 TH35). Stainless steel V2A. For mounting on left side of an ES4xx module.

Product	Order number
Angle bracket left	F 00K 107 175

10.5.2 Angle Bracket Right

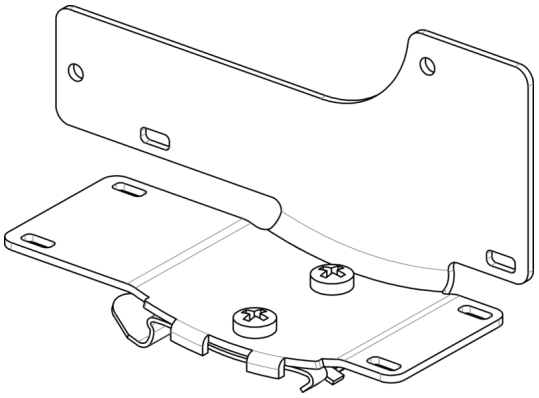


Fig. 10-37 Angle Bracket Right

Angle Bracket for mounting ES4xx modules to a DIN rail 35 x 7.5 (EN 60715 TH35). Stainless steel V2A. For mounting on right side of an ES4xx module.

Product	Order number
Angle bracket right	F 00K 107 176

11 Ordering Information

11.1 ES432.1

Order name	Short name	Order number
ES432.1 Lambda Module (1-CH)	ES432.1	F 00K 106 622
Package contents		
- ES432.1 Lambda Module (1-CH) - CDROM ES4xx_DRV_SW_CD (drivers for ES4xx and documentation) - List "Content of this Package" - ES4xx Safety Advice - China-RoHS-leaflet_Compact_green_cn - Calibration-Certification		

NOTE

Cables are not part of the scope of supplies of the module and must be ordered separately (see chapter 11.2.1 on page 122).

11.2 Accessories

11.2.1 Cables

NOTE

If you require customized cables, please contact your ETAS contact partner or sales.de@etas.com.

11.2.1.1 Cables for the connectors "IN" and "OUT"

Ethernet cable

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

Combined Ethernet and Power Supply Cable

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

Ethernet Bridge

Order name	Short name	Order number
Bridge to connect two assembled ES4xx Modules	ES4xx_BRIDGE	F 00K 105 684

11.2.1.2 Cables for the Connector "Sensor"

Order Name	Short Name	Order Number
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

11.2.2 Lambda Sensor

Order name	Short name	Order number
Lambda Sensor LSU 4.9, SR4, RB150 Code1, 300 Ohm, 1 m	LSUS_49	0 258 017 025
Lambda Sensor LSU ADV, Protection tube TP2, Trapezoid plug (Code A7), 300 Ohm, 1 m	LSU_ADV_G	F 00K 106 409

11.2.3 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_SOURIAU_8STA	F 00K 105 303

11.2.4 Angle Brackets

Order name	Short name	Order number
ES4xx Angle Bracket left	ES4xx_AB_L	F 00K 107 175
ES4xx Angle Bracket right	ES4xx_AB_R	F 00K 107 176

11.2.5 Calibration

NOTICE

ETAS recommends a calibration interval of 12 months.

11.2.5.1 Factory calibration

Factory calibration service

- Verification of measurement accuracy
- Issue a standard-compliant calibration certificate

Order name	Short name	Order number
Calibration service for ES432	C_ES432	F-00K-112-737

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 ES432	A_ES432	F-00K-106-629

11.2.5.2 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 ES432	DAkkS_C_ES432	F-00K-112-780

1. Accreditation by Deutsche Akkreditierungsstelle (DAkkS)
2. Supervision of the calibration certificate by DAkkS

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 ES432	DAkkS_A_ES432	F-00K-112-442

12 Contact Information

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