

A decorative graphic consisting of two red lines that intersect. One line starts from the top right and goes down towards the center. The other line starts from the top left and goes down towards the center, crossing the first line. There are small white circles at the intersection and at the end of the lower-left line.

ETAS ES415.1

High Definition A/D Module with Sensor
Supply

User Guide

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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
<i>Italic</i>	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:

- "Scope of Supply" on page 9
- "Additional Information" on page 9

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 10.1 on page 103).

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 103 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:

- "General Safety Information" on page 10
- "Requirements for Users and Duties for Operators" on page 10
- "Intended Use" on page 10

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.
- Ensure that the connections of the lab power supply, the power supply at the module and the vehicle battery are easily accessible!
- 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!



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!

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 use 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.

4 ES400 Product Family

This chapter contains information on the following topics:

- "Wiring Concepts in Test Vehicles" on page 15
- "Features of the ES400 Line" on page 16
- "Housing" on page 17
- "Ports" on page 18
- "LED" on page 19

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.

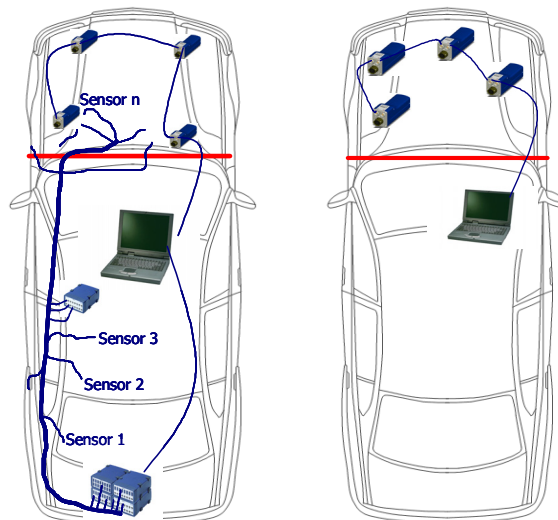


Fig. 4-1 Central and Decentral Sensor Cabling

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 High Definition A/D Module with Sensor Supplys 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 ES415.1, refer to the chapter “Technical Data” on page 69.

4.3 Housing

A sturdy metal housing is used for the ES415.1; it has ports on the front of the device so it can fit into tight spaces. The ES415.1 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 6.2 on page 37). 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 18).

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.

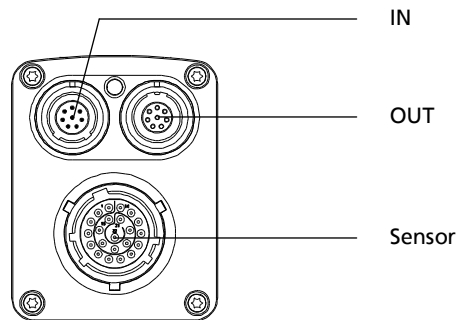


Fig. 4-2 Front

4.4.1 “Sensor” Port

The front of the ES415.1 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:


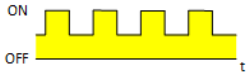


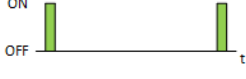
- “IN” (input)
- “OUT” (output)

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

5 Hardware Description

This chapter contains information on the following topics:

- "Features of the ES415.1" on page 20
- "Block Diagram" on page 21
- "Sensor Channels" on page 22
- "Data Transfer" on page 27
- "Power Supply" on page 32
- "Configuration" on page 35
- "Tool Integration" on page 35
- "Firmware Update" on page 35
- "Calibration" on page 35

5.1 Features of the ES415.1



Fig. 5-1 ES415.1 Housing

The ES415.1 High Definition A/D Module with Sensor Supply is a member of the family of ES400-Modules. The ES415.1 can acquire analog voltages at four input channels. There is a sensor supply for every channel.

- 4 electrically isolated A/D channels, separately configurable
- Measure range 100 mV to 60 V
- Signal conditioning cable available for expanded measure ranges
- Sample rate 0.5 Hz to 100 kHz (measuring and calibrating)
- Adjustable short circuit-proof sensor supply voltage (5 V to 15 V)
- Auto detect and configuration of sensors possible with TEDS (Transducer Electronic Data Sheet)

For the complete technical data of the ES415.1, refer to the chapter "Technical Data" on page 69.

5.2 Block Diagram

The ES415.1 is a module with four identical sensor channels, two shared Ethernet interfaces and a power supply.

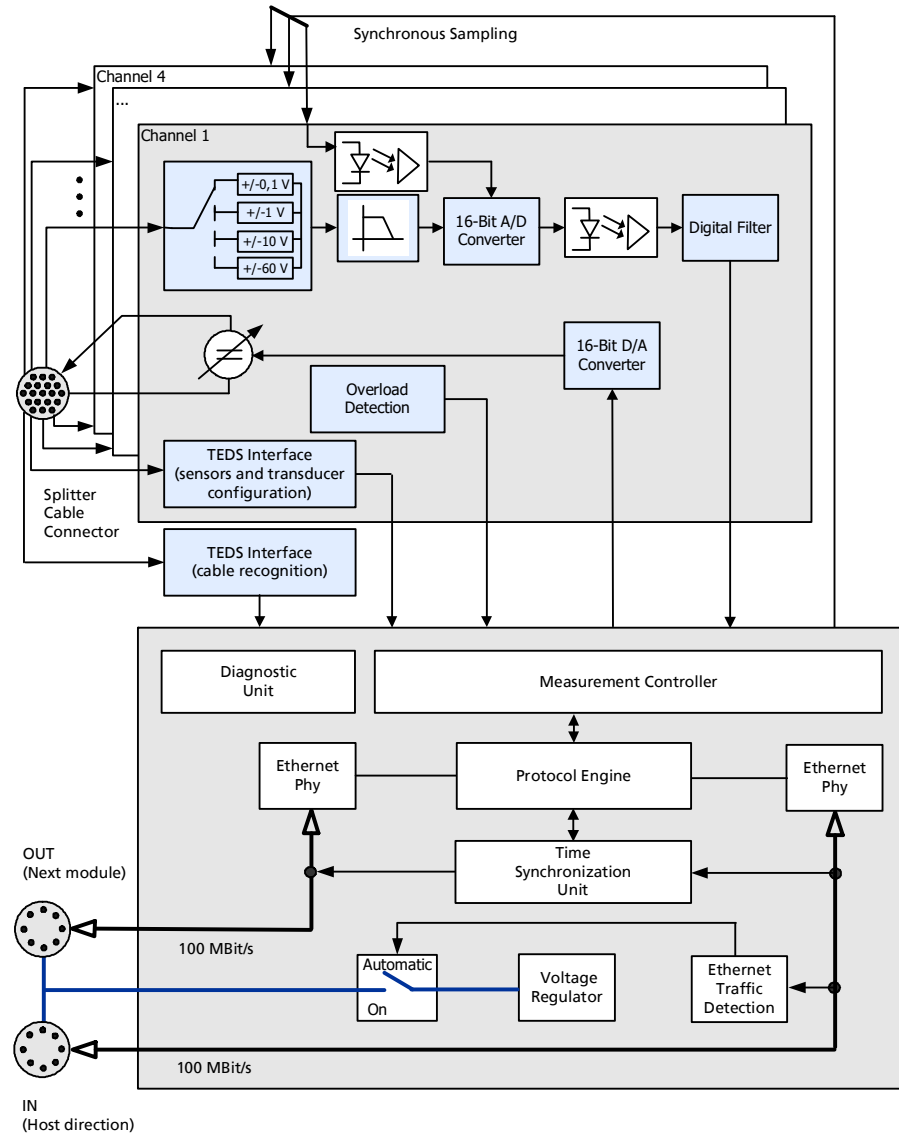


Fig. 5-2 Block Diagram

5.3 Sensor Channels

All sensor channels of the ES415.1 are identical. Every sensor channel consists of the function groups Signal Processing and Filter as well as Sensor Power Supply.

5.3.1 Signal Processing and Filters

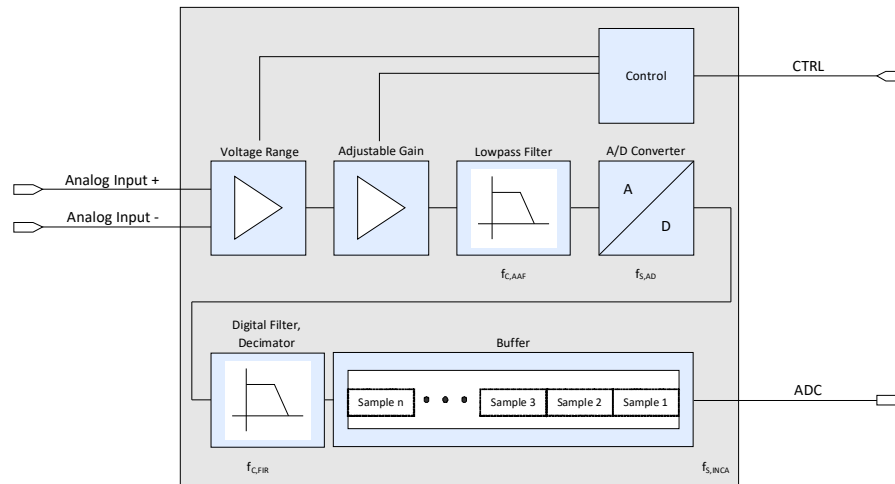


Fig. 5-3 Signal Processing and Filters of a Sensor Channel

5.3.2 Amplifier and analog Filter

The level of the input signal is limited in every sensor channel after the overvoltage protection by a capacitively compensated voltage divider. An amplifier adjusts the input signal to the following analog anti-aliasing filter according to the selection of the input voltage range. This 4th order analog filter with Butterworth characteristics has a cutoff frequency of 50 kHz.

5.3.3 A/D Converter

An A/D converter digitizes the output signal of the analog filter. The individual A/D converter available in every sensor channel guarantees synchronous sampling of the measure signals.

Sample Rates for Rapid Prototyping Applications

NOTE

For Rapid Prototyping applications, the sample rate of the ES415.1 module is limited to a maximum of 10 kHz. The sample rates 100 kHz, 50 kHz and 20 kHz are available only for measurement and calibration applications.

Sample rates to 10 kHz can be configured for measurement and calibration applications as well as for Rapid Prototyping applications in the application software.

To avoid the IRQ overload at the I/O port of the ES910.3, the sample rate of the ES415.1 module in this mode is automatically limited to 10 kHz.

If the ES415.1 would be operated at high sample rates for Rapid Prototyping applications, the ES910.3 could no longer process the data of the ES415.1 or other ETAS daisy chain modules due to IRQ overload at its I/O port and would discard the data.

If the user selects a higher sample rate in this mode (100 kHz, 50 kHz and 20 kHz), the application software prevents the initialization of the hardware and points to the limited selection of sample rates.

5.3.4 Digital Filter

A digital filter then processes the digital signal. The parameters of the CIC filter (Cascaded-Integrator-Comb filter) are automatically set upon selecting the sample rate in the configuration software. The digital filter can be switched off, parameters of the filter cannot be configured.

The data is written to a data buffer at the output of the digital filter. It can be queried there by the application program.

Compensating Group Delay

The group delay is the time it takes the input signal of an analog or digital filter to pass the filter. In the application program (e.g. INCA MDA), the signal must be delayed to compensate for the group delay.

A special feature of the ES415.1 is the compensation of the group delay within the module. The group delays of the analog anti-aliasing filter and the configurable digital filter are taken into consideration in this process. The signal in the application program (e.g. in MDA) no longer has to be delayed to compensate for the group delay.

Examples

To represent the group delay with digital filters, a test signal was sent to two filters of the same type:

- Filter A without compensation of the group delay
- Filter B with compensation of the group delay

The configuration of both filters is identical. The test signal is sampled with the sampling rate $f_{S,INCA} = 2 \text{ kHz}$ (0.5 ms). The filter channel was set to a cutoff frequency $f_{C,CIC} = 200 \text{ Hz}$.

Fig. 5-4 and Fig. 5-5 on page 24 show the relevant signal trace - in the upper part of the figure without a filter, in the lower part of the figures with a filter and without or with group delay compensation respectively.

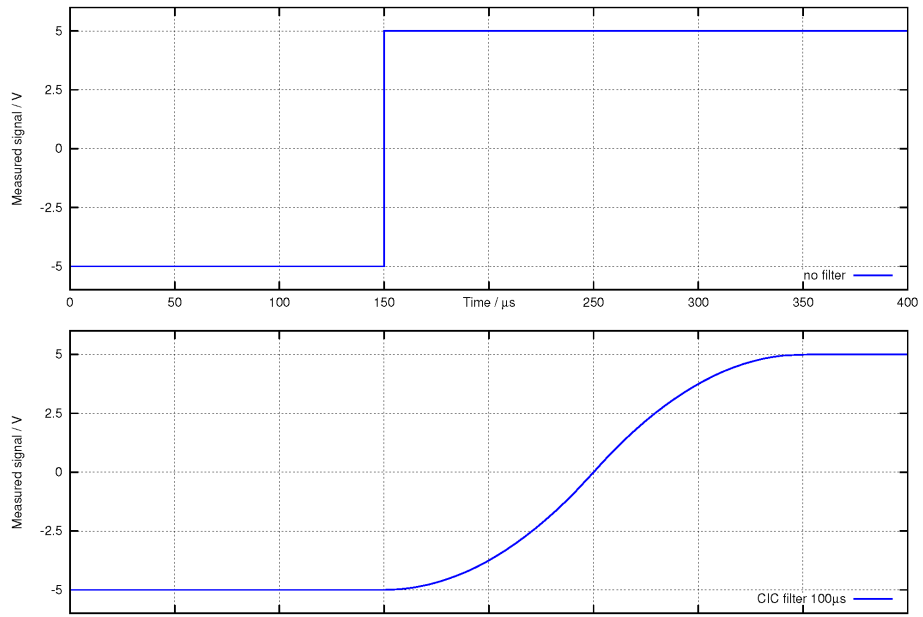


Fig. 5-4 Filter A: $f_{C,CIC} = 10 \text{ kHz}$ (without compensation of the group delay)

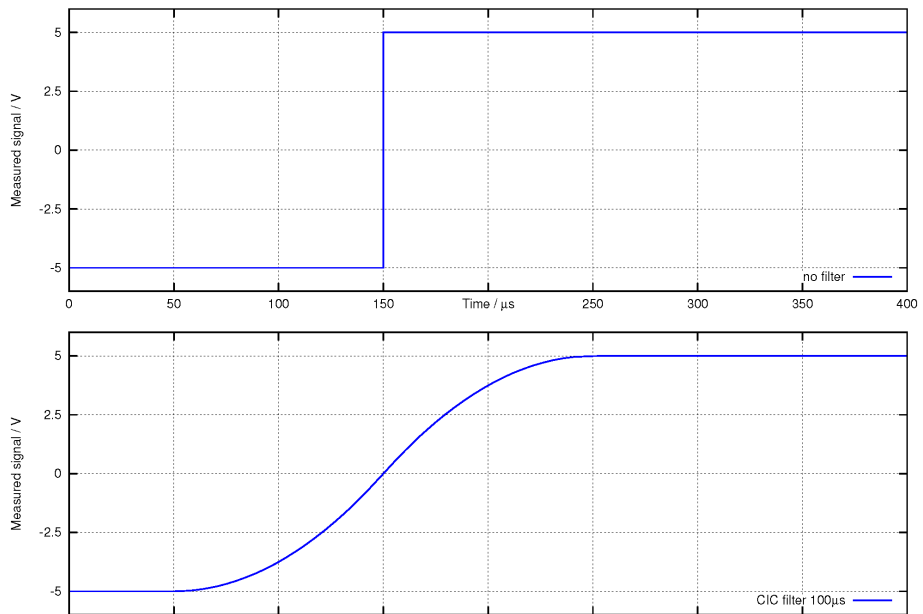


Fig. 5-5 ES415.1 Filter B: $f_{C,CIC} = 10 \text{ kHz}$ (with compensation of the group delay)

5.3.5 Maximum Input and Common-Mode Voltages

The maximum input voltage between two inputs and the maximum voltage between an input and the case ground is 60 V DC/ 30 V AC. For an explanation of the maximum input and common-mode voltages, see Fig. 5-6 on page 25 and the example.

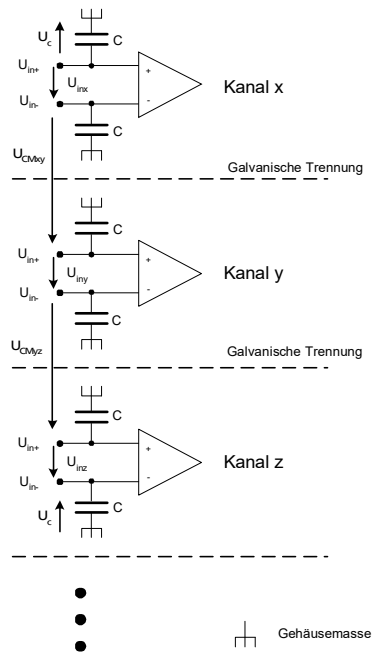


Fig. 5-6 Maximum Input and Common-Mode Voltages

All capacitors between the inputs (U_{in+} and U_{in-}) and case ground have the same capacity. The maximum voltage between any input and case ground is also 60 V DC/ 30 V AC.

Example

For the given input voltages U_{inx} , U_{iny} , U_{inz} and the common-mode voltage U_{CMxy} , the maximum allowed common-mode voltage U_{CMyz} is to be calculated.

$$U_{inx} = 10 \text{ V}$$

$$U_{iny} = 5 \text{ V}$$

$$U_{inz} = 10 \text{ V}$$

$$U_{CMxy} = 15 \text{ V}$$

$$\max(U_{inx} + U_{iny} + U_{inz} + U_{CMxy} + U_{CMyz}) = 60 \text{ V}$$

$$10 \text{ V} + 5 \text{ V} + 10 \text{ V} + 15 \text{ V} + \max(U_{CMyz}) = 60 \text{ V}$$

$$\max(U_{CMyz}) = 60 \text{ V} - 40 \text{ V} = 20 \text{ V}$$

5.3.6 Galvanically Isolation

The sensor channels are galvanically isolated from each other and from the power supply. The digitized transfer of the measurements on an Ethernet connection implicitly results in a separation of the sensor channels from the supply voltage.

5.3.7 Sensor Supply

Every sensor that can be switched to the ES415.1 has an individual sensor supply voltage which can be set separately.

The cable connected to the sensor port of the ES415.1 transfers both the sensor supply voltage and the sensor output voltage for the sensor. Additional cables or an additional external power supply for the sensor supply voltage are not required.

The sensor supply voltage is generated from the module operating voltage in every sensor channel. The sensor supply voltage can be modified in steps. The user can switch off the sensor supply voltage of each sensor channel in the application program, select one of the defined values between +5 V and +15 V or enter or define any value within the value range.

Behavior for Rapid Prototyping Applications

The already existing sensor voltage is briefly interrupted at the start of the Rapid Prototyping model on the ES910.3.

Electrical Isolation

The ground of the sensor supply voltage channels is connected with the ground of the operating voltage of the module and protected with a fuse.



NOTE

The supply voltages of the sensors are not galvanically isolated towards the operating voltage of the module.

Overvoltage Protection

Each sensor supply output is protected against overvoltages. Exceeding the maximum value trips a fuse.

Fuses

If a sensor supply output (ground) is connected with the supply voltage (positive) of the module, it trips a fuse.

Defective fuses cannot be replaced by the user. Please return defective modules to ETAS. Notes about the process are available from the local ETAS sales and service offices. The contact information is located in the chapter "Contact Information" on page 108.

Overload

Upon exceeding the maximum output of a channel, the output voltage of this channel is reduced.

Short-circuit Detection

In case of a short circuit of a sensor supply output (positive) to ground, the sensor power supply automatically switches off this channel.

Information in the Application Program

In case of short circuits and tripped fuse, the application program receives analyzable channel-specific information.

5.4 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.

5.4.1 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. 5-7 on page 27).

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.

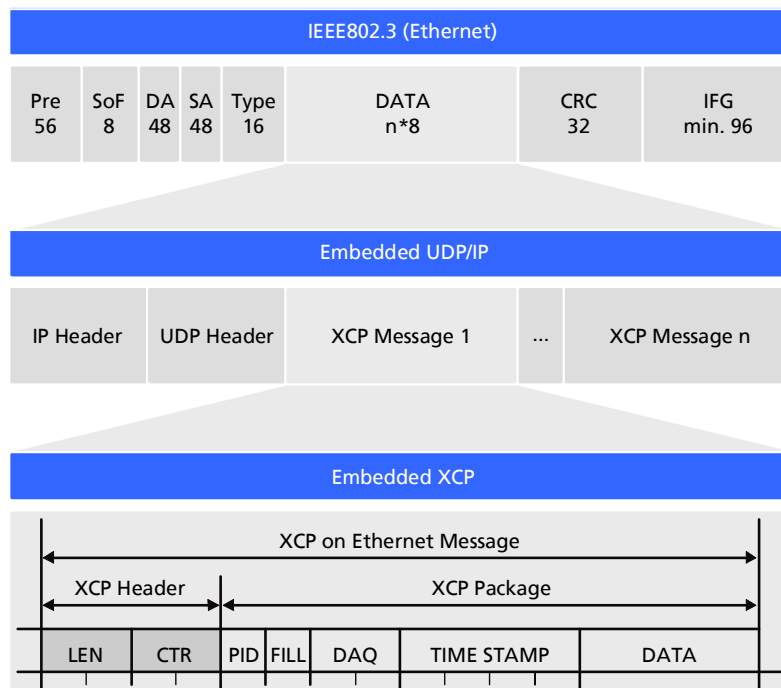


Fig. 5-7 Message Format "XCP on UDP" (Schematic)

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“ .

5.4.2 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.

5.4.3 Examples

Example 1

Fig. 5-8 on page 30 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. 5-9 on page 30.

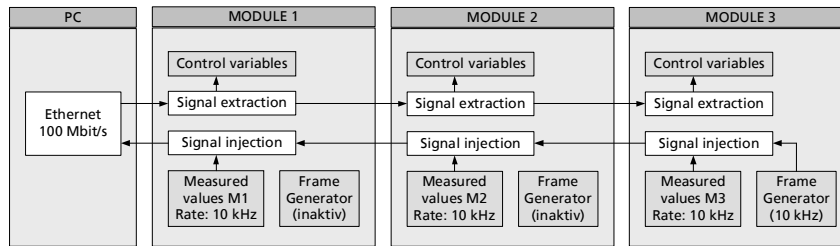


Fig. 5-8 Time-Multiplex Data Transfer Between an ES400 Module Chain and a PC

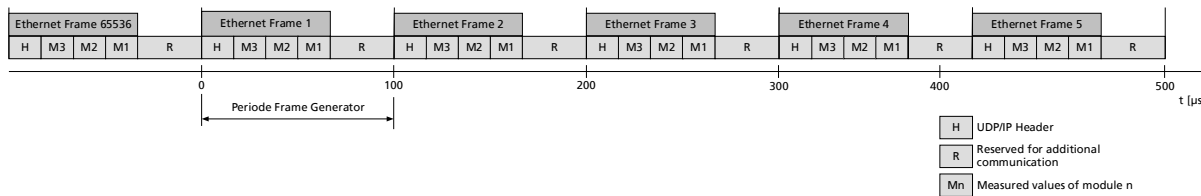


Fig. 5-9 Transfer Scheme for Example 1 (Simplified, Not True to Scale)

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. 5-9 on page 30). Independently of this, control variables can be transferred at the same time from the PC to the modules.

Example 2

Fig. 5-10 on page 31 shows an example in which three modules with different acquisition rates are linked to each other. The transfer scheme for this configuration is shown in Fig. 5-11 on page 31.

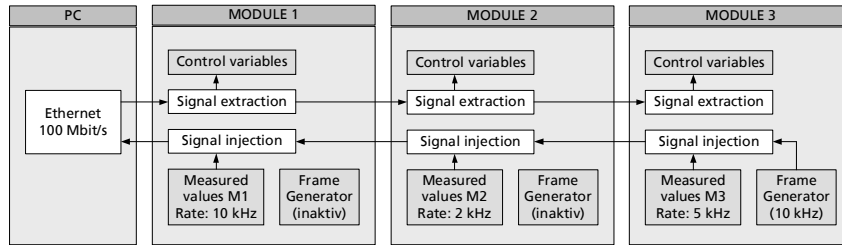


Fig. 5-10 Time-Multiplex Data Transfer Between an ES400 Module Chain and a PC

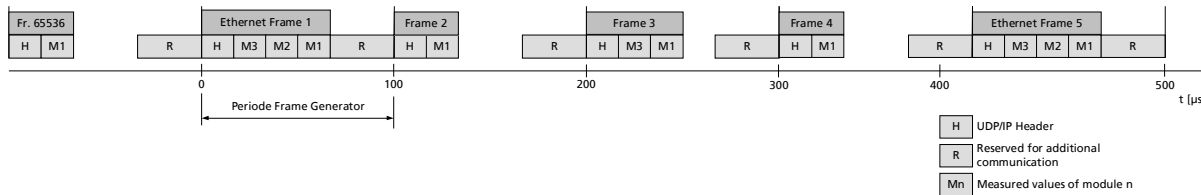


Fig. 5-11 Transfer Scheme for Example 2 (Simplified, Not True to Scale)

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.

5.5 Power Supply

5.5.1 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 ES415.1, you can use an automatic power-saving feature ("Standby") as well as a "Wake Up" function via the Ethernet interface.

5.5.2 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.

5.5.3 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 ES415.1 configurations.

Example 1:

For module chains which are equipped exclusively with ES410.1 or ES441.1, ETAS recommends the use of Y boost cables if the length of the module chain is longer than 10 modules.

Example 2:

For module chains which are equipped exclusively with ES411.1 or ES413.1 or ES421.1, ETAS recommends the use of Y boost cables if the length of the module chain

- is longer than 16 modules (without sensor feeding) or
- is longer than 10 modules (with sensor feeding).

Example 3:

For module chains which are equipped exclusively with ES415.1 or ES420.1, ETAS recommends the use of Y boost cables if the length of the module chain

- is longer than 8 modules (without sensor feeding) or
- is longer than 5 modules (with sensor feeding).

Example 4:

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

- nine ES420.1 or ES421.1 and
- four ES410.1 or ES411.1 or ES413.1 (without sensor feeding) and
- one ES441.1

Example 5:

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

- five ES420.1 or ES421.1 and
- two ES415.1 (without sensor feeding) and
- one ES441.1

Example 6:

With a minimum voltage of 9 V, no additional feeding is necessary with a Y cable if the module chain consists of the following modules:

- nine ES420.1 or ES421.1 and
- four ES410.1 or ES411.1 or ES413.1 (with sensor feeding) and
- one ES441.1

Example 7:

With a minimum voltage of 9 V, no additional feeding is necessary with a Y cable if the module chain consists of the following modules:

- five ES420.1 or ES421.1 and
- two ES415.1 (with sensor feeding) and
- one ES441.1



NOTE

All examples apply at 85 °C ambient temperature.

5.6 Configuration

The configuration of the ES415.1 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.

5.7 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.

5.8 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!

5.9 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 108). For information on ordering the calibration service, refer to chapter "Calibration" on page 106.

6 Getting Started

This chapter contains information on the following topics:

- "General Installation Recommendations" on page 36
- "Assembly" on page 37
- "Drilling Template" on page 50
- "Applications" on page 51
- "Wiring Examples" on page 53
- "Wiring" on page 58

6.1 General Installation Recommendations

6.1.1 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 8 on page 69).

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).

6.1.2 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.

6.1.3 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.

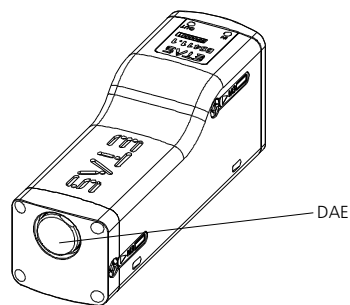


Fig. 6-1 Position of the Pressure Balance Element

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.

6.2 Assembly

6.2.1 How to Connect and Attach ES400 Modules

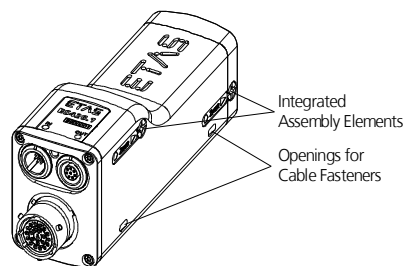


Fig. 6-2 How to Attach ES400 Modules

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).

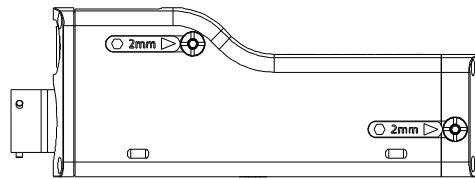


Fig. 6-3 Accessing the Integrated Assembly Elements

You can access and use the two integrated assembly elements of a module via the holes indicated (see Fig. 6-3 on page 38) on the right-hand side of the module.

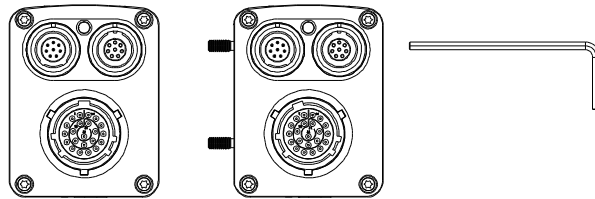


Fig. 6-4 Unscrewed Integrated Assembly Elements

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

6.2.2 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.

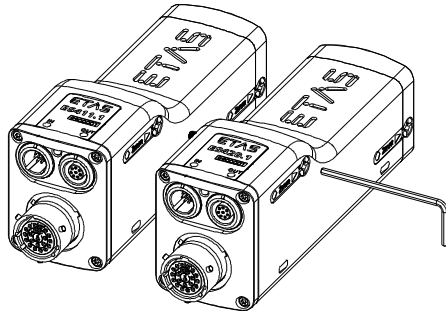


Fig. 6-5 Connecting Several ES400 Modules Using the Integrated Assembly Elements

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.

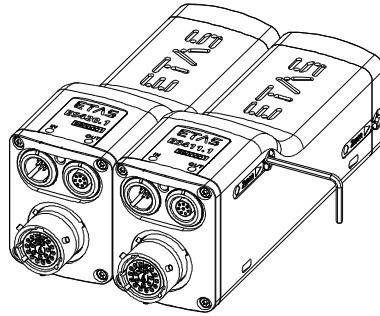
2. Position the modules so that their fronts are in a line.
3. Hold the two modules together firmly on their outer sides.

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. 6-6** Connected ES400 Modules

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

i 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.

i NOTE

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

Both modules are now completely connected mechanically.

Connecting to Other Modules**i 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 6.2.2 on page 39.

6.2.3 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.

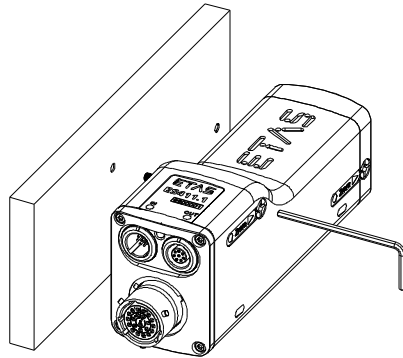


Fig. 6-7 Attaching a Module to Other Components with the Integrated Assembly Elements

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. 6-13 on page 50).

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 6.2.2 on page 39.

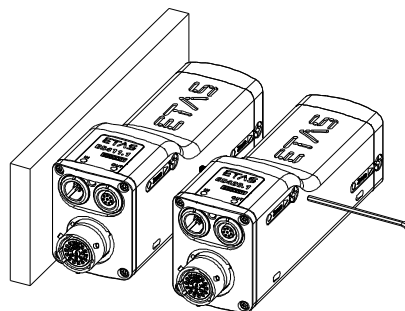


Fig. 6-8 Connecting to Other Modules

6.2.4 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.

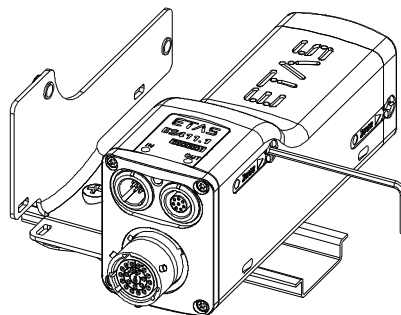


Fig. 6-9 Fastening to an ES4xx Angle Bracket (left) using the Integrated Assembly Elements

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 6.2.2 on page 39.

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.

6.2.5 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.

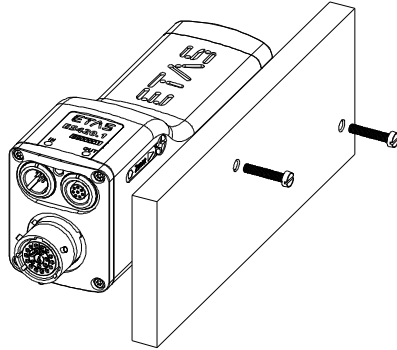


Fig. 6-10 Attaching to Other Components Using Additional Screws

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. 6-13 on page 50).

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 6.2.2 on page 39). The module on the extreme right of the module block is connected to the other component like an individual module - using screws.

6.2.6 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.

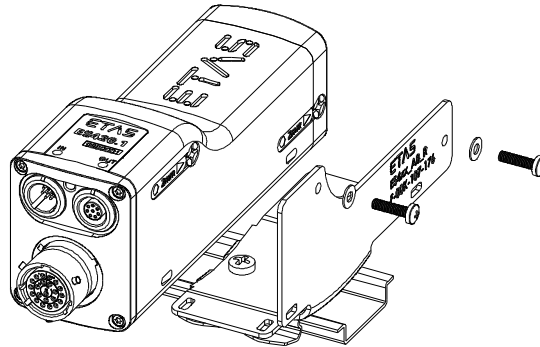


Fig. 6-11 Fastening on DIN Rails with Additional Screws

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:

i 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

i 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 6.2.2 on page 39). 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.

6.2.7 Attaching ES400 Modules to Other Components Using Cable Fasteners

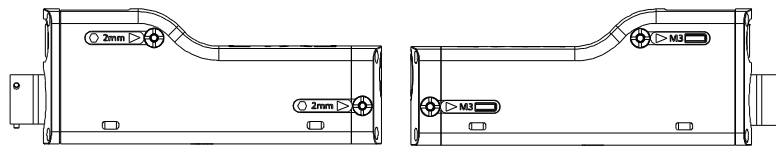


Fig. 6-12 Openings for Cable Fasteners in ES400 Modules

Every module base has openings for two cable fasteners each on the right- and left-hand side (see Fig. 6-12 on page 49). 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.

6.3 Drilling Template

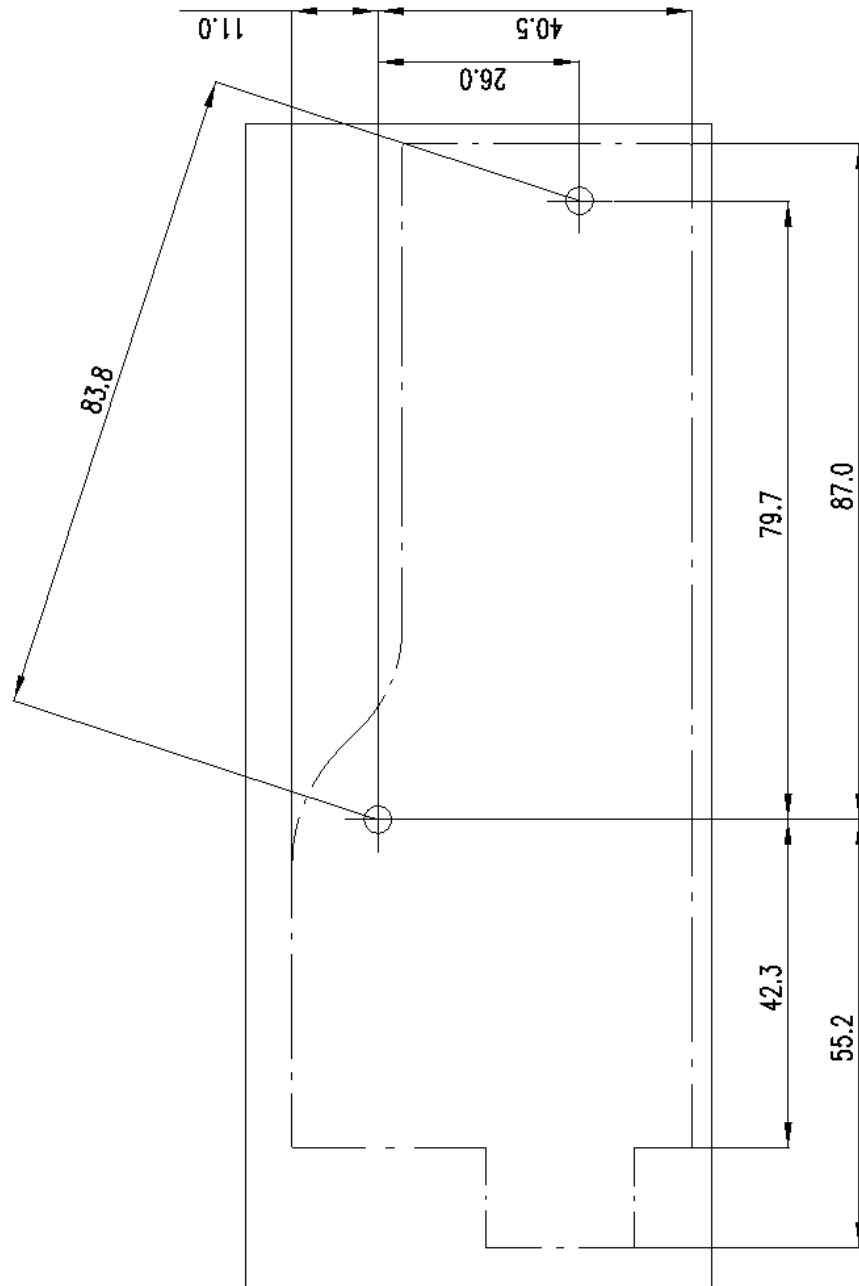


Fig. 6-13 Drilling Template

6.4 Applications

6.4.1 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.

6.4.2 ES415.1 with additional ETAS Modules (MC Application)

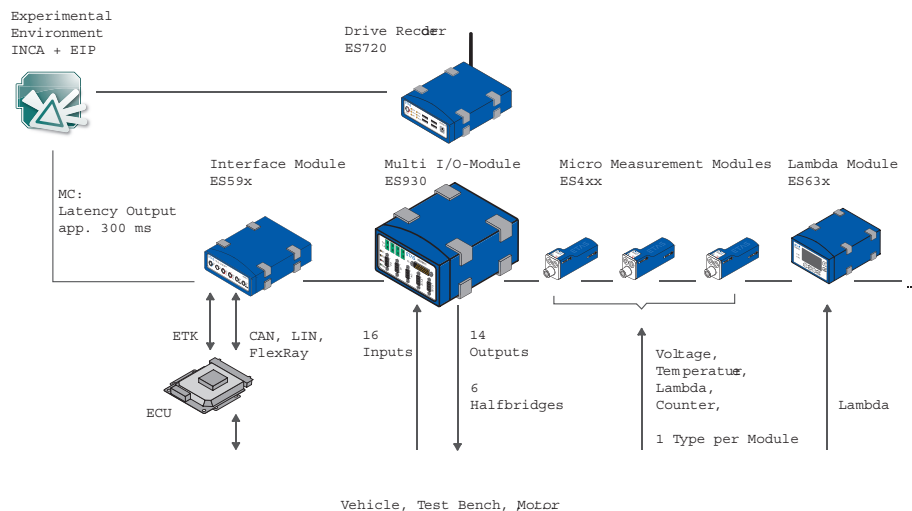


Fig. 6-14 ES415.1 with additional ETAS Modules for MC Applications

The ETAS Daisy Chain concept enables a simple network architecture since only the ES415.1 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.

6.4.3 ES415.1 with additional ETAS Modules (Rapid Prototyping Application)

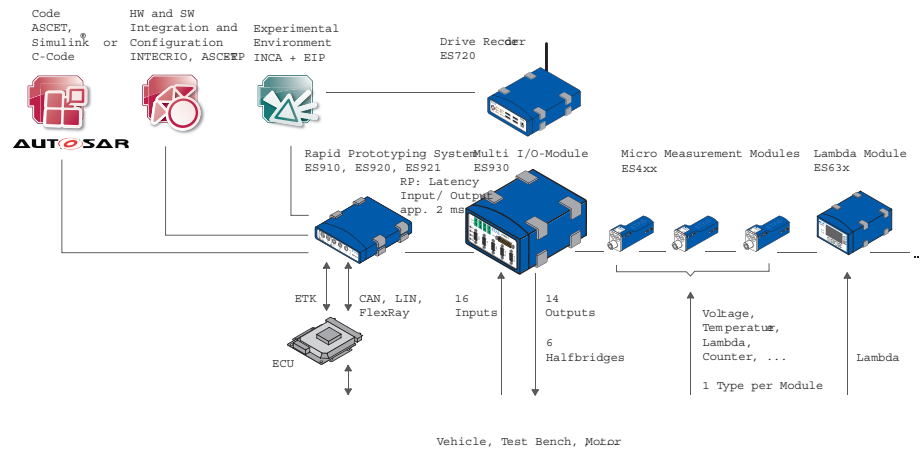


Fig. 6-15 ES415.1 with ES910.3 and additional ETAS Modules for Rapid Prototyping Applications

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 RTPRO-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.

6.5 Wiring Examples

6.5.1 ES400 Modules with additional ETAS Modules (Measurement and Calibration)

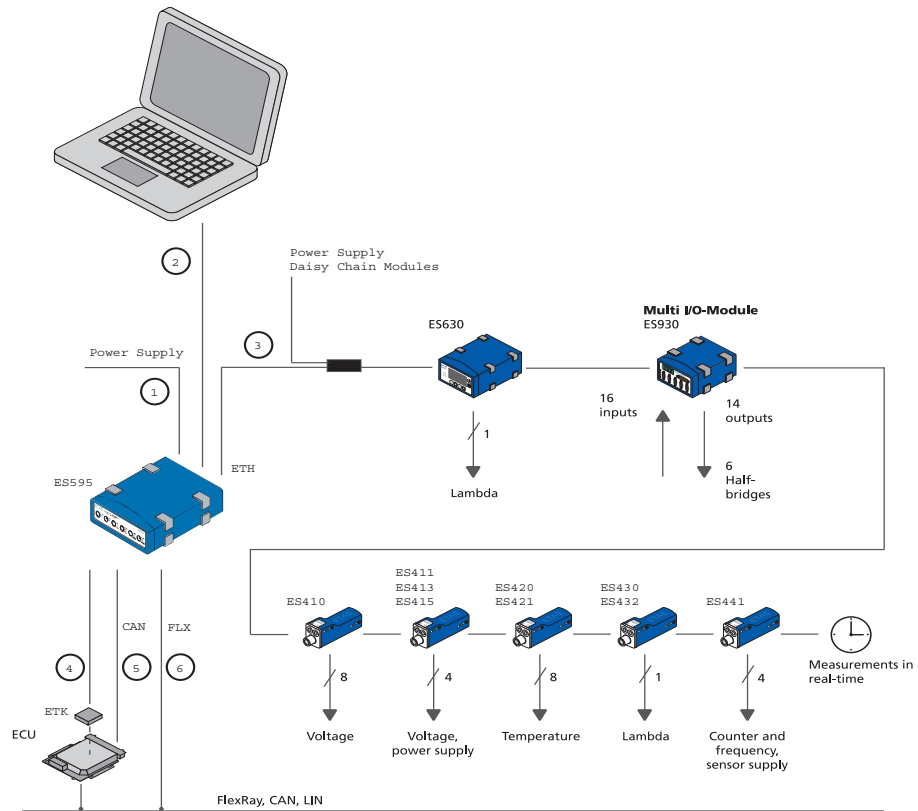


Fig. 6-16 ES400 Modules with add. ETAS Modules (Measurement and Calibration)

Cable in Fig. 6-16	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

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

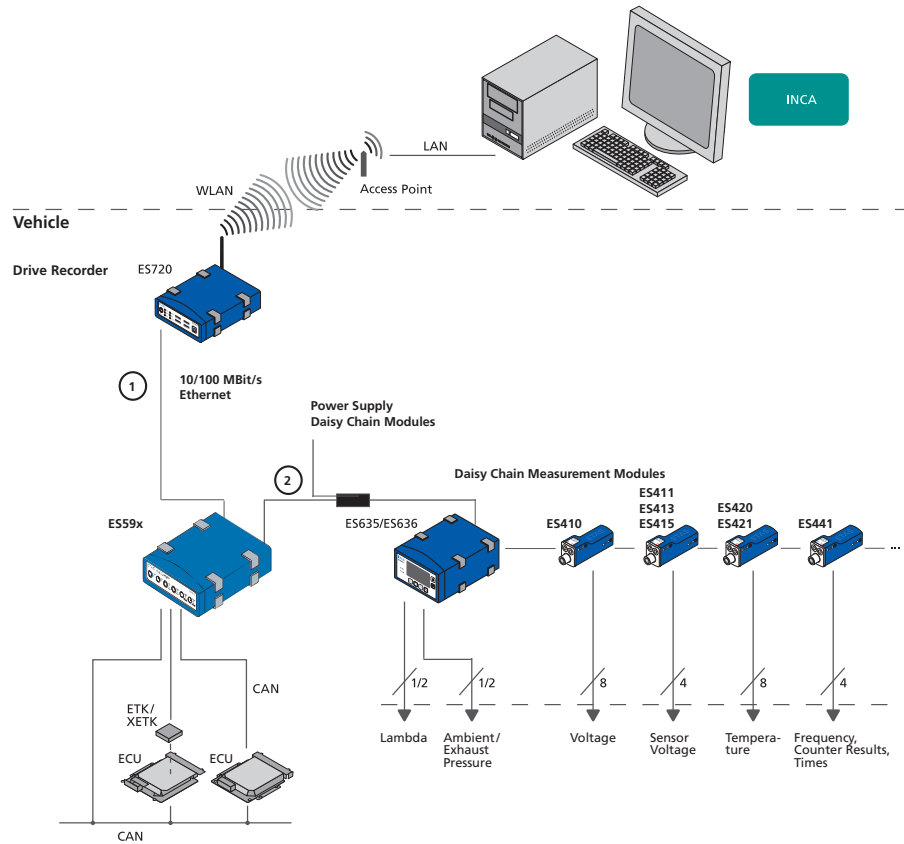


Fig. 6-17 ES400 Modules with additional ETAS Modules and Drive Recorder (Measurement and Calibration)

Cable in Fig. 6-17	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

6.5.3 ES400 Modules with ES910.3 (Rapid Prototyping)

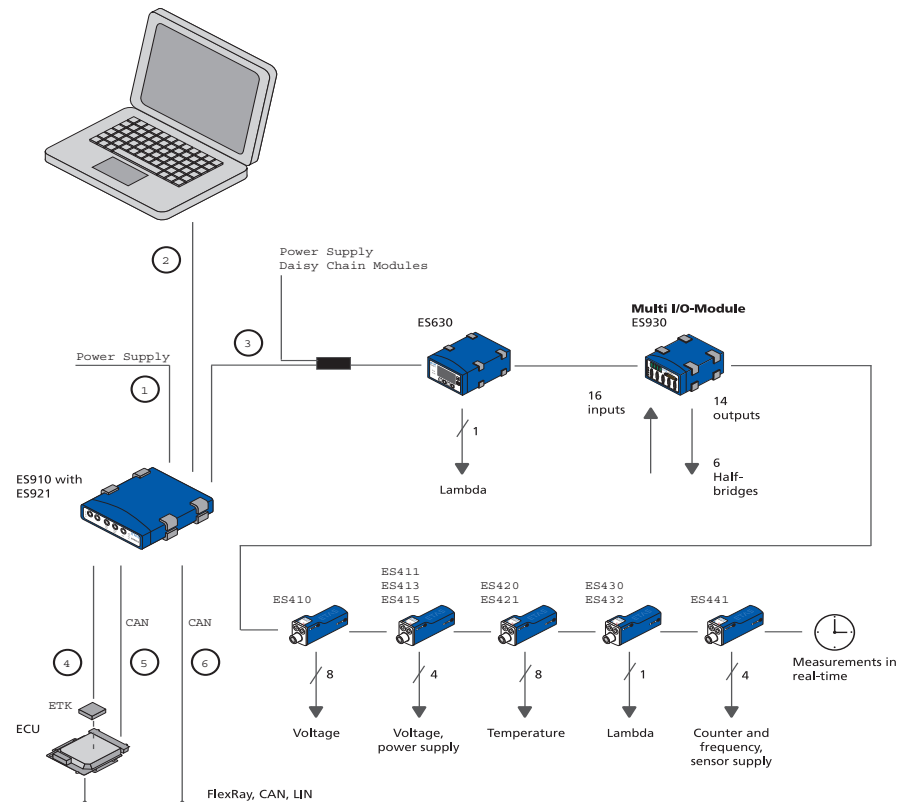


Fig. 6-18 ES400 Modules with ES910.3 (Rapid Prototyping)

Cable in Fig. 6-18	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	CBCF1100
	CAN connection cable (CAN only), at ES910.3, at ES921.1	CBAC130, CBAC140, CBAC150, CBCX130

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

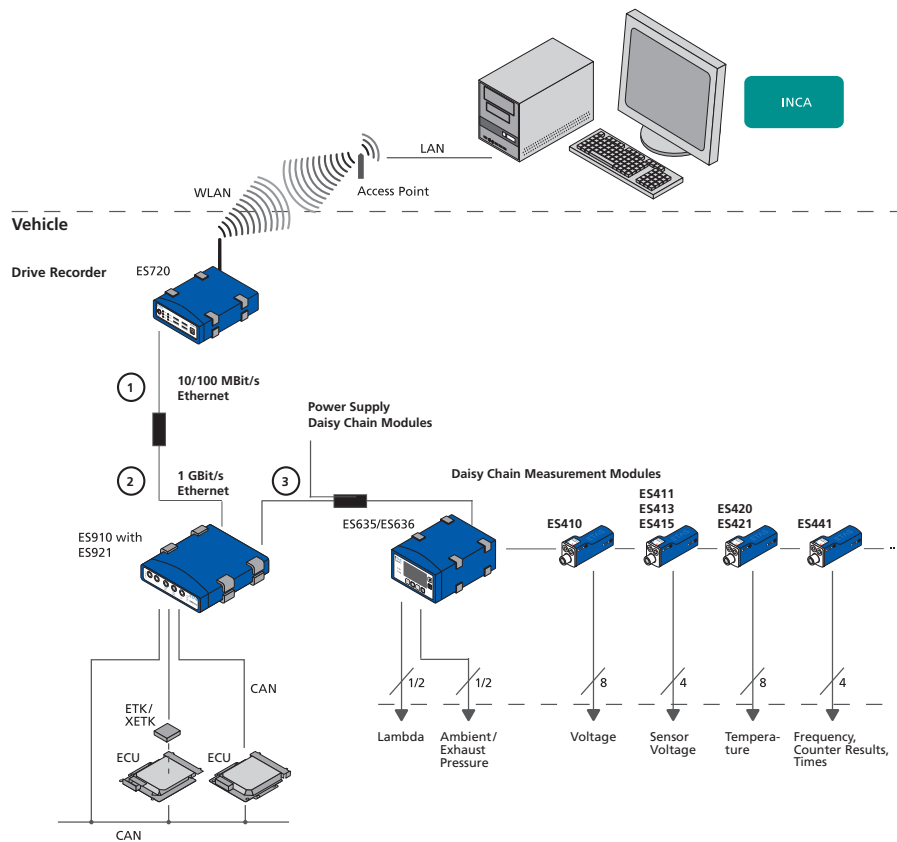


Fig. 6-19 ES400 Modules with ES910.3 and Drive Recorder (Rapid Prototyping)

Cable in Fig. 6-19	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

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

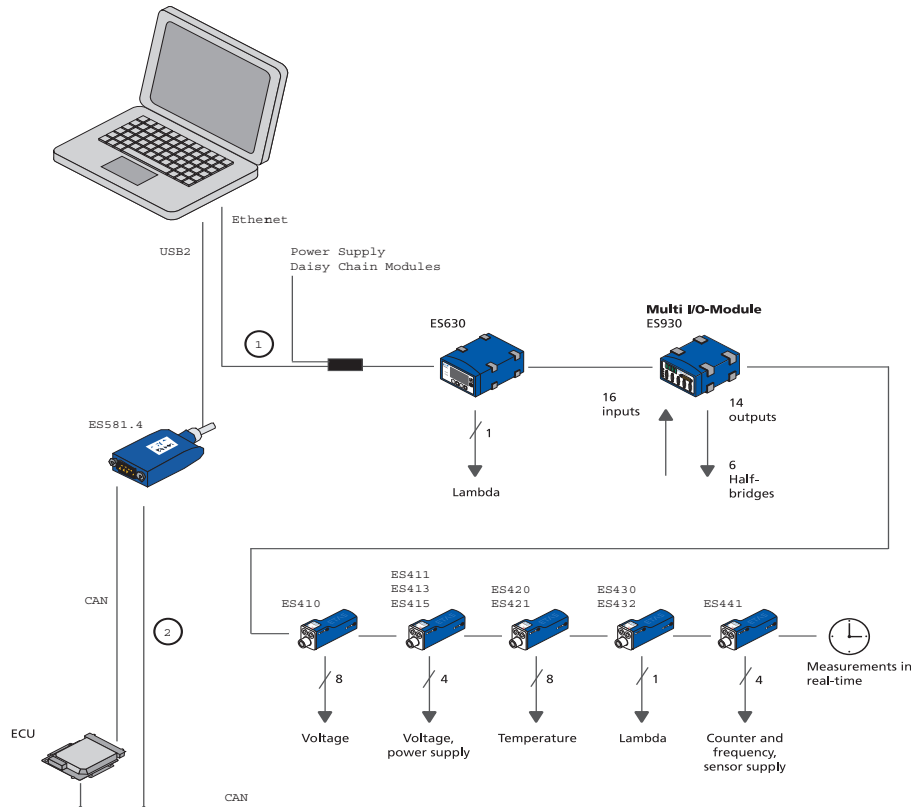


Fig. 6-20 ES400 Modules with ETAS RTPRO-PC (Rapid Prototyping)

Cable in Fig. 6-20	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

6.6 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 84.

6.6.1 "Sensor" Port

To connect the sensors with the ES415.1, you can use different standard and adapter cables as well as signal conditioning cables. Detailed information about the cables offered by ETAS is located in chapter "Cable for the Connection "Sensor"" on page 94 and in the user's guides of the Signal Conditioning Cables.

Standard and Adapter Cable

- Cable CBAV411.1
You can customize the open connection of cable CBAV411.1 and adapt it to the specific plug connector system of your measuring setup.
- Cable CBAV400.1
If you replaced modules with BNC cabling with ES415.1 modules in your measuring setup, the use of these adapter cables enables you to continue using the existing cabling of your measuring setup.
- Cable CBAV417.1

Signal Conditioning Cable

- CBN400.1 Isolating Measurement Probe
High-voltage cable, four input channels for voltages up to +/-1000 V DC and isolation up to +/-1000 V DC
- CBN401.1 Isolating Measurement Probe
High-voltage cable, four input channels for voltages up to +/-10 V DC and isolation up to +/-1000 V DC
- CBN41x.1 Current Probe
- CBN42x.1 Sensor Cable Providing Bipolar Sensor Supply
- CBN43x.1 Temperature Sensor Connection Cable

To wire the ES415.1 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 ES415.1.
3. Connect the sensors and transducers to the ports of the sensor cables of the ES415.1.
4. For your application program, jot down the assignment of the sensors to the inputs of the ES415.1 in accordance with the wiring of the test set-up.

6.6.2 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.

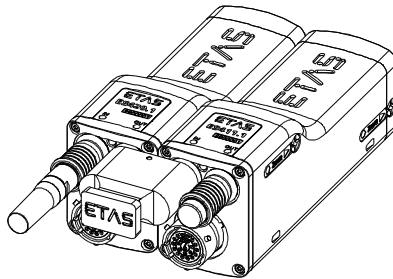


Fig. 6-21 ES415.1 with ES4xx_BRIDGE

**CAUTION**

The ports of the modules or the ES4xx_BRIDGE can be damaged!

Screw the two modules together without getting them off-thread as far as it will go within the module.

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

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

1. Connect the combined Ethernet and power supply cable to the "IN" port of the ES415.1.
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 ES415.1 of the last module of the chain towards the PC.
3. Connect the combined Ethernet and power supply cable to the "IN" port of the ES415.1 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 Troubleshooting Problems

This chapter contains information on the following topics:

- “LED Displays” on page 60
- “Troubleshooting ES415.1 Problems” on page 60
- “Problems and Solutions” on page 63

7.1 LED Displays

Please observe the LEDs which provide information on the functions of the interface and the ES415.1 (see the chapter “LED” on page 19) to be able to judge the operational state of the ES415.1 as well as troubleshooting measures.

7.2 Troubleshooting ES415.1 Problems

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 11 on page 108).

Problem	Diagnostic Questions	Possible Solutions
The application program cannot find any ETAS Daisy Chain 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 7.3 on page 63. 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 required firmware on the module?	Check with HSP whether the required firmware is installed on the module.
	Did you install the application software required?	Check that the application software installed on your PC corresponds to the requirements listed in section 8.9.2 on page 75.
	Power supply	Check that your power supply and test setup correspond to the requirements listed in section 5.5 on page 32.
	Is the hardware connected to the PC?	Check that the wiring is undamaged.
	Are the modules in the module chain connected correctly?	Check that the wiring is undamaged.

Problem	Diagnostic Questions	Possible Solutions
Measurement does not start.	Are you being prompted to carry out an update in the INCA-Monitorlog or in the Config-Tool?	Update the modules.
	Is there no data from the module?	<p>Check that your power supply and test setup correspond to the requirements listed in section 5.5 on page 32.</p> <p>Check that the wiring of the hardware to the PC is correct/intact.</p> <p>Check that the modules in the module chain are connected correctly.</p>
	You are using the ES4xx Configuration Tool and the module is supplying no data?	<p>Check whether the position of one or more modules in the chain has changed.</p> <p>Check that you are not using an incorrect A2L file.</p> <p>Check whether you have loaded the measure configuration to the module chain.</p> <p>Check that you have not assigned the same IP address to two module chains.</p>
	Is the module supplying usable data?	Check that the sensor is connected correctly.
Data is lost during data transfer.	Are you using WLAN in your test setup?	WLAN is not permissible within this ETAS network. Wire your test setup (ETAS modules and their connection to the PC) with ETAS cables only.
	Are you using the correct type of network card in your laptop?	Check whether you are using a PCMCIA network card in your laptop. PCMCIA cards with an 8- or 16-bit data bus are not suitable. Only use PCMCIA cards with a 32-bit data bus, mini-PCI or ExpressCards.
	Are you operating the ETAS Daisy Chain modules on a PC with multi-core processor?	Install a current driver for the network card that supports the NDIS protocol.
	Are you using ES415.1 modules common with other ES4xx modules?	Operate the ES415.1 modules at the beginning of the module chain close to the host (PC, drive recorder).

Problem	Diagnostic Questions	Possible Solutions
The LED is showing red.	Have you just carried out an update?	For users of the INCA/INTECRIO/ASCET-RP/ Configuration tool: Switch the module off and on again. For users of the Config tool: Switch the module off and on again. Load the measuring configuration again. 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 ETAS Daisy Chain modules separately.

¹⁾: The manufacturers of PC Cards have different names for this function.
Example: "Link down Power saving" (refer to Chapter 8.9.1 on page 74).

7.3 Problems and Solutions

7.3.1 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\Tcpip\Parameters\`
3. Click **Edit** → **Find** to search for the key `IPAutoconfigurationEnabled`.

If you cannot find any instances of the registry key mentioned, the APIPA mechanism has not been disabled on your system. i.e. there is no need to enable it. Otherwise proceed with the following steps:

4. Set the value of the key `IPAutoconfigurationEnabled` to 1 to enable the APIPA mechanism.

You may find several instances of this key in the Windows registry which either apply to the TCP/IP service in general or to a specific network adapter. You only need to change the value for the corresponding network adapter.
5. Close the registry editor.
6. Restart your workstation in order to make your changes take effect.

7.3.2 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 7.3.3 on page 66.

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 page 64)
- 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`.

7.3.3 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.

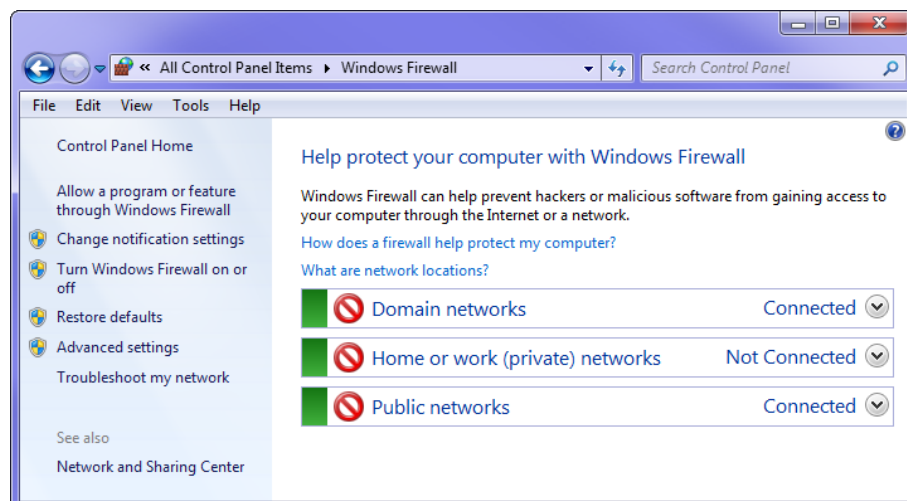
In Windows 7, 8.1 and 10, a Personal Firewall program is part of the scope of delivery and enabled by default. On many other systems, similar programs from independent providers can frequently be found, such as Symantec, McAfee or BlackIce. The procedure for the configuration of ports may differ in the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

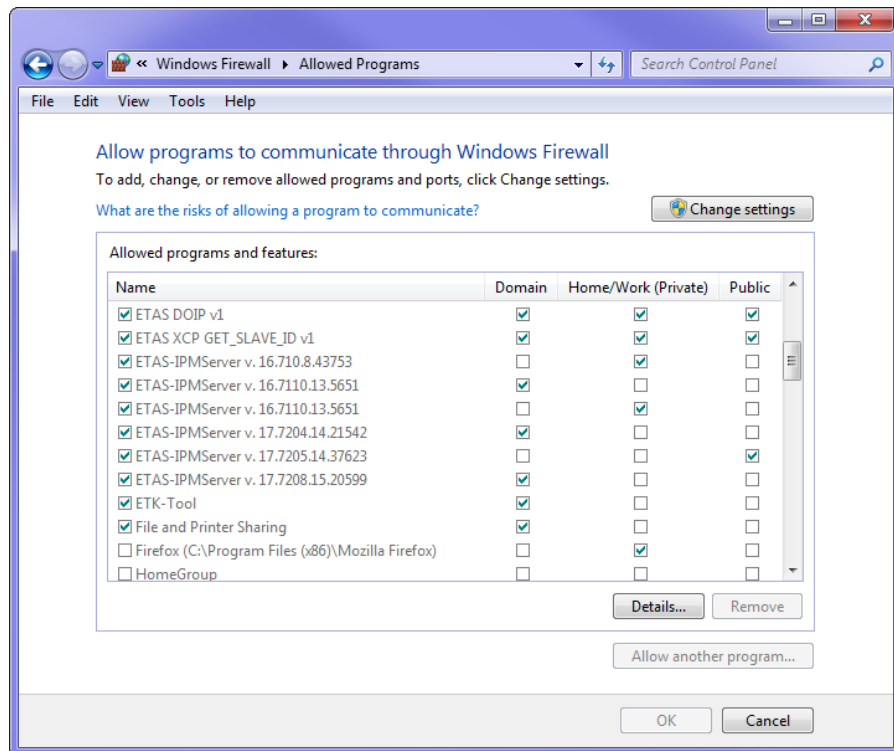
Solution for Windows Firewall, user with administrator rights

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. Click 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.

8 Technical Data

This chapter contains information on the following topics:







- "General Data" on page 69
- "RoHS conformity" on page 72
- "CE conformity" on page 73
- "Product return and recycling" on page 73
- "Declarable Substances" on page 74
- "Use of Open Source software" on page 74
- "System Requirements" on page 74
- "Electrical Data" on page 75
- "Pin Assignment" on page 81




8.1 General Data

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

8.1.1 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 10.1 on page 103
5-50V  Pmax=6W	Operating voltage range (DC), Power consumption
	Labeling for WEEE, see chapter 8.6 on page 73
	Marking for CE conformity (Chapter 8.3 on page 73)

Symbol	Description
	Marking for UKCA conformity (Chapter 8.4 on page 73)
	Marking for KCC conformity (Chapter 8.5 on page 73)
	Labeling for RoHS (China), see chapter on page 72

8.1.2 Standards and Norms

The module adheres to the following standards and norms:

Standard	Test
EN 61326	Electrical equipment for measurement, control and laboratory use - EMC requirements
EN 61000-6-2	Immunity (industrial environments) ¹⁾
EN 61000-6-4	Emission standard (industrial environments)

¹⁾: The module must be supplied by a DC power supply or a battery with operating voltage. Between module and voltage source, cables with a maximum length of 30 m are allowed.

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



WARNING

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

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: Temperature: Tu -40 °C / To +120 °C, Number of cycles: 10, Unit under test: active
DIN EN 60068-2-56	Humidity storage
DIN EN 60068-30, Variant 1	Climate change

Norm	Test
DIN EN 60068-2-64, ISO 16750-3	Vibration, noise: 3 space axis, test duration 4 h, Unit under test: active In addition, the combination was tested by cascaded modules.
ISO 16750-3, Sec. 4.2.2.2	Mech. shock 3 space axis, half sinus, Acceleration: 500 m/s ² , Shock duration: 6 ms, Shocks per direction and axis: 10, Units under test: active
ISO 16750-3, Sec. 4.3	Drop test Number of drops: 2, Height: 1 m, Surface: concrete, steel Units under test: passive
ISO 16750-4, Sec. 5.2	Phased temperature test
ISO 16750-4, Sec. 5.4.2	Splash water Air temperature: To +120 °C, Cycle duration: 30 min, Splash length: 3 s, Splash quantity: ca. 3 l, Splash water temperatur: +2 °C ± 2 °C, Medium: water, put in 3% Arizona dust fine, Number of cycles: 100, Unit under test: active
ISO 16750-4, Sec. 5.5.1.; DIN EN 60068-2-52	Salt fog: Severity level: 5, Test duration: 16 d, Units under test: passive
ISO 16750-5	Chemical resistance: Identification A-W, Prüflinge passiv
DIN 5596-1	Stone impact
IPX7	Protection class test: Protection class IP67

8.1.3 Environmental Conditions

Operating temperature range	-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 housing!

Works on the module housing may be executed only by qualified technical personnel.

8.1.4 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.

8.1.5 Cleaning the product

We recommend to clean the product with a dry cloth.

8.1.6 Mechanical Data

Dimensions (H x W x D)	51.5 mm x 40 mm x 139 mm / 37.5 mm x 40 mm x 124 mm 2.0 in x 1.57 in x 5.47 in 1.48 in x 1.57 in x 4.88 in
Weight	350 g / 0.77 lb

8.1.7 Modules in one chain

Modules in chain	Max. 254 in one chain
------------------	-----------------------

8.2 RoHS conformity

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.

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.

8.3 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.

8.4 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.

8.5 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.

8.6 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. 8-1 WEEE symbol

The WEEE symbol (see Fig. 8-1 on page 73) 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 11 on page 108).

8.7 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.

8.8 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.

8.9 System Requirements

This section tells you what hardware and software is needed to operate your ES415.1 module.

8.9.1 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".

8.9.2 Software

To configure the ES415.1 and for control and data acquisition, you need software in the following versions:

General

- ES4xx Configuration Tool V1.3.4 and higher from ES4xx_DRV_SW (stand-alone operation)
- HSP V9.9.3 and higher

Measurement and Calibration (MC)

- INCA V7.0 and higher with INCA Add-On ES4xx V1.3.4 and higher

Rapid Prototyping (RP)

- INTECRIO V4.2 and higher
or
- INTECRIO-RLINK V1.0 and higher
or
- ASCET-RP V6.1.3 and higher



NOTE

Operating the ES415.1 with older versions of software is not possible.

8.10 Electrical Data

This chapter contains information on the following topics:

- "Host Interface ("IN" Connection)" on page 76
- "Power Supply" on page 76
- "Sensor Power Supply" on page 77
- "Sensor Inputs" on page 78
- "Signal Processing" on page 80



NOTE

ETAS guarantees measurement accuracy of the ES415.1 for one year. Please use our calibration service (see section 5.9 on page 35)!



NOTE

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

8.10.1 Host Interface ("IN" Connection)

Connection	100Base-T Ethernet; 100 Mbit/s, Full Duplex
Protocol	XCP on UDP/IP
IP address	Dynamic via INCA or via ES4xx Configuration Tool (default setting: 192.168.40.44)



NOTE

For the successful initialization of the network card of your PC, observe chapter 8.9.1 on page 74.

8.10.2 Power Supply

Operating voltage (dry environment)	Temperature range -40 °C to +85 °C: 5 V to 50 V DC
	Temperature range -40 °C to +120 °C: 6 V to 50 V DC
Operating voltage (wet environment)	Temperature range -40 °C to +85 °C: 5 V to 32 V DC
	Temperature range -40 °C to +120 °C: 6 V to 32 V DC
Power consumption (operation, sensors not connected)	Typ. 2.2 W at 12 V DC
Power consumption (operation; all channels loaded with 30 mA)	Max. 6 W at 12 V DC
Power consumption (standby, sensors not connected, room temperature)	Typ. 25 mW at 12 V DC
Polarity inversion protection, load dump protection ¹⁾	With CBEP410, CBEP4105, CBEP415, CBEP4155, CBEP420, CBEP4205, CBEP425, CBEP4255, CBEP430, CBEP4305 cable

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

8.10.3 Sensor Power Supply

Features

Sensor power supply channels	4, separate per input channel
Output voltage	Each channel can be set separately: "Off", in steps (5 V, 8 V, 10 V, 12 V) or freely selectable as a value in the range 5 V to 15 V
D/A converter	16-bit (resolution 229 μ V)
Protection	Outputs (plus) short-circuit proof against ground and up to 26 V overvoltage. Ground connected to operating voltage ground and protected by a fuse.
Diagnostics	Short-circuit detection per channel; overload conditions reduce the output voltage

Characteristics

Parameter	Min	Max	Unit
Accuracy of the sensor supply voltage without load	-	± 10	mV
Accuracy of the sensor supply voltage with 3 k Ω load	-	± 5	mV
Resistance of analog outputs including CBAV411.1-2 cable	-	1.6	Ohm
Ripple voltage V_{pp} (measurement limited to 80 MHz)	-	20	mV
Max. voltage drift (temperature)	-1	+1.2	mV/K
Output current	-	30	mA

8.10.4 Sensor Inputs

Features

Input channels	4, with separate sensor power supply
A/D converter	One A/D converter per channel, 16-bit resolution
Hardware input filter	Low-pass 4th order, Butterworth, cutoff frequency 50 kHz
Input voltage ranges	-100 mV to +100 mV -1 V to +1 V -10 V to +10 V -60 V to +60 V
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

Characteristics

Maximum input voltage resolution (16-bit)	±100 mV measurement range: 3.6 μV
	±1 V measurement range: 37.2 μV
	±10 V measurement range: 366 μV
	±60 V measurement range: 2.16 mV
Maximum measurement error	±100 mV measurement range: $\pm(100 \mu\text{V} + U_{\text{IN}} * 0.1\%)$
	±1 V measurement range: $\pm(500 \mu\text{V} + U_{\text{IN}} * 0.05\%)$
	±10 V measurement range: $\pm(3 \text{ mV} + U_{\text{IN}} * 0.05\%)$
	±60 V measurement range: $\pm(16 \text{ mV} + U_{\text{IN}} * 0.2\%)$
Max. voltage drift (temperature), temperature range -40 °C to +85 °C	±100 mV measurement range: 8 μV/K
	±1 V measurement range: 8 μV/K
	±10 V measurement range: 36 μV/K
	±60 V measurement range: 3.6 mV/K
Max. voltage drift (temperature), temperature range +85 °C to +120 °C	±100 mV measurement range: 150 μV/K
	±1 V measurement range: 150 μV/K
	±10 V measurement range: 360 μV/K
	±60 V measurement range: 3.6 mV/K
Input impedance	Measurement ranges ±0.1 V, ±1V: > 10 MΩ < 300 pF
	Measurement ranges ±10 V, ±60 V: > 2 MΩ < 400 pF
	Module not powered: > 2 MΩ < 400 pF

8.10.5 Signal Processing

Resolution	16 Bit, increased with slow sampling rates
Sampling rate	Measurement and Calibration (MC): 0.5 to 100000 samples/s (100 kHz), can be configured individually for each channel Rapid Prototyping (RP): 0.5 to 10000 samples/s (10 kHz), can be configured individually for each channel
Hardware input filter	Low-pass 4th order, Butterwoth, Cutoff frequency 50 kHz
Digital low-pass filter	CIC filter (sinc filter), automatic filter setting with selection of scanning rate, can be disabled Averaging time $\tau_s = 10 \mu\text{s}$ to 2 s, Averaging time equal to scanning rate



NOTE

To avoid an IRQ overload at the I/O port of the ES910.3 Prototyping Module or ETAS RTPRO-PC, the sample rate of the ES415.1 module is automatically limited to 10 kHz for Rapid Prototyping applications (see chapter 5.3.3 on page 22).

8.11 Pin Assignment

This chapter contains information on the following topics:

- “IN” Connector” on page 81
- “OUT” Connector” on page 82
- “Sensor” Connector” on page 83

i **NOTE**

All connectors are shown with a view of the front of the ES415.1.
All shields are at case potential.

8.11.1 “IN” Connector

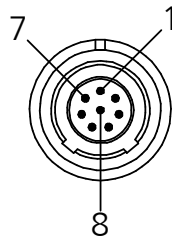


Fig. 8-2 “IN” Connector

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

The following plug is mounted on "IN" connector:

LEMO 1B 8-pin L-coding (connection identified in green)

8.11.2 "OUT" Connector

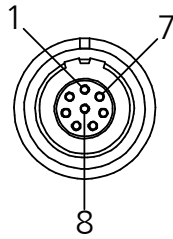


Fig. 8-3 "OUT" Connector

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

The following socket is mounted on "OUT" connector:

LEMO 1B 8-pin A-coding (connection identified in yellow)

8.11.3 "Sensor" Connector

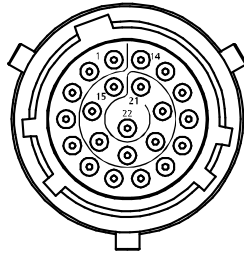


Fig. 8-4 "Sensor" Connector

Pin	Signal	Meaning
1	CH2 In+	Sensor channel 2, input plus
2	CH2 SGND	Sensor channel 2, Sensor supply voltage, GND ^{*)}
3	CH2 S+	Sensor channel 2, Sensor supply voltage, plus
4	CH3 SGND	Sensor channel 3, Sensor supply voltage, GND ^{*)}
5	CH3 S+	Sensor channel 3, Sensor supply voltage, plus
6	CH3 In-	Sensor channel 3, input minus
7	CH3 In+	Sensor channel 3, input plus
8	CH4 In+	Sensor channel 4, input plus
9	CH4 In-	Sensor channel 4, input minus
10	CH4 S+	Sensor channel 4, Sensor supply voltage, plus
11	CH4 SGND	Sensor channel 4, Sensor supply voltage, GND ^{*)}
12	CH1 S+	Sensor channel 1, Sensor supply voltage, plus
13	CH1 SGND	Sensor channel 1, Sensor supply voltage, GND ^{*)}
14	CH1 In+	Sensor channel 1, input plus
15	CH2 In-	Sensor channel 2, input minus
16	CH2 TEDS+	Sensor channel 2, TEDS+
17	CH3 TEDS+	Sensor channel 3, TEDS+
18	TEDS+	Cable, TEDS+
19	CH4 TEDS+	Sensor channel 4, TEDS+
20	CH1 TEDS+	Sensor channel 1, TEDS+
21	CH1 In-	Sensor channel 1, input -
22	CH1 TEDS- CH2 TEDS- CH3 TEDS- CH4 TEDS- TEDS-	Sensor channel 1, TEDS- Sensor channel 2, TEDS- Sensor channel 3, TEDS- Sensor channel 4, TEDS- Cable, TEDS-

^{*)}: connected with operating voltage ground

9 Cables and Accessories

This chapter contains information on the following topics:

- "Combined Ethernet and Power Supply Cable" on page 85
- "Ethernet Cable" on page 91
- "Cable for the Connection "Sensor"" on page 94
- "Measurement Probes and Cables" on page 97
- "Protective Caps" on page 101
- "Angle Brackets" on page 102



NOTE

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

9.1 Combined Ethernet and Power Supply Cable

This chapter contains information on the following cables:

- "CBEP410.1 Cable" on page 86
- "CBEP4105.1 Cable" on page 86
- "CBEP415.1 Cable" on page 87
- "CBEP4155.1 Cable" on page 87
- "CBEP420.1 Cable" on page 88
- "CBEP4205.1 Cable" on page 88
- "CBEP425.1 Cable" on page 89
- "CBEP4255.1 Cable" on page 89
- "CBEP430.1 Cable" on page 90
- "CBEP4305.1 Cable" on page 90

9.1.1 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

9.1.2 CBEP410.1 Cable

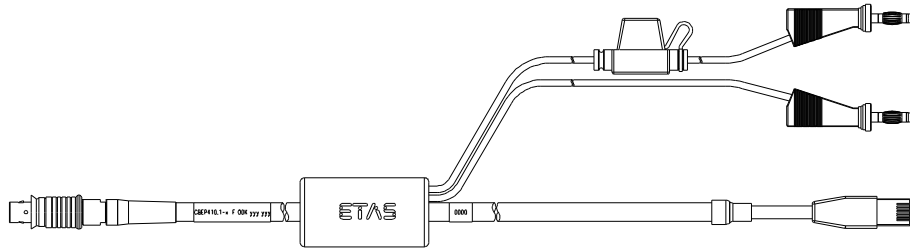


Fig. 9-1 CBEP410.1 Cable

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

9.1.3 CBEP4105.1 Cable

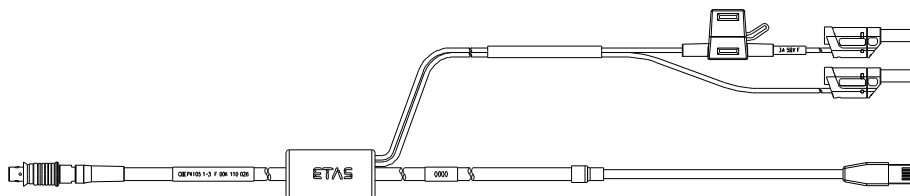


Fig. 9-2 CBEP4105.1 Cable

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

9.1.4 CBEP415.1 Cable

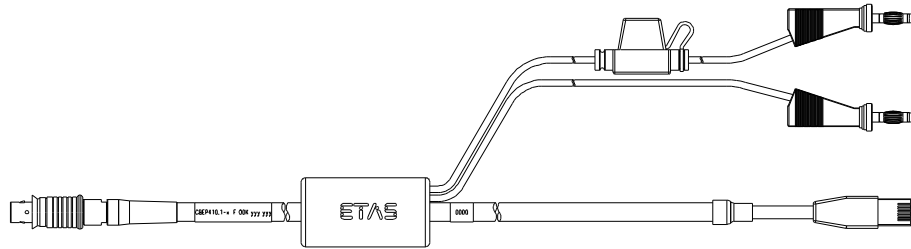


Fig. 9-3 CBEP415.1 Cable

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

9.1.5 CBEP4155.1 Cable

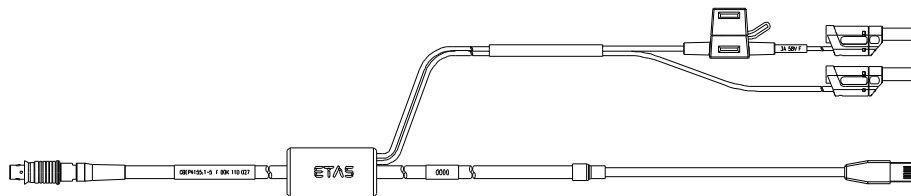


Fig. 9-4 CBEP4155.1 Cable

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

9.1.6 CBEP420.1 Cable

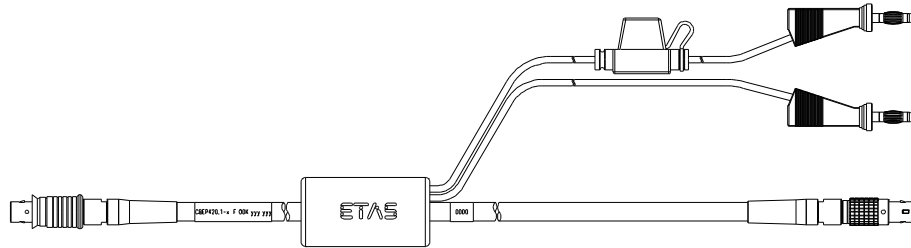


Fig. 9-5 CBEP420.1 Cable

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

9.1.7 CBEP4205.1 Cable

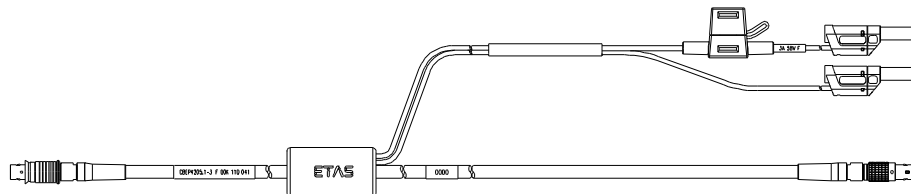


Fig. 9-6 CBEP4205.1 Cable

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

9.1.8 CBEP425.1 Cable

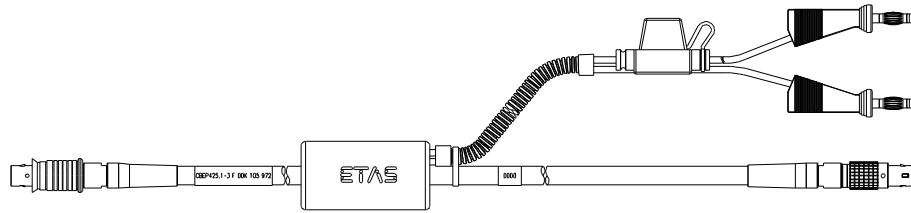


Fig. 9-7 CBEP425.1 Cable

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

9.1.9 CBEP4255.1 Cable

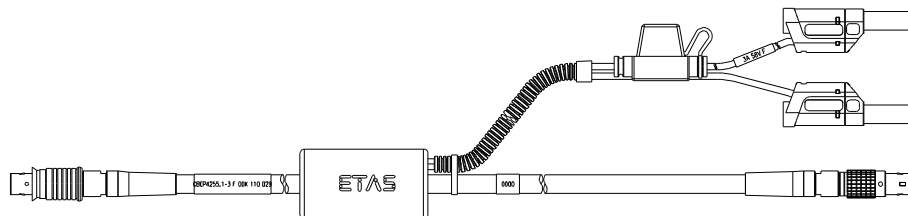


Fig. 9-8 CBEP4255.1 Cable

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

9.1.10 CBEP430.1 Cable

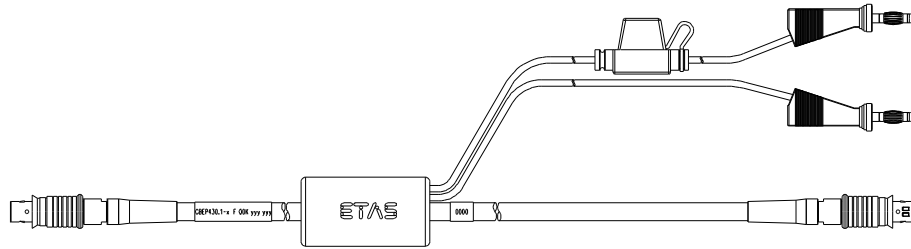


Fig. 9-9 CBEP430.1 Cable

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

9.1.11 CBEP4305.1 Cable

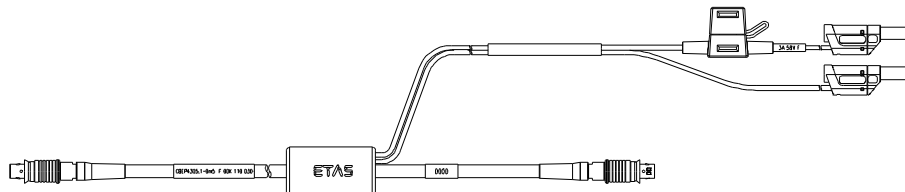


Fig. 9-10 CBEP4305.1 Cable

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

9.2 Ethernet Cable

This chapter contains information on the following cables:

- "CBE400.2 Cable" on page 91
- "CBE401.1 Cable" on page 91
- "CBE430.1 Cable" on page 92
- "CBE431.1 Cable" on page 92
- "CBEX400.1 Cable" on page 92
- "ES4xx_BRIDGE" on page 93

9.2.1 CBE400.2 Cable

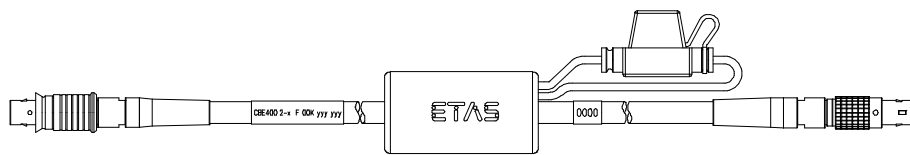


Fig. 9-11 CBE400.2 Cable

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

9.2.2 CBE401.1 Cable

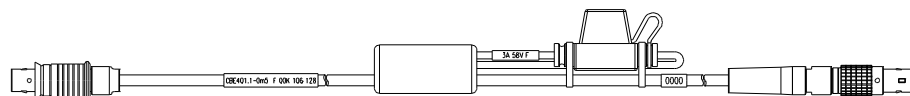


Fig. 9-12 CBE401.1 Cable

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

9.2.3 CBE430.1 Cable

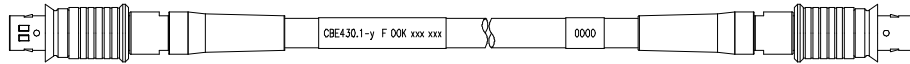


Fig. 9-13 CBE430.1 Cable

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

9.2.4 CBE431.1 Cable

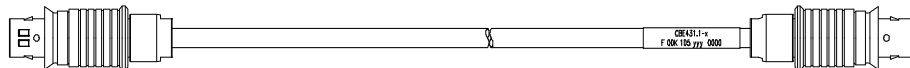


Fig. 9-14 CBE431.1 Cable

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

9.2.5 CBEX400.1 Cable

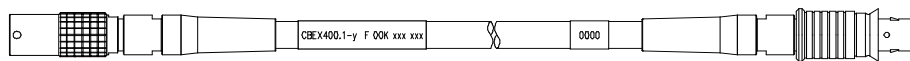


Fig. 9-15 CBEX400.1 Cable

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

9.2.6 ES4xx_BRIDGE

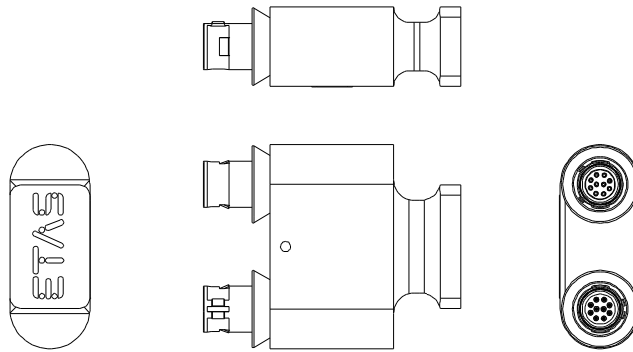


Fig. 9-16 ES4xx Bridge

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

Product	Order number
ES4xx_BRIDGE	F 00K 105 684

9.3 Cable for the Connection "Sensor"

9.3.1 CBAV400.1 Cable

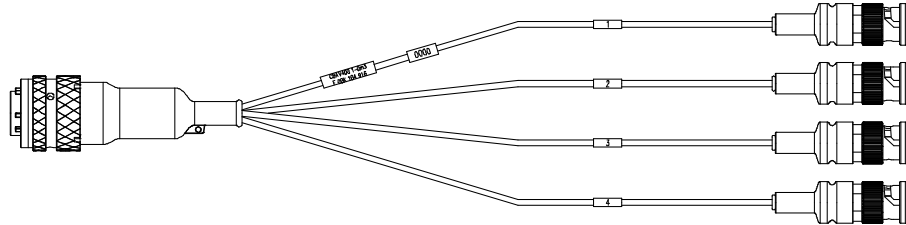



Fig. 9-17 CBAV400.1 Cable

The CBAV400.1 cable consists of four identical cable sections, marked n=1 to n=4. Each cable section [n] is assigned to an ES4xx measurement channel [n] and wired according to the same scheme.

 **NOTE**

The sensor supply voltage of the module **cannot** be used if the cable CBAV400.1 is used.

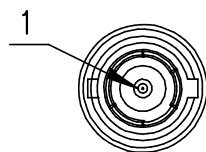


Fig. 9-18 Connection „Sensor“ (one Cable Section)

The assignment of the connections of the BNC connector of a cable section to the signals of a measurement channel [n] is shown in the table.

Pin	Signal	Meaning
1 (inside)	CH[n] In+	Measurement channel [n], input (+)
Outside	CH[n] In-	Measurement channel [n], input (-)

Notes about the Application

If you replaced modules with BNC cabling with ES4xx modules in your measuring setup, the use of these adapter cables enables you to continue using the existing cabling of your measuring setup.

Temperature rated for: -40 °C to +125 °C

Product	Length	Order number
CBAV400.1-0m3	0.3 m	F 00K 104 916

9.3.2 CBAV411.1 Cable

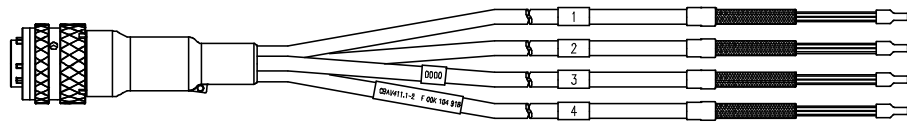


Fig. 9-19 CBAV411.1 Cable

The CBAV411.1 cable consists of four identical cable sections, marked n=1 to n=4. Each cable section [n] is assigned to an ES4xx measurement channel [n] and wired according to the same scheme.

The assignment of the cable connections of a cable section to the signals of a measurement channel [n] is shown in the table.

Signal	Meaning	Color
CH[n] In+	Measurement channel [n], input (+)	Green
CH[n] In-	Measurement channel [n], input (-)	Yellow
CH[n] S+	Measurement channel [n], sensor supply (+)	Brown
CH[n] SGND	Measurement channel [n], sensor supply (GND)	Pink
CH[n] TEDS+	Measurement channel [n], interface TEDS (+) ^{*)}	Gray
CH[n] TEDS-	Measurement channel [n], interface TEDS (-) ^{*)}	White

^{*)} TEDS acc. IEEE1451.4

Notes about the Application

With the universal cable CBAV411.1, sensors or measuring transducers can be connected to the ES4xx module.

You can customize the open connection of sensor cable CBAV411.1 and adapt it to the specific plug connector system of your measuring setup.

Temperature rated for: -40 °C to +125 °C

Product	Length	Order number
CBAV411.1-2	2 m	F 00K 104 918

9.3.3 CBAV417.1 Cable

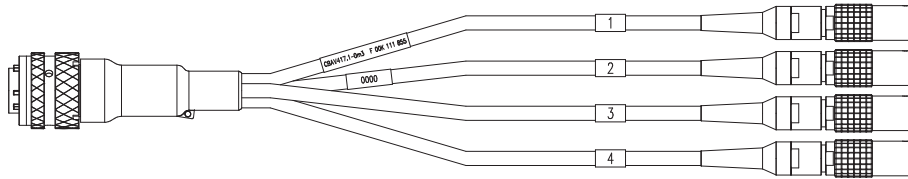


Fig. 9-20 CBAV417.1 Cable

The CBAV417.1 cable consists of four identical cable sections with LEMO plugs, marked n=1 to n=4. Each cable section [n] is assigned to an ES4xx measurement channel [n] and wired according to the same scheme.

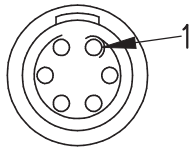


Fig. 9-21 Connection „Sensor“ (one Cable Section)

The assignment of the connections of the LEMO connector of a cable strand to the signals of a measurement channel [n] is represented in the table.

Pin	Signal	Meaning
1	CH[n] In+	Measurement channel [n], input (+)
2	CH[n] In-	Measurement channel [n], input (-)
4	CH[n] S+	Measurement channel [n], sensor supply (+)
5	CH[n] SGND	Measurement channel [n], sensor supply GND *)

*) : connected with operating voltage Ground

Notes about the Application

Temperature rated for: -40 °C bis +125 °C

Product	Length	Order number
CBAV417.1-0m3	0.3 m	F 00K 111 855

9.4 Measurement Probes and Cables

9.4.1 CBN400.1 Isolating Measurement Probe

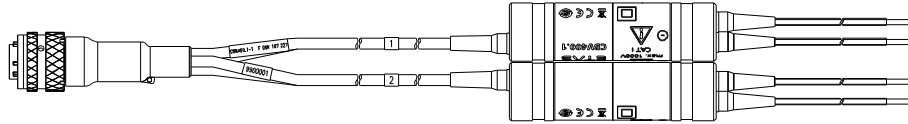


Fig. 9-22 CBN400.1 Isolating Measurement Probe

The CBN400.1 Isolating Measurement Probe for use with the ES411.1/ ES415.1 module offers four input channels for voltages up to +/-1000 V DC, a separate signal conditioning for each channel with voltage reduction and isolation (max. +/-1000 V DC). The cable meets the safety standard EN 61010-1.

Temperature rated for: -40 to +85°C

NOTE

For additional information, see the user's guide of the product.

Product	Length	Order number
CBN400.1-1	1 m	F 00K 107 227

9.4.2 CBN401.1 Isolating Measurement Probe

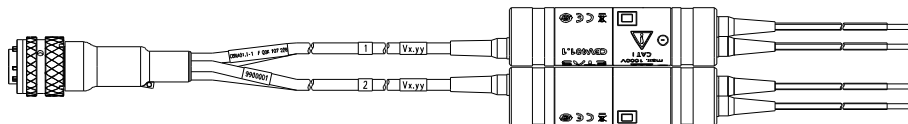


Fig. 9-23 CBN401.1 Isolating Measurement Probe

The CBN401.1 Isolating Measurement Probe for use with the ES411.1/ ES415.1 module offers four input channels for voltages up to +/-10 V DC, a separate signal conditioning for each channel with voltage reduction and isolation (max. +/-1000 V DC). The cable meets the safety standard EN 61010-1.

Temperature rated for: -40 to +85°C

NOTE

For additional information, see the user's guide of the product.

Product	Length	Order number
CBN401.1-1	1 m	F 00K 107 228

9.4.3 CBN41x.1 Current Probe

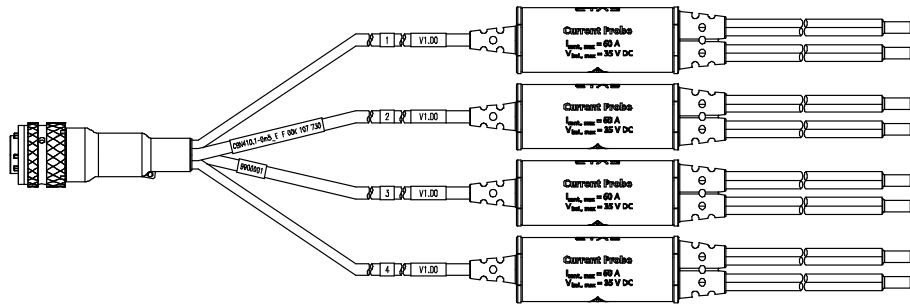


Fig. 9-24 CBN410.1 Current Probe

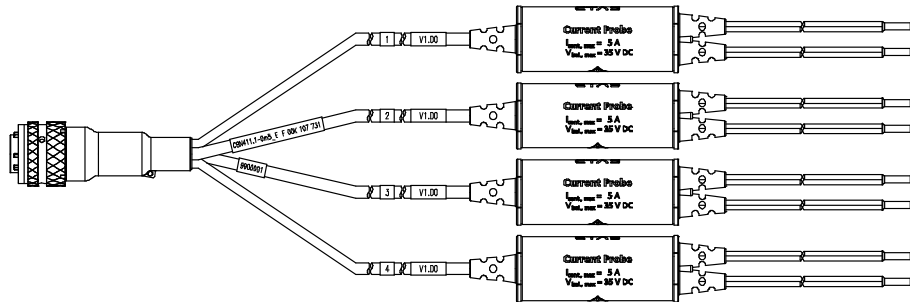


Fig. 9-25 CBN411.1 Current Probe

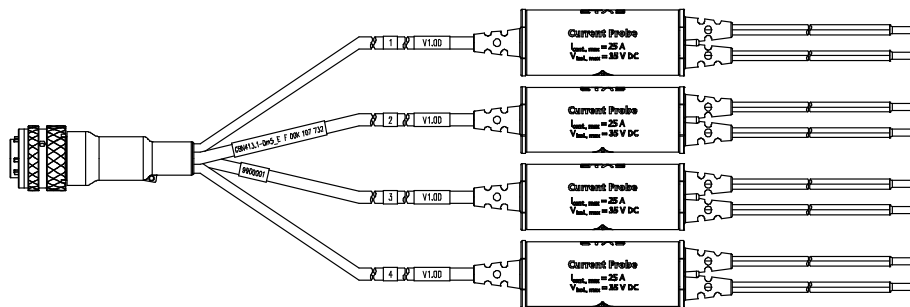


Fig. 9-26 CBN413.1 Current Probe

The CBN41x.1 Current Probe consists of four identical active current measuring channels that are integrated in a splitter cable and designed for the combined use with the ES411.1 / ES415.1 A/D module.

Application area: Measuring high currents

Temperature rated for: -40 to +85°C

Product	Measurement Range		Length	Order number
	Short-Term	Continuous		
CBN410.1-0m5	±100 A	±60 A	0.5 m	F 00K 107 722
CBN411.1-0m5	±5 A	±5 A	0.5 m	F 00K 107 723
CBN413.1-0m5	±30 A	±25 A	0.5 m	F 00K 107 724



NOTE

For additional information, see the user's guide of the product.

9.4.4 CBN42x.1 Sensor Cable

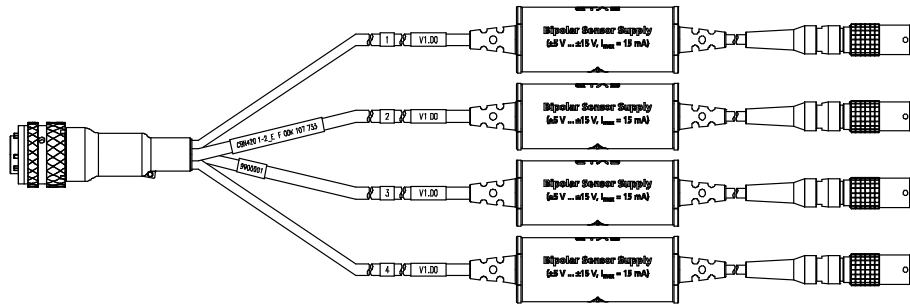


Fig. 9-27 CBN420.1 Sensor Cable

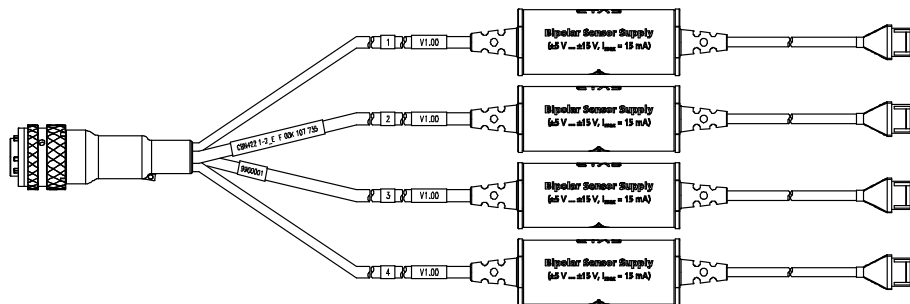


Fig. 9-28 CBN422.1 Sensor Cable

The CBN42x.1 Sensor Cable Providing Bipolar Sensor Supply consists of four identical active current measuring channels that are integrated in a splitter cable and designed for the combined use with the ES411.1 / ES415.1 A/D module.

Application area: potential-free measuring of high currents with current transformers from LEM (series HTR) or comparable current transformers and with other sensors with bipolar supply voltage.

Product	Sensor connection
CBN420.1	LEMO 1B PHG
CBN422.1	Molex 51191

NOTE

For additional information, see the user's guide of the product.

Product	Length	Order number
CBN420.1-2m	2 m	F 00K 107 564
CBN422.1-2m	2 m	F 00K 107 566

9.4.5 CBN430.1 Temperature Sensor Connection Cable

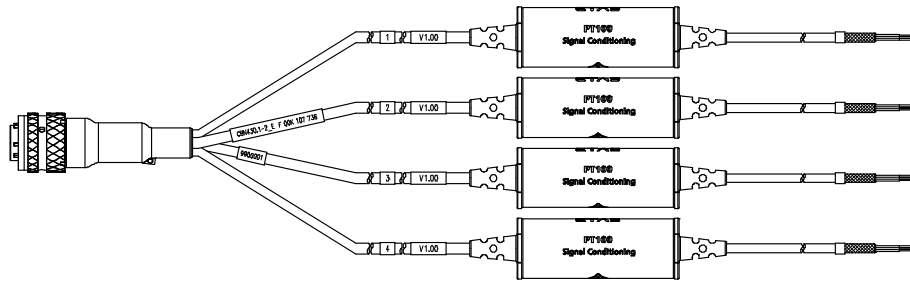


Fig. 9-29 CBN430.1

The CBN430.1 Temperature Sensor Connection Cable consists of four identical active current measuring channels that are integrated in a splitter cable and designed for the combined use with the ES411.1 / ES415.1 A/D module.

Application area: precise measuring of temperatures with platinum temperature sensors

Temperature rated for: -40 to +85°C



NOTE

For additional information, see the user's guide of the product.

Product	Length	Order number
CBN430.1-2m	2 m	F 00K 107 725

9.5 Protective Caps

The connections "IN" and "OUT" of the ES415.1 can be protected with different protective caps according to the operating conditions.

9.5.1 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.

9.5.2 Cap CAP_LEMO_1B

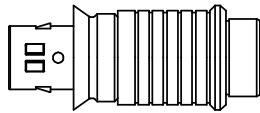


Fig. 9-30 Cap CAP_LEMO_1B

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

9.5.3 Cap CAP_LEMO_1B_LC

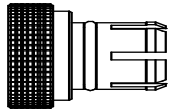


Fig. 9-31 Cap CAP_LEMO_1B_LC

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

9.5.4 Cap CAP_SOURIAU_8STA

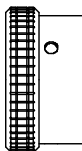


Fig. 9-32 Cap CAP_SOURIAU_8STA

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

Product	Order number
CAP_SOURIAU_8STA	F 00K 105 303

9.6 Angle Brackets

9.6.1 Angle Bracket Left

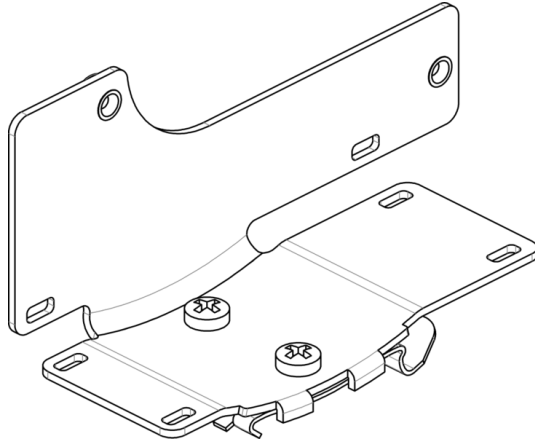


Fig. 9-33 Angle Bracket Left

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

9.6.2 Angle Bracket Right

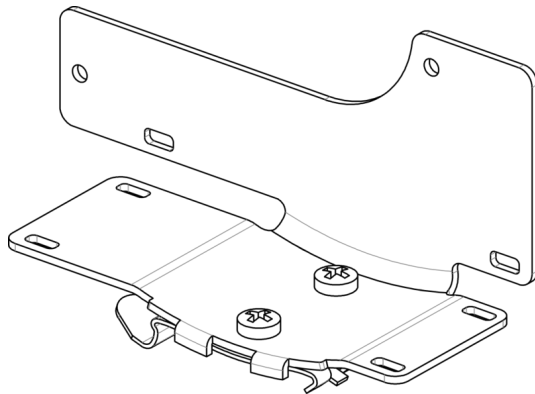


Fig. 9-34 Angle Bracket Right

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

10 Ordering Information

10.1 ES415.1

Order name	Short name	Order number
ES415.1 High Definition A/D Module with Sensor Supply	ES415.1	F 00K 107 908

Scope of supplies

ES415.1 High Definition A/D Module with Sensor Supply (4 channels, for universal splitter cable), 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 10.2.1 on page 103).

10.2 Accessories

10.2.1 Cables



NOTE

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

10.2.1.1 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

Order name	Short name	Order number
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

10.2.1.2 Cables for the connector "Sensor"

Analog input cables

Order name	Short name	Order number
Analog Input Splitter Cable with BNC Plug, Souriau 8ST12-35 - BNC (22mc-4x2fc), 0m3	CBAV400.1-0m3	F 00K 104 916
Analog Input Splitter Cable, Souriau 8ST12-35 - open wires (22mc-4c), 2 m	CBAV411.1-2	F 00K 104 918
Analog Input Splitter Cable, Souriau 8ST12-35 - Lemo 1B PHG (22mc-4x6fc), 0m3	CBAV417.1-0m3	F 00K 111 855

Signal conditioning cables

Order name	Short name	Order number
Voltage Probe, 1000V Isolation, 4 Channels, 1000V Range, Souriau 8ST12-35 4xOpen Wires (22mc 4x2c), 4 x 1m	CBN400.1-1	F 00K 107 227
Voltage Probe, 1000V Isolation, 4 Channels, 10V Range, Souriau 8ST12-35 4xOpen Wires (22mc 4x2c), 4 x 1m	CBN401.1-1	F 00K 107 228
CBN410.1 Current Probe, ± 100 A range, 4 Channels, Souriau 8ST12-35 4xOpen Wire, 0.5 m	CBN410.1-0m5	F 00K 107 722
CBN411.1 Current Probe, ± 5 A range, 4 Channels, Souriau 8ST12-35 4xOpen Wire, 0.5 m	CBN411.1-0m5	F 00K 107 723
CBN413.1 Current Probe, ± 30 A range, 4 Channels, Souriau 8ST12-35 4xOpen Wire, 0.5 m	CBN413.1-0m5	F 00K 107 724
CBN420.1 Sensor supply conditioning cable providing bipolar sensor supply voltage, 4 Channel, Souriau 4xLemo PHG.1B.304.CLLD, 2m	CBN420.1-2m	F 00K 107 564
CBN422.1 Sensor supply conditioning cable providing bipolar sensor supply voltage, 4 Channel, Souriau 4xMolex 51191-004, 2m	CBN422.1-2m	F 00K 107 566
CBN430.1 PT100 Sensor Connection Cable, 4 Channels, Souriau 8ST12-35 4xOpen Wire, 2 m	CBN430.1-2m	F 00K 107 725

10.2.2 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

10.2.3 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

10.2.4 Calibration

NOTICE

ETAS recommends a calibration interval of 12 months.

10.2.4.1 Factory calibration

Factory calibration service

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

Order name	Short name	Order number
Calibration service for ES415	C_ES415	F-00K-112-733

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 ES415	A_ES415	F-00K-108-033

10.2.4.2 Accredited calibration

Accredited calibration service according to ISO/IEC 17025

- Verification of measurement accuracy by accredited calibration laboratory¹
- Issue an internationally recognized ISO/IEC 17025 calibration certificate.²

Order name	Short name	Order number
DAkkS calibration service for ES415	DAkkS_C_ES415	F-00K-112-777

Accredited adjustment service according to ISO/IEC 17025

- Verification of measurement accuracy by accredited calibration laboratory¹
- 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 ES415	DAkkS_A_ES415	F-00K-111-776

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

11 Contact Information

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