ETAS

DRIVING EMBEDDED EXCELLENCE

# ETAS ES930.1 Multi-I/O Module

## User Guide

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# Contents

# 1 About this Document

## 1.1 Classification of Safety Messages

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

**DANGER**

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

**WARNING**

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

**CAUTION**

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

***NOTICE***

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

## 1.2 Presentation of Instructions

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

Target definition

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

> Result

## 1.3 Presentation of Supporting Information

**NOTE**

Contains additional supporting information.

# 2 Basic Safety Notices

This chapter contains information about the following topics:



## 2.1 General Safety Information

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

**NOTE**

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

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

## 2.2 Requirements for Users and Duties for Operators

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

### General safety at work

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

## 2.3 Intended Use

### Application area of the product

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

### Requirements for the technical state of the product

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

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

### Requirements for operation

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

### Electrical safety and power supply

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

### Power supply

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

### Connection to the power supply

- The power cable must not be connected directly to the vehicle battery or lab power supply, but via a fuse of up to 20 A.
- 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
  - 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.

## Approved cables

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

## Requirements for the location

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

## Fixing the modules on a carrier system

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

### Requirements on the ventilation

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

### Assembling (interconnecting) the modules

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

### Transport

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

### Maintenance

The product is maintenance-free.

### Repair

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

### Cleaning the module housing

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

### Ambient conditions

The housing and the connectors of the module as well as the plug connectors of the cables meet the degree of protection IP30.

### Opening the module

**CAUTION**

**Damage to the module and loss of properties based on IP30!**

Do not open or change the module housing!

Work on the module housing may only be performed by ETAS.

## Potential equalization

**CAUTION**

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

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

## Cabling

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

# 3 Hardware Description

The chapter "Hardware Description" provides an overview of the ES930.1, information about the housing, connections, LEDs, function groups, power supply, data transfer as well as signal acquisition and signal output.

## 3.1 Overview

The ES930.1 Multi-I/O Module is a compact, robust and powerful metrology module with numerous input and output channels.

The module can be used for a variety of measuring tasks or for the control of additional hardware in the development, application and validation of electronic vehicle systems in the vehicle or the lab.

### 3.1.1 Input and Output Channels

Overall, the ES930.1 module features 4 thermo, 8 analog and 4 digital inputs. 4 analog and 6 digital outputs are available as output channels, 4 sensor supplies and 6 half-bridge switches with current measurement as power stages. Since the power stages are integrated in the ES930.1 module, the external signal conditioning for the actuator control, such as valves or electrical motors, is omitted.

**Fig. 3-1** ES930.1 Multi-I/O Module

### 3.1.2 Integration in the measuring Setup

The ES930.1 module communicates with the PC via Ethernet and is integrated in the measuring setup within the decentral ETAS Ethernet topology (daisy chain). The number of channels can be expanded by connecting several ES930.1 modules to a chain. The acquisition of additional signal types is easily accomplished by expanding the measuring setup with ES4xx/ES63x measuring modules.

### 3.1.3 Combination with the ES910 Prototyping Module

The combination of the ES930.1 module with the ES910/ ES920 prototyping and interface module allows a broad spectrum of applications.

While the ES910/ ES920 modules are used for accessing ETK, XETK, FlexRay, CAN and LIN, the ES930.1 module allows simultaneously accessing analog and digital I/O signals. In the process, sensors and actuators are controlled and analyzed directly by the function model. Simulink®, ASCET-RP or C-code models can be used as function model.

### 3.1.4 Configuration and Data Acquisition

All configurations of the ES930.1 module can be defined for each channel in each case.

The sampling of the signal at the inputs and the output of signals are done independently of each other, either in a predefined, equidistant time grid or in the event-triggered mode whose event rasters are defined based on digital input signals.

The event rasters can be used to synchronously capture all the input data and initiate model triggers in the rapid prototyping module.

## 3.2 Properties

Overview of the most important properties of the ES930.1:

### 3.2.1 Decentral cabling Concept

Communication with the PC via an XCP-based protocol that is compatible with the existing ETAS Ethernet topology. The concept meets the following requirements:

- High bandwidth to be able to capture measured values with high resolution and high sampling rates,
- Low transfer times for applications in the function development,
- Exact synchronization possible with other measuring systems,
- Simple application based on the Ethernet integration in INCA, no complicated settings of bus parameters

### 3.2.2 Inputs and Outputs

The following inputs and outputs are available:

- 4 thermo inputs
- 8 analog inputs
- 4 digital inputs
- 4 analog outputs
- 4 sensor supplies
- 6 digital outputs, which also provide the control signals for the half-bridge switches
- 6 half-bridge switches with current measurement

### 3.2.3 Simple cabling Concept of Inputs and Outputs

- Overall, only three different cable types are required for connecting the inputs and outputs of the module.
- The open connections of these cables offered by ETAS can be individually fitted by the used, thereby adapting it to the specific plug connection system of the measuring setup.
- The DSUB cable connections of the inputs and outputs of the module allow the user a simple fitting of separate cables for flexible integration in the measuring setup.

### 3.2.4 Additional Properties

- Automotive-ready module that is suitable for the use in the development environment and in the vehicle on test tracks.
  - Neutral to extreme environmental conditions (temperature, EMC)
  - Expanded supply voltage range
  - High mechanical stability and robustness
- Integration in the ETAS MC software INCA and in the rapid prototyping software INTECRIO or ASCET-RP
- Standalone operation with ES93x configuration tool
- Updating the firmware of the module with HSP

The complete technical data of the ES930.1 can be found in chapter 13 on page 85.

## 3.3 Module

### 3.3.1 Housing

The ES930.1 uses a housing with connections on the front and the rear side of the device. The robust metal housing of the ES930.1 is equipped with non-slip plastic feet.

The module is designed for the accommodation in the vehicle or lab. In order to stabilize it, it can easily be screwed onto a support system. The housings of this device family can also be connected with each other – quickly and easily (see chapter 11.1 on page 66).

### 3.3.2 Front Side

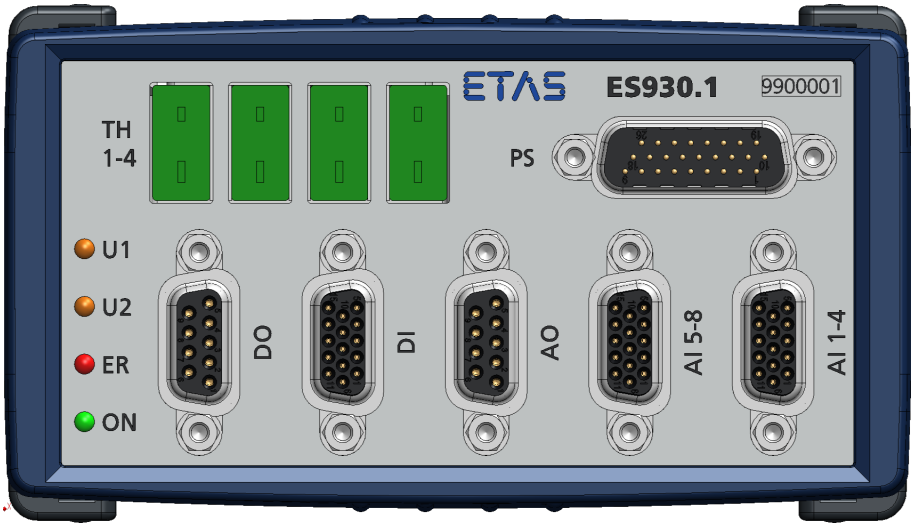



**Fig. 3-2** Front Side

#### 3.3.2.1 Connections

The front side of the ES930.1 features the following connections (see Fig. 3-2 on page 17):

| Name | Connection | Meaning |
|---|---|---|
| TH1-4 | Thermo channel | Thermo measurement (channel 1 to channel 4) |
| PS | Power stages | Power stages (6 Half-bridges with current measurement) and external supply |
| DO | Digital outputs | Digital output channels (channel 1 to channel 6) |
| DI | Digital inputs | Digital input channels (channel 1 to channel 4) |
| AO | Analog outputs | Analog output channels (channel 1 to channel 4) |
| AI 5-8 | Analog inputs | Analog input channels (channel 5 to channel 8); sensor supply channels (channel 3 and channel 4) |
| AI 1-4 | Analog inputs | Analog input channels (channel 1 to channel 4); sensor supply channels (channel 1 and channel 2) |

#### 3.3.2.2 LEDs

The front side of the ES930.1 module features four LEDs. The LEDs **U1** and **U2** can be configured by the user in the application software, the LEDs **ER** and **ON** indicate the following operating states of the module:

| LED ER | LED ON | Operating state | Comment |
|---|---|---|---|
| Off | Off | Module off | No power supply,<br>power supply defective |
| Off | Green | Normal | Module on, no error |
| Red | Off | Hardware error | Internal error |
| Red | Green | LED test | Briefly during initialization of the module |
| Red | Green | Internal error | Module features no valid calibration. Measurements are possible in principle. The measuring accuracy is out of specification. Send the module to ETAS for calibration/repair. |
| Red, flashing | Green | Update process | Update of firmware |

#### 3.3.2.3 Serial Number

The Serial number is located on the front side of the module. This number is important for the unique addressing of the module in the application software.

### 3.3.3 Rear Side

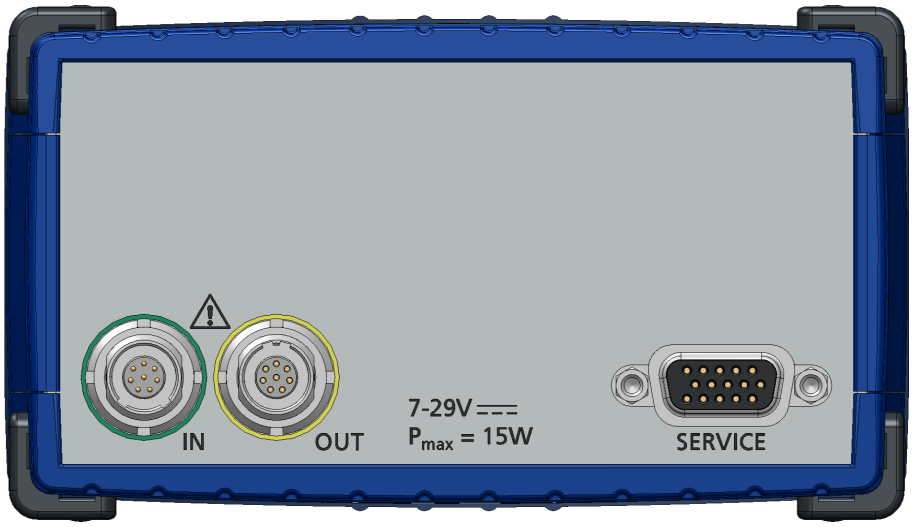



**Fig. 3-3** Rear Side

The rear side of the ES930.1 module features the following connections (see Fig. 3-3 on page 19):

| Name | Connection | Meaning |
|---|---|---|
| IN | Daisy chain In | Input; Ethernet connection to the previous module or the PC, power supply of the module |
| OUT | Daisy chain Out | Output; Ethernet connection and power supply of the succeeding module |
| SER-VICE | Service | Reserved; for ETAS-internal application only; no provision of functions for the customer |

## 3.4 Overview of Function Groups

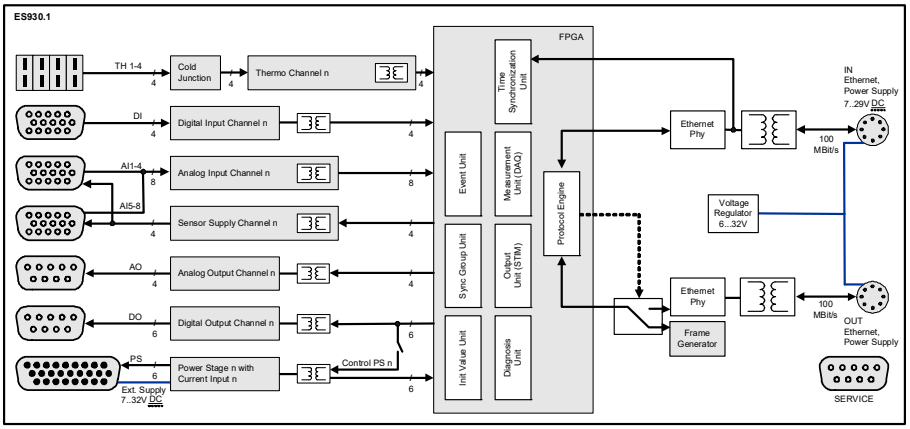



**Fig. 3-4** ES930.1 Block Diagram

The block diagram in Fig. 3-4 on page 20 displays function groups of the ES930.1 module that are described in the following chapters:

- Power supply (see chapter 3.5 on page 21)
- ETAS daisy chain connections "IN" and "OUT" (see chapter )
- Inputs and outputs
  - Thermo channels "TH1" to "TH4" (see chapter 4 on page 29)
  - "DI" digital input channels (see chapter 5 on page 31)
  - Analog input channels "AI 1" to "AI 8" (see chapter 6 on page 45)
  - Outputs to the sensor power supply (see chapter 7 on page 49)
  - "AO" analog output channels (see chapter 8 on page 51)
  - "DO" digital output channels (see chapter 9 on page 53)
  - "PS" Half-bridges (power stages) (see chapter 10 on page 59)

The function groups of the module are described in the following chapters.

## 3.5 Power Supply

### 3.5.1 Power Supply of Module

An external power supply or the vehicle battery supply the module with current.

### 3.5.2 Power Supply of Half-bridges (Power Stages) at the "PS" Connection

The power MOSFETs of the six Half-bridges require a separate supply voltage for operation. The separate supply voltage must be provided at the "PS" connection and is used jointly by all Half-bridges.

**NOTE**

The ES930.1 module and the Half-bridges (power stages) at the "PS" connection are supplied via separate voltage supply connections.

**NOTE**

The power supply of the ES930.1 module at the "IN" connection and the power supply of the Half-bridges (power stages) at the "PS" connection can be switching on or off in random order.

### 3.5.3 Power Supply of a Single Module

The ES930.1 module uses a daisy chain topology for cabling with the PC and additional modules.

The Ethernet data line and the power supply are looped through the daisy chain connections of the module:

- "IN" (input)
- "OUT" (output)

The PC, the ES600 network module, the ES910 or the ES720 drive recorder are connected at the "IN" (input) connection. The "OUT" (output) connection is connected with the subsequent ES930.1, ES63x or a module of the ES400 series or remains open at the last module of the chain.

### 3.5.4 Power Supply of additional Modules chained via Ethernet

In the simplest application case, the modules are directly chained at the daisy chain connections "IN" and "OUT". For this purpose, they are connected with the supply voltage via the respective preceding module.

#### 3.5.4.1 Additional Supply of the Modules via a Y Boost Cable

If the supply voltage should be too low at the infeed point (at the input) of a module due to the power consumption of the preceding modules, a multiple infeed of the supply voltage can ensure a sufficient supply voltage for this module and the following modules in longer module chains.

In this application case, you must open up the module chain. Exchange the existing connecting cable between the two modules with a Y boost cable for additional direct infeed of the supply voltage. The module chain is now closed again and the power supply of the subsequent modules is ensured.

The special design of the Y boost cable prevents a negative feed into the front portion of the module chain and resulting potential differences.

#### 3.5.4.2 When is it necessary to use a Y Boost Cable?

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

- Supply voltage of the first module at the infeed point
- Minimum supply voltage at the last module of the chain
- Number and type of modules
- Cable length
- Cable type
- Ambient temperature

The required minimum voltage for the supply of the system must be determined separately for every experimental arrangement.

### 3.5.5 Switching the Module on and off

The ES930.1 module is not equipped with the "Wake Up" function to ensure a controllable behavior of the outputs, including the Half-bridges (power stages) and circuits and devices connected to it, when switching the module on and off. For this reason, switching the power supply of the module on and off and, therefore, the module, must be done directly by the user.

**NOTE**

The ES930.1 dopes not forward the wake-up signal to subsequent modules in the chain.

### 3.5.6 ES93x Modules in mixed Module Chains

To be able to use the "Wake Up" function of the ES4xx modules in a mixed chain consisting of ES4xx and ES93x modules, the ES93x modules must be connected at the end of the module chain.

## 3.6 Data Transfer

The ES930.1 as well as the ES4xx and ES63x modules use a 100-Mbit/s Ethernet network connection in duplex mode for the data transfer. The data transfer can very flexibly be adapted to the measuring setup and the measuring task.

**NOTE**

The complete Ethernet bandwidth is available for measuring data as well as output variables.
Changes of output values and variables can be made in a rapid prototyping application while measuring data are captured at the same time.

The universal ASAM measuring and application protocol XCP is used for the serial communication. On the Ethernet transport and network layer, the UDP/IP protocol is used (see Fig. 3-5 on page 23).

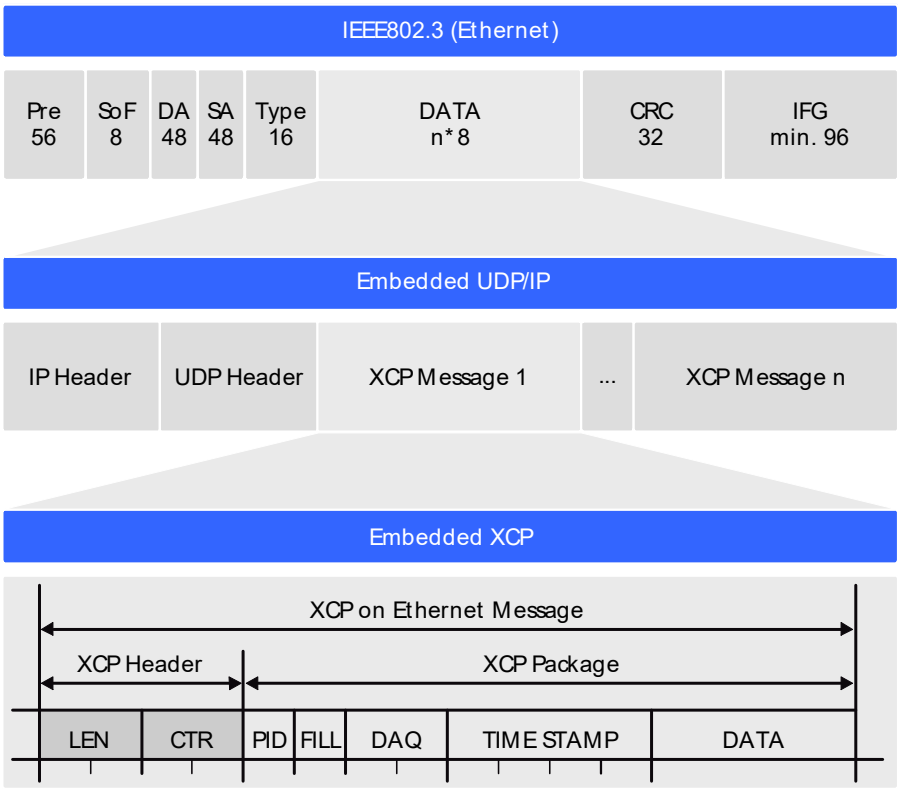



**Fig. 3-5** Message Format "XCP on UDP" (Schematic)

Within the XCP protocol, the modules also module identification, time stamp and measuring or stimulation data in a highly precise and predictable time grid. The communication protocol used for the modules avoids the repeated transfer of protocol data, as it is the case with handshake-based systems. This provides a high bandwidth for the useful data.

The use of the UDP/IP standard for data transfer allows a direct connection of the modules with a PC, a router or a switch. For the XCP communication, the PC takes on the master function.

In this case, no real-time demands are imposed on the application. A measuring data capture on a PC, which generally does not have to meet any high real-time requirements, can be connected directly to a module chain. With a real-time capable master, such as a rapid prototyping system, access to many different types of I/O signals is possible at extremely short cycle times.

# 3.7 Signal Acquisition and Signal Output

## 3.7.1 Signal Acquisition and Signal Conversion

### 3.7.1.1 Measure Variables

In the automotive sector, it is frequently necessary to measure non-electrical variables, such as temperature, torque, force, pressure, filling level, path (distance) and flow rate. These non-electrical physical variables are converted into electrical signals with transducers and sensors and subsequently processed further. The capture of these signals is the basis for determining information. The following table contains a few examples:

| Measuring function | Determinable information |
|---|---|
| Frequency measurement | Revolutions per minute |
| | Speed |
| Counter measurement | Flow rate |
| | Position |
| PWM measurement | Activation time of positioning motors |
| | Control of heating elements |

### 3.7.1.2 Configuration of the Signals

The captured signals can be configured in the application software, e.g. according to the following criteria:

- by name
- by unit
- by acquisition rate

### 3.7.1.3 Adaptation of the Signals

It is possible to adapt or correct the determined values in the application software using mathematical algorithms.

The following methods are available:

- Offset: Addition of a constant to the measured values
- Factor: Multiplication of the measured values with a fixed factor
  - Conversion to physical variables
    Example: Conversion from scan ratio to electrical power
  - Compensation of scaling factors of the measuring hardware
    Example: Predivider in turbocharger measuring sensors
    Example: Measurement in wheel wells with driven axles
- Linearization of the measurement curves or all measurement results
  - Correction of measurement errors
  - Compensation of nonlinearity of sensors
    Example: Flow sensor, axle speed is not proportional to flow rate

The measured signals and their adaptation allows a representation of the physical, technical and derived variables as well as the measure variables in the desired physical unit.

## 3.7.2 Requests

The sampling or acquisition of the signals and the control of the output of signals is done based on requests that can be configured in the application software for all input and output channels of the ES930.1. This configuration is possible independent of each other for all channels.

Requests for a channel of the ES930.1 are executed completely before additional requests for this channel are processed.

### 3.7.2.1 Sampling and Raster

The signal acquisition at the input channels can be initiated independent of each other in a predefined, equidistant time raster or in the event-triggered mode by events (event raster).

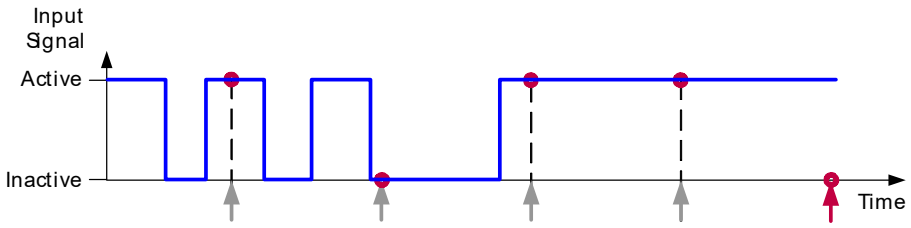



**Fig. 3-6** Sampling of the Data (fixed Raster)

In event-triggered mode, a measured value is acquired only if a certain event has occurred.

For each ES930.1 module, four events can be defined differently in the application software. The source of each of the events is the input signal of any digital input channel.

For each event, it is possible to define which edge of the digital input signal is selected for the event (active-inactive edge, inactive-active edge, both edges or the end of a cycle).

If an event occurs, the signals at all inputs of the ES930.1 are captured.

### 3.7.2.2 Behavior in Case of Oversampling by the Application Program

In case of oversampling, a signal with a higher sampling rate than it is actually required for the transfer of the signal bandwidth is captured.

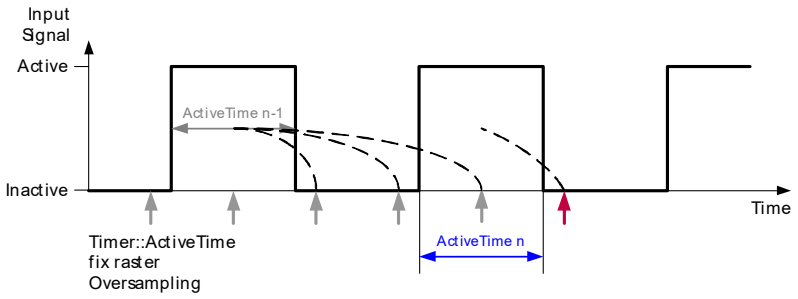



**Fig. 3-7** Oversampling at the digital Input Channel

If the relatively slow input signal is scanned with a high sampling rate (oversampling), a new measured value cannot be determined for every sampling, as shown by the example in Fig. 3-7 on page 26 (fixed sampling rate, digital input). In this case, the valid measured value captured last is used again.

## 3.7.3 Signal Output

### 3.7.3.1 Transfer of the Configuration Value

The output or change of signals at an output channel of the ES930.1 is triggered by a configuration value that is transferred with a STIM packet.

### 3.7.3.2 Response Time and Update Rate

For MC applications, the response time or update rate of the ES930.1 for the signal output is approx. 300 ms. This time is determined, among other things, by INCA. If an assigned input signal is used as stimuli, the outputs of the module are updated with the aforementioned rate.

**NOTE**

For input signals with higher base resolution (faster raster), the data are discarded or only the most current value is transferred.

## 3.7.4 Synchronization of the Model Process of the ES910 Rapid Prototyping Module

If events were defined for the ES930.1 module and the module is combined with the ES910 prototyping module, the model process can be synchronized in the rapid prototyping module to the events and the input signals of the ES930.1 captured at the same time.

## 3.7.5 Limited Data Acquisition

If the input signals of all channels of the ES930.1 should be captured at the same time, the module cannot capture the signal exactly at one channel.

If the user should attempt to capture all the signals/channels with a ES930.1 configured accordingly, an attempt is made to optimally distribute the existing resources within the module. The configuration software monitors this selection, provides support for the deselection of the non-required resources and informs users about the changed setting.

The user can change the default setting predefined in the configuration software and select any other channel which will then be excluded from the signal acquisition in the described case. The configuration software supports the user in this selection of non-required resources to ensure the desired data acquisition at the other channels.

## 3.7.6 Limited Data Transfer for MC Applications

If the ES930.1 module is operated at high rates for MC applications, it is possible that the PC can no longer process the data transfered by ES930.1 and discards data.

The Flow Control function can be used to prevent these data losses (packet losses) between ES930.1 and PC. The Flow Control function is supported by the ES930.1 module from HSP V9.7.0.

If data losses should occur between ES930.1 and PC, the user in INCA receives a message after the measurement is complete.

### 3.7.7 Overload for Rapid Prototyping Applications

If the ES930.1 is operated in event mode for the rapid prototyping applications, it is possible in the case of events with very quick succession and frequent occurrence that the ES910 can no longer process the data of the ES930.1. The ES910 discards data of the ES930.1 or data of other ETAS daisy chain modules that are present at its I/O port. The I/O port of the ES910 to which the ES930.1 is connected is overloaded.

If the ES910 detects the described overload case, an error bit is set.

**NOTE**

An overload event is possible only if the ES930.1 is operated in event mode for rapid prototyping applications.

To avoid additional overload cases, a new configuration of the ES930.1 is required which either generates fewer data or increases the time intervals between the transfer of data. This can also be done, for example, with events that follow in succession that are not too short or through fewer events.

#### 3.7.7.1 Short-term Overload

For short-term overload cases, the configuration can be transferred to the ES930.1 and, with according configuration, the overload situation can be ended.

#### 3.7.7.2 Permanent Overload

If the RP model has ended on the ES910, the ES930.1 continues to generate high data volumes due to the configuration that leads to a permanent overload. For this reason, the XCP connection between the I/O port of the ES910 and the daisy chain connection of the ES930.1 remains at a constant overload.

#### 3.7.7.3 Ending the Permanent Overload

To end the overload, a change of the configuration of ES930.1 is required. This cannot be easily accomplished during a permanently lasting overload situation:

- An adjusted RP model containing a new configuration of the ES930.1, cannot transfer this configuration over the overloaded XCP connection to the ES930.1.
- The ES930.1 connected to the overloaded I/O port of the ES910 can neither be accessed from the PC with the configuration program nor is it possible to perform a "Search for Hardware" with HSP.

The described permanent overload event can only be terminated,

- if the ES930.1 is disconnected from the I/O port of the ES910, connected directly with the PC and reconfigured, or
- if the source of the overload at the ES930.1, which generates the events at the digital input, is switched off or removed from the digital inputs and the module is reconfigured.

# 4 Thermo Channels ("TH1-4" Connections)

The ES930.1 is equipped with four mini-TC sockets ("TH1" to "TH4") for the connection of thermocouples of type K.

## 4.1 Assemblies of the Thermo Channels

### 4.1.1 Overview

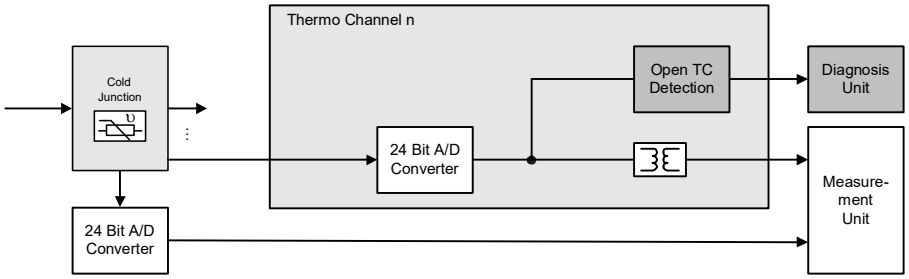



**Fig. 4-1** Thermo Channels "TH1" to "TH4"

The four thermo channels "TH1" to "TH4" of the ES930.1 feature an identical design. Each channel consists of the following assemblies (see block diagram in Fig. 4-1 on page 29):

- Cold-junction compensation with A/D converter
- A/D converter
- Open TC Detection (Open Thermocouple Detection)

The functionality of all thermo channels can be configured separately.

### 4.1.2 Cold-junction Compensation with A/D Converter

The integrated Mini-TC sockets for connecting the thermocouples consist of the same combination of materials as the thermocouples (NiCr and Ni) to achieve high accuracies across the entire temperature range.

The ES930.1 uses a common cold-junction compensation for the four thermo channels. Measuring the cold-junction is done together for all channels using a PTC (PT1000) that is installed close to the material transition in the module. The construction ensures that the measurement result is affected only by a few tenths of a Kelvin, even in case of fast changes of the ambient temperature or uneven temperature distribution.

The signal of the cold-junction compensation is digitized by an A/D converter with a resolution of 24 bit and provided to the measurement unit.

### 4.1.3 A/D Converter

The A/D converters of the thermo channels have a resolution of 24 bit. The maximum measuring range is -200 °C to +1372 °C and corresponds to the measuring range of thermocouples of type K.

### 4.1.4 Open TC Detection

The Open TC Detection assembly monitors the connections of the thermo channels. If an open connection is diagnosed, e.g. in case of missing thermocouples, this information can be displayed for every thermo channel in the application software.

## 4.2 Measurement Error

For the measurement with thermocouples, the entire maximum measurement error is comprised of different partial errors. The partial errors are:

- Base accuracy $\Delta T_g$
- Maximum temperature drift $\Delta T_d$
- Measurement error that depends on the internal resistance of the thermocouple $\Delta T_i$

The maximum total error to be expected is the sum of all partial errors.

$$\Delta T = \Delta T_g + \Delta T_d + \Delta T_i$$

The size of the partial errors depends on the type of thermocouple.

## 4.3 Electrical Isolation

The thermo channels are electrically isolated from each other. Each thermo channel is electrically isolated from the supply voltage and from the housing of the module.

Hence, the use of non-isolated thermocouples in non-floating installations is also possible without a restriction on accuracy.

# 5 Digital Input Channels ("DI" Connection)

The ES930.1 provides four digital input channels at the "DI" connection for different measuring functions (status, counter, timer).

## 5.1 Assemblies of the Digital Input Channels

### 5.1.1 Overview

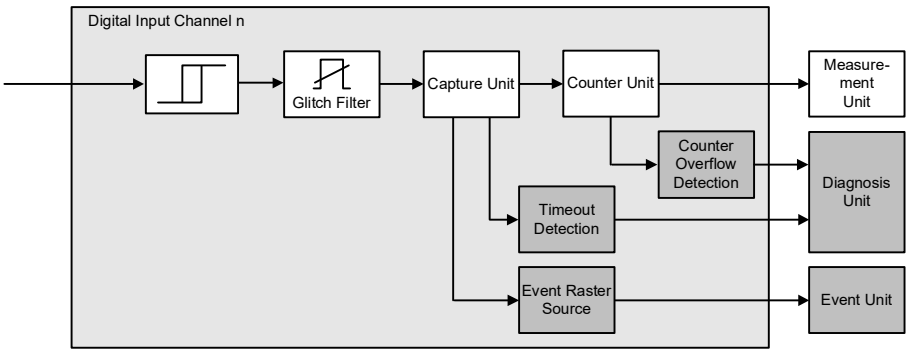



**Fig. 5-1** Digital Input Channels

The digital input channels "DI 1" to "DI 4" of the ES930.1 feature an identical design and consist of an input stage with signal acquisition and signal processing. The input stage of each channel (see in Fig. 5-1 on page 31) consists of the following assemblies :

- Schmitt trigger (TTL-compatible)
- Glitch filter
- Capture unit
- Counter unit
- Timeout detection
- Event raster source
- Counter overflow detection

The digital input channels are dimensioned for TTL-compatible input voltages. The minimum pulse width is restricted to 120 ns. This restriction avoids acquiring interference pulses at the measuring channels.

The functionality of all digital input channels can be configured separately.

### 5.1.2 Schmitt Trigger

The Schmitt trigger of the input stage has a fixed hysteresis, the corresponding switching thresholds for the LOW and HIGH levels are TTL-compatible.

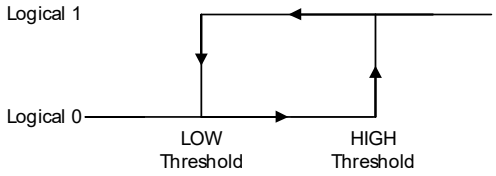



**Fig. 5-2** Definition of Hysteresis for the Input Channel

The hysteresis is completely defined by the two levels and the edge direction.

### 5.1.3 Glitch Filter

In the input stage, a glitch filter relieves the Input signal from short interference peaks or is used, e.g. for debouncing. The filter characteristic (duration) can be configured in the application software for the active or inactive status. The glitch filter can be switched off, if necessary.

### 5.1.4 Capture Unit

In the capture unit function group, the Input signal is captured and, depending on the selection in the application software, can be evaluated in normal or inverted logic independent of the channel within a period or a cycle. The variables status, active times and inactive times of the input signal are determined. These measuring functions of the ES930.1 are described in the chapters 5.2.3 on page 37 and 5.2.5 on page 40.

### 5.1.5 Counter Unit

In the counter unit function group, the edges of the Input signal are counted and processed according to the measuring function selected in the application software. These measuring functions of the ES930.1 are described in chapter 5.2.4 on page 38.

### 5.1.6 Timeout Detection

The timeout detection function group monitors the signals at the digital input channels. It is checked whether at least one signal change occurs within a period which can be configured separately for each measuring channel. If no signal change occurs in the defined period, it is recognized as timeout and the timeout flag is set for diagnostics purposes.

If the signal changes do not occur, no new timer measured values can be determined. If the timeout of the ES930.1 expired, the values measured last of the counters, the active and the inactive time are retained without changes. They are transferred to the application program during the next sampling.

### 5.1.7 Event Raster Source

In the event raster source function group, the input signal is analyzed for the occurrence of events that were defined for this channel in the application software (see chapter 3.7.2 on page 26).

If the digital input channel was defined as the source of events, they are forwarded to the event unit for processing.

### 5.1.8 Counter Overflow Detection

32-bit counters that are independent of each other are the basis for the counter function and for the time measurement. Each counter value corresponds to a time unit of 15 ns. If a counter reaches its maximum value, a counter overflow occurs. The counter continues the counting process. The counter overflow detection assembly transmits every counter overflow to the diagnostics unit.

### 5.1.9 Electrical Isolation

The digital input channels "DI 1" to "DI 4" are not electrically isolated against each other. The digital input channels are electrically isolated together as channel group to the supply voltage and as channel group to the housing of the module.

## 5.2 Measuring Functions

### 5.2.1 Definitions of the measuring Signals

This section defines signals that are used for the description of the measuring functions of the digital inputs of the ES930.1.

#### 5.2.1.1 Legend

Tab. 5-1 on page 34 summarizes the symbols used in the figures of the chapter on "Measuring Functions".

| Symbol | Meaning |
|---|---|
|  | Time stamp for preceding samplings (fixed grid) |
|  | Current time stamp (fixed grid) |
|  | Resulting scan value |

**Tab. 5-1** Symbols used

#### 5.2.1.2 Status

The term "state" describes the level of a signal to a sampling time. The state of an input signal is either active or inactive. The active state is represented by the value 1 or HIGH, the inactive state by the value 0 or LOW.

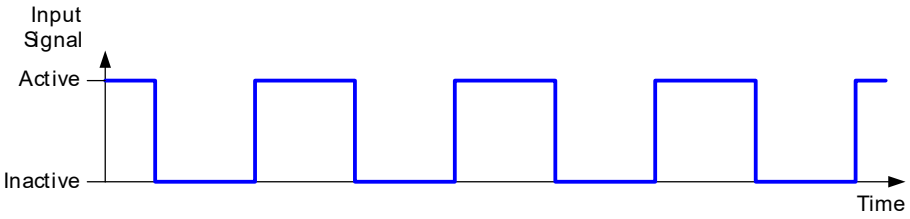



**Fig. 5-3** Active and inactive State

#### 5.2.1.3 Pulse

The term "pulse" describes the time characteristic of a signal change from one state to the other and back to the original state.

A pulse is framed exactly by one inactive-active and one active-inactive edge. The two edges follow in succession.

The pulse of an input signal is either active or inactive. An active pulse starts with an inactive-active edge, an inactive pulse starts with an active-inactive edge.

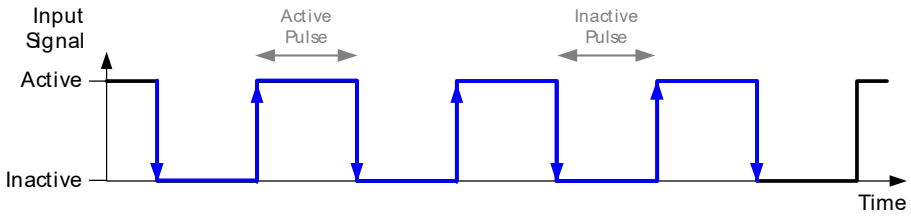



**Fig. 5-4** Active and inactive Pulse

### 5.2.1.4 Period

A period starts with a state change or an inactive-active or an active-inactive edge of the signal. It always consists of an active and an inactive pulse.

If the period starts with an inactive-active edge, then the period consists of the sequence active pulse with subsequent inactive pulse. If the period starts with an active-inactive edge, then the period consists of the sequence inactive pulse with subsequent active pulse.

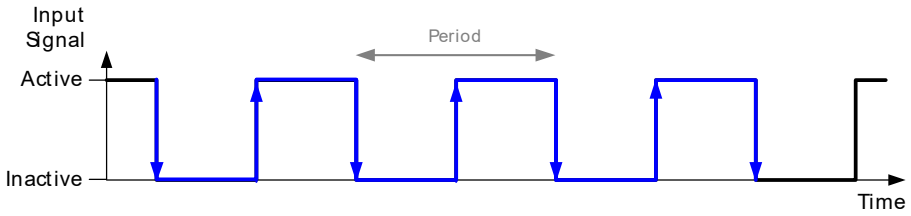



**Fig. 5-5** Period, starting with an active-inactive Edge

### 5.2.1.5 Cycle

A cycle encompasses a repeated succession of one or several periods.

A cycle describes an integer multiple of a period:

Cycle = n * period

A cycle can start with:

- an inactive-active edge
- an active-inactive edge

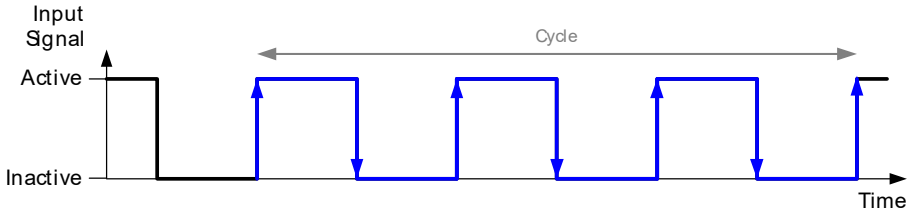



**Fig. 5-6** Cycle, starting with an inactive-active Edge and n=3

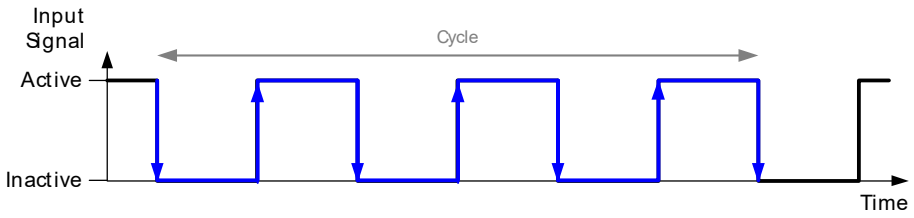



**Fig. 5-7** Cycle, starting with an active-inactive Edge and n=3

## 5.2.2 Overview of measuring Functions

The ES930.1 module can capture digital signals at the four input channels "DI 1" to "DI 4" and analyze them with the help of the following measuring functions:

| Measuring function | Measuring signal |
|---|---|
| State (signal state) | State |
| Event count | Events |
| Time measurement | Inactive duration |
| | Active duration |

All aforementioned signals can be captured simultaneously at all four channels of the ES930.1.

### 5.2.3 Measurement of the Signal State (State)

At each sampling point, the active or inactive state of the input signal is determined. The active state is represented by the value 1 or HIGH, the inactive state by the value 0 or LOW.

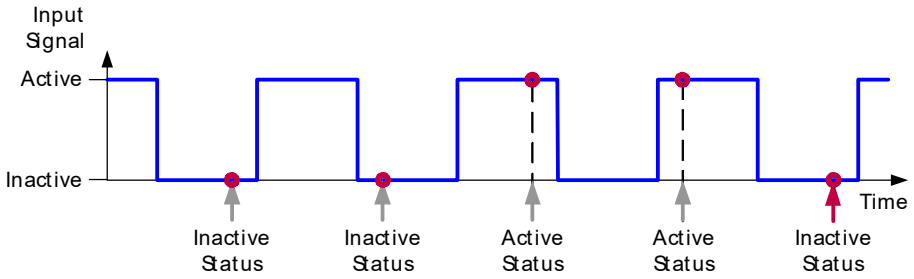



**Fig. 5-8** Measurement of active and inactive State (fixed measure Rate)

In the application software, it can be defined at which input channels of the ES930.1 the state should be measured.

**NOTE**

The state of a non-selected input channel is set to the value 0.

## 5.2.4 Counter

### Measuring Procedure

In the application software, the type of events to be counted (edges or cycles) for the event count can be selected for each digital input channel. All counter parameters are freely configurable in the application software.

The signal at the measuring channel is counted independent of signals at other measuring channels. The counter assigned to the measuring channel is configured as an up-counter.

The ES930.1 can count edges with the following measuring procedures according to the configuration in the application software:

- Count of edges when the input signal changes from inactive to active state
- Count of edges when the input signal changes from active to inactive state
- Count of edges when the input signal changes from inactive to active state and from active to inactive state
- Count of cycles

The following operating modes of the counter can be selected in the application software:

- Resetting the counter after every sampling point or
- Counter in free-running mode. The counter counts from the start of the measurement without being reset during the measurement. If the counting scope (overflow) is reached and the measurement is not yet finished, the counter starts counting again from the start. The overflow of the counter occurs after $2^{32}$ signal transitions to be counted.

**NOTE**

For rapid prototyping applications, select the operating mode "Reset counter after every sampling point".

The following figures show examples for counting procedures.

### Counting of inactive-active Edges

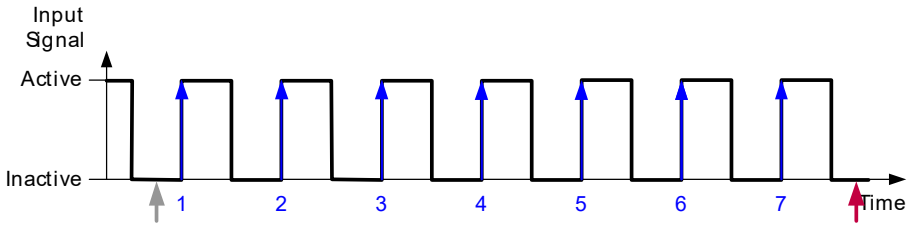



**Fig. 5-9** Counting of inactive-active Edges

In the example in Fig. 5-9, the counter is reset at every sampling point.

### Counting the active-inactive Edges

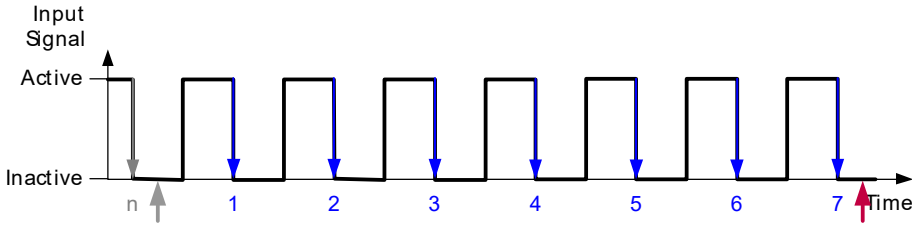



**Fig. 5-10** Counting of active-inactive Edges

In the example in Fig. 5-10, the counter is reset at every sampling point.

### Counting of inactive-active and active-inactive Edges

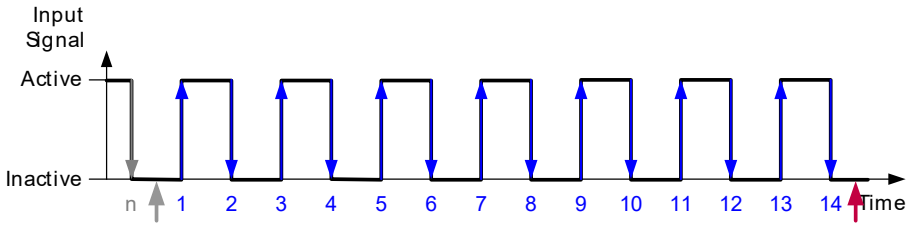



**Fig. 5-11** Counting of inactive-active and active-inactive Edges

In the example in Fig. 5-11, the counter is reset at every sampling point.

### Counting of Cycles

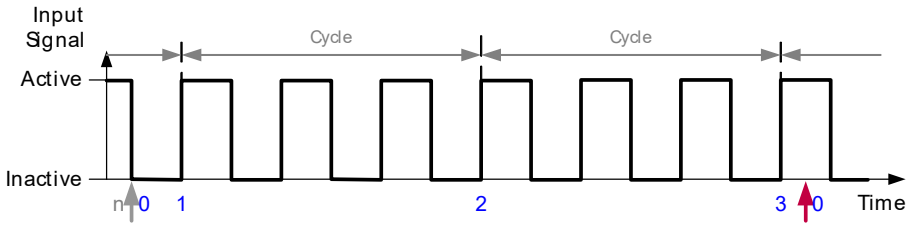



**Fig. 5-12** Counting of Cycles

The counter is reset at every sampling point.

## 5.2.5 Time Measurement

### Measuring Procedure

In the time measurement, the ES930.1 always acquires the active time and the inactive time of the signal at the measuring channel. With these measured values, the signals can be determined completely in different periods.

The signal at the measuring channel is used for the time measurement independent of signals at other measuring channels. With each measuring channel, the active and/or inactive duration of the input signal can be determined. The period for the measurement of this time is configured in the application software. The ES930.1 can determine active and inactive times with the following time-controlled measuring procedures:

- Measurement during the last period
- Measurement during the last complete cycle
- Measurement between two sampling points
- Measurement until the last current sampling point

The following operating modes can be selected in the application software for the time measurement:

- Resetting the timer after every sampling point or
- Timer in free running mode. The timer counts from the start of the measurement without being reset during the measurement. If the counting scope (overflow) is reached and the measurement is not yet finished, the timer starts counting again from the start. The overflow of the timer occurs after ($2^{32}$ - 1) signal transitions to be counted or after $2^{32}$ * 15 ns = 64 s.

The following figures show examples for determining different time sections from the start of the measurement added up until the current sampling point.

### Measurement of active Time during the last Period

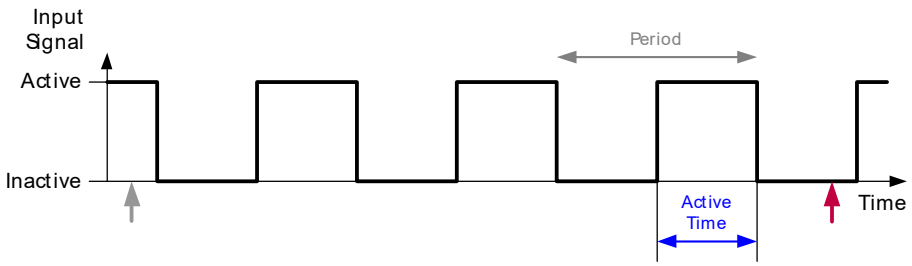



**Fig. 5-13** Measurement of active Time during the last Period

### Measurement of active Time of a Cycle

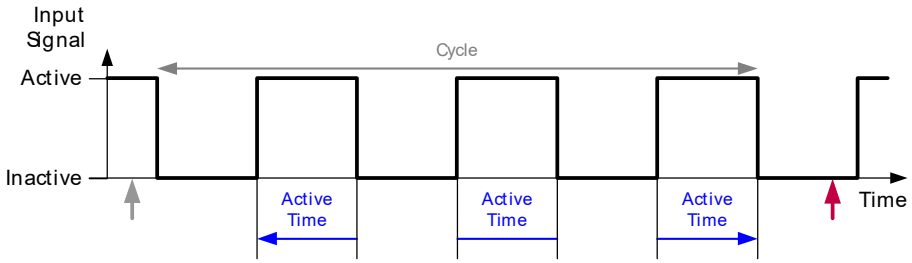



**Fig. 5-14** Measurement of active Time of a Cycle

### Measurement of active Time between two sampling Points

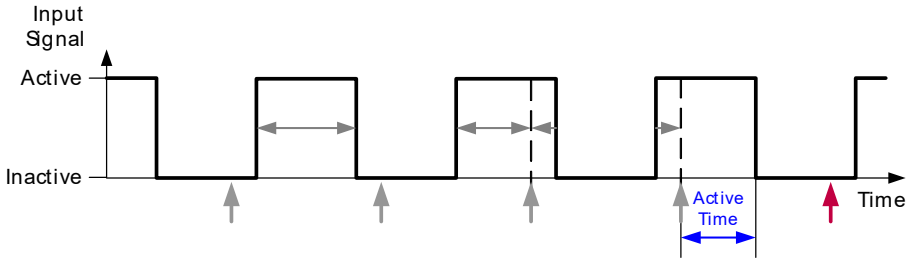



**Fig. 5-15** Measurement of active Time between two sampling Points

### Measurement of active Time until the last current sampling Point

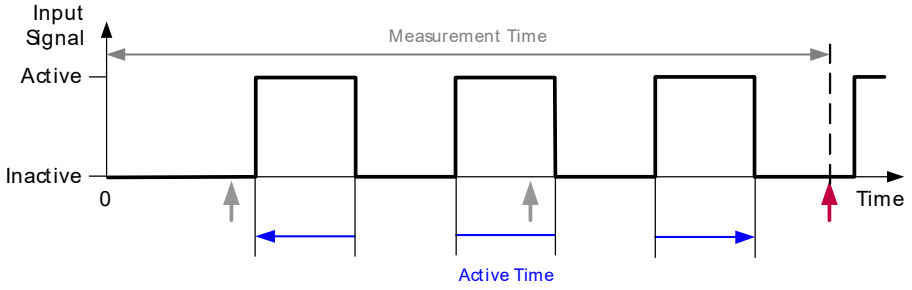



**Fig. 5-16** Measurement of active Time until the last current sampling Point

The sum of the active time can be determined over the entire measure time without any gaps (see Fig. 5-16 on page 41).

## 5.2.6 Calculation of Cycle Duration, Frequency and Scan Ratio

In the time measurement operating mode, the ES930.1 acquires the active and inactive time of a period or a cycle of the signal at the measuring channel. The measured times are the basis for calculating the cycle duration, frequency and scan ratio.

**NOTE**

The calculation of the cycle duration, frequency and scan ratio is done application-specific in INCA or in the RP model from the values for the active and inactive time determined by the ES930.1.

### Measuring Procedure

In the application software, parameters and measuring procedures can be selected for the time measurement for every measuring channel:

- Measurement of the duration of the last period
- Measurement of the duration of the last cycle

### Calculation of the Cycle Duration

The cycle duration T is the sum from active time and inactive time:

T = active time + inactive time

### Calculation of the Frequency

The frequency is the reciprocal value of the cycle duration T of the digital signal:

$$f = \frac{1}{T} = \frac{1}{\text{active time} + \text{inactive time}}$$

The frequency is determined from the measured values of the active and inactive time as reciprocal value of the sum of the active and inactive time during a period or during a cycle or from the reciprocal value of the scan ratio.

### Calculation of the Scan Ratio

The scan ratio indicates the ratio of the length of the active state (pulse duration) to the cycle duration of the digital signal in percent:

$$\text{Scan ratio} = \frac{\text{active time}}{\text{active time} + \text{inactive time}} \ [\%]$$

The scan ratio is determined from the measured values of the active and inactive time as quotient of the active time and the sum of the active and inactive time during a period or during a cycle.

## 5.2.7 Calculation of the Speed

### Application

In the automotive sector, the measurement of the rotational speed of wheels, gears, fans, water pumps, and turbines is decisive, e.g. to be able to determine the vehicle speed or the flow rate.

To determine the speed in revolutions per minute, an expanded configuration of the number of periods per revolution is required.

**NOTE**

The calculation of the speed is done application-specific in INCA or in the RP model from the values for the active and inactive time determined by the ES930.1.

### Measuring Procedure

In the application software, parameters and measuring procedures can be selected for the time measurement for every measuring channel:

- Measurement of the duration of the last period
- Measurement of the duration of the last cycle

### Simplified Example

A speed sensor wheel with 60-2 teeth installed on the crankshaft furnishes a periodically structured signal pattern via a sensor. The number of revolutions per time unit is a measure for the speed of the wheel. This wheel with the 60-part division generally has 58 teeth. The position of the two missing teeth defines the reference mark for the position of the crankshaft. A revolution of the wheel is described by a cycle consisting of 60-2=58 periods. The configuration principle is illustrated using the following simplified example.

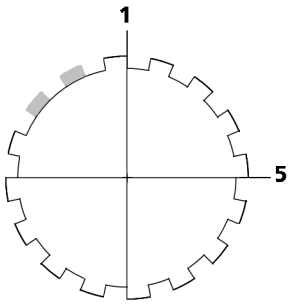



**Fig. 5-17** 16-2 "Speed Sensor Wheel"

To be able to determine a speed from periodic signal forms using the ES930.1, a cycle can be defined in the configuration software, e.g.:

1 revolution = 1 cycle = (16-2) periods = 14 periods

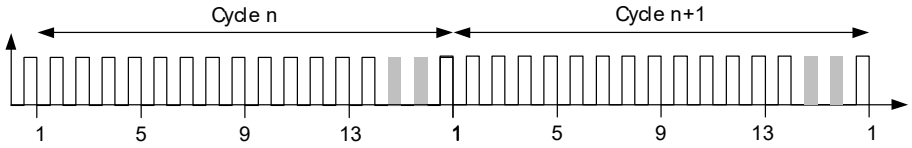



**Fig. 5-18** Principle of the input Signal of a "Speed Sensor Wheel"

Each cycle of the example has 14 periods (see Fig. 5-18 on page 44). A cycle can be assigned to a complete revolution or a section. The measurement result depends on the start of the cycle.

This process allows determining the average speed using periodic input signals:

$$\text{Speed} = \frac{60}{\text{active time} + \text{inactive time}} \text{ [rpm]}$$

# 6 Analog Input Channels ("AI 1-4"/"AI 5-8" Connections)

The ES930.1 provides four analog input channels each at the two "AI 1-4" and "AI 5-8" connections.

## 6.1 Channel Groups

The analog input channels 1, 2, 3 and 4 are provided at the "AI 1-4" connection and the analog input channels 5, 6, 7 and 8 at the "AI 5-8" connection.

## 6.2 Assemblies of the Analog Input Channels

### 6.2.1 Overview

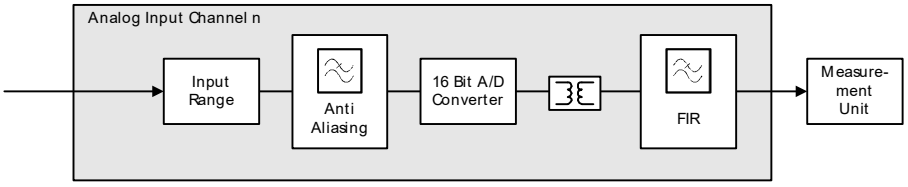



**Fig. 6-1** Analog input Channels "AI 1" to "AI 4"

The eight analog input channels "AI 1-4" and "AI 5-8" of the ES930.1 are identical in design. Each channel consists of the following assemblies (see block diagram in Fig. 6-1 on page 45):

- Input range
- Anti-aliasing filter
- A/D converter
- FIR filter

The functionality of all analog input channels can be configured separately.

**NOTE**

The software configurable filter of a measuring channel (analog inputs [AI] and current measurement channels [PS] of the Power Stages) is automatically deactivated when the measurement channel is operated in the event mode.

### 6.2.2 Input Range (Level Adjustment)

In each analog input channel, a capacitively compensated voltage divider limits the level of the input signal following the overvoltage protection. An amplifier adjusts the Input signal according to the selection of the input voltage range.

### 6.2.3 Anti-aliasing Filter

The anti-aliasing filter is a second order analog filter with Bessel characteristic and a limit frequency of 10 kHz. The filter can be neither configured nor bridged.

### 6.2.4 A/D Converter

A 16-bit A/D converter digitizes the output signal of the analog filter. The separate A/D converter, which is available in every analog input channel, ensures the synchronous sampling of the measuring signals.

### 6.2.5 Digital Filter

An FIR filter subsequently processes the output signal of the A/D converter. The FIR filter is implemented as a digital FIR low-pass of the 8th order (Butterworth) with adjustable limit frequency, and can be configured or disabled in the application program.

#### 6.2.5.1 Adjustability of the Filter

An overview of the possible settings and technical data of the digital filter is located in chapter 13.9.5 on page 95.

#### 6.2.5.2 Recommendations for the Configuration of the digital Filter

The -3-dB limit frequency of the digital filter system of the ES930.1 can be configured in the application program.

To avoid aliasing effects, recommendations for the configuration of the filter should be observed depending on the selected INCA sampling rate. The necessary instructions are located in the following table.

| Symbol | Meaning | Setting |
|---|---|---|
| $f_{C,AAF}$ | -3-dB limit frequency HW anti-aliasing filter | 10 kHz (fixed) |
| $f_{S,AD}$ | A/D converter sampling frequency | 40 kHz |
| $f_{C,FIR}$ | -3-dB limit frequency FIR filter (adjustable) | Recommendation: $f_{C,FIR} \leq 0.4 * f_{S,INCA}$ |
| $f_{S,INCA}$ | INCA sampling frequency | Configuration in the application program |

#### 6.2.5.3 Configuration of the digital Filter for Rapid Prototyping Applications

**NOTE**

For rapid prototyping applications, the digital filters of the analog input channels are automatically switched off.

## 6.3 Compensation of Group Runtime

The group runtime is the time required by the Input signal of an analog or digital filter to pass through the filter.

One property of the ES930.1 is the in-module compensation of the group runtime. For this purpose, the group runtimes of the analog anti-aliasing filter and the configurable digital filter are taken into account. A time shift of the signal in the application program (e.g. in MDA) for the compensation of the group runtime is no longer required.

To represent the group runtime for digital filters as an example, a test signal was applied to an input.

The test signal is scanned with the sampling frequency $f_{S,INCA}$ = 2 kHz (0.5 ms). The filter channel was set to the limit frequency $f_{C,FIR}$ = 200 Hz.

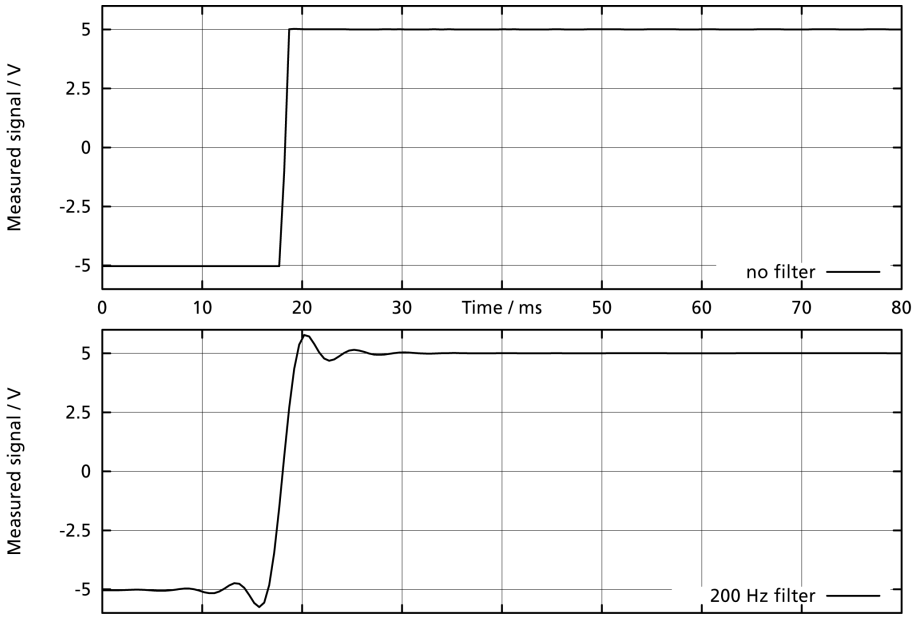



**Fig. 6-2** ES930.1 Filter: $f_{C,FIR}$ = 200 Hz (with Group Runtime Compensation)

Fig. 6-2 on page 47 shows the respective signal path in the upper portion of the figure without filter, in the lower portion of the figure with filter and group runtime compensation.

## 6.4 Maximum Input and Common Mode Voltages

### 6.4.1 Definitions

The maximum input voltage between two inputs each and the maximum voltage between one input and the housing ground is 60 V DC/ 30 V AC. For an explanation of the maximum input and common mode voltages, please observe Fig. 6-3 on page 48 and the calculation example.

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

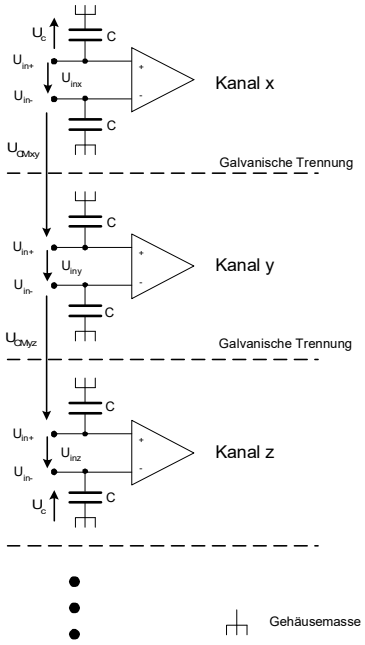



**Fig. 6-3** Maximum input and Common Mode Voltages

### 6.4.2 Example

The input voltages $U_{inx}$, $U_{iny}$, $U_{inz}$ and the common mode voltage $U_{CMxy}$ are predefined. The maximum permissible common mode voltage $U_{CMyz}$ is to be calculated.

$U_{inx}$ = 10 V

$U_{iny}$ = 5 V

$U_{inz}$ = 10 V

$U_{CMxy}$ = 15 V

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

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

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

## 6.5 Electrical Isolation

The analog input channels are electrically isolated from each other. Each analog input channel is electrically isolated from the supply voltage and from the housing of the module.

# 7 Outputs to the Sensor Power Supply

The ES930.1 is equipped with four outputs for the power supply of sensors that are available at the connections "AI 1-4" and "AI 5-8".

## 7.1 Channel Groups

The two sensor supply voltage channels at the "AI 1-4" connection and the two sensor supply voltage channels at the "AI 5-8" connection are combined into channel groups.

- Channel group at "AI 1-4" connection:

  Sensor power supplies, channel 1 and channel 2
- Channel group at "AI 5-8" connection:

  Sensor power supplies, channel 3 and channel 4

## 7.2 Assemblies of the Sensor Supply Channels

### 7.2.1 Overview

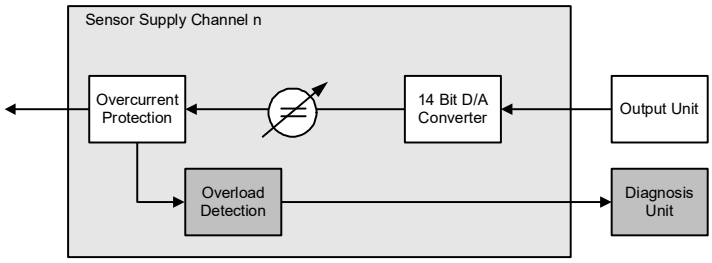



**Fig. 7-1** Sensor Supply Voltage Channel

The four sensor supply voltage channels of the ES930.1 feature an identical design and provide four individual, separately configurable sensor supply voltages. Each channel consists of the following assemblies (see block diagram in Fig. 7-1 on page 49):

- D/A converter
- Overcurrent protection
- Overload detection

The functionality of all sensor supply voltage channels can be configured separately. An additional external power supply device for the sensor supply voltage is not required. In each channel, the sensor supply voltage is generated from the module operating voltage.

### 7.2.2 D/A Converter

The 14-bit D/A converter of the channel transforms the digital input signal provided by the output unit into a changeable sensor supply voltage. The user can switch off the sensor supply voltage of each sensor channel in the application program, select one of the predefined values between +5 V and +15 V or enter or specify any value within the range of values.

### 7.2.3 Overcurrent Protection

In case of a short-circuit of the sensor supply output to ground, the sensor supply of this channel automatically switches off. Each sensor supply output is protected against overvoltages. Exceeding the maximum value trips a fuse.

The short-circuit detection of each channel is supplemented by a monitoring of the permissible total output of all sensor supply voltage channels. If the permissible total output is exceeded, all channels are switched off.

### 7.2.4 Overload Detection

The application program receives analyzable, channel-specific information in case of short-circuits, a tripped fuse and a violation of the permissible total output.

## 7.3 Assignment of Channels

The sensor supply voltage of each channel can be connected to analog or digital sensors.

## 7.4 Electrical Isolation

The sensor supply voltage channels are not electrically isolated against each other. The sensor supply voltage channels are electrically isolated as channel group to the housing of the module.

**NOTE**

The supply voltages of the sensors are not electrically isolated to the operating voltage of the module.

## 7.5 Behavior for Rapid Prototyping Applications

**NOTE**

For rapid prototyping applications, it is recommended to use the "On Power On" setting.

This configuration ensures that the sensor supply voltage is already present at the connected sensors before the start of the RP model when switching on the module. If the sensor supply voltage channels are not configured as described above, the already existing sensor voltage is briefly interrupted at the start of the RP model on the ES910.

# 8 Analog Output Channels ("AO" Connection)

The ES930.1 provides four identical analog output channels at the "AO" connection.

## 8.1 Assemblies of the Analog Output Channels

### 8.1.1 Overview

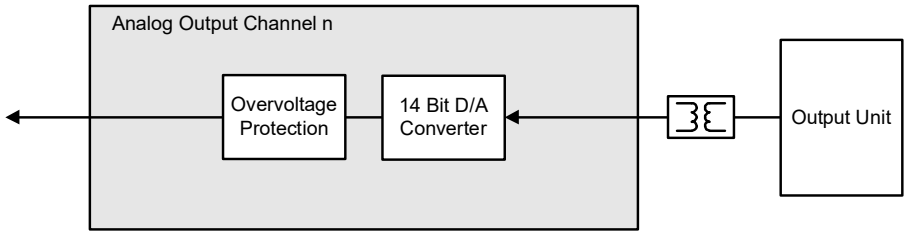



**Fig. 8-1** Analog Output Channels

The analog output channels "AO 1" to "AO 4" of the ES930.1 feature an identical design. Each channel consists of the following assemblies (see block diagram in Fig. 8-1 on page 51):

- D/A converter
- Overvoltage protection

The functionality of all analog output channels can be configured separately.

### 8.1.2 D/A Converter

The 14-bit D/A converter of the analog output channel converts the digital input signal provided by the output unit into an analog output voltage in the range of 0 V to +10 V. The maximum output current is 4 mA.

#### 8.1.2.1 Synchronous Groups and update Mode

The update mode can be configured independently for every analog output channel. The output signals of the analog channels can optionally be updated either asynchronously (individually or for each channel) or synchronously. For synchronous operation, the analog channel is assigned either to the synchronous group X or the synchronous group Y. All channels of a synchronous group are updated together.

During the synchronous operation, the digital values are applied simultaneously to the D/A converters of the channels of the synchronous group for transformation.

#### 8.1.2.2 Initial Value

The initial value of the output voltage of a channel after switching on the ES930.1 can be configured so that devices or measuring setups connected to the module are supplied with the corresponding signals before the initialization (e.g. through a rapid prototyping model) is completed.

### 8.1.3 Overvoltage Protection

Each output channel is equipped with an overvoltage protection and protected against overvoltages up to ±45 V DC.

## 8.2 Electrical Isolation

The analog output channels "AO 1" to "AO 4" are not electrically isolated against each other. The analog output channels are electrically isolated together as channel group to the supply voltage and as channel group to the housing of the module.

# 9 Digital Output Channels ("DO" Connection)

The ES930.1 provides six TTL-compatible digital output channels at the "DO" connection.

Each of the digital output channels can output signals independent of each other (Digital Out, Pulse Out and PWM Out). In addition, the channels for the control of the Half-bridges (power output stages "PS") can be used.

The output of each channel can be released or blocked with a separate signal ("Enable DO n"). A total of two output channels can each be assigned to one of the LEDs **U1** and **U2**.

## 9.1 Assemblies of Digital Output Channels

### 9.1.1 Overview

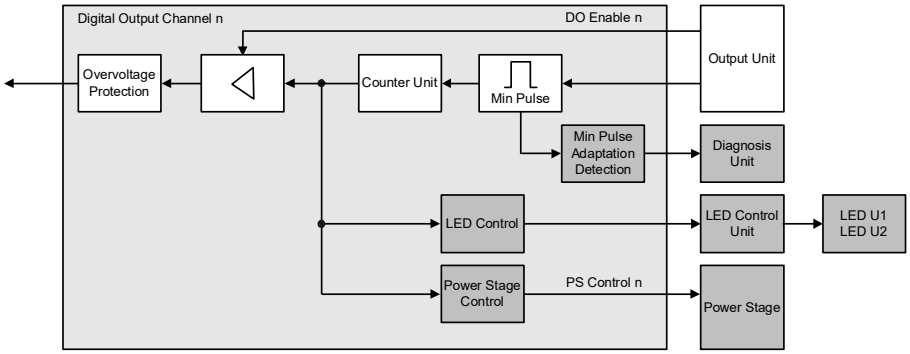



**Fig. 9-1** Block Diagram of a digital Output Channel

The digital output channels "DO 1" to "DO 6" of the ES930.1 feature an identical design. Each channel consists of the following assemblies (see block diagram in Fig. 9-1 on page 53):

- Counter unit
- Min pulse
- Output amplifier
- Overvoltage protection
- Min pulse adaptation detection
- LED control
- Power stage control

The functionality of all digital output channels can be configured separately.

### 9.1.2 Counter Unit

The counter unit generates digital output signals (Dig Out, Pulse Out, PWM Out) with a 32-bit counter.

The counter unit is controlled by the digital output unit according to the configuration in the application program or the definition in the model for rapid prototyping applications.

### 9.1.3 Output Amplifier

Each output channel is equipped with a TTL driver. The output driver and, therefore, the output signal of the channel can be released or blocked with the "Enable DO n" signal. With blocked output driver and after switching on the module, the channel is in the "Tristate" state.

### 9.1.4 Overvoltage Protection

Each output channel is equipped with an overvoltage protection and protected against overvoltages up to ±50 V DC.

### 9.1.5 Min Pulse

With combined use of the ES930.1 with the ES910 prototyping module, direct access from within the rapid prototyping experiment to the ES930.1 module is possible. The rapid prototyping model can control each ES930.1 signal of access each signal. In the rapid prototyping model, signals may have been defined which the counter unit may be able to generate with this "external" control, but which are to short for further assemblies of the ES930.1 module or which cannot be processed error-free. For this reason, the output signal of the counter unit is monitored with the Min Pulse assembly and, if necessary, limited to a minimum pulse width.

The minimum pulse width is firmly defined and cannot be underrun independent of the signals of the counter unit. The Min Pulse assembly limits the pulse width of the output signal wither to 150 ns or, if the output signal of the counter unit controls a Half-bridge (power stage), to 2.5 µs. The limiting is required to maintain the dynamic control conditions of the Half-bridge (power stage).

### 9.1.6 Min Pulse Adaptation Detection

The Min Pulse Adaptation Detection assembly signals the diagnostic unit of the module or the application program that a predefined model value has exceeded the limits of the pulse width described above and the output value of the digital channel was limited to the minimum permissible pulse width by the ES930.1.

### 9.1.7 Power Stage Control

The output signal of the channel can be released or blocked in the Power Stage Control assembly in order to control a Half-bridge as "Control PS n" signal. The output signal of each channel is firmly assigned to a Half-bridge (power stage). This assignment cannot be changed:

| Digital output channel | Assigned Half-bridge (power stage) |
|---|---|
| DO 1 | PS 1 |
| DO 2 | PS 2 |
| DO 3 | PS 3 |
| DO 4 | PS 4 |
| DO 5 | PS 5 |
| DO 6 | PS 6 |

If the control of a Half-bridge is released in the Power Stage Control assembly, the Min Pulse assembly limits the output signal to 2.5 µs.

**NOTE**

The release or blocking of the output signal in the Power Stage Control assembly affects only the control of a Half-bridge, not the digital output signal of the channel at the "DO n" connection.

### 9.1.8 Synchronous Groups and update Mode

The update mode can be configured independently for every digital output channel. The output signals of the digital channels can optionally be updated either asynchronously (for each channel) or synchronously. For synchronous operation, the digital channel is assigned either to the synchronous group A, synchronous group B or synchronous group C. All channels of a synchronous group are updated together.

### 9.1.9 LED Control

With the LED Control assembly. the output signal of the channel can be released for the LED control unit, where it can be assigned either to the LED **U1** or the LED **U2**.

### 9.1.10 LEDs U1 and U2

The user can assign the LEDs **U1** and **U2** to two random digital output channels ("DO 1" to is "DO 6") in the application software. The LED lights if the state of the signal of the assigned digital output channel is active.

It is not possible to assign one LED to different digital output channels at the same time.

### 9.1.11 Electrical Isolation

The digital output channels "DO 1" to "DO 6" are not electrically isolated against each other. The digital output channels are electrically isolated together as channel group to the supply voltage and as channel group to the housing of the module.

## 9.2 Properties

The digital output channels can provide signal frequencies in the range from 1 Hz to 60 kHz. The minimum pulse width is restricted to 150 ns. This restriction prevents the generation of spikes on the output channels.

### 9.2.1 Output Restrictions

Fig. 9-2 on page 56 describes the rising and falling edge of an output signal.

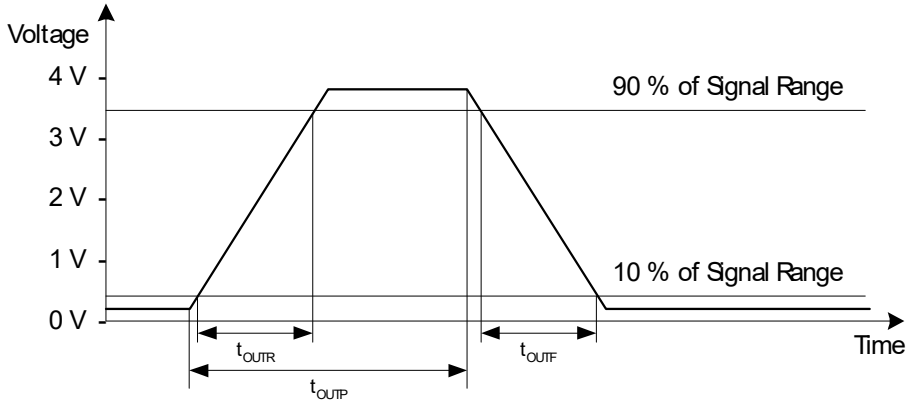



**Fig. 9-2** Simplified Diagram of the Output Channel Characteristics

| Symbol | Description | Typ. [1] |
|---|---|---|
| $t_{OUTR}$ | Output channel rise time | 200 ns |
| $t_{OUTF}$ | Output channel fall time | 200 ns |
| $t_{OUTP}$ | Output channel pulse high time | 150 ns |
| | | 2.5 µs [2] |

[1]: measured directly at the connection of the module, 470 pF load
[2]: with control of Half-bridges

**Tab. 9-1** Digital Output Channels – Rise and Fall Time

An additional capacitive load on an output channel increases the rise and fall times. For this reason, it is recommended that you use cables with a maximum length of 4 m.

### 9.2.2 PWM Output Accuracy

If the typical output characteristics (see Fig. 9-2 on page 56) are taken into account, the following accuracies can be derived for the PWM output signals.

| Frequency | Minimum scan ratio | Maximum scan ratio | Maximum relative error |
|---|---|---|---|
| 1 Hz - 50 Hz | 0.01% | 99.99% | 10% |
| 50 Hz - 500 Hz | 0.10% | 99.9% | 10% |
| 500 Hz - 5 kHz | 1% | 99% | 10% |
| 5 kHz - 60 kHz | 10% | 90% | 10% |

**Tab. 9-2** PWM Output Accuracy

The maximum relative error is determined from:

$$\text{Maximum relative error} = \frac{\text{Worst-case duty cycle - duty cycle}}{\text{Duty cycle}}$$

$$\text{Duty cycle} = \frac{\text{Active time}}{\text{Active time} + \text{Inactive time}}$$

$$\text{Worst-case duty cycle} = \frac{\text{Active time} + \Delta}{\text{Active time} + \text{Inactive time}}$$

For this purpose, the absolute maximum deviation can be set to $\Delta$ = 200 ns.

## 9.3 Functionalities

### 9.3.1 "Digital Output" Functionality

Upon request, the state of an output channel can be set to active or inactive. The request can be initiated by the simulation processor.

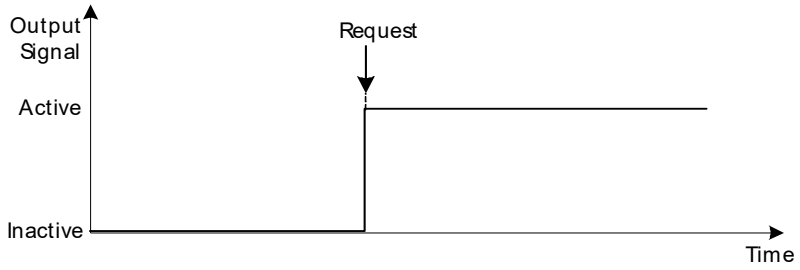



**Fig. 9-3** "Digital Output" Functionality

### 9.3.2 "PWM Output" Functionality

PWM signals can be generated with defined values for the active and inactive time.

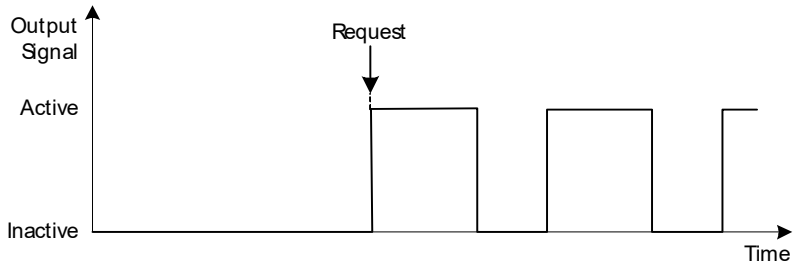



**Fig. 9-4** "PWM Output" Functionality

An additional request, which arrives during the processing of the first request, is discarded.

### 9.3.3 "Pulse Out" Functionality

Pulses can be generated with defined value for the active time.

.

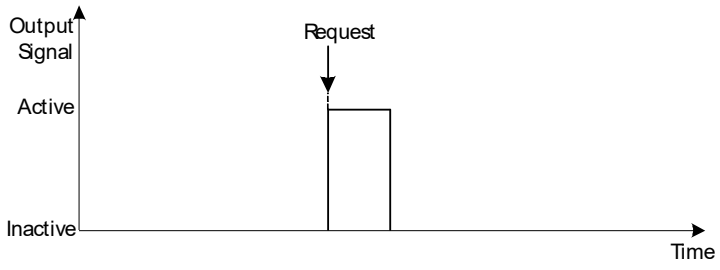



**Fig. 9-5** "Pulse Out" Functionality

An additional request, which arrives during the processing of the first request, is discarded.

# 10 Half-bridges ("PS" Connection)

The ES930.1 provides six MOSFET half-bridge switches with current measurement at the "PS" connection as power stages.

## 10.1 Half-bridges (Power Stages) and Half-bridge Channel Groups (Power Stage Groups)

The six Half-bridges (power stages) "PS 1" to "PS 6" of the ES930.1 are combined into three identical channel groups (power stage groups):

- Channel group 1: Half-bridges "PS 1" and "PS 2"
- Channel group 2: Half-bridges "PS 3" and "PS 4"
- Channel group 3: Half-bridges "PS 5" and "PS 6"

**NOTE**

Some assemblies and control signals are used jointly (in pairs) by the Half-bridges of a channel group.

## 10.2 Assemblies of a Half-bridge Channel Group

### 10.2.1 Overview

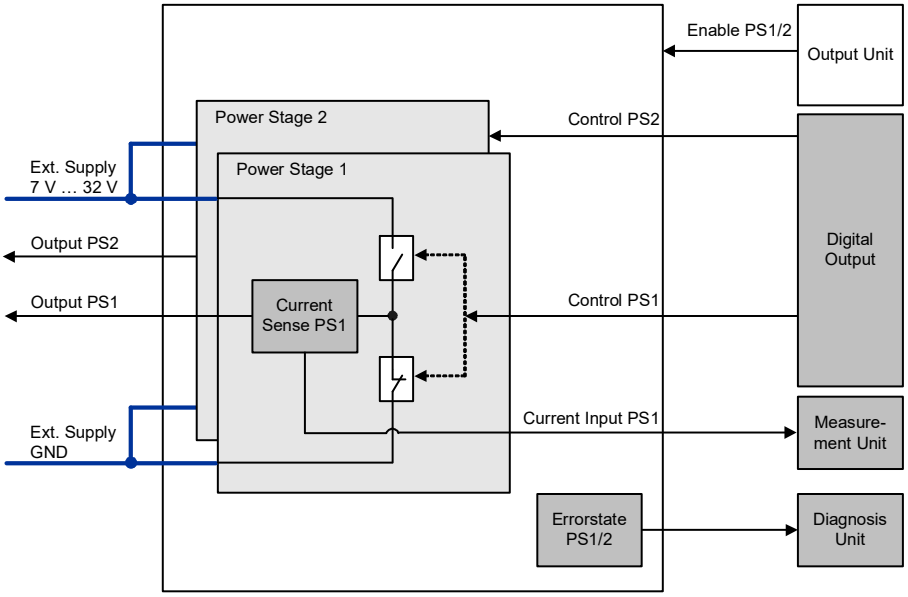



**Fig. 10-1** Half-bridge Channel Group (Power Stage Group)

The channel groups (power stage groups) of the Half-bridges "PS 1" to "PS 6" of ES930.1 feature an identical design. Each of the half-bridge channel groups PS n / PS n+1 consists of the following assemblies (see block diagram in Fig. 10-1 on page 59):

- Assigned Half-bridge (power stage)
  - Half-bridge switch n

  - Current sense PS n
- Half-bridge (power stage) n+1
  - Half-bridge switch n+1
  - Current sense PS n+1
- Error state PS n / PS n+1 (used jointly by the channel group)

The functionality of all power stages can be configured separately.

### 10.2.2 Error State PS n/n+1 Assembly used jointly by a Half-bridge Channel Group

The Error State PS n/n+1 diagnostics assembly is used jointly for both Half-bridges of a channel group (power stage group). It determines error states (short-circuit, overcurrent, overtemperature) within the half-bridge channel group and signals them to the diagnostics unit. In case of an error state, both channels of the half-bridge channel group are always switched off together to protect it.

## 10.3 Assemblies of a Half-bridge

### 10.3.1 Overview

The six Half-bridges "PS 1" to "PS 6" allow expanding the six digital output channels "DO 1" to "DO 6" to power stages.

Each Half-bridge is controlled by a digital output channel and is permanently assigned to this channel (see chapter 9.1.7 on page 54).

Since the control signal of a Half-bridge corresponds to the signal at the assigned digital output, the Half-bridge control signal can be checked with the oscilloscope at the assigned digital output during the initial startup of an experimental arrangement.

The control of the Half-bridges cannot be done independently, but solely via the digital output channels.

**NOTE**

The Half-bridges cannot be used as additional independent output channels, only together with digital output channels.

### 10.3.2 Half-bridge Switch

The two power MOSFETs (high-side switch and low-side switch) of a Half-bridge are controlled jointly by a digital output channel and alternately switch on and off. The power MOSFETs are alternately occupying one of the following switching states:

- High-side switch "On" and low-side switch "Off"
- High-side switch "Off" and low-side switch "On"

The half-bridge switches cannot be used individually, only together as Half-bridge.

The power MOSFETs are integrated in the Infineon TLE7182EM driver IC (see chapter 13.9.8 on page 100).

## 10.3.3 External operating Voltage

The power stages are not supplied by the internal operating voltage of the power supply of the module, but by an external operating voltage which must be connected to the "PS" connection.

## 10.3.4 Channel for Current Measurement (Current Sense PS n)

### 10.3.4.1 Overview

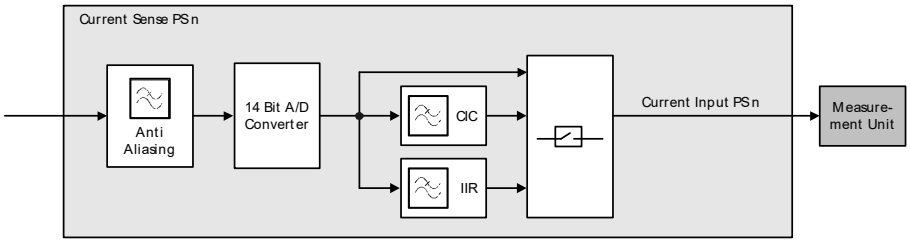



**Fig. 10-2** Current Measurement Channel

The two Half-bridges of each channel group are equipped with one channel each in the output branch for the current measurement (Current Sense PS n). The channels for the current measurement feature identical designs in all Half-bridges and consist of the following assemblies (see block diagram in Fig. 10-2 on page 61):

- Anti-aliasing filter
- A/D converter
- Digital filter
  - CIC filter
  - IIR filter
  - Digital filter jumpered

The functionality of all channels for current measurement can be configured separately.

**NOTE**

The six channels for the Current Sense PS n current measurement receive the same setting of the sampling rate during the configuration.

The Current Sense PS channel measures the current in the output path of the Half-bridge and transfers the measured value to the application program. The measured current is used as controlled variable for the control and monitoring of the Half-bridge.

### 10.3.4.2 Anti-aliasing Filter

The anti-aliasing filter is a 1st order analog low-pass with a limit frequency of 15 kHz. The filter can be neither configured nor bridged.

#### 10.3.4.3 A/D Converter

A 14-bit A/D converter digitizes the output signal of the analog filter with the sampling rate configured for the channel.

#### 10.3.4.4 Digital Filter

In the configuration software, it is possible to select whether or with which digital filter type the output signal of the A/D converter is processed:

- Use of a CIC filter or
- Use of an IIR filter or
- Digital filter jumpered

**NOTE**

The digital filters of the six channels for the Current Sense PS n current measurement receive the same settings during the configuration.

**NOTE**

The software configurable filter of a measuring channel (analog inputs [AI] and current measurement channels [PS] of the Power Stages) is automatically deactivated when the measurement channel is operated in the event mode.

#### 10.3.4.5 CIC Filter

The parameters of the CIC filter (Cascaded-Integrator-Comb filter) are automatically set in the configuration software upon selecting the sampling rate.

#### 10.3.4.6 IIR Filter

The IIR filter (Infinitive Impulse Response filter) is a 2nd order Bessel filter for which the user is automatically provided a matching selection of limit frequencies (0.4 Hz to 4 kHz) for the configuration depending on the sampling rate.

## 10.4 Control of the Channel Group and its Half-bridges

The Half-bridges are controlled with the "Control PS n" signals. The two Half-bridges of the channel group are jointly enabled or disabled with the "Enable PS n/n+1" signal..

### 10.4.1 Control PS

The "Control PS n" signal of a digital output channel is used to control a Half-bridge (see chapter 9.1.7 on page 54). The output signal of each one of the digital output channels is firmly assigned to a Half-bridge (power stage). This assignment cannot be changed:

| Digital Output Channel | Assigned Half-bridge (Power Stage) |
|---|---|
| DO 1 | PS 1 |
| DO 2 | PS 2 |
| DO 3 | PS 3 |
| DO 4 | PS 4 |
| DO 5 | PS 5 |
| DO 6 | PS 6 |

### 10.4.2 Enable PS

The "Enable PS n/n+1" signal allows releasing or blocking one channel group each, i.e. the two corresponding Half-bridges. The release or blocking of a single Half-bridge (power stage) is not possible. These control signals are assigned to the Half-bridges, i.e. one channel group each, as pairs:

- a common power stage enable signal for the Half-bridges 1 and 2
- a common power stage enable signal for the Half-bridges 3 and 4
- a common power stage enable signal for the Half-bridges 5 and 6

Start and default values of these control signals can be defined in the configuration software.

**NOTE**

For rapid prototyping applications, the release or blocking of the two Half-bridges of a channel group with the "Enable PS n/n+1" signals enables a safe starting and shutting down of the system during the Init and Exit tasks by the RP model according to the user definition.

## 10.5 Switching States of a Half-bridge

### 10.5.1 Table of states of a Half-bridge

The following table shows an overview of the possible switching states of the two MOSFET switches of a Half-bridge (see Fig. 10-1 on page 59) depending on the control signals of the Half-bridge channel group described above and the Half-bridge.

| Enable | Control | Power Stage n | |
|---|---|---|---|
| PS n/n+1 | PS n | Low-side Switch | High-side Switch |
| 0 | x | Off | Off |
| 1 | 0 | Off | On |
| 1 | 1 | On | Off |

### 10.5.2 State of the Half-bridges after switching on the Module

After switching on the module, the Half-bridges are blocked. In this state, the high-side MOSFET switch as well as the low-side MOSFET switch are switched off (see table of states in chapter 10.5.1 on page 64).

For additional switch-on sequences of the Half-bridges, i.e. for every transition from disable to enable, the low-side switch of each Half-bridge is briefly switched on for approx. 200 µs.

## 10.6 Interconnection of Half-bridges to Full-bridges

### 10.6.1 Grouping and Control

Two Half-bridges (power stages) can be interconnected to a Full-bridge for the control of a load.

**NOTE**

The interconnection to a Full-bridge (H-bridge) is only possible for the permanently assigned Half-bridge channel groups power stage 1/2, power stage 3/4 and power stage 5/6.

This grouping during the interconnection is recommended so that the jointly used Error State diagnostics assembly can also be used for a Full-bridge (see chapter 10.2.2 on page 60). In case of an error state, this allows switching off both channels of the power stage group used as Full-bridge together to protect it.

The "Enable PS n/n+1" signal allows releasing or blocking one channel group each, i.e. the two corresponding Half-bridges, if the Half-bridges are configured as Full-bridges in the described groups.

Two digital output channels are required for the control of a Full-bridge. The corresponding digital output channels must be configured so that a synchronous control of the two interconnected Half-bridges is ensured.

### 10.6.2 Table of States of a Full-bridge

The following table shows an overview of the possible switching states of the four MOSFET switches of a Full-bridge depending on the control signals of the half-bridge channel group described above and the Half-bridges (see Fig. 10-1 on page 59).

| Enable | Control | Control | Power stage n | | Power stage n+1 | |
|---|---|---|---|---|---|---|
| PS n/n+1 | PS n | PS n+1 | Low-side switch | High-side switch | Low-side switch | High-side switch |
| 0 | x | x | Off | Off | Off | Off |
| 1 | 0 | 0 | Off | On | Off | On |
| 1 | 1 | 0 | On | Off | Off | On |
| 1 | 0 | 1 | Off | On | On | Off |
| 1 | 1 | 1 | On | Off | On | Off |

## 10.7 Electrical Isolation

The separate operating voltage of the Half-bridges (power stages) is internally electrically isolated from the operating voltage of the module.

The six Half-bridges "PS 1" to "PS 6" are not electrically isolated against each other. The digital input channels are electrically isolated together as channel group to the supply voltage of the module and as channel group to the housing of the module.

## 10.8 Protection of the Assembly

### 10.8.1 Protection of the Half-bridges

Each of the six Half-bridges is protected against overcurrent or short-circuit.

### 10.8.2 Safeguarding the "PS" total Assembly

The PS total assembly ("PS 1" to "PS 6"), but not the Individual power stages or power stage groups, is protected against the (external) supply voltage and against ground with an electronic assembly in the module in each case. Defective electronic protection assemblies cannot be replaced by the user. Please return defective modules to ETAS.

Notes about the procedure are available from the local ETAS sales and service locations. The contact information is located in the chapter 16 on page 133.

### 10.8.3 Protection in the CBAV422.1 Cable

The external operating voltage for the power stages total assembly ("PS 1" to "PS 6") is equipped with a replaceable fuse in the CBAV422.1 cable (see chapter 14.2.3 on page 118).

# 11 Startup

The chapter "Startup" contains general installation recommendations, a description of the connection and installation options, an overview of the applications and notes about the cabling of the ES930.1.

## 11.1 Installation and Blocking

### 11.1.1 General Installation Recommendations

**CAUTION**

**Damage or destruction of the module is possible.**

The modules are approved only for the installation and operation on components or at locations that ensure that the technical data of the modules are maintained during their operation (see chapter 13 on page 85).

### 11.1.2 Fastening the Module onto a Carrier System

The ES930.1 has a robust metal housing equipped with non-slip plastic feet. The module can easily be screwed onto a support system for fastening in the vehicle or lab. The screw threads for fastening the module are already in the housing and easily accessible.

Fastening the housing of the ES930.1:

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

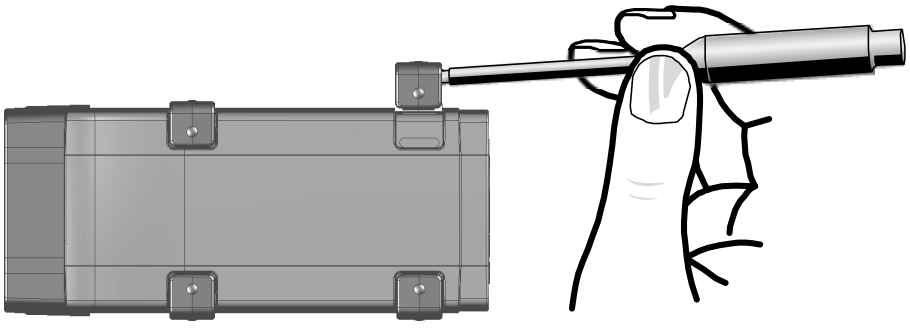


**Fig. 11-1** Prying off the Plastic Foot

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

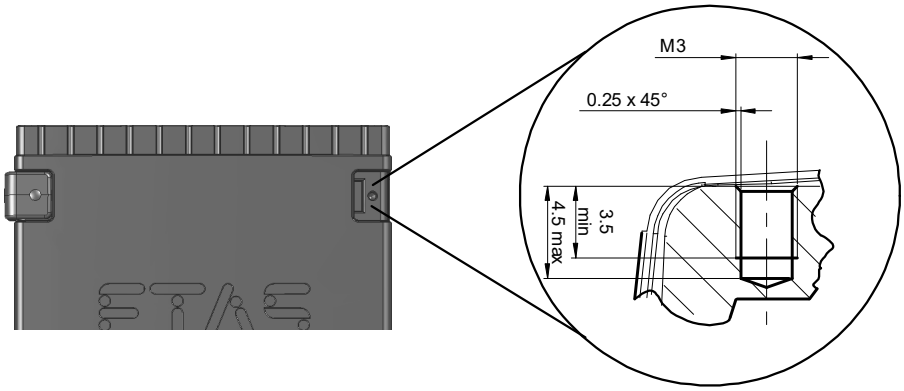



**Fig. 11-2** Threaded blind Hole

**CAUTION**

**Damage or destruction of the electronics is possible.**

Do not rework the existing threaded hole.

**NOTE**

Screw the module onto your carrier system using **exclusively** M3 fillister head screws and a max. torque of 0.8 Nm.
The maximum screw-in depth in the threaded blind hole of the housing is 3 mm (see Fig. 11-2 on page 67).

### 11.1.3 Connecting several Modules mechanically

Because of the use of ETAS system enclosures, the ES930.1 can also be combined with modules of the ETAS compact series (ES59x, ES6xx, ES910). They can simply be combined into larger blocks by using the supplied T-connectors.

An additional module of the ETAS compact series can be fastened underneath the ES930.1. TO do so, remove the four respective plastic feet at the corresponding device sides and install the supplied T-connectors in their place.

Connecting several modules mechanically:

1. Remove the four plastic feet on the underside of the ES930.1 to be able to fasten another module.

   This exposes the installation openings for the T-connectors.

   You can fasten an additional module underneath the ES930.1.
2. Remove the four plastic feet on the corresponding side of the second module.
3. Turn the fasteners of the T-connectors transverse to the longitudinal axis of the connectors
4. Click two connectors into the installation openings at one longitudinal side of the first module.
5. Click the second module into the two T-connectors.

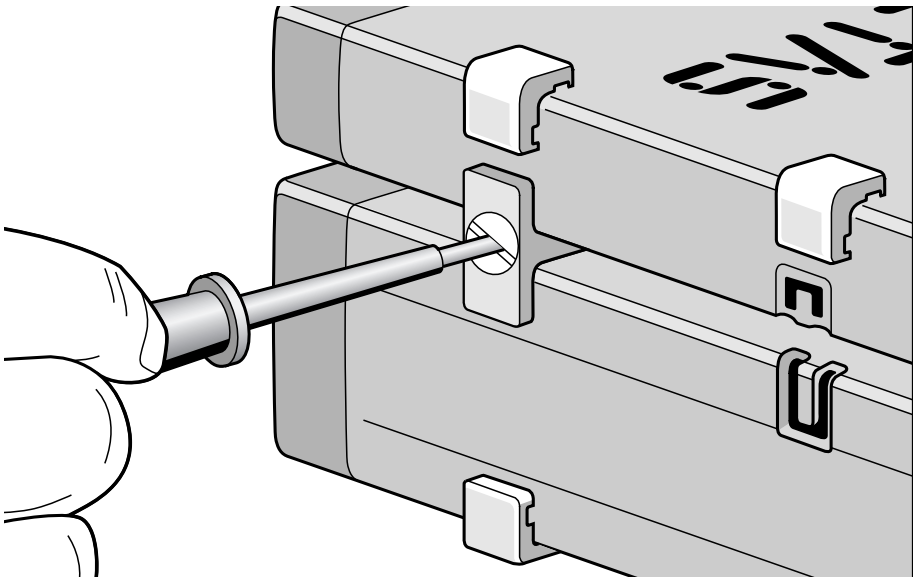


**Fig. 11-3** Connecting the ES930.1 with another Module

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

## 11.2 Applications

### 11.2.1 ES930.1 with additional ETAS Modules (MC Applications)

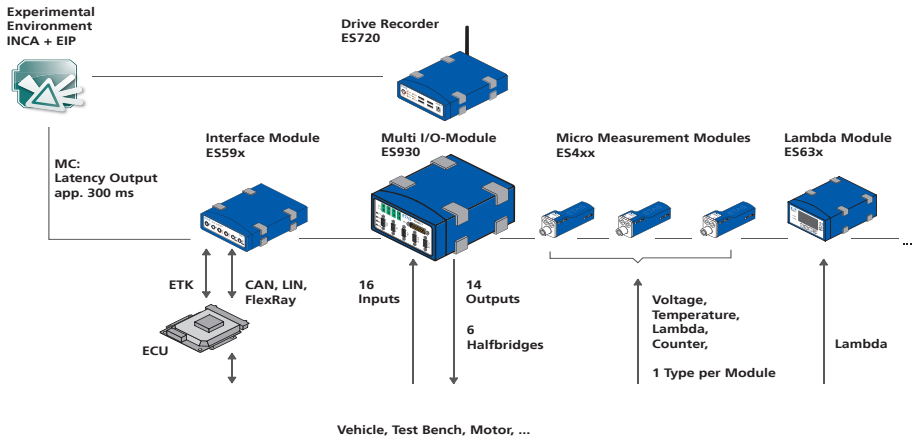



**Fig. 11-4** ES930.1 and additional ETAS Modules for MC Applications

The ES930.1 can be used individually or as a component of an ES4xx/ES63x/ES93x module chain for measurement and calibration with INCA.

The ETAS daisy chain concept enables a simple network architecture, since only the ES930.1 or the first module of the module chain must be connected with the "OUT" connection of the ES930.1. Additional bus analysis functions on the buses CAN, LIN and FlexRay as well as (X)ETK bypass applications with measuring and calibrating can be made accessible with ES59x modules.

### 11.2.2 ES930.1 with ES910 and additional ETAS Modules for Rapid Prototyping Applications

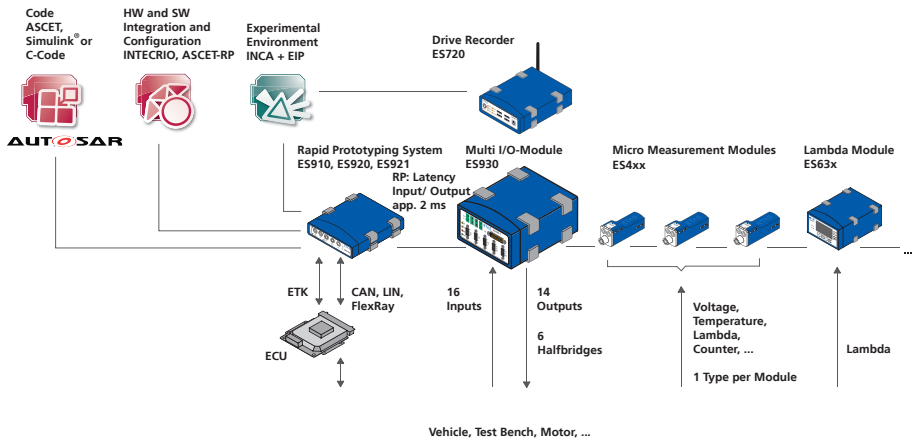



**Fig. 11-5** ES930.1 with ES910 and additional ETAS Modules for Rapid Prototyping Applications

The ES930.1 can be used individually or as a component of an ES4xx/ES63x/ES93x module chain for rapid prototyping with INTECRIO or ASCET-RP and the ES910 module.

The ETAS daisy chain concept enables a simple network architecture since only the ES930.1 or the first module of the module chain must be connected with the "IO" connection of the ES910.

If the ES910 is used, it is possible to access the connected modules whose signals can be processed directly in the rapid prototyping model from within the rapid prototyping model. The ES910 can access all custom ECU interfaces (ETK, XETK, CAN, LIN, FlexRay) and calculate the new control functions in the bypass.

By combining the modules ES930.1 and ES910, information from sensors can be processed in the RP model and actuators can be controlled. Parallel to the aforementioned bypass RP functionality, INCA can be used to access all control and diagnostics parameters as well as all measuring signals of the connected ECU. In addition, INCA/INCA EIP offers access to all bypass and model variables that have been created in the ES910 prototyping module.

## 11.3 Cabling

The order of the cabling of the connections of the ES930.1 is random.

Special connecting cables are available which can be ordered separately. An overview is located in chapter “Accessories” on page 129.

**NOTE**

Ensure that all connections are de-energized before you start with the cabling.

**NOTE**

Carefully check the designations of the cables used. Incorrect cables can negatively impact the functional capability of your ES930.1 or ES930.1 and damage the devices connected to them.

## 11.3.1 Cabling of the ES930.1 for MC Applications

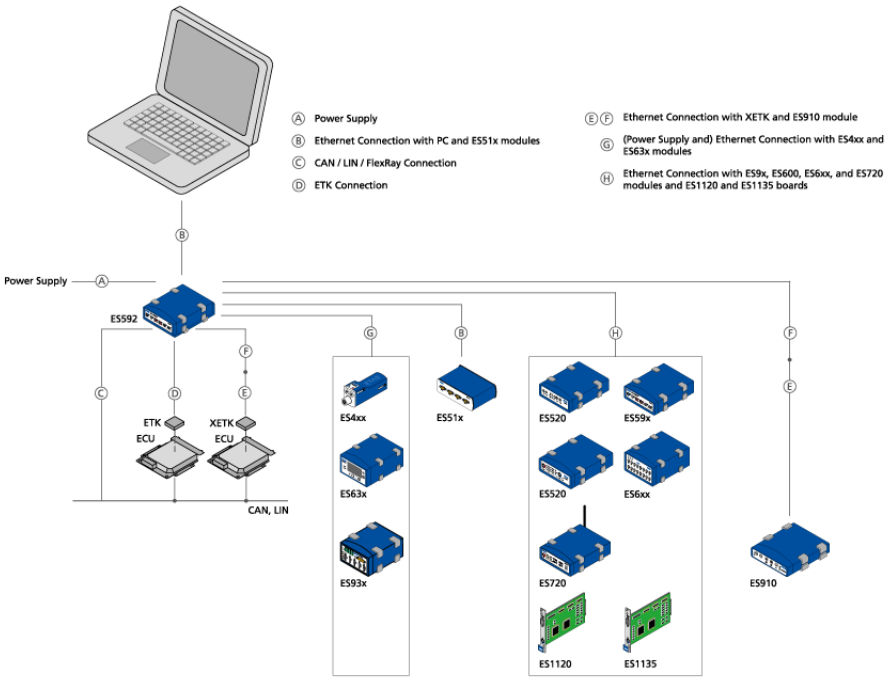



**Fig. 11-6** Cabling of the ES930.1 with ETAS Modules (MC Application)

| Cables in Fig. 11-6 | Function | Short name |
|---|---|---|
| A | Power supply cable | CBP120, CBP1205 |
| B | PC or ES51x Ethernet cable | CBE100 |
| C | CAN/ LIN/ FlexRay connection cable | CBCFI100 |
| D | ETK connection cable | CBM150 |
| E | Ethernet adapter cable (100 Mbit/s); [connected to cable F] | CBAE230 |
| F | Ethernet cable (1 Gbit/s); [connected to cable E] | CBAE330 |
| G | Combined power supply and Ethernet cable | CBEP420, CBEP4205, CBEP425, CBEP4255 |
| H | ES520, ES59x, ES6xx, ES1120 or ES1135 Ethernet cable | CBE130, CBE140 |

## 11.3.2 Cabling of ES930.1 for RP Applications

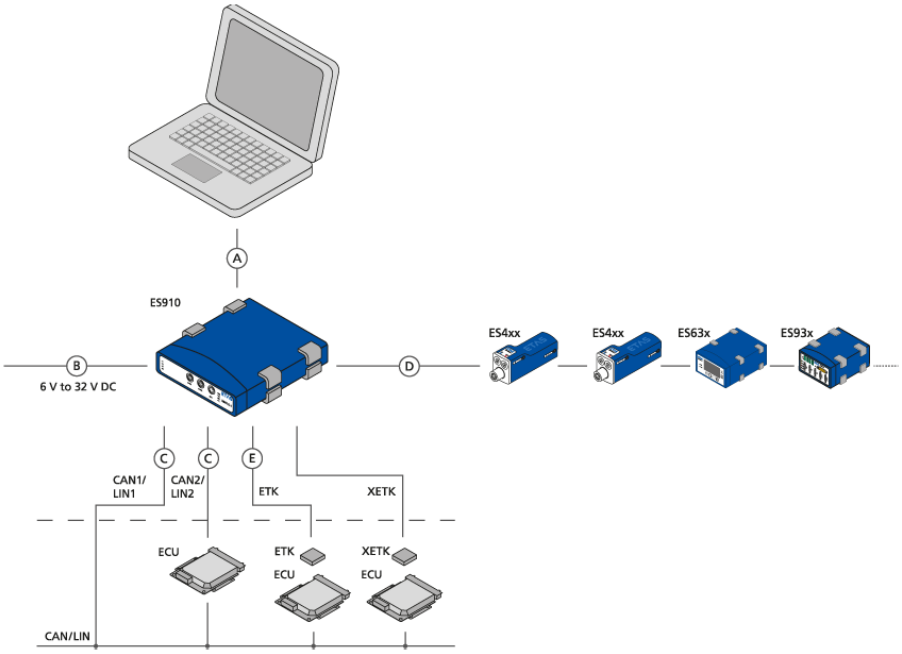



**Fig. 11-7** Cabling of ES930.1 with ETAS Modules (RP Application)

| Cables in Fig. 11-7 | Function | Short name |
|---|---|---|
| A | PC connection cable | CBE200 |
| B | Power supply cable | CBP120, CBP1205 |
| C | CAN/ LIN/ FlexRay connection cable | CBCFI100 |
| D | Combined power supply and Ethernet cable | CBEP430, CBEP4305 |
| E | ETK connection cable | CBM150 |

## 11.3.3 Daisy Chain Connections ("IN", "OUT")

### 11.3.3.1 Connection with the PC

For the connection of the PC with the ES930.1 module ("IN" connection), you need a combined Ethernet and power supply cable (CBEP410, CBEP4105, CBEP415 or CBEP4155).

Cabling the ES930.1 with the PC and the power supply

1. Connect the combined Ethernet and power supply cable (CBEP410, CBEP4105, CBEP415 or CBEP4155) with the "IN" connection of the ES930.1.
2. Connect the RJ-45 plug connector with the free Ethernet interface of your PC.
3. Connect the power supply connectors of the combined Ethernet and power supply cable with the desired power supply.

   Observe the color coding of the plug connectors.

   Observe the power consumption of the ES930.1 and its supply voltage range. The permissible values are located in chapter 13.9.1 on page 92.

### 11.3.3.2 Connection with additional ETAS Daisy Chain Modules

The cabling is done from the PC to the first module in the direction of the end of the module chain.

Cabling the ES930.1 with the subsequent ETAS daisy chain module

1. Connect an Ethernet cable with the "OUT" connection of the ES930.1.
2. Connect the Ethernet cable with the "IN" connection of the subsequent ETAS daisy chain module.
3. Cable or connect additional modules as describe above.

Cabling module chain with additional current supply

1. Disconnect the module chain after the last module whose power supply is still ensured over the entire operating range.
2. Connect the combined Ethernet and power supply cable with the "OUT" connection of the last module of the chain in the direction of the PC.
3. Connect the combined Ethernet and power supply cable with the "IN" connection of the ES930.1 of the module following in the direction of the end of the chain.
4. Connect the power supply connectors of the combined Ethernet and power supply cable with the desired power supply.

   Observe the color coding of the plug connectors.

   Observe the power consumption of the ES930.1 and its supply voltage range. The permissible values are located in chapter 13.9.1 on page 92.

### 11.3.4 Inputs (Connections "DI", "AI 1-4" and "AI 5-8")

For the connection of the inputs "DI", "AI 1-4" and "AI 5-8" of the module, three CBAV420.1 cables are required.

Cabling the inputs of the ES930.1

1. Connect a CBAV420.1 cable with the "DI" connection of the ES930.1.
2. Connect a CBAV420.1 cable with the "AI 1-4" connection of the ES930.1.
3. Connect a CBAV420.1 cable with the "AI 5-8" connection of the ES930.1.
4. Connect the open ends of the cables with the measuring setup.

### 11.3.5 Outputs (Connections "DO" and "AO")

To connect the outputs "DO" and "AO" of the module, two CBAV421.1 cables are required.

Cabling the outputs of the ES930.1

1. Connect a CBAV421.1 cable with the "DO" connection of the ES930.1.
2. Connect a CBAV421.1 cable with the "AO" connection of the ES930.1.
3. Connect the open ends of the cables with the measuring setup.

### 11.3.6 Half-bridges ("PS" Connection)

To connect the Half-bridges of the module, a CBAV422.1 cable is required.

Cabling the Half-bridges of the ES930.1

1. Connect a CBAV422.1 cable with the "PS" connection of the ES930.1.
2. Connect the open ends of the cable with the measuring setup and the supply voltage for the Half-bridges.

### 11.3.7 "SERVICE" Connection

No functions are provided at the "SERVICE" connection. The connection is reserved exclusively for ETAS-internal applications.

# 12 Handling of Problems

This chapter provides information about the steps to be taken in case of problems with the ES930.1 and general problems that are not specific to a single hardware or software product.

## 12.1 LED Displays

To assess the operating state and for fault removal of the ES930.1, please observe the LED displays, which provide information about the function of the Interfaces and the ES930.1 (see chapter 3.3.2 on page 17).

## 12.2 Protection of the "PS" Assembly

The CBAV422.1 cable is equipped with a replaceable fuse (see chapter 14.2.3 on page 118).

The total PS assembly ("PS 1" to "PS 6") is also safeguarded with an electronic assembly in the module. Observe the detailed notes in chapter 10.8.2 on page 65.

## 12.3 Problems with the ES930.1

The following table lists some possible problems together with a possible solution. In case of additional questions, please contact our technical service (see chapter 16 on page 133).

| Problem | Diagnostics questions | Possible solutions |
|---|---|---|
| The ES930.1 cannot be found by the application software. | Is the network card correctly configured? | Check whether your network card is configured according to chapter 13.8.2 on page 90. |
| | Is the hardware connected to the PC? | Check whether the connection is correct |
| The application software does not find any ETAS daisy chain modules. | Is the **ER** LED of the ES930.1 flashing red and are the LEDs of the ETAS daisy chain modules flashing green? | Check whether the function for automatically switching to the power-save mode is enabled on your PC card [1)]. Disable this function. |
| | Is the network card correctly configured? | INCA, Config Tool and HSP mode:<br>Check whether your network card is configured according to chapter 13.8.2 on page 90. |
| | 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 required application software? | Check whether the application software installed on your PC meets the requirements in chapter 13.8.3 on page 91. |
| | Power supply | Check whether your power supply and your measuring setup meets the requirements according to chapter 3.5 on page 21. |
| | Is the hardware connected to the PC or the I/O port of the ES910? | Check whether the cabling is correct. |
| | Are the modules in the module chain correctly connected? | Check whether the cabling is correct. |

| Problem | Diagnostics questions | Possible solutions |
|---|---|---|
| The measurements do not start. | Are you being asked to update in the INCA monitor log or in the Config tool? | Update the modules. |
| | Does the module not furnish any data? | Check whether your power supply and your measuring setup meets the requirements according to chapter 3.5 on page 21. |
| | | Check whether the cabling of the hardware to the PC is correct and functional. |
| | | Check whether the modules in the module chain are correctly connected. |
| | You are using the ETAS daisy chain configuration tool and the module does not furnish any data? | Check whether you changed the position of one or several modules in the chain. |
| | | Check whether you loaded the measuring configuration into the module chain. |
| | | Check whether you assigned the same IP address to two module chains. |
| | Does the module not furnish any usable data? | Check whether the sensor or the sensor supply is correctly connected. |

| Problem | Diagnostics questions | Possible solutions |
|---|---|---|
| Data losses (packet losses) occur during the transfer. | Are you using WLAN in your measuring setup? | WLAN is not allowed within this ETAS network. Use only ETAS cables for the cabling of your measuring setup (ETAS modules and their cable connection to the PC). |
| | Are you using the correct network card type in your laptop? | Check whether you are using a PCMCIA network card in your laptop. PCMCIA cards with 8-bit or 16-bit data bus are not suitable. Use only PCMCIA cards with 32-bit data bus, mini-PCI or ExpressCards. |
| | Are you operating the ES930.1 on a PC with multi-core processor? | Install a current driver for the network card that supports the NDIS protocol. |
| The LED lights red. | Did you just perform an update? | For users of the INCA/ INTECRIO/ ASCET-RP/ Configuration tool:<br>Switch the module off and on again.<br>For users of the Config tool:<br>Switch the module off and on again.<br>Load the measuring configuration again. |
| | | If the LED is still lit, return the module to ETAS for repair. |
| The firmware of one or several 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 the PC cards refer to this function in different ways. Example: "Link down Power saving"

## 12.4 Problems and Solutions

### 12.4.1 Network Adapter Cannot Be Selected via Network Manager

#### Cause: APIPA is disabled

The alternative mechanism for IP addressing (APIPA) is usually enabled on all Windows 7, 8.1 and 10 systems. Network security policies, however, may request the APIPA mechanism to be disabled. In this case, you cannot use a network adapter which is configured for DHCP to access ETAS hardware. The ETAS Network Manager displays a warning message.

The APIPA mechanism can be enabled by editing the Windows registry. This is permitted only to users who have administrator privileges. It should be done only in coordination with your network administrator.

To enable the APIPA mechanism:

1. Open the Registry Editor:
   - Windows 7, 8.1:
     1.1 Click on the Windows symbol.
     1.2 Enter `regedit` in the entry field.
     1.3 Push <ENTER>.
   - Windows 10:
     1.1 Rightclick on the Windows symbol.
     1.2 Click on **Search**.
     1.3 Enter `regedit` in the entry field.
     1.4 Push <ENTER>.

   The registry editor is displayed.
2. Open the folder `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\Tcpic\Parameters\`
3. Click **Edit** → **Find** to search for the key `IPAutoconfigurationEnabled`.

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

4. Set the value of the key `IPAutoconfiguratio-nEnabled` to `1` to enable the APIPA mechanism.

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

## 12.4.2 Search for Ethernet Hardware Fails

### Cause: Personal Firewall blocks Communication

For a detailed description on problems caused by personal firewalls and possible solutions see chapter 12.4.3 on page 82.

### 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 page80)
- 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`.

## 12.4.3 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.

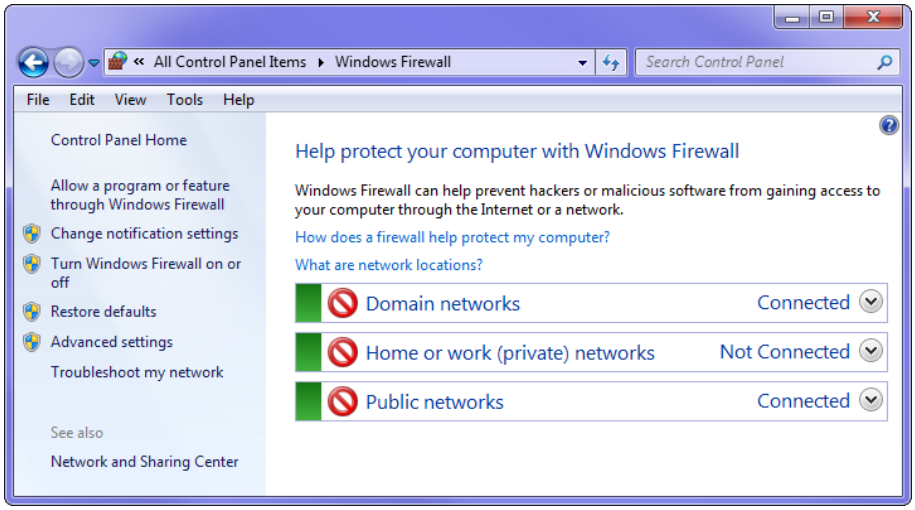
In Windows 7, 8.1 and 10, a Personal Firewall program is part of the scope of delivery and enabled by default. On many other systems, similar programs from independent providers can frequently be found, such as Symantec, McAfee or BlackIce. The procedure for the configuration of ports may differ in the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

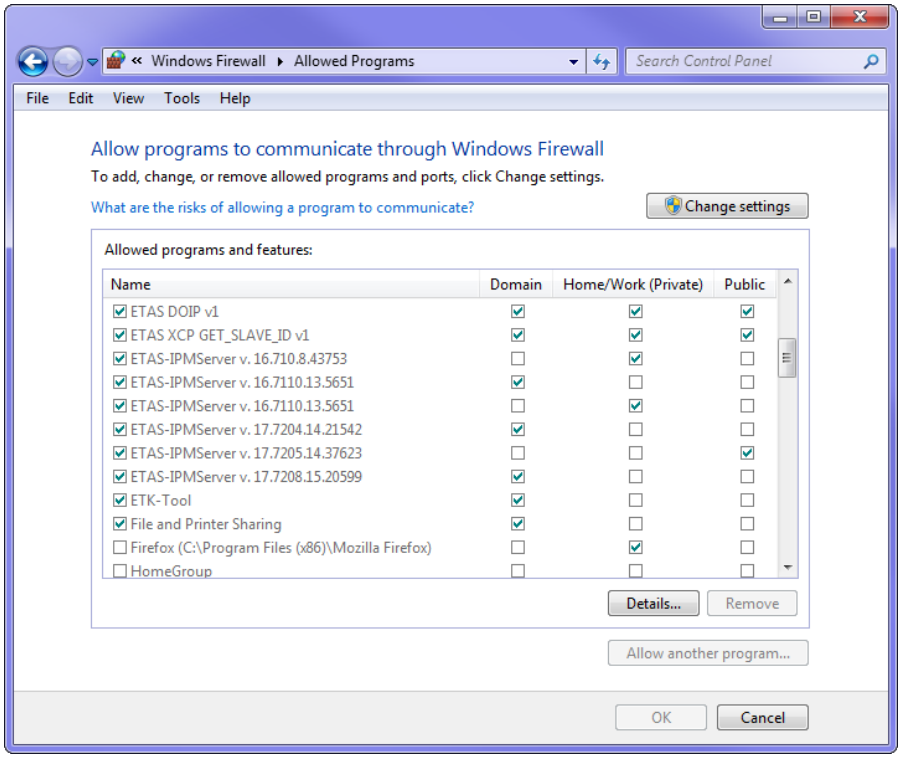
### Solution for Windows Firewall, user with administrator rights

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.

# 13 Technical Data

This chapter contains information on the following topics:



## 13.1 Labels on the Product

### 13.1.1 Product Label

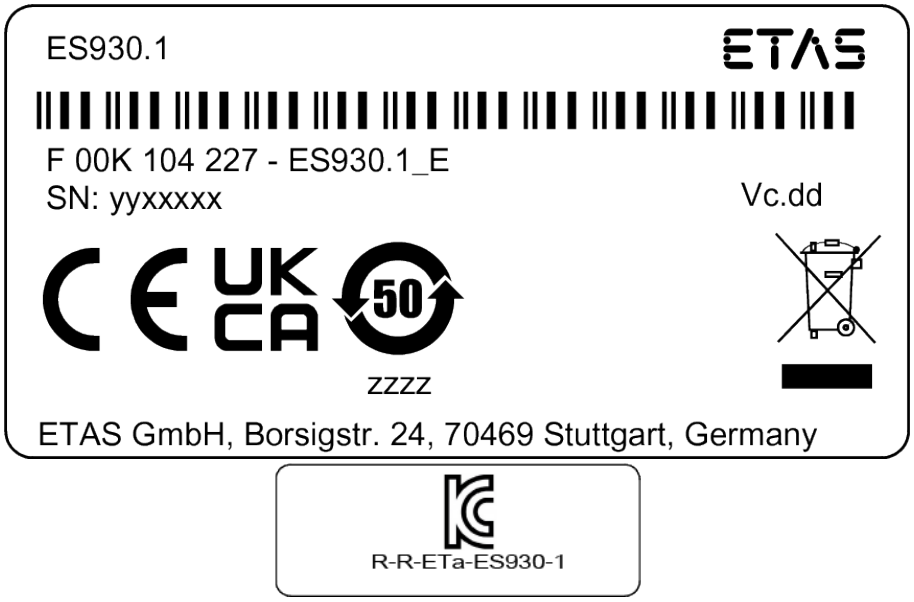



**Fig. 13-1** Product Label

### 13.1.2 Used Symbols

| Symbol | Description |
|---|---|
|  | Prior to operating the product, be sure to read the User Guide! |
| ETAS GmbH | Product manufacturer |
| ES930.1 | Product name |
| F 00K 123 456 | Ordering number of the product, see chapter 15.1 on page 129 |
| SN: yyxxxxx | Serial number (seven-digit), with bar code |
| Vc.dd | Hardware version |
| zzzz | Year of production |
| 7-29V ⎓ | Operating voltage range (DC) |
| $P_{max}$ = 15 W | Power consumption, max. |
|  | Labeling for RoHS (China), see chapter13.3.1.2 on page 87 |
|  | Marking for CE conformity, see chapter 13.3.2 on page 87 |
|  | Marking for UKCA conformity, see chapter 13.3.2.2 on page 88 |
|  | Marking for KCC conformity, see chapter 13.3.2.3 on page 88 |
|  | Labeling for WEEE, see chapter 13.5 on page 88 |

### 13.1.3 Labeling of the Connections

| Symbol | Description |
|---|---|
|  | Labeling of the daisy chain port„IN“ (input) |
|  | Labeling of the daisy chain port„OUT“ (output) |

## 13.2 Standards and Norms

The module adheres to the following standards and norms:

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

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

**NOTE**

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.

## 13.3 Declarations of Conformity

### 13.3.1 RoHS Conformity

#### 13.3.1.1 European Union (EU)

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

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

#### 13.3.1.2 Peoples Republic of China

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

### 13.3.2 CE Conformity

#### 13.3.2.1 European Union (EU)

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.

#### 13.3.2.2 UKCA Conformity (Great Britain)

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.

#### 13.3.2.3 KCC Conformity (Republic of Korea)

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.

## 13.4 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.

## 13.5 Taking the Product Back and Recycling

The European Union has passed a directive called Waste Electrical and Electronic Equipment, or WEEE for short, to ensure that systems are setup throughout the EU for the collection, treating and recycling of electronic waste. This ensures that the devices are recycled in a resource-saving way representing no danger to health or the environment.

**Fig. 13-2** WEEE Symbol

The WEEE symbol (see Fig. 13-2 on page 88) on the product or its packaging shows that the product must not be disposed of as residual garbage. The user is obliged to collect the old devices separately and return them to the WEEE take-back system for recycling. The WEEE directive concerns all ETAS devices but not external cables or batteries.

For more information on the ETAS GmbH Recycling Program, contact the ETAS sales and service locations (see chapter 16 on page 133).

## 13.6 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.

## 13.7 Mechanical Data

| | |
|---|---|
| Dimensions (H x W x D) | 73 mm x 128 mm x 174 mm |
| | 2.9 in x 5.0 in x 6.8 in |
| Weight | Approx. 1.1 kg / 2.4 lbs |

### 13.7.1 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.

### 13.7.2 Cleaning the Product

We recommend to clean the product with a dry cloth.

## 13.8 System Requirements

### 13.8.1 Environmental Conditions

| | |
|---|---|
| Operating temperature range | -40 °C to +70 °C |
| | -40 °F to +158 °F |
| Storage temperature range (module without packaging) | -40 °C to +85 °C |
| | -40 °F to +185 °F |
| Altitude | Max. 5000 m / 16400 ft |
| Protection class | IP30 |
| Contamination level | 2 |

**CAUTION**

**Loss of features as defined by IP30!**

Do not open or change the module!

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

**NOTE**

The module is suitable for use in interiors, in the passenger cell or in the trunk of vehicles. The module is **not** suitable for installation in the engine compartment and similar environments.

### 13.8.2 Hardware

Operating the ES930.1 module requires a DC voltage supply of 7 V to 29 V and operating the Half-bridges (power stages) of the ES930.1 requires a DC voltage supply of 7 V to 32 V.

#### 13.8.2.1 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!

#### 13.8.2.2 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".

#### 13.8.2.3 ETAS Hardware (Rapid Prototyping)

ES910.2, ES910.3

### 13.8.3 Software

The following software in the following versions (and higher) is required for configuring the ES930.1 as well as for control and data acquisition:

#### 13.8.3.1 General

- ES93x Configuration Tool V1.3.0
- ES4xx/ES63x Configuration Tool V1.3.0 (optional)
- HSP V9.5.0

> **NOTE**
>
> The Flow Control function is supported by the ES930.1 module from HSP V9.7.0 (see chapter 3.7.6 on page 27).

#### 13.8.3.2 Measurement and Calibration (MC)

- INCA V7.0.0, Hotfix 4 with INCA Add-On ES93x V1.3.0

#### 13.8.3.3 Rapid Prototyping (RP)

- INTECRIO V4.0
- ASCET-RP V6.1.3

## 13.9 Electrical Data

**NOTE**

Unless described otherwise, the electrical data of the ES930.1 were measured directly at the contacts of the module.

### 13.9.1 Power Supply

| | |
|---|---|
| Operating voltage | Operating voltage for the module at "IN" connection:<br>7 V to 29 V DC |
| | Separate operating voltage for the Half-bridges at "PS" connection:<br>7 V to 32 V DC |
| Power consumption [1)] | Typ. 4.5 W at 12 V |
| Power consumption [2)] | Typ. 7.8 W at 12 V |
| Power consumption | Max. 15 W |
| Overvoltage category (AC mains supply) | II |

[1)]: without sensor supply
[2)]: with sensor supply, 30 mA load at 15 V

### 13.9.2 Host ("IN" Connection)

| | |
|---|---|
| Connection | 100Base-T Ethernet; 100 Mbit/s, full duplex |
| Protocol | XCP on UDP/IP |
| IP address | Dynamic via INCA or ES93x Configuration Tool (default setting 192.168.40.44) |

**NOTE**

For the successful initialization of the network card of your PC, observe chapter 13.8.2 on page 90.

### 13.9.3 Thermo Channels ("TH1-4" Connections)

| | |
|---|---|
| Number of channels | 4 |
| Supported thermocouples | Type K |
| Measuring range | -200 °C to +1372 °C (type K) |
| Resolution | 1 mK (24 bit; Sigma-Delta A/D converter) |
| Sampling rate | 0.1 samples/s to 10 samples/s, additionally events; configurable per channel |
| Anti-aliasing filter (hardware filter) | Low-pass, 1st order, 3 dB limit frequency 350 Hz |
| Common-mode voltage | ±100 V to ground of supply voltage |
| Max. measurement error (at room temperature) | ±(1.5 K + 0.5% * ($T_{meas}$ - 25 °C)) |
| Maximum measurement error $\Delta T_i$ for internal resistances of thermo coupler > 50 Ω, | ±0.002 K/Ω |
| Maximum temperature drift $\Delta T_d$ | ±0.05 K/K |
| Input impedance | 20 MΩ \|\| 250 nF |
| Maximum input voltage | Input, "+" to "-":<br>±5 V DC |
| | Input-to-input:<br>60 V DC / 30 V AC |
| | Input-to-ground of voltage supply:<br>60 V DC / 30 V AC |
| | Input-to-housing:<br>60 V DC / 30 V AC |
| Electrical isolation | Input-to-input, input-to-supply voltage, input-to-housing |

Reference temperature $T_0$ for $\Delta T_d$ is 25 °C (corresponds to 298.15 K)

### 13.9.4 Digital Input Channels ("DI" Connection)

| | |
|---|---|
| Number of channels | 4 |
| Input voltage | 0 V to 5 V |
| Switching thresholds | TTL-compatible,<br>(high: 2.2 V typ., low: 1.2 V typ.) |
| Sampling rate | 0.5 samples/s to 10 ksamples/s, additionally events; configurable per channel |
| Time resolution (clock rate) | 15 ns (66.667 MHz) |
| Counter | 32 bit |
| Pulse width | 120 ns to 64.4 s (= $[2^{32} - 1] * 15$ ns);<br>resolution 15 ns |
| Frequency range | 0.02 Hz to 3 MHz |
| Glitch filter | Digital software filter;<br>configurable per channel:<br>120 ns to 3000 ns or "Off"; resolution 15 ns |
| Timeout | Configurable per channel:<br>0.1 s to 64.4 s or "Off" |
| Input impedance | typ. 1.5 MΩ \|\| 50 pF |
| Maximum input voltage | Input:<br>±50 V DC |
| | Input-to-ground of voltage supply:<br>60 V DC / 30 V AC |
| | Input-to-housing:<br>60 V DC / 30 V AC |
| Electrical isolation | All 4 inputs together as channel group to supply voltage and to housing |
| Measuring functions | Event count, active time, inactive time, status, measurement across several cycles; parallel per channel; with overflow or timeout control |
| Events | 4 event sources per module can be configured differently |
| | Events for triggering a synchronous data acquisition on the ES930.1 module |
| | Events for triggering the model trigger in the ES910 prototyping module |

### 13.9.5 Analog Input Channels ("AI" Connection)

| | |
|---|---|
| Number of channels | 8 |
| Measuring ranges | -1 V to +1 V<br>-10 V to +10 V<br>-60 V to +60 V |
| Resolution | 16 bit, one A/D converter per channel |
| Sampling rate | 0.5 samples/s to 10 ksamples/s, additionally events; configurable per channel |
| Anti-aliasing filter (hardware filter) | Low-pass 2nd order (Bessel),<br>3-dB limit frequency 10 kHz |
| Digital low-pass filter | Digital FIR low-pass 8th order (Butterworth) with adjustable limit frequency, can be disabled |
| | Automatic setting:<br>0.4 * sampling frequency |
| | Manual setting:<br>see table |
| Input impedance | Measuring ranges ±10 V, ±60 V:<br>2 MΩ \|\| 350 pF |
| | Measuring range ±1 V:<br>10 MΩ \|\| 250 pF |
| Maximum measurement error (at room temperature) | Measuring range ±1 V:<br>$\pm(0.5\ mV + \lvert U_{IN}\rvert * 0.1\%)$ |
| | Measuring range ±10 V:<br>$\pm(5\ mV + \lvert U_{IN}\rvert * 0.1\%)$ |
| | Measuring range ±60 V:<br>$\pm(30\ mV + \lvert U_{IN}\rvert * 0.1\%)$ |
| Max. voltage drift (temperature), temperature range -40 °C to +70 °C | Measuring range ±1 V:<br>$\pm(10\ \mu V + \lvert U_{IN}\rvert * 50\ ppm)/K$ |
| | Measuring range ±10 V:<br>$\pm(100\ \mu V + \lvert U_{IN}\rvert * 50\ ppm)/K$ |
| | Measuring range ±60 V:<br>$\pm(600\ \mu V + \lvert U_{IN}\rvert * 50\ ppm)/K$ |
| Maximum input voltage | Input:<br>±60 V DC, all measuring ranges |
| | Input-to-input:<br>60 V DC / 30 V AC |
| | Input-to-ground of voltage supply:<br>60 V DC / 30 V AC |
| | Input-to-housing:<br>60 V DC / 30 V AC |
| Electrical isolation | Input-to-input, input-to-supply voltage, input-to-housing |

## Characteristics of Low-pass Filter

| Sampling rate | Sampling time | $f_{C,FIR}$ | | |
|---|---|---|---|---|
| | | Filter 1 ("Auto" filter) | Filter 2 | Filter 3 |
| 10 kHz | 100 µs | 4 kHz | 2 kHz | 800 Hz |
| 5 kHz | 200 µs | 2 kHz | 800 Hz | 400 Hz |
| 2 kHz | 500 µs | 800 Hz | 400 Hz | 200 Hz |
| 1 kHz | 1 ms | 400 Hz | 200 Hz | 80 Hz |
| 500 Hz | 2 ms | 200 Hz | 80 Hz | 40 Hz |
| 200 Hz | 5 ms | 80 Hz | 40 Hz | 20 Hz |
| 100 Hz | 10 ms | 40 Hz | 20 Hz | 8 Hz |
| 50 Hz | 20 ms | 20 Hz | 8 Hz | 4 Hz |
| 20 Hz | 50 ms | 8 Hz | 4 Hz | 2 Hz |
| 10 Hz | 100 ms | 4 Hz | 2 Hz | 0.8 Hz |
| 5 Hz | 200 ms | 2 Hz | 0.8 Hz | |
| 2 Hz | 500 ms | 0.8 Hz | | |
| 1 Hz | 1 s | 0.8 Hz | | |
| 0.5 Hz | 2 s | 0.8 Hz | | |
| Event | - | Off | Off | Off |

**NOTE**

The software configurable filter of a measuring channel (analog inputs [AI] and current measurement channels [PS] of the Power Stages) is automatically deactivated when the measurement channel is operated in the event mode.

## Sensor Supply

| | |
|---|---|
| Number of channels | 4 |
| Arrangement of channels | 2 channels at "AI 1-4" connection and 2 channels at "AI 5-8" connection |
| Assignment of channels | Assignment to sensors or input channels of the ES930.1 can be randomly configured |
| Output voltage | Configurable per channel:<br>predefined values ("Off", +5 V, +8 V, +10 V, +12 V, +15 V) or<br>user-defined (+5 V to +15 V, resolution 10 mV) |
| Output current | Max. 50 mA per channel (at 5 V output voltage) |
| | Max. 30 mA per channel (at 15 V output voltage, all channels loaded simultaneously) |
| Output resistance | <0.5 Ω (measured at connector) |
| Accuracy of output voltage | ±(5 mV + $V_{sensor}$ * 0.2%) (with 500 Ω load) |
| Ripple of output voltage $V_{pp}$ | <30 mV (20 MHz bandwidth) |
| Max. voltage drift (temperature) | ±2 mV/K |
| Run up time of output voltage | 32 ms (all channels simultaneously) |
| Electrical connection | Sensor supply voltage ground connected with supply voltage ground of module |
| Maximum voltage | 0 V (short circuit) to +26 V DC |
| Protection | Outputs CH(n) and ground CH(n)_GND protected each with a fuse against fault-current |
| Diagnostics | Short-circuit detection per channel; if permissible total output is exceeded, all channels are switched off |

### 13.9.6 Analog Output Channels ("AO" Connection)

| | |
|---|---|
| Number of channels | 4 |
| Output voltage | 0 V to +10 V |
| Resolution | 14 bit, one D/A converter per channel |
| Accuracy of output voltage | ±(5 mV + $U_{out}$ * 0.1%) without load, at room temperature |
| | slew rate approx. 0.6 V/µs |
| | rise time approx. 25 µs to 1% of level change value at 10 V change |
| Drift output voltage over temperature | ±(50 µV + $U_{Out}$ * 50 ppm)/K |
| Output current | ±4 mA (max.) |
| Output resistance | typ. 0.5 Ω (virtual, measured at connector) |
| Skew | Synchronous update of all channels, typ. no offset between channels |
| Update of output value | RP: ES910 RP model (~ min. 1 ms) |
| | MC: INCA-PC (~ min. 300 ms) |
| Maximum voltage | Output:<br>±45 V DC |
| | Output-to-ground of voltage supply:<br>60 V DC / 30 V AC |
| | Output-to-housing:<br>60 V DC / 30 V AC |
| Electrical isolation | All 4 outputs together as channel group to supply voltage and to housing |

### 13.9.7 Digital Output Channels ("DO" Connection)

| | |
|---|---|
| Number of channels | 6 |
| Output voltage | Low: 0 V, max. 0.8 V ($I_{out}$ = -10 mA) |
| | High: 5 V, min. 4.0 V ($I_{out}$ = +10 mA) |
| | TTL-compatible (typ. 60 Ω output resistance |
| Time resolution | 15 ns (66.667 MHz) |
| Counter | 32 bit |
| Pulse width | 150 ns to 64.4 s<br>($f_{max}$ = 3 MHz @ 50% duty cycle;<br>$f_{max}$ = 30 kHz @ 95% duty cycle) |
| | 2.5 µs to 64.4 s<br>($f_{max}$ = 20 kHz @ 95% duty cycle) for control of Half-bridges |
| Update of output value | RP: ES910 RP model (~ min. 1 ms) |
| | MC: INCA-PC (~ min. 300 ms) |
| Maximum voltage | Output:<br>±45 V DC |
| | Output-to-ground of voltage supply:<br>60 V DC / 30 V AC |
| | Output-to-housing:<br>60 V DC / 30 V AC |
| Electrical isolation | All 6 outputs together as channel group to supply voltage and to housing |
| Functions | Digital Out, Pulse Out, PWM Out and simultaneously activation of power stages "PS"; synchronous channel groups can be configured |

## 13.9.8 Power Stage ("PS" Connection)

### 13.9.8.1 Half-bridges

| | |
|---|---|
| Number of channels | 6 Half-bridges |
| Power supply of Half-bridges | Separate, 7 V DC to 32 V DC |
| Activation of Half-bridges | One digital output controls the two switches of a Half-bridge |
| Switching current | ±5 A rated current (max., per channel) |
| | ±7 A short-term current peaks (max., per channel) |
| | 20 A max. rated current at power supply plus or minus |
| Frequency | 20 kHz (max.) |
| Minimum pulse width for Half-bridge switch | 2.5 µs (min.) |
| Electrical isolation | All 6 Half-bridges together as channel group to the supply voltage of the module and to housing |
| Fault protection of Half-bridges | Switch-off at overtemperature, overcurrent, short-circuit |
| | Monitoring, fault protection and switch-off always jointly for two Half-bridges (channels 1 and 2, channels 3 and 4, channels 5 and 6) |
| | Setting of diagnostics bit at switch-off |
| Maximum voltage | Limitation (clamping) of the output voltage to the external power supply of the half-bridges |
| | Output-to-ground of voltage supply of the module:<br>60 V DC / 30 V AC |
| | Output-to-housing:<br>60 V DC / 30 V AC |
| Assemblies | Half-bridge consists of 2 push-pull switches with current measurement (current input), diagnostics assembly |
| Functions | Depending on the configuration and connection as high-side, low-side, half-bridge switch (Full-bridge through external connection) |

For the Half-bridges, the driver ICs Infineon TLE7182EM are used.
The data sheet "TLE7182EM H-Bridge and Dual Half-bridge Driver IC (Data Sheet, Rev 1.1, Sept. 2010)" with detailed information is available on the Infineon Internet page.

**NOTE**

It must be observed that the interconnection with a Full-bridge (H-bridge) is only possible for the permanently assigned Half-bridge channel groups (see chapter 10.6.1 on page 64).

**NOTE**

Observe the notes about Switch-on behavior of Half-bridges in chapter 10.5.2 on page 64.

### 13.9.8.2 Current Input (CI)

| | |
|---|---|
| Number of channels | 6 |
| Function | Current measurement with shunt in output path of half-bridge switch |
| Measuring range | -5 A to 5 A (clipping) |
| Measuring accuracy | ±(50 mA + $\|I_{meas}\|$ * 0.5%) |
| Measuring accuracy (drift/temperature) | ±(0.5 mA + $\|I_{meas}\|$ * 300 ppm)/K |
| Measuring accuracy over output voltage | ±(2 mA/V * $\|U_{out}$ - 12 V$\|$) |
| Sampling rate, configurable per module | 0.5 samples/s bis 10 ksamples/s, additionally events |
| Anti-aliasing filter (hardware filter) | Low-pass 1st order,<br>3-dB limit frequency 15 kHz |
| Digital filter (software), configurable per module | Configuration 1:<br>Off |
| | Configuration 2:<br>CIC filter (sinc filter), automatic filter setting with selection of sampling rate<br>Averaging time $\tau_s$ = 100 µs to 2 s,<br>Averaging time equal to sampling rate |
| | Configuration 3:<br>IIR filter 2nd order (Bessel) with adjustable limit frequency (0.4 Hz to 4 kHz) |

**NOTE**

The software configurable filter of a measuring channel (analog inputs [AI] and current measurement channels [PS] of the Power Stages) is automatically deactivated when the measurement channel is operated in the event mode.

# 14 Pin Assignment and Accessories

## 14.1 Pin Assignment

### 14.1.1 "DO" Connection

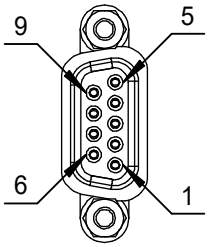



**Fig. 14-1** "DO" Connection

| ES930.1 "DO" connection | | Meaning |
|---|---|---|
| Pin | Signal | |
| 1 | DO_CH1 | Digital output channel 1 |
| 2 | DO_CH2 | Digital output channel 2 |
| 3 | DO_CH3 | Digital output channel 3 |
| 4 | DO_CH4 | Digital output channel 4 |
| 5 | DO_CH5 | Digital output channel 5 |
| 6 | DO_CH6 | Digital output channel 6 |
| 7 | DO_GND | Digital output channel, ground *) |
| 8 | DO_GND | Digital output channel, ground *) |
| 9 | DO_GND | Digital output channel, ground *) |

*) : common ground

A 9-pin DSUB socket is installed at the "DO" connection.

An overview of the assignment of the open ends of the CBAV421.1 cable for use at the "DO" connection is located in chapter 14.2.2 on page 116.

**CAUTION**

Users who want to fit their own cables for the "DO" connection must observe the notes about the design of the CBAV421.1 cable offered by ETAS to avoid damage to the module (see chapter 14.2.2 on page 116).

### 14.1.2 "DI" Connection

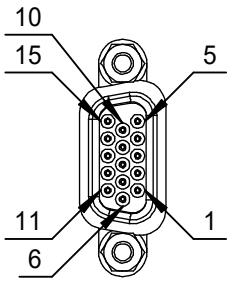



**Fig. 14-2** "DI" Connection

| ES930.1 "DI" connection | | Meaning |
|---|---|---|
| Pin | Signal | |
| 1 | DI_CH1 | Digital input channel 1 |
| 2 | DI_CH2 | Digital input channel 2 |
| 3 | DI_CH3 | Digital input channel 3 |
| 4 | DI_CH4 | Digital input channel 4 |
| 6 | DI_CH1_GND | Digital input channel 1, ground *) |
| 7 | DI_CH2_GND | Digital input channel 2, ground *) |
| 8 | DI_CH3_GND | Digital input channel 3, ground *) |
| 9 | DI_CH4_GND | Digital input channel 4, ground *) |
| 5, 10, 11, 12, 13, 14, 15 | N.C. | Not connected |

*) : common ground

A 15-pin high density DSUB socket is installed at the "DI" connection.

An overview of the assignment of the open ends of the CBAV420.1 cable for use at the "DI" connection is located in chapter 14.2.1 on page 112.

**CAUTION**

Users who want to fit their own cables for the "DI" connection, must observe the notes about the design of the CBAV420.1 cable offered by ETAS to avoid damage to the module (see chapter 14.2.1 on page 112).

**CAUTION**

Please observe the recommendation for measurement setups with different ground potentials or with measurement points separated in distance (see chapter 14.2.1 on page 112).

### 14.1.3 "AO" Connection

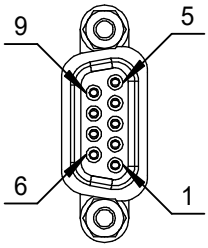



**Fig. 14-3** "AO" Connection

| ES930.1 "AO" connection | | Meaning |
|---|---|---|
| Pin | Signal | |
| 1 | AO_CH1 | Analog output channel 1 |
| 2 | AO_CH2 | Analog output channel 2 |
| 3 | AO_CH3 | Analog output channel 3 |
| 4 | AO_CH4 | Analog output channel 4 |
| 5 | N.C. | Not connected |
| 6 | N.C. | Not connected |
| 7 | AO_GND | Analog output channel, ground *) |
| 8 | AO_GND | Analog output channel, ground *) |
| 9 | AO_GND | Analog output channel, ground *) |

*) : common ground

A 9-pin DSUB socket is installed at the "AO" connection.

An overview of the assignment of the open ends of the CBAV421.1 cable for use at the "AO" connection is located in chapter 14.2.2 on page 116.

**CAUTION**

Users who want to fit their own cables for the "AO" connection, must observe the notes about the design of the CBAV421.1 cable offered by ETAS to avoid damage to the module (see chapter 14.2.2 on page 116).

### 14.1.4 "AI 5-8" Connection

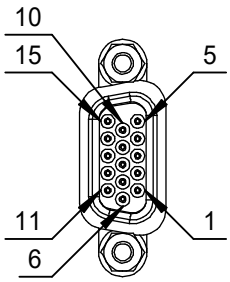



**Fig. 14-4** "AI 5-8" Connection

| ES930.1 "AI 5-8" connection | | Meaning |
|---|---|---|
| Pin | Signal | |
| 1 | AI_CH5 | Analog input channel 5 |
| 2 | AI_CH6 | Analog input channel 6 |
| 3 | AI_CH7 | Analog input channel 7 |
| 4 | AI_CH8 | Analog input channel 8 |
| 5 | N.C. | Not connected |
| 6 | AI_CH5_GND | Analog input channel 5, ground |
| 7 | AI_CH6_GND | Analog input channel 6, ground |
| 8 | AI_CH7_GND | Analog input channel 7, ground |
| 9 | AI_CH8_GND | Analog input channel 8, ground |
| 10 | N.C. | Not connected |
| 11 | SensorSupply_CH3 | Sensor power supply, channel 3 |
| 12 | SensorSupply_CH3_GND | Sensor power supply, channel 3, ground |
| 13 | SensorSupply_CH4 | Sensor power supply, channel 4 |
| 14 | SensorSupply_CH4_GND | Sensor power supply, channel 4, ground |
| 15 | N.C. | Not connected |

A 15-pin high density DSUB socket is installed at the "AI 5-8" connection.

An overview of the assignment of the open ends of the CBAV420.1 cable for use at the "AI 5-8" connection is located in chapter 14.2.1 on page 112.

**CAUTION**

Users who want to fit their own cables for the "AI 5-8" connection, must observe the notes about the design of the CBAV420.1 cable offered by ETAS to avoid damage to the module (see chapter 14.2.1 on page 112).

### 14.1.5 "AI 1-4" Connection

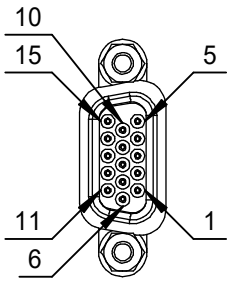



**Fig. 14-5** "AI 1-4" Connection

| ES930.1 "AI 1-4" connection | | Meaning |
|---|---|---|
| Pin | Signal | |
| 1 | AI_CH1 | Analog input channel 1 |
| 2 | AI_CH2 | Analog input channel 2 |
| 3 | AI_CH3 | Analog input channel 3 |
| 4 | AI_CH4 | Analog input channel 4 |
| 5 | N.C. | Not connected |
| 6 | AI_CH1_GND | Analog input channel 1, ground |
| 7 | AI_CH2_GND | Analog input channel 2, ground |
| 8 | AI_CH3_GND | Analog input channel 3, ground |
| 9 | AI_CH4_GND | Analog input channel 4, ground |
| 10 | N.C. | Not connected |
| 11 | SensorSupply_CH1 | Sensor power supply, channel 1 |
| 12 | SensorSupply_CH1_GND | Sensor power supply, channel 1, ground |
| 13 | SensorSupply_CH2 | Sensor power supply, channel 2 |
| 14 | SensorSupply_CH2_GND | Sensor power supply, channel 2, ground |
| 15 | N.C. | Not connected |

A 15-pin high density DSUB socket is installed at the "AI 1-4" connection.

An overview of the assignment of the open ends of the CBAV420.1 cable for use at the "AI 1-4" connection is located in chapter 14.2.1 on page 112.

**CAUTION**

Users who want to fit their own cables for the "AI 1-4" connection, must observe the notes about the design of the CBAV420.1 cable offered by ETAS to avoid damage to the module (see chapter 14.2.1 on page 112).

### 14.1.6 "PS" Connection

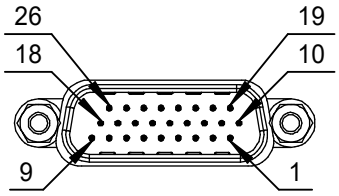



**Fig. 14-6** "PS" Connection

| ES930.1 "PS" connection | | Meaning |
|---|---|---|
| Pin | Signal | |
| 1, 10 | PS_CH1 | Power stage, channel 1 |
| 2, 11 | PS_CH2 | Power stage, channel 2 |
| 3, 12 | PS_CH3 | Power stage, channel 3 |
| 4, 13 | PS_CH4 | Power stage, channel 4 |
| 5, 14 | PS_CH5 | Power stage, channel 5 |
| 6, 15 | PS_CH6 | Power stage, channel 6 |
| 7, 8, 9, 16, 17, 18, 26 | PS_GND | Power stage, external power supply ground |
| 19, 20, 21, 22, 23, 24, 25 | PS_UBAT | Power stage, external power supply |

A 26-pin high density DSUB plug is installed at the "PS" connection.

An overview of the assignment of the open ends of the CBAV422.2 cable for use at the "PS" connection is located in chapter 14.2.3 on page 118.

**CAUTION**

Users who want to fit their own cables for the "DO" connection, must observe the notes about the design of the CBAV422.1 cable offered by ETAS to avoid damage to the module (see chapter 14.2.3 on page 118).

### 14.1.7 "TH1-4" Connection

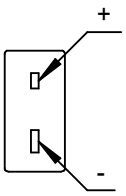



**Fig. 14-7** "TH1-4" Connection

| ES930.1 "TH1-4" connection | | Meaning |
|---|---|---|
| Pin | Signal | |
| + | In+ | Input (+) |
| - | In- | Input (-) |

Mini-TC sockets are installed at the "TH1-4" connections.

### 14.1.8 "IN" Connection

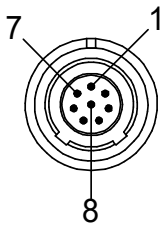



**Fig. 14-8** "IN" Connection

| ES930.1 "IN" connection | | Meaning |
|---|---|---|
| Pin | Signal | |
| 1 | UBatt | Operating voltage |
| 2 | Ground | Ground |
| 3 | RX- | Receive data, minus |
| 4 | TX- | Send data, minus |
| 5 | RX+ | Receive data, plus |
| 6 | Ground | Ground |
| 7 | UBatt | Operating voltage |
| 8 | TX+ | Send data, plus |

A LEMO 1B 8-pin connector with L-coding (connection identified in green) is installed at the "IN" connection.

### 14.1.9 "OUT" Connection

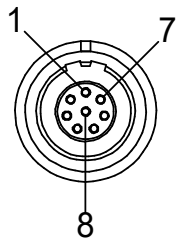



**Fig. 14-9** "OUT" Connection

| ES930.1 "IN" connection | | Meaning |
|---|---|---|
| Pin | Signal | |
| 1 | UBatt | Operating voltage |
| 2 | UBatt | Operating voltage |
| 3 | Ground | Ground |
| 4 | RX+ | Receive data, plus |
| 5 | TX- | Send data, minus |
| 6 | RX- | Receive data, minus |
| 7 | Ground | Ground |
| 8 | TX+ | Send data, plus |

A LEMO 1B 8-pin socket with A-coding (connection identified in yellow) is installed at the "OUT" connection.

## 14.2 Cable for Inputs and Outputs

The CBAV420.1 cable is used for the inputs, the CBAV421.1 cable for the outputs and the CBAV422.1 cable for the Half-bridges (power stages) (see Fig. 14-10 on page 111 and the following table).

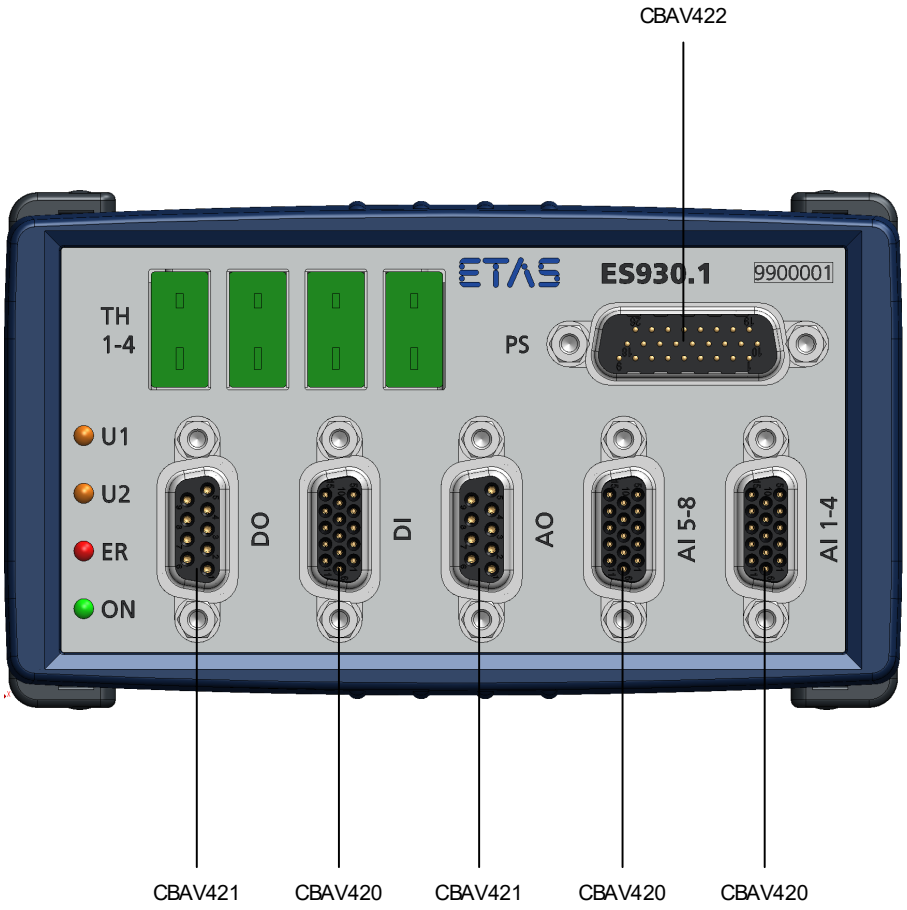



**Fig. 14-10** Cable for Inputs and Outputs

| ES930.1 connection | | Cable |
|---|---|---|
| TH1-4 | Thermo channel | Thermocouple |
| PS | Power stages | CBAV422.1 |
| DO | Digital outputs | CBAV421.1 |
| DI | Digital inputs | CBAV420.1 |
| AO | Analog outputs | CBAV421.1 |
| AI 5-8 | Analog inputs | CBAV420.1 |
| AI 1-4 | Analog inputs | CBAV420.1 |

For the connection of the inputs and outputs of the module, three CBAV420.1 cables, two CBAV421.1 cables and one CBAV422.1 cable are required.

The open connections of the cables CBAV420.1, CBAV421.1 and CBAV422.1 can be fitted individually by the user, so that it can be adapted to the specific plug connector system of the measuring setup.

### 14.2.1 CBAV420.1 Cable

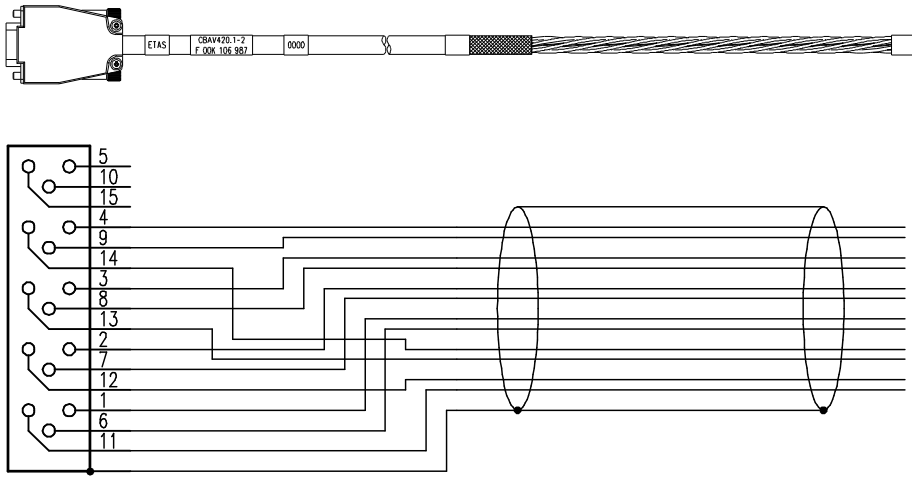



**Fig. 14-11** CBAV420.1 Cable with wiring Plan

| Product | Length | Order number |
|---|---|---|
| CBAV420.1-2 | 2 m / 6.5 ft | F 00K 106 987 |

#### 14.2.1.1 Recommendation for Measurement Setups with different Ground Potentials or with Measurement Points separated in Distance

**CAUTION**

To avoid in such measurement setups fault currents within the module ES930.1 between the ground terminals of the connector "DI", we recommend to connect the ground connections DI_CH1_GND to DI_CH4_GND either at the open end of the CBAV240.1 cable or directly in the connector of a self-assembled cable.
Cables with such connections may be used only at the connector "DI".

#### 14.2.1.2 Assignment of the CBAV420.1 Cable when used at "DI" Connection

| HD-SUBD | Signal | Open cable end | |
|---|---|---|---|
| Pin | | Pair | Color |
| 4 | DI_CH4 | 1 | white |
| 9 | DI_CH4_GND | 1 | brown |
| 3 | DI_CH3 | 2 | green |
| 8 | DI_CH3_GND | 2 | yellow |
| 2 | DI_CH2 | 3 | gray |
| 7 | DI_CH2_GND | 3 | pink |
| 1 | DI_CH1 | 4 | blue |
| 6 | DI_CH1_GND | 4 | red |
| 14 | N.C. | 5 | black |
| 13 | N.C. | 5 | violet |
| 12 | N.C. | 6 | gray/pink |
| 11 | N.C. | 6 | red/blue |
| 5, 10, 15 | N.C. | | |
| Housing | | Shield | |

#### 14.2.1.3 Assignment of the CBAV420.1 Cable when used at "AI 5-8" Connection

| HD-SUBD | Signal | Open cable end | |
|---|---|---|---|
| Pin | | Pair | Color |
| 4 | AI_CH8 | 1 | white |
| 9 | AI_CH8_GND | 1 | brown |
| 3 | AI_CH7 | 2 | green |
| 8 | AI_CH7_GND | 2 | yellow |
| 2 | AI_CH6 | 3 | gray |
| 7 | AI_CH6_GND | 3 | pink |
| 1 | AI_CH5 | 4 | blue |
| 6 | AI_CH5_GND | 4 | red |
| 14 | SensorSupply_CH4_GND | 5 | black |
| 13 | SensorSupply_CH4 | 5 | violet |
| 12 | SensorSupply_CH3_GND | 6 | gray/pink |
| 11 | SensorSupply_CH3 | 6 | red/blue |
| 5, 10, 15 | N.C. | | |
| Housing | | Shield | |

#### 14.2.1.4 Assignment of the CBAV420.1 Cable when used at "AI 1-4" Connection

| HD-SUBD | Signal | Open cable end | |
|---|---|---|---|
| Pin | | Pair | Color |
| 4 | AI_CH4 | 1 | white |
| 9 | AI_CH4_GND | 1 | brown |
| 3 | AI_CH3 | 2 | green |
| 8 | AI_CH3_GND | 2 | yellow |
| 2 | AI_CH2 | 3 | gray |
| 7 | AI_CH2_GND | 3 | pink |
| 1 | AI_CH1 | 4 | blue |
| 6 | AI_CH1_GND | 4 | red |
| 14 | SensorSupply_CH2_GND | 5 | black |
| 13 | SensorSupply_CH2 | 5 | violet |
| 12 | SensorSupply_CH1_GND | 6 | gray/pink |
| 11 | SensorSupply_CH1 | 6 | red/blue |
| 5, 10, 15 | N.C. | | |
| Housing | | Shield | |

#### 14.2.1.5 Overview: Assignment of the CBAV420.1 Cable for use at the Connections "DI", "AI 5-8" and "AI 1-4"

| "DI" / "AI 1-4" / "AI 5-8" | "DI" connection | "AI 5-8" connection | "AI 1-4" connection | CBAV420.1: Open cable end | |
|---|---|---|---|---|---|
| Pin | Signal | Signal | Signal | Pair | Color |
| 4 | DI_CH4 | AI_CH8 | AI_CH4 | 1 | White |
| 9 | DI_GND | AI_CH8_GND | AI_CH4_GND | 1 | Brown |
| 3 | DI_CH3 | AI_CH7 | AI_CH3 | 2 | Green |
| 8 | DI_GND | AI_CH7_GND | AI_CH3_GND | 2 | Yellow |
| 2 | DI_CH2 | AI_CH6 | AI_CH2 | 3 | Gray |
| 7 | DI_GND | AI_CH6_GND | AI_CH2_GND | 3 | Pink |
| 1 | DI_CH1 | AI_CH5 | AI_CH1 | 4 | Blue |
| 6 | DI_GND | AI_CH5_GND | AI_CH1_GND | 4 | Red |
| 14 | N.C. | SensorSupply_CH4_GND | SensorSupply_CH2_GND | 5 | Black |
| 13 | N.C. | SensorSupply_CH4 | SensorSupply_CH2 | 5 | Violet |
| 12 | N.C. | SensorSupply_CH3_GND | SensorSupply_CH1_GND | 6 | Gray/pink |
| 11 | N.C. | SensorSupply_CH3 | SensorSupply_CH1 | 6 | Red/blue |
| 5, 10, 15 | N.C. | N.C. | N.C. | | |
| Housing | | | | Shield | |

### 14.2.2 CBAV421.1 Cable

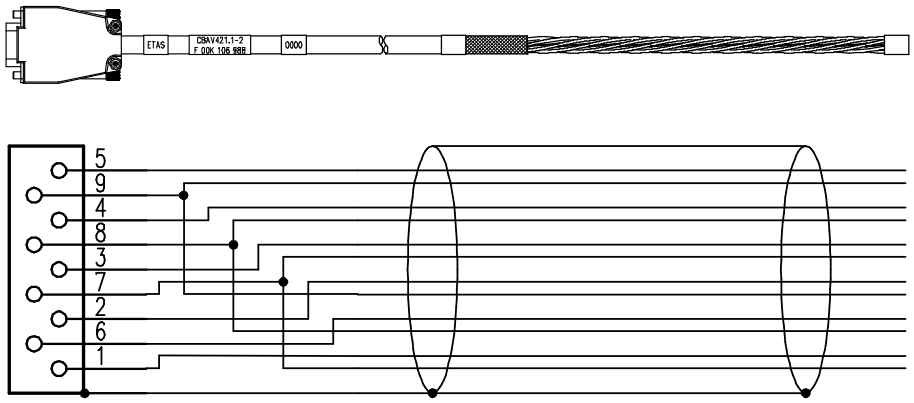



**Fig. 14-12** CBAV421.1 Cable with wiring Plan

| Product | Length | Order number |
|---|---|---|
| CBAV421.1-2 | 2 m / 6.5 ft | F 00K 106 988 |

#### 14.2.2.1 Assignment of the CBAV421.1 Cable when used at "DO" Connection

| SUBD | Signal | Open cable end | |
|---|---|---|---|
| Pin | | Pair | Color |
| 5 | DO_CH5 | 1 | White |
| 9 | DO_GND | 1 | Brown |
| 4 | DO_CH4 | 2 | Green |
| 8 | DO_GND | 2 | Yellow |
| 3 | DO_CH3 | 3 | Gray |
| 7 | DO_GND | 3 | Pink |
| 2 | DO_CH2 | 4 | Blue |
| 9 | DO_GND | 4 | Red |
| 6 | DO_CH6 | 5 | Black |
| 8 | DO_GND | 5 | Violet |
| 1 | DO_CH1 | 6 | Gray/pink |
| 7 | DO_GND | 6 | Red/blue |
| Housing | | Shield | |

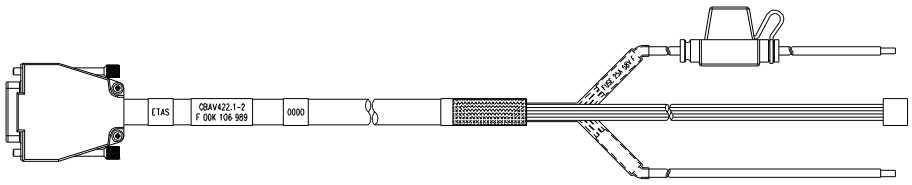
#### 14.2.2.2 Assignment of the CBAV421.1 Cable when used at the "AO" Connection

| SUBD | | Open cable end | |
|---|---|---|---|
| Pin | Signal | Pair | Color |
| 5 | N.C. | 1 | White |
| 9 | AO_GND | 1 | Brown |
| 4 | AO_CH4 | 2 | Green |
| 8 | AO_GND | 2 | Yellow |
| 3 | AO_CH3 | 3 | Gray |
| 7 | AO_GND | 3 | Pink |
| 2 | AO_CH2 | 4 | Blue |
| 9 | AO_GND | 4 | Red |
| 6 | N.C. | 5 | Black |
| 8 | AO_GND | 5 | Violet |
| 1 | AO_CH1 | 6 | Gray/pink |
| 7 | AO_GND | 6 | Red/blue |
| Housing | | Shield | |

#### 14.2.2.3 Overview: Assignment of CBAV421.1 Cable for use at the Connections "DO" and "AO"

| DO / AO | DO connection | AO connection | CBAV421.1: Open cable end | |
|---|---|---|---|---|
| Pin | Signal | Signal | Pair | Color |
| 5 | DO_CH5 | N.C. | 1 | White |
| 9 | DO_GND | AO_GND | 1 | Brown |
| 4 | DO_CH4 | AO_CH4 | 2 | Green |
| 8 | DO_GND | AO_GND | 2 | Yellow |
| 3 | DO_CH3 | AO_CH3 | 3 | Gray |
| 7 | DO_GND | AO_GND | 3 | Pink |
| 2 | DO_CH2 | AO_CH2 | 4 | Blue |
| 9 | DO_GND | AO_GND | 4 | Red |
| 6 | DO_CH6 | N.C. | 5 | Black |
| 8 | DO_GND | N.C. | 5 | Violet |
| 1 | DO_CH1 | AO_CH1 | 6 | Gray/pink |
| 7 | DO_GND | AO_GND | 6 | Red/blue |
| Housing | | | | |

### 14.2.3 CBAV422.1 Cable




Page A

Page B

Page C

Page D

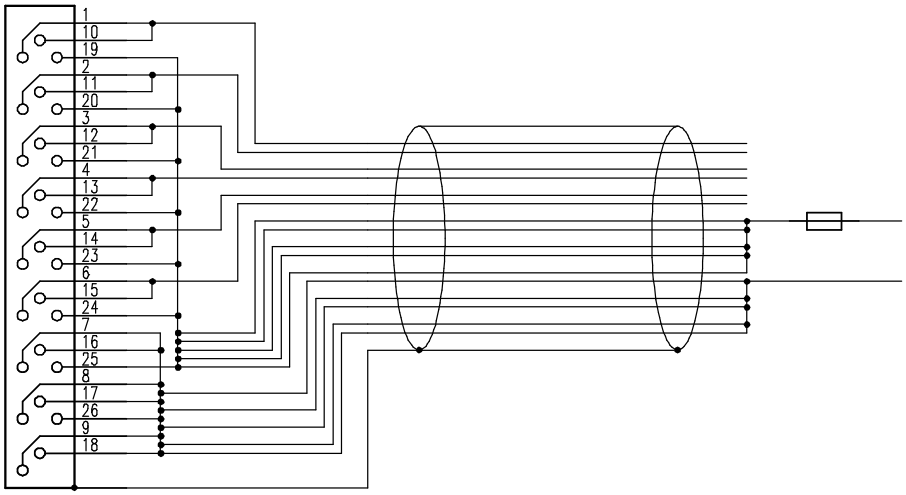



**Fig. 14-13** CBAV422.1 Cable with wiring Plan

| Product | Length | Order number |
|---|---|---|
| CBAV422.1-2 | 2 m / 6.5 ft | F 00K 106 989 |

#### 14.2.3.1 Fuse

A replaceable fuse is located in the connection for the operating voltage in the CBAV422.1 cable:

MINI flat automotive fuse, quick-response, 42 V, 25 A

#### 14.2.3.2 Fitting the Cable by User

**CAUTION**

**Electrical overload of the cable is possible!**

Always cable all PS_UBAT connections together!

All PS_GND connections must be cabled together!

**CAUTION**

**Half-bridges could be destroyed!**

When fitting your own cables, the Half-bridges must be protected with a fuse in the operating voltage feed for the Half-bridges!

#### 14.2.3.3 Assignment of the CBAV422.1 Cable when used at the "PS" Connection

| HD-SUBD Pin | Signal | Open cable end Color | |
|---|---|---|---|
| 1, 10 | PS_CH1 | white | Page C |
| 2, 11 | PS_CH2 | brown | |
| 3, 12 | PS_CH3 | green | |
| 4, 13 | PS_CH4 | yellow | |
| 5, 14 | PS_CH5 | gray | |
| 6, 15 | PS_CH6 | pink | |
| 19, 20, 21, 22, 23, 24, 25 | PS_UBAT | blue | Page B |
| | PS_UBAT | red | |
| | PS_UBAT | black | |
| | PS_UBAT | violet | |
| | PS_UBAT | gray/pink | |
| 7, 8, 9, 16, 17, 18, 26 | PS_GND | red/blue | Page D |
| | PS_GND | white/green | |
| | PS_GND | brown/green | |
| | PS_GND | white/yellow | |
| | PS_GND | yellow/brown | |
| Housing | | Shield | |

## 14.3 Cable for the Connections "IN"/ "OUT"

### 14.3.1 Ethernet Cable

#### 14.3.1.1 CBE400.2 Cable

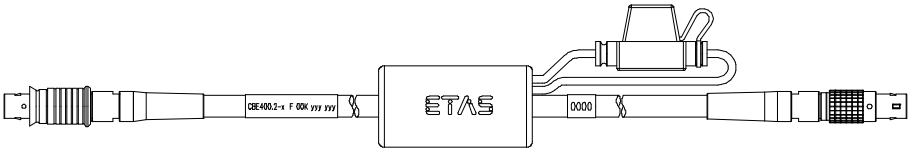



**Fig. 14-14** CBE400.2 Cable

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. Robust, waterproof and dust-proof (IP67).

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

#### 14.3.1.2 CBE401.1 Cable

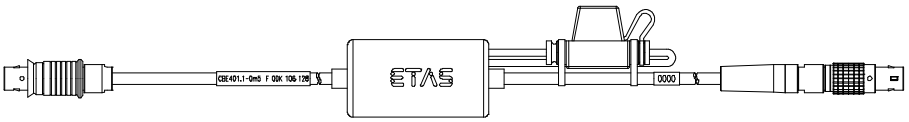



**Fig. 14-15** CBE401.1 Cable

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. Robust, waterproof and dust-proof (IP67).

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

#### 14.3.1.3 CBE430.1 Cable

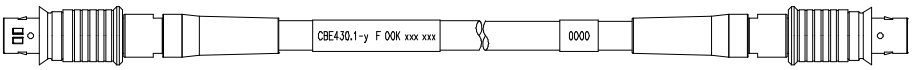



**Fig. 14-16** CBE430.1 Cable

Cable for chaining ES4xx/ES63x/ES93x modules. Robust, waterproof and dust-proof (IP67).

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

### 14.3.1.4 CBE431.1 Cable

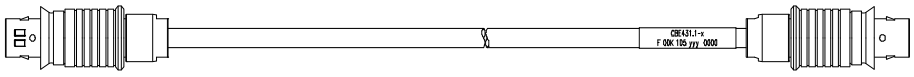



**Fig. 14-17** CBE431.1 Cable

Flexible cable for chaining successive ES4xx/ES63x/ES93x modules. Robust, waterproof and dust-proof (IP67).

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

### 14.3.1.5 CBEX400.1 Cable

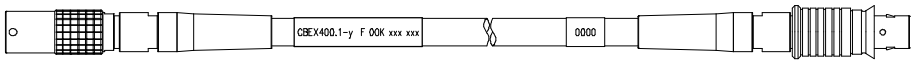



**Fig. 14-18** CBEX400.1 Cable

Ethernet extension cable for ES4xx/ES63x/ES93x modules. Robust, waterproof and dust-proof (IP67).

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

### 14.3.2 Combined Ethernet and Power Supply Cable

**DANGER**

**Dangerous electrical voltage!**

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

To prevent an inadvertent insertion in power outlets, ETAS recommends to equip the 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 |

### 14.3.2.1 CBEP410.1 Cable

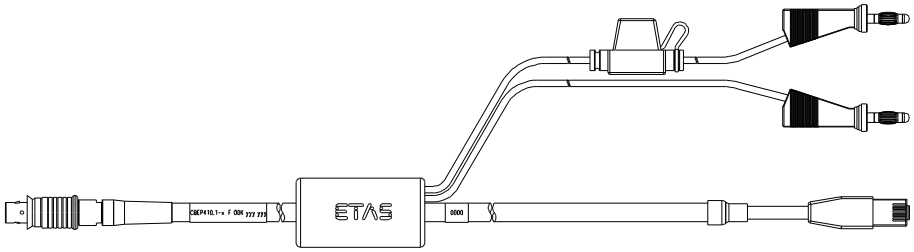



**Fig. 14-19** CBEP410.1 Cable

Connection of an ES4xx/ES63x/ES93x module to PC and power supply (stand-alone operation). Supply battery in the vicinity of the module. Robust, water-proof and dust-proof (IP67).

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

### 14.3.2.2 CBEP4105.1 Cable

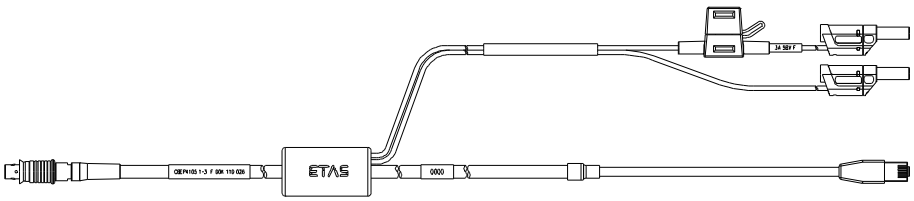



**Fig. 14-20** CBEP4105.1 Cable

Connection of an ES4xx/ES63x/ES93x module to PC and power supply (stand-alone operation). Supply battery in the vicinity of the module. Robust, water-proof and dust-proof (IP67).

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

### 14.3.2.3 CBEP415.1 Cable

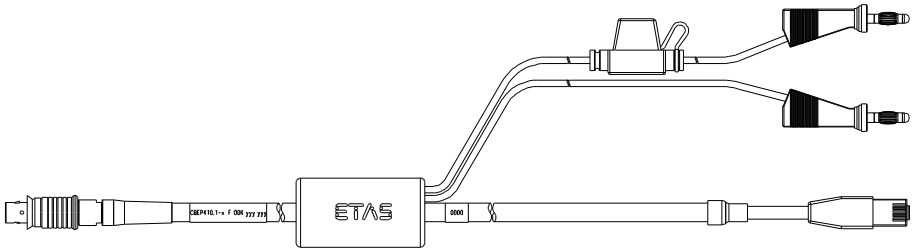



**Fig. 14-21** CBEP415.1 Cable

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). Robust, waterproof and dust-proof (IP67).

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

### 14.3.2.4 CBEP4155.1 Cable

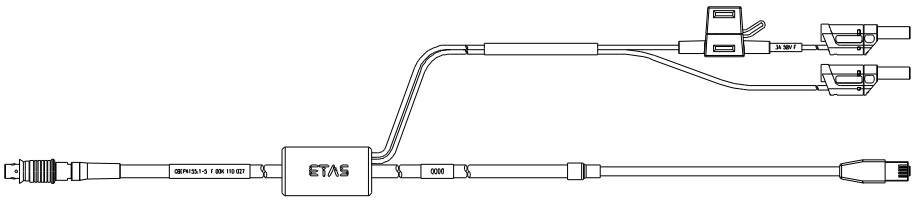



**Fig. 14-22** CBEP4155.1 Cable

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). Robust, waterproof and dust-proof (IP67).

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

### 14.3.2.5 CBEP420.1 Cable

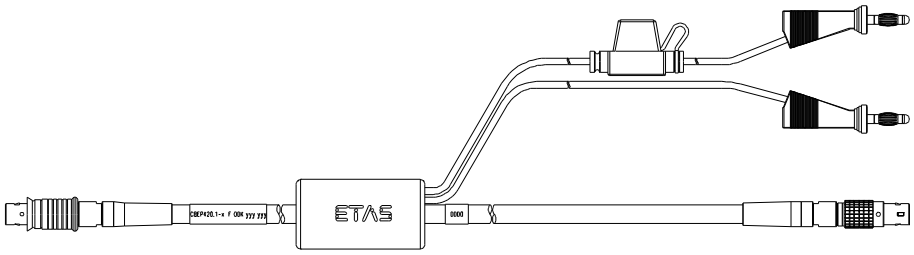


**Fig. 14-23** CBEP420.1 Cable

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. Robust, waterproof and dust-proof (IP67).

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

### 14.3.2.6 CBEP4205.1 Cable

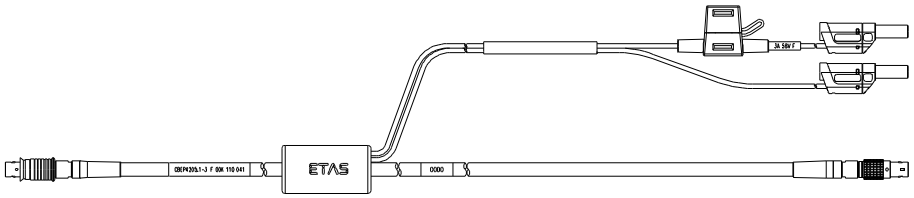


**Fig. 14-24** CBEP4205.1 Cable

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. Robust, waterproof and dust-proof (IP67).

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

### 14.3.2.7 CBEP425.1 Cable

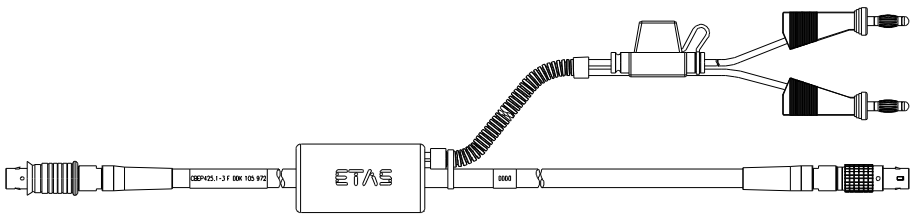



**Fig. 14-25** CBEP425.1 Cable

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 chain exceeds 2.5 A), an ES1135 simulation/system controller card or an ES720 drive recorder. Robust, waterproof and dust-proof (IP67).

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

### 14.3.2.8 CBEP4255.1 Cable

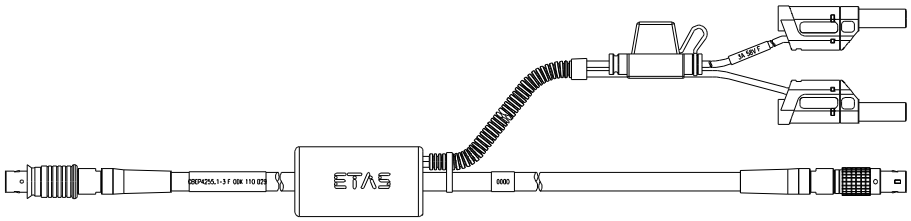



**Fig. 14-26** CBEP4255.1 Cable

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 chain exceeds 2.5 A), an ES1135 simulation/system controller card or an ES720 drive recorder. Robust, waterproof and dust-proof (IP67).

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

### 14.3.2.9 CBEP430.1 Cable

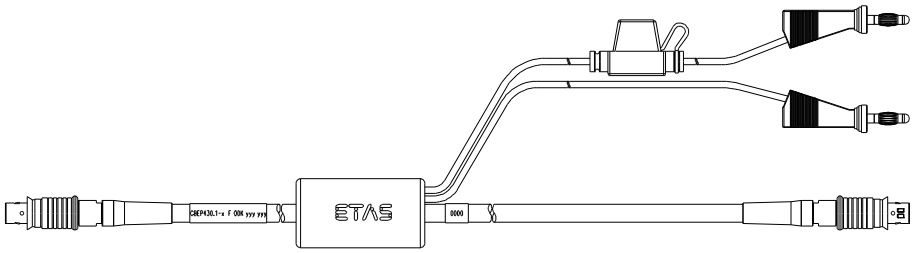


**Fig. 14-27** CBEP430.1 Cable

To chain ES4xx/ES63x/ES93x modules and connect an ES4xx/ES63x/ES93x chain to an ES910 rapid prototyping module. Additional connection to the power supply to compensate for voltage losses in long chains. Robust, water-proof and dust-proof (IP67).

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

### CBEP4305.1 Cable

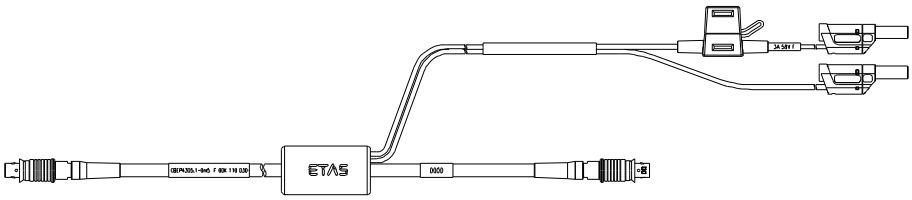


**Fig. 14-28** CBEP4305.1 Cable

To chain ES4xx/ES63x/ES93x modules and connect an ES4xx/ES63x/ES93x chain to an ES910 rapid prototyping module. Additional connection to the power supply to compensate for voltage losses in long chains. Robust, water-proof and dust-proof (IP67).

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

## 14.4 Protective Caps

The connections "IN" and "OUT" of the ES930.1 can be protected with different protective caps according to the operating conditions.

### 14.4.1 Cap CAP_Lemo_1B

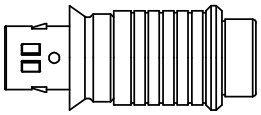


**Fig. 14-29** Cap CAP_Lemo_1B

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 |

### 14.4.2 Cap CAP_Lemo_1B_LC

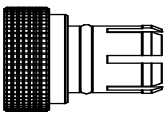


**Fig. 14-30** Cap CAP_Lemo_1B_LC

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 |

# 15 Ordering Information

## 15.1 ES930.1

| Order name | Short name | Order number |
|---|---|---|
| ES930.1 Multi-I/O Module | ES930.1 | F 00K 104 250 |
| **Scope of supplies** | | |
| ES930.1 Multi-I/O Module,<br>T-Bracket for Housing,<br>List "Content of this Package",<br>Calibration-Certification,<br>ES930 Safety Advice,<br>China-RoHS-leaflet_Compact_green_cn | | |

**NOTE**

Cables are not part of the scope of supplies of the module and must be ordered separately (see chapter 15.2.1 on page 129).

## 15.2 Accessories

### 15.2.1 Cables

**NOTE**

At the connections of the ES930.1, the ETAS cables listed in this User Guide should be used as far as possible. The maximum permissible cable lengths must be adhered to.

**NOTE**

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

**NOTE**

For the connection of the inputs and outputs of the module, three CBAV420.1 cables, two CBAV421.1 cables and one CBAV422.1 cable are required.

#### 15.2.1.1 Cables for the Connectors "AI" and "DI"

| Order name | Short name | Order number |
|---|---|---|
| ES930 Input Cable, DSUB - Open Wire (15fc - 15c), 2 m / 6.5 ft | CBAV420.1-2 | F 00K 106 987 |

#### 15.2.1.2 Cables for the Connectors "AO" and "DO"

| Order name | Short name | Order number |
|---|---|---|
| ES930 Output Cable, DSUB - Open Wire (9fc - 9c), 2 m / 6.5 ft | CBAV421.1-2 | F 00K 106 988 |

#### 15.2.1.3 Cables for the Connector "PS"

| Order name | Short name | Order number |
|---|---|---|
| ES930 Power Stage Cable, DSUB - Open Wire (26mc-26c), 2 m / 6.5 ft | CBAV422.1-2 | F 00K 106 989 |

#### 15.2.1.4 Cables for the Connectors "IN" and "OUT"

##### Ethernet Cable

| Order name | Short name | Order number |
|---|---|---|
| Ethernet Chain Connection Cable, Lemo 1B FGF - Lemo 1B FGL (8mc-8fc), 3 m | CBE400.2-3 | F 00K 104 920 |
| Ethernet Chain Connection Cable, Highly Flexible, Lemo 1B FGF - Lemo 1B FGL (8mc-8fc), 0.5 m | CBE401.1-0m5 | F 00K 106 128 |
| Ethernet Chain Connection Cable, Lemo 1B FGA - Lemo 1B FGL (8mc-8fc), 0m45 | CBE430.1-0m45 | F 00K 104 923 |
| Ethernet Chain Connection Cable, Highly Flexible, Lemo 1B FGA - Lemo 1B FGL (8mc-8fc, 0m14) | CBE431.1-0m14 | F 00K 105 676 |
| Ethernet Chain Connection Cable, Highly Flexible, Lemo 1B FGA - Lemo 1B FGL (8mc-8fc, 0m30) | CBE431.1-0m30 | F 00K 105 685 |
| Ethernet Extension Cable, Lemo 1B PHL - Lemo 1B FGL (8mc-8fc), 3 m | CBEX400.1-3 | F 00K 105 294 |

##### Combined Ethernet and Power Supply Cable

| Order name | Short name | Order number |
|---|---|---|
| Ethernet PC Connection and Power Supply Cable, Lemo 1B FGL - RJ45 - Banana (8fc-8mc-2mc), 3 m | CBEP410.1-3 | F 00K 104 927 |
| Ethernet PC Connection and Power Supply Cable, Lemo 1B FGL - RJ45 - Safety Banana (8fc-8mc-2mc), 3 m | CBEP4105.1-3 | F 00K 110 026 |
| Ethernet PC Connection and Power Supply Cable, Power Feeder close to PC, Lemo 1B FGL - RJ45 - Banana (8fc-8mc-2mc), 5 m | CBEP415.1-5 | F 00K 105 680 |
| Ethernet PC Connection and Power Supply Cable, Power Feeder close to PC, Lemo 1B FGL - RJ45 - Safety Banana (8fc-8mc-2mc), 5 m | CBEP4155.1-5 | F 00K 110 027 |

| Order name | Short name | Order number |
|---|---|---|
| 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 |

### 15.2.2 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 |

### 15.2.3 Housing Accessories

| Order name | Short name | Order number |
|---|---|---|
| T-bracket for ES600 housing | ES600_H_TB | F 00K 001 925 |

## 15.3 Calibration

**NOTE**

ETAS recommends for measurement modules an calibration interval of 12 months.

## 15.3.1 Factory Calibration

### 15.3.1.1 Calibration Service

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

| Order name | Short name | Order number |
|---|---|---|
| Calibration service for ES930 | C_ES930 | F 00K 114 115 |

### 15.3.1.2 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 ES8930 | A_ES930 | F 00K 106 991 |

## 15.3.2 Accredited Calibration

The accredited calibration service and the accredited adjustment service according to ISO/IEC 17025 are performed in an accredited calibration laboratory[1]. For the module ISO/IEC 17025 compliant calibration certificates[2] are issued.

### 15.3.2.1 Calibration Service

- Verification of measurement accuracy by accredited calibration laboratory
- Issue of an ISO/IEC 17025 calibration certificate

| Order name | Short name | Order number |
|---|---|---|
| DAkkS calibration service for ES850 | DAkkS_C_ES930 | F 00K 114 117 |

### 15.3.2.2 Adjustment Service

- Verification of measurement accuracy by accredited calibration laboratory
- Adjustment of the measuring accuracy to the smallest possible deviation
- Issue of an ISO/IEC 17025 compliant calibration certificates for "pre-adjustment" and "post-adjustment"

| Order name | Short name | Order number |
|---|---|---|
| DAkkS adjustment service for ES930 | DAkkS_A_ES850 | F 00K 114 116 |

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

# 16 Contact Information

## ETAS Headquarters

ETAS GmbH

| | | |
|---|---|---|
| Borsigstraße 24 | Phone: | +49 711 3423-0 |
| 70469 Stuttgart | Fax: | +49 711 3423-2106 |
| Germany | Internet: | www.etas.com |


## ETAS Subsidiaries and Technical Support

For details of your local sales office as well as your local technical support team and product hotlines, take a look at the ETAS website:

| | | |
|---|---|---|
| ETAS subsidiaries | Internet: | www.etas.com/en/contact.php |
| ETAS technical support | Internet: | www.etas.com/en/hotlines.php |

# Figures

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## Symbols



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## D



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## F