



DRIVING EMBEDDED EXCELLENCE

ETAS ES650.1 A/D and Thermo Module User Guide

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1 About this Document

1.1 Classification of Safety Messages

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



DANGER

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



WARNING

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



CAUTION

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

NOTICE

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

1.2 Presentation of Instructions

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

Target definition

1. Step 1
2. Step 2
3. Step 3
- > Result

1.3 Typographical Conventions

Hardware

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

1.4 Presentation of Supporting Information



NOTE

Contains additional supporting information.

1.5 Scope of supply

Prior to the initial commissioning of the module, please check whether the module was delivered with all required components and cables (see chapter 7 on page 40).

Additional cables and adapters can be obtained separately from ETAS. A list of available accessories and their order designation is located in chapter "Accessories" on page 40 of this manual or in the ETAS product catalog.

1.6 Additional information

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

2 Basic safety notices

This chapter contains information about the following topics:

- General safety information 7
- Requirements for users and duties for operators 7
- Intended use 7

2.1 General safety information

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



NOTE

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

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

2.2 Requirements for users and duties for operators

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

The assembler of the system is responsible for the safety of any system incorporating the equipment.

General safety at work

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

2.3 Intended use

Application area of the product

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

Requirements for the technical state of the product

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

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

Requirements for operation

- Use the product only according to the specifications in the corresponding User's Guide. With any deviating operation, the product safety is no longer ensured.



DANGER

The measuring terminals of the module may not be used for measurement of mains voltage!



DANGER

Thermocouples should not be placed on energized parts!

- 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 cord in such a way that it is protected against abrasion, damages, deformation and kinking. Do not place any objects on the power cord!



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 cord or the plug of the power cord at the connection of the module
or
 - Disconnecting the module from the vehicle battery
Separating device is the lab plug of the power cord or the plug of the power cord 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 use any sprays, solvents or abrasive cleaners which could damage the housing.
- Ensure that no moisture enters the housing. Never spray cleaning agents directly onto the module.

Ambient conditions

The housing and the connectors of the module as well as the plug connectors of the cables meet the degree of protection IP20.

Opening the module



CAUTION

Damage to the module and loss of properties based on IP20!

Do not open or change the module housing!

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

Potential equalization



CAUTION

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

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

Cabling

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

3 Hardware Description

This chapter contains information on the following topics:

- ES600 Measurement Modules 12
- ES650.1 A/D and Thermo Module 13
- Package Contents 15
- Housing 15
- Ports and Indicators 16
- Maximum Input and Common-Mode Voltages 19
- Measurement Accuracy 20

3.1 ES600 Measurement Modules

The ES6xx series comprises a range of advanced and powerful measurement and interface modules. All modules are designed for use under harsh environmental conditions and are therefore ideally suited for automotive use. This applies both to the housings of the ES6xx series and all cable connections. The ability of these modules to operate under a wide range of ambient temperatures and power supply voltages further contributes to their suitability for automotive applications.

The compact and rugged housings of the ES6xx series allow easy mounting even under difficult installation conditions. By installing the modules close to the signal source, it is possible to avoid long signal lines that would corrupt measurement signals. The housings of the ES6xx series stack easily to build larger blocks of units.

The measurement modules provide a high sampling rate with high resolution and accuracy. The accuracy is guaranteed across A/D and Thermo Module the entire extensive ambient temperature range.

The interface modules provide the connection to the popular bus systems used in motor vehicles and to various emulator probes (ETK).

Each module is equipped with a powerful Ethernet interface that ensures high-speed data exchange with the host PC.

A synchronization and power management module makes it possible to connect several measurement and interface modules to one Ethernet interface on the host PC. This synchronization and power management module also ensures simultaneous sampling of all measurement channels—even in large module networks. The periodic synchronization signal is superimposed onto the Ethernet signals without affecting data transfer. This excludes the possibility of a phase shift between the individual signals, even when measurements are taken from different modules.

All modules of the ES6xx series have an automatic power saving feature. For this purpose, the modules are equipped with a link signal detector that is controlled directly by the Ethernet interface. As soon as a device connected to the ES650.1 starts to send link signals via the Ethernet interface, the module is

“awakened” from its power-saving standby mode and is ready for operation. When it no longer receives any more link signals, the ES650.1 switches back into standby mode automatically after a delay.

NOTE

The ES650.1 only switches from the power-saving standby mode to operation mode when it receives link pulses via the Ethernet interface. To ensure that a connected PC sends link pulses, its Ethernet adapter must be properly configured. A data transfer via the Ethernet interface automatically switches the ES650.1 into operation mode.

The modules are configured using the INCA's graphical user interface (GUI). INCA also provides you the functionality for data acquisition and data evaluation.

3.2 ES650.1 A/D and Thermo Module

3.2.1 Overview

The ES650.1 is designed to measure analog input voltages and temperatures. It provides you with eight channels for input voltages and eight channels for temperature measurement using thermocouples.

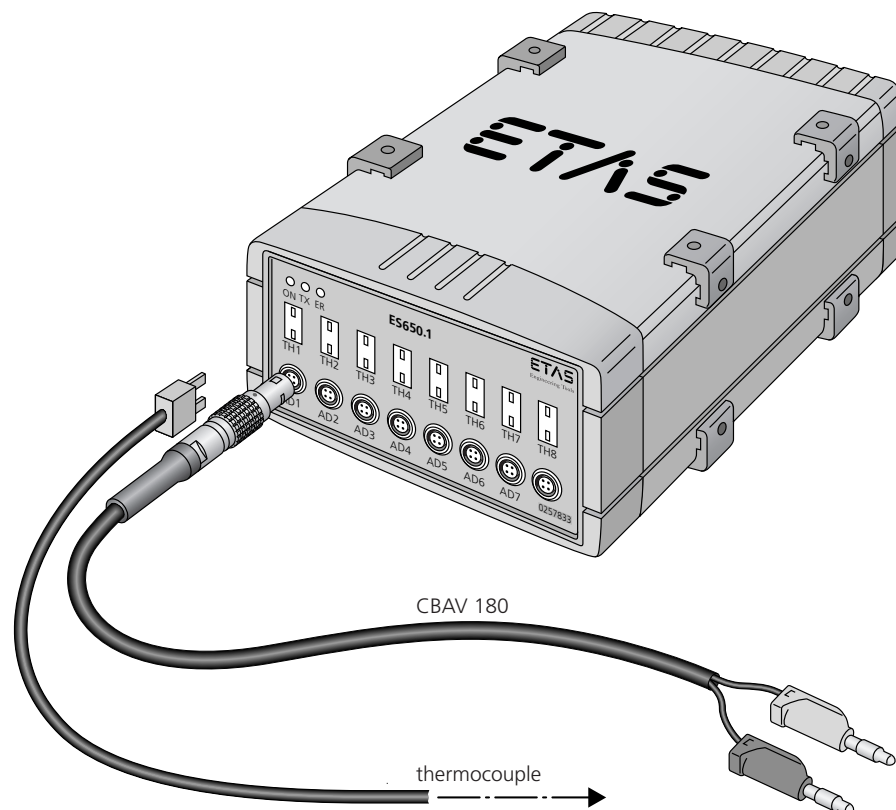


Fig. 3-1 ES650.1 A/D and Thermo Module

The channels for analog input voltages have two input voltage ranges. The resolution is 16 bits, the inaccuracy is 2 mV in the 10 V range or 12 mV in the 60 V range, depending on the input voltage.

The thermocouple channels have a resolution of 21 bits. You can use B-, E-, J-, K-, N-, R-, S- and T-type thermocouples. The maximum measuring range is -210 °C to +1,820 °C. Each thermocouple channel is fitted with a cold junction compensation directly in the connector. This ensures accuracy even when the housing is not heated uniformly. The thermocouples are galvanically isolated from each other and from case ground.

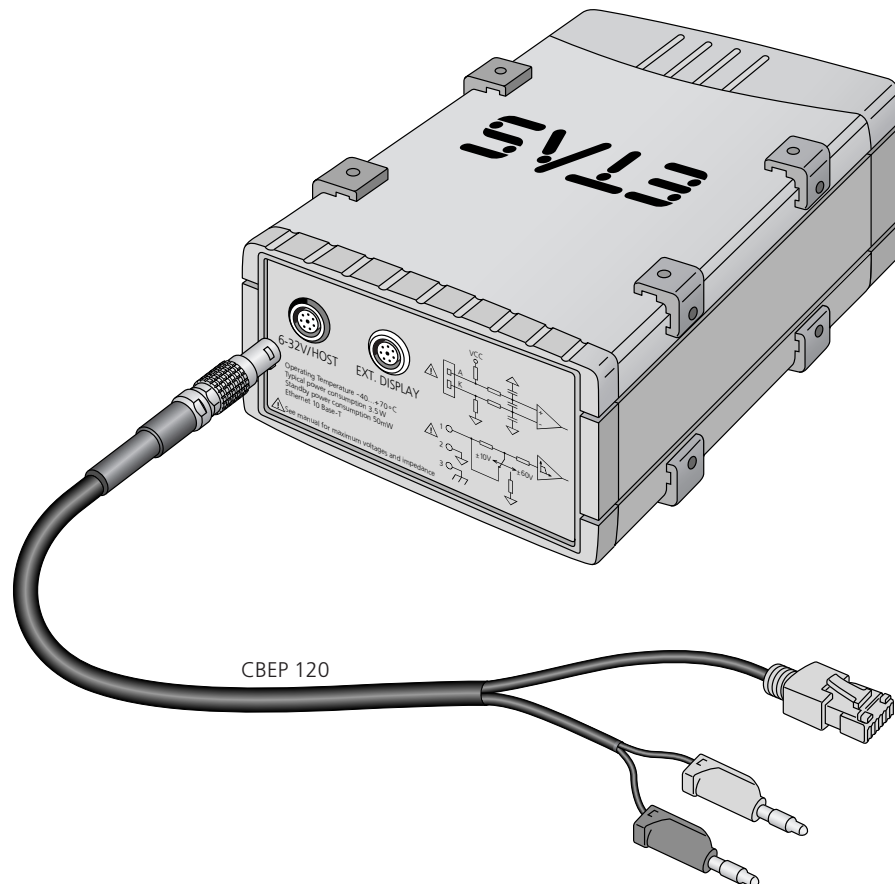


Fig. 3-2 ES650.1 A/D and Thermo Module back panel

3.2.2 Features

Overview of the major features of the ES650.1:

- Eight galvanically isolated measurement channels for analog voltages
- Two measuring ranges of ± 10 V DC and ± 60 V DC
- Eight galvanically isolated measurement channels for thermocouples
- Measuring range from -210 °C to +1,820 °C (depending on type of thermocouple)
- Measurement channels galvanically isolated from each other and from the supply voltage
- Settable acquisition rate per channel

- Parameterized software filters for signal smoothing with adaptive cutoff frequency
- High resolution
- Data transfer via Ethernet
- Synchronous data acquisition
- Automatic power saving feature (standby mode)
- Rugged, functional metal housing
- Member of the ETAS Tool Suite – supported by INCA

For complete technical data of the ES650.1, refer to Chapter “Technical Data” on page 27.

3.3 Package Contents

The ES650.1 is available as two different packages.

- Package variant „ES650.1“ includes the following parts:
 - the ES650.1 A/D and Thermo Module
 - a combined Ethernet cable and power supply cord CBEP110-2, 2 m
 - four T-brackets to daisy-chain the housings
- Package variant „ES650.1-SCB“ includes the following parts:
 - the ES650.1 A/D and Thermo Module
 - four T-brackets to daisy-chain the housings

Additional connection cables for connection to the sensors and extension cables can be ordered separately from ETAS. A list of available accessories and ordering information can be found in Chapter “Ordering Information” on page 40 of this manual or in the ETAS product catalog.

Before using your ES650.1, check that the unit has been delivered with all required parts and cables.

3.4 Housing

The ES650.1 uses a housing with connections on the front and the rear side of the device. The robust metal housing of the ES650.1 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 4.1 on page 22).

3.5 Ports and Indicators

The ES650.1 has three indicators (LEDs), sixteen ports for sensors and transducers, one combined Ethernet/power supply port, and one port for an external display.

3.5.1 Front Side

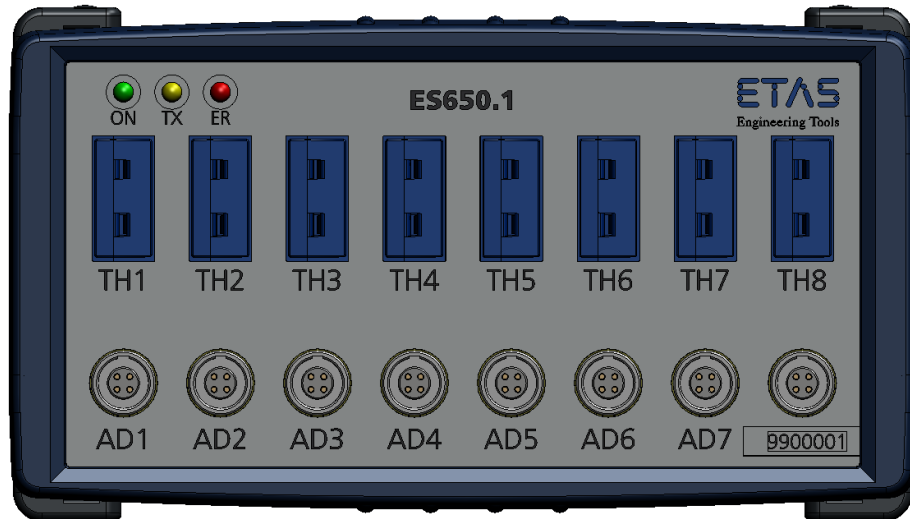


Fig. 3-3 ES650.1 Front panel

Ports

The eight ports TH1 to TH8 for the thermocouples are located in the top terminal row on the front panel. The eight ports AD1 to AD8 for the analog input voltages are located in the bottom terminal row on the front panel.



DANGER

The measuring terminals of the module may not be used for measurement of mains voltage!







DANGER

Thermocouples should not be placed on energized parts!

3.5.2 Indicators

The three indicators (LEDs) are located in the top left corner on the front panel. They indicate the following operational states of the ES650.1:

Indicator	Indication	Operational State
ON	green	The unit is powered on.
	green, blinking 	The unit is in standby mode.
	green, pulse, intermittent brightness 	The unit is synchronizing with the ES600.
TX	yellow	Host connection exists.
	yellow, blinking	Data are being transferred.
ER	red (duration > 5 s)	An error has occurred. Measurement accuracy may be out of specification. Please send the unit to ETAS for service.
	red, bright blinking 	A serious error has occurred. Measurements are no longer possible. Please send the unit to ETAS for repair.
	red, pulse, intermittent brightness 	Device identification activated from INCA.

When enabling the device identification in INCA, the ER LED lights up for 5 s with intermittent brightness. This allows you to identify the device selected in INCA within a device block.

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.

3.5.3 Rear Side

The ports for Ethernet, power supply and the external display are located on the back panel.

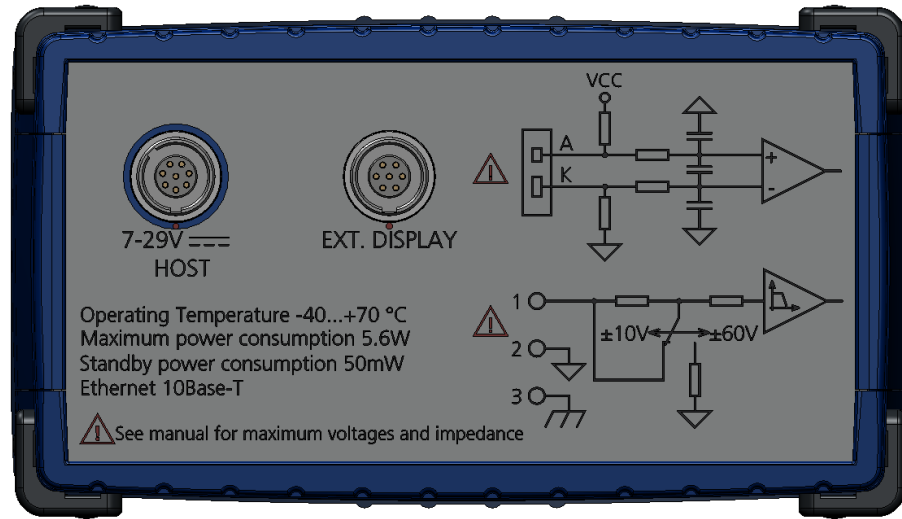


Fig. 3-4 ES650.1 Back panel

Ports

The port for an external display is located on the back panel. The current firmware version does not yet support this external display; however, the port has been built in to provide for future use.

3.6 Maximum Input and Common-Mode Voltages

The maximum input voltage between two inputs and the maximum voltage between an input and case ground is 60 V DC / 30 V AC.

For an explanation of the maximum input and common-mode voltages, see the illustration and example below.

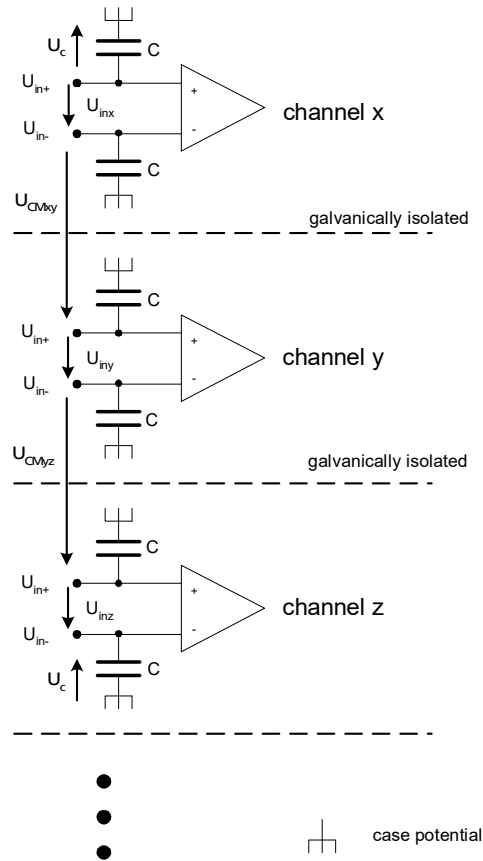


Fig. 3-5 Maximum input and common-mode voltages

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

Example

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

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

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

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

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

$$\max(U_{inx} + U_{iny} + U_{inz} + U_{CMxy} + U_{CMyz}) = 2 U_c = 60 \text{ V}$$

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

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

3.7 Measurement Accuracy

While measuring temperatures with thermocouples the total measurement inaccuracy is determined by different parts. These parts are:

- Basic accuracy ΔT_g
- Temperature drift of thermocouple inputs ΔT_d
- Inaccuracy depending on the internal resistance of the thermocouple ΔT_i
- Inaccuracy of cold junction compensation ΔT_{cjc}
- Temperature drift of cold junction compensation ΔT_{dcjc}

The maximum total inaccuracy is the sum of all parts.

$$\Delta T = \Delta T_g + \Delta T_d + \Delta T_i + \Delta T_{cjc} + \Delta T_{dcjc}$$

The amount of the parts depends on the type of thermocouple. The figures are listed in table "Thermocouple Inputs" on page 33.

Two examples show you how to calculate the maximum total inaccuracy.

Example 1

A thermocouple of type K with an internal resistance R_i of less than 50Ω is used to measure a temperature T_m of $200 \text{ }^\circ\text{C}$ (473.15 K ; $392 \text{ }^\circ\text{F}$) at an ambient temperature T_a of $25 \text{ }^\circ\text{C}$ ($77 \text{ }^\circ\text{F}$).

$$\Delta T_g = (|T_m - T_0| * 0.025 \%) + 0.25 \text{ K}$$

$$\Delta T_g = (|473.15 \text{ K} - 298.15 \text{ K}| * 0.025 \%) + 0.25 \text{ K}$$

$$\Delta T_g = 0.29 \text{ K}$$

$$\Delta T_d = 0.005 \text{ K/K} * |T_a - T_0|$$

$$\Delta T_d = 0.005 \text{ K/K} * |25 \text{ }^\circ\text{C} - 25 \text{ }^\circ\text{C}|$$

$$\Delta T_d = 0.00 \text{ K}$$

$$\Delta T_i = 0 \text{ because the internal resistance is less than } 50 \Omega$$

$$\Delta T_{cjc} = 1 \text{ K}$$

$$\Delta T_{dcjc} = 0.008 \text{ K/K} * |T_a - T_0|$$

$$\Delta T_{dcjc} = 0.008 \text{ K/K} * |25 \text{ }^\circ\text{C} - 25 \text{ }^\circ\text{C}|$$

$$\Delta T_{dcjc} = 0.00 \text{ K}$$

The maximum total inaccuracy is:

$$\Delta T = \Delta T_g + \Delta T_d + \Delta T_i + \Delta T_{cjc} + \Delta T_{dcjc}$$

$$\Delta T = 0.29 \text{ K} + 0.00 \text{ K} + 0.00 \text{ K} + 1 \text{ K} + 0.00 \text{ K}$$

$$\Delta T = 1.29 \text{ K}$$

In this example the maximum total inaccuracy is determined by the inaccuracy of the cold junction compensation.

Example 2

A thermocouple of type K with an internal resistance R_i of 150Ω is used to measure a temperature T_m of $400 \text{ }^\circ\text{C}$ (673.15 K ; $752 \text{ }^\circ\text{F}$) at an ambient temperature T_a of $50 \text{ }^\circ\text{C}$ ($122 \text{ }^\circ\text{F}$).

$$\Delta T_g = (|T_m - T_0| * 0.025 \%) + 0.25 \text{ K}$$

$$\Delta T_g = (|673.15 \text{ K} - 298.15 \text{ K}| * 0.025 \%) + 0.25 \text{ K}$$

$$\Delta T_g = 0.34 \text{ K}$$

$$\Delta T_d = 0.005 \text{ K/K} * |T_a - T_0|$$

$$\Delta T_d = 0.005 \text{ K/K} * |50 \text{ }^\circ\text{C} - 25 \text{ }^\circ\text{C}|$$

$$\Delta T_d = 0.13 \text{ K}$$

$$\Delta T_i = 0.004 \text{ K}/\Omega * R_i$$

$$\Delta T_i = 0.004 \text{ K}/\Omega * 150 \Omega$$

$$\Delta T_i = 0.60 \text{ K}$$

$$\Delta T_{cjc} = 1 \text{ K}$$

$$\Delta T_{dcjc} = 0.008 \text{ K/K} * |T_a - T_0|$$

$$\Delta T_{dcjc} = 0.008 \text{ K/K} * |50 \text{ }^\circ\text{C} - 25 \text{ }^\circ\text{C}|$$

$$\Delta T_{dcjc} = 0.20 \text{ K}$$

The maximum total inaccuracy is:

$$\Delta T = \Delta T_g + \Delta T_d + \Delta T_i + \Delta T_{cjc} + \Delta T_{dcjc}$$

$$\Delta T = 0.34 \text{ K} + 0.13 \text{ K} + 0.60 \text{ K} + 1 \text{ K} + 0.20 \text{ K}$$

$$\Delta T = 2.27 \text{ K}$$

In this example the maximum total inaccuracy is determined by the inaccuracy of the cold junction compensation and the part of the inaccuracy that depends on the internal resistance of the thermocouple.

Determinating the Internal Resistance of a Thermocouple

The internal resistance of a thermocouple can be measured with an ohmmeter.

The error appearing from the enclosed thermo voltage is negligible.

4 Getting Started

This chapter contains information on the following topics:

- Installation and blocking 22
- Cabling 24
- Configuration 26
- Calibration 26

4.1 Installation and blocking

4.1.1 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 5 on page 27).

4.1.2 Fastening the module onto a carrier system

The ES650.1 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 ES650.1:

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.

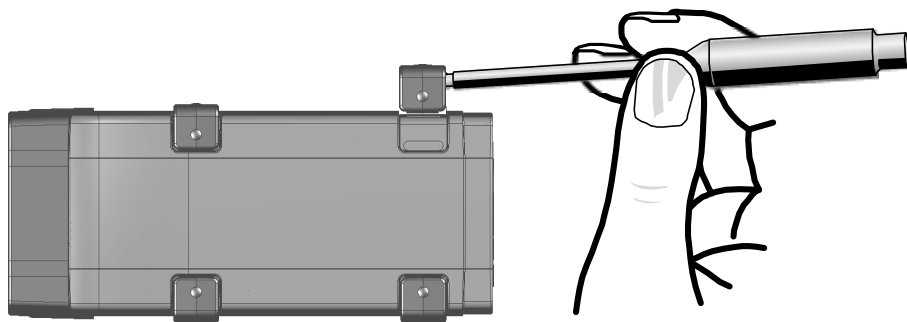


Fig. 4-1 Prying off the plastic foot

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

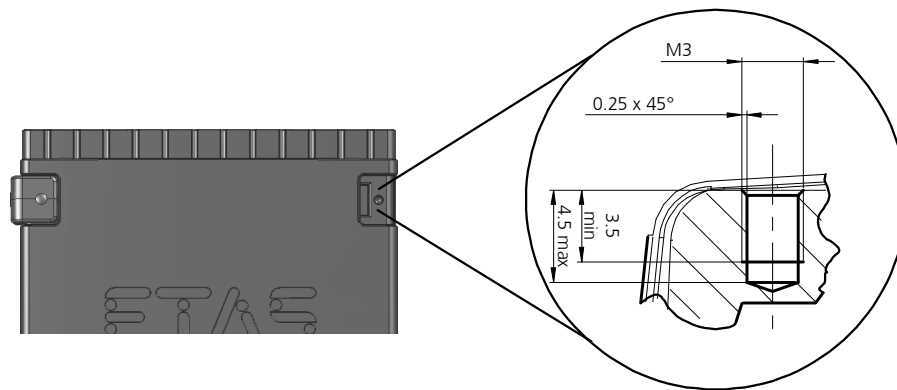


Fig. 4-2 Threaded blind hole



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. 4-2 on page 23).

4.1.3 Connecting several modules mechanically

Because of the use of ETAS system enclosures, the ES650.1 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 ES650.1. 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 ES650.1 to be able to fasten another module.
This exposes the installation openings for the T-connectors.
You can fasten an additional module underneath the ES650.1.
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.

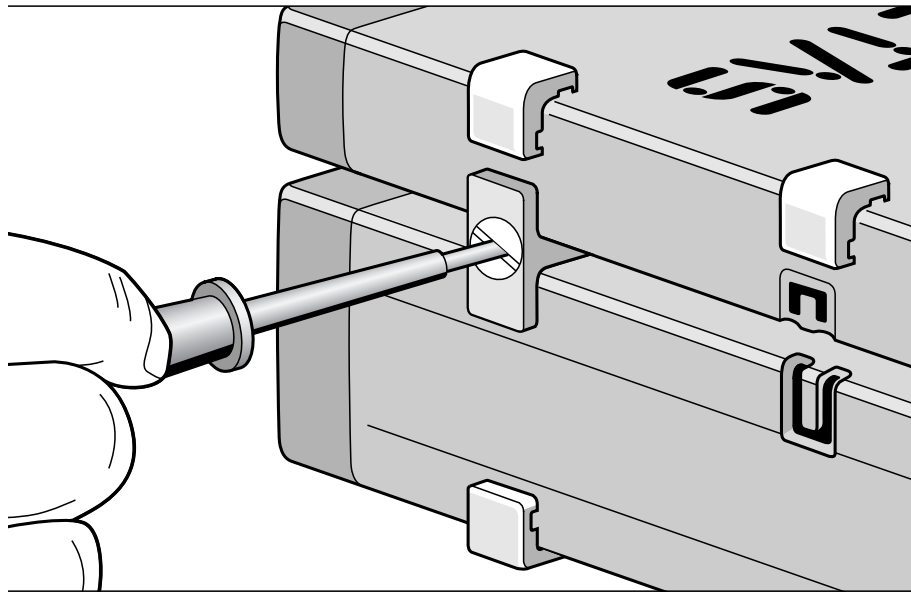


Fig. 4-3 Connecting the ES650.1 with another module

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 and also lock those connectors.
8. If you want to stack additional modules and fasten them on top of each other, repeat the process with the next module.

4.2 Cabling

This section describes how to connect the sensors, transducers and the host PC to your ES650.1 A/D and Thermo Module. For information on how to connect several ES6xx series devices to a host PC, see the ES600 User Manual.

NOTE

The ports of the ES650.1 and of the sensors may carry dangerous voltages even when the unit is powered off. Be sure to check that the ports are dead, before starting the cabling.

NOTE

All cables used for the ES650.1 are rated for a maximum operational voltage of 60 V DC / 30 V AC.

Make sure that the maximum operating voltage of the cables and the maximum input and common-mode voltages are not exceeded under any circumstances.

The connections of the ES650.1 may be cabled in any order.

Special connection cables that can be ordered separately are available for connecting the analog input voltages. An overview is contained in Chapter "Ordering Information" on page 40. To manufacture the connection cables yourself, see the information about pin assignment in Section "Pin Assignment" on page 34. When manufacturing the connection cables yourself, make certain that the shielding and the ground signals are routed properly.

**NOTE**

Carefully check the names of the cables used. The wrong cables can keep your ES650.1 from functioning properly or damage the ES650.1 and devices connected to it.

To use a single ES650.1 on a host PC:

1. Connect the sensors and transducers to the inputs of the ES650.1.
2. Write down which signal you have connected to which input of the ES650.1. Use the configuration sheet in Section "Configuration" on page 43 for this purpose. Be sure not to exceed the maximum allowed input voltages, common-mode voltages, and maximum insulation voltages between the channels.
3. Connect the combined Ethernet cable/power supply cord with the **7-29 V / HOST** port of the ES650.1, observing the color coding of the connectors.
4. Connect the RJ-45 connector with the available Ethernet interface port of your PC.
5. Connect the power supply connector of the combined cable to the power supply you want to use. Observe the current consumption of the ES650.1 and the range of its supply voltage. The allowed values are specified in Section "Electrical Data" on page 32.
6. Start INCA. For information on the configuration and on data acquisition, refer to the INCA Online Help.

To use the ES650.1 with additional ES6xx series devices:

1. To use your ES650.1 with several ES6xx series devices, connect the **7-29 V / HOST** port of the ES650.1 to an ES600 via a CBE130 or a CBE140 cable that can be ordered separately. Be sure to observe the color coding of the connectors. For further information on this, see the ES600 User Manual.
2. Start INCA. For information on the configuration and on data acquisition, refer to the INCA Online Help.

4.3 Configuration

The ES650.1 has no switches or controls. The configuration is exclusively performed by software within INCA.

Write down which signal you have connected to which input of the ES650.1. Use the configuration sheet in Section "Configuration" on page 43 for this purpose. This information will enable you to easily configure your ES650.1 in INCA later on.

4.4 Calibration

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

NOTICE

ETAS recommends a calibration interval of 12 months.

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

Please contact your local ETAS representative for information on obtaining the calibration service (see chapter "Contact Information" on page 44). For information on ordering the calibration service, refer to chapter "Calibration" on page 41.

5 Technical Data







This chapter contains information on the following topics:

- General Data 27
- RoHS Conformity 29
- CE conformity 29
- UKCA conformity 29
- KCC conformity 29
- Taking the Product Back and Recycling 29
- Use of Open Source software 30
- System Requirements 30
- Electrical Data 32
- Pin Assignment 34

5.1 General Data

5.1.1 Product labeling

The following symbols are used for product labeling:

Symbol	Description
	Prior to operating the product, be sure to read the user's guide!
SN: 1234567	Serial number (seven-digit)
Vx.y.z	Hardware version of the product
F 00K 123 456	Ordering number of the product, see chapter 7 on page 40
7-29V ===	Operating voltage range (DC)
$P_{max} = xy \text{ W}$	Power consumption, max.
	Labeling for WEEE, see chapter 5.6 on page 29
	Marking for CE conformity (Chapter 5.3 on page 29)
	Marking for UKCA conformity (Chapter 5.4 on page 29)
	Marking for KCC conformity (Chapter 5.5 on page 29)
	Labeling for RoHS (China), see chapter on page 29

5.1.2 Fulfilled 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 61000-6-3	Emission standard (residential, commercial and light-industrial environments)
EN 60 068-2-30	
EN 60 068-2-14 Na	
EN 60 068-2-14 Nb	
EN 60 068-2-6	
EN 60 068-2-27	

5.1.3 Environmental Conditions

Operating temperature range	-40 °C to +70 °C/ -40 °F to +158 °F
Storage temperature range	-40 °C to +85 °C/ -40 °F to +185 °F
Relative humidity (non-condensing)	0 to 95%
Implementation altitude	max. 5000 m/ 16400 ft
Protection Class	IP20
Degree of pollution	2



NOTE

The module is suited for use in interiors, in the passenger compartment or in the luggage compartment of vehicles. The ES650.1 is **not** suited for installation in the engine compartment and similar environments.

5.1.4 Maintenance the Product

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

5.1.5 Cleaning the product

We recommend to clean the product with a dry cloth.

5.1.6 Mechanical Data

Dimensions (H x W x D)	72 mm x 126 mm x 160 mm
Weight	1,085 g

5.2 RoHS Conformity

European Union

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

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

China

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

5.3 CE conformity

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

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

5.4 UKCA conformity

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

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

5.5 KCC conformity

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

5.6 Taking the Product Back and Recycling

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

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



Fig. 5-1 WEEE Symbol

The WEEE symbol (see Fig. 5-1 on page 29) 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 "Contact Information" on page 44).

5.7 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.

5.8 System Requirements

5.8.1 Hardware

Operating the ES650.1 module requires a DC voltage supply of 7 V to 29 V.

PC with one Ethernet interface

A PC with one open Ethernet interface (10 Mbit/s, full duplex) with RJ-45 connection is required. Ethernet interfaces that are implemented with an additional network card in the PC must feature a 32-bit data bus.

Requirement to ensure successful initialization of the module



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

To deactivate the power saving mode

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

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

Example:

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

5.8.2 Software

INCA V4.0 and higher is required for the configuration of the ES650.1 and for control and data acquisition. INCA V5.2.1 and HSP4.1 are required for use of B-, E-, R-, S- and T-type thermocouples. It is not possible to run the ES650.1 with earlier INCA versions.

5.9 Electrical Data

5.9.1 Power Supply

Operating voltage (reverse-polarity protected)	7 to 29 V \pm 10 % (DC); load-dump protected
Power consumption (operation)	max. 5.6 W
Power consumption (standby)	typ. 50 mW
Fuse	MINI, fast, 58 V, 3 A

5.9.2 Host Interface

Port	Base-T Ethernet; 10 Mbps
Protocol	TCP/IP
IP address	dynamic via INCA

5.9.3 Analog Voltage Inputs

Resolution	16 bits, higher at slower sampling rates
Sampling rate	0.5 to 2000 samples/sec, configurable for each channel
Input voltage ranges	-10 V to +10 V (DC) -60 V to +60 V (DC)
Maximum input voltage	Input-to-input: 60 V DC / 30 V AC Input-to-ground of voltage supply or housing: 60 V DC / 30 V AC
Hardware input filter	4th order low-pass, Cutoff frequency 1 kHz, max. overshooting 3%
Digital low-pass filter	Digital Bessel 2nd order low-pass with adjustable cutoff frequency, can be disabled Automatic: 0.5 times sample rate Manual: between 1 Hz and 1 kHz with an resolution of 1 Hz
Input impedance	> 15 M Ω 1 nF in \pm 10 V measuring range; 2 M Ω 1 nF im \pm 60 V measuring range
Maximum inaccuracy	0.05% + 2 mV in \pm 10 V measuring range; 0,05% + 12 mV in \pm 60 V measuring range
Maximum temperature drift	10 ppm / K

5.9.4 Thermocouple Inputs

Resolution	21 bits; corresponding to 0.01 K for J-, K- and N-type thermocouples
Sampling rate	0.1 to 10 samples/sec, configurable for each channel
Measuring range	+250 to +1820 °C (type B) -200 to +1000 °C (type E) -210 to +1200 °C (type J) -200 to +1372 °C (type K) -200 to +1300 °C (type N) -50 to +1768 °C (type R) -50 to +1768 °C (type S) -200 to +400 °C (type T)
Cutoff frequency	10 Hz
Input impedance	> 10 M Ω 10 nF
Maximum inaccuracy ΔT_g	0.050 % + 5.00 K for type B 0.050 % + 0.20 K for type E 0.030 % + 0.20 K for type J 0.025 % + 0.25 K for type K 0.035 % + 0.38 K for type N 0.050 % + 2.0 K for type R 0.050 % + 2.0 K for type S 0.050 % + 0.30 K for type T
Maximum temperature drift ΔT_d	± 0.1 K/K for type B ± 0.0040 K/K for type E ± 0.004 K/K for type J ± 0.005 K/K for type K ± 0.008 K/K for type N ± 0.0400 K/K for type R ± 0.0400 K/K for type S ± 0.0050 K/K for type T
Maximum inaccuracy ΔT_i depending on the internal resistance of the thermocouple at internal resistances > 50 Ω	± 0.0800 K/ Ω for type B ± 0.0030 K/ Ω for type E ± 0.003 K/ Ω for type J ± 0.004 K/ Ω for type K ± 0.006 K/ Ω for type N ± 0.0300 K/ Ω for type R ± 0.0300 K/ Ω for type S ± 0.0040 K/ Ω for type T
Maximum inaccuracy of cold junction compensation ΔT_{cjc}	± 1 K
Possible increased measurement error under influence of electromagnetic fields in industrial environments ΔT_{emc}	+16 K /-45 K
Maximum temperature drift of cold junction compensation ΔT_d	± 0.008 K/K
Maximum allowed input voltage	32 V DC

Reference temperature T_0 for ΔT_g , ΔT_d and ΔT_d is 25 °C (equivalent to 298.15 K).

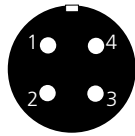
5.10 Pin Assignment

This section specifies the pin assignment of the electrical connectors of the ES650.1. All connectors are shown as seen on the front or back panel of the ES650.1.

NOTE

All shieldings are at case potential. The housings are galvanically isolated from all inputs and outputs. The maximum allowed voltage between the case potential, the inputs and outputs, as well as between all inputs and outputs themselves is 60 V DC / 30 V AC.

5.10.1 Analog Inputs



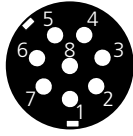
Pin	Signal	Meaning
1	Uin+	Input voltage, plus
2	Uin-	Input voltage, minus
3	GND	Case ground
4	nc	free

5.10.2 Thermocouple Inputs



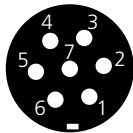
Pin	Signal	Meaning
A	Anode	Anode of thermocouple (+)
K	Cathode	Cathode of thermocouple (-)

5.10.3 Ethernet Interface, Power Supply



Pin	Signal	Meaning
1	Ubatt+	Supply voltage, plus
2	Ubatt+	Supply voltage, plus
3	Ubatt-	Supply voltage, minus
4	RX+	Receive data, plus
5	TX-	Send data, minus
6	RX-	Receive data, minus
7	Ubatt-	Supply voltage, minus
8	TX+	Send data, plus

5.10.4 External Display



Pin	Signal	Meaning
1	STBY5V	Supply voltage, standby, 5 V
2	RX	Receive data
3	TX	Send data
4	DTRE	Ready to receive
5	GND	Ground
6	GND	Ground
7	VCC5	Supply voltage, 5 V




NOTE

The current firmware version does not yet support the external display.

6 Cables and Accessories

This chapter contains information on the following topics:

- Measuring Cable 36
- Adapter Cable with BNC Plugs 36
- Ethernet Cable/Power Supply Cable 37

 **NOTE**

Only use ETAS cables at the interfaces of the ES650.1. The maximum admissible cable lengths must be adhered to.

6.1 Measuring Cable

6.1.1 Measuring Cable with Banana Plugs

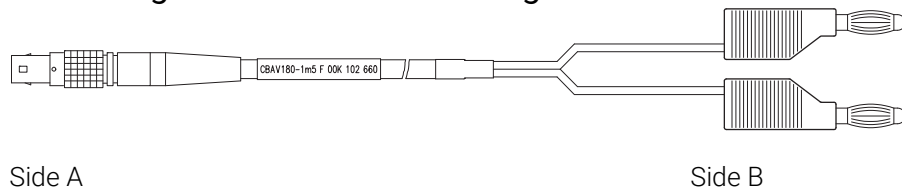


Fig. 6-1 CBAV180-1m5 Cable

Product	Length	Order Number
CBAV180-1m5	1.5 m	F 00K 102 660

6.1.2 Measuring Cable with BNC Plugs

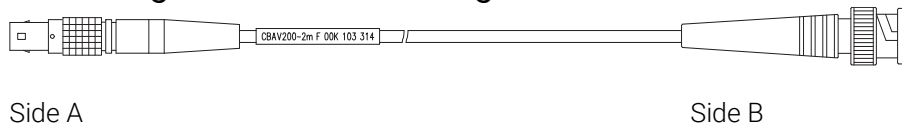


Fig. 6-2 CBAV200-2 Cable

Product	Length	Order Number
CBAV200-2	2 m	F 00K 103 314

6.2 Adapter Cable with BNC Plugs

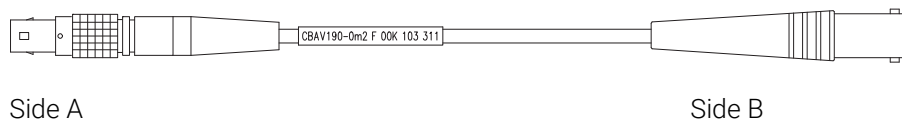



Fig. 6-3 CBAV190-0m2 Adapter

Product	Length	Order Number
CBAV190-0m2	0.2 m	F 00K 103 311

6.3 Ethernet Cable/Power Supply Cable



DANGER

Dangerous electrical voltage!
 Connect the power cable only with a suitable vehicle battery or with a suitable lab power supply! The connection to power outlets is not allowed!
 To prevent an inadvertent insertion in power outlets, ETAS recommends to equip the power cables with safety banana plugs CBEP1105 or CBEP1205 in areas with power outlets.

6.3.1 Y-Cable (ES650.1 in Stand-alone Mode)

CBEP110

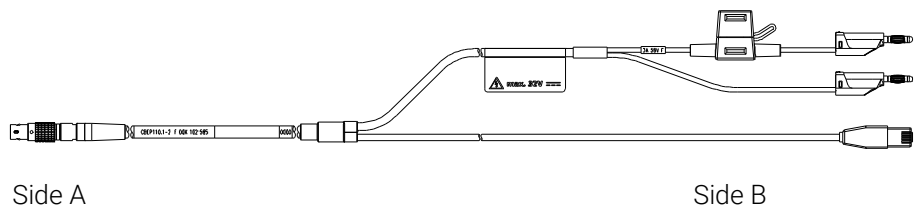


Fig. 6-4 CBEP110-2 Cable

Product	Length	Order Number
CBEP110-2	2 m	F 00K 102 585

CBEP1105

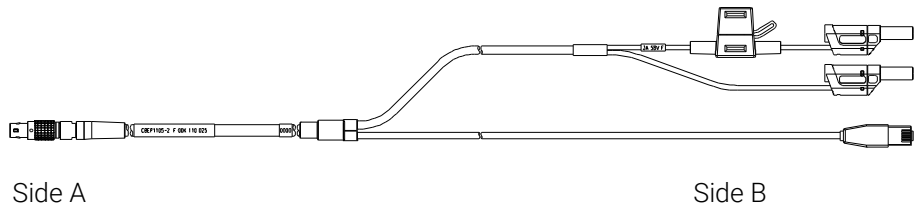


Fig. 6-5 CBEP1105-2 Cable

Product	Length	Order Number
CBEP1105-2	2 m	F 00K 110 025

CBEP120

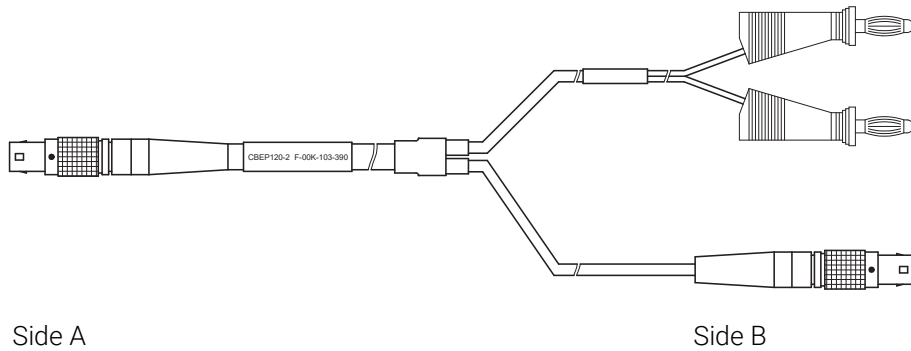


Fig. 6-6 CBEP120-2 Cable

Product	Length	Order Number
CBEP120-2	2 m	F 00K 103 390

CBEP1205

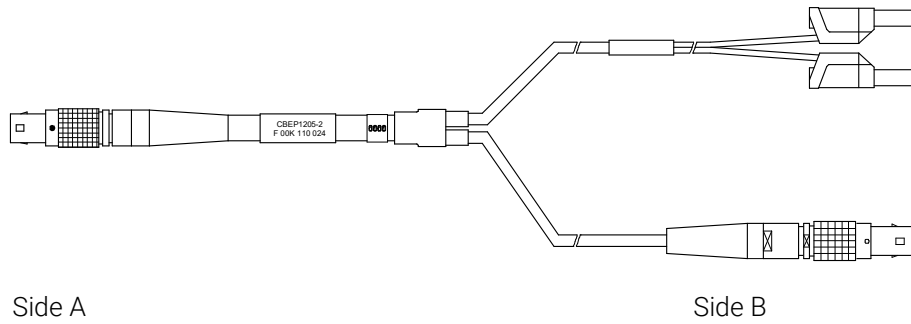


Fig. 6-7 CBEP1205-2 Cable

Product	Length	Order Number
CBEP1205-2	2 m	F 00K 110 024

6.3.2 Connecting Cables to the ES600.1

CBE130 (Straight Cable)

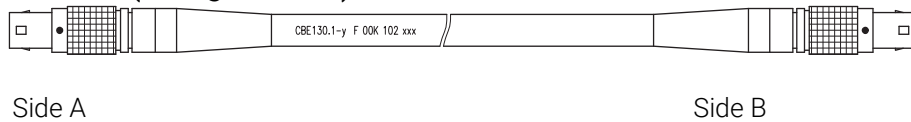


Fig. 6-8 CBE130-x Cable

Product	Length	Order Number
CBE130-0m45	0.45 m	F 00K 102 748
CBE130-1	1 m	F 00K 102 588
CBE130-3	3 m	F 00K 102 587
CBE130-8	8 m	F 00K 102 586

CBE140 (Angled Cable)

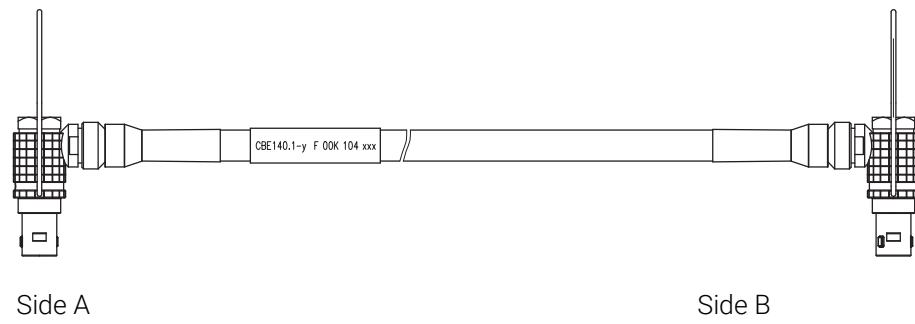


Fig. 6-9 CBE140-0m45 Cable

Product	Length	Order Number
CBE140-0m45	0.45 m	F 00K 104 153
CBE140-1	1 m	F 00K 104 154
CBE140-3	3 m	F 00K 104 155
CBE140-8	8 m	F 00K 104 156

7 Ordering Information

7.1 ES650.1

Order Name	Short Name	Order Number
ES650.1 Module, Cable CBEP110-2, 4 T-Brackets for ES600 Housing	ES650.1	F 00K 102 751
ES650.1 Module, 4 T-Brackets for ES600 Housing	ES650.1-SCB	F 00K 104 056

7.2 Accessories

Combined Ethernet Cable and Power Supply Cord (Y-Cable)

Connectors	Length	Short Name	Order Number
RJ-45, Banana - Lemo	2 m	CBEP110-2	F-00K-102-585
RJ-45, Safety Banana - Lemo	2 m	CBEP1105-2	F-00K-110-025
RJ-45, Banana - Lemo	2 m	CBEP120-2	F-00K-103-390
RJ-45, Safety Banana - Lemo	2 m	CBEP1205-2	F-00K-110-024

Combined Ethernet Cable and Power Supply Cord (Straight)

Connectors	Length	Short Name	Order Number
Lemo - Lemo	0.45 m	CBE130-0m45	F-00K-102-748
	3 m	CBE130-3	F-00K-102-587

Combined Ethernet Cable and Power Supply Cord (Angled)

Connectors	Length	Short Name	Order Number
Lemo - Lemo	0.45 m	CBE140-0m45	F-00K-104-153
	1 m	CBE140-1	F-00K-104-154
	3 m	CBE140-3	F-00K-104-155
	8 m	CBE140-8	F-00K-104-156

Measuring Cable with Banana Plugs

Connectors	Length	Short Name	Order Number
Banana - Lemo	1.5 m	CBAV180-1m5	F-00K-102-660
Banana - Lemo Set of 8 CBAV180-1m5	1.5 m	CBAV180- 1m5_SET8	F-00K-103-107
Banana - Lemo Set of 16 CBAV180-1m5	1.5 m	CBAV180- 1m5_SET16	F-00K-103-106

Adapter Cable with BNC Plugs

Connectors	Length	Short Name	Order Number
BNC - Lemo	0.2 m	CBAV190-0m2	F-00K-103-311
BNC - Lemo Set of 8 CBAV190-0m2	0.2 m	CBAV190- 0m25_SET8	F-00K-103-313
BNC - Lemo Set of 16 CBAV190-0m2	0.2 m	CBAV190- 0m2_SET16	F-00K-103-312

Measuring Cable with BNC Plugs

Connectors	Length	Short Name	Order Number
BNC - Lemo	2 m	CBAV200-2	F-00K-103-314
BNC - Lemo Set of 8 CBAV200-2	2 m	CBAV200- 2_SET8	F-00K-103-327
BNC - Lemo Set of 16 CBAV200-2	2 m	CBAV200- 2_SET16	F-00K-103-326

Housing

Description		Short Name	Order Number
T-bracket for housing	-	ES600_H_TB	F-00K-001-925
Unit feet	-	ES600_H_F	F-00K-001-924

7.2.1 Calibration

NOTICE

ETAS recommends a calibration interval of 12 months.

7.2.1.1 Factory calibration

Factory calibration service

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

Order name	Short name	Order number
Calibration service for ES650	C_ES650	F-00K-112-746

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 ES650	A_ES650	F-00K-103-110

7.2.1.2 Accredited calibration

Accredited calibration service according to ISO/IEC 17025

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

Order name	Short name	Order number
DAkkS calibration service for ES650	DAkkS_C_ES650	F-00K-112-788

Accredited adjustment service according to ISO/IEC 17025

- Verification of measurement accuracy by accredited calibration laboratory¹
- Adjustment of the measuring accuracy to the smallest possible deviation
- Issue of internationally recognized, ISO/IEC 17025 compliant calibration certificates for "pre-adjustment" and "post-adjustment"²

Order name	Short name	Order number
DAkkS adjustment service for ES650	DAkkS_A_ES650	F-00K-111-156

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

8 Configuration

The following form can be used to note the individual connections to your ES650.1. These data will assist you in configuring your ES650.1 in INCA later on.

Copy this page and fill out the tables when cabling your measuring system. Since INCA identifies the modules by their serial number, be sure to enter the serial number of your ES650.1.

Device type	ES650.1 A/D and Thermo Module
Serial number	

Analog Input Voltages

No.	Chan.	Name	Physical Variable	Measuring Range/V
1		AD1		
2		AD2		
3		AD3		
4		AD4		
5		AD5		
6		AD6		
7		AD7		
8		AD8		
9		TH1		
10		TH2		
11		TH3		
12		TH4		
13		TH5		
14		TH6		
15		TH7		
16		TH8		

9 Contact Information

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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

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