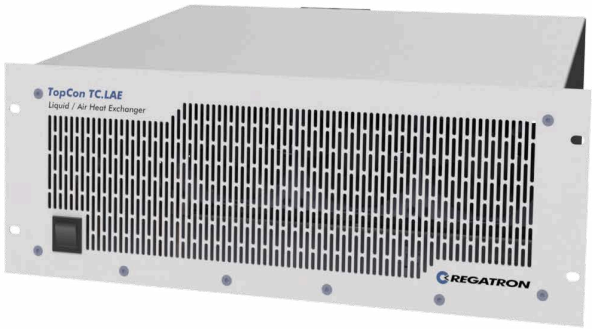
REGATRON
programmable power supplies

TC.ACS

Regenerative Grid Simulator

(optional Liquid to Air Heat Exchanger TC.LAE included)



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General Information

Usage of the Document

This document serves as a guide and also as a reference work. Familiarize yourself with the contents of the document to operate the product efficiently. The document must be available at all times to the personnel who are operating the product.

Copyright Information

The information in this documentation corresponds to the development situation at the time of going to print and is therefore not of a binding nature. Regatron AG reserves the right to make changes at any time for the purpose of technical progress or product improvement, without stating the reasons. In general we refer to the applicable issue of our “Terms of delivery”.

Customer Support

If you have any questions, your Regatron AG sales partner will be pleased to be of assistance. However, you can also reach Regatron Customer Support at **support@regatron.com**.

*For more information on Regatron Customer Support see section **6.2**.*

1 General Safety Information

1.1 Warning and Mandatory Symbols

Throughout this document the following symbols are used, wherever necessary, to indicate and specify hazardous or potentially hazardous situations:

Symbol	Indication
 **DANGER**	Indicates an immediate hazardous situation which, if not avoided, will result in death or serious injury
 **WARNING**	Indicates a possible hazardous situation which, if not avoided, could result in death or serious injury.
 **CAUTION**	Hazardous situation which, if not avoided, could result in minor or moderate injury
NOTICE	Hazardous situation which, if not avoided, could result in damage to the product or other items in its surroundings
	Hazard due to high voltage
	Hazard due to suspended load
	Hazard due to hot surface
	Hazard due to a substance or mixture of substances which cause eczema, allergies or poisoning. Avoid contact with skin!
	Potentially lethal hazard due to a substance or a mixture of substances. Do not touch, do not swallow, do not breathe in!
	Wear a helmet!
	Wear a light breathing protection for low concentrated short-term steams, fumes or aerosols!
	Wear protective gloves!

1.2 Ordinances and Regulations

Follow the mounting and installation instructions during electrical installation!

In particular, in the countries of the European Union the following standard applies:

EN 62477-1 Safety requirements for power electronic converter systems and equipment

If you want to use the electrical power supply in special applications, you must comply with the related standards and health and safety regulations.

Due to the high operating voltage and the high output voltages, an industrial electrical power supply represents a mortal hazard.

To avoid serious injuries or significant damage, only appropriately qualified personnel who are familiar with industrial electrical power supplies are allowed to work on the devices. These individuals must carefully read these operating instructions prior to installation and commissioning and follow the safety instructions.

Electronic devices are in principle not fail-safe. The user is responsible for ensuring that the electrical power supply, mains supplies and loads connected to it are placed in a safe state in the event of a failure of the device.

1.3 Categorization of the hazard Areas

The assessment of the effects of hazards from low-voltage systems with a flow of energy for supply and possibly regeneration is divided into the following areas:

- Personnel Area (1.3.1)
- Systems and Material Area (1.3.2)
- Mains Connection Area (1.3.3)
- Surrounding Area (1.3.4)
- Area related to Interaction with the Device (1.3.5)

1.3.1 Personnel Area

The utmost attention is to be paid to the hazards for individuals. There are various risks and hazards, the most important of which are mentioned here.

1.3.1.1 Electric shock

The system can produce electrical potentials that can be dangerous or even fatal for individuals. During work on the system the following guidelines are to be observed:

- Work in electrically isolated state

  This is the recommended way of working, it should be rigorously applied during all connection and wiring work. Follow the rules:

  - Electrically isolate.
  - Secure against switching back on.
  - Discharge and short-circuit capacitors, disconnect and isolate batteries.
  - Verify the voltage free status by measurement.
  - Connect to earth.
  - Report and instruct.

- Work in the vicinity of live parts

  In these circumstances an increased hazard potential is to be expected. Minimize the risks by means of:

  - Guards
  - Covers
  - Insulating encapsulation, cladding
  - Imposed separation by means of mechanical features, protective grilles
  - Supervision, reporting

- Work on live equipment

  It is imperative that this form of working is avoided. If it cannot be avoided, careful work preparation is essential. Pay attention to the following:

  - The personnel must be specially trained.
  - Work in accordance with recognized specialist methods.
  - Controlled personal protective equipment must be available (passive protection).
  - Organization of the working areas.
  - Supervision and preparatory measures (active protection).
  - Use appropriate protection against physical contact throughout.
  - Set up a suitable emergency stop chain and test it at regular intervals.
  - Mark all wires and cables to prevent mistakes.

1.3.1.2 Electrical Heating

TC.ACS power supply systems operate with significant amounts of energy. High currents can cause heating of cables and wires. In particular, during unmonitored endurance tests insulation fires and short-circuits may be caused.

- At particular risk are connectors, switchgear and cable terminals. Check these parts particularly carefully and at regular intervals.
- Use wiring material suitable and stipulated for your application with the related insulation class.
- Monitor your system actively or passively using appropriate sensors or by monitoring parameters.

1.3.1.3 Arcing and sparking on opening Contacts

Note that on opening a circuit through which a current is flowing, arcing with very high energies can be produced depending on the inductance!

In some circumstances this arcing can result in burns, damage to the eyes as well as damage, destruction or fire on parts of the system. The usage of appropriate DC contactors as isolating devices in DC circuits is recommended! In case of doubt contact the related manufacturer. Take into consideration that the protective devices on the TC.ACS system cannot detect an arc as a fault condition, as this situation may be a required function.

1.3.1.4 Mechanical Injury

As on all electrical installations, mechanical injuries to the head and hands may be caused on removing and fitting covers, wire and cable connections. Always use the correct tool. If necessary protect the head and hands against injuries due to cuts and impacts.

1.3.1.5 Chemical Injury

While handling with cooling liquid, open doors and windows and ensure the room is well ventilated also on the ground level. Avoid work which leads to the formation of aerosols. Use, if necessary the personal safety equipment:

- Use the respiratory protection at short time and existing low concentrations of vapor and aerosols. Use breathing apparatus with independent air supply at long time and high concentrations of vapor and aerosols.
- Use protective gloves which are resistant against acids and solvents and safety gloves to avoid direct skin contact.

1.3.2 Systems and Material Area

1.3.2.1 Fire

TC.ACS power supply systems are manufactured from nonflammable materials exclusively.

In case of fire, electrically isolate the system immediately, on the one hand to interrupt the supply of energy and on the other hand to shut down the fans.

Fight the fire from bottom to top in accordance with the rules in your organization using suitable firefighting equipment (CO_2 fire extinguisher). If possible use fire extinguishers with asphyxiation action to keep the secondary damage low.

1.3.2.2 Electromagnetic Fields

Like any electrical system, TC.ACS systems produce electrical and magnetic fields. However, these fields comply fully with the usual standards.

Note that particularly the EM fields from your wires and equipment connected could nevertheless produce interference on objects in the immediate area.

- Keep data carriers and PC-based measuring environments at an adequate distance from live wires to prevent interference and data loss.
- Protect highly-sensitive sensors and instruments.
- Test effects on communication networks, in particular radio networks.
- Make individuals with electronic implants aware that implants may be affected.

1.3.2.3 Noise and Noise Level

The inductive elements as well as the fans on the TC.ACS low voltage system produce a lower or higher noise level dependent on the operating mode. However, in the immediate vicinity of the cabinet this noise is under the tolerance limit that would make acoustic protection equipment necessary.

The usage of acoustic protection equipment or acoustic insulation measures can be necessary in specific circumstances.

1.3.2.4 Mechanical Damage

Incorrect operation of the systems can result in mechanical damage to the downstream equipment and systems. In particular, on the supply of power to drives it is to be ensured, that excessively high speeds cannot result in load shedding. The monitoring of the maximum speed with intervention in the safety chain is recommended above all.

1.3.2.5 Handling Storage Systems containing large Amounts of Energy

Modern energy storage systems are able to absorb very large amounts of energy. This situation has the following consequences:

- The cabling should not just comply with the maximum charging and discharging currents to be expected, to some extent significantly higher peak currents are to be expected during switching processes.
- A short circuit or failure can be very serious in the case of storage elements containing large amounts of energy. Due to the high currents serious injuries and serious damage can be caused. The following, incomplete list indicates some of this damage:
  - Burning of wires and connectors
  - Sparking
  - Fires, insulation fires
  - Arcing, welding
  - Electric shocks
- Never short-circuit energy storage systems to discharge them! Always use a suitable discharge resistor of appropriate power rating!
- Visibly secure a discharged energy storage element using a short-circuit bridge.
- Always monitor the maximum storage element voltage, also during practical test operation.
- Use a device that clearly indicates the charge state of the energy storage element, e.g. by monitoring the voltage.

1.3.3 Mains Connection Area

When a TC.ACS power supply device is switched on, there may be an uneven load on the three phases; this uneven load may cause older residual current circuit breakers to trip. Here a modern make of residual current circuit breaker is to be used that will tolerate such asymmetries during the switch-on process.

1.3.4 Surrounding Area

TC.ACS power supply devices are generally forced-air cooled (some are water-cooled in addition). Despite the very high efficiency, a power loss occurs in the components that must be dissipated in the form of heat to the surroundings. The energy is dissipated with the aid of forced ventilation to the rear of the TC.ACS device. It is to be ensured that the rooms in which TC.ACS power supply devices operate are cool so that the heat produced can be removed. It is to be ensured that there are no undesirable effects (e.g. stirring up of dust or sand, deformation due to the action of heat etc.) due to the flow of air and the heat, which at high load may be powerful.

1.3.5 Area related to Interaction with the Device

Compliance with the design data for the specific device is a prerequisite for malfunction-free operation. Load systems can have significant effects on the power source. The following points are to be noted:

- The maximum voltage specified must not be exceeded.
- Protective measures must be provided against voltage spikes on the load side and their function must be monitored (voltage spikes could damage the filter capacitors and semiconductors in the device).
- Periodic over currents are to be avoided.
- The ripple currents produced on the load side are to be monitored to avoid overloading filter capacitors; in case of doubt ask the manufacturer.
- The device is always to be operated within the permissible temperature range. High temperatures will significantly reduce the service life of various components.

2 Introduction

This section includes the following subsections:

- Range of Application (2.1)
- Control Interface (2.2)
- Multi-Device System (2.3)
- Model Identifier (2.3)

2.1 Range of Application

The TC.ACS Regenerative Grid Simulator allows for all relevant testing according to the grid-feed-in regulations (CENELEC, DIN, IEC). It can be operated in the following modes:

- Waveform Generator Mode (2.1.1)
- Amplifier Mode (2.1.2)
- Load Simulation Mode (Option) (2.1.3)

Generally, the TC.ACS device supports the Source Mode and the Sink Mode. Here the sign of the power determines the direction of the energy flow, and thus which of the two modes is active.

Alternating grids change between source mode and sink mode according to their reactive power by phase shifting between voltage and current.

2.1.1 Waveform Generator Mode

There are the following kinds of the waveform generator mode:

- Basic Waveform Generator Mode (2.1.1.1)
- Full Waveform Generator Mode (Option) (2.1.1.2)

2.1.1.1 Basic Waveform Generator Mode

In the basic waveform generator mode the TC.ACS device simulates a grid. I.e. it generates a signal waveform that resembles the signal given by a grid, i.e. a sine wave. This signal can be configured and controlled via ACSControl.

2.1.1.2 Full Waveform Generator Mode (Option)

In the full waveform generator mode the TC.ACS device simulates a grid or any other kind of electrical source. I.e. it generates signal functions that resemble those being generated by the respective source. Here ACSControl allows to generate all kinds of signal waveforms and sequences of these in order to represent the influences of various factors (e.g. failures or interferences in the power system).

2.1.2 Amplifier Mode

In the amplifier mode the TC.ACS device works as a triphase voltage or current (option) amplifier. I.e. it receives external signals via its analogue interfaces for each phase. These signals are amplified and then transferred to the output. Here any device, which creates electrical signals, can be used as an external signal generator.

2.1.3 Load Simulation Mode (Option)

In the load simulation mode the TC.ACS device simulates loads and their properties within specified RLC-circuit topologies.

	The load simulation mode is an optional feature. It needs to be enabled via key code and an external hardware filter may be needed in some applications (see Application Notes). Contact Regatron Customer Support, if necessary.

2.1.4 Source Mode

In the source mode energy flows from the mains to the device under test (DUT):

2.1.5 Sink Mode

In the sink mode energy flows from the device under test (DUT) to the mains:

2.2 Control Interface

The TC.ACS device can be operated via a PC with the software ACSControl, exclusively.

	The software ACSControl is included in the scope of delivery.

2.3 Model Identifier

	The model identifier is given on the type plate on the rear of the device.

For a specific TC.ACS device the model identifier holds the following information:

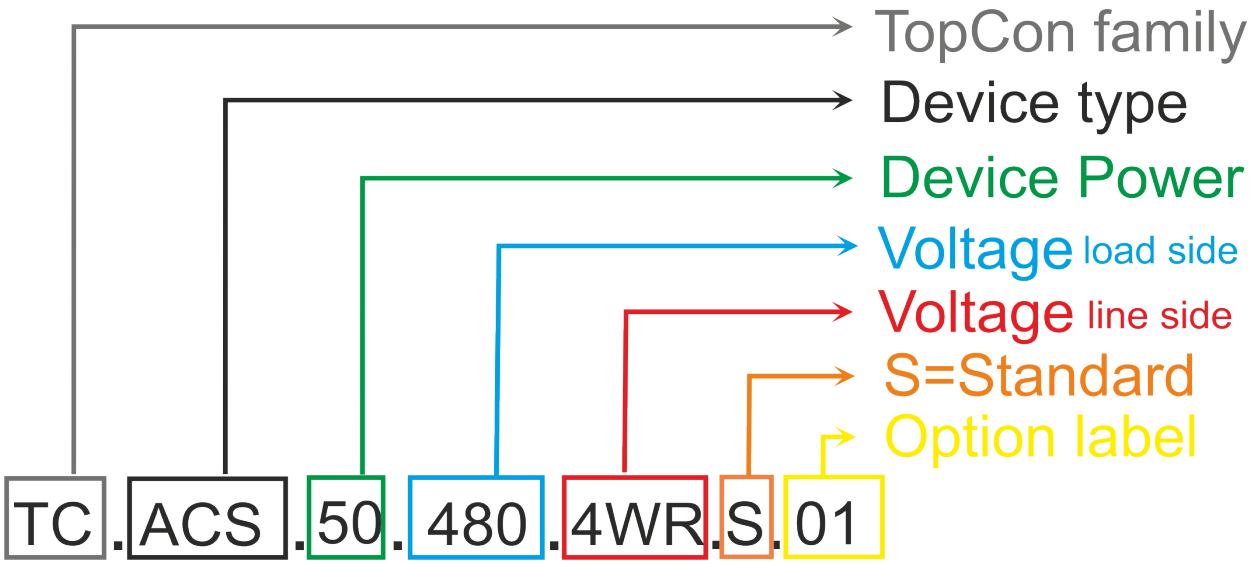


Fig. 1: *Model identifier (example)*

	Detailed information on your product variant is given in the related data sheet.

2.4 Multi-Device System

2.4.1 Introduction

In order to obtain a higher output current/power, several TC.ACS devices can be connected in parallel (at the output) to a multi-device system.

Fig. 2: *Example: Multi-device system of 16 TC.ACS devices*

The communication within a multi-device system of TC.ACS devices is structured by the Master-Slave Principle (2.4.2) and provided by Multi-Device Communication Bus and RS-485 Bus Connections (4.5.1).

2.4.2 Master-Slave Principle

The master-slave principle states that necessarily one - and only one - device in a system is considered the master. All other devices within the system are considered slaves.

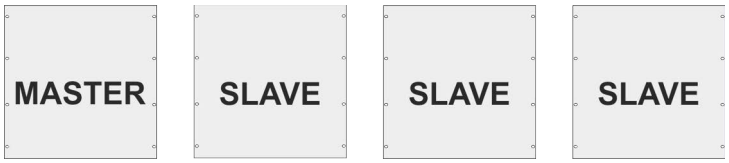


Fig. 3: *Multi-device system of 4 devices with one master and three slaves*

Here, the master device is the communication interface between the external control and the slave devices, i.e. it passes on the parameter input values via the internal system communication.

	Whether an individual TC.ACS device is considered to be the master or a slave is determined via the software TC.ACScontrol (see the related sofware manual).

3 Interfaces, Controls and Displays

	For more information on any of the individual interfaces see the related data sheet. There is a specific data sheet with respect to the optional interfaces.

3.1 Interfaces, Controls and Displays on the Front Side

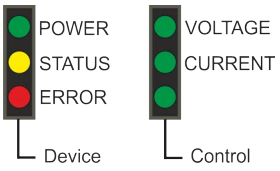
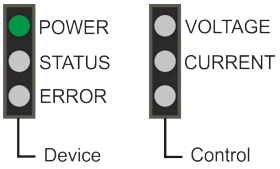
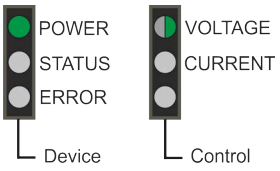
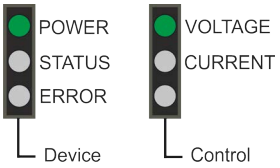
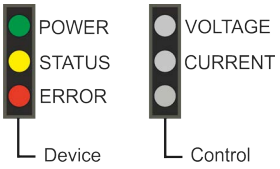
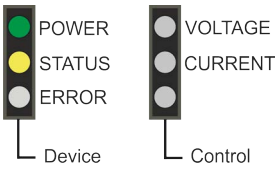
3.1.1 Overview

Fig. 4: *Interfaces, displays and controls on the front side*

Interfaces, displays and controls on the front side	
1	**Device address selection switch** *NOTE: The selection switch is currently not used.*
2	**LED indication** indicates the current state of the device (for the possible indications and their meanings see 3.1.2)
3	**Main switch, circuit breaker**

3.1.2 LED Indications and their Meanings

The following LED patterns indicate the following states of the device:

Indication	State of the Device
	**Power-up** The device is powering up (including internal tests). There is no energy flow on the load side. *NOTE: This is an intermediate state. After successfully powering up, the standby state is automatically assumed.*
	**Standby** The device is running. There is no energy flow on the load side.
	**Ready** The device is running and the intermediate circuit is charged. There is no energy flow on the load side.
	**Switched on** The device is running and power is supplied to drawn from the load. There is energy flow on the load side.
	**Update** A firmware update is being performed. There is no energy flow on the load side.
	**Different**

In any case, a flashing red LED (ERROR) indicates an error and a flashing yellow LED (STATUS) indicates a warning.

	*In case of an error the device automatically switches to standby state.*

3.2 Interfaces on the Rear Side

3.2.1 Overview

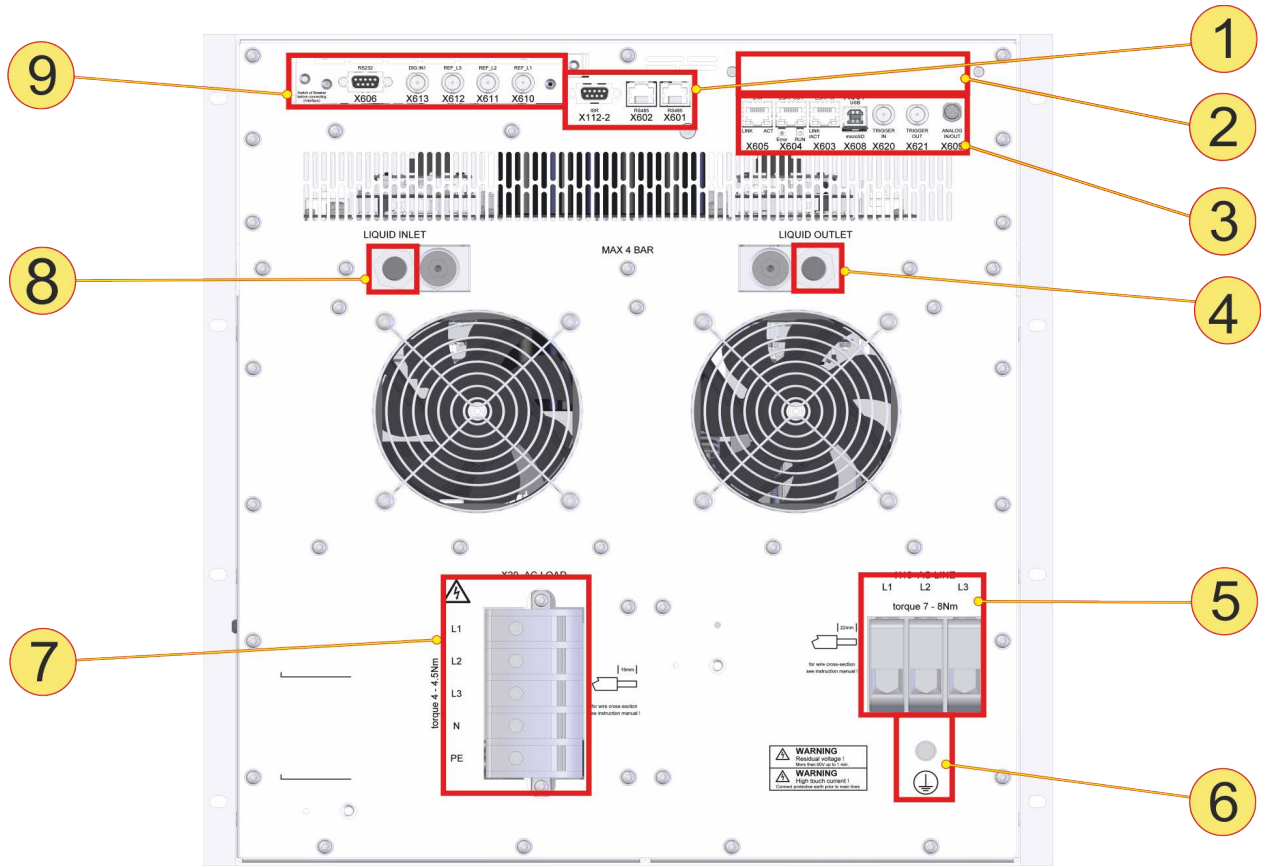


Fig. 5: *Interfaces on the rear side*

Interfaces on the rear side			
1	**X112-2**	ISR interface *NOTE: The interface must be terminated with the dummy plug X112, if not used. For more information see 3.2.2.*	
	X601/ X602	Preset distribution interfaces (only used for multi-unit-systems) *NOTE: In single device use one of these interfaces must be terminated with 100 ohms.*	
2	*Bay for optional interface cards, e.g. Option: Digital I/O Interface (TC.ACS.DIG8IOST) (see 8) or Option: TC.ACS.CANmp Interface (see 11)*		
3	**X605**	Ethernet-LAN interface to connect to a PC	
	X604	Multi-device communication bus output interface (only used for a Multi-Device System)	
	X603	Multi-device communication bus input interface (only used for a Multi-Device System)	
	X607	USB-Interface to connect to a PC	
	X608	Micro SD card slot (only for service)	
	X620	Trigger input *NOTE: For configuring the trigger input please contact Regatron Customer Support.*	
	X621	Trigger output *NOTE: The trigger output can be configured via the software ACSControl (see the related software manual).*	
	X609	Analog input and output for general usage *NOTE: To use the interface you need a specific plug.* - *Manufacturer: PHOENIX CONTACT AG* - *Order number: 1430048* - *REGATRON item number: 452-01244* *For the pin definition see **3.2.3**.*	
4	Outlet interface for cooling circuit (thread: G1/2” with connection fitting )		
5	**X10**	AC line input terminal (L1, L2, L3)	
6	Additional earthing stud *NOTE: Due to high leakage current the additional earthing stud must be connected to earth.*		
7	**X20**	AC load output terminal (L1, L2, L3, N, PE) *NOTE: Due to high leakage current the PE clamp must be connected to earth.*	
8	Inlet interface for cooling circuit (thread: G1/2” with connection fitting )		
9	*NOTE: The figure above shows the standard version. As an option, the following interfaces may be replaced by a senseboard (see **7**).*		
	X606	Service interface RS232 (only used for software update) *NOTE: This interface requires a cable with braided shield.*	
	X613	Digital input interface (currently not supported)	
	X612	Signal input for phase L3 on the load side	for Connecting an external Signal Generator
	X611	Signal input for phase L2 on the load side	
	X610	Signal input for phase L1 on the load side	

3.2.2 Integrated Safety Relay (ISR)

3.2.2.1 Range of Application

The integrated safety relay (ISR) allows for connecting an external safety circuit. Here, the external safety circuit can be connected to the interface **X112-2** (see 3.2.1).

	As the ISR operates on two channels, performance level PL e can be reached when using an external safety module.

3.2.2.2 General Function Description

When the ISR is triggered it disconnects the power electronics of the TC device from its controller electronics. This way the energy flow is interrupted while the device remains accessible for communication.

	*If the ISR is not used, the interface **X112-2** must be terminated with the related dummy plug (see **3.2.2.5**).*

3.2.2.3 Type of Connection

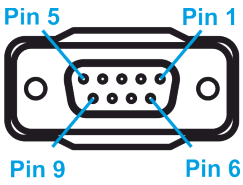


Fig. 6: *Type of connection of interface X112-2: D-Sub, 9-pin, socket*

3.2.2.4 Pin Definition

Pin	Signal	I/O	Description
1	+24 VDC	O	Low voltage internal supply + 24 V_{DC}
2	RELAY2	I	Coil a) of ISR relay 2
3	NC	I/O	Relay contact NC
4	RELAY1	I	Coil a) of ISR relay 1
5	COMMON	I/O	Common contact
6	GND	O	Low voltage 0 V_{DC}
7	RELAY2	I	Coil b) of ISR 2
8	---	---	---
9	RELAY1	I	Coil b) of ISR 1
Cover	Shield	---	Cable screen, tied to earth (PE) internally

Tab. 1: *Pin definition of interface X112-2*

	The polarity of relay coil pins 2 and 7 resp. 4 and 9 is of no importance.

3.2.2.5 Dummy Plug X112

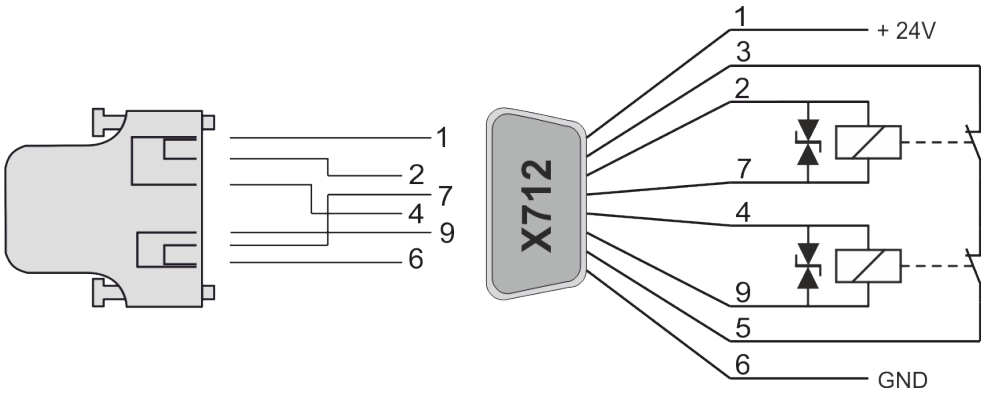


Fig. 7: *Dummy plug X112 for the interface X112-2*

3.2.2.6 Application Example: Category 1 PL c

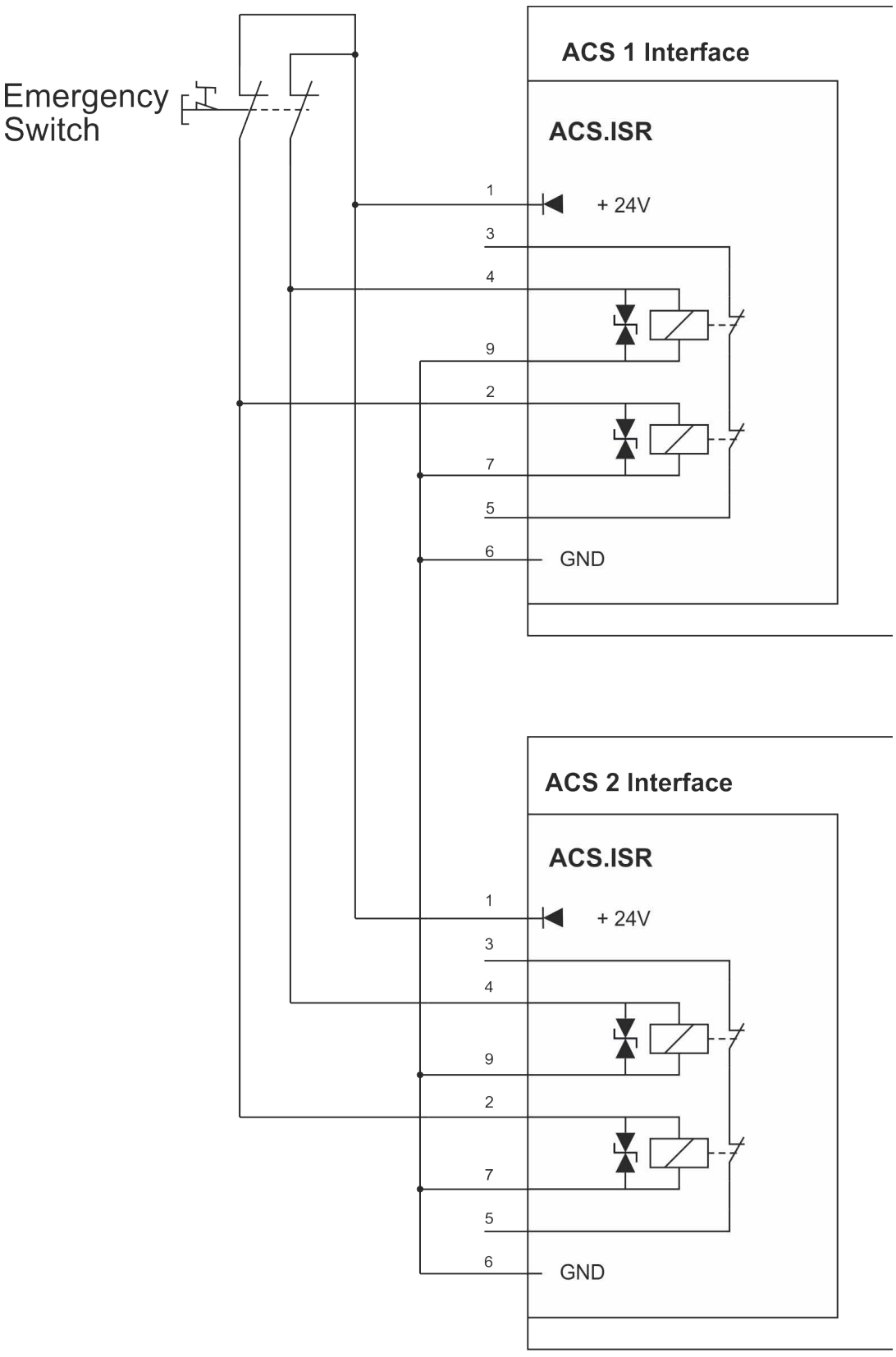


Fig. 8: *Wiring diagram using a two-channel external safety loop*

3.2.2.7 Application Example: Category 3 PL e

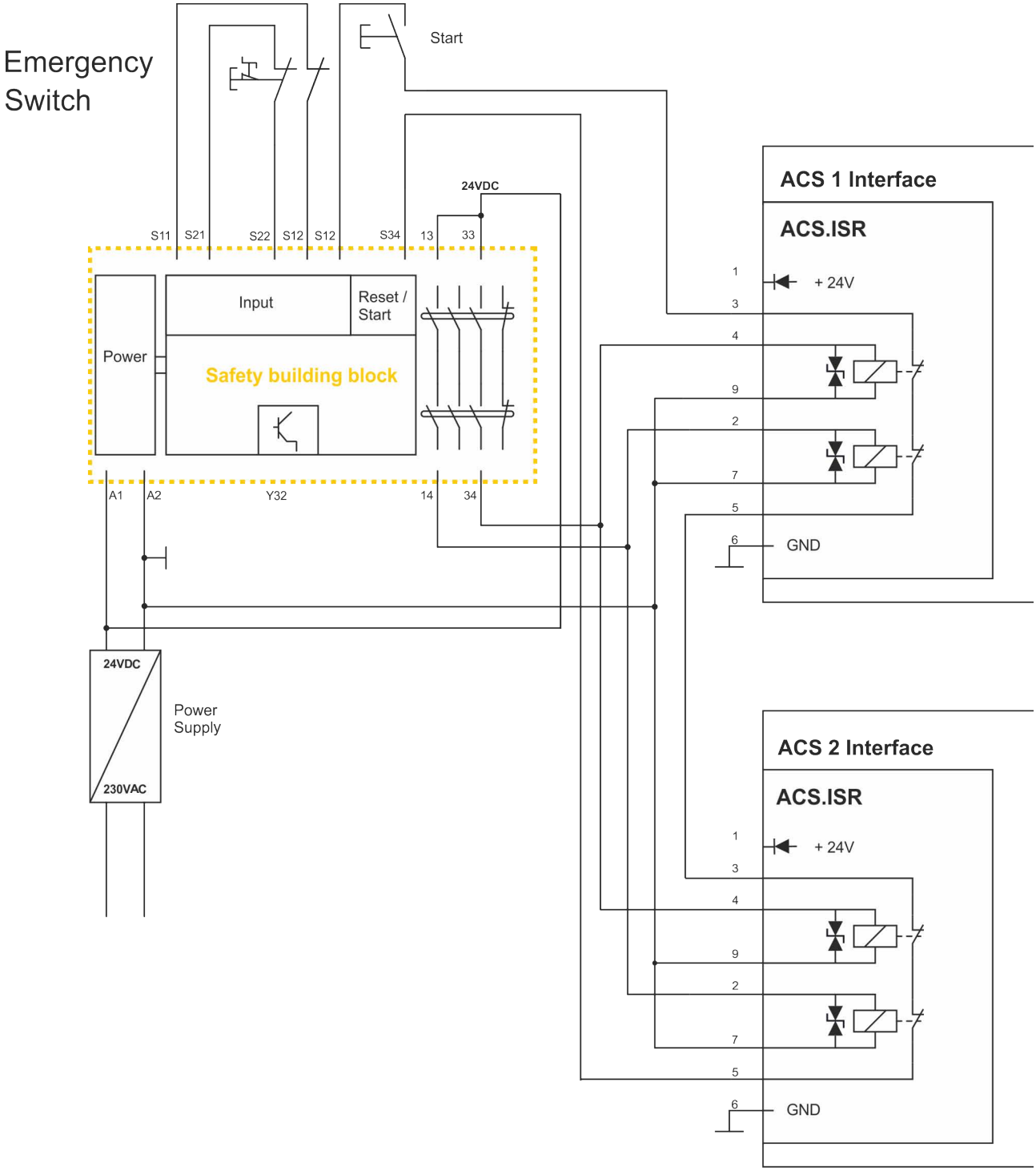
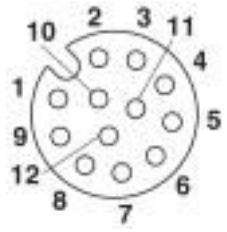


Fig. 9: *Wiring diagram using an external safety module, two-channel safety loop*

3.2.3 Pin Definition of Interface X609

Order of Pins	Pin	Signal	Description
	**1**	AIN1	Analog input 1 (filtered or unfiltered)
	2	AIN2	Analog input 2 (filtered or unfiltered)
	3	AIN3	Analog input 3 (filtered or unfiltered)
	4	AIN4	Analog input 4 (filtered or unfiltered)
	5	GNDA_ISO	Analog ground
	6	+10V_ISO	+10V reference voltage
	7	-10V_ISO	-10V reference voltage
	8	GNDA_ISO	Analog ground
	9	AOUT1	Analog output 1 (unfiltered)
	10	AOUT2	Analog output 2 (unfiltered)
	11	AOUT3	Analog output 3 (unfiltered)
	12	AOUT4	Analog output 4 (unfiltered)

Measurands may be configured via the software ACSControl, see the related software manual.
For physical specifications of the interface X609 see the TC.ACS datasheet.

4 Installation and Commissioning

4.1 Overview

The installation and commissioning of the TC.ACS includes the following steps:

- Case Installation (4.3)
- Electrical Installation (4.4)
- If necessary, Setting up a Multi-Device System (4.5)
- Connecting a Cooling System (4.6)
- Connecting a PC (4.7)
- Connecting an external Signal Generator (4.8)
- Starting the TC.ACS (4.9)
- Running a Function Test (4.10)

 **DANGER**	***Electric shock!*** ***Avoidance:*** *Without the optional discharge feature XCDBox, mobile operation is not permitted!*

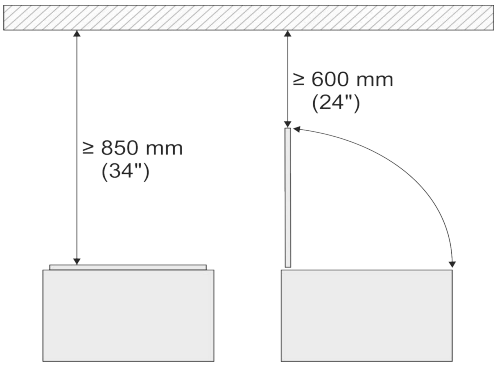
	***Connecting an external Signal Generator*** *is necessary only if you want to operate the TC.ACS device in* ***Amplifier Mode*** *(see* ***2.1.2****).* *For installing and commissioning the* ***Option: Liquid to Air Heat Exchanger TC.LAE*** *see* ***10.3****, if necessary.*

	*The TC.ACS device is to be used exclusively as a built-in device in a cabinet system. Here, the basic protection of the connection terminals must be provided in the end application, so that IP20 applies.* *With respect to the installation location the site conditions (see* ***4.2****) have to be regarded.*

4.2 Site Conditions

NOTICE	***Electric surge!*** *The system is designed for use in LPZ1 (Lightning Protection Zone 1).*

NOTICE	***Overheating!*** *Make sure that the warm exhaust air is not drawn back into the system.*

Installation conditions		
Over voltage category (according to EN 62477-1)		3
Distance at the front to the nearest wall or large surface area body		> 850 mm For access to the front as well as for drawing in the cooling air *NOTE: If there is a cabinet door, an escape route of > 600 mm width must be provided in front of the open door. This is independent of the 850 mm distance.*
Distance at the rear to the nearest wall or large surface area body		> 850 mm For access to the rear, as well as for exhaust of the cooling air *NOTE: If there is a cabinet door, an escape route of > 600 mm width must be provided behind the open door. This is independent of the 850 mm distance.*

Environmental conditions		
Maximum altitude	2000 meters above sea level	
Temperature	5...40 °C	
Humidity	0...95%	
Moisture condition of the skin (according to EN 62477-1)	Dry	
Vibrations (according to IEC-60068-2-6)	Test Fc	
Pollution degree (according to EN 62477-1)	2	
Environmental operating conditions (according to IEC 60721-3-3)	Climate	3K22
	Pollution degree	*see above*
	Special climatic conditions	3Z1
	Mechanically active substances	3S5
	Mechanical	3M11
	Biological	3B1

Load side conditions	
Over voltage category (according to EN62477-1)	1
NOTE: If this is not the case, use surge protection devices (SPD's), an inductor or a transformer.	

4.3 Case Installation

NOTICE	***Possible damage!*** - *Due to soiling and foreign bodies at the installation location* - *Due to a build-up of heat* ***Avoidance:*** - *The installation location must be free of conductive and aggressive substances as well as moisture.* - *No foreign bodies such as drilling swarf or screws are to be allowed to fall into the system.* - *The site conditions (see technical datasheet) must be met.* - *The ventilation openings on the front panel and rear wall of the devices must not be covered or sealed.*

The TC.ACS is intended to be installed in a standard 19” switch cabinet with an external air flow. In this case it is to be placed on rails or shelves and fastened at the holes on the left and right edges of the front panel. Usually M6 screws can be used.

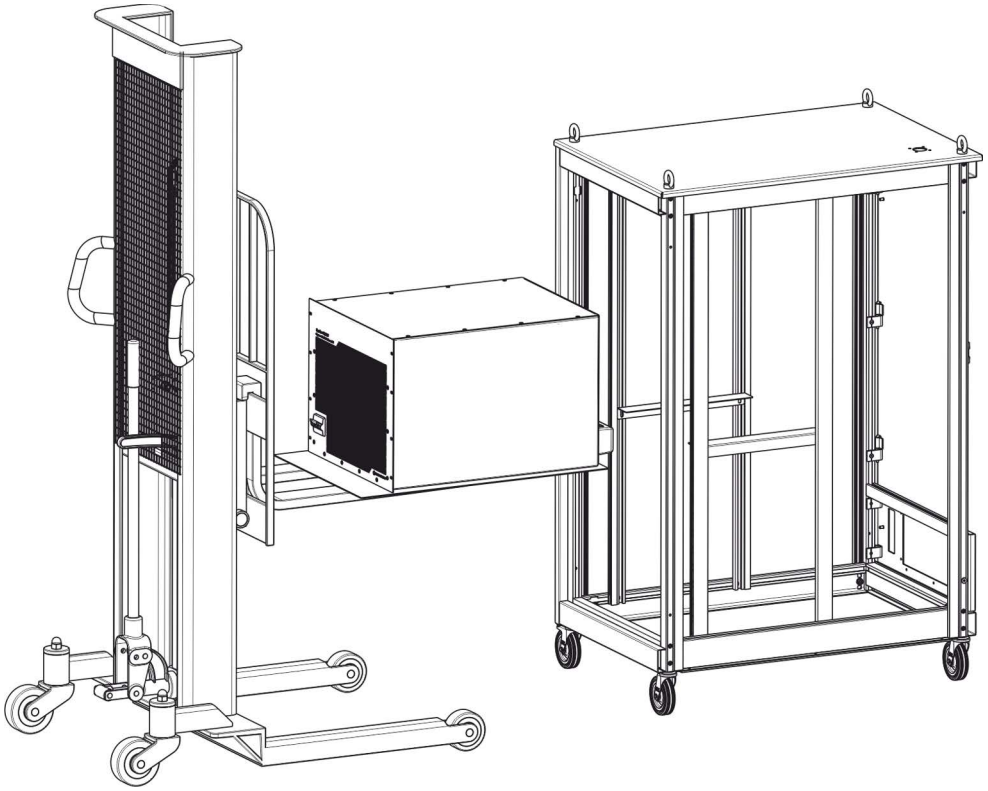


Fig. 10: *Case installation with the help of a trolley*

	Due to the weight of the device the following is to be regarded: - *Rails or shelves must be robust.* - *The case for a TC.ACS must be in contact over full installation depth.* - *At the rear a cross-member must be installed for additional fastening.*

4.4 Electrical Installation

4.4.1 Safety Advice

 **DANGER**	***Electric shock!*** ***Avoidance:*** - *The electrical installation is to be undertaken by personnel with electrical training.* - *Never connect or disconnect electrical connections while they are live.* - *After switching off the system, wait 5 minutes before working on it! In the devices built-in dangerous voltages may be present after switching off the mains voltage, as well as in case of loads that store energy.* - *The system must be electrically isolated and secured against being switched on.* - *Use cables carrying high currents with adequate cable cross-section area (refer to your national standards and the information on the type plates).* - *Your mains voltage must equal the nominal voltage of the system (given on the type plate).* - *Output bus bars must be protected against touching (e.g. by fitting a suitable housing).* - *After the installation, check the cables for firm fixing.* - *The highest permissible unaffected short-circuit (i.e. 10 kA) as well as the smallest required unaffected short-circuit current (i.e. 1 kA) for each input port of the TC device must be considered.*
 **WARNING**	***Electric shock!*** ***Avoidance:*** *For secure grounding the device must be connected to a grounding network of type TN.* *TT- or IT-systems are not permitted.*
NOTICE	***Possible damage to the device!*** - *Due to conductive aggressive substances in the installation location* - *Due to a larger amount of moisture in the installation location* - *Due to foreign objects within the system* ***Avoidance:*** - *If necessary, clean the installation location of aggressive substances or moisture using cloths.* - *Remove foreign objects such as drilling sward or screws from the system before you fit new devices*
	*If you want to use a residual current device, please consider the varying requirements for protection against fire and the protection of individuals. Regatron recommends the usage of a residual current device sensitive to AC and DC leakage currents. If such a device is to be installed, a Type B or Type B+ must be chosen in order to avoid false tripping or lack of appropriate protection. A type B RCD allows both for processing AC/DC fault currents as also for considerations of HF components up to the kHz range with up-weighted levels for HF.* *The TC device has protection class I according to EN61140.*
	*Prior to the electrical installation, Regatron recommends to confirm the following aspects:* - *The type plate matches the data in the order and delivery documents.* - *The device nominal data are suitable for the intended application.* - *The supplied cables/connectors match the intended connections.*

4.4.2 Prerequisites

For the electrical installation of the TC.ACS device the electrical cabinet or whatever the TC.ACS device is to be connected to, must be galvanically isolated, disconnected from the mains and secured against being reconnected.

Furthermore, the following must be given:

- Correct Size of Cables and Cable Ends (4.4.2.1)
- Electromagnetic Compatibility of Cables (4.4.2.2)

4.4.2.1 Correct Size of Cables and Cable Ends

	Cables carrying high currents must have an adequate cable cross-section area. *If necessary, refer to your national standards and the information on the type plates in order to determine the correct size of cables.*

The terminals X10 (AC line input) and X20 (AC load output) allow for different types of cable ends, i.e. the following:

- flexible cable ends
- rigid cable ends
- cable ferrules

	Regatron recommends to use cable ferrules.

In any case, the cable ends must meet the following conditions regarding their cross-section and their stripping length:

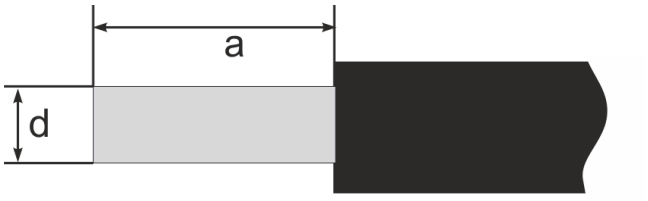


Fig. 11: *Cable end with diameter* **d** *and stripping length* **a**

Clamp	Type of cable end	Cross-section area A (= π d^2/4)		Stripping length
		mm^2	AWG/kcmil	
X20	**Flexible**	10 … 25	10 … 2	19 mm
	Rigid	6 … 35		
	Ferrule	4 … 25		
X10	**All**	25 … 50	2 … 0/1	22 mm

	The touch current in the grounding cables exceeds the limit of 3.5 mA. Therefore the minimum cross-section of the grounding cable must comply with the local safety regulations for equipment with high current in the grounding cable. This is 10 mm^2 for fixed connection.

Grounding cables must have a cross-section area equal to that of the external conductors and with:

- **fixed connection** at least 10 mm^2
- **mobile operation of the device**, the following:

Cross-section Area	
External Conductors	**Grounding Cables**
up to 16 mm^2	equal to external conductors
16 mm^2 to 35 mm^2	16 mm^2
35 mm^2 and more	half of external conductors

4.4.2.2 Electromagnetic Compatibility of Cables

	*The system is equipped with interference suppression filters in all power and signal connections. Correct installation ensures conformity with the applicable standards.*

For electromagnetic compatibility of cables the following must be given:

- Large area earthing (suitable for EMI)
- Shielded cables with shields earthed on both ends
- Star topology earthing (suitable for EMI) of the device

4.4.3 Procedure

To electrically install the TC.ACS, do the following:

⇨ Connect the mains via the X10 AC line input terminal.

⇨ Connect the load to the X20 AC load output terminal.

⇨ Connect the earthing connector (PE) of the X20 AC load output terminal to earth.

⇨ Connect the additional earthing stud on the rear of the device to earth.

4.5 Setting up a Multi-Device System

To set up a Multi-Device System you need to connect several TC.ACS devices in parallel (at the output) and establish the communication connections as seen in 4.5.1.

4.5.1 Multi-Device Communication Bus and RS-485 Bus Connections

Within a multi-device system of TC.ACS devices the communication is provided by a multi-device communcation bus and RS-485 bus connections:

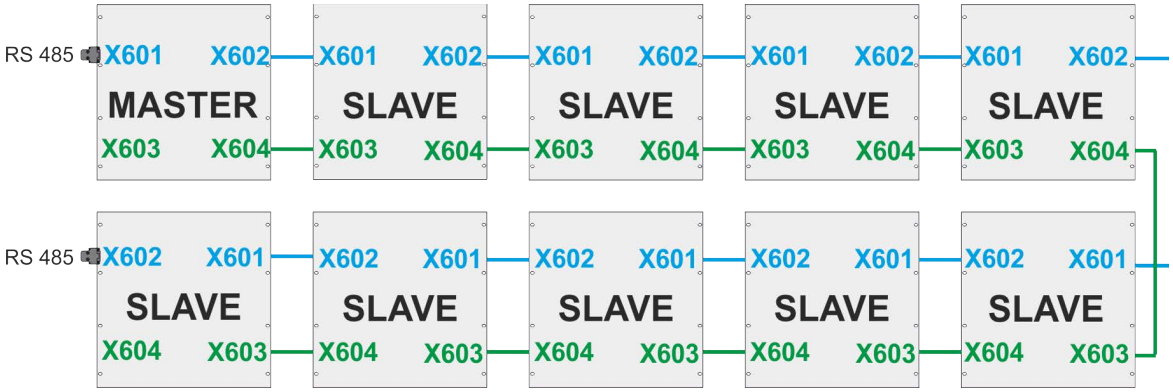


Fig. 12: *Multi-device communication bus (green) and RS-485 bus (blue) connections in a TC.ACS multi-device system of 10 devices*

To the connections the following applies:

- **RS-485 bus:** The connection starts from the master device and runs through all slave devices serially, each from interface **X602** to **X601** or vice versa. Both ends are terminated by the termination resistor **RS 485**.
- **Multi-device communication bus:** The connection starts from the master device and runs through all slave devices serially, each from interface **X604** to **X603** or vice versa. Termination is not required.

Furthermore, the connection cables have to be meet following specifications:

General specifications	**RS-485 bus**	**Multi-device communication bus**
Cable construction	4x2	
Cable type	S/FTP	Industrial Ethernet/EtherCAT patch cable
Cable coating	-	PUR
Connector type, connection 1	RJ45 8(8)	
Connector type, connection 2	RJ45 8(8)	
Electrical specifications	**RS-485 bus**	**Multi-device communication bus**
EMC	Shielded, pair and overall shielding	Shielded
GBit/s	Up to 10 GBit/s	-
Category	6A (IEC)	5
NVP %	78	-
Pin assignment	1:1	-
Mechanical specifications	**RS-485 bus**	**Multi-device communication bus**
AWG	26	

Error-free communication cannot be guaranteed when using cables that do not comply with the specification. Appropriate cables can be ordered from Regatron. Please contact Regatron Support if required.

4.6 Connecting a Cooling System

4.6.1 Introduction

In order to dissipate the generated heat, the TC.ACS is equipped with an internal heat-exchanger. This heat exchanger necessarily needs to be connected to an external cooling system.

	*The **Option: Liquid to Air Heat Exchanger TC.LAE** is designed to be used as an external cooling system with the TC.ACS.* *Any other external cooling system has to meet specific requirements (see **4.6.2**).*

NOTICE	***Possible damage to the device!*** *Due to condensation inside the device or on the supply tube.* ***Avoidance:*** *Keep the inlet temperature of the cooling liquid at a temperature level above the dew point.* *For the relevant dew point refer to a dew point table.* ***Damage to the device due to condensed water is excluded from the warranty.***

4.6.2 Requirements to a Cooling System

The requirements to a cooling system are given by the following:

- Specifications of the internal Heat Exchanger (4.6.2.1)
- Requirements to the Cooling Liquid (4.6.2.2)
- Pressure Differences and Flow Rates (4.6.2.3)

4.6.2.1 Specifications of the internal Heat Exchanger

General specifications	
Connections	G1/2” (see 3.2)
Heat sink material	EN AW-5083
Thermal rating	5 kW
Approx. thermal resistance	< 0.01 K/W
Performance data with a cooling liquid with a specific heat capacity of 4.19 kJ/kgK	
Recommended flow rate	5 l/min
Min. flow rate	2.5 l/min
Max. inlet temperature	25 °C @ 2.5 l/min, 50 °C @ 8 l/min

4.6.2.2 Requirements to the Cooling Liquid

NOTICE	***Possible damage to the device!*** - *Due to electrolytic and/or chemical corrosion* - *Due to the deposition of fine sludge* - *Due to coating with foreign substances and as a result degradation of the heat transfer* - *Due to the deposition of foreign bodies on the heat exchanger surfaces* ***Avoidance:*** - *Never use deionised water as a cooling liquid.* - *Use fine filters to keep back fine sludge particles.* - *Meet the following requirements.*

In general, any cooling liquid to be used to cool the TC.ACS device must meet the following requirements:

Requirements to the Cooling Liquid		
Parameter	**Unit**	**Limit value**
ph-value	-	6 - 8
Total hardness	[°dH][2]	< 15
Carbonate hardness	[°dH][2]	< 6
Non-carbonate hardness	[mmol/l][3]	< 1.60
Carbon dioxide, free	[mg/l]	< 3
Organic substances	[mg/l]	< 10
Algae and fungi	Not allowed	
Sand and sludge	Not allowed	
Sulphate SO_3	[mg/l]	< 50
Chlorine CL	[mg/l]	< 30
Undissolved iron Fe	[mg/l]	< 1
Phosphate P_2O_5	Not allowed	
Total salt content	[mg/l]	< 3000
Manganese Mn	[mg/l]	< 0.1

The quality of the cooling liquid affects the performance of the system in the long term. For a restriced time the quality of normal purified, soft and largely chlorine-free drinking water is adequate. After some time, however, corrosion will occur and algae and fungi will also be present.

	*As a cooling liquid REGATRON AG recommends using a mixture of 30% Antifrogen® N (manufacturer: Clariant) and 70% normal purified, soft and largely chlorine-free drinking water.*

4.6.2.3 Pressure Differences and Flow Rates

The maximum permissible cooling liquid pressure is 4 bar = 4000 hPa. The pressure drops for on-site feed pipes, manifolds and pressure and flow rate sensors are also to be taken into account. In particular, on the parallel supply of several power supplies an appropriate safety margin is to be included.

Standard connection with G ½“		
Heat sink with internal pipework, ready for connection of cooling liquid on site at the rear side of the device	**Pressure difference**	**Flow rate**
	0.02 bar	2.5 l/min.
	0.04 bar	3.5 l/min.
	0.07 bar (recommended)	5 l/min.
	0.12 bar	7 l/min.

Connection with quick-release isolating valves		
Heat sink with internal pipework, ready for connection of cooling liquid on site at the rear side of the device plus 2 quick-release isolating valves (on customer request), inside diameter = 6 mm	**Pressure difference**	**Flow rate**
	0.06 bar	2.5 l/min.
	0.15 bar	3.5 l/min.
	0.24 bar (recommended)	4.5 l/min.
	0.38 bar (recommended)	6 l/min.
	0.48 bar	7 l/min.

4.6.3 Safety Advice

WARNING

Possible harm by cooling liquid!

Danger of serious damage to health by prolonged exposure through inhalation and if swallowed:

- *Possible damage to organs (H373).*
- *Possible damage to the fertility or to a child in womb (H361).*

Avoidance:

- *Pay attention to the warning signs on the device.*
- *While handling with cooling liquid, open doors and windows and ensure the room is well ventilated also on the ground level.*
- *Use the personal protective equipment at existing concentrations of vapour and aerosols. E.g. the respiratory protection and protective cloves which are resistant against solvents.*
- *Close cooling liquid vessels immediately.*

4.6.4 Procedure

To connect a cooling system to the TC.ACS, do the following:

⇨ Remove the rubber plugs from the connection fittings on the rear side of the TC.ACS (see 3.2).

⇨ Establish the following connections, e.g. using a suitable coolant hose:

- ➢ Output interface of TC.ACS to input interface of an external cooling system
- ➢ Input interface TC.ACS to output interface of an external cooling system

4.7 Connecting a PC

In order to be able to operate the TC.ACS device you need to connect a PC to the software ACSControl. You can connect the PC via the USB-interface **X607** or the Ethernet-LAN-interface **X605** (see 3.2).

	*The software ACSControl is included in the scope of delivery.*

4.8 Connecting an external Signal Generator

	*If you do not want to operate the TC.ACS device in **Amplifier Mode**, you do not need to connect an external signal generator.*

In order to operate the TC.ACS device in Amplifier Mode, you need to connect an external signal generator to the TC.ACS device. You can connect the external signal generator via the interfaces **X610**, **X611** and **X612** on the rear of the device (see 3.2).

4.9 Starting the TC.ACS

4.9.1 Safety Advice

 **DANGER**	***Electric shock!*** ***Avoidance:*** - *Device and load must be isolated against accidental contact.* - *No maintenance work must be carried out.* - *Warning signs must be used and the area must be cordoned off.*

NOTICE	***Possible damage to the device!*** *Due to condensation inside the device or on the supply tube of the cooling system.* ***Avoidance:*** - *If there is any water condensation, it will show on the rear side of the device (especially between the input and the output interface for cooling circuit (see **3.2**). Check visually and if so, do not start the device.* - *Keep the inlet temperature of the cooling liquid at a temperature level above the dew point. For the relevant dew point refer to a dew point table.* ***Damage to the device due to condensed water is excluded from the warranty.***

4.9.2 Prerequisites

For starting the TC.ACS, the following must be given:

- The device is electrically installed (see 4.4).
- A cooling system is connected (see 4.6) and it is running.

4.9.3 Procedure

To start the TC.ACS, do the following:

⇨ Switch on the main switch (see 3.1).

✓ The device boots and a device self-test is performed.

✓ When finished, the LED for POWER (see 3.1.2) lights up.

	*If any other LED also lights up or flashes, then there is a warning or an error. Detailed information is provided by the software ACSControl.*

4.10 Running a Function Test

With the software ACSControl you can run a function test on the TC.ACS to confirm that it actually works as intended.

	*For installing the software ACSControl as well as detailed information on how to use it, see the related software manual.*

4.10.1 Prerequisites

For running a function test, the following must be given:

- The TC.ACS is connected to a PC (see 4.7).
- The TC.ACS has been started (see 4.9).
- The software ACSControl is running and it is connected to the TC.ACS.
- The TC.ACS has no error.

4.10.2 Procedure

To run a function test, do the following via the software ACSControl:

⇨ Open the tab **Basic Waveform Generator**.

⇨ Specify amplitude, voltages, frequency and number of phases in the respective fields.

⇨ In the toolbar, click on  .

✓ On the front of the TC.ACS the LED for VOLTAGE ON (see 3.1.2) lights up.

	*If there is a warning or an error, detailed information is provided by the software ACSControl.*

5 Transport, Packaging and Disposal

This section adresses the following subjects:

- Transport (5.1)
- Packaging (5.2)
- Disposal (5.3)

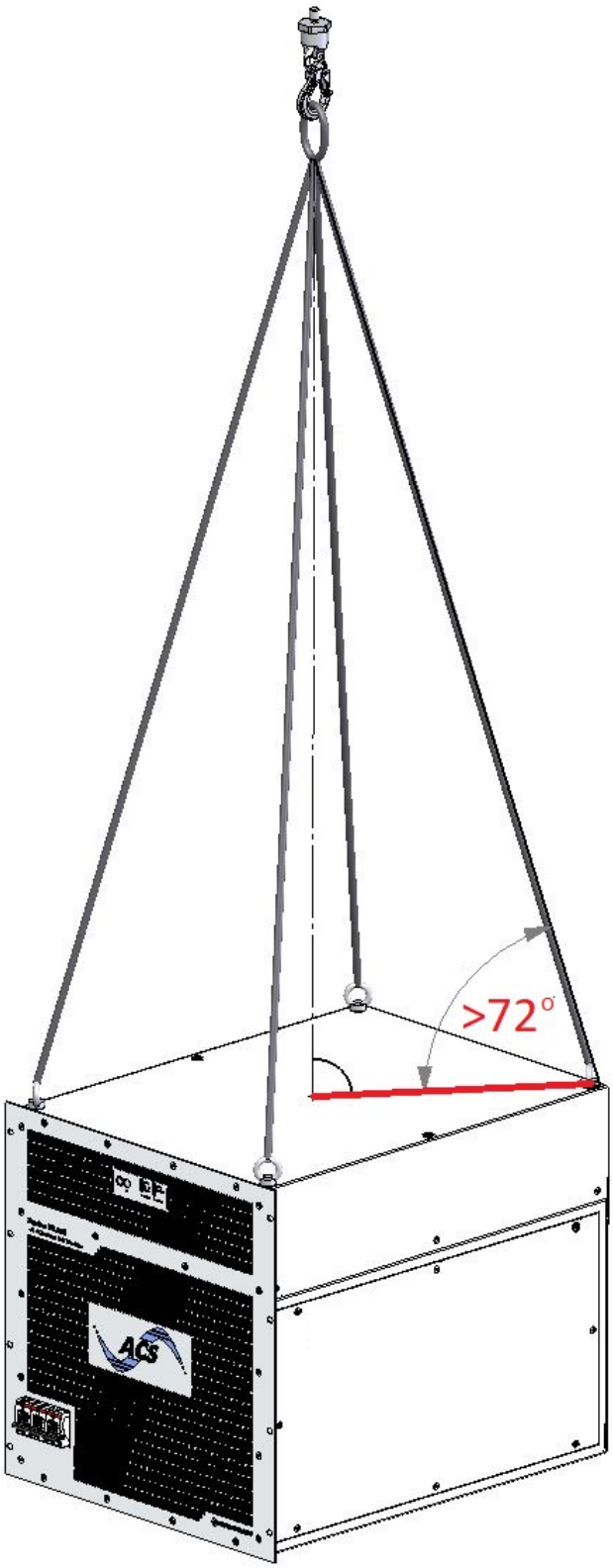
5.1 Transport

CAUTION	***Possible damage!*** ***Avoidance:*** *Before transporting a TC.ACS device, the following points are to be regarded:* - *All cables must be removed.* - *Protruding parts such as main switch, controls and fan covers must not be damaged by transport aids (straps, blocks of wood, etc.).* - *Due to the weight of the device, a robust trolley, a forklift, or a crane should be used.* - *The device may only be transported horizontally.*

The TC.ACS is equipped with four eyelet rings, which allow to attach hoisting slings.

⇨ Use the eyelet rings to lift the TC.ACS.

CAUTION	***Possible damage!*** ***Avoidance:*** *Make sure that the angle between hoist and device top side is greater than 72°.*



5.2 Packaging

The TC.ACS is shipped in a standard packaging:

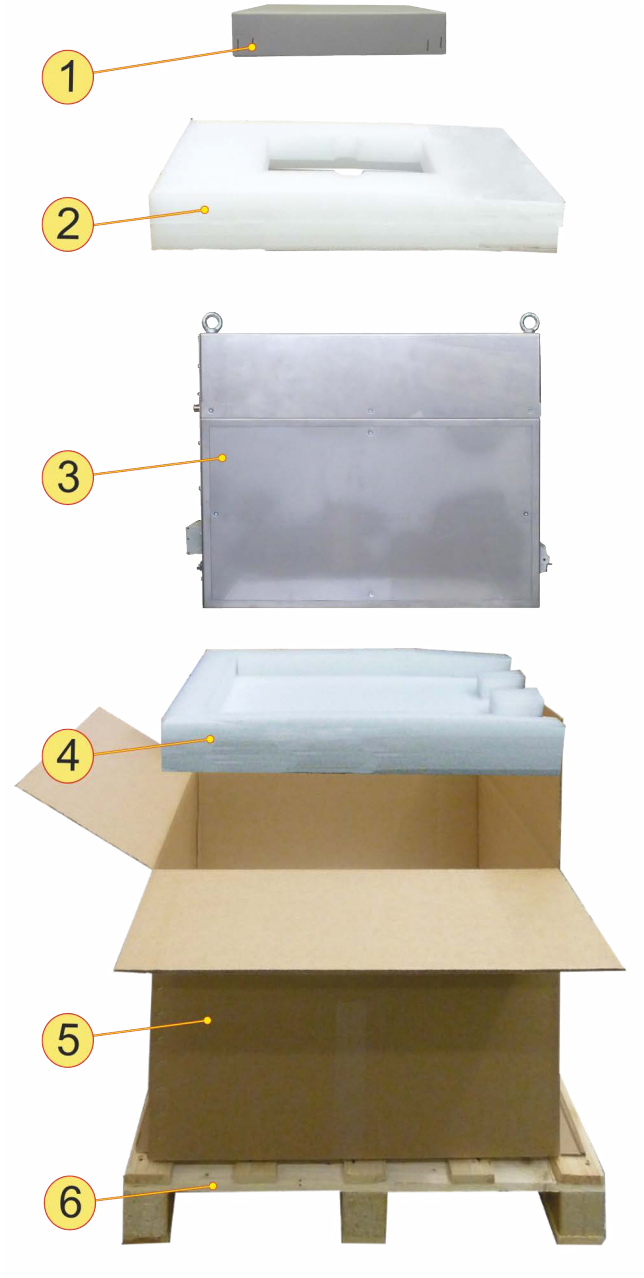


Fig. 13: *Standard shipping packaging*
1. Box of accessories
2. Upper cover
3. TC.ACS device
4. Lower protective support
5. Cardboard box
6. Transport pallet

	You can order new shipping packaging from Regatron Customer Support. Here you can also get additional package protection for the front and the sides, if necessary (e.g. for overseas shipping).

5.3 Disposal

When disposing a TC.ACS device, the following points are to be regarded:

- *Electrical equipment is too valuable for household waste.*
- *Disposal with due care for the environment.*
- *On the disposal of electrical equipment, comply with national laws.*

6 Maintenance and Support

This section includes the following subsections:

- Maintenance (6.1)
- Support (6.2)

6.1 Maintenance

The TC.ACS device is generally maintenance-free. However, the following measures may be needed:

- Adjusting the Accuracy of the Output Values (6.1.1)
- Updating the Firmware (6.1.2)
- Replacing the Batteries of the Real-time-Clock in the Controller Board (6.1.3)

*For the maintenance of the **Option: Liquid to Air Heat Exchanger TC.LAE** see **10.4**, if necessary.*

6.1.1 Adjusting the Accuracy of the Output Values

The accuracy of the device output values can be adjusted by Regatron AG. If necessary, please contact support@regatron.com.

6.1.2 Updating the Firmware

You can update the firmware of the TC.ACS device via the software ACSControl, if necessary. For more information see the related software manual.

6.1.3 Replacing the Batteries of the Real-time-Clock in the Controller Board

The life expectancy of the batteries of the real-time-clock in the controller board is approx. 10 years at room temperature. You can replace the batteries by yourself. Please contact support@regatron.com.

6.2 Support

Regatron Customer Support assists you in case of questions on hardware, software, interfaces and maintenance as well as in the event of a repair.

This section answers the following questions:

- How can you contact Regatron Customer Support? (6.2.1)
- What does Regatron Customer Support need to know? (6.2.2)

6.2.1 How can you contact Regatron Customer Support?

The Regatron Customer Support address is the following:

Regatron AG
Technical Customer Support
Feldmuehlestrasse 50
9400 Rorschach
SWITZERLAND

E-mail: tc.support@regatron.com

Phone: +41 (0)71 846 67 44

Web: www.regatron.com

6.2.2 What does Regatron Customer Support need to know?

To help you in a most efficient way, Regatron Customer Support needs the following information:

- Contact Information (6.2.2.1)
- Device Information (6.2.2.2)
- Problem Description (6.2.2.3)

*You can send **Contact Information** and **Device Information** in advance. This way Regatron Customer Support will have it available in the support case.*

6.2.2.1 Contact Information

Contact information is the following:

- Name of your company
- Name of a contact person, i.e. the person with whom further contact will be made
- E-mail address, telephone number (extension) of the contact person
- Support number, e.g. S12345678 (if you have already received one for your problem from Regatron customer support)

6.2.2.2 Device Information

The most important device information is the following:

- Device Type, input and output data
- Serial number
- Version(s) of software(s)
- Installed hardware and software options

Device Type, input and output data as well as the serial number are given on the type plate attached to the device on its rear side. Depending on how your device is controlled, further information may be provided by the software or by the human machine interface TC.HMI.

6.2.2.3 Problem Description

A problem description should document the actual technical problem using measured results, logs, photographs, screenshots, etc..

In specific, answers to the following questions would be of help:

- How exactly is the device applied?
- What kind of load is connected?
- What is the operating point of the application (voltage, current, power)?
- What are the operating conditions (laboratory, ambient temperature, pollution, etc.)?
- How does the problem show?
- When did the problem first occur?
- Does the problem occur permanently or does it occur sporadically?

7 Option: Senseboard (TC.ACSUSense)

7.1 Application

The senseboard allows to measure the voltage directly at the DUT. Thus the voltage can be controlled more accurately and the voltage drop over the load cables can be compensated.

	*If your TC.ACS device is equipped with the senseboard, the senseboard is placed on the rear side of the devcice instead of the interfaces **X606** and **X610**...**X613** (see **3.2.1**).*

7.2 Interfaces

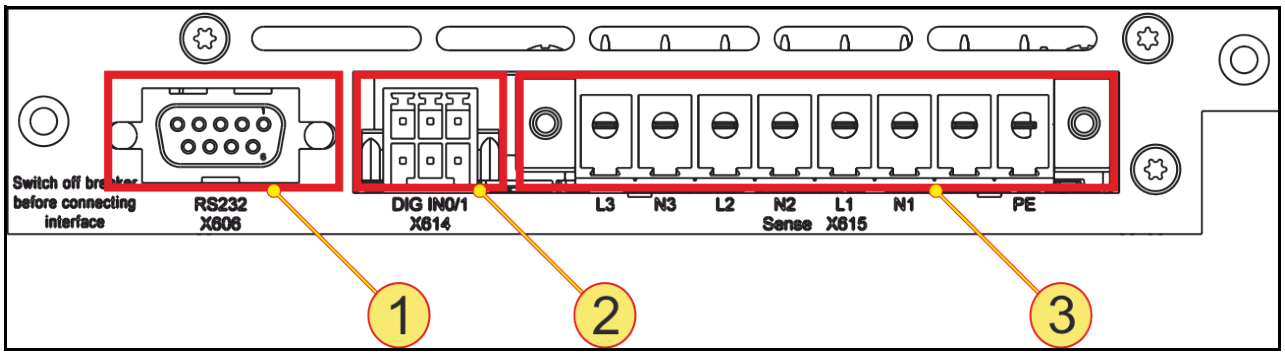


Fig. 14: *Senseboard (optional)*

Interfaces of the senseboard	
1	X606 Service interface RS232 (only used for software update) *NOTE: This interface requires a cable with braided shield.*
2	X614 Digital input interface (currently not supported)
3	X615 Sense input interface

7.3 Connecting the Sense Interface

If you want to use the sense functionality, connect the DUT to the sense interface with appropriate sense cables.

NOTICE	***Possible damage to the sense cables!*** *Due to short circuit.* ***Avoidance:*** *Use fuses or a circuit breaker (~ 0.5 A) with the appropriate voltage class.*

	For the sense connection use cables that are insulated from each other and from PE according to the required voltage.

8 Option: Digital I/O Interface (TC.ACS.DIG8IOST)

8.1 Application

The digital I/O interface provides additional digital inputs and outputs, which are programmable via ACSControl.

8.2 Interfaces

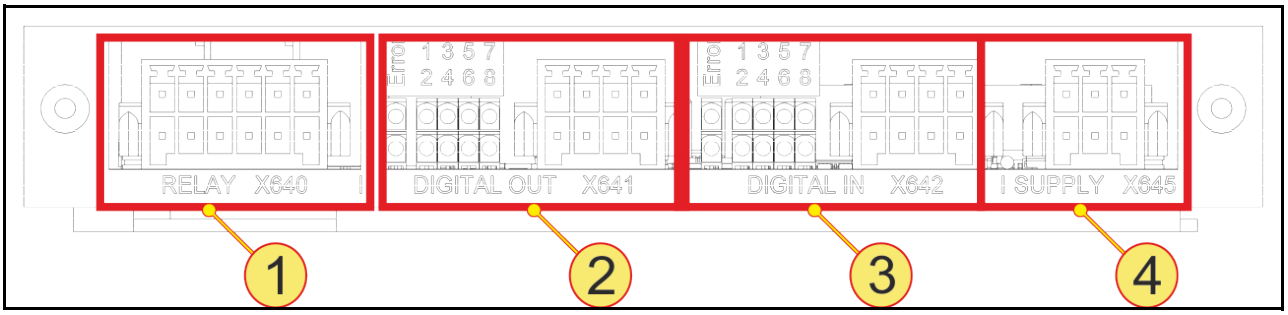
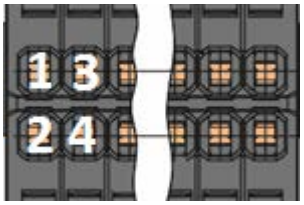


Fig. 15: *Interfaces of the digital I/O interface*

Interfaces on the digital I/O interface	
1	X640 Relay contacts (output) (for pin definitions see 8.3.1)
2	X641 Digital output (for pin definitions see 8.3.2)
3	X642 Digital input (for pin definitions see 8.3.2)
4	X645 Auxiliary voltage supply +24 V (for pin definitions see 8.3.4)

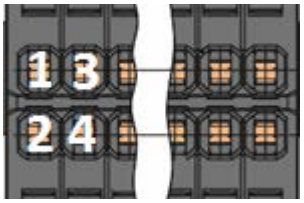
8.3 Pin Definitions

8.3.1 X640 Relay Contacts (output)

Order of Pins	Pin	Signal	Description
	**1**	Relay 8/14	Relay 8 NO, parallel to digital output 8
	2	Relay 8/12	Relay 8 NC, parallel to digital output 8
	3	Relay 8/11	Relay 8 COM, parallel to digital output 8
	4	Relay 7/14	Relay 7 NO, parallel to digital output 7
	5	Relay 7/12	Relay 7 NC, parallel to digital output 7
	6	Relay 7/11	Relay 7 COM, parallel to digital output 7
	7	Relay 6/14	Relay 6 NO, parallel to digital output 6
	8	Relay 6/12	Relay 6 NC, parallel to digital output 6
	9	Relay 6/11	Relay 6 COM, parallel to digital output 6
	10	Relay 5/14	Relay 5 NO, parallel to digital output 5
	11	Relay 5/12	Relay 5 NC, parallel to digital output 5
	12	Relay 5/11	Relay 5 COM, parallel to digital output 5

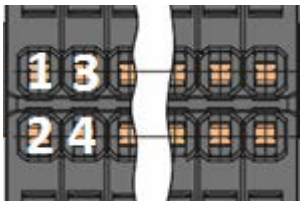
Tab. 2: *Pin definitions of X640 relay contacts (output)*

8.3.2 X641 digital Output

Order of Pins	Pin	Signal	Description
	**1**	Output 1	Digital output 1
	2	Output 2	Digital output 2
	3	Output 3	Digital output 3
	4	Output 4	Digital output 4
	5	Output 5	Digital output 5, parallel to relay 5
	6	Output 6	Digital output 6, parallel to relay 6
	7	Output 7	Digital output 7, parallel to relay 7
	8	Output 8	Digital output 8, parallel to relay 8

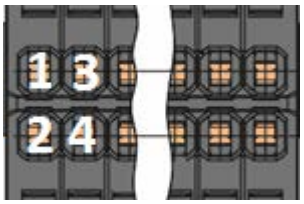
Tab. 3: *Pin definitions of X641 digital output*

8.3.3 X642 digital Input

Order of Pins	Pin	Signal	Description
	**1**	Input 1	Digital input 1
	2	Input 2	Digital input 2
	3	Input 3	Digital input 3
	4	Input 4	Digital input 4
	5	Input 5	Digital input 5
	6	Input 6	Digital input 6
	7	Input 7	Digital input 7
	8	Input 8	Digital input 8

Tab. 4: *Pin definitions of X642 digital input*

8.3.4 X645 auxiliary Voltage

Order of Pins	Pin	Signal	Description
	**1**	GND Ext	GND
	2	GND Ext	
	3	+24V Ext	+24 V_{DC} input (needs to be supplied for the interface to work)
	4	+24V Ext	
	5	+24V Aux	+24 V_{DC} auxiliary power, output (may be connected to 3+4 for standalone operation)
	6	+24V Aux	

Tab. 5: *Pin definitions of X645 auxiliary voltage*

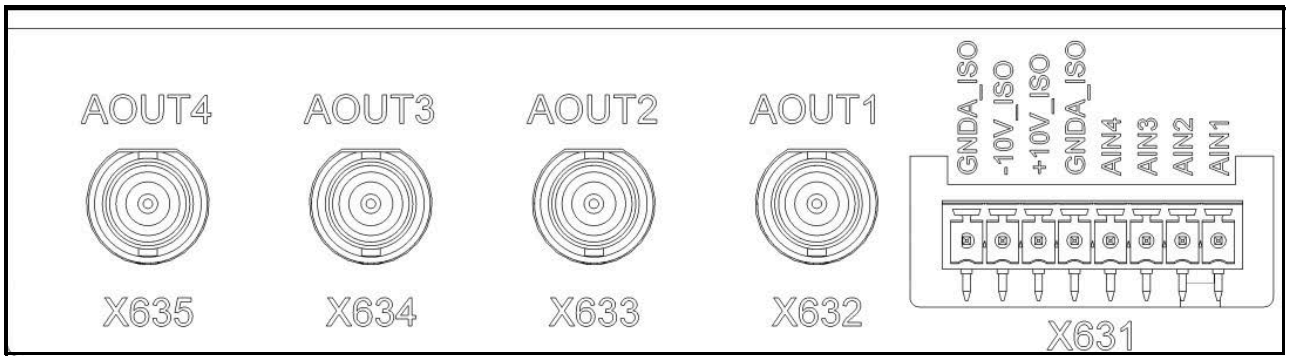
9 Option: Analog I/O Adaptor (TC.ACS X609 Adapter)

9.1 Application

The analog I/O adaptor is designed to offer an easier access to the interface X609 on the rear side of the TC.ACS device (see 3.2) than the original M12 flush-type connector. It can be connected to the interface X609 via its interface X630 and it also offers the interface X609 itself. In addition, it provides BNC connectors as well as a multiple connector that individually represent the pins of interface X609 (see 3.2.3).

*The input and output of the TC.ACS X609 adaptor can be filtered by a low pass filter, if necessary (see **9.4**).*

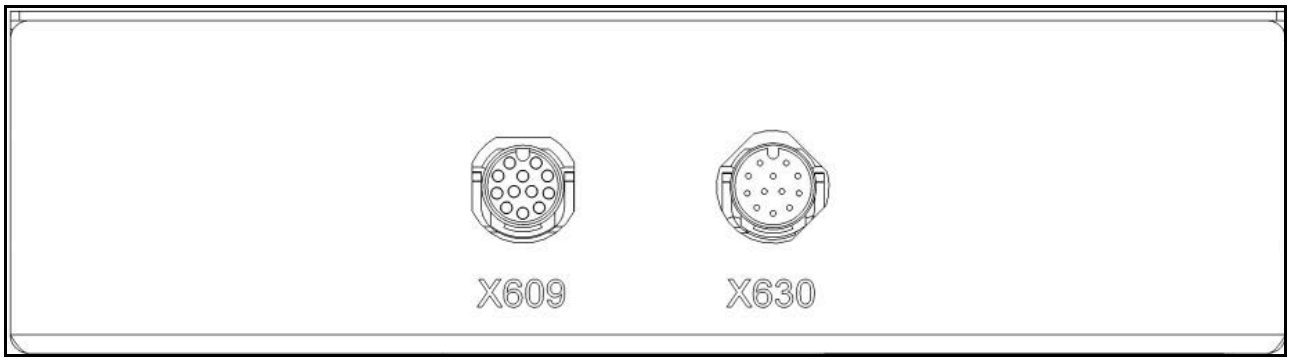
9.2 Interfaces on the Front



Interfaces on the front of the analog I/O adaptor				
Interface	**Type**	**Pins of X609 of TC.ACS**	**Signal**	**Description**
X631	8-pin multipole connector	Pins 1 - 8	AIN1	Analog input 1 (filtered or **unfiltered**)
			AIN2	Analog input 2 (filtered or **unfiltered**)
			AIN3	Analog input 3 (filtered or **unfiltered**)
			AIN4	Analog input 4 (filtered or **unfiltered**)
			GNDA_ISO	Analog ground
			+10V_ISO	+10V reference voltage
			-10V_ISO	-10V reference voltage
			GNDA_ISO	Analog ground
X632	BNC female	Pin 9	AOUT1	Analog output 1 (**filtered** or unfiltered)
X633	BNC female	Pin 10	AOUT2	Analog output 2 (**filtered** or unfiltered)
X634	BNC female	Pin 11	AOUT3	Analog output 3 (**filtered** or unfiltered)
X635	BNC female	Pin 12	AOUT4	Analog output 4 (**filtered** or unfiltered)

Tab. 6: *Interfaces of the analog I/O adaptor (front, from right to left), bold letters indicate the status of delivery*

9.3 Interfaces on the Rear



Interfaces on the rear of the analog I/O adaptor			
Interface	**Type**		**Function**
X609	M12 flush-type connector	female	Repetition of interface X609 of TC.ACS
X630		male	Connection to interface X609 of TC.ACS

Tab. 7: *Interfaces of the analog I/O adaptor (rear)*

9.4 Low Pass Filter

Each of the inputs and outputs can be individually filtered, if necessary. Here the filters are passive RLC second order low pass filters with the following characteristics:

- f_{-3dB} = 70.7 kHz
- Q = 0.51
- Damping ratio = 0.98
- No exaggeration in the frequency response
- No transient in step response

	Due to the damping ratio the -3 dB point is not at the cut-off frequency.

Whether or not an individual signal is filtered is determined by the position of a related jumper inside the adaptor box. Here, the jumpers JU1 - 4 belong to the inputs AIN1 - 4 and the jumpers JU5 - 8 belong to the outputs AOUT1-4. Each jumper can be set to one of two positions: 1/2 or 2/3.

Here, the following holds:

- Jumper is set to position 1/2 -> signal is filtered
- Jumper is set to position 2/3 -> signal is unfiltered

10 Option: Liquid to Air Heat Exchanger TC.LAE

10.1 Introduction

10.1.1 Application

The liquid to air heat exchanger TC.LAE is an external cooling system designed to cool the TC.ACS device in operation. Here, the TC.ACS and the TC.LAE are part of a closed cooling circuit:

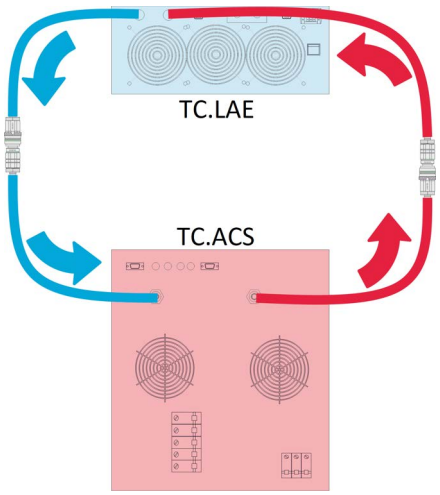


Fig. 16: *Cooling circuit of TC.LAE and TC.ACS*

The heat energy generated in the TC.ACS is transported to the TC.LAE via cooling liquid. Here, the heat energy is transferred to the surrounding air via an integrated liquid to air heat exchanger and the rear mounted cooling fans. The cooled cooling liquid is then returned to the TC.ACS.

NOTICE	*The TC.LAE cannot be used with more than one TC.ACS device at a time.*

10.1.2 Model Identifier

	The model identifier is given on the type plate on the rear of the device.

For a specific TC.ACS device the model identifier holds the following information:

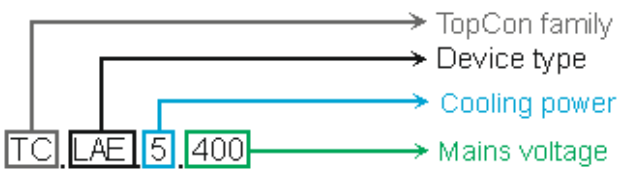


Fig. 17: *Model identifier (example)*

	Detailed information on your product variant is given in the related datasheet.

10.2 Interfaces, Controls and Displays

10.2.1 Front Side

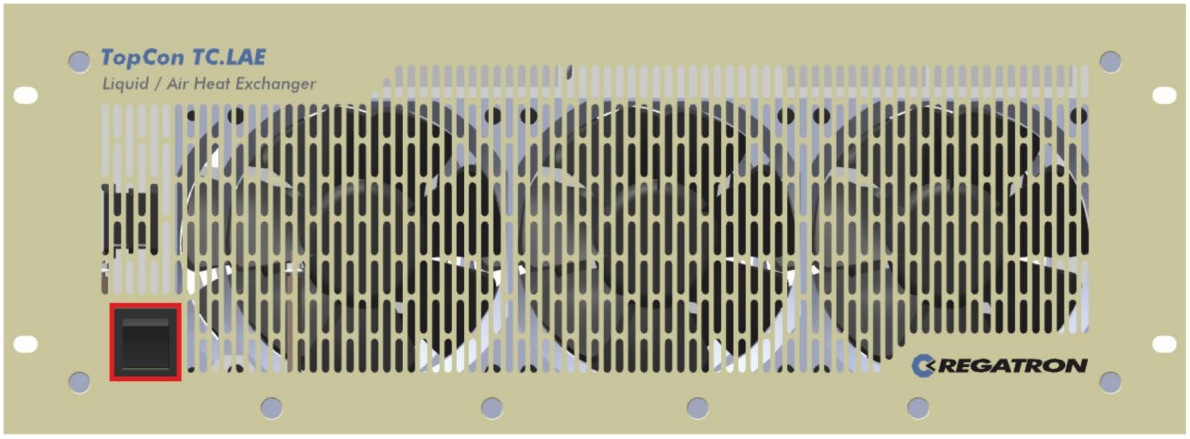


Fig. 18: *Main switch (front side)*

10.2.2 Rear Side

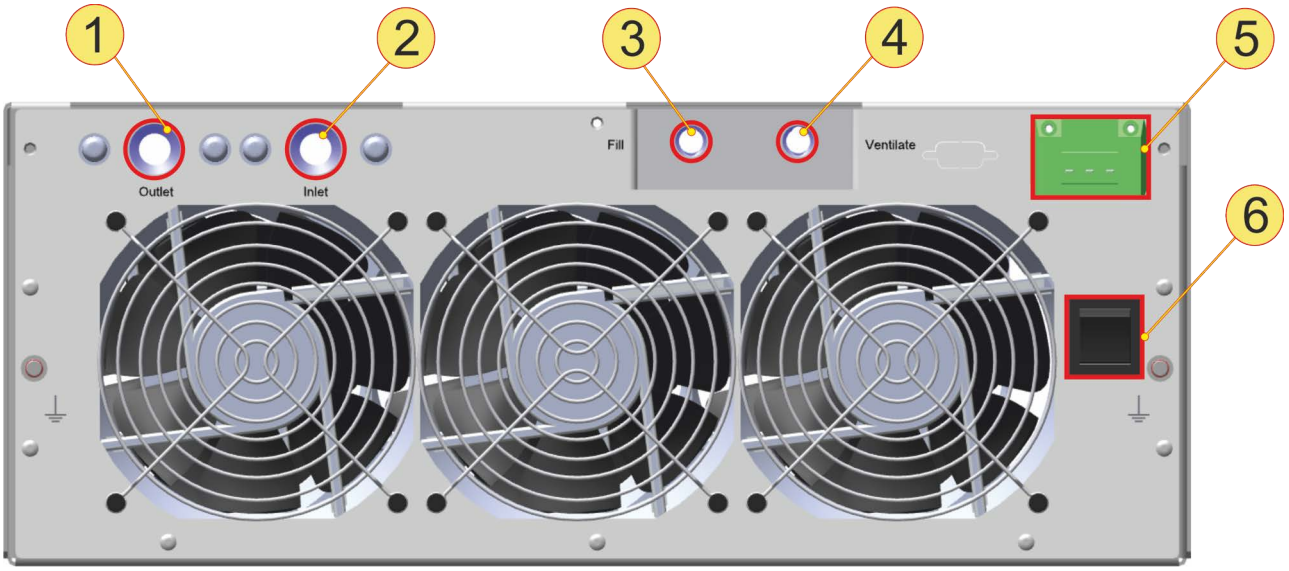


Fig. 19: *Interfaces, controls and displays (rear side)*

Interfaces, controls and displays (rear side)		
1	Interface **Outlet** (thread: G1/2”)	
2	Interface **Inlet** (thread: G1/2”)	
3	Interface **Fill** (thread: G1/2”)	*NOTE: For practical reasons these interfaces are duplicated on the top.*
4	Interface **Ventilate** (thread: G1/2”)	
5	Mains connection	
6	Pump switch	

10.3 Installation and Commissioning

10.3.1 Safety Advice

 **DANGER**	***Electric shock!*** ***Avoidance:*** - *The electrical installation is to be undertaken by personnel with electrical training.* - *Never connect or disconnect electrical connections while they are live.* - *The system must be electrically isolated and secured against being switched on.* - *Use cables carrying high currents with adequate cable cross-section area (refer to your national standards and the information on the type plates).* - *Your mains voltage must equal the nominal voltage of the system (given on the type plate).* - *After the installation, check the cables for firm fixing.* - *The highest permissible unaffected short-circuit (i.e. 12,5 kA) as well as the smallest required unaffected short-circuit current (i.e. 50 A) for each input port of the TC.LAE device must be considered.*

 **WARNING**	***Electric shock!*** ***Avoidance:*** *For secure grounding the device must be connected to a grounding network of type TN.* *TT- or IT-systems are not permitted.*

NOTICE	***Possible damage to the device!*** - *Due to conductive aggressive substances in the installation location* - *Due to a larger amount of moisture in the installation location* - *Due to foreign objects within the system* ***Avoidance:*** - *If necessary, clean the installation location of aggressive substances or moisture using cloths.* - *Remove foreign objects such as drilling sward or screws from the system before you fit new devices*

10.3.2 Overview

The installation and commissioning of the TC.LAE includes the following steps:

- Case Installation (10.3.3)
- Setting up the Cooling Circuit (10.3.4)
- Connecting the TC.LAE to the Mains (10.3.5)
- Filling of Cooling Liquid (10.3.6)
- Starting the TC.LAE (10.3.7)

	*If necessary, see **10.3.9** for **Emptying of Cooling Liquid**.*

10.3.3 Case Installation

NOTICE	***Possible damage!*** - *Due to soiling and foreign bodies at the installation location* - *Due to a build-up of heat* ***Avoidance:*** - *The installation location must be free of conductive and aggressive substances as well as moisture.* - *No foreign bodies such as drilling swarf or screws are to be allowed to fall into the system.* - *The site conditions (see technical datasheet) must be met.* - *The ventilation openings on the front panel and rear wall of the devices must not be covered or sealed.*

	*The TC.ACS device is to be used exclusively as a built-in device in a cabinet system. Here, the basic protection of the connection terminals must be provided in the end application, so that IP20 applies.*

The TC.LAE device is intended to be installed in horizontal position in a standard 19” case or switch cabinet with an external air flow. It is to be placed on rails or shelves and fastened at the holes on the left and right edges of the front panel. Usually M6 screws can be used.

	*The following points need to be regarded:* - *Rails or shelves must be robust.* - *The case for a TC.LAE must be in contact over full installation depth.* - *At the rear a cross-member is to be installed for additional fastening.*
	*When the TC.LAE is placed above the TC.ACS, the **Filling of Cooling Liquid** is easier.*

10.3.4 Setting up the Cooling Circuit

To set up the cooling circuit, do the following:

⇨ Establish the following connections via the shipped liquid hoses:

- **Outlet** interface for cooling circuit on the rear of the **TC.ACS** (see 3.2) ***to*** **inlet** interface for cooling circuit of the **TC.LAE** (see 10.2)
- **Inlet** interface for cooling circuit on the rear of the **TC.ACS** (see 3.2) ***to*** **outlet** interface for cooling circuit of the **TC.LAE** (see 10.2)

10.3.5 Connecting the TC.LAE to the Mains

To connect the TC.LAE to the mains, do the following:

⇨ Connect the TC.LAE to the mains via the mains connection on the rear side (see 10.2).

10.3.6 Filling of Cooling Liquid

	*You can order cooling liquid directly from the retailer Clariant. The product is named Antifrogen® N 30%.* *If necessary see **10.3.9** for **Emptying of Cooling Liquid**.*

10.3.6.1 Safety Advice

 **WARNING**	***Possible harm by cooling liquid!*** *According to the GHS the recommended cooling liquid Antifrogen® N 30% is classified as being hazardous in the following ways:* - *Harmful if swallowed (H302)* - *May cause damage to organs through prolonged or repeated exposure (H373)* ***Avoidance:*** *When handling with cooling liquid, do the following:* - *pay attention to the warning signs on the product.* - *open doors and windows and ensure the room is well ventilated also on the ground level.* - *use respiratory protection and protective cloves which are resistant against solvents.* - *close cooling liquid vessels immediately.* - *keep out of the reach of children.* - *avoid contact with skin and eyes.* *If exposed or concerned: Get medical advice!*

NOTICE	***Damage of the Device!*** *A short circuit may occur due to moisture (cooling liquid) in the device.* ***Avoidance:*** *- Make sure that both the TC.ACS device and the TC.LAE device are switched off.* *- Keep the cooling liquid from spilling on and into the devices.*

10.3.6.2 Prerequisites

For the filling of cooling liquid to the cooling circuit the following must be given:

- Both the TC.ACS device and the TC.LAE device are in horizontal position.
- Both the TC.ACS device and the TC.LAE device are switched off.
- The following material is provided:
  - ➢ Regatron AG fill-up kit, including: 2,5 l cooling liquid Antifrogen® N 30%, 1 funnel, 2 hoses with fittings attached
  - ➢ 6 mm Allen wrench
  - ➢ Collection vessel
  - ➢ Absorbent cloth or paper

	*The vessel and cloth are needed to catch spilling and excess cooling liquid.*

10.3.6.3 Procedure

To fill cooling liquid into the cooling circuit, do the following:

⇨ Open the interfaces **Fill** and **Ventilate** (see 10.2), either on the rear or on the top side, by removing the relevant screws.

	*Which pair of interfaces you actually use, i.e. on the rear or on the top side, is irrelevant for the result. You can simply choose those interfaces, which better suit your reqirements and any given local space constraints.*

⇨ To either interface, mount a hose via the attached fitting.

	*Both hoses must be directed upwards.*

⇨ Place the funnel to the open end of the filling hose (i.e. the one attached to the interface **Fill**).

⇨ Slowly fill in the cooling liquid via the funnel.

✓ The cooling liquid fills the internal circuit of the TC.LAE device. At some point, it appears in the venting hose (i.e. the one attached to the interface **Ventilate**).

⇨ Once the cooling liquid has reached half way of the venting hose, stop filling.

⇨ Start the TC.LAE (see 10.3.7).

⇨ Switch on the pump with pump switch (see 10.2.2).

✓ The cooling liquid is being pumped into the greater cooling circuit including the TC.ACS device.

⇨ When no more cooling liquid is visible in the venting hose, switch off the pump.

⇨ Repeat the filling and pumping procedure until the coolant level stays unchanged when pumping.

⇨ Switch off the pump.

⇨ Stop the TC.LAE (see 10.3.8).

⇨ While keeping the cloth or paper underneath, empty the filling hose as well as the venting hose into the collection vessel.

⇨ Remove the hoses and close the interfaces **Fill** and **Ventilate**.

10.3.7 Starting the TC.LAE

 **DANGER**	***Electric shock!*** ***Avoidance:*** - *Device and load must be isolated against accidental contact.* - *No maintenance work must be carried out.* - *Warning signs must be used and the area must be cordoned off.*

NOTICE	***Possible damage of the device!*** *When the pump of the TC.LAE runs dry, it will be damaged.* ***Avoidance:*** *Never let the pump run dry.*

Prerequisites: - The cooling circuit has been set up (see 10.3.4).

- The TC.LAE is connected to the mains (see 10.3.5).

⇨ To start the TC.LAE, switch on the main switch (10.2.1).

10.3.8 Stopping the TC.LAE

⇨ To stop the TC.LAE, switch off the main switch (10.2.2).

10.3.9 Emptying of Cooling Liquid

10.3.9.1 Safety Advice

 **WARNING**	***Possible harm by cooling liquid!*** *According to the GHS the recommended cooling liquid Antifrogen® N 30% is classified as being hazardous in the following ways:* - *Harmful if swallowed (H302)* - *May cause damage to organs through prolonged or repeated exposure (H373)* ***Avoidance:*** *When handling with cooling liquid, do the following:* - *pay attention to the warning signs on the product.* - *open doors and windows and ensure the room is well ventilated also on the ground level.* - *use respiratory protection and protective cloves which are resistant against solvents.* - *close cooling liquid vessels immediately.* - *keep out of the reach of children.* - *avoid contact with skin and eyes.* *If exposed or concerned: Get medical advice!*

NOTICE	***Damage of the Device!*** *A short circuit may occur due to moisture (cooling liquid) in the device.* ***Avoidance:*** *- Make sure that both the TC.ACS device and the TC.LAE device are switched off.* *- Keep the cooling liquid from spilling on and into the devices.*

10.3.9.2 Prerequisites

For the emptying of cooling liquid the following must be given:

- Both the TC.ACS device and the TC.LAE device are in horizontal position.
- Both the TC.ACS device and the TC.LAE device are switched off.
- The following material is provided:
  - ➢ Collection vessel
  - ➢ Absorbent cloth or paper

	*The vessel and cloth are needed to catch spilling and excess cooling liquid.*

10.3.9.3 Procedure

To empty the cooling liquid from the cooling circuit, do the following:

⇨ While keeping the cloth or paper underneath, disconnect the hose from the input interface of the upper device and put it into the collection vessel.

⇨ Start the TC.LAE (see 10.3.7).

⇨ Switch on the pump with the pump switch (see 10.2.2).

✓ The cooling liquid is being pumped out of the cooling circuit and flows into the vessel.

⇨ As soon as no more cooling liquid flows into the vessel, switch off the pump.

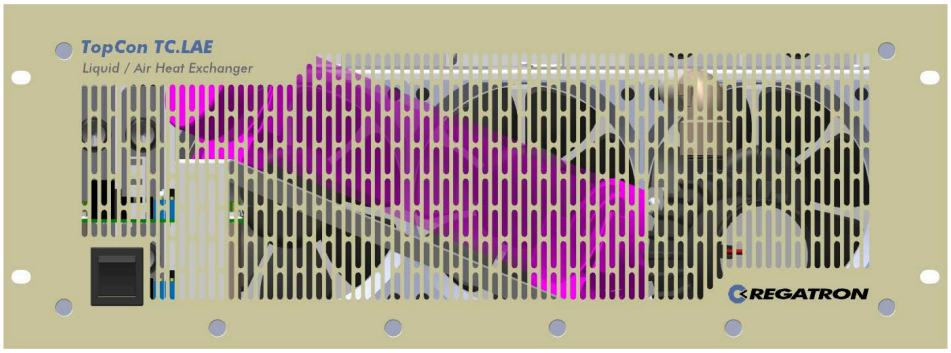
⇨ Stop the TC.LAE (see 10.3.8).

⇨ Reconnect the hose.

10.4 Maintenance

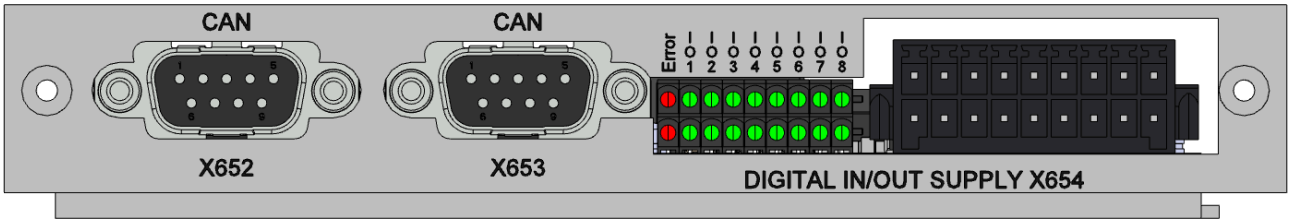
In order to make sure, that there is enough cooling liquid in the cooling circuit, do the following (in regular intervals of 6 month):

⇨ Visually check the filling level of the cooling liquid in the internal expansion reservoir (here highlighted pink):



⇨ If the filling level has fallen below the minimum level (marked on the expansion reservoir), fill up the cooling liquid (see 10.3.6).

11 Option: TC.ACS.CANmp Interface



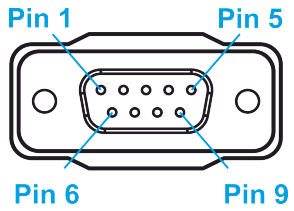
11.1 Application

The TC.ACS.CANmp (CAN multiprotocol) interface (X652/X653) is a standard CAN interface according to ISO 11898; Layer 1 and 2 in the ISO/OSI layer model. It is designed to build a CAN bus for the communication between the TC.ACS device and other devices.

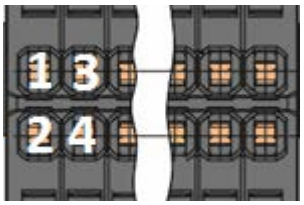
	In general, the following applies to a CAN bus: - *The maximum possible bus length depends on the baud rate (e.g. 30 m @ 1 Mbit/s, 100 m @ 500 Kbit/s, ...).* - *It is possible to connect 32 bus members. In case of distance reduction and transfer rate reduction more bus members are possible.* - *The bus end needs to be terminated with a resistance of 120 Ω. A corresponding terminal resistor is supplied.* - *The shield must be connected over the entire length of the bus cable and galvanically grounded to one point only to avoid ground loops.*

The digital I/O interface (X654) provides additional digital inputs and outputs, which are programmable via ACSControl.

11.2 Interfaces X652/X653

Order of Pins	Pin	Signal	I/O	Description
	**1**	---	I/O	n.c. (signal will be looped through)
	2	CAN L	I/O	Signal: Dominant Low
	3	CAN GND	O	Common ground
	4	---	---	n.c. (signal will be looped through)
	5	CAN SHLD	---	High resistance connection to common ground (can be connected via a jumper)
	6	CAN GND	---	n.c. (signal will be looped through)
	7	CAN H	I/O	Signal: Dominant High
	8	---	O	n.c. (signal will be looped through)
	9	CAN V+	---	n.c. (signal will be looped through)
	Cover	Shield		Connected to earth

11.3 Interface X654

Order of Pins	Pin	Signal	Description
	**1**	Input 1	Digital input
	2	Output 1	Digital output
	3	Input 2	Digital input
	4	Output 2	Digital output
	5	Input 3	Digital input
	6	Output 3	Digital output
	7	Input 4	Digital input
	8	Output 4	Digital output
	9	Input 5	Digital input
	10	Output 5	Digital output
	11	Input 6	Digital input
	12	Output 6	Digital output
	13	Input 7	Digital input
	14	Output 7	Digital output
	15	Input 8	Digital input
	16	Output 8	Digital output
	17	+24 V Ext	+24 VDC input (needs to be supplied for the interface to work)
	18	GND Ext	GND

11.4 Connecting an external Control Device

You can connect an external control device to your TC.ACS device as a remote control via the TC.ACS.CANmp interface.

With respect to the TC.ACS.CANmp interface the following applies:
- *It is fully isolated.*
- *It fulfills the ISO 11898 standard.*

To connect an external control device via the TC.ACS.CANmp interface, do the following:

⇨ Physically connect the external control device to the TC.ACS device via one plug, either X652 or X653 of the TC.ACS.CANmp interface with an appropriate CAN cable.

⇨ Unless the other plug is connected to another CAN device, terminate it with the related terminal resistor.

11.5 Configuration of a CAN Protocol

To use the CANmp interface a CAN protocol must be configured and written to the TC.ACS device.

For more information on configuring a CAN protocol and writing it to the TC.ACS device see the user manual of the CANmp Configuration Tool.

Within a CAN protocol, a maximum of 50 messages can be configured and for each message a maximum of 4 signals (each 16 bit). The length of a signal may vary between 16 and 64 bit depending on the used data type. The number of configurable signals in a message may be different, because the payload has a maximum length of 64 bit.

Here, a message can be configured with respect to the following attributes:

- CAN ID
- DLC (data length code, number of bytes of payload)
- Type of message, i.e.:
  - ➢ RX message (receives a message)
  - ➢ TX message (transmits a message), including the following kinds:
    - Cyclic message (transmits a message at regular intervals)
    - Sync message (transmits a message after receiving a specified number of sync signals)
    - SyncID message (transmits a message after receiving a specified syncID)
- Structure of included signals
  - ➢ Start bit
  - ➢ Length
  - ➢ Byte order
  - ➢ Data type
  - ➢ Factor for multiplication or determination of the number of decimal places of the signal value for the data type integer

11.5.1 Definitions

11.5.1.1 Direction of Transmission

TX message:	Regatron -> Customer
RX message:	Customer -> Regatron

11.5.1.2 Data Types

Sint16, Sint32, Sint64:	Signed integer 16, 32 and 64 bit (signed value)
Uint16, Uint32, Uint64:	Unsigned integer 16, 32 and 64 bit (unsigned value)
Float32, Float64:	Floating point number single (32 bit, Float32) and double precision (64 bit, Float64)

11.5.2 General Configurations

CAN baud rate:	The CAN baud rate is the speed of data transfer via a CAN bus. Possible settings are: 1 Mbit/s, 500 kbit/s, 250 kbit/s, 125 kbit/s, 50 kbit/s, 20 kbit/s.
Customized signal factor:	A signal is multiplied by the signal factor. It can be used to represent the number of decimal places or to multiply the signal value (with low accuracy requirements) in a 16 bit signal, which would require at least a 32 bit signal (Uint32, Sint32, Float32). 0 to 3 decimal places (signal factor 1, 0.1, 0.01, 0.001) or a multiplication of the signal value with 10, 100 or 1000 are default configurations. Is this not sufficient then up to 3 customized signal factors can be configured. There are no limitations for the configurable values.

11.5.3 Message Attributes and their possible Values

CAN ID:	Valid ID's are 0 … 0x7FF. 29 bit identifier is currently not supported. A received message with an ID greater than 0x7FF would be ignored (CAN standard 2.0B).
RX message:	To configure an RX message the cycle time has to be 0.
Cyclic message:	Configurable cycle times are: 1 ms, 2 ms, 5 ms, 10 ms, 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1000 ms.
Sync message:	In a sync message is the number of received sync signals configurable until the sync message is to be sent. Valid values for the number of sync signals are 1 … 8191.
SyncID message:	A syncID message is sent when a syncID signal with the configured syncID is received. Valid values for the syncID are 0…8191.
DLC:	The DLC (data length code) defines how many bytes of the payload will be sent. If only the first byte of a 16 bit signal is a valid value, then an appropriate configuration of the DLC can prevent the sending of the second byte. Valid values for the DLC are 1 … 8 depending on the number of configured signals and data types.

11.5.4 Signal Attributes and their possible Values

Byte order: Byte order Intel (little endian) means that the least significant byte is on the lowest position of a signal. Byte order Motorola (big endian) means that the least significant byte is on the highest position of a signal.

Start bit: The start bit defines the position of the first bit of a signal within a message. Valid values are: Byte order Intel: 0, 16, 32, 48 and byte order Motorola: 8, 24, 40, 56.

Data type: The configurable data types are depending on the choice of the signal (see chapters 11.5.4.1 Definition of TX Signals and 11.5.4.2 Definition of RX Signals).

Signal factor: A signal is multiplied by the signal factor. It can be used to represent the number of decimal places or to multiply the signal value (with low accuracy requirements) in a 16 bit signal, which would require at least a 32 bit signal (Uint32, Sint32, Float32). 0 to 3 decimal places (signal factor 1, 0.1, 0.01, 0.001) or a multiplication of the signal value with 10, 100 or 1000 are default configurations. Is this not sufficient then could be configured up to 3 customized signal factors. There are no limitations for the configurable values. For the data types Float32 and Float64 is only the signal factor 1 configurable. Configurable signal factors depending on a signal are listed in the chapters 11.5.4.1 Definition of TX Signals and 11.5.4.2 Definition of RX Signals.

Signal name: The signal name defines which data in a message will be sent or received. The chapters 11.5.4.1 Definition of TX Signals and 11.5.4.2 Definition of RX Signals show which signals are configurable. In RX messages only RX signals and in TX messages only TX signals can be configured.

11.5.4.1 Definition of TX Signals

Definition of TX Signals			
Signal name	**Configurable data types/ signal factors**	**Description (see ACSControl or Software Manual)**	
ActState	**Uint16:** Signal factor	Actual system state (0 = undefined; 1 = power up; 2 = standby; 3 = ready; 4 = switched on; 5 = update; 6 = test; 7 = different; 99 = reset) *NOTE: The state 'Test' (6) is for internal use and the state 'reset' (99) is only a transitional state.*	**Status bar**
ActCommand		Actual process state of SetCommand (0 = idle, i.e. no command or command proceeded; 1 = command is in progress; 2 = command is not possible in actual state; 3 = command is not possible due to blocking incidents; 4 = timeout while executing command; 5 = command could not be set on slave; 6 = command cannot be forced; 7 = command is not possible due to flash activity)	**n.a.**
ActErrorCode		Actual system error code *NOTE: Detailed information on error codes is given in the related incident list.*	**n.a.**
ActSystemInfoMaxOutVoltageVmax	**Sint16, Sint32:** All signal factors **Float32:** Signal factor 1	Maximum output voltage L-N [V_{peak}]	**Info > Device Info**
ActSystemInfoMaxOutFrequencyFmax		Maximum output frequency [Hz]	
ActSystemInfoMinOutFrequencyFmin		Minimum output frequency [Hz]	
ActSystemInfoMaxOutCurrentImax		Maximum output current [A_{peak}]	
ActDeviceId	**Uint16:** Signal factor 1	Device ID (in a multi-device system) 0 = master, 1 = slave 1, 2 = slave 2, …	**n.a.**

Definition of TX Signals			
Signal name	**Configurable data types/ signal factors**	**Description (see ACSControl or Software Manual)**	
ActVoltagePhaseL1	**Sint16, Sint32:** All signal factors **Float32:** Signal factor 1	Voltage [V] phase L1	**Tab 'Live Viewer'**
ActSenseVoltagePhaseL1		Sense voltage [V] phase L1	
ActCurrentPhaseL1		Current [A] phase L1	
ActApparentPowerPhaseL1		Apparent power [VA] phase L1	
ActActivePowerPhaseL1		Active power [W] phase L1	
ActReactivePowerPhaseL1		Reactive power [var] phase L1	
ActVoltagePhaseL2		Voltage [V] phase L2	
ActSenseVoltagePhaseL2		Sense voltage [V] phase L2	
ActCurrentPhaseL2		Current [A] phase L2	
ActApparentPowerPhaseL2		Apparent power [VA] phase L2	
ActActivePowerPhaseL2		Active power [W] phase L2	
ActReactivePowerPhaseL2		Reactive power [var] phase L2	
ActVoltagePhaseL3		Voltage [V] phase L3	
ActSenseVoltagePhaseL3		Sense voltage [V] phase L3	
ActCurrentPhaseL3		Current [A] (phase L3)	
ActApparentPowerPhaseL3		Apparent power [VA] phase L3	
ActActivePowerPhaseL3		Active power [W] phase L3	
ActReactivePowerPhaseL3		Reactive power [var] phase L3	
ActVoltagePhaseL4		Voltage [V] neutral conductor N	
ActCurrentPhaseL4		Current [A] neutral conductor N	
ActMeanValuePhaseCurrentGrid		Current [A] mains	
ActReactivePowerGrid		Reactive power [var] mains	
ActApparentPowerGrid		Apparent power [VA] mains	
ActActivePowerGrid		Active power [W] mains	
ActPowerFactorGrid		Power factor (cos φ) mains	
ActSenseVoltagePhaseL4		Sense voltage [V] neutral conductor N	**n.a.**
ActApparentPowerPhaseL4		Apparent power [VA] neutral conductor N	
ActActivePowerPhaseL4		Active power [W] neutral conductor N	
ActReactivePowerPhaseL4		Reactive power [var] neutral conductor N	
ActCANmpInterfaceVersion	**Uint16:** Signal factor 1	Version of the CANmp interface (bit 8...15 = function; bit 0...7 = feature) *NOTE: A change of the function means that it is not backwards compatible.*	

Definition of TX Signals			
Signal name	**Configurable data types/ signal factors**	**Description (see ACSControl or Software Manual)**	
ActFwVersionAcscBootloader	**Uint32:** Signal factor 1	Communication (CTR.ACSC) DSP bootloader version (bit 0...7: build; bit 8...15: rev; bit 16...23: sub; bit 24...31: main)	**Info > Device Info > Type Plate/Boards**
ActFwVersionAcscMain	**Uint32:** Signal factor 1	Communication (CTR.ACSC) DSP main version (bit 0...7: build; bit 8...15: rev; bit 16...23: sub; bit 24...31: main)	
ActFwVersionAcsoPld		Load (CTR.ACSO) PLD version (bit 0...7: build; bit 8...15: rev; bit 16...23: sub; bit 24...31: main)	
ActFwVersionAcsoBootloader		Load (CTR.ACSO) DSP bootloader version (bit 0...7: build; bit 8...15: rev; bit 16...23: sub; bit 24...31: main)	
ActFwVersionAcsoMain		Load (CTR.ACSO) DSP main version (bit 0...7: build; bit 8...15: rev; bit 16...23: sub; bit 24...31: main)	
ActFwVersionAcsiPld		Grid (CTR.ACSI) PLD version (bit 0...7: build; bit 8...15: rev; bit 16...23: sub; bit 24...31: main)	
ActFwVersionAcsiBootloader		Grid (CTR.ACSI) DSP bootloader version (bit 0...7: build; bit 8...15: rev; bit 16...23: sub; bit 24...31: main)	
ActFwVersionAcsiMain		Grid (CTR.ACSI) DSP main version (bit 0...7: build; bit 8...15: rev; bit 16...23: sub; bit 24...31: main)	
ActSerialNumber		Serial number of the device	
ActSetLimitersLoadConnectionType	**Uint16:** Signal factor 1	Current limit load connection type (0 = star; 1 = delta; 2 = single phase)	**Tab 'System Config'**
ActSetLimitersLoadCurrent	**Sint16, Sint32:** All signal factors **Float32:** Signal factor 1	Current limit per phase [A]	
ActSetLimitersLoadVoltage		Voltage limit per phase [V]	
ActSetLimitersLoadRefSlope		Reference slope [V/µs]	
ActSetTriplevelsLoadOvercurrent		Phase overcurrent 2 [A]	
ActSetTriplevelsLoadErrorTime		Phase overcurrent 2 error time [ms]	
ActSetI2tLimitHigh		I^2t Supervision I limit high [A]	
ActSetI2tLimitLow		I^2t Supervision I limit low [A]	
ActSetI2tErrorTime		I^2t Supervision I Time [s]	

Definition of TX Signals			
Signal name	**Configurable data types/ signal factors**	**Description (see ACSControl or Software Manual)**	
ActSetOperationMode	**Uint16:** Signal factor 1	ACS operation mode (0 = no changes 1 = Amplifier Mode 2 = TC.ACS.CANmp Waveform Generator Mode 3 = Amplifier Mode X609 4 = Power Mode 65535 = invalid mode for CANmp)	**Tab'System Control Config'**
ActSetControlMode		Controller mode selection (1 = Current Controlled 11 = Voltage Controlled 21 = Power Controlled 65535 = adjust)	
ActSetVoltageLimitSense	**Sint16, Sint32:** All signal factors **Float32:** Signal factor 1	Voltage limit sense per phase [V]	**Tab'System Config'**
ActSetVoltageTripLimitSense		Voltage triplimit sense per phase [V]	
ActSetMaxVoltageDeviationSense		Max voltage scaling deviation [%]	
ActSetOutputGainVoltage		Voltage gain (Usense/Udevice)	
ActSetOutputGainCurrent		Current gain (Isense/Idevice)	
ActSetDcVoltageRejection	**Uint16:** Signal factor 1	DC voltage rejection (0 = disabled; 1 = enabled)	
ActSetRmsControlVoltage		RMS control voltage (0 = disabled; 1 = internal; 2 = sense)	
ActSetDeviceType	**Uint16:** Signal factor 1	Multi device configuration: roles of individual devices Result is 0xFFFF when SetDeviceType was invalid (8bit MSB = device ID; 8bit LSB = device type, i.e. 0 = single; 1 = master; 2 = slave)	**Tab 'Device Config'**
ActSetNumberOfDevices		Multi device configuration: number of devices Result is 0xFFFF when SetNumberOfDevices was invalid (8bit MSB = device ID; 8bit LSB = number of devices)	
ActSetDigitalOutputs	**Uint16:** Signal factor 1	Actual state of digital outputs and trigger out (bit 0 = trigger out; bit 1...8 = digital outputs 1...8)	**Tab 'I/O Config'**
ActDigitalInputs		Actual state of digital inputs and trigger in (bit 0 = trigger in; bit 1...8 = digital inputs 1...8)	

Definition of TX Signals			
Signal name	**Configurable data types/ signal factors**	**Description (see ACSControl or Software Manual)**	
ActSystemIncident	**Uint32:** Signal factor 1	Read system incidents Readout process: 1. Write SetFirstSystemIncident 2. Read ActSystemIncident 3. Repeat 2. until result is '0' (all incidents read) (bit 16...31 = system incident code bit 8...15 = device ID of the relevant device bit 5...7 = reserved bit 4 = incident is blocking bit 3 = incident is clearable bit 0...2 = incident type, i.e. 0 = invalid; 1 = error; 2 = warning; 3 = event)	**Dialogs 'Error/Warning details'**
ActParameterReadResult	**Uint64** Signal factor 1	Result of selective parameter read: Content of result if reading idle/busy: (bit 32…63 = 0 when idle (nothing to read), 65535 when busy (read pending) bit 0…31 = 0xFFFF'FFFF) Content of result if reading successful: (bit 32...63 = data bit 16...31 = parameter index bit 8...15 = parameter subIndex bit 1...7 = device ID (0...127) bit 0 = is 32 bit access) Content of result if reading fault: (bit 32...63 = error data bit 16...31 = 0xFFFF bit 8...15 = 0xFF bit 0...7 = device ID (0...127) *NOTE: This signal is for customer-specific functions only, contact customer support.*	**Tab 'Parameter'**

Definition of TX Signals			
Signal name	**Configurable data types/ signal factors**	**Description (see ACSControl or Software Manual)**	
ActParameterWriteResult	**Uint64** Signal factor 1	Result of selective parameter write: Content of result if writing idle/busy: (bit 32…63 = 0 when idle (nothing to write), 65535 when busy (write pending) bit 0…31 = 0xFFFF'FFFF) Content of result if writing successful: (bit 32...63 = data bit 16...31 = parameter index bit 8...15 = parameter subIndex bit 0...7 = device ID (0...127) bit 0 = Is 32 bit access) Content of result if writing fault: (bit 32...63 = error data bit 16...31 = 0xFFFF bit 8...15 = 0xFF bit 0...7 = device ID (0...127) bit 0 = is 32 bit access) Error data: (bit 16…31 = parameter index bit 8…15 = parameter subIndex bit 0…7 = talk result (0xFE = general talk error, 0xFD = value out of valid range, 0xFC = parameter does not exist, 0xFB = access violation (e.g. device is in wrong state or write on read only parameter), 0xFA = license is missing)) *NOTE: This signal is for customer-specific functions only, contact customer support.*	**Tab 'Parameter'**
ActWatchdog	**Uint16:** Signal factor 1	Watchdog status (0 = deactivated; 1…65535 = activated with timeout [ms])	**n.a.**
ActSetPhaseConnection		Phase connection *(1 = 3L (AC/DC)* *2 = 1L (AC/DC double current)* *3 = 2L (AC/DC double voltage/current)* *4 = 1L (DC triple current))*	**Tab 'System Control Config'**
ActSetRmsControlCurrent		RMS control current (0 = disabled, 1 = enabled)	**Tab 'System Config'**
ActSetBlockSwitchSource		Source and point in time of a block switch (bit 0 = block switch pending, bit 1 = source 'communication interface' is selected, bit 2 = source 'trigger input' is selected, bit 3 = point in time of a block switch initiated via communication interface (0 = immediately, 1 = period end), bit 4 = point in time of a block switch initiated via trigger input (0 = immediately, 1 = period end))	

Definition of TX Signals			
Signal name	**Configurable data types/ signal factors**	**Description (see ACSControl or Software Manual)**	
ActSystemInfoOutputCapacitance	**Sint16, Sint32:** All signal factors **Float32:** Signal factor 1	Output filter capacitance [F]	**Tab 'System Info'**
ActSystemInfoMaxApparentPower		Actual maximum apparent power of system [kVA]	
ActSetSoftstartActivationTime		Actual activation time [ms] (resolution is 100 ms) (Value '0' means soft start is disabled)	
ActSetSoftstartCurrentLimitReduction		Actual reduction of current limit [%]	
ActSetLimitersLoadRefSlopeCurrent		Actual set max. current reference slope [A/µs]	
ActSetPwrModeLimiterApparentPower		Actual set max. apparent power of system [kVA]	
ActSetPwrModeLimiterRefSlope		Actual set max. power reference slope [kVA/ms]	

11.5.4.2 Definition of RX Signals

Definition of RX Signals			
Signal name	**Configurable data types/ signal factors**	**Function (see ACSControl or Software Manual)**	
SetSyncSignal	**Uint16:** Signal factor 1	Necessary preparation before sending Sync or SyncID messages to the device bit 0: sync signal for sync messages bit 1: syncID signal for syncID messages bit 2...15: syncID for syncID messages	**n.a.**
SetCommand		Operating the device (0 = none; 1 = run; 2 = stop; 3 = discharge; 4 = clear incidents; 5 = store settings; 99 = reset) *NOTE: 'Run' starts both the device and the Function Generator. 'Stop' stops the Function Generator and puts the device into the state 'Ready'.*	**Toolbar/Statusbar**
SetSynchronisation		Enable Synchronous Mode bit 0: phase L1 bit 1: phase L2 bit 2: phase L3 *NOTE: For enabling Synchronous Mode the TC.ACS must be stopped. Disabling Synchronous Mode is always possible.*	**n.a.**
SetFuncGenCommand		Operating the Waveform Generator (0 = none; 1 = stopping a Block or Sequence; 2 = running a Block or a Sequence; 3 = deactivating the Waveform Generator; 4 = activating the Waveform Generator; 5 = pausing a running Block or Sequence; 6 = resuming a paused Block or Sequence; 7 = jumping to the next Block in a Sequence; 99 = resetting Waveform Generator configuration) *NOTE: Deactivating the Waveform Generator is not possible in Synchronization Mode.*	**Toolbar**

Definition of RX Signals			
Signal name	**Configurable data types/ signal factors**	**Function (see ACSControl or Software Manual)**	
SetFuncGenCreateBlock	**Uint16:** Signal factor 1	Creating a new block in the Waveform Generator Signal value = number of repetitions of the new block A signal value of '0' means an infinite number of repetitions. *NOTE: The number of blocks that can be created is limited to 10.*	**Tab 'Block'**
SetFuncGenPhaseNo		Set phase selection (0 = phase L1; 1 = phase L2; 2 = phase L3; 3 = phase L4)	
SetFuncGenFunctionType		Set the basic waveform of the currently selected phase (0 = none; 1 = sine; 2 = exponential wave; 3 = DC; 4 = saw tooth down; 5 = saw tooth up; 6 = square wave; 7 = triangle)	
SetFuncGenPhaseAngle	**Sint16, Sint32:** All signal factors **Float32:** Signal factor 1	Set phase angle [°] of currently selected phase	
SetFuncGenFrequency		Set frequency [Hz] of currently selected phase	
SetFuncGenAmplitude		Set amplitude of currently selected phase Û [V] or Î [A] depending on controller mode	
SetFuncGenBlockDuration	**Sint16, Sint32:** All signal factors **Float32:** Signal factor 1	Set duration time Signal value = duration of the block in [s] A signal value of '0' means an infinite duration time.	
SetFuncGenPhaseFlags	**Uint16:** Signal factor 1	Set flags of the Waveform Generator to activate specific functions bit 0: Ignore start angle on a block change to this block bit 1: Set trigger output on a block change to this block bit 2: Select phase for Synchronous Mode (enabling synchronous mode see signal SetSynchronisation)) bit 3: phase failure (power output is switched to high impedance for this block) bit 4...15: reserved	**n.a.**
SetLimitersLoadConnectionType	**Uint16:** Signal factor 1	Set current limit load connection type (0 = star; 1 = delta; 2 = single phase)	**Tab 'System Config'**
SetLimitersLoadCurrent	**Sint16, Sint32:** All signal factors **Float32:** Signal factor 1	Set current limit per phase [A]	
SetLimitersLoadVoltage		Set voltage limit per phase [V]	
SetLimitersLoadRefSlope		Set reference slope [V/µs]	
SetTriplevelsLoadOvercurrent		Set phase overcurrent 2 [A]	
SetTriplevelsLoadErrorTime		Set phase overcurrent 2 error time [ms]	
SetI2tLimitLow		Set I^2t limit low [A]	
SetI2tLimitHigh		Set I^2t limit high [A]	
SetI2tErrorTime		Set time [s]	

Definition of RX Signals			
Signal name	**Configurable data types/ signal factors**	**Function (see ACSControl or Software Manual)**	
SetOperationMode	**Uint16:** Signal factor 1	Set ACS operation mode (0 = no changes 1 = Amplifier Mode 2 = TC.ACS.CANmp Waveform Generator Mode 3 = Amplifier Mode X609 4 = Power Mode)	**Tab 'System Control Config'**
SetControlMode		Set controller mode selection (0 = no changes 1 = Current Controlled 11 = Voltage Controlled 21 = Power Controlled) *NOTE: For the controller mode 'Current Controlled' the license 'Current Control' is needed.*	
SetVoltageLimitSense	**Sint16, Sint32:** All signal factors **Float32:** Signal factor 1	Set voltage limit sense per phase [V]	**Tab 'System Config'**
SetVoltageTripLimitSense		Set voltage triplimit sense per phase [V]	
SetMaxVoltageDeviationSense		Set max voltage scaling deviation sense [%]	
SetOutputGainVoltage		Set voltage gain (Usense/Udevice)	
SetOutputGainCurrent		Set current gain (Isense/Idevice)	
SetDcVoltageRejection	**Uint16:** Signal factor 1	Set DC voltage rejection (0 = disabled; 1 = enabled)	
SetRmsControlVoltage		Set input source RMS control voltage (0 = disabled; 1 = internal; 2 = sense)	

Definition of RX Signals			
Signal name	**Configurable data types/ signal factors**	**Function (see ACSControl or Software Manual)**	
SetDeviceType	**Uint16:** Signal factor 1	Set multi device configuration: roles of individual devices Result is 0xFFFF when SetDeviceType was invalid (8bit MSB = device ID; 8bit LSB = device type, i.e. 0 = single; 1 = master; 2 = slave) *NOTE: Storing the settings and a reboot is required to make changes effective.*	**Tab 'Device Config'**
SetNumberOfDevices		Set multi device configuration: number of devices Result is 0xFFFF when SetNumberOfDevices was invalid (8bit MSB = device ID; 8bit LSB = number of devices) *NOTE: This signal is only used when device is set as master. Storing the settings and a reboot is required to make changes effective.*	
SetDigitalOutputs		Set digital outputs and trigger out (needs to be configured by ACSControl) (bit 0 = trigger out; bit 1...8 = digital outputs 1...8)	**Tab 'I/O Config'**
SetFirstSystemIncident		Reset system incident readout and start with first incident. Write before reading with ActSystemIncident. (0 = do nothing; 1...65535 = reset)	**Dialogs 'Error/ Warning details'**
SetParameterRead	**Uint32:** Signal factor 1	Set selective parameter address to read from (bit 16...31 = parameter index; bit 8...15 = parameter subIndex; bit 1...7 = device ID (0...127); bit 0 = is 32 bit access) *NOTE: This signal is for customer-specific functions only, contact customer support.*	**Tab 'Parameter'**
SetParameterWrite	**Uint64:** Signal factor 1	Set selective parameter address to write to (bit 32...63 = data; bit 16...31 = parameter index; bit 8...15 = parameter subIndex; it 1...7 = device ID (0...127); bit 0 = is 32 bit access) *NOTE: This signal is for customer-specific functions only, contact customer support.*	

Definition of RX Signals			
Signal name	**Configurable data types/ signal factors**	**Function (see ACSControl or Software Manual)**	
SetWatchdog	**Uint16:** Signal factor 1	Set watchdog configuration (0 = deactivate; 1...65535 = activate with timeout [ms])	**n.a.**
SetPhaseConnection		Set phase connection (0 = no changes, 1 = 3L (AC/DC) 2 = 1L (AC/DC double current) 3 = 2L (AC/DC double voltage/current) 4 = 1L (DC triple current)) *NOTE: For the phase connections '1L (AC/DC double current)', '2L (AC/DC double voltage/current)' and '1L (DC triple current)' the license 'Phase Connection' is needed.*	**Tab 'System Control Config'**
SetRmsControlCurrent		Set RMS control current (0 = disable, 1 = enable)	**Tab 'System Config'**
SetBlockSwitchSource		Set source and point in time of a block switch (bit 0 = set block switch configuration (if this bit is not set, the configuration will not be changed), bit 1 = select source 'communication interface', bit 2 = select source 'trigger input', bit 3 = set point in time of a block switch initiated via communication interface (0 = immediately, 1 = period end), bit 4 = set point in time of a block switch initiated via trigger input (0 = immediately, 1 = period end))	
SetSoftstartActivationTime	**Sint16, Sint31:** All signal factors **Float32:** Signal factor 1	*Set activation time [ms] (resolution is 100 ms) NOTE: Value '0' means soft start is disabled.*	
SetSoftstartCurrentLimitReduction		Set reduction of current limit [%]	
SetLimitersLoadRefSlopeCurrent		Set limiters load max current reference slope [A/µs]	
SetPwrModeLimiterApparentPower		Set max apparent power of system [kVA]	
SetPwrModeLimiterRefSlope		Set max. power reference slope [kVA/ms]	

Definition of RX Signals			
Signal name	**Configurable data types/ signal factors**	**Function (see ACSControl or Software Manual)**	
SetPowerModeInputFormat	**Uint16:** Signal factor 1	Set power mode input format (0 = S, cos(φ) (default), 1 = P, Q)	**Tab 'Power Mode'**
SetPowerModeLoadType		Set power mode load type (0 = inductive (lead) (default), 1 = capacitive (lag)) *NOTE: The input is only accepted if SetPwrModeLimiterRefSlope is '0'.*	
SetPowerModeApparentPower	**Sint16, Sint31:** All signal factors **Float32:** Signal factor 1	Set power mode apparent power [kVA] *NOTE: The input is only accepted if SetPwrModeLimiterRefSlope is '0'.*	
SetPowerModeCosPhi		Set power mode cos(φ) [0, 1] *NOTE: The input is only accepted if SetPwrModeLimiterRefSlope is '0'.*	
SetPowerModeActivePower		Set power mode active power [kW] *NOTE: The input is only accepted if SetPwrModeLimiterRefSlope is '1'.*	
SetPowerModeReactivePower		Set power mode reactive power [kvar] *NOTE: The input is only accepted if SetPwrModeLimiterRefSlope is '1'.*	
SetPowerModeTransitionTime	**Uint32:** Signal factor 1	Set power mode transition time [ms] (transition time from actual power value at output to new set value) *NOTE: The signal works with both input formats.*	-

This product is developed, produced and tested according to ISO 9001 by REGATRON.

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