ATESTEO

Excellence in drivetrain testing

IRTS-P Manual

Temperature telemetry system

IRTS-P Manual
Version 1.0 08.2023

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1 Introduction

Thank you for choosing an ATESTEO quality product. Please read the system description carefully so you make the most of the versatile features of your product.

This operating manual is a component of the IRTS-P system and should always be carefully kept with the IRTS-P system until it is disposed of.

It is impossible to eliminate every danger to persons or material that the IRTS-P system might present. For this reason, every person working at the IRTS-P system or is involved in its transport, setting up, control, maintenance or repair must be properly instructed and be informed of the possible dangers.

For this purpose, the operating instructions and, especially, the safety instructions must be carefully read, understood and observed.

Company ATESTEO reserves the right to carry out changes at its products, which serve the technical further development the company ATESTEO. These changes are not documented expressly in every individual case.

This operator's manual and the information contained in it were compiled with the advisable care.

Company ATESTEO GmbH & Co.KG takes on no liability for misprints or other faults or damages resulting from it the company ATESTEO GmbH & Co.KG, however.

The brands mentioned in this operator's manual and product names are trademarks or registered trademarks of the respective titleholders.

Please do not miss to contact us if there is anything in the operating instructions that you cannot clearly understand. We are grateful for any kind of suggestion or criticism that you may wish to make. Please let us know or write to us. This will help us to make the operating instruction still more user-friendly in taking account of your wishes and requirements.

1.1 Change log

V1.0 11.08.2023:

• First manual version

1.2 Product description

The IRTS-P system is a measurement system for rotating parts to measure up to 16 temperature channels. It was designed for the usage in a test bench and aim on installations

- inside of specimen with rotating parts,
- onto rotating shafts or
- side-by-side attached to a torquemeter.

Temperature sensors are usually supplied by the customer and are not part of the IRTS-P system since they are often pre-installed in specimen or devices.

1.2.1 Functionality

The temperatures at the measuring points are measured with simple type K sensors. Electronics on the rotating side (sender) is connected to the sensors and is responsible for processing the measurement signals.

The sender transmits the measured temperatures digitally via an optical transmission system to the IRTS stator. This supplies the sender at the same time inductively with voltage. The transferred temperature signals are processed in the IRTS stator and transferred as differential RS422 signals to the TCU5-IRTS evaluation unit.

The signals are linearized and filtered in the evaluation unit. The linearization can be changed by the operator or optimized to a certain temperature range. The filter settings are individual for each temperature measuring channel and each output channel adjustable.

All measured values can be read via the web interface or transferred via the CAN interface. There are also four analogue outputs available to which each a temperature measuring channel with an individual temperature range can be assigned. One measuring channel can also be selected for several analogue outputs and be configured with different filters. This enables an optimal design of the system to the respective customer needs.

Note
Please note that the IRTS-P system is a high-precision measuring instrument. Mechanical effects e.g. hammer impacts lead to deformation of the measuring body, which changes its torsional behavior and thus worsens the balancing! Before mounting, make sure that the fits of your adapters comply with the specified installation tolerances and that they are free from contamination. Only in this way, optimum concentricity can be guaranteed.

Note

Dust and dirt in the environment and air can cover the optical data transmission system and disturb the data transfer from rotor to stator. The system needs to be cleaned from time to time in that case. Please contact the service team.

1.2.2 System variants

The IRTS system can be purchased in different variants. Due to the variants, the system can be optimally adapted to the measuring task. The variants differ mainly in the mechanics. The electronics and software are with all systems identical.

The following system variants are available and will be described in this manual:

System variant	Name
IRTS with half-shells	IRTS-P Half shells
IRTS with temperature measuring disc	IRTS-P Tempdisc

Table 1 System variants

1.2.2.1 IRTS-P Half shells

The half-shell system consists of two parts on the rotor side and can be clamped onto a shaft without much effort. To do this, the two half-shells are simply plugged together and screwed together. The half-shells contain the firmly integrated transmitter electronics (sender) and are connected to the temperature sensors by the customer via plugs. The system is available with different diameters. The manual is based on the diameter of 60 mm.
The stator consists of an electronics housing, a "gooseneck" for data transmission and a copper ring for power supply.

Figure 1 System variant IRTS-P with half-shells

1.2.2.2 IRTS-P Tempdisc

The IRTS tempdisc has a disc on the rotor side on which the electronics (sender) are installed. The disc is fixed to a machine and optionally screwed to a suitable torque measuring flange (e. g. TeS Z50 or SeS Z50). The temperature disc is supplied with voltage via the "eS" ring stator. The received data are sent from the ring stator to the IRTS stator. The temperature disc variant comes in different constructions (designs). Electronic installation and functionality are mostly identical. Mechanical installation may differ between the siblings. This manual focusses on the following design type:

Design type	Name
M S070-40 90 01 01	IRTS Temperature measuring disc 4 channel system

Table 2 Design type of IRTS-P Tempdisc

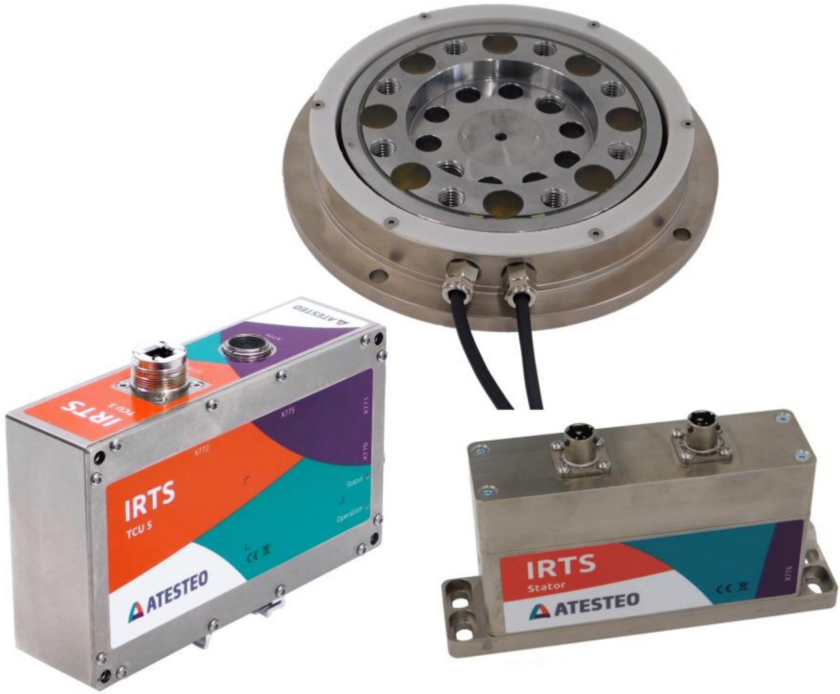

Figure 2 System variant IRTS-P with tempdisc

1.3 Software versions

The software versions mentioned in Table 3 were the latest ones when this manual has been released (date of release see 1.1). The software is updated more frequently than the manuals. The latest versions incl. their change logs can be requested from the ATESTEO service.

Software	Version
TCU5-IRTS firmware	V1.0.1
IRTS sender (rotor) firmware	V1.3.0

Table 3 Software versions

1.4 Manufacturer

ATESTEO GmbH & Co.KG
(Hereinafter referred to as manufacturer)

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Service:
service-pm@atesteo.com

1.5 Manufacturer´s Declaration

The manufacturer declaration can be requested at ATESTEO.

1.6 Disposal and environment

Electrical and electronic products are subject to special conditions for disposal. Proper disposal of old equipment prevents health hazards and environmental damage.

Packaging

The original packaging of ATESTEO equipment can be recycled, as it is made of recyclable material. However, you should keep the packaging for at least the warranty period. In the event of a complaint, the torque flange, as well as the accessories, must be returned in the original packaging.

Legally prescribed labelling for disposal

Electrical and electronic devices bearing the symbol  are subject to European Directive 2002/96 / EC on waste electrical and electronic equipment. The symbol indicates that waste equipment that is no longer usable must be disposed of separately from regular household waste in accordance with European environmental protection and recycling regulations.

However, the disposal regulations vary from country to country, which is why we ask you, if necessary, your supplier how to dispose your waste.

1.7 Scope of supply

1.7.1 IRTS-P Tempdisc

The package contains the following terms:

1. Rotor as temperature disc
2. eS stator ring
3. IRTS stator electronics
4. Central cable (default length 15m)
5. TCU5-IRTS
6. 12-pin connector
7. 16-pin connector
8. Operating manual
9. Test report

1.7.2 IRTS-P Half Shells

The package contains the following terms:

1. IRTS half shells
2. IRTS stator incl. half ring and electronics
3. Central cable (default length 15m)
4. TCU5-IRTS
5. 12-pin connector
6. 16-pin connector
7. Operating manual
8. Test report

2 Safety Instructions

2.1 General safety instructions

The manual must be read carefully before start-up, maintenance work or any other work on the measuring system. Prerequisite for the safe and proper handling of the equipment knows all safety instructions and safety regulations of the attachment.

Every safeguard needs to be correctly mounted and fully functional before any start-up.

Exclusively qualified laborers are allowed to do maintenance work on any electrical components (see chapter Qualified personnel).
If the IRTS-P system is sold on, these safety instructions must be included.

2.2 Explanation of symbols and notice

Warnings
Warnings are indicated by symbols in these safety instructions. The hints are going through
Signal words are introduced, which express the extent of the hazard. It is imperative that you follow the instructions and act with care to avoid accidents, personal injury and material damage.

Information
Draws attention to important information about correct handling.

Caution

Warns of a potentially dangerous situation in which failure to comply with safety requirements can result in slight or moderate physical injury.

2.3 Appropriate use

The IRTS-P system is highly accurate and resistant to rotational speed. The signals from the system serve to control the test bench and to analyses the components.
The IRTS-P system is used just for temperature measurement tasks within the limits in the specification (see 3.1). Any other use is not permitted.

The IRTS-P system is not allowed for use as a safety component.

Note
Operation of the system is only permitted if it (Rotor, Stator) is mounted according to the mounting instructions.

2.4 Modifications/conversions

Any modifications/ conversions of the design or safety engineering of the IRTS-P system without the explicit agreement from ATESTEO will lead to the loss of warranty or liability. Any damages or injuries of personnel therefrom are in responsibility of the operator.

2.5 Operator’s responsibility

Standards

The ATESTEO torquemeter was designed and constructed taking account of a risk analysis and careful selection of harmonized standards and other technical specifications with which it complies. It represents the state of the art and guarantees a maximum degree of safety.

Qualified personnel

Qualified personnel are persons who by reason of their training, experience, instruction and their knowledge of the relevant standards, regulations, accident prevention rules and working conditions have been authorized by the person responsible for the safety of the machine/product to perform the appropriate activities required, and thereby are able to recognize and prevent potentially dangerous situations (For the definition of skilled workers see VDE 0 105 or IEC 364, which also regulate the prohibition of the employment of unqualified persons).
Knowledge of first aid and the local rescue organization must also be available.

Transportation, assembly, installation, commissioning, maintenance and repair will be performed by qualified personnel or controlled by responsible skilled hands.

Safety relevant disconnecting device

The IRTS-P system cannot implement any safety relevant cut-offs. It is in the operator´s responsibility to integrate the system into superior safety system. The electronical conditioning the measurement signal should be designed so that measurement signal failure does not subsequently cause damage.

Rooms at risk of explosion

The IRTS-P system must not be used in potentially explosive atmospheres.

Residual risks

The power and scope of delivery of the system covers only a subset of the temperature measurement technology. Safety aspects of temperature measurement technology must be planned, implemented and taken into account by the system planner, supplier or operator in such a way that residual risks are minimized. Each existing regulations must be observed. Attention should be drawn to residual risks associated with temperature measuring technology
In the case of a shaft/flange/shell break, you must ensure that there is no risk of injury. This should be done with a shaft protection cover in a closed test room with corresponding security doors. During operation, no person should stay in the test room.

Usage recommendations for personal protective equipment

Working in a workshop generally requires the wearing of safety shoes.

Use suitable gloves when handling corrosive or irritating solutions and adhesives.

2.6 Transport and storage

Check the delivery immediately for completeness and shipping damage.

Use working gloves and shoes during transport/ assembly/ maintenance.

Storage

- Do not store outdoors
- Store dry and dust-free
- do not expose to aggressive media
- protect from sunlight
- avoid mechanical shocks
- Storage temperature according data sheet

If stored for more than 3 months, regularly check the general condition of all parts and packaging.

2.7 Safety notes for assembly

Tightening torque
When tightening the screws, the specified tightening torques (see mounting instruction) must be observed.

Electric wire
All cables must be professionally laid according to the actual standards.

Rotating parts
Rotating parts can generate static electricity during/after operation. Apply required countermeasures before dismounting or touching parts.

- Electrical components must be protected against overvoltage (e.g. lightening) via fuses and the facility's electrical safety systematics.
- The whole rotating shaft system (incl. IRTS-P components) must be aligned and balanced to avoid dangerous oscillations.

2.8 Safety notes for operation

As accident prevention, a covering has to be fitted once the rotating parts of IRTS-P have been mounted. This is the fact if the system is already fully protected by the design of the machine or by existing safety precautions. Please pay attention to following requirements for the covering as accident prevention:

- The covering must not be free to rotate
- Covering must be positioned at a suitable distance or be so arranged that there is no access to any moving parts within.
- Covering should prevent squeezing or shearing and provide sufficient protection against parts that might come loose.

- Covering must still be attached even if the rotating parts of the IRTS-P system are installed outside people´s movement and working range.
- All open rotating system parts must be secured.
- Thermocouples must be fixed and secured against centrifugal force.
- All system-specific covers must be used.
- The IRTS-P system may only be used indoors in closed testing rooms.

Note
Improper use and handling as well as constructional changes will invalidate the EC declaration of conformity.

Damaged systems
The IRTS-P system may only be operated in an undamaged condition

People with medical implants
The function of medical implants can be disturbed by the IRTS-P system.

Rotating parts
Rotating parts and the cables must undergo an electrical clearance measurement by a specialist after each operation.

2.9 Load limits

Observe technical data sheets when using the IRTS-P system. Pay particular attention to never exceed the respective maximum loads. For example:

- Temperature limits,
- limits of electrical load-carrying capacity,
- rotational speed limits,
- max. transmissible torque.

3 System description

3.1 Technical data

Description	Value
Power supply	24V DC max. 2A
Sampling rate - Thermocouples	25 Samples / s
Dynamic – Analogue voltage output	≤ 6 kHz
Dynamic – CAN bus	≤ 2,000 Samples/s
Modulation range – Voltage	-12 … 12 V
CAN interface	CAN2B Max. 1 MBaud
Configuration interface	Ethernet (via integrated website)
Nominal temperature range (rotor)	0…125 °C
Operation temperature range (rotor)	-20…125 °C
Storage temperature range (rotor)	-20…125 °C
Nominal temperature range (stator)	0…80 °C
Operation temperature range (stator)	-20…85 °C
Storage temperature range (stator)	-30…85 °C
Nominal temperature range (TCU5)	0…70 °C
Operation temperature range (TCU5)	-20…70 °C
Storage temperature range (TCU5)	-30…85 °C
Protection class	IP54

Table 4 Technical data

3.2 IRTS-P Tempdisc

3.2.1 System overview (electrical)

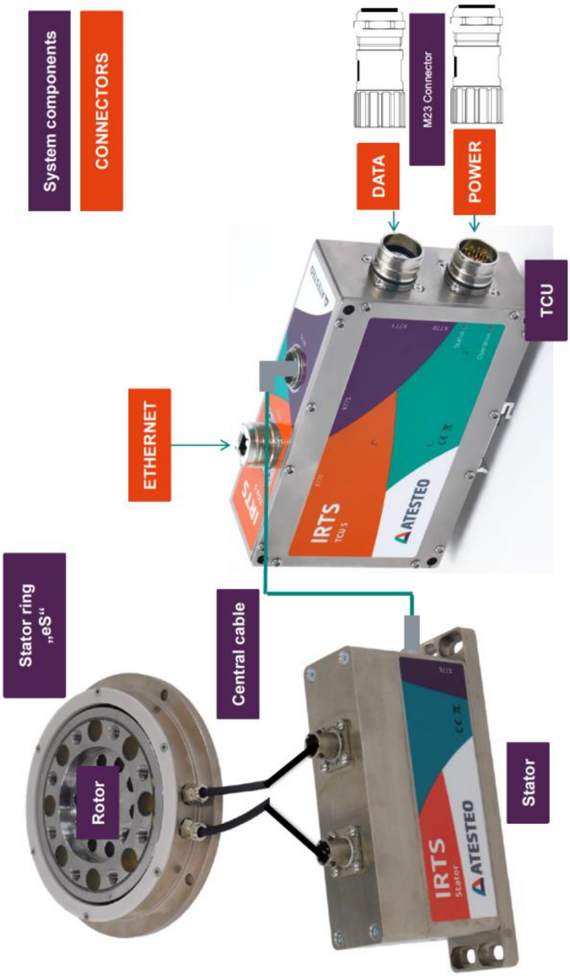

Figure 3 IRTS-P Tempdisc overview (electrical)

3.2.2 System overview (functional areas)

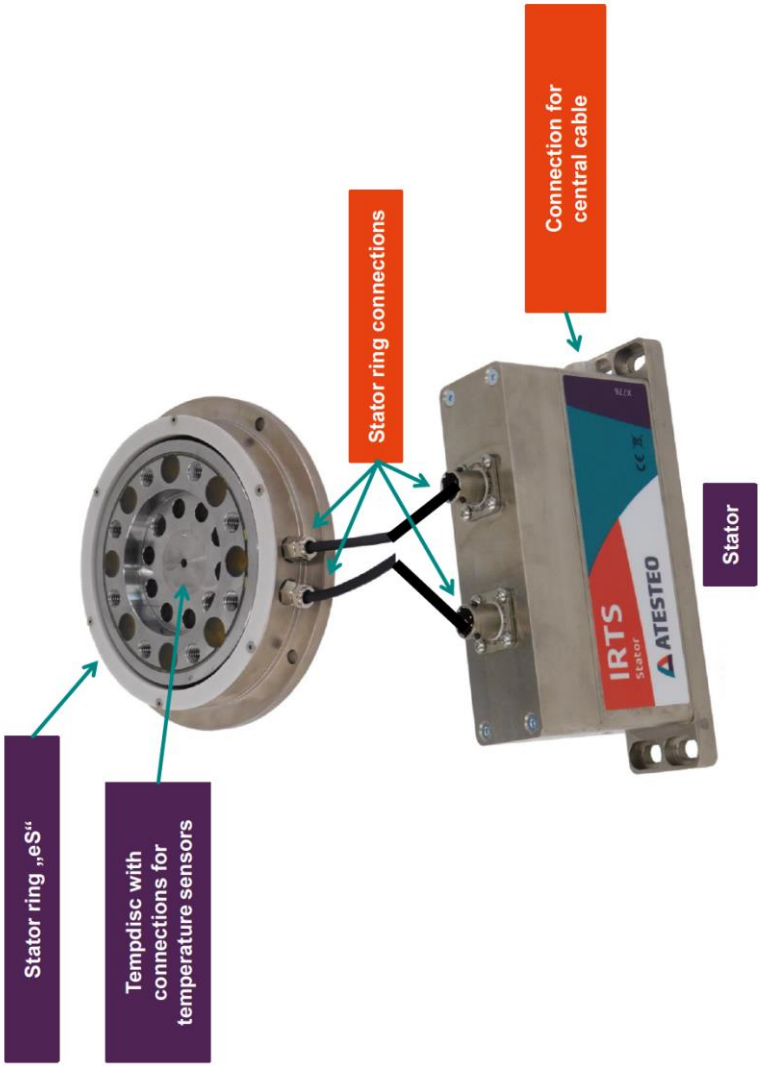

Figure 4 IRTS-P Tempdisc overview (functional)

3.2.3 System overview (mechanical)

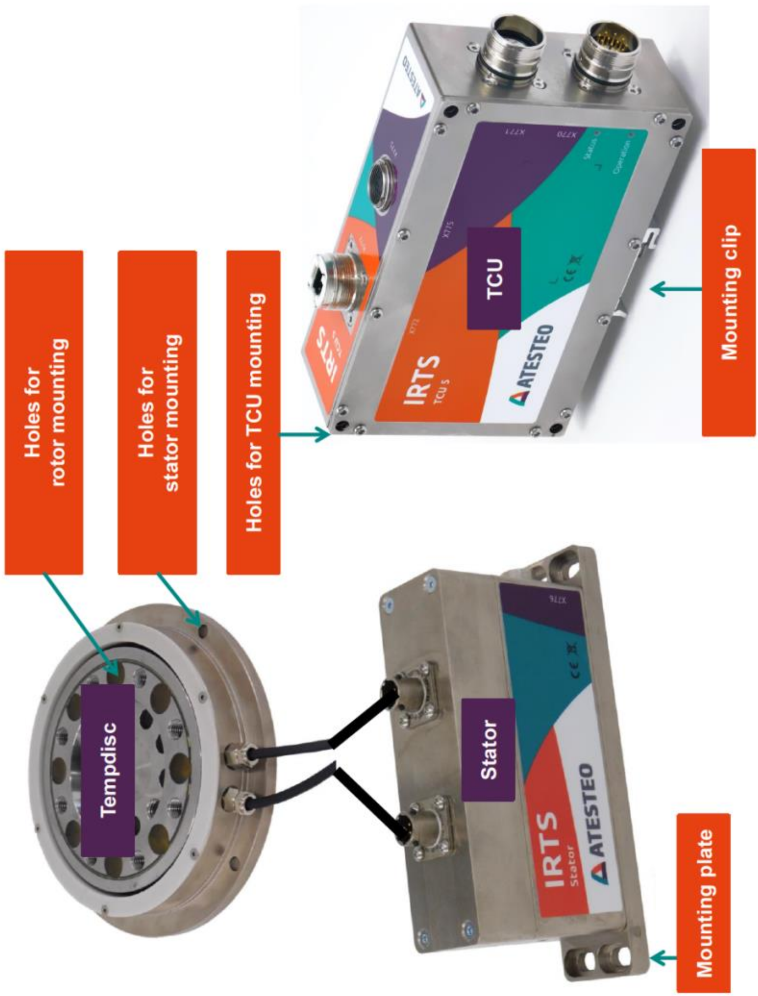

Figure 5 IRTS-P overview (mechanical)

3.3 IRTS-P Half shells

3.3.1 System overview (electrical)

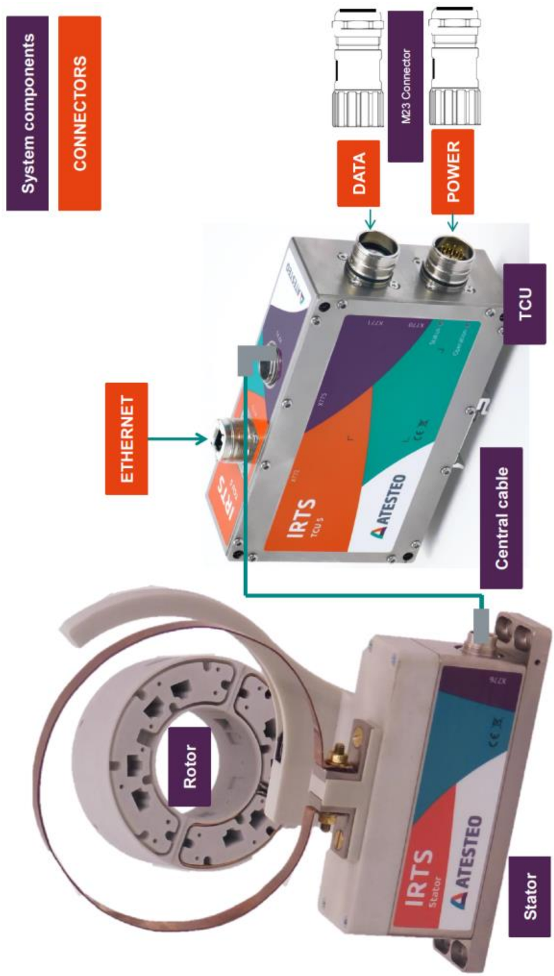

Figure 6 IRTS-P Half shells overview (electrical)

3.3.2 System overview (Functional areas)

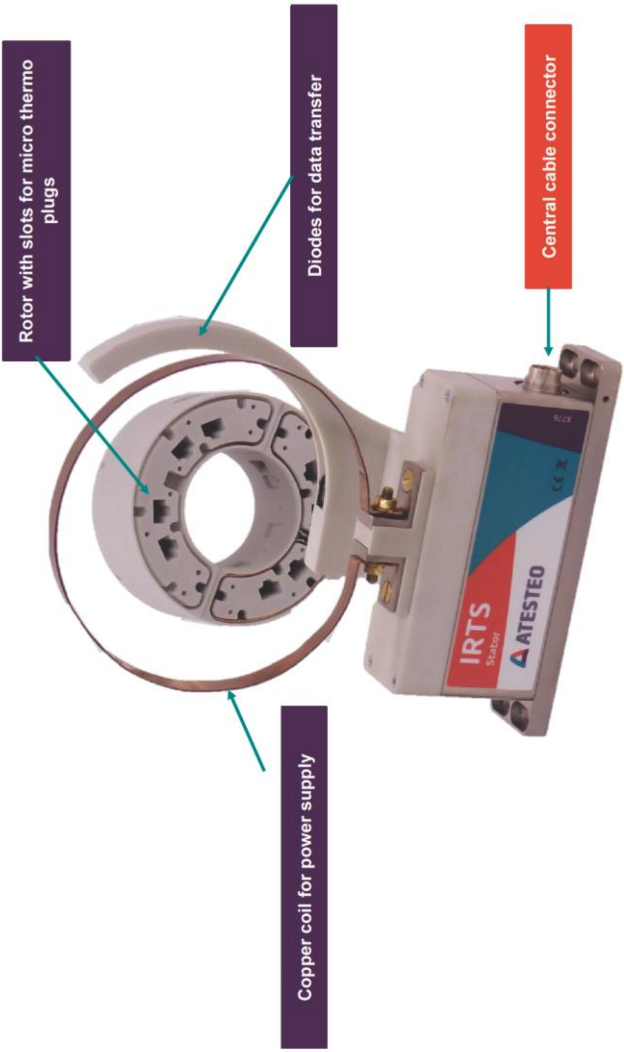

Figure 7 IRTS-P Half shells overview (functional)

3.3.3 System overview (mechanical)

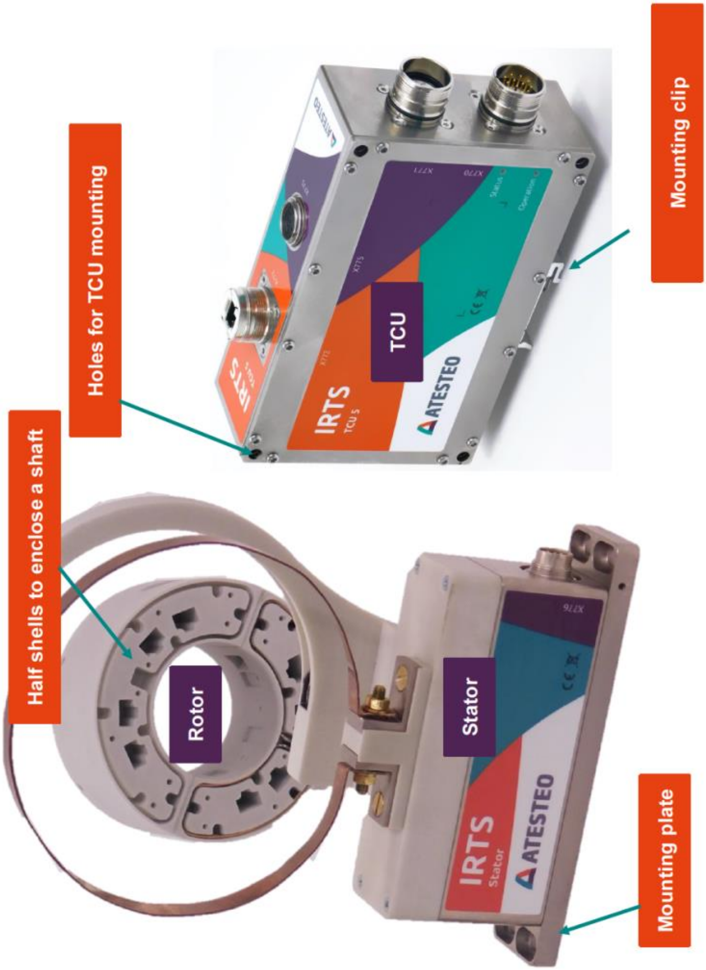

Figure 8 IRTS-P Half shells overview (mechanical)

3.4 Test report

The measuring system IRTS-P is delivered with a test report. It shows the deviations between measured temperatures to values of a calibrator. The typical verification range is from -40 to 300 °C. Based on the measured points, correction factor and offset are defined and stored on the system. Customization of the correction values (calibration, other verification range) are possible at any time.

The following figure shows the example of a standard test report:

ATESTEO

IRTS - Test report

Rotor - SN: **230017**

Reference device: Gossen Metrawatt Process Calibrator (SN: ZK1529)

Channel 1: Offset: **-1,2**
TC Typ K Factor: **0,99584**

Temp	Reading	Deviation
-40	-39,8	0,2
-20	-19,7	0,3
0	-0,1	0,1
20	20	0
40	39,9	0,1
60	59,8	0,2
80	79,9	0,1
100	99,9	0,1
120	120,1	0,1
140	140,1	0,1
160	160	0
180	179,9	0,1
200	200	0
220	220	0
240	240,1	0,1
260	260,1	0,1
280	280	0
300	300	0

Channel 2: Offset: **-1,5**
TC Typ K Factor: **0,99633**

Temp	Reading	Deviation
-40	-39,8	0,2
-20	-19,8	0,2
0	0	0
20	20	0
40	39,9	0,1
60	59,9	0,1
80	80	0
100	99,9	0,1
120	120,1	0,1
140	140,3	0,3
160	160	0
180	180,1	0,1
200	200,2	0,2
220	220,1	0,1
240	240,1	0,1
260	260	0
280	280,1	0,1
300	300	0

Channel 3: Offset: **-1,3**
TC Typ K Factor: **0,9968**

Temp	Reading	Deviation
-40	-39,7	0,3
-20	-19,8	0,2
0	0	0
20	20	0
40	40	0
60	59,8	0,2
80	79,9	0,1
100	99,9	0,1
120	119,9	0,1
140	140	0
160	160,1	0,1
180	180	0
200	200,1	0,1
220	220	0
240	240	0
260	260	0
280	280,2	0,2
300	300,1	0,1

Channel 4: Offset: **-1**
TC Typ K Factor: **0,99635**

Temp	Reading	Deviation
-40	-39,8	0,2
-20	-19,8	0,2
0	0	0
20	20	0
40	39,9	0,1
60	59,8	0,2
80	79,8	0,2
100	99,9	0,1
120	120,1	0,1
140	140	0
160	160	0
180	180,1	0,1
200	200,1	0,1
220	220,1	0,1
240	240	0
260	260	0
280	280,1	0,1
300	300	0

Test date: 20.07.2023

Tested by: Marcel Clermont

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Certified according to ISO 9001:2015 and ISO 14001:2015

Report form v1.0

Figure 9 Test report example

3.5 Functions

3.5.1 Controller test signal

The controller test signal simulates an offset jump of 100 °C at the four analogue voltage outputs. Measurement values are ignored while the test signal is active. CAN bus signals are not affected by the test signal. A feedback bit will be true (1) on the CAN bus as long as the test signal is active.

Note:

Test signals must be disabled before measuring

3.5.2 Error signal

In case of problems between sender and a temperature channel (converter IC) an error signal of -1,000 °C is transferred on the related channel while the cold junction temperature is sent with -500°C (both physically impossible -> error). Broken wires in the temperatures sensor or its cables will lead to an error signal of -1,000 °C for the channel. The cold junction temperature will be transferred normally. The error signals are available on the CAN bus and the web interface. The analog output is set to 116% of the voltage range.

3.5.3 Reset IP address

If the IP address was changed from standard and not written on the free area on the type label, the following two solutions will help you in case the IP address is lost:

- The tool “TCU Discover” can be used to search TCU5 in a local network. The tool can be downloaded from the ATESTEO website.
- Reset of IP address via digital input (see 7.1).

3.5.4 Filter

A moving average filter is available for each output. The number of values for filtering can be chosen from 0 to 25, while 0 will deactivate the filter.

3.5.4.1 Filter of analogue voltage outputs

A filter can be set for each analogue voltage output. Use the menu “Filter” –> “Filter Settings Analog” to make a configuration of the “Moving filter”. Channels linked to more than one output, the different filters will not influence each other.

3.5.4.2 Filter of CAN outputs

All available temperature channels are shown in the menu “Filter” -> “Filter settings CAN”. Individual filter lengths can be set for each channel. One TAP corresponds to one measured value. With two TAPS, the current measured value x(t) is averaged with the previous measured value x(t-1).

In case the transmission rate of the CAN bus is lower than the sampling rate of the temperature channels, this is adapted via a block filter. This means that between the transmission of two CAN messages all measured values of a temperature channel are collected and averaged. The maximum transmission rate of the CAN bus and the sampling rate of the thermocouples are listed in Table 4. Downsampling reduces the maximum displayable measured value change to the update rate of the CAN bus.

3.6 LED coding

3.6.1 TCU5-IRTS (evaluation unit)

The TCU has a red and green LED on the top to display the system status. The coding is described in the following table:

Red LED	Green LED	State / Meaning
Off	Off	System switched off.
Off	On	Test signal of TCU is active.
On	Off	Critical system error. System will reboot.
On	On	System is starting.
Blinking every 2 seconds	Blinking every 2 seconds	Search for optimum power supply voltage
Blinking every second	Every state	Disturbance in data transfer or insufficient

		power supply of the sender.
Every state	Blinking every second	Normal operating.

Table 5 TCU LEDs

3.6.2 IRTS stator

The IRTS stator has a green LED on the side to display the transmission status. The coding is described in the following table:

Green LED	State / Meaning
Off or sometimes off	The signal amplitude received by the sender is too low. Check the alignment of stator to rotor and check the inductive power supply.
Permanent on	The signal amplitude received by the sender is sufficient for data transmission.

Table 6 IRTS stator LED

4 Mechanical & electrical installation

4.1 Transportation

The IRTS-P system of ATESTEO are high precise measurement sensors. Transport must be done with care. Try to use the original packaging whenever possible.

4.2 Lifting components

The IRTS-P components typically have weights below 10 kg. Those can be lifted without crane. If own or national regulations require a support (crane) for lifting, please contact ATESTEO service to get information about the proper mechanical lifting interface for each rotor.

4.3 Mechanical installation

Please respect the required mounting distances and tolerances between rotor and stator. They are individual and mentioned in this document.

Please refer to the technical drawings for information about dimensions. Drawings can be requested from ATESTEO at any time.

TCU5-IRTS dimensions:

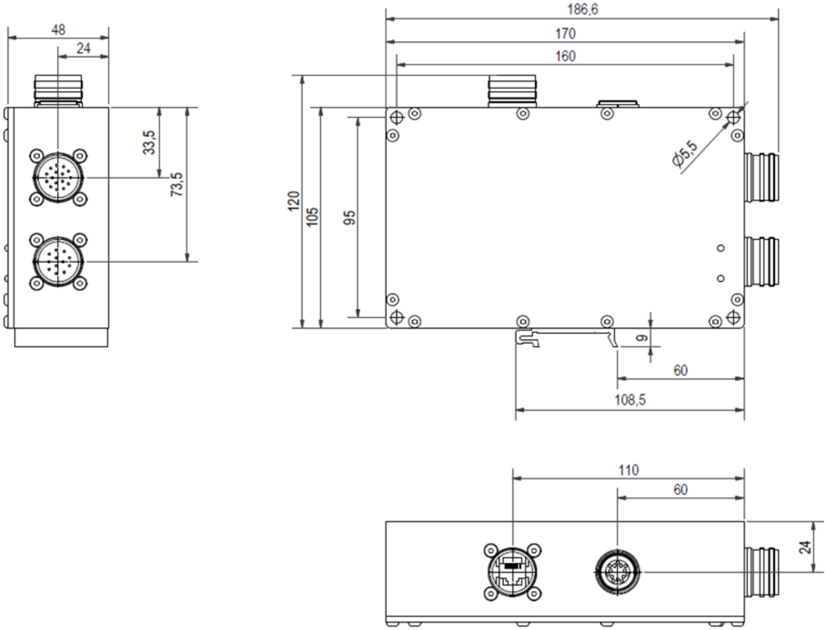


Figure 10 Dimensions of TCU5-IRTS

4.3.1 Mechanical installation IRTS-P Tempdisc

4.3.1.1 Mounting distances

Distances depend on the system design. Use the drawing number of your system for identification.

System M S070-40 90 01 01	Value in mm		
	min	norm	max
Axial distance between rotor and stator (without centering)	1	2	3
Radial distance between rotor and stator	1.5	2.5	3.5

Table 7 Mounting distances IRTS-P Tempdisc M S070-40 90 01 01

4.3.1.2 Rotor installation

Connect the rotor by screws with shaft of the rotating system. Fix the rotor at the machine side first. Use the small tunnel bore hole in the centre of the rotor as pipe for the wires of the temperature sensors. Before fixing the rotor at the machine, the temperature wire must reach the other side of the rotor. Do not squeeze or crimp the wires when mounting the rotor.
Once the rotor is fixed at the machine, the temperature sensors can be connected to the rotor (see 4.3.1.5 & 4.3.1.6).

Figure 11 IRTS-P Tempdisc: Rotor (Machine side)

Fix the rotor at the shaft side after all temperature sensors have been connected.

Figure 12 IRTS-P Tempdisc: Rotor (Shaft side)

Drawing „System“ Drawing „Rotor”	M S070-40 90 01 01 M S070-10 90 01 01
Amount of screws	8
Type of screws	M10x (12.9)
Tightening torque	80 Nm
Max. transmissible torque	1,300 Nm

Table 8 Screws for rotor IRTS-P Tempdisc M S070-10 90 01 01

4.3.1.3 eS ring installation

Fix the eS stator ring via four holes at the machine or a holder. The screw holes are individual.

Drawing „System“ Drawing „Stator“	M S070-40 90 01 01 M S070-20 90 02 01
Screw holes	4 x Ø7mm

Table 9 Screw holes stator IRTS-P Tempscheibe M S070-20 90 02 01

Table 10 IRTS-P Tempdisc: eS stator ring

4.3.1.4 Stator installation

Use all four holes to fix the stator with M6 screws. The stator must be connected to ground by a ground screw. See chapter 4.5 for more information about the ground requirements.

Figure 13 IRTS-P Tempdisc: Stator installation

Connect the stator and the eS ring with the two attached cables from the eS ring. Plug the two cables at the slot at the top of the stator. Pay attention since one plug has two pins; the other plug has three pins.

Figure 14 IRTS-P Tempdisc: eS stator ring with connectors

4.3.1.5 Connecting temperature sensors (Soldering)

Release two screws at the cover of rotor (shaft side). You will see the electronic board where you have to solder the temperature sensors to.

Figure 15 IRTS-P Tempdisc: Rotor without cover

One sensor must be soldered to a pair of K+ and K-. The contact plates on the PCB are labelled accordingly. Each pair is numbered for identification as channel. If a contact plate pair remains empty, the related channel will send an error code (see 3.5.2, broken wire).

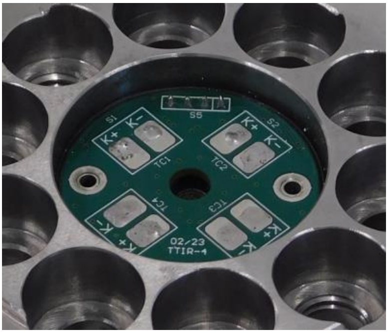


Figure 16 IRTS-P Tempdisc: Rotor with contact plates for soldering

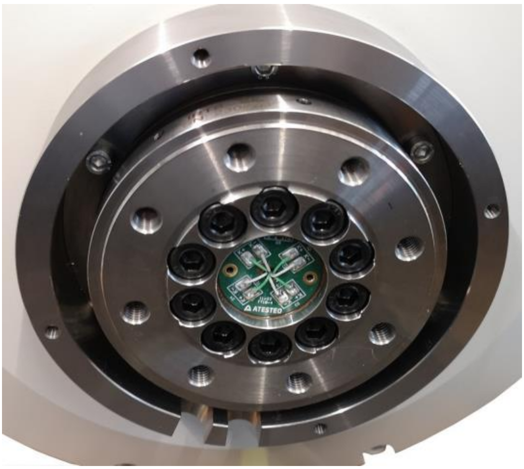


Figure 17 IRTS-P Tempdisc: Rotor with connected sensors

A functional test is recommended after the sensors installation. Finally close the cover and fix with the two screws again. Apply the screw hand-tight.

4.3.1.6 Connecting temperature sensors (Plugs)

Remove the cover at the rotor (shaft side) by releasing the four TORX screws. You will see the slots for the sensor plugs. Solder the wire of each sensor to a micro thermos plug. Insert the micro thermos plug into a slot of the rotor. Each slot has an identifier as link to its measurement channel.

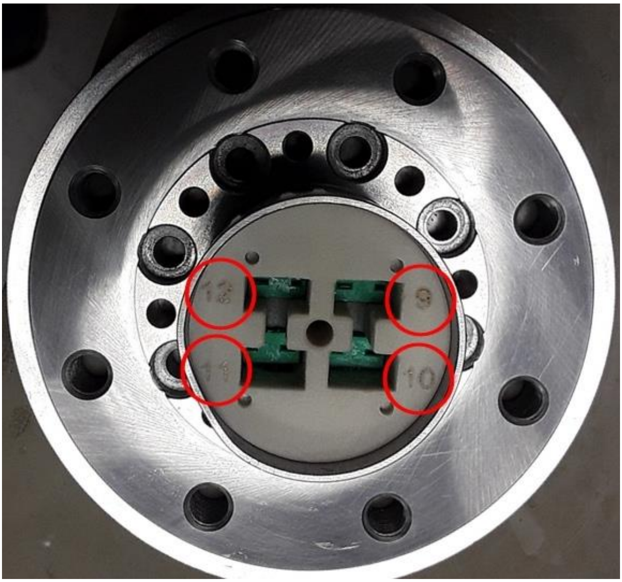


Figure 18 IRTS-P Tempdisc: Rotor with slots

A functional test is recommended after the sensors installation. Finally close the cover and fix with the two screws again. Apply the screw hand-tight.

4.3.2 Mechanical installation IRTS-P Half shells

4.3.2.1 Mounting distances

Align the stator at the rotor according to the following distances:

Drawing M S065-40 90 02 01	Distance in mm		
	min	Norm	max
Axial distance between Rotor and Stator	-1	0	1
Radial distance between Rotor and Stator	1.5	2.5	3.5

Table 11 IRTS-P Half shells: Mounting distances D60

4.3.2.2 Rotor installation

Enclose the shaft nearby the specimen by the two half shells of the IRTS-P system. Plugs both shells together and make sure the electrical connectors are linked well. Secure the shells by screws.

Drawing	M S065-40 90 02 01
Inner diameter of half shells	60 mm
Outer diameter of half shells	115 mm
Amount of screws	2
Type of screws	M8x30, Allen screw, DIN912

Table 12 Screws for IRTS-P Half shells D60

Figure 19 IRTS-P Half shells: Illustration of rotor installation

4.3.2.3 Stator installation

Use all four holes to fix the stator with M6 screws. The stator must be connected to ground by a ground screw. See chapter 4.5 for more information about the ground requirements.

4.3.2.4 Connecting temperature sensors (Plugs)

The slots for the temperature sensors are on the side of the half shells which is not filled with potting material. Connect the temperature sensors to those slots. To do this, screw the two wires of the sensors into the micro thermal plugs. The slots are numbered by engraving for identification.

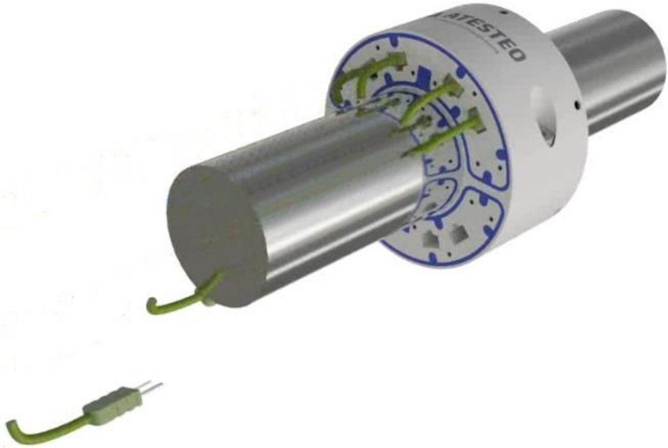


Figure 20 IRTS-P Half shells: Illustration of sensor installation

After all required temperature sensors have been connected a functional test is recommended. After that, the cover of each half shell must be installed again (8xM3x8 flat head screw). The screws must be hand tightened.

Figure 21 IRTS-P Half shells: Illustration of sensors with cover

4.4 Assembly evaluation unit (TCU5)

The evaluation unit is not protected against splash or condensation water. That is why the evaluation unit should be assembled in a dry place with a maximum relative humidity of 80 %. The ambient temperature must be between -20 and +70 °C.

4.4.1 Type of installation

The evaluation unit can be mounted in two ways. It can be mounted on an electrically conductive 35 mm DIN rail (cap rail) or on an electrically conductive metal plate.

<u>DIN rail mounting</u>
For mounting on a DIN rail, a metal clip is located on one side of the evaluation unit. The following figure shows the position of the metal clip:

Figure 22 Mounting of TCU5 (with clip)

The TCU can be easily hooked with the clip from top to bottom on the DIN rail. Please connect the DIN rail to the central ground point of the test bench via a grounding strap.

<u>Metal plate installation</u>

For mounting on a metal plate, there are four drill holes on the front of the evaluation unit. The following figure shows the position of the holes:

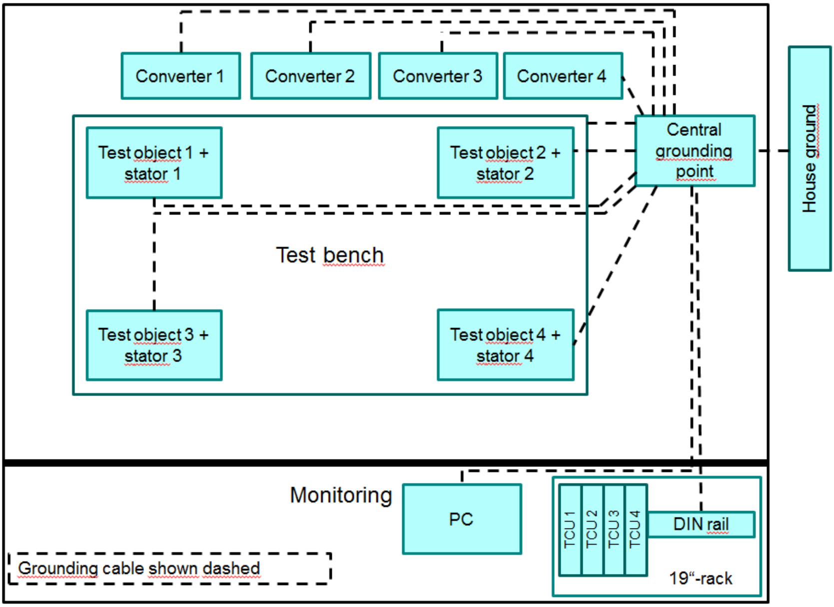
Figure 23 Mounting of TCU5 (with screws)

Attach the evaluation unit to the metal plate with four M5 cylinder head bolts. The drill holes for the screws each have a depth of 48 mm. Please connect the metal plate via a grounding strap to the central ground point of the test bench. The connection of the grounding strap should be placed as close as possible to the evaluation unit. For coated metal plates, the earth strap must be fastened to the evaluation unit via a ring cable lug on one of the four screws mentioned.

4.5 Grounding at the test bench

Today's demands of test stand claims require a powerful and high frequency clocking hardware. Electronic components are sensitive towards electromagnetic emission. That is why the avoiding of electromagnetic emissions is really important when it comes to test facility planning. The IRTS-P series hardware is designed to derive electromagnetic interference. These protection circuits only work if the stator and the evaluation unit are each connected via their own cables directly to a central mass point with the test bench ground. It is the same for the remaining hardware in the test bench. If all the components are directly connected to a mass point without detours it enables a low –impedance dissipation of broadband electromagnetic interference and at the same time it avoids unwanted ground loops by different line potentials.

The following illustration outlines the example of a point-to-point grounding concept:



In addition to a sophisticated earthing concept, it makes sense to separate all power cables by the use of separate cable ducts from the sensitive signal lines of the test bench. A spatial separation of the power cables is the best option, but if it is not possible, the cables should at least not be laid parallel to each other. The central cable between the stator and the TCU transmits sensitive signals. That is why it shouldn’t be laid with the power cables. To add the cable shield protects the cable against external interference. A diligent planning of the grounding concept and the guideways can avoid costly error search and error correction on the fully assembled test bench!

4.5.1 Stator ground screw

Figure 24 Stator ground screw

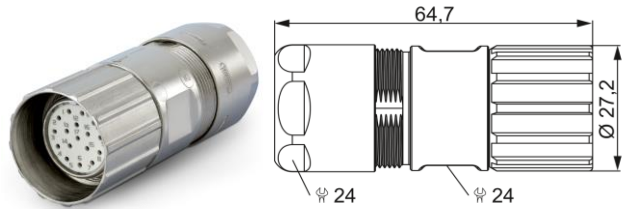
4.6 The wiring of the evaluation unit

The evaluation unit has four device plugs. The respective connector designation is written on the housing cover of the evaluation unit. Device connectors X770 and X771 connect the evaluation unit to the test bench peripherals. Device plug X772 connects the Ethernet interface to the evaluation unit. The central cable connects the device plug X775 of the evaluation unit with the stator. The central cable is not allowed to be longer than 50m. Only use the following cable connectors:

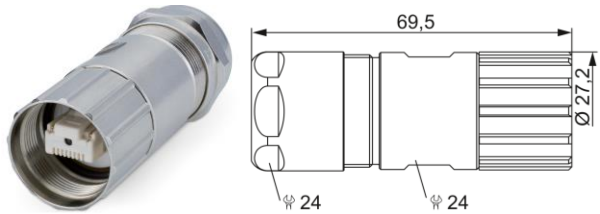
Device plugs	Cable connector (manufactures – manufacturer part number)
X770 (12-polig)	Hummel – 7106500000 + Hummel - 7001912104
X771 (16-polig)	Hummel – 7106500000 + Hummel - 7001916103
X772 (Rj45)	Hummel – 7R10400000*1 + Hummel – A7RJ-821M51*1 Or protective cap: Hummel – 7010900102
X775	Binder – 99 5629 75 12

*1) not included in the scope of supply

Cable connector for connection X770 and X771



Cable connector for connection X772



If you do not use the housing plug X772, please use the protective cap (included in the delivery) to protect it from electromagnetic field and dirt particles. You can find the pin assignment of the individual plugs in the appendix.

4.7 Power and data cable

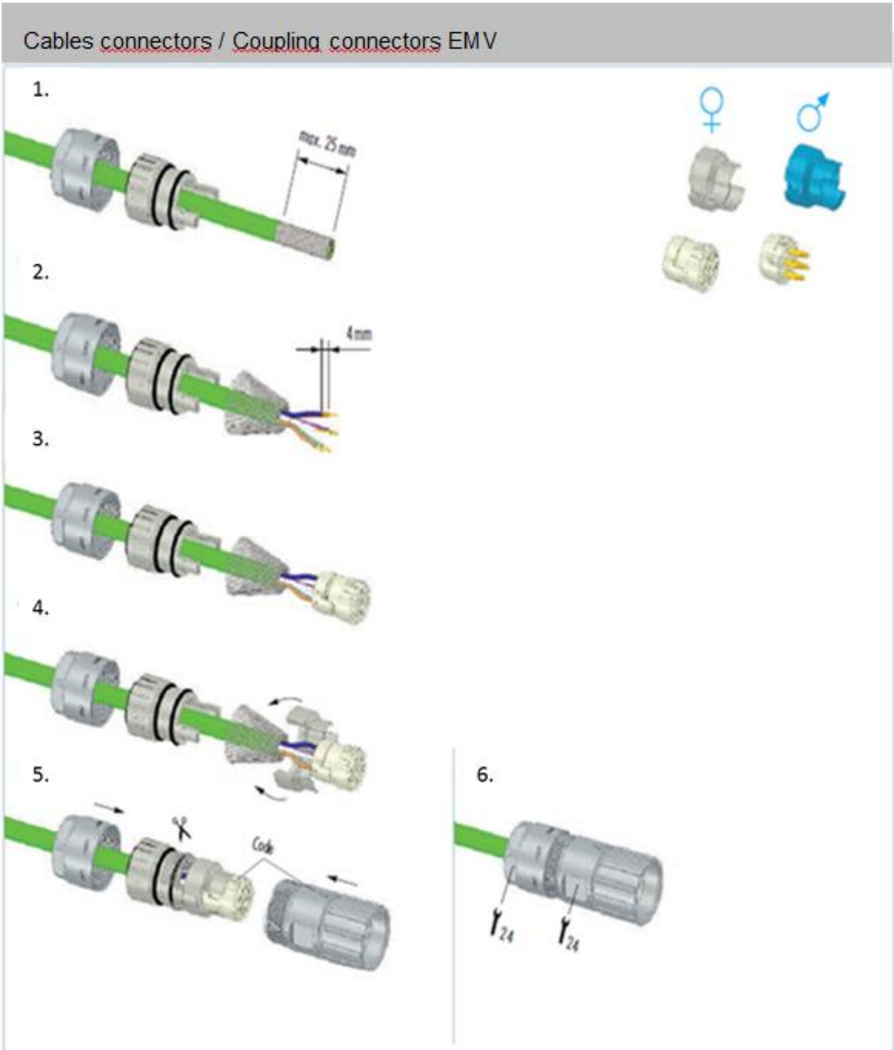
In order to comply with the EMC standards EN61000-6-4 / VDE 0839 parts 6 to 4, the following procedure for connecting and lying the power/data cable is recommended:
Please use a shielded cable with 4x 2x 0.14mm^2 (twisted pair) + 4x 0.5mm^2 for connection to X770 and a shielded cable with 8x 2x 0.25mm^2 wire (twisted pair) for connection to X771. The shielding of the cables must be placed on both ends. The shield must also be placed on the measuring flange side and in the measuring cabinet.

Pin assignment see 7.

Information
We recommend installing a fuse in the control cabinet with an on-and off-switch.

Information
Prefabricated cables are optionally available ex works.

Assembling the power and data cable



5 Start-up

5.1 The first switch on

Before you switch on for the first time, make sure that all system components have been connected and aligned in accordance with the installation instructions in this manual. Check all cable connections for correct and safe mounting. The IRTS system has three LEDs, which indicate the respective operating status. Two LEDs are located on the evaluation unit and one LED on the side of the IRTS stator.

You will find an overview of all flashing codes with the associated system states in the chapter 3.5.4.

The following chapter describes the setup of the web interface needed to configure the measuring system.

5.2 Installation of a Web browser

Use a common web browser for your system such as Firefox, Chrome, Edge or Safari.

Note
Please use the latest version of the browser

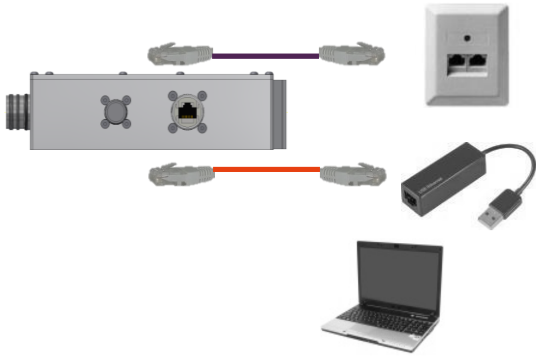
5.3 Network connection

You need a CAT5-Patchcable and an RJ35-connection to connect the TCU5 to an evaluation computer.

Three options to connect to network:

1. **Connect directly**

   Connect with a patch cable directly from the Ethernet socket of the computer.



2. **Connect with network-to-USB adapter:**

   The adapter needs to be installed on the computer. Now connect TCU 5 with a patch cable to the adapter.

3. **Connect in domain network:**

   Connect the TCU 5 using the patch cable with a free network socket.

The TCU5 does not support the ping protocol. Even with correct IP settings, the TCU5 will not reply on ping requests.

5.4 Network settings

Network settings need to be changed, if the system (torquemeter, computer) is not connected to each other with a domain.

Ask your IT department to set up the following IP settings on your computer:

- ID address: 172.16.86.2
- Subnet mask: 255.255.255.0

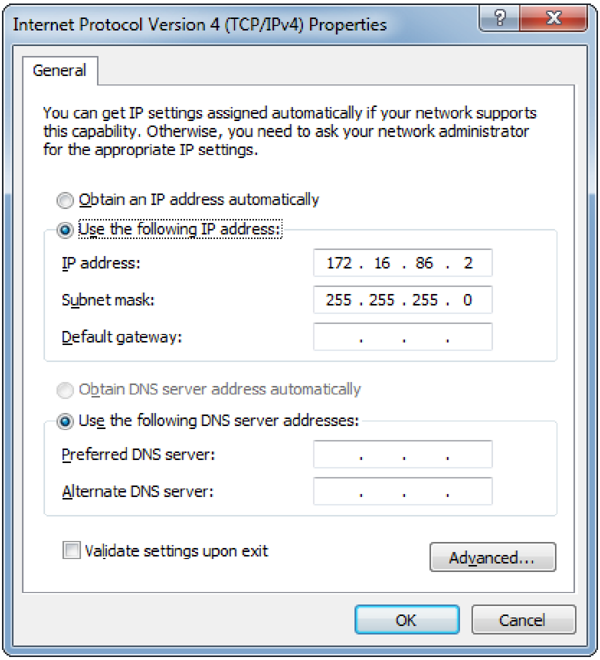


Figure 25 IP configuration (Windows)

5.5 Proxy configuration

Add a new exception for the proxy system for the following address space: 172.16.86.*

5.6 Web interface

The web address of the TCU 5 is needed to open the web interface. There are two different ways to open it.

Open your web browser and enter the link:
"tcu16k-" and [SERIAL NUMBER]

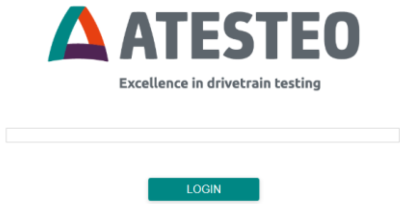
Or you can use the following IP address as link to open the web interface:

http://172.16.86.3

In case the IP address is unknown and not default, the IP address can be reset (see 3.5.3).

6 Using the web interface

LOGIN

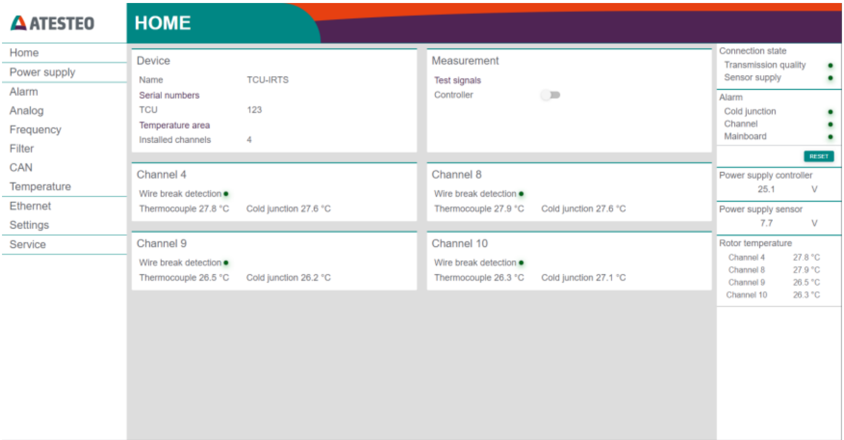


The password must be entered to log in. If the password is not changed, the password is: **admin**.

Important
The password can be changed in the item settings menu. Protect you measuring system from unauthorized access!

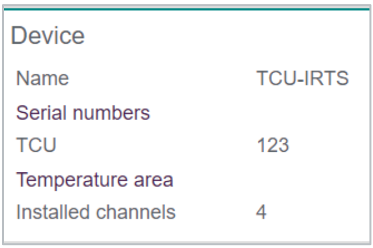
The web interface is only available in English language.

6.1 Home Menu



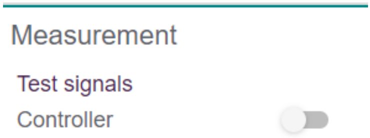
The Web-Interface is divided into different parts:

Device information:



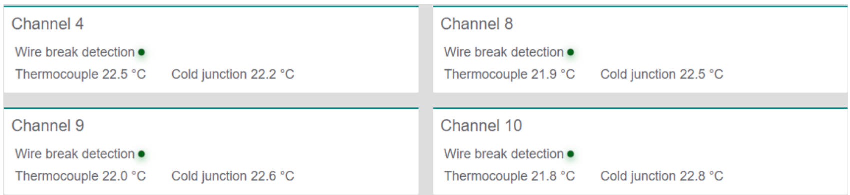
This overview of currently connected devices includes information about the version of the TCU and number of installed temperature channels. The device name is editable in the Settings menu.

Measurement:



The test signal (see 3.5.1) is enabled or disabled by the – button.

6.1.1 Temperature channel overview



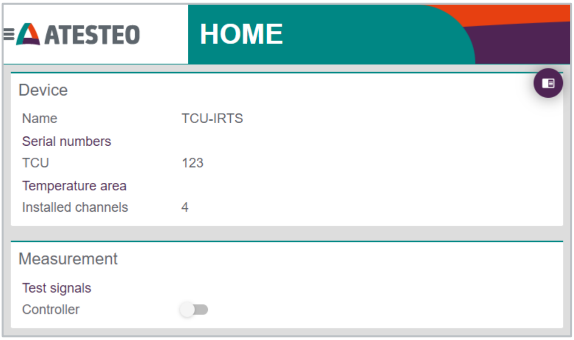
All available temperature measurement channels are shown in the center. Up to 16 channels are technically possible. For each channel the temperature value and the cold junction temperature is displayed. The green LED will light up when a broken wire has been detected.

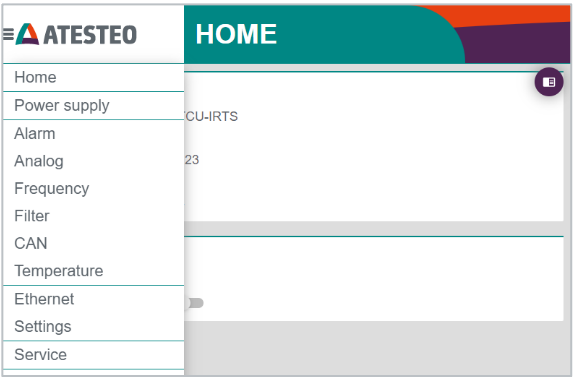
Note

Signals are not displayed in real-time. This may lead to de layed representations.

6.1.2 Navigation menu

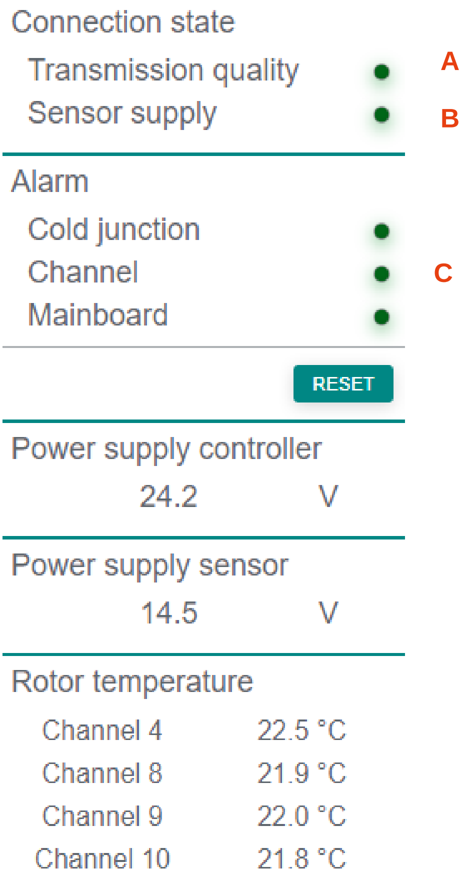
If the navigation bar is closed, click on the company logo to open it again.





6.2 System overview

The signal bar is shown on the right-hand side of the website.



- **A** Transmitting (green) | No Transmitting (gray)
- **B** Optimal (green) **|** Okay (yellow) **|** Bad (red)
- **C** Value below threshold (green) | Value above threshold (red)

Note

Signals are not displayed in real-time. This may lead to delayed representations.

Important

Check the supply voltage and the alignment between rotor and stator-antenna to guarantee an optimal transmission quality.

Connection state

The “Connection state” tab contains information about the transmission status of the system. The LED “’Transmission quality” is an indicator of transmission quality of measured data from rotor to TCU. The “Sensor supply” LED indicates the status of the torque sensor supply voltage.

Alarm states

Alarm values are displayed in the “Alarm” section. Red indicates that threshold is exceeded. Alarms can be reset by pressing


-button. Alarm limits can be set in the “Alarm” settings menu.

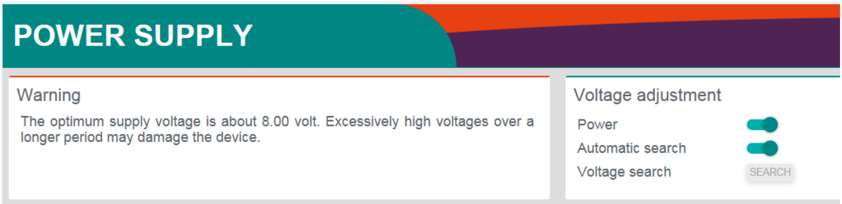
Power supply

The alarm states show the status of the power supply for the TCU (Power supply controller) and the rotor (Power supply sensor).

Values of the temperature channels

Section “Rotor temperature” shows all temperatures of active channels in Celsius degree.

6.3 Power supply



In the menu “Power supply”, the supply voltage of the rotor will be adjusted. The power-switch activates and deactivates the power supply. If the power supply is activated, a search is started automatically, which sets the optimum operating point. This also applies to system startup. Because the inductively transmitted power depends on the gap between rotor and stator antenna the supply voltage has to be re-adjusted after change of position. The optimal supply voltage of the rotor is 15.0 V ±0.5 V. There are 2 methods for adjusting:

1. By pressing the SEARCH button, the optimal supply voltage is automatically set.
2. Use the slider the set up the voltage supply manually. Moving the slider right will increase the rotor supply.

In the following section, the influence of the torque sensor voltage to the signal quality is shown:

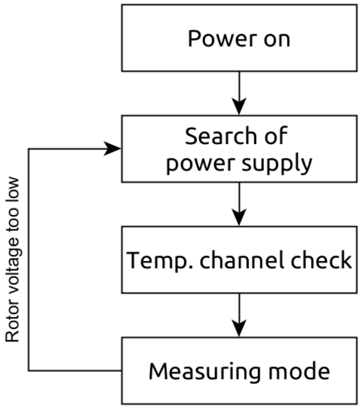
Sensor voltage	LED “Sensor supply”	Description
15.0 V ± 0.5 V	Green	Optimal supply voltage

15.0 V ± 1.0 V	Yellow	Supply voltage is OK. Interruption caused by fluctuation of supply voltage possible.
15.0 V ± > 1.0 V	Red	Poor supply voltage. Possibly interrupted transmission, possibly invalid measurement values

Table 13 Power supply of rotor

Important

The optimal torque sensor supply voltage should be at 15.0 V. Power supply will be deactivated and set back to zero, if a critically value is adjusted, in order to prevent damage of inductive power supply components. Measurement values can be invalid if the voltage drops



6.4 Alarm settings

Set up individual limit for each temperature channels. The general alarm output is “OR” connected to each channel alarm state. A limit for the sender mainboard (PCB) and the cold junctions can also be defined. Once a single cold junction exceed the limit, the alarm will be triggered.

The alarm is transferred via the status word (CAN bus) and via the X771 plug.

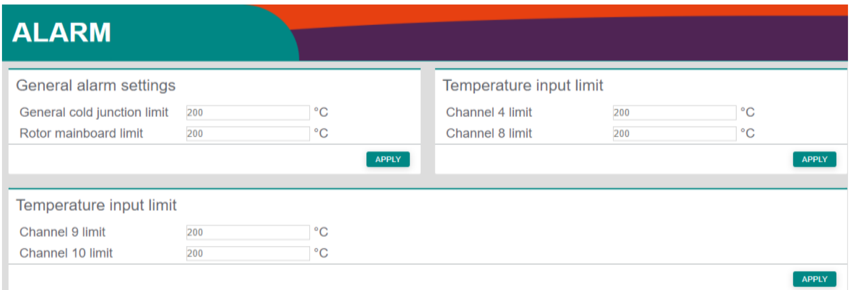


Figure 26 Page "ALARM"

6.5 Filter settings

The filter settings influence the analogue voltage output, frequency output and CAN bus output. Details are given in 3.5.4.

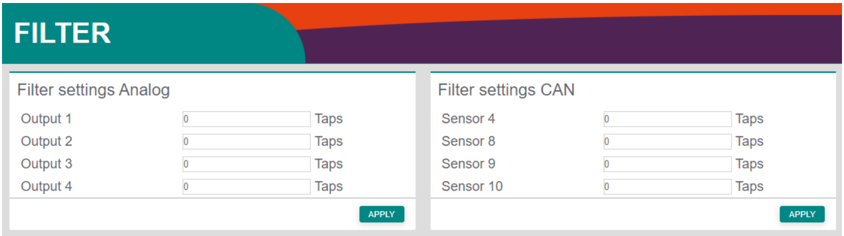


Figure 27 Page "FILTER"

6.6 Analog settings

On this page you can modify the properties of the analogue outputs. Chose the voltage output range which will have an effect on all four outputs. Each output can be linked (mapped) with a temperature channel.

It is also possible to have a temperature channel on two analogue outputs with different scales.

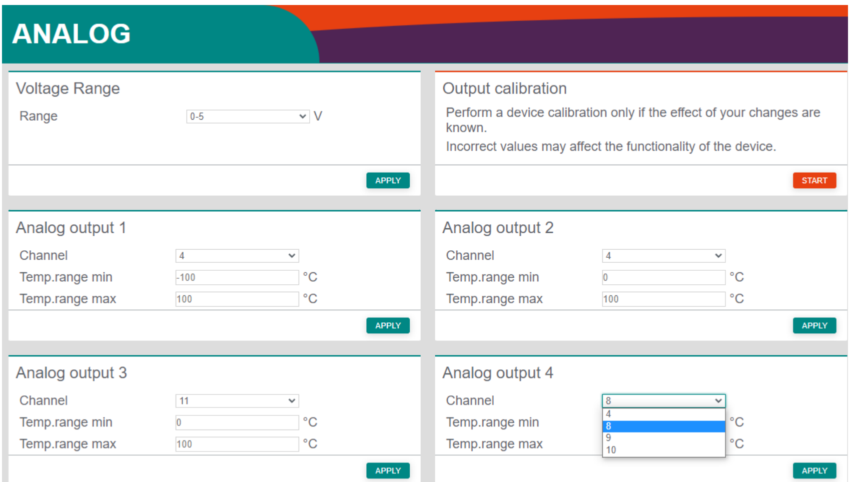


Figure 28 Page "ANALOG"

The outputs may only be calibrated by trained personnel. Incorrect values falsify measurements.
The outputs are calibrated at the factory and there is no need to recalibrate them.

6.7 CAN settings

Each temperature signal is transmitted on its own message. The first four bytes transfer the temperature of sensor. The second four bytes contain the temperature of the cold junction. The values are transferred as digital values in data type UInt32. The data words must be converted into a temperature value after receipt by division by the scaling factor "Scaling factor" 100:

$$\frac{Received\ data\ word}{100} = Temperature\ in\ °C$$

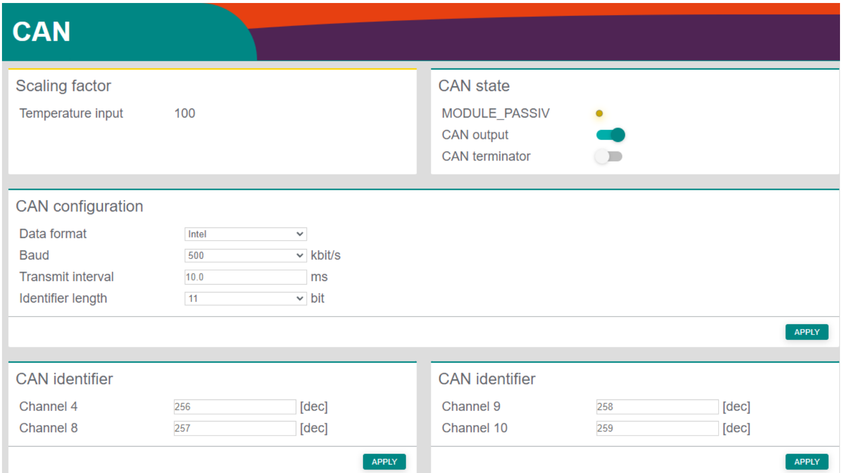


Figure 29 Page "CAN"

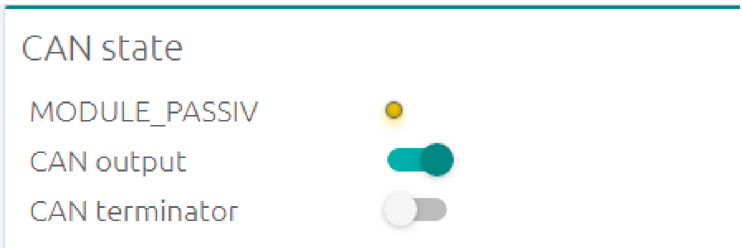
The CAN interface can be configured in the CAN menu.

6.7.1 CAN state

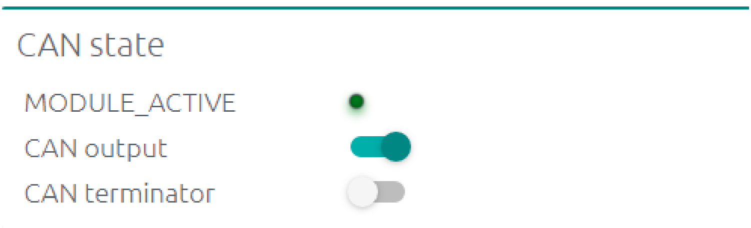
CAN transmission is enabled and disabled by toggling the button at “CAN output”. The internal bus termination of 120 Ω can be activated at the button at “CAN terminator”. The terminator is not activated by the manufacturer.

The “CAN State” tab also contains information about the current state of the CAN bus. The different states are explained in the following sections.

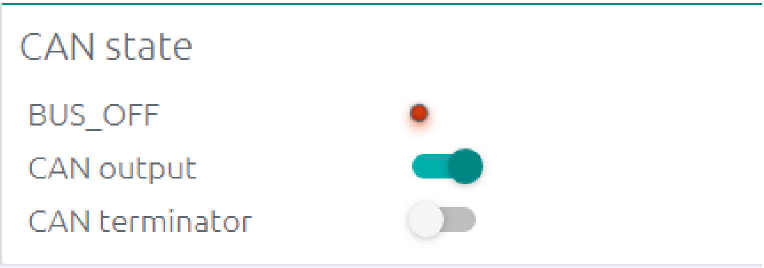
MODULE_ACTIVE: The CAN bus is working without any significant problems. The *receive error counter (RX)* and the *transmit error counter (TX)* are < 128.



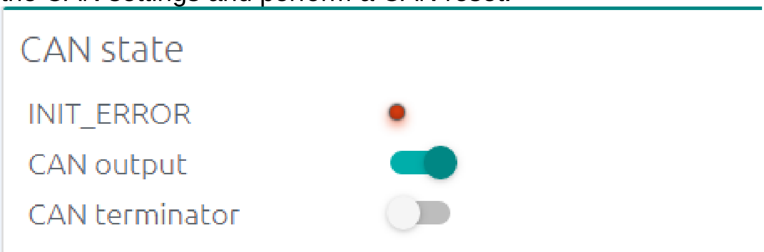
MODULE_PASSIV: The CAN bus works, however, a transmission or reception error occurred. TX or RX is > 127. In case that no more errors occurred, the counters are decremented and the status changes to MODULE_ACTIVE. Otherwise, the bus should be checked.



BUS_OFF: The CAN module has been disconnected due to many transmission errors (TX > 255).Check the CAN settings and perform a CAN reset.

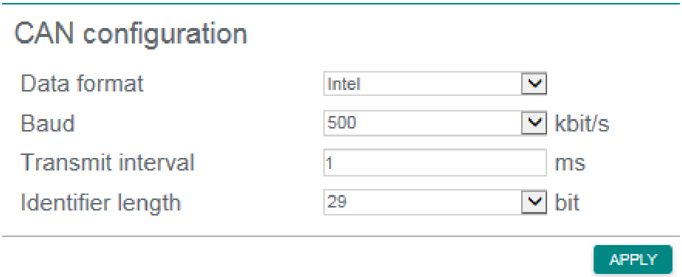


INIT_ERROR: The CAN module cannot connect to the CAN bus. Check the CAN settings and perform a CAN reset.



NOTE: CAN State can be reset by switching the output off and on again.

6.7.2 CAN configuration

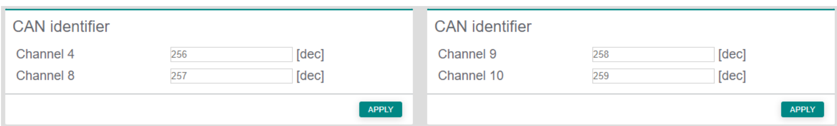


The general CAN transmission can be configured. Selected values need to fit the values of the current receiver system.

- Data format (Intel, Motorola)
- Baud rate (250kbit, 500kbit, 1Mbit)
- Transmit interval (between 1 and 1000 ms)
- Identifier-Length (11 Bit, 29 Bit)
- Message IDs

6.7.2.1 CAN message IDs

Chose the target CAN identifier for each available temperature channel. Each temperature channel has an own CAN message. Enter the values in decimal format.



6.7.2.2 Send messages

Send messages are sent from the system to the CAN bus. CAN messages are formatted (dependent on configurations) in the following way:

Intel	Data byte 0-3				Data byte 4-7			
Identifier	**D0**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
	Temperature channel				Cold junction temperature			

Motorola	Data byte 0-3				Date byte 4-7			
Identifier	**D3**	**D2**	**D1**	**D0**	**D7**	**D6**	**D5**	**D4**
	Temperature channel				Cold junction temperature			

6.7.2.3 CAN receive messages

Receive messages can be sent from any CAN bus component to the IRTS system. The receiving identifier for CAN command message can be chosen. The following CAN commands can be received:

Command	Command code	
	Hex	**Dec**
Test signal (on)	0x4B2	1202

Test signal (off)	0x4B3	1203
Power supply (off)	0x514	1300
Power supply (on)	0x515	1301
Alarm reset	0x578	1400
Request Ethernet settings	0xD05	3333

Table 14 CAN command list

The command must be included in the first 4 bytes [data bytes 0-3]. While receiving, distinction is made between Motorola and Intel. A response message is sent if a message is successfully received. The response massage is formatted in the following way:

Response message		
Identifier	**Data byte [0-3]**	**Data byte [4-7]**
receive identifier +1	last command	state

6.7.3 Status word

The status word of IRTS-P systems uses all 8 Byte of one CAN message and is separated in two parts. These are available separately in the selection menu for the CAN messages. The assignment within the CAN status message is fix. The following table shows the assignment:

State Part 2	State Part 1
Byte 7 - 4	Byte 3 - 0

Each State Part is 32 bits long. The following table describes the functions of the individual bits:

State Part 2			
Bit	Name	Description	Category
31	Rotor connected	Voltage search completed and nominal voltage reached	Connectivity
30	CAN active	CAN output activated	
29	-	Reserved	
28	-	Reserved	
27	-	Reserved	
26	-	Reserved	
25	-	Reserved	
24	-	Reserved	
23	-	Reserved	
22	-	Reserved	
21	Power supply	Rotor power supply activated	System supply
20	Voltage search	System is in voltage search	
19	-	Reserved	
18	-	Reserved	
17	-	Reserved	
16	-	Reserved	
15	-	Reserved	
14	-	Reserved	
13	-	Reserved	
12	-	Reserved	

State Part 2			
Bit	Name	Description	Category
11	Internal service parameter	-	Test/Service
10	Test signal TCU	Test signal TCU was triggered	
9	Internal service parameter	-	
8	Internal service parameter	-	
7	Watchdog	Counter 0-255 (Increments in transmission speed)	
6			
5			
4			
3			
2			
1			
0			

Table 15 CAN status word part 2

State Part 1			
Bit	Name	Description	Category
31	Alarm system	System not ready for operation	Alarm/Error
30	Alarm TC	Alarm temperature channel	
29	Alarm CJ	Alarm cold junction	

State Part 1			
Bit	**Name**	**Description**	**Category**
28	Alarm Trans.	Alarm sender temperature	
27	-	Reserved	
26	-	Reserved	
25	Alarm Overcurrent	Royer current >= 1.4A || Royer current >= 1.2A (~ 5 minutes)	
24	Positioning error	Overcurrent during voltage search	
23	Version error	Incompatible equipment combination	
22	OS error	Fatal system error	
21	Current warning W1	Royer current >= 1.2A (~ 1 minute)	Warning
20	Current warning W2	Royer current >= 1.2A (~ 4 minute)	
19	Internal service parameter	-	
18	-	Reserved	
17	-	Reserved	
16	-	Reserved	
15	-	Reserved	
14	-	Reserved	
13	-	Reserved	
12	-	Reserved	

State Part 1			
Bit	Name	Description	Category
11	System ready	System ready for operation	Measurement
10	Internal service parameter	-	
9	Internal service parameter	-	
8	Internal service parameter	-	
7	-	Reserved	
6	-	Reserved	
5	-	Reserved	
4	-	Reserved	
3	-	Reserved	
2	-	Reserved	
1	-	Reserved	
0	-	Reserved	

Table 16 CAN status word part 1

6.8 Ethernet settings

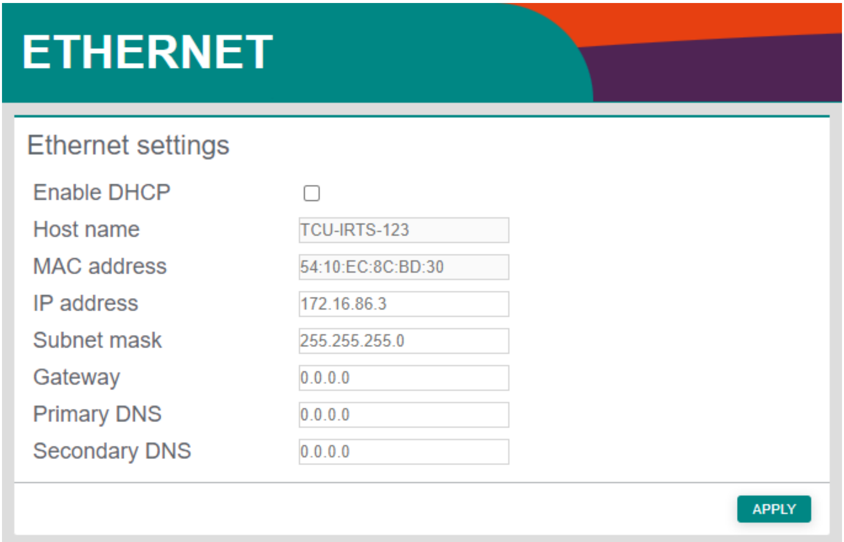


Figure 30 Page "ETHERNET"

Relevant adjustments for embedded measurement system in the intranet can be configured.

Important

Improper settings can break the device. In some cases, the device cannot be reconfigured! In that case, the torque control unit must be reprogrammed in factory. Administration must be consulted before configuring to get the proper settings.
If the network settings of the TCU have been forgotten, the settings can be queried via the following CAN command:

Command		Command code	
		Hex	**Dec**
Request settings	**Ethernet**	0xD05	3333

Table 17 CAN command to request Ethernet settings

The response of the TCU has the structure IP address, subnet mask:

Type	IP Address				Subnet Mask			
Byte i	**Byte 0**	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Content (HEX)	AC	10	56	2	FF	FF	FF	0
Result (DEC)	172	16	86	3	255	255	255	0

Table 18 CAN Response code of TCU

6.9 Temperature settings

The temperature channels can be adjusted on this page. There is an offset and a factor for each channel. The first adjustment is carried out before delivery of ATESTEO and made available to the customer as a protocol (test report).

These values must be entered manually. The data is rotor-specific, but is not stored in the rotor, only in the TCU via user input on the website.

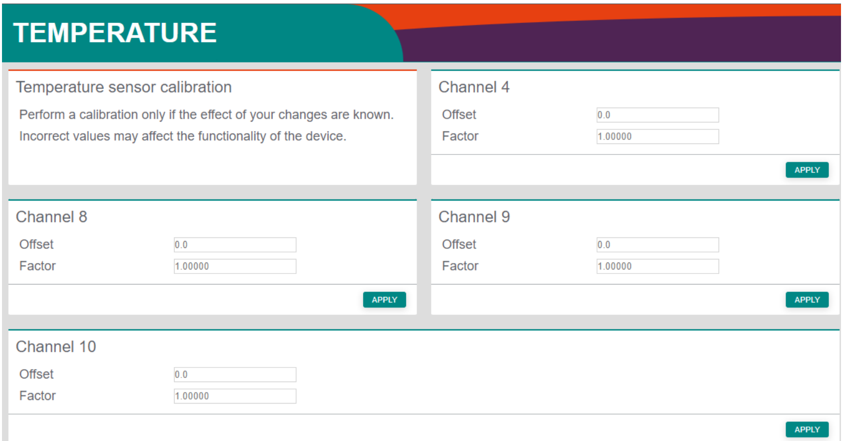
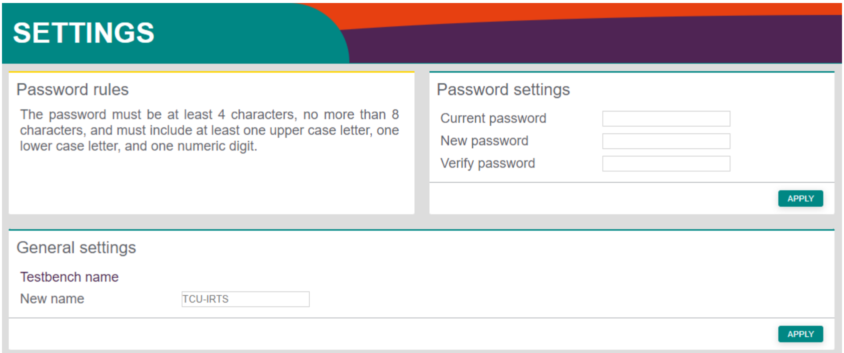


Figure 31 Page "TEMPERATURE"

6.10 General settings

Username and password for first access:
Username: **customer**
Password: **admin**



A password and a device name for the measurement system can be adjusted.

Following password characteristics must be fulfilled:

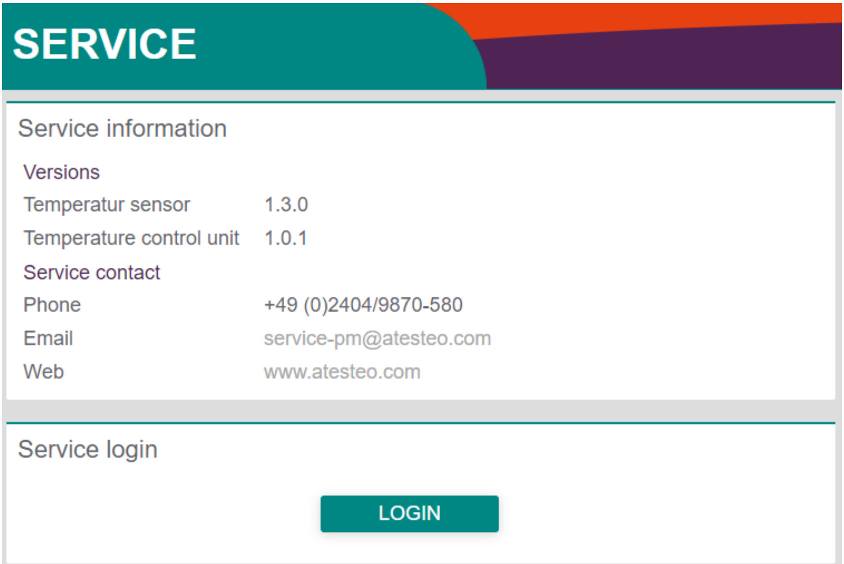
- Total length between 4 and 8 signs
- At least one upper-case letter
- At least one lower-case letter
- At least one digit

Important

Write down your password and keep it in a safe place. Please contact the service if you cannot remember your password anymore.

Test bench name allows defining a customized name for the TCU5.

6.11 Service information



The installed firmware version of the device and manufacturer’s contact details can be found on the Service page.

The "Service login" area is only permitted for use by the ATESTEO service team. The login is additionally prevented by a service password.

7 Pin allocations

7.1 X770 Power supply

12-pin connector, type M23				
Pin	**Signal**	**Description**	**Cable color (cable optional)**	**Cross-Section in mm**
1	F2_out	Not available	White	0.25
2	F2_out		Brown	0.25
3	N2_out		Gray	0.25
4	N2_out		Pink	0.25
5	N1_out		Blue	0.25
6	N1_out		Red	0.25
7	F1_out		Yellow	0.25
8	F1_out		Green	0.25
9	IP-reset_in	Reset IP-Configuration	White	0.5
10	Power+	Power supply 24 - 30 V / 1 A	Green	0.5
11	Power-		Yellow	0.5
12	Digital GND	Ground connection of digital signals	Brown	0.5

Table 19 X770

IP-reset_in

The IP reset signal resets the IP configuration of the Ethernet interface to the factory setting (see product label). For security reasons, the following procedure must be used for recovery:

1
- Turn on the IP reset signal
- X770 Pin 9   3.3 V <= U <= 30 V

2
- Turn on the TCU.

3
- Wait until the red LED flashes and the green LED is off.

4
- Wait until the red and green LEDs light up constantly.

5
- Turn off the IP reset signal. The TCU automatically restarts, with the reset IP configuration.

Power supply

Connect the positive and negative power pins with an external power supply. The power supply must have a supply voltage between 24 and 30 Volt and must be able to supply 1 A constant current.

7.2 X771 Analogue / CAN / Alarm / Input

16-pin connector, type M23				
Pin	**Signal**	**Description**	**Cable color (cable optional)**	**Cross-Section in mm**
1	Test_in	Activates test signal	White	0.25
2	Zero_in	Not available	Brown	0.25
3	Digital GND	Ground connection of digital signals	Green	0.25
4	Digital GND		Yellow	0.25
5	CAN_H	CAN HIGH	Grey	0.25
6	CAN_L	CAN LOW	Pink	0.25
7	An4_out	Galvanic isolated analog voltage output	Blue	0.25
8	An2_out	Galvanic isolated analog voltage output	Red	0.25
9	An3_out	Galvanic isolated analog voltage output	Black	0.25
10	An1_out	Galvanic isolated analog voltage output	Purple	0.25
11	Alarm TC_out	Alarm temperature channel	Grey/Pink	0.25

16-pin connector, type M23				
12	Analog GND	Ground connection of analog signals	Red/Blue	0.25
13	Alarm CJ_out	Alarm cold junction	White/Green	0.25
14	Alarm TX_out	System error	Brown/Green	0.25
15	Alarm reset_in	Not available	White/Yellow	0.25
16	Aux_in	Not available	Yellow/Brown	0.25

Table 20 X771

Test_in
The test_in signal activates the test signal as soon as thecircuit is closed for at least one second until the signal is switched off again. The test signal produces a positive full-scale at all outputs for measured values. A voltage level 3.3 – 30 V (via supply voltage) between test_in pin and digital GND is applied for the control. The signal is active high. Function description see 3.5.1.

CAN
The CAN interface allow the customer to receive the measured data in digital form and simultaneously send control signals to the TCU. The CAN_High and CAN_Low pins have to be connected with a 120 Ohm terminated CAN-Bus.

Analog_out
The input signals for the four analogue outputs can be set via the web interface.

Four different modes are available for the voltage range at the outputs, which are defined once for all outputs. The web interface is also used to set the temperature at which the maximum and minimum voltage value is reached.

The analogue outputs 1-4 are single ended galvanic isolated voltage outputs with separately analog GND.

Alarm TC_out
The alarm-TC output indicates that at least one temperature channel has an error. The alarm output consists of an open collector circuit. In the active state, it connects the Alarm-MD_out pin with digital GND directly.

Alarm CJ_out
The alarm CJ output indicates that the at least one cold junction threshold is exceeded. The alarm output consists of an open collector circuit. In the active state, it connects the Alarm-N_out pin with digital GND directly.

Alarm TX_out
System error or rotor not connected (low, Open-collector). When active, systems works well and rotor connected (high).

Alarm-reset_in
The alarm-reset signal resets all alarm-signals as soon as the circuit is closed for at least one second. The reset is executed only once after trigging. A voltage level 3.3 – 30 V (via supply voltage) between alarm-reset_in pin and digital GND must be applied for the control. The signal is active high.

7.3 X772 Ethernet

Can be connect with a standard Kat 5e cable for diagnostics or setup. For permanent installation inside the test bench use the special connector.
Hummel - 7R10400000

7.4 X775 / X776 Central cable

15-pin connector, Type M16 **Not for** outdoor usage				
Pin	**Signal**	**Description**	**Cable color**	**Cross-Section in mm² / Type**
A	Power-	Supply voltage	Black	0.25 / straight
B	7V-Power+	Supply voltage	Purple	0.25 / straight
C	Data-in+	Digital rotor data – RS422	Yellow	0.14 / twisted
D	N0+	Not available	Grey	0.14 / twisted

E	N0-	Not available	Pink	0.14 / twisted
F	7V- Power-	Supply voltage	Grey/Pink	0.25 / straight
G	Power+	Supply voltage	Red/Blue	0.25 / straight
H	N1-	Not available	Red	0.14 / twisted
J	N2+	Not available	White	0.14 / twisted
K	N2-	Not available	Brown	0.14 / twisted
L	Data-in-	Digital rotor data – RS422	Green	0.14 / twisted
M	N1+	Not available	Blue	0.14 / twisted

Table 21 X775/X776

8 Appendix

8.1 Table of figures

8.2 Table of tables

Your notes

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