Heraeus

Electro-Nite

iM2Sensor Lab, Sensor Lab Steel, Sensor Lab Multilance

v. 8.3.1 20/01/25

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1. Introduction

1.1. Document Identification

This manual provides information required to use and maintain the Sensor Lab system. It is written for technically skilled personnel such as engineers, programmers, or maintenance specialists who have been specially trained and who have the specialized knowledge required in the field of instrumentation, electronics and control.

This manual is an integral part of the instrument or device. For the sake of clarity, not all details of all versions of the instrument or device are described, nor can it cover all conceivable cases regarding installation, operation, and maintenance. If you require further information or face special problems that have not been dealt with in sufficient detail in this manual, contact your local Heraeus Electro-Nite representative.

We would also point out that the contents of this manual shall not become a part of, or modify, any prior or existing agreement, commitment, or legal relationship. The Purchase Agreement contains the complete and exclusive obligations of Heraeus Electro-Nite. Any statements contained in this manual do not create new warranties or restrict the existing warranty.

1.2. General Description

The Intuitive Molten Metal Sensor Lab (*i*M^{2}Sensor Lab®) is an instrument for analyzing temperature, oxygen, and carbon measurements in steel melts. Depending on the probe connected, it can also measure bath level and slag thickness.

Sensor Lab Steel and Sensor Lab Multilance are based on the *i*M^{2}Sensor Lab®. In this user manual, all three instruments are described. When an option or a feature is different or not available, this is indicated with a note.

Note: *This manual refers to instruments with software versions 2.3.x. Refer to section 3.2.3. to review the software version of your instrument.*

2. Safety and Usage Notes

2.1. Skilled Personnel

Only skilled personnel should be allowed to work on this device or system. Non-compliance with the warnings contained in this manual or appearing on the device or system itself can result in death or severe personal injury or damage to property. Skilled personnel includes:

- System planning and design engineers who are familiar with the safety concepts of automation equipment, instruments, or electronic devices and are capable of system planning and design..
- An structural engineer who can calculate the strength of the structure to mount the installation if necessary.
- Operating personnel who have been trained to work with automation equipment, instruments, or electronic devices, and are conversant with the content of the manual in as far as it is connected with the actual operation of the instrument or device.
- Commissioning and service personnel who are trained to repair such automation equipment, instruments, or electronic devices, and who are authorized to energize, de-energize, clear, ground, and tag circuits, equipment, and systems in accordance with established safety practices.
- Access Control: Access to the equipment should be restricted to authorized personnel only. The equipment is to be located in a locked room or area to prevent unauthorized access. Unauthorized tampering with the equipment can lead to safety hazards and operational issues.

Note: *Additional Note: Changing Instrument Settings:*

Making adjustments to the settings of the industrial instrument may affect its performance and the accuracy of the measurements obtained. It's important to understand that altering settings without proper knowledge or authorization can lead to unintended consequences, including:

1. Performance Issues: Incorrect settings may result in the instrument not operating as intended, leading to inaccuracies in measurements or malfunctions.
2. Measurement Inaccuracies: Changes to critical settings can impact the precision and reliability of the measurements taken by the instrument, compromising the quality of the data collected.

Therefore, it is strongly recommended that only trained and authorized personnel make adjustments to the instrument settings. Before modifying any settings, ensure that you have a clear understanding of the implications and seek approval from the appropriate authorities if necessary.

2.2. Danger Notices

The notices and guidelines that follow are intended to ensure personal safety, as well as protecting the instrument or device and any connected equipment against damage.

The safety notices are warnings for protection against loss of life (yours or service personnel) or for protection against damage to property and are highlighted in this manual by the terms and pictograms defined here. The terms used in this manual and marked on the instrument itself have the following significance:

DANGER: *Indicates a hazardous situation that, if not avoided, will result in death or serious injury.*

Warning: *Indicates a hazardous situation that, if not avoided, could result in death or serious injury.*

CAUTION: *Indicates a hazardous situation that, if not avoided, could result in minor or moderate personal injury or property damage.*

Note: *Indicates important information about the product, its operation, or a part of the manual to which special attention is drawn.*

2.3. Proper Usage

The device or system may only be used for the applications described in the manual or the technical description, and only in combination with the equipment, components, and devices of other manufacturers as far as this is recommended or permitted by Heraeus Electro-Nite.

The device or system described has been developed, manufactured, tested, and the manual compiled in keeping with the relevant safety standards.

Consequently, if the handling instructions and safety guidelines described for planning, installation, operation, and maintenance are followed, the device or system, under normal conditions, will not be a source of danger to property or life.

Warning: *When the device or system is used in a manner not specified by Heraeus Electro-Nite in this manual, the protection provided by the device may be impaired.*

CAUTION: *This device or system is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.*

2.4. Safety Regulations

The unit must be connected in compliance with the VDE 0100 "Regulations for establishing high voltage equipment with mains voltages below 1000 V".

DANGER:

- Before opening the equipment, it is essential that the mains voltage is switched off to all channels or that the mains plug is disconnected.
- Connected devices (signalling system, horn) could have their own power supply, which must also be disconnected. Work on active system components may only be carried out with the utmost care by properly trained and qualified personnel.
- Mains outlet cord should not be over 3m in length and the mains wall outlet should always be reachable.

2.5. Looking After the Instrument

The Sensor Lab measurement system requires little maintenance. However, since it is subject to thermal and mechanical stress, it is recommended you check it once a week to ensure accurate results.

For a combined calibration and function test of the measuring system, we recommend the use of our Checkmate lance and calibration check instrument.

CAUTION: *Make sure that the lance cable is disconnected from the instrument before isolation checks are carried out.*

2.5.1. Cleaning Notes

The Sensor Lab instrument can be cleaned with a damp cloth and mild detergent. This applies to the cabinet exterior only. Prior to cleaning the Sensor Lab cabinet exterior with a damp cloth and mild detergent, disconnect all sources of power from the Sensor Lab cabinet.

2.6. Procedures for Maintenance and Repair

Warning:

- Unauthorized opening of equipment and improper repairs can result in loss of life or severe personal injury as well as substantial property damage.
- Repairs to an item of automation equipment may only be carried out by Heraeus Electro-Nite service personnel.
- Do not throw batteries into an open fire and do not carry out any soldering work on batteries (danger of explosion). Maximum ambient temperature 100°C. Lithium batteries or batteries containing mercury should not be opened or recharged. Make sure that the same type is used when replacing batteries.

Note:

- For replacement purposes, use only parts or components contained in the Spare Parts List section of this manual.
- Only use the fuse types specified in the technical specifications or the maintenance instructions of this manual.

2.7. Calibrate the system

CAUTION: *Only authorised personnel may calibrate the system. The instrument should only be calibrated if the result measurements can't be adjusted with the offset adjust parameter. The instrument must be calibrated within one year of bringing it into first service.*

Before calibration, ensure the instrument is acclimatized. To calibrate you need a calibration instrument with mV output like an AOIP. The calibration is performed on 10mV, 40mV, 200mV, and 1000mV. For isolation checks you must open the measurement circuit at the input connector. All calibration factors are stored in the non-violated memory of the instrument.

Because the instrument is calibrated on mV, ensure you use copper/copper wiring all the way to the mainboard. Compensated thermocouple wiring gives incorrect calibration.

2.8. Transport

Report damage during or immediately after delivery to the transport company and to Heraeus Electro-Nite. Take all necessary steps to prevent further damage.

2.8.1. Packaging of the Instrument

Since the instrument or device is a high-quality electronic measurement unit, it should only be dispatched in its original packing. If the original packing is no longer present, then it is advisable to properly pack the device in a sufficiently large box lined with a shock-absorbing material such as PUR foam, polystyrene flakes, or similar. The shock-absorbing layer should have a minimal thickness of 10cm on all sides. Before packing the instrument, it must be wrapped in paper or plastic film.

For overseas transportation, the unit should be welded into an air-tight plastic film, ideally with a desiccant added. These packing recommendations also apply when returning the unit to Heraeus Electro-Nite.

2.9. Guidelines for Handling Electrostatic Discharge

Electronic VLSI components are, by their nature, very sensitive to over voltages and thus to electrostatic discharge (ESD).

This pictogram and warning label is used on cabinets and packing. It suggests that modules are susceptible to damage by ESD

Before starting maintenance or installation make sure that you have sufficient protection against ESD.

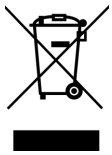
Electronic devices can be destroyed by voltage and energy levels that are far below 200V, the level perceptible to human beings. Such voltages can occur when a component or a module is touched by a person who has not been electrostatically discharged. In most cases, the components subjected to such over voltages, cannot be immediately detected as faulty. ESD problems are in many cases dormant as they can manifest themselves after a long time of normal operations.

2.10. Restriction of Hazardous Substances (RoHS) Regulations

All electrical devices sold in the European market from the July 1, 2006 must comply with EU Directive 2002/95/EC, and RoHS 2 directive 2011/65/EU, on the Restriction of the use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) as well as the national laws derived from it. According to the definition in Annex I of EU Directive 2012/19/EU WEEE, Heraeus Electro-Nite measuring instruments and analysis devices belong to category 9 – industrial monitoring and control instruments.

All Heraeus Electro-Nite instruments placed on the market after 1 July 2006 do not contain materials prohibited according to the RoHS directive.

2.11. Waste Electrical and Electronic Equipment (WEEE) Regulations



According to the EU Directive 2012/19/EU WEEE, all electrical devices sold in the European market from the 13 August 2005 must be marked with a special symbol. This symbol (crossed out waste disposal receptacle with thick black bar underneath) indicates to the customer that the device must not be placed in household waste but must be either deposited at a collection place for commercial scrap or returned to the manufacturer.

Heraeus Electro-Nite devices are exclusively for industrial commercial use and may not be transferred to private use. Devices must be disposed of according to local or national, statutory regulations for commercial electrical scrap. You must also follow the EU Directive WEEE regulations and their national conversion. If in doubt, ask your local Heraeus Electro-Nite representative.

2.12. Disposal of instrument or parts

If components of the instrument or device have to be replaced due to malfunction, these components have to be returned to Heraeus Electro-Nite.

In general, old Heraeus Electro-Nite devices can be disposed by simple shipping it back to Heraeus Electro-Nite premises. In this case the customer only pays for the transport and disposal costs will be handled by Heraeus Electro-Nite.

If the instrument will be disposed at your own premises, think about the following recycling issues. The device consists of several components that can be disposed of separately:

- The electronic cards for electronic recycling
- The housing for metal recycling
- All cables in our instruments and cabling linked to our sensors contain copper. Copper is identified in the European Union legislation to be of high critical raw materials recovery potential.
- All these components can be easily unscrewed from the instrument before disposal.

For further disposal information, always follow the local legislation.

2.13. CE Declaration of Conformity

Hereby, Heraeus Electro-Nite declares that this equipment is in compliance with the CE-directives on Machinery 2006/42/EC, EMC 2014/30/EU, Low Voltage Directive (LVD) 2014/35/EU, FCC Code of Federal Regulations, Title 47 – Part 15 and RF Exposure requirements. The full text of the EU Declaration Of Conformity is available at the following internet address: www.heraeus-electro-nite.com. To maintain compliance with the regulatory requirements, only use Heraeus Electro-Nite accessories intended for use with this product, installed according to the instructions in this manual.

The instrument complies with applicable laws, regulations and administrative provisions, for as far the operating limits, described in the documents accompanying the machinery, are followed. Test procedures, based on Harmonised Standards, have been carried out by a conformity assessment body for demonstrating product compliance with essential requirements and EU Directives.

Technical construction files are available, describing the apparatus, circuit diagrams, parts listing and attestation reports. Delegate for compiling the dossier, Industrialization Manager Instrumentation & Manipulators

The Sensor Lab is manufactured by:

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 Heraeus Electro-Nite International N.V.
Centrum Zuid 1105
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```
3530 Houthalen, Belgium
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  ML&S manufacturing, logistics & services GmbH & Co.
KG Siemensallee 1
17489 Greifswald, Germany
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3. System Description

3.1. The instrument

The Sensor Lab instrument can be located on the shop floor or in the control room. There are two versions:

- With an integrated touchscreen
- Without a touchscreen

Additional VGA screen and/or human-machine interfaces (HMIs) can be connected to the instruments for control and monitoring purposes.

The instrument can be used with portable handlances or fixed autolances. These lances can be connected to the instrument by wire or using the QUBE® unit. This unit sends measurement results using a wireless interface (see section 4.4.).

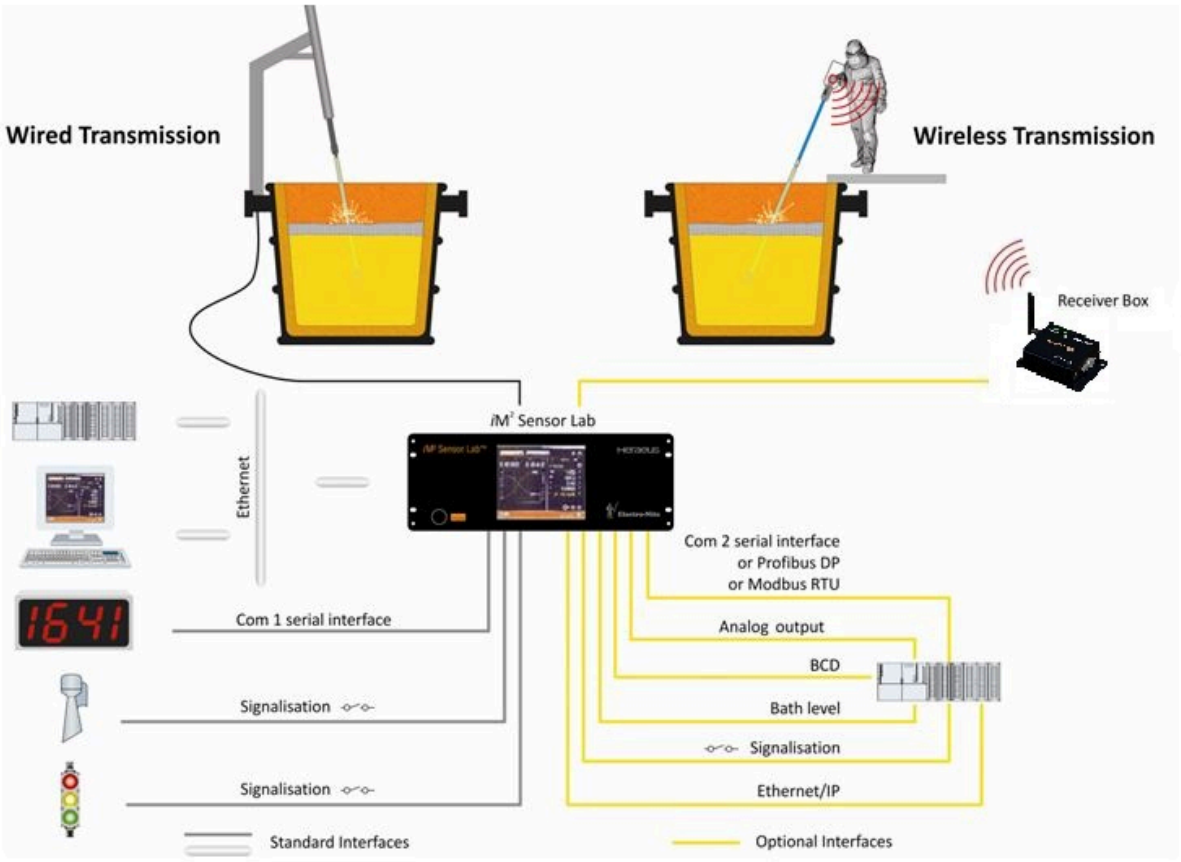


Figure 1: Sensor Lab instrument with integrated display

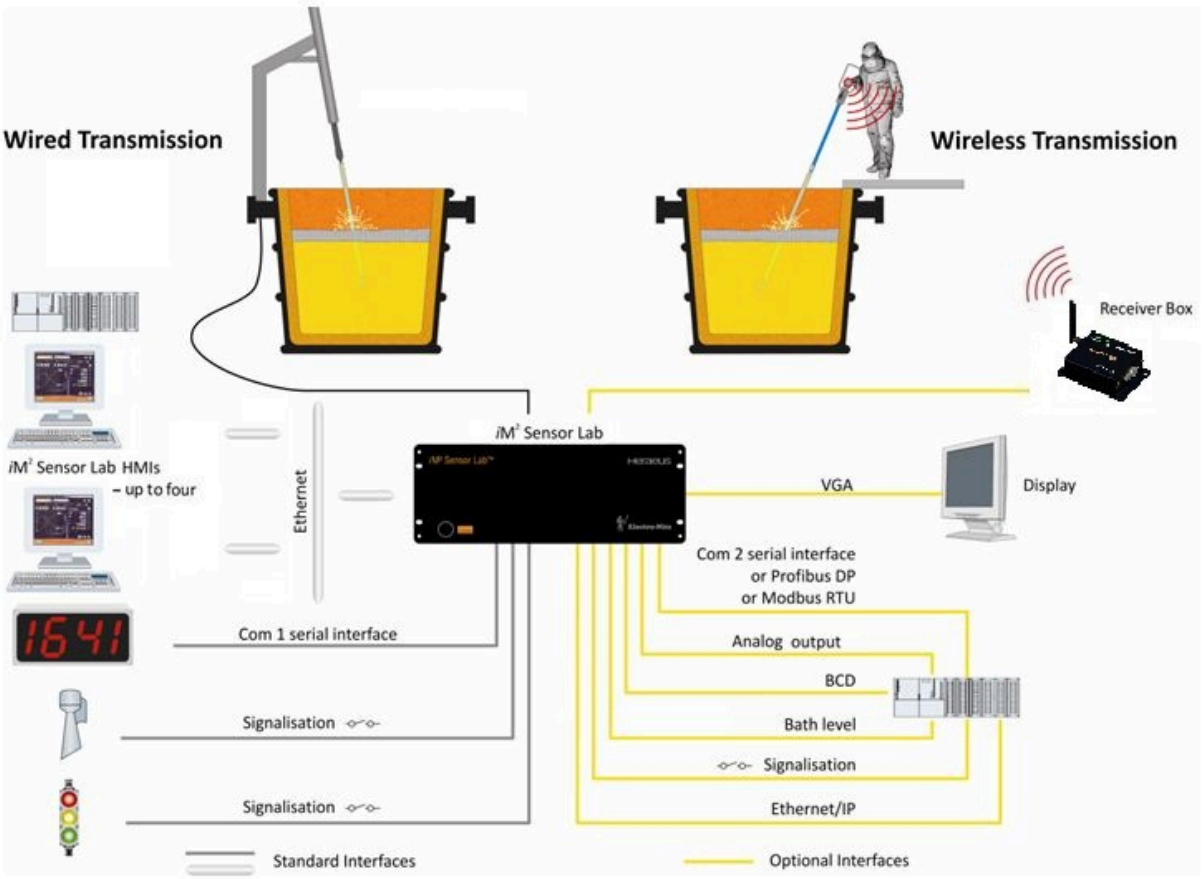


Figure 2: Sensor Lab instrument with separate remote displays

The Sensor Lab can perform the following measurements:

- Temperature and oxygen activity measurement in liquid steel.
- Carbon calculation program for primary steelmaking.
- Carbon calculation using the liquidus temperature.
- Aluminum calculation program for secondary metallurgy.
- Oxygen activity measurement and FeO determination in molten slag.
- Bath level determination can be obtained in automatic dipping applications when used with both Positherm temperature sensors and combined oxygen/temperature sensors.
- Accurate slag thickness using a Delta-Dist L (DDL) sensor.

Sensor Lab Steel and Sensor Lab Multilance are based on the *i*M² Sensor Lab®. In this user manual, all three instruments are described. When an option or a feature is different or not available, this is indicated with a note.

3.2. General configuration

3.2.1. Measurement input channels

The main purpose of the Sensor Lab is to measure the individual composition of molten metals. To do this, the unit has four measurement input channels.

There are four measurement input channels set for temperature readings or EMF readings, with DDL slag thickness capability. Depending on the probe used, different configurations apply.

There are two fully differential input (ADC) channels for each station with programmable gain appropriate for the input ranges required.

Station 1 uses:

- Channel 0 for thermocouple input and probe recognition.
- Channel 1 for thermocouple input, EMF input, and probe recognition.

Station 2 uses:

- Channel 2 for thermocouple input and probe recognition.
- Channel 3 for thermocouple input, EMF input, and probe recognition.

3.2.2. Interface connections

Apart from the measurement inputs, the Sensor Lab provides various interface connections. These facilities can be used to transfer the measurement data or status information of the Sensor Lab to or from peripheral equipment.

Standard connections:

- Two dual measurement inputs - thermocouple/EMF with DDL capability
- One Ethernet port
- Three USB ports - one on the front and two on the back
- Eight AC relay/triac outputs - 240VAC/1A max (active or passive lighting) *(passive AC output not available for Sensor Lab Steel)*
- One RS232/TTY serial Sub-D 25-pin male *(TTY is not available for Sensor Lab Steel)*
- One RS485/RS422 serial port **only** for the receiver box

Optional connections:

- 16 channel digital IO (24V (DC)/0.5A PLC compatible), can be used for BCD lance position input *(not available for Sensor Lab Steel)*
- Second RS232/TTY serial *(TTY is not available for Sensor Lab Steel, second serial RS232 is foreseen by default)*
- Profibus DP slave (one or two)
- Modbus TCP
- Modbus RTU
- Profinet
- Ethernet/IP using an extra real-time Ethernet connection
- Digital outputs organized as BCD output (five digits + DP) *(not available for Sensor Lab Steel)*
- Analog milliampere output
- Analog milliampere input (only for lance input readings)

Note: *The Sensor Lab Steel instrument can have only one optional connection.*

Optional wireless connectivity:

- Radio frequency (RF) transceiver connected to RS422 port *(by default available for Sensor Lab Steel)*

3.2.3. About the system

After log in (see 5.3.), you can open the About window to display information about the Sensor Lab application and the installed software and hardware components.

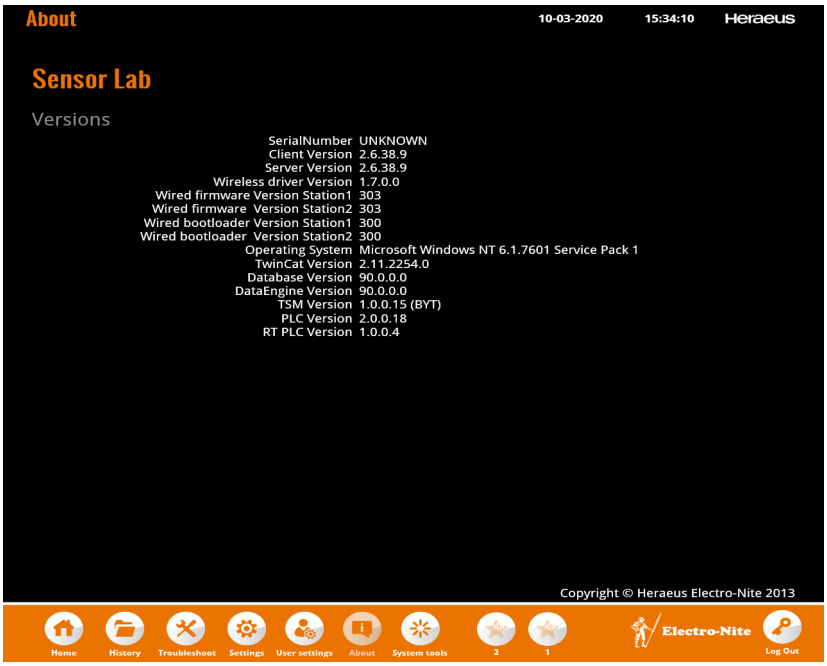


Figure 3: About window

Note: *This manual refers to instruments with software versions 2.3.x.*

4. Hardware Overview

4.1. *i*M²Sensor Lab®

Figure 4: Front view of the *i*M²Sensor Lab

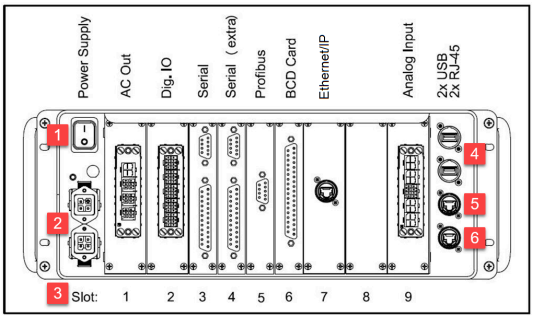


Figure 5: Back view of the *i*M²Sensor Lab

1 Power switch

2 Mains input

3 Example of slot combination (not all combinations are possible)

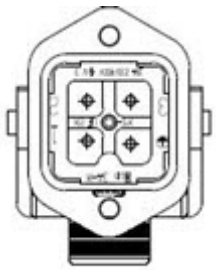
4 USB ports

5 LAN

6 EtherCAT

4.1.1. In- and outputs

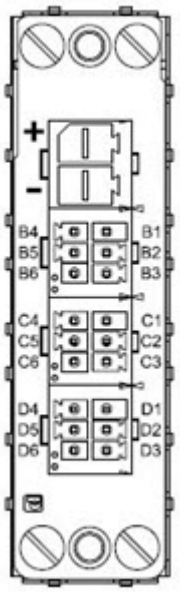
4.1.1.1. Mains input



Number	Type
1	L
2	N
3	n.c.
⏚	PE

4.1.1.2. Slot1 AC Out Active

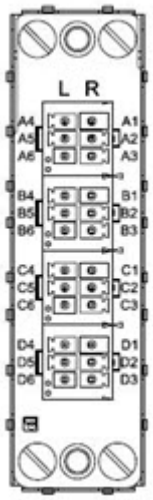
The horn or blue lamp depends on the configuration in the Sensor Lab basic instrument setup.



Left connector row		Right connector row	
B4	COM	B1	red light
B5	COM	B2	yellow light
B6	COM	B3	green light
C4	COM	C1	horn or blue lamp
C5	COM	C2	red light
C6	COM	C3	yellow light
D4	COM	D1	green light
D5	COM	D2	horn or blue lamp
D6	COM	D3	

4.1.1.3. Slot 1 AC Out Passive

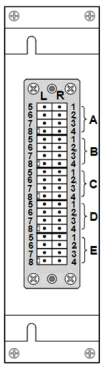
The horn or blue lamp depends on the configuration in the Sensor Lab basic instrument setup.



Module 0 Channel 0+1	A4	Common Module 0 (AC)	
	A5	Output 0	red light
	A6	Output 1	yellow light
	B4	Output 2	green light
	B5	Output 3	horn or blue lamp
	B6	Common Module 0 (AC)	
	C4	Common Module 1 (AC)	
	C5	Output 0	red light
	C6	Output 1	yellow light
	D4	Output 2	green light
	D5	Output 3	horn or blue lamp
	D6	Common Module 1 (AC)	

240VAC/1A max per output

4.1.1.4. Slot 2 Digital IO Module



Left connector row			
			Input card Option (*)
Module 2 (Optional add-on board)	A5		Com. Mod. 2
	A6		In 0, cm (bit 0)
	A7		In 1, cm (bit 1)
	A8		In 2, cm (bit 2)
	B5		In 3, cm (bit 3)
	B6		In 4, dm (bit 0)
	B7		In 5, dm (bit 1)
	B8		In 6, dm (bit 2)
	C5		In 7, dm (bit 3)
	C6		Com. Mod. 2
Module 3 (Optional add-on board)	C7		Com. Mod. 3
	C8		In 0, m (bit 0)
	D5		In 1, m (bit 1)
	D6		In 2, m (bit 2)
	D7		In 3, m (bit 3)
	D8		In 4, dc (bit 0)
	E5		In 5, dc (bit 1)
	E6		In 6, dc (bit 2)
	E7		In 7, dc (bit 3)
	E8		Com. Mod. 3

Right connector row			
Module 0 Channel 0+1	A1	Common Module 0	
	A2	Output 0	Red
	A3	Output 1	Yellow
	A4	Output 2	Green
	B1	Output 3	Error
	B2	Output 4	Liquidus
	B3	Output 5	Bath level
	B4	Output 6	EMF meas.
	C1	Output 7	TXD compl.
	C2	Common Module 0	
Module 1 Channel 2+3	C3	Common Module 1	
	C4	Output 0	Red
	D1	Output 1	Yellow
	D2	Output 2	Green
	D3	Output 3	Error
	D4	Output 4	Liquidus
	E1	Output 5	Bath level
	E2	Output 6	EMF meas.
	E3	Output 7	TXD compl.
	E4	Common Module 1	

Digital inputs:

Can be used for BCD lance input

- Common module 2 for dm and cm
- Common module 3 for m and dc

Digital outputs:

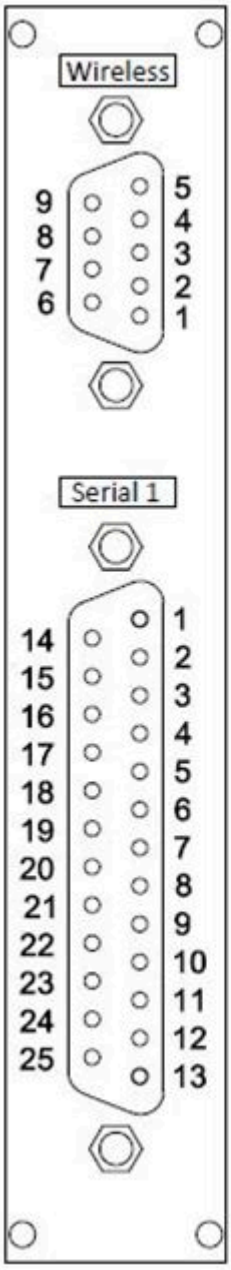
- Common module 0 for station A
- Common module 1 for station B

Slag thickness measurement wiring

Slag thickness and lance position measurement uses the yellow and red Digital IO signals. Their function is depicted below. The signals respond in real time with the actual situation.

Signal	Function
Yellow	Slag level is detected and measurement is ongoing
Red	Steel level is detected and the measurement has completed

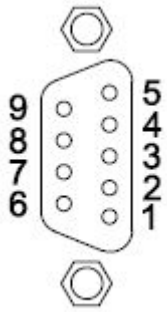
4.1.1.5. Slot 3/4 (extra) serial port 9 and 25 pins



RS485/RS422	
1	24V Rec Box Supply
2	Tx+
3	Rx+
4	-
5	GND
6	+5V
7	Tx-
8	Rx-
9	GND for 24V

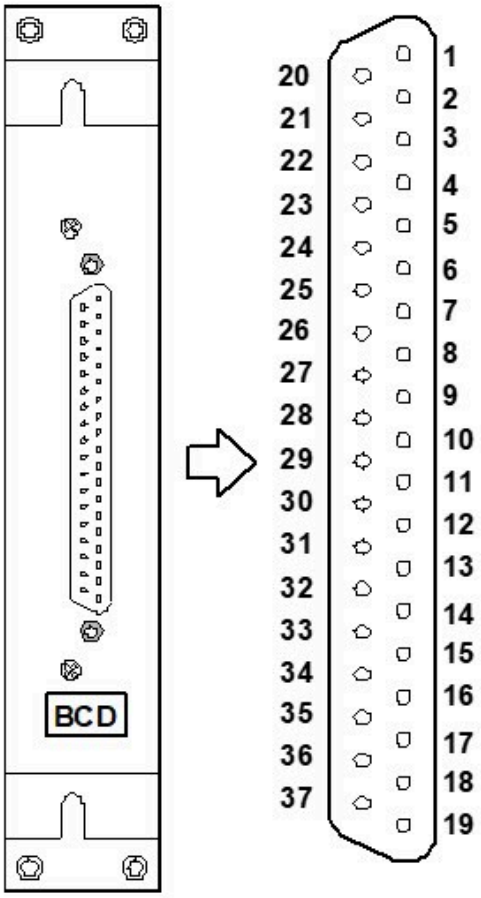
Serial connector (25p subd - Male)			
1	Strobe	14	20mA RTS+
2	TXD/TXD-	15	
3	RXD/RXD-	16	
4	RTS/TXD+	17	
5	CTS/RXD+	18	20mA TXD-
6	232 DSR	19	
7	GNDIS	20	232 D TR
8	232 DCD	21	
9	20mA CTS+	22	232 RI
10	20mA RXD-	23	
11	20mA CTS-	24	
12	20mA RXD+	25	20mA TXD+
13	20mA RTS-		

4.1.1.6. Slot 5 Serial port Profibus or Modbus RTU



Pin	Profibus	Modbus RTU
1		
2		T+
3	B+	R+
4		
5	GND	GND
6	VP (+5V)	
7		T-
8	A-	R-
9		

4.1.1.7. Slot 6 BCD Output



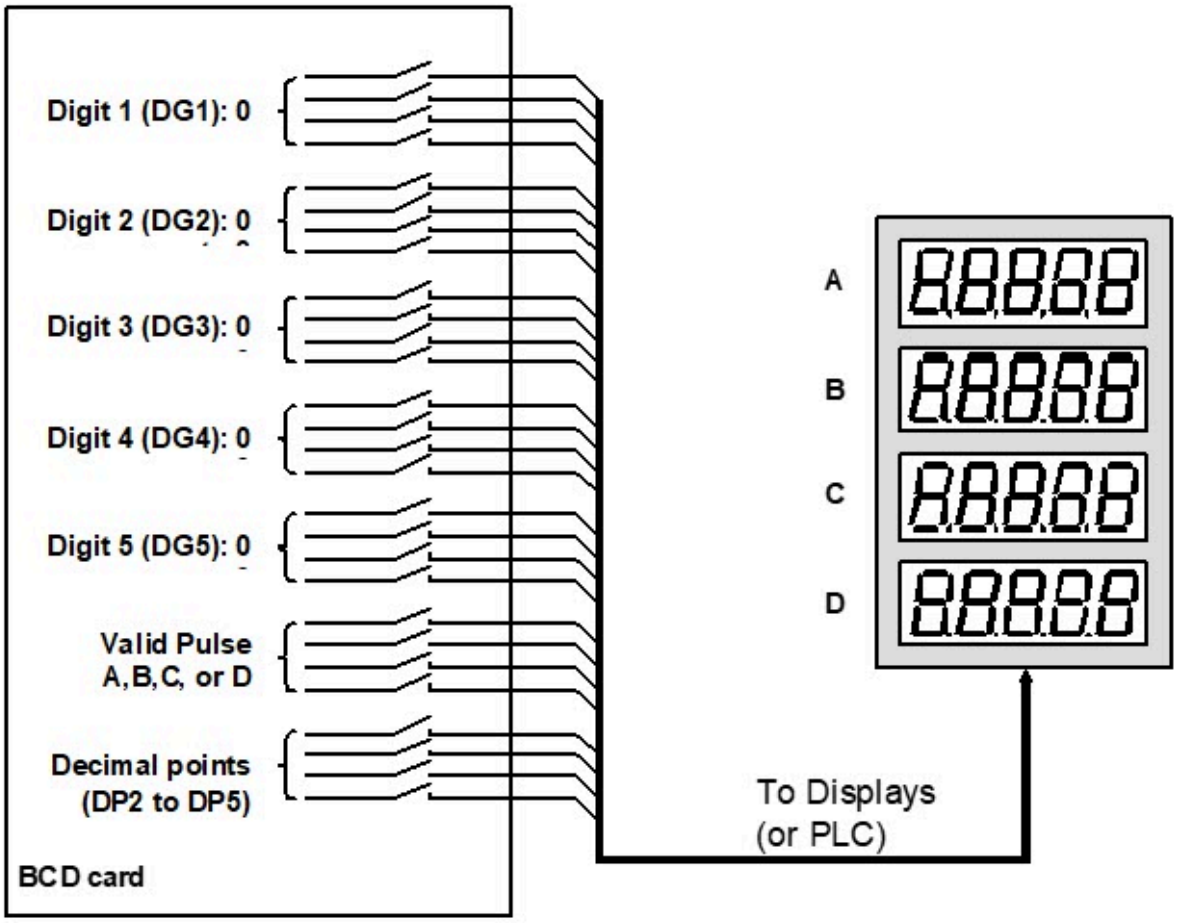
BCD connector (37p subd - Male)			
1	COM	20	Valid D
2	Valid C	21	Valid B
3	Valid A	22	COM
4	DP5	23	DP4
5	DP3	24	DP2
6	COM	25	Digit 5 - bit 3
7	Digit 5 - bit 2	26	Digit 5 - bit 1
8	Digit 5 - bit 0	27	COM
9	Digit 4 - bit 3	28	Digit 4 - bit 2
10	COM	29	Digit 4 - bit 1
11	Digit 4 - bit 0	30	COM
12	Digit 3 - bit 3	31	Digit 3 - bit 2
13	Digit 3 - bit 1	32	Digit 3 - bit 0
14	COM	33	Digit 2 - bit 3
15	Digit 2 - bit 2	34	Digit 2 - bit 1
16	Digit 2 - bit 0	35	COM
17	Digit 1 - bit 3	36	Digit 1 - bit 2
18	Digit 1 - bit 1	37	Digit 1 - bit 0
19	COM		

The Sensor Lab can have up to two optional Binary Coded Decimal (BCD) cards.

A BCD card is intended for use where BCD output is needed, either driving seven-segment displays or giving BCD output to a PLC.

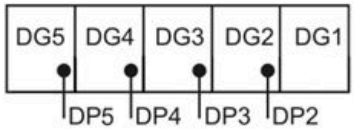
Each BCD card represents five BCD digits with four decimal points and four individual valid pulse contacts A, B, C, and D.

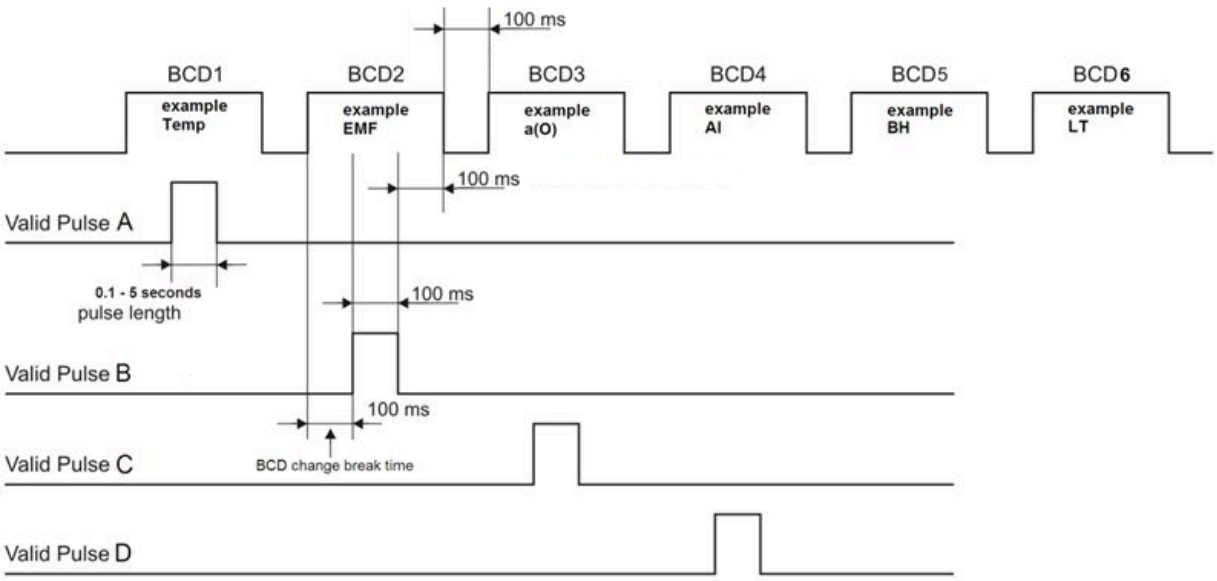
Each BCD digit represents four NO (= normal open) contacts. Each decimal point represents one NO contact. For negative values or measurement results, decimal point five (DG5) is used.



A five-digit, four-decimal point display can be addressed by enabling one of four valid pulse contacts. The duration (‘Valid Pulse Time’) of a valid pulse can be set from 0.1s to 5s. The BCD change break time corresponds to the time before and after the valid pulse time and is the same as the valid pulse time. The time in between the data streams is also the same.

The following example shows a valid pulse time of 0.1 seconds, which applies to all four times shown:





The following shows some examples for presenting values in code:

	DG5	DP5	DG4	DP4	DG3	DP3	DG2	DP2	DG1			
Temp	1		2		0		0	.	0	=	1200.0	°C
	1		7		6		0	.	0	=	1760.0	°C
	2		1		9		0	.	0	=	2190.0	°F
	3		2		0		0	.	0	=	3200.0	°F
EMF	3		0		0	.	0		0	=	300.00	mV
	5		0	.	0		0		0	=	50.000	mV
	0		5	.	0		0		0	=	5.000	mV
	0	.	5	.	0		0		0	=	-5.000	mV
	0	.	5		0	.	0		0	=	-50.00	mV
	0	.	3		0		0	.	0	=	-300.0	mV
A(O)	0		1	.	0		0		0	=	1.000	ppm
	2		0	.	0		0		0	=	20.000	ppm
	3		0		0	.	0		0	=	300.00	ppm
	1		5		0		0	.	0	=	1500.0	ppm
C	0		0	.	0		0		5	=	0.005	%
	0		0	.	0		2		5	=	0.025	%
	0		0	.	1		8		0	=	0.180	%
AI	0		0	.	0		0		5	=	0.005	%
	0		0	.	0		5		0	=	0.050	%
	0		0	.	3		2		0	=	0.320	%
	0		1	.	0		0		0	=	1.000	%

4.1.1.8. Slot 7 Ethernet/IP or Modbus TCP or Profinet

4.1.1.9. Slot 7 or 8 Analog mA output option

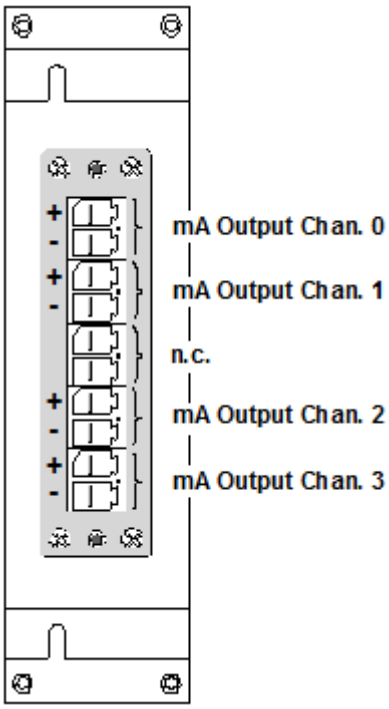
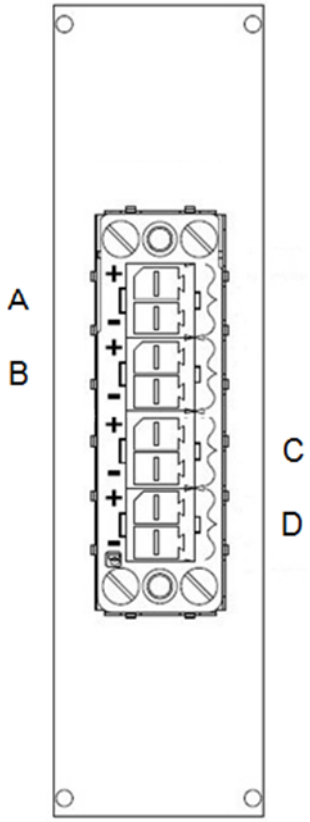


Table 1: Default parameter settings

Channel 0:		Channel 1:	
Min mA:	4.0	Min mA:	4.0
Max mA:	20.0	Max mA:	20.0
Channel 2:		Channel 3:	
Min mA:	4.0	Min mA:	4.0
Max mA:	20.0	Max mA:	20.0
Error:			
Min mA:	off		
Max mA:	on		

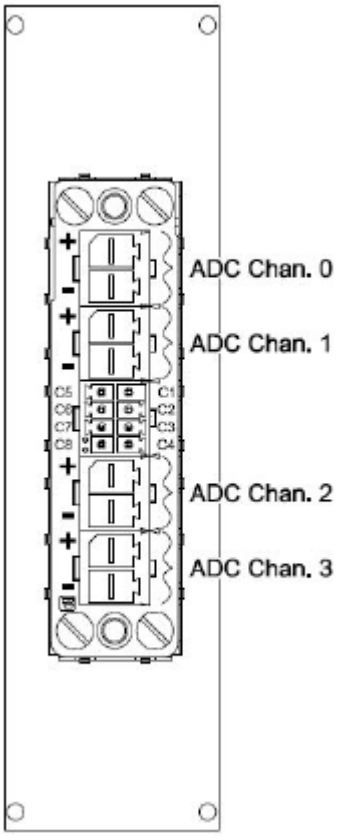
4.1.1.10. Slot 7 or 8 Analog mA input option



Connections for the mA input option (to be used with an absolute analog 0/4-20mA encoder):

A1	+Vs supply
A2	Current encoder
B1	+Vs supply
B2	GND supply
C1	+Vs supply
C2	Current encoder
D1	+Vs supply
D2	GND supply

4.1.1.11. Slot 9 Analog input



A1	CH0 Temp+
A2	CH0 Temp-
B1	CH1 Oxygen/Carb+
B2	CH1 Oxygen/Carb-
D1	CH2 Temp+
D2	CH2 Temp-
E1	CH3 Oxygen/Carb+
E2	CH3 Oxygen/Carb-

4.1.2. Technical data

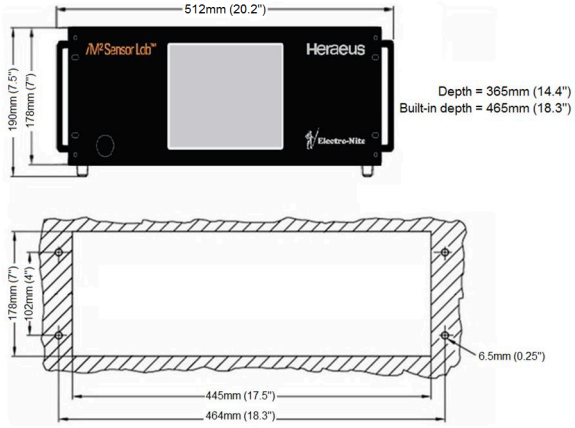
Table 2: Technical data iM2 Sensor Lab

Item	Description	
Applications	Bath temperature, oxygen, carbon measurement,	bath level determination
Additional calculation function	Aluminium and FeO determination in steel slag	
Measurement input	Two individual measurement channels both for temperature and EMF	Each measurement channel with automatic probe recognition
Temperature measurement[1]	Thermocouple types S, R, B	Arithmetically linearized according to IPTS48, IPTS68, or ITS90 (default) temperature °C/°F, resolution 0.1°C (0.18°F)
EMF measurement	+/- 1000mV	Resolution 0.1mV
Sample rate	Maximum 250/sec	
Accuracy	+/-0.5°C (0.9°F) for thermocouples	0.2mV for EMF signals
Display	8.4-inch TFT colour display Resolution 800x600	For measurement results and menu display
Operation	Touch screen (on instrument or on HMI)	Menu controlled
Result storage	3000 measurements	
Data interfaces	Serial interface (additional serial interface optional) with TTY 20 mA/RS232 and serial connection for wireless (only connection to receiver box) LAN (Ethernet) Analog mA input	Serial interface with modem and programmable data transmission Ethernet interface with TCP/IP protocol and programmable data transmission
Heat number entry	Eight digits, input using touch screen	External input as additional using serial interface or Ethernet
Optional relay signal outputs	Ready, Measurement, Complete, Error Celox, End of data communication, Bath level, TXD Complete	2 x 8 relays, allocation programmable, max. 48V DC, max. 100mA, max. 24VA
Solid state signal outputs	Ready, measurement, complete, horn for both measuring stations	2 x 4 solid state relays, 240VAC/1A max per output channel
Housing,	Metal housing, height 4 HU for 19 inch rack mounting, panel or bench mounting	

1 ***Note:*** The cold junction compensation temperature is taken **in** the connector. Internal wiring is always Cu/Cu, independent of the type of thermocouple used.

2 mA and BCD output available on request

Table 2: Technical data iM2 Sensor Lab

Item	Description	
Dimensions	h = 178mm (7“), w = 512mm (20.2“), d = 365mm (14.4“) built-in depth 465mm (18.3“), panel cut-out +1mm (0.039“) h and w 	
Weight	approximately 13kg (28.6lb)	
Environmental protection	Protection front IP54, protection housing IP51	
Connections	All instrument inputs and outputs with plugs	
Operating range	Power supply, ambient temperature	100–240VAC, 47–63Hz, 0,4 + 3,15A, -10°C (14°F) to 60°C (140°F)
Operating Humidity Range	5 to 95% RH non condensing	
Operating Altitude	Up to 2000m	
AC-out	Range Fuse	100-240VAC 3,15A 250V fast act
Pollution Degree Rating	PDII	
Storage range	Ambient temperature, relative humidity	-20°C (-4°F) to 70°C (158°F), max. 90% RH non-condensing
Bath level determination	By evaluation of the measurement curve slope or Delta-Dist L function	Bath level contact output potential-free contact max. 48V DC, 24VA
Profibus-DP (option)	Industrial field bus	Freely programmable data telegrams
Ethernet-IP (option)	Industrial Ethernet field bus	Standard protocol
Profinet (option)	Industrial Ethernet field bus	Freely programmable data telegrams
Modbus (option)	Field bus	Freely programmable data telegrams
BCD input	4 digits without decimal point	
BCD [2]output, with 4 outputs with valid pulses	5 digits with decimal point 4 valid pulses for the first four data outputs (maximum seven outputs possible)	Data output programmable potential-free output using reed relays, active/on max. 48V DC, 24VA
Analog output with 2/4 data outputs	0/4 – 20mA * = output range, galvanically separated, dynamic or memorized, output range programmable, load (burden) 0 to maximum 500W	Programmable data output Accuracy: 0.1% full scale

1 ***Note:*** The cold junction compensation temperature is taken **in** the connector. Internal wiring is always Cu/Cu, independent of the type of thermocouple used.

2 mA and BCD output available on request

Table 3: iM2 Sensor Lab - wireless connection

Channel	Parameter	Positherm	Celox	Celox SLAC (QuiK-Slag)	Tap-Tip	Econ-O-Carb
0/2	Input type	Thermocouple S, R, B	Thermocouple S, R, B	Short circuit	Thermocouple S, R, B	Open circuit
	Input range	-22 to +22mV	-22 to +22mV		-22 to +22mV	
	Burnout current	typically 150nA				
	Accuracy class a	5uV	5uV	1k	5uV	
	Accuracy class b	10uV	10uV	5k	10uV	
1/3	Input type	EMF	EMF	EMF + 50kΩ par-allel	Thermocouple S, R, B	Thermocouple S, R, B
	Input range	-1 to +1V	-1 to +1V	-1 to +1V 0k to 200kΩ	-22 to +22mV	-22 to +22mV
	Burnout current	100 to 400nA				
	Accuracy class a	5uV	0.2mV	0.2mV/1kΩ	5uV	5uV
	Accuracy class b	10uV	1mV	1mV/5kΩ	10uV	10uV

4.2. Sensor Lab Steel

1 Power LED indicator

2 USB ports

Figure 6: Front view of the Sensor Lab Steel

1 Power supply
2 Main fuse
3 VGA for external monitor
4 LAN
5 USB
6 AC Out
7 2 Fuses
8 Connector for receiver box (RS248/RS422)
9 Serial connector for Serial#1 (RS232)
10 Serial connector for Serial#2 (RS232)
11 Option [1]
12 Analog input 1
13 Analog input 2
14 Option - mA input
15 Option - mA output

Figure 7: Back view of the Sensor Lab Steel

1 Sensor Lab Steel supports only one level 2 communication network. Available options: Ethernet/IP, Profibus, Profinet, Modbus TCP and Modbus RTU.

4.2.1. In- and outputs

4.2.1.1. Power supply

Table 4: Power cord technical data

Item	Specifications
Ratings UL/CSA	10 A / 125 VAC; 50/60 Hz
Dielectric Strength	> 2 kVDC between L-N > 2 kVAC between L/N-PE (1 min/50 Hz)
Allowable Operation Temp.	-10 °C (4°F) to 60 °C (140°F)
IP-Protection	from front side IP 20 acc. to IEC 60529

Table 4: Power cord technical data

Item	Specifications
Insulation cover	Suitable for appliances with protection class I acc. to IEC 61140
Terminal	moulded
Material	Housing PVC, black
Appliance inlet/-outlet	C13 acc. to IEC 60320-1 IEC 60320-1 UL 498, CSA C22.2 no. 42 (for cold conditions) pin-temperature 70 °C, 10 A, Protection Class I

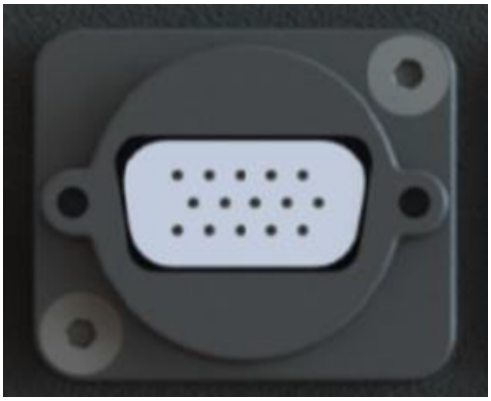
4.2.1.2. AC out 1 and 2

1 Horn or blue lamp
2 Green
3 Yellow
4 Red
5 N/C
6 Neutral/common
7 Ground/PE

Warning: *These connectors provide control voltages considered as hazardous live. Maintain separation of these circuits from any accessible part of other secondary circuits that are double insulation from mains in the final connection configuration.*

4.2.1.3. Fuse 1 and 2

4.2.1.4. VGA port



Note: *This connector is sourced from a safety-isolated source internal to the equipment. Connect only to other circuits separated from mains by double or reinforced insulation.*

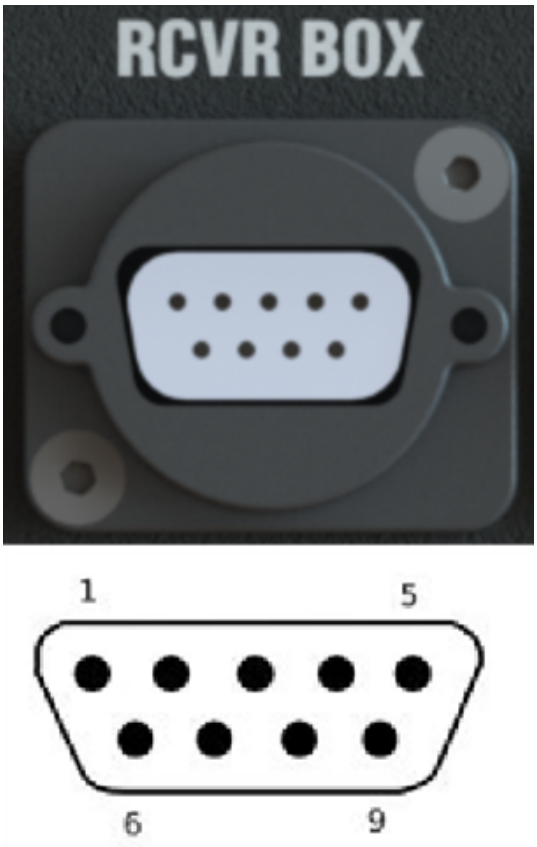
4.2.1.5. LAN port

Note: *This connector is sourced from a safety-isolated source internal to the equipment. Connect only to other circuits separated from mains by double or reinforced insulation.*

4.2.1.6. USB port

Note: *This connector is sourced from a safety-isolated source internal to the equipment. Connect only to other circuits separated from mains by double or reinforced insulation.*

4.2.1.7. Receiver box: RS485



1 24V RCVR box supply

2 Tx+

3 Rx+

4 -

5 GND

6 +5V

7 Tx-

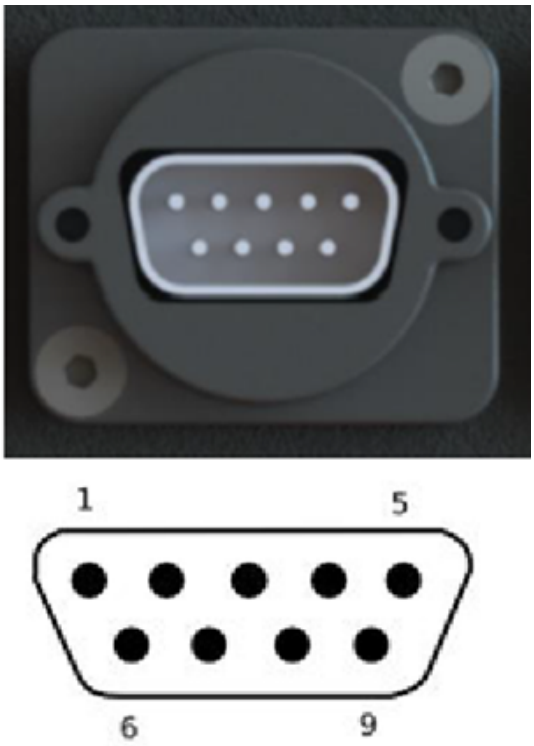
8 Rx-

9 GND for 24V

Figure 8: Pin out receiver box

Note: *This connector is sourced from a safety-isolated source internal to the equipment. Connect only to other circuits separated from mains by double or reinforced insulation.*

4.2.1.8. Serial #1 and #2: RS232



1 DCD
2 Rx
3 Tx
4 DTR
5 GND
6 DSR
7 RTS
8 CTS
9 N/C

Figure 9: Pin out serial connector

Note: *This connector is sourced from a safety-isolated source internal to the equipment. Connect only to other circuits separated from mains by double or reinforced insulation.*

4.2.1.9. Analog input 1 and 2

1 T- (small pin) (red wire)
2 O+ (green wire)
3 O- (white wire)
4 T+ (black wire)

Figure 10: Pin out analog connector

4.2.1.10. Communication network options

The Sensor Lab Steel supports one of five available level 2 communication network options (choose from Ethernet/IP, Profibus, Profinet, Modbus TCP or Modbus RTU). Along with an available single analog mA input and single analog mA output option. By default is Ethernet/IP installed and no analog options.

Ethernet/IP

Note: *This connector is sourced from a safety-isolated source internal to the equipment. Connect only to other circuits separated from mains by double or reinforced insulation.*

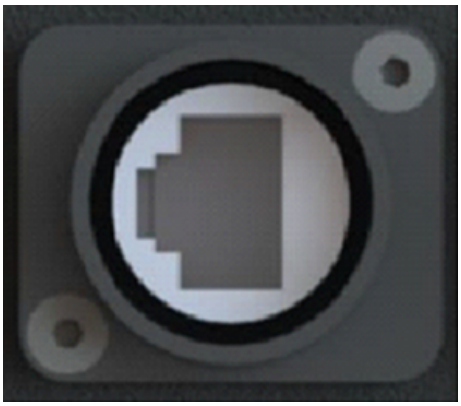
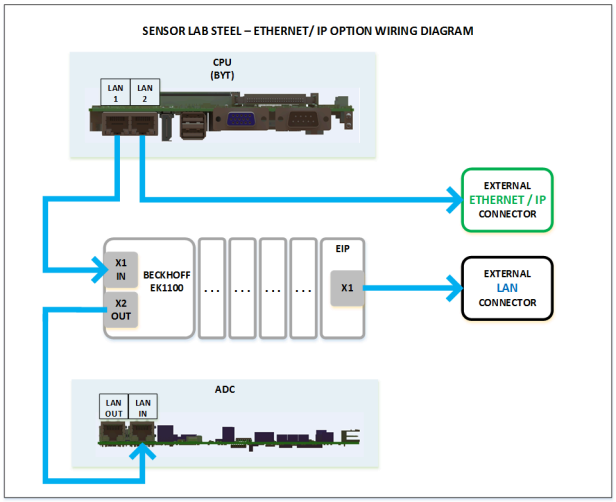


Figure 11: Ethernet/IP connector



Cable	From	To
ETHERNET (RJ45)	CPU - LAN 1	BECKHOFF EK1100 – X1
ETHERNET (RJ45)	CPU – LAN 2	EXTERNAL ETHERNET / IP CONNECTOR
ETHERNET (RJ45)	BECKHOFF EK1100 – X2	ADC – LAN IN
ETHERNET (RJ45)	EIP – X1	EXTERNAL LAN CONNECTOR

Profibus

Note: *This connector is sourced from a safety-isolated source internal to the equipment. Connect only to other circuits separated from mains by double or reinforced insulation.*

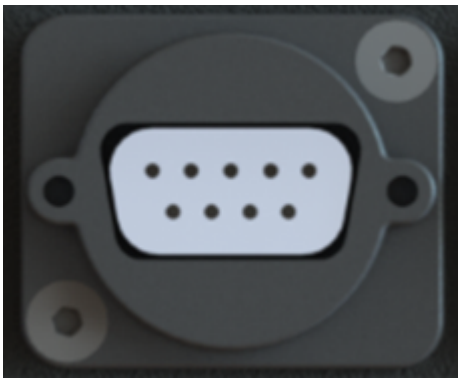
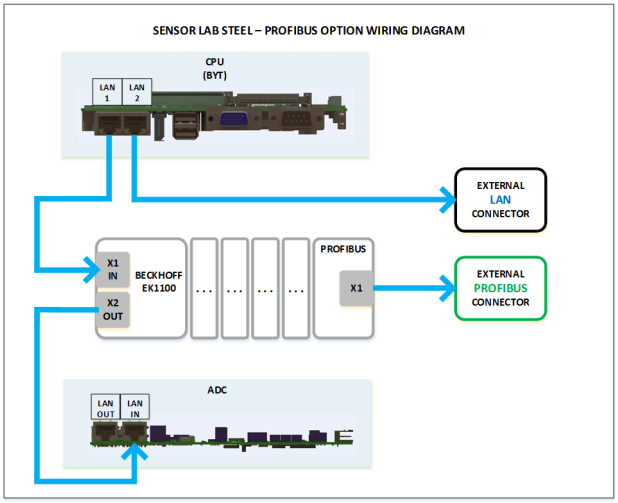


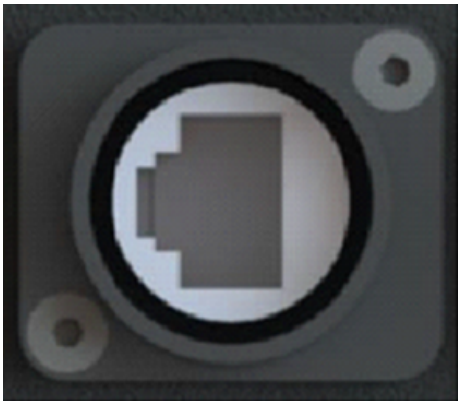
Figure 12: Profibus connector

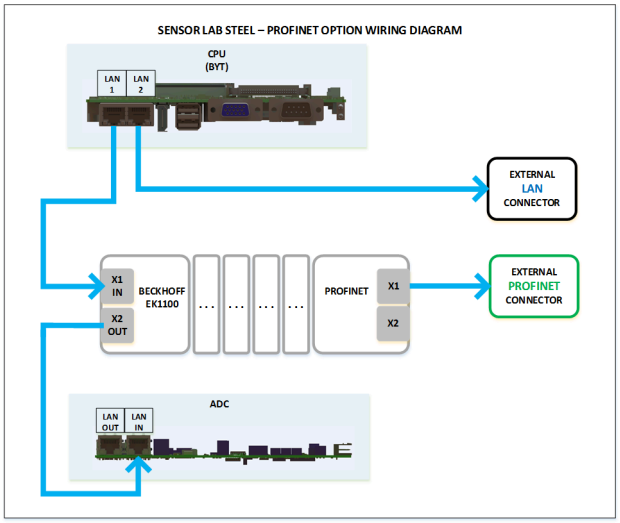


Cable	From	To
ETHERNET (RJ45)	CPU - LAN 1	BECKHOFF EK1100 – X1
ETHERNET (RJ45)	CPU – LAN 2	EXTERNAL LAN CONNECTOR
ETHERNET (RJ45)	BECKHOFF EK1100 – X2	ADC – LAN IN
SERIAL RIBBON (DB9)	PROFIBUS – X1	EXTERNAL PROFIBUS CONNECTOR

Profinet

Note: *This connector is sourced from a safety-isolated source internal to the equipment. Connect only to other circuits separated from mains by double or reinforced insulation.*

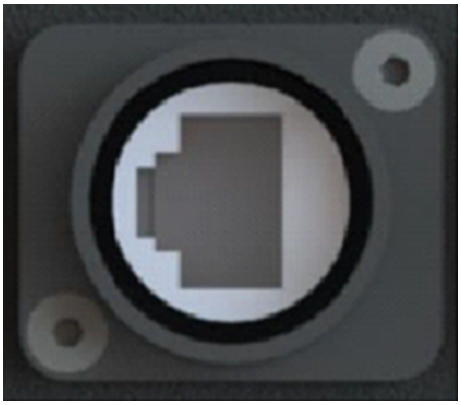


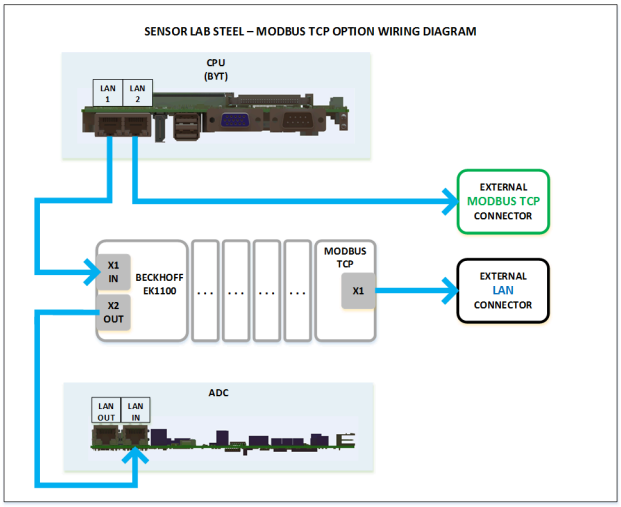


Cable	From	To
ETHERNET (RJ45)	CPU - LAN 1	BECKHOFF EK1100 – X1
ETHERNET (RJ45)	CPU – LAN 2	EXTERNAL LAN CONNECTOR
ETHERNET (RJ45)	BECKHOFF EK1100 – X2	ADC – LAN IN
ETHERNET (RJ45)	PROFINET – X1	EXTERNAL PROFINET CONNECTOR

Modbus TCP

Note: *This connector is sourced from a safety-isolated source internal to the equipment. Connect only to other circuits separated from mains by double or reinforced insulation.*

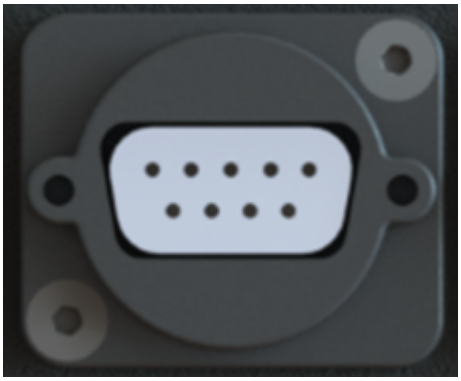


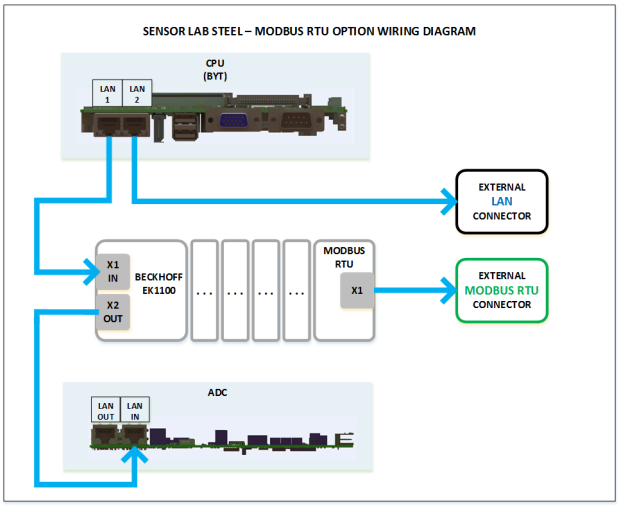


Cable	From	To
ETHERNET (RJ45)	CPU - LAN 1	BECKHOFF EK1100 – X1
ETHERNET (RJ45)	CPU – LAN 2	EXTERNAL MODBUS TCP CONNECTOR
ETHERNET (RJ45)	BECKHOFF EK1100 – X2	ADC – LAN IN
ETHERNET (RJ45)	MODBUS TCP – X1	EXTERNAL LAN CONNECTOR

Modbus RTU

Note: *This connector is sourced from a safety-isolated source internal to the equipment. Connect only to other circuits separated from mains by double or reinforced insulation.*



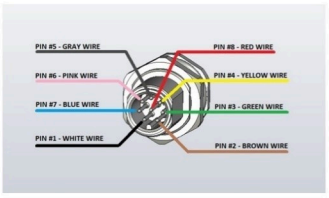


Cable	From	To
ETHERNET (RJ45)	CPU - LAN 1	BECKHOFF EK1100 – X1
ETHERNET (RJ45)	CPU – LAN 2	EXTERNAL LAN CONNECTOR
ETHERNET (RJ45)	BECKHOFF EK1100 – X2	ADC – LAN IN
SERIAL RIBBON (DB9)	MODBUS RTU – X1	EXTERNAL MODBUS RTU CONNECTOR

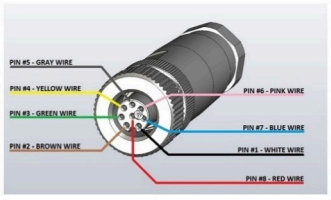
Analog mA Input

Note: *This connector is sourced from a safety-isolated source internal to the equipment. Connect only to other circuits separated from mains by double or reinforced insulation.*

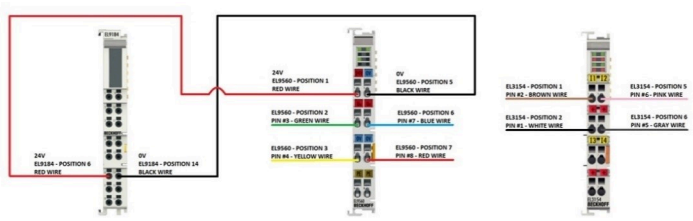
SLS mA INPUT CHASSIS BULKHEAD PLUG



EXTERNAL mA INPUT MATING CONNECTOR



BECKHOFF mA INPUT WIRING DIAGRAM

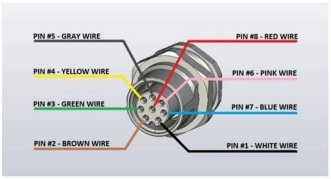


Cable	From		To	
RED	EL9184 POSITION 6	24V	EL9560 – POSITION 1	INPUT 24V
BLACK	EL9184 POSITION 14	0V	EL9560 – POSITION 5	INPUT 0V
WHITE	EL3154 – POSITION 2	24V	CONNECTOR PIN #1	ANALOG SOURCE 24V
BROWN	EL3154 – POSITION 1	INPUT 1	CONNECTOR PIN #2	ANALOG INPUT 1
GREEN	EL9560 – POSITION 2	+24V OUTPUT	CONNECTOR PIN #3	DEVICE 1 POWER 24V
YELLOW	EL9560 – POSITION 3	0V OUTPUT	CONNECTOR PIN #4	DEVICE 1 POWER 0V
GRAY	EL3154 – POSITION 6	24V	CONNECTOR PIN #5	ANALOG SOURCE 24V
PINK	EL3154 – POSITION 5	INPUT 2	CONNECTOR PIN #6	ANALOG INPUT 2
BLUE	EL9560 – POSITION 6	+24V OUTPUT	CONNECTOR PIN #7	DEVICE 2 POWER 24V
RED	EL9560 – POSITION 7	0V OUTPUT	CONNECTOR PIN #8	DEVICE 2 POWER 0V

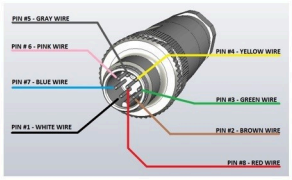
Analog mA Output

Note: *This connector is sourced from a safety-isolated source internal to the equipment. Connect only to other circuits separated from mains by double or reinforced insulation.*

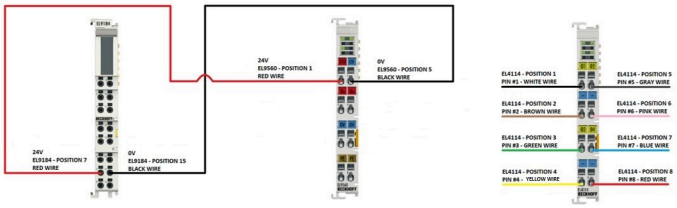
SLS mA OUTPUT CHASSIS BULKHEAD PLUG



EXTERNAL mA OUTPUT MATING CONNECTOR



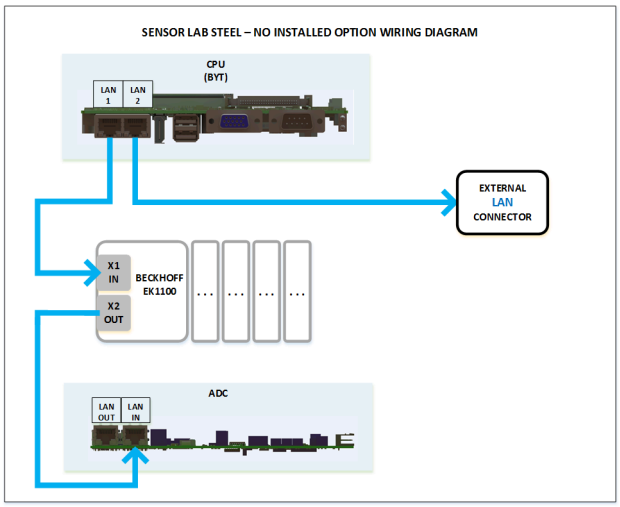
BECKHOFF mA OUTPUT WIRING DIAGRAM



Cable	From		To	
RED	EL9184 POSITION 7	24V	EL9560 – POSITION 1	INPUT 24V
BLACK	EL9184 POSITION 15	0V	EL9560 – POSITION 5	INPUT 0V
WHITE	EL4114 – POSITION 1	OUTPUT 1	CONNECTOR PIN #1	ANALOG OUTPUT 1
BROWN	EL4114 – POSITION 2	0V	CONNECTOR PIN #2	ANALOG RETURN 1
GREEN	EL4114 – POSITION 3	OUTPUT 2	CONNECTOR PIN #3	ANALOG OUTPUT 2
YELLOW	EL4114 – POSITION 4	0V	CONNECTOR PIN #4	ANALOG RETURN 2
GRAY	EL4114 – POSITION 5	OUTPUT 3	CONNECTOR PIN #5	ANALOG OUTPUT 3
PINK	EL4114 – POSITION 6	0V	CONNECTOR PIN #6	ANALOG RETURN 3
BLUE	EL4114 – POSITION 7	OUTPUT 4	CONNECTOR PIN #7	ANALOG OUTPUT 4
RED	EL4114 – POSITION 8	0V	CONNECTOR PIN #8	ANALOG RETURN 4

No option installed

Note: *This connector is sourced from a safety-isolated source internal to the equipment. Connect only to other circuits separated from mains by double or reinforced insulation.*

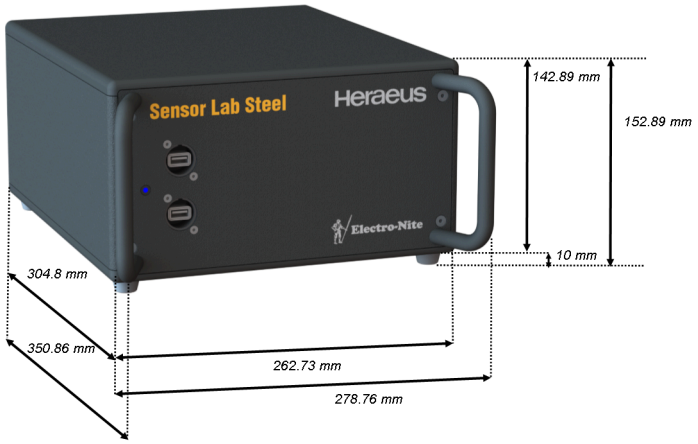


Cable	From	To
ETHERNET (RJ45)	CPU - LAN 1	BECKHOFF EK1100 – X1
ETHERNET (RJ45)	CPU – LAN 2	EXTERNAL LAN CONNECTOR
ETHERNET (RJ45)	BECKHOFF EK1100 – X2	ADC – LAN IN

4.2.2. Technical data

Item	Description	
Applications	Bath temperature, oxygen, carbon measure-ment,	bath level and slag thickness determination
Additional calculation function	Aluminium and FeO determination in steel slag	
Measurement input	Two individual measurement channels both for temperature and EMF	Each measurement channel with automatic probe recognition
Temperature measurement	Thermocouple types S, R, B	Arithmetically linearized according to IPTS48, IPTS68, or ITS90 (default) temperature °C/°F, resolution 0.1°C (0.18°F)
EMF measurement	+/- 1000mV	Resolution 0.1mV
Sample rate	Maximum 250/sec	
Accuracy	+/-1°C (1.8°F) for thermocouples	0.2mV for EMF signals
Display	Optional external touchscreen Resolution 1024x768 recommended	For measurement results and menu display
Operation	Touch screen or mouse (on instrument or on HMI)	Menu controlled
Result storage	3000 measurements	

Item	Description	
Data interfaces	2 x RS-232 serial interface 1 x RS-422 serial interface for wireless receiver box (for connection to QUBE wireless transmitter) LAN (Ethernet) Analog mA input (for encoder input) Analog mA output (0/4-20 mA)	Serial interface with programmable data transmission Ethernet interface with TCP/IP protocol and programmable data transmission
Heat number entry	Eight digits, input using touch screen	External input as additional using serial interface or Ethernet
Solid state signal outputs	Ready, measurement, complete, horn for both measuring stations	2 x 4 solid state relays, 100 – 240V, 47 – 63Hz, 100VA per output channel
Housing,	Aluminum housing	
Dimensions	h = 153 mm, w = 279 mm, d = 351 mm (with handles)	
Weight	approximately 5.9 kg (13lbs)	
Environmental protection	IP51	
Connections	All instrument inputs and outputs with plugs	
Operating range	Power supply, ambient temperature	100–240VAC, 47–63Hz, 0,4 + 3,15A, -10°C (14°F) to 60°C (140°F)
Pollution Degree Rating	PDII	
Storage range	Ambient temperature, relative humidity	-20°C (-4°F) to 70°C (158°F), max. 90% RH non-condensing
Sound power and pressure levels	Under 70 db	
Fuse characteristics	Power inlet fuse Lightset fuses	4.0 A 250 V lag 3.15 A 250 V fast act
Useable for	Overvoltage Category II, Pollution degree 2 Environments for altitudes up to 2000 m above sea level	
Bath level determination	By evaluation of the measurement curve slope or Delta-Dist L function	
Profibus-DP (option)	Industrial field bus	Freely programmable data telegrams



Item	Description	
Ethernet-IP (option)	Industrial Ethernet field bus	Standard protocol
Profinet (option)	Industrial Ethernet field bus	Freely programmable data telegrams
Modbus (option)	Field bus	Freely programmable data telegrams
Analog output with 2/4 data outputs	0/4 – 20mA * = output range, galvanically separated, dynamic or memorized, output range programmable, load (burden) 0 to maximum 500W	Programmable data output Accuracy: 0.1% full scale

4.3. Probes

Temperature measurement: Positherm®: expendable temperature probes for measurement in liquid steel.

Temperature and chemical composition measurement:

- Celox®: expendable oxygen/temperature probes for measurements in liquid steel.
- TAPTIP®: expendable bath/liquidus temperature probes for carbon measurements in liquid steel.
- Celox Hot Metal: expendable oxygen/temperature probes for sulfur/silicon measurements in liquid steel.
- Celox SLAC® (QuiK-Slag): expendable probes for oxygen measurements in molten slag.
- ECON-O-CARB® (QuiK-Carb): expendable probes for rapid carbon detection.
- Multi-Lance®: TSC & TSO

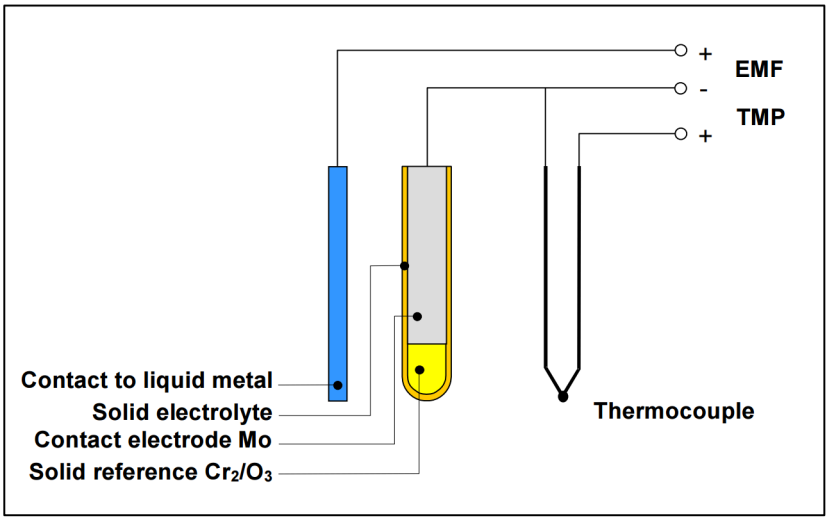
Special measurements Delta-Dist L: expendable level sensor for slag thickness measurement.

4.3.1. Positherm® application

Positherm® probes are expendable immersion thermocouples that provide an accurate, reproducible, and reliable measurement of the molten metal bath temperature. Knowledge of the correct temperature is essential to achieve the optimum quality before the heat or melt can be tapped or cast. The probes are available in type B, R, and S.

4.3.2. Celox® application

Besides the thermocouple for the temperature registration (TMP), an electro-chemical cell generates a characteristic voltage (EMF) dependent on the free oxygen activity of the liquid metal.



The EMF is a voltage [mV] signal that is the basis in the Sensor Lab for:

- Oxygen measurement (a(O) in %)
- Carbon calculation (C in %)
- Aluminum calculation (Al in %)

The thermocouple of the Celox® probe can be calibrated as type S, R, or B.

4.3.3. TAPTIP® application

The TAPTIP® application provides bath and liquidus temperature measurement and carbon calculation in liquid steel. The Sensor Lab has extensive metallurgical calculation programs. A freely programmable carbon formula enables an easy match to different steel grades.

4.3.4. Celox hot metal application

The Hot Metal application measures the temperature and the sulfur and silicon concentrations of hot metal in the torpedo and in the transfer ladle. The hot metal probe is fully compatible with all standard Heraeus Electro-Nite hardware; contact blocks, probe holders, and cabling.

4.3.5. Celox SLAC® application

The Celox SLAC® application measures FeO or FeO-MnO in ferrous ladle slag. The cell in the probe has an open zirconium thimble that picks up slag during immersion. Celox SLAC® works together with standard Celox hardware. Celox SLAC® is used like a normal Celox® sensor, but must be immersed through liquid slag into the steel to obtain a reading.

4.3.6. ECON-O-CARB® application

ECON-O-CARB® expendable test cups measure the liquidus arrest temperature of a solidifying steel sample and from that calculate the carbon content. The thermocouple inside the cup is of type R or S. The carbon result is obtained within seconds.

4.3.7. Delta-Dist® L application

The Delta-Dist® L application provides temperature and EMF measurement, oxygen and slag oxygen determination, and slag thickness measurement. As well as needing optional software, the Delta-Dist® L sensor needs optional hardware.

The Delta-Dist® L sensor is used on automatic immersion lances. These lances work with a known constant speed, which is used to calculate the slag thickness.

The Delta-Dist® L is installed on existing hardware for Celox® probes. No modification of contact blocks or lance hardware is required.

4.4. Wireless Interface

There are three versions of the QUBE® wireless transmission unit:

- QUBE®-T for temperature only measurements
- QUBE®-O for temperature, oxygen, and carbon measurements
- QUBE®-L for temperature, oxygen, and carbon measurement, as well as wireless bath level and DDL probe (slag thickness) measurements

The QUBE® unit fits on all Heraeus Electro-Nite lances and converts them to wireless operation. All versions of the unit can be used together with the *i*M² Sensor Lab instrument. Signals sent to the instrument from the QUBE® unit are first routed through a receiver box.

The Sensor Lab and QUBE® unit can be used to take the following measurements:

- Temperature (including bath level) using Positherm probes
- Temperature (including bath level) and oxygen using Celox probes
- Temperature (including bath level) and carbon using Tap-Tip probes
- Carbon using Econ-O-Carb cups or QuiK-Carb probes
- Slag oxygen using Celox SLAC probes
- Slag and steel level using DDL probes

The QUBE® unit eliminates the need for external compensation cabling on the lance, which results in improved usability, safety, and reliability.

The *i*M² Sensorlab software provides a wireless safety feature for preventing matching a QUBE® with the wrong instrument. By default, wireless safety is enabled.

The following figure illustrates the typical situation in which the Sensor Lab Wireless instrument is configured for wireless operation:

Figure 13: Wireless locking scenario

Wireless safety is enabled by default. For safety reasons, a wireless module can be locked to only 1 instrument. This means that only this module can be used on a certain instrument. Any other module will be rejected by the instrument software. This behavior prevents measurement at a different physical location than intended if the location ID of the wireless module is incorrectly configured for any reason. For example the location ID of QUBE® 2 is set to 1 by mistake, as illustrated in the figure below.

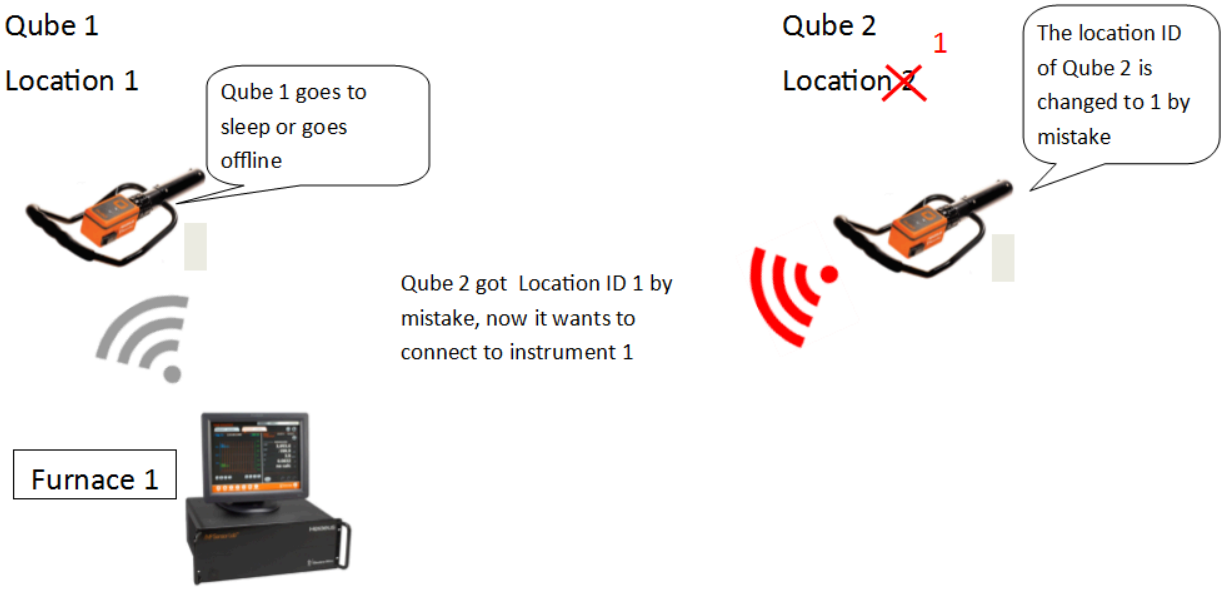


Figure 14: Wireless locking scenario error

Figure 15: What happens when wireless safety is enabled

When wireless safety is enabled, no connection can be made with instrument 1 since QUBE® 1 is already locked. The QUBE® 2 module will indicate that it does not have a connection: LED indicator on the QUBE® remains orange. The measurement data is not sent to the wrong instrument and the erroneous change in location ID will be discovered.

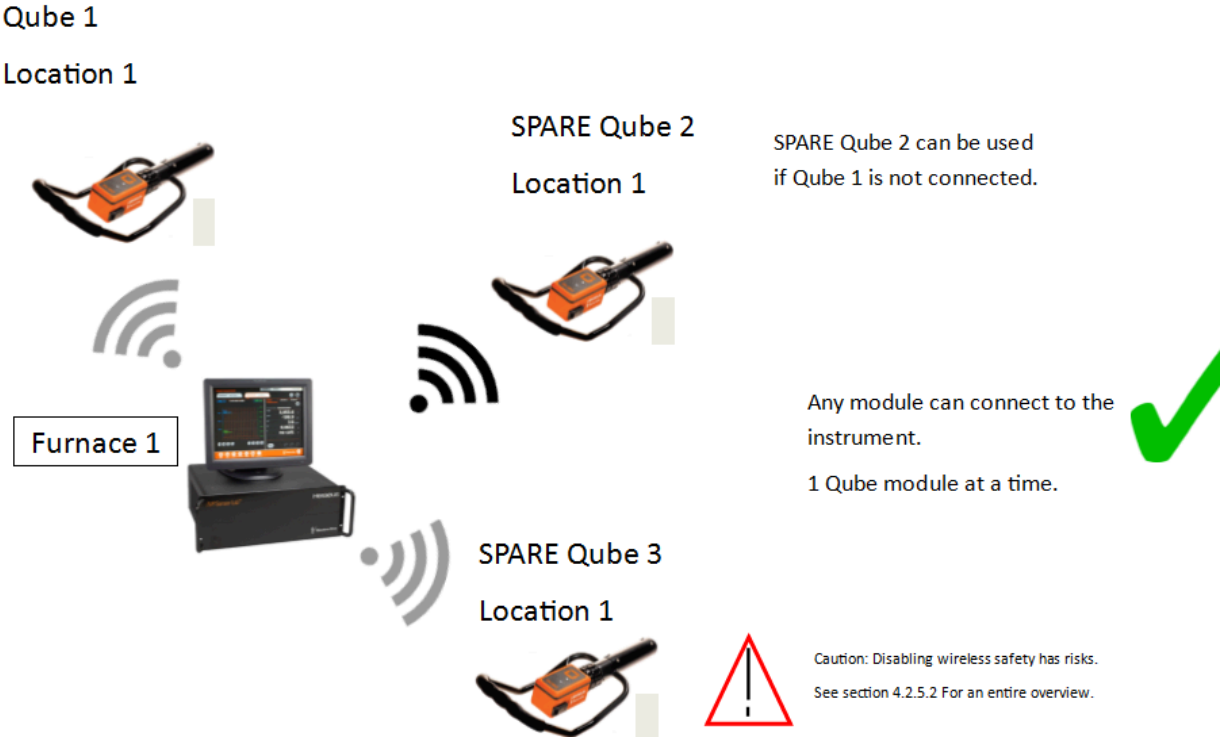


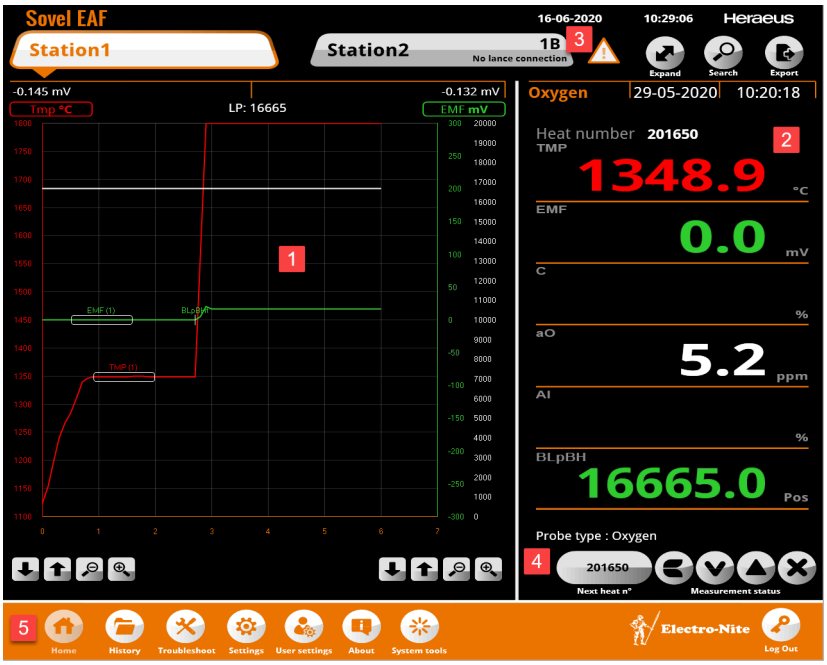
Figure 16: What happens when wireless safety is disabled:

When wireless safety is disabled, measurements may be received at the wrong measurement station.

Note: *If another QUBE® needs to be paired with a location ID that is locked, for instance when the paired QUBE® is broken. You can reset the pairing of a locked system by setting parameter [0.3] to yes. This action will reset the lock.*

5. User Interface Design

5.1. User interface



#	Name	Detail
1	Chart area	The curves of the measuring channels are shown here.
2	Measurement results	The last measured values are displayed until a new measurement value is available to display. These values are displayed in the same color that is shown on the graph.
3	Alerts tab	Shows any warning messages generated by the system
4	Measurement status buttons	Information on the connected probe and the measurement status.
5	Navigation buttons	Navigation buttons (Home, History, Troubleshoot, Settings, User settings, About, System tools, Presets and Login)

5.2. Signalisation

The measurement status is shown on the bottom right of the home screen.

Signal	Measurement status
	idle
	green, ready to measure
	yellow, busy, the instrument is calculating the result
	red, complete, end of measurement

The **Alerts tab** shows any warning messages generated by the system and indicated at the time with an exclamation mark in a triangle at the top of the window in the home screen.

If you click on the warning sign the Hardware check window is opened (see 7.4.).

Examples of warnings that might be generated are:

- Low battery indication on QUBE units
- Cold junction failure
- Wireless firmware out of date
- Wireless module locked

These warnings are automatically removed when the issue is resolved. The Plant Engineer is responsible for dealing with these warnings.

5.3. User levels

There are multiple user levels which enable different access to the machine:

- operator (no password)
- engineer, supervisor, lab technician (2-4-4-8)
- service engineer (day password provided by your local Heraeus Electro-Nite contact)

To enter the supervisor or engineer interface login is required.

1 Click the **Login** button on the navigation bar
2 Login screen pops-up

3 Enter the password and then click **Go**
4 Extra button(s) will appear on the navigation bar

Note: *After a preset time without activity the system will automatically logout.*

6. Installation

6.1. Prepare for first use

The plant engineer must perform the following tasks in the order specified. These tasks are normally done only once, at first use or when a change in system configuration or measurement application is required:

1 Specify the LAN settings (see section 6.2.)
2 Specify the instrument time (see section 6.3.)
3 Specify the instrument name (see section 6.4.)
4 Connect external displays (see section 6.5.)
5 Specify the user settings (see section 6.6.)
6 Edit basic settings (see section 8.6.1.)
7 Edit applications settings (see section 8.6.2.)
8 Edit communication settings (see section 8.6.3.)
9 Edit advanced settings (see section 8.6.4.)

6.2. Specify the LAN settings

To perform this task you need to log in first.

Procedure

1 Click the **Settings** button.

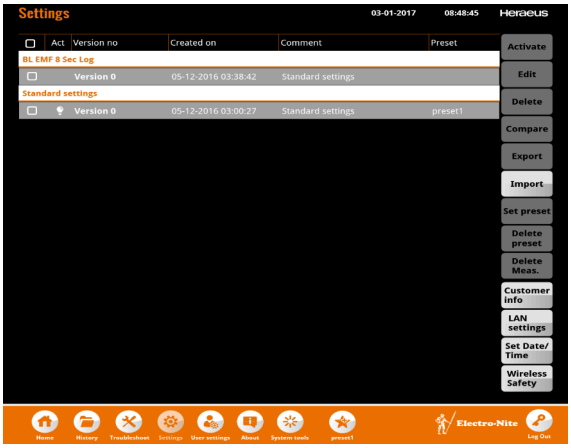


Figure 17: Settings window

2 Click the LAN Settings button on the right side of the screen.

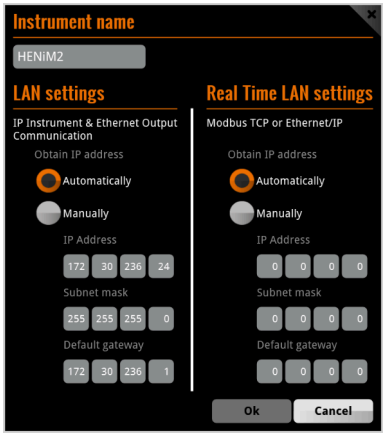


Figure 18: LAN settings window

3 Obtain the IP address manually or automatically using DHCP
DHCP, Dynamic Host Configuration Protocol is a network protocol used to configure network devices so that they can communicate on a LAN network.

4 After specifying the IP address click **Ok**.

6.3. Specify date and time

To perform this task you need to log in first.

The time and date are important identifying parameters that are stored along with each measurement result. To specify the instrument time:

Procedure

1 Click **Settings**
The settings window is displayed.

2 Click the Set Date/Time button on the right side of the screen.

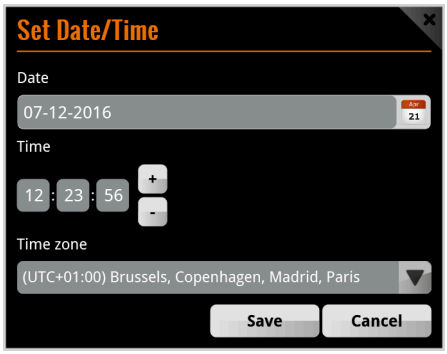


Figure 19: Set Date/Time window

3 Set the date, time, and time zone as required.

4 Click **Save**.

Note: *You normally set the instrument time once, at the very start of installation.*

6.4. Specify the instrument name

To perform this task you need to log in first.

Procedure

1 Click **Settings**
The settings window is displayed.
2 Click the LAN Settings button on the right side of the screen.

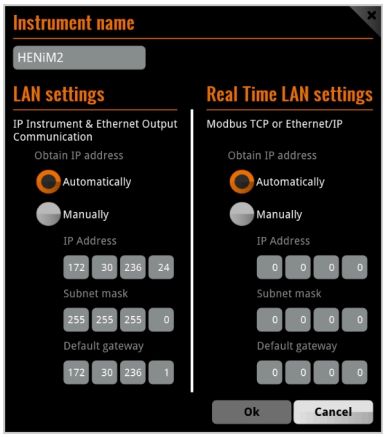


Figure 20: LAN settings window

3 Enter the name for the instrument then click **Save**.

Note: *Normally, you set the instrument name once, at the very start of installation.*

When using DHCP, you can connect in the connection manager in the HMI or remote client by making use of this name.

6.5. Connect external displays

The following external displays can be connected:

- VGA monitor (see 6.5.1.)
- HMI (see 6.5.2.)
- Remote client (see 6.5.3.)

6.5.1. Connect a VGA monitor

To connect a VGA monitor to the *i*M^2 Sensor Lab:

Procedure

1 Connect the VGA cable from the VGA port at the back of the Sensor Lab to the VGA connector on the monitor.
2 Power cycle the instrument.
3 If the monitor has multiple sources, select the VGA source, for example, Source 1: Analog input.

Note: *Most monitors automatically detect the input source.*

6.5.2. Connect an HMI

The HMI client and remote client applications can connect to the Sensor Lab instrument from a remote location. The HMI is a panel PC with a 17” touch screen that runs only the Sensor Lab software. The remote client application allows the user to view and control the Sensor Lab instrument on a computer.

Both applications connect to the instrument in the same way – using an Ethernet connection. A connection can be made by IP address or DNS name of the instrument.

The following explains how to connect an HMI to the Sensor Lab instrument through an Ethernet connection. This connection can be made through a switch or directly between the HMI and the instrument if only one HMI is used.

Up to four external HMIs can be connected.

Hardware:

To connect one HMI directly:

1 On the Sensor Lab instrument, plug the Ethernet cable in the network connection labeled “LAN” at the back.

2 On the HMI, plug the Ethernet cable into any one of the Ethernet ports.

To connect more than one HMI:

1 On the Sensor Lab instrument, plug the Ethernet cable in the network connection labeled “LAN” at the back and plug the other end into a port of the Ethernet switch box. Which port of the switch to choose is for the Plant Engineer or Plant ICT coordinator to decide.

2 On the HMIs, plug the Ethernet cable in any Ethernet port and plug the other end into a port of the Ethernet switch box. Which port of the switch to choose is for the Plant Engineer or Plant ICT Coordinator to decide.

Software:

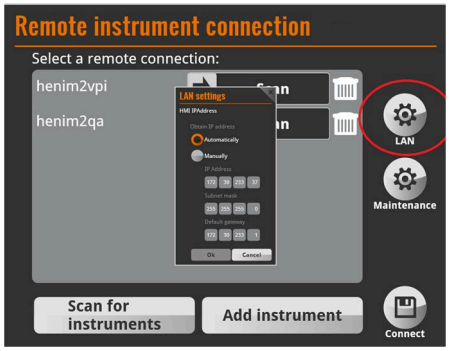
To connect one HMI directly, a fixed IP needs to be set on the Sensor Lab and on the HMI to ensure connection. The IP range can be chosen in this case, for example, the Sensor Lab has 192.168.1.1 and the HMI has 192.168.1.2.

To connect one or more HMIs using a switch, a fixed IP is still required, but the range to be used is for the Plant Engineer or Plant ICT Coordinator to decide. Setting the fixed IP from within the Sensor Lab software is done by a Plant Engineer. Refer to section 6.2. .

To connect the Sensor Lab to an HMI client or a remote client, both parties require an IP address in the same range.

To connect one or more HMIs using a router with or without a switch in between, they will both receive their IP addresses from this router. The IP address should be set to automatic.

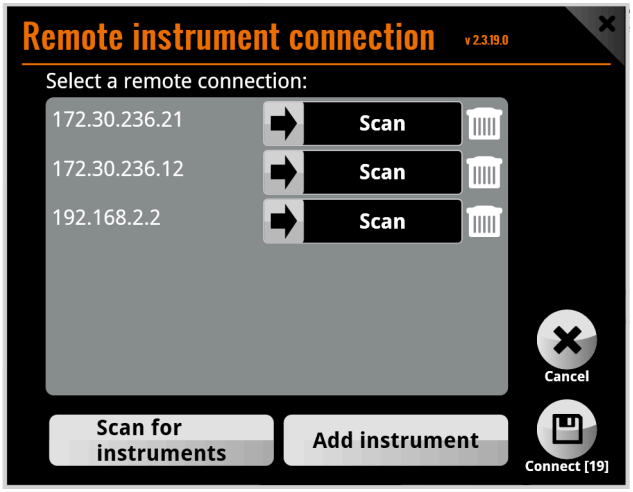
To configure the LAN settings in the HMI open the Remote Instrument connection:



When using a remote client on a computer, the LAN settings must be configured in the Windows Network Connections.

Running the client software:

1 Start the client software, the connection manager is displayed.



2 Click Scan for instruments. The instruments found will be displayed by DNS name. So that an instrument can be automatically scanned, it must have a unique computer name in the network.

3 If an instrument was not found in the network, it can be added by entering the IP address manually using the **Add instrument** button.

4 Click or swipe the Scan button to test the connection.

5 To connect to an instrument, select the name and click **Connect**.

To configure the Sensor Lab, open LAN settings in the Settings window – see section 6.2. .

6.5.3. Connect a remote client

The following explains how to remotely connect to a Sensor Lab instrument. There are two ways to do this:

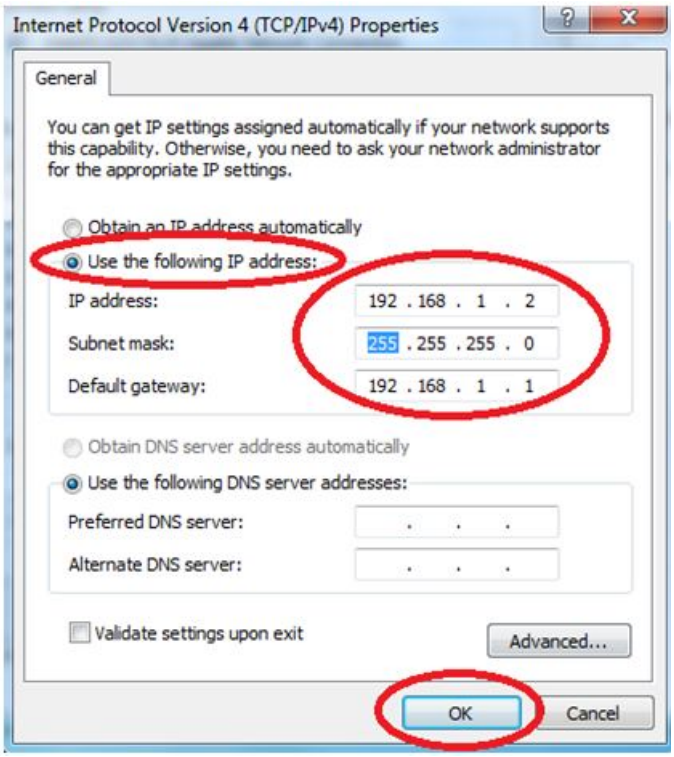
1 HMI client: runs only on a dedicated computer with an HMI touch screen.

2 Remote client: runs on any computer with the following minimum requirements:

- Windows XP SP3
- .Net Framework 4.0
- Ethernet connection

The delivered dongle must be present when you want to use the remote client.

For the remote client, make sure a correct IP address is set, compatible with the Sensor Lab instrument:



The connection manager must be the same version as the instrument to which it connects. If a connection is made to an instrument of another version, the connection manager will notify you that an upgrade or downgrade is required, and the installer will be automatically downloaded from the Sensor Lab and installed on the HMI or computer from which it ran.

The HMI only supports one HMI client application, which means that if an HMI is often connected to more than one Sensor Lab that have different software versions, the HMI client application will be upgraded or downgraded each time a connection is made to the Sensor Lab with a different software version.

The remote client application on a computer supports multiple versions installed parallel to each other.

6.6. Specify the user settings

To perform this task you need to log in first.

When you click the User settings button the next window is displayed:

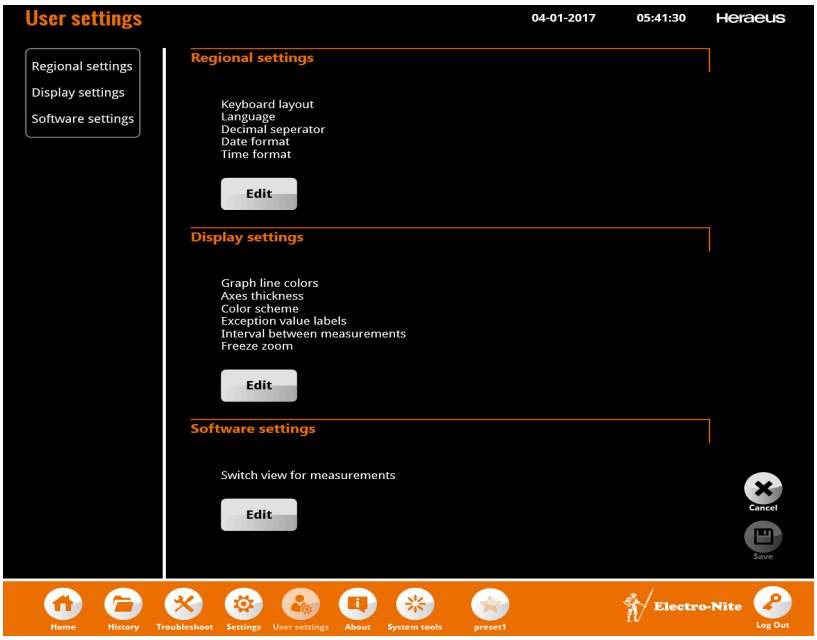
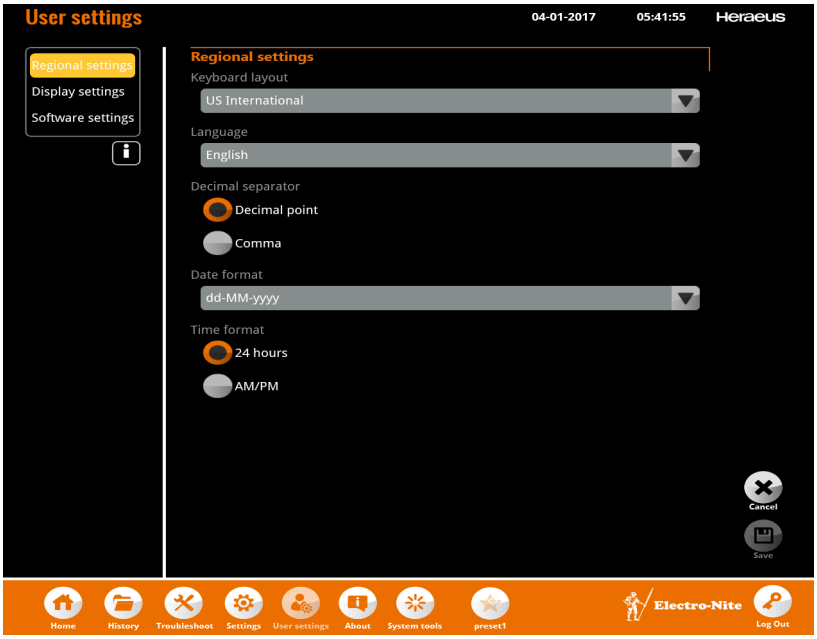


Figure 21: User settings window

In this window you can add or change:

- Regional settings
- Display settings
- Software settings

6.6.1. Regional settings

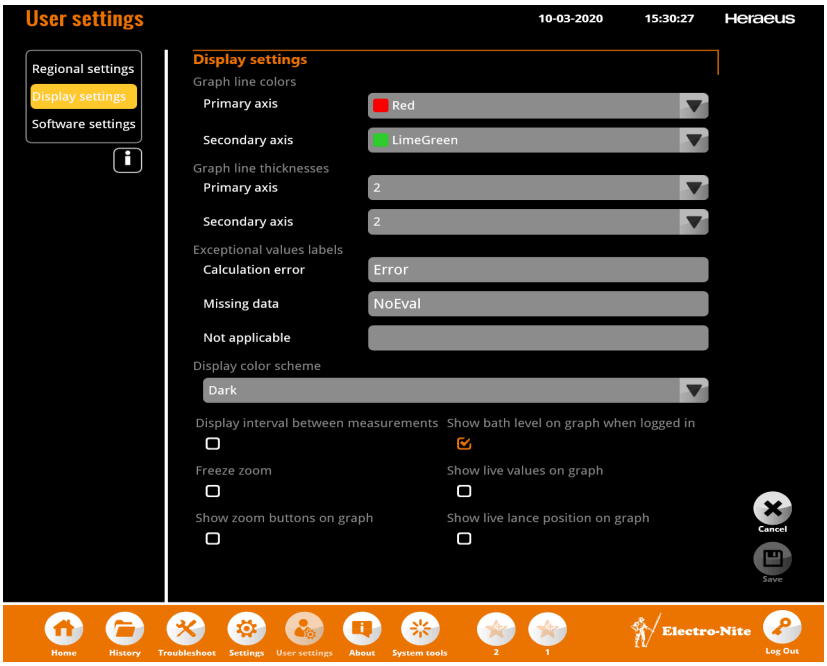


In this window you can select:

- Keyboard layout and language
- Decimal separator used throughout the Sensor Lab software application
- Date and time format

Click **Save** to save your changes or **Cancel** to leave the window without making any changes.

6.6.2. Display settings



In this window you can select:

- Colours of the graph axes
- Thickness of the graph axes

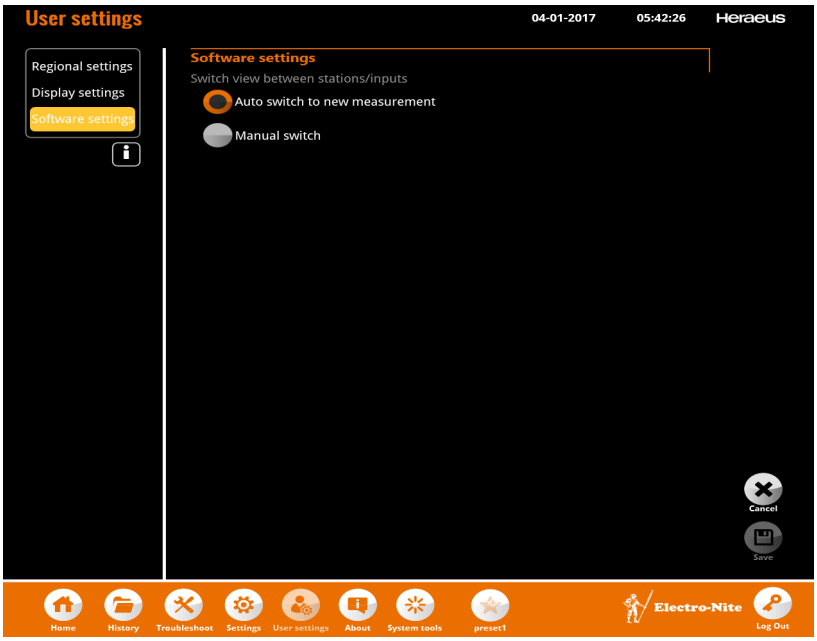
You can enter or change the exceptional values labels for:

- Calculation error – error in the equation used to calculate a result.
- Missing data - the input to a variable used in an equation is missing, for example, aO can't be calculated as the EMF isn't correctly measured. This label is also shown when EMF is fluctuating and the fluctuation is outside the evaluation window.
- Not applicable - the input is outside the range expected in the equation.

You can also:

- Select the colour scheme of the display
- Enable the display of the time interval between two measurements on the home screen for each station. This is displayed above the graph.
- Enable the Freeze zoom check box so that you can scroll through the history measurements without losing your own zoom settings of the detailed measurement views. Note that the Set default button in the Measurement detail window restores the zoom setting back to the default zoom position.
- Show the bath level on the graph when logged in
- Show the live valies on the graph
- Show the zoom buttons on the graph

6.6.3. Software settings



Use this window to specify that you want to switch the view of the measurement between station A or B or between measurement inputs:

- Automatically (default)
- Manually

When Auto switch to new measurement is enabled, the place at which a measurement has started is automatically shown on the measurement window.

After making changes in this window, click **Save** to save your changes or **Cancel** to leave the window without making any changes.

7. Operation

7.1. Operator screen

Figure 22: Operator screen

#	Name	Detail
1	Instrument name	The name by which the Sensor Lab instrument is known within the plant. This name is set by the plant engineer (see 6.4.)
2	Measurement station	The Sensor Labinstrument can support one or two measurement stations. Touch the tab of the measurement station to see measurement data for that station.
3	Date and time	To configure see 6.3.
4	Expand	Click the Expand button to see the measurement data as large numbers, allowing them to be viewed from a distance.
5	Search	Click the Search button to search for a particular previous measurement or range of previous measurements (see 7.3.3.).
6	Export	Click the Export button to send the measurement data to a file (see 7.3.4.).
7	Measurement data	The last measured values are displayed until a new measurement value is available to display. These values are displayed in the same color that is shown on the graph (see 7.3.1.).
8	Chart area	The curves of the measuring channels are shown here. For example, temperature against time and/or EMF against time (see 7.3.1.).
9	Probe type	The probe type is indicated.
10	Next HeatNo	Click this button to set the heat number of the next measurement.
11	Lamp	The lamp icon is always displayed, but only turns blue when a probe that measures carbon is connected to the lance (e.g. QUIK-CARB®, ECON-O-CARB®, TAPTIP®)
12	Measurement status	The ready (green), measuring (yellow), or completed (red) measurement status indicators.

#	Name	Detail
13	Navigation bar	Navigation buttons to navigate between the different operator screens.
14	Presets	Regularly used measurement settings can be saved by the plant engineer as ‘presets’. These are accessible via this button. Presets can be thought of as ‘favourites’ or ‘shortcuts’ and allow operators to quickly switch between regularly used settings by selecting them from the navigation bar. Click the button to see all the defined presets. The name of the currently active setting is shown next to the button. ***Note:*** *If you have only two presets, both are shown in the navigation bar.*
15	Login	Click this button to log in and make extra screens accessible (see).

7.2. Perform a measurement

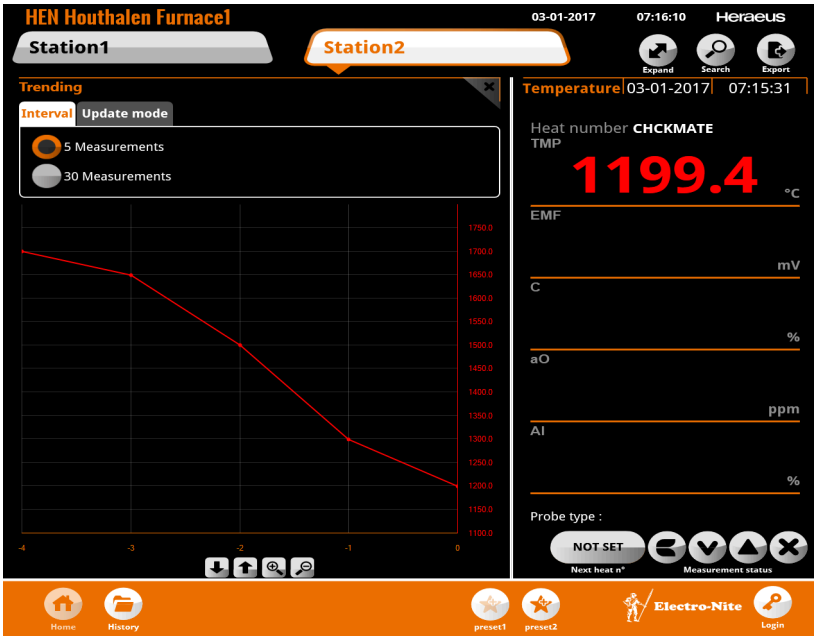
The ready (green) signal indicates that the instrument is ready to measure with the sensor attached. The busy (yellow) signal indicates that the instrument is calculating the result. The complete (red) signal indicates the end of measurement. Remove the lance from the melt when the red signal is displayed.

7.3. Evaluate the results

7.3.1. During the measurement

During the busy state, the instrument converts and evaluates the EMF (mV) and/or temperature readings. Plateaus in readings are determined by arithmetic tolerance comparison and mean value. The resulting mV and/or temperature values are displayed until the next measurement takes place. Up to six values can be displayed.

Click a value to see a trend of that value over time in the graphical area on the left side of the window. The following shows a temperature trend, where the red dots are the values joined up to represent the trend:

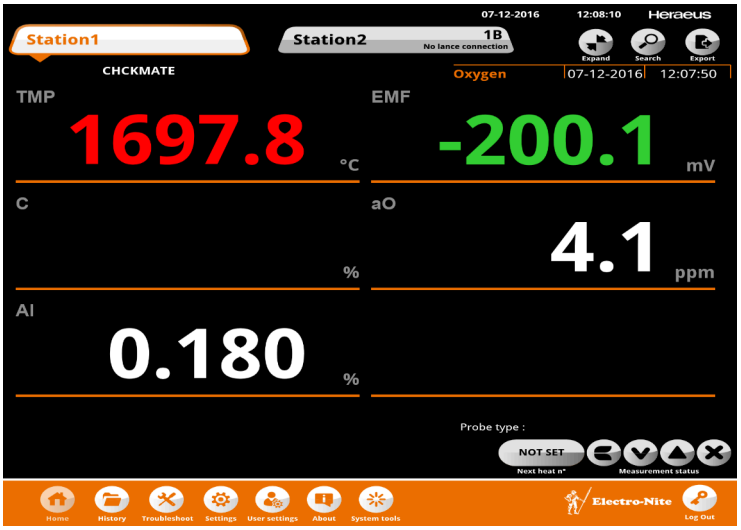


If no previous values have been recorded, the text “No trending data found” is displayed. The Trending pane has two tabs: Interval and Update mode.

- In Interval, select either 5 or 30 measurements to appear in the trend.
- In Update mode, select the way in which new measurements are included in the trend.
  - On demand means the measurement is included when you touch it in the right of the window.
  - Live means the trend is updated when a measurement is taken.

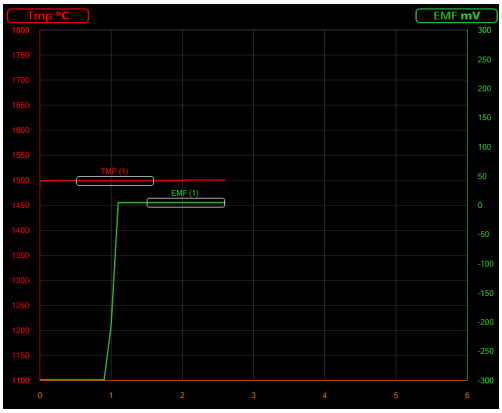
Note: *These two tabs appear and work the same way in all Trending panes. However, only the Interval tab is available if you initiated the trending from the History window – the update mode is not applicable because these measurements are historic.*

Click the to see the measurement data as large numbers, allowing them to be viewed from a distance.



Click the button again to switch back to the graphical view.

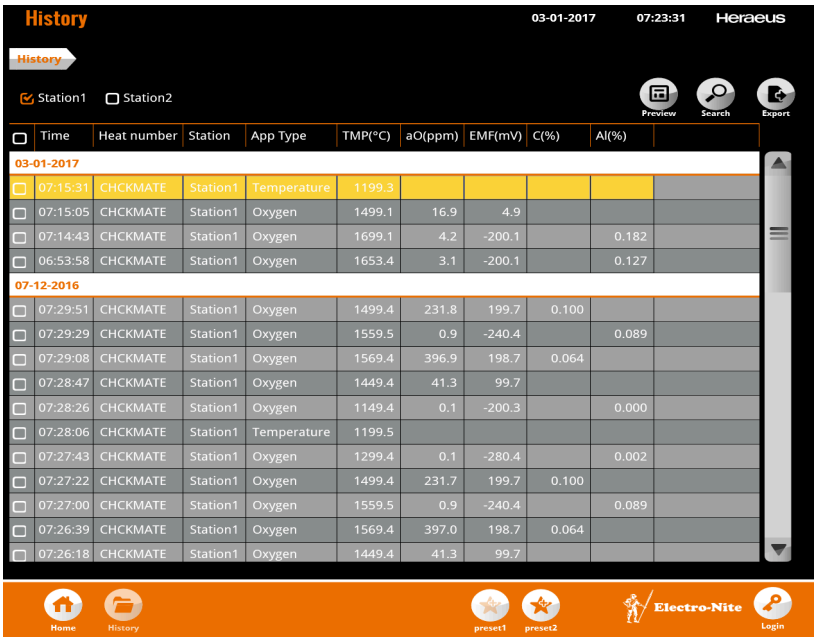
The graphical display shows the time flow of the measured signals. The rectangle on each curve shows the evaluation window (tolerance and plateau) for the measurement. For some measurements, the quality of the measurement is also displayed from Q1 to Q4, where Q1 is the best quality.



In this example, the temperature curve (trace) is shown in red and the EMF curve in green. The scale for temperature is shown on the left. The unit can be displayed in °C or in °F. The scale for EMF is shown on the right in units of voltage (mV). On the X-axis is the time scale.

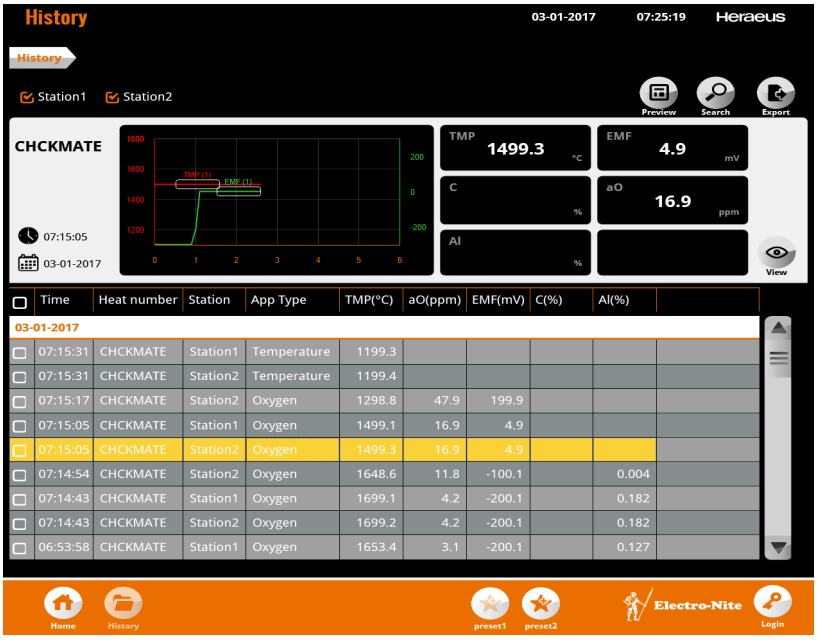
7.3.2. History

All measurement data and curves are stored in a database so that you can access them at a later time. To do this, touch History. The following window is displayed:



Select the station(s) at the top of the window for which you want to see measurement history. The history isn't automatically refreshed – press History again at the top of the window to refresh.

Click the Preview button to switch to preview mode:



Click Preview again to return to the History window.

Click View to see a selected measurement in detail.

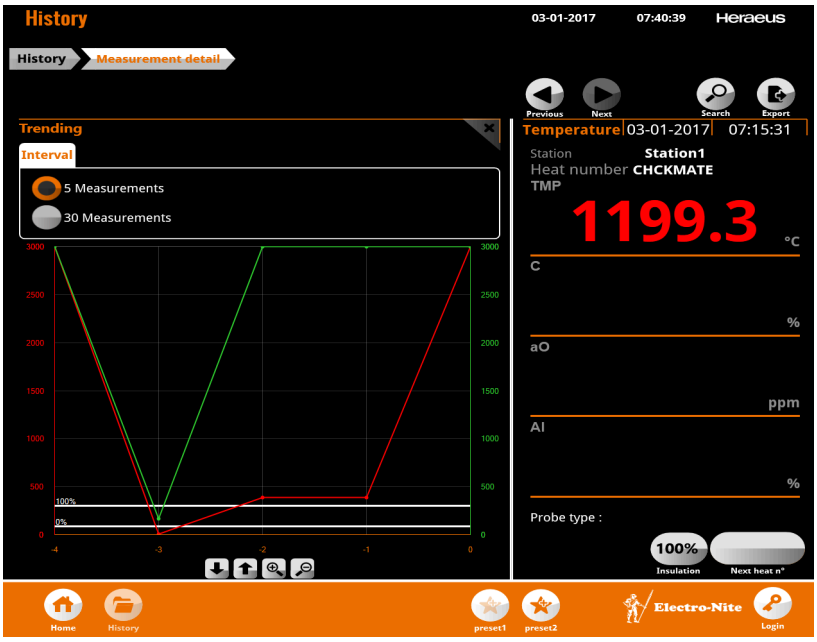
decrease or increase the Y-axis

zoom in or zoom out in the graphical display for the corresponding axis

sets the default zoom position in the Measurement detail window for both axes

On the bottom right is also shown the insulation status indicator of the connected lance. The % value is calculated based on the kΩ values of each measurement channel.

Click the Insulation button to see a trend of the insulation values over time in the graphical area on the left side of the window. The following shows an example of a trend:



7.3.2.1. Perform a 'what if' analysis

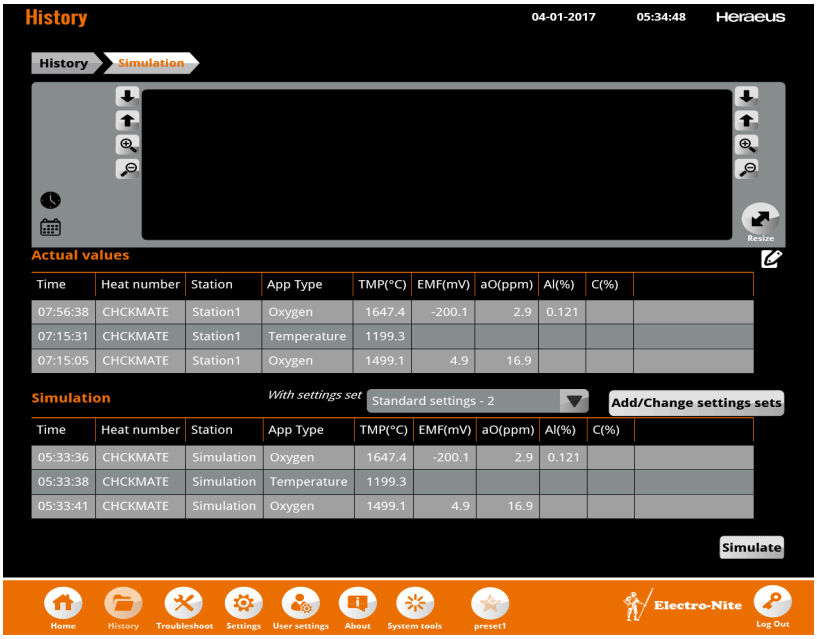
To perform this task you need to log in first.

Procedure

1 Open the History window.

2 Select a measurement and click Preview and Simulate.

The following window is displayed:



The actual values are displayed in the bottom half of the window.

3 Click Add/Change settings sets to select the settings set then click Simulate to display the simulated values.

These show what the existing measurement would have looked like with the other, selected settings set.

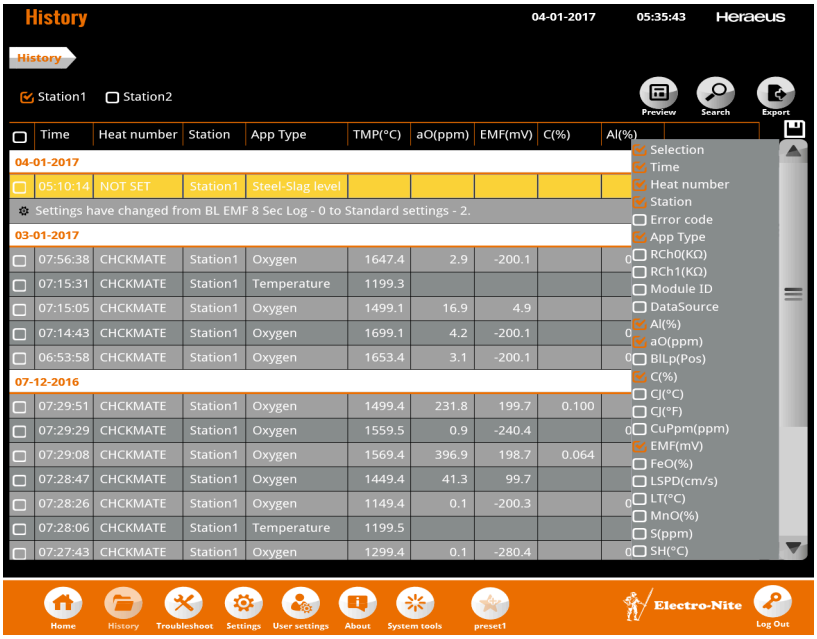
7.3.2.2. Change the history display

You can specify which columns will be shown in the History window.

To perform this task you need to log in first.

Procedure

1 Click the edit button at the right end of the column headings to display the values as shown below:

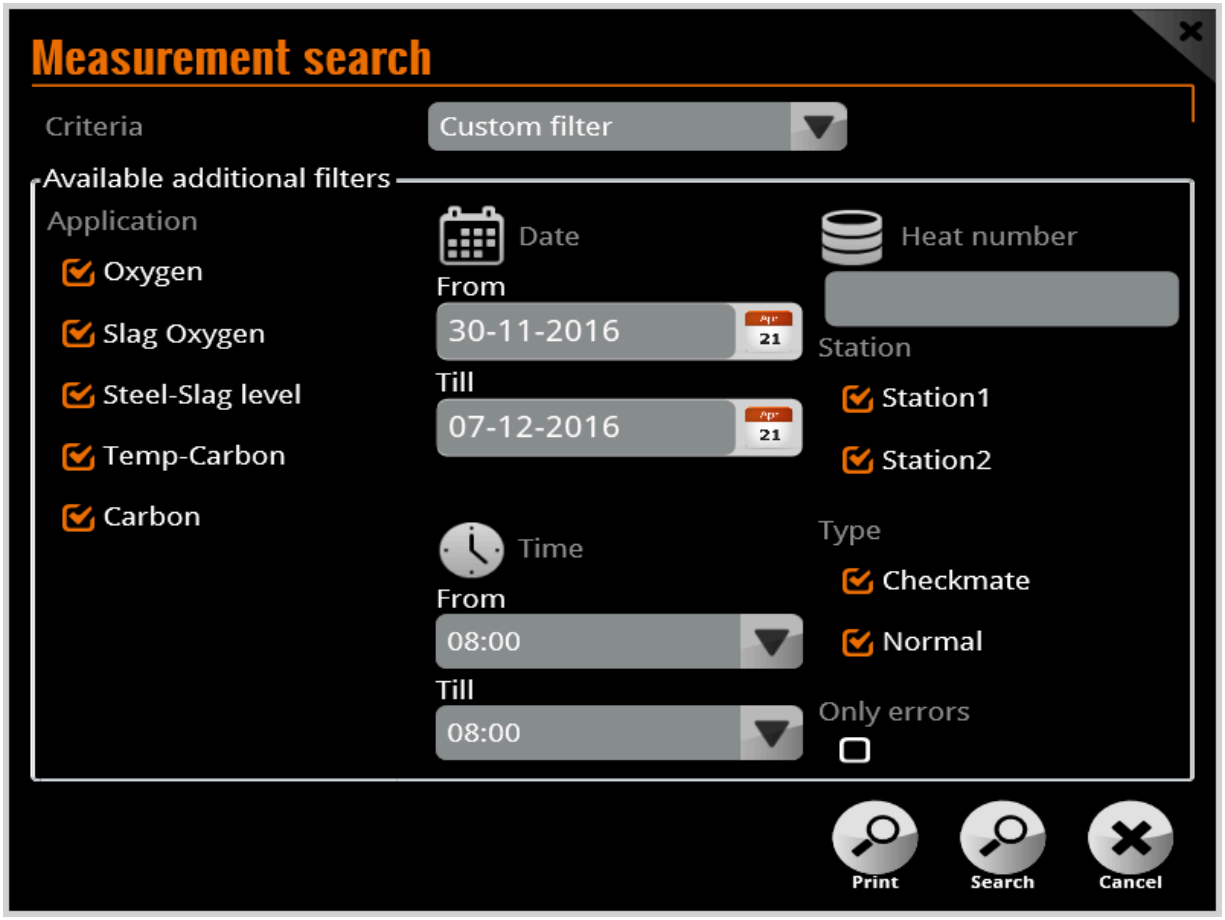


2 Select or deselect the columns to be displayed in the History window.

3 Click the save icon at the top right of the columns list to save your selections. You can re-order the columns by dragging and dropping.

7.3.3. Search

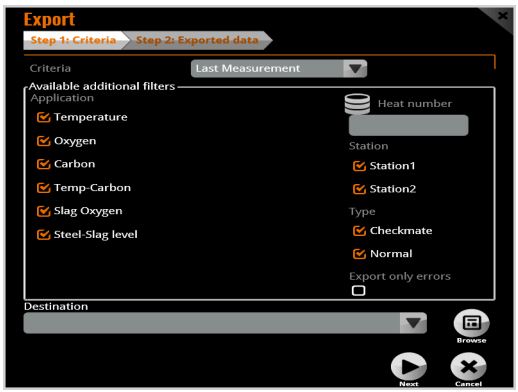
You can also click the Search button, top right of the operator screen, to search for a particular previous measurement or range of previous measurements:



You can specify a date and time range within which to search or perform a search by heat number. You can also search for measurements within a station or place, a measurement type, or measurement application. You can also search for error measurements only. Click Search after specifying the criteria.

7.3.4. Export

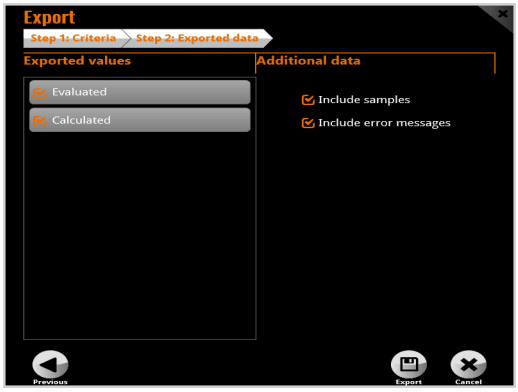
Click the Export button to send the measurement data to a file:



You can specify the exact measurement data you want to export by selecting the:

- Application
- Time period. The drop-down list at the top of the window contains some predefined time periods. If you select Custom filter, as in the example window above, you can see further fields in which you can specify your own time period. You can also select to export just the last measurement or the entire database of measurements. Note that if you select either of these options, you must also select at least one application, one station, and one type. For example, if you select Entire list, you can choose to export all Celox measurements by deselecting all the others. Or if you select Last measurement, you can choose to export the last Celox measurement by deselecting all the others.
- Heat number
- Station
- Type
- Errors only box

After specifying the criteria, click Browse to select the destination, then click Next to continue with the export:



In **Exported values**, you can select both evaluated and calculated values. Evaluated values are measured values like TMP and EMF. Calculated values are measured values used in an equation to generate a further result. Calculated values can be found in the Equations window and are, for example, C, aO, Al and so on.

Place a check mark in the Evaluated and/or Calculated box to include all evaluated and/or calculated measurements in the export. Leave the Evaluated and/or Calculated box empty to include no evaluated and/or calculated measurements in the export. Click the Evaluated or Calculated label to select or deselect individual measurements. Orange fields show measurements selected for export and grey fields show measurements not selected for export, for example:

In **Additional data**, you can include:

- Samples to include all the samples (or measured points) that make up a measurement.
- Error messages to include error messages for each measurement. This is different to the option you had in the first Export window that was used to export only measurements that contain errors.

  If the measurement wasn't an error measurement, the error message is NO_ERROR.

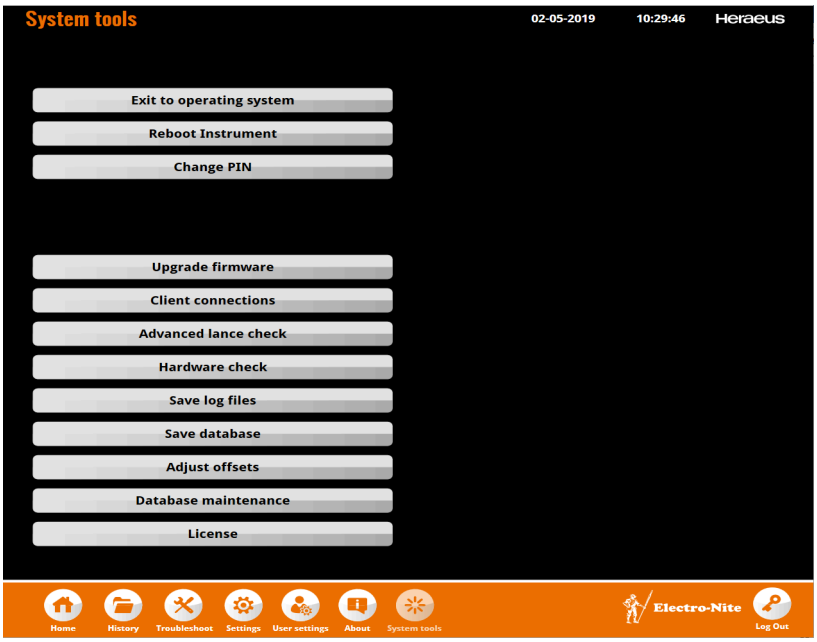
  Error messages are:

  - NO_ERROR: No error
  - WIRE_BREAK: Wire broken
  - NO_EVALUATION No evaluation was found
  - RF_LINK_BROKEN RF link is broken
  - RF_LINK_BAD RF link is bad, too many consecutive samples lost
  - UNSUPPORTED_PROBE Probe is not supported by the instrument
  - NO_STEEL Steel level was not found
  - NO_CJC Cold junction was not found

Click the Export button to export all measurement data selected to the selected destination.

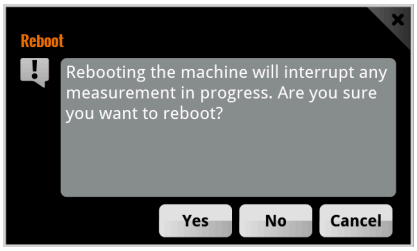
7.4. System tools

To open the System tools, first log in and then click the System tools button. The following window is displayed:



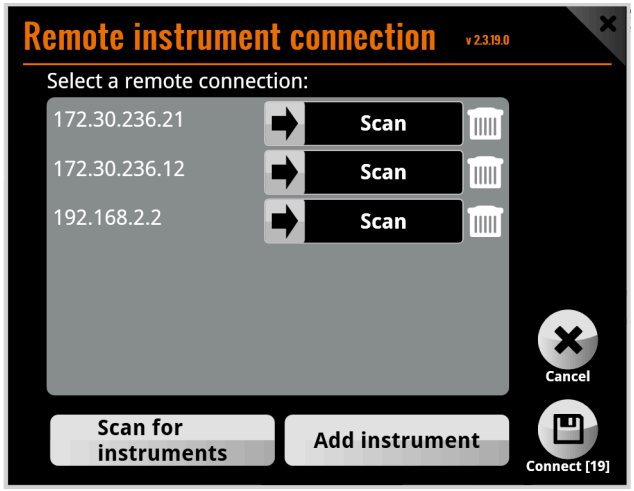
Note: *There is another option called Connection manager, which is only shown if you are remotely connected to the Sensor Lab instrument.*

Click **Reboot Instrument**, the following message is displayed:



Click Yes to reboot the instrument, No to not reboot the instrument, or Cancel to return to the previous window with no further action.

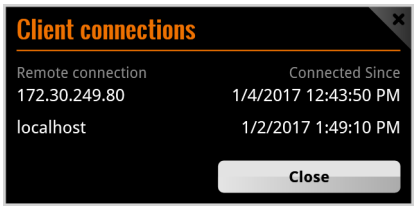
If you are remotely connected to the Sensor Lab instrument, click **Connection manager** to display the following window:



To set up a connection between the HMI and the Sensor Lab, click Scan for instruments to scan the network for Sensor Labs on that network. A Sensor Lab can also be added by directly entering the IP address after clicking Add instrument.

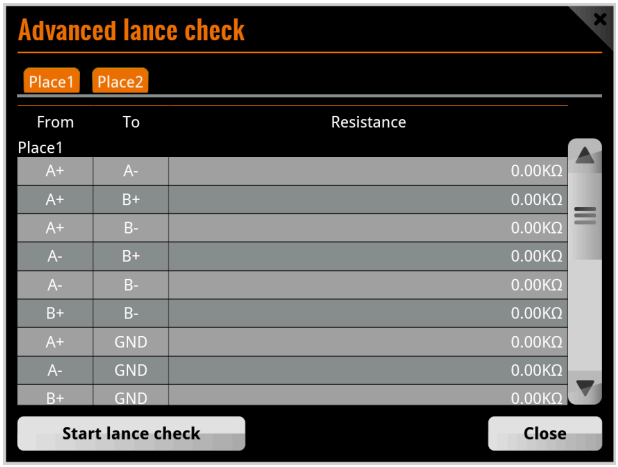
In order for an instrument to be automatically scanned, it must have a unique computer name in the network.

Click **Client connections** to display the following window:



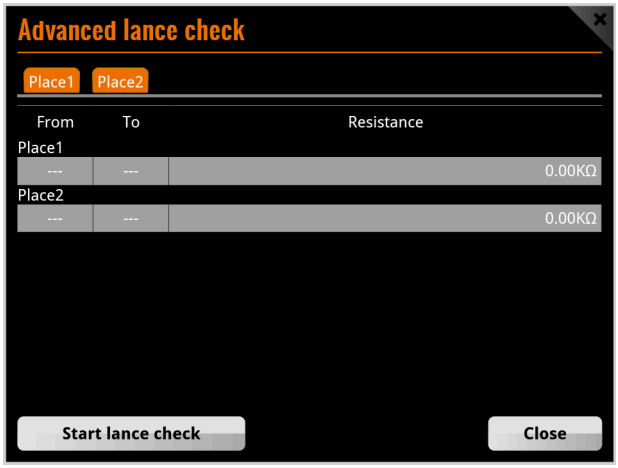
All client connections are displayed, which can help in debugging connection problems. Click Close to close the window.

Click **Advanced lance check** to display the following window:



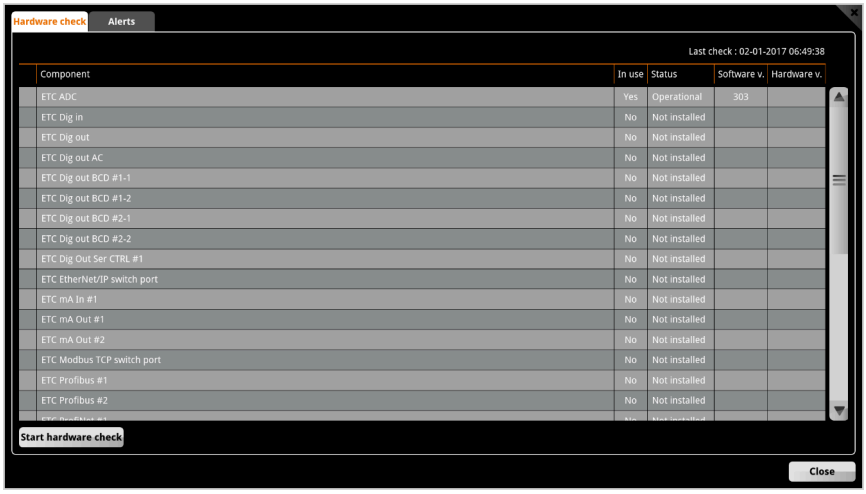
Click Start lance check to check the wiring to the lance for insulation losses. The Ohmic insulation of the connected lance is displayed.

Note: *You can only perform this check if no probe is attached to the lance. Also, for lances configured for wireless operation, only one resistance is shown – see below:*



Click Close to close the window.

Click **Hardware check** to display the following window:



Click Start hardware check to check the operation of all software and hardware components.

The Alerts tab shows any warning messages generated by the system and indicated at the time with an exclamation mark in a triangle at the top of the window in the home screen:

Examples of warnings that might be generated are:

- Low battery indication on QUBE units
- Cold junction failure
- Wireless firmware out of date
- Wireless module locked

These warnings are automatically removed when the issue is resolved.

7.5. Troubleshoot

To perform this task you need to log in first.

Open the troubleshoot window to see instrument and measurement information that can help to diagnose problems:

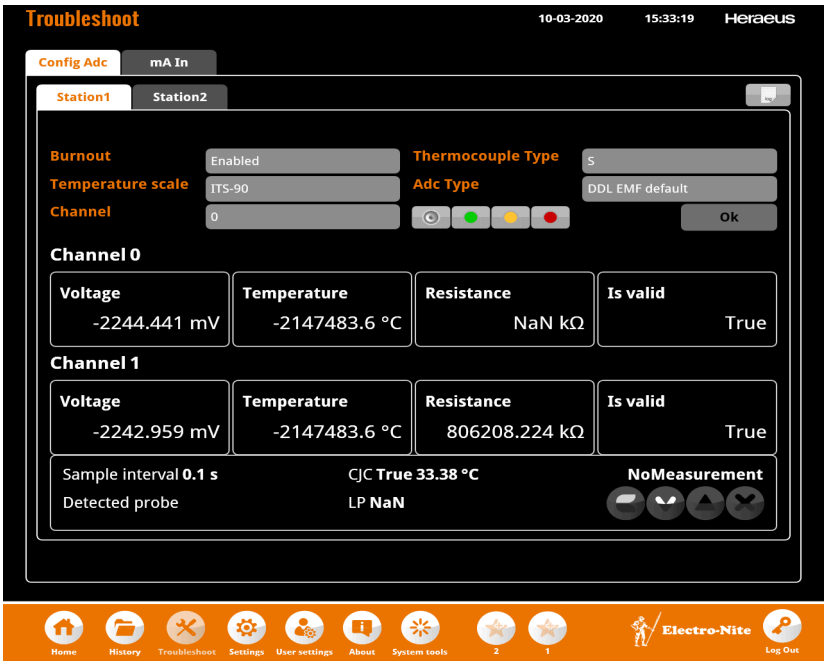


Figure 23: Troubleshoot window

Click this icon to open the Troubleshooting Log window to start exporting troubleshooting information for station 1 or 2 to an XML file. You can specify the directory path to which the file will be saved.

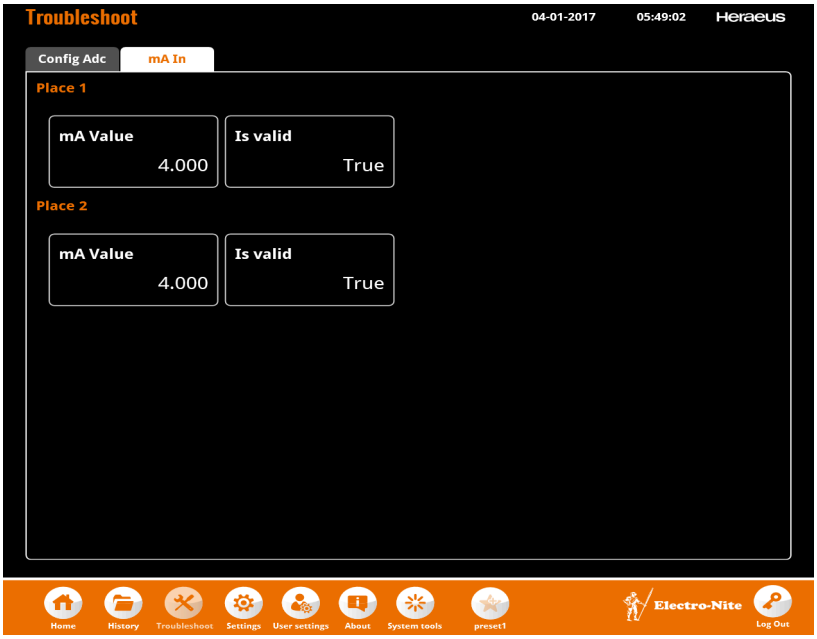
Diagnostics information is displayed for each channel:

- Current voltage on the channel. If no probe is attached, the burnout voltage is shown.
- Measured temperature.
- Resistance of the lance.
- Whether or not the sample received is valid according to the current configuration.

Also displayed at the bottom of the window, for both channels:

- Sample interval.
- The temperature of the cold junction. If not available, False would be displayed – no measurement is possible.
- Measurement status.
- The type of probe detected.

Select the mA In tab to display the following:



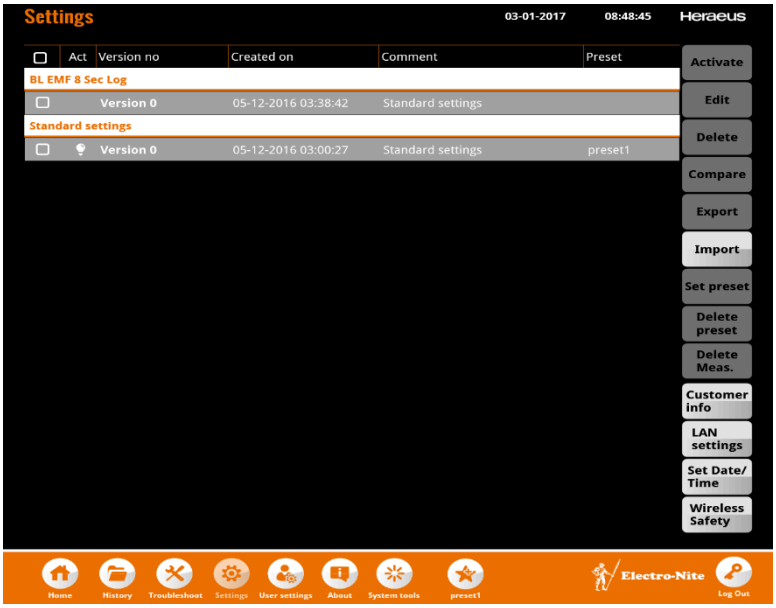
Diagnostics information is displayed for each place:

- mA value
- Whether or not the sample received is valid according to the current configuration.

8. Settings

8.1. Settings screen

To access the settings screen you need to login with the engineer password (5.3.).



Button name	Detail
Activate	Select a particular row of settings to make those settings active.
Edit	Select a particular row of settings to edit those settings.
Delete	Select a particular row of settings to delete those settings. You can only delete settings if there are no associated measurements. Confirmation is needed.
Compare	To compare two selected settings in a new window.
Export	To export the selected settings to a file.
Import	To import a settings file.
Set preset	To make the selected setting a preset. These presets will appear in the navigation bar at the bottom of the operator screen.
Delete preset	To delete an existing preset.
Delete meas.	To delete measurements. ***Note:*** *This button is restricted to use by higher level users.*
Customer info	
LAN settings	Specify the Lan Settings (6.2.)
Set Date/Time	6.3.
Wireless Safety	8.6.1.2.

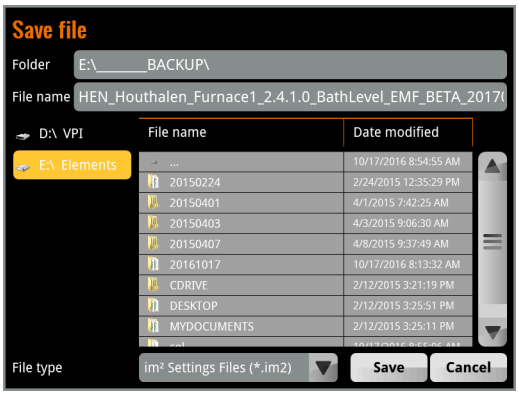
8.2. Compare settings

If you click compare the following window is displayed:

Click **Back** to return to the Settings list.

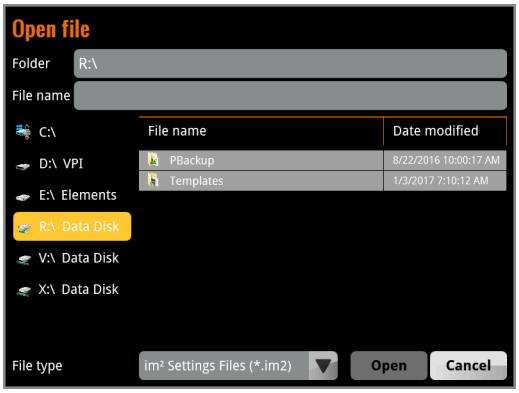
8.3. Export settings

If you click export the following window is displayed, in which you specify the path name for the file.



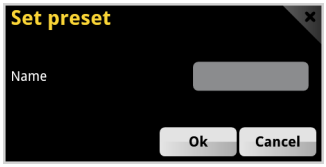
8.4. Import settings

If you click import settings, the following window is displayed in which you select the settings file to import:



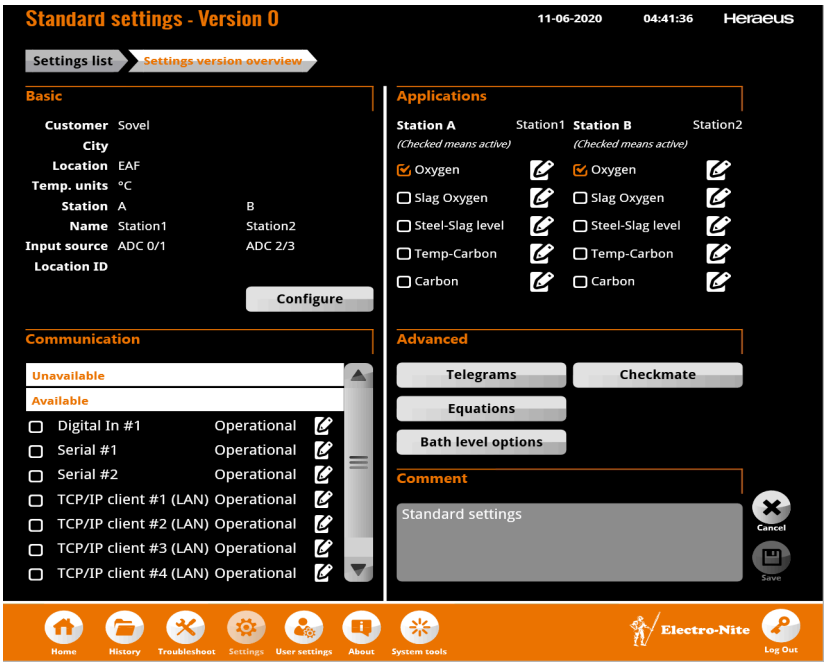
8.5. Set preset

Click Set preset to make the selected setting a preset. These presets will appear in the navigation bar at the bottom of the operator screen. After clicking Set preset, the following window is displayed in which you specify the name for the preset:



8.6. Edit settings

If you click edit the following window is displayed.



This window is divided into four sections:

- Basic: for basic instrument and measurement settings
- Applications: for more detailed measurement application settings
- Communication: for communication settings
- Advanced: for various advanced settings

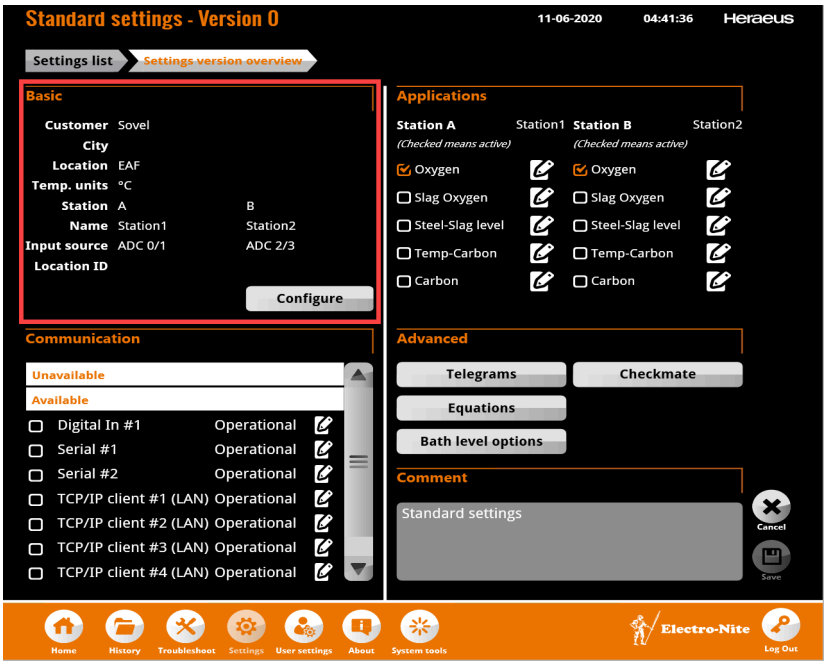
Note: *If all you do is edit only the comment about a setting, this does not save a new version of the settings. Any further changes create a new version of the setting.*

8.6.1. Edit basic settings

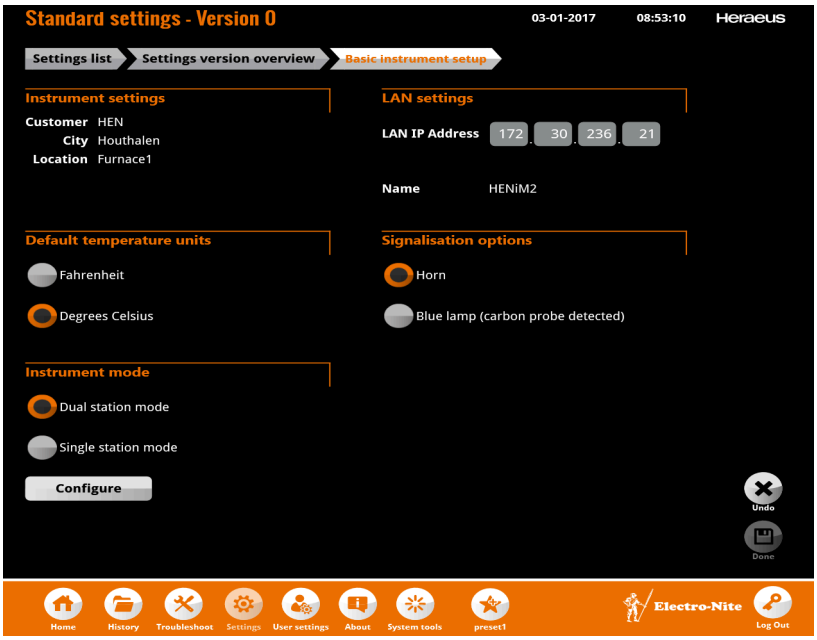
To perform this task you need to log in first.

Procedure

1 In the Settings window select the version you would like to configure by clicking on the check box in front. At first use this will be version 0. Click edit.
The next screen is displayed:



2 Click in the Basic section (top left) the Configure button.
The next screen is displayed:



On top the instrument and LAN settings are displayed. To change the LAN settings see 6.2.
.

3 Choose the default temperature unit.

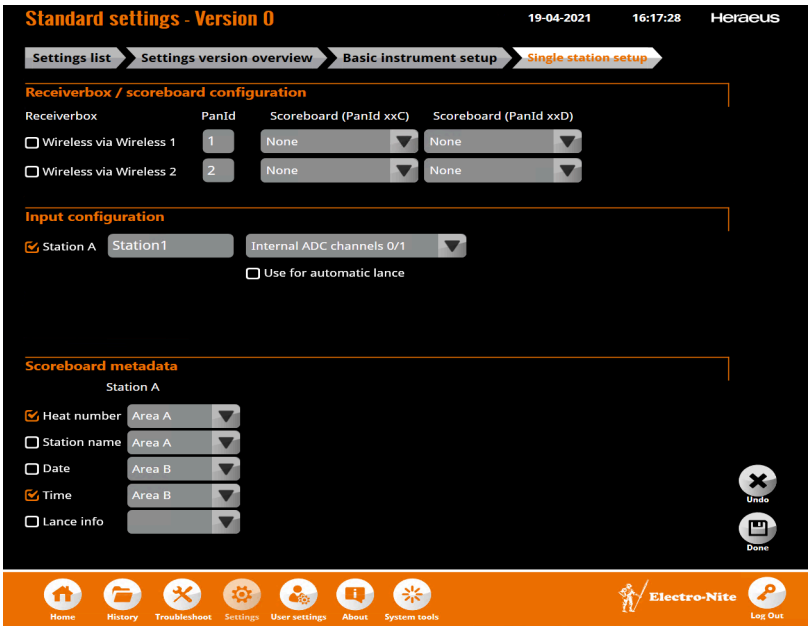
> ***Note:*** *This is an important setting and is normally only set on first use. If you change the temperature unit afterwards, standard settings are automatically loaded.*

4 Choose the signalisation option.
There can be either a horn or a blue lamp, but not both because they use the same connection. The blue lamp lights up when a carbon probe is detected.

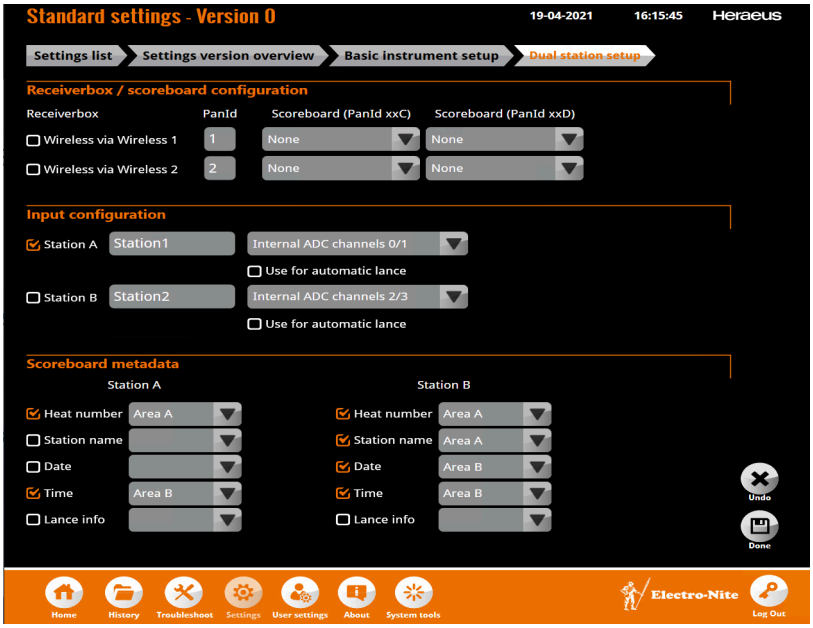
5 Choose the instrument mode: Dual or Single station mode.

6 Click Configure to configure the chosen station mode.

a Configure single station mode.



b Configure dual station mode.



Different combinations of number of locations, number of receiver boxes, number of stations and number of displays are possible. For more details see Annex I.

7 To configure the receiverbox/scoreboard, assign displays.

a Choose between: Station 1 or none for single station mode and Station 1, Station 2, All stations or none for dual station mode.

b Assign to Pan ID xxC or xxD

This ID is configured inside the Remote Display

8 Configure input for each station

a Enable or disable Station A (and/or B).

b Enter the name of the station(s).
This name is shown on the measurement window instead of the default Station1 and Station2.

c Specify the input channels – wired or wireless.

Note: *The iM²Sensor Lab® instrument can support one or two measurement stations, either:*
- One wired
- One wireless
- Two wired
- Two wireless
- One wired and one wireless

Note: *For Sensor Lab Steel, only one wireless option is possible. Therefore, the Wireless via Wireless 2 option is not available.*

d Enable use on an automatic lance.
This prevents the unit from going to sleep.

Note: *Advised to use 2 receiver boxes when 2 Qube's are used on automatic lance together with Remote displays*

9 Configure metadata for Station A (and/or B).
Maximum 2 data fields for each Area.

10 Click **Done** to save your changes or **Undo** to return to the previous window without making any changes.

8.6.1.1. Set up a wireless station

If the instrument has the wireless interface enabled, the wireless coverage area around the *i*M²Sensor Lab Receiver Box is known as the 'location'. Each location is assigned a unique number, since locations may overlap. In each location, one or two measurement stations may be covered. Wireless measurement stations within a location are denoted 'A' or 'B'. Wireless lances are assigned to a measurement station by selecting the location number (1 to 39) and station (A or B).

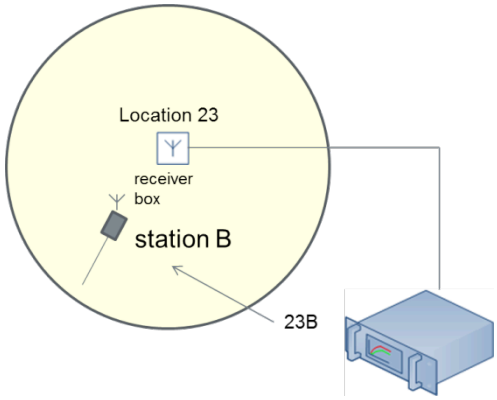
If measurement stations are located too far apart to be covered by one receiver box, another receiver box can be added to the *i*M²Sensor Lab instrument.

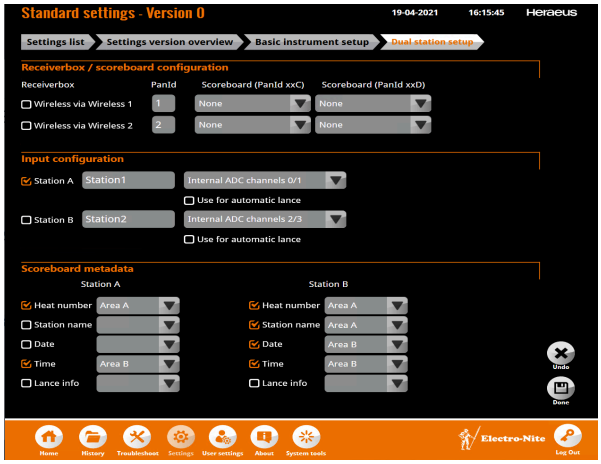
Although multiple lances with QUBE® units attached to them may be assigned to the same station, only one can be active. The first QUBE® unit to wake up reserves the communication channel and blocks any other QUBE® units that might awake.

The following are wireless configuration examples.

A single wireless station

1 Connect a single receiver box to either Wireless1 or Wireless2.
2 Configure the required stations' input channel to the appropriate input option (Wireless1 or Wireless2)
3 Enter an arbitrary location ID in the range 1 to 39.
4 Make sure the location ID is unique within the plant since neighbouring receiver boxes with identical location IDs will interfere.
5 Set the QUBE® unit to the configured location ID. Take note that the location ID is complemented by A or B depending on the configured station.





Two Wireless Stations Covered by Two Receiver Boxes

1 Connect two receiver boxes, one for each physical location. Take note which receiver box is connected to Wireless1 and which one to Wireless2.

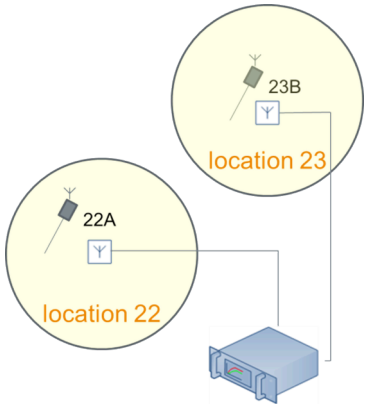
2 Configure both stations' input channel selection to the appropriate input option. Here we assume that station A is covered by the receiver connected to the Wireless1, and station B is connected to Wireless2.

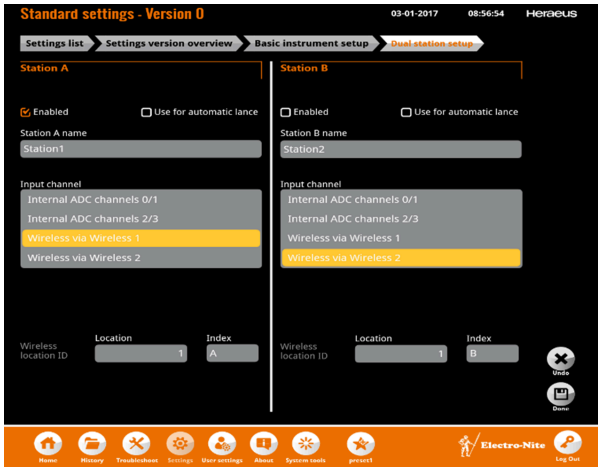
3 Enter, for each station, an arbitrary, but different location ID in the range 1 to 39.

4 Make sure the location ID is unique within the plant since neighbouring receiver boxes with identical location IDs will interfere.

5 Set the QUBE® units to the configured location IDs. Take note that the location ID is complemented by A or B depending on the configured station. Here, units at station A need to be set to location 22A and units at station B need to be set to location 23B.

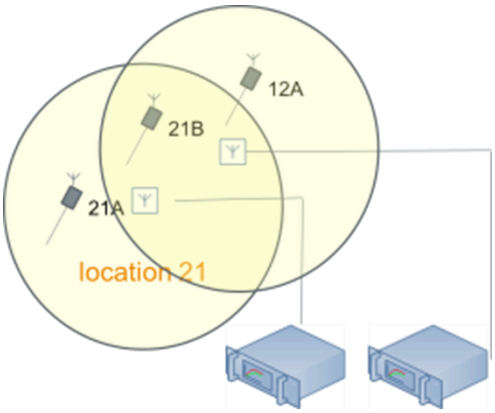
Note: *For Sensor Lab Steel, only one wireless option is possible. Therefore, the Wireless via Wireless 2 option is not available.*





More than Two Wireless Stations

Since only two stations are supported by aSensor Lab instrument, you must divide the number of wireless stations over multiple instruments. Remember that multiple locations may overlap provided that their location IDs are unique.



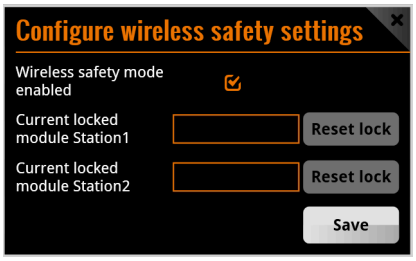
8.6.1.2. Configure wireless safety

This section describes how to configure wireless safety in the Sensor Lab. For an overview of how wireless safety should be used, see section 4.4. .

To perform this task you need to log in first.

Procedure

1 In the Settings window click the Wireless Safety button on the right side of the screen. Following window will be shown:

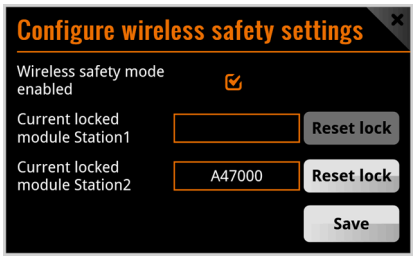


By default wireless safety is enabled. Wireless safety enabled means that a wireless module must be locked to the instrument before it can perform measurements.

The locking principle is the following when wireless safety is enabled:

- No Wireless module modules are locked initially
- A Wireless module wakes up or is already online on the Location ID configured on the Sensorlab: instrument enables a hard link with the Wireless module and a hard link is established between the instrument and the Wireless module.
- When the locked Wireless module is offline, no other Wireless module can make a connection with the instrument to prevent the use of a wireless module with the wrong location.

2 When the module is paired, its ID will be displayed:



3 When another module tries to make connection and the wireless safety mode is enabled, following message is displayed:

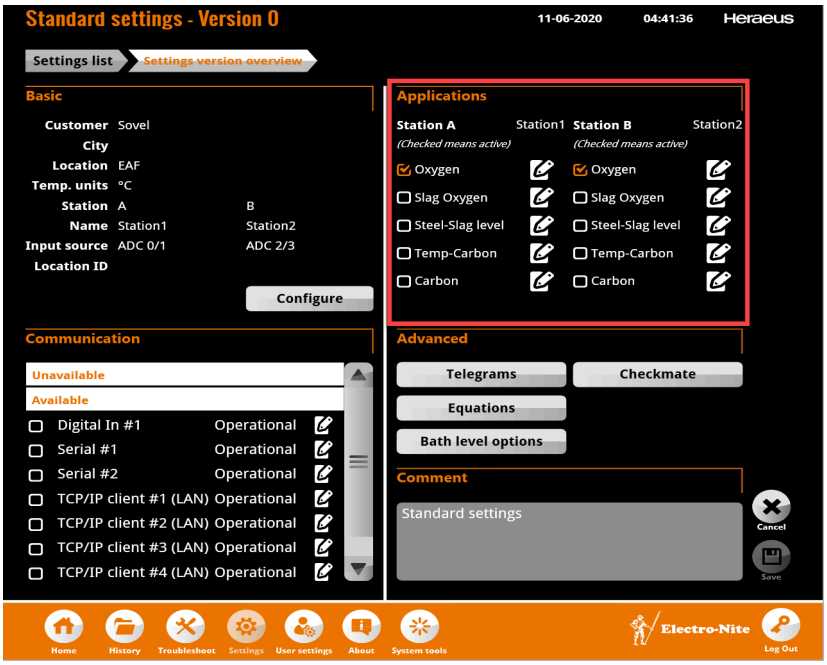
4 To connect the module, click Reset lock on the previous module.
Now, the first module set to the location ID of the instrument will be locked.

8.6.2. Edit application settings

To perform this task you need to log in first.

Procedure

1 In the Settings window select the version you would like to configure by clicking on the check box in front. At first use this will be version 0. Click edit.
The next screen is displayed:



2 Click in the Applications section (top right) on the edit button next to the measurement application you wish to edit.

> ***Note:*** *The Sensor Lab automatically recognizes the attached probe used for the measurement application. To reduce the chances of probe recognition being incorrect for whatever reason, only enable those measurement applications you really need.*

Select:

- Multilance TSO for the measurement of oxygen and temperature using Celox® or Positherm® probes. Note that this type of application also includes the measurement of oxygen and temperature to calculate sulfur and silicon content in liquid steel using Celox Hot Metal probes.
- Slag Oxygen for the measurement of oxygen in slag using Celox SLAC® or QuiK-Slag probes.
- Steel-Slag level for the measurement of slag thickness using Delta-Dist® L probes.
- Multi-Lance® TSC for the measurement of temperature and carbon using TAPTIP® probes.
- Carbon for the measurement of carbon only using ECON-O-CARB® cups or QUIK-CARB® probes.

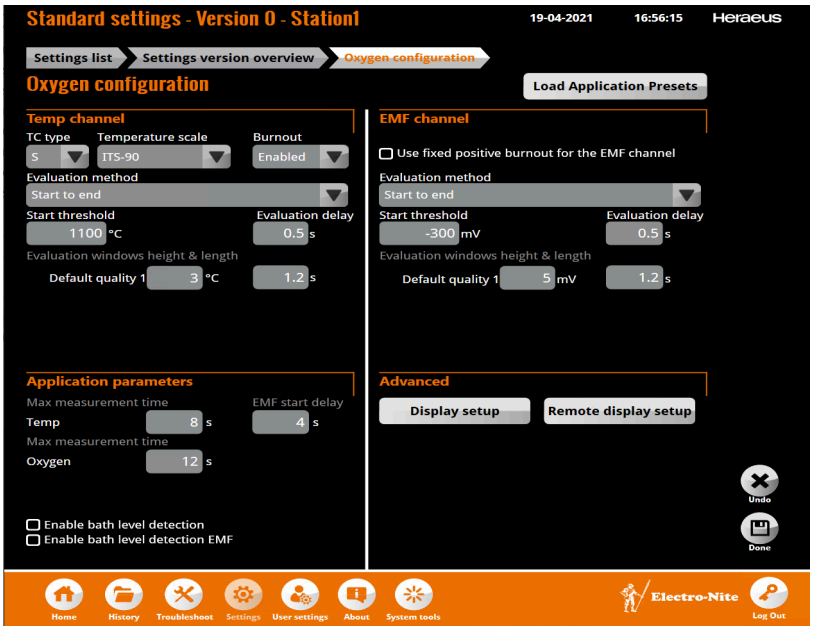
8.6.2.1. Configure oxygen measurements

To perform this task you need to log in first.

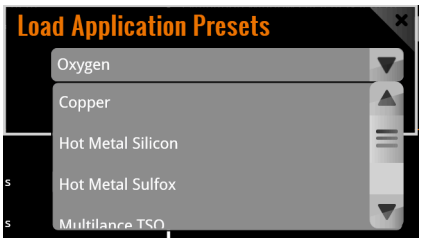
Procedure

1 In the Settings window select the version you would like to configure by clicking on the check box in front. Click **Edit**.

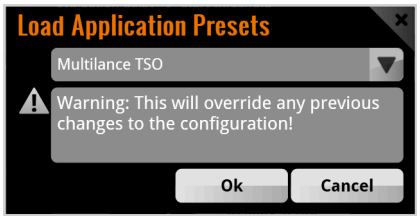
2 Click in the Applications section (top right) on the edit button next to Oxygen.
The next screen is displayed:



3 Click Load Application Presets.
The next screen pops-up:



4 Select the type of oxygen measurement from the list then click **Ok** – note the warning.



5 Back in the Oxygen configuration window, in the **Temp channel section**, select the TC (thermocouple) type, Temperature scale, Burnout control and Evaluation method.

The evaluation is a user-defined signal condition stage. It determines the time the temperature must be stable within selected limits (tolerance level) in order to conclude that the measurement value is reliable. There are two evaluation methods available:

- Start to end: search for a plateau from the start to the end of the measurement window. The measurement ends once the evaluation is found.
- End to start: search for a plateau from the end to the start of the measurement window. The measurement has a fixed time. When the time has elapsed, the evaluation can be found.

6 Enter the Start threshold in units of temperature.

The measurement starts and the evaluation can begin as soon as the temperature exceeds this threshold value.

7 Enter the evaluation delay.

This is the time, in seconds, before evaluation begins after the start threshold is exceeded.

8 Enter the default quality values.

These two parameters define the evaluation level: deviation of temperature (in °C or °F) and plateau length (in seconds). Depending on the application there can be up to four quality values where quality 1 is best quality. To be able to deal with less appropriate signal conditions, evaluation can be done at four tolerance levels, each level less accurate than the former.

9 In the **EMF channel section** enable or disable the use of a fixed positive burnout for the EMF channel.

When enabled, a positive burnout is used for the EMF channel and a negative burnout is used for the temperature channel. When disabled, both channels use a negative burnout. Positive burnout is only applicable during measurement. The burnout switches to a positive burnout value when a probe is attached. On open line, both channels use a negative burnout.

10 Select the evaluation method.

The evaluation is a user-defined signal condition stage. It determines the time the EMF signal must be stable within selected limits (tolerance level) in order to conclude that the measurement value is reliable. There are two evaluation methods available:

- Start to end: search for a plateau from the start to the end of the measurement window. The measurement ends once the evaluation is found.
- End to start: search for a plateau from the end to the start of the measurement window. The measurement has a fixed time. When the time has elapsed, the evaluation can be found.

11 Enter or change the Start threshold.

The evaluation begins as soon as the EMF signal exceeds this threshold value.

12 Enter or change the Evaluation delay.
This is the time, in seconds, before evaluation begins after the start threshold is exceeded.

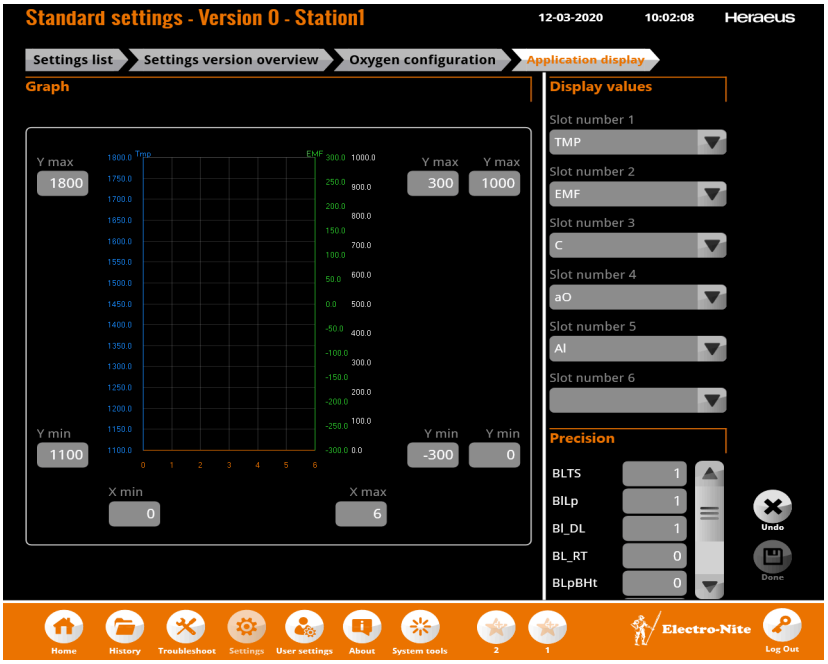
13 Enter or change the Default quality values.
These two parameters define the evaluation level: deviation of EMF (in mV) and plateau length (in seconds). Depending on the application there can be up to four quality values where quality 1 is best quality. To be able to deal with less appropriate signal conditions, evaluation can be done at four tolerance levels, each level less accurate than the former.

14 In the **Application parameters section** enter or change the maximum time allowed for a temperature measurement and for an oxygen measurement.
After this time has elapsed, the measurement ends.

15 Enter or change the maximum delay before an EMF measurement.
Normally, a measurement stops as soon as an evaluation level is detected, but not before the period set in EMF start delay has elapsed. When no evaluation level has been detected within the maximum measuring period, no result is displayed on the screen and an error message is created. The measurement time set in Max measurement time must be larger than the EMF start delay.

16 Enable or disable bath level detection.
This is bathlevel detection on TC on ingoing. Bathlevel DIO will be triggerd on this detection. See section 8.6.4.2. for more information about bath level detection.

17 In the **Advanced section** you can configure the display and Remote display setup. Click the Display setup button.
The next screen is displayed:



18 Set minimum and maximum values for the axes in the graphical results display.

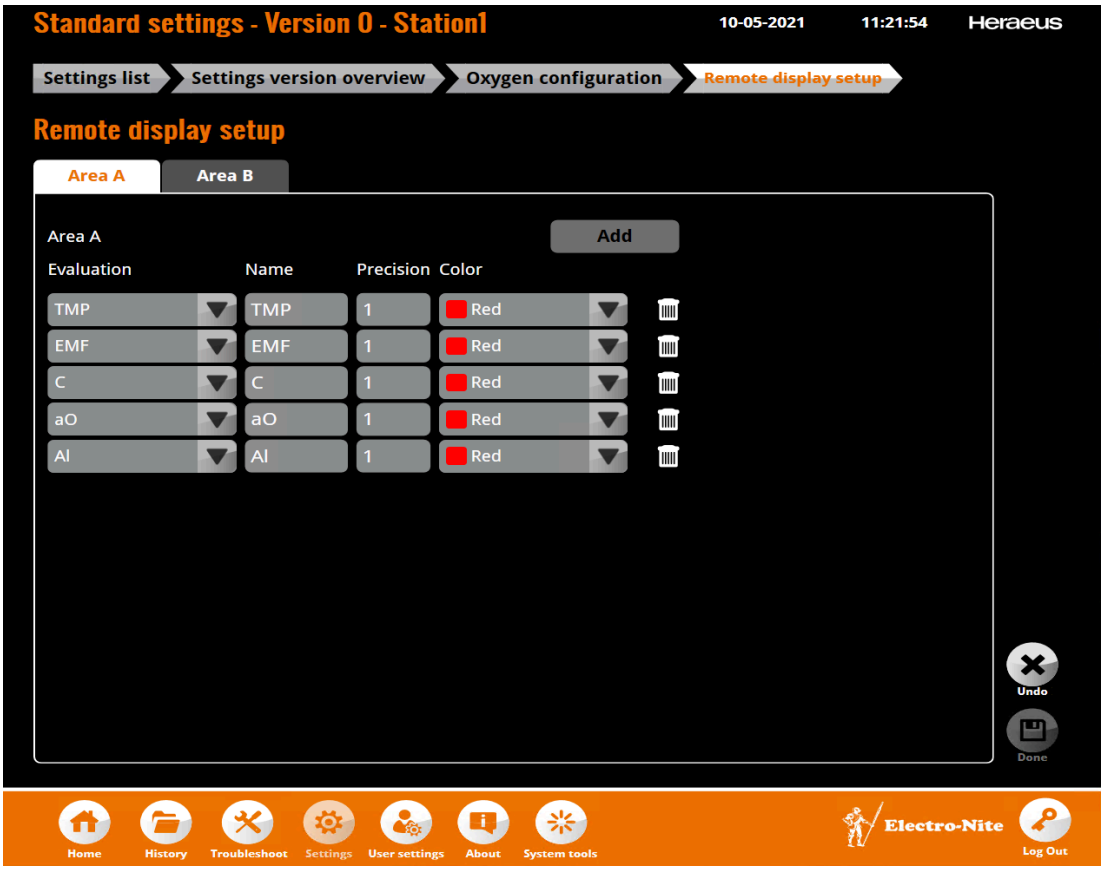
19 Select which results to display in which position on the window.

> ***Note:*** *You can also show equation results in any position – see section 8.6.4.1. for more details.*

20 Enter the precision with which results will be displayed.
For example, entering 1 for TMP means that the temperature result will be displayed with one value after the decimal place.

21 To configure a Remote display, click the Remote display setup button.

The next screen is displayed:



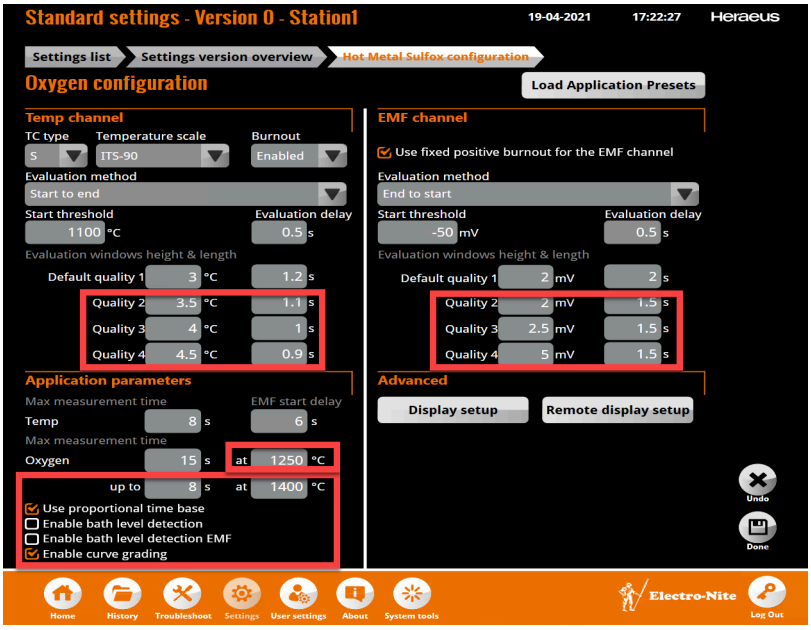
You can configure up to 5 scrolling results (the list of all possible results is automatically shown). Precision, name (max 5 characters) and colors (7 different colors) can be configured.

Note: *The current displays RD251 and RD231 have only two areas.*

22 After making changes in any of the sections in the configuration window, click **Save** to save your changes or **Undo** to undo your changes.

Configure Hot metal sulfur, Hot metal silicon and Copper applications

Configuration is similar to what is described for the oxygen measurements (see former paragraph). For the Hot Metal Sulfur or Hot Metal Silicon or Copper applications, there are some additional fields in the Application parameters section of the configuration window:



The Use proportional time base check box is checked by default. It opens up three additional fields (marked with the red rectangle) in which you can specify the number of seconds for which oxygen will be measured at a certain temperature. The maximum measurement time is set to 10 seconds by default.

Using a proportional time base means, in the example Oxygen configuration window above:

- When the temperature is exactly 1250°C the maximum measurement time is 15s.
- All temperatures under 1250°C have a maximum measurement time of 15s.
- When the temperature is exactly 1400°C, the maximum measurement time is 8s.
- All temperatures above 1400°C have a maximum measurement time of 8s.
- When the temperature is between 1250°C and 1400°C, a linear interpolation of the maximum measurement time is done between 8s (for 1400°C) and 15s (for 1250°C).

Additionally, bath level detection and curve grading can be enabled or disabled. When curve grading is enabled, indications of measurement quality are included in graphical displays.

You must also change the Display setup to manually specify how the Hot Metal Sulfur or Hot Metal Silicon results will be displayed.

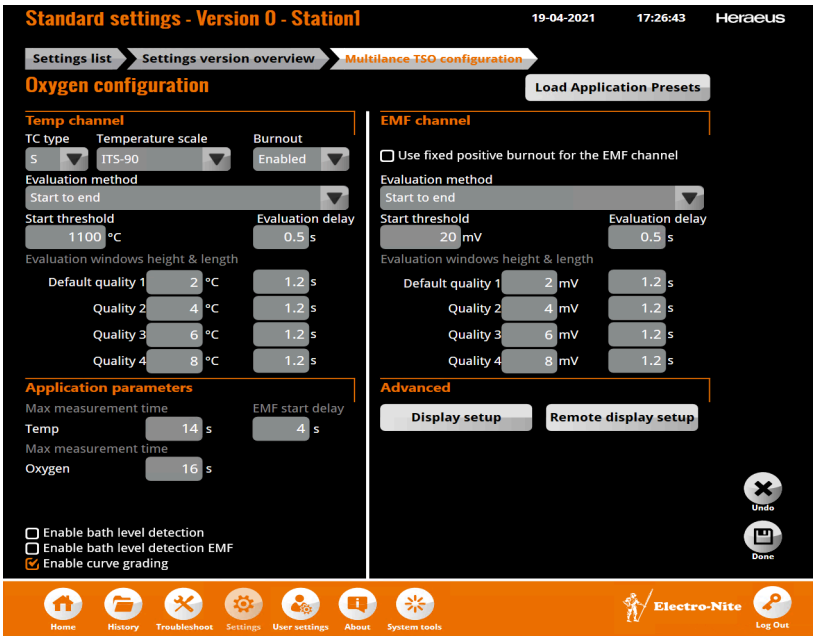
Only the values of the selected application are included in the list of the slots for the display setup. If you want to add another value for this application you have to add (or copy) a new formula configured to the correct application. Then you can select this equation in the slots.

For the oxygen application this is more complex. You can select any formula in the display setup, but they won't all show up at measurement time on the measurement window since the application is divided into sub-applications. To check which applications can be selected, check the formula editor where all sub-applications are divided in different sections.

For example, for the oxygen application, you can select EMF, but this won't be shown at measurement time when you are measuring with a Positherm® probe since it cannot measure EMF. For Celox® probes, EMF is shown.

Configure Multi-Lance® TSO

The configuration of the the Temp channel, EMF channel and application parameters is similar to the other oxygen measurements (see former paragraphs).



Additionally in the application parameters settings section

- You can enable or disable bath level detection EMF. This is a post Bath height calculation based upon TC and EMF signal. The calculated value is the actual lance position at found BLpBHt.
- You can enable or disable curve grading. This allows you to use different qualities for evaluations.

The graph in the advanced section also shows a second Y-axis, needed to configure the lance position in the bath level application.

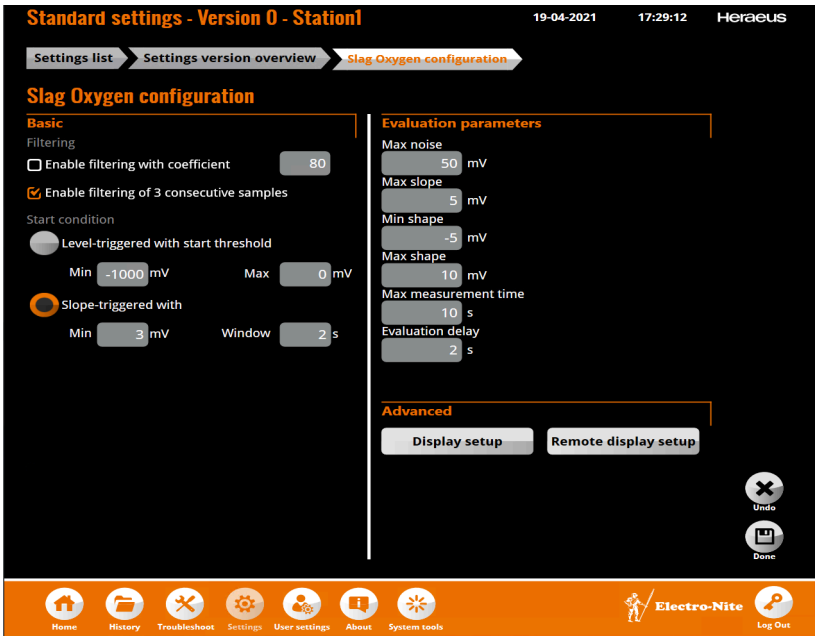
8.6.2.2. Configure slag oxygen measurements

To perform this task you need to log in first.

Procedure

1 In the Settings window select the version you would like to configure by clicking on the check box in front. Click **Edit**.

2 Click in the Applications section (top right) on the edit button next to Slag Oxygen.
The next screen is displayed:



3 In the **Basic section** (left side) enable or disable filtering with the specified coefficient.
This field switches the digital filtering on the input signals on or off. When switched on, you can enter the digital filter coefficient as a percentage value.

4 Enable or disable filtering of three consecutive samples.

5 For instruments with positive burnout, select level triggering with the specified minimum and maximum start threshold values in millivolts.

***Note:** With positive burnout, Checkmate measurements are not possible.*

***Note:** When °F is used as the default temperature unit, positive burnout is selected by default and the slag setting is set to level-triggered and both filters are enabled.*

6 For instruments with negative burnout, select slope triggering with the specified minimum slope rise in millivolts and window length in seconds.

7 In the **Evaluation parameters section** enter or change the Max noise.
The maximum allowed noise on the plateau of the measured curve, after which the measurement algorithm stops searching for a better evaluation candidate.

8 Enter of change the Max slope.
The slope is a measure of plateau stability. The maximum slope value marks the upper limit of plateau stability.

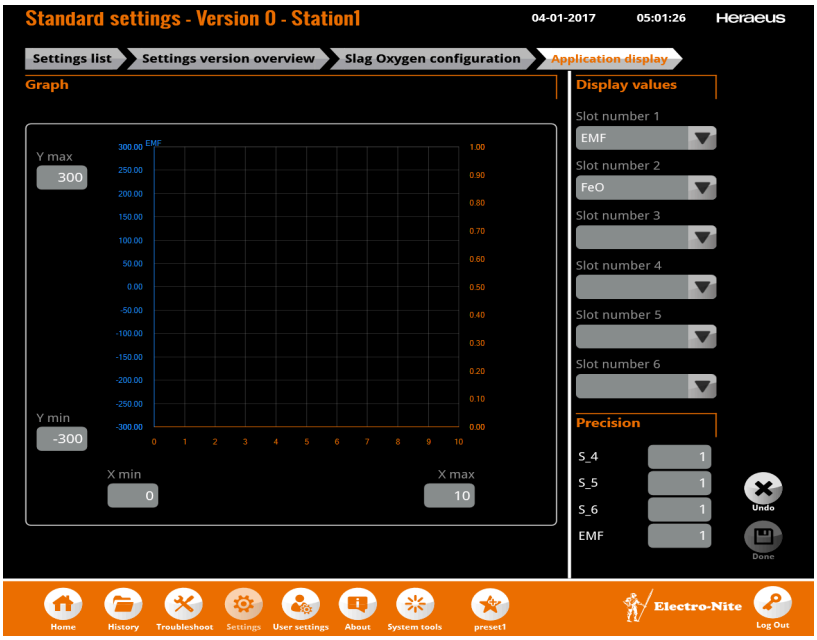
9 Enter or change the Min shape.
The minimum shape value marks the lower limit of trace stability at which no evaluation is found and the measurement is aborted.

10 Enter or change the Max shape.
The maximum shape value marks the upper limit of trace stability at which no evaluation is found and the measurement is aborted.

11 Enter or change the Max measuring time.
The maximum measuring time in which the result must be found. If this time is exceeded, the measurement ends and no evaluation is found.

12 Enter of change the Evaluation delay.
The time delay after the measurement starts before finding an evaluation.

13 In the **Advanced section** you can configure the display and Remote display setup. Click the Display setup button.
The next screen is displayed:



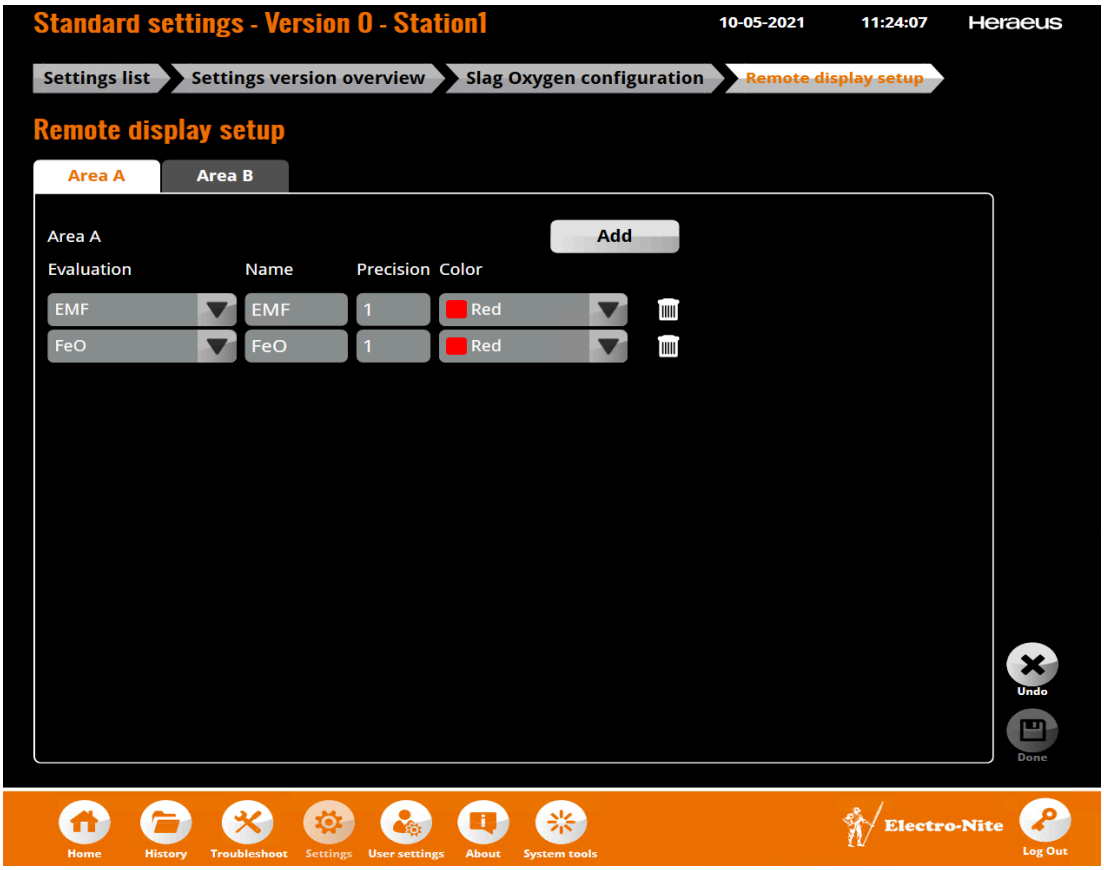
14 Set minimum and maximum values for the axes in the graphical results display.

15 Select which results to display in which position on the window.

> ***Note:*** *You can also show equation results in any position – see section 8.6.4.1. for more details.*

16 Enter the precision with which results will be displayed.
For example, entering 1 for EMF means that the EMF result will be displayed with one value after the decimal place.

17 To configure a Remote display, click the Remote display setup button.
The next screen is displayed:



You can configure up to 5 scrolling results (the list of all possible results is automatically shown). Precision, name (max 5 characters) and colors (7 different colors) can be configured.

Note: *The current displays RD251 and RD231 have only two areas.*

18 After making changes in any of the sections in the configuration window, click **Save** to save your changes or **Undo** to undo your changes.

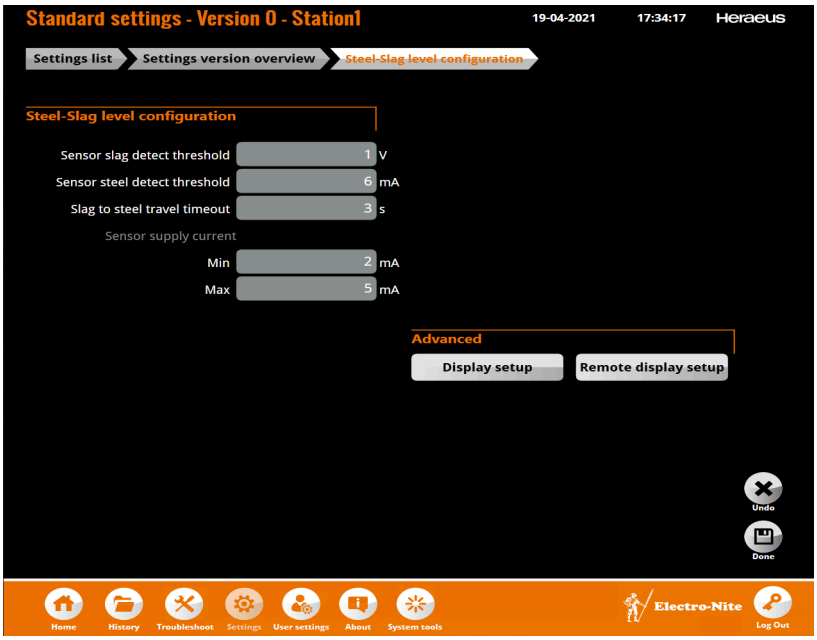
8.6.2.3. Configure slag thickness measurements

To perform this task you need to log in first.

Procedure

1 In the Settings window select the version you would like to configure by clicking on the check box in front. Click **Edit**.

2 Click in the Applications section (top right) on the edit button next to Steel-Slag level.
The next screen is displayed:



3 Enter or change the sensor slag detect threshold.
Detects the slag level at this voltage.

4 Enter or change the sensor steel detect threshold.
Detects the bath level at this mA value.

5 Enter or change the slag to steel travel timeout.
The number of seconds allowed for the sensor to move down through the slag to the steel.

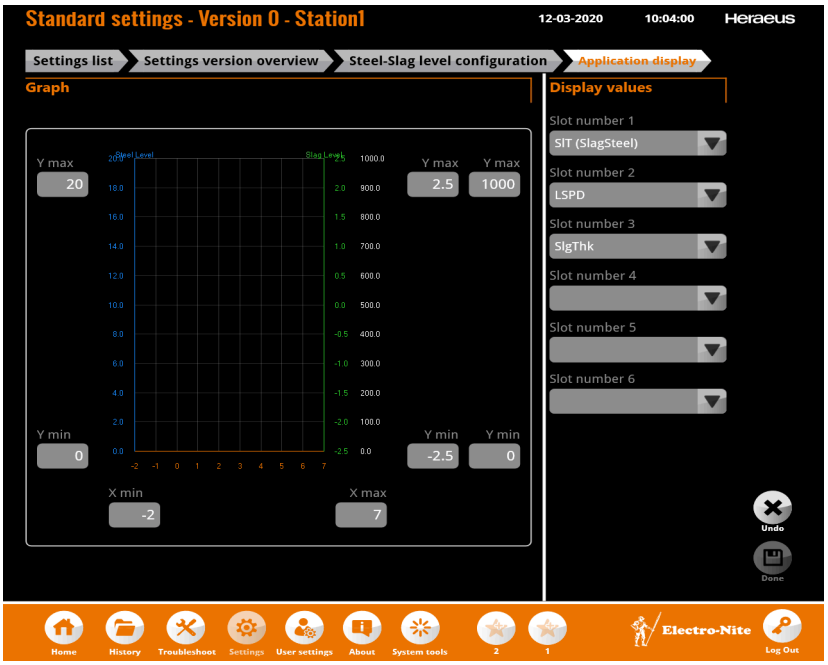
6 Enter or change the minimum sensor supply current.
The minimum supply current in mA needed for the DDL sensor.

7 Enter or change the maximum sensor supply current.
The maximum supply current in mA needed for the DDL sensor.

When a DDL sensor is attached, the system checks the power supply current and a green light is only given when the current is between the minimum and maximum sensor supply current values.

The steel-slag measurement can be taken at any time, but you cannot connect the cables of this station in parallel with another instrument since the steel-slag measurement uses a current loop.

8 In the **Advanced section** you can configure the display and Remote display setup. Click the Display setup button.
The next screen is displayed:

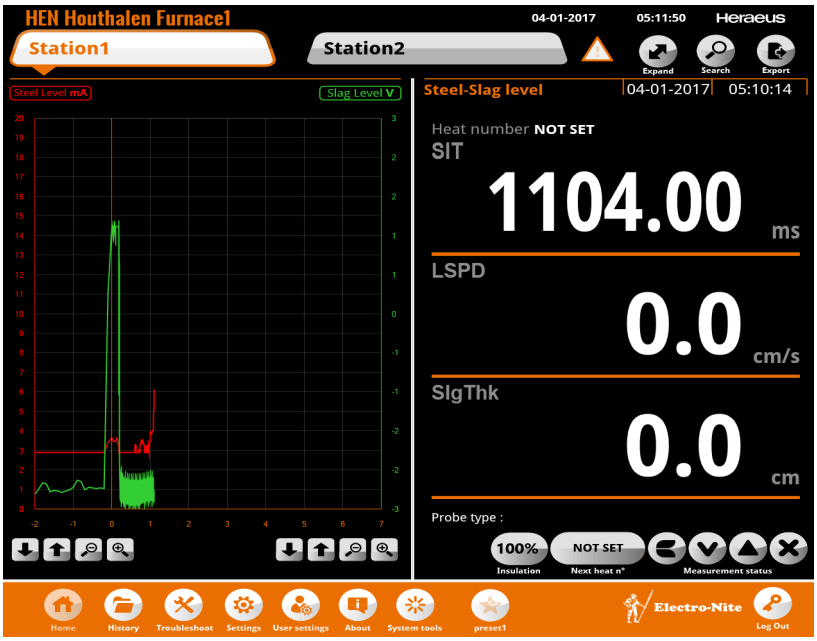


9 Set minimum and maximum values for the axes in the graphical results display.

10 Select which results to display in which position on the window.

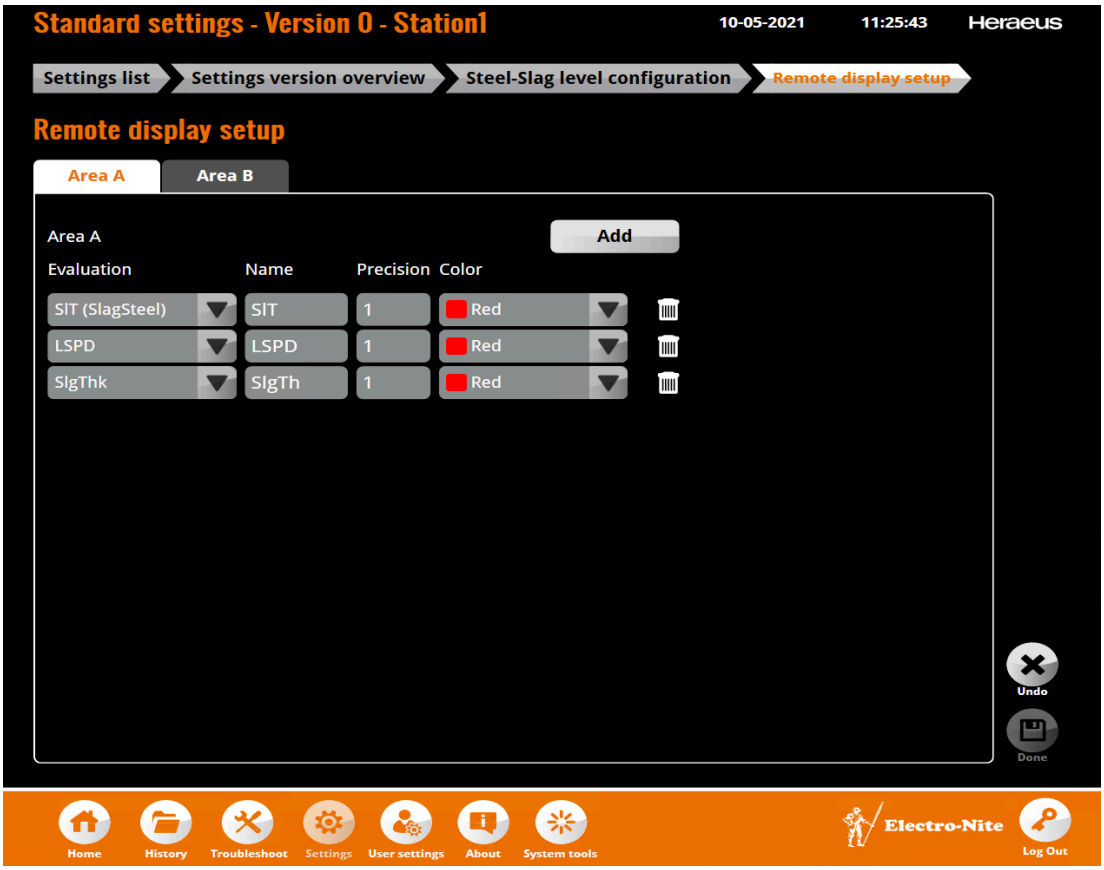
> ***Note:*** *You can also show equation results in any position – see section 8.6.4.1. for more details.*

The following shows a DDL measurement:



- SIT is slag travel time in milliseconds.
- SlgThc is slag thickness in centimeters.
- LSPD is lance speed in centimeters per second (cm/s). The default is 0.0 cm/s. If the lance speed is different to this, you must change it in the Equations window – see section 0 for more information.

11 To configure a Remote display, click the Remote display setup button.
The next screen is displayed:



You can configure up to 5 scrolling results (the list of all possible results is automatically shown). Precision, name (max 5 characters) and colors (7 different colors) can be configured.

Note: *The current displays RD251 and RD231 have only two areas.*

12 After making changes in any of the sections in the measurement configuration window, click **Save** to save your changes or **Undo** to undo your changes.

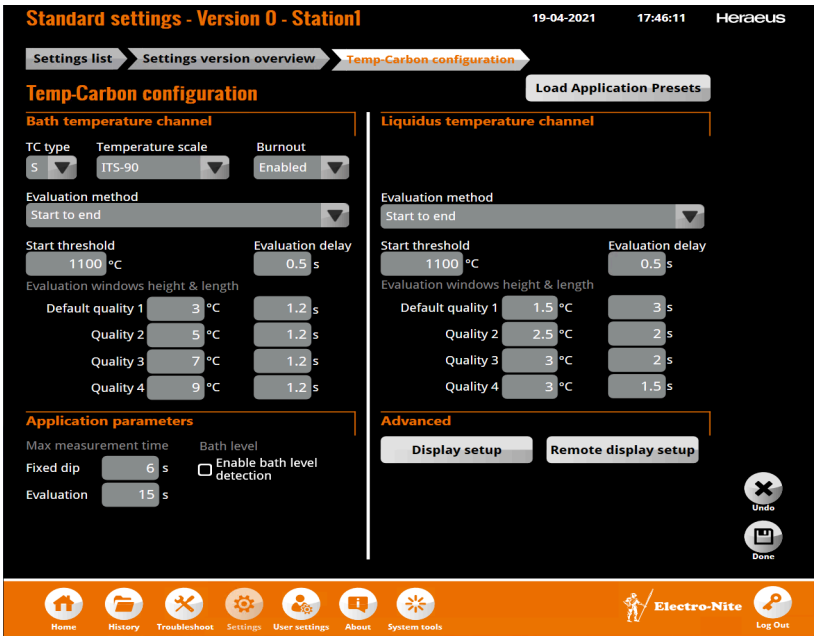
8.6.2.4. Configure temperature/carbon measurements

To perform this task you need to log in first.

Procedure

1 In the Settings window select the version you would like to configure by clicking on the check box in front. Click **Edit**.

2 Click in the Applications section (top right) on the edit button next to Temp Carbon.
The next screen is displayed:



3 In the **Bath temperature channel section** (top left) select TC (thermocouple) type, temperature scale, burnout control and evaluation method.

The evaluation is a user-defined signal condition stage. It determines the time the temperature must be stable within selected limits (tolerance level) in order to conclude that the measurement value is reliable. There are two evaluation methods available:

- Start to end: search for a plateau from the start to the end of the measurement window. The measurement ends once the evaluation is found.
- End to start: search for a plateau from the end to the start of the measurement window. The measurement has a fixed time. When the time has elapsed, the evaluation can be found.

4 Enter or change the start threshold in units of temperature.

The measurement starts and the evaluation can begin as soon as the temperature exceeds this threshold value.

5 Enter or change the evaluation delay.

This is the time, in seconds, before evaluation begins after the start threshold is exceeded.

6 Enter or change the default quality values.

These two parameters define the evaluation level: deviation of temperature (in °C or °F) and plateau length (in seconds). There can be up to four quality values where quality 1 is best quality. To be able to deal with less appropriate signal conditions, evaluation can be done at four tolerance levels, each level less accurate than the former.

7 In the **Liquidus temperature channel section** select the evaluation method.

The evaluation is a user-defined signal condition stage. It determines the time the temperature signal must be stable within selected limits (tolerance level) in order to conclude that the measurement value is reliable. There are two evaluation methods available:

- Start to end: search for a plateau from the start to the end of the measurement window. The measurement ends once the evaluation is found.
- End to start: search for a plateau from the end to the start of the measurement window. The measurement has a fixed time. When the time has elapsed, the evaluation can be found.

8 Enter or change the start threshold.

The measurement starts and the evaluation can begin as soon as the temperature signal exceeds this threshold value.

9 Enter or change the evaluation delay.

This is the time, in seconds, before evaluation begins after the start threshold is exceeded.

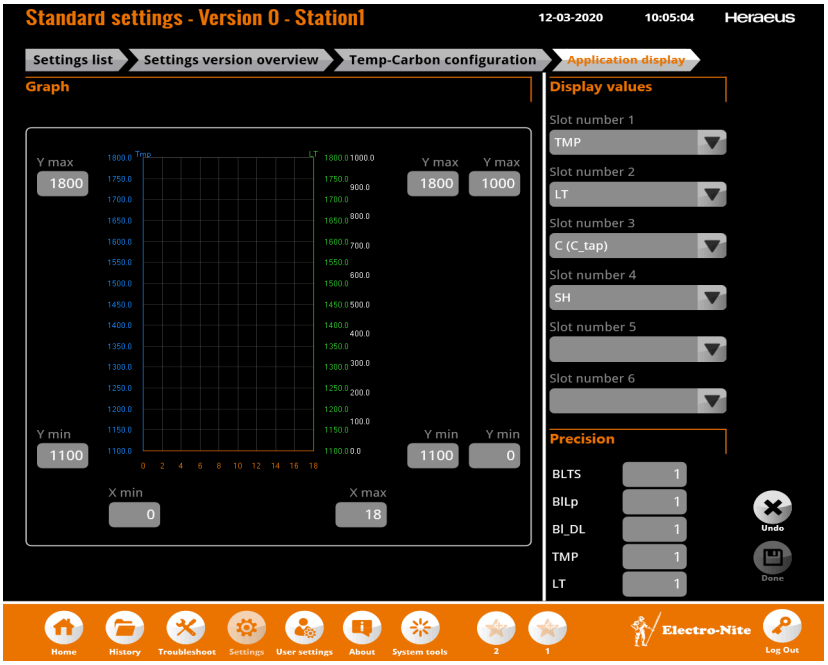
10 Enter or change the default quality values.
These two parameters define the evaluation level: deviation of temperature (in °C or °F) and plateau length (in seconds). There can be up to four quality values where quality 1 is best quality. To be able to deal with less appropriate signal conditions, evaluation can be done at four tolerance levels, each level less accurate than the former.

11 In the **Application parameters section** enter or change the fixed measurement time for a dip temperature measurement.
After this time has elapsed, a first red light indicates that the probe must be removed from the melt (Fixed dip is not used for Multi-Lance® application only for TAPTIP®).

12 Enter or change the maximum time allowed for evaluation.
After this time has elapsed, the measurement ends.

13 Enable or disable bath level detection.
See section 8.6.4.2. for more information about bath level detection.

14 In the **Advanced section** you can configure the display and Remote display setup. Click the Display setup button.
The next screen is displayed:



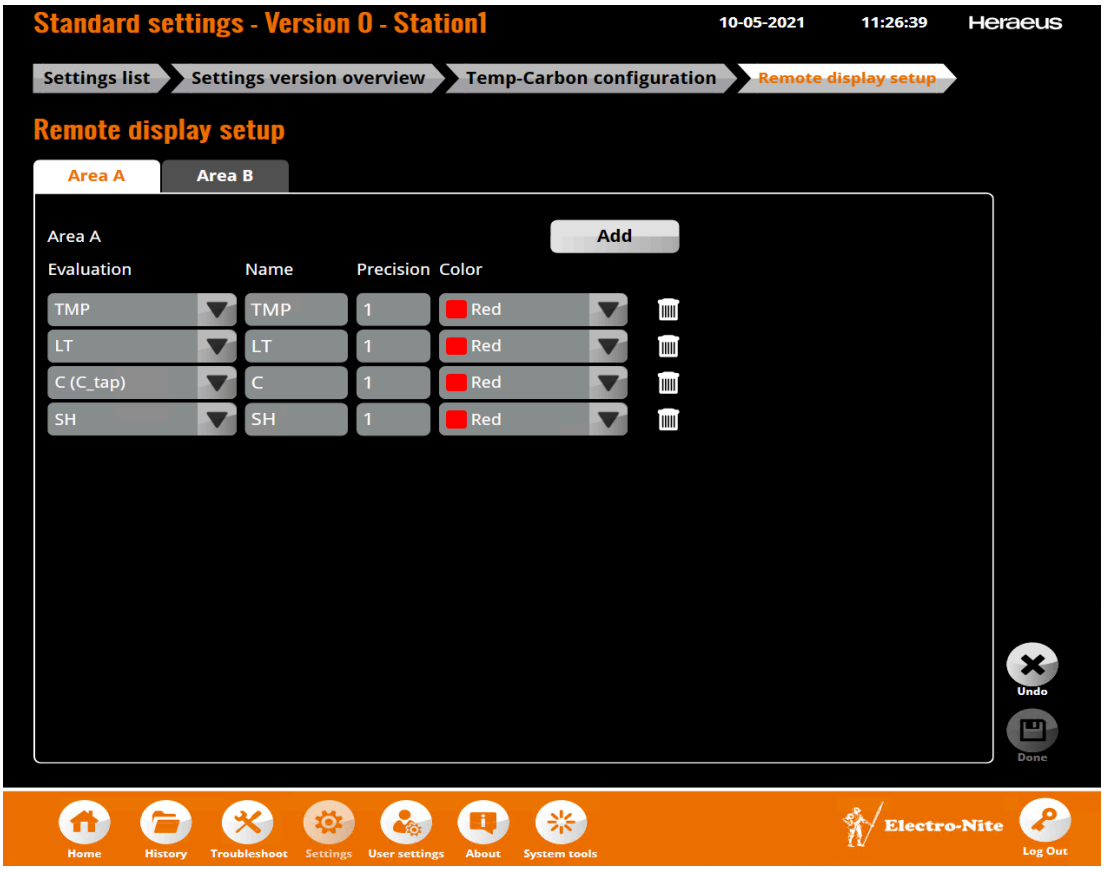
15 Set minimum and maximum values for the axes in the graphical results display.

16 Select which results to display in which position on the window.

> ***Note:*** *You can also show equation results in any position – see section 8.6.4.1. for more details.*

17 Enter the precision with which results will be displayed.
For example, entering 1 for TMP means that the temperature result will be displayed with one value after the decimal place.

18 To configure a Remote display, click the Remote display setup button.
The next screen is displayed:



You can configure up to 5 scrolling results (the list of all possible results is automatically shown). Precision, name (max 5 characters) and colors (7 different colors) can be configured.

Note: *The current displays RD251 and RD231 have only two areas.*

19 After making changes in any of the sections in the measurement configuration window, click **Save** to save your changes or **Undo** to undo your changes.

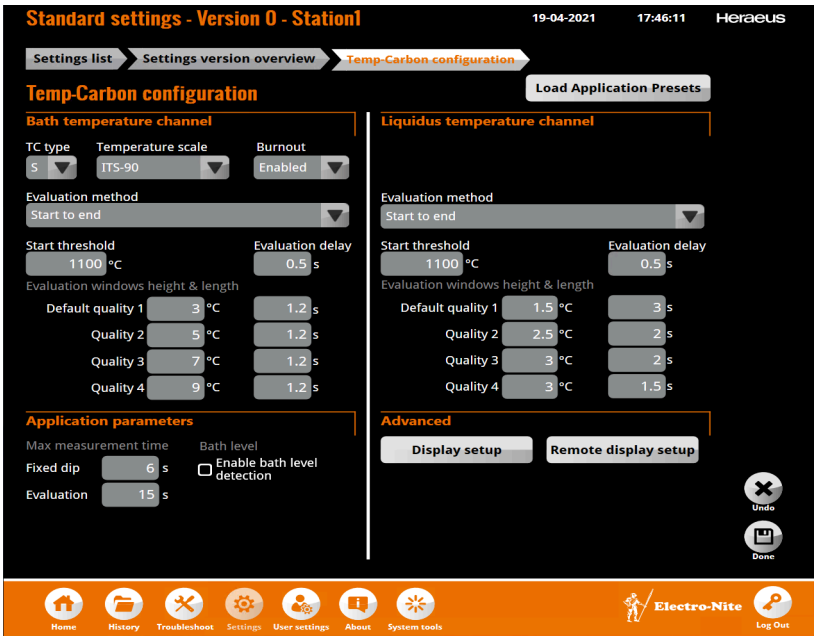
8.6.2.5. Configure Multi-Lance® TSC measurements

To perform this task you need to log in first.

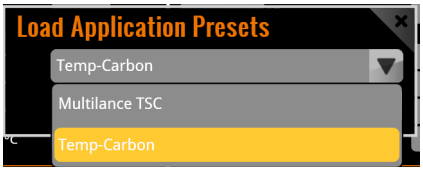
Procedure

1 In the Settings window select the version you would like to configure by clicking on the check box in front. Click **Edit**.

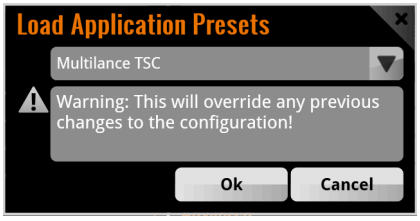
2 Click in the Applications section (top right) on the edit button next to Temp Carbon.
The next screen is displayed:



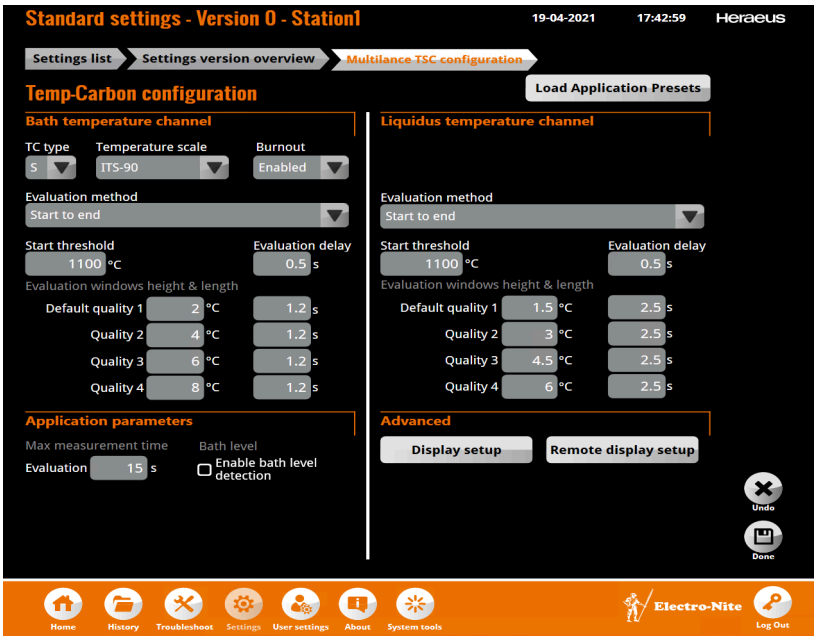
3 Click Load Application Presets.
The next screen pops-up:



4 Select Multilance-TSC from the list then click **Ok** – note the warning.



The next screen is displayed:



Configuration of Multilance TSC is similar to the Temp-Carbon configuration (8.6.2.4.).

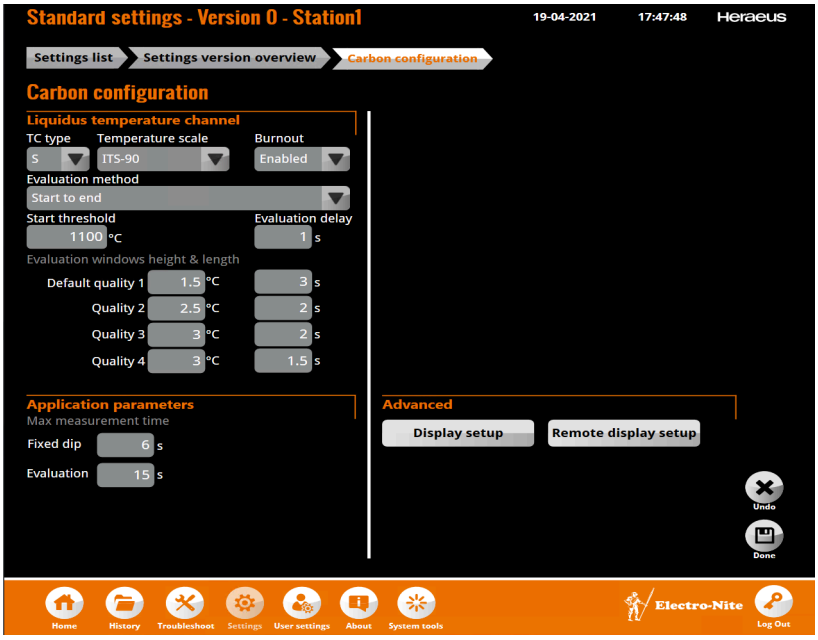
8.6.2.6. Configure carbon only measurements

To perform this task you need to log in first.

Procedure

1 In the Settings window select the version you would like to configure by clicking on the check box in front. Click **Edit**.

2 Click in the Applications section (top right) on the edit button next to Carbon.
The next screen is displayed:



3 In the **Liquidus temperature channel section** (top left) select TC (thermocouple) type, temperature scale, burnout control and evaluation method.

The evaluation is a user-defined signal condition stage. It determines the time the temperature must be stable within selected limits (tolerance level) in order to conclude that the measurement value is reliable. There are two evaluation methods available:

- Start to end: search for a plateau from the start to the end of the measurement window. The measurement ends once the evaluation is found.
- End to start: search for a plateau from the end to the start of the measurement window. The measurement has a fixed time. When the time has elapsed, the evaluation can be found.

4 Enter or change the start threshold in units of temperature.
The measurement starts and the evaluation can begin as soon as the temperature exceeds this threshold value.

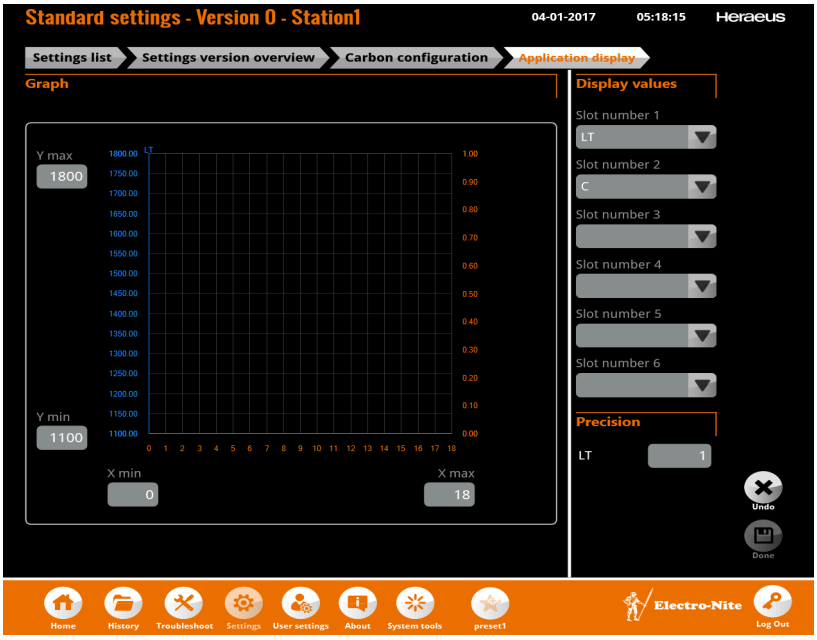
5 Enter or change the evaluation delay.
This is the time, in seconds, before evaluation begins after the start threshold is exceeded.

6 Enter or change the default quality values.
These two parameters define the evaluation level: deviation of temperature (in °C or °F) and plateau length (in seconds). There can be up to four quality values where quality 1 is best quality. To be able to deal with less appropriate signal conditions, evaluation can be done at four tolerance levels, each level less accurate than the former.

7 In the **Application parameters section** enter or change the fixed measurement time for a dip temperature measurement.
After this time has elapsed, a first red light indicates that the probe must be removed from the melt (Fixed dip is not used for Multi-Lance® application only for TAPTIP®).

8 Enter or change the maximum time allowed for evaluation.
After this time has elapsed, the measurement ends.

9 In the **Advanced section** you can configure the display and Remote display setup. Click the Display setup button.
The next screen is displayed:



10 Set minimum and maximum values for the axes in the graphical results display.

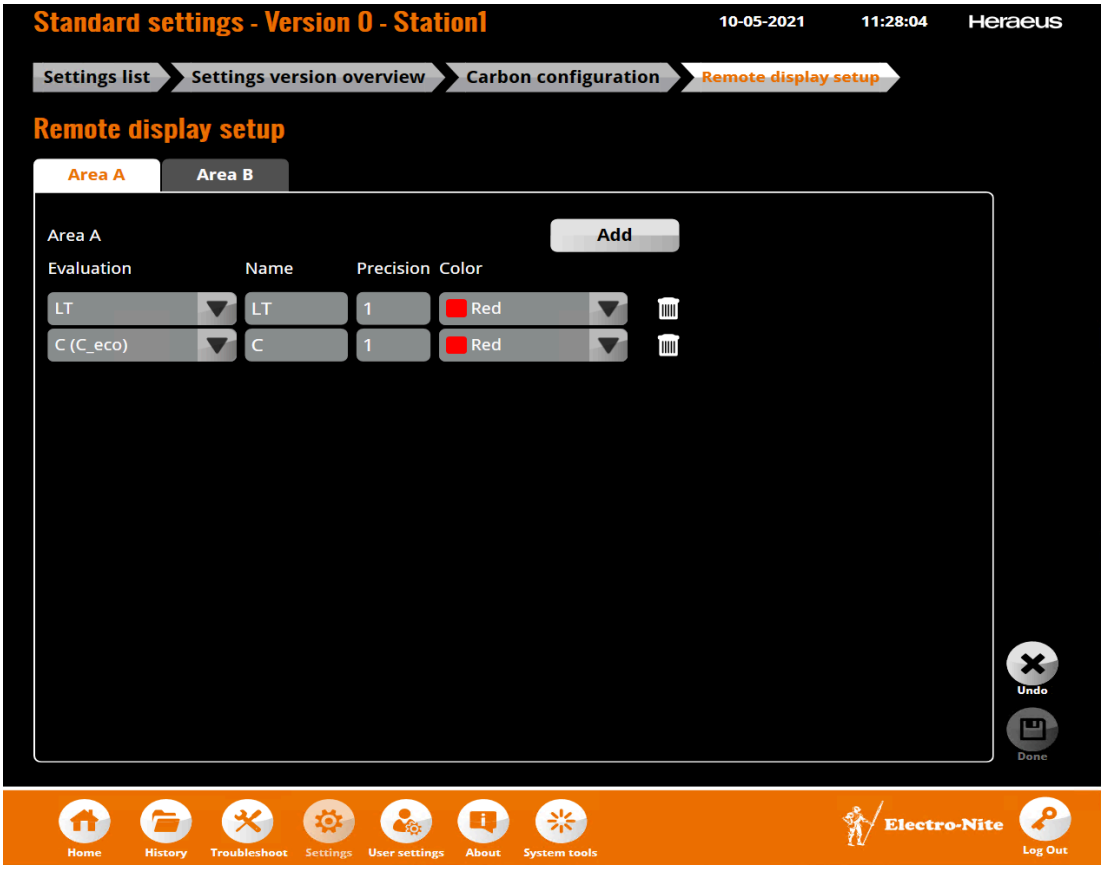
11 Select which results to display in which position on the window.

Note: *You can also show equation results in any position – see section 8.6.4.1. for more details.*

12 Enter the precision with which results will be displayed.

For example, entering 1 for LT means that the liquidus temperature result will be displayed with one value after the decimal place.

13 To configure a Remote display, click the Remote display setup button.
The next screen is displayed:



You can configure up to 5 scrolling results (the list of all possible results is automatically shown). Precision, name (max 5 characters) and colors (7 different colors) can be configured.

Note: *The current displays RD251 and RD231 have only two areas.*

14 After making changes in any of the sections in the measurement configuration window, click **Save** to save your changes or **Undo** to undo your changes.

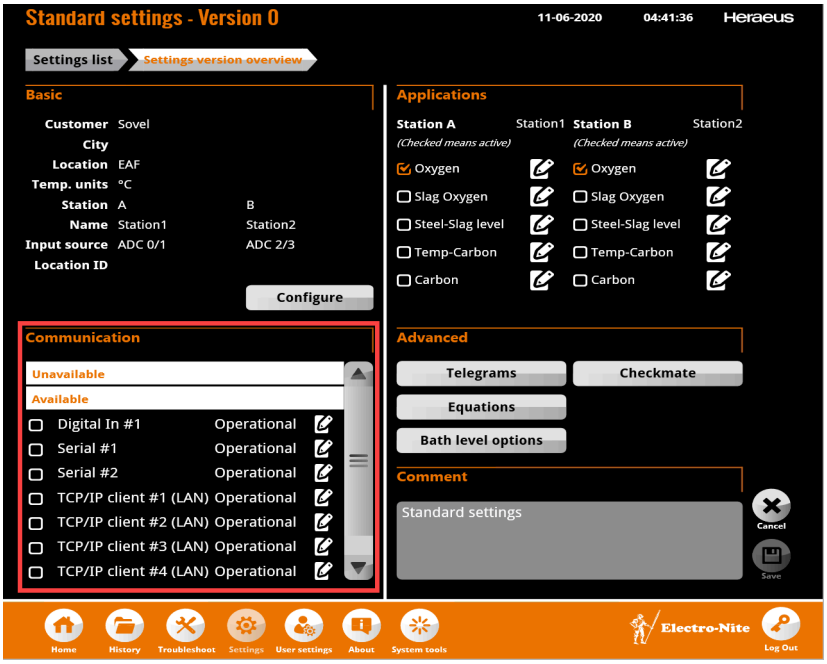
8.6.3. Edit the communications settings

The Sensor Lab has various interface connections. These can be used to transfer measurement or status information to or from peripheral equipment. These connections are:

- BCD out (1 and 2)
- Digital in #1
- EtherNet/IP
- mA in
- mA out (1 and 2)
- Modbus RTU (1 and 2)
- Profibus (1 and 2)
- Profinet (1 and 2)

- Serial (1 and 2)
- TCP/IP client LAN (1-4)
- TCP/IP server LAN
- Modbus TCP

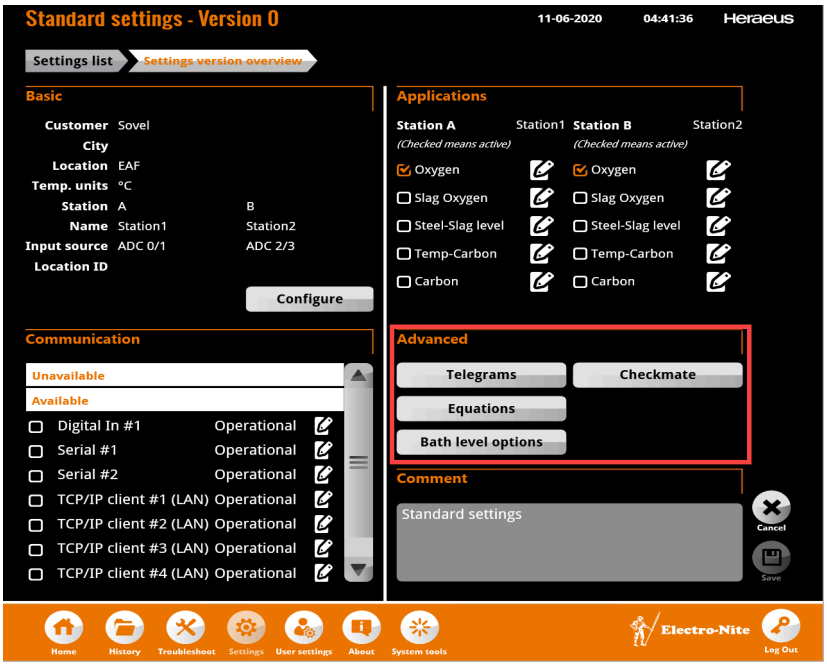
These are listed in the Communication section of the Settings version overview window (bottom left).



Click the edit button next to the available communication output you want to configure. The available communication outputs are those that are installed.

Each communication type can send out (transmit) information about a measurement. Most do it in the form of a telegram, but the mA out and BCD out do it using current and voltage. See section 9.4. for information about creating telegrams. Most communication types can also send out data through registers, see the communication section for more information.

8.6.4. Edit advanced settings



In the advanced settings you can configure:

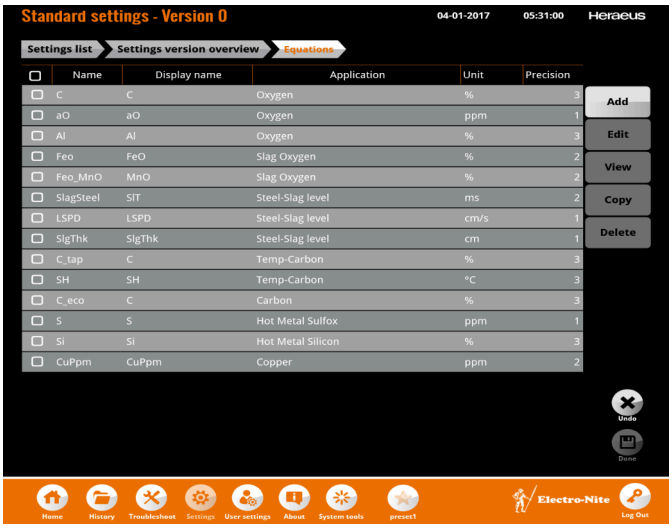
- Data telegrams (9.4.)
- Equations (8.6.4.1.)
- Bath level options (8.6.4.2.)
- Checkmate detection (8.6.4.3.)

8.6.4.1. Create equations

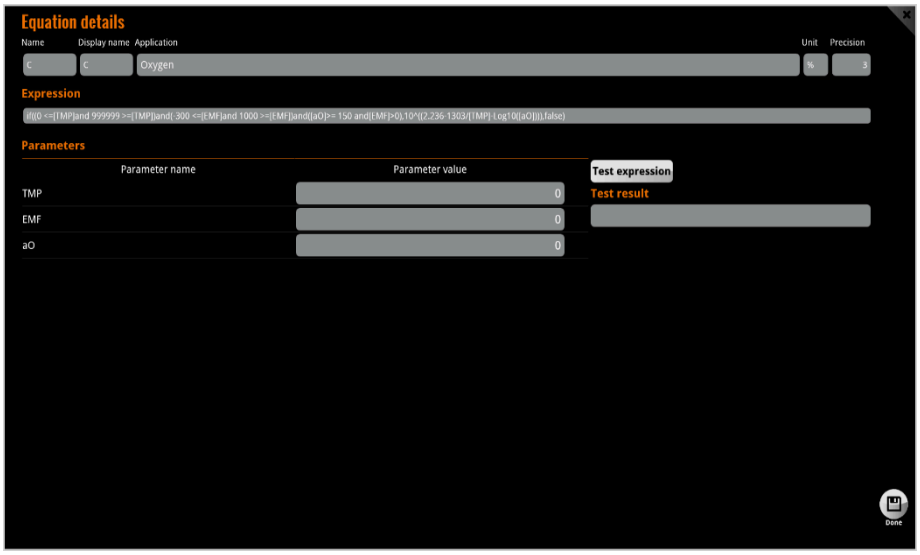
Besides measuring temperature and EMF values, the Sensor Lab provides values obtained by calculation equations. In the advanced settings section you can see and manage these equations.
To perform this task you need to log in first.

Procedure

1 In the Settings window select the version you would like to configure by clicking on the check box in front. Click **Edit**.
2 In the Settings version overview window, click Equations in the Advanced section:



3 To **view** the contents of an equation, click the equation then click View. The Equation details window is displayed:



4 Click the Test expression button to test the equation using the parameter values entered. The Test result field shows the result. Click Done to close the window.

> ***Note:*** *'expression' is just a word for how the equation is expressed.*

5 To **edit** an equation, select the equation you want to edit then click Edit. The Equation editor window is displayed. Of the default equations, only S, Si, and LSPD can be edited.

6 To **copy** an equation, select the equation you want to copy then click Copy. The Equation editor window is displayed. You can adjust the fields and give a new, unique name for the copied equation.

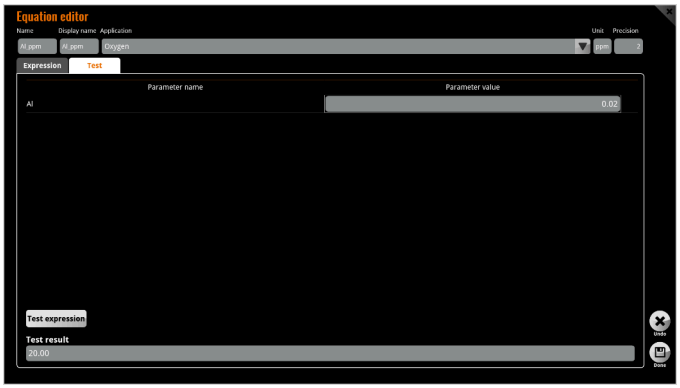
7 To **delete** an equation, select the equation you want to delete then click Delete. Confirmation is then needed. Of the default equations, only S, Si, and LSPD can be deleted. Also, you can only delete an equation if it not in use by another equation.

8 To **add** an equation, click Add. The Equation editor window is displayed.

Note: *Because they are reserved as names of evaluated results, you cannot use the following as a name for a new equation: TMP, EMF, SLAG, STEEL, LT and SH.*

In the following example, Al has been chosen from Variables & Equations:

Click Test to display the following:



The parameter value 0.02 has been entered and Test expression clicked to test the new equation with that value. The test result shows 20.00 ppm, which is rounded because the precision was set to 2 in the Properties tab of the Equation editor window.

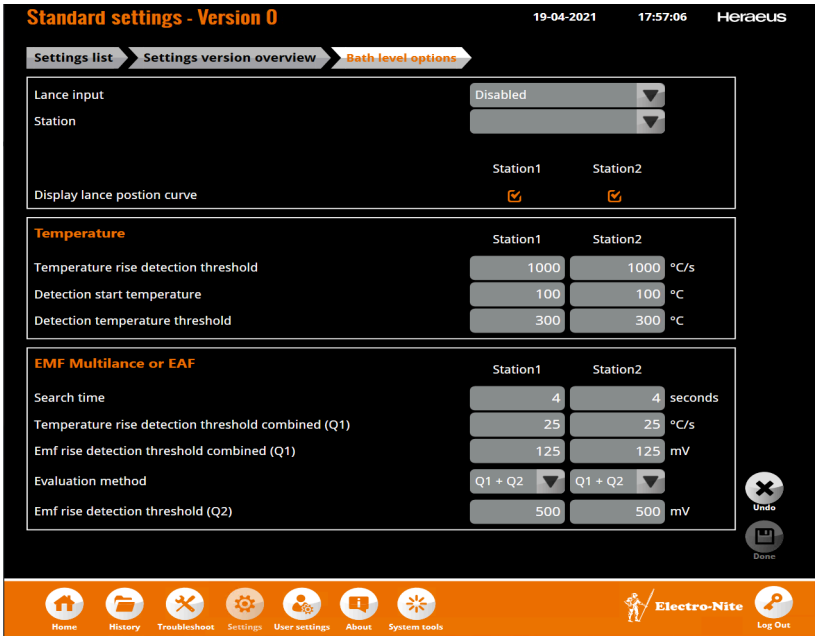
Note: *Equation results can be shown in any of the display values (slots 1 to 6) on the measurement window for the application selected in the equation editor, for example, the temperature/oxygen measurement application. Equation results can also be used in telegrams.*

8.6.4.2. Bath level options

Probes with a bath temperature sensing thermocouple have an optional bath level output. To have the most accurate detection of bath level with these probes, the digital IO option must be installed. If not, a bit in the status word can also be used.

The pulse can be used to control the automatic lance movements. Bath level is detected using the temperature signal. The bath level is determined by detecting the rapid rise of temperature as the probe enters the bath.

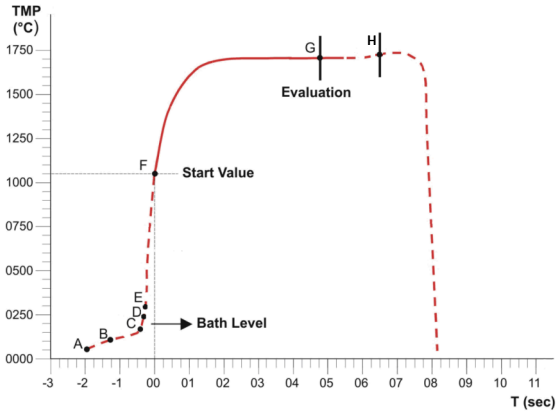
To configure the bath level options, press Bath level options in the Advanced section to display the following window:



In the first block select from which source the lance input position should be used and select the station.

In the second block, Temperature, define the start temperature and thresholds for detection. The goal is to provide feedback when the probe reaches the melt surface for level estimation and immersion depth control. The detection mechanism is based on the fast temperature rise when the probe approaches the melt. ‘Fast temperature rise’ means that the slope is 1000°C or more or the threshold of 300°C has been exceeded. In this case, and if enabled in the active settings set, bath level is found and shown in the measurement window.

The following graph shows the principle of temperature against time for bath level detection:



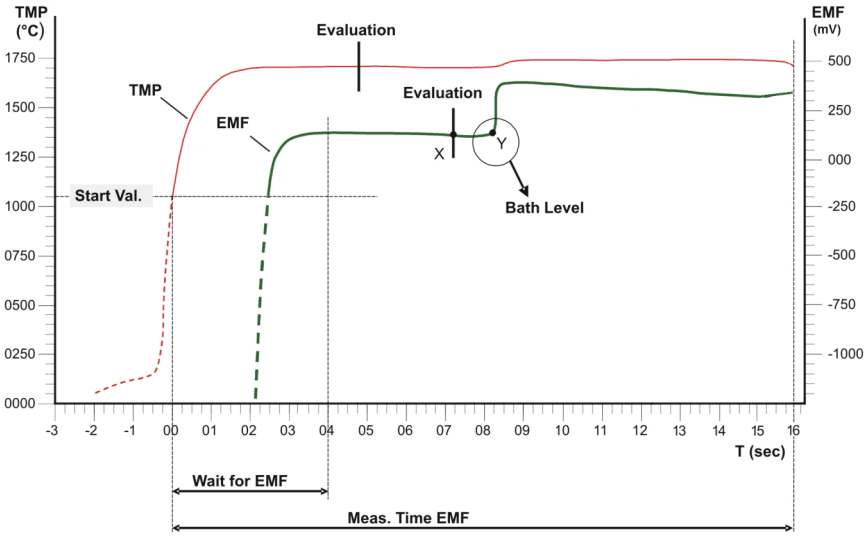
A	The temperature of the probe increases when it approaches the bath surface.
B	The bath level detection system is enabled (Detection start temperature).
C + D	The probe enters the bath (rapid temperature rise in the curve). Bath level is detected at this point. C is the slope of the temperature curve (Temperature rise detection threshold).
E	Emergency stop position of probe. The probe is stopped when this temperature (300°C) is reached, in case the previous attempt failed. This level is set by Detection temperature threshold.
F	The measurement curve is displayed on the screen.
G	The temperature evaluation is complete. The instrument switches to END status (red light). The curve display on the screen stops and the probe rises.
H	The probe leaves the bath (slight temperature rise when passing the slag layer). This is only visible for a ‘fixed time measurment’.

In the third block, EMF Multilance or EAF, configure the Search time. This can differ per station setup. This is the time to configure the search time after evaluation of both channels. Bathlevel algorithm will start after evaluations are found for TMP and EMF. Configure the threshold for °C/s and mV.

Bath level can be determined through post calculation by the rise of the temperature when the lance is going out the bath on retraction (conditions defined in block 2). It can also be derived from the EMF signal of the probe when it is leaving the bath (conditions defined in block 3). When the probe comes out of the liquid steel, it must pass the slag layer floating on the surface. Because this slag has a significantly higher oxygen activity, the probe generates a sudden rise of the EMF signal. This transition is recognised as the bath level.

When bathlevel is determined based upon the combined trigger of TC and EMF, you get a Q1 measurement. When bathlevel is determined only based on the EMF curve, you get a Q2 measurement.

The figure below shows the TMP and the EMF measuring curves. The EMF curve starts a few seconds after the TMP curve.

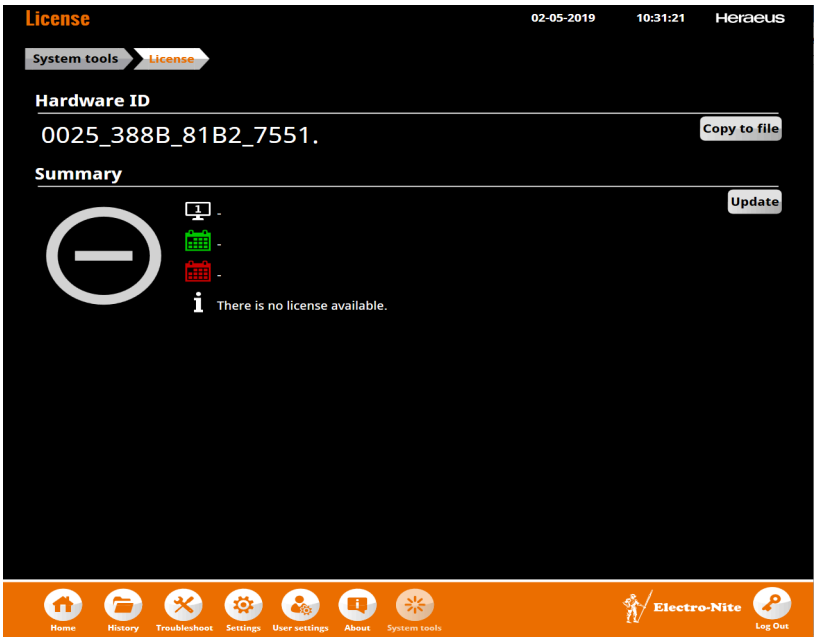


The Sensor lab instrument signals the detection of the bath surface by switching the “Bath Level” signal active upon detection. (See section for details.) The signal will reset again after the measurement has completed.

Enter or change details in the fields as required then click **Save** to save your changes or **Cancel** to abort your changes and return to the previous window.

There is a licence necessary for bathlevel EMF.

- Click on License in the Systems tools screen (7.4.).
- Copy Hardware ID to file and send file to after-sales-instruments.electro-nite.be@heraeus.com.
  Heraeus Electro-Nite generates a license code to activate the Bathlevel Post calculation.
- To update the licence a day password is required.
- License is limited in time.

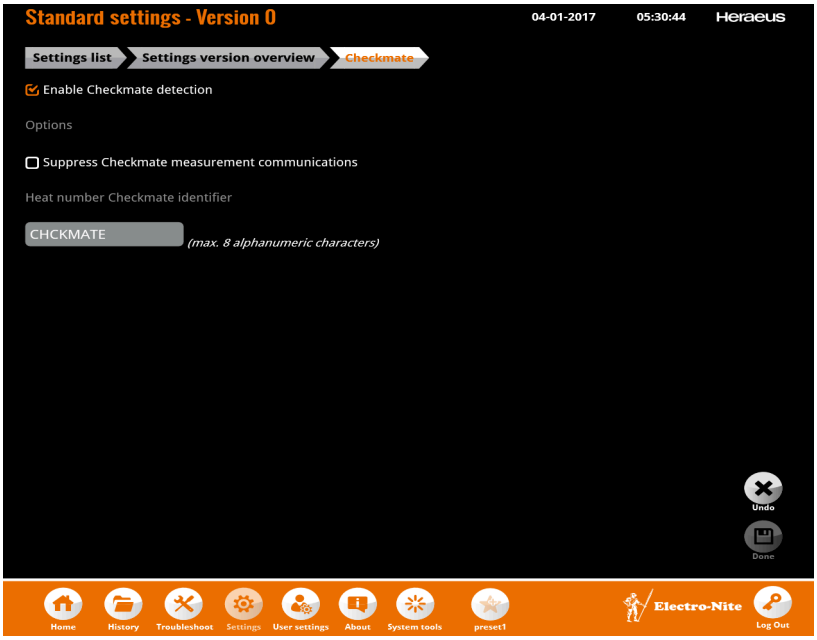


8.6.4.3. Enable checkmate detection

To perform this task you need to log in first.

In the Settings window select the version you would like to configure by clicking on the check box in front. Click **Edit**.

In the Settings version overview window, clcik Checkmate in the Advanced section to display the following window:



You can:

- Enable or disable detection of measurements taken with a Checkmate instrument
- Allow (or not) Checkmate measurements to be included in telegrams. This is very important for testing the telegrams, for example, during instrument installation.
- Enter up to eight alphanumeric characters to identify a Checkmate instrument in the history. The heat number identifier is replaced by the checkmate identifier string.

The Checkmate is an instrument for checking the correct working of the Sensor Lab in its temperature range.

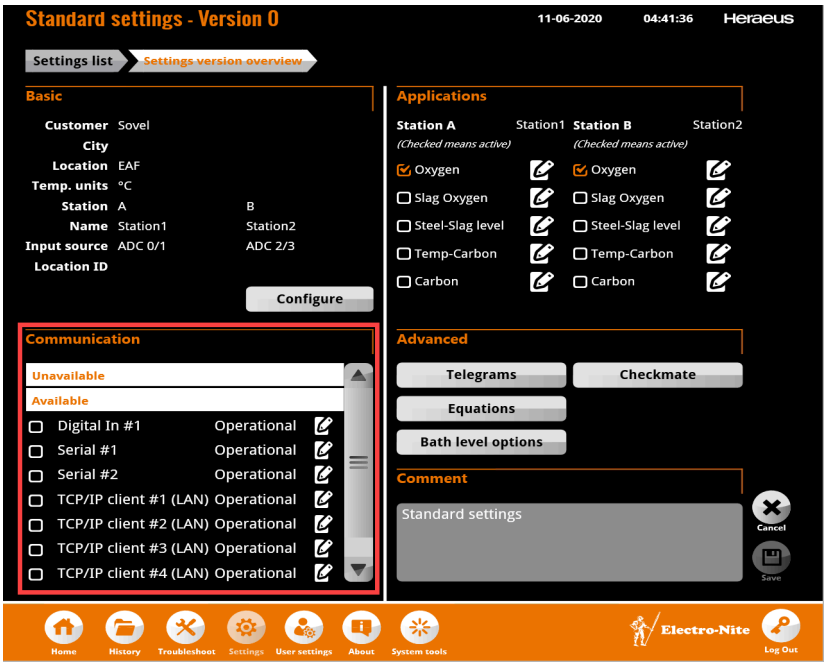
Click **Save** to save your changes or **Cancel** to abort your changes and return to the previous window.

9. Level2 communication

The Sensor Lab has various interface connections. These can be used to transfer measurement or status information to or from peripheral equipment. These connections are:

- BCD out (1 and 2)
- Digital in #1
- EtherNet/IP
- mA in
- mA out (1 and 2)
- Modbus RTU (1 and 2)
- Profibus (1 and 2)
- Profinet (1 and 2)
- Serial (1 and 2)
- TCP/IP client LAN (1-4)
- TCP/IP server LAN
- Modbus TCP

These are listed in the Communication section of the Settings version overview window (bottom left).



Click the edit button next to the available communication output you want to configure. The available communication outputs are those that are installed.

Table 5: Level2 function overview

	Lance input	Output via signal cable	Divar	Input telegram	Output telegram	Register mode
BCD out (1 and 2)	no	yes (4)	no	no	no	no
Digital in #1	yes (BCD)	no	yes	no	no	no
EtherNet/IP	yes	no	no	yes	yes	yes
mA in	yes	no	no	no	no	no
mA out (1 and 2)	no	yes(4)	no	no	no	no
Modbus RTU (1 and 2)	no	no	no	yes	yes	no

Table 5: Level2 function overview

	Lance input	Output via signal cable	Divar	Input telegram	Output telegram	Register mode
Profibus (1 and 2)	yes	no	no	yes	yes	yes
Profinet (1 and 2)	yes	no	no	yes	yes	yes
Serial (1 and 2)	no	no	no	yes	yes	no
TCP/IP client LAN (1-4)	no	no	no	yes	yes	no
TCP/IP server LAN	no	no	no	yes	yes	no
Modbus TCP	yes	no	no	yes	yes	yes

9.1. Output registers

When you make use of registers for output, the instrument only updates the properties that have been modified. A non fixed output register of 128 bytes (big & little endian) is available on all communication buses that are marked to use registers instead of telegrams. The following are the default output registers:

Table 6: Ouput registers

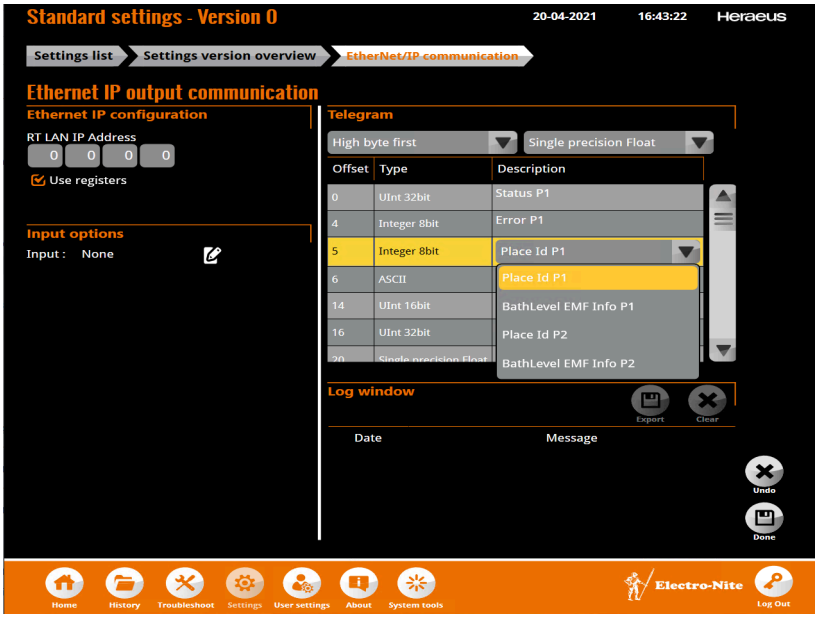
Offset	Place	Property	Format
0	1	Status	bytes
4	1	Error	byte
5	1	Place ID, Bathlevel EMF[1]	byte
6	1	Heat Number	ascii
14	1	UTC Date	Integer (Total milliseconds since midnight)
16	1	UTC Time	double integer (Number of days since 01/01/1990)
20	1	TMP [2]	float
24	1	EMF	float
28	1	Ao	float
32	1	Al	float
36	1	C	float
40	1	FeO	float
44	1	Sample Index	float
48	1	Sample CH 0	float
52	1	Sample CH 1	float
56	1	Resistance CH 0	float
60	1	Resistance CH 1	float
64	2	Status	bytes
68	2	Error	byte
69	2	Place ID, Bathlevel EMF [1]	byte
70	2	Heat Number	ascii

1 Dropdown menu
2 From Offset 20 - 40 and 84 - 120 you can choose the result from a drop down list

Table 6: Ouput registers

Offset	Place	Property	Format
78	2	UTC Date	Integer (Total milliseconds since midnight)
80	2	UTC Time	double integer (Number of days since 01/01/1990)
84	2	TMP [2]	float
88	2	EMF	float
92	2	Ao	float
96	2	Al	float
100	2	C	float
104	2	FeO	float
108	2	Sample Index	float
112	2	Sample CH 0	float
116	2	Sample CH 1	float
120	2	Resistance CH 0	float
124	2	Resistance CH 1	float

1 Dropdown menu
2 From Offset 20 - 40 and 84 - 120 you can choose the result from a drop down list



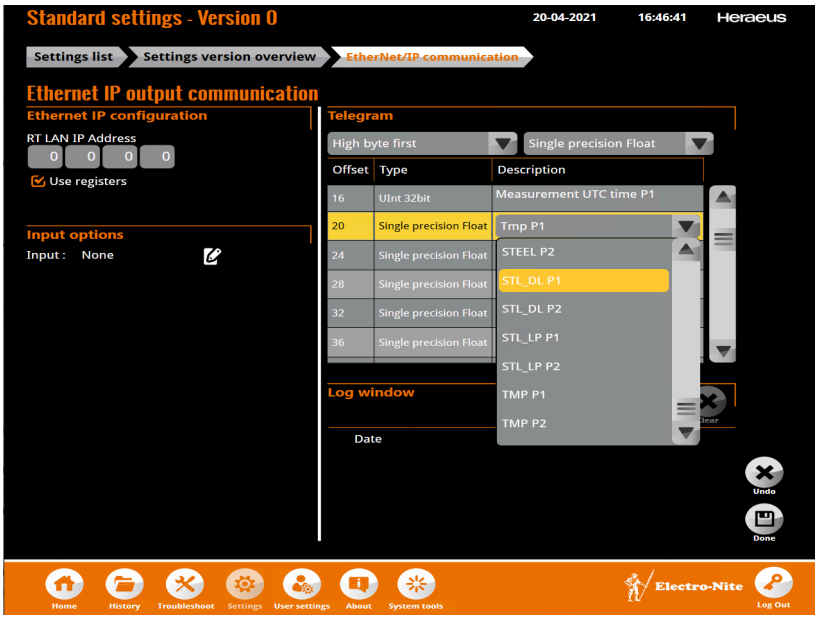


Table 7: Example: High Byte First; Big Endian, standard register output

Word	Station	Description+length	Value (example)	Detailed description
0	1	status byte 3 - bit 0	0	E (HEX)
		status byte 3 - bit 1	0	
		status byte 3 - bit 2	1	
		status byte 3 - bit 3	1	
		status byte 3 - bit 4	0	4 (HEX)
		status byte 3 - bit 5	1	
		status byte 3 - bit 6	0	
		status byte 3 - bit 7	0	
		status byte 4 - bit 0	1	bit : Place 1
		status byte 4 - bit 1	0	bit : Place 2
		status byte 4 - bit 2	0	
		status byte 4 - bit 3	0	
		status byte 4 - bit 4	0	
		status byte 4 - bit 5	0	
		status byte 4 - bit 6	0	
		status byte 4 - bit 7	0	

Table 7: Example: High Byte First; Big Endian, standard register output

Word	Station	Description+length	Value (example)	Detailed description
1	1	status byte 1 - bit 0	0	Red - End of measurement
		status byte 1 - bit 1	0	Yellow - Measurement busy
		status byte 1 - bit 2	1	Green - Probe detected
		status byte 1 - bit 3	0	Error measurement
		status byte 1 - bit 4	0	Carbon measurement
		status byte 1 - bit 5	0	Bath Level
		status byte 1 - bit 6	0	Celox Probe (Emf) Measurement
		status byte 1 - bit 7	0	Txd Complete - End of communication
		status byte 2 - bit 0	0	start measurement viewer
		status byte 2 - bit 1	0	Lines Open
		status byte 2 - bit 2	0	End Measurement Viewer
		status byte 2 - bit 3	0	Level Probe
		status byte 2 - bit 4	0	Celox Slac Probe
		status byte 2 - bit 5	0	Insulation Warning
		status byte 2 - bit 6	0	Blinking Active
		status byte 2 - bit 7	0	Horn Active
2	1	Place ID byte 3 - bit 0	0	
		Place ID byte 3 - bit 1	0	
		Place ID byte 3 - bit 2	0	
		Place ID byte 3 - bit 3	0	
		Place ID byte 3 - bit 4	0	
		Place ID byte 3 - bit 5	0	
		Place ID byte 3 - bit 6	0	
		Place ID byte 3 - bit 7	0	
		Error byte 4 - bit 0	0	No Cold Junction
		Error byte 4 - bit 1	0	TC Break
		Error byte 4 - bit 2	0	N/A
		Error byte 4 - bit 3	0	N/A
		Error byte 4 - bit 4	0	RF Link Wireless broken during Measurement
		Error byte 4 - bit 5	0	Bad Reception, RF link has bad Connection
		Error byte 4 - bit 6	0	No Evaluation (NE)
		Error byte 4 - bit 7	0	N/A
3	1	Heat byte 2 | 1 ascii char	0x3231	ASCII "2" "1"
4	1	Heat byte 4 | 3 ASCII CHAR	0x3433	ASCII "4" "3"
5	1	HEAT 6 | 5 ASCII CHAR	0x3635	ASCII "6" "5"
6	1	HEAT 8|7 ASCII CHAR	0x3837	ASCII "8" "7"

Table 7: Example: High Byte First; Big Endian, standard register output

Word	Station	Description+length	Value (example)	Detailed description
7	1	DATE UTC integer	6699	Integer (Total milliseconds since midnight)
8	1	TIME UTC double integer long	49232723	double integer (Number of days since 01/01/1990)
9				
10	1	TEMP float (real)	1698.74	Temperature of Place 1
11				
12	1	EMF FLOAT(real)	200.05	EMF of Place 1
13				
14	1	aO FLOAT(real)	1113.15	Ao
15				
16	1	AL FLOAT(real)	1,36E-14	AL
17				
18	1	C FLOAT(real)	0.0264	C
19				
20	1	FEO FLOAT(real)	1,36E-19	FeO
21				
22	1	Sample Index float(real)	2.8	Sample Index (counter)
23				
24	1	sample CH0 float(real)	1697.94	Sample Ch0 (TMP) (with above sample index number)
25				
26	1	sample CH1 float(real) 2	200.01	Sample Ch1 (EMF) (with above sample index number)
27				
28	1	RES CH0 float(real) 22	108928	Online Resistance CH 0
29				
30	1	RES CH1 float(real) 23	2,25628E+13	Online Resistance CH 1
31				

Table 7: Example: High Byte First; Big Endian, standard register output

Word	Station	Description+length	Value (example)	Detailed description
32	2	status byte 3 - bit 0	0	E (HEX)
		status byte 3 - bit 1	0	
		status byte 3 - bit 2	1	
		status byte 3 - bit 3	1	
		status byte 3 - bit 4	0	4 (HEX)
		status byte 3 - bit 5	1	
		status byte 3 - bit 6	0	
		status byte 3 - bit 7	0	
		status byte 4 - bit 0	1	bit : Place 1
		status byte 4 - bit 1	0	bit : Place 2
		status byte 4 - bit 2	0	
		status byte 4 - bit 3	0	
		status byte 4 - bit 4	0	
		status byte 4 - bit 5	0	
		status byte 4 - bit 6	0	
		status byte 4 - bit 7	0	
33	2	status byte 1 - bit 0	0	Red - End of measurement
		status byte 1 - bit 1	0	Yellow - Measurement busy
		status byte 1 - bit 2	1	Green - Probe detected
		status byte 1 - bit 3	0	Error measurement
		status byte 1 - bit 4	0	Carbon measurement
		status byte 1 - bit 5	0	Bath Level
		status byte 1 - bit 6	0	Celox Probe (Emf) Measurement
		status byte 1 - bit 7	0	Txd Complete - End of communication
		status byte 2 - bit 0	0	start measurement viewer
		status byte 2 - bit 1	0	Lines Open
		status byte 2 - bit 2	0	End Measurement Viewer
		status byte 2 - bit 3	0	Level Probe
		status byte 2 - bit 4	0	Celox Slac Probe
		status byte 2 - bit 5	0	Insulation Warning
		status byte 2 - bit 6	0	Blinking Active
		status byte 2 - bit 7	0	Horn Active

Table 7: Example: High Byte First; Big Endian, standard register output

Word	Station	Description+length	Value (example)	Detailed description
34	2	Place ID byte 3 - bit 0	1	
		Place ID byte 3 - bit 1	0	
		Place ID byte 3 - bit 2	0	
		Place ID byte 3 - bit 3	0	
		Place ID byte 3 - bit 4	0	
		Place ID byte 3 - bit 5	0	
		Place ID byte 3 - bit 6	0	
		Place ID byte 3 - bit 7	0	
		Error byte 4 - bit 0	0	No Cold Junction
		Error byte 4 - bit 1	0	TC Break
		Error byte 4 - bit 2	0	N/A
		Error byte 4 - bit 3	0	N/A
		Error byte 4 - bit 4	0	RF Link Wireless broken during Measurement
		Error byte 4 - bit 5	0	Bad Reception, RF link has bad Connection
		Error byte 4 - bit 6	0	No Evaluation (NE)
		Error byte 4 - bit 7	0	N/A
35	2	Heat byte 2 | 1 ascii char	0x3231	ASCII "2" "1"
36	2	Heat byte 4 | 3 ASCII CHAR	0x3433	ASCII "4" "3"
37	2	HEAT 6 | 5 ASCII CHAR	0x3635	ASCII "6" "5"
38	2	HEAT 8|7 ASCII CHAR	0x3837	ASCII "8" "7"
39	2	DATE UTC integer	6699	Integer (Total milliseconds since midnight)
40	2	TIME UTC double integer long	49232723	double integer (Number of days since 01/01/1990)
41				
42	2	TEMP float (real)	1698.74	Temperature of Place 2
43				
44	2	EMF FLOAT(real)	200.05	EMF of Place 2
45				
46	2	aO FLOAT(real)	1113.15	Ao
47				
48	2	AL FLOAT(real)	1,36E-14	AL
49				
50	2	C FLOAT(real)	0.0264	C
51				
52	2	FEO FLOAT(real)	1,36E-19	FeO
53				

Table 7: Example: High Byte First; Big Endian, standard register output

Word	Station	Description+length	Value (example)	Detailed description
54	2	Sample Index float(real)	2.8	Sample Index (counter)
55				
56	2	sample CH0 float(real)	1697.94	Sample Ch0 (TMP) (with above sample index number)
57				
58	2	sample CH1 float(real) 2	200.01	Sample Ch1 (EMF) (with above sample index number)
59				
60	2	RES CH0 float(real) 22	108928	Online Resistance CH 0
61				
62	2	RES CH1 float(real) 23	2,25628E+13	Online Resistance CH 1
63				

You can choose between high byte or low byte first. All float results are editable and can be configured from the variable list available. Also Int32bit configuration is possible. See the following picture:

9.1.1. Status Bytes

The status is represented by four bytes:

Word	Description + length	Value (example)	Detailed description
0	status byte 1 - bit 0	0	Red - End of measurement
	status byte 1 - bit 1	0	Yellow - Measurement busy
	status byte 1 - bit 2	1	Green - Probe detected
	status byte 1 - bit 3	0	Error measurement
	status byte 1 - bit 4	0	Carbon measurement
	status byte 1 - bit 5	0	Bath Level
	status byte 1 - bit 6	0	Celox Probe (Emf) Measurement
	status byte 1 - bit 7	0	Txd Complete - End of communication
	status byte 2 - bit 0	0	start measurement viewer
	status byte 2 - bit 1	0	Lines Open
	status byte 2 - bit 2	0	End Measurement Viewer
	status byte 2 - bit 3	0	Level Probe
	status byte 2 - bit 4	0	Celox Slac Probe
	status byte 2 - bit 5	0	Insulation Warning
	status byte 2 - bit 6	0	Blinking Active
	status byte 2 - bit 7	0	Horn Active
1	status byte 3 - bit 0	0	E (HEX) (for the different probe types see table below)
	status byte 3 - bit 1	0	
	status byte 3 - bit 2	1	
	status byte 3 - bit 3	1	
	status byte 3 - bit 4	0	4 (HEX) (for the different probe types see table below)
	status byte 3 - bit 5	1	
	status byte 3 - bit 6	0	
	status byte 3 - bit 7	0	
	status byte 4 - bit 0	1	bit : Station 1 [1]
	status byte 4 - bit 1	0	bit : Station 2 [1]
	status byte 4 - bit 2	0	
	status byte 4 - bit 3	0	
	status byte 4 - bit 4	0	
	status byte 4 - bit 5	0	
	status byte 4 - bit 6	0	
	status byte 4 - bit 7	0	

1 The measurement place byte. This byte is 0x00 for station 1 and 0x01 for station 2.

Table 8: Possible probe types for status byte 3

HEX	ASCII	Probe type
4E	N	no probe, open line
54	T	temperature
43	C	carbon
4F	O	oxygen
44	D	carbon+oxygen
53	S	oxygen in slag
4C	L	level
45	E	E-con-O-Carb

- N: Open lines
- T: Temperature measurement on channel 0, for example, probes like Positherm
- O: Oxygen - temperature + EMF, for example, probes like Celox
- C: Carbon - temperature measurement on channel 1 and 2, for example, probes like Tap-Tip
- L: Level probe (Delta-Dist L)
- E: Temperature measurement on channel 1, for example, probes like Econ-O-Carb
- D: Double - carbon and oxygen, temperature, and temperature + EMF
- S: EMF measurement on channel 1 (only when the Celox SLAC probe is connected)

9.1.2. Channel Evaluation Status Byte

The channel evaluation status byte can be found in the telegram composer under the name “info”. An evaluation byte can be selected for each channel.

Bit	7	6	5	4	3	2	1	0
Value	CM	NE	N/A	N/A	Ev4	Ev3	Ev2	Ev1

CM = Checkmate measurement.

- CM = 1 when Checkmate detection is enabled and Checkmate measurement is detected.
- CM = 0 at end Red and Probe off.

NE = No evaluation.

- NE = 1 when no evaluation was found after maximum or fixed measurement time.
- NE = 0 at end Red and Probe off.

EvX = Quality of the evaluation:

- Ev1 = Evaluation of quality 1 is found (best quality)
- Ev2 = Evaluation of quality 2 is found
- Ev3 = Evaluation of quality 3 is found
- Ev4 = Evaluation of quality 4 is found

9.1.3. Error Bytes

The error byte can be found in the telegram composer under the name “Error byte”.

Word	Description + length	Value (example)	Detailed description
2	Place ID byte 3 - bit 0	0	
	Place ID byte 3 - bit 1	0	
	Place ID byte 3 - bit 2	0	
	Place ID byte 3 - bit 3	0	
	Place ID byte 3 - bit 4	0	
	Place ID byte 3 - bit 5	0	
	Place ID byte 3 - bit 6	0	
	Place ID byte 3 - bit 7	0	
	Error byte 4 - bit 0	0	No Cold Junction
	Error byte 4 - bit 1	0	TC Break
	Error byte 4 - bit 2	0	N/A
	Error byte 4 - bit 3	0	N/A
	Error byte 4 - bit 4	0	RF Link Wireless broken during Measurement
	Error byte 4 - bit 5	0	Bad Reception, RF link has bad Connection
	Error byte 4 - bit 6	0	No Evaluation (NE)
	Error byte 4 - bit 7	0	N/A

- NE = No evaluation = 1 if any evaluation fails. NE = 0 at end Red and Probe off
- Bad reception = RF link has bad connection = 1.
- RF Link = RF link broken during measurement. Cleared at end Red and Probe off.
- TC Break = Thermocouple break detected before evaluation. Cleared at end Red and Probe off.
- NoCJC = No cold junction compensation available.

9.1.4. Bathlevel Bytes

The bath level info byte details can be found in the telegram composer under the name “Bathlevel EMF info”.

Description + length	Value (example)	Detailed description
Bathlevel EMF info - bit 0	0	NoEval
Bathlevel EMF info - bit 1	0	Quality 1
Bathlevel EMF info - bit 2	0	Quality 2
Bathlevel EMF info - bit 3	0	Reserved
Bathlevel EMF info - bit 4	0	Reserved
Bathlevel EMF info - bit 5	0	Reserved
Bathlevel EMF info - bit 6	0	Reserved
Bathlevel EMF info - bit 7	0	Reserved

- NoEval = no bath level could be calculated
- Quality 1 = Bathlevel measurement based upon combined trigger of TC and EMF curve
- Quality 2 = Bathlevel measurements only on EMF curve

9.2. Input registers

You can choose to use registers for input. A fixed input register of 128 bytes (big endian) is available on all communication buses that are marked to use registers instead of telegrams. The formats used for the specific properties (heat number, settings preset name, date and time) conform to the input telegrams described in the section 9.5. .
The following are the input registers:

Offset	Place	Property	Format
0	1	Heat Number	Ascii
8	1	Date	Ascii (yyyyMMdd)
16	1	Time	Ascii (HH:mm:ss)
24	1	Settings preset name	Ascii
32	1	Lance	Int32
36	1	VAR1_1	Floating point
40	1	VAR2_1	Floating point
44	1	VAR3_1	Floating point
48	1	VAR4_1	Floating point
52	1	VAR5_1	Floating point
56	1	VAR6_1	Floating point
60	2	Heat number	Ascii
68	2	Date	Ascii (yyyyMMdd)
76	2	Time	Ascii (HH:mm:ss)
84	2	Settings preset name	Ascii
92	2	Lance	Int32

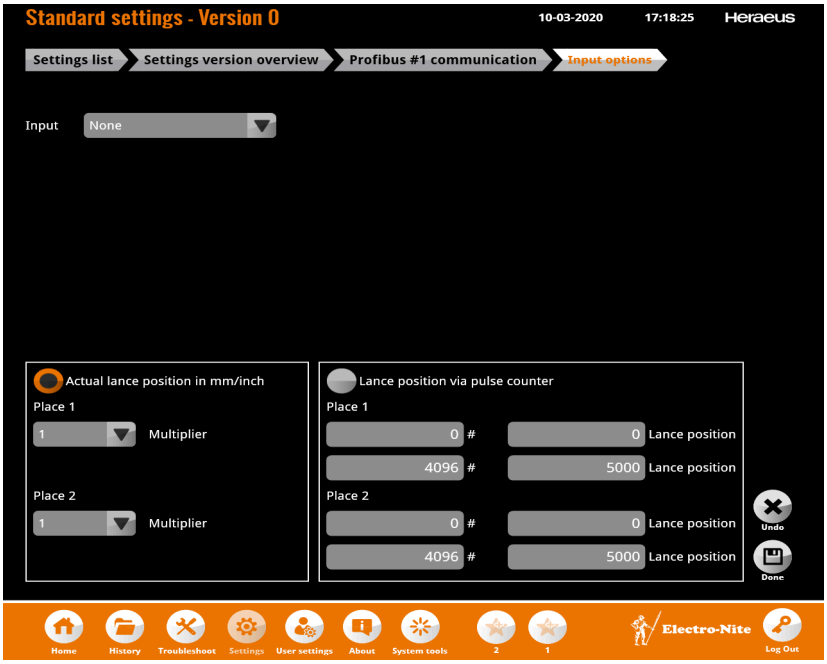
Offset	Place	Property	Format
96	2	VAR1_2	Floating point
100	2	VAR2_2	Floating point
104	2	VAR3_2	Floating point
108	2	VAR4_2	Floating point
112	2	VAR5_2	Floating point
116	2	VAR6_2	Floating point

Note: *If all bytes are set to the null byte or blank space, a property is marked as unused and is ignored. A property is only updated when it is changed. Properties having values, but with no changes are ignored*

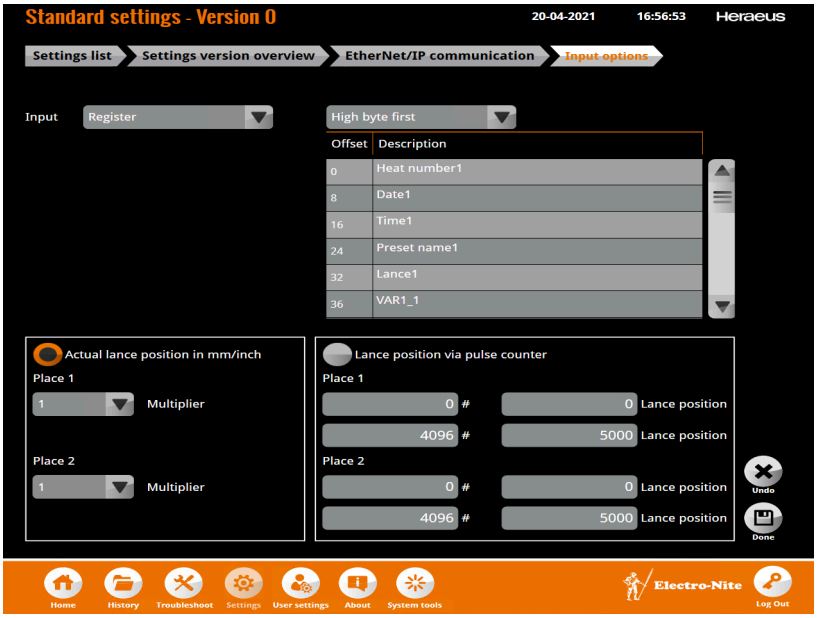
Note: *The VAR inputs can be used within measurements to have variable inputs for calculating formulas.*

9.2.1. Register input

Click on the edit button next to input. The following screen is displayed.



Change input to Register. The following screen is displayed.



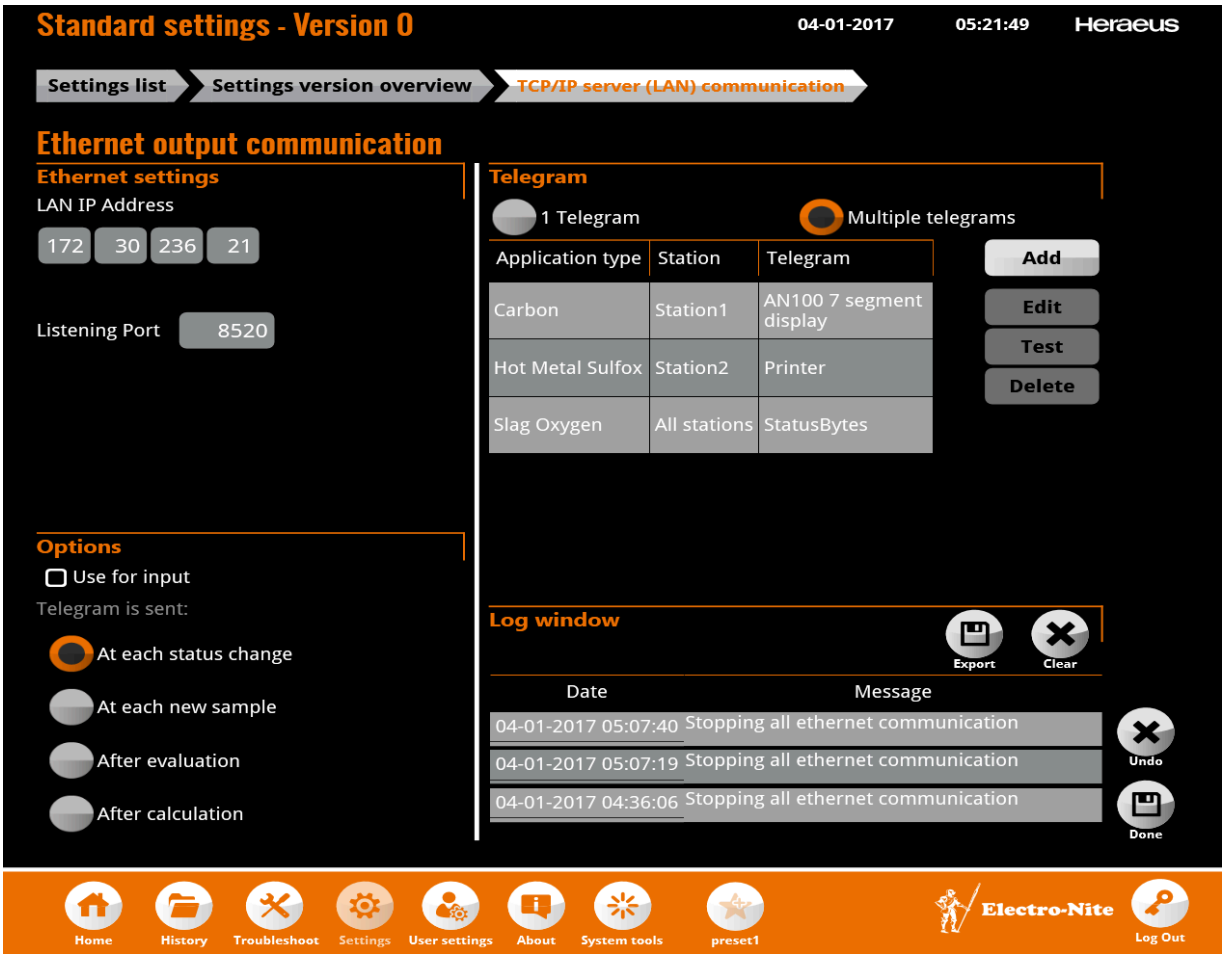
Choose high byte or low byte first.

Note: *If variable inputs are added in the input register these changes are activated when a new input from the level 2 system of the customer is received.*

Choose between the actual lance position or defining the lance position via the pulse counter. Set values.

9.3. Output telegrams

In the Telegram section of most output settings, select the 1 Telegram radio button to send one telegram for each application or select the Multiple telegrams radio button to send a different telegram for each application.



Touch the Test button to send out the selected telegram over the configured communication type, provided that this communication type is already configured and enabled in the current, active settings set. The configuration data of the active set is used to send the data. The data in the test telegram consists of the configured test data for the selected telegram in the telegram composer. For example, if the Standard telegram is configured as 1 or multiple telegram for the selected communication type. To change the data of the test telegram in the telegram composer:

1 Edit the Standard telegram.
2 Touch Edit test data.
3 Save the changes.
4 Return to the selected communication type.
5 Select the telegram (highlighted in yellow).
6 Touch the Test button.

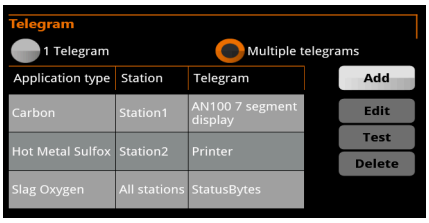
The Sensor Lab can have more than one communication type running at the same time and you might, for example, want to use serial communication for Temperature-Carbon measurements and Ethernet/IP for Oxygen measurements. Also, for example, you might only want station 1 to transmit telegrams using Ethernet/IP, but not station 2.

For the selected communication type, you can bind telegrams to applications and stations. For example, for the EtherNet/IP output communication type, you can transmit the Standard telegram for the Oxygen application and the Standard TapTip telegram for the Temperature-Carbon application. You can also bind one telegram to one measurement application and one measurement station. You are free to bind other telegrams to the other measurement station for the same measurement application.

An example of using the Multiple telegrams radio button:

- Station 1 measures temperature, oxygen, and carbon. The Standard telegram is selected for temperature, the StatusBytes telegram for carbon, and the Printer telegram for oxygen.

- Station 2 measures steel slag level. A custom-made telegram called my_steelSlagTelegram transmits measurement information.

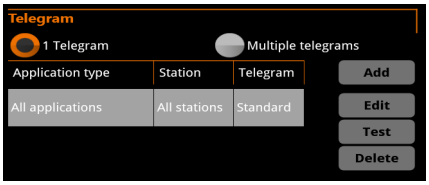


The Multiple telegrams radio button has been selected because different telegrams are needed for the same measurement station. For example, when a:

- Temperature measurement is taken on station 1, the standard telegram is transmitted.
- Temperature measurement is taken on station 2, no telegram is transmitted.
- Steel slag measurement is taken on station 2, the custom-made telegram is transmitted
- Steel slag measurement is taken on station 1, no telegram is transmitted.

An example of using the 1 Telegram radio button:

Although different measurements are taken at both measurement stations, only the status information is needed, for example, to configure the plant PLC.



The 1 Telegram radio button has been selected so that the StatusBytes telegram transmits status information about a measurement for every measurement application and every measurement station. Now both stations are selected, you could also select a particular telegram for all applications for either station 1 or station 2. This means the only options available when using the 1 Telegram radio button are:

Application type	Station	Telegram
All applications	All stations	Telegram of choice
All applications	Station 1	Telegram of choice
All applications	Station 2	Telegram of choice

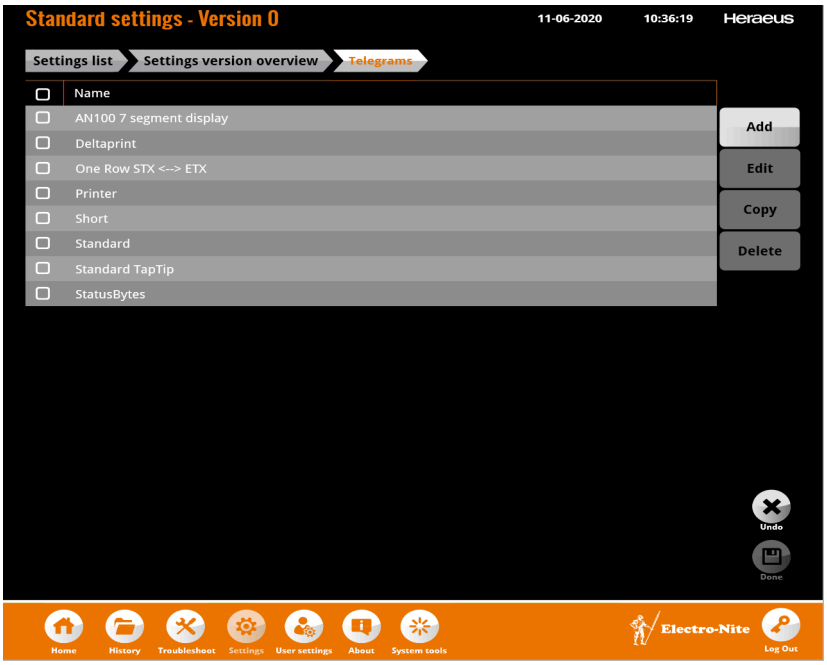
9.4. Create data telegrams

To perform this task you need to log in first.

In the Settings window select the version you would like to configure by clicking on the check box in front. Click **Edit**.

In the Advanced section click Telegrams.

The next screen is displayed:



All existing telegrams are displayed.

Click **Done** to save any changes you make in subsequent windows or **Undo** to leave the window without making any changes.

To **edit** a telegram, select the telegram then click **Edit**. The Telegram definition window is displayed.

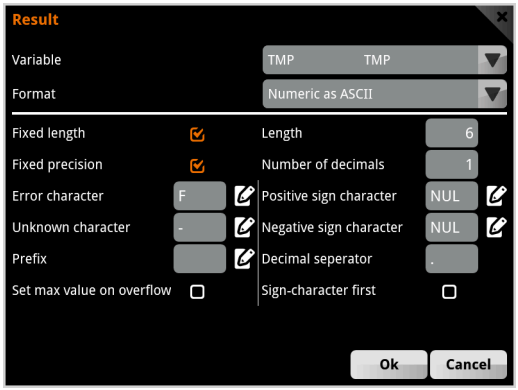
To **copy** a telegram, select the telegram then click **Copy**. The **Add** a new telegram window is displayed in which you change the name of the copied telegram and click **Ok**. The Telegram definition window is displayed.

To **delete** a telegram, select the telegram then click **Delete**. You must confirm the deletion. You can only delete a telegram if it is not in use by any communication type.

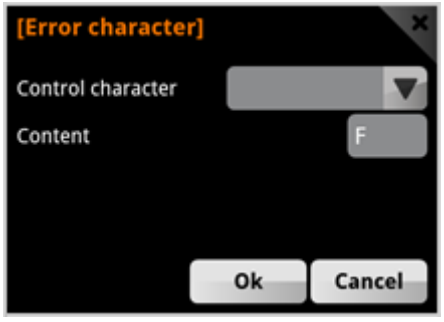
To **add** a new telegram, click **Add**. The Add a new telegram window is displayed in which you enter a name of up to 30 alphanumeric characters for the new telegram. After doing this, the Telegram definition window is displayed. The telegram definition window shown above shows a new telegram called Print String A being created. Blocks have been dragged from the Available blocks section in the top right into the telegram definition box in the top left.

Once in the telegram definition section, you can:

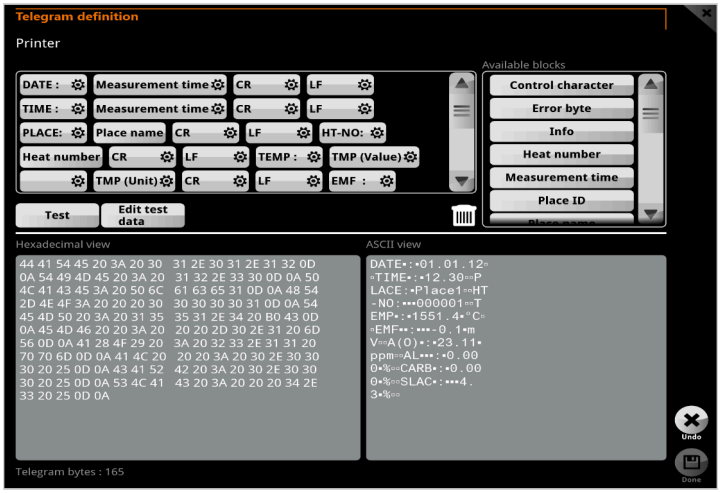
- Drag blocks around to adjust their order in the telegram
- Drag a block into the bin icon to remove it from the telegram
- Click the bin icon to remove all blocks in the telegram after confirmation
- Edit a block by clicking it. Another window is displayed in which you specify formatting and display options for the block – if there are any for that block. The following picture shows an example window.



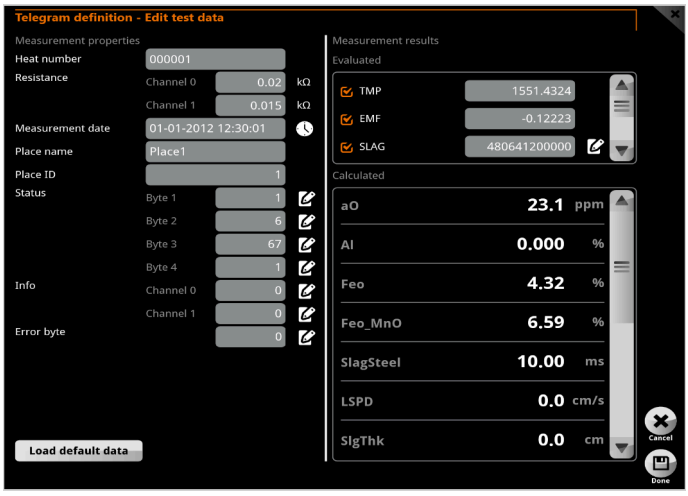
The edit button beside a field indicates that you can enter further values. For example, clicking this button beside the Error character field opens the following window:



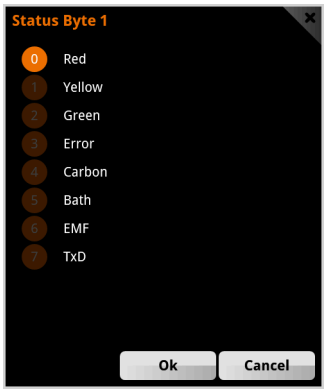
In the telegram definition window click Test to show the telegram definition in both hexadecimal and ASCII format:

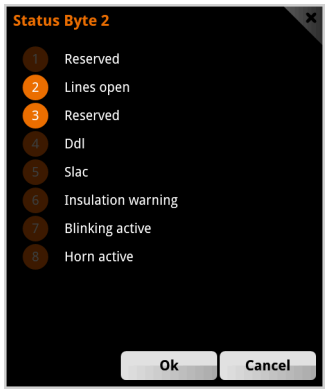


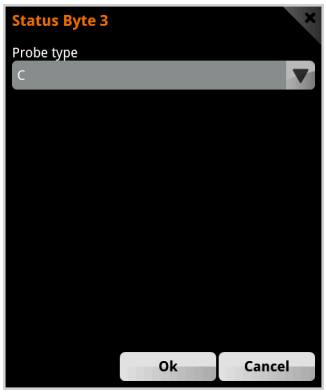
The telegram definition contains default data, but if you want to see what the telegram looks like with other data, click Edit test data. The following window is displayed:



You can edit the test data and apply the data to different measurement applications.
The edit button beside a field indicates further details, for example, for the four Status byte fields:







On the Telegram definition – Edit test data window touch Load default data to restore the default settings to the telegram definition.

9.5. Input telegrams

Input telegrams are available for most communication types and use two different protocols: a first protocol has a 32-byte format. The second protocol has a 40-byte format.

9.5.1. 32-byte format

This telegram protocol includes the station identifier, heat number used for the next measurement, and the instrument date and time. The format of this telegram is as follows:

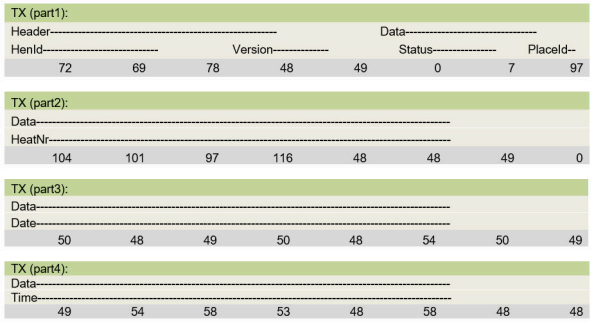
Format = <Header><Data>

- Header = <HenId><ProtocolVersion>
  - HenId = HEN
  - ProtocolVersion = 2 ASCII bytes = 0 1 for this version
- Data = <StatusFlags><PlaceId><Heatnumber><Date><Time>
  - StatusFlags = StatusFormat
  - PlaceId = PlaceIdFormat
  - Heatnumber = StringFormat-8
  - Date = DateFormat
  - Tiem = TimeFormat

Protocol formats (all formats are high-byte first):

Format	Description		
StatusFormat	16-bit flags	bit	
		0:	Enable this bit to update the heat number
		1:	Enable this bit to update the date
		2:	Enable this bit to update the time
		3 to 14:	not used
		15:	should always be 1
PlaceIdFormat	ASCII byte		
		'a'	station 1
		'b'	station 2
StringFormat-N	ASCII-encoded, fixed-size string (N characters). In case the value is smaller than the size, append the string with sufficient NULL bytes or blank spaces.		
DateFormat	Fixed-date format parsed with the regional settings of the receiver. Format = yyyyMMdd		
TimeFormat	Fixed-time format parsed with the regional settings of the receiver. Format = HH:mm:ss		

The example below (in decimal) updates the heat number (heat001) on Station 1, changes the time (16:50), and changes the date (21/06/2012):



9.5.2. 40-byte format

This telegram protocol includes the station identifier, heat number used for the next measurement, instrument date and time, and the preset you want to activate. The format of this telegram is as follows:
Format = <Header><Data>

- Header = <HenId><ProtocolVersion>
  - HenId = HEN
  - ProtocolVersion = 2 ASCII bytes = 0 2 for this version
- Data = <StatusFlags><PlaceId><Heatnumber><Date><Time><PresetName>
  - StatusFlags = StatusFormat
  - PlaceId = PlaceIdFormat
  - Heatnumber = StringFormat-8
  - Date = DateFormat
  - Tiem = TimeFormat
  - PresetName = StringFormat-8

Protocol formats (all formats are high-byte first):

Format	Description		
StatusFormat	16-bit flags	bit	
		0:	Enable this bit to update the heat number
		1:	Enable this bit to update the date
		2:	Enable this bit to update the time
		3:	Not used
		4:	Active preset
		5 to 14:	not used
		15:	Should always be 1
PlaceIdFormat	ASCII byte		
		'a'	station 1
		'b'	station 2
StringFormat-N	ASCII-encoded, fixed-size string (N characters). In case the value is smaller than the size, append the string with sufficient NULL bytes or blank spaces.		
DateFormat	Fixed-date format parsed with the regional settings of the receiver. Format = yyyyMMdd		
TimeFormat	Fixed-time format parsed with the regional settings of the receiver. Format = HH:mm:ss		

The example below (in decimal) updates the heat number (heat001) on place A, changes the time (16:50), changes the date (21/06/2012), and activates a preset with the name “6".

TX (part1):							
Header					Data		
HenId		Version			Status		PlaceId
72	69	78	48	49	0	7	97

TX (part2):							
Data							
HeatNr							
104	101	97	116	48	48	49	0

TX (part3):							
Data							
Date							
50	48	49	50	48	54	50	49

TX (part4):							
Data							
Time							
49	54	58	53	48	58	48	48

TX (part5):							
Data							
PresetName							
54	48	48	48	48	48	48	48

9.6. Serial settings

After touching the edit button beside Serialoutput, the following window is displayed:

In the **COM port settings** section you can select the:

- Baud rate for communication.
- Parity for communication.
- Data bits for communication.
- Handshake for communication.
- Stop bits for communication.
- Mode for communication: TTY is a current-based serial communication system. Recommended Standard (RS) 232 is a standard in telecommunications for serial binary data signals. *(note that TTY is not available for Sensor Lab Steel)*
- Protocol for communication.

The following are the supported baud rates and data sets for serial communication:

Baud rates	Data sets
300	7E1
600	7O1
1200	8N1
2400	8E1
4800	8O1
9600	7E2
19200	7O2
38400	8N2
57600	8E2
115200	8O2

Where 7E1 means: 7 data bits, Even parity, and 1 stop bit. (O is odd parity, N is No parity.)

In the **Telegram** section, select the 1 Telegram radio button to send one telegram for each application or select the Multiple telegrams radio button to send a different telegram for each application. See section 9.3. for more information on smart telegrams.

In the **Options** section, enable the Use for time/heatno synchronisation option to allow time and heat number information to be sent in an input telegram from the plant PLC to the instrument using this output communication. See section 9.5. for more information about input telegrams.

You can also choose to send a telegram over this output communication:

- On a change of status (see section 9.1.1.)
- After evaluation
- After the end of measurement

Touch Done to save any changes you make or Undo to leave the window without making any changes.

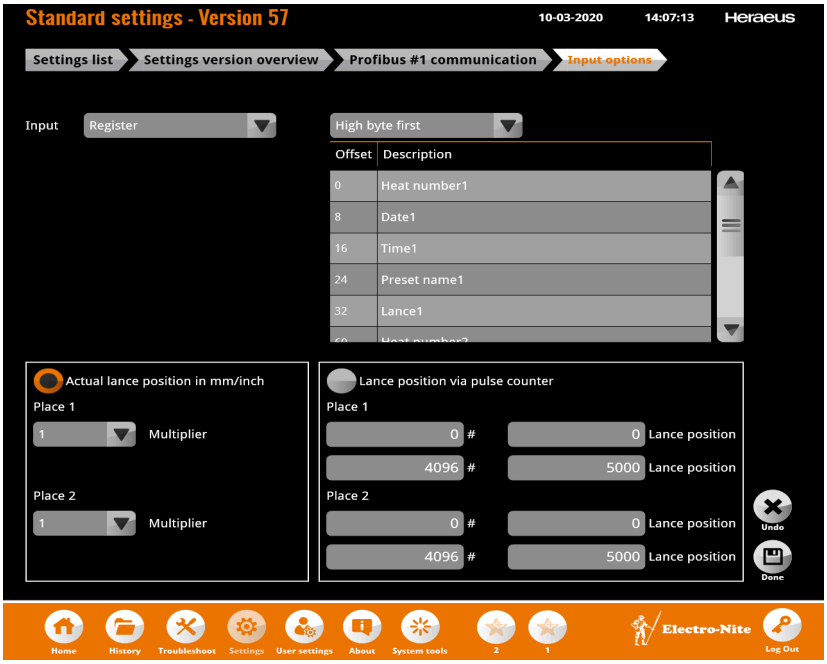
9.7. Profibus settings

After touching the edit button beside Profibusoutput, the following window is displayed:

In the **Profibus settings** section, enter the Profibus station ID. The station ID is used for Profibus communication between the master and slave. You can enable or disable the use of registers instead of telegrams for Profibus communication to and from level2. If you choose to use registers, then a fixed register is used as described in section 9.1. .

In the **Options** section you can edit the input options to configure Input.

The following screen opens:



Input configuration:

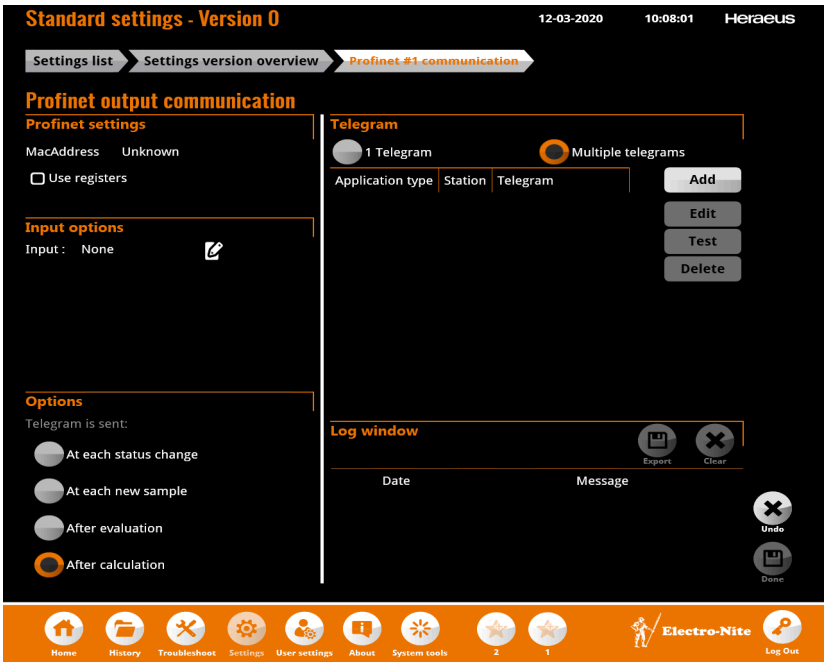
- Activate register telegram when using for Lance input
- Choose between high or low byte first.
- Int 32 or int 16 are possible.
- Description of telegram on right side
- On bottom side, choose between actual lance position or pulse counter.

Press Done to save any changes you make or Undo to leave the window without making any changes.

Note: *When lance position input is used, bath level options also need to be configured (see paragraph 8.6.4.2.)*

9.8. Profinet settings

After touching the edit button beside Profinetoutput, the following window is displayed:



In the **Profinet settings** section, the Mac address is the device address. The MAC address can be used in the PLC to allocate the module. The IP addressed with Profinet is programmed from the PLC, not locally.

You can enable or disable the use of registers instead of telegrams for Profinet communication to and from level2. If you choose to use registers, then a fixed register is used as described in section 9.1. .

In the **Telegram** section, select the 1 Telegram radio button to send one telegram for each application or select the Multiple telegrams radio button to send a different telegram for each application. See section 9.3. for more information on smart telegrams.

In the **Options** section, enable the Use for time/heatno synchronisation option to allow time and heat number information to be sent in an input telegram from the plant PLC to the instrument using this output communication. See section 9.5. for more information about input telegrams.

You can also choose to send a telegram over this output communication:

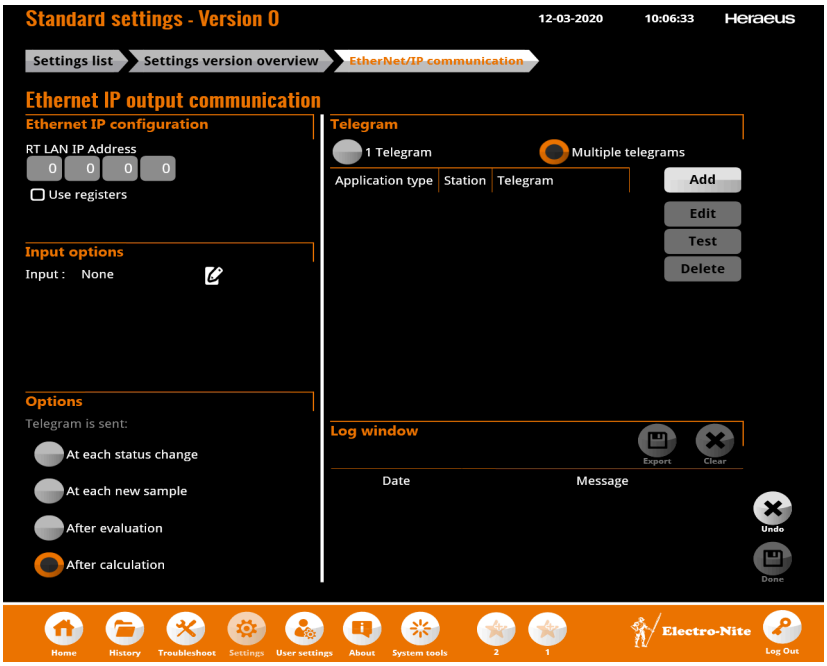
- On a change of status (see section 9.1.1.)
- At each new sample
- After evaluation
- After the end of measurement

Touch Done to save any changes you make or Undo to leave the window without making any changes.

Note: *When lance position input is used, bath level options also need to be configured (see paragraph 8.6.4.2.)*

9.9. Ethernet/IP settings

After touching the edit button beside EtherNet/IPoutput, the following window is displayed:



In the **Ethernet IP configuration** section, the IP address of the real-time (RT) LAN connection is displayed. See section 4.2.1 for information about changing the LAN settings. You can enable or disable the use of registers instead of telegrams for Ethernet/IP communication to and from level2. If you choose to use registers, then a fixed register is used as described in section 9.1. .

In the **Telegram** section, select the 1 Telegram radio button to send one telegram for each application or select the Multiple telegrams radio button to send a different telegram for each application. See section 9.3. for more information on smart telegrams.

In the **Options** section, enable the Use for time/heatno synchronisation option to allow time and heat number information to be sent in an input telegram from the plant PLC to the instrument using this output communication. See section 9.5. for more information about input telegrams.

Back in the Ethernet IP output communication window, you can also choose to send a telegram over this output communication:

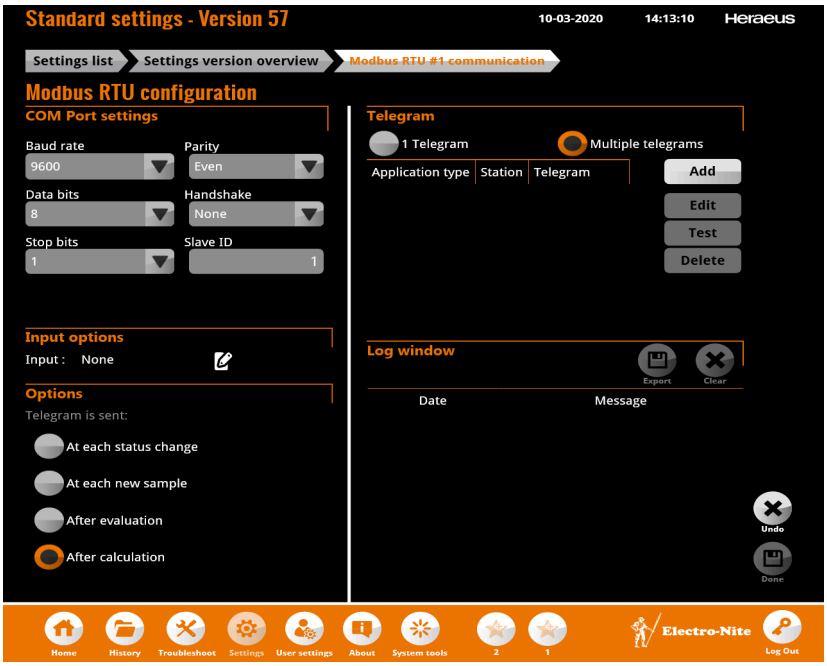
- On a change of status (see section 9.1.1.)
- At each new sample
- After evaluation
- After the end of measurement

Touch Done to save any changes you make or Undo to leave the window without making any changes.

Note: *When lance position input is used, bath level options also need to be configured (see paragraph 8.6.4.2.)*

9.10. Modbus RTU settings

After touching the edit button beside Modbus RTUoutput, the following window is displayed:



In the **COM port settings** section you can:

- Select the baud rate for communication.
- Select the parity for communication.
- Select the data bits for communication.
- Select the handshake for communication.
- Select the stop bits for communication.
- Enter the Slave ID for communication.

The following are the supported baud rates and data sets for Modbus RTU communication:

Baud rates	Data sets
300	7E1
600	7O1
1200	8N1
2400	8E1
4800	8O1
9600	7E2
19200	7O2
38400	8N2
57600	8E2
115200	8O2

In the **Telegram** section, select the 1 Telegram radio button to send one telegram for each application or select the Multiple telegrams radio button to send a different telegram for each application. See section 9.3. for more information on smart telegrams.

In the **Options** section, enable the Use for time/heatno synchronisation option to allow time and heat number information to be sent in an input telegram from the plant PLC to the instrument using this output communication. See section 9.5. for more information about input telegrams.

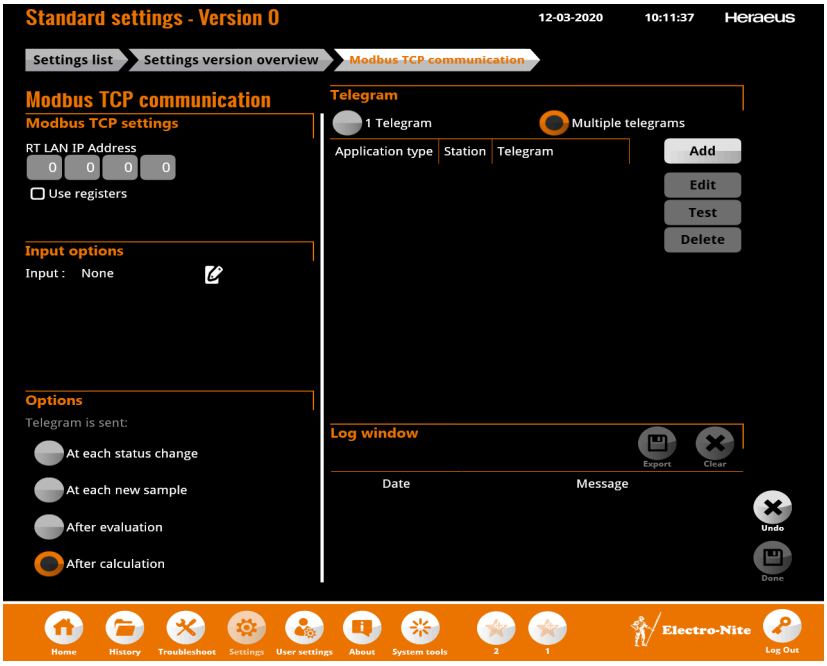
You can also choose to send a telegram over this output communication:

- On a change of status (see section 9.1.1.)
- At each new sample
- After evaluation
- After the end of measurement

Touch Done to save any changes you make or Undo to leave the window without making any changes.

9.11. Modbus TCP settings

After touching the edit button beside Modbus TCPoutput, the following window is displayed:



In the **Modbus TCP settings** section, the IP address of the real-time (RT) LAN connection is displayed. See section 4.2.1 for information about changing the LAN settings. You can enable or disable the use of registers instead of telegrams for Modbus TCP communication to and from level2. If you choose to use registers, then a fixed register is used as described in section 9.1. .

In the **Telegram** section, select the 1 Telegram radio button to send one telegram for each application or select the Multiple telegrams radio button to send a different telegram for each application. See section 9.3. for more information on smart telegrams.

In the **Options** section, enable the Use for time/heatno synchronisation option to allow time and heat number information to be sent in an input telegram from the plant PLC to the instrument using this output communication. See section 9.5. for more information about input telegrams.

You can also choose to send a telegram over this output communication:

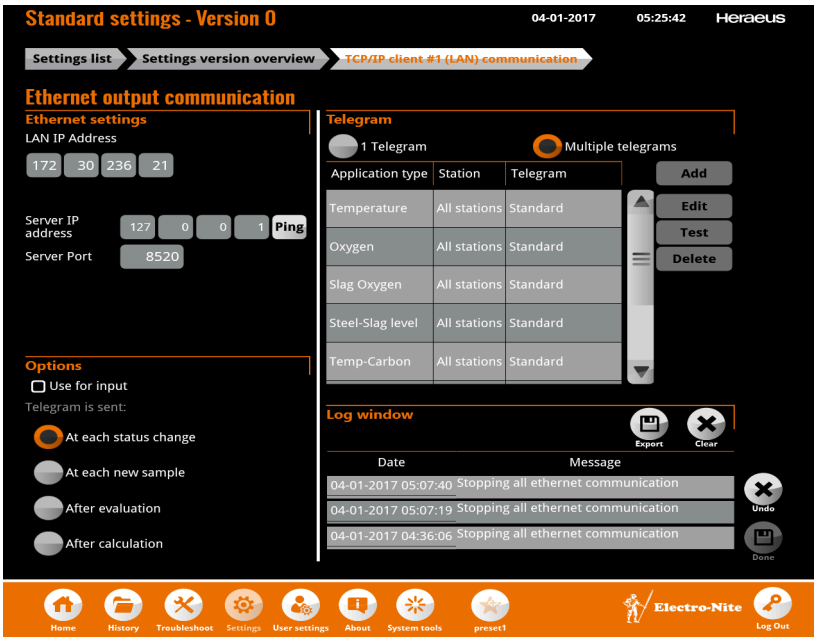
- On a change of status (see section 9.1.1.)
- At each new sample
- After evaluation
- After the end of measurement

Touch Done to save any changes you make or Undo to leave the window without making any changes.

Note: *When lance position input is used, bath level options also need to be configured (see paragraph 8.6.4.2.)*

9.12. TCP/IP Client settings

The Sensor Lab can participate in a private local network – local area network (LAN). The supporting protocol and structure used in this network in Transport Control Protocol/Internet Protocol (TCP/IP). After touching the edit button beside TCP/IP clientoutput, the following window is displayed:



In the **Ethernet Settings** section, the IP address of the LAN connection is displayed. You can:

- Enter the IP address of the server
- Enter the port number of the server
- Ping to the server to test the connection

In the **Telegram** section, select the 1 Telegram radio button to send one telegram for each application or select the Multiple telegrams radio button to send a different telegram for each application. See section 9.3. for more information on smart telegrams.

In the **Options** section, enable the Use for time/heatno synchronisation option to allow time and heat number information to be sent in an input telegram from the plant PLC to the instrument using this output communication. See section 9.5. for more information about input telegrams.

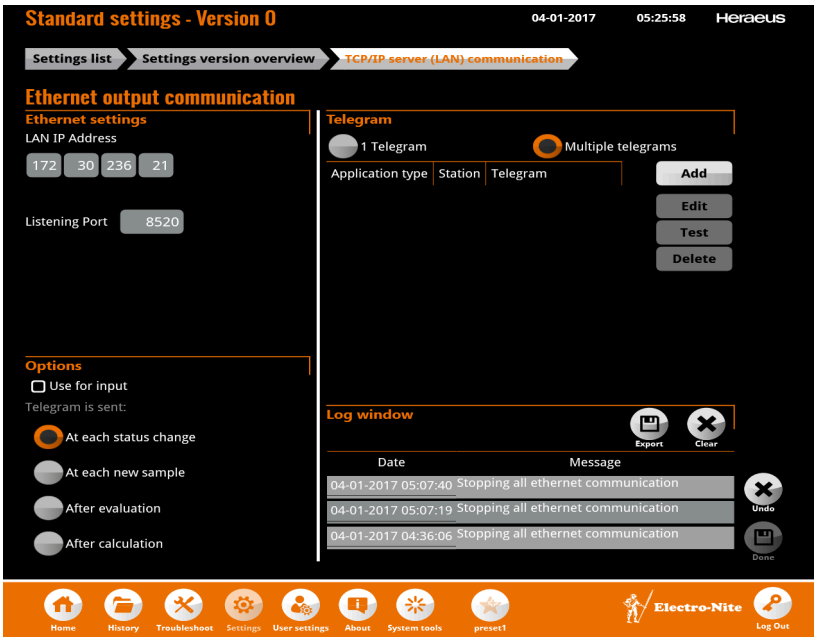
You can also choose to send a telegram over this output communication:

- On a change of status (see section 9.1.1.)
- At each new sample
- After evaluation
- After the end of measurement

Touch Done to save any changes you make or Undo to leave the window without making any changes.

9.13. TCP/IP Server settings

After touching the edit button beside TCP/IP serveroutput, the following window is displayed:



In the **Ethernet Settings** section, the IP address of the LAN connection is displayed. You can enter the port number of the listening server.

In the **Telegram** section, select the 1 Telegram radio button to send one telegram for each application or select the Multiple telegrams radio button to send a different telegram for each application. See section 9.3. for more information on smart telegrams.

In the **Options** section, enable the Use for time/heatno synchronisation option to allow time and heat number information to be sent in an input telegram from the plant PLC to the instrument using this output communication. See section 9.5. for more information about input telegrams.

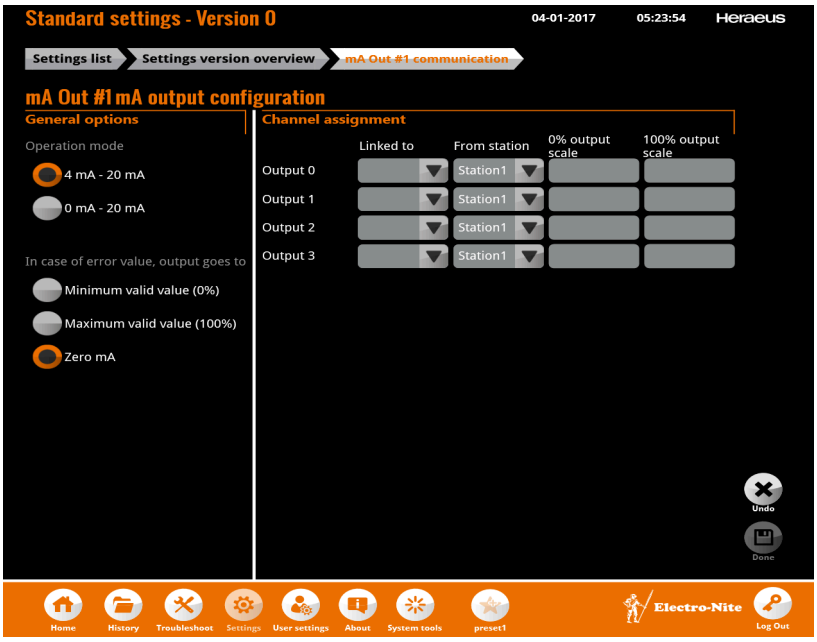
You can also choose to send a telegram over this output communication:

- On a change of status (see section 9.1.1.)
- At each new sample
- After evaluation
- After the end of measurement

Touch Done to save any changes you make or Undo to leave the window without making any changes.

9.14. mA Out settings

After touching the edit button beside mA Outoutput, the following window is displayed:



In the **General options** section you can select the operation mode and also the value to which the output defaults after an error.

In the **Channel assignment** section, you can link outputs to results and stations for both the 0% output scale and the 100% output scale. There are four outputs that can be configured for each scale.

For example, Output 0 linked to TMP from station A with 0% 1100°C and 100% 1700°C with operation mode 4mA – 20mA and error output 0mA:

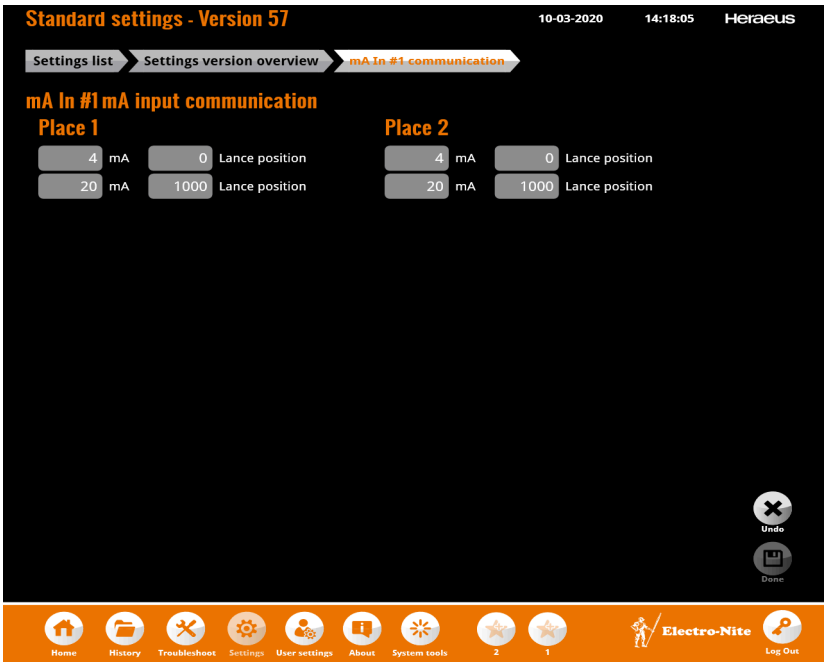
- Measurement of 1100°C => 4mA at output
- Measurement of 1700°C => 20mA at output
- Measurement values in between are linearly interpolated, for example, 1400°C is 12mA
- Error measurement: 0 mA

***Note:** The output is always memorised, meaning that the last value remains as output until a new value is output.*

Touch Done to save any changes you make or Undo to leave the window without making any changes.

9.15. mA In settings

After touching the edit button beside mA In, the following window is displayed:



You can provide lance position input and then create custom formulas to calculate steel height and slag thickness. Lance position input can be provided in real time by mA input.

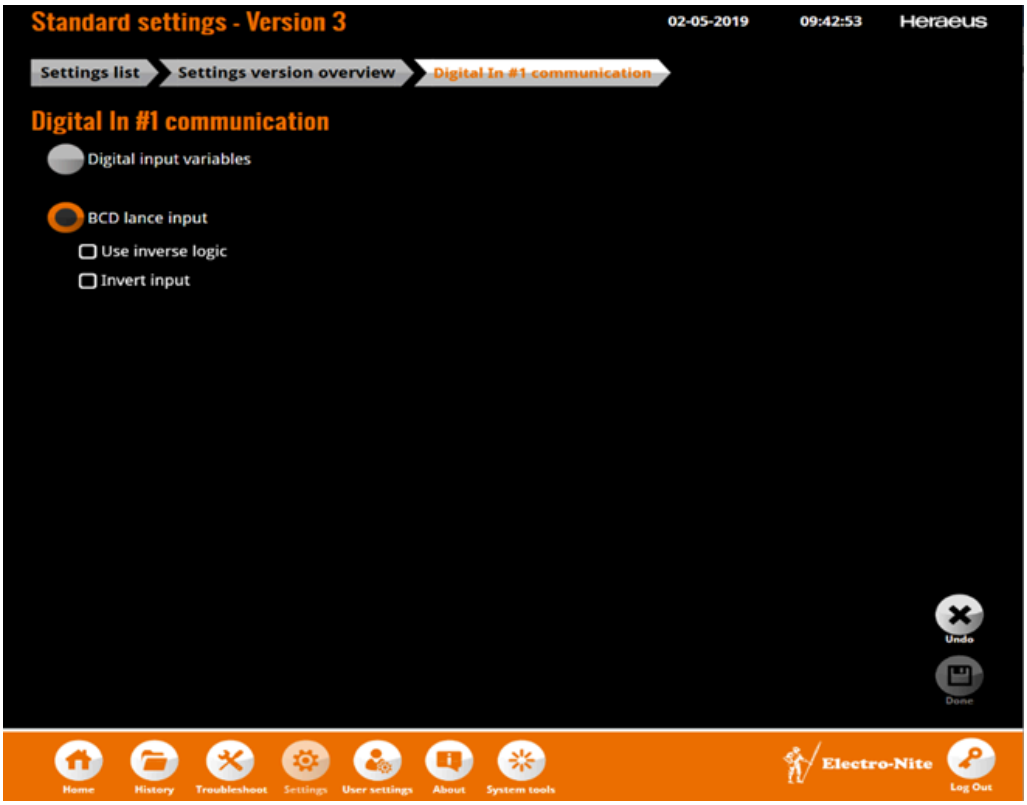
The Sensor Lab synchronizes the lance position with the bath level, steel level, and slag level events.

If lance position input is enabled, the Sensor Lab provides the results of the corresponding lance position input taken at the real time moment of the event. The unit of the results is the same as the unit of the lance position input.

Touch Done to save any changes you make or Undo to leave the window without making any changes.

9.16. Digital In #1 settings

After touching the edit button beside Digital In #1 In, the following window is displayed:



Invert input means a positive value will become negative.
Inverse logic means that logic 0 will be 1.

9.17. BCD output settings

After touching the edit button beside BCDoutput, the following window is displayed:

In the **General options** section:

- Enter the valid pulse time. This is the period of time the valid pulse remains high or low before the value in the BCD register is output.
- Enable or disable the use of inverse logic. When inverse logic is enabled, the valid pulse signal is set to active low. When inverse logic is disabled, the valid pulse signal is set to active high. The value in the BCD register is output when the signal goes high (no inverse logic) or low (inverse logic).

In the **Channel assignment** section, you can link BCD output to results and stations. There are four BCD outputs that can be configured. See section 5.2.12 for more information about BCD outputs.

Touch Done to save any changes you make or Undo to leave the window without making any changes.

Note: *This option is not available for Sensor Lab Steel.*

10. Spare parts

If repairs are necessary, contact your local Heraeus Electro-Nite sales representative.
When ordering spare parts, always provide the instrument type and instrument serial number.

Note: *Key spare parts, whether new or used, essential to the good functioning of the product, are available for at least eight years after placing the last unit of the model on the market.*

10.1. Spare parts list

UCS Number	Name	Figure
iM2 Spare Parts		
91860121	iM2 Power cord 125VAC (US market)	
31329004	iM2 AD	
31329005	iM2 AC Passive	
31329006	iM2 AC Active	
31329007	iM2 Serial	
31229000	iM² DC IO option (all included)	
31329008	iM2 DC (without Beckhoff modules)	
31329009	iM2 mA output	
31329010	iM2 Profibus DP slave	
31329011	iM2 Profinet	
31329012	iM2 Modbus RTU	
31329013	iM2 Modbus TCP IP	
31329014	iM2 Ethernet IP	
31329015	iM2 BCD	
31229011	iM2 mA input	
31989006	iM2 Cold Junction	
31989007	iM2 Plug Accessories Kit	
31229009	iM2 Profibus DP slave 2	
Sensor Lab Steel Spare Parts		
98300143	SLS Power cord V-Lock 10A 125VAC (US market)	
91821011	SLS Male type S Russellstoll insert (4 pin)	
91820711	SLS Russellstoll light duty housing	
39910182	SLS Mating light set connector	
39990097	SLS Power MAIN fuse 4A 250V	
39990098	SLS AC Output fast-blow fuse 3.15A 250 V	
39250002	SLS Option – Ethernet IP kit	
39250003	SLS Option – Profibus kit	
39250004	SLS Option – Profinet kit	
39250005	SLS Option – Modbus TCP kit	

UCS Number	Name	Figure
39250006	SLS Option – Modbus RTU kit	
39250008	SLS Option – Analog mA input kit	
39910202	SLS Analog mA input external mating connector (included with 39250008)	
39250009	SLS Option – Analog mA output kit	
39910203	SLS Analog mA output external mating connector (included with 39250009)	
Qube Spare Parts		
39000030	QUBE T2 (temperature only, 2 pins for US market)	
39000020	QUBE T4 (temperature only, 4 pins for EU market)	
39020090	QUBE O (temperature, oxygen, carbon)	
39020100	QUBE L (all probes plus DDL)	
39350000	QUBE L Grounding Kit	
39970004	Power Pack	
39980258	Charging Station	
39050060	Receiver Box	
30800090	QUBE Handle	
31059001	Receiver Box + serial cable	
98300129	Serial Cable (for receiver box)	
Other Spare Parts		
39250001	19” touchscreen monitor	
39270002	Lightset with horn (includes 8 meters of cable and mating connector)	

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