

OPERATION AND SERVICE MANUAL

Sensor system
Base station BET214
Ice sensor CET214

eologix sensor technology gmbh
Kratkystrasse 2 | 8020 Graz | Austria

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We have inspected the content of this documentation regarding accordance with the described hardware and software.

Nevertheless, deviations, remaining errors and omissions cannot be excluded, which is why no liability is assumed for damages resulting from this.

However, the information in this printed document is regularly revised and necessary corrections will be included in the editions to follow. We appreciate any suggestions for improvement.

Technical modifications reserved!

PREFACE

We thank you for your trust and for choosing our product. Our product has been designed and manufactured in accordance with European norms and regulations.

Please read this operation manual carefully before commissioning/use. Please contact us in the event of uncertainties, questions or damages to the product.

Anybody who in any way works with this product must have **read, understood** and **accepted** this document and implement it to the best of their knowledge and belief.

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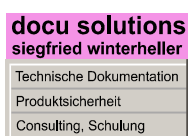
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VERSION

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0.1	09/10/2018	Draft 0	docu solutions
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1.1	17/01/2019	Draft 2	docu solutions
1.2	01/11/2019	Final version	eologix
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Translation of original operation and service manual.



Document created by:

docu solutions siegfried winterheller

Unterer Bründlweg 15, 8054 Graz

www.docusolutions.at

office@docusolutions.at

1 INTRODUCTION

1.1 Contact information manufacturer

Should faults occur whose causes cannot be rectified with the help of this documentation, please contact eologix sensor technology gmbh.

eologix sensor technology gmbh

Kratkystraße 2, 8020 Graz, Austria

Phone: +43 (0)316 931215 100

E-Mail: office@eologix.com

Homepage: www.eologix.com

All components of the product delivered by eologix sensor technology gmbh are identified as follows:

1.2 Identification

The sensor system is made up of the base station and the wireless sensor.

Base station

Product designation eologix base station

Type designation BET214

Serial number XXXX.XXXX

Years of manufacture 20XX

Wireless sensor

Product designation eologix wireless sensor

Type designation CET214

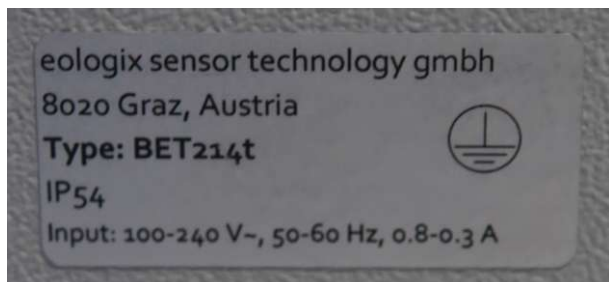
Serial number XXXX.XXXX

Year of manufacture 20XX

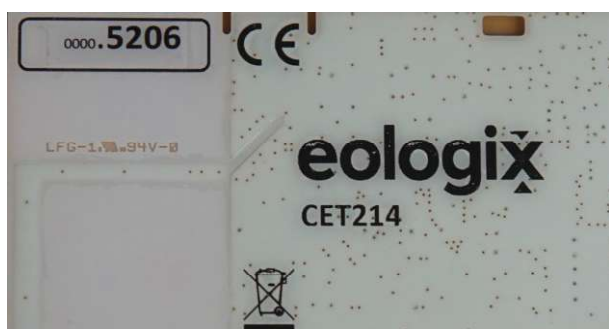
1.3 Marking

The product is clearly identified by the content of its label.

Base station



Sensor



CE marking acc.to Directive 2014/53/EU (Radio Equipment Directive).

1.4 Technical specifications

Technical specifications base station

Dimensions switch box (width x height x depth)	200 x 300 x 180 mm
Supply voltage	100-240 V AC
Control voltage	24 V DC

Technical specifications sensor element

Dimensions sensor (length x width x height)	360 x 254 x 0,3 to 2 mm
Voltage	max. 3,2 V DC
Sensor supply	Rechargeable button cell
Charging sensor supply	Solar panel

Further technical data can be found in the documentation supplied and in chapters 4.1.3 for the base station and 4.2.2 for the wireless sensor.

1.5 Copyright

All documents are protected by copyright laws. Disclosure and reproduction of documents or parts of the documents as well as sharing their contents are prohibited, unless explicitly permitted. Any breach or infringement will result in liability for damages.

1.6 Liability

In accordance with European regulations, we provide a 2-year warranty for our product. This operation manual serves the purpose of a fault-free operation of the product and is a requirement for the fulfilment of any warranty claims.

The claims expire, for instance, in the even

- Improper use
- Incorrect safeguarding
- Operation with defective or improperly installed safety devices and protective devices
- Non-compliance with the instructions of this documentation
- Use of spare parts other than original spare parts
- Modifications without our written approval
- Improperly carried out repairs
- Cases of disaster, influences from extraneous elements and force majeure.

Wear parts are not included in the scope of liability.

As a rule, the product's operational safety must always be inspected before the product is initiated.

1.7 Content and purpose of this documentation

This documentation includes relevant information which makes it possible to work with and on the product as safely as possible. Observing the instructions included in this document serves the purpose of avoiding risks and damages to the product.

In addition to this operation manual, the applicable regulations for accident prevention and environmental protection of the country of use and the installation site must be observed.

Retaining this documentation

This document must be available near the product and must, in the latest version, always be available for the users either electronically or as a print version. The manufacturer is obligated to retain this documentation at least throughout the operating life of the product.

Effectivity

This manual is exclusively valid for the product with the marking CET214 and the name eologix wireless sensor in combination with the product with the marking BET214 and the name eologix base station. The product was placed on the market by eologix sensor technology gmbh and transferred into the responsibility of the operator upon delivery.

2 LIMIT OF USE

2.1 Intended use

The intended use of the sensor system consisting of base station and wireless sensors is ice detection, temperature measurement and pitch angle measurement for wind turbines.

Icing and its layer thickness is detected by measuring the impedance on the surface. The surface temperature is measured with an accuracy of $\pm 0.25^{\circ}\text{C}$. The measurement data is transmitted wirelessly to the base station with a range of at least 250m. The system consists of a base station and several flexible sensors, which are applied on the rotor blades. The sensors are glued to the blade surface (no drilling or similar - the rotor blade is not damaged) and can also be retrofitted during regular inspections. The system measures icing at the point where it happens. Observation of the effectiveness of existing anti- or de-icing solutions is possible.

Detection of relative pitch angles is accomplished by measuring inertial sensing (accelerations), which is an optional feature of the wireless sensor platform. This typically features $\pm 16\text{g}$. The acquired data is transferred to servers of eologix sensor technology gmbh during the application of the pitch angle measurement, which then calculate the relative pitch angle by means of an algorithm and provide the determined value to the customer via a dashboard.

A flexible solar cell ensures the energy supply, without light the function is maintained by energy buffer for approx. 1000h.

The sensor is moulded on the blade erosion tape. Before installation, please carefully read the installation information of 3M and prepare the blade surface accordingly. For more information, visit the blade erosion tape manufacturer's website www.3M.com/wind for instructions on applying 3M™ Wind Protection Tape 2.0/2.1 (W8750, W8751).

For compliance against DNV certificate, the number and position of sensors must be coordinated with eologix (depending on turbine size, turbine type, application: "ice detection", "ice free detection", "operation under ice load", "pitch angle measurement" etc.).

The product is built in accordance with the state of the art and recognized safety rules. Nevertheless, its use may result in danger to life and health of the operator or third parties or impairment of the product and other material assets. Intended use also includes observing the operating instructions and complying with the maintenance requirements. Only use the product when it is in perfect working order.

Use the product as intended and in a safety-conscious manner. If malfunctions or damage occur that could impair safety, have them repaired immediately.

2.2 Reasonably foreseeable misuse

Non-intended use can cause dangers for persons and damage to the product.

The wireless sensors may not be used on other components.

- Deinstallation, manipulation or deactivation of the safety devices is prohibited.
- It is prohibited to technically modify the product.
- Original spare parts must be used.
- Further, neither liability nor guarantee are assumed in the event of non-compliance with the intended use.
- The product may only be operated under the operating conditions specified in the documentation.

2.3 Limits of the product

The limits of use of the product are as follows:

Spatial limits

- Installation at all kinds of wind power plants.
- The system consists of various sensors and one receiving unit per turbine.
- The sensors are adhered to the surface of the rotor blades

Temporal limits

- The product is designed for outdoor use.
- The operating life of the product is defined as 20 years.

Limits of use

- The sensors can be applied anywhere on the rotor blades, but also on the nacelle or the tower.

Further limits

- Installation site of the base station: inside, dry, dust-free
- The installation site of the base station must have an even and stable ground
- Supply voltage 230V

2.4 Target group and prior knowledge

This documentation is addressed to qualified personnel for commissioning, operation and maintenance of the product. The commissioning, operating and maintenance personnel must be chosen by the operator and must meet the following requirements:

General

Personnel which do not meet the requirement of being "qualified personnel" must acquire the necessary qualification by means of appropriate trainings. It is the aim of such trainings to be able to operate the product properly and as intended as well as to independently be able to detect and avoid risks and dangers that might arise from the product.

Installation personnel

The independent installation of the product may only be carried out by qualified personnel who

- have been instructed regarding the installation of the product and who have read and understood this operation and service manual,
- have, in written form, been charged with the task of installing the product,
- have fundamental electrical and mechanical professional knowledge.
- In the case of application of the sensors at existing wind power plants, the respective national safety and work regulations for rope access and positioning techniques apply.

To make it possible to acquire the necessary skills and knowledge, the operator must implement the following measures:

- Product training (written confirmation by the trained persons)
- Regular safety briefing
- Inspection, service, cleaning as well as corrective maintenance may only be carried out by technical professionals with product-specific training as well as mechanical and/or electrical training.
- When choosing the personnel, the legal minimum age must be considered.
- Professionals with product-specific training must be charged with and held liable for planning and inspection of the activities.

Maintenance personnel

Maintenance activities may only be carried out by qualified personnel. The maintenance personnel must have read this operation and service manual. Cleaning activities on the product

may only be carried out by instructed personnel who have been informed about the dangers that can arise from the product.

Operating personnel

The following physical qualities are considered requirements for operating the product:

- User knowledge in the IT area, especially regarding the use and operation of Microsoft® Windows operating systems,
- may not be under the influence of addictive substances,
- no pacemaker or implanted defibrillator

2.5 Principle

The product is a state-of-the-art product and meets the relevant safety and health regulations. Nevertheless, dangers can arise in the event of maloperation or misuse.

- to life and health of users or third parties
- to the product and other material assets of the operator
- to the efficient use of the product

3 SAFETY

This documentation is structured in accordance with the effective EU regulations and includes safety instructions. The operator of the product is responsible for ensuring that the installation and operating personnel receive the necessary safety-relevant information and that they read this documentation. The individuals are responsible for complying with the safety instructions.

This chapter includes a general introduction of the safety instructions as well as a description of the warnings and safety instructions of the safety signs attached to the product. Important information regarding accident prevention can also be found here.

Classification of notices

This document includes the following types of notices:

- Safety instructions
- Notices
- Information

3.1 Safety instructions

This document includes **safety instructions** that must be observed for the sake of your own personal safety, the safety of other personnel and for the sake of avoiding material damage. Warnings and safety instructions inform the user about dangers that might result in minor, major injuries, even death, or considerable material damage if the respective instructions are not observed.

In the respective chapter, **warnings** inform about the dangers possible there. The structure of warnings and safety instructions is identical.

Safety instructions as well as warnings are highlighted by means of a warning triangle and must in any case be observed closely. They are shown as follows.

3.1.1 Structure of safety instructions

Operational warnings in the operation manual are structured as follows:

 Warning, mandatory or prohibition sign	 SIGNAL WORD and COLOR (GRAVITY OF DANGER) Type and source of danger Possible consequences of non-observance – Measure 1 to prevent/avoid a danger – Possible further measures to prevent/avoid a danger
---	--

3.1.2 Signal words used in safety instructions



The word Danger with a red background indicates an imminent threat of danger.
Serious and permanent physical injuries or death can be the consequence.



The word Warning with an orange background indicates a possibly dangerous situation.
Serious injuries or death can be the consequence.



The word Caution with a yellow background indicates a possibly dangerous situation.
Minor injuries or damages to the product can be the consequence.

3.1.3 Warning, mandatory and prohibition signs used in safety instructions

Warning sign Pictogram	Meaning	Description
	General warning sign	W001
	Warning of electric voltage	W012
	Warning of danger of falling	W008
	Warning of dangers due to charging batteries	W026
	Warning of explosive substances	W002

Mandatory sign Pictogram	Meaning	Description
	General mandatory sign	M001
	Observe manual	M002
	Use ear protection	M003
	Use hand protection	M009
	Use head protection	M014
	Use safety harness	M018
	Disconnect before service or repair activities	M021

3.2 Notices

This document includes **notices** which are structured as follows. Notices include important information regarding a product, use of the product or the respective part of the documentation that attention is supposed to be drawn to and whose non-observance can have adverse consequences which, as a rule, only lead to dangers for personnel or the product in individual or exceptional cases.

Notices must in any case be carefully read and observed to ensure correct operation and function.

Example:

	NOTICE
	Possibly harmful situation. Damages on the product or in their surroundings.

3.3 Information

Information included in this document is structured as follows. Information refers to additions to a section in this manual or further information on the product, the use of the product or the respective part of the documentation that attention is supposed to be drawn to and whose observance is recommended because of a possible benefit.

Information should be read carefully and observed for the sake of optimum use and operation of the product.

Example:

	INFORMATION
	Refers to advice on use and other especially useful information that should be considered before the operational steps.

3.4 Residual risks

In spite of maximum diligence when constructing and building the product and in spite of observing all safety-relevant facts, residual risks which have been evaluated by means of a risk assessment can exist.

3.4.1 Base station

	NOTICE
	Environmental damage due to improper disposal of packaging material. – Dispose of the packaging materials immediately and in an environmentally compatible way. – Recycle as much of it as possible.

	⚠ WARNING
	Danger due to electric voltage. Possibility of serious injuries or death when opening the base station. – Only qualified electricians may open the base station. – Installation and commissioning of the base station may only be carried out by qualified electricians. – Only install or deinstall the base station when it is disconnected from the power supply.

	⚠ WARNING
	Touchable voltage-carrying parts due to damages to the device. Danger of fire due to damages to the device. Serious injuries up to death due to electric shock or burns. – If the device, its casing or its insulation are damaged, do not operate the device until it has been inspected and repaired by the manufacturer eologix sensor technology gmbh.



! WARNING

In the service rooms or at the wind turbine, there might be increased noise exposure. Possible hearing damage.

- In the event of increased noise exposure due to environmental noise, ear protection must be worn.



! WARNING

Possible dangers due to electric voltage.

Serious injuries or death can occur when opening the base station.

- Only the manufacturer or licensed qualified electricians may open the base station.
- Disconnect the base station from the power supply before opening it.



! WARNING

Possible dangers due to electric voltage.

Serious injuries or death can occur while carrying out cleaning activities.

- Do NOT use flammable substances in the device's surroundings to avoid causing a fire or electric shock.
- Ensure that the device is switched off.
- Use neutral detergents. Using volatile substances like diluents or benzine damages the outer surface of the device.



! WARNING

Possible dangers due to the consequences of human failure.

Serious injuries or death can occur in the event of improper use.

- Read this operation and service manual before switching on the device.
- Observe all safety instructions.
- This operation and service manual must be retained!

NOTICE



Environmental damage due to improper disposal of waste electric equipment.

- Return the base station to the manufacturer eologix sensor technology gmbh once the operational lifetime has been exceeded or in the case of damages.
- Recycle electrical waste.

WARNING



Possible dangers due to loss of function

- Observe all safety instructions and notices regarding installation, use and maintenance included in this operation and service manual.
- At least two antennae must be used to ensure the reliability for the transfer of data.
- Lines may not be damaged, lines may not be pulled on, lines may not be crushed, bending radii must be observed and the base station must be grounded properly.
- The power supply must be connected or switched on as the last step.

3.4.2 Residual risk sensor



! WARNING

Danger of falling. Danger due to falling down objects or bumping.

Possibility of serious injuries or death during sensor application.

- The sensors may only be applied by trained personnel that is secured by fall protection.
- The sensors may only be applied when the wind wheel is deactivated and cannot rotate.
- Wear a protective helmet.
- Safety briefing with written confirmation.
- Training and commissioning by manufacturer required.



! WARNING

Danger of falling. Danger due to falling down objects or bumping.

Possibility of serious injuries or death during maintenance, service and cleaning.

- The sensors may only be serviced and cleaned by trained personnel who are secured by fall protection.
- The sensors may only be serviced when the wind wheel is deactivated and cannot rotate.
- Wear a protective helmet.
- Safety briefing with written confirmation.
- Training and commissioning by manufacturer required.



! WARNING

Possible dangers due to electric voltage or chemicals.

Serious injuries can occur when opening the sensor.

- Modifications are not permitted.
- The sensor may only be replaced entirely.



WARNING

Possible dangers due to fire or chemicals.

Serious injuries can occur in the event of improper handling of the battery cells.

- Battery cells may only be replaced by the manufacturer eologix gmbh.
- Do not open, burn or short-circuit batteries, do not expose them to great heat or wetness.



WARNING

Possible dangers due to the consequences of human failure.

Serious injuries or death can occur in the event of improper use.

- Read this operation and service manual before switching on the device.
- Observe all safety instructions.
- This operation and service manual must be retained!



NOTICE

Environmental damage due to improper disposal of waste electric equipment.

- Return the sensors to the manufacturer eologix sensor technology gmbh once the operational lifetime has been exceeded or in the case of damages.



WARNING

Possible dangers due to loss of sensor function.

- Observe all safety instructions and notices regarding installation, use and maintenance included in this operation and service manual.
- Observe the notices regarding application (adhering process, positions, etc.) of the sensors included in this operation and service manual.
- The sensors must be located at least one meter away from lightning receptors, otherwise they might be damaged. Avoid areas on the rotor blade where the distance between sensor and lightning arresters within the blade is less than 3 cm.

3.5 General safety instructions and regulations

In general, the following safety regulations and obligations apply when handling the product:

- The product may only be operated when it is clean and in immaculate condition.
- It is prohibited to remove, change, bypass or bridge any protective, safety or monitoring device.
- It is prohibited to modify or change the structure of the product.
- The operator must immediately be informed about faults or damages.
- For any activity other than the intended use, the product must be disconnected from the power supply.
- Repairs may only be carried out by the manufacturer.
- Only original spare parts may be used.
- The safety instructions and operating instructions from the documentations of the used components must in any case be observed.
- Only instructed, trained and qualified persons may perform activities in the area of the product.
- The installation activities must be carried out in accordance with the installation plan and must be documented.

3.6 Personal protective equipment

Use your personal protective equipment in accordance with the local regulations resp. the operator's regulations and always carry it with you.

In addition to the compulsory personal protective equipment, the following personal protective equipment must be worn for the below-mentioned activities:

	⚠ DANGER Danger of falling During installation activities at existing systems, there is a danger of falling when working at height – Always wear fall protection when carrying out installation activities at height. – Only trained and briefed personnel may carry out installation activities at height.
	⚠ WARNING Danger of being hit by objects or bumping Possible consequences of non-observance – Always wear protective helmet during installation activities.
	⚠ WARNING Danger due to noise Possible hearing damage when working in areas with increased noise emission. – Always wear ear protection when working in loud areas.
	⚠ CAUTION Danger due to substances Working with the adhesive tape and the edge sealer might lead to dermal injuries. – Always wear protective gloves when working with adhesives and edge sealers.

3.7 Warning, mandatory and prohibition signs on the product

Safety instructions indicating dangers/residual risks are attached to the product. The instructions of the safety signs on the product must be complied with under any circumstances. Should the safety signs fade or be damaged throughout the product's operational lifetime, they must immediately be replaced. The legibility and completeness must regularly be checked.

As soon as the signs are not recognizable or understandable at first glance, the product may not be operated anymore until new signs have been attached to it.

Pictogram	Meaning	Description
	Warning of electric voltage	W012
	Observe manual	M002

3.7.1 Notices on the base station



Figure 1 Notices on the base station

Pos.	Location	Description	Dimensions
1	Base station	Warning of electric voltage	Height at least 25 mm
2	Base station	Observe manual	Height at least 25 mm

3.7.2 Notices on the sensor

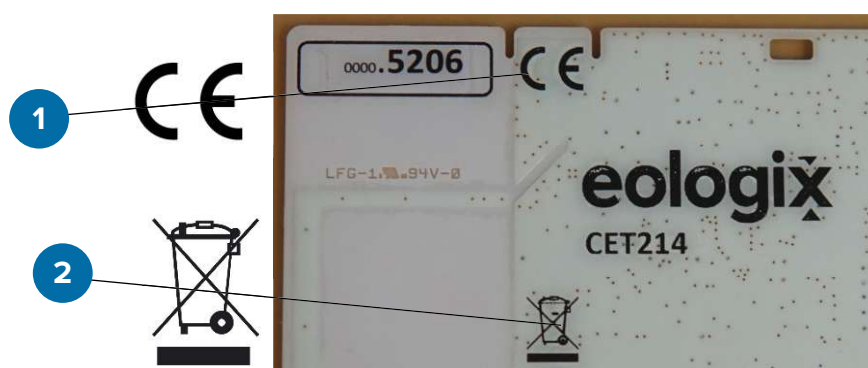


Figure 2 Notices on the sensor

Pos.	Location	Description	Dimensions
1	Sensor	CE marking	Height at least 5 mm
2	Sensor	Do not dispose of waste electronic equipment as domestic waste but return it to eologix	Height at least 5 mm

3.8 Training

The installation and corrective maintenance personnel must be specifically trained regarding their activities on the product. During training, the following aspects must be emphasized:

- Close attention must be paid to safety instructions!
- Information and warnings regarding residual risks required.
- New personnel must be instructed before starting to work on and with the product.
- Recurring training for the entire personnel is required.

Scope of training

The training measures include safety training, operation, servicing and corrective maintenance of the product delivered, installed and commissioned by eologix sensor technology gmbh.

Training personnel

The initial training is, as a rule, provided by eologix sensor technology gmbh resp. by the operator's correspondingly trained and qualified personnel. In-house training at the facilities of the product's operator (i.e. training of new employees) may only be carried out by personnel authorized and trained to do so by eologix sensor technology gmbh.

In addition, if the employee tasked with the staff training is unable to conduct the training or resigns, the operator of the product is obligated to authorize and train at least one additional employee for staff training.

If the initial training is not provided by eologix sensor technology gmbh, it is the operator's responsibility to ensure proper training (in accordance with the scope of training outlined above).

Training records

All trainings must be documented in a training record; in any case, the scope of training, the trained persons and the person(s) providing the training must be included therein.

4 STRUCTURE

The following figure provides an overview of the structure of the product.



Figure 3 Overview of the sensor system

Pos.	Component
1	Sensor units 
2	Receiving unit (Base station) 

The eologix sensor system is a blade-based measuring system. This means that a defined number of sensors (depending on the application and, in some cases, the rotor diameter) measure directly on the surface of the rotor blade. The sensors measure the temperature, inertial data (optional) and capture the ice thickness directly at their application position, that means at the surface of the rotor blades.

The measured data is transmitted wirelessly to a receiver (base station). The base station receives the measurement data of all sensors, evaluates them and can be integrated via various interfaces depending on the customer's requirements.

For the application of the relative pitch angle, the acquired inertial data is transmitted to servers hosted by eologix, which use an algorithm to determine the relative pitch angles and then transfer them to an online dashboard accessible to the customer. This means that a data connection is also necessary for this application.

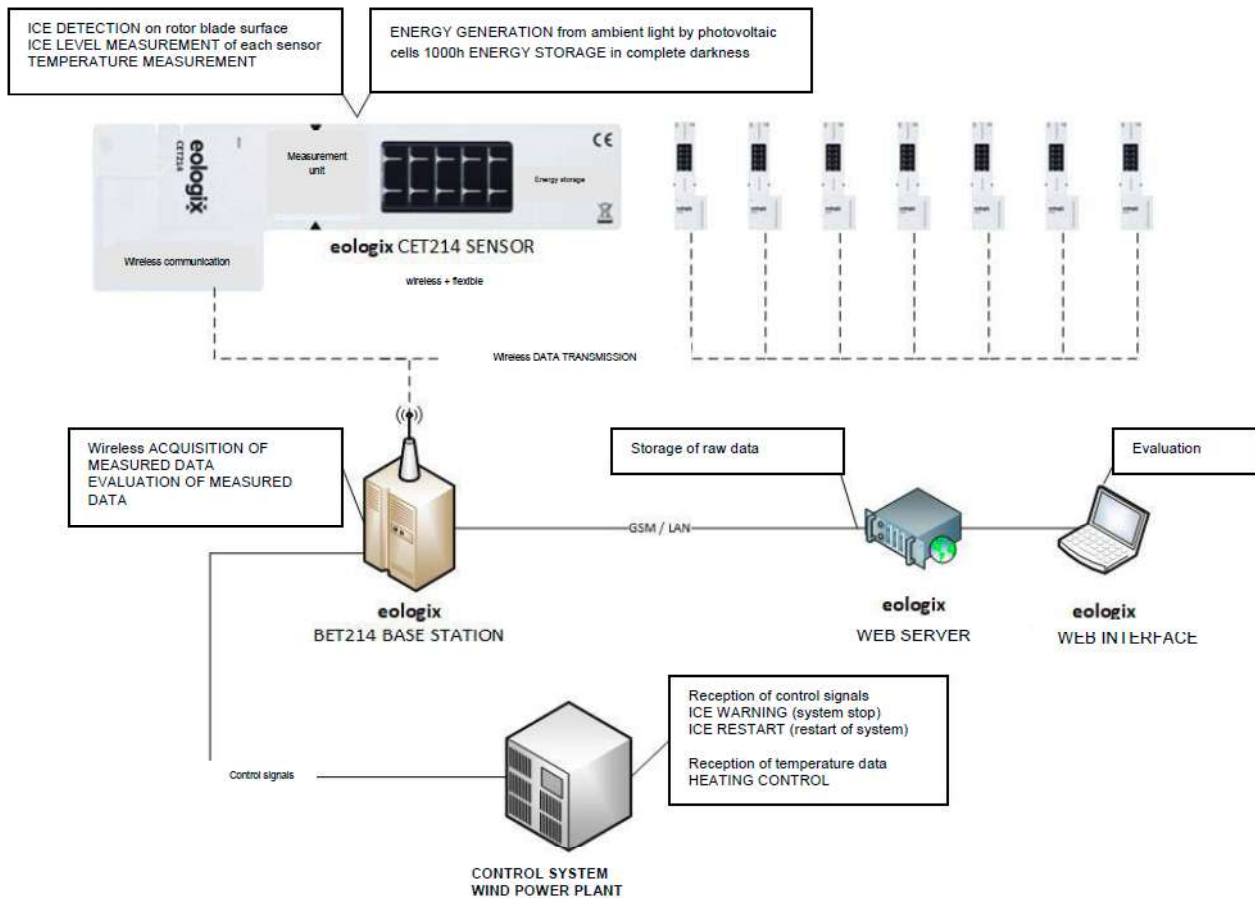


Figure 4 Overview transfer of measured data and interface integration (Ice application)

The following applications can be realised with the system according to DNV component certificate CCA-DNVGL-SE-0441-00526-01¹:

- Ice detection (meaning, i.e., system stop because of icing)
- Ice-free-detection (meaning automatic restart of the wind power plant once it is ice-free after a system-stop because of icing)

No control of the system is necessary for the pitch angle application, i.e. it is purely a monitoring tool, so no DNV component certificate is required in this case - but in order to obtain an external qualification, a certification process is also currently being carried out for the pitch angle application.

¹ Component Certificate DNV (Issued 2020-09-09 and valid until 2023-09-08)

4.1 Base station

The following section provides an overview of the base station that can also be referred to as receiving unit.

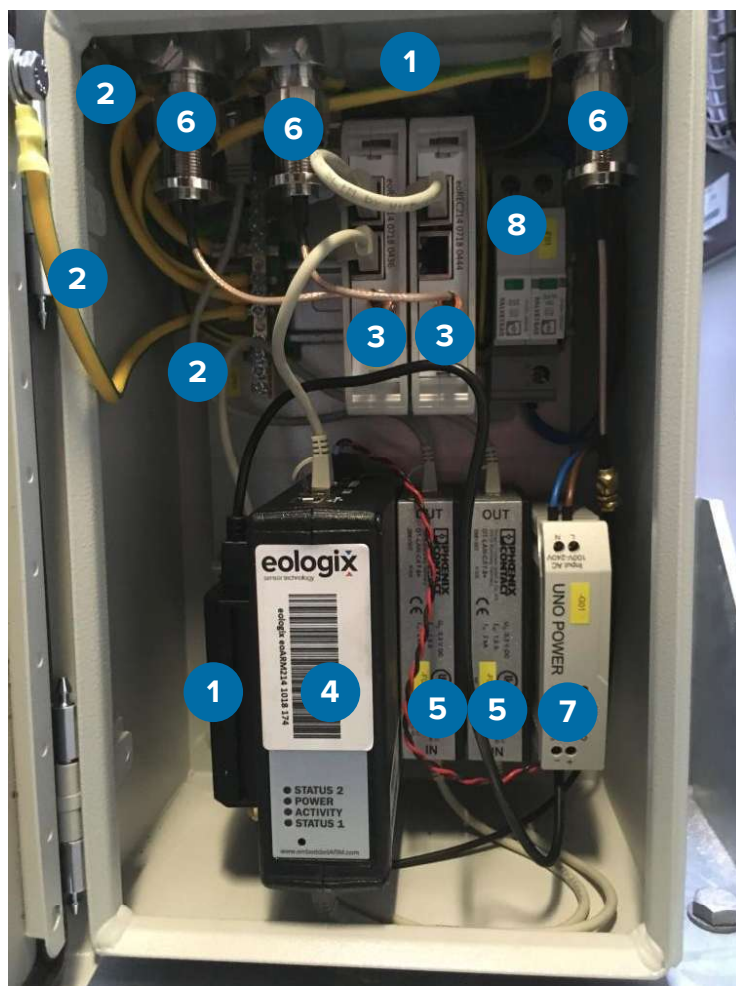


Figure 5 Inside view base station

Pos.	Component
1	Relay or wireless communication modem
2	Earthing connection
3	eologix receiver
4	eologix IPC
5	Surge diverter ethernet

- 6 Surge diverter antenna
- 7 Power supply unit 24 volt
- 8 Surge diverter power supply

4.1.1 Function description base station

The base station receives the measurement data from the sensors by means of two antennas, evaluates them and can be connected to the customer's system via various interfaces. The antennas are mounted inside or outside the nacelle of the wind turbine, depending on its condition. With an existing internet connection of the base station, it is also possible to store the measurement data online (on own servers at the location of eologix in Graz, Austria) and to display historical data by means of visualisation (see Chapter 6.4).

Possible interfaces

- 2 x or 3 x relay output (system status ok/not ok, ice stop yes/no, restart yes/no)
- ModBus TCP/IP
- CAN
- RS485
- Network interface 1 for connection to eologix online system
- Network interface 2 for connection to OEM control or SCADA system
- Further interfaces possible on request

The power consumption of the base station is typically 5 W (maximum 10 W).

Function principle

The eologix BET214 base station is a receiving unit for the eologix CET214 sensors and also other compatible ice and temperature sensors. Typical installation positions of the base station are in the nacelle or near the tower but are not limited (also e.g. sub-station or transformer station). One base station is used per turbine.

The base station consists of the electrical cabinet and one or more receiving antennas, depending on the designated installation. The base station antenna(s) receive(s) the signal from the CET214 sensors (or compatible sensors). The base station stores and sends the data to the eologix server for data processing or data usage for the customer. Furthermore, switching signals are generated or various bus signals can be provided for turbine control.

The BET214 base station receives data packets from the sensors. The signals for the switching relays are generated from these data packets:

- System OK/ System NOT OK,
- Ice-stop / NO ice-stop,
- Restart / NO restart.
- Optional: Inertial data (transmission to eologix server for further calculation of relative blade angle errors)

The data is also transferred online (to the eologix server) for further evaluation of the data. In addition, various bus systems are supported by the system.

4.1.2 Key features base station

BET214

Characteristics	Boundary conditions	Minimum value	Typical value	Maximum Value	Unit
Surrounding temperature	During operation	-40		60	°C
Humidity	Non-condensing	0		95	% rh
Transmission range	Linear distance		250		m
Lightning protection devices in the electric cabinet	Ethernet, antenna, 100-240 V AC	0	0B		Zone
Measuring rate		0.5	1	2	1/min
Dimensions of the box	L x W x H		200x180x300		mm
Weight			6		kg
CE conformity			Passed Yes		
Insulation class	Electric cabinet closed		IP55		

4.1.3 Technical specification base station

BET214

Characteristics	Boundary conditions	Minimum value	Typical value	Maximum Value	Unit
Power consumption			5	10	W
Input voltage	AC	100		240	V
Frequency			50	60	Hz
Input voltage	optional DC	12	24	28	V
Grounding cable	Copper	16			mm ²
Cable length	Per antenna		10		m
Transmission relay	Voltage		24	30	V
Transmission relay	Power			2	A
Transmission relay	Number	0		3	Pieces
Output 1 relay OK/not OK	1=System OK 0=System not OK	0		1	-
Output 2 relay Ice/no ice	1=NO ice-stop 0=ice-stop	0		1	-
Output 3 relay restart	1=restart OK 0=NO restart	0		1	-
Digital bus system	Standard		Modbus TCP		
Digital bus system	Optional		CAN RS45 Modbus RTU		
Digital bus system	Other		On request		
Online status- monitoring system	Optional		Via Ethernet or GSM		

4.1.4 Connections



Figure 6 Connections

Pos.	Description connection
1	Antenna 1
2	Antenna 2
3	Power supply
4	Relay
5	Ethernet
6	Modbus TCP
7	Condensation drain
8	Grounding
9	<i>OPTIONAL Antenna GSM Modem</i>

4.1.4.1 Relay contacts

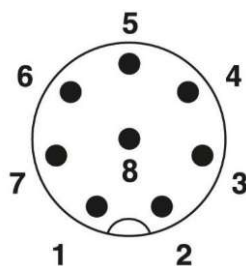


Figure 7 Relay contact (Front view)

eologix offers three relay connection contacts. Basically, we recommend two relay connections for the eologix:safe and three relay connections for the eologix:restart system. However, for both systems a minimum configuration with the use of only one relay is possible.

The hardware is equipped with a relay interface with all relay contacts (as shown Figure 7 Relay contact (Front view)) and depending on the number of connection points, the appropriate software is then configured by us.

Overview of all relay contacts

PIN	Allocation	Description
1 (WH)	24 V	24 V from the system
2 (BN)	GND	0 V from the system
3 (GN)	Relay 1 COM	System OK, 24V to PIN 3 Connection between PIN 1 and 3, none between 2 and 3
4 (YE)	Relay 2 COM	NO ice-stop, 24V to PIN 4 Connection between PIN 1 and 4, none between 2 u. 4
5 (GY)	Relay 3 COM	Restart OK, 24V to PIN 5 Connection between PIN 1 and 5, none between 2 u. 5
6 (PI)		Not used
7 (BL)		Not used
8 (RE)		Not used

Function assignment - use of two relay connection contacts for eologix:restart

PIN	Allocation	Description
3 (GN)	Relay 1 COM	System OK, 24V to PIN 3 Connection between PIN 1 and 3, none between 2 u- 3
4 (YE)	Relay 2 COM	NO Ice-stop / Restart OK, 24V to PIN 4 Connection between PIN 1 and 4, none between 2 u. 4

Function assignment - use of two relay connection contacts for eologix:restart

PIN	Allocation	Description
4 (YE)	Relay 2 (!) COM	System OK / NO STOP due ice / Restart possible, 24V to PIN 4 Connection between PIN 1 and 4, None between 2 and 4

4.2 Sensor unit

The patented sensor is flexible, wireless, has a self-sufficient energy supply and consists of the following components:

- Sensor unit (2 mm thick), adhesive foil (0.3 mm thick)
- Radio interface for data transmission
- Measuring surface for determining the electrical impedance of the surface (direct measurement of the icing condition, icing with a thickness of less than 1 mm can be detected)
- Measurement of temperature with a resolution of $\pm 0.25\text{ }^{\circ}\text{C}$
- Flexible photovoltaic cell for energy generation from ambient light
- Energy storage for back-up absolute darkness (a function of the sensor in absolute darkness of more than 1000 h is guaranteed)
- **Optional:** acceleration sensor for measuring inertial data



Figure 8 Sensor components

Pos.	Function
1	Sensor unit
2	Self-adhesive tape
3	Optional - In the version with acceleration sensors (possibility to measure inertial data) for the pitch angle application, an "angle symbol" is also displayed on the sensor

The sensor units can be mounted anywhere on the rotor blades, but also on the nacelle or tower. Their flexible design makes them easy to install even on curvy surfaces. They are delivered as a self-adhesive patch with an erosion protection film, and can be mounted within minutes.



Figure 9 Display of the sensors mechanical flexibility

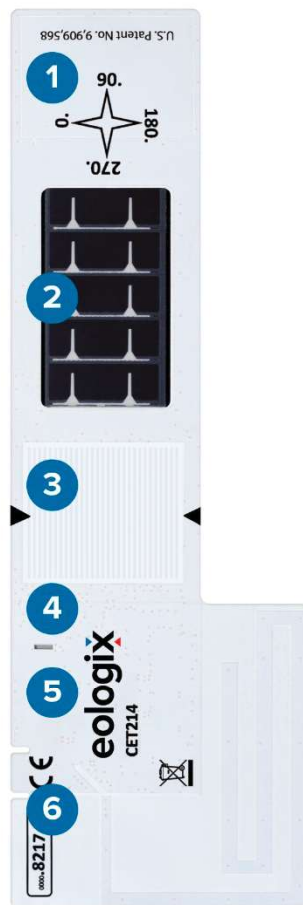


Figure 10 Structure sensor unit

Pos.	Function
1	Energy buffer
2	Power supply by solar cells
3	Sensors for icing detection
4	Sensors for temperature measurement
5	Sensors for measuring inertial data (optional)
6	Module for wireless transmission of information

4.2.1 Key features sensor

CET214

Characteristics	Boundary conditions	Minimum value	Typical value	Maximum value	Unit
Surrounding temperature	During operation	-30		60	°C
Humidity		0		100	% rh
Range of transmission	Linear distance		250		m
Temperature	Measuring range	-40		+85	°C
Temperature	Measuring resolution		0.25		°C
Temperature	Measuring accuracy		0.25	0.5	°C
Measurement repetition rate	Set during production	0.5	1	2	1/min
Minimum density of ice	For detection		0.25		kg/dm ³
Accelerations (inertial sensors)	Optional function		+16g		kg/dm ³
Dimensions LxWxH	Sensor		240x100x2		mm
Dimensions LxWxH	Tape (adhesive tape)		360x254x0.3		mm
Weight	Sensor		35		g
Weight	Sensor + tape		80		g
Sensors per rotor blade	Recommended (depending on application)	3			Pieces

4.2.2 Technical specifications sensor

CET214

Characteristics	Boundary conditions	Minimum value	Typical value	Maximum value	Unit
Minimum bending radius		50			mm
Recommended storage temperature	Ambient light > 1000 Lux	0	25	40	°C
Charge time (after brief power cuts)	AM1.5, 1000 W/m ² 20°C		10		h
Operation time in darkness			1000		h
Charge cycles (calculated)	5 % discharge, 20°C		5000		1
Battery voltage				3.2	V
Battery capacity			68		mAh
Transmission performance		1		10	mW
Average transmission performance			1	2	μW
Transmission frequency (EU)		863	868	870	MHz
Transmission frequency (North America)		902	913	928	MHz

Materials

- Adhesive material: 3M W8751 or W8750 wind blade protection tape, transparent
- Other materials that come into contact with the blade surface: Potting compound for electronics (silicone, polyurethane).

4.2.3 Function description ice measurement

The eologix CET214 is a wireless sensor for measuring ice, temperature and inertial data. It uses an SRD communication band powered by a photovoltaic cell as a standard power supply in combination with accumulators (to bridge nights and longer icing times). The sensor unit is completely isolated and requires no external power supply. The sensor controller has the following two tasks:

- Importing and processing the measured data and
- wireless transmission of the data.

The ice detection is based on an integrated circuit for impedance measurement.

The base station BET214 or a BET214-compatible unit is required.

The following signal levels including their meaning are measured and output per sensor for ice detection: The following images were created in an ice wind tunnel and show the corresponding ice thickness per signal level as an example:



Figure 11 Display ice thickness

Signal Level	Description
1	Free sensor surface
2	„activity“, i.e. moistness, water, rime, etc. (no ice >1 mm)
3	Ice with a thickness of more than approximately 1 mm
4	Ice with a thickness of more than approximately 10 mm
5	Ice with a thickness of more than approximately 15 mm

4.2.4 Function description temperature measurement

The surface temperature is measured by the sensor with an accuracy of $\pm 0,25^{\circ}\text{C}$ in the range of -40°C bis $+85^{\circ}\text{C}$.

4.2.5 Function description pitch angle measurement

The sensor system can also be used for relative pitch angle measurement. In contrast to ground-based systems, the sensor system from eologix measures continuously.

There is a continuous measurement of the pitch angles, but because of different possible occurrences (e.g. strong gusts, etc.) a result is only guaranteed once a week. For a successful evaluation, the system must generally be in operation (no standstill and no spinning).

For installation and commissioning, an internet connection and a power connection are required. If the customer cannot provide a LAN, the manufacturer can provide a SIM card as an add-on (the customer must check the GSM reception at the location in advance - without an internet connection (gondola network, SIM card, etc.) no system is possible, since the calculation and evaluation of the data take place on the company's own secure server in Graz, Austria.

5 INSTALLATION

The installation of the sensor system is covered in the following chapters. This includes requirements for transport, storage, the installation site, mounting and commissioning of the base station and sensor.

The base station can be attached to a mounting location in the nacelle. See chapter 5.4

The sensor is delivered applied to a wind blade protection tape; by means of this tape and a self-adhesive back side of the sensor, installation on the rotor blade is carried out at the same time. Installation is possible at the manufacturer, on the construction site and also for already erected wind turbines. See chapter 5.6

5.1 Transport

If the product is not delivered by eologix sensor technology gmbh, appropriate packaging must be chosen for transport, as well as an appropriate transport company. The product components must be packaged in appropriate transport containers and appropriately secured for transport.

5.2 Storage

Regarding storage of the product, the following must be observed.

- Depending on the ambient conditions, the product must be protected accordingly.
- If necessary, the components must be treated accordingly to protect them against corrosion damages.

Storage of the sensors

- The sensors are exposed to light while in storage at the manufacturer's and are therefore ready for use upon delivery.
- Regarding storage at the operator's, it must be ensured that the batteries are not deeply discharged by longer storage at a dark location.
- If the sensors are stored at darkness for a period of time that exceeds the maximum operation time at darkness, the sensors must be charged in conditions similar to daylight or sunlight at least once for four hours within two weeks. This means that, in the event of permanent storage, the charging process must be repeated at least every two weeks for four hours. If in doubt, please contact eologix sensor technology gmbh.

5.3 Installation position of the base station

The base station can be flexibly attached to any mounting location in the nacelle using four clamp connections, screws or magnets. The two antennas are connected to the base station via coaxial cables.

- Transportation regulations must be observed!
- Attachment of base station on firm, load-bearing ground
- Connection of the cabling according to the plan

Installation site

- The space required by the product must be taken into consideration in accordance with the installation plan.
- The place of installation must be suitable for the weight of the base station.
- The connections of the electric lines must be taken into consideration.

5.4 Installation of base station



⚠ WARNING

During installation activities, improperly carried out activities can lead to additional dangers.

If the product is not installed properly, dangers for persons can arise.

- Installation works may only be performed by authorized and trained personnel.

When installing the base station, the following must be considered:

- Before installing the base station, it must be inspected for completeness and transport damages. Any deviations must immediately be reported to eologix sensor technology gmbh! Subsequent complaints cannot be taken into consideration.
- The base station must be installed on solid ground within the nacelle.
- Installation on a suitable surface with suitable magnets, or
- installation on a frame, rack or the wall using screws, or
- installation on a frame or rack using clamped connections.

The BET214 base station and the corresponding antennae are individually configured for the specific installation site. This includes:

- Outside the turbine (in the transformer station or intermediate station)
- Inside the nacelle (on an optional installation device or in an electric cabinet)
- Outside the nacelle (provided that the nacelle's casing is made of metal resp. conductive material).

5.4.1 Cable connection



Figure 12 Connections

- The grounding of the base station must be connected to the grounding of the nacelle. See Figure 13.
- The two antennae are connected to the base station using coaxial cables.
- Connection of the two corresponding data interfaces.
- Connection of the power supply. Must be installed by a qualified electrician and designed in accordance with the respective standards.



Figure 13 Example of a cabling (previous version)

5.4.2 Mounting with wall brackets

Necessary installation holes for the base station for 4xM8 screws in a rectangular grid 160mmx260mm.

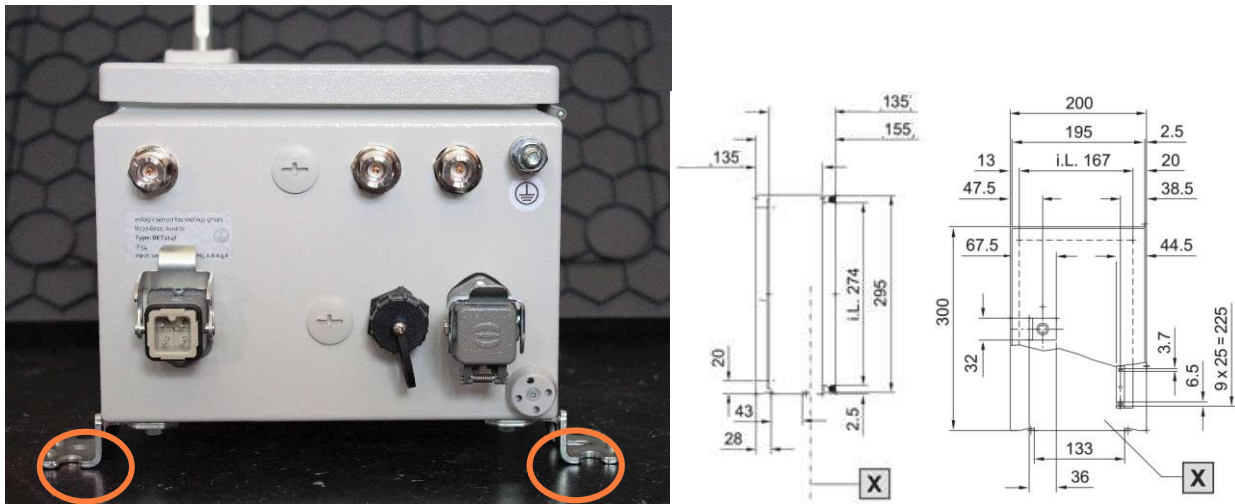


Figure 14 Mounting base station by means of the pre-mounted wall brackets (4 pieces)

Required mounting holes for the base station for 4x M8 screws in a rectangular grid 230mm x 240mm.

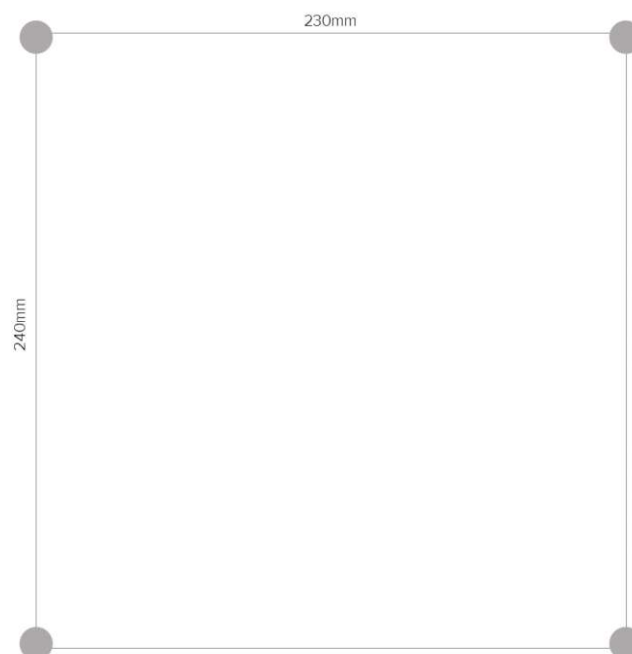


Figure 15 Required mounting holes for mounting by means of wall bracket

5.4.3 Mounting using clamps for mounting on H-profiles

The option of mounting by using clamps on H-profiles is also available and is not part of the standard equipment of the eologix base station.

The following pictures show the back of the base station with four clamp connections.

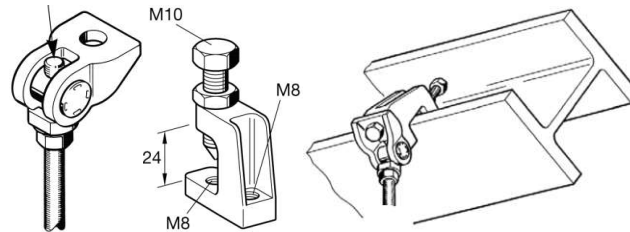


Figure 16 Clamped connections

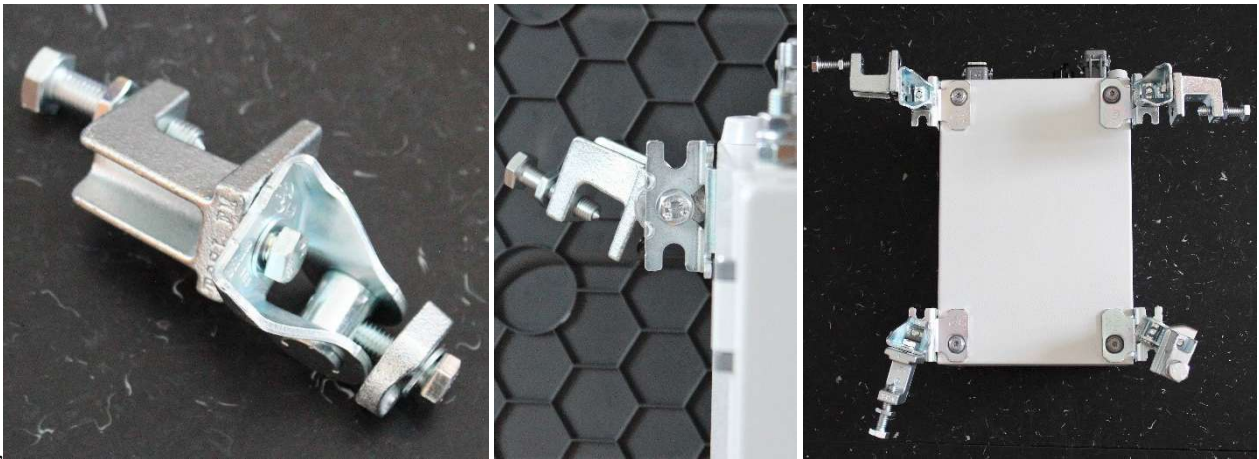


Figure 17 Back side of the base station

This allows the base station to be mounted on the most commonly used H-profiles.



Figure 18 Example of an installed base station (previous version)

5.4.4 Mounting the receiving antennas

For redundancy reasons, the base station is equipped with two receiving antennas.

The standard antennas are shown in the following figure.



Figure 19 Rod antenna incl. antenna cable



Figure 20 Panel-antenna incl. antenna cable

The type and mounting location of the antennas depend on several factors such as the material of the nacelle outer wall, turbine diameter, etc. and differ depending on the turbine type.

The mounting location of the antennas is defined by eologix in cooperation with the customer on a project-specific basis. The following illustrations show examples of antenna installation.



Figure 21 Example of antenna mounting inside with clamps



Figure 22 Antenna mounting outside with clamps

5.5 Application positions of ice sensors

- It must be ensured that the mounting location is flat and free of contamination.
- As a rule, the product is applied by qualified personnel from eologix sensor technology gmbh.
- Requirements for the mounting location are coordinated in advance with the operator, the original equipment manufacturer (OEM), etc.

5.5.1 Application positions 9 ice sensors eologix:safe (9 ice sensors)

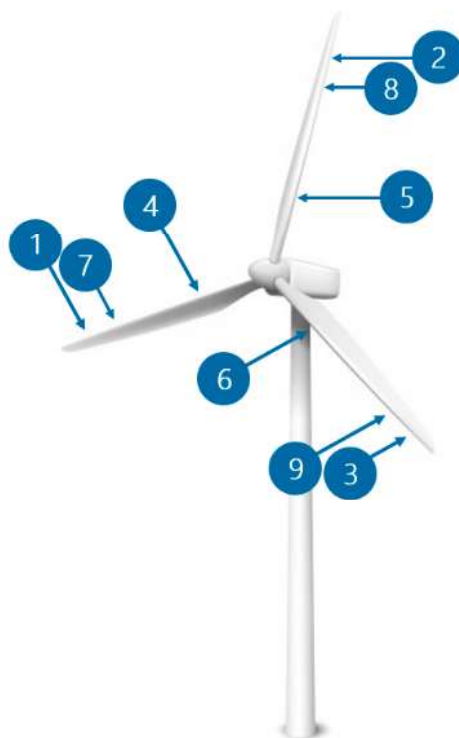


Figure 23 Application positions 9 sensors

The number of sensors on the eologix:safe does not depend on the rotor blade length. The positions of the sensors are shown as follows:

eologix:safe	(9 sensors)
Tolerance of all length specifications	±1 meter
All sensors (1-9)	Leading edge
6 sensors (sensor 1/7/2/8/9/3 in the figure 23) at the three blade tips	Distance from root: > 70% of blade length
3 sensors (sensor 4/5/6 in the figure 23) at the three blade roots	Distance from root: < 20% of blade length
Conditions for redundancy	Operation for ice detection as long as two sensors are active at the blade tip and one sensor is active at the root
Distance lightning receptors	Distance to each lightning receptor must be at least 1 m

5.5.2 Application positions automatic restart

In this mode, another signal (in addition to the "stop" signal) is generated according to the algorithm as per the DNV component certificate, which signals the system to restart automatically after a stop due to icing. I.e. the system detects when there is no more ice on the rotor blades of the turbine and signals the turbine to restart it.

In an eologix:restart system, the necessary positions for ice detection are covered several times. This means that every eologix:restart system is also suitable for the ice detection function. The number of sensors used in the eologix:restart system depends on the size of the wind turbine. The following system size (i.e. number of sensors) is used depending on the blade length:

Rotor blade length in m	Number of sensors per turbine
≤ 30 m	18
> 30 m and ≤ 60 m	21
> 60 m and ≤ 90 m	24
> 90 m	27

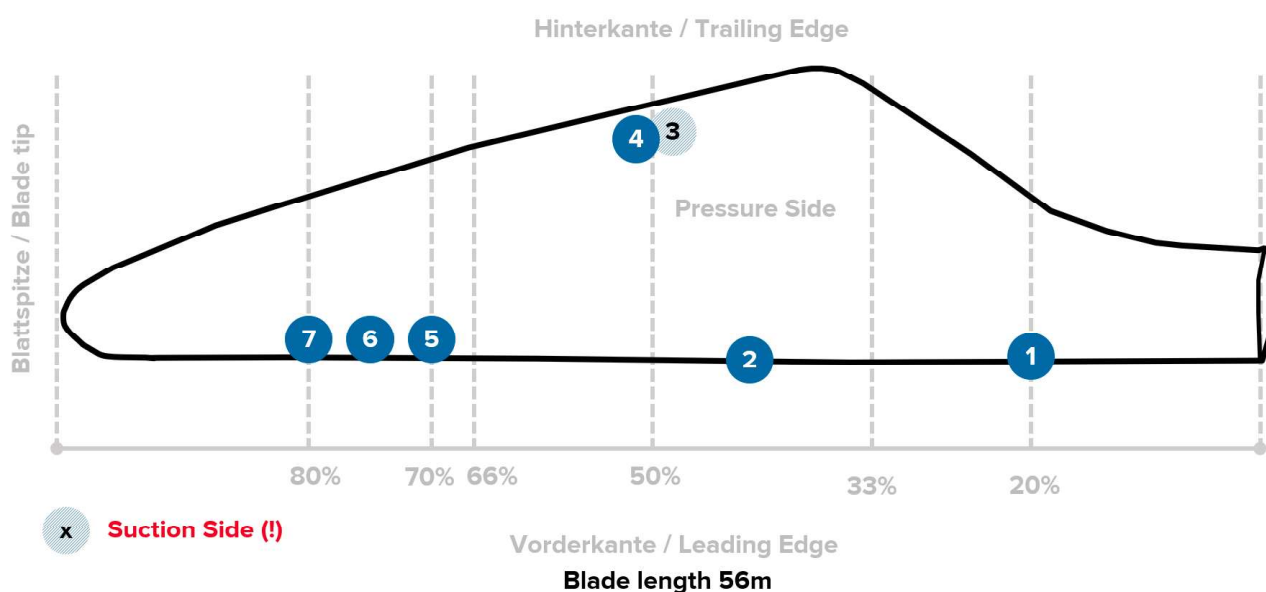


Figure 24 Example of application positions eologix:restart (with 56m rotor blade length)

Automatic restart (eologix:restart)	one blade as example shown, all three rotor blades have to be equipped symmetrically) using the example of 21 sensors for a system with a blade length of 56 m
Tolerance of all length specifications	±1 meter
Conditions for redundancy	Operation to detect ice (no automatic restart) as long as 2 sensors at the tip and 1 sensor at the root are active
Distance of lightning receptors	Distance to each lightning receptor must be at least 1 m
Number of sensors	In detail – as shown in Chapter 6.1.2
Sensor 1, 2	Leading Edge (100% Distance trailing edge); Distance from the root 20% and >40%
Sensor 3	Suction side (10% Distance trailing edge) Distance from the root 50%
Sensor 4	Pressure Side (10% Distance trailing edge) Distance from the root 50%
Sensor 5-7	Pressure Side (>90% Distance trailing edge) Distance from the root >70%

5.6 Application of a sensor

The sensor is delivered applied to wind blade protection tape; by means of this tape and a self-adhesive back side of the sensor, application on the rotor blade is carried out at the same time. The wind blade protection tape by 3M (W8751 resp. W8750) that is used has been used for more than ten years in wind power to protect the leading edge.

The sensors can be applied by the manufacturer, on the construction site (before lifting the blades) as well as at existing systems (retrofitting by means of manlift or industrial climbers). Application can be carried out by the customer themselves. Training by eologix necessary.



Figure 25 Mounting on an existing installation



Figure 26 Mounting of the sensors on the ground

When applying the sensors, the following must be considered:

- Before applying the sensors, they must be inspected for completeness and transport damages. Any deviations must immediately be reported to eologix sensor technology gmbh! Subsequent complaints cannot be taken into consideration.
- The product must be attached to a clean, firm and even surface.
- Position the unpacked product in accordance with the installation plan.
- The guidelines of the following installation plan must be observed.

5.6.1 Requirements

Required qualifications of installation personnel

Experience in the installation of blade erosion tape. For more information, visit the manufacturer of the blade erosion tape website www.3M.com/wind for instructions on the application of 3M™ Wind Protection Tape 2.0/2.1 (W8750, W8751).

If the sensors are applied to already erected wind turbines, the respective national safety and work guidelines for rope access and positioning techniques apply. Furthermore, we recommend a short consultation with an eologix service contact (to be reached via service@eologix.com) to clarify any open questions and/or to receive useful tips.



NOTICE

The temperature of the rotor blade should be 16° C or higher to ensure proper adhesion of the tape.

If in doubt regarding methods to warm up the rotor blade, contact the manufacturer eologix sensor technology. It must be ensured that the rotor blade is not damaged while it is warmed up and that the sensor's maximum temperature of 60°C is not exceeded.

Ground

- No tears or damages
- No dirt

5.6.2 Preparation for application

Preparation for application by manufacturer or before lifting in warm surroundings:

Make sure to have all the following required tools ready before starting the mounting of the sensors:



Adhesion Promotor
(3M™ Wind Tape Adhesion Promotor W9910 and additionally paper wipes, wipes and adhesive tape)



Mounting spray
(3M™ Application Solution Spray 75% water + 25% Isopropyl)



Edge sealing
(3M™ Wind Protection Tape Edge Sealer W2600 and EPX mixing nozzles, as well as a plastic spatula)



Applicator
3M™ EPX™ Applicator for edge sealing



Spatula Wet or Dry Rubber Squeegee
(3M™ Part.No 05517)



Pressure sprayer
min. 0.5l



Rubber gloves
Disposable; Nitrile rubber



Insulating tape
for marking the mounting positions



Manual reader
(provided on request by eologix)



Sandpaper
(Grit 250-500)



Smartphone or camera
with good resolution for image documentation (more on this in the chapter "Documentation")



Distance measuring device or rolling measure
for determining the mounting positions

Preparation rope installation

For installation by industrial climbers, the following tools and materials are necessary:

- Personal protective equipment against falling
- Disposable protective gloves nitrile rubber

- Sanding sponge or sanding paper (grit 250 – 500)
- Cleaning cloths, clean and lint free, at least 1 piece
- Rubber squeegee (3M squeegee gold or blue), 2 pc.
- Application spray
(3M Application Solution Spray, 25% isopropyl mixed with 75% water), 3l
- Infrared thermometer, 1 pc.
- Spray bottle, 2 pc.
- Paper roll, 1 pc.
- Promotor (3M Adhesion Promotor W9910) 1 can
- Brush, 2 pcs. (to apply the Adhesion Promotor W9910)
- Roller, 1 pc. (to evenly apply the sensor), 1 pc.
- Edge sealer (3M Edge Sealer W2600), 3 packets
- Applicator (3M Applicator EP-X, „gun“ for edge sealer), 2 pcs.
- Plastic body scraper, thin, > 5 pcs (to apply and smoothen the edge sealer)
- Handheld indicator eologix handheld indicator (to inspect the eologix sensors), 1 pc.
- Spare batteries for handheld indicator, 4 pcs.
- Camera for documentation
- Refuse bags, > 3 pcs.
- Sensors

The following documents are provided by eologix:

- Mounting positions of the sensors (PDF) - please print out in advance
- Excel file for collecting the sensor IDs (part of the written documentation)
- Handheld reader (provided by eologix)
- ev. File for positioning the sensors (only necessary for the pitch angle application)



NOTICE

Please observe the associated instructions for positioning the sensors **for the pitch angle application** "eologix_align_Positioning_the_Sensors_vX.X.pdf" for proper installation and correct position in the latest valid version!



NOTICE

If the sensor has been stored in the dark for a longer period of time (e.g. during transport), the sensor should be exposed to direct sunlight or artificial light similar to daylight for at least 1 hour before installation.

The sensor must be checked for proper functioning with the handheld reader before installation.

Step 1: Mounting positions.

Please measure the position of the sensors to be mounted as specified in the turbine-specific document with mounting positions provided by eologix (depends on system type and application!) and mark them on the rotor blade, e.g. using a piece of insulating tape. Ensure that the minimum required distance to the lightning receptors is maintained. (as seen in Chapter 5.5).



Figure 27 Mark assembly positions

5.6.3 Clean surface & apply Adhesion Promoter W9910

Step 2: Clean surface and apply adhesion promoter

The marked mounting surfaces must be cleaned of dirt, dust, grease or silicone. If necessary, use sandpaper (grit 250 - 500) to smoothen the surface. Any cracks must be filled beforehand to create a suitable base surface before the sensors can be applied.

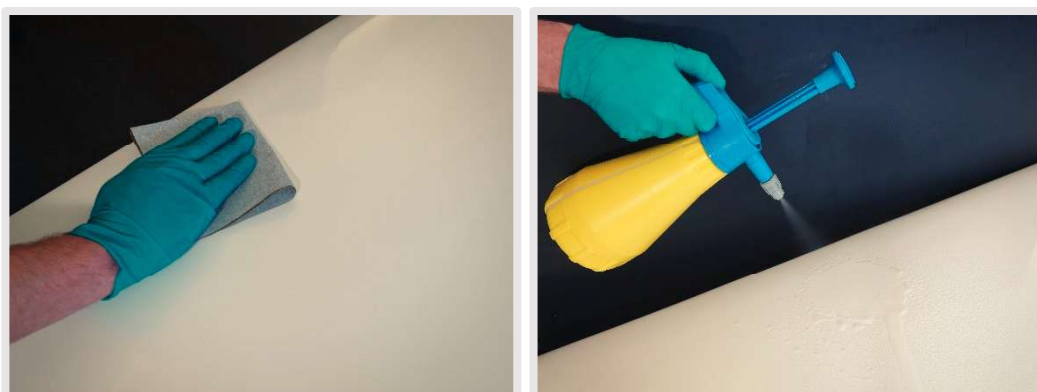


Figure 28 Prepare surface

Apply a thin film of 3M™ Wind Tape Adhesion Promotor W9910 to the intended adhesive area of the sensor with a wipe or brush (alternative: use "3M™ Wind Tape Adhesion Promotor W9910 Wipes"). The Adhesion Promotor W9910 is necessary to ensure the initial adhesion of the 3M™ Wind Tape. After applying the promotor to the cleaned and sanded surface, it must dry for at least 10 minutes before the sensor can be applied.



Figure 29 Apply Adhesion Promoter W9910

5.6.4 Unpacking

Step 3: Unpacking

In the next step, please remove the sensor from the packaging as shown.



Figure 30 Unpacking the sensor

5.6.5 Preparing

Step 4: Removing the brown protective paper

In step four, carefully remove the brown protective paper from the back of the sensor. Be careful not to inadvertently pull off the double-sided adhesive tape attached to the sensor. You can check this as follows: after removing the brown protective paper, the protective paper must NOT feel sticky.



Figure 31 Removing the brown protective paper on the backside of the sensor



NOTICE

Do not cut pieces out of the sensor tape without prior consultation with eologix.
The sensor could be damaged, or the adhesive tape might lose its adhesion.

5.6.6 Adjusting

The degree on the wind rose, which points to the root of the rotor blade (in this example: 90°) must be noted in the documentation (see also section "Documentation").



Figure 32 Adjusting the sensor

Distance from the trailing edge of the rotor blade

The following figure explains the distance from the trailing edge of the rotor blade (Distance trailing edge (%)).

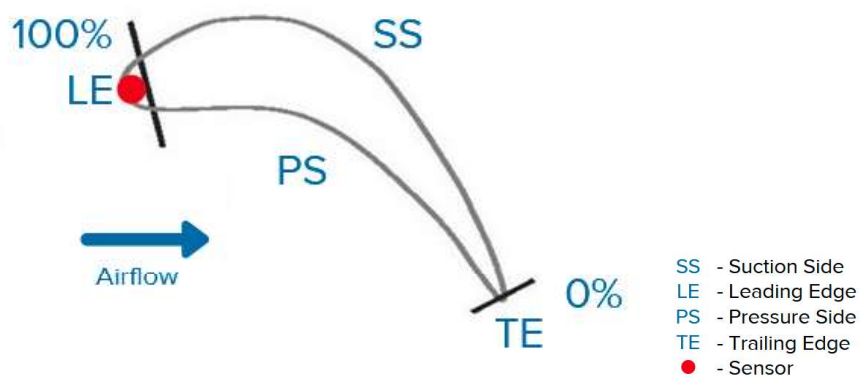


Figure 33 Distance Trailing Edge in % - with an example of a sensor at 100%.

The distance from the trailing edge of the rotor blade is given in [%] (see mounting positions (Distance trailing edge (%))):

How the sensor is adjusted depends on the application position in relation to the rotor blade's trailing edge. The distance from the rotor blade's trailing edge is given in [%]:

100% = LE - Distance trailing edge (%)

Sensor is mounted directly on the leading edge of the rotor blade (only 0° or 180° orientation is allowed)

>= 90% = LE - Distance trailing edge (%)

Sensor is mounted as close as possible to the leading edge of the rotor blade (only 90° or 270° orientations are permitted). **The erosion protection foil of the sensor ("thin" area) must always be taped over the leading edge.** See section: "Important notes".

50% = MID - Distance trailing edge (%)

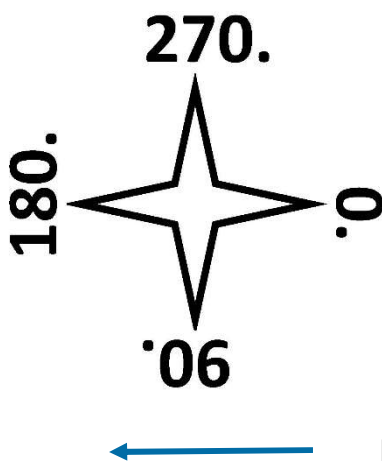
Chordwise in the middle between the leading and trailing edge of the rotor blade.

<= 10% = TE - Distance trailing edge (%)

The erosion protection tape must cover over the trailing edge of the rotor blade (i.e. the entire sensor plus tape must be sticked on one side of the blade)

The wind rose shown on the sensor is used to correctly align the sensor.

Wind rose (the number pointing in the direction of the rotor blade root is noted in the documentation).



Direction to rotor blade root (in this example 180°)

Figure 34 Wind rose on the sensor



⚠ WARNING

There must be a distance of at least 1 m between the sensors and lightning receptors, otherwise they might be damaged.

Avoid areas on the rotor blade where the distance between sensor and lightning arresters within the blade is less than 3 cm.



NOTICE

If the sensor is applied directly at the rotor blade's leading edge (>90%), the wide side of the tape must be applied over the rotor blade's leading edge: wind rose 90° (as shown below)

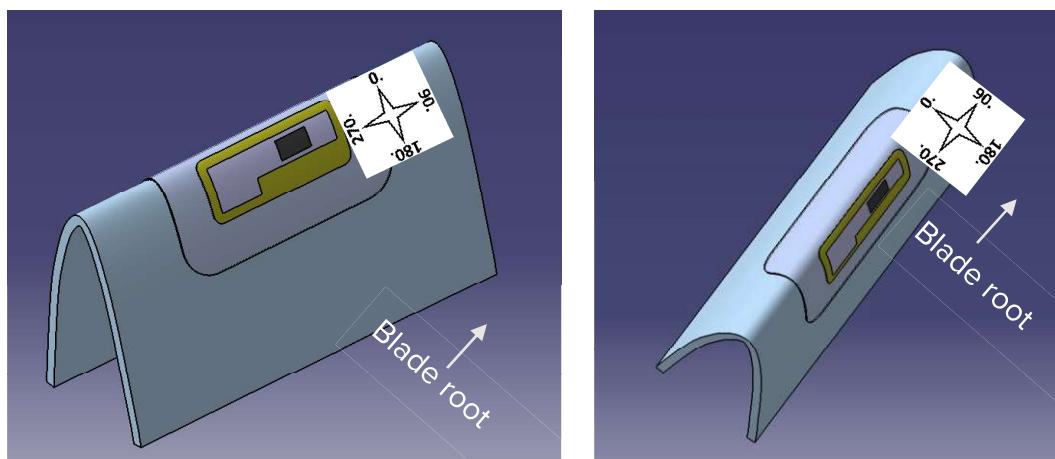


Figure 35 Alignment at the root of the rotor blade

5.6.7 Adhering

Step 5: Apply the sensor correctly.

In this step, the sensor with the now self-adhesive back is glued onto the rotor blade in the correct position (according to the specified mounting positions and the following explanations).



Figure 36 Adhering the sensor

NOTICE



The edges of the sensor tape may especially at the rotor blade's leading edge not be directly exposed to wind flow - in that case, it may be necessary to apply an additional tape after consultation with eologix sensor technology but it has to be ensured that no second tape layer is applied onto the sensor area (marked with two black triangles)

Step 6: Applying the assembly spray.

Wet the surface of the rotor blade with installation spray (75% water & 25% isopropanol): the surface on which the erosion protection tape will be placed should be completely wetted.

NOTICE



There may not be any liquid underneath the sensor. It must, as outlined in step 5, already be firmly adhered to the rotor blade before the application spray is applied.



Figure 37 Apply assembly spray

For more information, visit the assembly spray manufacturer's website www.3M.com/wind for instructions on how to use 3M™ Application Solution Spray.

Step 7: Remove the protective tape from the surrounding Wind Protection Tape.

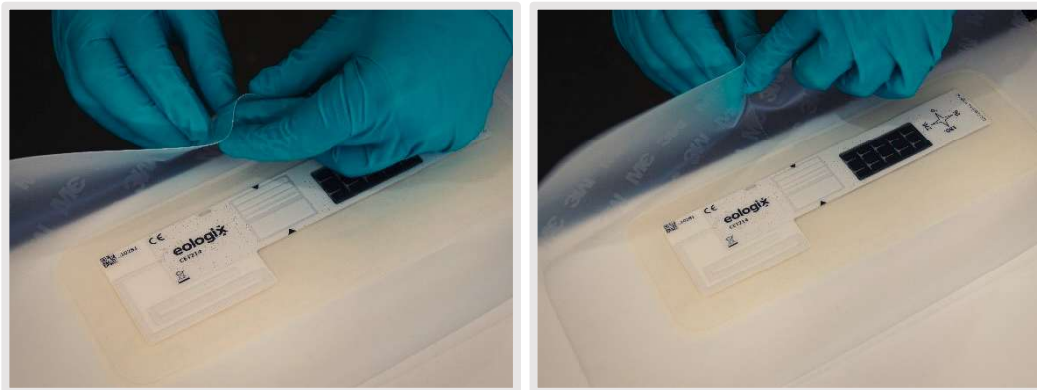


Figure 38 Remove protective tape from surrounding

In step 7, remove the transparent protective tape (patterned with "3M™"). Now also spray the sticky side of the Wind Protection Tape with mounting spray. Then apply the erosion protection tape to the blade surface.

Step 8: Strike out application solution

Spread the Application Solution between the tape and the rotor blade surface with the spatula
- For this step 3M™ recommends the "Wet or Dry Rubber Squeegee Part.No 05517".

Only the erosion protection foil around the circuit board may be worked on with the spatula!



Figure 39 Strike out application solution



NOTICE

The raised part of the sensor (circuit board, white) must NOT be worked on with the spatula.

5.6.8 Inspection

Step 9: Checking the sensor and removing the marking

After mounting, check the sensor with the eologix handheld reader. Each sensor ID displayed on the handheld reader confirms the function of this sensor. If a sensor is not displayed even after one hour in daylight, proceed as follows:

- Remove sensor (as seen in Chapter 8.3)
- Attach a new sensor.
- Send the defective sensor including the picture documentation of the attachment and removal back to eologix in order to clarify the cause of the defect

After the sensor has been successfully tested, the piece of insulating tape used for must be removed again.

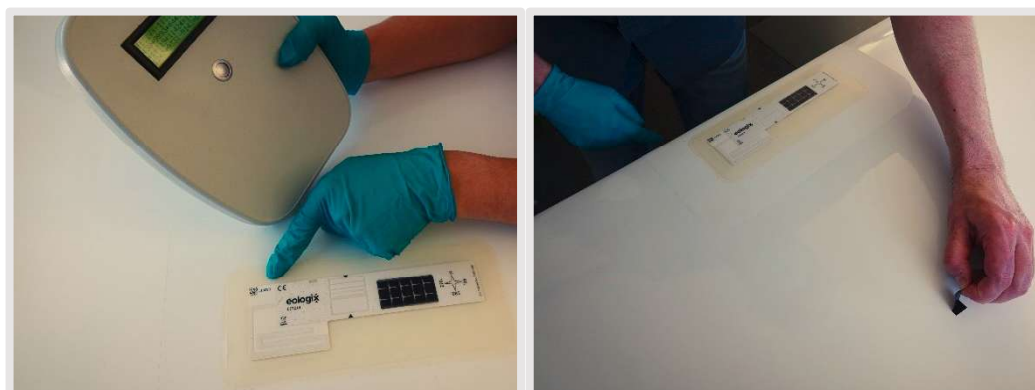


Figure 40 Inspection of the sensor

5.6.9 Sealing

Step 10: Edge sealing

Make sure the surface is dry. Use 3M™ Wind Protection Tape Edge Sealer W2600 with the 3M™ EPX Applicator to seal the edge between the tape and the rotor blade (as shown in the 3M™ [video²](#)). Use a plastic spatula to spread the sealer evenly.



Source: How to install: 3M™ Wind Blade Protection Tape

Please refer to the relevant [3M™ data sheet³](#) for the application of 3M™ Wind Protection Tape Edge Sealer W2600. Furthermore, ensure dry weather conditions (no wet rotor blade surface, no rain, condensing mist, etc.) before and during installation as well as for a few hours afterwards (curing time which is temperature dependent). The Edge Sealer must NEVER be exposed to moisture before and during curing.

Once the Edge Sealer has been applied, the sensor installation is complete. Now all steps of the mounting process are completed. Now follows the documentation of all glued sensors.

The following figure shows an example of what a fully assembled sensor should look like:



Figure 41 Example of an applied sensor

² <https://www.youtube.com/watch?v=YzWu4frzz04>

³ <https://multimedia.3m.com/mws/media/6307970/3m-wind-protection-tape-edge-sealer-w2600.pdf>

5.6.10 Documentation

Step 11: Documentation

Two documentations must be prepared for each sensor: Image documentation and written documentation.

Image documentation

The image documentation must be in high resolution (per sensor ONE close-up image incl. readable sensor ID and ONE distance image incl. foil, seal and sensor ID must be readable).

The following is an example of sufficient image documentation:



Figure 42 Image documentation an example

Written documentation

The written documentation consists of two parts: on the one hand, the written documentation of the position of the sensor IDs in the XLSX file, which is provided as a template by eologix, and on the other hand, the function check by using the manual reader and its confirmation by the rope access worker.

Written documentation: ID Position

The written documentation is done in the positioning table provided by eologix (see exemplary in Figure 5). The ID numbers of the sensors are documented in the respective cell (position on the sheet) of the Excel.

ENERCON E-82 DNV-GL 2020

Monteure / Technicians:		[NAME]						
WEA Nr. / Turbine number if available:		[SERIENNUMMER/ SERIALNUMBER]				Datum:		[TAG DER INSTALLATION] [DAY OF INSTALLATION]
Blattsatz Nr. / blade set ID						[SERIENNUMMER / SERIALNUMBER]-		
				Blattlänge / blade length		82		
Blatt ID / blade ID						[ID Blatt]	[ID Blatt]	[ID Blatt]
Blatt Ausrichtung / blade direction after blade mounting (A, B or C)						A	B	C
Sensor-Nr.	Rotorblatt- oberfläche	Abstand Hinterkante (%)	Distanz Wurzel (%)	Distanz Wurzel (METER)	Windrose (°)	Sensor ID		
1	DS	100	20%	16	180	[sensor ID]	[sensor ID]	[sensor ID]
2	DS	90	70%	57	90	[sensor ID]	[sensor ID]	[sensor ID]
3	DS	90	80%	66	90	[sensor ID]	[sensor ID]	[sensor ID]

Figure 43 Written Documentation Part 1: ID Sensor | Excel Sheet

The fully completed Excel file with all installed sensors and inserted sensor IDs and their positions must be sent to service@eologix.com after installation.

Written documentation: Functional check

The functional check after mounting the sensor to the rotor blade using the manual reader must be clearly documented (by means of photos of the handheld reader with the respective sensor ID or a written confirmation of the function).

5.7 Commissioning and test operation

Commissioning and test operation of the product at the customer's may only be carried out by qualified personnel of eologix sensor technology gmbh.



⚠ WARNING

During commissioning, unexpected movements and processes can lead to different dangers.

- The product may only be commissioned by authorized and trained personnel

6 OPERATION

The following chapters provide an overview of the operation of the product.

6.1 Use

The eologix ice detection system is certified by DNV. The certificate distinguishes between three operating modes

- Ice detection, meaning system stop because of icing
- Automatic restart, meaning automatic system start if ice-free
- Operation under ice load, meaning by means of measurement of ice thickness.

Only the first two operating modes will be covered in detail below. Customer-specific variations of the sensor configuration (especially additional equipment or individual equipment for specific purposes) are always possible.

6.1.1 Ice detection

Algorithm ice detection

The signal „ICE“ (meaning: ice is detected and the system must be stopped) is output, if

- any sensor delivers „Signal Level 5“, or
- two adjacent sensors deliver „Signal Level 4“, or
- at least 66% of the sensors on the tip (meaning >70% of the blade length) deliver „Signal Level 3“.

Redundancy ice detection

In accordance with the certificate, the system requires at least two sensors at the tip and one sensor at the root to be able to carry out the function „ice detection“. The different systems offered by eologix for the function „ice detection“ are presented below.

eologix:safe (9 sensors)

In this mode, a signal is generated according to the algorithm in the DNV component certificate, which signals the system to stop due to safety-relevant icing. The positions of the sensors are shown in chapter 5.5.1. The number of sensors does not depend on the blade length.

6.1.2 Automatic restart

Algorithm Automatic restart (Restart)

As soon as a sensor delivers "SIGNAL LEVEL 5" or a sensor delivers "SIGNAL LEVEL 4" or two sensors on one blade deliver "SIGNAL LEVEL 3", the signal "AUTOSTART NOT OK" is output.

If this is not the case, the signal "AUTOSTART OK" is output and the system can restart automatically.

Redundancy Automatic restart (Restart)

The function "Ice-free detection" can be continued as long as:

- at least 66% of all sensors of the minimum requirement are active,
- at least 2 blade tip sensors (sensors at positions >70% of the blade length) are active on 2 blades,
- at least one sensor is active every 30 m on each leading edge.

If not all of the above conditions are met, the signal "AUTOSTART NOT OK" is always output. Here, too, each sensor is redundant at least once (i.e. each sensor position is covered by at least one other sensor).

eologix:restart (number of sensors depending on blade length)

For the detection of ice-free conditions and thus the automatic restart, a higher number of sensors must be used and this also depends on the blade length. In the following, the required number of sensors according to the certificate is listed for exemplary wind turbine manufacturers and blade lengths:

Turbine type	Blade length	Number of sensors
X70	34 m	21
X82	39,5 m	21
X90	43,5 m	21
X115	56 m	21
X126	61,5 m	24
X136	66,5 m	24
X180	88 m	24

With every eologix:restart system, the necessary positions for ice detection are covered several times. This means that every eologix:restart system is also suitable for the ice detection function.

6.1.3 Operation under ice load

Operation under ice load, i.e. due to the continuous ice thickness measurement, the system can continue to be operated in non-safety-critical areas up to a certain degree of icing. Further information on this is available on request.

6.2 Handling

The product is set up via the interface in the course of commissioning. Afterwards, no further operational steps are necessary, the eologix sensor system is fully automated.

6.3 Assessment of probability of failure

DNV certification requires a probability of failure assessment in accordance with ISO 13849:2008.

- Redundancy of the sensors
- Redundancy of the receiving units:
 - 2 antennas and
 - 2 separate receiving units in the base station as well as
- various measures in the control unit, e.g.
 - Hardware watchdog,
 - test equipment according to FMEA and
 - plausibility check of the measurement data

the following property could be verified according to ISO 13849:2008:

Performance Level=PLr=d, this corresponds to a failure probability of 10^{-7} to 10^{-6} .

6.4 Read-out

With an existing internet connection of the base station, it is also possible to store the measurement data online (on own eologix servers in Graz, Austria) and to display historical data via the eologix web interface by means of visualisation.

6.4.1 Login

On our online portal <http://online.eologix.com> you have the possibility to receive automated measurement data of your wind turbine from our eologix server. To do this, use your current user password combination in the login area. If you do not know any login data, please contact us at service@eologix.com.

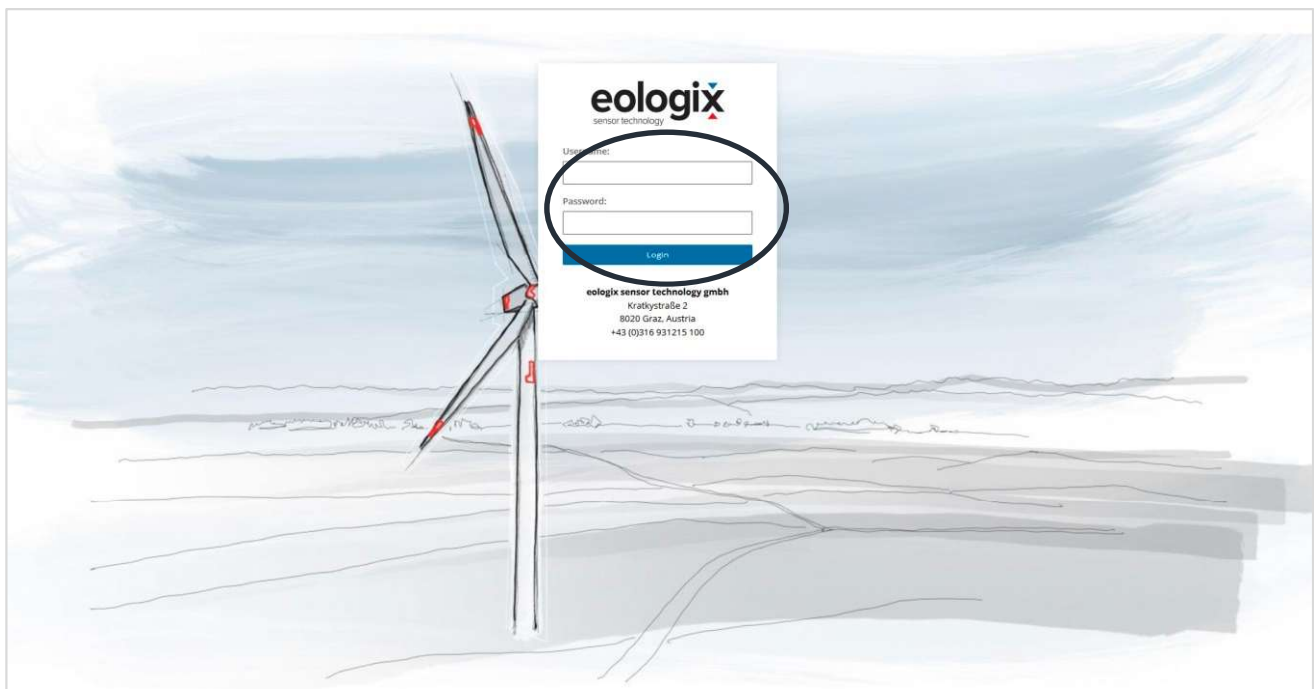


Figure 44 Login

6.4.2 Main page

After logging in, you are directly on our main page - in your own home area. This area offers you the possibility to check and evaluate all current and historical data of your system.

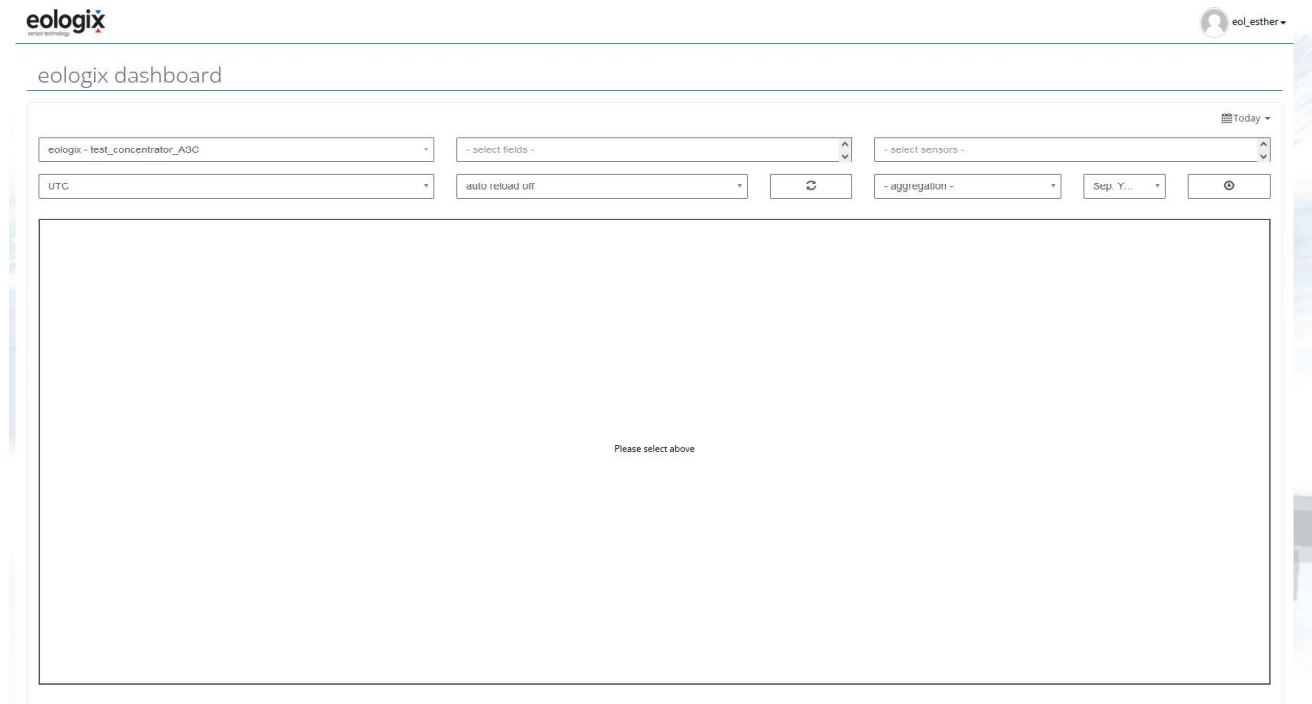
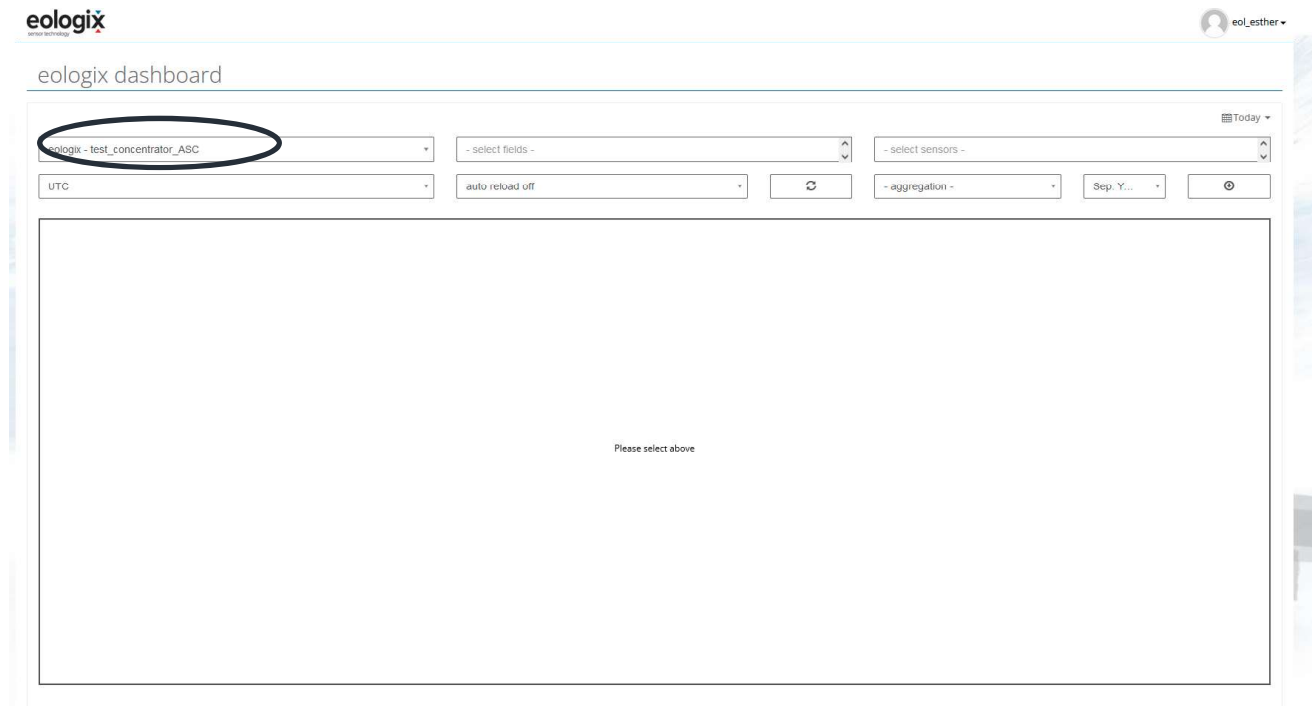


Figure 45 Main page

6.4.3 Selection base station

You can now select your desired eologix system in the field shown below.



The screenshot shows the 'eologix dashboard' interface. At the top left is the 'eologix' logo. At the top right is a user profile icon labeled 'eol_esther'. Below the header, the dashboard title 'eologix dashboard' is displayed. The main content area contains a form with several dropdown menus and buttons. The first dropdown menu, labeled 'eologix - test_concentrator_ASC', is circled in red. Other dropdown menus include '- select fields -', '- select sensors -', 'UTC', 'auto reload off', and '- aggregation -'. There are also buttons for 'Today', 'Sep. Y...', and a refresh icon. The main content area is currently empty, displaying the text 'Please select above'.

Figure 46 Select your base station

6.4.4 Time

Define a time - you can choose between a time or a period. If you do not enter a time, data from the current day will be displayed (Today). Alternatively, you can also zoom in the graph with your mouse wheel or move the graph forward or backward in time by holding down the left mouse button.

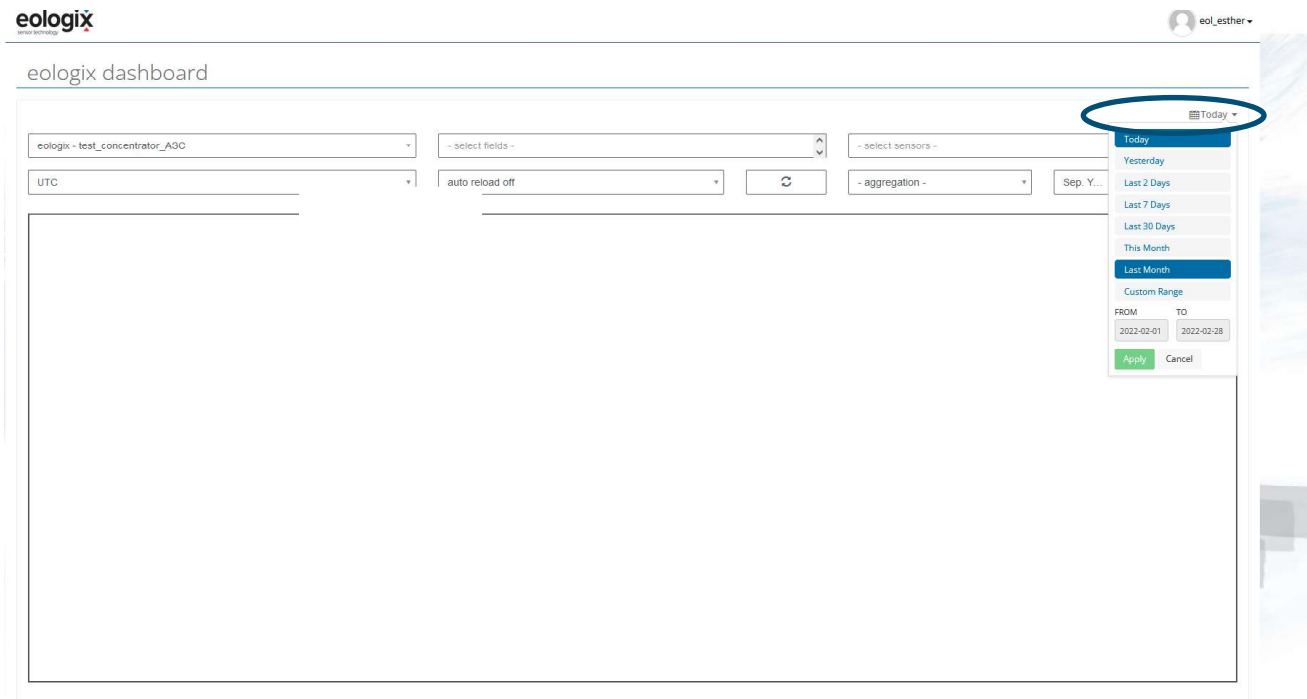


Figure 47 Time

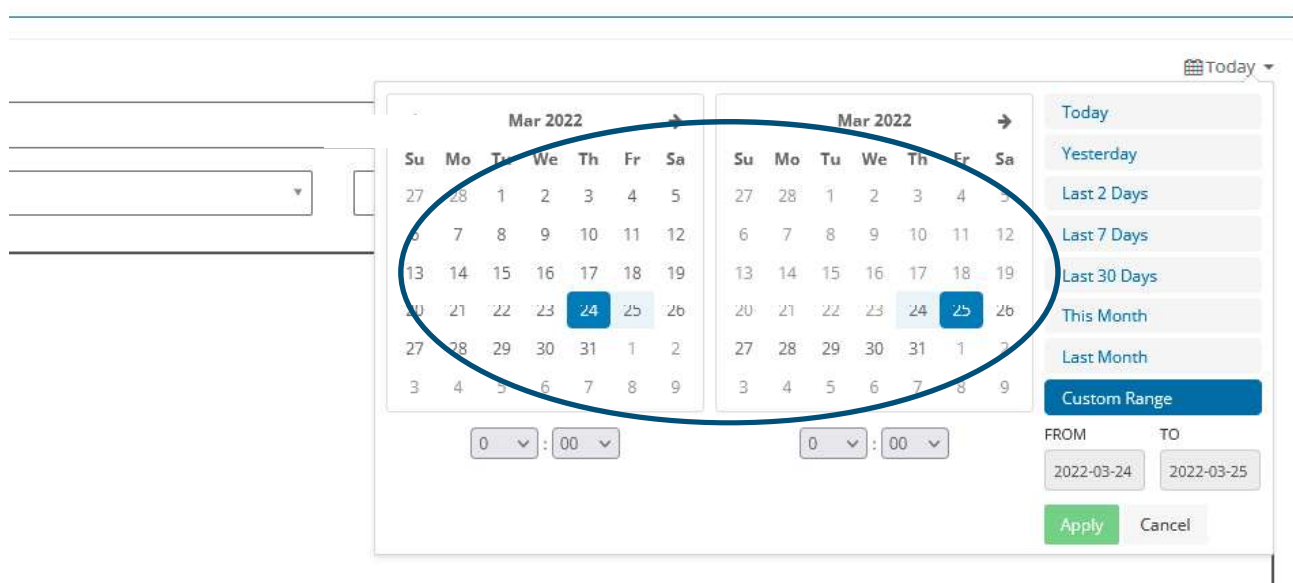


Figure 48 Selecting a time period

6.4.5 Sensor selection

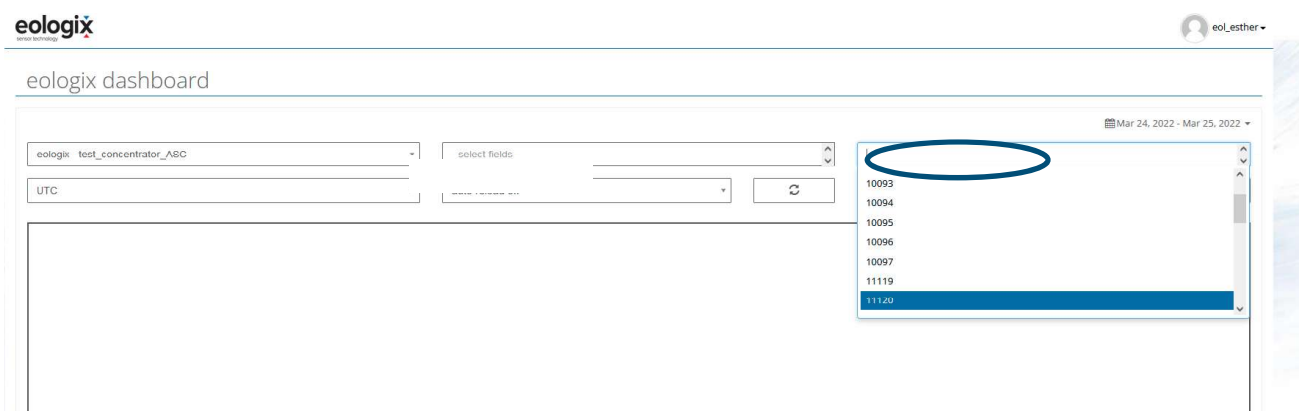


Figure 49 Sensor selection

6.4.6 Measured variables

Measured variable	Type of signal	Description
Temperature	Individual signals of individual sensors	Surface temperature of every individual sensor
Ice Signal	Individual signals of individual sensors	Ice level (meaning ice thickness on surface) of each individual sensor (Level 1 – 5).
Ice Warning	System signal	Ice-stop signal of system
Ice Restart	System signal	Automatic restart signal

6.4.7 Temperature

An exemplary temperature curve is shown below.

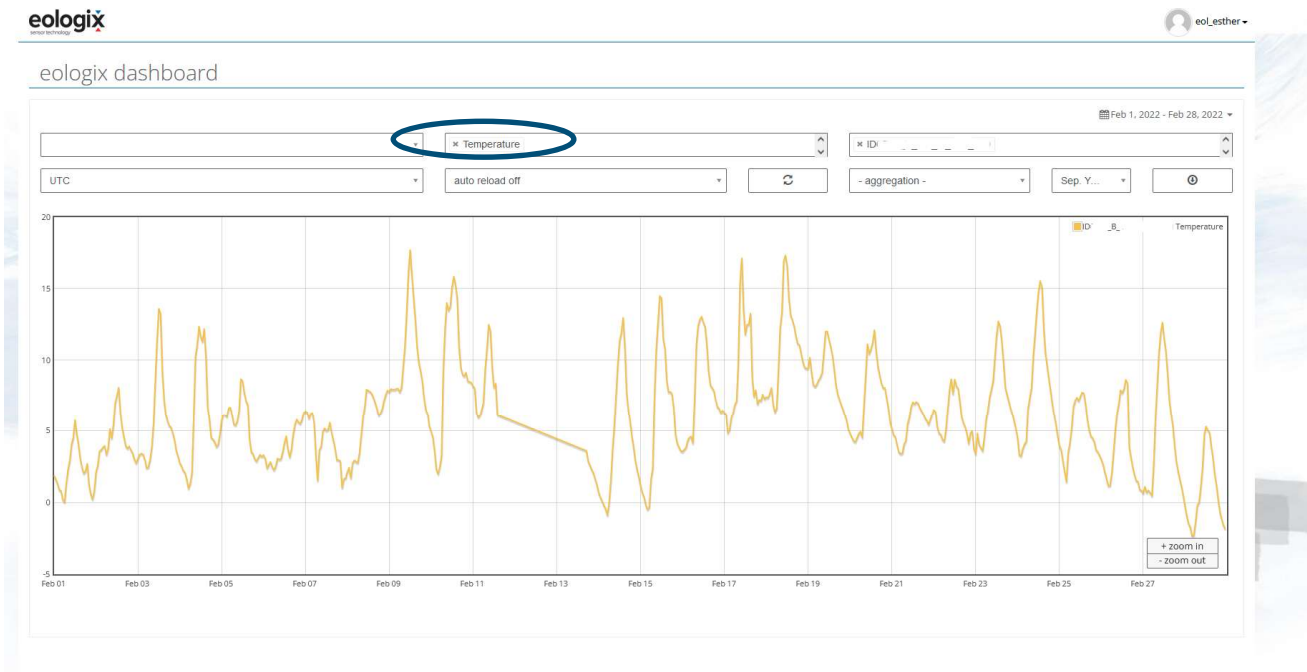


Figure 50 Temperature curve (example 1 sensor)

6.4.8 Ice Signal

This value shows you the current and historical ice levels for each sensor. The four discrete ice levels (1, 2, 3, or 4) indicate the surface condition in relation to ice. For a detailed description of the sensor's ice levels, see chapter 4.2.3:

- 1 = Free surface
- 2 = Very thin layer (<1 mm) or wetness
- 3 = Ice from 1-2 mm
- 4 = Ice from 10 mm
- 5 = Ice from 15 mm

In the web interface, this data can again be displayed retrospectively and in real time.

eologix dashboard

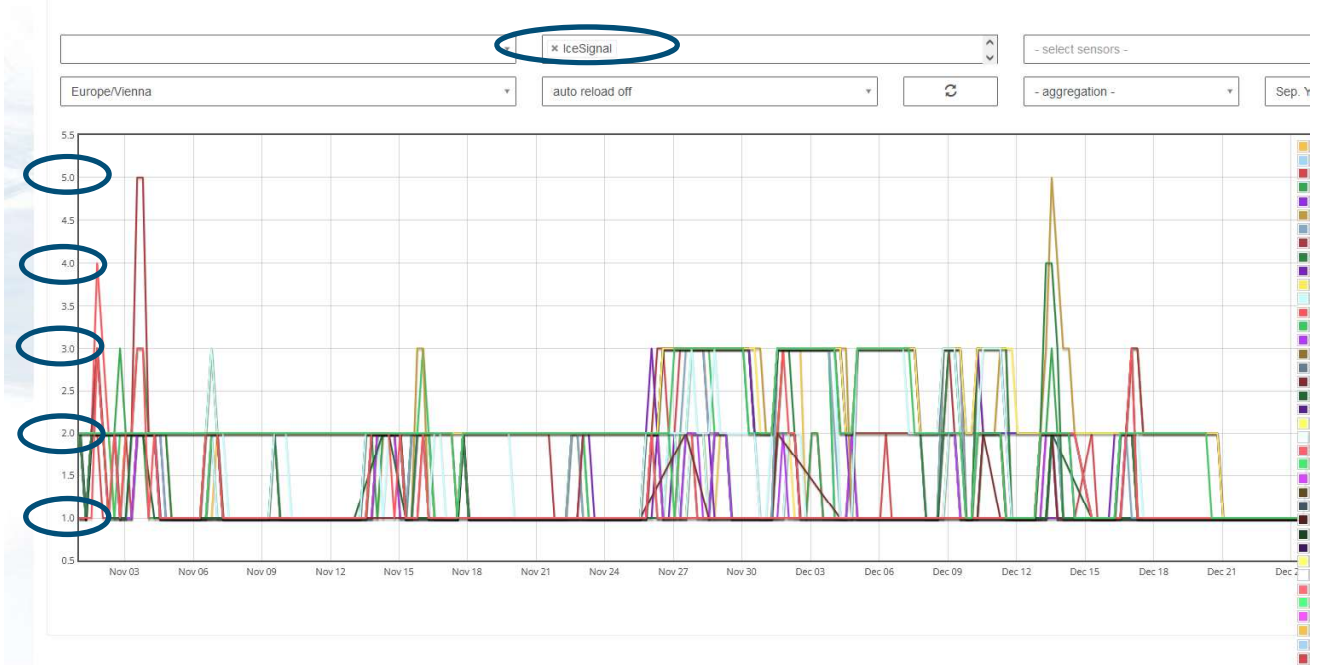


Figure 51 Ice Signal

6.4.9 Ice Warning

The Ice Warning (formerly Ice Output) displays your base station's control signal to stop the system due to ice. Each sensor gives you the same sensor output signal.

- 1: Wind turbine is stopped due to icing
- 0: Wind turbine can be operated

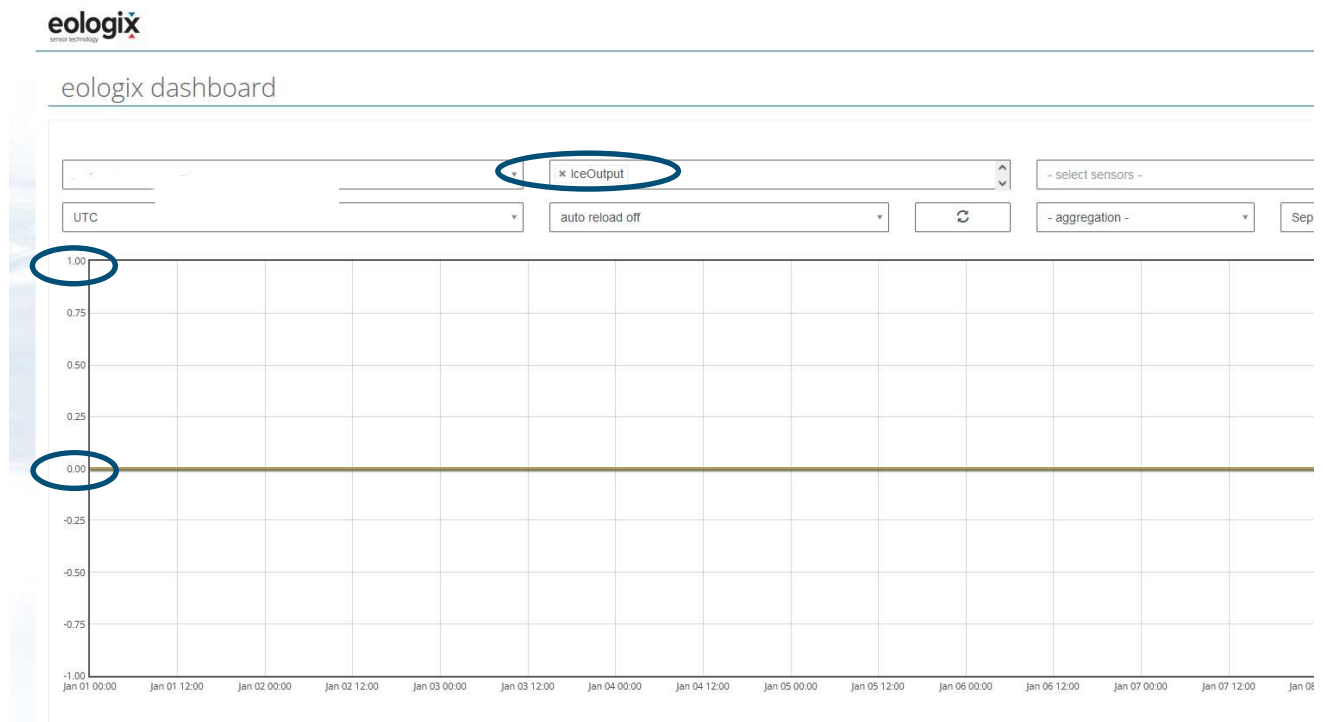


Figure 52 Ice Warning

6.4.10 Ice Restart

This control signal defines a possible automatic restart of the wind turbine after an ice stop.

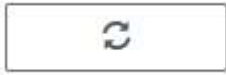
- 1: automatic restart of the wind turbine is possible
- 0: Automatic restart of the wind turbine is NOT possible.



Figure 53 Ice Restart

6.4.11 Update settings

You have the possibility to update your data. Please use the following button:

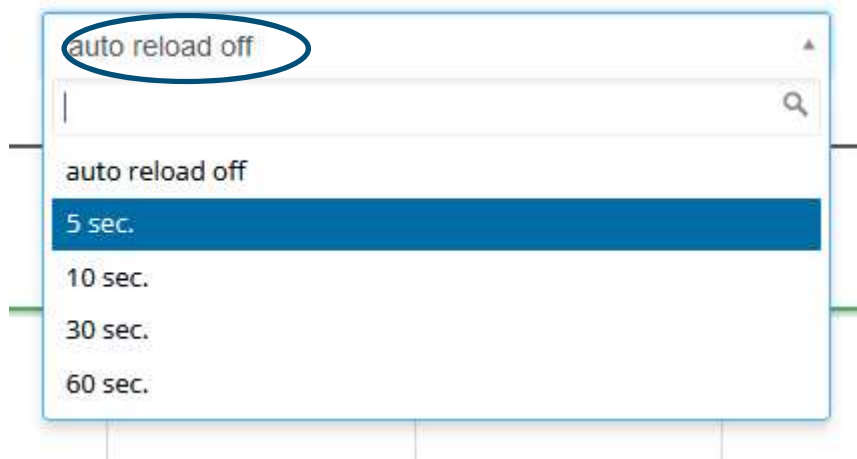


The data can also be updated automatically.



Choose between the following updates:

- 5 seconds
- 10 seconds
- 30 seconds
- 60 seconds
- auto reload off (no automatic update)



6.4.12 Data download

You can also view and save your current and historical data externally. Use the download button to create a .csv file of the selected period.



Download starts automatically.

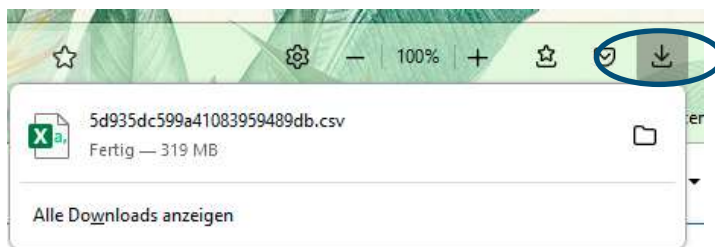


Figure 54 Data download

Data is opened in MS Excel, for example.

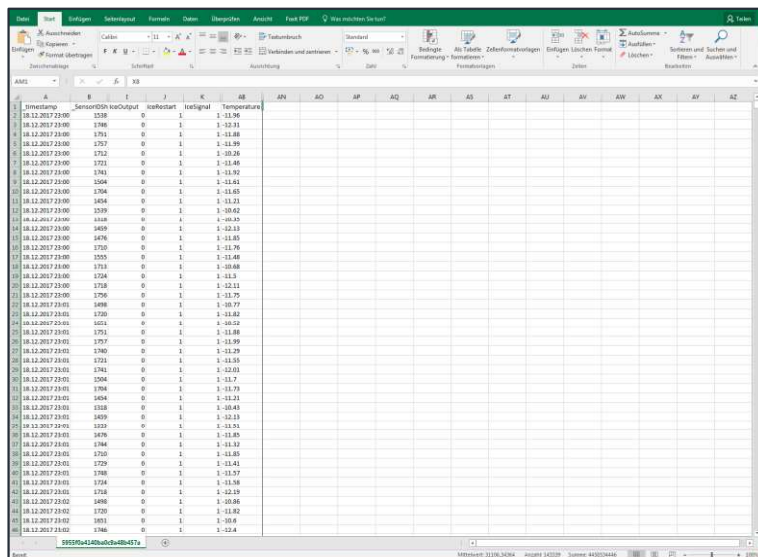


Figure 55 Data export as .csv

6.4.13 Automatic data download

An HTML link is entered directly in the browser to download data on a specific eologix system in a specific time period.

Depending on whether the time is to be displayed in days or in seconds, there are 2 different links

1. Time defined in days

http://USER:PASSWORD@online.eologix.com/api/download?uid=CONCENTRATOR_UID&from=DATE_FROM&to=DATE_TO

2. Time defined in seconds

http://USER:PASSWORD@online.eologix.com/api/download?uid=CONCENTRATOR_UID&from=TIMESTAMP_EPOCH_FROM&to=TIMESTAMP_EPOCH_TO

The link must be adapted depending on the desired evaluation result and contains:

- **USER:** User data from the dashboard (e.g.: eol_Kunde1)
- **PASSWORD:** Password for the user of the dashboard
- **CONCENTRATOR_UID:** provided by eologix

Define time in days:

- **DATE_FROM:** Start date of the download (e.g.: 2021-06-21)
- **DATE_TO:** Date end of download (e.g.: 2021-06-22)

Define time in seconds:

- **TIMESTAMP_EPOCH_FROM:** Date Start of download in ms in Unix time (e.g. 1624230000000).
- **TIMESTAMP_EPOCH_TO:** Date End of download in ms in Unix time (e.g. 1624316400000).

Explanation of Unix time: <https://de.wikipedia.org/wiki/Unixzeit>

Convert: <https://tools.confirado.de/timestampconverter/index.php>

6.5 Hardware and interface specification

For further tables with Modbus registers see appendix or contact eologix sensor technology if required.

6.5.1 User interface

Inside the base station, there are LEDs on the IPC that indicate the following functionalities:

Colour	Description	Status	Description
Green	POWER	On	Supply voltage available
Green	POWER	Off	No supply voltage available
Green	STATUS	2x blinking	Microchip (μ C) Heartbeat
Red	STATUS	On	The controller has received a message from a sensor assigned to the system on this very turbine
Blue	STATUS 2	1x blinking	System has connection to network
Blue	STATUS 2	2x blinking	System has connection to eologix database
Orange	ACTIVITY	blinking	The controller has a message from any sensor

6.6 Faults/error recovery

Malfunctions may occur in the product, which are indicated by the status message. In the event of malfunctions or errors, contact eologix sensor technology gmbh immediately. The following table lists common malfunction messages, their causes and steps to correct the problem.

Fault	Cause	Measure
LED Power not green	No supply voltage	Check supply voltage
No LED on eologix IPC	No supply voltage	Check supply voltage

7 MAINTENANCE

The tasks necessary for maintenance are outlined in the following chapters: inspection, cleaning, servicing, spare part management as well as corrective maintenance.

NOTICE



General notices.

- The following information must be observed, additionally, the notices included in the respective documentation by the original manufacturer may not be ignored.
- The operator is responsible for ensuring that this information is observed.
- All measures necessary for inspection, corrective maintenance and servicing must be carried out in accordance with the national regulations of the country of use.
- All services, tests and retests defined by standards, laws, regulations and other provisions must be planned and carried out by the operator or they must commission somebody to carry them out.

7.1 Cleaning

When carrying out cleaning activities on the product, the following must be observed:

- Before cleaning, the product must be disconnected from the power supply and depressurized.
- Cleaning activities may only be carried out by instructed personnel who have been informed about the dangers that could arise from this product.

NOTICE



General notices regarding cleaning activities.

- only with soft, non-scratching cleaning cloths
- when cold, with cleaning fluid
- never use compressed air for cleaning
- wear adequate personal protective equipment

7.2 Service

Service includes measures to slow down the reduction of the wear contingency („preventive servicing"), especially by means of settings (i.e. adjusting) or by means of replacing filters, seals and lubricants, cleaning etc.

A regular inspection of the product every two years contributes to safety and saves time and money.

7.2.1 Service manual base station

Recurring service measures of the base station are restricted to visual inspection regarding visible damages (i.e. due to bumps, vibrations, heat exposure).

In the event of detected damages, the customer is asked to immediately inform eologix and to consult with eologix regarding the necessary procedure.

The base station CET214 must be replaced entirely. In individual cases it may be advisable to, if instructed to do so, have individual components replaced by trained personnel. This refers to the following components on the top-hat rail in the device (also see list of spare parts 7.2.3):

- eologix receiver
- eologix IPC
- Surge protector ethernet
- Surge protector element in the holder

7.2.2 Service manual sensor

The service measures include the regular visual inspection alongside the customary rotor blade inspections (approx. every 2 years). In the event of detected damages (especially to the wind blade protection tape of the sensor) the customer is asked to immediately inform eologix sensor technology and to consult with eologix regarding the necessary procedure.

Minor damages to the wind blade protection tape can possibly be remedied by applying another layer of tape (especially when the tape is damaged in areas outside the sensor). Consult with eologix sensor technology regarding this procedure. Make sure not to apply a second layer of tape onto the sensor area (marked with two black triangles).

7.2.3 List of spare parts

For information regarding spare parts, please refer to the following list of spare parts. In the event of uncertainties or questions or to order spare parts, please contact eologix sensor technology.

Component	Type	Connections
eologix receiver	eoREC214	1x cable RJ45 1x cable SMA
eologix IPC	eoARM214	3x cable RJ45, 1x screw clamp 24VDC 2-polig 1x plug strip modem connection
Phoenix Contact surge protector	Ethernet DT-LAN-CAT.6+ No. 2881007	2x connections RJ45
Phoenix Contact surge protector	VAL-SEC-T2-1S-350-FM No. 2905333	1x element in holder



WARNING

Not using original spare parts and modifying the system can cause different dangers.

- Only use original spare parts in accordance with the list of spare and wear parts. Functional guarantee is only possible when original spare parts are used.

7.3 Corrective maintenance

Corrective maintenance includes activities that exceed service as well as activities for fault-free operation.

Corrective maintenance concludes, after inspection and service, the maintenance cycle and ensures a long operational lifetime of the product and systems.

	 WARNING
	Miscellaneous hazardous events
	During corrective maintenance activities on the product, additional locations of dangers might be accessible. – Corrective maintenance activities may only be carried out by authorized, trained personnel. These personnel must also have read and understood this documentation.

	NOTICE
	Improperly carried out corrective maintenance can lead to damage to the product.
	– Corrective maintenance activities resp. replacement of wear parts must be carried out by qualified personnel. – The maintenance personnel must, if applicable, observe the instructions of this documentation and the instructions included in the displayed work instructions.

8 DECOMMISSIONING

8.1 Switching off

To switch off the product, the following activities must be carried out:

- 1. Disconnect the base station from the power supply.
- 2. Protect the product against unauthorized recommissioning
- 3. If necessary, clean the product observing the instructions included in the respective chapter

8.2 Final closing down

The following activities must be carried out before deinstalling the product for final closing down in addition to the activities included in Switching off:

- 1. Switch off the product's power supply.
- 2. Disconnect the product from the power supply.
- 3. Remove equipment.
- 4. Deinstallation.

8.3 Deinstallation

	⚠ WARNING
	During deinstallation activities, improperly carried out activities can lead to additional dangers. If the product is not deinstalled properly, dangers to persons might arise or the product might be damaged. – Deinstallation activities on the product may only be carried out by authorized and trained personnel.

When deinstalling the product, the following must be observed:

- Transport activities may only be carried out observing the transportation regulations included in chapter 5.1 Transport.
- If the product is put in storage after deinstallation, the requirements regarding the storage locations included in chapter 5.2 Storage must be fulfilled.
- If the product is disposed of, it must be disposed of observing the principle included in chapter Disposal.

8.3.1 Instructions for sensor removal

Tools

- Knife (pointed blade, must be able to puncture the wind tape)
- Storage container (i.e. bag) for removed sensors, trash bag
- Spreader, sanding paper 320
- poss. heating pad, hot-air blower depending on ambient conditions
- poss. 3M TARR W9900, gloves, spreader, synthetic foil
- Cotton or microfiber cloth

Step 1: Removing the sensor

- Cut through wind tape and silicone encapsulation using a knife in the area of the bevel of the silicone encapsulation and cut out the sensor (for cutting lines, see image below).
- Do not damage the electronics located in the indicated area.
- Retain the sensor to later return it (inspection, recycling/disposal, poss. further use) and do not fold it!

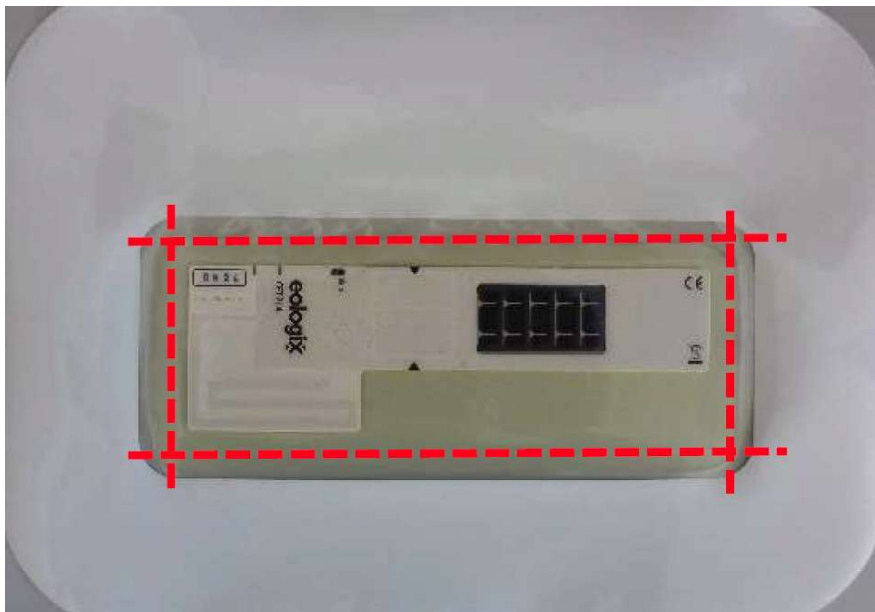


Figure 56 Deinstallation

Step 2: Removing the remaining wind tape

- Remove the remaining tape (dispose), if necessary, using a heat source and/or a spreader
- Remove adhesive residues: sanding paper or suitable electric tool
- Clean with application spray (3M Application Solution Spray)
- if necessary: 3M TARR W9900 (+ thin synthetic foil for cover, spreader, gloves, cloth)

When done: always return de-applied sensors to eologix sensor technology for inspection.

Ambient conditions

Higher blade temperatures make the adhesive on the back side of the wind tape more elastic. It is then easier to remove the adhesive foil, but adhesive residues on the blade are typically harder to remove.

Notices regarding 3M TARR

For further information go to the website of the manufacturer www.3M.com/wind for instructions regarding the use of 3M TARR W9900.

8.4 Disposal

Base station

	INFORMATION
	Disposal - Principle – Dispose of the parts of the product in the course of final decommissioning in a way that does not harm nature and sorted by material (waste electronic equipment at respective collection points, metal to respective scrap metal, plastics to plastic waste, waste oil and liquids in accordance with legal regulations etc.!).

Principle

Before disposing of materials and parts of the product, check whether they are reusable. Recycle as much of it as possible.

Careless or wrong disposal can result in unforeseeable damages.

Dispose of materials and parts of the product in a way that does not harm man, nature and environment.

Thereby, observe the information provided by the manufacturers and the applicable laws and regulations.

Base station

Dispose of the materials and parts of the base station after separating them by material.

- Electric waste at waste treatment points for electric waste equipment and collection points
- Plastics

Sensor

Always return the sensor element that is to be disposed of to eologix sensor technology:

- For inspection
- for recycling and proper disposal of batteries and electronic components

9 ATTACHMENT

9.1 Declaration of EC-conformity base station

	Herstellererklärung	No.: 008a Rev.-No.: A
EG-Konformitätserklärung eologix sensor technology gmbh Kratkystraße 2 8020 Graz, Austria +43 316 931215 100 office@eologix.com als Hersteller erklärt in alleiniger Verantwortung, dass das Produkt eologix Base Station Typ: BET214t auf das sich diese Erklärung bezieht, allen Bestimmungen der folgenden Richtlinien entspricht: Richtlinie 2014/53/EU des europäischen Parlamentes und des Rates vom 16. April 2014 über die Harmonisierung der Rechtsvorschriften der Mitgliedstaaten über die Bereitstellung von Funkanlagen auf dem Markt und zur Aufhebung der Richtlinie 1999/5/EG Richtlinie 2011/65/EU des Europäischen Parlaments und des Rates zur Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten Das Produkt entspricht weiterhin allen Bestimmungen der folgenden harmonisierten Normen: EN 62368-1:2014 - Einrichtungen für Audio/Video-, Informations- und Kommunikationstechnik Teil 1: Sicherheitsanforderungen EN 62479:2010 - Beurteilung der Übereinstimmung von elektronischen und elektrischen Geräten kleiner Leistung mit den Basisgrenzwerten für die Sicherheit von Personen in elektromagnetischen Feldern (10 MHz bis 300 GHz)		

2019_Declaration of EC-Conformity eologix Base Station_DE.doc

EN 301 489-1 V2.1.1 - Elektromagnetische Verträglichkeit für Funkeinrichtungen und -dienste - Teil 1: Gemeinsame technische Anforderungen

EN 301 489-3 V2.1.1 - Elektromagnetische Verträglichkeit und Funkspektrumangelegenheiten (ERM) - Elektromagnetische Verträglichkeit (EMV) für Funkeinrichtungen und -dienste - Teil 3: Spezifische Bedingungen für Funkgeräte geringer Reichweite (SRD) für den Einsatz auf Frequenzen zwischen 9 kHz und 246 GHz

EN 300 220-2 V3.1.1 - Funkanlagen mit geringer Reichweite (SRD), die im Frequenzbereich 25 MHz bis 1 000 MHz arbeiten - Teil 2: Harmonisierte EN für den Zugriff auf Funkspektrum für unspezifische Funkgeräte

EN 50581:2012 - Technische Dokumentation zur Beurteilung von Elektro- und Elektronikgeräten hinsichtlich der Beschränkung gefährlicher Stoffe

Graz, am 1.11.2019

eologix
sensor technology

eologix sensor technology gmbh
Marktplatz 2, 8010 Graz, Austria
Office: +43 (0)316 881111, ATU60483330

Firmenmäßige Zeichnung:.....

Dr. Michael Moser

Autor:	Datum:	Überprüft:	Datum:	Freigegeben:	Datum:
M. Moser	1.11.2019	T. Schlegl	1.11.2019	M. Moser	1.11.2019

9.3 Declaration of EC-conformity sensor unit

	Herstellererklärung	No.: 007a Rev.-No.: A
EG-Konformitätserklärung eologix sensor technology gmbh Kratkystraße 2 8020 Graz, Austria +43 316 931215 100 office@eologix.com als Hersteller erklärt in alleiniger Verantwortung, dass das Produkt eologix Ice Sensor Typ: CET214 auf das sich diese Erklärung bezieht, allen Bestimmungen der folgenden Richtlinien entspricht: Richtlinie 2014/53/EU des europäischen Parlamentes und des Rates vom 16. April 2014 über die Harmonisierung der Rechtsvorschriften der Mitgliedstaaten über die Bereitstellung von Funkanlagen auf dem Markt und zur Aufhebung der Richtlinie 1999/5/EG Richtlinie 2011/65/EU des Europäischen Parlaments und des Rates zur Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten Das Produkt entspricht weiterhin allen Bestimmungen der folgenden harmonisierten Normen: EN 62368-1:2014 - Einrichtungen für Audio/Video-, Informations- und Kommunikationstechnik Teil 1: Sicherheitsanforderungen EN 62479:2010 - Beurteilung der Übereinstimmung von elektronischen und elektrischen Geräten kleiner Leistung mit den Basisgrenzwerten für die Sicherheit von Personen in elektromagnetischen Feldern (10 MHz bis 300 GHz)		

2019_Declaration of EC-Conformity_eologix_CET214_858_DE.doc

EN 301 489-1 V2.1.1 - Elektromagnetische Verträglichkeit für Funkeinrichtungen und -dienste - Teil 1: Gemeinsame technische Anforderungen

EN 301 489-3 V2.1.1 - Elektromagnetische Verträglichkeit und Funkspektrumangelegenheiten (ERM) - Elektromagnetische Verträglichkeit (EMV) für Funkeinrichtungen und -dienste - Teil 3: Spezifische Bedingungen für Funkgeräte geringer Reichweite (SRD) für den Einsatz auf Frequenzen zwischen 9 kHz und 246 GHz

EN 300 220-2 V3.1.1 - Funkanlagen mit geringer Reichweite (SRD), die im Frequenzbereich 25 MHz bis 1 000 MHz arbeiten - Teil 2: Harmonisierte EN für den Zugriff auf Funkspektrum für unspezifische Funkgeräte

EN 50581:2012 - Technische Dokumentation zur Beurteilung von Elektro- und Elektronikgeräten hinsichtlich der Beschränkung gefährlicher Stoffe

Graz, am 1.11.2019

eologix

sensor technology

eologix sensor technology gmbh

Krakkystraße 2 8020 Graz, Austria

office@eologix.com, info@eologix.com

Firmenmäßige Zeichnung:.....

Dr. Michael Moser

Autor:	Datum:	Überprüft:	Datum:	Freigegeben:	Datum:
M. Moser	1.11.2019	T. Schlegl	1.11.2019	M. Moser	1.11.2019

9.5 Modbus Specifications

9.5.1 Modbus Hardware/Interface Specifications

The Modbus daemon is available on both RJ-45 interfaces on BET214n.

Interfaces 'A' and 'B' will be configured according to customer requirements.

IP address interface 'A'	customer requirements (DHCP or fixed IP)
IP address interface 'B'	customer requirements (DHCP or fixed IP)
TCP port	502
Modbus server ID	17

For the Modbus TCP/IP interface, the eologix base station works as a server in the Modbus Client/Server architecture. Thus, any client has to pull a request for the sensor data or push data to the server.

The eologix Modbus daemon implements the following data sets:

Data Set	Register Type	Description	Start Address	No. of registers
System Temps	Input	System Temperatures	64	7
Receiver RSSIs	Input	Receiver RSSI Values	80	2
Sensor Status	Input	Sensor Availability	96	2
Black Channel	Input	Security related data	128	4
Static Info 32bit	Input	System configuration (32bit)	240	6
Static Info	Input	System configuration and versioning information	256	8
Sensor Info	Input	Dynamic measurement data from sensors	264	8-64
System Errors	Input	Error Values	1024	6

Attention: Values larger than a single register must be read with a single access spanning all relevant registers.

9.5.2 Server and Document Versions

The functionality of different Modbus server versions is shown below.

server / document version	system temps	receiver RRSIs	sensor status	input registers		static info	static info	sensor info	system errors
				black channel	static info 32				
17.1							✓		
17.2							✓	✓ ¹	
17.3				✓			✓	✓	
17.4				bugfix release					
17.5				bugfix release					
17.6				bugfix release					
17.7.x				bugfix release					
17.8	✓			✓	✓		✓	✓	✓
17.9	✓			✓	✓		✓	✓	✓
17.10				bugfix release					
17.11				bugfix release					
17.12				bugfix release					
17.13				bugfix release					
17.14				bugfix release					
18.1	✓			✓	✓		✓	✓	✓
18.2				bugfix release					
20.1				bugfix release					
20.1.1				specification extension					

¹ SensorID 16bit only.

9.5.3 Document formatting notes

Registers listed in light blue and marked [unused] are not implemented. Registers marked as [RES]

are implemented and can be accessed.

Bitfields inside registers listed in light blue marked [unused] or [undefined] are implemented and can be accessed.

Values in registers and bitfields typed in **bold face** are the default values in the unconfigured state.

9.5.4 Modbus Register Overview

Offset	Input Registers Upper Byte	Lower Byte
0 .. 63		[unused]
64		TEMP_CPU_CORE
65		TEMP_UC
66 .. 70		[RES for temperatures]
71 .. 79		[unused]
80		RSSI_RX1_MAX
81		RSSI_RX2_MAX
82 .. 95		[unused]
96		ICING_STATUS
97		RESTART_STATUS
98 .. 127		[unused]
128	ID_BC	NUM_PKT_BC
129	ICING	[unused]
130	[unused]	PROT_VERS
131		CRC_BC
132 .. 239		[unused]
240		ID_ARM_32 [upper]
241		ID_ARM_32 [lower]
242		ID_RX1_32 [upper]
243		ID_RX1_32 [lower]
244		ID_RX2_32 [upper]
245		ID_RX2_32 [lower]
246 .. 255		[unused]
256		SERVER_VERSION
257		TIMESTAMP_ARM [upper]
258		TIMESTAMP_ARM [lower]
259		ID_ARM
260		ID_RX1
261		ID_RX2
262		NB_REGS_PER_SENSOR
263		NB_SENSORS
264		Sensor 1: Timestamp [upper]
265		Sensor 1: Timestamp [lower]
266		Sensor 1: Sensor ID [upper]
267		Sensor 1: Sensor ID [lower]
268		Sensor 1: Temperature [upper]
269		Sensor 1: Temperature [lower]
270		Sensor 1: Ice Signal
271		Sensor 1: Error Signal
272 .. 279		Sensor 2 (signals as above)
280 .. 767		Sensors 3-63 (signals as above)
768 .. 775		Sensor 64 (signals as above)
776..1023		[unused]
1024		IPC_ERROR [upper]
1025		IPC_ERROR [lower]
1026		RX1_ERROR [upper]
1027		RX1_ERROR [lower]
1028		RX2_ERROR [upper]
1029		RX2_ERROR [lower]
1030		[unused]

9.5.5 Data Volatility

Input Registers		
Range	Data set	Volatility
64..70	System Temps	single shot
80 .. 81	Receiver RSSIs	single shot
96 .. 97	Sensor Status	single shot
128 .. 131	Black Channel	single shot
240 .. 245	Static Info 32b	static
256	server version	static
257 .. 258	timestamp	single shot
259 .. 263	IDs	static
264 .. 775	Sensor Info	single shot
1024 .. 1029	System Errors	single shot

Remark: a single shot volatility denotes discrete measurement points, with no relation to past values, or calculated values.

Remark: static registers contain constant values, only changing on hardware exchanges or software updates.

9.5.6 Modbus Register Specifications: System Temperatures

They are of type InputRegister and therefore read-only.

Reg. Name	Offset	Datatype	Content	Byte order ²
TEMP_CPU_CORE	64	sint16	IPC CPU core temperature LSB 0.01°C	B2-B1
TEMP_UC	65	sint16	support uC temperature LSB 0.01°C	B2-B1
[RES]	66	--	[15..0] undefined	n/a
[RES]	67	--	[15..0] undefined	n/a
[RES]	68	--	[15..0] undefined	n/a
[RES]	69	--	[15..0] undefined	n/a
[RES]	70	--	[15..0] undefined	n/a

If any sensor information cannot be accessed, the respective register will show an error value as outlined below. These values are chosen to be out-of-band of valid values.

temperature	-273.15 °C
-------------	------------

² Big endian. B1 least significant byte (bit0 to bit7), B4 most significant byte (bit24 to bit31). Upper register of 32bit words listed first. Upper 8 bits of register listed first.

9.5.7 Modbus Register Specifications: Receiver RSSI values

They are of type InputRegister and therefore read-only.

Reg. Name	Offset	Datatype	Content	Byte order ³
RSSI_RX1_MAX	80	sint16	current max. RSSI for receiver 1 over all available sensors LSB dBm	B2-B1
RSSI_RX2_MAX	81	sint16	current max. RSSI for receiver 1 over all available sensors LSB dBm	B2-B1

If any sensor information cannot be accessed, the respective register will show an error value as outlined below. These values are chosen to be out-of-band of valid values.

RSSI	-999 dBm
------	----------

³ Big endian. B1 least significant byte (bit0 to bit7), B4 most significant byte (bit24 to bit31). Upper register of 32bit words listed first. Upper 8 bits of register listed first.

9.5.8 Modbus Register Specifications: Sensor Status

They are of type InputRegister and therefore read-only.

Reg. Name	Offset	Datatype	Content	Byte order ⁴
ICING_STATUS	96	sint16	sensor availability for icing -1 = insufficient configuration 0 = insufficient sensors available 1 = one sensor until fail 2 = at least 2 sensors until fail	B2-B1
RESTART_STATUS	97	sint16	sensor availability for restart -1 = insufficient configuration 0 = insufficient sensors available 1 = one sensor until fail 2 = at least 2 sensors until fail	B2-B1

‘1’: Functionality will not be available anymore if 1 further relevant sensor fails.

‘2’: Two or more sensor would need to fail before functionality would not be available anymore.

⁴ Big endian. B1 least significant byte (bit0 to bit7), B4 most significant byte (bit24 to bit31). Upper register of 32bit words listed first. Upper 8 bits of register listed first.

9.5.9 Modbus Register Specifications: Black Channel

They are of type InputRegister and therefore read-only.

Reg. Name	Offset	Datatype	Content	Byte order ⁴
ID_BC	128.hi	uint8	magic no. '101'd (ASCII 'e')	n/a
NUM_PKT_BC	128.lo	uint8	packet number increased every 10s int(Linux epoch/10)	n/a
ICING	129.hi	uint8	[7..6] undefined [5] 1 = ice warning (depending on protocol version, see below) [4..3] reserved for cond.monitoring [2] 1 = ice-free detected (where available) [1] 1 = system OK [0] 1 = icing detected	n/a
[RES]	129.lo	--	[7..0] undefined	--
[RES]	130.hi	--	[15..8] undefined	--
PROT_VERS	130.lo	uint8	protocol version 0x00: version 0 0x01: version 1 (current)	n/a
CRC_BC	131	uint16	byte-wise CRC checksum registers 128..130, MSB first polynome 0xc5db	B2-B1

Remark: The implementation uses the Koopman-reversed polynome *0xedd1*.

Behaviour of ICING bits – Protocol Version 0

This output behaviour is only valid during operational states (SYS_xx). For all other states, see behaviour description.

Note: bit 5 has not been activated in this protocol version, thus always showing 0.

base station state	no. of sensors received ⁵	internal systemlc eOK state	internal systemR estartOK state	bit 0 icing	bit 1 system OK	bit 2 ice-free	bit 5 ice warn
OK	>=min. restart	OK	OK	0/1	1	0/1	0
OK	>=min. icing	OK	NOK	0/1	1	0	0

⁴ Big endian. B1 least significant byte (bit0 to bit7), B4 most significant byte (bit24 to bit31). Upper register of 32bit words listed first. Upper 8 bits of register listed first.

⁵ For definition of icing see register ICING_MODE.

OK	<min. icing	NOK	NOK	0	0	0	0
NOK	n/a	NOK	NOK	0	0	0	0

Behaviour of ICING bits – Protocol Version 1

This output behaviour is only valid during operational states (SYS_xx).

base station state	no. of sensors received ⁶	internal systemlc eOK state	internal systemR eStartOK state	bit 0 icing	bit 1 system OK	bit 2 ice-free	bit 5 ice warn
OK	>=min. restart	OK	OK	0/1	1	0/1	0/1
OK	>=min. icing	OK	NOK	0/1	1	0	0/1
OK	<min. icing	NOK	NOK	0	0	0	0
NOK	n/a	NOK	NOK	0	0	0	0

Relais outputs

Up to 3 SPDT safety relais outputs are optionally available at the base station at dedicated connectors. Please refer to the connection description available separately.

Switching is configured as fail-to-safe, i.e. in case of power-loss at any point in the base station, the relais will fall back and signal both ‘ice detected’ and ‘system NOT OK’.

Depending on the system configuration, the following signalling is implemented.

eologixSafe

Relais	Type	NO contact	NC contact
sysOK	SPDT	open: system NOT OK conn'd to COM: system OK	[not to be used for fail-to-safe]
iceOutput	SPDT	open: ice detected conn'd to COM: no ice detected	[not to be used for fail-to-safe]
restart	SPDT	[unused]	[unused]

⁶ For definition of icing see register ICING_MODE.

iceOutput denotes a signal to stop the turbine. No information on restart options is given. If this signal falls back, it merely means that a turbine stop is not required anymore. If, however, the turbine has already been stopped, it must not be re-started automatically.

eologixRestart

Relais	Type	NO contact	NC contact
sysOK	SPDT	open: system NOT OK conn'd to COM: system OK	[not to be used for fail-to-safe]
iceOutput	SPDT	open: restart possible conn'd to COM: no restart	[not to be used for fail-to-safe]
restart	SPDT	open: restart possible conn'd to COM: no restart	[not to be used for fail-to-safe]

iceOutput reflects the state whether the turbine is free of ice. In this configuration, an automatic turbine restart is possible.

9.5.10 Modbus Register Specifications: Static Info 32bit

These registers are initialized once on start-up or reboot of the BET214n.

They are of type InputRegister and therefore read-only.

Register Name	Offset	Datatype	Content	Byte order ⁷
ID_ARM_32	240	uint32	serial number of base	B4-B3-B2-B1
ID_RX1_32	242	uint32	serial number of receiver 1	B4-B3-B2-B1
ID_RX2_32	244	uint32	serial number of receiver 2	B4-B3-B2-B1

If there is only one receiver present in the system, ID_RX2_32 will read '0'.

9.5.11 Modbus Register Specifications: Static Info

These registers are initialized once on start-up or reboot of the BET214n.

They are of type InputRegister and therefore read-only.

Register Name	Offset	Datatype	Content	Byte order ⁸
SERVER_VERSION	256	uint16	major.minor version	MAJOR-MINOR
TIMESTAMP_ARM	257	uint32	Linux epoch ⁹	B4-B3-B2-B1
ID_ARM	259	uint16	serial number of base	B2-B1
ID_RX1	260	uint16	serial number of receiver 1	B2-B1
ID_RX2	261	uint16	serial number of receiver 2	B2-B1
NB_REGS_PER_SENSOR	262	uint16	registers per sensors	B2-B1
NB_SENSORS	263	uint16	total number of sensors	B2-B1

If there is only one receiver present in the system, ID_RX2 will read '0'.

⁷ Big endian. B1 least significant byte (bit0 to bit7), B4 most significant byte (bit24 to bit31). Upper register of 32bit words listed first. Upper 8 bits of register listed first.

⁸ Big endian. B1 least significant byte (bit0 to bit7), B4 most significant byte (bit24 to bit31). Upper register of 32bit words listed first. Upper 8 bits of register listed first.

⁹ timestamp in seconds, starting from "01.01.1970 00:00"

9.5.12 Modbus Register Specifications: Sensor Info

Sensors are appearing in ascending order of the sensor ID.

They are of type InputRegister and therefore read-only.

Sensor Nbr.	Offset	Datatype	Content	Byte order ¹⁰
1	264	uint32	timestamp ¹¹	B4-B3-B2-B1
	266	uint32	sensor ID	B4-B3-B2-B1
	268	float 32 bit	temperature	B1-B2-B3-B4
	270	uint16	ice signal	B2-B1
	271	uint16	error signal	B2-B1
2	272	uint32	timestamp	B4-B3-B2-B1
	274	uint32	sensor ID	B4-B3-B2-B1
	276	float 32 bit	temperature	B1-B2-B3-B4
	278	uint16	ice signal	B2-B1
	279	uint16	error signal	B2-B1
3	...	...	...	...
	...	...	...	...

‘timestamp’ is set to the point in time of the last received message from the respective sensor. All the other values of the respective sensor are from that last message.

If any sensor information cannot be accessed, the respective registers of that sensor will show an error value as outlined below. These values are chosen to be out-of-band of valid values. This can occur after a powerup or reboot if a sensor has not yet been received at least once.

timestamp	0
temperature	-273.15 °C
ice signal	9
error signal	65280 (0xff00)

¹⁰ Big endian. B1 least significant byte (bit0 to bit7), B4 most significant byte (bit24 to bit31). Upper register of 32bit words listed first. Upper 8 bits of register listed first. Contrary to the rest of the Modbus definitions, the Modbus float datatype is defined as little endian.

¹¹ timestamp in seconds, starting from “01.01.1970 00:00”

Sensor Error Values

Bit	Description
0	1 = ice sensor fault
1	1 = temperature sensor fault
2	[RES]
3	[RES]
4	[RES]
5	[RES]
6	[RES]
7	[RES]
8..15	0xfe = sensor error signal implausible 0xff = sensor not received since last reboot

9.5.13 Modbus Register Specifications: System Errors

These registers are of type InputRegister and therefore read-only.

Register Name	Offset	Datatype	Content	Byte order ¹²¹²
IPC_ERROR	1024	uint32	IPC error value [31:30] support uC [29..9] always read '0' [8] 1 = turbine params not fully set [7..3] always read '0' [2] 1 = CONF_CRC mismatch [1] 1 = CRC_PD mismatch [0] 1 = error handling not available	B4-B3-B2-B1
RX1_ERROR	1026	uint32	RX1 error value [31..1] always read '0' [0] 1 = error handling not available	B4-B3-B2-B1
RX2_ERROR	1028	uint32	RX2 error value [31..1] always read '0' [0] 1 = error handling not available	B4-B3-B2

Remark: IPC_ERROR[8] is set, if at least one register of the block contains 0.

Remark: IPC_ERROR[2:1] is set, if the respective CRC does not match or if all respective registers contain 0.

Support µC Error Values

Bits	Description
00	no error
01	one of the internal IPC voltages too low (>10% of nominal voltage)
10	one of the internal IPC voltages too high (>10% of nominal voltage)
11	support µC cannot be accessed

¹² Big endian. B1 least significant byte (bit0 to bit7), B4 most significant byte (bit24 to bit31). Upper register of 32bit words listed first. Upper 8 bits of register listed first.

9.6 Register of units

The register of all used unit abbreviations can be found in this table.

Abbreviation	Meaning
kW	Kilowatt
Hz	Hertz
V	Volt
°C	Degree Celsius
%	Percent
mm	Millimetre
m	Meter
m³	Cubic meter
s	Second
min	Minute
h	Hour
kg	Kilogram
bar	Bar (pressure)
l	Litre



eologix sensor technology gmbh
Kratkystrasse 2 | 8020 Graz | Austria

Phone
+43 316 931215 100

E-Mail
office@eologix.com

Web
eologix.com