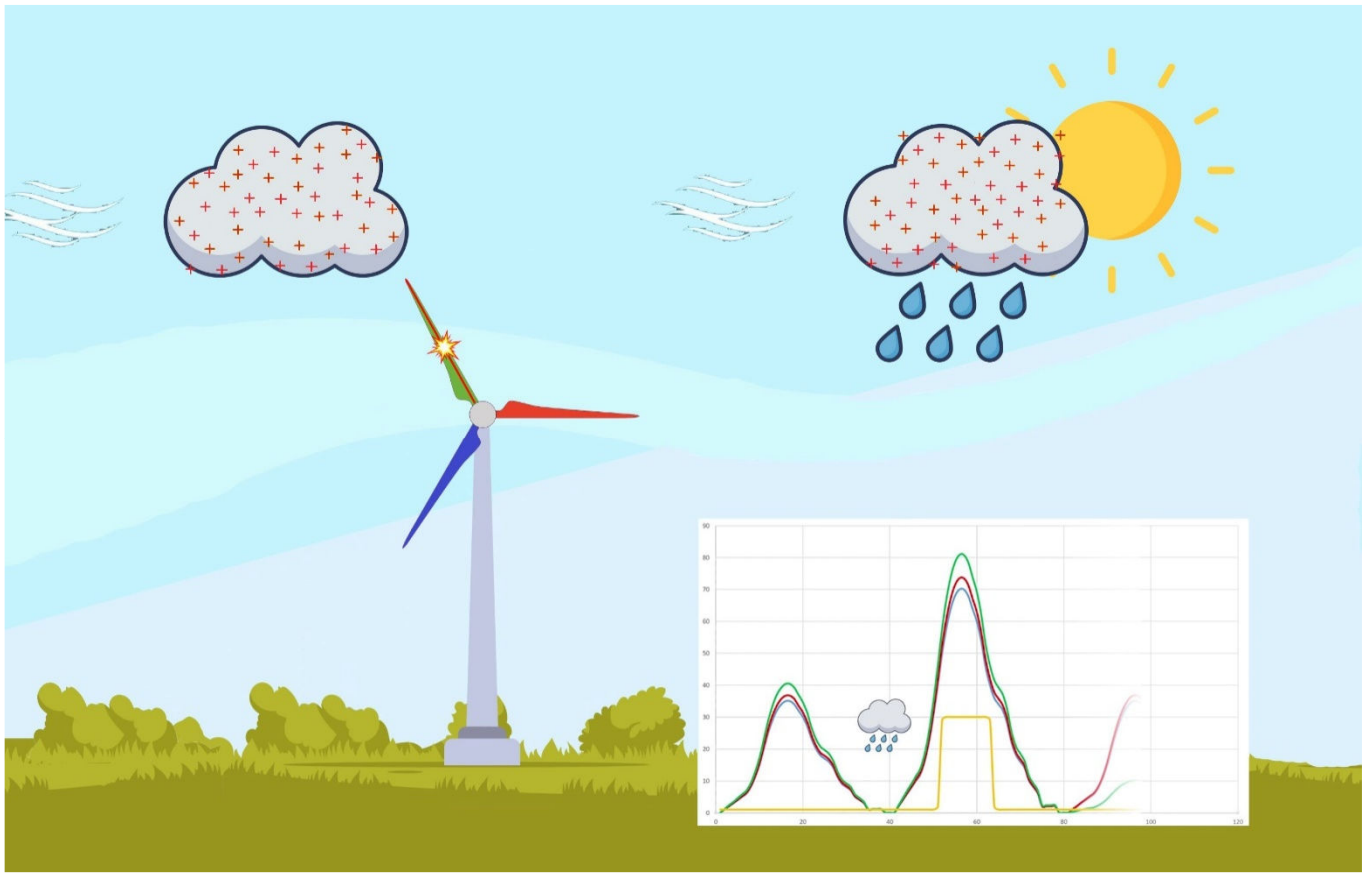

- **Detect broken down conductors**

- **Early detection of rain and hail towards the blades**

    - Lower the rotational speed to extend blade life time

The Jomitek Blade Lightning Down Conductor Sensor (LDCS)

Datasheet as of 21 November 2022

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General description

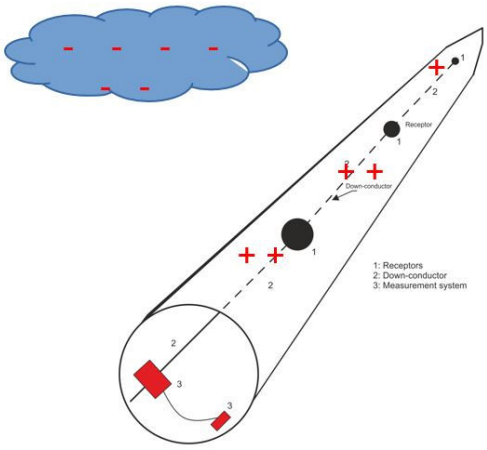
The Jomitek Down Conductor Sensor provides an alarm, when a down conductor inside a blade is broken. It also make an alarm for rain/hail towards the blade.

Using a novel patented detection method, continuous detection of the operational state of the blade down conductors in a wind turbine is enabled. The method make use of the atmospheric charge that is naturally present around the wind turbine, to compare the relative length of the down conductors.

The system consists of a sensor installed internallyat the root of each blade, where the down conductor interface between blade and hub is located, as well as a data analysis and control unit placed in the hub.Each sensor transmit measurements to the control unit through an optical cable.

The sensors are self powered by the charge collected by the blade down conductors, and acts as a spark gap inserted in series with the down conductor.

The control unit will continuously analyse the sensor input to determine if historic data (in the range of minutes to hours) indicate a need to signal an alarm for a broken down conductor.



Product input/output features

- Alarm relay interface
- Alarm LED's and alarm test option
- Ethernet interface (web / FTP / Modbus / IEC)
- Reset option on front panel

The Jomitek Blade Lightning Down Conductor Sensor (LDCS)

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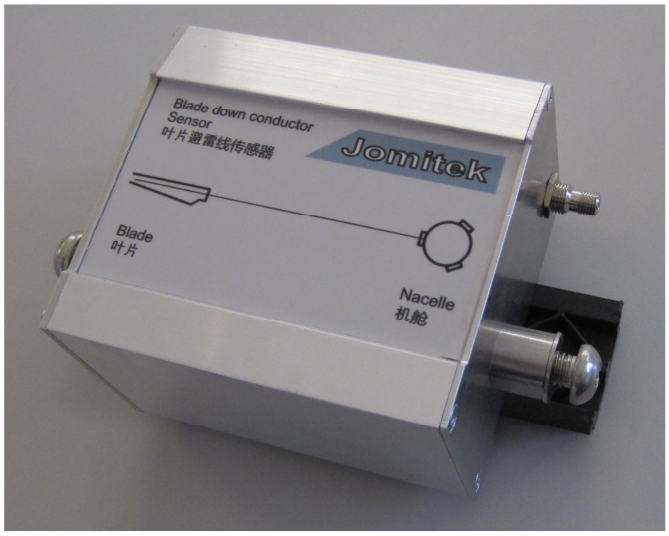
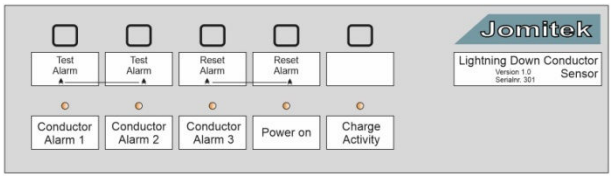
The sensor

The sensor is an advanced spark gap that include a charge measuring circuit, with an optical output.



The logic unit

The logic unit collect optical signals from the sensors, and analysethis input todetermine if a down conductor is broken.



Alarm and power status is indicated by LEDs.
The push buttons are for local alarm reset and for generation of alarms for installation and maintenance test.

The Jomitek Blade Lightning Down Conductor Sensor (LDCS)

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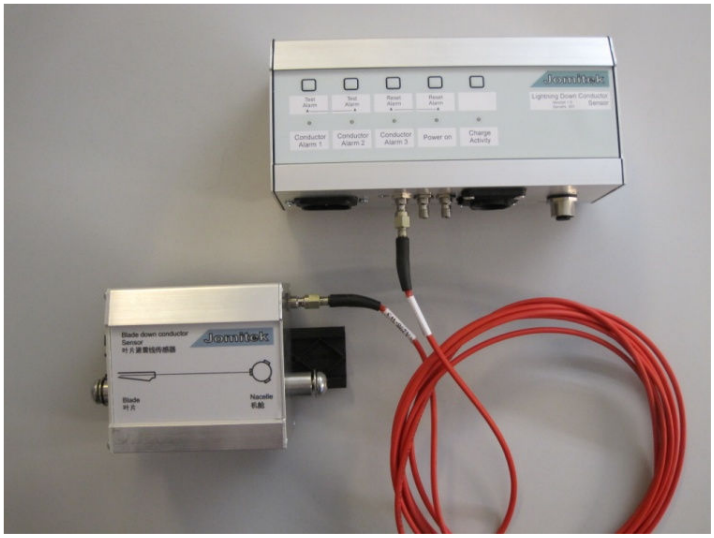
System components

For a turbine, one control unit and 3 sensors are needed.



One sensor connected to the control unit

Connectors

The logic unit has 2 options for power supply:

1. 230VAC
2. 24VDC

The 24VDC is supplied through the alarm connector.

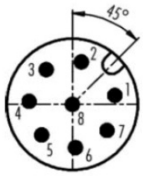
The Ethernet connector is for interfacing to turbine control or a PC via a switch.

Connectors on the controlunit

Connector configuration

M12 Standard - with DC-in:

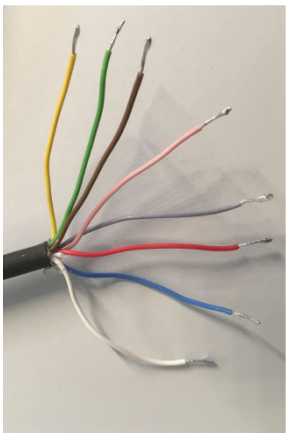
Pin	Description
1	Power Failure
2*	Blade Alarm 1 / Common Blade Alarm
3	Common (-)
4	Alarm Reset
5	Blade Alarm 2
6	Blade Alarm 3
7	DC supply in +/-
8	DC supply in +/-
Shield	Earth



	X	Y
1	2,69	0,57
2	0,57	2,69
3	-1,66	2,20
4	-2,75	0,19
5	-1,94	-1,94
6	0,19	-2,74
7	2,20	-1,65
8	0,00	0,00

1 weiß/*white*
2 braun/*brown*
3 grün/*green*
4 gelb/*yellow*
5 grau/*grey*
6 rosa/*pink*
7 blau/*blue*
8 rot/*red*

Geschirmte Versionen: Schirm auf Gehäuse oder Pin 8
Shielded versions: shield on housing or pin 8



* pin 2 functionality is configurable via software. Default setup is 'Blade Alarm 1', unless otherwise requested by customer before or during ordering.

The Jomitek Blade Lightning Down Conductor Sensor (LDCS)

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Technical specification

Power supply input	
1.	230/115 VAC*
2.	24-48VDC
Power consumption,	
typical, DC-in	1.3 VA
typical, AC-in	3 VA
Maximum	10 VA
Ethernet Interface	RJ45
Protection	IP67
Control signal connector	M12, 8 wire
Protection class	IP55
Mounting	DIN rail
Operating temperature	-30 to +65 degree C
Storage temperature	-45 to +65 degree C
Dimensions of control unit (lxdxh)(connectors not included)	185x65x90 mm
Dimensions ofsensor unit(lxdxh)(connectors not included)	90x65x90mm
Weights	
Logic box	700g
Sensor box – one	450g
Optical fibre	150g
Interface cable	300g
Total system	2500g

* 115VAC Supply voltage to be specified when ordering. 230VAC is standard.

The device fulfils below standards:

EMC directive
- Emission: EN 50081-2:1993
- Immunity: EN 61000-6-2:2005

Low Voltage directive
- EN 61010-1:2010

International Protection Rating (IP Code)
- IP55 (dust protected, water jets)

Wind Energy Generation Systems – Part 24: Lightning protection,
- IEC 61400-24

where the sensor is equivalent to a spark gap in the conduction path to ground.

Fulfillment of standard IEC 61400-24

The sensor is mounted in series with the down conductor from the blade to the hub.

As this is the only intended path for the lightning current to pass down, it is important to be able to measure the continuity of the overall Lightning Protection System (LPS). The sensor is seen as a spark gap in this context, and should be treated as such as detailed in chapter 12.2.4 of the standard.

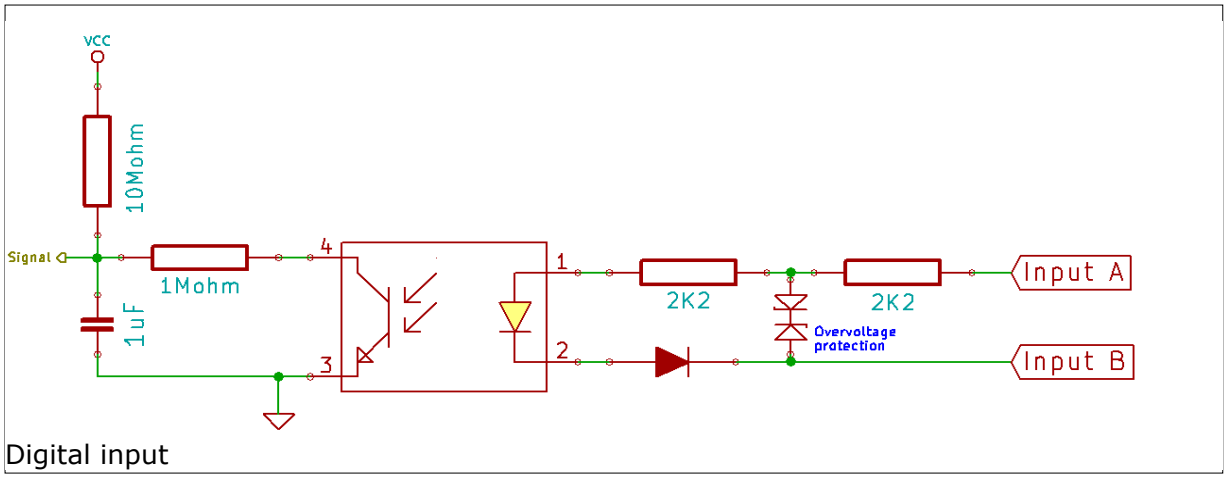
Extract of IEC 61400-24 chapter 12.2.4

Continuity measurements shall be made in accordance with IEC 62305-3 and shall be made with an appropriate instrument, such as a four-wire micro ohm meter.

NOTE Connections via brushes or spark gaps or equivalent can be short circuited if necessary, to make a continuity measurement of other parts of the LPS.

Electrical interface

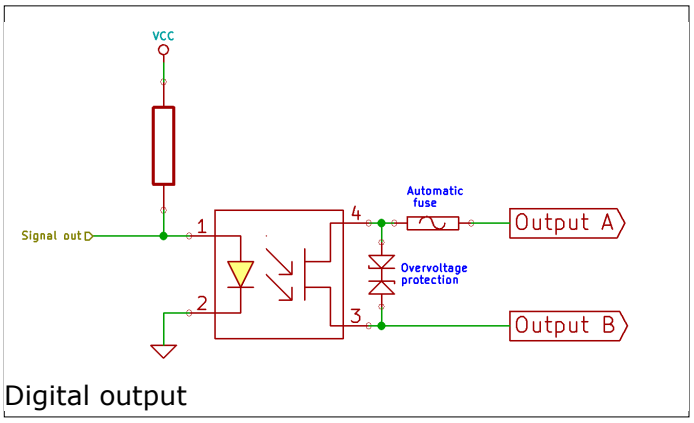
All inputs and outputs are isolated by optocouplers.



Digital input

Digital inputs are:
- Reset alarm
- Test alarm

Digital outputs are:
- Lightning alarm(s)
- Power failure alarm



Digital output

Testing of system after installation

After installation of the system components a simple integration test must be performed:

1. Disconnect the optical fiber at the sensor. Use a flash light (e.g. in a cell phone) to send light into the open end of the fiber. Check that the system shows activity on the 'Charge Activity' LED.
2. On the interface box press the 2 buttons 'Test Alarm' at the same time and check that the alarm relay(s)are triggered.
3. Clear the alarms using either the push buttons, or via Ethernet, e.g. using the web interface.

Ordering information:

Description	Partnumber
Blade Down Conductor Sensor	J350 00020 001
Blade Down Conductor Control Unit	J350 00021 001
Interface cable 2.1 meters (last 3 digits=length in dm)	J710 00004 021
Optical fiber 10 meters (last 3 digits=length in dm)	J720 00008 100

Note that the AC power cable, if used, is most cost efficiently sourced by the customer. A standard IEC 60320 C13 connector must be applied.

The Jomitek Blade Lightning Down Conductor Sensor (LDCS)

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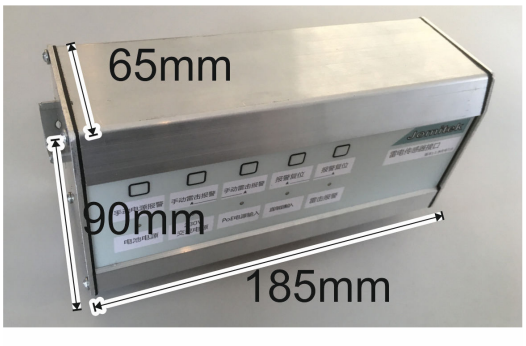
Product and system details:

Connectors at bottom

DIN rail mounting

Text insert for customizable language



Dimensions

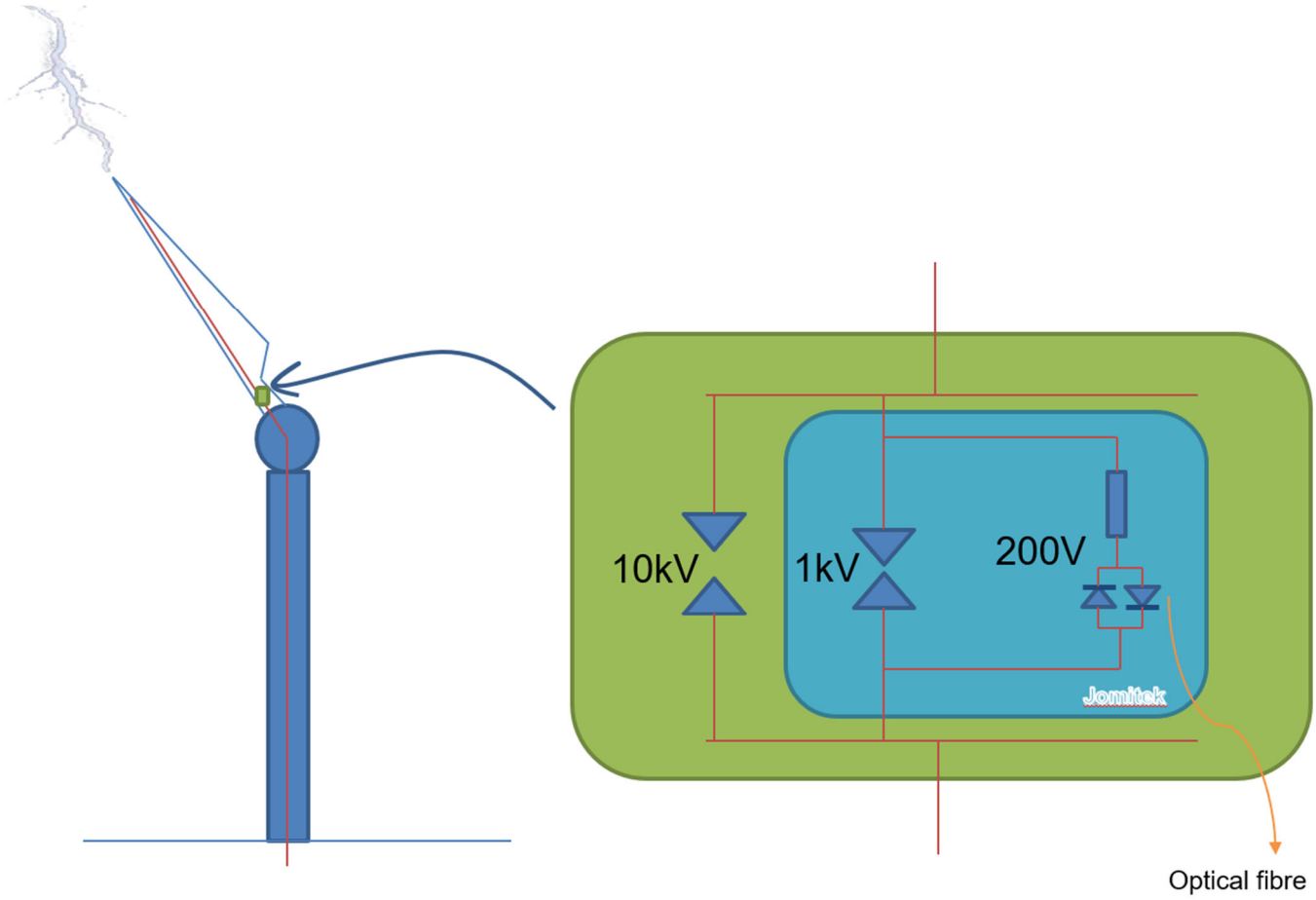
Optical fiber cable

Interface cable

Safety considerations:

As the sensor is mounted in series with the blade down conductor it is crucial that the conduction path to ground is ensured during a lightning event.

The sensor is based on a spark gap, which is inside the sensor box.
A schematic diagram is show below:



The spark gap illustrated in the blue box is the internal spark gap. The spark gap illustrated outside the blue box is an external gap made by the mechanical installation hardware. The external spark gap is recommended as an extra safety feature, in the event that the internal spark gap malfunctions. The electronic circuit illustrated next to the internal spark gap is protected against lightning strike damage.

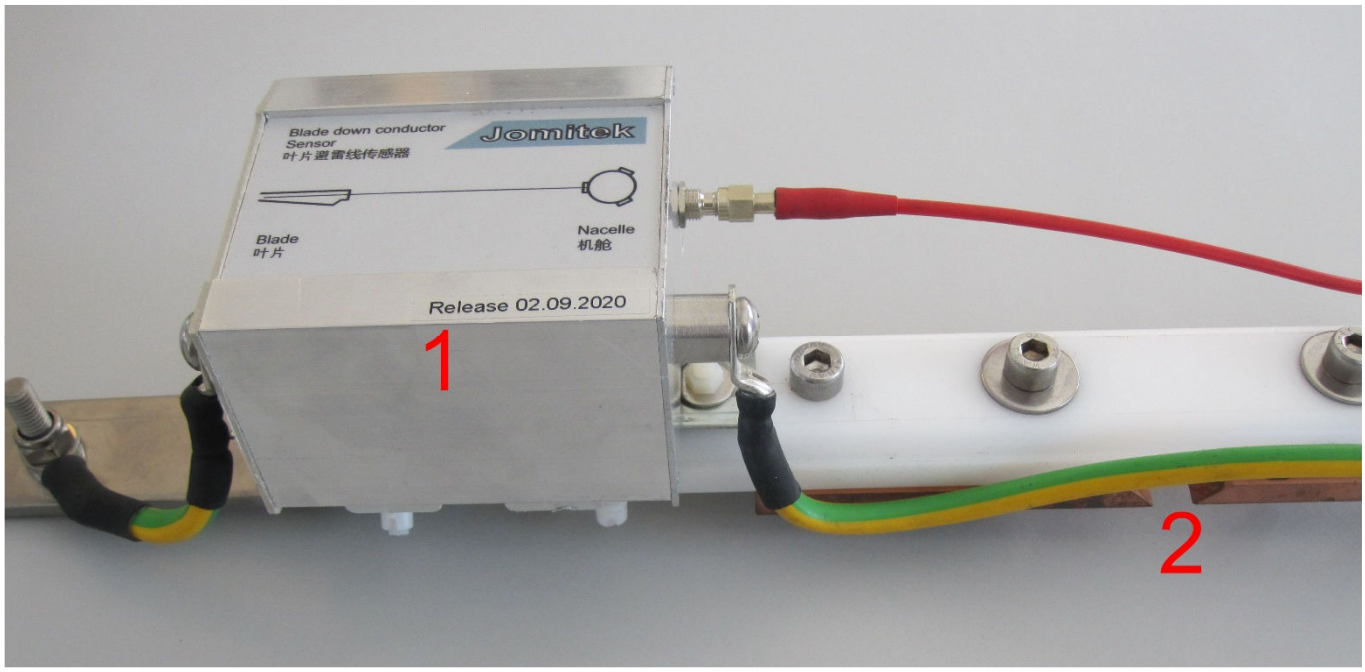
During normal operation the internal electronic circuit will keep the potential difference across the spark gap below 200V. The low voltage will give the blades a voltage level very close to earth potential compared to that of the skies. The Jomitek sensor will not affect the function of the receptor based lightning protection system.

The external spark gap can be assembled using 2 opposing pieces of metal, presenting a physical distance of 2-10mm, depending on the layout.

Note that industrial spark gaps, such as the internal spark gap used in the LDCS, are rated to no more than 100kA peak lightning. In the event that the peak lightning pulse exceeds 100kA (very

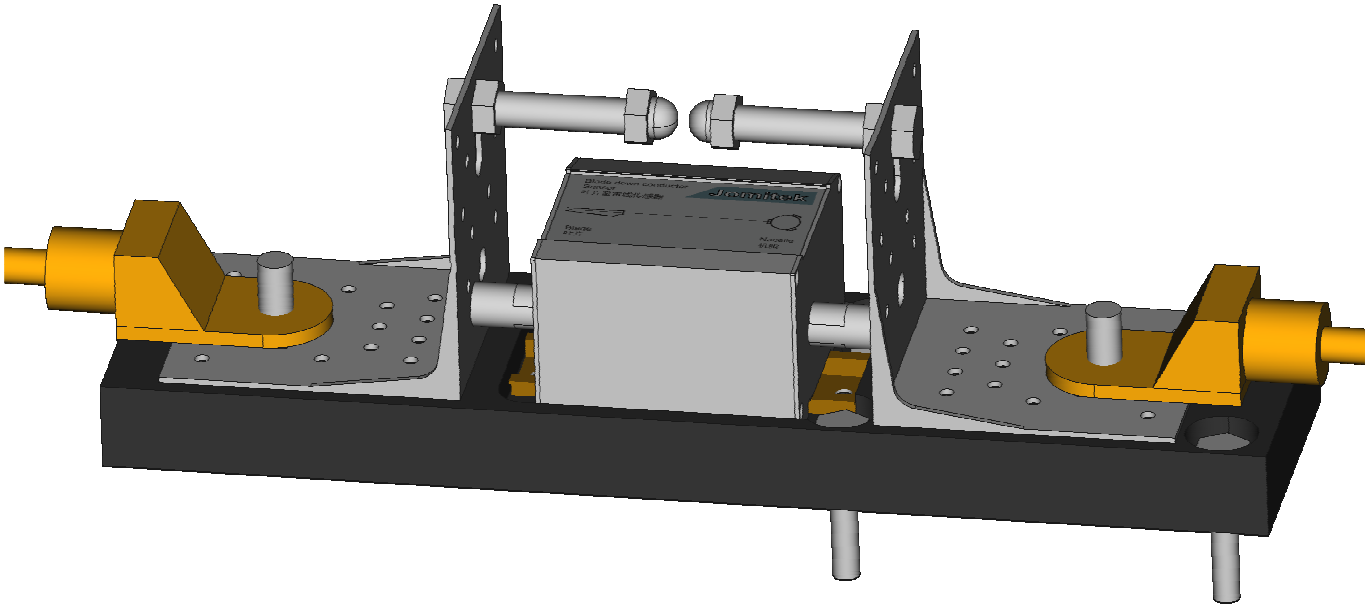
rare), the external spark gap ensures compliance with Lightning Protection Level I, where up to 200kA peak currents must be supported by the lightning down conductor system.

An example assembly is shown below.



The internal spark gap is 1) and the external spark gap 2) is made by flat and sharp edged copper.

Another example assembly may be based on the design principle illustrated below, ensuring a mechanically robust, well isolated, compact, and widely applicable mounting frame. In this case, the external spark gap is placed above the sensor casing, using industry standard nuts and bolts.



Installation guide:

1. Carefully follow the safety procedures at the actual site.
2. Make sure that the down conductor is the only conductive path between the blade and the hub area. Use a simple ohmic measurement to verify a resistance higher than 100kohm when the down conductor cable between the hub and blade is disconnected during installation.
3. Mount a sensor at the root of each blade in series with the blade down conductor.
4. From each of the 3 sensors, place the optical fibre by cable strips so that they will not be damaged by the pitch regulation mechanism. Coil the fibers at the assembly point for the Logic box.
5. Carefully mark the blade number to the sensor input number.
6. Apply the power supply to the Logic box, 230VAC or 24VDC.
7. If Relay output is used, attach the M12 connector cable to the nacelle interface. If Ethernet WiFi is used, install a WiFi router.
8. When power is applied, test the fiber connection by sending light (ex. from a mobile phone) into the fiber at the sensor end and let another person check that the 'acitivity' LED blinks accordingly on the Logic box.
9. Restart the turbine.
10. To detect a damaged lightning down conductor within a blade, the sensor will need a few days in operation before an alarm is triggered.

Please refer to the Jomitek Lightning Down Conductor Sensor manual for additional detailing of the installation, setup and verification process for the sensor system. See http://jomitek.dk/en/downloads/product-information/