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User Manual

Dragonfly®

User Manual Dragonfly®

1 Unboxing

Before they are installed on test objects, Dragonfly® sensors must be handled with care. Please follow our recommendations on p3.

2 Test the sensor

Dragonfly® sensors should be checked before installation. Depending on your sensor, please follow the following procedures:

- Passive sensors (dgf-xxx-**aa**00000-00), refer to p4.
- WIE sensors (dgf-xxx-**w**00000-00), refer to p4.

3 Install the sensor

Dragonfly® sensors are strain sensors, which must be bonded to the surface to be measured. The accuracy of the strain measurements depends on the bonding quality. For optimal installation please follow the next steps:

- Surface preparation p5.
- Choosing the right glue p6.
- Gluing p7.
- Applying a protective layer p8.

4 Test the sensor

Once the sensors have been installed on the test object, they must be tested to verify that they have not been damaged during the handling and the bonding process. Depending on your sensor, please follow the following procedures:

- Passive sensors (dgf-xxx-**aa**00000-00), refer to p4.
- WIE sensors (dgf-xxx-**w**00000-00), refer to p4.

5 Connect the sensor to the acquisition system

Dragonfly® sensors are fully shielded to be protected against electromagnetic noise. For the shield to be fully operational, it is important to check the grounding of your measurement system. Please follow the guidelines on p9.

The choice of your acquisition system may influence the performance of the sensor. Depending on the type of Dragonfly sensor:

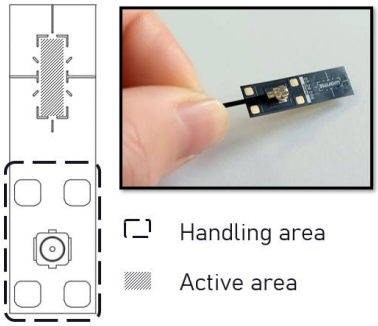
- For passive Dragonfly® sensors (dgf-xxx-**aa**00000-00) please refer to p9.
- For IEPE sensors (dgf-xxx-**w**00000-00), please refer to p10.

6 Start measurements

General information on how to analyze the signals measured by the Dragonfly® sensors is provided on p12.

1 Unboxing and handling recommendations

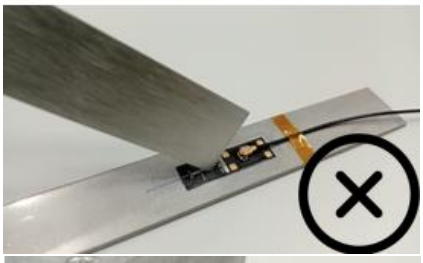
Warning: before they are installed on test objects, Dragonfly® sensors must be handled with care.



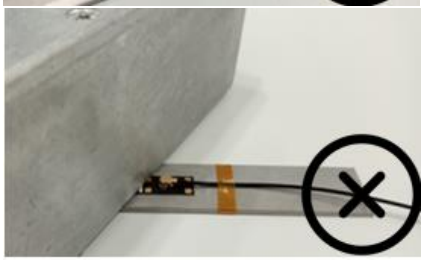
- Sensor should be manipulated by the wire or connector area.
- Avoid contact with the active area prior to installation.

- Pick and manipulate the sensor by the cable.

- Avoid any bending of the sensor prior to installation.



- Avoid local puncture points on the sensor.



- Avoid mechanical loads over the sensor.

2 Sensor check

Sensor check is vital to be sure that the sensor works as expected. It should be performed at least two times:

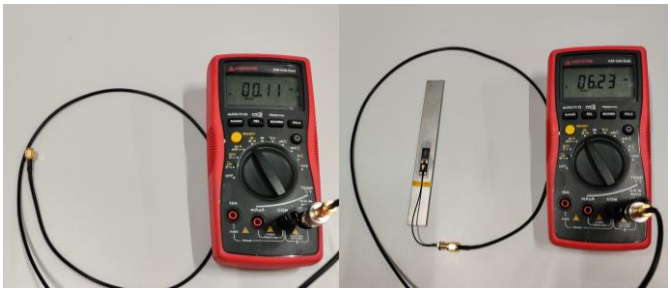
- After unboxing the sensor
- After sensor installation

It can be repeated at any moment to ensure sensor functionality after an event (ex: mechanical collision or extreme deformation). The testing procedure depends on the Dragonfly® reference (passive or IEPE). Refer to the one of the following sections.

Warning: If there is any doubt about the quality of the signal from the sensor, this is the first check that should be performed.

2.1 Passive Dragonfly®

Applies to the following references : dgf-omn-aa20205-10



Sensor capacitance measurement

- Use a multimeter that has a calibrated capacitance function and a measure range between 1 and 10nF.
- Set range for auto or 10 nF.
- The capacitance should be within range specified in the datasheet.
- The wire capacitance should be accounted for (0,11 nF in the example).
- **If the capacitance is outside of the range specified in the datasheet, contact our support team.**

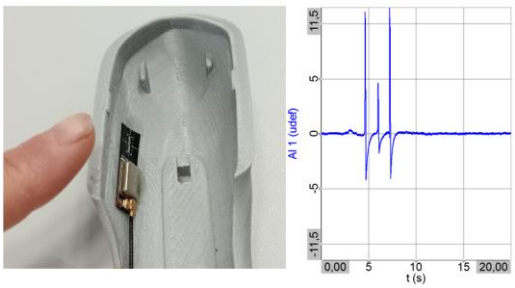
2.2 IEPE Dragonfly®

Applies to the following references: dgf-omn-w120205-10

To test the IEPE sensors, the method based on the capacitance explained in the previous section does not work. The sensor must be connected to an IEPE acquisition system which provides a current supply to power the Dragonfly® internal charge amplifier. Refer to p.11 for instructions to connect the IEPE Dragonfly® to an IEPE acquisition system. The two following tests must be completed to check the sensor integrity.

IEPE Supply DC testing

- While the IEPE sensor is powered up, the IEPE DC level can be measured by using a T-junction and a multimeter in DC voltage mode.
- After DC stabilization, the supply DC must between 6 and 18 V.
- If not, contact our support team.



Knock test

- Knock close to the sensor area and observe the signal on your acquisition system. Make sure not to knock on the sensor active area.
- If the sensor is not installed on the test object yet, tap gently on the metal cover while holding the sensor by the cable.

The response amplitude and width will vary greatly depending on the test object.

3 Sensor installation

3.1 Surface preparation

Roughening

- Use an emery paper to roughen a 3cm² surface where the sensor will be installed. Use the grain size recommended for the glue that will be used.

Cleaning

- Clean the surface using microfiber fabric and a solvent such as isopropyl alcohol.

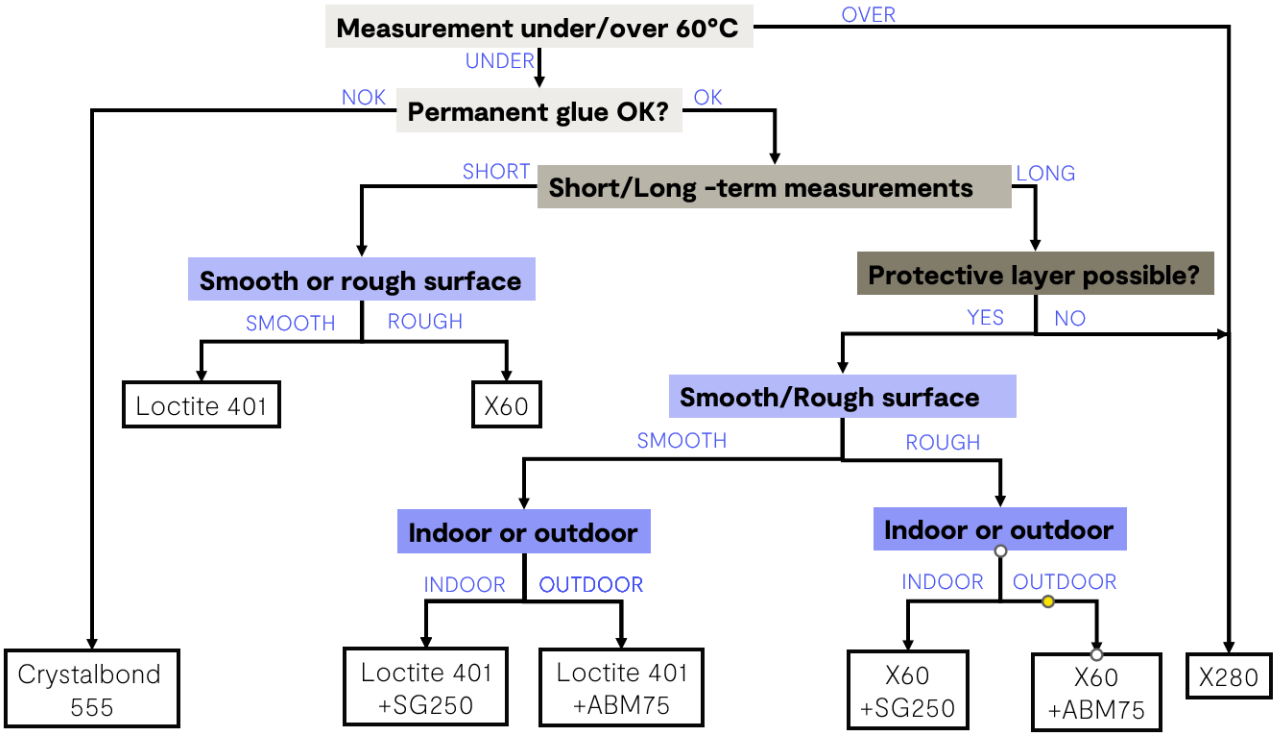
3.2 Choosing the glue

The interface between the sensor and the test object must be very rigid to transmit the deformation.

- Double-face tape is flexible and **should not** be used for installation as it will not transmit the deformation to the sensor.
- Clamping the sensor **is not** an installation solution as it will not transmit the deformation to the sensor.

The sensor **should not** be scrapped with a solid object after gluing. Use a soft material to apply the pressure (thumb or flexible silicone).

The following schematic proposes glue usage for different contexts. The recommended glues have been qualified for Dragonfly®.



The table below gives further information on the recommended glues.

Glue	Manufacturer	Composition	Usage	Downsides
Loctite 401	Loctite	Cyanoacrylate	Quick measures	Cyanoacrylates are known to degrade with time in humid environment
X60	HBK	Methacrylate	Rough surfaces	Thicker bonding interfaces
X280	HBK	Room-temperature epoxy	Long term measure	Requires mechanical clamping during the curing of the glue
Crystalbon555	Aremco	Wax	Non-permanent gluing	Thick interface and low mechanical strength

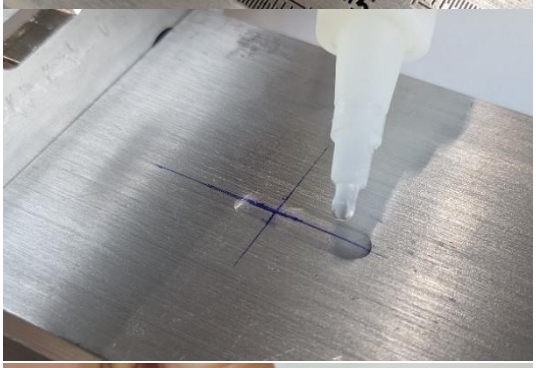
3.3 Gluing

Unboxing and manipulation

- Pick and manipulate the sensor by the cable.
- Avoid bending or squeezing the sensor prior to installation, See Sensor Recommendations p3 for further instructions.

Position Identification

- Make an alignment mark on the surface.

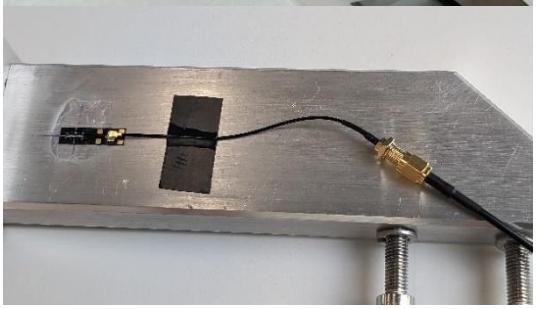


Apply glue on the surface

- Use a glue appropriate to your test context and substrate material.
- Apply enough glue to cover the entire sensor area.

Sensor bonding

- Align the sensor with your mark.
- Apply homogeneous pressure on the full sensor area. Use a Teflon or silicone pad to prevent adhesion between the applicator and the test object.
- In the case of cyanoacrylate glue, press gently with your fingers on a Teflon paper for 30 seconds.



Sensor connection

- Fix the wire with adhesive tape to prevent direct pull on the bonding interface.
- Wait the used glue specified setting time before connecting.
- Test sensor to validate installation (p4).

Note on non-permanent gluing

In the case where permanent gluing is not possible, hot wax can be used to install the sensor. We recommend using Crystalbond 555 wax and an air gun at 100°C.

- The best practice is to precoat the sensor before installation. To achieve this, the sensor should be lightly dipped on the surface of melted wax. Ensure there is a homogenous coverage. Let the wax cool down.
- Just before installation, heat the sensor with the air gun. Wait for the wax to be fully transparent.
- Place the sensor at the desired location and quickly apply homogenous pressure. As the sensor contacts the object, the heat will diffuse and the wax will settle within a few seconds.
- Extra precautions should be taken to prevent wire pulling as the wax mechanical interface is a lot weaker than permanent glue.

Warning: as the wax interface is thick and uneven, the sensitivity of the Dragonfly® sensor may vary depending on the installation procedure.

3.4 Applying a protective layer

For rough environments (humidity, heat, light), sensor protection is advised to prevent glue interface degradation. The following products are recommended.

Glue	Manufacturer	Composition	Usage
ABM75	HBK	Kneadable putty and aluminum	Outdoor protection
SG250	HBK	Silicone	Lab and indoor

4 Sensor testing

Please refer to section 2 on page 2

5 Connecting the sensor to the acquisition system

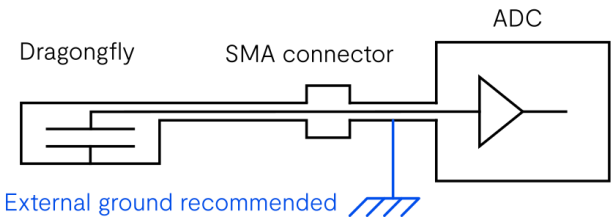
5.1 Grounding and shielding

The whole system should be shielded, from the sensor to the acquisition device. Coaxial wires (BNC, SMA or microdot) should be used on the complete line.

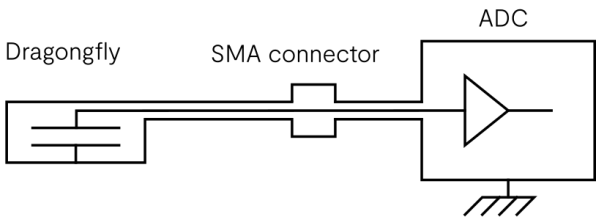
The signal must be acquired in “referenced” mode: the negative pin of the sensor (the shield of the coaxial cable) must be connected to the ground.

Some acquisition systems are not directly grounded. Adding an external ground can help to reduce ambient electromagnetic radiation noise on the measured signal (see figure below).

Referenced aquisition system without ground



Referenced aquisition system with ground: OK



5.2 Acquisition of passive Dragonfly® sensors

Applies to the following references:

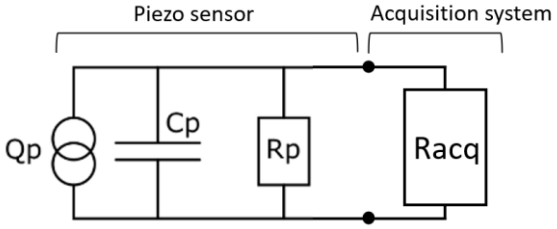
- dgf-omn-aa20205-10

Dragonfly® passive sensors behave electrically as a capacitance, in parallel with a leakage resistor. It can be measured in two different modes depending on the needs of the user, and on the available acquisition system.

Warning: Be careful not to connect passive Dragonfly® sensors on IEPE inputs, which may potentially damage the sensors by applying a too high voltage.

Voltage mode

A piezoelectric sensor equivalent electrical schematic is shown below. The lowest measurable frequency depends on the type of acquisition system used for the measurement.



In voltage mode, the lower cut-off frequency (f_{LC}) is a couple between the sensor electrical properties (R_p and C_p) and the acquisition system input impedance (R_{acq}).

$$R_{eq} = (R_p * R_{acq})/(R_p + R_{acq})$$

$$f_{LC} = \frac{1}{2\pi C_p R_{eq}}$$

The lowest achievable cutting frequency is typically of the order of 0.5Hz for acquisition systems with a very high input impedance.

Charge mode

When operated in charge mode (using a charge amplifier), the cut-off frequency is determined by the charge amplifier itself and can be very low (<0.01Hz) with a dedicated design. Piezo-electric sensors cannot measure infinitely slow strain variations, due to the leakage currents in the amplifier. However stable measurements over several minutes are possible with a limited error (<1%).

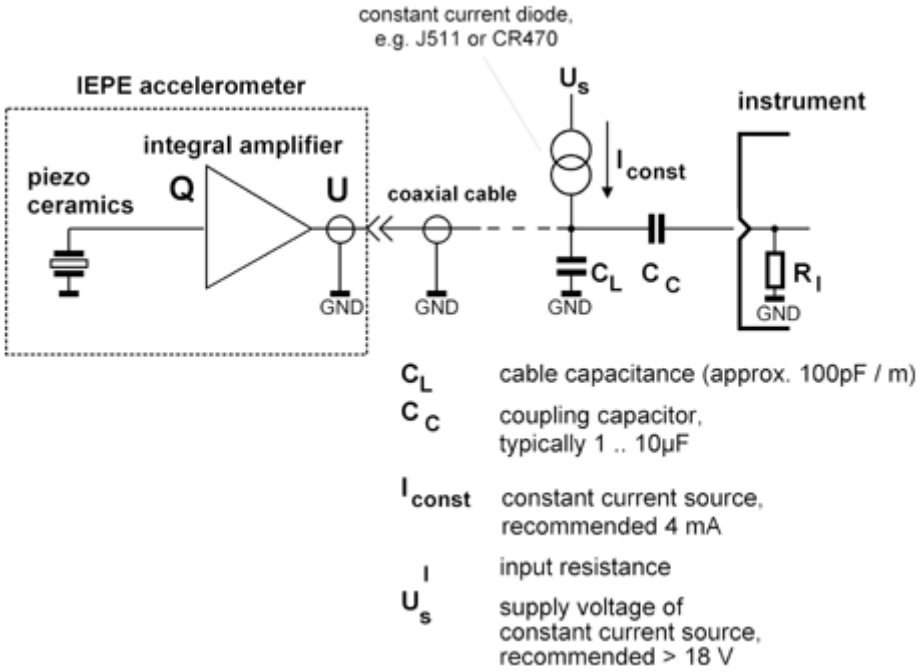
Warning: standard coaxial cables may create triboelectric noise when they are deformed. As the impedance of passive Dragonfly® is very high this can create spurious noise in the measured signal. Special low noise cable coaxial cables exist if you encounter this problem. Moreover, IEPE Dragonfly® sensors are much more robust against triboelectric noise from the cables as they are pre-amplified.

5.3 Acquisition of IEPE Dragonfly® sensors

Applies to the following references:

- dgf-omn-w120205-10

IEPE Dragonfly® sensors integrate an onboard charge amplifier, which is powered by a current supplied by the acquisition system. These sensors are compatible with all acquisition systems which follow the IEPE standard which is often used for accelerometers. Find below the schematics of a typical IEPE interface.

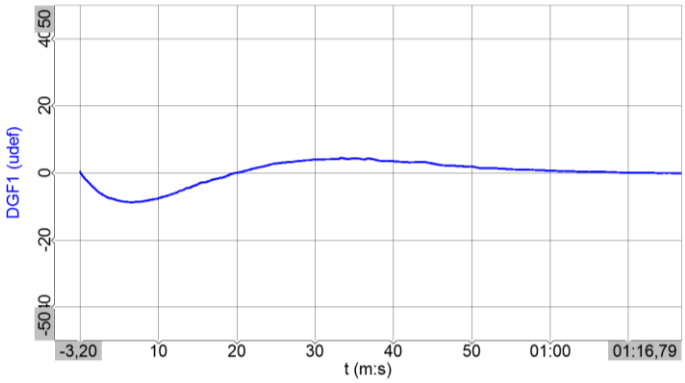


Warning: IEPE Dragonfly® sensors will not work without the supply current and required dedicated IEPE inputs. IEPE range is specified between 2mA and 20mA. Our sensor work within this range but has been specifically tuned to operate at 4mA.

The low cutting frequency of the Dragonfly® measured by an IEPE acquisition system depends on two components:

- The charge amplifier embedded in the Dragonfly® sensor itself, whose low cutting frequency is 0.02Hz.
- The cutting frequency of the IEPE input, which depends on the acquisition system only (more specifically on the values of C_C and R_I in the schematics above). Depending on the model of the IEPE acquisition system, the cutting frequency may typically vary in the range 0.01Hz to 1Hz. Please refer to the technical information of your acquisition device.

When the IEPE Dragonfly® is connected to the IEPE input, the current loads the embedded charge amplifier, which results in oscillations of the measured signal during a period around 300s. Please wait until the signal has stabilized before starting your measurements.



Signal DC stabilization

- Right after power-up, the DC signal is expected to fluctuate before stabilizing at zero within 300 seconds.
- Wait for 300s after connecting the Dragonfly® to the IEPE supply before starting your measurements.

6 Analyzing Dragonfly® signals

6.1 Discovering nano-deformations

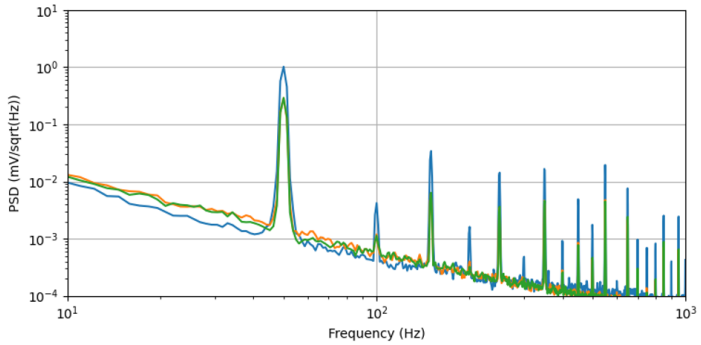
The sensitivity of Dragonfly® sensors outperforms the sensitivity of traditional strain gauges, so many events and small deformations which could not be measured are now accessible. Don't be surprised if the sensor signal does not look like standard strain gauge signals!

Please check our whitepapers to see how Dragonfly® behaves in real situations:

Tuning Fork Resonance | Structural Health Monitoring | Human-Machine Interfaces

6.2 Common issues

EMC noise



If you encounter EMC noise in the measured signal, which typically arises as peaks in the power spectral density of the measured signals at multiples of the frequency of the electricity supply (50Hz or 60Hz), please check the grounding of your measurement system, see p9. Please also check that you have used shielded cables and connectors from the sensor to the acquisition device.

The sensor does not seem to work

If you think that the sensor does not behave as expected, please perform the sensor test as described on p4.

I cannot measure static deformations

Dragonfly® is a piezoelectric strain sensor and cannot measure static deformations by nature. In voltage mode the voltage created by the piezoelectric crystal will discharge in the leakage resistance of the sensor, and in charge mode leakage currents in the charge amplifier also limit the stability of the measurement at low frequencies. However stable measurements over several minutes are possible with a limited error when using dedicated quasi-static charge amplifiers.

If you are interested in slow strain variations, we recommend you connect the passive Dragonfly® on a charge amplifier with a low cutting frequency, or use the IEPE Dragonfly® which has a built in cutting frequency of 0.02Hz.

Other issues

Please contact us at contact@wormsensing.com for further support.