FREQUENTLY ASKED QUESTIONS

I.   Basics

1. *What is the technological principle of the force sensor?*

Kindly view our whitepaper for a thorough explanation on the principle of the force sensor at:

http://optoforce.com/wp-content/uploads/2015/12/OptoForce_WhitePaper_Optical_Force_Sensors.pdf

2. *What is the maximum overload of a force sensor?*

OptoForce sensors, due to the flexible properties of silicone, can withstand extreme overloads up to 600% (depending on sensor model), without any permanent damage, while regaining their original shape. The typical single axis deformation of the sensors is 200%.

For information on each sensor's single axis overload limitations, please see the datasheet for the given sensor.

3. *What is the maximum readout frequency of the sensors?*

The maximum readout frequency of the sensors is 1 kHz.

4. *Are the force sensors water and/or dust-proof?*

The OptoForce force 3 axis sensors are IP 67. IP means Ingress Protection, IP 67 refers to total dust protection and protection from underwater immersion between 15 cm-1m, so they work in humid areas and dusty terrain as well.

The integrated, 6 axis Force/Torque sensors and its converter boxes have a rating of IP 66 (total dust protection)

It is important to take into account, that the DAQ's are IP 41 rated.

5. *Oil and fuel resistance*

The silicone material of the sensors are not oil and fuel resistant. For more information, please take a look at the "Silicone Chemical Compatibility" document.

6. *What is the delivery time of a product?*

After a purchase has been finalised, delivery takes about two weeks.

7. *What is the sensitivity of a sensor at nominal capacity?*

Sensitivity @ N.C. = Nominal Capacity,/Counts at nominal capacity

For example, the sensitivity at nominal capacity of our OMD-20-FE-200N force sensor, during compression, on the Fz axis is::

200 Newtons / 16 000 Counts

which equals: 0.0125 Newton/Count

Please note that the sensitivity of our sensors is not linear over the whole measurement range, detailed explanation can be found in question 8.

Also, please note that the semi-spherical sensors are only calibrated in Z+ direction.

8. *What is Non-Linearity?*

Non-linearity is defined as the error from an ideal linear output at the nominal maximum capacity.

Non-linearity values of OptoForce sensors range from 1% - 5% depending on the model – upon request integrated software compensation in the DAQ can improve it to 0.5% - 1.5%.
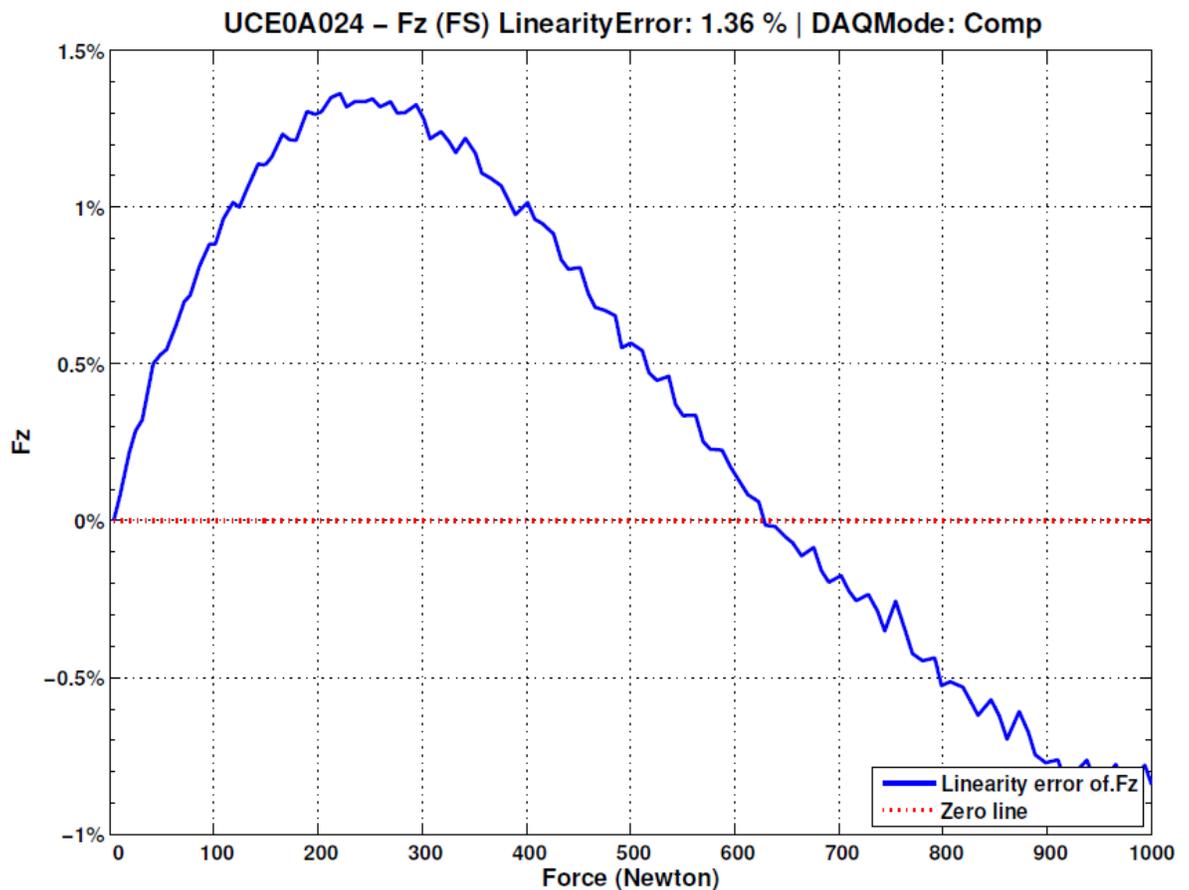
The nonlinearity of the HEX-70-XE-1000N F/T sensor

It is important to keep in mind that the non-linearity of a certain sensor is given according to its nominal capacity. The non-linearity for a measurement at 10N, using a 2000N force sensor would be more significant, because the 2000N force sensor is calibrated to measure forces close to its nominal capacity of 2000N.

9. *What is temperature compensation?*

Our sensors, all have a working temperature range of -40 degrees C to +80 degrees C. Temperature compensation is present on this entire range, but it is most precise on the scale

of -10 degrees C to +40 degrees C. This means, that outside of this temperature compensation range, the sensors will work, and you are able to measure with them extremely accurately, but there is a chance of having a 10-15 Count additive error.

10. *What is crosstalk?*

Crosstalk is measuring how measurements along one axis create an error along other axes. Our crosstalk values are normally below 5% and depend on the shape and material.

11. *How durable are the silicone pads?*

The silicone pads are glued on to the sensor and then calibrated as well. We use high quality industrial silicone rubbers with exceptional durability properties. The abrasion of the sensors depends on how frequently the sensors are used. Aging of the material is minimized, if the operational temperature is constant.

12. *What determines the capacity of your sensors and what is the relationship with the hardness?*

The bigger the sensor's outer diameter the higher its nominal capacity in that axis. Also, the harder the silicone material (higher shore hardness) the higher the nominal capacity of the sensor made from that specific material.

13. *How do I calculate the deformation?*

Assuming that the deformation has a linear dependence on the acting forces (which is a good approximation) the deformation of the sensing device in case of a given force load can be calculated as follows.

The ratio of the current force load and the nominal capacity is equal to the ratio of the deformation at the current load and at the nominal capacity.

For example: If deformation at 100 N = 1.2 mm, then at 50 N, it would be 0.6 mm.

The deformation of the sensor at its nominal capacity can be found in the datasheet.

14. *What is the maximum/minimum sensed deformation of the sensors?*

Even though the scale is not linear, if you divide the deflection value of the Fz axis by the counts value, then you would get a close estimate (for example: 2mm / 8000 = 250nm).

15. *Are there any hard stop possibilities with the sensors?*

Since the deflection value of the sensors are relatively big (>1mm), compared to loadcell technology, the implementation of a hard stop by our customers is fairly easy. We are planning to add this to our products in the future.

16. *What is the drift of the sensor?*

By the drift of the sensor, we mean a random change in output under constant load conditions, but this change is determined by the load applied. This drift is a physical property of the silicone. This is a very small value. Please take a look at the "Sensor Drift" document for more information. Drift, however, does not effect zeroing.

17. *How long does the warranty last for each product?*

The warranty for each sensor lasts for 365 days.

18. *Is the sensor influenced by exterior light sources?*

External light does not effect the sensors.

19. *What is the hardness of different types of silicone?*

Silicone hardnesses: Shore A: G - 18, E - 42, H - 70

HEX-70-CE-2000N in this sensor for example, the E in the sensor name tells the user which type of silicone was used.

20. *Is there a specific torque threshold required while mounting the bolts of a 6 axis force sensor?*

Torques larger than 10 Nm, are not advised for the mounting. For M6 bolts, a maximum of 2 Nm, for M4 bolts, a maximum of 0.38 Nm is advised.

21. *What should I do when I encounter any technical difficulties while using the force sensors?*

Feel free to contact our team at any time. Part of our troubleshooting is using a troubleshooter tool, with which we can see the data that your sensors are producing, and can give you a solution based on that data. The steps for using this troubleshooter are as follows:

a) Download the troubleshooter tool at:
http://optoforce.com/software/Configurator_v1.0.5.exe

b) While using the connected force sensor, open the „Debug" tab, and take a screenshot for us.

c) Contact our client service at: marton.gyarmati@optoforce.com and Send us your „Debug" screenshot, with a description of your issue, and we will get back to you as soon as possible.

22. *How do I order?*

You can order directly from us, or from one of our distributors.

Please see our website for our contact information and the list of our distributors.

II.   Electronics

23. *What does a force sensor come with?*

- A <u>3 axis</u> force sensor comes with a DAQ (Data Acquisition Unit). Also, a data visualization software and a C++ API is part of the package. The standard interface for our products is USB, but Ethernet, EtherCAT, UART, and CAN, output are all available interfaces, depending on the request of the customer. The software is cross-platform, so they work on Windows, and Linux as well. The sensors come with a 2.5 mm thick,

flexible PVC mini-USB cable with a standard length of 1 meter. The sensor is undetachable from the DAQ. The DAQ can be directly connected to the processing unit (PC or microcontroller). We also send you a USB stick which contains the software, and the sensitivity report of the sensor, containing the calibration data.

- A <u>6 axis</u>, HEX type sensor comes with a DAQ (Data Acquisition Unit). Also, a data visualization software and a C++ API is part of the package. The standard interface for our products is USB, but Ethernet, EtherCAT, UART, and CAN, output are all available interfaces, depending on the request of the customer. The software is cross-platform, so they work on Windows, and Linux as well. The sensors come with a 2.5 mm thick, flexible PVC mini-USB cable with a standard length of 1 meter. The sensor is undetachable from the DAQ. The DAQ can be directly connected to the processing unit (PC or microcontroller). We also send you a USB stick which contains the software, and the sensitivity report of the sensor, containing the calibration data, and an .osr file, which contains the sensitivity report of the 6 axis sensor in a file.

- An <u>integrated 6 axis</u> HEX-X type sensor has the DAQ (Data Acquisition Unit) unit built-in into its housing, but if the user chooses Ethernet or EtherCAT as the operational interface, then it also comes with an outer converter box. The standard interface for our products is USB/Ethernet but EtherCAT, and CAN, output are all available interfaces, depending on the request of the customer. The software is cross-platform, so they work on Windows, and Linux as well. The sensors come with an M8 type with a standard length of 5 meters, with a digital signal coming from the sensor, since the DAQ is integrated. We also send you a USB stick which contains the software, and the sensitivity report of the sensor, containing the calibration data, and an .osr file, which contains the sensitivity report of the 6 axis sensor in a file.

24. *Can I purchase a force sensor without a DAQ?*

Our products are all calibrated to work together, so it is not possible to purchase a force sensor without a DAQ. The DAQ not only does the digital-analog conversion, but it does other sensor-dependent calculations to properly compensate the measured signal against noises and temperature effects.

25. *How do I connect the sensor to my computer? What is the standard interface of a force sensor? What interfaces are available?*

The standard interface for our force sensors are USB, and you can easily connect to your computer using these ports. Ethernet, EtherCAT, UART and CAN are all available interfaces, depending on the request of the customer.

26. *What are the dimensions of the DAQ's?*

Below are the dimensions of the DAQ:
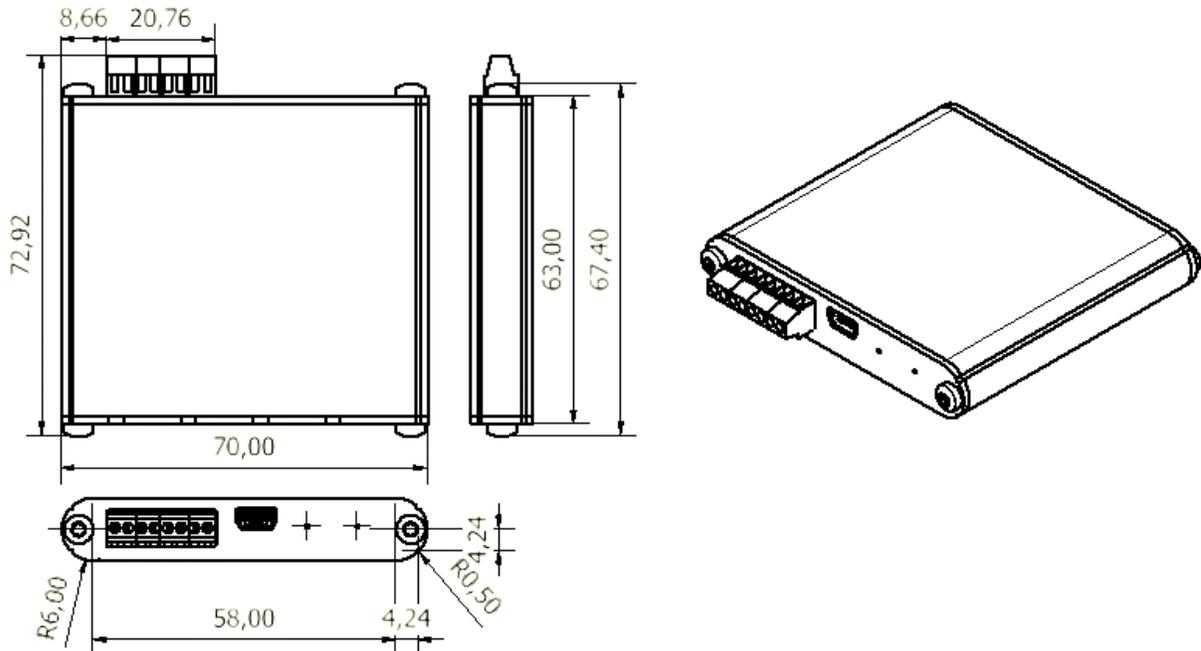
27. *I would like to connect multiple sensors to the same DAQ to save space. Is there a solution to this?*

Yes. Our force sensors at OptoForce all come with a 4channel DAQ, with which you can simultaneously use up to 4 sensors, but we do the connection of the sensors during production, so it is something that we need to know in advance.

28. *What kind of platforms does the data visualization software run on, and what are its requirements?*

The ODV2 software currently runs on Win7/8/10 as a 32 bit application. It also runs on Ubuntu 14.04 and higher, as a 64 bit application (1.5.1 API).

29. *Which versions of Linux and ROS are supported?*

We are using 14.04 Linux Ubuntu and ROS indigo. We provide ROS support only for the Ethernet protocol. For all other ROS inquiries, there is a third party link available.

30. *Can the C++ API be used within a ROS program?*

Our C++ API uses the USB protocol. As ROS is only supported through Ethernet, you will not be able to use both.

31. *Is there an available ROS framework for the force sensors?*

There is a 3rd party ROS link available at: https://github.com/shadow-robot/optoforce
However, since this is a 3rd party link, we do not take any responsibility for it.

For Ethernet, there is another ROS link available at:https://github.com/OptoForce/etherdaq_ros

Our official ROS driver for Ethernet is available at: http://optoforce.com/support/

31. *What kind of technical support is there for integrating the sensor with a robot?*

For in-depth information on how to connect your sensor with a robot, please see the "OptoForce Guide for Universal Robots" document.