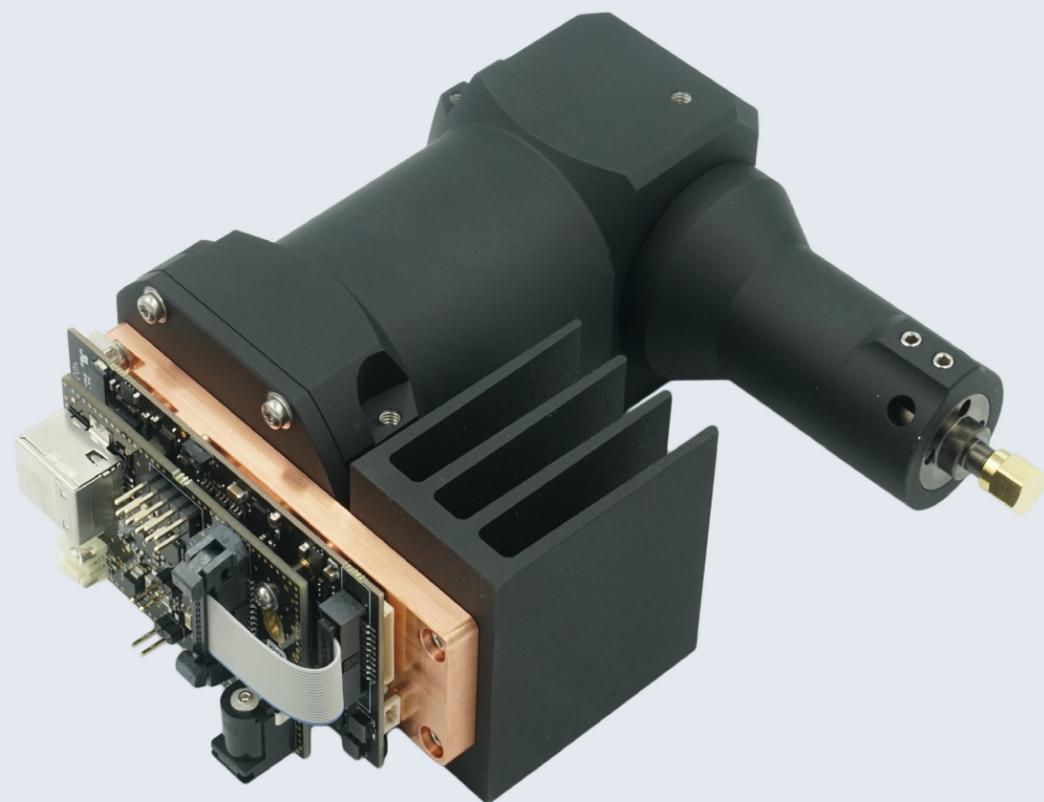




**EAGLE Raman HR**

Ibsen Photonics' Most Flexible High-Performance Raman Spectrometer





## EAGLE Raman HR - High quality Raman spectra in a compact design

The EAGLE Raman HR spectrometer provides high quality Raman spectra in a more compact, practical, and robust design than other similar high-end spectrometers. It is based on Ibsen's own transmission gratings that are optimal for Raman spectroscopy, enabling you to detect all Raman signals. It offers a wide range of design options, which allows the design to be optimized for your specific needs.

### Design flexibility

Ibsen Photonics' EAGLE Raman HR platform is an adaptable and versatile system, configurable to meet the requirements of the individual application.

The different slit options enable you to optimize the design for the highest resolution or maximum throughput. A Raman filter can also be built into the spectrometer to reduce Rayleigh scattering.

The design comes with many different detector options, which can maximize throughput and sensitivity. The temperature regulated S11850-1106 detector is optimal for samples requiring long exposure times. The taller S14651-2048 detector combines temperature regulation with more throughput, resulting in even higher sensitivity. The type of detector can be chosen when ordering the product.

Each detector can be paired with the Ibsen Photonics DISB (Digital Image Sensor Board) electronics, allowing for full control of the detector and temperature regulation, via either an SPI output or USB 2.0.

If the design options described here do not match your needs, we also provide fully customized spectrometers. Our sales team is always happy to discuss your project.

### Advantages of the EAGLE Raman HR spectrometer

- Provides industry-leading sensitivity for its size
- Resolutions down to  $5.8 \text{ cm}^{-1}$
- Grating efficiencies of  $>90\%$
- Covers the full spectral range from  $0\text{-}3480 \text{ cm}^{-1}$  (785) and  $0\text{-}5136 \text{ cm}^{-1}$  (532)
- Multiple options for optical input and detector
- Temperature regulated to  $+5 \text{ }^\circ\text{C}$
- Long-term stability

### Layout and design

The EAGLE Raman HR spectrometer is based on Ibsen Photonics' athermal spectrometer design, centered around our fused silica transmission gratings, designed and optimized for Raman spectroscopy. The nature of the athermal design enables a very low temperature-induced wavelength shift of  $<0.02 \text{ nm}/^\circ\text{C}$ .

## Technical Specifications

		EAGLE Raman HR 532	EAGLE Raman HR 785	Comments
<b>Spectral range</b>		532 nm - 732 nm 0 - 5136 cm <sup>-1</sup> (532 nm laser)	785 nm - 1080 nm 0 - 3480 cm <sup>-1</sup> (785 nm laser)	For 28 mm detector length, such as Hamamatsu S11850-1106 and S14651-2048  Raman HR 532 with 632 nm excitation: 0 - 2162 cm <sup>-1</sup> Raman HR 785 with 830 nm excitation: 0 - 2780 cm <sup>-1</sup>
<b>Spectrometer resolution</b>	Slit size 20 x 1000 μm / 50 x 1000 μm 20 x 3000 μm / 50 x 3000 μm	532 nm excitation laser 8.5 / 12.9 cm <sup>-1</sup> 13.0 / 16.5 cm <sup>-1</sup>	785 nm excitation laser 5.8 / 9.1 cm <sup>-1</sup> 7.8 / 10.8 cm <sup>-1</sup>	Maximum resolution when using the S11850 detector Maximum resolution when using the S14651 detector  Achievable resolution is largely dependent on detector pixel broadening
<b>Numerical aperture</b>		0.2	0.2	
<b>Internal Raman filter</b>		Optional	Optional	Contact us for more information
<b>Detectors</b>				
<b>385</b>	BT-CCD	Hamamatsu S11850-1106 2048 x 64 pixels 14 x 14 μm pixel size One-stage TE-cooled to +5 °C Full well capacity 300 ke-	Hamamatsu S11850-1106 2048 x 64 pixels 14 x 14 μm pixel size One-stage TE-cooled to +5 °C Full well capacity 300 ke-	1000 μm slit height
<b>388</b>	BT-CCD	Hamamatsu S14651-2048 2048 x 192 pixels 14 x 14 μm pixel size One-stage TE-cooled to +5 °C Full well capacity 300 ke-	Hamamatsu S14651-2048 2048 x 192 pixels 14 x 14 μm pixel size One-stage TE-cooled to +5 °C Full well capacity 300 ke-	3000 μm slit height
<b>Interface</b>		DISB w SPI, DISB w USB 2.0	DISB w SPI, DISB w USB 2.0	An OEM version with direct access to detector pins is also available
<b>Temperature induced shift</b>		< 0.02 nm/°C	< 0.02 nm/°C	
<b>Operating temperature range</b>		0 °C to +40 °C	0 °C to +40 °C	Non-condensing
<b>Storage temperature range</b>		-40 °C to +70 °C	-40 °C to +70 °C	Non-condensing
<b>Dimensions</b>		125 mm x 139 mm x 60 mm	125 mm x 139 mm x 60 mm	With DISB-386 and cooling fin
<b>Weight</b>		0.81 kg	0.81 kg	With DISB-386 and cooling fin

## EAGLE Raman HR 532 / EAGLE Raman HR 785



### Transmission Gratings

The EAGLE Raman HR spectrometer utilizes the Ibsen Photonics Raman transmission grating, designed and optimized for the spectrometer. The grating is made of low thermal expansion fused silica, and provides a high even diffraction efficiency, as shown by the absolute diffraction efficiency graph displayed above.

The design also provides very low polarization dependence as an added benefit.

Every grating used in the EAGLE Raman HR spectrometer platform is a master grating fabricated at Ibsen Photonics' clean-room facility in Denmark.

## Detectors

### 385 – Hamamatsu S11850-1106

This Hamamatsu S11850-1106 cooled detector is optimized towards low read-out noise, making it the detector of choice when working with applications where either signal strength is low or the signal-to-noise is the primary concern. This is further supported by the detector TEC being able to cool down to 5 °C at room temperature. The back-thinned CCD provides an excellent and smooth quantum efficiency throughout its entire spectral range, while being optimized to exhibit a significantly reduced etalon effect compared to most back-thinned CCDs.

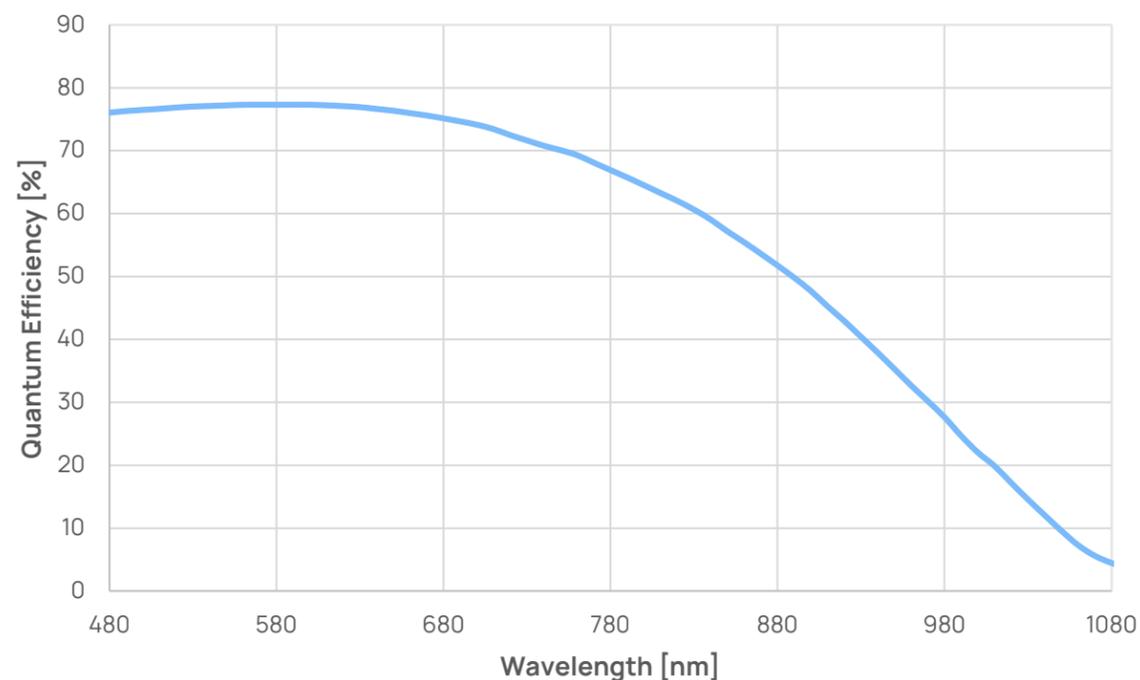
The detector has a 2048 x 64 pixels array, with square 14 x 14 μm pixels, creating an active array size of 28.762 x 0.896 mm.

### 388 – Hamamatsu S14651-2048

The Hamamatsu S14651-2048 detector has all the same features as the S11850-1106, but with the added benefit of the active area being 2.688 mm tall, compared to the 0.896 mm tall S11850-1106. The increased height enables measurements with 3 times the optical throughput when compared to using the S11850-1106.

The detector has a 2048 x 192 pixels array, with square 14 x 14 μm pixels, creating an active array size of 28.762 x 2.688 mm.

S11850 & S14651 detector QE

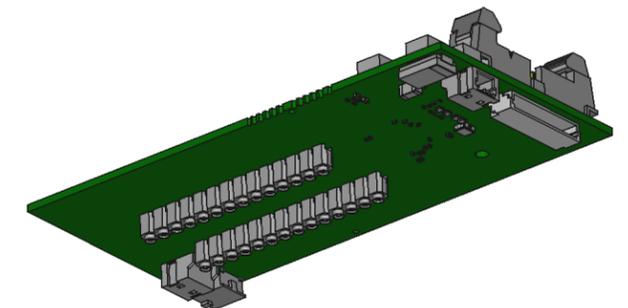
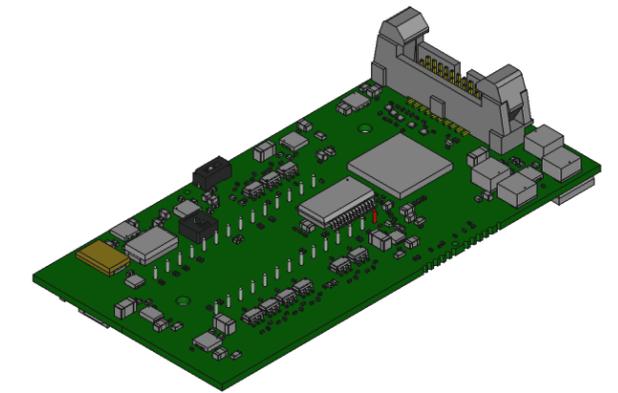


## Electronics

For easy integration of the spectrometer into your application, Ibsen Photonics supplies its Digital Image Sensor Boards (DISB). The DISB is designed to effortlessly convert the analogue signal of the detector into a digital one and facilitate temperature control of the TE cooled detector, while operating via hardware commands over a Serial Peripheral Interface (SPI). The DISB electronics can also be supplied with a DISB-to-USB Bridge board, which converts the SPI connection to a standard USB 2.0 for convenient connection to a PC.

Alternatively, the spectrometer can be purchased without any accompanying electronics, giving direct access to the pins on the chosen detector.

	DISB-386
	S11850   S14651
Read-out speed	100 Hz   83 Hz
A/D bit depth	16-bit
Communication interface	SPI
Software trigger	Yes
Ext. hardware trigger	Yes
Min. trigger delay	4.987 ms   6.532 ms
Trigger jitter	20 ns
Time increments	2 μs
Exposure time	4.987 ms   6.532 ms - 8589 s
On-board calibration data	Yes
On-board averaging	Yes
GPIO pinout	Yes
Programmable lamp control	Yes
Region of interest	Yes
Temperature sensor	Yes
TEC control	Yes



## Software interfacing

The **DISB-to-USB bridge** board developed by Ibsen Photonics is an additional board that can be added to any spectrometer equipped with DISB electronics, to convert the DISB's SPI connection to a standard USB 2.0 connector, for convenient use via a standard PC.

The DISB-to-USB board is based around the **FTDI FT4222H** chipset, with drivers available for Windows, Linux, or Mac. The entire USB protocol is handled in the chip with no requirement for specific complicated USB firmware programming.

Ibsen Photonics supplies its LabVIEW-developed **Ibsen DISB-USB Evaluation software** as standard with the bridge board. This allows for the operation of the spectrometer and its features in a straightforward fashion using the Windows operating system.

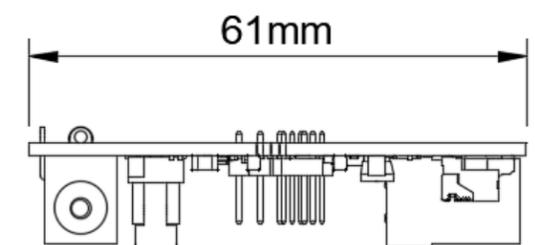
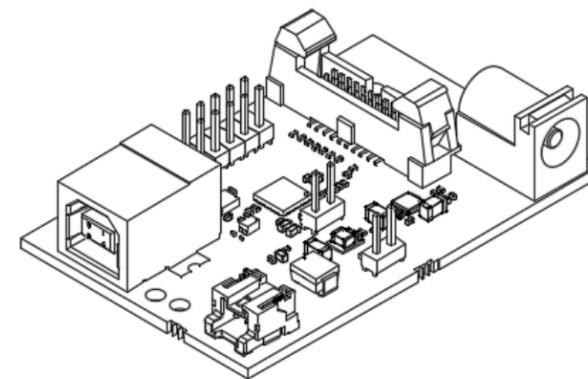
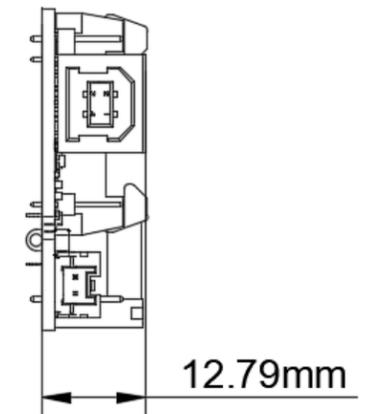
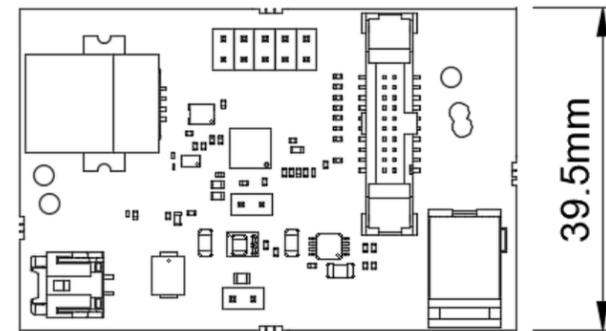
Additionally, an **SDK** is available for the bridge board, allowing for simple, intuitive, and fast deployment of instruction sets and code via C/C++, C#, LabVIEW, Python, or MATLAB, via DLL and accompanying header files. The proprietary Ibsen command set allows for initialization, spectrum capturing, and closing of the spectrometer connection, with as little as three commands, as shown below.

`IBSEN_InitSpectrometer`

`IBSEN_produceSpectra`

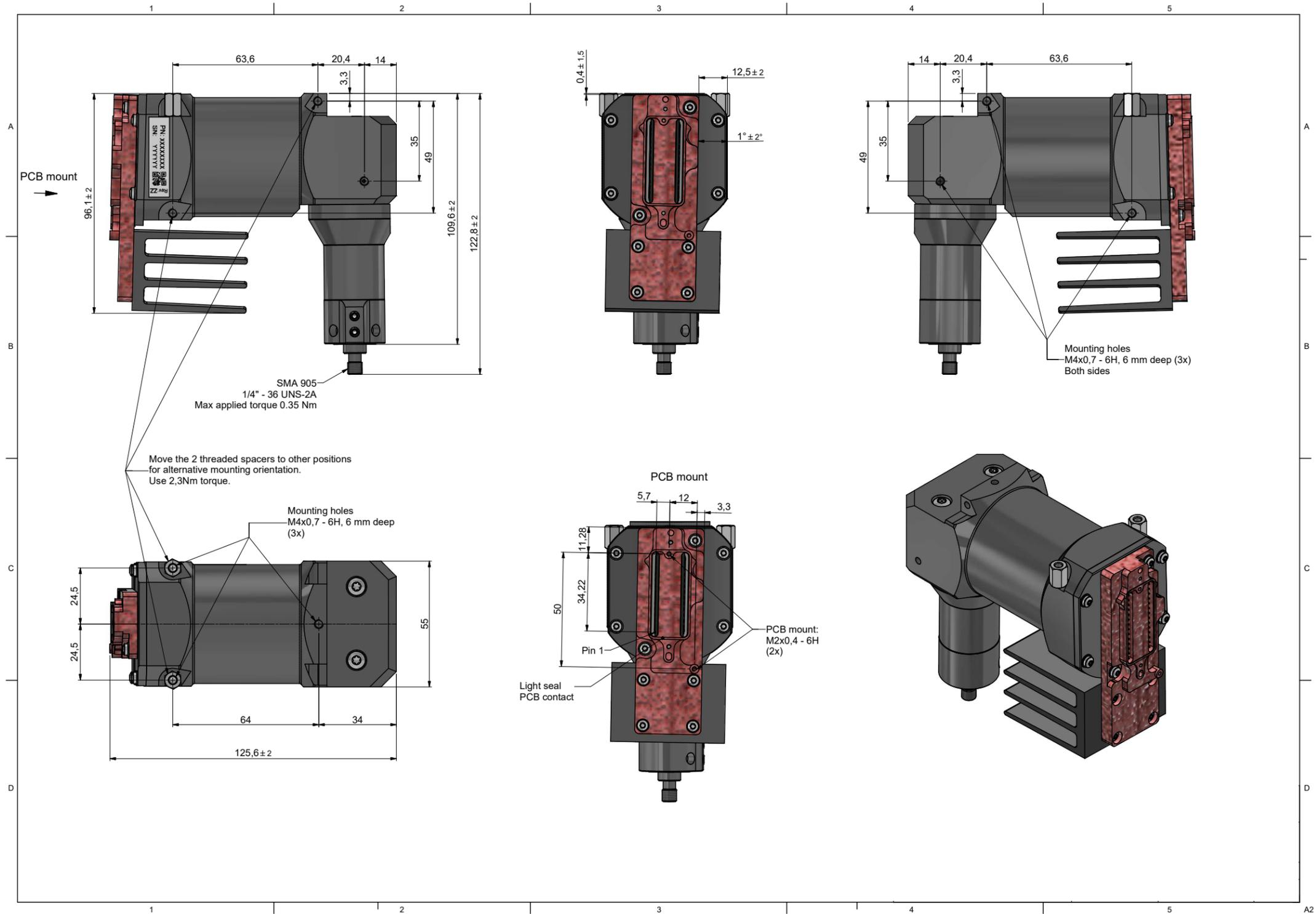
`IBSEN_closeDevice`

It is also possible to interface with FT4222H library files directly. Code samples using C/C++, C#, LabVIEW, and Python are available, if you need to develop your own implementation from the ground up.



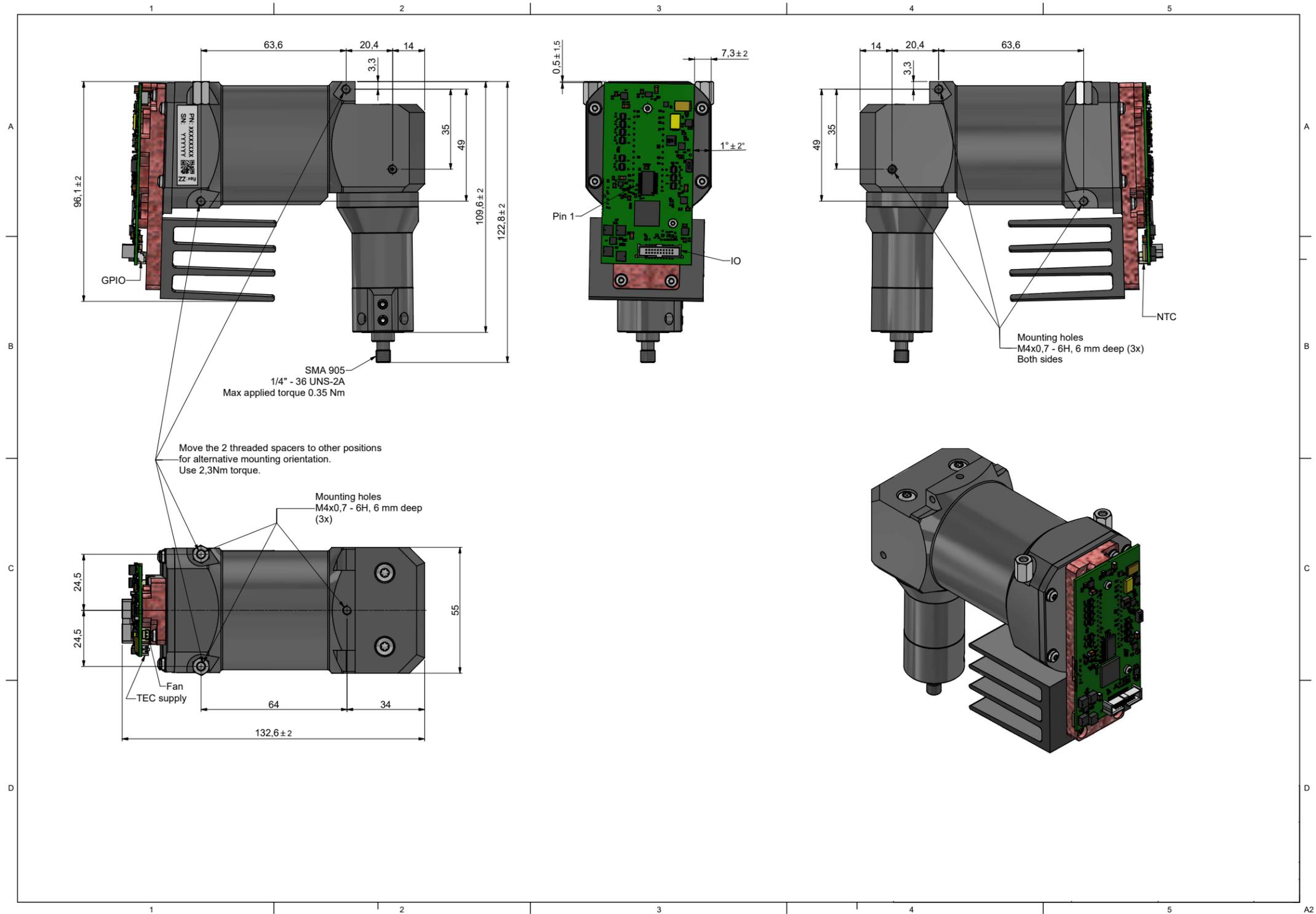
# Mechanical Drawings

## EAGLE Raman HR excluding DISB-386



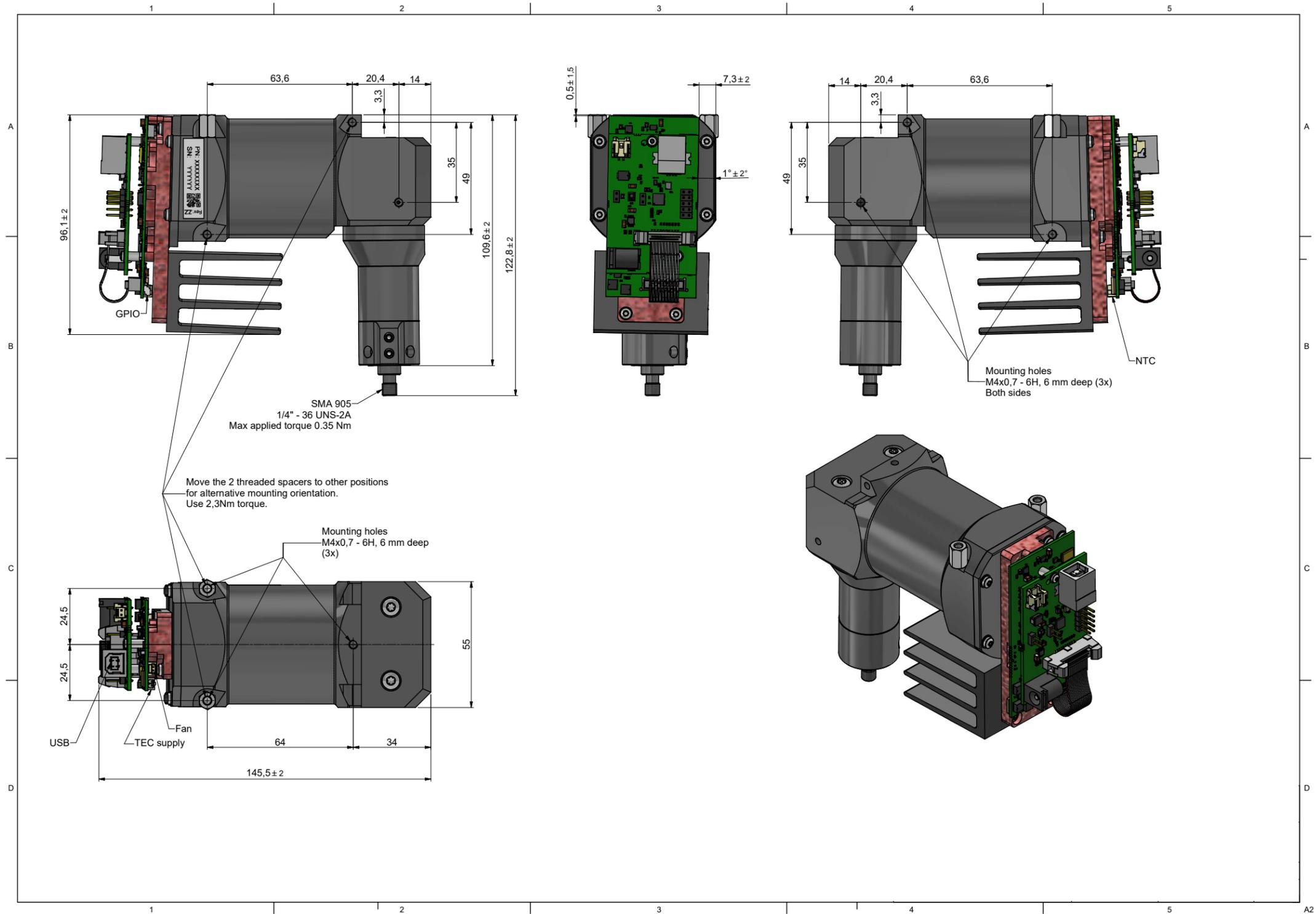
# Mechanical Drawings

## EAGLE Raman HR including DISB-386



# Mechanical Drawings

## EAGLE Raman HR including DISB-386 and DISB-USB



## About Ibsen Photonics

Ibsen was founded in 1991 by Per Ibsen under the name of Ibsen Micro Structures A/S. Today, 88% of Ibsen Photonics is majority owned by Foss A/S, a world leader in analytical solutions for the Food and Agricultural industries. Ibsen management and employees own 12 % of the shares in the company.

The Ibsen spirit combines the dynamic, entrepreneurial culture of a medium size company with a disciplined, operational mentality of a large corporation. With an average employee tenure of more than 10 years, Ibsen makes for a very effective organization that builds on more than 30 years of experience as a company.

Ibsen employs more than 75 people at our R&D and manufacturing facility in Denmark and achieved a turnover of more than 150 MDKK in 2023.

## Working with Ibsen Photonics

The core expertise of Ibsen Photonics lies in opto-mechanical design, grating technology and metrology. We master the cycle from optics, grating simulation and design, through optical and semiconductor production technologies, to high volume assembly, packaging and testing. Over the years we have developed many new designs, technologies and processes - many patented.

Our customers are large to medium-sized manufacturers of advanced optical devices and instruments, into which our products are integrated. With a highly organized production process, we are able to help customers obtain smooth instrument production, low unit-to-unit variation, high level of right first time, no field returns, and a low level of rework.

Our grating production facilities are world-class, including class 10 cleanroom facilities that we designed and built in 2000/2001, in which all environmental parameters are under continuous surveillance.

Our spectrometers are produced under strict quality control in our assembly facility in Denmark, certified to ISO 9001, ISO 13485, ISO 14001 and ISO 45001. This confirms Ibsen's capability to consistently produce high quality products that meet market standards and all regulatory requirements.

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