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Dragonfly Series Product Sheet

Description

The Dragonfly (DF) Series spectrometers feature the digital light processing (DLP) technology, which utilizes a digital micro-mirror device (DMD) chip in combination with single photon InGaAs photodiodes to achieve the goals of high optical efficiency, higher number of pixels, and miniaturization. The DMD used in this series is a two-dimensional array device consisting of 854x480 near-infrared (NIR) micro mirrors. Each mirror can be turned on/off through programming, giving users the flexibility to manipulate its scan mode to reduce scanning time. This series utilizes single-photon InGaAs photodiode (SPAD) to provide larger light detecting area than linear sensors for better light detection efficiency. The DMD coupled by the Hadamard mode can greatly enhance the signal-to-noise ratio (SNR).

The standard version of the DF Series comes with exposed circuit boards without heat source in the optical bench to provide excellent wavelength stability. OtO also provides casing options for customers who need to protect the circuit boards.

The DF Series is powered by USB via the USB connection with a computer. In addition, it provides an UART interface for connecting external devices.

This document provides detailed information about the DF Series and how to work with it. The DF Series uses Hamamatsu G12180 series high sensitivity image sensor. (For more information about Hamamatsu G12180 series, please visit Hamamatsu website: www.hamamatsu.com.)

The DF Series is operated through its built-in 32-bit ARM Cortex-M4F RISC microcontroller.

✓ 900-1700nm: DF1514 / DF1510

✓ 1340-2280nm: DF1934 / DF1930 with 2-stage thermoelectric (TE) cooling

This document is intended for sales and marketing purposes only and may not serve as a product specification document for shipping or contracts. If a customer requires a formal document for product approval or incoming quality control (IQC), OtO can discuss the specifications with the customer and provide a formal product approval document to the customer.

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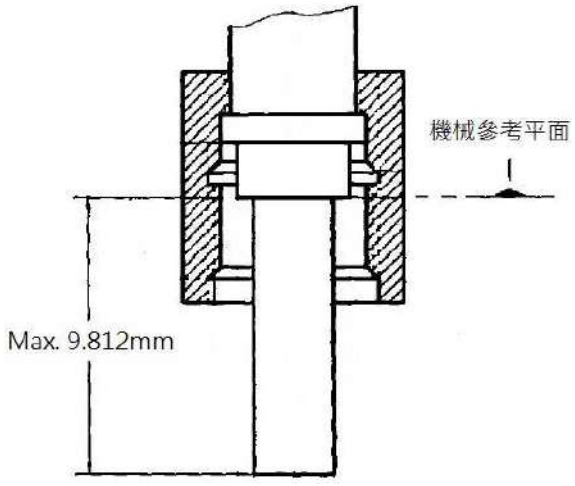
Precautions

Illustration	Description
	Screw in the fiber optic connector with fingers. Do not use any tool to tighten it. Using tools such as wrenches to tighten the connector may cause the connector to press against and damage the inlet slit of the spectrometer. Such damage is not covered by the warranty. In cases where the connector needs to be firmly in place for long-term use, it is advised to apply a little glue to where the SMA905 connector is connected to the spectrometer.
	The SMA905 connectors on all spectrometers made by OtO Photonics is manufactured in accordance with international standards. Customers should ensure that the ferrule length of the fiber used is not longer than 9.812mm to avoid damaging the slit in the SMA950 connector. Such damage is not covered by the warranty.

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Overview

► 1.1 DF Series Products

Model	Wavelength range (nm)		SNR*1	A/D	Stray Light	Thermal Stability Test
	NIRC2 900 - 1700	NIRM 1340 - 2280				
DF1510 / DF1514	√		8000	24 Bits	<0.2%	<0.08nm/℃
DF1930 / DF1934		√	NA			

*1: Single measurement results
*2 : The dynamic range is calculated using the average dark noise value of multiple spectrometers

► 1.1 Response Curve Comparison

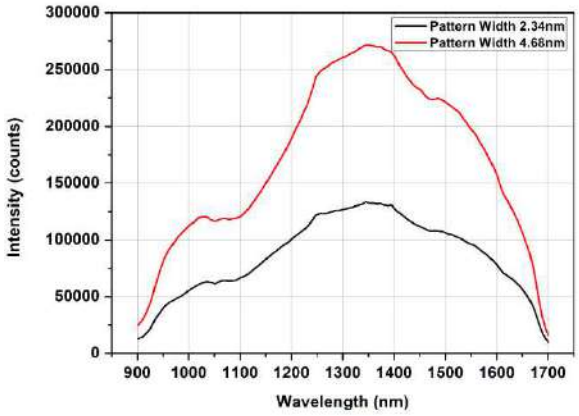

Figure 1. DF1514 response curve for halogen lamp, exposure time: 0.635ms

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Major Specifications

► 2.1 Specifications

Features	Specifications	
	DF1510/DF1514	DF1930/DF1934
Image Sensor	ϕ1mm InGaAs PIN photodiodes	Φ1mm, 2 StageTEC InGaAs PIN photodiodes
Wavelength range	900-1700 nm	1340-2280 nm
Slit width	25 um	
Resolution (Average, with minimal variation allowed)	10 nm (Pattern Width: 2.34 nm, Slit: 25 nm)	12 nm (Pattern Width: 2.34 nm, Slit: 25 nm)
Stray Light	<0.2%	
Wavelength accuracy	±1 nm	
Thermal Stability	<0.08 nm/°C	
Optical system characteristics	f/#: , NA:, Focal Length (R1-R2): 52-60 Recommendation: the inlet numerical aperture (NA) of the user's design should be higher than that of the spectrometer	
Dark Noise (Average)	25	NA
SNR	8000	NA
Thermoelectric (TE) cooling	NA	Ambient temperature of 25°C can be lowered to -20°C
Power supply	Micro USB, DC 5V@500mA	
Power consumption	Idle: <0.7W; Measuring: <1.4W	NA
Data transfer interface	Micro USB, UART	
Indicator lights	Green LED: Power, Red LED: Scanning	
Scan mode	Column scan / Hadamard scan / Slew scan	
Dimensions (mm)	71.5 (L) x 57 (W) x 25 (H); circuit boards included	76.7 (L) x 60 (W) x 40 (H) mm; circuit boards included
Weight	76.8g	NA
Fiber optic interface	SMA905: Φ3.18±0.005mm	
Exposure time	The minimum exposure time 0.635ms increases proportionally with the number of sections and the exposure time configured. Increasing this value will not improve the intensity of the spectrum, but it will increase the scan time and the SNR.	

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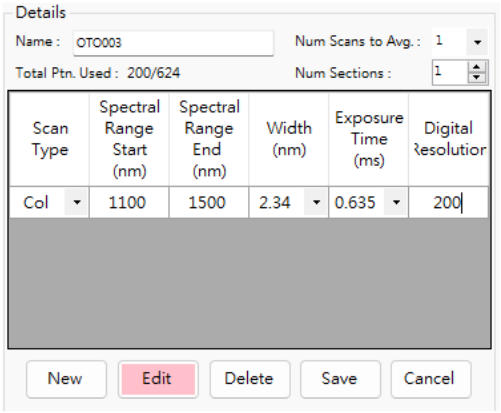
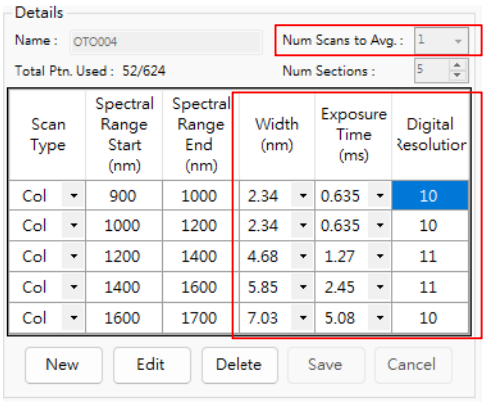
Features		Specifications	
		DF1510/DF1514	DF1930/DF1934
Environmental requirements	Storage temperature	-30°C to +70°C	
	Operating temperature	0°C to 40°C	
	Relative Humidity	0% - 85%	

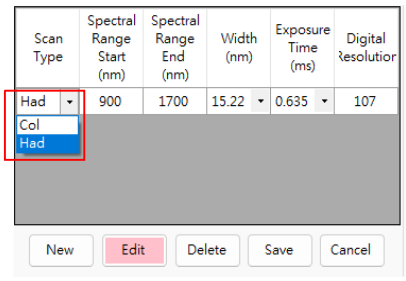
► 2.2 Characteristics

- The DF Series utilizes a digital micro-mirror device (DMD) chip in combination with InGaAs photodiodes to replace the InGaAs linear sensor in traditional spectrometers, leveraging the programmability of the DMD chip to allow the user to set the optimal scanning parameters for a certain range of wavelength or ignoring unimportant wavelength ranges to save scanning time.
- Its wavelength range 900-1700nm can be divided into 5 sections, each with its own pattern width, exposure time, and digital resolution. See the following picture.





- The DF Series can work in three scan modes: Column (Col), Hadamard (Had), and Slew (Col+ Had). See the following picture. The Column mode scans one wavelength range at a time, while the Hadamard mode scans a set of multiple wavelength ranges at a time and then decodes the results into each individual range. The Hadamard mode collects more light and hence provides better SNR than the Column mode. The Slew mode, on the other hand, is a combination of the Column mode and the Hadamard mode. It is worth noting that under the same exposure time, the SNR of the Hadamard mode is 2-7 times better.



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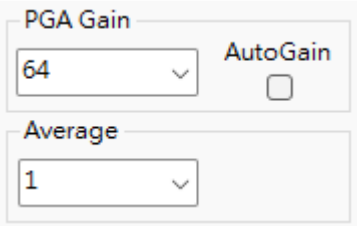
- Exposure Time: The minimum exposure time 0.635ms increases proportionally with the number of sections and the exposure time configured. Increasing this value will not improve the intensity of the spectrum, but it will increase the scan time and the SNR. For example, increasing the exposure time from 0.635ms to 5.08ms will increase the SNR by 2.8 times. ($\sqrt{\frac{5.08}{0.635}} \sim 2.8$)

- Pattern Width: The DMD chip used in this series has a total of 854 x 480 digital micro-mirrors. The wavelength range 900-1700 nm is mapped to 683 lines of micro-mirrors, so each micro-mirror corresponds to a wavelength width of about 1.17 nm. The minimum and maximum widths allowed are 2.34 nm and 60.89 nm. A larger pattern width creates a spectrum with higher density and smoother curve. A smaller width, on the other hand, provides higher digital resolutions.

- Digital Resolution and Sampling Points: The number sampling points is the number of data points acquired in the specified spectrum range. The digital resolution is the number of patterns that can be laid out on the DMD based on the pattern width. Normally, the digital resolution should be set at twice the maximum optical resolution (FWHM) desired. However, over-extending the digital resolution can lead to skewed results due to over-sampling. Increasing the digital resolution also increases the scan time.

- PGA Gain (programmable gain): As shown in the picture below, when "AutoGain" is selected, each scan is conducted using quick scan with the maximum possible gain without causing over-exposure. If a certain value is specified for the PGA gain, the value will be used for all scans. So, it should be configured properly without causing over-exposure. In theory, when the PGA gain is doubled, the intensity of the spectrum is also doubled.



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Mechanical Designs

► 3.1 DF1514 Mechanical Drawing

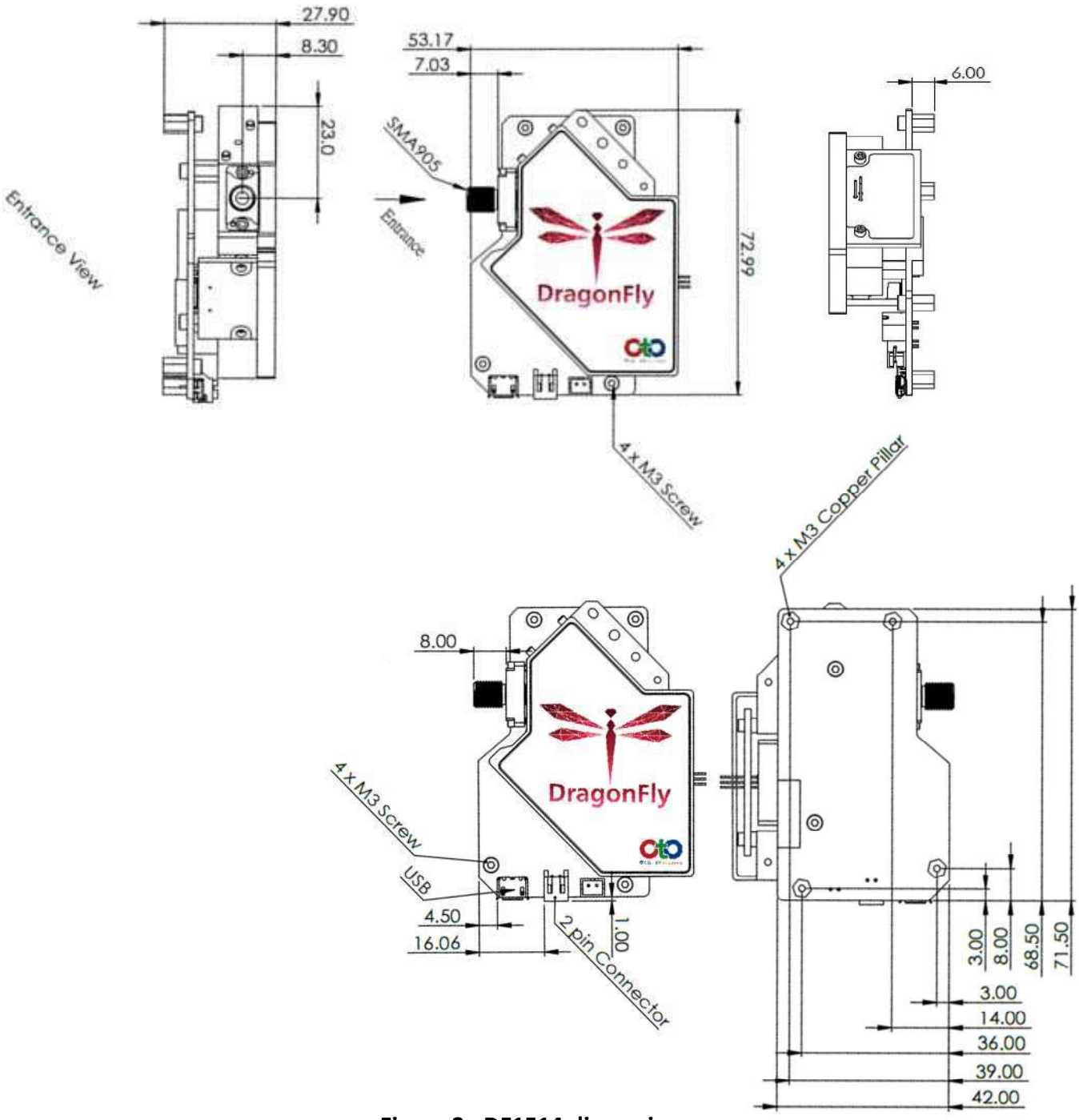

Figure 3. DF1514 dimensions

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► 3.2 DF1934 Mechanical Drawing

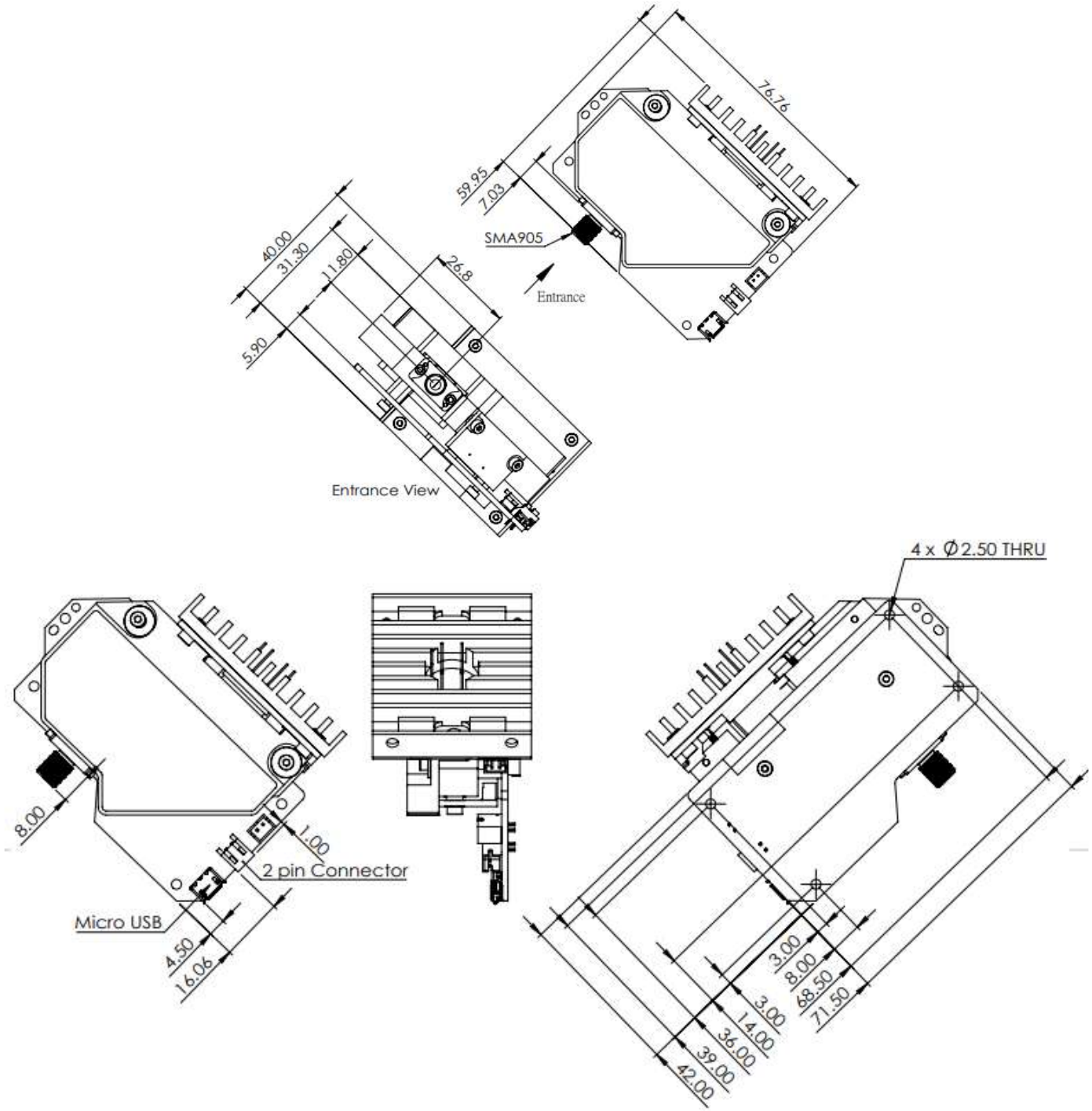

Figure 3. DF1934 dimensions

▶ 3.3 Electronic Output Pin Assignments

The DF Series provides 1x Micro USB and 1x 10-pin 1.0 mm expansion port.

● External Ports

The following pictures show the external ports on the DF series. Viewing from left to right: the Micro USB and the rear external ports.

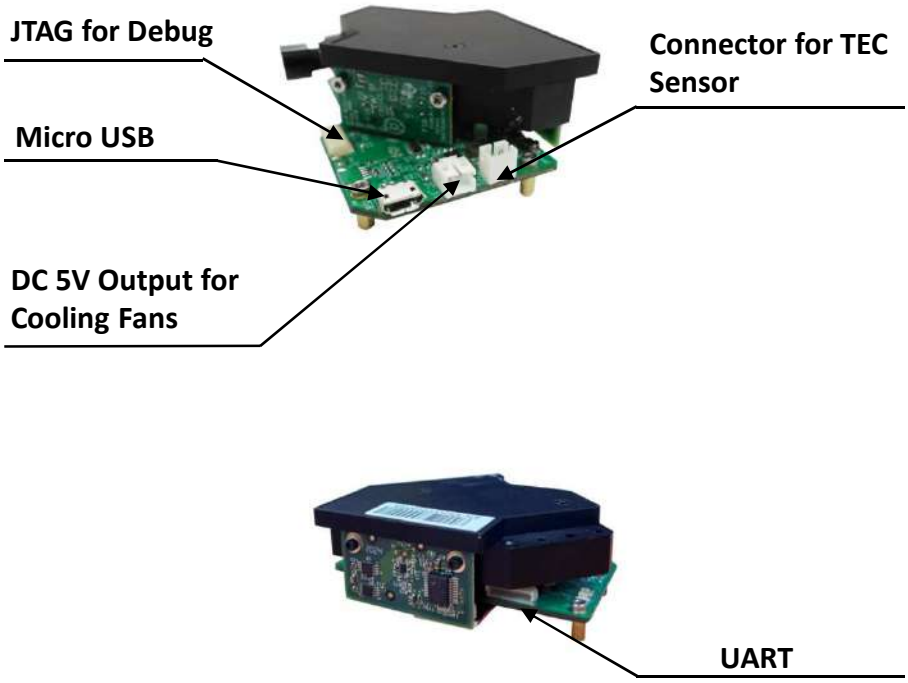

Figure 4. External ports on the DF Series

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Pin Assignments on the External I/O Port:

*All I/Os are TTL-Level input/output.
*This series comes in two versions with different types of connectors: 10-pin or 8-pin. Please refer to the following table to see the actual pin assignments for the version of spectrometer you have.

- **10-Pin Version**

Pin number	I/O direction	Pin name	Description
1	Output	3.3V Output	When the spectrometer is connected via USB to a computer, this pin connects to the VBUS so that the spectrometer can provide 0.1A of power to the external device
2	GND	Ground	Grounding
3	Input	U4RX	UART4 receive (U4RX) or SSI0 clock
4	Output	U4TX	UART4 transmit (U4TX) or SSI0 frame sync
5	Input/Output	SSIOXDATA0	SSI0 Data0
6	Input/Output	SSIOXDATA1	SSI0 Data1
7	Input/Output	U4RTS	UART4 RTS
8	Input/Output	U4CTS	UART4 CTS
9	GND	Ground	Grounding
10	Input	Tiva wake	SW_ON/OFF

- **8-Pin Version**

Pin number	I/O direction	Pin name	Description
1	Power	3.3V Output	When the spectrometer is connected via USB to a computer, this pin connects to the VBUS so that the spectrometer can provide 0.1A of power to the external device
2	Input	U4RX	UART RX. RX is the input to the RISC microcontroller
3	Output	U4TX	UART TX. TX is the output from the RISC microcontroller
4	Output	GPIO0	General purpose output #0
5	Output	GPIO1	General purpose output #1
6	Output	LS-ON	Lamp on
7	Input	Trigger_ In	External trigger signal
8	GND	GND	Grounding

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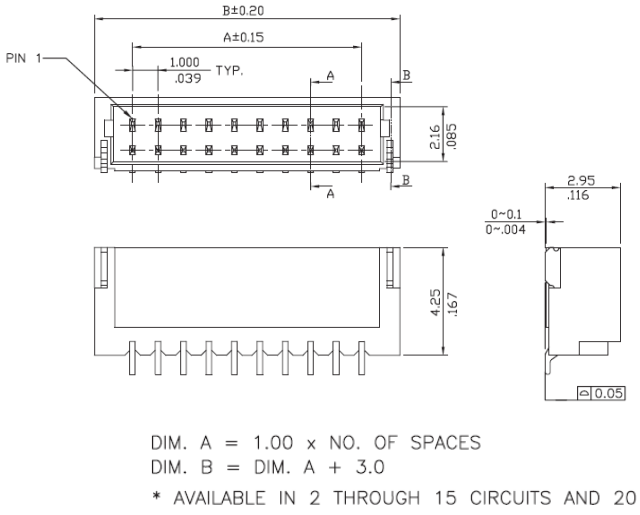

Figure 5. The 8-pin 1.0 mm external I/O port

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USB Data Transfer and Controls

Overview

The DF Series is a compact spectrometer with an embedded microcontroller and supports USB data transfer. This section provides the computer programming details on how to control the DF Series vial USB. This information is intended only for those who intend to develop their own software instead of using the standard software provided by OtO Photonics (SpectraSmart).

Hardware Description

The DF Series leverages the built-in 32-bit RISC microcontroller in the USB 2.0 chip. The program codes and data are stored in the SPI Flash. This RISC microcontroller provides 64MByte of DDR and 64Mbits of Flash.

USB Information

DF Series USB Vendor ID: 0x0451; Product ID: 0x4200 The DF Series supports USB 2.0 connection and uses HID transfers for data transfer between the spectrometer and the computer. For more information on USB, please visit the USBIF website:http://www.usb.org.