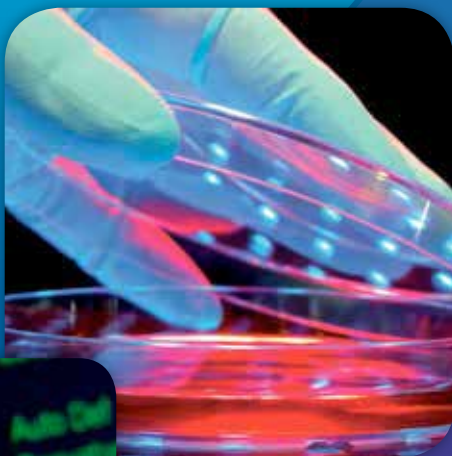


AVANTES

enlightening spectroscopy



Catalog IX

INTRODUCTION

Dear customer,

After being over 20 years in this industry I am still excited and proud to present to you our new catalog. In this 9th edition we show you our instruments for fiber optic spectroscopy.

As the leading innovator in the development and application of miniature spectrometers we continue to develop and introduce new instruments. Avantes instruments and accessories are also integrated into many OEM applications in many industries and markets throughout the world. With over 2 decades of experience in fiber optic spectroscopy and thousands of instruments in the field, Avantes is eager to help our customers with Enlightening Spectroscopy.

Avantes works with customers in a variety of markets, including chemical, (bio)medical, environmental, glass & coating, life-science, chemistry, lighting semiconductor, agricultural and food processing technology. Additionally, Avantes works with research organizations and universities, aiding in

developing research and teaching opportunities.

Our OEM program is designed to work with our customers to identify needs and customize an Avantes' spectroscopy solution based on our customer's needs and Avantes technical knowledge and experience. Avantes' continued growth is based upon a commitment to providing exceptional technology and superb customer satisfaction.

Avantes engineering, manufacturing, sales, and service headquarters is in the Netherlands.

The company also operates direct offices in China, United Kingdom, Germany and North America. In addition, Avantes has a growing worldwide distribution network of more than 40 qualified distributors to meet our customer's needs worldwide.

In this catalog you will find a complete and detailed overview of our products. As we are continuously improving our

products and introduce new instruments regularly we recommend to check the digital version on our website for an up to date version of this catalog.

We are looking forward to build up a long term relationship with you



Benno Oderkerk

CEO and founder Avantes

OUR MISSION

We provide state of the art, innovative measuring equipment that helps mankind live longer, healthier, and saving the planet for generations to come.

VALUES

Avantes is the innovative, trusted leader in high quality and customer oriented optical instruments and solutions. We achieve this through service-oriented thinking and acting, encouraging and motivating each-other with a positive critical and professional attitude of each Avantes employee.

VISION

To enrich the lives of mankind in the world we live in.

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NEW IN THIS CATALOG

Avantes is proud to announce the latest additions to our extensive line of products. The highlights are:

EVO Series; AvaSpec-ULS2048L-EVO the next step in spectroscopy!

GigaEthernet and USB3.0 communication, more memory and fast data processing.

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AvaLight-HAL-S-Mini

New improved and more compact Halogen lightsource.

page 100



AvaSpec-ULSi

Miniature sized spectrometer with integrated electronics for OEM users.

page 77



AvaSpec-UV/VIS/NIR

Great combination of UV/VIS and NIR spectrometer offering a broadband measurement solution.

page 64



AvaSpec-NIR256-2.5-HSC

New improved and downsized NIR spectrometer with great performance.

page 60



AvaSpec-Mini

Compact sized spectrometers where (small) size matters.

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AvaSpec-ULS2048x64-TEC

extension of the SensLine offering a cooled backthinned spectrometer for instance fluorescence applications.

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Raman Solutions

High end Raman system for your demanding applications.

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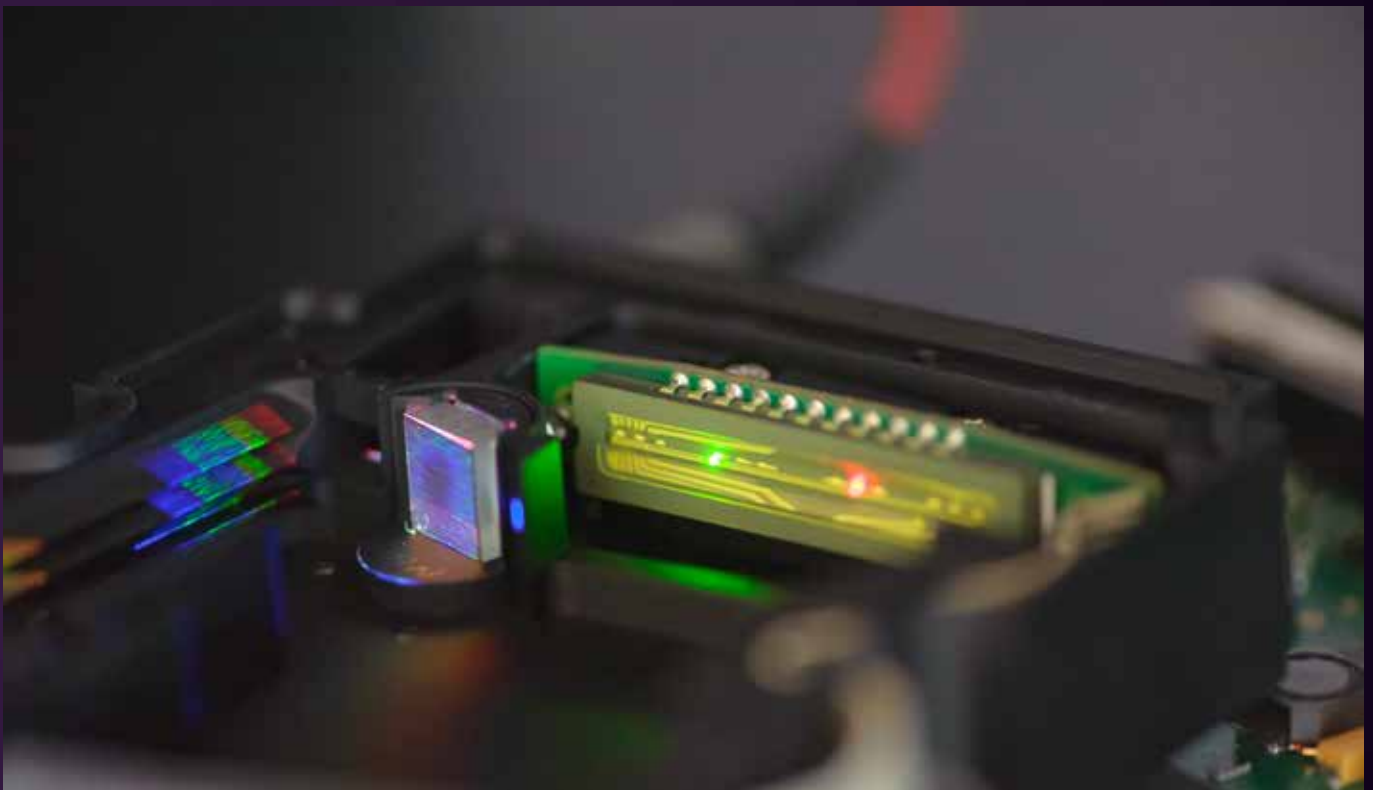
INTRODUCTION

A spectroscopic instrument or spectrometer generally consists of entrance slit, collimator, a dispersive element, such as a grating or prism, focusing optics and detector. In a monochromator system there is normally also an exit slit, and only a narrow portion of the spectrum is projected on a one-element detector. In monochromators the entrance and exit slits are in a fixed position and can be changed in width. Rotating the grating scans the spectrum.

The development of micro-electronics during the 90's in the field of multi-element optical detectors, such as Charged Coupled Devices (CCD) arrays and Photo-Diode (PD) arrays, enabled the production of low cost scanners, CCD cameras, etc. These same CCD and PDA detectors are now used in the Avantes AvaSpec line of spectrometers, enabling fast scanning of the spectrum, without the need for a moving grating.

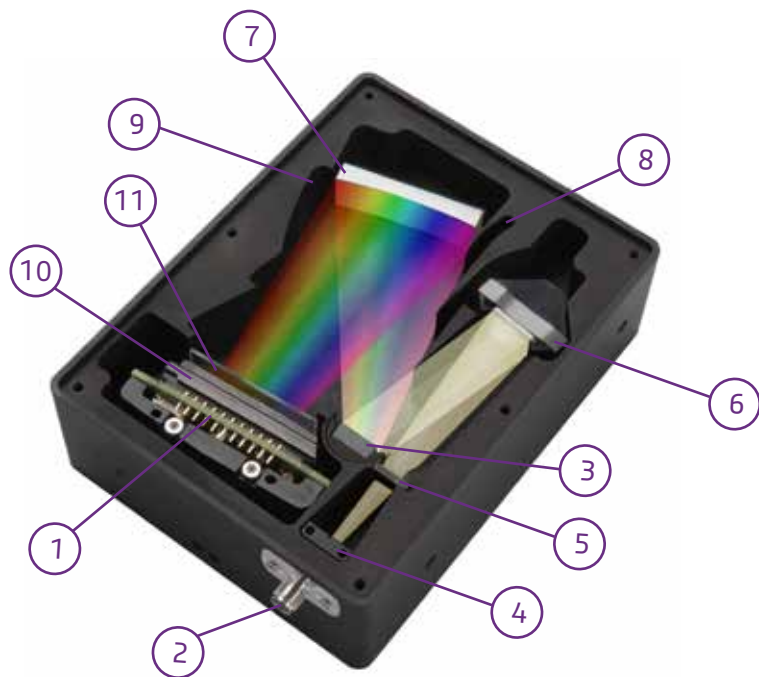
Thanks to the need for fiber-optics in the communication technology, low absorption silica fibers have been developed. Similar fibers can be used as measurement fibers to transport light from the sample to the optical bench of the spectrometer. The easy coupling of fibers allows a modular build-up of a system that consists of light source, sampling accessories and fiber-optic spectrometer. Furthermore fiber-optic enable the introduction of sampling into harsh and difficult to access environments.

The modularity, flexibility and speed of measurement made possible by fiber-optic spectrometers have resulted in wide adoption of this technology in a variety of industries.



Three years
limited warranty on
all Avantes spectrometers,
light sources and accessories

Optical Bench Design



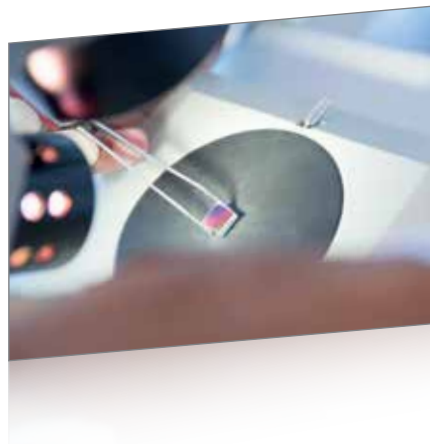
Avaspec-ULS Optical Bench Design: Symmetrical Czerny-Turner

- | | |
|------------------------|--------------------|
| 1. Detector | 7. Focusing mirror |
| 2. SMA Connector | 8. CPC light traps |
| 3. Grating | 9. CPC light traps |
| 4. Slit, mode stripper | 10. DCL-UV/VIS |
| 5. 2nd mode stripper | 11. OSC-filter |
| 6. Collimating mirror | |

The heart of most AvaSpec fiber-optic spectrometers is an optical bench with 37.5, 45, 50, 75 or 100 mm focal length, developed in a symmetrical Czerny-Turner design. Light enters the optical bench through a standard SMA-905 connector and is collimated by a spherical mirror. A plain grating diffracts the collimated light; a second spherical mirror focuses the resulting diffracted light. An image of the spectrum is projected onto a 1-dimensional linear detector array.

Avantes AvaSpec-HS1024x58/122 high-sensitivity spectrometers have a revolutionary new optical bench design with multiple toroid mirrors which ensure that the full numerical aperture of the fiber entrance will be projected on the backthinned CCD array.

All of our optical benches have a number of components installed inside, allowing a wide variety of different configurations, depending on the intended application. The choice of these components such as the diffraction grating, entrance slit, order-sorting filter, and detector coating have a strong influence on system specifications such as sensitivity, resolution, bandwidth and stray-light. Each of these specification will be discussed in detail in the following paragraphs.



Broadband gratings provide the greatest flexibility but may not provide the best performance for specific applications. Contact an Avantes Sales Engineer or representative for a recommended grating configuration.

Detector Choice

The choice of your wavelength range along with the demands of your measurement speed and accuracy often suggests the appropriate detector for your application.

How to configure a spectrometer for your application?

The modular AvaSpec line of instruments provides you with a number of configuration options to optimize the optical and spectroscopic performance of your instrument for your application.

This section provides you some guidance on how to choose the right grating, slit, detector and other configuration options, to be installed in your AvaSpec.

Wavelength Range

In the determination of the optimal configuration of a spectrometer system the

wavelength range is key parameter that defines the appropriate grating choice. If you are looking for a wide (broadband) wavelength range, we recommend the use of a 300 lines/mm grating known as an "A" type grating in the Avantes product line. For lesser range (approximately 500 nm) but higher resolution, you might consider a 600 lines/mm or "B"-type grating. Higher lines/mm gratings (1200 – C type, 1800 – D type, 2400 – E type, 3600 – F type) provide higher resolution for applications that require this (see Grating selection table in the spectrometer product section).

Avantes offers 15 different detector types with each different sensitivity curves (see figure 3, page 18 and figure 4, page 20). The AvaSpec instrument line is divided into multiple groups based upon general requirements. The AvaSpec-Starline is comprised of general purpose UV/VIS instruments with low-cost CCD and PDA detectors. The AvaSpec Sensline is comprised of higher performance back-thinned CCDs and thermo-electrically cooled CCDs UV/VIS instruments. The instruments are particularly better in the UV and NIR relative to standard CCD detectors. The AvaSpec NIRLine is comprised of instruments with InGaAs arrays for longer wavelength measurements ranging from 900-2500 nm. For applications where the size of the instrument is a critical factor, Avantes offers the CompactLine with spectrometers having a small form factor.

For high-speed applications, the 2048 pixel CCD detectors in the AvaSpec-ULS2048 and AvaSpec-ULS2048L from the StarLine are normally the best options. For VIS-only applications where high-resolution is not needed but speed and signal to noise are important, the 128 pixel PDA detector in the AvaSpec-128-USB2 may be the best option. For low-light level applications such as fluorescence and Raman, the SensLine instruments may be the most appropriate. The AvaSpec NIRLine features 7 different InGaAs detectors for various applications.

The modularity and inter-compatibility of the AvaSpec line also make it possible to combine two or more detectors in a single instrument enclosure to provide optimal performance over a broad wavelength range. For example, an AvaSpec StarLine (UV/VIS) spectrometer can be combined with a NIRLine spectrometer to enable measurements from 200-2500 nm in a single instrument.

Optical Resolution & Slit size

If high optical resolution is required, you may want to consider a grating with higher lines/mm (1200 – C type, 1800 – D type, 2400 – E type, 3600 – F type), thus limiting the range of the instrument to a more narrow range. Additionally, it is advisable to consider a detector with 2048 or 3648 pixels and a small slit (10 or 5 μm). For the best resolution with all other criteria of lesser importance, the AvaSpec-3648 with a 5 micron slit is optimal.

Slit size is a key factor in determining both resolution and throughput of the optical bench. It is important to balance your need for resolution with the need for sensitivity and throughput of the optical bench. If resolution is optimized without considering

the need for throughput, you may not have adequate light to get a stable measurement. As previously mentioned, for optimal resolution our smallest slit (5 microns) is recommended. If your application does not require the highest possible resolution and is not one that has an excess of light (laser measurement for example), we recommend that you consider as large a slit as possible to maximize throughput into the optical bench.

The AvaSpec-RS with replaceable slit makes your spectrometer a versatile instrument for both high-resolution and high-sensitivity measurements.

Sensitivity

When considering sensitivity, it is very important to distinguish between photometric sensitivity (How much light do I need for a detectable signal?) and chemometric sensitivity (What absorbance difference level can still be detected?)

a. Photometric Sensitivity

For the best photometric sensitivity a combination of a high-throughput optical bench and a high quantum-efficiency (QE) detector is recommended. The instruments in the AvaSpec SensLine are specifically optimized for photometric sensitivity.

For example fluorescence applications require high photometric sensitivity. Avantes AvaSpec-HS1024x122-TEC-USB2 is the highest performance instrument we offer for this application. For Raman applications, where the combination of resolution and sensitivity is required, we commonly recommend our AvaSpec-ULS2048L with TEC cooling. To further enhance photometric sensitivity, we recommend the use of a detector collection lens (DCL-UV/VIS or DCL-UV/VIS-200), which is a cylindrical lens with focuses light from larger core fiber-optics and bundles down onto the smaller detector pixels.

For additional photometric sensitivity, a larger slit or no slit and a 300 line/mm grating to minimize light dispersion are available. Some more demanding applications also require thermo-electric cooling of the CCD detector (see product section AvaSpec-ULS2048LTEC and AvaSpec-ULS3648TEC) to minimize noise and increase dynamic range at long integration times (up to 60 seconds).

For our detector types the photometric sensitivity is given in table 4 (page 17) and table 5 (page 19), the spectral sensitivity for each detector is depicted in figures 3 and 4.



b. Chemometric Sensitivity

To detect drastically different absorbance values, close to each other with maximum sensitivity, you need high Signal to Noise (S/N) performance. The detectors with best S/N performance are again in the AvaSpec SensLine series spectrometers with the AvaSpec-HS1024x122-TEC at the top of the line. The S/N performance can also be enhanced by averaging multiple spectra. The square root of the number of averages translates to the improvement in signal to noise.

Timing and Speed

The data capture process is inherently faster with linear detector arrays and no moving parts as compared with a monochromator design, however, there are optimal detectors for each application. For high-speed applications such as measurements involving pulsed lasers and light sources, we recommend the AvaSpec-128-USB2, AvaSpec-ULS2048-USB2, AvaSpec-ULS2048L-USB2 or the AvaSpec-FAST spectrometers.

Each of these instruments supports high-speed data acquisition with the capability of starting an acquisition as fast as within 1.3 microseconds of receiving an external trigger. The AvaSpec-FAST spectrometers can support integration times as low as 0.5 milliseconds, the AvaSpec-128-USB2 supports 0.07 milliseconds and the AvaSpec-2048 and 2048L support 1.05 millisecond integration times. Since data transfer time is critical for these applications, Avantes' unique Store-to-RAM mode enables on board storage of up to 5000 spectra to the instrument RAM buffer.

The above parameters are the most important in choosing the right spectrometer configuration. Please contact our application engineers to optimize and fine-tune the system to your needs. Table 1 on the next page provides a quick reference guide for spectrometer selection for many common applications. The system recommendations in this table are for simple configurations of mostly single channel spectrometers. For more elaborate explanations of specific explanations, see the applications section at the back of the catalog.

Application	AvaSpec-type	Grating	WL range (nm)	Coating	Slit (μm)	FWHM Resolution (nm)	DCL	OSF	OSC
Biomedical	ULS2048	NB	500-1000	-	50	1.2	-	475	-
Chemometry	ULS2048	UA	200-1100	-	50	2.3	-	-	OSC-UA
Color	128	VA	360-780	-	100	7.2	X/-	-	-
	ULS2048	BB	360-780	-	200	4.5	X/-	-	-
Fluorescence	ULS2048x64TEC	VA, VB, UB	350-1100, 300-800	-	200	9.2	X	305	OSC
	ULS2048XL					4.6			
	HS1024x122TEC	HS-500-0.33	200-1160	-	200	10.0	-	-	OSC
	HS2048XL								
Fruit-sugar	128	IA	800-1100	-	50	6.4	X	600	-
Gemology	ULS2048	VA	350-1100	-	25	1.2	X	-	OSC
High-resolution	ULS2048	VD	600-700	-	10	0.12	-	550	-
	ULS3648	VD	600-700	-	10	0.05	-	550	-
High UV/NIR-Sensitivity	HS1024x122TEC	HS-500-0.33	200-1160	-	200	10.0	-	-	OSC
Irradiance	ULS2048	UA	200-1100	DUV	50	2.3	X/-	-	OSC-UA
Laserdiode	ULS2048	NC	700-800	-	10	0.18	-	600	-
LED	ULS2048	VA	350-1100	-	25	1.2	X/-	-	OSC
LIBS	ULS2048	D,E,F	200-900	DUV	10	0.09	-	-	-
Raman	ULS2048LTEC	NC	780-930	-	25	0.3	X	600	-
	ULS2048x64TEC								
Solar	ULS2048XL	VA	300-1100		50	2.5		305	OSC
Thin Films	ULS2048	UA	200-1100	DUV	100	4.6	X	-	OSC-UA
UV/VIS/NIR	ULS2048	UA	200-1100	DUV	25	1.2	X/-	-	OSC-UA
	ULS2048XL	UA	200-1100	-	25	1.5	-	-	OSC-UA
NIR	NIR512-1.7TEC	NIR200-1.5	1000-1750	-	25	6.0	-	1000	-
	NIR256-2.0TEC	NIR150-2.0	1000-2000	-	50	10.0	-	1000	-
	NIR256-2.5TEC	NIR100-2.5	1000-2500	-	50	15.0	-	1000	OSC-NIR

Table 1 Quick reference guide for spectrometer configuration

The grating can only be changed by Avantes.
Therefore, choose your grating wisely.
Our application specialists are available to support you with your choice.
In general, a higher resolution means a lower bandwidth.
By combining multiple spectrometers
in our AvaSpec-Dual or rack-mountable versions,
you can create one virtual spectrometer with high-resolution
and high bandwidth.

How to choose the right Grating?

A diffraction grating is an optical element that separates incident polychromatic radiation into its constituent wavelengths. A grating consists of series of equally spaced parallel grooves formed in a reflective coating deposited on a suitable substrate. The way in which the grooves are formed separates gratings in two types, holographic and ruled.

The ruled gratings are physically formed onto a reflective surface with a diamond on a ruling machine. Gratings produced from laser constructed interference patterns and a photolithographic process are known as holographic gratings.

Avantes AvaSpec spectrometers come with a permanently installed grating that must be specified by the user. Additionally, the user needs to indicate what wavelength range needs to reach the detector. Sometimes the specified usable range of a grating is larger than the range that can be projected on the detector. In order to cover a broader range, a dual or multi-channel spectrometer can be chosen. In this configuration each channel may have different gratings covering a segment of the range

of interest. In addition to broader range, a dual or multi-channel spectrometer also affords higher resolution for each channel. For each spectrometer type a grating selection table is shown in the spectrometer platform section.

Table 2 illustrates how to read the grating selection table. The spectral range to select in Table 2 depends on the starting wavelength of the grating and the number of lines/mm; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

In Figure 2a and 2b grating efficiency curves are shown. When looking at the grating efficiency curves, please realize that the total system efficiency will be a combination of fiber transmission, grating and mirror efficiency, detector quantum efficiency and coating sensitivities. The all new dual-blazed grating is a 300 lines/mm broadband grating (covering 200-1100 nm) that has optimized efficiency in both UV and NIR. In Figure 2c the grating dispersion curves are shown for the AvaSpec-ULS2048.

Different diffraction gratings

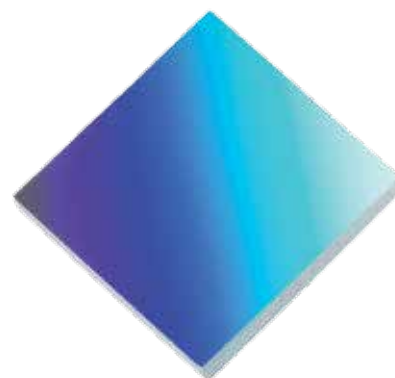


Table 2 Example of Spectral range and gratings

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1100	900	300	300	UA
UV/VIS	200-850	520	600	300	UB
UV	200-750	250-220*	1200	250	UC
UV	200-650	165-145*	1800	UV	UD
UV	200-580	115-70*	2400	UV	UE
UV	220-400	70-45*	3600	UV	UF
UV/VIS	250-850	520	600	400	BB
		800			VA

Please select Spectral range bandwidth from the useable Wavelength range, for example: grating UE (200-315 nm)
* the spectral range depends on the starting wavelength of the grating; the higher the wavelength, the smaller the range. For example: Grating UE (510-580 nm)

The order code is defined by 2 letters: the first is the Blaze (U= 250/300 nm or UV for holographic, B=400 nm, V=500 nm or VIS for holographic, N=750 nm, I=1000 nm) and the second the nr of lines/mm (Z=150, A=300, B=600, C=1200, D=1800, E=2400, F=3600 lines/mm)

For newer types a different nomenclature is used stating the product line, lines/mm and blaze.

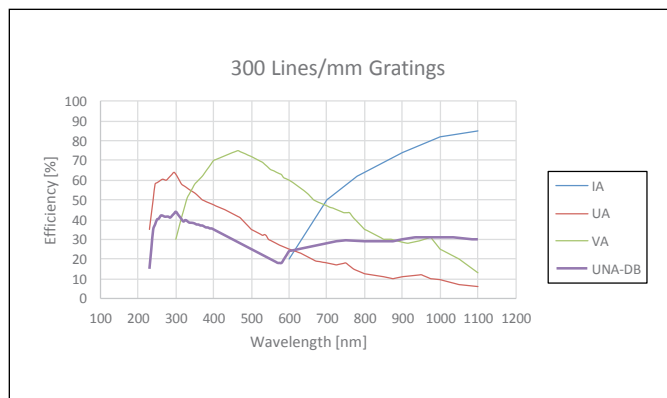
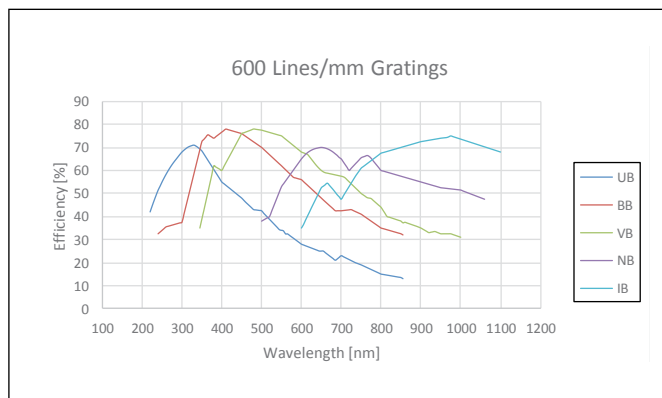
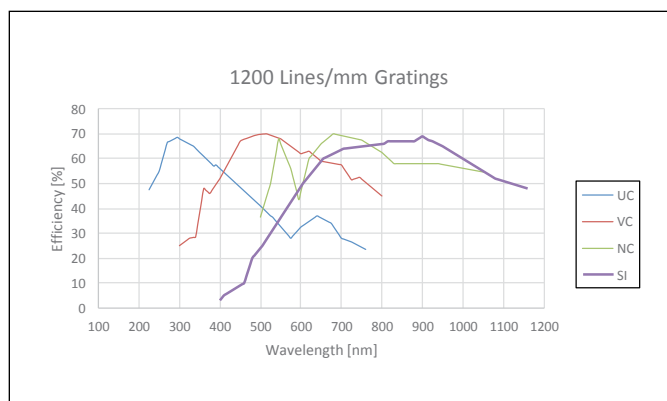
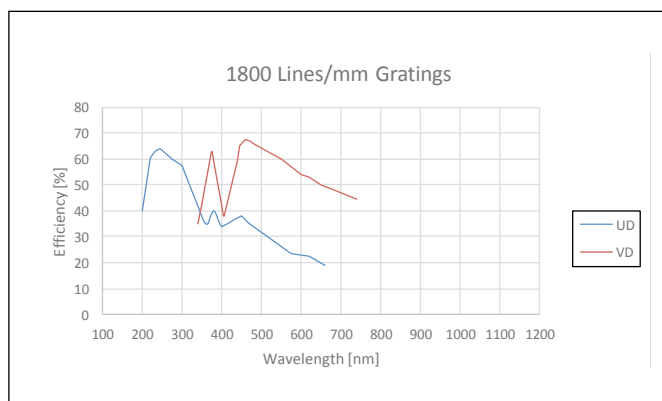
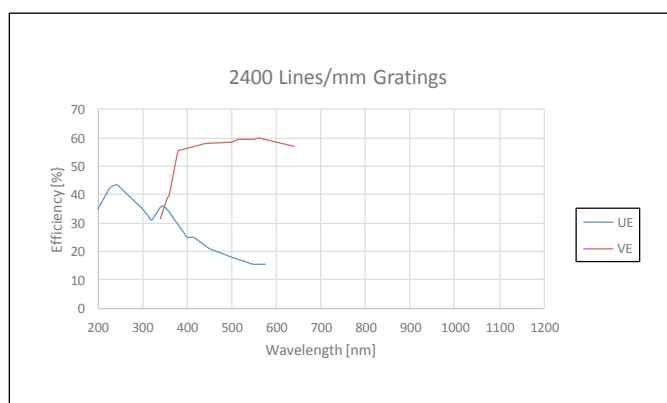
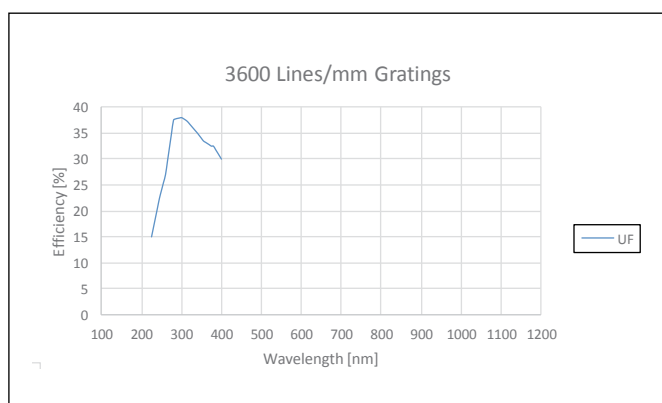
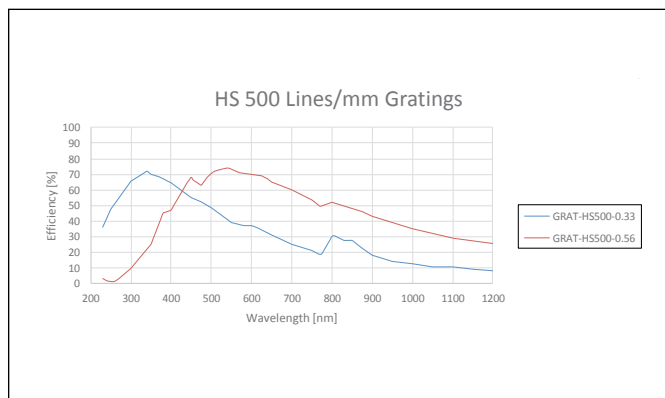
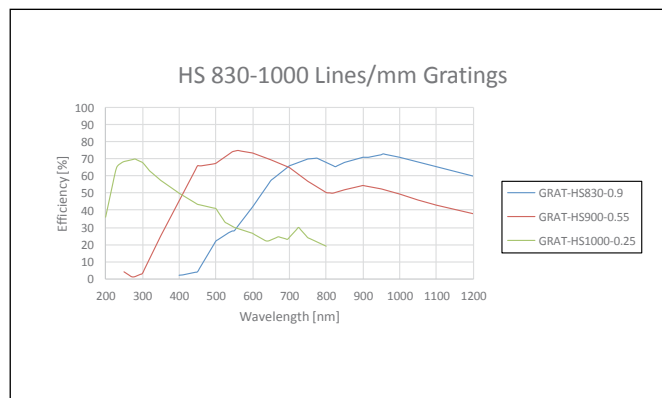
Figure 2a Grating Efficiency Curves**300 lines/mm Gratings****600 lines/mm Gratings****1200 lines/mm Gratings****1800 lines/mm Gratings****2400 lines/mm Gratings****3600 lines/mm Grating**

Figure 2b Grating Efficiency Curves

HS 500 lines/mm Gratings



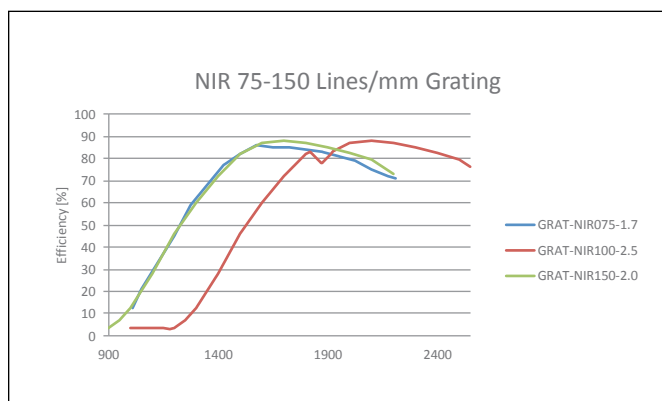
HS 830-1000 lines/mm Gratings



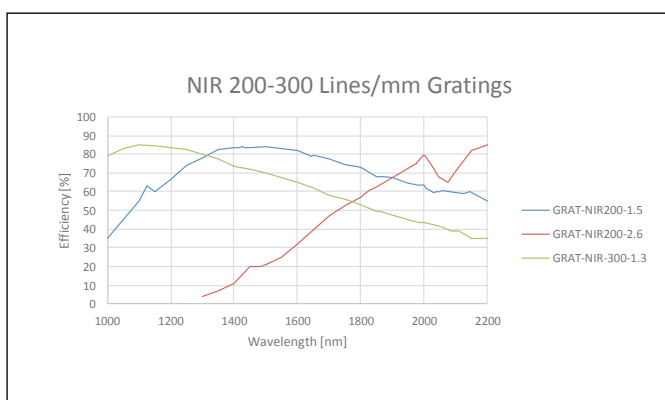
HS 1200 lines/mm Gratings



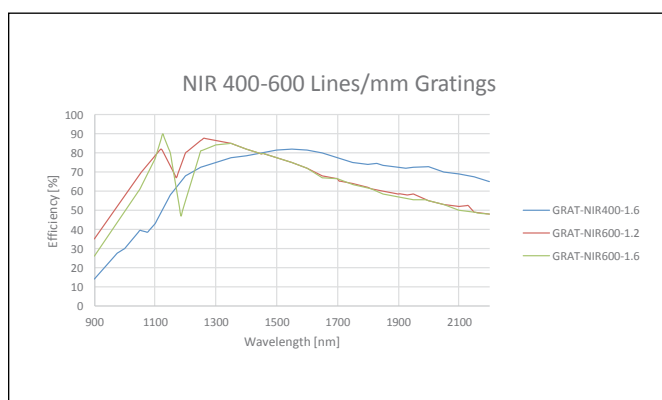
NIR 075-150 lines/mm Gratings



NIR 200-300 lines/mm Gratings



NIR 400-600 lines/mm Gratings



How to select optimal Optical Resolution?

Installed Slit in SMA Adapter



The optical resolution is defined as the minimum difference in wavelength that can be separated by the spectrometer. For separation of two spectral lines it is necessary to project them at least two array-pixels apart.

Because the grating determines how far different wavelengths are separated (dispersed) at the detector array, it is an important variable for the resolution. The other important parameter is the width of the light beam entering the spectrometer. This is basically the installed fixed entrance slit in the spectrometer, or the fiber core when no slit is installed.

For AvaSpec spectrometers the available slit widths are 5, 10, 25, 50, 100, or 200 μm wide x 1000 μm high, or 500 μm wide x 2000 μm high. The slit image on the detector array for a given wavelength will cover a number of pixels. For two spectral lines to be separated, it is necessary that they are dispersed over at least this image size plus one pixel. When large core fibers are used the resolution can be improved by a slit of smaller size than the fiber core. This effectively reduces the width of the light beam entering the spectrometer optical bench.

The influence of the chosen grating and the effective width of the light beam (fiber core or entrance slit) are shown in the tables provided for each AvaSpec spectrometer instrument.

In Table 3 the typical resolution can be found for the AvaSpec-ULS2048. Please note that for the higher lines/mm gratings the pixel dispersion varies along the wavelength range and improves towards the

longer wavelengths.

The resolution in this table is defined as Full Width Half Maximum (FWHM), which is defined as the width in nm of the peak at 50% of the maximum intensity.

Graphs with information about the pixel dispersion can be found in the gratings section as well, so you can optimally determine the right grating and resolution for your specific application.

For larger pixel-height detectors (3648, 2048L, 2048XL) in combination with thick fibers (>200 μm) and a larger grating angle the actual FWHM value can be 10-20% higher than the value in the table. For best resolution small core diameter fibers are recommended.

All data in the resolution tables are based on averages of actual measured data (with 200 μm fibers) of our Quality Control System during the production process. A typical standard deviation of 10-25%, depending on the slit diameter and the grating should be taken into account. For 10 μm slits the typical standard deviation is somewhat higher, which is inherent to the laws of physics. The peak may fall exactly within one pixel, but may cover 2 pixels causing, a lower measured resolution.

The replaceable slit feature is available on all ULS and NIR spectrometers.

The spectrometers come with one installed slit and a slit kit which includes all 3 other slit sizes, so you can opt for higher resolution (25 μm slit) or higher throughput (200 μm slit) or somewhere in between (50 or 100 μm slits).

Table 3 Resolution (FWHM in nm) for the AvaSpec-ULS2048-USB2

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	0.80 – 0.90*	1.10-1.20*	2.30	4.60	9.00	20.0
600	0.40 – 0.50*	0.63	1.15	2.31	4.50	10.0
830	0.28	0.40	0.80	1.60	3.20	8.0
1200	0.18 – 0.22*	0.29	0.61	1.18	2.20	5.4
1800	0.10 – 0.16*	0.19	0.35-0.42*	0.80	1.60	3.6
2400	0.08 – 0.11*	0.10 – 0.15*	0.28	0.55	1.10	2.7
3600	0.05 – 0.08*	0.10	0.18	0.38	0.75	1.8

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the higher the resolution

Detector arrays

The AvaSpec line of spectrometers can be equipped with several types of detector arrays. Presently we offer silicon-based CCDs, back-thinned CCDs, and Photo-Diode Arrays for the 200-1100 nm range. A complete overview of each is given in the next section "Sensitivity" in Table 4. For the NIR range (1000-2500 nm) InGaAs arrays are implemented.

All detectors are tested in incoming goods inspection, before they are used in our instruments. Avantes offers full traceability on following detector specifications:

- Dark noise
- Signal to noise
- Photo Response Non-Uniformity
- Hot pixels

StarLine and CompactLine CCD Detectors (AvaSpec-ULS2048/2048L/3648)

The Charged Coupled Device (CCD) detector stores the charge, dissipated as photons strike the photoactive surface. At the end of a controlled time-interval (integration time), the remaining charge is transferred to a buffer and then this signal is being transferred to the AD converter. CCD detectors are naturally integrating and therefore have enormous dynamic range, only limited by the dark (thermal) current and the speed of the AD converter. The 3648-pixel CCD has an integrated electronic shutter function, so an integration time of 10µs can be achieved.

+ Advantages for the CCD detectors are large numbers of pixels (2048 or 3648),

high-sensitivity and high-speed.

- Main disadvantage is the lower S/N ratio relative to other detector types.

UV enhancement

For applications below 350 nm with the AvaSpec-ULS2048/2048L/3648 a special DUV-detector coating is required. The uncoated CCD-response below 350 nm is very poor; the DUV lumogen coating enhances the detector response in the region 150-350 nm. The DUV coating has a very fast decay time, typ. in ns range and is therefore useful for fast-trigger LIBS applications.



Photo-Diode Arrays (AvaSpec-128)

A silicon photodiode array consists of a linear array of multiple photo-diode elements, for the AvaSpec-128 this is 128 pixels. Each pixel consists of a P/N junction with a positively doped P-region and a negatively doped N-region. When light enters the photodiode, electrons will become excited and generate an electrical signal. Most photodiode arrays have an integrated

signal processing circuit with readout/integration amplifier on the same chip.

- + Advantages for the Photodiode detector are high NIR sensitivity and high-speed.
- Disadvantages are limited amount of pixels and no UV-response.



SensLine Back-thinned CCD Detectors (AvaSpec-ULS2048XL/-2048x64/-HS1024x58/122)

For applications requiring high quantum efficiency in the UV (200-350 nm) and NIR (900-1160 nm) range, combined with good S/N and a wide dynamic-range, back-thinned CCD detectors are the right choice.

Avantes offers cooled and uncooled versions. In case of a 2D-detection the vertical pixels are binned, giving effectively one high pixel to increase sensitivity.

- + Advantage of the back-thinned CCD detector is the good UV and NIR sensitivity, combined with good S/N and dynamic range.
- Disadvantage is the relatively higher cost.



NIRLine InGaAs linear image sensors (AvaSpec-NIR256/512)



The InGaAs linear image sensors deliver high-sensitivity in the NIR wavelength range. The detector consists of a charge-amplifier array with CMOS transistors, a shift-register and timing generator. For InGaAs detectors the dynamic range is limited by the dark noise. For ranges up to 1.75 μm no cooling is required and these detectors are available in both 256 and 512 pixels. Detectors for the extended range 2.0-2.5 μm all have 2-stage TE-cooling to reduce dark noise and are available in 256 and 512 pixel versions (1.7 and 2.2 detectors only).

7 versions of detectors are available:

- 256 pixel non-cooled InGaAs detector for the 900-1750 nm range
- 256/512 pixel cooled InGaAs detector for the 900-1750 nm range
- 256 pixel 2-stage cooled Extended InGaAs detector for the 1000-2000 nm range
- 256/512 pixel 2-stage cooled Extended InGaAs detector for the 1000-2200 nm range
- 256 pixel 2-stage cooled Extended InGaAs detector for the 1000-2500 nm range

Sensitivity

The sensitivity of a detector pixel at a certain wavelength is defined as the detector electrical output per unit of radiation energy (photons) incident to that pixel. With a given A/D converter this can be expressed as the number of counts per mJ of incident radiation.

The relation between light energy entering the optical bench and the amount hitting a single detector pixel depends on the optical bench configuration. The efficiency curve of the grating used, the size of the input fiber or slit, the mirror performance and the use of a Detector Collection Lens are the main parameters. With a given set-up it is possible to do measurements over about 6-7 decades of irradiance levels. Some standard detector specifications can be found in Table 4 detector specifications. Optionally a DCL (Cylindrical Detector Collection) lens can be mounted directly on the detector array. The quartz lens (DCL-UV/VIS for AvaSpec-ULS2048/3648) will increase the system sensitivity by a factor of 3-5, depending on the fiber diameter used. The DCL-UV/VIS-200 can be used for the AvaSpec-ULS2048L/3648/2048XL/2048x64 to have a better vertical distribution of light focusing on the detector and is primarily for fiber diameters larger than 200 μm and round- to-linear assemblies. The SensLine has the most sensitive detectors in Avantes' instrument line, three backthinned detectors and two cooled CCD detectors.

In Table 4 the UV/VIS detectors are depicted

ed with their specifications, please find below some additional information on how those specifications are determined.

Pixel Well Depth (electrons)

This value is specified by the detector supplier and defines how many electrons can fit in a pixel well before it is saturated, this value determines the best reachable Signal to Noise ($=V(\text{Pixel well depth})$).

Sensitivity in Photons/count @ 600 nm

The number of Photons of 600 nm that are needed to generate one count of signal on a 16-bit AD converter, the lower this number is, the better is the sensitivity of the detector.

The calculation of the number of Photons/count is $(\text{Pixel Well depth in electrons})/16\text{-bit AD/Quantum Efficiency @ 600 nm}$.

Sensitivity in counts/ μW per ms integration time

Sensitivity here is for the detector types currently used in the UV/VIS AvaSpec spectrometers as output in counts per ms integration time for a 16-bit AD converter. To compare the different detector arrays we have them all built up with an optical bench with UA 300 lines/mm grating covering 200-1100 nm (AvaSpec-128 with grating VZ 350-1100 nm), DCL if applicable, and 50 μm slit.

The measurement setup for 350-1100 nm has a 600 μm fiber connected to an AvaSpec-50-LS-HAL, equivalent to an opti-



cal power of 1.14 μ W.
For the UV/VIS measurement at 220-1100 nm we connected the 600 μ m fiber to an AvaLight-DHS through a CC-VIS/NIR dif-fuser, equivalent to 2.7 μ W power.

Peak wavelength and QE @ peak

The peak wavelength is provided by the detector supplier as well as the Quantum Efficiency, defined as the number of electrons generated by one photon.

Signal/Noise

Signal/Noise is measured for every detector at Avantes' Quality Control Inspection and defined as the illuminated maximum Signal/Noise in Root Mean Square for the shortest integration time. The RMS is calculated over 100 scans.

Dark Noise

Dark noise is measured for every detector at Avantes' Quality Control Inspection and defined as the non-illuminated noise in

Root Mean Square for the shortest integration time. The RMS is calculated over 100 scans.

Dynamic Range

The dynamic range is defined as the (maximum signal level- baseline dark level)/dark noise RMS.

Photo Response Non-Uniformity

Photo Response Non-Uniformity is defined as the max difference between output of pixels when uniformly illuminated, divided by average signal of those pixels. PRNU is measured for every detector at Avantes' Quality Control Inspection.

Frequency

The frequency is the clock frequency at which the data pixels are clocked out through the AD-converter.

Table 4 Detector Specifications (based on a 16-bit AD converter)

Detector	StarLine				SensLine			
	TAOS128	SONY-2048	SONY-2048L	TOS3648	HAM-2048XL	HAM-2048x64	HAM-1024x58	HAM-1024x122
Type	Photo-diode array	CCD linear array	CCD linear array	CCD linear array	Back-thinned CCD array	Back-thinned CCD array	Cooled Back-thinned CCD array	Cooled Back-thinned CCD array
# Pixels, pitch	128, 63.5 μ m	2048, 14 μ m	2048, 14 μ m	3648, 8 μ m	2048, 14 μ m	2048x64, 14 μ m	1024 x 58, 24 μ m	1024 x 122, 24 μ m
Pixel width x height (μ m)	55.5 x 63.5	14 x 56	14 x 200	8 x 200	14 x 500	14 x 14 (total height 896 μ m)	24 x 24 (total height 1.4 mm)	24 x 24 (total height 2.9 mm)
Pixel well depth (electrons)	250,000	40,000	90,000	120,000	200,000	200,000	1,000,000	1,000,000
Sensitivity Photons/ count @600 nm	10	2	4	5	4	4	16	16
Sensitivity in counts/ μ W per ms integration time	430,000 (AvaSpec-128)	310,000 (AvaSpec-ULS2048)	470,000 (AvaSpec-ULS2048L)	160,000 (AvaSpec-ULS3648)	460,000 (AvaSpec-ULS2048XL)	600,000 (AvaSpec-ULS2048x64)	850,000 (AvaSpec-HS1024x58)	1,270,000 (AvaSpec-HS1024x122)
Peak wavelength	750 nm	550 nm	450 nm	550 nm	650 nm	650 nm	650 nm	650 nm
QE (%) @ peak	40%	40%	40%	40%	78%	78%	92%	92%
Signal/Noise	500:1	200 :1	300 :1	350 :1	450 :1	450 :1	1000:1	1000:1
Dark noise (counts RMS)	15	33	20	34	17	17	8	8
Dynamic Range	4380	2000	3300	1900	3800	3800	8,000	8,000
PRNU**	$\pm$ 4%	$\pm$ 5%	$\pm$ 5%	$\pm$ 5%	$\pm$ 3%	$\pm$ 3%	$\pm$ 3%	$\pm$ 3%
Wavelength range (nm)	360-1100	200*-1100	200*-1100	200*-1100	200-1160	200-1160	200-1160	200-1160
Frequency	2 MHz	2 MHz	2 MHz	1 MHz	1 MHz	1 MHz	250 kHz	250 kHz

* DUV coated

** Photo-Response Non-Uniformity

Figure 3a Sensitivity Curve StarLine

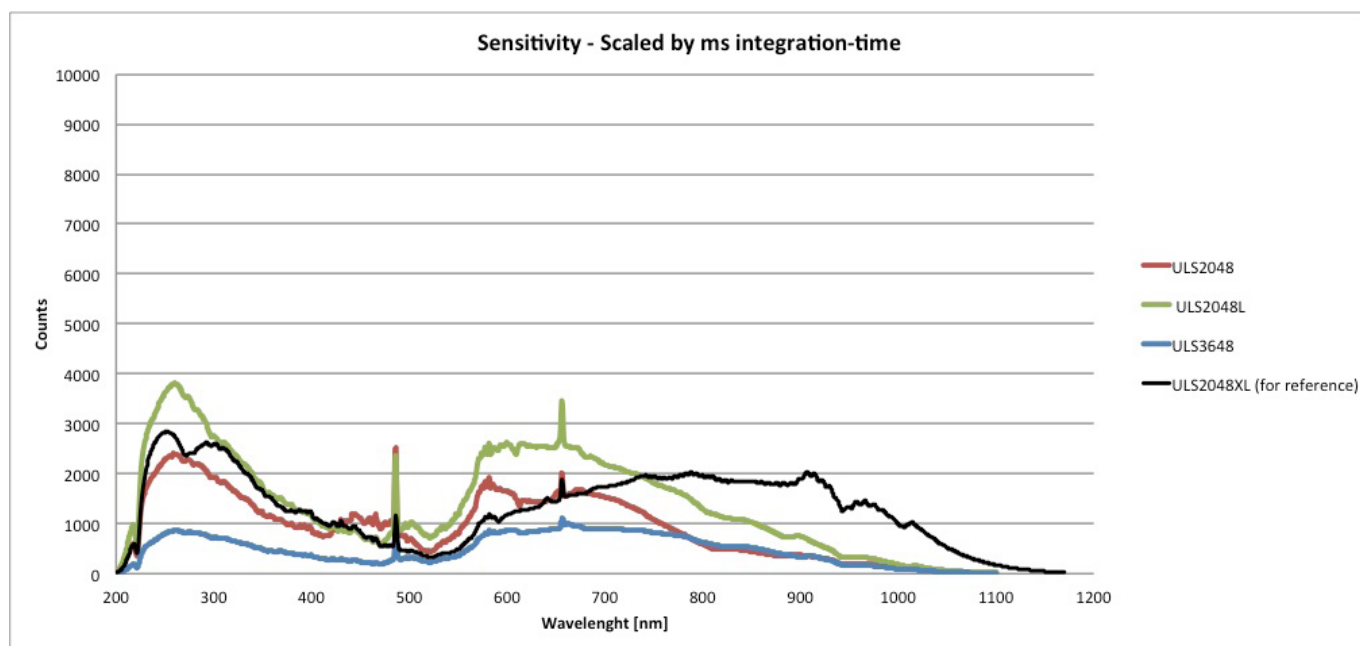
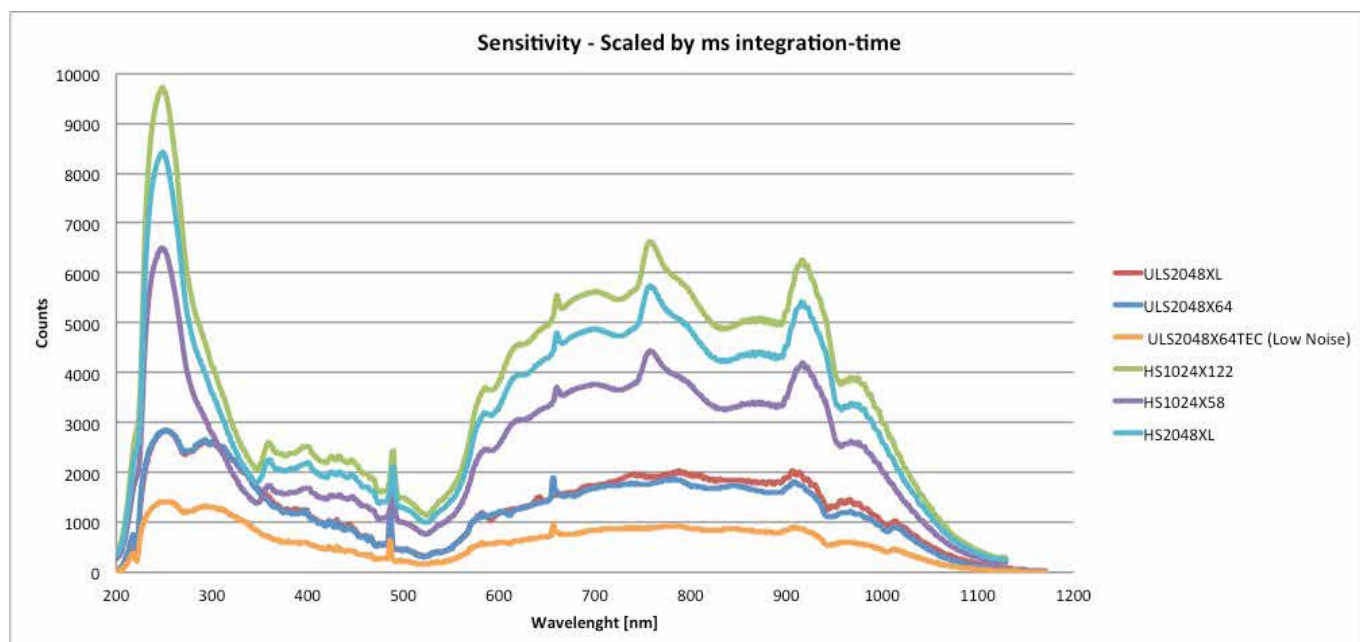


Figure 3b Sensitivity Curve SensLine



In Table 5 the specification is given for the NIR spectrometers, in Figure 3 and Figure 4 the spectral response curves for the different detector types are depicted as built into the respective products and with the same configuration, all scaled to the counts/ms integration time.

Sensitivity

For NIR detectors 2 different modes are available, the default setting is for high-sensitivity mode (HS), this means more signal at a shorter integration time. The other mode of operation is low-noise (LN), this means a better S/N performance.

Sensitivity, S/N, dark noise and Dynamic Range are given as HS and LN values.

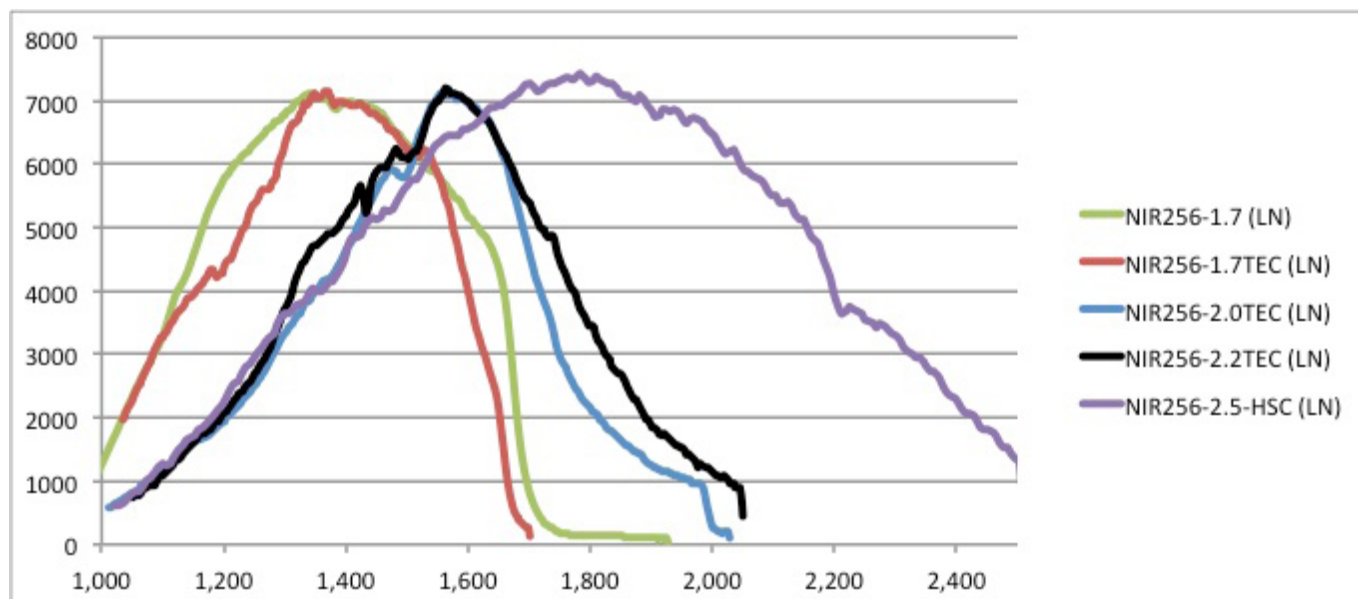
Table 5 NIRLine Detector Specifications

Detector	NIR256-1.7	NIR256-1.7TEC	NIR512-1.7TEC	NIR256-2.0TEC	NIR256-2.2TEC	NIR512-2.2TEC	NIR256-2.5TEC
Type	Linear InGaAs array	Linear InGaAs array with 2-stage TE cooling	Linear InGaAs array with 2-stage TE cooling	Linear InGaAs array with 2-stage TE cooling	Linear InGaAs array with 2-stage TE cooling	Linear InGaAs array with 2-stage TE cooling	Linear InGaAs array with 2-stage TE cooling
# Pixels, pitch	256, 50 μm	256, 50 μm	512, 25 μm	256, 50 μm	256, 50 μm	512, 25 μm	256, 50 μm
pixel width x height (μm)	50 x 500	50 x 500	25 x 500	50 x 250	50 x 500	25 x 500	50 x 250
Sensitivity HS in counts/ μW per ms	1,300,000 (integral 1000-1750 nm)	2,770,000 (integral 1000-1750 nm)	1,385,000 (integral 1000-1750 nm)	70,000 (integral 1000-2000 nm)	77,000 (integral 1200-2200 nm)	38,500 (integral 1200-2200 nm)	70,000 (integral 1000-2500 nm)
Signal/Noise (HS)	2000:1	1700:1	1700:1	1500 :1	1200 :1	1200:1	1500 :1
Dark noise HS (counts RMS)	14	13	13	21	12	12	23
Dynamic Range HS	4000	5000	5000	3300	4800	4800	2800
Sensitivity LN in counts/ μW per ms	74,000 (integral 1000-1750 nm)	96,000 (integral 1000-1750 nm)	48,000 (integral 1000-1750 nm)	4,000 (integral 1000-2000 nm)	2,750 (integral 1200-2200 nm)	1,375 (integral 1200-2200 nm)	4,000 (integral 1000-2500 nm)
Signal/Noise (LN)	6000:1	3600:1	3600:1	4000:1	4100:1	4100:1	2700:1
Dark noise LN (counts RMS)	8	8	8	16	8	8	18
Dynamic Range LN	8000	8000	8000	4000	8000	8000	3600
Peak wavelength	1550 nm	1500 nm	1500 nm	1850 nm	2000 nm	2000 nm	2300 nm
QE (%) @ peak	90%	70%	70%	80%	60%	60%	65%
PNRU**	$\pm 5\%$	10%	10%	$\pm 5\%$	10%	10%	$\pm 5\%$
Defective pixels (max)	0	0	0	12	5	10	12
Wavelength range (nm)	900-1750	900-1750	900-1750	1000-2000	1000-2200	1000-2200	1000-2500
Frequency	500 kHz	2.4 MHz	2.4 MHz	500 kHz	2.4 MHz	2.4 MHz	500 kHz

** Photo-Response Non-Uniformity

Add flexibility
to your spectrometer with
the Replaceable Slit (-RS) option

Figure 4 Sensitivity Curve NIRLine



Thermal Stability

Change of performance depending on the temperature can be of great importance in certain applications where accurate, repeatable results are vital.

All AvaSpec spectrometers have no moving parts inside and are in nature extremely robust and stable.

The ULS (Ultra Low Straylight) bench design provides exceptional thermal stability.

The thermal stability of our spectrometers is part of our comprehensive Quality Control procedure and therefore closely monitored during the production and assembly process. All of our spectrometers undergo overnight thermal cycling, during which wavelength shift, intensity drop and spectral tilt are registered and checked against our QC acceptance norm. More specifically, the following test are being carried out during the thermal cycling from 15°C to 25°C to 35°C back to 25°C:

Full Width Half Maximum

During the thermal cycling the average FWHM value is measured and has to fit with a certain standard deviation within the QC acceptance norm.

Peakshift

During thermal cycling the shift of peaks is monitored and depicted as shift in pixels per °C. Depending on the grating angle the maximum allowed peakshift is defined, for most gratings the below values are the QC acceptance norm. For gratings with many lines/mm starting at high wavelengths (VD, VE), the peak shift can double.

The max allowed peakshift ± 0.1 pixel per °C for an AvaSpec-ULS2048 with a pixel pitch of 14µm. Average peakshift is ± 0.04 pixel per °C for an AvaSpec-ULS2048.

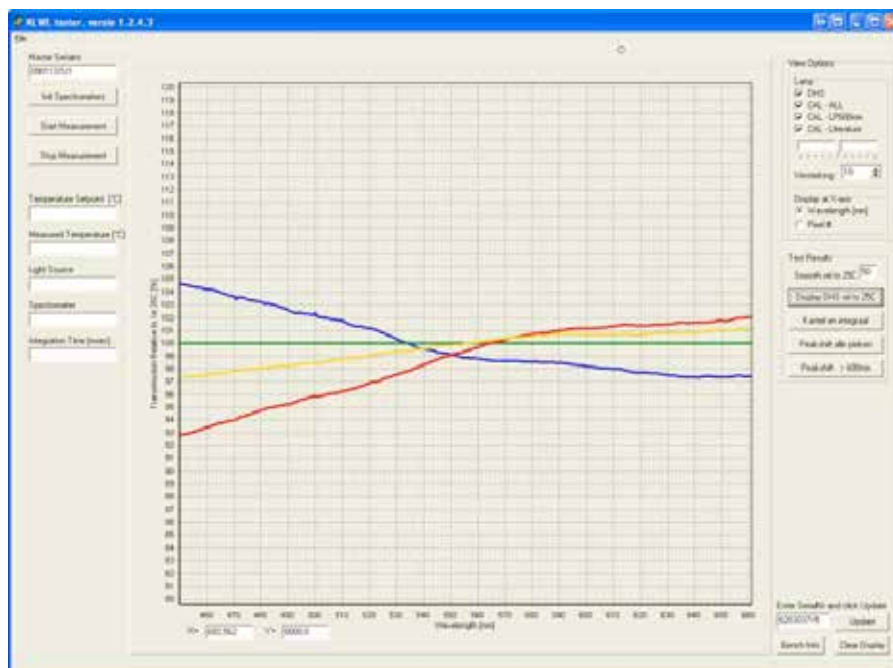
For an AvaSpec-ULS3648 with a pixel pitch of 8µm the max allowed peakshift is ± 0.17 pixel per °C. For the AvaSpec-128 and for the AvaSpec-NIR256 with relative large pixels of 50µm the peakshift is limited to ± 0.03 pixel per °C. For backthinned and NIR detectors with a 25µm pitch as in the AvaSpec-HS1024x58/122 and AvaSpec-NIR512 the peakshift is limited to ± 0.06 pixel per °C.

Intensity stability and Spectral tilt

Temperature sensitivity on the intensity axis can have a number of reasons. First, the CCD detector itself has a temperature dependency, for most detectors there are black pixels that are read out and are subtracted from the rest of the data pixels, the so-called Correct for Dynamic dark (CDD). However, CDD will not correct for spectral tilt, which is partially also a detector property. The aluminum optical bench and the optical components are engineered in such a way that the thermal expansion does not lead to large increase in tilt or sensitivity. For most spectrometers the average intensity increase/decrease is within $\pm 4\%$ for $\pm 10^\circ\text{C}$ thermal cycling.

Minimal tilt-parameters can be achieved with back-thinned detectors.

In the figure below a typical test result for a thermal cycling can be seen.

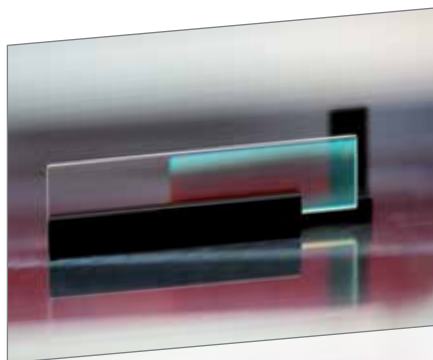


Stray-Light and second order effects

Stray-light is radiation of undesired wavelengths that activates a signal at a detector element. Sources of stray-light can be:

- Ambient light
- Scattering light from imperfect optical components, or reflections of non-optical components
- Order overlap

Order-Sorting Window in holder



Avantes symmetrical Czerny-Turner optical bench designs favor stray-light rejection relative to crossed designs. Additionally, Avantes Ultra-Low Stray-light (AvaSpec-ULS) spectrometers have a number of internal measures to reduce stray-light from zero order and backscattering.

When working at the detection limit of the spectrometer system, the stray-light level from the optical bench, grating and focusing mirrors will determine the ultimate limit of detection. Most gratings used are holographic gratings, known for their low level of stray-light. Stray-light measurements are conducted using a halogen light source and long-pass or band-pass filters.

Typical stray-light performance for the AvaSpec-ULS and a B-type grating is <0.06% at 250-500 nm. Second order effects, which can play an important role for gratings with low groove frequency, and therefore a wide wavelength range, are usually caused by the 2nd order diffracted beam of the grating. The effects of these higher orders sometimes need to be addressed using filtering. The strategy is to limit the light to the region of the spectra, where order overlap is not possible.

Second order effects can be filtered out, using a permanently installed long-pass optical filter in the SMA entrance con-

ductor or an order-sorting coating on a window in front of the detector. The order-sorting coatings on the window typically have one long-pass filter (600 nm) or 2 long-pass filters (350 nm and 600 nm), depending on the type and range of the selected grating.

In Table 6, a wide range of optical filters for installation in the optical bench can be found. The filter types that are 3 mm thick give a much better 2nd order reduction than the 1 mm filters. The use of following long-pass filters is recommended: OSF-475 for grating NB and NC, OSF-515 / 550 for grating NB and OSF-600 for grating IB. For backthinned detectors, such as the 2048XL and 1024x58/122 we recommend an OSF-305 Filter, when the starting wavelength is 300 nm and higher.

In addition to the order-sorting coatings, we apply partial DUV coatings on the Sony 2048 detectors to avoid second-order effects from UV response and to enhance sensitivity and decrease noise in the visible range.

This partial DUV coating is done automatically for the following grating types:

- UA for 200-1100 nm, DUV400, only first 400 pixels coated
- UB for 200-700 nm, DUV800, only first 800 pixels coated

Table 6 Filters installed in AvaSpec spectrometer series

OSF-305	Permanently installed order-sorting filter @ 305 nm
OSF-395	Permanently installed order-sorting filter @ 395 nm
OSF-475	Permanently installed order-sorting filter @ 475 nm
OSF-515	Permanently installed order-sorting filter @ 515 nm
OSF-550	Permanently installed order-sorting filter @ 550 nm
OSF-600	Permanently installed order-sorting filter @ 600 nm
OSF-850	Permanently installed order-sorting filter @ 850 nm
OSC	Order-sorting coating with 600 nm long-pass filter for VA, BB (>350 nm) and VB gratings in AvaSpec-ULS2048(L)/3648/2048XL
OSC-UA	Order-sorting coating with 350 and 600 nm long-pass filter for UA gratings in AvaSpec-ULS2048(L)/3648/2048XL
OSC-UB	Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings in AvaSpec-ULS2048(L)/3648/2048XL
OSC-HS500	Order-sorting coating with 350 and 600 nm long-pass filter for HS500 gratings in AvaSpec-HS
OSC-HS900	Order-sorting coating with 600 nm long-pass filter for HS900 gratings in AvaSpec-HS
OSC-HS1000	Order-sorting coating with 350 nm long-pass filter for HS1000 gratings in AvaSpec-HS
OSC-NIR	Order-sorting coating with 1400 nm long-pass filter for NIR100-2.5 and NIR150-2.0 gratings in AvaSpec-NIR256/512-2.2/2.5TEC

Spectrometer platforms

AvaSpec StarLine

The AvaSpec StarLine family of instruments comprises high-performance spectrometers which exceed the demands of most general spectroscopy applications. The StarLine includes high-speed instruments for process control (AvaSpec-128 and AvaSpec-FAST-series), high-resolution instruments for demanding measurements like atomic emission (AvaSpec-ULS3648) and versatile instruments for common applications such as irradiance and absorbance chemistry (AvaSpec-ULS2048 & AvaSpec-ULS2048L). This instrument line offers an array of solutions for varied uses, while providing excellent price-to-performance ratios.



The AvaSpec-ULS2048/2048L and AvaSpec-ULS3648 are based on front illuminated linear CCD arrays and thanks to Avantes' DUV coating, can measure wavelengths from 200-1100 nm. The AvaSpec-FAST series of instruments is specially designed for high-speed acquisitions such as pulsed light source and laser measurements. The AvaSpec-128 is an ultrafast photo-diode array-based instrument for visible and near-infrared applications.

Instruments in the AvaSpec StarLine family are designed to perform in a variety of applications such as:

- Reflection and transmission measurements for optics, coatings and color measurement
- Irradiance and emission measurements for environmental, light characterization, and optical emission spectroscopy
- High-speed measurements for process control, LIBS or laser/pulsed source characterization
- Absorbance chemistry

AvaSpec StarLine instruments are fully integrated with Avantes' modular platform, allowing them to function stand-alone, or as multi-channel instruments.

These products are fully compatible with other AvaSpec instruments in our AvaSpec SensLine and NIRLine. The entire AvaSpec StarLine is available as an individual lab instrument as an OEM module for integration into a customers' existing system.

The StarLine instruments are available with our standard AvaBench-45 optical bench (45 mm focal length) or the ultra-low stray-light (ULS) optical bench (75 mm focal length). The AvaSpec StarLine instruments are also available with a number of premium options such as irradiance/intensity calibration and non-linearity calibration.



AvaSpec CompactLine

In cases where size matters, the AvaSpec CompactLine family offers spectrometers with the smallest form factor. This enables easier integration of our spectrometers into machines or handheld devices. The AvaSpec CompactLine is based on the 2048, 2048L and 3648 models of the StarLine. Squeezing the size down

hardly compromises the performance of the instruments, but limits the customer a bit in the configurations possible. Customization is possible for adequate volumes needed. Therefore the CompactLine is especially suited for OEM users wanting to integrate a spectrometer into their instrument.

For external triggering Avantes offers the AvaTrigger, featuring optical triggering, external TTL or manually through the pushbutton.

AvaSpec SensLine

The AvaSpec SensLine family of products is Avantes' response to customers who require higher performance for demanding spectroscopy applications such as fluorescence, luminescence and Raman. The AvaSpec SensLine product line includes several high-sensitivity, low-noise spectrometers. Some of the instruments are based on back-thinned detector technology, of which three feature high-performance thermoelectrically cooled detectors. The other models are based on standard CCDs, upgraded to high-performance instruments as a result of Avantes' unique and recently improved detector cooling technology. The back-thinned CCD detectors featured in the AvaSpec SensLine product family are high quantum efficiency detectors with excellent response in the UV, VIS and NIR from 200-1160 nm.

AvaSpec SensLine instruments are fully integrated with Avantes' modular platform, allowing them to function as stand-alone, or as multi-channel instruments. These products are fully compatible with other AvaSpec instruments in our AvaSpec

StarLine and AvaSpec NIRLine product families. The entire AvaSpec SensLine is available as a lab instrument or an OEM module for integration into a customers' existing system.

Avantes' innovative ultra-low stray-light (ULS) and revolutionary High-Sensitivity (HS) optical benches are the core optical technologies in the AvaSpec SensLine. These highly stable optical benches combined with our high-performance electronics board deliver high-performance instruments at affordable prices.

All members of the AvaSpec SensLine are designed to provide performance features such as:

- High-stability
- High-sensitivity
- High-speed acquisition
- Low-noise



AvaSpec NIRLine

The AvaSpec NIRLine instruments are high-performance, near-infrared spectrometers that are optimized for the demands of measuring long wavelengths. This line provides leading-edge performance for dispersive NIR instruments with toroidal focusing mirrors and dynamic dark correction for enhanced stability. The NIRLine is comprised of both thermo-electrically cooled and un-cooled instruments. AvaSpec-NIR256-1.7 features an uncooled 256 pixel InGaAs detector. All other instruments in the NIRLine have thermo-electric, peltier-cooled InGaAs detectors which support cooling down to -25°C against ambient.

AvaSpec NIRLine instruments are fully compatible with our AvaSpec StarLine and SensLine spectrometers. Avantes' AvaSpec NIRLine instruments are available as laboratory instruments or OEM modules. AvaSpec NIRLine instruments are available

with a number of premium options such as irradiance/intensity calibration and non-linearity calibration.

The AvaSpec NIRLine instruments are designed to perform in a variety of applications such as:

- Moisture content measurement of liquids, solids and powders for inline and quality control purposes
- Quantitative and qualitative measurement of volatile organics such as ethanol, and methanol
- Plastic characterization and material identification
- Irradiance measurements, such as solar monitoring
- Qualitative measurements of feed and food

For the latest information,
go to www.avantes.com

AvaSpec Pre-configured Fiber-optic Spectrometers (In stock, ready to ship)

For customers with urgent needs and general flexibility in their specifications, Avantes offers a variety of pre-configured spectrometers, which are ready to ship. Four of the instruments are configured for UV-VIS-NIR measurements (200-1100 nm), one for VIS-NIR (360-1100 nm), and one for the visible range (360-880 nm). All configurations are priced at a discount off of list pricing and include an upgrade to AvaSoft-Full.

Of course a USB2-cable and an extensive manual are included. These spectrometers are off the shelf and ready to ship.



Technical Data

Name	AvaSpec- ULS3648- USB2-UA-25	AvaSpec- ULS2048- USB2-UA-50	AvaSpec- ULS2048L- USB2-UA-RS	AvaSpec- ULS2048- USB2-VA-50	AvaSpec- ULS2048L- USB2-BB-50	AvaSpec- ULS2048XL- USB2-UA-50
Uses	UV/VIS/NIR			VIS/NIR	VIS	UV/VIS/NIR
Range	200-1100 nm			360-1100 nm	360-880 nm	200-1160 nm
Slit/Connector	25 µm SMA-905 connector	50 µm SMA-905 connector	25 µm SMA-905 Replaceable Slit connector	50 µm SMA-905 connector		
Resolution (FWHM)	1.4 nm	2.4 nm	1.4 nm	2.4 nm	1.2 nm	2.4 nm
A/D Converter	16-bit					
Interface	USB 2.0					
Included options	Deep-UV Coating Order-sorting coating	Detector collection lens Deep-UV Coating Order-sorting coating		Detector collection lens Order-sorting coating		
Applications	High-resolution measurements from high intensity sources (lasers, powerful light sources, plasma)	Highly versatile broadband spectrometer. Ideal for absorbance, emission, irradiance measurements		Color measurements, visible irradiance measurements		Highly sensitivity applications such as fluorescence or irradiance from very low intensity sources
AvaSoft-Full	Included					

Ordering Information

AvaSpec-ULS3648-USB2-UA-25	UV/VIS/NIR spectrometer, 3648 pixel CCD detector, grating UA (200-1100 nm), slit-25, OSC-UA, DUV3648, USB2 high-speed interface, including USB interface cable and AvaSoft-Full.
AvaSpec-ULS2048-USB2-UA-50	UV/VIS/NIR spectrometer, 2048 pixel CCD detector, grating UA (200-1100 nm), slit-50, OSC-UA, DCL-UV/VIS, DUV400, USB2 high-speed interface, including USB interface cable and AvaSoft-Full.
AvaSpec-ULS2048L-USB2-UA-RS	UV/VIS/NIR spectrometer, 2048 large pixel CCD detector, grating UA (200-1100 nm), slit-25-RS, OSC, DCL-UV/VIS-200, USB2 high-speed interface, including USB interface cable and AvaSoft-Full, including SLIT-KIT-SMA.
AvaSpec-ULS2048-USB2-VA-50	VIS/NIR spectrometer, 2048 pixel CCD detector, grating VA (360-1100 nm), slit-50, OSC, DCL-UV/VIS, USB2 high-speed interface, including USB interface cable and AvaSoft-Full.
AvaSpec-ULS2048L-USB2-BB-50	VIS spectrometer, 2048 large pixel CCD detector, grating BB (360-880 nm), slit-50, OSC, DCL-UV/VIS-200, USB2 high-speed interface, including USB interface cable and AvaSoft-Full.
AvaSpec-ULS2048XL-USB2-UA-50	UV/VIS/NIR spectrometer, 2048 pixel backthinned CCD detector, grating UA (200-1150 nm), slit-50, OSC-UA, DCL-UV/VIS-200, USB2 high-speed interface, including USB interface cable and AvaSoft-Full.

AvaSpec-Mini: Small and powerful OEM spectrometer



Looking for a very small spectrometer with a resolution of up to 0.1 nm? Then the AvaSpec-Mini is an ideal choice. It's only the size of a deck of cards, yet delivers a dynamic range of 2000:1, stray-light levels lower than 0.17% and weighs only 174 grams. Easy to take anywhere you like.

The AvaSpec-Mini finds its way into many areas of research, such as light analysis, chemical research and Raman spectroscopy. Or use it as a tiny OEM-spectrometer in your application. The possibilities are endless.

Of course, the AvaSpec-Mini works seamlessly with Avantes spectroscopy software and the Windows and Linux libraries.

Technical Data

Name	AvaSpec-Mini 2048	AvaSpec-Mini 2048L	AvaSpec-Mini 3648
Optical Bench	Symmetrical Czerny-Turner, 75 mm focal length		
Wavelength range	220-1000 nm		
Stray-light	<0.2%		
Sensitivity	Similar to ULS2048 (no DCL)	Similar to ULS2048 (no DCL)	Similar to ULS3648 (no DCL)
Detector	Sony CCD linear array, 2048 pixels	Sony CCD linear array, 2048 (Large) pixels	Toshiba CCD linear array, 3648 pixels
Signal/Noise	200:1	300:1	350:1
AD converter	16-bit, 2 MHz		
Integration time	1.05ms - 10 minutes		10µs - 10 minutes
Interface	USB 2.0 (480 Mbps) / RS-232(115200 bps)		
Sample speed with on-board averaging	3.0 ms/scan		7.4 ms/scan
Data transfer speed	4.6 ms/scan		7.4 ms/scan
I/O	6 bidirectional programmable I/O; 2 analog out; 2 analog in		
Dimensions, weight	95 x 68 x 20 mm, 174 grams		
Power supply	Default USB power, 250 mA; external 5-15Vdc (Rs232)		
Temperature range	0-55°C		

Grating selection table for AvaSpec-Mini

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
2048(L)					
UV	200-400	167	1800	250	MN 1800-0.25
VIS	330-900	530	600	500	MN 600-0.50
NIR	550-1100	520	600	1000	MN 600-1.00
3648					
UV	200-400	170	1800	250	MN 1800-0.25
VIS	330-900	535	600	500	MN 600-0.50
NIR	550-1100	525	600	1000	MN 600-1.00

Resolution table (FWHM in nm) for AvaSpec-Mini*

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
2048 (L)						
600	0.40-0.53	0.70	1.20	2.40	4.60	10.80
1800	0.10-0.18	0.20-0.29	0.34-0.42	0.80	1.60	3.60
3648						
600	0.30-0.36	0.58-0.60	1.17	2.20	4.50	10.00
1800	0.09-0.11	0.18	0.36-0.40	0.78	1.50	3.70

* Typical values. Small deviations are possible.

Ordering Information

AvaSpec-Mini2048

- Mini Fiber-optic Spectrometer, 75 mm focal length, 2048 pixel CCD detector, USB 2 powered interface

AvaSpec-Mini2048L

- Mini Fiber-optic Spectrometer, 75 mm focal length, 2048L pixel CCD detector, USB 2 powered interface

AvaSpec-Mini3648

- Mini Fiber-optic Spectrometer, 75 mm focal length, 3648 pixel CCD detector, USB 2 powered interface

Specify grating, wavelength range and options.

Options

- DUV** • Deep UV detector coating (start wavelength <350nm)
- SLIT-XX** • Slit size, please specify XX = 10, 25, 50, 100, 200 or 500 μm
- FCPC** • FC/PC fiber-optic entrance
- OSC** • Order sorting coating for grating MN 600-0.50, recommended with OSF-305
- OSF-YYY** • Order-sorting filter for reduction of 2nd order effects, please specify YYY= 550 or 600 nm, depends on range

For non-OEM users a set of preconfigured models are available

NEW EVO Series: StarLine AvaSpec-ULS2048L-EVO Spectrometer

EVO series: AvaSpec-ULS2048L



The first instrument in our new EVO series: the AvaSpec-ULS2048L-EVO. Using the new electronics board AS 7010 this spectrometer has all the advantages of the current AvaSpec-ULS2048L-USB2 but offers USB3.0 communication as well, which means 10x higher speed compared to USB2.

Unique is the second communication port which offers Gigabit Ethernet for integration in your company network and possibility for long distance communication at an affordable price. Besides the high speed communication options, the EVO also offers a fast microprocessor and 50x more memory which can help you to store more spectra onboard and realise more functionality.

This unique, first to the market combination enables you to create high speed multichannels systems, perfectly suited for most industrial applications.

Options include a deep-UV detector coating, for better performance in the deep-UV-range, a detector collection lens to enhance sensitivity in the 200-1100 nm range and order-sorting filter to reduce 2nd order effects. Furthermore, the AvaSpec-2048L is available with a wide range of slit sizes, gratings and fiber-optic entrance connectors.

It comes complete with AvaSoft-Basic software, USB cable and an extensive manual.

Technical Data

Optical Bench	ULS Symmetrical Czerny-Turner, 75 mm focal length
Wavelength range	200-1100 nm
Resolution	0.06 -20 nm, depending on configuration (see table)
Stray-light	0.04-0.1%, depending on the grating
Sensitivity	470,000 counts/ μ W per ms integration time
Detector	CCD linear array, 2048 pixels
Signal/Noise	300:1
AD converter	16-bit, 2 MHz
Integration time	1.11 ms – 10 minutes
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet 1 Gbps
Sample speed with on-board averaging	1.1 ms /scan
Data transfer speed	1.1 ms/scan (USB3), 3.8 ms (ETH)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital bidirectional, trigger, sync., strobe, laser
Power supply	Default USB3 power, 500 mA Or 12VDC, 300 mA
Dimensions, weight	177 x 127 x 44,5 mm (1 channel), 1135 grams

EVOLutionary spectroscopy:

- SPEED
- NETWORK INTEGRATION
- MULTICHANNEL BENEFITS

Grating selection table for AvaSpec-ULS2048L-EVO

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1100**	900**	300	300	UA
UV/VIS/NIR	200-1100**	900**	300	300/1000	UNA-DB
UV/VIS	200-850	520	600	300	UB
UV	200-750	250-220*	1200	250	UC
UV	200-650	165-145*	1800	UV	UD
UV	200-580	115-70*	2400	UV	UE
UV	200-400	70-45*	3600	UV	UF
UV/VIS	250-850	520	600	400	BB
VIS/NIR	300-1100**	800**	300	500	VA
VIS	360-1000	500	600	500	VB
VIS	300-800	250-200*	1200	500	VC
VIS	350-750	145-90*	1800	500	VD
VIS	350-640	75-50*	2400	VIS	VE
NIR	500-1050	500	600	750	NB
NIR	500-1050	220-150*	1200	750	NC
NIR	600-1160	350-300	830	800	SI
NIR	600-1100**	500**	300	1000	IA
NIR	600-1100	500	600	1000	IB

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

** please note that not all 2048 pixels will be used for the useable range

Resolution table (FWHM in nm) for AvaSpec-ULS2048L-EVO

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	1.0	1.4	2.5	4.8	9.2	21.3
600	0.40-0.53*	0.7	1.2	2.4	4.6	10.8
830	0.32	0.48	0.93	1.7	3.4	8.5
1200	0.20-0.28*	0.27-0.38*	0.52-0.66*	1.1	2.3	5.4
1800	0.10-0.18*	0.20-0.29*	0.34-0.42*	0.8	1.6	3.6
2400	0.09-0.13*	0.13-0.17*	0.26-0.34*	0.44-0.64*	1.1	2.7
3600	0.06-0.08*	0.10	0.19	0.4	0.8	1.8

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

Ordering Information

AvaSpec-ULS2048L-EVO

- Fiber-optic Spectrometer, 75 mm AvaBench, 2048 pixel CCD detector 14 x 200 μm, USB powered, high-speed USB 3.0 and ETH interface, incl. AvaSoft-Basic, USB interface cable.
- Specify grating, wavelength range and options. See for options AvaSpec-ULS2048L-USB2.

This first to the market combination enables you to create high speed multichannel systems

AvaSpec-128 StarLine Ultrafast Fiber-optic Spectrometer

AvaSpec-128



The AvaSpec-128 is blazingly fast and supports integration times as short as 70 μ s. The affordable price and range from 360-1100 nm make it an ideal instrument for inline process control measurements.

The AvaSpec-128 has a USB2-port to connect to your computer and transfers data at 1.1 ms per scan. Data sampling is done at a rate of 8000 scans per second. It comes complete with AvaSoft-basic software, an extensive manual and USB-cable. It's also available in dual-channel or multi-channel configurations (up to 10, built into a 19" rackmount), where all spectra are stored simultaneously. The resolution (FWHM) capability is between 1.7 and 64 nm, depending on slit and grating configurations.

For the fiber-optic entrance connector you can choose between SMA (default) and FC/PC. Furthermore you can select from a wide range of gratings, slit sizes, and second-order sorting filters. Other options are a detector collection lens for enhanced sensitivity and a switch to select between USB or external power.

Technical Data

Optical Bench	Symmetrical Czerny-Turner, 45 mm focal length
Wavelength range	360-1100 nm
Resolution	1.7 – 64 nm, depending on configuration (see table)
Stray-light	< 0.3%
Sensitivity	430,000 counts/ μ W per ms integration time
Detector	Photo-diode array, 128 pixels
Signal/Noise	500:1
AD converter	16-bit, 2 MHz
Integration time	0.07 ms – 10 minutes
Interface	USB 2.0 high-speed, 480 Mbps RS-232, 115.200 bps
Sample speed with store to RAM	0.12 ms
Data transfer speed	1.1 ms / scan (USB2) 30 ms / scan (RS-232)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, sync.
Power supply	Default USB power, 350 mA Or with SPU2 external 12VDC, 150 mA
Dimensions, weight	175 x 110 x 44 mm (1 channel), 716 grams

Grating selection table for AvaSpec-128

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
VIS/NIR	360-1100	500	300	300	UA
VIS	360-750	100	1200	250	UC
VIS	360-850	240	600	400	BB
VIS/NIR	360-1100*	740*	150	500	VZ
VIS/NIR	360-1100	500	300	500	VA
VIS	360-850	235	600	500	VB
VIS	400-980	100	1200	500	VC
NIR	500-935	215	600	750	NB
NIR	500-1000	100	1200	750	NC
NIR	600-1100	475	300	1000	IA
NIR	600-1100	200	600	1000	IB

* please note that not all 128 pixels will be used for the useable range

Resolution table (FWHM in nm) for AvaSpec-128

Grating (lines/mm)	Slit size (μm)			
	50	100	200	500
150	13.0	14.0	28.0	64.0
300	6.4	7.2	15.0	32.0
600	2.6	3.5	7.2	16.0
1200	1.7	2.1	4.0	8.0

Ordering Information

AvaSpec-128-USB2	- Fiber-optic Spectrometer, 45 mm AvaBench, 128 pixel PDA detector, USB powered, high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable. - Specify grating, wavelength range and options
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Options

-SPU2	incl. switch for USB powered USB2 or external power for RS-232
-FCPC	FC/PC fiber-optic entrance
DCL-VIS	Detector collection lens to enhance sensitivity, BK7, 360-1100 nm
SLIT-XX	Slit size, please specify XX = 50, 100, 200 or 500 μm
OSF-YYY-3	Order-sorting filter for reduction of 2nd order effects, 3 mm thick, please specify YYY= 395, 475, 515, 550 or 600 nm

AvaSpec-ULS2048 StarLine

Versatile Fiber-optic Spectrometer

AvaSpec-ULS2048



The workhorse of our spectrometer line-up, the AvaSpec-ULS2048. Used in many applications in the UV/VIS-range, it is particularly useful in time-critical situations thanks to its exceptional response speed. Priced affordably, the AvaSpec-ULS2048 is the choice of many of our most demanding customers.

Options include deep-UV detector coating for better performance in the deep-UV-range, a detector collection lens to enhance sensitivity in the 200-1100 nm range and order-sorting filters to reduce 2nd order effects. Furthermore, the AvaSpec-ULS2048 is available with a wide range of slit sizes, gratings and fiber-optic entrance connectors.

The AvaSpec-ULS2048 is also available in dual or multi-channel versions (up to 10 spectrometers in a 19" rack), where all spectra are taken simultaneously.

Connection with your PC is done via USB2-connection, delivering a scan every 1.8 milliseconds. Integration time can be as short as 1.05 milliseconds up to a maximum of 10 minutes. It comes complete with AvaSoft-Basic software, USB cable and an extensive manual, including a quick start guide in four languages.

Technical Data

Optical Bench	ULS Symmetrical Czerny-Turner, 75 mm focal length
Wavelength range	200-1100 nm
Resolution	0.05 -20 nm, depending on configuration (see table)
Stray-light	0.06-0.19%, depending on the grating
Sensitivity	310,000 counts/ μ W per ms integration time
Detector	CCD linear array, 2048 pixels
Signal/Noise	200:1
AD converter	16-bit, 2 MHz
Integration time	1.05 ms - 10 minutes
Interface	USB 2.0 high-speed, 480 Mbps RS-232, 115.200 bps
Sample speed with store to RAM	1.05 ms /scan
Data transfer speed	1.8 ms /scan (USB2) 430 ms/scan (RS-232)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, sync.
Power supply	Default USB power, 350 mA Or with SPU2 external 12VDC, 150 mA
Dimensions, weight	175 x 110 x 44 mm (1 channel), 716 grams

Pre-configured
spectrometers can be shipped
within 24 hours

Grating selection table for AvaSpec-ULS2048

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1100**	900**	300	350	UA
UV/VIS/NIR	200-1100**	900**	300	300/1000	UNA-DB
UV/VIS	200-850	520	600	300	UB
UV	200-750	250-220*	1200	250	UC
UV	200-650	165-145*	1800	UV	UD
UV	200-580	115-70*	2400	UV	UE
UV	200-400	70-45*	3600	UV	UF
UV/VIS	250-850	520	600	400	BB
VIS/NIR	300-1100**	800**	300	500	VA
VIS	360-1000	500	600	500	VB
VIS	300-800	250-200*	1200	500	VC
VIS	350-750	145-90*	1800	500	VD
VIS	350-610	75-50*	2400	VIS	VE
NIR	500-1050	500	600	750	NB
NIR	500-1050	220-150*	1200	750	NC
NIR	600-1100	350-300	830	800	SI
NIR	600-1100**	500**	300	1000	IA
NIR	600-1100	500	600	1000	IB

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

** please note that not all 2048 pixels will be used for the useable range

Resolution table (FWHM in nm) for AvaSpec-ULS2048

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	0.80 – 0.90*	1.10-1.20*	2.30	4.60	9.00	20.0
600	0.40 – 0.50*	0.63	1.15	2.31	4.50	10.0
830	0.28	0.40	0.80	1.60	3.20	8.0
1200	0.18 – 0.22*	0.29	0.61	1.18	2.20	5.4
1800	0.10 – 0.16*	0.19	0.35-0.42*	0.80	1.60	3.6
2400	0.08 – 0.11*	0.10 – 0.15*	0.28	0.55	1.10	2.7
3600	0.05 – 0.08*	0.10	0.18	0.38	0.75	1.8

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

Ordering Information

AvaSpec-ULS2048-USB2

- Fiber-optic Spectrometer, 75 mm AvaBench, 2048 pixel CCD detector, USB powered, high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable.
- Specify grating, wavelength range and options

Options

-SPU2	• incl. switch for USB powered USB2 or external power for RS-232
-RS	• Replaceable slit, see page 41
DUV	• Deep-UV detector coating >150 nm
DCL-UV/VIS	• Detector Collection Lens to enhance sensitivity, Quartz, 200-1100 nm
SLIT-XX	• Slit size, please specify XX = 5, 10, 25, 50, 100, 200 or 500 μm
SLIT-XX-RS	• Replaceable slit with SMA connector, specify slit size XX=25, 50, 100 or 200 μm . Only in combination with AvaSpec-ULS2048-USB2-RS
SLIT-XX-RS-FCPC	• as SLIT-XX-RS, but with FC/PC connector
OSF-YYY	• Order-sorting filter for reduction of 2 nd order effects please specify YYY= 305, 395, 475, 515, 550 or 600 nm
OSC	• Order-sorting coating with 600 nm long-pass filter for VA, BB (>350 nm) and VB gratings in AvaSpec-ULS2048
OSC-UA	• Order-sorting coating with 350 and 600 nm long-pass filter for UA gratings in AvaSpec-ULS2048
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings in AvaSpec-ULS2048
-FCPC	• FC/PC fiber-optic connector

To calibrate your spectrometer,
take a look at the AvaLight-CAL calibration light source.
Alternatively Avantes has in-house calibration possibilities.
Contact an application specialist for more information.

AvaSpec-ULS3648 StarLine

High-resolution Fiber-optic Spectrometer

When you're looking for high-resolution, then take a look at the AvaSpec-ULS3648. Featuring an electronic shutter, it can support integration times as short as 10 microseconds, making it also ideal for CW laser measurements.

Options include order-sorting filters to prevent 2nd order effects, deep-UV detector coating for better sensitivity in the deep-UV-range, and a detector collection lens to enhance overall sensitivity. Also, a wide range of slit sizes, gratings and fiber-optic entrance connectors are available.

Configurations with two to ten channel spectrometers are available. These give you the possibility for multiple simultaneous

readouts or higher optical resolution in which several spectrometers are arrayed with each covering a short range with high-resolution. For more information, see pages 62 and 63.

The connection to your computer is done through USB2 at 480 Mbps. This translates into 3.7 ms per scan data transfer speed. Of course it's supplied with AvaSoft-Basic, USB cable and an extensive manual, including a quick start guide in four languages.

AvaSpec-ULS3648



Technical Data

Optical Bench	ULS Symmetrical Czerny-Turner, 75 mm focal length
Wavelength range	200 - 1100 nm
Resolution	0.05 -20 nm, depending on configuration (see table)
Stray-light	0.38-0.53%, depending on the grating
Sensitivity	160,000 counts/μW per ms integration time
Detector	CCD linear array, 3648 pixels
Signal/Noise	350:1
AD converter	16-bit, 1 MHz
Integration time	10 μs - 10 minutes
Interface	USB 2.0 high-speed, 480 Mbps RS-232, 115.200 bps
Sample speed with store to RAM	3.7 ms /scan
Data transfer speed	3.7 ms /scan (USB2) 750 ms/scan (RS-232)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, synchronization
Power supply	Default USB power, 350 mA Or with SPU2 external 12VDC, 150 mA
Dimensions, weight	175 x 110 x 44 mm (1 channel), 716 grams

Grating selection table for AvaSpec-ULS3648

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1100**	900**	300	300	UA
UV/VIS/NIR	200-1100**	900**	300	300/1000	UNA-DB
UV/VIS	200-850	520	600	300	UB
UV	200-750	250-220*	1200	250	UC
UV	200-650	165-145*	1800	UV	UD
UV	200-580	115-70*	2400	UV	UE
UV	200-400	70-45*	3600	UV	UF
UV/VIS	250-850	520	600	400	BB
VIS/NIR	300-1100**	800**	300	500	VA
VIS	360-1000	500	600	500	VB
VIS	300-800	250-200*	1200	500	VC
VIS	350-750	145-100*	1800	500	VD
VIS	350-610	75-50*	2400	VIS	VE
NIR	500-1050	500	600	750	NB
NIR	500-1050	220-150*	1200	750	NC
NIR	600-1100	350-300	830	800	SI
NIR	600-1100**	500**	300	1000	IA
NIR	600-1100	500	600	1000	IB

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

** please note that not all 3648 pixels will be used for the useable range

Resolution table (FWHM in nm) for AvaSpec-ULS3648

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	0.60 – 0.70*	1.10-1.30*	2.20-2.40*	4.60	9.00	20.0
600	0.30 – 0.36*	0.58-0.68*	1.17	2.20	4.50	10.0
830	0.25	0.48	0.93	1.70	3.40	8.0
1200	0.14 – 0.18*	0.30	0.62	1.08	2.20	5.0
1800	0.09 – 0.11*	0.18	0.36-0.40*	0.78	1.50	3.7
2400	0.07 – 0.09*	0.13 – 0.15*	0.26-0.32*	0.52-0.64*	1.10	2.7
3600	0.05 – 0.06*	0.10	0.19	0.40	0.80	2.0

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

Ordering Information

AvaSpec-ULS3648-USB2

- Fiber-optic Spectrometer, 75 mm AvaBench, 3648 pixel CCD detector, USB powered, high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable. Specify grating, wavelength range and options

Options

-SPU2	• incl. switch for USB powered or external power for RS-232
-RS	• Replaceable slit, see page 41
DUV	• Deep-UV detector coating >150 nm
DCL-UV/VIS-200	• Quartz Detector Collection Lens (200-1100 nm)
SLIT-XX	• Slit size, please specify XX = 5, 10, 25, 50, 100, 200 or 500 μm
SLIT-XX-RS	• Replaceable slit with SMA connector , specify slit size XX=25, 50, 100 or 200 μm . Only in combination with AvaSpec-ULS3648-USB2-RS
SLIT-XX-RS-FCPC	• as SLIT-XX-RS, but with FC/PC connector
OSF-YYY	• Order-sorting filter for reduction of 2nd order effects please specify YYY= 305, 395, 475, 515, 550 or 600 nm
OSC	• Order-sorting coating with 600 nm long-pass filter for BB (>305 nm) and VB gratings in AvaSpec-ULS3648, recommended with OSF-305
OSC-UA	• Order-sorting coating with 350 and 600 nm long-pass filter for UA, VA gratings in AvaSpec-ULS3648
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings in AvaSpec-ULS3648
-FCPC	• FC/PC fiber-optic connector

The grating can only be changed by Avantes.
Therefore, choose your grating wisely.
Our application specialists are available to support you with your choice.
In general, a higher resolution means a lower bandwidth.
By combining multiple spectrometers
in our AvaSpec-Dual or rack-mountable versions,
you can create one virtual spectrometer with high-resolution
and high bandwidth.

AvaSpec-ULS2048L StarLine Versatile Fiber-optic Spectrometer

AvaSpec-ULS2048L



A close cousin to the AvaSpec-ULS2048 but with larger pixels, is the AvaSpec-ULS2048L. It provides enhanced sensitivity at an affordable price. The AvaSpec-ULS2048L has pixels that are almost four times higher than those in the AvaSpec-ULS2048. It gives you a better signal to noise ratio and 40% less dark noise.

Options include a deep-UV detector coating, for better performance in the deep-UV-range, a detector collection lens to enhance sensitivity in the 200-1100 nm range and order-sorting filter to reduce 2nd order effects. Furthermore, the AvaSpec-ULS2048L is available with a wide range of slit sizes, gratings and fiber-optic entrance connectors.

The AvaSpec-2048L is also available in dual or multi-channel versions (up to 10 spectrometers), where all spectra are taken simultaneously.

Connection to your PC is handled via USB2-connection, delivering a scan every 1.8 milliseconds. Integration time can be as short as 1.05 milliseconds up to a maximum of 10 minutes. It comes complete with AvaSoft-Basic software, USB cable and an extensive manual, including a quick start guide in four languages.

Technical Data

Optical Bench	ULS Symmetrical Czerny-Turner, 75 mm focal length
Wavelength range	200-1100 nm
Resolution	0.06 –20 nm, depending on configuration (see table)
Stray-light	0.16-0.28%, depending on the grating
Sensitivity	470,000 counts/μW per ms integration time
Detector	CCD linear array, 2048 pixels
Signal/Noise	300:1
AD converter	16-bit, 2 MHz
Integration time	1.05 ms – 10 minutes
Interface	USB 2.0 high-speed, 480 Mbps RS-232, 115.200 bps
Sample speed with store to RAM	1.05 ms /scan
Data transfer speed	1.8 ms/scan (USB2) 430 ms/scan (RS-232)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, sync.
Power supply	Default USB power, 350 mA Or with SPU2 external 12VDC, 150 mA
Dimensions, weight	175 x 110 x 44 mm (1 channel), 716 grams

Add flexibility
to your spectrometer with
the Replaceable Slit (-RS) option

Grating selection table for AvaSpec-ULS2048L

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1100**	900**	300	300	UA
UV/VIS/NIR	200-1100**	900**	300	300/1000	UNA-DB
UV/VIS	200-850	520	600	300	UB
UV	200-750	250-220*	1200	250	UC
UV	200-650	165-145*	1800	UV	UD
UV	200-580	115-70*	2400	UV	UE
UV	200-400	70-45*	3600	UV	UF
UV/VIS	250-850	520	600	400	BB
VIS/NIR	300-1100**	800**	300	500	VA
VIS	360-1000	500	600	500	VB
VIS	300-800	250-200*	1200	500	VC
VIS	350-750	145-90*	1800	500	VD
VIS	350-610	75-50*	2400	VIS	VE
NIR	500-1050	500	600	750	NB
NIR	500-1050	220-150*	1200	750	NC
NIR	600-1100	350-300	830	800	SI
NIR	600-1100**	500**	300	1000	IA
NIR	600-1100	500	600	1000	IB

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

** please note that not all 2048 pixels will be used for the useable range

Resolution table (FWHM in nm) for AvaSpec-ULS2048L

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	1.0	1.4	2.5	4.8	9.2	21.3
600	0.40-0.53*	0.7	1.2	2.4	4.6	10.8
830	0.32	0.48	0.93	1.7	3.4	8.5
1200	0.20-0.28*	0.27-0.38*	0.52-0.66*	1.1	2.3	5.4
1800	0.10-0.18*	0.20-0.29*	0.34-0.42*	0.8	1.6	3.6
2400	0.09-0.13*	0.13-0.17*	0.26-0.34*	0.44-0.64*	1.1	2.7
3600	0.06-0.08*	0.10	0.19	0.4	0.8	1.8

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

Ordering Information

AvaSpec-ULS2048L-USB2

- Fiber-optic Spectrometer, 75 mm AvaBench, 2048 pixel CCD detector 14 x 200 μm, USB powered, high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable. Specify grating, wavelength range and options

We can also calibrate
your AvaSpec series
spectrometer

Options

-SPU2	• incl. switch for USB powered USB2 or external power for RS-232
-RS	• Replaceable slit, see page 41
DUV	• Deep-UV detector coating >150 nm
DCL-UV/VIS-200	• Detector Collection Lens to enhance sensitivity, Quartz, 200-1100 nm
SLIT-XX	• Slit size, please specify XX = 5, 10, 25, 50, 100, 200 or 500 μm
SLIT-XX-RS	• Replaceable slit with SMA connector, specify slit size XX=25, 50, 100 or 200 μm . Only in combination with AvaSpec-ULS2048L-USB2-RS
SLIT-XX-RS-FCPC	• as SLIT-XX-RS, but with FC/PC connector
OSF-YYY	• Order-sorting filter for reduction of 2nd order effects, please specify YYY= 305, 395, 475, 515, 550 or 600 nm
OSC	• Order-sorting coating with 600 nm long-pass filter for BB (>350 nm) and VB gratings in AvaSpec-ULS2048L, recommended with OSF-305
OSC-UA	• Order-sorting coating with 350 and 600 nm long-pass filter for UA, VA gratings in AvaSpec-ULS2048L
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings in AvaSpec-ULS2048L
-FCPC	• FC/PC fiber-optic connector

For extra sensitivity:
take a look at the
AvaSpec-ULS2048XL

AvaSpec-RS

Replaceable-Slit Spectrometer

AvaSpec-RS

For most customers the choice between throughput and resolution is not an easy one. Avantes now offers the possibility for end-users to easily replace a slit through the introduction of our replaceable-slit feature. The replaceable slit option is only available on ULS Ultra-low Stray-light AvaSpecs and the NIR256-1.7 spectrometer. The slit sets contain 25, 50, 100 and 200 μm slits along with a screwdriver tool to facilitate the

change. Slit kits are available with SMA-905 connector, as well as FC/PC connectors. Slit sets can be ordered separately for the -RS spectrometer.

No recalibration of the spectrometer is needed when changing slit because of the high-precision slit positioning.



Technical Data

Slit set connectors	SMA-905 or FC/PC
Slit sizes	25, 50, 100, 200 μm (width) x 1 mm (height)
Material	Stainless steel
Fixing screws	Torx (included)

Ordering Information

-RS	Replaceable slit, to be added to the product code of the AvaSpec-ULS or AvaSpec-NIR256-1.7
SLIT-XX-RS	Replaceable slit with SMA connector. Specify slit size XX=25, 50, 100 or 200 μm, only in combination with AvaSpec-ULS-RS spectrometers and AvaSpec-NIR256-1.7-RS
SLIT-XX-RS-FCPC	as SLIT-XX-RS, but with FC/PC connector

Slit Kit

To fully utilize your AvaSpec-RS series spectrometer with replaceable slit, the Slit Kit is available. It features a complete set with four slits, of 25, 50, 100 and 200 μm . Also included in the kit are the tools to easily change the slit in the spectrometer.

The Slit Kit is available in SMA and FC/PC versions. Both kits can be used on any spectrometer with the replaceable slit option installed.



Ordering information

SLITKIT-SMA	Slit kit containing 25, 50, 100 and 200 μm slits, and the tools to replace the slit. SMA-connectors
SLITKIT-FCPC	As SLITKIT-SMA, but with FC/PC connectors

Don't forget to order
a fiber cable

AvaSpec-Fast StarLine Ultra-fast Spectrometer for High-speed Applications

AvaSpec-Fast



For ultra-fast spectral acquisition the AvaSpec-Fast offers the best solution. Up to 5637 spectra can be stored at 0.20 ms per scan using Avantes unique store-to-RAM functionality. Depending on the configuration chosen, between 1254 and 5637 spectra can be stored during one burst.

The AvaSpec-FAST series is available in five different configurations; the difference being the number of active pixels. More pixels provide higher resolution or more bandwidth, but slower minimum integration time. For all models, start/stop pixels can be set in our software to increase the number of scans stored on board over a shorter wavelength range.

The AvaSpec-FAST can be configured in CR or SS mode. CR, or continuous run mode, means a single external trigger (through the DB26-connector) results in a customer-set number of scans automatically to be measured. SS-mode, for single scan, means a single spectrum is acquired at every external trigger. CR or SS mode must be specified at the time of order.

Possible configurations are single or dual channel, desktop or Rack-mounted. The instrument is available with all the options and gratings of the AvaSpec-ULS2048. The AvaSpec Fast series is based on the AvaSpec-ULS2048. Optional it can also be based upon the AvaSpec-ULS2048L.

Technical Data

FAST Series Model	Min Integration Time	Pixels	Max. Frequency (Hz) in CR-Store to RAM	Max amount of spectra Store to RAM
AvaSpec-ULS350F-USB2	0.20 ms	350	5000	5637
AvaSpec-ULS750F-USB2	0.40 ms	750	2500	2716
AvaSpec-ULS950F-USB2	0.50 ms	950	2000	2157
AvaSpec-ULS1350F-USB2	0.70 ms	1350	1400	1528
AvaSpec-ULS1650F-USB2	0.85 ms	1650	1100	1254

Grating selection table for AvaSpec-FAST

Grating	Lines/mm	Spectral range AvaSpec-ULS350F (nm)	Spectral range AvaSpec-ULS750F (nm)	Spectral range AvaSpec-ULS950F (nm)	Spectral range AvaSpec-ULS1350F (nm)	Spectral range AvaSpec-ULS1650F (nm)
Z	150	400	850	900	n.a.	n.a.
A	300	190	400	520	750	900
B	600	90	200	250	360	450
C	1200	45	100	120	180	210
D	1800	30	60	80	110	140
E	2400	20	45	50	80	100
F	3600	10	27	30	50	60

Ordering Information

AvaSpec-ULS350F-USB2	Ultra-fast Fiber-optic Spectrometer, 75 mm low stray-light AvaBench, 350 pixel CCD detector, USB/RS-232 interface, incl. AvaSoft-Basic, USB2 cable. Specify grating, wavelength range and options
AvaSpec-ULS750F-USB2	As AvaSpec-ULS350F-USB2, but 750 pixel CCD detector
AvaSpec-ULS950F-USB2	As AvaSpec-ULS350F-USB2, but 950 pixel CCD detector
AvaSpec-ULS1350F-USB2	As AvaSpec-ULS350F-USB2, but 1350 pixel CCD detector
AvaSpec-ULS1650F-USB2	As AvaSpec-ULS350F-USB2, but 1650 pixel CCD detector

Options

- See AvaSpec-ULS2048-USB2

AvaSpec-ULS2048XL SensLine

High UV- and NIR-sensitivity back-thinned CCD Spectrometer

Combining exceptional quantum efficiency with high-speed is the value proposition of the AvaSpec-ULS2048XL spectrometer. Unlike many back-thinned CCD spectrometers, which have two dimensional arrays, the ULS2048XL has large monolithic pixels of 14x500 microns with exceptional efficiency in the UV, from 200-400 nm, and the NIR, from 950-1160 nm. The instrument also has an electronic shutter, which enables integration times as low as 2 microseconds. To further enhance sensitivity, a detector collection lens is available which improves sensitivity up to 60% when combined with larger core fibers.

Options include order-sorting filter, to reduce 2nd order effects and purge ports for deep-UV measurements. The AvaSpec-ULS2048XL comes with a wide range of slit sizes, gratings and may be configured with SMA or FC/PC fiber-optic entrance connectors.

The AvaSpec-ULS2048XL is also available in dual or multi-channel versions (up to 10 spectrometers), where all spectra are acquired simultaneously.

Connection to your PC is handled via a USB2-connection, delivering a scan every 2 milliseconds. The instrument comes complete with AvaSoft-basic software, USB cable and an extensive manual, including a quick start guide in four languages.

AvaSpec-ULS2048XL



Technical Data

Optical Bench	ULS, Symmetrical Czerny-Turner, 75 mm focal length
Wavelength range	200 - 1160 nm
Resolution	0.09 -20 nm, depending on configuration (see table)
Stray-light	< 0.3%
Sensitivity	460,000 counts/μW per ms int. time
UV Quantum efficiency	60% (200-300 nm)
Detector	Back-thinned CCD image sensor 2048 pixels
Signal/Noise	450:1
AD converter	16-bit, 1 MHz
Integration time	2 μs - 20 seconds
Interface	USB 2.0 high-speed, 480 Mbps RS-232, 115.200 bps
Sample speed with store to RAM	2.09 ms /scan
Data transfer speed	2.09 ms /scan (USB2) 432 ms / scan (RS-232)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, synchronization
Power supply	Default USB power, 450 mA. Or with SPU2 external 12VDC, 200 mA
Dimensions, weight	175 x 110 x 44 mm (1 channel), 855 grams

Grating selection table for AvaSpec-ULS2048XL

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1160**	960**	300	300	UA
UV/VIS/NIR	200-1100**	900**	300	300/1000	UNA-DB
UV/VIS	200-850	520	600	300	UB
UV	200-750	250-220*	1200	250	UC
UV	200-650	165-145*	1800	UV	UD
UV	200-580	115-70*	2400	UV	UE
UV	200-400	70-45*	3600	UV	UF
UV/VIS	250-850	520	600	400	BB
VIS/NIR	300-1160**	860**	300	500	VA
VIS	360-1000	500	600	500	VB
VIS	300-800	250-200*	1200	500	VC
VIS	350-750	145-100*	1800	500	VD
VIS	350-640	75-50*	2400	VIS	VE
NIR	500-1050	500	600	750	NB
NIR	500-1050	220-150*	1200	750	NC
NIR	600-1160	350-300	830	800	SI
NIR	600-1160**	560**	300	1000	IA
NIR	600-1160	500	600	1000	IB

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

** please note that not all 2048 pixels will be used for the useable range

Resolution table (FWHM in nm) for AvaSpec-ULS2048XL

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	1.40	1.50	2.5	4.8	9.2	21.3
600	0.70 - 0.80*	0.75-0.85*	1.2	2.4	4.6	10.8
830	0.42 - 0.48*	0.50-0.58*	0.93	1.7	3.4	8.5
1200	0.25 - 0.31*	0.37 - 0.43*	0.52-0.66*	1.1	2.3	5.4
1800	0.17 - 0.21*	0.26 - 0.32*	0.34-0.42*	0.8	1.6	3.6
2400	0.12 - 0.18*	0.18 - 0.24*	0.26-0.34*	0.44-0.64*	1.1	2.7
3600	0.09 - 0.12*	0.11 - 0.15*	0.19	0.4	0.8	1.8

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

Ordering Information

AvaSpec-ULS2048XL-USB2

- Ultra-low Stray-light Fiber-optic Spectrometer, 75 mm AvaBench, 2048 large 500 μm pixel back-thinned CCD detector, USB powered, high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable.
- Specify grating, wavelength range and options

Why is the XL so sensitive?
We're using back-illuminated detectors.
They have the electronics on the backside of the detector,
allowing more light to be caught by the front side.

Options

-SPU2	• incl. switch for USB power or external power for RS-232
-RS	• Replaceable slit, see page 41
DCL-UV/VIS-200	• Quartz Detector Collection Lens (200-1100 nm)
SLIT-XX	• Slit size, please specify XX = 10, 25, 50, 100, 200 or 500 μm
SLIT-XX-RS	• Replaceable slit with SMA connector, specify slit size XX=25, 50, 100 or 200 μm . Only in combination with AvaSpec-ULS2048XL-USB2-RS
SLIT-XX-RS-FCPC	• as SLIT-XX-RS, but with FC/PC connector
OSF-YYY	• Order-sorting filter for reduction of 2 nd order effects, 1 mm thick, please specify YYY= 305, 395, 475, 515, 550 or 600 nm
OSC	• Order-sorting coating with 600 nm long-pass filter for BB (>350 nm) and VB gratings in AvaSpec-2048XL, recommended with OSF-305
OSC-UA	• Order-sorting coating with 350 and 600 nm long-pass filter for UA, VA gratings in AvaSpec-ULS2048XL
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings in AvaSpec-ULS2048XL
-FCPC	• FC/PC fiber-optic connector

The grating can only be changed by Avantes.
Therefore, choose your grating wisely.
Our application specialists are available to support you with your choice.
In general, a higher resolution means a lower bandwidth.
By combining multiple spectrometers
in our AvaSpec-Dual or rack-mountable versions,
you can create one virtual spectrometer with high-resolution
and high bandwidth.

AvaSpec-HS2048XL SensLine

High UV and NIR sensitivity back-thinned CCD Spectrometer

AvaSpec-HS2048XL



For high sensitivity applications where high resolution is not of paramount concern, the AvaSpec-HS2048XL is an exceptional instrument. Featuring Avantes' HS optical bench which has a full 0.22 numerical aperture for superior throughput, the AvaSpec-HS2048XL has a back-thinned CCD detector with 2048 pixels measuring 14X500 microns.

Unlike many back-thinned CCD spectrometers, which have two dimensional arrays the HS2048XL has large monolithic pixels with exceptional efficiency in the UV, from 200-400 nm, and the NIR, from 950-1160 nm, while retaining sensitivity in the visible range. The unique optical design features torroid collimating and focusing mirrors to control image magnification and enhance efficiency. The instrument also features an electronic shutter, which enables integration times as low as 2 microseconds.

For configurations, which require second order filtering, order-sorting filters are available. The AvaSpec-HS2048XL is available with a wide range of slit sizes, gratings and may be configured with SMA or FC/ PC fiber-optic entrance connectors.

Technical Data

Optical Bench	High-sensitivity asymmetrical design, 37.5 mm focal length; NA – 0.22, f/2.27
Wavelength range	200 - 1160 nm
Resolution	1 - 10 nm, depending on configuration (see table)
Stray-light	< 1 %
Sensitivity	1,100,000 counts/μW per ms int. time
UV Quantum efficiency	60% 200-250 nm 78% 550- 750 nm
Detector	Back-thinned CCD image sensor 2048 pixels
Signal/Noise	450:1
AD converter	16-bit, 1 MHz
Integration time	2 μs – 600 seconds
Interface	USB 2.0 high-speed, 480 Mbps RS-232, 115.200 bps
Sample speed with on-board averaging	2.09 ms /scan
Data transfer speed	2.09 ms /scan (USB2) 432 ms / scan (RS-232)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, synchronization
Power supply	Default USB power, 450 mA. or with SPU2 external 12VDC, 200 mA
Dimensions, weight	175 x 165 x 85 mm, 1,950 kg

Grating selection table for AvaSpec-HS2048XL

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1160	900	500	330	HS500-0.33
UV/VIS	200-660	440	1000	250	HS1000-0.25
UV	200-850	520	600	300	HS600-0.30
UV/VIS	200-850	520	600	400	HS600-0.40
UV/VIS	300-1160	860	500	560	HS500-0.56
VIS	360-1000	500	600	500	HS600-0.50
NIR	500-1050	500	600	750	HS600-0.75
VIS	350-850	460	900	550	HS900-0.55
VIS	400-722	322	1200	500	HS1200-0.5
NIR	600-1100	500	600	1000	HS600-1.0
NIR	600-1160	350	830	900	HS830-0.9
NIR	750-990	240	1200	1000	HS1200-1.0

Resolution table (FWHM in nm) for AvaSpec-HS2048XL

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
500	2.6	4.5	5.5	6.5	10.0	22.0
600	2.2	3.8	4.5	5.5	7.5	18.0
830*	2.1	3.6	4.0	5.0	7.0	15.0
900*	2.0	3.5	3.8	4.8	6.8	14.5
1000*	1.9	3.3	3.6	4.6	6.6	14.0
1200*	1.8	3.0	3.3	4.3	6.2	13.5

* theoretical values

Ordering Information

AvaSpec-HS2048XL-USB2

- High-sensitivity fiber-optic Spectrometer, 2048 large 500 μm pixel back-thinned CCD detector, USB powered, high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable. Specify grating, wavelength range and options

Options

SLIT-XX	• Slit size, please specify XX = 10, 25, 50, 100, 200 or 500 μm
OSF-YYY	• Order-sorting filter for reduction of 2nd order effects, 1 mm thick, please specify YYY= 305, 385, 475, 515, 550 or 600 nm
OSC-HS500	• Order-sorting coating with 350 and 600 nm long-pass filter for HS500 gratings in AvaSpec-HS
OSC-HS600	• Order-sorting coating with 350 and 600 nm long-pass filter for HS600 gratings in AvaSpec-HS
OSC-HS900	• Order-sorting coating with 600 nm long-pass filter for HS900 gratings in AvaSpec-HS
OSC-HS1000	• Order-sorting coating with 350 nm long-pass filter for HS1000 gratings in AvaSpec-HS
FCPC	• FC/PC fiber optic connector

The AvaSpec-HS2048XL-USB2 is ideally suited for diffuse reflection measurements (UV, VIS, NIR) and fluorescence.

AvaSpec-HS1024x58/122 TEC SensLine High UV- and NIR-sensitivity TE-cooled CCD Spectrometer

AvaSpec-HS1024x58/122TEC



AvaSpec-HS1024x58 and HS1024x122 High-sensitivity Fiber-optic Spectrometers are top performing instruments in the SensLine High-sensitivity spectrometer family, with high quantum efficiency in the UV and near infrared spectral regions. The detector pixels in the AvaSpec-HS1024x58 measure 1392 μm high and for the AvaSpec-HS1024x122 they measure 2928 μm high. The instrument's optical bench design is based on a revolutionary concept with high numerical (0.22) aperture and throughput. TE-cooled backthinned CCD detectors are used as a linear array of 1024 pixels, binning the vertical 58 or 122 pixels for optimal efficiency. The spectrometers have a fiber-optic entrance connector (standard SMA, other options available), toroid collimating and focusing mirrors and are available with choice of 7 different standard diffraction gratings to enable applications in the 200-1160 nm range. The AvaSpec-HS1024x58/122 include a 16-bit AD converter, and USB2.0 high-speed

interface. These instruments are especially suitable for measuring low light, fluorescence and UV applications and also have superior NIR sensitivity relative to front illuminated CCDs. Digital IO ports enable external triggering, control of shutters, and pulsed light sources from the Avantes line of instruments.

AvaSpec-HS1024x58/122 have TE-cooled detectors with lower dark noise, better signal to noise, and enhanced sensitivity that is even 3 times more sensitive than the nearest spectrometer in our Sensline. The AvaSpec-HS-1024x58/122 runs on 100-240VAC power and comes with AvaSoft-Basic, a manual and USB interface cable.

Technical Data

Spectrometer Type	AvaSpec-HS1024x58TEC	AvaSpec-HS1024x122TEC
Optical Bench	High-sensitivity asymmetrical design 37.5 mm focal length, N.A. 0.22, f/2.27	
Wavelength range	200 - 1160 nm	
Resolution	1.2 - 20 nm, depending on configuration (see table)	
Stray-light	< 1%	< 1%
Sensitivity (counts/ μW per ms int. time)	850,000	1,270,000
UV Quantum efficiency	80% (200-250 nm), >90% (550-750 nm)	
Detector	Back-thinned TE-cooled CCD image sensor 1024x58 pixels	Back-thinned TE-cooled CCD image sensor 1024x122 pixels
Signal/Noise	1000:1	
AD converter	16-bit, 250 KHz	
Integration time	5.22 ms - 60 seconds	6.24 ms - 60 seconds
Interface	USB 2.0 high-speed, 480 Mbps RS-232, 115.200 bps	
Sample speed with store to RAM	5.22 ms /scan	6.24 ms /scan
Data transfer speed	5.22 ms /scan (USB2) 220 ms / scan (RS-232)	6.24 ms /scan (USB2) 220 ms / scan (RS-232)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, synchronization	
Power supply	100-240 VAC, 50-60 Hz, 35W	
Dimensions, weight	245 x 175 x 140 mm, 3.9 kg	

Grating selection table for AvaSpec-HS1024x58/122TEC

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1100	900	500	330	HS500-0.33
UV/VIS	200-660	440	1000	250	HS1000-0.25
VIS/NIR	300-1160	860	500	560	HS500-0.56
VIS	350-850	460	900	550	HS900-0.55
VIS	400-722	322	1200	500	HS1200-0.5
NIR	600-1160	350	830	900	HS830-0.9
NIR	750-990	240	1200	1000	HS1200-1.0

Resolution table (FWHM in nm) for AvaSpec-HS1024x58/122TEC

Grating (lines/mm)	Slit size (μm)				
	25	50	100	200	500
500	3.8	4.5	5.5	10.5	24.0
830	2.9	3.5	4.2	7.0	15.0
900	2.7	3.2	4.1	6.8	14.5
1000	2.6	3.0	4.0	6.6	14.0
1200	2.4	2.8	3.8	6.2	13.5

* Best resolution in the center of the range

Ordering Information

AvaSpec-HS1024x58TEC-USB2

- High-sensitivity Fiber-optic Spectrometer, 1024x58 pixel back-thinned TE-cooled CCD detector, high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable. Specify grating, wavelength range and options

AvaSpec-ULS1024x122-USB2

- High-sensitivity Fiber-optic Spectrometer, 1024x122 pixel back-thinned TE-cooled CCD detector, high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable. Specify grating, wavelength range and options

Options

SLIT-XX	• Slit size, please specify XX = 25, 50, 100, 200 or 500 μm
OSF-YYY	• Order-sorting filter for reduction of 2 nd order effects, 1 mm thick, please specify YYY= 305, 395, 475, 515, 550 or 600 nm
OSC-HS500	• Order-sorting coating with 350 and 600 nm long-pass filter for HS500 gratings in AvaSpec-HS
OSC-HS900	• Order-sorting coating with 600 nm long-pass filter for HS900 gratings in AvaSpec-HS
OSC-HS1000	• Order-sorting coating with 350 nm long-pass filter for HS1000 gratings in AvaSpec-HS

Download the latest software for your AvaSpec at www.avantes.com

AvaSpec-ULS2048LTEC SensLine

Thermo-Electric Cooled

Fiber-optic Spectrometer

AvaSpec-ULS2048LTEC



Long integration times in general are equivalent to higher dark noise. Avantes Thermo-Electric Cooled (TEC) spectrometers systems overcome this problem by cooling the detector. These instruments are equipped with triple stage cooling, keeping your detector at optimal 5 degrees Celsius (maximum -35°C difference from ambient temperature).

The detector cooling provides a significantly lower and more stable dark baseline and PRNU level. Dark noise is reduced by a factor of 2-3. This allows the ULS2048LTEC to be used in very low light conditions, such

as fluorescence and Raman measurements. If needed, integration times of more than 5 seconds are possible.

The AvaSpec-ULS2048LTEC has an integrated temperature regulator, USB2.0 high-speed interface and two cooling fans to actively ventilate the heat sink of the Peltier cooling elements. The spectrometer power supply is integrated into the housing.

Technical Data

Optical Bench	ULS Symmetrical Czerny-Turner, 75 mm focal length
Wavelength range	200-1100 nm
Resolution	0.06 -20 nm, depending on configuration (see table)
Stray-light	0.04-0.1%, depending on the grating
Sensitivity	470,000 counts/μW per ms integration time
Detector	CCD linear array, 2048 pixels
Temperature cooled CCD	Max. ΔT = -35 °C versus ambient
Time to stabilize	4 minutes
Dark baseline improvement @ ΔT=-35°C and it>5 sec	> Factor 6
PRNU improvement @ ΔT=-35°C and it>5 sec	> Factor 8
3-stage Peltier cooling internal Power supply @ ΔT=-35°C	5VDC, 3.0A
Signal/Noise	300:1
AD converter	16-bit, 2 MHz
Integration time	1.11 ms – 10 minutes
Interface	USB 2.0 high-speed, 480 Mbps RS-232, 115.200 bps
Sample speed with store to RAM	1.1 ms /scan
Data transfer speed	1.8 ms /scan (USB2) 430 ms/scan (RS-232)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, sync.
Power supply	100-240 VAC, 50W
Dimensions, weight	250 x 179 x 144 mm, 3.6 kg

Our TEC-spectrometers
are kept at a steady 5°C
for maximum precision

Grating selection table for AvaSpec-ULS2048LTEC

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1100**	900**	300	300	UA
UV/VIS/NIR	200-1100**	900**	300	300/1000	UNA-DB
UV/VIS	200-850	520	600	300	UB
UV	200-750	250-220*	1200	250	UC
UV	200-650	165-145*	1800	UV	UD
UV	200-580	115-70*	2400	UV	UE
UV	200-400	70-45*	3600	UV	UF
UV/VIS	250-850	520	600	400	BB
VIS/NIR	300-1100**	800**	300	500	VA
VIS	360-1000	500	600	500	VB
VIS	300-800	250-200*	1200	500	VC
VIS	350-750	145-90*	1800	500	VD
VIS	350-640	75-50*	2400	VIS	VE
NIR	500-1050	500	600	750	NB
NIR	500-1050	220-150*	1200	750	NC
NIR	600-1160	350-300	830	800	SI
NIR	600-1100**	500**	300	1000	IA
NIR	600-1100	500	600	1000	IB

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

** please note that not all 2048 pixels will be used for the useable range

Resolution table (FWHM in nm) for AvaSpec-ULS2048LTEC

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	1.0	1.4	2.5	4.8	9.2	21.3
600	0.40-0.53*	0.7	1.2	2.4	4.6	10.8
830	0.32	0.48	0.93	1.7	3.4	8.5
1200	0.20-0.28*	0.27-0.38*	0.52-0.66*	1.1	2.3	5.4
1800	0.10-0.18*	0.20-0.29*	0.34-0.42*	0.8	1.6	3.6
2400	0.09-0.13*	0.13-0.17*	0.26-0.34*	0.44-0.64*	1.1	2.7
3600	0.06-0.08*	0.10	0.19	0.4	0.8	1.8

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

Ordering Information

AvaSpec-ULS2048LTEC-USB2

- Thermo-Electric Cooled Fiber-optic Spectrometer, 75 mm Ultra-Low Stray-light AvaBench, 2048L pixel 3-stage TE-cooled and regulated CCD detector, USB2 high-speed interface, incl. AvaSoft-Basic, USB cable, desktop housing.
- Specify grating, wavelength range and options

Options

DUV	• Deep-UV detector coating >150 nm
DCL-UV/VIS-200	• Detector Collection Lens to enhance sensitivity, Quartz, 200-1100 nm
SLIT-XX	• Slit size, please specify XX = 10, 25, 50, 100, 200 or 500 μm
OSF-YYY	• Order-sorting filter for reduction of 2nd order effects, please specify YYY= 305, 395, 475, 515, 550 or 600 nm
OSC	• Order-sorting coating with 600 nm long-pass filter for BB (>350 nm) and VB gratings in AvaSpec-ULS2048L, recommended with OSF-305
OSC-UA	• Order-sorting coating with 350 and 600 nm long-pass filter for UA, VA gratings in AvaSpec-ULS2048L
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings in AvaSpec-ULS2048L
-FCPC	• FC/PC fiber optic connector
- RS	• Replaceable Slit

AvaSpec-ULS3648TEC SensLine Thermo-Electric Cooled Fiber-optic Spectrometer

AvaSpec-ULS 3648TEC



The AvaSpec-ULS3648TEC spectrometer is one of the newest spectrometers in the SensLine. The instrument features our re-designed three-stage Peltier cooling device integrated into our exclusive ultra-low stray-light optical bench, which can reduce the temperature of the CCD chip by -35°C against ambient, improving the dark baseline and PRNU level by a significant factor. The detector cooling also reduces the dark noise by a factor of 2-3.

The size of the ULS3648TEC is reduced by more than 35% compared with Avantes previous TEC spectrometers.

The above mentioned features make the AvaSpec-ULS3648TEC an excellent choice for low light-level applications, such as fluorescence and Raman measurements, where integration times of more than 5 seconds may be needed. The AvaSpec-ULS3648TEC can be delivered as 1- or 2-channel instrument and has all the standard options, gratings and specifications of the standard AvaSpec-ULS3648. The AvaSpec-ULS3648TEC is built into a newly designed housing with an integrated temperature regulator, USB2 high-speed communication, dual cooling fans and an integrated power supply.

Technical Data

Optical Bench	ULS Symmetrical Czerny-Turner, 75 mm focal length
Wavelength range	200-1100 nm
Resolution	0.05 –20 nm, depending on configuration (see table)
Stray-light	0.04-0.1%, depending on the grating
Sensitivity	160,000 counts/ μW per ms integration time
Detector	CCD linear array, 3648 pixels
Temperature cooled CCD	Max. $\Delta T = -35^{\circ}\text{C}$ versus ambient
Time to stabilize	4 minutes
Dark baseline improvement @ $\Delta T = -35^{\circ}\text{C}$ and $t > 5$ sec	> Factor 6
PRNU improvement @ $\Delta T = -35^{\circ}\text{C}$ and $t > 5$ sec	> Factor 8
3-stage Peltier cooling internal Power supply @ $\Delta T = -35^{\circ}\text{C}$	5VDC, 3.0A
Signal/Noise	350:1
AD converter	16-bit, 1 MHz
Integration time	10 μs – 10 minutes
Interface	USB 2.0 high-speed, 480 Mbps RS-232, 115.200 bps
Sample speed with store to RAM	3.7 ms /scan
Data transfer speed	3.7 ms /scan (USB2) 750 ms/scan (RS-232)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, sync.
Power supply	100-240 VAC, 50W
Dimensions, weight	250 x 179 x 144 mm, 3.6 kg

Grating selection table for AvaSpec-ULS3648TEC

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1100**	900**	300	300	UA
UV/VIS/NIR	200-1100**	900**	300	300/1000	UNA-DB
UV/VIS	200-850	520	600	300	UB
UV	200-750	250-220*	1200	250	UC
UV	200-650	165-145*	1800	UV	UD
UV	200-580	115-70*	2400	UV	UE
UV	200-400	70-45*	3600	UV	UF
UV/VIS	250-850	520	600	400	BB
VIS/NIR	300-1100**	800**	300	500	VA
VIS	360-1000	500	600	500	VB
VIS	300-800	250-200*	1200	500	VC
VIS	350-750	145-90*	1800	500	VD
VIS	350-640	75-50*	2400	VIS	VE
NIR	500-1050	500	600	750	NB
NIR	500-1050	220-150*	1200	750	NC
NIR	600-1160	350-300	830	800	SI
NIR	600-1100**	500**	300	1000	IA
NIR	600-1100	500	600	1000	IB

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

** please note that not all 3648 pixels will be used for the useable range

Resolution table (FWHM in nm) for AvaSpec-ULS3648TEC

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	0.60 – 0.70*	1.10-1.30*	2.20-2.40*	4.60	9.00	20.0
600	0.30 – 0.36*	0.58-0.68*	1.17	2.20	4.50	10.0
830	0.25	0.48	0.93	1.70	3.40	8.0
1200	0.14 – 0.18*	0.30	0.62	1.08	2.20	5.0
1800	0.09 – 0.11*	0.18	0.36-0.40*	0.78	1.50	3.7
2400	0.07 – 0.09*	0.13 – 0.15*	0.26-0.32*	0.40-0.64*	1.10	2.7
3600	0.05 – 0.06*	0.10	0.19	0.40	0.80	2.0

*depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

Ordering Information

AvaSpec-ULS3648TEC-USB2

- Thermo-Electric Cooled Fiber-optic Spectrometer, 75 mm Ultra-Low Stray-light AvaBench, 3648 pixel 3-stage TE-cooled and regulated CCD detector, USB2 high-speed interface, incl. AvaSoft-Basic, USB cable, desktop housing.
- Specify grating, wavelength range and options

Options

DUV	• Deep-UV detector coating >150 nm
DCL-UV/VIS-200	• Detector Collection Lens to enhance sensitivity, Quartz, 200-1100 nm
SLIT-XX	• Slit size, please specify XX = 10, 25, 50, 100, 200 or 500 μm
OSF-YYY	• Order-sorting filter for reduction of 2nd order effects please specify YYY= 305, 395, 475, 515, 550 or 600 nm
OSC	• Order-sorting coating with 600 nm long-pass filter for BB (>305 nm) and VB gratings in AvaSpec-ULS3648, recommended with OSF-305
OSC-UA	• Order-sorting coating with 350 and 600 nm long-pass filter for UA, VA gratings in AvaSpec-ULS3648
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings in AvaSpec-ULS3648
-FCPC	• FC/PC fiber optic connector
- RS	• Replaceable slit

AvaSpec-ULS2048x64TEC SensLine Thermo-Electric Cooled Fiber-optic Spectrometer

AvaSpec-ULS 2048x64TEC



The AvaSpec-ULS2048x64TEC spectrometer is one of the newest spectrometers in the SensLine.

This instrument enhances the Sensline series. With a cooled, backthinned detector. The backthinned detector has good sensitivity in the UV and IR region. The 64 pixelheight (0.89 mm) enables catching as many photons as possible while the cooling enables long integration times up to 500 seconds with low noise values.

The instrument features our re-designed three-stage Peltier cooling device integrated into our exclusive ultra-low stray-light optical bench, which can reduce the temperature of the CCD chip by -35 °C against ambient, improving the dark baseline and PRNU level by a significant factor. The detector cooling also reduces the dark noise by a factor of 2-3.

The AvaSpec-ULS2048x64TEC-USB2 uses a special low noise version of the 2048x64 detector .

All the features mentioned above make this instrument ideally suited for measuring low light applications like for instance fluorescence.

Optimal flexibility is guaranteed with the (optional) replaceable slit making the instrument suitable for different kind of applications.

The above mentioned make the AvaSpec-ULS2048x64TEC an excellent choice for low light-level applications, such as fluorescence and Raman measurements, where integration times of more than 5 seconds may be needed.

The AvaSpec-ULS3648TEC can be delivered as 1- or 2-channel instrument and has all the standard options, gratings and specifications of the standard AvaSpec-ULS3648. The AvaSpec-ULS3648TEC is built into a newly designed housing with an integrated temperature regulator, USB2 high-speed communication, dual cooling fans and an integrated power supply.

Technical Data

Optical Bench	ULS Symmetrical Czerny-Turner, 75 mm focal length
Wavelength range	200-1160 nm
Resolution	0.09 -20 nm, depending on configuration (see table)
Stray-light	<1%, depending on the grating
Sensitivity	300,000 counts/μW per ms integration time
Detector	Backthinned CCD, 2048x64 pixels, Low Noise
Temperature cooled CCD	Max. ΔT = -35 °C versus ambient. Optimal setting: 5 °C
3-stage Peltier cooling internal Power supply @ ΔT=-35°C	5VDC, 3.0A
Signal/Noise	550:1
AD converter	16-bit, 500 KHz
Integration time	9.7 ms - 500s
Interface	USB 2.0 high-speed, 480 Mbps RS-232, 115.200 bps
Sample speed with on-board averaging	9.7 ms /scan
Data transfer speed	9.7 ms /scan (USB2) 432 ms/scan (RS-232)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, sync.
Power supply	100-240 VAC, 50W
Dimensions, weight	250 x 179 x 144 mm, 3.6 kg

Grating selection table for AvaSpec-ULS2048x64TEC

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1160**	960**	300	300	UA
UV/VIS/NIR	200-1100**	900**	300	300/1000	UNA-DB
UV/VIS	200-850	520	600	300	UB
UV	200-750	250-220*	1200	250	UC
UV	200-650	165-145*	1800	UV	UD
UV	200-580	115-70*	2400	UV	UE
UV	200-400	70-45*	3600	UV	UF
UV/VIS	250-850	520	600	400	BB
VIS/NIR	300-1160**	860**	300	500	VA
VIS	360-1000	500	600	500	VB
VIS	300-800	250-200*	1200	500	VC
VIS	350-750	145-90*	1800	500	VD
VIS	350-640	75-50*	2400	VIS	VE
NIR	500-1050	500	600	750	NB
NIR	500-1050	220-150*	1200	750	NC
NIR	600-1160	350-300	830	800	SI
NIR	600-1160**	560**	300	1000	IA
NIR	600-1160	500	600	1000	IB

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

** please note that not all 2048 pixels will be used for the useable range

Resolution table (FWHM in nm) for AvaSpec-ULS2048x64TEC

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	1.40	1.50	2.5	4.8	9.2	21.3
600	0.70-0.80*	0.75-0.85*	1.2	2.4	4.6	10.8
830	0.42-0.48*	0.50-0.58*	0.93	1.7	3.4	8.5
1200	0.25-0.31*	0.37-0.43*	0.52-0.66*	1.1	2.3	5.4
1800	0.17-0.21*	0.26-0.32*	0.34-0.42*	0.8	1.6	3.6
2400	0.12-0.18*	0.18-0.24*	0.26-0.34*	0.44-0.64*	1.1	2.7
3600	0.09-0.12*	0.11-0.15*	0.19	0.4	0.8	1.8

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

Ordering Information

AvaSpec-ULS2048x64TEC-USB2

- Thermo-Electric Cooled Fiber-optic Spectrometer, 75 mm Ultra-Low Stray-light AvaBench, 2048x64 pixel 3-stage TE-cooled and regulated CCD detector, USB2 high-speed interface, incl. AvaSoft-Basic, USB cable, desktop housing.
- Specify grating, wavelength range and options

Options

DCL-UV/VIS-200

- Detector Collection Lens to enhance sensitivity, Quartz, 200-1100 nm

SLIT-XX

- Slit size, please specify XX = 10, 25, 50, 100, 200 or 500 μm

SLIT-RS

- Replaceable slit with SMA connector. Specify slit size XX=25, 50, 100 or 200 μm

OSF-YYY

- Order-sorting filter for reduction of 2nd order effects, 1 mm thick, please specify YYY= 305, 395, 475, 515, 550 or 600 nm

OSC

- Order-sorting coating with 600 nm long-pass filter for BB (>350 nm) and VB gratings in AvaSpec-2048XL, recommended with OSF-305

OSC-UA

- Order-sorting coating with 350 and 600 nm long-pass filter for UA, VA gratings in AvaSpec-ULS2048XL

OSC-UB

- Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings in AvaSpec-ULS2048XL

-RS

- Replaceable slit for the AvaSpec-ULS2048x64TEC

-FCPC

- FC/PC fiber optic connector

AvaSpec-NIR256/512-1.7(TEC) NIRLine Near-Infrared Fiber-optic Spectrometer

AvaSpec-NIR256-1.7TEC



For measurements in the near infrared range out to 1.7 μm , Avantes offers three spectrometer configurations. The AvaSpec-NIR256-1.7 is the most economical in the NIR-range of spectrometers made by Avantes, but offers exceptional performance specifications such as a sample speed of only 1.06 ms/scan and integration times as fast as 10 μs . This instrument is also available in RS-version meaning you can easily change the slit in a matter of seconds.

The AvaSpec-NIR256/512-1.7 TEC spectrometers are also affordably priced and can be operated in two distinct gain-setting

modes, the high-sensitivity mode (HS, default) and the low-noise (LN) mode. Setting of the different gain modes can be done via a software option.

All NIR-1.7 instruments are available with a choice of four different gratings, making it possible to choose the bandwidth fitting your application. Digital and analog I/O ports enable external triggering and control over the shutter and pulsed light sources from the Avantes line of products. The uncooled AvaSpec-NIR256-1.7 is USB2 powered, while the TEC cooled instruments require external power.

Technical Data

	Spectrometer	AvaSpec-NIR256-1.7	AvaSpec-NIR256-1.7TEC	AvaSpec-NIR512-1.7TEC
	Optical Bench	Symmetrical Czerny-Turner, 50 mm focal length	Symmetrical Czerny-Turner, 50 mm focal length, TE-cooled	
	Wavelength range	900 - 1750 nm		
	Resolution (slit & grating dependent)	2.0 - 50 nm		1.5 - 50 nm
	Stray-light	< 1%	<0.5%	<0.5%
	Sensitivity HS in counts / μ W per ms	1,300,000 (integral 1000-1750 nm)	2,770,000 (integral 1000-1750 nm)	1,385,000 (integral 1000-1750 nm)
	Signal/Noise HS	2000:1	1700:1	1700:1
	Integration time HS	10 μ s – 750 ms	20 μ s – 1 second	20 μ s – 1 second
	Sensitivity LN in counts / μ W per ms	74,000 (integral 1000-1750 nm)	96,000 (integral 1000-1750 nm)	48,000 (integral 1000-1750 nm)
	Signal/Noise LN	6000:1	3600:1	3600:1
	Integration time LN	10 μ s – 8 seconds	20 μ s – 35 seconds	20 μ s – 35 seconds
	Detector	InGaAs linear array, 256 pixels, 50 μ m x 500 μ m	TE-cooled InGaAs linear array, 256 pixels, 50 μ m x 500 μ m	TE-cooled InGaAs linear array, 512 pixels, 25 μ m x 500 μ m
	AD converter	16-bit, 500kHz	16-bit, 2.4 MHz	16-bit, 2.4 MHz
	Interface	USB 2.0 high-speed, 480 Mbps RS-232, 115.200 bps		
	Sample speed with store to RAM	1.06 ms /scan	0.19 ms /scan @ 0.08 ms int. time	0.31 ms /scan @ 0.09 ms int. time
	Data transfer speed	1.56 ms /scan (USB2) 60 ms /scan (RS-232)	1.0 ms /scan (USB2) 60 ms /scan (RS-232)	1.2 ms /scan (USB2) 120 ms /scan (RS-232)
	Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, synchronization		
	Power supply	Default USB power, 350 mA or with SPU2 external 12VDC, 150 mA	100-240 VAC, 50-60 Hz, 35W	
	Dimensions, weight	175 x 165 x 85 mm, 2.2 kg	244 x 144 x 254 mm, 5.1 kg	

Grating selection table for AvaSpec-NIR256/512-1.7

Use	Useable range (nm)	Spectral range (nm)		Lines/mm	Blaze (nm)	Order code
		256	256/512TEC			
NIR	900-1750	850	650	200	1500	NIR200-1.5
NIR	1000-1700	340	250	400	1600	NIR400-1.6
NIR	900-1400	200	n.a.	600	1200	NIR600-1.2
NIR	1300-1600	152	n.a.	600	1600	NIR600-1.6

Resolution table (FWHM in nm) for AvaSpec-NIR256/512-1.7

Grating (lines/mm)	Slit size (μm)				
	25*	50	100	200	500
200	5	6	12	24	50
400	2.5	3	6	12	25
600	n.a.	2	4	8	18

* only for AvaSpec-NIR512TEC

Ordering Information

AvaSpec-NIR256-1.7	Fiber-optic Spectrometer, 50 mm AvaBench, 256 pixel InGaAs detector, USB powered high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable, OSF-850/1000-3. Specify grating, wavelength range and slit
AvaSpec-NIR256-1.7TEC	Fiber-optic Spectrometer, 50 mm AvaBench, 256 pixel InGaAs detector with 2-stage TE cooling, high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable, OSF-850/1000-3. Specify grating, wavelength range and slit
AvaSpec-NIR512-1.7TEC	Fiber-optic Spectrometer, 50 mm AvaBench, 512 pixel InGaAs detector with 2-stage TE cooling, high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable, OSF-850/1000-3. Specify grating, wavelength range and slit

Options

-RS	Replaceable slit for the AvaSpec-NIR256-1.7 only, see page 41
SLIT-XX-RS	Replaceable slit with SMA connector, specify slit size XX=25, 50, 100 or 200 μm, only in combination with the AvaSpec-NIR256-1.7-RS
SLIT-XX-RS-FCPC	as SLIT-XX-RS, but with FC/PC connector
SLIT-XX	Slit size, please specify XX = 25*, 50, 100, 200 or 500 μm

* only for AvaSpec-NIR512TEC

For external triggering Avantes offers the AvaTrigger featuring optical triggering, external TTL or manually through the pushbutton.

AvaSpec-NIR256/512-2.0/2.2TEC

NIRLine Near-Infrared Fiber-optic Spectrometer

AvaSpec-NIR256-2.2TEC



Avantes offers a wide range of NIR spectrometers. The 2.x-series extended InGaAs instruments feature 256 or 512 pixel detectors and are available in configurations enabling measurements up to 2000, 2200 and 2500 nm. Resolution can be as high as 4 nm (on the 512 pixel version) or 10 nm (256 pixel). Integration times can go as low as 10 microseconds. Three different gratings are possible.

A new feature of the NIR-series is the user-selectable gain setting mode: LN (low-noise, standard setting), which gives you a longer integration time and higher signal to noise ratio, or HS (high-sensitivity) for measuring in low-light conditions. This

setting can easily be changed in AvaSoft 8. Analog and digital IO ports enable external triggering and control of shuttered and pulsed light sources from the AvaLight series of illumination sources.

All instrument feature a dual stage thermo-electrical Peltier-cooled InGaAs detector, especially designed for measuring in the NIR range. Connection to the computer is managed through the USB2.0 interface. Data is transferred in 1.0 ms. All instruments are supplied with AvaSoft-Basic, a manual and USB/power cable.

Technical Data

Spectrometer platform	AvaSpec- NIR256-2.0TEC	AvaSpec- NIR256-2.2TEC	AvaSpec- NIR512-2.2TEC
Optical Bench	TE-cooled Symmetrical Czerny-Turner, 50 mm focal length		
Wavelength range	1000 - 2000 nm	1000 - 2200 nm	
Resolution (slit & grating dependent)	6 - 60 nm	6 - 60 nm	4 - 60 nm
Stray-light	< 1%		
Sensitivity HS in counts /μW per μs	70,000 (integral 1000-2000 nm)	77,000 (integral 1200-2200 nm)	38,500 (integral 1200-2200 nm)
Signal/Noise HS	1500:1	1200:1	
Integration time HS	10 μs - 350 ms	20 μs – 1 ms	
Sensitivity LN in counts /μW per μs	4,000 (integral 1000-2000 nm)	2,750 (integral 1200-2200 nm)	1,375 (integral 1200-2200 nm)
Signal/Noise LN	4000:1	4100:1	
Integration time LN	10μs – 6 seconds	20μs – 50 ms	
Detector	InGaAs linear array with 2-stage TE-cooling, 256 pixels	InGaAs linear array with 2-stage TE-cooling, 256 pixels	InGaAs linear array with 2-stage TE-cooling, 512 pixels
Pixel size (WxH)	50 μm x 250 μm	50 μm x 500 μm	25 μm x 500 μm
AD converter	16-bit, 500kHz	16-bit, 2.4 MHz	
Interface	USB 2.0 high-speed, 480 Mbps RS-232, 115.200 bps		
Sample speed with store to RAM	0.54 ms /scan	0.19 ms / scan @ 0.08 ms int.time	0.31 ms / scan @ 0.09 ms int.time
Data transfer speed	1.0 msec /scan (USB2) 60 ms / scan (RS-232)		1.2 msec /scan (USB2) 120 ms / scan (RS-232)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, synchronization		
Power supply	100-240 VAC, 50/60Hz, 35 W		
Dimensions, weight	315 x 235 x 135 mm, 5.1 kg		

Grating selection table for AvaSpec-NIR256/512-2.0/2.2

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
NIR	1000-2200	980	150	2000	NIR150-2.0
NIR	900-1750	750	200	1500	NIR200-1.5
NIR	650	650	200	2600	NIR200-2.6

Resolution table (FWHM in nm) for AvaSpec-NIR256/512-2.0/2.2

Grating (lines/mm)	Slit size (μm)				
	25*	50	100	200	500
150	6	10	15	30	60
200	4	6-8	12	24	50

* only for AvaSpec-NIR512TEC

Ordering Information

AvaSpec-NIR256-2.0TEC

- Fiber-optic Spectrometer, 50 mm AvaBench, 256 pixel InGaAs detector with 2-stage TEC, high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable. Specify grating and wavelength range, OSF-1000, slit

AvaSpec-NIR256-2.2TEC

- Fiber-optic Spectrometer, 50 mm AvaBench, 256 pixel InGaAs detector with 2-stage TEC, high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable. Specify grating and wavelength range, OSF-1000, slit

AvaSpec-NIR512-2.2TEC

- Fiber-optic Spectrometer, 50 mm AvaBench, 512 pixel InGaAs detector with 2-stage TEC, high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable. Specify grating and wavelength range, OSF-1000, slit

Options

SLIT-XX

- Slit size, please specify XX = 25*, 50, 100, 200 or 500 μm

* only for AvaSpec-NIR512TEC

The low-noise/high-sensitivity setting makes your instrument even more versatile

AvaSpec-NIR256-2.5-HSC

NIRLine Near-infrared Fiber Optic Spectrometer



Avantes offers a wide range of NIR spectrometers. The 2.x-series extended InGaAs instruments feature 256 or 512 pixel detectors and are available in configurations enabling measurements up to 2000, 2200 and 2500 nm. The -HSC is the improved version of the AvaSpec-NIR2.5TEC and offers improved sensitivity, less weight and less size. It is based on a 100mm optical bench with a NA of 0.13 offering optimal balance between resolution and sensitivity. A range of gratings are available offering the possibility to tailor the instrument for optimal performance in your application.

Also available on the -HSC is the user selectable gain setting mode: LN (low-noise, standard setting), which gives you a longer integration time and higher signal to noise ratio, or HS (high-sensitivity) for

measuring in low-light conditions. Analog and digital IO ports enable external triggering and control of shuttered and pulsed light sources from the AvaLight series of illumination sources.

The instrument features a dual stage thermo-electrical Peltier-cooled InGaAs detector, especially designed for measuring in the NIR range. Connection to the computer is managed through the USB2.0 interface. Data is transferred in 1.1 ms. All instruments are supplied with AvaSoft-Basic, a manual and USB/power cables.

The instrument is equipped with a replaceable slit which offers you great flexibility for your experiment.

Technical Data

Spectrometer platform	AvaSpec-NIR256-2.5-HSC
Optical Bench	TE-cooled Symmetrical Czerny Turner, 100 mm focal length
Wavelength Range	1000 - 2500 nm
Resolution (slit & grating dependent)	4.8-77 nm
Stray-light	<1.0%
Sensitivity HS in counts / μW per ms (1000-2500 nm)	995,000
Signal/Noise HS	1400:1
Integration time HS	10 μ s -5ms
Sensitivity LN in counts / μW per ms (1000-2500nm)	57,500
Signal/Noise LN	3685:1
Integration time LN	10 μ s -100ms
Detector	InGaAs linear array with 2-stage TE-cooling, 256 pixel
Pixel size (WxH)	50x250 μ m
AD converter	16 bit, 500kHz
Interface	USB2.0 high speed, 480Mbps / RS232, 115.200 bps
Sample speed with on-board averaging	0.54 ms/scan (USB2)
Data transfer speed	1.11ms/scan (USB2)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, TLL trigger, synchronization
Power supply	12 V, 40W
Temperature range	0- 55 °C
Cooling	45 °C versus ambient
Dimensions, weight	185 x 145 x 185 mm, 3.5 kg.

Grating selection table for AvaSpec-NIR256-2.5-HSC

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
NIR	1000-2500	1500	75	1700	NIR075-1.7
NIR	1000-2500	1173 - 1150*	100	2500	NIR100-2.5
NIR	1000-2500	800 - 660*	150	2000	NIR150-2.0
NIR	1000-2500	815 - 700*	150	2600	NIR150-2.6
NIR	1000-2500	574 - 530*	200	1500	NIR200-1.5

*Depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

Resolution table (FWMH in nm) for AvaSpec-NIR256-2.5-HSC

Grating (lines/mm)	Slit size (μm)			
	50	100	200	500
75	12.1	15.7	30.8	77.0
100	9.5	12.4	21.0	52.5
150	6.4	8.3	14.0	35.0
200	4.8	6.1	10.6	26.5

Ordering Information

AvaSpec-NIR256-2.5-HSC

- Fiber-optic Spectrometer, 100 mm AvaBench, 256 pixel InGaAs detector with 2-stage TEC, USB powered, high-speed USB2 interface, incl. AvaSoft-Basic, USB interface cable. Specify grating, wavelength range, OSF-1000, slit

Options

SLIT-XX-RS

- Slit size, please specify XX = 50, 100, 200 or 500 μm
- Values shown are typical values

This instrument is perfect for grain, corn, wheat, soya and other analysis.

AvaSpec Dual-Channel Fiber-optic Spectrometer

AvaSpec-ULS3648-2-USB2



Sometimes a single channel spectrometer is not enough, for example when you want higher resolution or to do two redundant measurements at the same time. The AvaSpec dual channel spectrometers are designed specifically for this purpose. Each spectrometer can be configured independently. It is also possible to have different detector types in each channel.

Please contact one of our application specialists to configure the perfect solution for your application.

Technical Data

Connections	2 x USB2.0
	2 x DB26 (DIO/RS232)
	2 x SMB (synch)
	2 x power connector
Dimensions, weight	175 x 165 x 85 mm, 1800 grams

Ordering Information

AvaSpec-DDDD-2-USB2	Dual-channel AvaSpec-USB2 Fiber-optic Spectrometer with 2 channels with the same detector in one housing, including synchronization cable. For both channels specify Detector type DDDD (128/ULS2048/ULS3648/ULS2048L/2048XL), grating, wavelength range and options.
AvaSpec-MMMM/SSSS-2-USB2	Dual-channel AvaSpec-USB2 Fiber-optic Spectrometer with 2 channels with different detectors in one housing, including synchronization cable. For both channels specify Detector type MMMM and SSSS (128/ULS2048/ULS3648/ULS2048L/ULS2048XL), grating, wavelength range and options.

Pre-configured spectrometers can be shipped within 24 hours

AvaSpec Multi-Channel Spectrometer

Do you need more precise measurements over a broad range? Or multiple measurements at the same moment for process control? AvaSpec multi-channel spectrometers fulfill your every need. You can select from our range of spectrometer detectors, choose different slits or gratings: anything is possible.

Two enclosure options are available: the 9" desktop housing for up to 4 channels and the 19" rack-mountable which holds a maximum of 10 spectrometers. All channels are connected to the computer through one single USB 2.0-cable.

Benefits:

- Combine up to 10 channels in one enclosure
- Any channel fully configurable to your needs
- Different integration times and averaging settings for each channel
- Ideal for process control



Technical Data

Housing	Desktop	Rack-mount
Max nr. Channels	4	10 (UV/VIS)
Dimensions	315 x 235 x 135 mm (d x w x h)	315 x 445 x 135 mm

Ordering Information

AVS-DESKTOP-USB2	• Desktop for USB2 platform multichannel AvaSpec, incl. channel synchronization, USB2-hub and 100-240VAC power supply, supports max. 4 Rack-mount spectrometer units.
AVS-RACKMOUNT-USB2	• 19" Rack-mount for USB2 platform multichannel AvaSpec, incl. channel synchronization, USB2-hub and 100-240VAC power supply, supports max. 10 Rack-mount spectrometer units.
AvaSpec-DDDD-USB2-RM	• Rack-mount Unit USB2 Fiber-optic Spectrometer, self powered high-speed USB2 interface, incl. AvaSoft-Basic software, USB cable and sync cable, specify detector type DDDD (128/ULS2048/ULS3648/ULS2048L/ULS2048XL/NIR256/512), grating, wavelength range and options. Desktop/Rack-mount needs to be ordered separately

Synchronize all channels
easily with
internal sync cables

AvaSpec-UV/VIS/NIR: Broadband Spectrometer



Avantes introduces this versatile broadband spectrometer, suited for various measurements in the complete UV/VIS/NIR area. This all comes in one package, no separate units necessary. This dual spectrometer is suited for 200-1700 nm.

This solution for versatile needs is an ideal companion in the areas Bioscience, Medical Diagnoses, Semiconductor & Solar Industry, Food & Agriculture, Geology & Mineralogy, Pharmaceutical Industry,

Environmental Science, Forensic analysis, and many more.

The first channel is based on a AvaSpec-ULS2048L. The second channel is based on Avaspec-NIR256-1.7 (uncooled version). Both with replaceable slit option. Available configurations are similar to the options of both spectrometer models mentioned. Detailed info please check these data-sheets.

Technical data

	2 x USB2.0
	2 x DB26 (DIO/RS232)
	2 x SMB (synch)
Dimensions, weight	250 x 144 x 179 mm, 4.1 kg
Power supply	Default USB power, 250/350 mA

Ordering Information

AvaSpec-UV/VIS/NIR	- Dual Channel Broad Band Spectrometer consisting of: - Channel 1: UV/VIS Spectrometer based on the 2048L detector with replaceable slit - Channel 2: NIR Spectrometer based on the uncooled 1.7 detector with replaceable slit - Incl.: USB cables, Sync cable, Avasoft-Basic - Excl.: Options for both channels (grating, settings, slit, etc.) - For both channels specify grating, wavelength range and options
Ordering Example	- AvaSpec-UV/VIS/NIR - Channel 1: Grating - UA set for 200-1100nm, DUV, OSC-UA, Slit-25-RS - Channel 2: Grating NIR200-1.5 set for 950-1700nm, Slit-50-RS - Avasoft-Full

AvaSpec Stand-alone Fiber-optic Spectrometer

Any Avantes AvaSpec spectrometer can operate in stand-alone mode in which the spectrometer is not connected to a computer. The stand-alone mode is developed for process control applications, in which the spectrometer must output analog or digital signals that can be directly coupled to Programmable Logical Controllers (PLC) in a process control environment.

In order to get the desired stand-alone functionality of a spectrometer, it is important to define functions in which the parameters that need to be controlled can be measured.

These functions can be defined as (max. 8) History Channel Functions and the output values as 8 digital TTL-functions for which

thresholds can be set using the AvaSoft-PROC process control software. Two functions can also be used to output an 8-bit analog value in the 0-5V Voltage range. After a successful implementation using a PC connected spectrometer, Avantes can be contacted to implement the desired functions into the firmware on-board of the USB2 platform spectrometer. Since most of this functionality is customer-specific, please contact our Technical Sales-Department for more information.



Technical Data Stand-alone mode

Spectrometer	All AvaSpec-USB2 platform spectrometers
Power consumption	5-12 VDC, 155 mA
Measurement speed	2 ms (spectrometer and function dependent)
Analog in	2 channel, 0-5 VDC, 10-bit
Digital In	3 Digital in (TTL level) 1 External hardware Trigger
Analog out	2 channel, 0-5VDC, 8-bit
Digital out	10 programmable Digital out TTL level, 0 or 5VDC, max 10 mA 1 external strobe digital out, 1 laser trigger digital out

Ordering Information

Stand-alone	One time NRE cost to implement desired functionality in AvaSpec-USB2 spectrometer
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For external triggering Avantes offers the AvaTrigger featuring optical triggering, external TTL or manually through the pushbutton.

AvaRaman Bundle



Raman Spectroscopy allows obtaining individual spectral 'fingerprints' of materials. Commonly used in chemistry, pharmaceutical and medical fields, to provide information by which molecules can be identified.

To offer our customers optimal performance for a reasonable price, Avantes joint forces with 2 partners to offer you a Raman Bundle consisting of a great spectrometer (3 different models), a unique Laser-Probe combination (785nm) supplying enhanced signals and an outstanding Software package to analyze the Raman spectra.

These 3 Bundles have in common:

For excitation:

AvaLaser785 (incl.: 785 nm laser safety goggles). It has an ultra-high throughput integrated Raman probe. This novel device includes an integrated wavelength stabilized laser source with Raman filter packs, beam shaping optics and high efficiency Raman spectra collection optics.

For Analysis:

Panorama-Light: Panorama Light is a modular, high-end software platform for spectroscopic data evaluation. The application meets all requirements for a comprehensive spectroscopy working environment, offering:

- Measurement with an instrument
- 2D & 3D data visualization
- Searching in libraries
- Archiving in spectral libraries, including additional information

For Detection:

We offer state of the art spectrometers based on the Avantes Star- and SensLine spectrometers, tailored for optimal performance in the Raman range of interest.

Type of measurements:

Raman techniques are used for many different materials. The Avantes bundles are really good for the use of powders and liquids. When strong signals are available (aromatic compounds, alcohol based liquids) in general Ava-Raman-A is useful to perform the measurement.

When weak Raman signals occur (Integration time longer than 5 seconds) the thermo-electric-cooled (TEC) spectrometer is recommended. This is added in the Ava-Raman-B.

For very weak signals (possibly together with fluorescence background) the Ava-Raman-C is recommended. Thanks to Higher quantum efficiency in NIR and better signal /noise performance.

Ordering Information

AvaRaman-A

Based on an uncooled spectrometer this is the entry bundle for reasonable strong signals

- Range : 150 cm^{-1} - 3600 cm^{-1}
- Resolution: 6 cm^{-1}
- AvaSpec-ULS2048L-USB2 set for (788-1100nm), slit-25, DCL-UV/VIS200, FC-PC connector)
- Also including: AvaLaser785 (incl. probe), AvaRaman software: Panorama Light
- Optional: Replaceable slit (add -RS)

AvaRaman-B

Based on the cooled version of the spectrometer offered in the bundle Ava-Raman-A. Cooling enables you to work with longer integration times, yet keeping the thermal noise limited.

- Range : 150 cm^{-1} - 3600 cm^{-1}
- Resolution: 6 cm^{-1}
- AvaSpec-ULS2048L-TEC-USB2 set for (788-1100nm), slit-25, DCL-UV/VIS200, FC-PC connector)
- Also including: AvaLaser785 (incl. probe) AvaRaman software: Panorama Light
- Optional: Replaceable slit (add -RS)

AvaRaman-C

For the most demanding applications. The spectrometer used in this bundle makes use of a cooled spectrometer with a special low-noise Back-Thinned detector. Back thinned detectors have much better sensitivity in the NIR range (800-1160nm) in comparison to standard Si-detectors.

- Range : 150 cm^{-1} - 3600 cm^{-1}
- Resolution: 6 cm^{-1}
- AvaSpec-ULS2048x64TEC-USB2 set for (788-1100nm), slit-25, DCL-UV/VIS200, FC-PC connector)
- Also including: AvaLaser785 (incl. probe) AvaRaman software: Panorama Light
- Optional: Replaceable slit (add -RS)

Raman spectroscopy:

- Analysis of liquids, powders, tablets, gels
- Measurements through transparent and semi-transparent packages

AvaRaman Fiber-optic Raman System

Raman spectroscopy is especially useful for reaction monitoring, product identification, remote sensing and the characterization of highly scattering particulate matter in aqueous solutions. Based on the principle discovered by Prof. Chandrasekhara Venkata Raman, it measures the result of the inelastic scattering of photons.

Avantes uses the high-sensitivity AvaSpec spectrometers in combination with a 532 nm, 633 nm or 785 nm laser to give you the best result for your Raman measurements. The spectrometers are appropriately configured according to the wavelength of the laser.

AvaRaman-TEC series spectrometers have a three-stage Peltier cooling systems, which provides ΔT down to -30°C cooling

to ambient for superior dark noise reduction, keeping the detector at a steady 5°C . Thanks to the PID controller, this temperature is stable within a 0.1°C bandwidth. All AvaRaman systems are delivered with special AvaSoft-Raman software. Complementary Panorama-Pro software is available for Raman interpretation and functional group assignment.

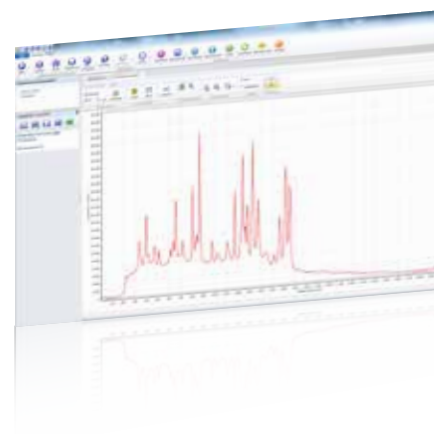
A selection of different probes is available to select the right one for your application. For more information on our software solutions including AvaSoft-Raman and Panorama-Pro, please refer to the software pages in this catalog.



Technical Data

	AvaRaman-532TEC	AvaRaman-785TEC
	Cooled	Cooled
Signal to noise Ratio	200:1 for Benzene	300:1 for Benzene
Resolution*	$\pm 6 \text{ cm}^{-1}$	$\pm 6 \text{ cm}^{-1}$
Spectrometer	AvaSpec-ULS2048L-TEC with grating NC (535-752 nm), slit-25, DCL-UV/VIS TE-cooled	AvaSpec-ULS2048L-TEC with grating SI (785-1080 nm), slit-25, DCL-UV/VIS-200 TE-cooled
Raman Shift	100-5400 cm^{-1}	100-3500 cm^{-1}
Laser output	532 nm, 50 mW	785 nm, 500 mW, Class 3b
Laser Wavelength	532 nm	785 nm
Laser Bandwidth	$< 0.1 \text{ nm}$	$< 0.2 \text{ nm}$
Dimensions housing	240 (L) x 140 (W) x 250 (H) mm	

* typical resolution: higher resolution possible on request



Pre-configured spectrometers can be shipped within 24 hours



AvaRaman probes

AvaRaman-PRB-XXX

3/8" SS low-cost focusing probe with a 200 μm excitation fiber and 400 μm read fiber. Multiple focal lengths available (5 mm, 7.5 mm (standard), 10 mm). It can withstand 80°C. Manual shutter included, 1.5 m fibers. Specify XXX=excitation wavelength

AvaRaman-PRB-FP-XXX

1/2" SS focusing probe with a 200 μm excitation fiber and 400 μm read fiber. Multiple focal lengths available (5 mm (standard), 7.5 mm, 10 mm). It can withstand 80°C. Specify XXX=excitation wavelength

AvaRaman-PRB-FIP-XXX

5/8" SS immersible focusing probe for in-situ measurements with a 200 μm excitation fiber and 400 μm read fiber. It can withstand 200°C. Specify XXX=excitation wavelength

AvaRaman-PRB-FC-XXX

3/8" SS immersible process probe for in-situ measurements with a 200 μm excitation fiber and 400 μm read fiber. It can withstand 500°C and 3000psi, the probe optics provide complete background filtering. Specify XXX=excitation wavelength

Ordering Information

Consisting of following elements:

- Solid state 500 mW laser 532 nm, FWHM 0.2 nm
- TE-cooled AvaSpec-ULS2048L-TEC-USB2 Spectrometer with 1200 lines/mm grating set 535-752 nm, 25 μm slit, DCL-UV/VIS
- AvaSoft-Raman stand-alone software for the AvaRaman system, AvaRaman-GL-532 laser safety goggles

AvaRaman-532-TEC-USB2

Consisting of following elements:

- Solid state 500 mW laser 785 nm, FWHM 0.2 nm
- TE-cooled AvaSpec-ULS2048L-TEC-USB2 Spectrometer with 830 lines/mm grating set 785-1080 nm, 25 μm slit, DCL-UV/VIS-200
- AvaSoft-Raman stand-alone software for the AvaRaman system, AvaRaman-GL-785 laser safety goggles

AvaRaman-785TEC-USB2

Different Raman probes available, please see table above

Other accessories

AvaRaman-SH-3/8"

- Rugged sample holder for secure positioning of 3/8" Raman probes

AvaRaman-SH-1/2"

- Rugged sample holder for secure positioning of 1/2" Raman probes

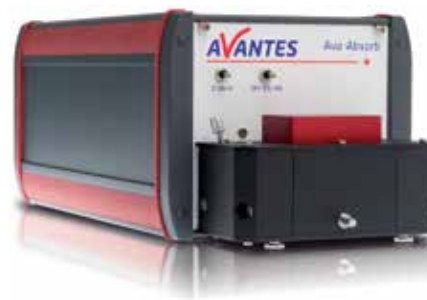
AvaRaman-Calibrationtile

- PTFE White tile in holder for 3/8" Raman probe

AvaAbsorb

The AvaAbsorb system was designed for those situations in which you would like to do consecutive sample and reference measurements in a controlled environment. This setup is normally referred to as dual beam spectroscopy. No fiber cables are used and drifting of the light source is automatically corrected in AvaSoft. It has two cuvette holders in the front, which can be covered to prevent any interference of light. The selection between the two paths is easily done through AvaSoft or the front side switch. The path length is variable up to 60 mm, making low concentration measurements possible.

Inside, the AvaAbsorb features the AvaSpec-ULS2048L spectrometer (VA300-1100nm; Slit 50), combined with an AvaLight-HAL series Halogen light source. This means easy measurements in the visible and near infrared range. The spectrometer features extra high detector pixels, giving better signal-to-noise ratio and long term stability.



Technical Data

Path length	Up to 60 mm
Light beam diameter	3 mm
Cuvette dimensions	Up to 60 mm long Up to 12 mm wide
Wavelength range	300-1100 nm
Resolution	2,5 nm
Stray-light	0.1%
Photometric range	Up to 2,5 AU
Detector	CCD linear array, 2048 pixels
Signal/Noise	300:1
AD converter	16-bit, 2 MHz
Integration time	1.11 ms – 10 minutes
Interface	USB 2.0 high-speed, 480 Mbps RS-232, 115.200 bps
Sample speed with on-board averaging	1.1 ms /scan
Data transfer speed	1.8 ms /scan (USB2) 430 ms/scan (RS-232)
Power supply	110-220 V

Ordering Information

AvaAbsorb-2048L-HAL

- Absorbance system for two (flow) cuvette's, Avalight-HAL and ULS2048L spectrometer integrated. Full automatic measurement possible, AvaSoft-FULL and CHEM included.

AvaSpec Spectrometer Interface Cables

Interface cables



Avantes offers a wide range of cables to connect your AvaSpec spectrometer to an AvaLight series light source or one of our many accessories (Fiber-optic switches, AvaTrigger, etc).

In the table below, the cable options for your light source or accessory application can be found. Please note that the cables generally are 2 meters long, but custom lengths are available on request.

USB2 platform spectrometers (dB26 / SMB connector)

Connect to	Product code	Description
RS-232	IC-DB26/DB9-2	Interface cable AvaSpec-USB2 platform DB26 male to RS232 DB9 female cable, 2 m
USB2	IC-USB2-2	Interface cable AvaSpec to USB port on PC, 2 m
AvaLight-S / AvaLight-XE	IC-DB26-2	Interface cable AvaSpec-USB2 platform to DB15 for AvaLight-S with shutter for auto-save dark/ lamp off, AvaLight-XE control
BNC-Ext. hardware trigger	IC-DB26-EXTRIG-BNC-2	Interface cable AvaSpec-USB2 platform to BNC plug External trigger, 2 m
External Hardware Trigger	IC-Extrig-USB2	Interface cable AvaSpec-USB2 to External trigger pushbutton, 2 m
RS-232 AvaLight-S / AvaLight-XE	IC-DB26/DB9/DB15-2	Interface Y cable AvaSpec-USB2 platform to RS-232 (DB9) and AvaLight-S (DB15) with shutter for auto save dark/ lamp off, AvaLight-XE control
Avalight-S / Avalight-XE External Hardware Trigger	IC-DB26-Extrig-USB2	Interface Y-cable AvaSpec-USB2 to External trigger pushbutton and AvaLight-S with shutter, 2 m
Avalight-S FOS-2	IC-DB26-FOS2-2	Interface Y-cable AvaSpec-USB1 platform to FOS-2 and AvaLight-S with shutter, 2 m
Other USB2 spectrometer	IC-COAX-SMB-0.25	Synchronization coax cable with 2 SMB connectors 0.25 m for AvaSpec USB2 platform

AvaSpec Services and Calibrations

Wavelength Calibration

All AvaSpec spectrometers come standard with a wavelength calibration and coefficients, to calculate wavelength from pixel number. This information is installed on-board, on the AvaSpec's EEPROM. Under normal conditions the wavelength calibration does not need to be redone, since the spectrometers have no moving elements inside. If a wavelength shift is measured versus the original wavelength calibration, the spectrometer can be recalibrated by the end-user, using the AvaLight-CAL and the auto-calibration software routine in AvaSoft-Full. As an option the spectrometer can also be returned to Avantes for recalibration, (Spectral-cal-service). Before returning the spectrometer an RMA authorization number needs to be obtained.

Non-linearity Calibration

Most detectors of the AvaSpec spectrometers have a good linear behavior in their detector response, which means that there is a better than 95% correlation between raw signal in A/D counts and the light intensity at the spectrometer entrance. However for some applications, which require a wide dynamic range, such as highly absorbing substances or low light level applications, combined with a need for high accuracy, a non-linearity calibration of the detector is recommended. This NL-calibration is performed on the detector array and the output signal is linearized to better than 99%. A complete calibration report and the calculated NL calibration coefficients are delivered with the spectrometer. For irradiance calibrations the NL-calibration is automatically included.

Irradiance Calibration

Applications that use spectrometers to measure the light energy of radiant sources require an irradiance-calibrated spectrometer. For all AvaSpec spectrometers



both irradiance and radiance NIST traceable calibrations can be offered. Irradiance calibrations ($\mu\text{W}/\text{cm}^2$) are normally performed on a system with a fiber-optic cable and a cosine corrector or integrating sphere. Radiance calibrations ($\mu\text{W}/\text{cm}^2/\text{sr}$) can be performed on a spectrometer and a bare fiber or fiber with collimating lens looking at a diffuse illuminated surface. The (ir)radiance calibrations can be performed over 3 different wavelength ranges, UV (200-400 nm), VIS (360-1100 nm) and NIR (1100-2500 nm). All systems are calibrated against a NIST traceable irradiance calibration standard and come with a complete report and calibration files, which are stored on the EEPROM of the spectrometer and can be loaded directly into the AvaSoft-IRRAD software module to obtain irradiance parametric measurements.

More information on irradiance can be found in the software section (AvaSoft-IRRAD) and the section Applications - Irradiance Measurements.

As an alternative to Avantes irradiance calibration services, irradiance calibrated light sources, such as AvaLight-DHS-CAL and AvaLight-HAL-CAL-Mini are available to perform your own irradiance calibration.

Ordering Information

Spectral-cal-service	• Spectral calibration service for an AvaSpec, incl. calibration sheet
NL-calibration	• Non-linearity calibration service (per channel)
IRRAD-CAL-UV	• Irradiance calibration service UV range (200-400 nm) per channel, incl. NL-calibration, needs AvaSoft-Full, AvaSoft-IRRAD and -SR fibers
IRRAD-CAL-VIS	• Irradiance calibration service VIS range (360-1100 nm) per channel, incl. NL-calibration, needs AvaSoft-Full and AvaSoft-IRRAD
IRRAD-CAL-NIR	• Irradiance calibration service NIR range (1100-2500 nm) per channel, incl. NL-calibration, needs AvaSoft-Full and AvaSoft-IRRAD
IRRAD-CAL-UV/VIS	• Irradiance calibration service UV/VIS range (200-1100 nm) per channel, incl. NL-calibration, needs AvaSoft-Full, AvaSoft-IRRAD and -SR fibers

OEM Spectrometer: AS-5216 Microprocessor board



The AS-5216 microprocessor board provides both flexibility and ease of integration. It features high-speed USB 2.0 communication and can be used in combination with the following detectors:

- Sony ILX554B and ILX511B
- TAOS 1401
- Toshiba 1304
- Hamamatsu S11155/S7031 and G92xx series with/without TEC
- Sensors Unlimited 256 and 512

The board is equipped with an HD26 digital I/O connector with 13 programmable I/O port (3 digital in, 10 digital out), 2 analog out ports and 2 analog in ports. One digital out port is generally used to control the flash rate of an AvaLight-XE pulsed Xenon light source, another digital out it used to control external TTL-shutter devices and a third is reserved for external control for flashing a laser source in LIBS applications. A digital in may be used for external hardware triggering. A maximum of 127 AS-5216s can be coupled and synchronized through the USB 2.0 interface. This means easy and simultaneous sampling of 2-127 channels. The AS-5216 board can be synchronized with other

AS-5216 boards to control the simultaneous data-sampling of multiple channels, all connected to USB2.0 high-speed interface. On-board signal processing allows data reduction to speed up scan transfer time. Data reduction can be achieved by defining a start and stop pixel and On-Board Averaging.

This board is compatible with the extensive AS-5216-DLL software development kit, enabling full control over the spectrometer in customer-designed software.

Technical specifications AS5216

Microprocessor	Coldfire® 5216, 32-bit, 64 MHz
Memory	512 KB Flash Memory, 64KB RAM
A/D converter	16-bit, 2 channels for video signal
Integration time	2 µs – 10 minutes (detector dependent)
Data Transfer speed	1.8 ms/scan for Sony ILX554 2048 pixels, 2 MHz
	1.8 ms /scan for Sony ILX511 2048 pixels, 2 MHz
	1.1 ms/scan for TAOS 1401 2 MHz
	3.7 ms /scan for Toshiba TCD1304, 1 MHz
	2.09 ms/scan for Hamamatsu S11155, 1 MHz
	5.22 ms/scan for Hamamatsu S7031, 250 kHz
USB interface	1.56 ms/scan for Hamamatsu 92XX, 500 kHz
	1.0 ms/scan for Sensors Unlimited NIR, 2.4 MHz
USB interface	2.0 high-speed, 480 Mbps
RS-232 interface	Baudrate 115200 bps, HD-26 female connector
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, synchronization
Power supply	Default USB power, 350 mA
	12 VDC, reverse polarity protection, 150 mA
Temperature range	0- 55 °C
Dimensions, weight	162,5 x 100 mm, 97 grams

Ordering Information

AS-5216	• Microprocessor board 16-bit AD and USB2.0/RS-232 interface. Specify detector type, see below
----------------	---

For all boards, specify detector type

- ILX	for Sony ILX554B detectors (AvaSpec-ULS2048-USB2)
-ILX511	for Sony ILX511B detectors (AvaSpec-ULS2048L-USB2)
- TAOS128	for TAOS 1401 detectors (AvaSpec-128-USB2)
- TOS3648	for Toshiba 1304 detectors (AvaSpec-3648-USB2)
- HAM2048XL	for Hamamatsu S11155 detectors (AvaSpec-ULS2048XL-USB2), extra pcb incl.
HAM1024x58/122	for Hamamatsu S7031 detectors (AvaSpec-HS1024x58/122-USB2), extra pcb incl.
- NIR256	Hamamatsu G92xx series InGaAs NIR detectors (AvaSpec-NIR256-1.7)
- NIR256TEC	Hamamatsu G92xx series with TEC InGaAs NIR detectors (AvaSpec-NIR256-2.0/2.5TEC), extra pcb incl.
-NIRSU256	Sensors Unlimited 256 InGaAs NIR detectors (AvaSpec-NIR256-1.7/2.2TEC)
-NIRSU512	Sensors Unlimited 512 InGaAs NIR detectors (AvaSpec-NIR512-1.7/2.2TEC)

OEM Spectrometer: ASC-5216 Microprocessor board

The ASC-5216 is the smallest OEM electronics board Avantes offers. It can be used with the Sony (ILX511, ILX554B) and Toshiba (TCD-1304) CCD detectors. Featuring the same powerful 5126 Coldfire® processor as used in the AS-5216, it's equipped with a Hirose ST60-36p connector. It has 12 programmable IO ports (3 DI, 9 DO), 2 analog out ports and 2 analog in ports. One digital out port is used for controlling the flash rate of an external Xenon strobe (AvaLight-XE), one digital out port is used to control external TTL-shutter devices, one digital output is reserved for external control for flashing a laser source in LIBS applications. One digital in is used for external hardware triggering.

The ASC-5216 board can be synchronized with other ASC-5216 boards to control the simultaneous data sampling of multiple channels, all connected to USB2.0 high-speed interface.

On-board signal processing allows data reduction to speed up scan transfer time. Data reduction can be achieved by defining a start and stop pixel and On-Board Averaging. The board can be operated by the extensive AS-5216-DLL software development kit with many functions to control the electronics board and data sampling parameters.



Technical specifications ASC-5216

Microprocessor	Coldfire® 5216, 32-bit, 64 MHz
Memory	512 KB Flash Memory, 64KB RAM
A/D converter	16-bit, 2 channels for video signal
Integration time	2 µs – 10 minutes (detector dependent)
Data Transfer speed	1.8 ms/scan for Sony ILX554/511B 2048 pixels, 2 MHz 3.7 ms /scan for Toshiba TCD1304, 1MHz
USB interface	2.0 high-speed, 480 Mbps
RS-232 interface	Baudrate 115200 bps,
Digital IO	Hirose ST60-36P connector, 2 Analog in, 2 Analog out, 3 Digital in, 9 Digital out, trigger, synchronization, TTL
Power supply	Default USB power, 350 mA 12 VDC, reverse polarity protection, 350 mA
Temperature range	0 - 55 °C
Dimensions, weight	113.8 x 81 mm, 90 gr.

Ordering Information

ASC-5216	Microprocessor board 16-bit AD and USB2.0/RS-232 interface. Specify detector type
IC-USB2-MINI	Interface cable ASM-5216 to USB2, shielded

OEM Spectrometer: AS-7010 Microprocessor board



The AS-7010 is the all new electronic platform and the base for Avantes' future spectrometer models.

It is equipped with a powerful Xilinx Zynq 7010 microprocessor. It combines the software programmability of a Processor with the hardware programmability of an FPGA, resulting in unrivalled levels of system performance and flexibility. The generous 100 Mpixel memory enables onboard storage of spectra and custom programming. Equipped with 2 different AD converters optimal performance for each detector type is assured.

The AS-7010 comes with the ability of 2 communication ports: High Speed USB3.0 and GigaEthernet.

Also on board is the HD26 digital I/O connector with 13 programmable digital I/O ports, 2 analog out ports and 2 analog in ports. The connector is compatible with the AS-5216 I/O connector.

Technical specifications AS7010

Microprocessor	Xilinx Zynq 7010
Memory	100 Mpixel
A/D converter	16-bit, 2 channels for video signal / 16-bit, high end – low noise (detector dependent)
Integration time	2 μ s – 10 minutes (detector dependent)
Data Transfer speed	1.1 ms/scan for Sony ILX511 2048 pixels (USB3.0) 3.8 ms /scan for Sony ILX511 2048 pixels (ETH)
USB interface	3.0 high-speed, 5 Gbps
ETHERnet interface	Giga Ethernet, 1 Gbps
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital bidirectional, trigger, synchronization, strobe, laser
Power supply	Default USB3.0 power, 500 mA 12 VDC, reverse polarity protection, 300 mA
Temperature range	0- 55 °C
Dimensions, weight	162,5 x 100 mm, 97 grams

Ordering Information

AS-7010	Microprocessor board 16-bit AD and USB3.0/Ethernet interface. Specify detector type, see below
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For all boards, specify detector type

- ILX511	for Sony ILX511B detectors (AvaSpec-ULS2048L-EVO)
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OEM spectrometer: AvaBench Optical Bench

AvaSpec optical benches are available with or without one of our electronics boards for integration into customer's systems. Avantes has developed four types of UV/VIS optical benches, especially for OEM customers. The optical benches AvaBench-45 (StarLine), AvaBench-75-ULS (used in both StarLine and SensLine), AvaBench-75-ULSTEC (SensLine) and AvaBench-37.5-HS (SensLine) are Czerny-Turner designs with fiber-optic entrance connectors (Standard SMA, others possible), collimating and focusing mirrors and a diffraction grating. A choice of different gratings with different dispersions and blaze angles enable applications in the 200-1100 nm range. The newly designed high numerical aperture AvaBench-37.5-HS has full mechanical compatibility for mounting holes with the AvaBench-75-ULS, so for OEM customers it is easy to upgrade to a higher-throughput optical bench.

AvaBench-75-ULS



Wavelength ranges, resolution tables, detector specifications and AvaBench options can be found in the instrument page corresponding to each spectrometer type. In the table below the detailed key specifications can be found. All AvaBench optical benches are fully compatible with Avantes electronics board or may be interfaced to customer specific electronics. Video output is handled through a separate mini-coax cable.

Technical Data

	AvaBench-45	AvaBench-75-ULS	AvaBench-75-ULSTEC	AvaBench-37.5-HS
Implemented in	AvaSpec-128	AvaSpec-ULS2048/3648/2048L/2048XL/2048x16/64	AvaSpec-ULS2048LTEC/ULS3648TEC	AvaSpec-HS1024x58/122TEC/2048XL
Focal length	45 mm	75 mm	75 mm	37.5 mm asym.
Numerical aperture	0.11	0.07	0.07	0.22
Wavelength range	350-1100 nm	200-1160 nm	200-1100 nm	200-1160 nm
Resolution (FWHM)	1.5 -64 nm	0.05 - 20 nm	0.05 - 20 nm	1.2 -20 nm
Stray-light	< 0.3%	0.04-0.1%	0.04-0.1%	<1%
Gratings	different	different	different	different
Slits	25, 50, 100, 200, 500 µm	10, 25, 50, 100, 250, 500 µm	10, 25, 50, 100, 250, 500 µm	25, 50, 100, 200, 500 µm
Detector	TAOS 128	SONY 2048(L) / TOSHIBA 3648 /HAM 2048XL/2048x16/64	SONY 2048L / TOSHIBA 3648	HAM 1024x58/122/2048XL
Detector lens	VIS, for TAOS only	UV/VIS	UV/VIS-200	n.a.
Order-sorting filter	See options	See options	See options	See options
Dimensions, weight	82 x 72 x 20 mm, 130 gr.	120 x 91 x 21 mm, 350 gr.	120 x 91 x 62 mm, 760 gr.	95 x 152 x 42 mm, 722 gr

Download the latest software for your AvaSpec at www.avantes.com

Ordering Information

AvaBench-45-128-U2	• OEM optical bench, 45 mm focal length, 128 pixel PDA detector. Specify grating, wavelength range and options.
AvaBench-75-ULS2048-U2	• OEM ultra-low stray-light optical bench, 75 mm focal length, 2048 pixel CCD detector. Specify grating, wavelength range and options.
AvaBench-75-ULS3648-U2	• OEM ultra-low stray-light optical bench, 75 mm focal length, 3648 pixel CCD detector. Specify grating, wavelength range and options.
AvaBench-75-ULS2048L-U2	• OEM ultra-low stray-light optical bench, 75 mm focal length, 2048 pixel CCD detector. Specify grating, wavelength range and options.
AvaBench-75-ULS2048XL-U2	• OEM ultra-low stray-light optical bench, 75 mm focal length, 2048XL pixel back-thinned CCD detector. Specify grating, wavelength range and options.
AvaBench-75-ULS2048x16-U2	• OEM ultra-low stray-light optical bench, 75 mm focal length, 2048x16 pixel back-thinned CCD detector, specify grating, wavelength range and options
AvaBench-75-ULS2048x64-U2	• OEM ultra-low stray-light optical bench, 75 mm focal length, 2048x64 pixel back-thinned CCD detector, specify grating, wavelength range and options
AvaBench-75-ULS2048LTEC-U2	• OEM ultra-low stray-light optical bench, 75 mm focal length, TE-cooled 2048 large pixel detector. Specify grating, wavelength range and options.
AvaBench-75-ULS3648TEC-U2	• OEM ultra-low stray-light optical bench, 75 mm focal length, TE-cooled 3648 large pixel detector. Specify grating, wavelength range and options.
AvaBench-37.5-HS2048XL-U2	• OEM High-sensitivity optical bench, 37.5 mm focal length, 2048XL pixel back-thinned CCD detector, specify grating, wavelength range and options
AvaBench-37.5-HS1024x58TEC-U2	• OEM High-sensitivity optical bench, 37.5 mm focal length, 1024x58 pixel TE-cooled back-thinned CCD detector. Specify grating, wavelength range and options.
AvaBench-37.5-HS1024x122TEC-U2	• OEM High-sensitivity optical bench, 37.5 mm focal length, 1024x122 pixel TE-cooled back-thinned CCD detector. Specify grating, wavelength range and options.

The grating can only be changed by Avantes.
Therefore, choose your grating wisely.
Our application specialists are available to support you with your choice.
In general, a higher resolution means a lower bandwidth.
By combining multiple spectrometers
in our AvaSpec-Dual or rack-mountable versions,
you can create one virtual spectrometer with high-resolution
and high bandwidth.

ULSi : Integrated Miniature Spectrometer

The same quality Avantes is well-known for, now in an easy-to-install package: the ULSi is the ideal choice for any system integrator. Fiber optic spectrometers have been integrated into many end-user systems in almost all areas of research and detection. Now Avantes releases its first completely integrated spectrometer: one housing including the optimum Ultra Low Straylight optical bench and a miniaturized

version of our flexible AS5216 electronics board. The ULSi is available with the three best-selling detectors Avantes offers: the Sony ILX554B with 2048 pixels, the Sony ILX511 with 2048 high pixels for extra sensitivity and the Toshiba TCD1304 high resolution 3648 pixels. The same wide range of slits, gratings and other options available in the mainline spectroscopy lineup are also available for the ULSi.



Technical Data

Microprocessor	Coldfire, 5216, 32 bit, 64 MHz
Memory	512 KB Flash Memory, 64KB RAM
A/D converter	16 bit, 2 channels for video signal
Integration time	2 μ s - 10 minutes (detector dependent)
Data Transfer speed	Detector dependent 1-5 ms
USB interface	2.0 high speed, 480 Mbps
RS-232 interface	Baudrate 115200 bps
Digital IO	36 pin Samtec connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, synchronization
Power supply	Default USB power, 350 mA 12 VDC, reverse polarity protection, 350 mA
Temperature range	0- 55 °C
Dimensions, weight	90 x 120 x 35 mm, 580 gr.

Note: For optical specifications see AvaSpec-ULS3648 and AvaSpec-ULS2048(L)

Ordering Information

AvaSpec-ULSi2048-USB2	• OEM integrated ultra-low stray-light optical bench, 75 mm focal length, 2048 pixel CCD detector, specify grating, wavelength range and options
AvaSpec-ULSi3648-USB2	• OEM integrated ultra-low stray-light optical bench, 75 mm focal length, 3648 pixel CCD detector, specify grating, wavelength range and options
AvaSpec-ULSi2048L-USB2	• OEM integrated ultra-low stray-light optical bench, 75 mm focal length, 2048 pixel CCD detector, specify grating, wavelength range and options

OEM spectrometer: AvaBench NIR Optical Bench

AvaBench-50



For OEM applications in the NIR, Avantes AvaBench-50 and AvaBench-100 offers our line of AvaBench NIR optical benches. The AvaBench-50 optical bench is available in the 1000-1750 nm range for uncooled detectors. The AvaBench-50TEC is developed for NIR range from 1000-2200 nm with thermo-electric cooling. The AvaBench-50TEC supports two different TE-cooled detectors with 256 pixels and two TE-cooled detectors with 512 pixels.

New in the line is the AvaBench-100TEC. A 100mm optical bench offering optimal balance between optical throughput and resolution. To keep the size compact it has a uniquely folding mirror in it. All AvaBench NIR optical benches have symmetrical Czerny-Turner designs with a fiber-optic entrance connector (Standard SMA, others possible), collimating and a special designed focussing mirror and diffraction grating. A choice of different NIR gratings can be selected with the products.

Wavelength ranges, resolution tables, detector specifications and AvaBench options can be found in the instrument page corresponding to each spectrometer type. In the table below the key specifications of

the NIR optical benches are listed. The NIR AvaBenches are fully compatible with Avantes electronics boards or may be interfaced to customer specific electronics. The NIR optical benches have a separate video output through a mini-coax cable. The TEC NIR benches have a heatsink and additional electrical connections for both temperature sensor and power for the 2-stage Peltier cooling.

Technical Data

	AvaBench-50	AvaBench-50TEC	AvaBench-100TEC
Implemented in	AvaSpec-NIR256-1.7	AvaSpec-NIR256-1.7TEC AvaSpec-NIR256-2.0/2.2 AvaSpec-NIR512-1.7/2.2TEC	AvaSpec-NIR256-2.5-HSC
Focal length	50 mm	50 mm	100 mm
Numerical aperture	0.24	0.24	0.14
Wavelength range	1000-1750 nm	1000-2200 nm	1000-2500 nm
Resolution (FWHM)	2-50 nm	1.5-90 nm	4.8-77 nm
Stray-light	< 1%	< 0.5%	< 0.5%
Gratings	different	different	different
Slits	50, 100, 200, 500 µm	25, 50, 100, 250, 500 µm	50, 100, 250, 500 µm
Detector	HAM-NIR256-1.7	SU-NIR256/512-1.7 HAM-NIR256-2.0 SU-NIR256/512-2.2	HAM-NIR256-2.5
TE Cooling	No	Yes	Yes
Order-sorting filter	OSF-850-3/OSF-1000-3	OSF-1000-3 and OSC-NIR for 2.2	OSF-1000-3 and OSC-NIR
Dimensions, weight	100 x 130 x 40 mm, 875 gr.	177 x 125 x 108 mm / 2.5 Kg	185 x 145 x 185 mm, 3.5 kg.

Ordering Information

AvaBench-50-NIR256-1.7	• OEM optical bench with AS-5216 interface, 50 mm focal length, 256 pixel InGaAs detector. Specify grating, wavelength range and slit, OSF-850-3 or OSF-1000-3.
AvaBench-50-NIR256-1.7TEC	• OEM optical bench with AS-5216 interface, 50 mm focal length, 256 pixel TE-cooled InGaAs detector. Specify grating, wavelength range and slit, OSF-850-3 or OSF-1000-3.
AvaBench-50-NIR512-1.7TEC	• OEM optical bench with AS-5216 interface, 50 mm focal length, 512 pixel TE-cooled InGaAs detector. Specify grating, wavelength range and slit, OSF-850-3 or OSF-1000-3.
AvaBench-50-NIR256-2.0TEC	• OEM optical bench with AS-5216 interface, 50 mm focal length, 256 pixel TE-cooled InGaAs detector 2.0 µm. Specify grating, wavelength range and slit, OSF-1000-3.
AvaBench-50-NIR256-2.2TEC	• OEM optical bench with AS-5216 interface, 50 mm focal length, 256 pixel TE-cooled InGaAs detector 2.2 µm. Specify grating, wavelength range and slit, OSF-1000-3, OSC-NIR.
AvaBench-100-NIR256-2.5TEC	• OEM optical bench with AS-5216 interface, 100 mm focal length, 512 pixel TE-cooled InGaAs detector 2.2 µm. Specify grating, wavelength range and slit, OSF-1000-3, OSC-NIR.

OEM Spectrometer: Enclosure

For OEM customers Avantes offers a line of neutral black enclosures in which either 1 or 2 channel spectrometers can be integrated.

The black enclosures have mounting ears and are available in single and dual channel housing.

Both the AvaBench-45/75 and the AS-5216 electronic board fit into the 1-channel OEM housing. In 2-channel OEM housings 2 AvaBenches and 2 electronics boards will fit easily.



Technical Data

Product	AVS-HOUSING-IND	AVS-HOUSING-DUAL-IND
Material	Black aluminum	
Size	203 x 106 x 50 mm	203 x 106 x 93 mm
Weight	40 grams	55 grams

Ordering Information

AVS-HOUSING-IND	• Neutral black aluminum housing to fit AvaBench-45/75 and AS-5216 board with mounting ears
AVS-HOUSING-DUAL-IND	• 2-channel Neutral black aluminum housing to fit 2 AvaBench-45/75 and 2 AS-5216 board with mounting ears

Software



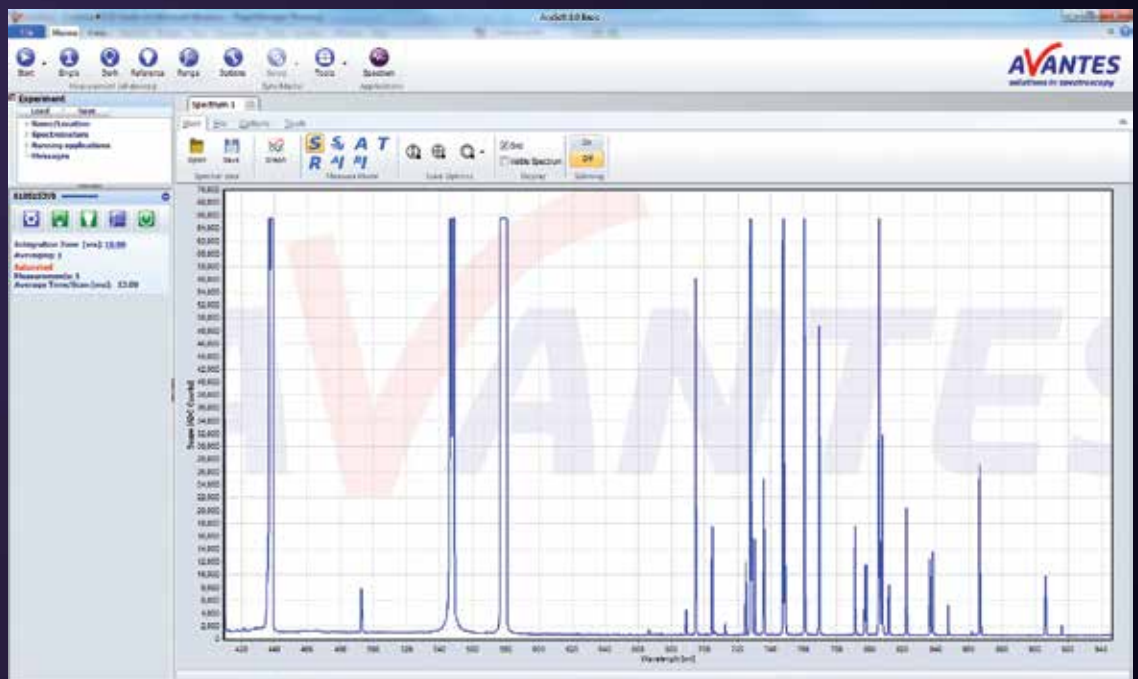
INTRODUCTION

AvaSoft is a software package that can be used to control all Avantes spectrometers and a wide range of accessories. The latest version can be used with Windows XP up to Windows 10. Since the initial version of AvaSoft in 1996, a major upgrade has been released at least once a year, featuring new options and possibilities.

Our state of the art modular software is available as a scalable platform:

- AvaSoft-Basic: Everything needed for basic measurements and controlling your AvaSpec series spectrometer, including basic data acquisition. Basic allows you to save and display data in the following modes: scope, transmission, absorption and relative irradiance.
- AvaSoft-Full: Includes all possibilities of AvaSoft-Basic and adds many other options, such as history channel functions, auto-calibration procedures and external triggering.
- Application add-on modules for AvaSoft-Full enable special measurement procedures: color measurements, absolute irradiance, chemometrics, process control and real-time export to Excel.
- AvaSoft-All, which includes AvaSoft-Full and all add-on application modules in one package.
- Stand-alone AvaSoft packages for pre-configured systems, such as AvaSoft-Raman for our Raman line of systems and AvaSoft-Thinfilmm for measurements with the AvaThinfilmm system.
- Dynamic Link Library (DLL) interface packages with support for basic spectrometer control, color measurements and irradiance measurements.

Visit our website at www.avantes.com to download the latest version of the AvaSoft spectroscopy software free of charge. When no spectrometer is connected to the computer, AvaSoft will start in demo-mode, making it ideal to try out our software. In demo-mode, the software will work as AvaSoft-Full, making it possible to test spectrometer functions and display and analyze spectra offline.



AvaSoft-Basic Software

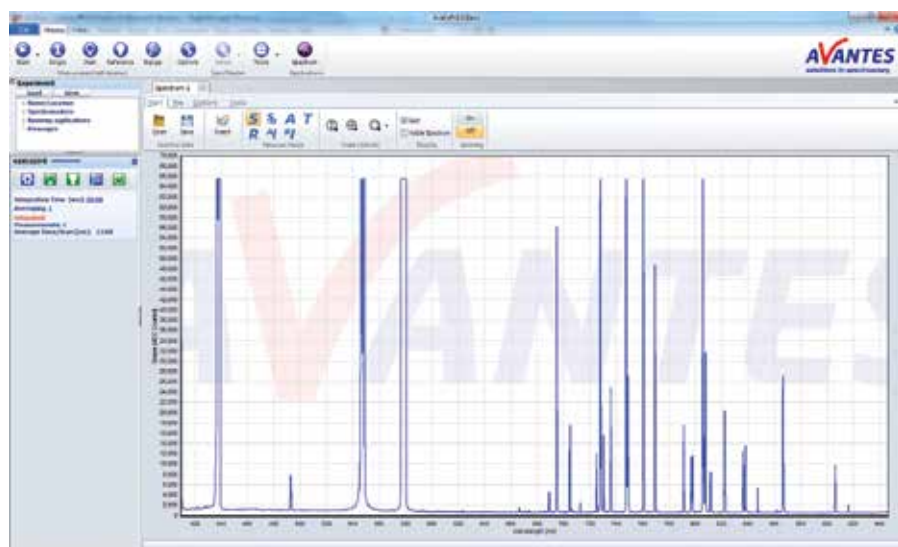
To facilitate the use of our AvaSpec series spectrometers, we provide our AvaSoft-Basic, free of charge. It features user-friendly controls, pull down menus and is mouse oriented. Mouse clicks control movements of a data cursor for instantaneous readout of wavelength, pixel and Y-axis magnitude. The multi-window and multi-monitor interface enables side by side comparison of measurements. Use mouse dragging for easy and fast zoom-in/out on both X and Y axes. An unlimited number of AvaSpec series spectrometers can be connected to the computer, either through USB or, by using the AvaGigE, through the network.

In the main window, controls for on-line/off-line spectral analysis are available. Software icons facilitate easy saving of reference, dark and experiment spectra. Additionally, changing the measurement units to absorbance, transmittance, irradiance or raw scope data can be done with one click of the mouse. Rescaling the Y-axis, setting the scale for X- and Y-axis and peak/valley searching are also available.

Instrument control and data collection parameters are user-definable, such as detector integration time, auto-dark correction, signal averaging and spectral smoothing. Saved graphics can be exported to ASCII and be exported into Excel and other data processing software.

Other options are a 3D display functionality and the option to save a graph directly as a PDF-file. File management features flexible file filters.

The latest version of AvaSoft-Basic can be downloaded from the Avantes website. Please contact us for upgrading to AvaSoft-Full or -All.



Ordering information

- | | |
|----------------------|---|
| AvaSoft-Basic | <ul style="list-style-type: none"> • Free Basic Spectrometer software for Windows XP through 8 |
|----------------------|---|

For the latest information,
go to www.avantes.com

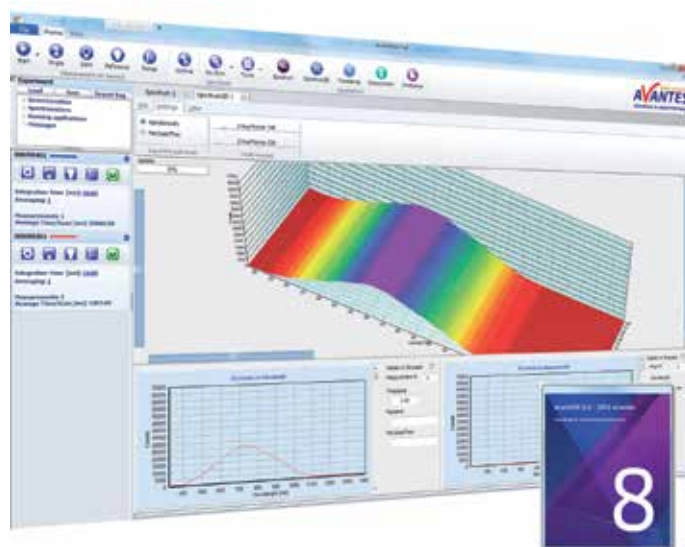
AvaSoft-Full and AvaSoft-All

AvaSoft-Full

The AvaSoft-Full version offers many more possibilities and options than AvaSoft-Basic. In the table below you can find the similarities and differences between the two versions.

AvaSoft-All

For the greatest flexibility, AvaSoft-All includes AvaSoft-Full and all application modules described in the subsequent pages. This means you can do color, irradiance, chemometry measurements, process control and real-time exporting to Excel all in one convenient software package.



Comparison AvaSoft-Basic and AvaSoft-Full

	Basic	Full
Editable data collection parameters per channel, such as detector integration time, auto-dark correction, signal averaging, spline interpolation and spectral smoothing.	X	X
Display data in scope-, transmittance-, absorbance-, or relative irradiance mode. Multiple spectrometer channels are displayed in the same graph, optional grid display. 3D display for multiple spectra in time series.	X	X
Zoom-, (Auto)scale- and panning functions to expand quickly an interesting part of the spectrum (both X- and Y-axis) to the full graph, save graph to a wide variety of file formats.	X	X
Mouse drag controls movement of a data cursor for instantaneous readout of wavelength- and Y-axis magnitude. Peak finder for moving cursor fast to nearest peak.	X	X
Save spectra, and display online measurements against (multiple) saved spectra background. Print (multiple) spectra in color. Convert saved spectra to ASCII format in equidistance (nm) with start wavelength in nm.	X	X
Help menu option to find quickly a description about any AvaSoft topic.	X	X
History Channel Application, in which the output of user defined functions, integrals, peaks (intensity, wavelength) can be followed simultaneously against time. Functions can be entered in Visual-Basic script. Time series measurements can be saved/loaded and printed. Zoom- and panning functions can be applied to expand quickly an interesting part of the time series measurement to the full graph.		X
Auto Wavelength Calibration. In combination with a Mercury-Argon Light Source, a number of peaks can be detected automatically. These peaks are then compared with the wavelengths where they should have been detected, and a regression fit is performed to calculate the best wavelength calibration coefficients.		X
Correct for drift. Master and slave channels with similar range can be used to correct for changes in the light source.		X
Automatic save spectra periodically (save a spectrum every x seconds).		X
Store to RAM for ultrafast Data saving for a limited amount of scans.		X
External Trigger control to acquire spectral data only if a TTL signal is presented with optional integration time delay settings.		X
Convert spectra to J-CAMP format for further data processing e.g. in GRAMS32.		X
Convert spectra to Excel, multiple spectra in one file, multiple channels in worksheets.		X
Merging spectra of multiple channels to one spectrum.		X
Full Width Half Max calculations, online or on saved spectra. Graphically displayed.		X
Integral calculations, online or on saved spectra, graphically displayed.		X
Auto-configure integration time: AvaSoft searches for an optimal integration time.		X
Automatic Save Dark by TTL shutter.		X
Auto-detect saturated pixels in a spectrum, optionally autocorrect inverted saturated pixels, optionally visualize saturated pixels and log saturated wavelength regions in time series.		X
LIBS application.		X

Custom made modifications are possible, please contact us for more details.

Ordering information

AvaSoft-Full	• Full version AvaSpec software for Microsoft Windows XP through 8
AvaSoft-All	• Full version AvaSpec software, including all applications

AvaSoft - Color



For online and offline reflective color measurements, AvaSoft-COL is the ideal companion. This application provides a precise way to perform color measurements using the basic principles and techniques defined by the International Commission on Illumination (CIE). The CIE 1976 $L^*a^*b^*$ color parameters are calculated, along with other parameters, like Hue, Chroma and X, Y, Z.

These parameters can be displayed in a CIELAB chart or in a graph versus time. Another possibility is saving the measured $L^*a^*b^*$ values to an online database and using one of the products from the database as a reference color. Color differences (ΔE_{Lab} , ΔL^* , Δa^* , or Δb^*) are made through comparing the measured $L^*a^*b^*$ values to the stored database values.

The color of an object can be expressed by the CIE 1976 ($L^*a^*b^*$) color space. L^* describes the brightness of the color. A positive value of a^* describes the redness of the color, a negative a^* the greenness. Similarly, yellowness is a positive b^* , where blue is a negative b^* . The $L^*a^*b^*$ values are derived from the CIE tristimulus values X, Y and Z of the sample (object) and the standard illuminant tristimulus values X_n , Y_n and Z_n .

The standard illuminant tristimulus values for X_n , Y_n , and Z_n are constant and depend only on the type of standard illuminant that has been chosen.

The CIE tristimulus values X, Y and Z of the color of an object are obtained by multiplying the relative power P of a standard illuminant, the reflectance R (or the transmittance) of the object, and the 1931 or 1964 CIE standard observer functions x_n , y_n and z_n (2 and 10 degree angles). The integral of these products over all the wavelengths in the visible spectrum (380 to 780 nm with a 5 nm interval) gives the tristimulus values.

Color chart

The color chart display features:

- Display in CIELAB chart, the actual sample color as well as the reference color with the corresponding ΔE_{Lab} , ΔL^* , Δa^* , or Δb^* values are displayed and saved as well.
- The settings for the LAB chart display can be changed, such as no graphical display of reference and sample color in order to speed up the measurements.
- The standard observer angle is selectable for 2° or 10° .
- The reference color can be saved to and loaded from a color database. The database contains, apart from all color parameters, a product ID and a display of the actual color. The database can be sorted alphabetically or in either value column.

Time series

The time series display has following features:

- Display in time series can be selected for any number of channels.
- For each channel a color parameter (L^* , a^* , b^* , hue, C, X, Y, Z, ΔE_{Lab} , ΔL^* , Δa^* , or Δb^*) can be selected. For each channel a different reference color can be selected, enabling color sorting.
- For each channel the time axis can be set to a different scale, allowing simultaneous display of long time and short term monitoring of the same parameter.
- For each channel the actual measured color, as well as the reference color (if in ΔE_{Lab} , ΔL^* , Δa^* , or Δb^* mode) is displayed.
- The saved time series data can be displayed with extensive zooming and dragging options.

Ordering information

AvaSoft-COL	• Color application add-on software, to be ordered with AvaSoft-Full
COLOR-DLL	• 32-bit DLL for Color application (see COLOR-DLL)

AvaSoft - Irradiance

Avantes spectrometers measure radiated optical energy, which can be quantified as a radiant flux, in energy per second (Watt) radiated from a source. The radiated optical energy can also be correlated with human vision (photometry), as defined in the CIE, to obtain a spectral luminous efficiency function to characterize the vision of an average human observer.

An Avantes irradiance calibrated spectrometer system can measure both radiometric as well as photometric quantities. Radiometric quantities are radiant energy (in Joule), Radiant power or flux (in Watt) or irradiance (Watt per cm^2). Related photometric quantities are luminous flux (lumen) or illuminance (lux or lumen per m^2).

The measured spectral distribution is used to calculate the above-mentioned parameters. An intensity calibrated light source such as those in Avantes' factory calibration laboratory or our field calibration lamps, the AvaLight-HAL-CAL or AvaLight-DH-CAL, with known energy output (in $\mu\text{Watt}/\text{cm}^2/\text{nm}$) are used as a reference. Calibrations can be performed at Avantes' factory laboratory or in the field and stored on the EEPROM of the spectrometer (or an independent file) for future usage. AvaSoft-IRRAD Software is required for either type of calibration.

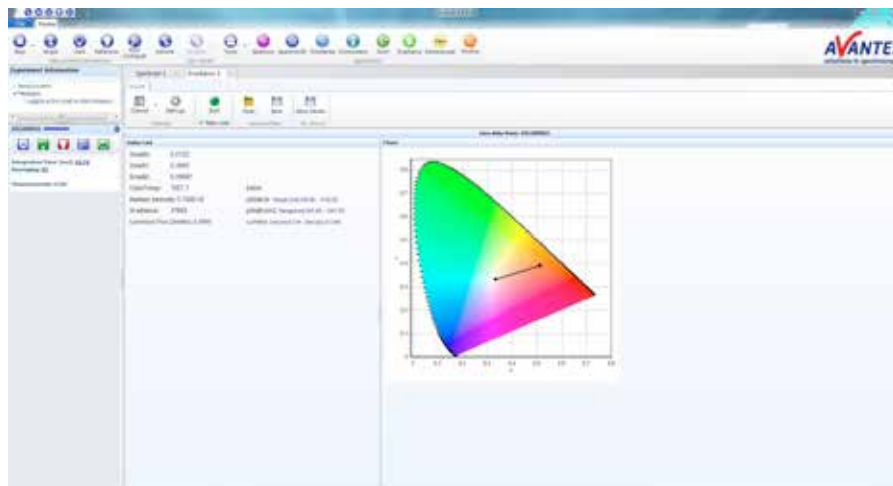
The color of light parameters can be expressed by the chromaticity coordinates x, y and z. These chromaticity coordinates are obtained by taking the ratios of the tristimulus values (X, Y and Z) to their sum. The tristimulus values X, Y and Z and the spectral irradiance are computed in a wavelength range from 380 nm to 780 nm, using a 1 nm interval. These parameters, as well as the coordinates u and v, and the color temperature of an external light source can be calculated and displayed in real-time in the AvaSoft-IRRAD module.

The CRI color-rendering index of a light source is also included in the AvaSoft IRRAD module. The color rendering index of a light source with a color temperature <5000K is a measure of how close a light source matches a perfect black body radiant. Additionally AvaSoft-IRRAD features a setting for auto-adjusting the integration time during a time sequence measure-

ment, so a large dynamic range can be achieved for applications that have both a very high light level and a very low light level, such as solar measurements.

AvaSoft-IRRAD enables two ways to display and save calculated output:

- Data can be displayed as spectral irradiance in $\mu\text{Watt}/\text{nm}$ versus wavelength. Additionally, the following output parameters can be displayed: radiometric quantities $\mu\text{Watt}/\text{cm}^2$, $\mu\text{Joule}/\text{cm}^2$, μWatt or μJoule , photometric quantities Lux or Lumen, color coordinates X, Y, Z, x, y, z, u, v, color rendering index and color temperature, and number of photons $\mu\text{Mol}/\text{s}\cdot\text{m}^2$, $\mu\text{Mol}/\text{m}^2$, $\mu\text{Mol}/\text{s}$ and μMol . The AvaSoft-IRRAD module also displays raw data in Scope mode as well as the X-Y Chromaticity diagram, including parameters, which are useful for LED measurements, such as: Dominant Wavelength, Purity, Central Wavelength, Peak Wavelength, Centroid, etc.
- In Time Measurement mode, any number of functions can be displayed simultaneously against time. For each function, a different radiometric, photometric, photon or color coordinate output parameter and/or wavelength range may be selected, as well as a different spectrometer channel.



Ordering information

AvaSoft-IRRAD
IRRAD-DLL

- Irradiance application add-on software, to be ordered with AvaSoft-Full
- 32-bit DLL for Irradiance/LED application

AvaSoft - Chemometry

The AvaSoft-CHEM module enables online concentration determination with a spectroscopy system. Lambert-Beer's law states there is a linear relationship between absorbance and concentration:

$$A = e * c * l$$

where A is the absorbance (or extinction), e is the extinction coefficient of the compound to be measured, c is the concentration and l is the optical path length.

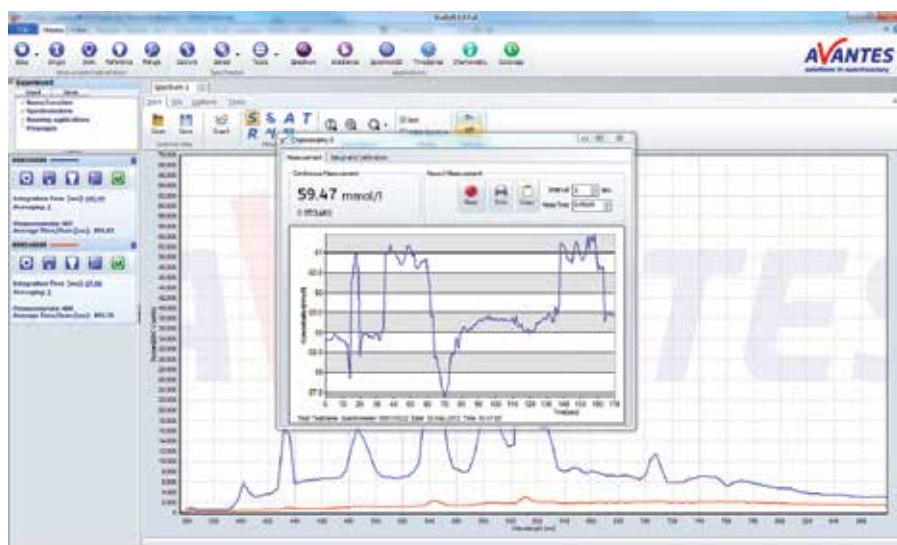
In practice this relation is only linear at rea-

sonably low absorbance levels (less than 2 Au). To measure the absorbance, a few samples with known concentrations are needed. It is important to always measure the absorbance at the same wavelength and use more samples of different concentrations in order to provide a better chemometric model.

The absorbance values are used in AvaSoft-CHEM to create a linear (or second order - quadratic) calibration line. This calibration line is then used to measure the concentration of unknown samples or to measure the change in concentration over time.

AvaSoft-CHEM can display and save the calculated concentration in the following ways:

- Online display of concentration in a separate display window
- Up to eight history channel functions can be selected to display and save concentration values against time. This application can be combined with the Excel and Process-Control applications.



Ordering information

AvaSoft-CHEM

- Chemometry application add-on software for concentration measurements, to be ordered with AvaSoft-Full

Download the latest software for your AvaSpec series spectrometer at www.avantes.com

Exporting in Real-time to Excel with AvaSoft

AvaSoft-Full supports post-process conversion of a saved spectrum to Excel, but to directly export to Excel in real-time, AvaSoft-XLS is required. This add on module enables the output of history channel data and/or complete spectra to Microsoft Excel in real-time. Due to the OLE (Object Link Embedding)-Automation, it enables remote control over Excel, including opening sheets and copying data into cells.

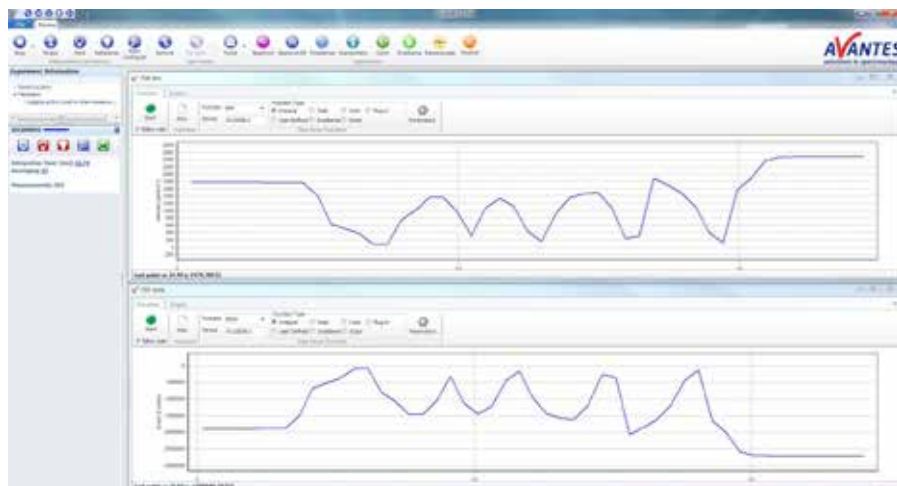
Two modes are available:

- Exporting data online to Excel workbooks; for each spectra or function output a new column or row is created. After a pre-defined number of scans, the export is stopped and the file is saved.
 - Exporting data to a fixed position in a predefined Excel worksheet. This works in an overwrite mode; each output is copied to the same position as the previous one.
- The user can now address those data cells from other applications, such as Labview or Matlab, enabling on-line data processing and analyses.

The output functions to be exported can be history channel functions, color parameters (with AvaSoft-COL), irradiance parameters (in combination with AvaSoft-IRRAD) and chemometric parameters (with AvaSoft-CHEM).

	A1	B	C	D	E	F	G	H	I
1	Time	21/06/2012 09:28:47	21/06/2012 09:28:48	21/06/2012 09:28:48	21/06/2012 09:28:49	21/06/2012 09:28:50	21/06/2012 09:28:50	21/06/2012 09:28:51	21/06/2012 09:28:51
2	Standard error	33826643	33827536	33828300	33829071	33829595	33830266	33830958	33831650
3	Wavelength (nm)								
4	340.50	1200.7	1204.3	1207.9	1211.5	1215.1	1218.7	1222.3	1225.9
5	340.85	1201.7	1205.3	1208.9	1212.5	1216.1	1219.7	1223.3	1226.9
6	341.00	1202.7	1206.3	1209.9	1213.5	1217.1	1220.7	1224.3	1227.9
7	341.35	1203.7	1207.3	1210.9	1214.5	1218.1	1221.7	1225.3	1228.9
8	341.67	1204.7	1208.3	1211.9	1215.5	1219.1	1222.7	1226.3	1229.9
9	342.01	1205.7	1209.3	1212.9	1216.5	1220.1	1223.7	1227.3	1230.9
10	342.26	1206.7	1210.3	1213.9	1217.5	1221.1	1224.7	1228.3	1231.9
11	342.55	1207.7	1211.3	1214.9	1218.5	1222.1	1225.7	1229.3	1232.9
12	342.88	1208.7	1212.3	1215.9	1219.5	1223.1	1226.7	1230.3	1233.9
13	343.14	1209.7	1213.3	1216.9	1220.5	1224.1	1227.7	1231.3	1234.9
14	343.43	1210.7	1214.3	1217.9	1221.5	1225.1	1228.7	1232.3	1235.9
15	343.72	1211.7	1215.3	1218.9	1222.5	1226.1	1229.7	1233.3	1236.9
16	344.02	1212.7	1216.3	1219.9	1223.5	1227.1	1230.7	1234.3	1237.9
17	344.31	1213.7	1217.3	1220.9	1224.5	1228.1	1231.7	1235.3	1238.9
18	344.60	1214.7	1218.3	1221.9	1225.5	1229.1	1232.7	1236.3	1239.9
19	344.90	1215.7	1219.3	1222.9	1226.5	1230.1	1233.7	1237.3	1240.9
20	345.18	1216.7	1220.3	1223.9	1227.5	1231.1	1234.7	1238.3	1241.9
21	345.48	1217.7	1221.3	1224.9	1228.5	1232.1	1235.7	1239.3	1242.9
22	345.77	1218.7	1222.3	1225.9	1229.5	1233.1	1236.7	1240.3	1243.9
23	346.07	1219.7	1223.3	1226.9	1230.5	1234.1	1237.7	1241.3	1244.9
24	346.36	1220.7	1224.3	1227.9	1231.5	1235.1	1238.7	1242.3	1245.9

AvaSoft - Process Control



The AvaSoft-PROC software module enables the user to define minimum and maximum threshold values for all time series functions. These can be user-defined functions, integrals or peak values (intensity, wavelength) as defined in the history application. In combination with AvaSoft-CHEM, AvaSoft-COL and/or AvaSoft-IRRAD, the process control functions can be facilitate chemometric, color and/or irradiance parameter measurements.

AvaSpec series spectrometers feature eight on-board TTL-output signals that will respond when the user defined thresholds for the time series functions are exceeded. In an industrial environment, these TTLS can be connected directly to PLCs. Two of the History Channel Functions are also available to be converted to analog outputs of 0-5V.

Ordering information

AvaSoft-PROC

- Process control application add-on software, to be ordered with AvaSoft-FULL. Controls 8 on-board TTL output signals.

Fiber-optic Multiplexer Control Software

In order to facilitate customized software development for the Avantes Fiber-optic Multiplexer, Avantes has developed a DLL package. It enables full control over the multiplexer, allowing one to set all parameters:

- Find reference position (mandatory after power-up and after the stop command)
- Go to channel, move the disk to a specified optical channel from 1 to 16
- Go to step, the disk can move 360 degrees from the reference position. With this feature the position of the disk can be set by the number of steps from

the reference position. The 360 degrees are divided in 3200 motor steps.

- Immediately stop the motor,
- Get status, which will return the status, power and position of the motor

The motor speed parameters are given as parameters with the options to go to channel and go to step. Finding a reference position is done with a fixed speed.

Ordering information

FOM-DLL

- Interface DLL package for Fiber-optic Multiplexer (FOM-UVIR400-1x16, FOM-UVIR400-2x8 and FOM-UVIR400-4x4) for Windows XP through 8.

Raman Spectroscopy Software

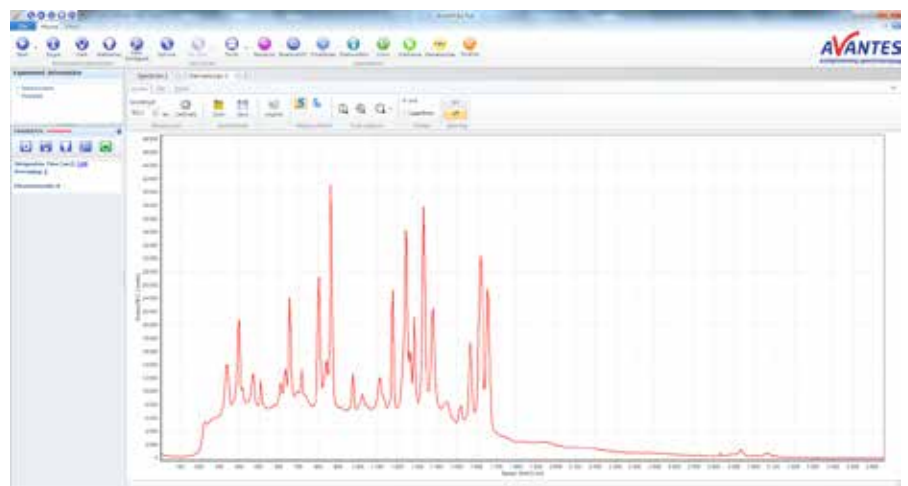
Included with the AvaRaman systems, AvaSoft-Raman enables full control over your Raman spectroscopy system.

In addition to most of the features available in AvaSoft-FULL, AvaSoft-Raman, which is a standalone application, also features:

- Display of the wavelength axis in cm^{-1}
- Auto calibration routines to determine the excitation laser peak (please note that an AvaRaman-Calibration tile is needed, sold separately)
- Integration time progress bar to indicate integration time status for longer spectral acquisitions
- View signal in normalized counts
- Software baseline correction for fluorescence suppression

AvaSoft-Raman also features history channel functions to monitor peak values or concentration versus time.

Process control and export to Excel add on modules are also available for online analyses and control.



Ordering information

AvaSoft-Raman

- Raman stand-alone Software for the AvaRaman system

Three years
limited warranty on all
Avantes spectrometers,
light sources and accessories

AvaSoft-ThinfilM

AvaSoft-ThinfilM software is a standalone package to control the system and conduct measurements on thin film coatings.

The software calculates a layer thickness from the reflection interference spectrum for optically transparent layers with known optical parameters. Two different methods for thin film calculations are implemented

in the AvaSoft-ThinfilM software: the Fast Fourier Transform (FFT) and the best-fit optimization algorithm (match spectrum). The FFT method determines the frequency of the interference pattern; this is mostly used for thick layers. The match spectrum optimization determines the best fit for various thickness calculations. Fitting parameters are adjustable for quality of fit monitoring and to speed up the data processing.

Included in the software is an extensive database of the optical constants "n" and "k" of substrates and coatings. The database includes substrate and coating materials used in important application fields, such as semiconductor and optical coatings.

Process-control and export to Excel add-ons modules are also available for AvaSoft-ThinfilM.



Ordering information

AvaSoft-ThinfilM

- Thin film stand-alone Software for the AvaThinfilM system

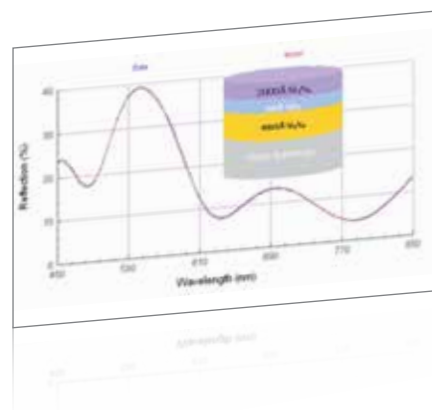
Thinfilmmulti-Layer Measurement Software

To measure film thickness and optical constants (n & k) up to 5 layers, TFProbe® multilayer thin film measurement software is the ideal software. It can be used for real-time or in-line thickness and refractive index monitoring and it comes with a comprehensive optical constants database and library.

To facilitate nk table, dispersion or effective media approximation (EMA) for each individual film or substrate, an advanced optical constants editor is included. TFProbe® supports AvaSpec spectrometer single or multiple channel systems in the UV/VIS and NIR from 200-1700 nm.

The software runs simulations on reflection, transmission and optical constants. It can perform simulations or measurement at non-normal incident angles. Various data output options and 2D & 3D graphic presentations are available in the graphical user interface.

TFProbe supports USB or RS-232 communication with a host controller. Auto log functions for spectrum, measured resolution and fitting graphs are included. For easy presentation, it also enables transmission thin film measurements.



Reflection / Measurement		Reference	Background	Check Signal and View Video	Layer Stack
Load Layer Stack Apply to Layer Stack Save Layer Stack Reset Layer Stack					
Minimum Wavelength for This Layer Stack (nm): 200		Maximum Wavelength for This Layer Stack (nm): 1600			
Layer ID	Layer Stack	Dispersion	EMA	Design Thickness (nm)	Fitting Control and Results
Incident Medium	n=1.0	☐	☐	512	Fitting Tolerance: 3.001
Layer 5	TiO2	☐	☐	605	Measured Thickness (nm): 499.88
Layer 4	SiO2 + 5% Void	☐	☒	490	800.96
Layer 3	TiO2	☐	☐	790	500.59
Layer 2	Dispersion Layer	☒	☐	503	799.97
Layer 1	TiO2	☐	☐		499.91
Substrate	Si	☐ Check to Use Dispersion for Materials ☐ Check to Use EMA		Substrate Thickness (nm): 1000	☐ Check for Back Side Reflection Fitting Signs: 000183 Iteration Number: 6
Online Dispersion: N0:1.4500 N2:0.0050 N4:0.0000 K0:0.0000 K2:0.0000 K4:0.0000 Material Name: Dispersion Layer Apply Dispersion to Layer 2					

Ordering information

TFProbe® • Thinfilmmultilayer measurement software

Panorama® Spectroscopy Software

Panorama® software is a sophisticated modular spectroscopy software application for demanding end users that require special analytical functions. The software enables manipulation of all 2D and 3D spectroscopic data with just a few mouse clicks. Manipulation operations can be undone and redone unlimited times with ease. Math operation history contains frequently used mathematical operations that are automatically stored and applied to subsequent data sets.

By adding the Security module all data manipulations are logged in an audit trail. This trail is attached to the manipulated object for full CFR 21 part 11 compliance. In the audit train window, changed control history of an object can be tracked. Software user permission levels may also be assigned.

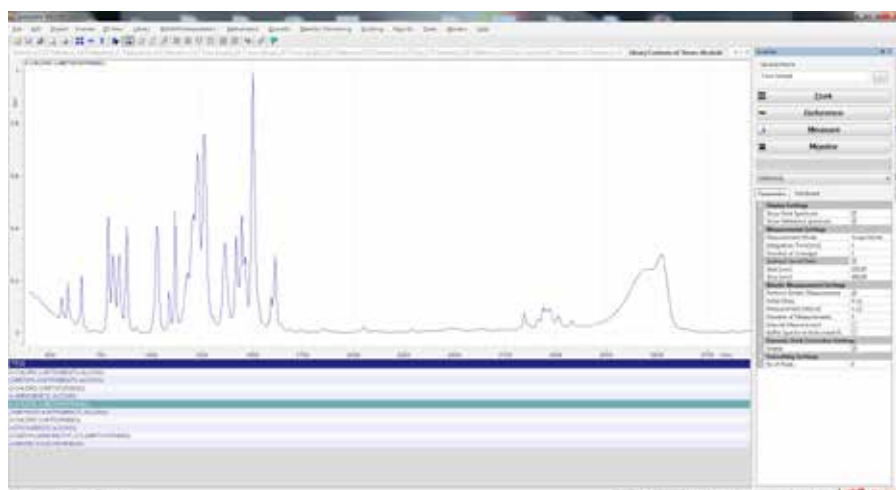
The Panorama-Quantify module enables major multivariate analysis methods such as PLS-1, PLS-2, SIMPLS, MLR, PCA, PCR for sophisticated NIR spectroscopy analysis.

Some of the mathematical options included in the Panorama-Pro software are:

- ATR correct / multiplicative scatter corrections / standard normal variate correction
- Exponential functions
- Zapping / cutting
- Arithmetic calculation / spectrum arithmetic
- Noise statistics / user defined peak evaluation
- Detrending / stretch x-axis
- Data point manipulation
- Thickness correction / advanced two-point baseline correction
- Unit conversion for X- and Y-axis
- Converting of many known data formats
- Calculate polynomial fits

Available add-ons to Panorama-Pro are:

- A Search module, which includes a powerful library module that allows archiving and searching of spectroscopic data on libraries or on your own hard disk
- Reaction Monitoring module provides users with optimal support analyzing characteristic properties and features of spectroscopic data. This facilitates quantification and
- prediction of spectroscopic trends based on 2D and 3D data spectral.



Ordering information

Panorama-Pro	• Spectroscopic Mathematic Data processing Software package, 2D/3D display
Panorama-Search	• Add-on to Panorama Pro, incl. library module & spectrum search module
Panorama-Quantify	• Add-on to Panorama Pro, incl. Multivariate Data Analysis with PLS, MLR
Panorama-Raman	• Add-on to Panorama Pro, incl. Raman Interpretation and functional group assignment
Panorama-Security	• Add-on to Panorama Pro, full 21 CFR part 11 compliance. Ideal for FDA/GXP regulated environments

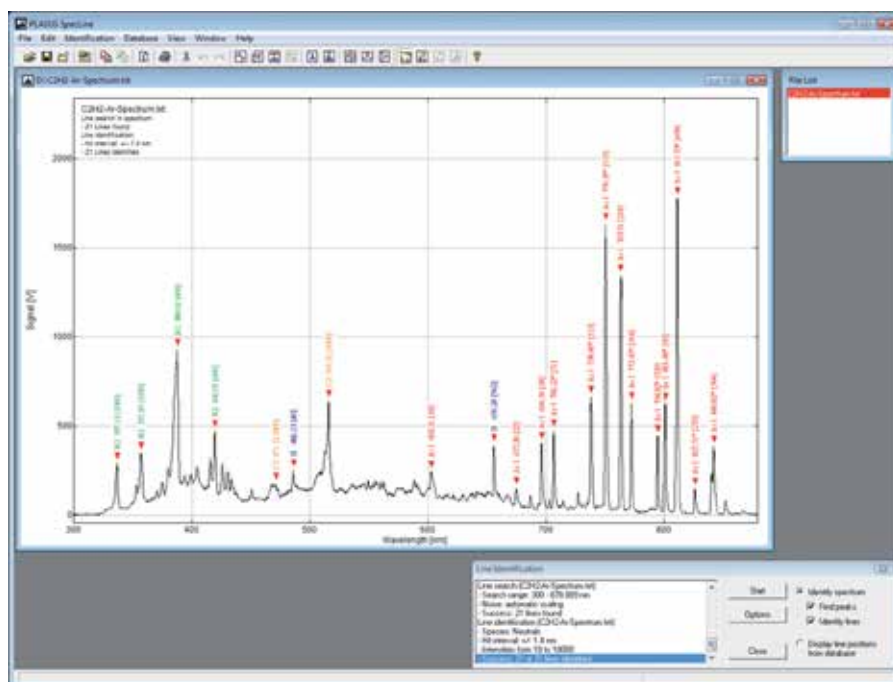
Specline analytical Software

To easily identify and analyze atoms, ions and molecules, Specline® analytical software offers an extensive database. It enables analysis of spectral data, imported directly from AvaSoft spectroscopy software along with other standard formats.

This unique database for atoms and molecules makes line identification fast and easy. To support you in analyzing and comparing the spectra, many evaluation functions are available including:

- Search algorithms for automatic peak finding in the spectra
- Identification of atoms, molecules and their ions using the included extensive database
- Data evaluation and smoothing, integral, scaling, peak value, calibration, arithmetic of spectra (+, -, *, /)

- Comparison of data: several spectra can be overlaid and compared, even when they have different file formats
- Search the periodic table for atoms and ions, wavelength and intensity range
- Data export to ASCII, binary and Excel (CSV) formats, graphical export to BMP, WMF and WPG formats



Ordering information

AvaLIBS-Specline-A

- Spectroscopy software for peak finding and identifying spectral lines, complete version with database for atoms and ions

AvaLIBS-Specline-AM

- Spectroscopy software for peak finding and identifying spectral lines and molecular bands, complete version with data base for atoms, molecules and ions

AvaLIBS-Specline-AMS

- Spectroscopy software for peak finding and identifying spectral lines and molecular bands, complete version with data base for atoms, molecules, extended by many special molecules (e.g molecular hydrogen and polyatomic molecules)

Interface Packages and Libraries for Windows and Linux

AS-5216-DLL Windows and Linux interface packages

Available in both Linux and Windows (XP through 10) versions, the interface packages allow you to easily write custom software solutions for AvaSpec series spectrometers.

The Windows version, AS-5216-DLL, is 32-bit software that works seamlessly under 64-bit versions of Windows in a mode called WoW64. The Windows version also includes a 64-bit version (as5216x64.dll) which can be used when a 64-bit programming environment is used.

The software can be used for the following actions:

- Establishing connections to one or more connected USB spectrometers, activation and deactivation.
 - Setting and retrieving device hardware parameters from the spectrometer's EEPROM. This includes wavelength coefficients, gain and offset values and optional parameters that can be added. These include non-linearity calibration, irradiance calibration and others. Data collection parameters, such as integration time, averaging, smoothing and start/stop pixel can be stored to the EEPROM.
 - Data acquisition and transferring of the spectra to your application
 - Communicating with other devices by using TTL and/or analog output signals. The AvaSpec series spectrometers are equipped with a 26-pin digital I/O connector: 3 grounds, 1 digital-in (pre-defined for external hardware trigger), 3 programmable digital-in, 1 digital-out to control a pulsed light source (such as AvaLight-XE), 1 digital-out to synchronize a pulsed laser (e.g. for LIBS applications) and 10 programmable (TTL level with 6 outputs programmable with pulse width modulation – PWM) digital-out signals. 2 analog-out and 2 analog-in are included as well. The packages include options to control the TTLs of this external I/O connector. The hardware synchronization between the connected spectrometers can be software controlled.
- The packages also include a number of sample programs to give examples on how to write your programs. They are an excellent starting position.

Example source code in multiple languages are included please visit website for complete list.

AvaSpec-DLL Windows interface packages

To fully support the ethernet functionality on the new AS-7010 platform, Avantes will soon replace the AS-5216-DLL with a new AvaSpec-DLL. The AvaSpec-DLL will be downward compatible with the AS-5216 to ensure ease of integration.

FOM-DLL Windows interface package for fiber-optic multiplexer

To facilitate writing custom software solutions for the fiber-optic multiplexer under Windows, the FOM-DLL has been developed. It runs under Windows XP through 10 and contains options to control the position of the multiplexer to one of the 16 positions, travel to the step motor's reference position and to request status information. Example source code in Visual C++, Delphi, C++ Builder and LabView demonstrate how to use the MUX-DLL is included in the package.

Color-DLL

The Color-DLL is used to calculate the color parameters L^* , a^* and b^* as well as their hue angle (h^*) and Chroma (C^*) and X, Y, Z values from an array of reflection values, representing the reflectance values between 380 and 780 nm with a 5 nm interval. It runs under Windows XP through 10.

Besides the reflectance array, the function requires another input variable: the illuminant. A choice can be made between 7 different illuminants: A, B, C, D50, D55, D65 and D75.

An example program in Delphi is provided with the software package.

Irradiance-DLL

The Irradiance-DLL includes the possibility to calculate colorimetric, radiometric, photometric and peak parameters from an array of irradiance values ($\mu\text{W}/\text{nm}\cdot\text{cm}^2$) as well as the CRI. Example programs in C++ and Labview are included as well. It runs under Windows XP through 10.

A person in silhouette is standing on a platform, adjusting a piece of equipment on a rig. The background is a bright, hazy sky with a sun or light source visible on the right. The image has a green color overlay.

Light Sources

INTRODUCTION

For applications such as transmission, absorption and reflection, illumination sources are needed. Avantes offers a wide range of different light sources, to suit your specific needs. An overview of the different options can be found on this page.

Tungsten Halogen light sources are mostly used to do measurements in the visible and NIR range. AvaLight Halogen sources provide a very stable output combined with long bulb lifetime. The high-stability enables their use in reflection and transmission configurations or as an irradiance calibration light source. Most importantly, the Halogen light's spectral output is a smooth black body curve which provides for maximized dynamic range.

Avantes Deuterium light sources are known for their stable output and are used for UV absorption or reflection measurements. These can also be used as irradiance calibration sources due to their high-stability. The standard AvaLight-DH-S mixes the Halogen light with the Deuterium light, thus producing a wide spectral range light source. The output spectrum of Deuterium light sources exhibits several peaks, with a prominent peak at 656 nm. The AvaLight-DH-S-BAL incorporates a dichroic beam splitter installed to minimize these peaks, providing a smooth spectrum from 200-2500 nm.

Our pulsed Xenon light source is used in applications where a long lifetime and high output power is needed, such as in fluorescence measurements. This is an affordable UV source, but the spectral output is not as smooth and continuous as the AvaLight Halogen and Deuterium light sources. LED light sources provide high power at a precise wavelength. A typical application for AvaLight-LED sources is fluorescence. They provide long lifetime, short warm-up time and high-stability.

For wavelength calibration Avantes offers a variety of sources including Argon, Mercury-Argon, Neon, Zinc and Cadmium. All Avantes spectrometers are factory wavelength calibrated and do not require recalibration as they have fixed slits and optics. For those customers who wish to do their own calibrations, the AvaLight-CAL light sources can be used for recalibration purposes. For auto-calibration AvaSoft-Full provides a calibration procedure to make this easy.

New to the AvaLight illumination sources family is the AvaLight-LDXE, a very high brightness light source. It has an extremely long lamp life, a spectral range from 200 nm to 1100 nm and a high-stability.

Table 8 Overview light sources

	Wavelength Range	Type	Principle	Product
Color / VIS / NIR	360-2500 nm	Tungsten Halogen	Continuous	AvaLight-HAL(-S)-MINI
DUV	190-400 nm	Deuterium	Continuous	AvaLight-D-S-DUV
UV	215-400 nm	Deuterium	Continuous	AvaLight-D-S
UV/VIS/NIR refl./abs	215-2500 nm	Deuterium/Halogen	Continuous	AvaLight-DH-S-(BAL)
UV/VIS/NIR absorption	200-2500 nm	Deuterium/Halogen	Continuous	AvaLight-DHc
UV/VIS	200-1000 nm	Xenon	Pulsed	AvaLight-XE
Fluorescence	Multiple possible	LED	Continuous	AvaLight-LED
Wavelength Calibration	253-1704 nm	Mercury-Argon Neon / Argon	Continuous	AvaLight-CAL
	200-700 nm	Zinc/Cadmium	Continuous	AvaLight-CAL-CAD/Zinc
Irradiance Calibration	360-2500 nm	Tungsten Halogen	Continuous	AvaLight-HAL-CAL-MINI
	200-1100 nm	Deuterium/Halogen	Continuous	AvaLight-DH-(BAL)-CAL
Radiance Calibration	360-2500 nm	Tungsten Halogen	Continuous	AvaSphere-50-LS-HAL-CAL

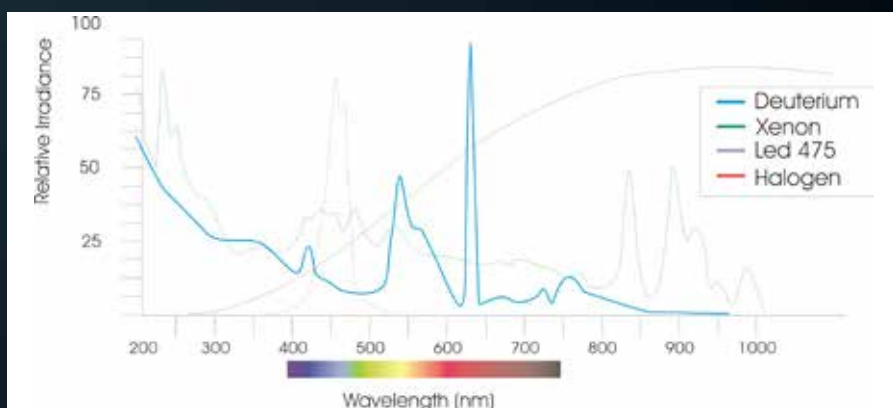


Figure 7 spectral distribution of different Light Sources

AvaLight-DHc

Full-range Compact Light Source

AvaLight-DHc



Get the best out of two worlds with the AvaLight-DHc. It has both a deuterium light source and a halogen light source, providing you with adequate light between 200 and 2500 nm for nearly all absorbance chemistry applications. Deuterium emits light between 200 and 550 nm, where the halogen takes over up to 2500 nm. Coupling this lightsource to the rest of your spectroscopy system is easy with the SMA connector.

Optionally the AvaLight-DHc is available in a rack-mountable version, to be used in the 19" rack or the 9.5" desktop system.

- Combined Deuterium-Halogen
- Integrated TTL-shutter

A direct-attach cuvette holder CUV-DA (see section accessories) is available for fluorescence or absorbance measurements.

This light source is recommended in settings with large fiber cables or direct-attachment to a cuvette holder such as the CUV-DA, due to its relatively low output energy. The integrated TTL-shutter makes saving a dark measurement very simple in combination with AvaSoft (extra IC-DB26-2 needed).

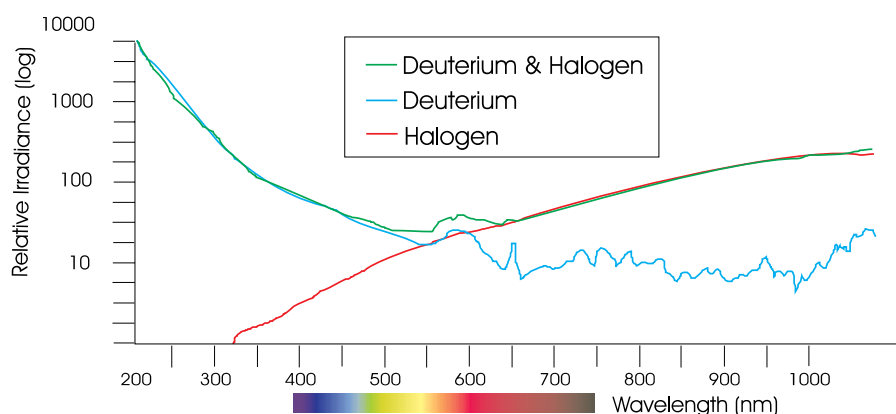


Figure 8 Spectral output of AvaLight-DHc

Technical Data

	Deuterium Light Source	Halogen Light Source
Wavelength Range	200 - 400 nm	400 - 2500 nm
Stability	< 1 mAU	< 1 mAU
Warm-up time	8 min	1 min
Drift	< 0.25% / h	< 0.25% / h
Optical Power in 600 μm fiber	0.2 μ Watt	7 μ Watt
Lamp Lifetime	1000 hours	2000 hours
Temp. Range	5°C - 35°C	
Power Supply	12VDC / 450 mA	
Dimensions	175 x 110 x 44 mm	
Lifetime shutter	1.000.000 cycles (typical)	

Ordering information

AvaLight-DHc	• Compact Deuterium Halogen Light Source with TTL Shutter
IC-DB26-2	• Interface cable AvaSpec-USB2 platform to AvaLight-DHc-TTL-shutter
AvaLight-DHc-RM	• Rackmount Compact Deuterium Halogen Light Source with TTL Shutter
AvaLight-DHc-B	• Compact Deuterium Halogen Replacement Bulb
CUV-DA	• Direct-attach cuvette holder for AvaLight-DHc/XE/LED
PS-12V/1.0A	• Power supply 100-240VAC/12VDC, 1.0A for AvaLight-DHc



Three years
limited warranty on all
Avantes spectrometers,
light sources and accessories

AvaLight-HAL-(S)-MINI Tungsten-Halogen Light Source

AvaLight-HAL-S-MINI



From visible light to near infrared, that's where the AvaLight-HAL-Mini works best. It's a compact, stabilized halogen light source, with adjustable focusing of the fiber connection, maximizing output power at the desired wavelength. The light source also has adjustable output power to provide extra power or longer bulb life.

A filter-slot mounted on the front of the AvaLight-HAL-Mini accepts 1" round or 2" x 2" square filters, to block specific ranges of wavelengths or instantly lower the intensity.

The adjustable focus on the AvaLight-HAL-Mini helps you get the most out of your light source: it makes sure all possible power is transmitted through your optical fiber. Bulb replacement is easy and can be done in a matter of minutes.

Optionally a combined direct-attach cuvette holder and attenuator is available (CUV-ATT-DA-HAL). for attenuation you can use the Inline Filterholder, FH-INL, or the Inline attenuator, ATT-INL.

The optical output can be controlled through a dongle at the backside or from your spectrometer. At low setting the

lamp has a color temperature of 2700K but provides over 13000 hours of lifetime. The standard or medium setting changes the color temperature to 2850K and provides 50% more power with a bulb lifetime of 4000 hours. The high power setting gives a color temperature of 3000K, double power compared to the long-life setting and gives you up to 1000 hours of lifetime.

The AvaLight-HAL-S-Mini features an internal TTL-shutter, controllable from your AvaSpec spectrometer. This gives you the ability to use the auto-save dark option in AvaSoft spectroscopy software.

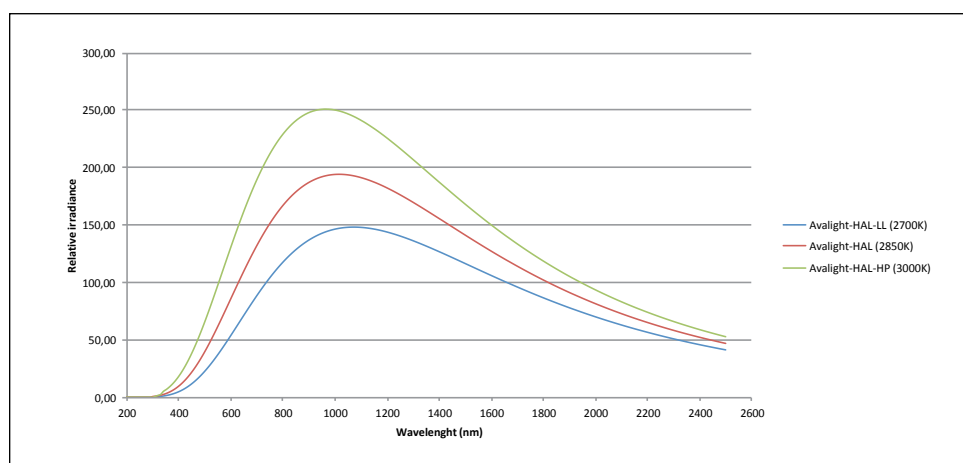


Figure 9 Spectral output of AvaLight-HAL-Mini

Technical Data

	AvaLight-HAL-(S)-Mini (standard)	AvaLight-HAL-(S)-Mini (long life)	AvaLight-HAL-(S)-Mini (high power)
Wavelength Range	360-2500 nm		
Stability	± 0.1% / °C		
Time to stabilize	Ca. 10 min.		
Output to bulb	12.0 VDC / 0.83A	11.3 VDC / 0.8A	14.1 VDC / 1.0A
Bulb Life	4000 hrs	> 13000 hrs	< 1000 hrs
Min. Optical power* 200 µm fiber	0.5 mWatt	0.35 mWatt	0.7 mWatt
Min. Optical power* 600 µm fiber	4.5 mWatt	3.2 mWatt	6 mWatt
Min. Optical power* 1000 µm fiber	10 mWatt	7 mWatt	14 mWatt
Bulb Color Temperature	2,850 K	2,730 K	3,000 K
Power requirement	12 VDC / 1.5A		
Temperature range	0-55 °C		
Dimensions, weight	150 x 78 x 37 mm, 510 grams		
Lifetime shutter	1,000,000 cycles (typical)		

* Optical power measured from 350-1100nm

Separate 50x50 mm filters to install in AvaLight-HAL-(S)-Mini

GL-WG305-3	Separate 50 x 50 x 3 mm long-pass filter > 305 nm
GL-KG3-3	Separate 50 x 50 x 3 mm band-pass filter, transparent > 325 nm and < 700 nm
GL-BG28-3	Separate 50 x 50 x 3 mm band-pass filter, transparent > 360 nm and < 500 nm
GL-GG385-3	Separate 50 x 50 x 3 mm long-pass filter > 385 nm
GL-GG475-3	Separate 50 x 50 x 3 mm long-pass filter > 475 nm
GL-OG515-3	Separate 50 x 50 x 3 mm long-pass filter > 515 nm
GL-OG550-3	Separate 50 x 50 x 3 mm long-pass filter > 550 nm
GL-OG590-3	Separate 50 x 50 x 3 mm long-pass filter > 590 nm
GL-NG9-1	Separate 50 x 50 x 1 mm Neutral Density filter (transmission 10%, 400-1100 nm)
GL-NG9-2	Separate 50 x 50 x 2 mm Neutral Density filter (transmission 1%, 400-1100 nm)
GL-NG9-3	Separate 50 x 50 x 3 mm Neutral Density filter (transmission 0.1%, 400-1100 nm)

More filter types available, please contact us for ordering information

Ordering Information

AvaLight-HAL-Mini	• 10W Tungsten Halogen Lamp, fan-cooled, needs extra PS-12V/1.5A power supply
AvaLight-HAL-S-Mini	• As AvaLight-HAL-Mini, incl. TTL shutter, needs extra PS-12V/1.5A power supply
AvaLight-HAL-S-RM	• Rack-mounted version of AvaLight-HAL-S-Mini
IC-DB26-2	• Interface cable AvaSpec-USB2 platform to AvaLight-HAL-(S)-Mini
AvaLight-HAL-B-Mini	• 10W Tungsten Halogen Replacement bulb for AvaLight-HAL-(S)-Mini
PS-12V/1.5A	• Power supply 100-240VAC/12VDC, 1.5A, necessary for AvaLight-HAL-Mini
DONGLE-Mini-H	• Dongle for high power setting
DONGLE-Mini-L	• Dongle for long life setting

AvaLight-DH-S Deuterium-Halogen Light Source

AvaLight-DH-S



In need of more power than the AvaLight-DHc? The AvaLight-DH-S is Avantes' most powerful deuterium halogen source. Like the DHc it is also a combined deuterium and halogen light source, capable of transmitting light in the UV/VIS/NIR-range, but has 35 times more halogen output and up to 300 times more deuterium power. The source has a prominent 656 nm deuterium peak which can limit dynamic range (see AvaLight-DH-S-BAL as an alternative). It includes a focusing lens assembly, to fully utilize the possibilities and size of your fiber.

The AvaLight-D-S is a deuterium light source only, making it a great option for measurements in the UV range, 190-400 nm. The AvaLight-D-S-DUV version starts even lower at 175 nm, for your deep-UV experiments. This version also offers twice the intensity at 200nm.

The output of the AvaLight-DH-S is optimized for fibers or bundles up to 600 micrometers. For larger fibers the focal point is manually adjustable to optimize the light coupling into your fiber.

The AvaLight-D(H)-S features an integrated TTL-shutter and filter holder for filters of up to 50x50x5.0 mm.

- Combined Deuterium-Halogen
- UV-VIS-NIR
- Deep-UV optional
- Powerful

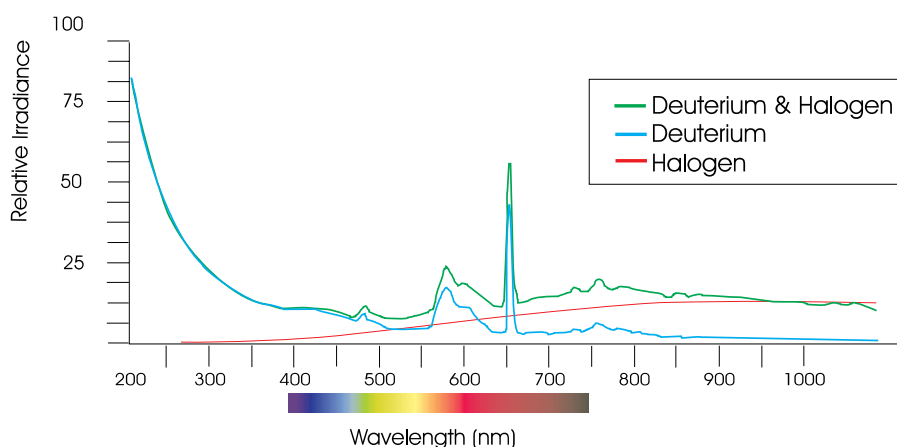


Figure 10 Spectral output AvaLight-DH-S

Technical Data

	Deuterium (Deep-UV) Long life	Deuterium (Standard) Long life	Halogen
Wavelength Range	175-400 nm	190-400 nm	360-2500 nm
Warm-up Time	30 min.		20 min.
Lamp Power	78W / 0.75A		5W /0.5A
Lamp Lifetime	2000 h		1000 h
Noise (AU)	2×10^{-5}		10^{-4}
Max. drift	$\pm 0.5\%/h$		$\pm 0.1\%/h$
Color Temperature	-	-	3000 K
Optical Power* in 200µm fiber	11 µW	11 µW	43 µW
Optical Power* in 600µm fiber	72 µW	72 µW	239 µW
Optical Power* in 1000µm fiber	206 µW	206 µW	354 µW
Power consumption	90 Watt (190Watt for heating D-Lamp 4-5 sec.)		
Power Requirements	100-240VAC 50/60 Hz		
Dimensions / Weight	315 x 165 x 140 mm / ca 5 kg.		
Lifetime shutter	1,000,000 cycles (typical)		

* total power for the specified wavelength range

For a table of separate 50x50 mm filters to install in AvaLight-D(H)-S see AvaLight-HAL.

Ordering Information

AvaLight-D-S	• Deuterium light source, 190-400 nm, incl. TTL shutter, -SR fibers needed
AvaLight-DH-S	• Deuterium-Halogen light source, 190-2500 nm, incl. TTL shutter, -SR fibers needed
AvaLight-D-S-DUV	• Deep-UV deuterium light source, 175-400 nm , TTL shutter, -SR fibers needed, 2000h
AvaLight-DH-S-DUV	• Deep-UV deuterium-halogen light source, 175-2500 nm , TTL shutter, -SR fibers needed
IC-DB26-2	• Interface cable AvaSpec-USB2 platform to AvaLight-D(H)S-BAL
AvaLight-D-B	• Replacement deuterium bulb for AvaLight-D/AvaLight DH-BAL light source
AvaLight-D-B-DUV	• Replacement deep-UV deuterium bulb for AvaLight-D/AvaLight DH-BAL light source
AvaLight-DH-B	• Replacement halogen bulb for AvaLight-DH-BAL light source
CUV-DA-DHS	• Direct-attach cuvette holder for AvaLight-D(H)S-BAL

AvaLight-DH-S-BAL Balanced Power

AvaLight-DH-S-BAL



The AvaLight-DH-S is a powerful deuterium halogen source, but like any unbalanced deuterium halogen source it does have a very dominant alpha peak at 656 nm. This is why Avantes developed the DH-S-BAL, in which this peak is drastically reduced by a dichroic filter. This means less power, but an increase in the dynamic range of a factor 20. A comparison spectrum, which is taken with a standard AvaSpec-2048, is shown on the next page.

The light source delivers a continuous spectrum with high efficiency. The highest stability is in the ultraviolet, visible and near infrared range, from 215 to 2500 nm. An integrated TTL-shutter and filter holder for filters of up to 50x50x5.0 mm are included. The TTL-shutter can be controlled from any AvaSpec spectrometer, which means the auto-save dark-option in AvaSoft software can be used (please note: IC-DB26-2 cable needed).

Connection to the fiber is done through an SMA-905 connector, which features an adjustable focusing lens assembly. This ensures you getting the maximum possible power into your fiber. For all deuterium light sources solarization resistant fibers (-SR) are recommended (see the fiber-optic section of this catalog). The output of the AvaLight-DH-S-BAL is optimized for fibers or bundles up to 600 μm .

- Balanced light source
- Wide spectrum: 215-2500 nm
- Integrated TTL shutter
- High efficiency
- Increased dynamic range

The filter holder can be easily replaced by a direct-attach cuvette holder CUV-DA-DHS (see section accessories) useful for fluorescence or absorbance measurements.

	Balanced Deuterium (Standard)	Balanced Halogen Lamp
Wavelength Range	215-500 nm	500-2500 nm
Warm-up Time	30 min.	20 min.
Lamp Power	78 W / 0.75 A	5 W / 0.5 A
Lamp Lifetime	2000 hrs	1000 hrs
Noise (AU)	2×10^{-5}	10^{-4}
Max. drift	$\pm 0.5\%/hr$	$\pm 0.1\%/hr$
Color Temperature	-	3000 K
Optical Power in 200 μm fiber	6 μW	17 μW
Optical Power in 600 μm fiber	33 μW	160 μW
Optical Power in 1000 μm fiber	90 μW	448 μW
Power consumption	90 Watt (190 Watt for heating D-Lamp 4-5 sec.)	
Power Requirements	100-240VAC 50/60 Hz	
Dimensions / Weight	315 x 165 x 140 mm / ca 5 kg.	
Lifetime shutter	1,000,000 cycles (typical)	

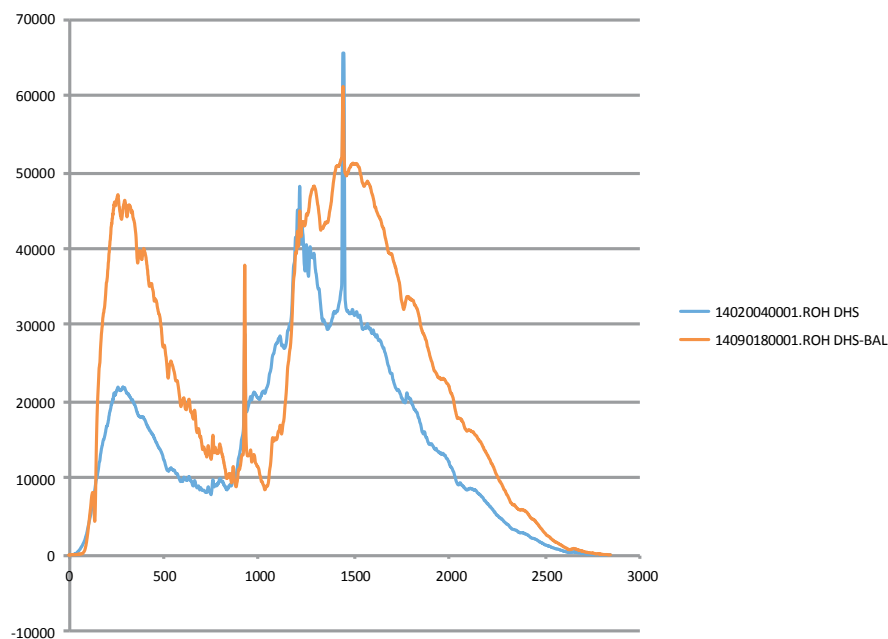


Figure 11 Spectral output AvaLight-DH-S-BAL (red) vs. AvaLight-DH-S (blue)

Ordering Information

AvaLight-D-S-BAL	Balanced Deuterium light source, 215-500nm, incl. TTL shutter, -SR fibers needed
AvaLight-DH-S-BAL	Balanced Deuterium-Halogen light source, 215-2500 nm, incl. TTL shutter, -SR fibers needed
IC-DB26-2	Interface cable AvaSpec-USB2 platform to AvaLight-D(H)S-BAL
AvaLight-D-B	Replacement deuterium bulb for AvaLight-D/AvaLight DH-BAL light source
AvaLight-DH-B	Replacement halogen bulb for AvaLight-DH-BAL light source
CUV-DA-DHS	Direct-attach cuvette holder for AvaLight-D(H)S-BAL

Add flexibility
to your spectrometer with
the Replaceable Slit (-RS) option

AvaLight-XE Pulsed Xenon

AvaLight-XE



Perfect for ultraviolet applications like fluorescence, the AvaLight-XE is a pulsed xenon light source. When connected to your AvaSpec spectrometer through the IC-DB26-2 cable (sold separately), the flashes are synchronized with the data collected by the spectrometer. In AvaSoft the number of flashes per scan can be selected.

With a special DUV bulb the AvaLight-XE can be used for deep ultraviolet application (below 200 nm). A special direct-attach cuvette holder is available for your fluorescence applications. For transmission measurements, the AvaLight-XE can be used in conjunction with the CUV-ATT-DA which has an iris attenuator to limit the light output and to avoid saturation.

- Pulsed light source
- Perfect for fluorescence
- Cuvette holder available
- Long lifetime

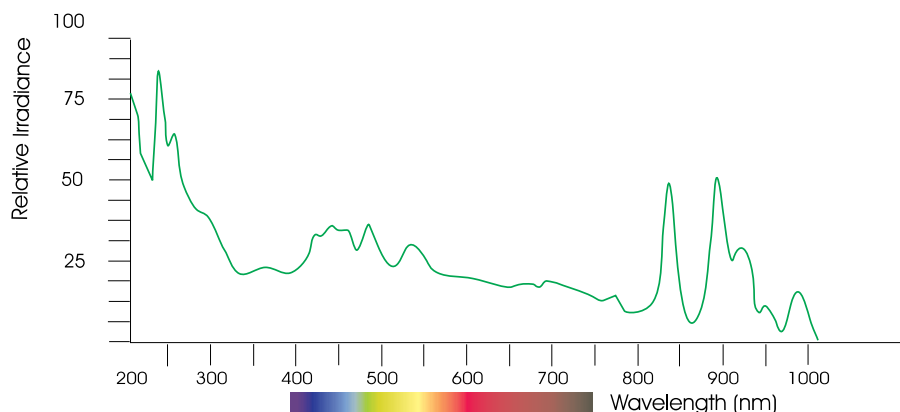


Figure 12 Spectral output of the AvaLight-XE

Technical Data

Spectral Output	200 nm to 1000 nm
Total Optical Power output	39 μ J per pulse (average 66 mW)
Optical Power in 200 μm fiber	0.66 μ J per pulse (average 20 μ W)
Optical Power in 600 μm fiber	3.2 μ J per pulse (average 320 μ W)
Optical Power in 1000 μm fiber	7.4 μ J per pulse (average 744 μ W)
Synchronization Input	15 pin sub-D connector, TTL level
Pulse Duration	5 μ s (at 1/3 height)
Pulse delay	6 μ s
Pulse rate (max.)	100 Hz
Bulb Life	min. 10 ⁹ pulses
Connector	SMA-905 connector
Power requirement	12 VDC/550 mA
Dimensions, weight	175 x 110 x 44 mm, 540 grams

Ordering Information

AvaLight-XE	• Xenon Light Source (200-1000 nm), needs interface cable and power supply
AvaLight-XE-DUV	• DUV (160-1000 nm) version of the AvaLight-XE, needs interface cable and power supply
AvaLight-XE-B	• Spare bulb for the AvaLight-XE (200-1000 nm)
AvaLight-XE-B-DUV	• Spare bulb for the AvaLight-XE-DUV (160-1000 nm)
IC-DB26-2	• Interface cable AvaSpec-USB2 platform to AvaLight-XE
CUV-DA	• Direct-attach cuvette holder for AvaLight-DHc/XE/LED
ATT-DA	• Direct-attach attenuator for AvaLight-DHc/XE/LED
CUV-ATT-DA	• Direct-attach cuvette holder and attenuator for AvaLight-DHc/XE/LED
PS-12V/1.0A	• Power supply 100-240VAC/12VDC, 1.0A for AvaLight-XE

AvaLight-HAL-CAL-Mini and AvaLight-DH-CAL Calibrated Light Sources

AvaLight-HAL-CAL-Mini

Calibrating your spectrometer has never been easier: the AvaLight-HAL-CAL-Mini and AvaLight-DH-CAL are NIST traceable calibrated light sources which measure absolute spectral intensity.

The AvaLight-HAL-CAL-Mini is a compact, affordable light source. It is calibrated for the visible range (350-1095 nm). Optionally, an extended calibration for the near-infrared spectral range (1100-2500 nm) can be ordered. It has a built-in diffuser, a cosine corrector with SMA adapter and comes with a calibration file in ASCII format.

Calibration can be done using the AvaSoft software.

The AvaLight-HAL-CAL-ISPxx-Mini is a special version of the AvaLight-HAL-CAL-Mini, which enables coupling any of Avantes' AvaSphere-xx-IRRAD integrating spheres to the lightsource (xx=30, 50 or 80) for calibration. This source is supplied with a special bottom plate to stabilize the AvaSphere. The AvaLight-HAL-CAL-Mini and AvaLight-HAL-CAL-ISPxx-Mini include a power supply.



- Field calibration
- Visible and optional NIR range
- Built-in diffuser
- Versatile



AvaSphere-50-LS-HAL-CAL

For radiance calibration in the visible spectral range (360-1100 nm), Avantes offers the AvaSphere-50-LS-HAL-CAL. This radiance calibration sphere is normally used to calibrate a spectrometer and a bare fiber with an SMA connector. This uniform source ensures that the fiber is homogeneously illuminated during calibration.

The AvaSphere-LS-HAL-CAL is supplied with a power supply and a CD-ROM with the calibration file in ASCII-format.

- Radiance calibration
- Visible range
- For homogeneous illuminated areas

AvaLight-DH-CAL

For calibrations in the ultraviolet and visible range (200-1099 nm), the AvaLight-DH-CAL is the best solution. This source can be used with all AvaSpec spectrometers to calibrate for absolute spectral intensity. It is supplied with a built-in diffuser, a cosine corrector (CC-VIS/NIR) with SMA adapter and a CD-ROM containing the calibration files in ASCII format.

Two calibration files are included: one for irradiance calibration over the full range (200-1099 nm) and one over the visible and near infrared range (350-1099 nm). For the first file, both the deuterium and the halogen bulb should be used during calibration. The second file is to be used with only the halogen light. The halogen only spectrum provides a smoother black body calibration spectrum for the longer wavelengths.

For a more balanced spectrum across the 200-1100 nm range, Avantes offers the AvaLight-DH-BAL-CAL. For ultraviolet range calibration only (200-400 nm), the AvaLight-D-CAL is the right choice.

The calibration files can be imported in the AvaSoft-IRRAD application software, for intensity calibration which turns your spectrometer into a spectroradiometer.

The AvaLight-DH-CAL-ISPxx is a special version of these calibrated light sources, meant to facilitate coupling of the AvaSphere-xx-IRRAD integrating spheres to the light source. (xx is 30, 50 or 80). The AvaLight-DH-CAL, AvaLight-DH-BAL-CAL and AvaLight-D-BAL-CAL all include a power supply.



- Flexible calibration
- Ultraviolet and visible range
- Built-in diffuser and cosine corrector

Technical Data

	AvaLight-HAL-CAL-Mini	AvaSphere-50-LS-HAL-CAL	AvaLight-DH-(BAL)-CAL
Calibration use	Irradiance $\mu\text{W cm}^{-2} \text{ nm}^{-1}$	Radiance $\mu\text{W sr}^{-1} \text{ cm}^{-2} \text{ nm}^{-1}$	Irradiance $\mu\text{W cm}^{-2} \text{ nm}^{-1}$
Calibrated surface	CC-VIS/NIR or AvaSphere	Bare fiber	CC-VIS/VIR or AvaSphere
Wavelength Range	350-1095 nm / 1100-2500 nm*	350-1095 nm / 1100-2500 nm*	200-1099 nm
Calibration Repeatability	$\pm 0.5 \%$	$\pm 0.5 \%$	$\pm 1.0\%$
Calibration Relative Uncertainty to NIST standard	$\pm 9.5\%$ (350-1100 nm) $\pm 6.5\%$ (1100-1950 nm) $\pm 9.5\%$ (1950-2500 nm)	$\pm 9.5\%$ (350-1100 nm)	$\pm 10\%$ (200-240 nm) $\pm 9\%$ (240-350 nm) $\pm 10\%$ (350-400 nm) $\pm 9.5\%$ (400-1100 nm)
Calibration valid for	60 hrs	60 hrs	60 hrs
Warm-up Time	Ca. 15 min.	Ca. 15 min.	Ca. 30 min.
Bulb Output	170 $\mu\text{W cm}^{-2} \text{ nm}^{-1}$ (@800 nm)	100 $\mu\text{W sr}^{-1} \text{ cm}^{-2} \text{ nm}^{-1}$ (@800 nm)	80 $\mu\text{W cm}^{-2} \text{ nm}^{-1}$ (@215 nm) 5 $\mu\text{W cm}^{-2} \text{ nm}^{-1}$ (@800 nm)
Power requirement	12 V / 2.08A	24 VDC / 0.3 A	100-240 VAC
Dimensions	150 x 78 x 37 mm	70 round x 75 mm height	315 x 165 x 140 mm

* optional extended range NIR calibration

Ordering Information

AvaLight-HAL-CAL-Mini	NIST traceable Halogen Lamp with CC- VIS/NIR diffuser, incl. PS-12V/2.08A
AvaLight-HAL-CAL-ISP30-Mini	NIST traceable Halogen Lamp for use with AvaSphere-30-IRRAD, incl. PS-12V/2.08A and special sphere holder bottom plate
AvaLight-HAL-CAL-ISP50-Mini	As AvaLight-HAL-CAL-ISP30-Mini for use with AvaSphere-50-IRRAD
AvaLight-HAL-CAL-ISP80-Mini	As AvaLight-HAL-CAL-ISP30-Mini for use with AvaSphere-80-IRRAD
AvaSphere-50-LS-HAL-CAL	NIST traceable radiance calibration source, 10 mm and SMA adapter calibrated, incl PS-24V/1.25A
HL-Recal	AvaLight-HAL-CAL recalibration service 350-1095 nm
HL-Recal-NIR	AvaLight-HAL-CAL extended or recalibration service 1100-2500 nm
AvaLight-D-CAL	NIST traceable UV Deuterium Lamp with CC-UV/VIS diffuser, -SR fibers recommended
AvaLight-DH-CAL	NIST traceable UV/VIS Deuterium/Halogen Lamp with CC-UV/VIS diffuser, -SR fibers recommended
AvaLight-DH-BAL-CAL	As AvaLight-DH-CAL, but balanced UV/VIS Deuterium/Halogen
AvaLight-DH-CAL-ISP30	NIST traceable UV/VIS Deuterium/Halogen Lamp for use with AvaSphere-30-IRRAD, incl. special sphere holder bottom plate, -SR fibers recommended
AvaLight-DH-CAL-ISP50	As AvaLight-DH-CAL-ISP30 for use with AvaSphere-50-IRRAD
AvaLight-DH-CAL-ISP80	As AvaLight-DH-CAL-ISP30 for use with AvaSphere-80-IRRAD
DH-Recal	AvaLight-DH-CAL recalibration service 200-1099 nm
AvaSoft-IRRAD	Irradiance add-on software, to be ordered with AvaSoft-Full

Did you know
Avantes is specialized
in custom made
fiber-optic cables?

AvaLight-CAL Spectral Calibration Source

The AvaLight-CAL is a spectral calibration lamp. It's available in Mercury-Argon (253.6-922.5 nm), Neon (337-1084.5 nm), Argon (696.5-1704 nm) Zinc (202.5-636.2 nm) and Cadmium (214.4-643.8 nm) versions. The major lines including their relative intensity and structures are shown on the bottom surface.

The standard SMA-905 connector supplies an easy connection between the lamp and optical fibers, making the AvaLight-CAL a low cost wavelength calibration system for any fiber-optic spectrometer. AvaSoft-Full spectroscopy software includes an automatic recalibration procedure.

The AvaLight-CAL can also be delivered in rack-mountable version, to be integrated in Avantes 19" Rack-mount or the 9.5" desktop housing. The PS-12V/1.0A power supply should be ordered separately.

- Calibration light source
- Low cost
- Available in a variety of wavelength ranges (UV to NIR)

AvaLight-CAL

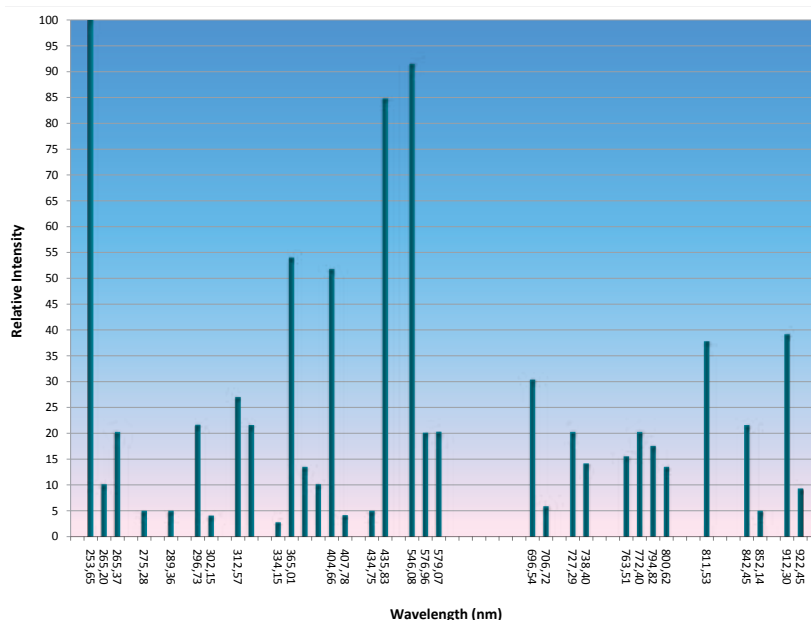


Figure 14 Spectral lines - AvaLight-CAL

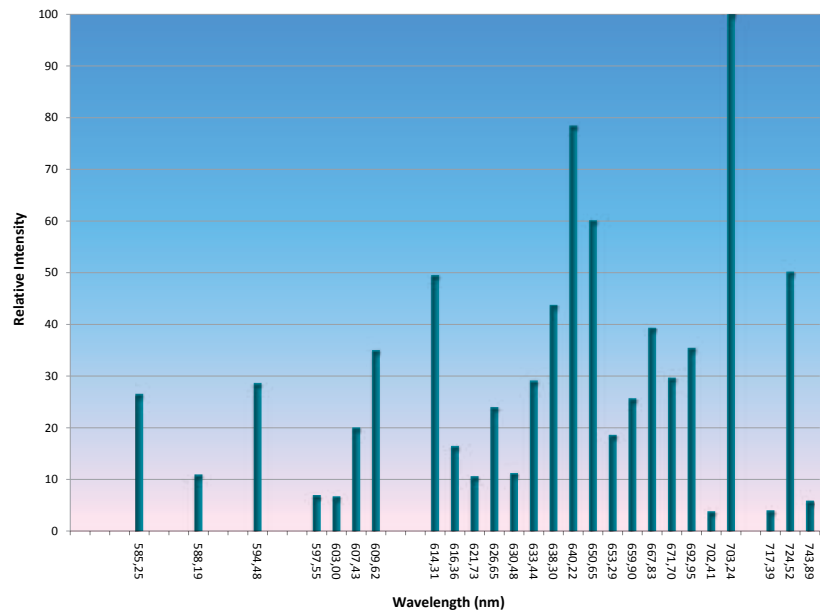


Figure 15 Spectral lines AvaLight-CAL-Neon

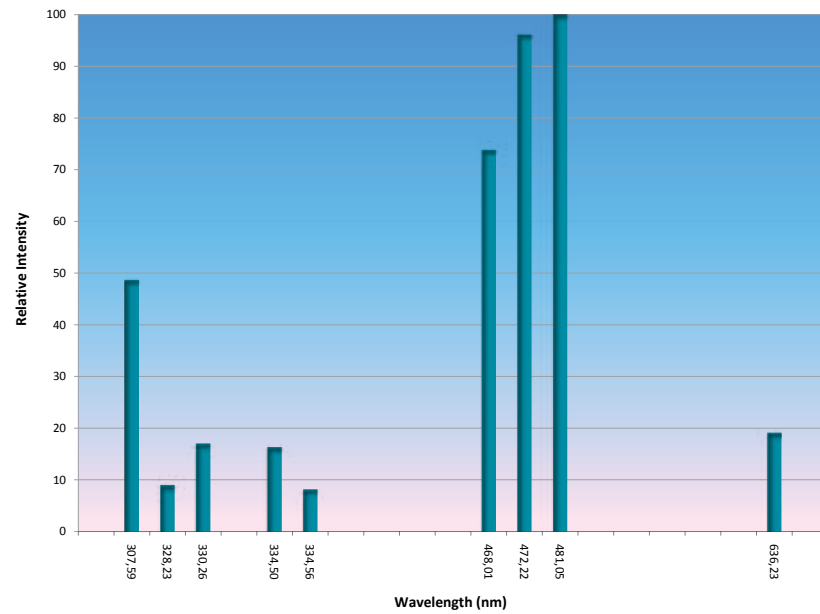


Figure 16 Spectral lines AvaLight-CAL-Zinc

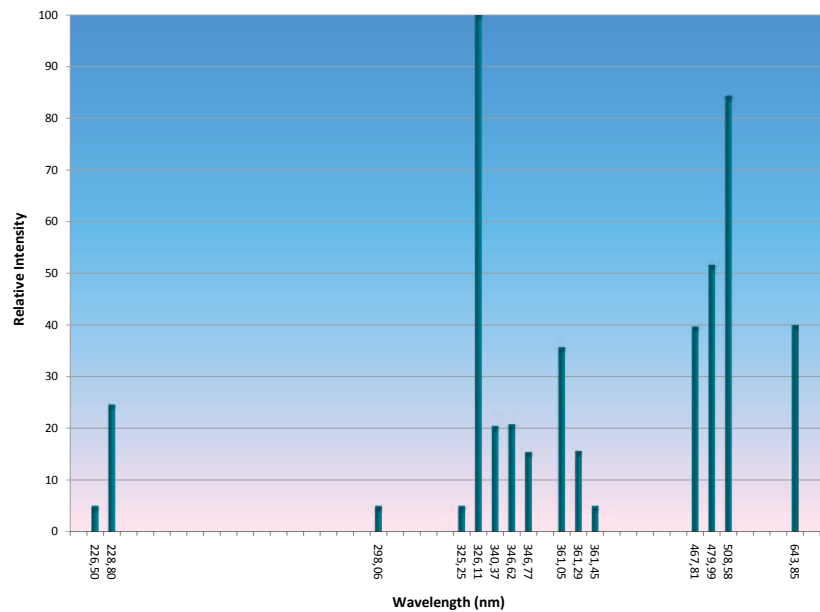


Figure 17 Spectral lines AvaLight-CAL-CAD

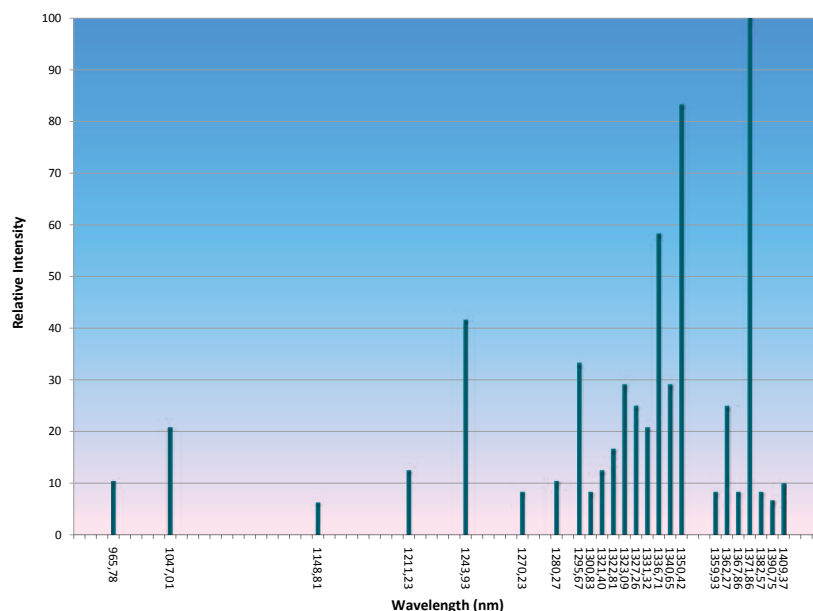


Figure 18 Spectral lines AvaLight-CAL-AR

Technical Data

Lamp	HgAr	Neon	Ar	Zinc	Cadmium
Output	253.6–922.5 nm	337–1084.4 nm	696.5–1704 nm	202.5–636.2 nm	214.4–643.8 nm
Optical power in 600 µm fiber	1.6 µW				
Connector	SMA-905 connector				
Internal Voltage	1200 Volts AC at 30 kHz, 10 mA			1500 Volts AC at 27 kHz, 47.5 mA	
Warm up	1 minute for vapor stabilization			< 10 min.	
Lamp lifetime	5000 hrs.			1000 hrs.	
Power requirement	12VDC supply, 240 mA			85–240 VAC, 1.0A	
Dimensions, weight	175 x 110 x 44 mm, 480 grams			Lamp unit :	
				175 x 110 x 44 mm, 480 grams	
				Power supply unit :	
				102 x 167 x 58 mm, 450 grams	

Ordering Information

AvaLight-CAL	• Mercury Argon Calibration source needs extra PS-12V/1.0A power supply, SMA
AvaLight-CAL-NEON	• Neon Calibration source needs extra PS-12V/1.0A power supply, SMA
AvaLight-CAL-AR	• Argon Calibration source needs extra PS-12V/1.0A power supply, SMA
AvaLight-CAL-RM	• Rack-mounted version of AvaLight-CAL
AvaLight-CAL-B	• Replacement bulb, Mercury-Argon
AvaLight-CAL-NEON-B	• Replacement bulb, Neon
AvaLight-CAL-AR-B	• Replacement bulb, Argon
AvaLight-CAL-ZINC	• Zinc Calibration Light source, including power supply
AvaLight-CAL-CAD	• Cadmium Calibration Light source, including power supply
AvaLight-CAL-ZINC-B	• Zinc replacement bulb
AvaLight-CAL-CAD-B	• Cadmium replacement bulb
PS-12V/1.0A	• Power supply 100–240 VAC/12 VDC, 1.0 A for AvaLight-CAL series

AvaLight-LED Light Source for fluorescence applications

AvaLight-LED



The Avalight-LED is a compact, low-cost light source meant for fluorescence applications. It produces continuous or pulsed spectral output at different wavelengths. Some standard excitation wavelengths are shown in the table on this page, but other wavelengths are available upon request. The sources have an SMA-905 connector to couple to fiber-optics. Please note that the power supply (PS-12V/1.0A) has to be ordered separately.

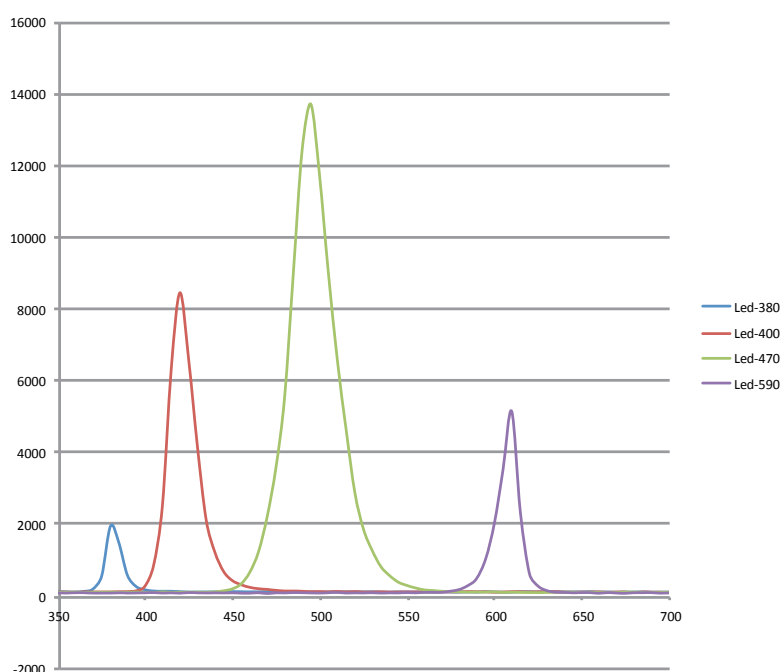
The AvaLight-LED can be used as a DC source or pulsed with a programmable Pulse Width Modulation

(PWM), supplied by an AvaSpec-USB2 spectrometer (IC-DB26-2 cable needed).

The CUV-DA is a cuvette cell holder that has an integrated LED for direct illumination of the cell. This provides greater excitation energy for fluorophores with low quantum efficiency.

Other accessories include the CUV-FL and CUV-ALL cuvette holders and the FCR-UV fluorescence probes. They can be found in the accessories and fiber-optics chapters of this catalog. At the end of the catalog, an example fluorescence setup can be found.

- Fluorescence excitation
- Compact
- Flexible excitation wavelength



Technical Data

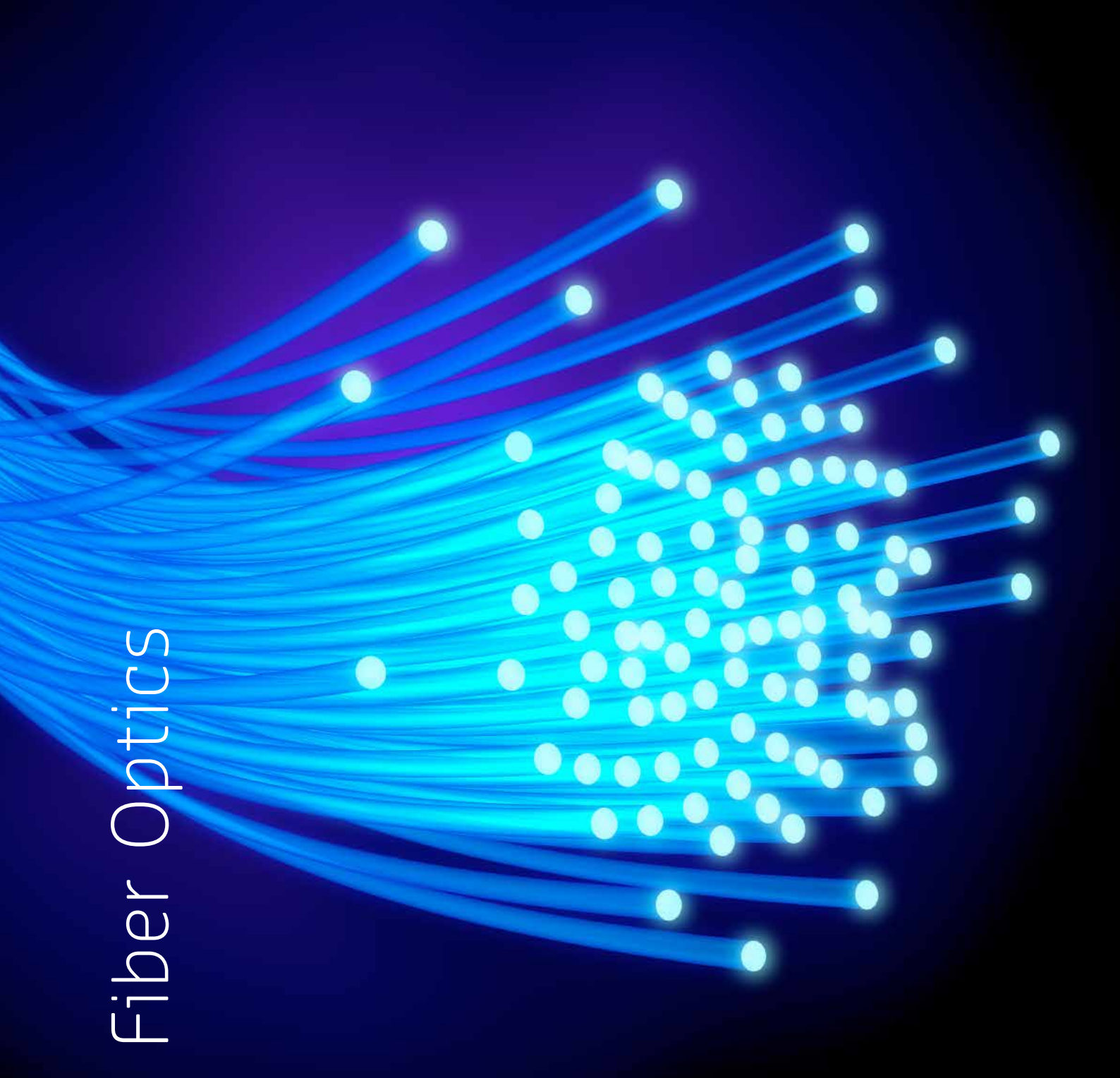
	AvaLight-LED 355/380	AvaLight-LED 400/410/430	AvaLight-LED 450/470/490	AvaLight-LED 530/590/780
Spectral Range*	355/380 nm	400/410/430 nm	450/470/490 nm	530/590/780 nm
FWHM (nm)	15 nm	11 nm	30 nm	30 nm
Optical power 600 µm fiber	10 µWatt	25 µWatt	25 µWatt	25 µWatt
Connector	SMA-905			
Power supply	12 VDC, 40 mA			
Dimensions, weight	175 x 110 x 44 mm, 480 grams			

* other wavelengths available on request

Ordering Information

AvaLight-LED-XXX	• Light Emitting Diode Lightsource, specify wavelength XXX
AvaLight-LED-XXX-RM	• Rackmount version of the Light Emitting Diode Lightsource, specify wavelength XXX
AvaLight-LED-CON	• LED lightsource control unit with electrical connector to LED, needs extra PS-12V/1.0A and interface cable.
CUV-LED-XXX	• LED holder for Cuvette, specify LED wavelength XXX.
CUV-DA	• Direct-attach cuvette holder for AvaLight-DHc/XE/LED
IC-DB26-2	• Interface cable AvaSpec-USB2 platform to AvaLight-LED for PWM
PS-12V/1.0A	• Power supply 100-240 VAC/12VDC, 1.0 A for AvaLight-LED

Fiber Optics



INTRODUCTION

The use of fiber-optics as light guidance allows a great modularity and flexibility in the setup of an optical measurement system. Optical fibers can be made of many materials, such as plastic, glasses and silicates (SiO_2). For high quality fiber-optics, as used in spectroscopic applications, synthetic fused silica (amorphous silicon dioxide) is used, that can be intentionally doped with trace elements to adjust the optical properties of the glass.

The basic principle of light transport through an optical fiber is total internal reflection. This means that the light within the numerical aperture of a fiber (NA = input acceptance cone) will be reflected and transported through the fiber. The size of the numerical aperture depends on the materials used for core and cladding.

Two basic types of silica fibers can be distinguished; single-mode and multi-mode fibers, depending on the propagation state of the light, traveling down the fiber. For most spectroscopic applications multi-mode fibers are used. Multi-mode fibers can be divided into 2 subcategories, step-index and graded-index. A relatively large core and high NA allow light to be easily coupled into the fiber, which allows the use of relatively inexpensive termination techniques. Step-index fibers are mainly used in spectroscopic applications.

Graded-index multimode fibers have a refractive index gradually decreasing from the core out through the cladding. Since the light travels faster in material with lower refractive index, the modal dispersion (amount of pulse-spreading) will be less. These graded-index fibers are mainly used in telecommunication application, where dispersion at long distance (2-15 km) plays an important role.

Product codes

For example FC-20UV200-3-BX-SR

A product code is designed as follows:

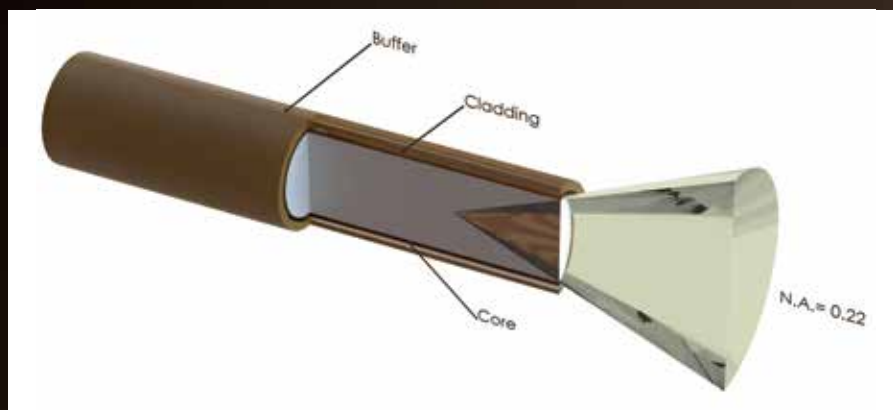
Type of Product	Number of fibers	Wavelength	Fiber core diameter	Overall Length	Jacketing	Other options
FC = standard fiber cable FCB = bifurcated fiber FCR = fiber reflection probe FDP = fiber dip probe	almost any number possible	UV = 200-800 nm IR = 350-2500 nm UVIR = 250-2500 nm	8 µm* 50 µm** 100 µm 200 µm 400 µm 600 µm 800 µm** 1000 µm**	in meters	BX = stainless steel ME = chrome-plated brass MS = metall silicone FX = fixed	SR = solarization resistant HT= high temperature HTX= extreme high temperature PK= PEEK HY= Hastelloy®

*Only for IR fibers

** Only for UV or IR fibers



FIBER-OPTIC DESIGN



Core

For spectroscopic applications, generally, multi-mode step index silica fibers are used. These range in core thickness from 50 to 1000 microns. The core is made out of pure silica. Other fiber cores with much higher absorption are made out of certain glass types or plastics. These are not offered in this catalog.

First a distinction is made between silica with high or low OH content. Silica fibers with high OH (600-1000 PPM) are used in the UV/VIS wavelength range because of the low absorption in the UV. They are referred to as UV/VIS fibers. For Deep-UV applications (below 230 nm) special solar-

ization resistant fibers can be used.

The water content causes strong absorption peaks in the NIR wavelength range. In order to get good fibers for the NIR range, the "water" is removed from the silica. This results in low OH fibers (<2 PPM) with low absorption in the NIR. They are referred to as VIS/NIR fibers.

New in this catalog are the so-called broadband fibers, which can be used for the UV-NIR range (250-2500 nm), the product code for these fibers is UVIR.

Cladding

In order to get the light guiding effect the core is cladded with a lower index of refraction material. For the highest quality fibers with the lowest absorption this is a fluorine-doped silica, the so-called silica-silica or all-silica fibers with a numerical aperture (NA) of 0.22.

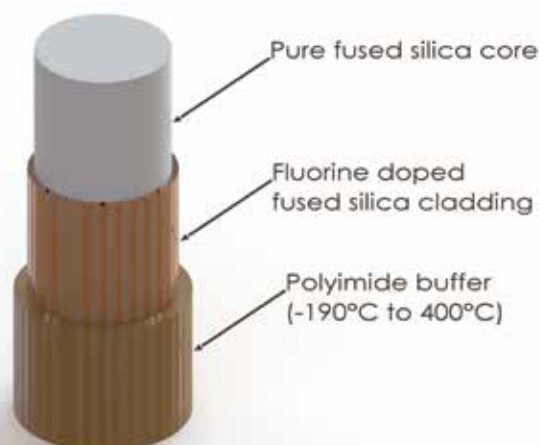
Buffers

Without further protection fibers would easily break, because of small scratches or other irregularities on the surface. Therefore a next layer, the buffer, is added. This buffer also determines under what circumstances the fiber can be used. Temperature range, radiation, vacuum, chemical environment and bending are factors to be considered.

Polyimide buffers offer a wide temperature range (-100 to 400°C) and superior solvent resistance. Also, this material is non-flammable. Drawbacks are sensitivity to micro bending and the difficulty to remove it.

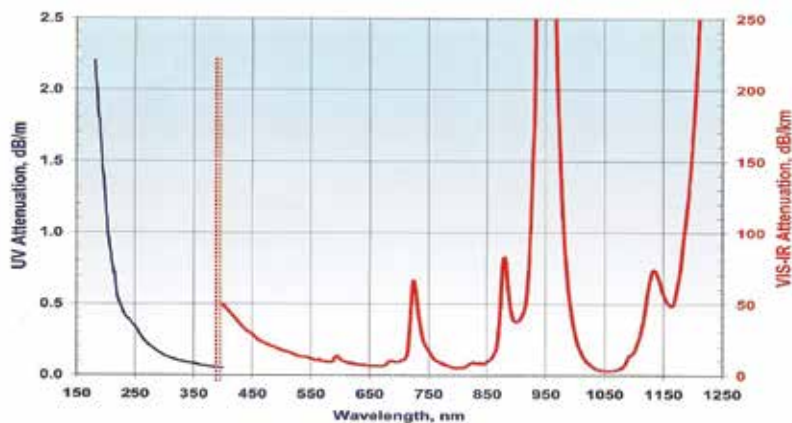
For extreme temperatures (-270 to 700°C) metal buffers are used. Metal buffers can withstand a continuous high temperature up to 500 °C and intermittent even up to 700°C. Low outgassing makes them also excellent for use in UHV environments.

Fiber Design

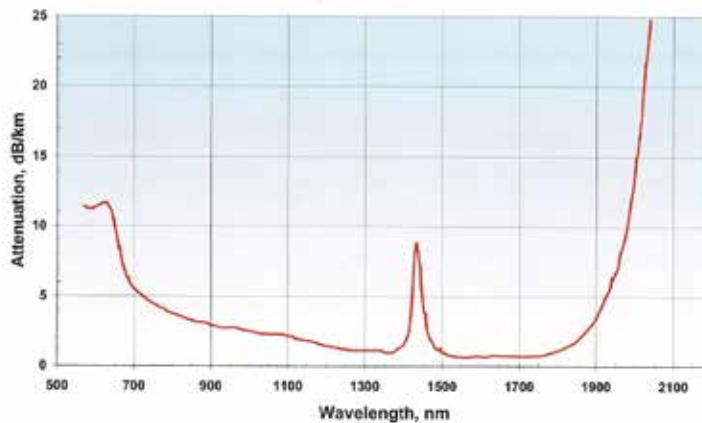


Fiber Material	Standard
Temperature Range	-190 °C to +400°C
Fiber type	Step index Multimode
Core Numerical Aperture	0.22 ± 0.02
Buffer	Polyimide
Available Diameters	50/100/200/400/600/800/1000 µm
Laser damage resistant core	1,3 kW/mm ² CW at 1060 nm, up to 10 J, pulsed
Bend radius	momentary 100 x clad radius long term 600 x clad radius

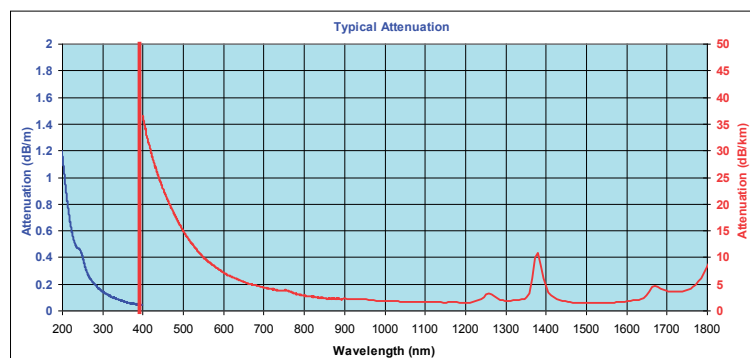
Technical Data



Transmission UV/VIS fibers



Transmission VIS/NIR fibers



Transmission UV/VIS/NIR broadband

Solarization Resistant Fibers for Deep-UV applications

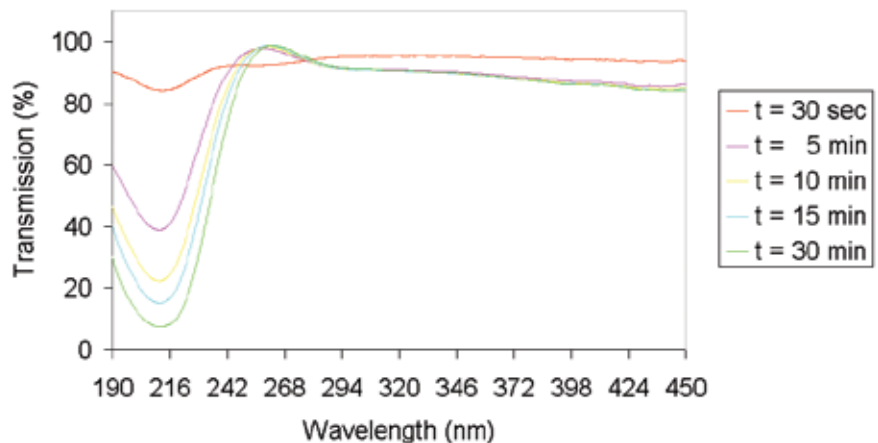
Most spectroscopic applications with fiber-optics have been restricted to wavelength ranges above 230 nm, because standard silica fibers with an undoped core and fluorine doped cladding are frequently damaged by exposure to deep-UV light (below 230 nm). This solarization effect is induced by the formation of “color centers” with an absorbance band of 214 nm. These color centers are formed when impurities (like Cl) exist in the core fiber material and form unbound electron pairs on the Si atom, which are affected by the deep-UV radiation.

Not long ago, solarization resistant fibers, which were hydrogen loaded, were developed (UVI). The disadvantage of these fibers is the limitation on smaller fiber

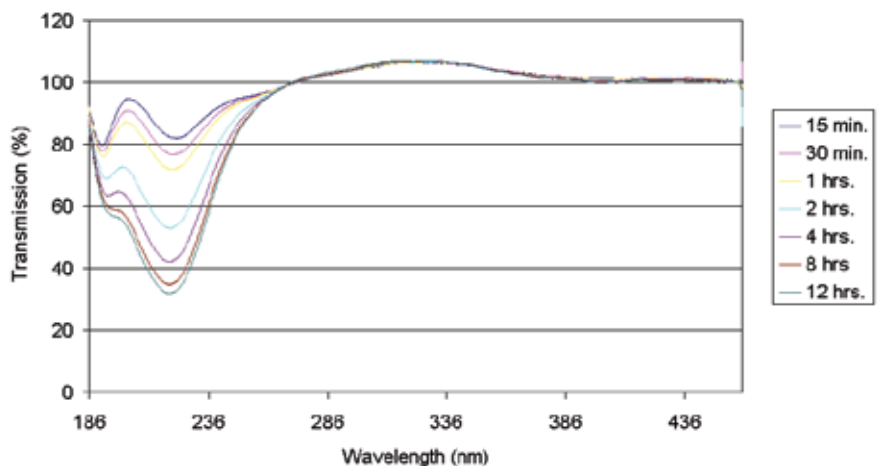
diameters and limited lifetime, caused by the H₂ outgassing from the fiber. Recently, with the availability of a modified core preform, a new fiber became available (UVM). This fiber provides long-term stability at 30-40% transmission (for 215 nm).

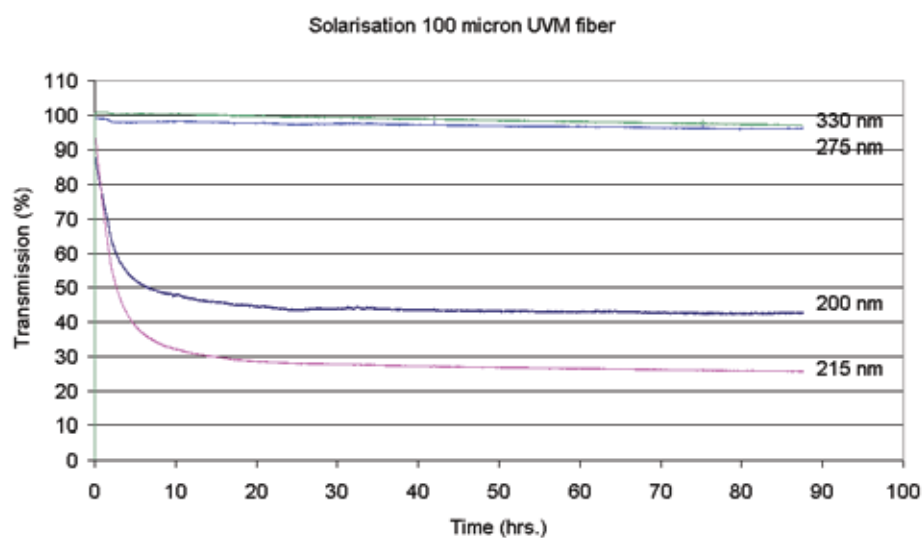
All UV/VIS fiber-optic probes, cables and bundles with core diameters of 100 µm, 200 µm, 400 µm, 600 µm, 800 µm and 1000 µm can be delivered with solarization resistant fibers. All assemblies, made by Avantes, are pre-solarized for an 8-hrs period, to have a constant transmission of 30-40% @ 215 nm.

Solarisation normal UV400



Solarization UVM100





Ordering Information

- SR** • Solarization resistant fiber for DUV applications



Fiber-optic Jacketing

For different applications Avantes offers different jacketing material. Standard fiber-optic cables and bifurcated cables are protected by a Kevlar reinforced polypropylene inner tubing with PVC red outer jacket. All of our standard reflection probes are protected by a flexible stainless steel jacket with interlocking profile (BX) or a chrome-plated brass outer jacket, with hooked profile (ME) for optimal strain relief with silicon or PTFE inner tubing. For waterproof and some medical applications stainless steel spiral jacketing with glas-

silk and gray outer silicon rubber coating can be provided. Inside this jacket silicon or PTFE inner tubing is used as well. For heavy industrial environments we advise the metal stainless steel (-BX) jacketing. It features a tensile strength of 950N. For special cases we can offer our form holding jacketing (FX). Some specifics on the jacketing can be found in the following technical information.

Contact us if you have any special conditions requirements.

Technical Data

Jacketing material	Kevlar reinforced PVC	Chrome plated brass (ME)	Stainless Steel (BX)	Silicon coated stainless steel (MS)	Stainless Steel (FX)
Inner Tubing	Polypropylene	Silicon/PTFE	Silicon/PTFE	Silicon/PTFE	Steel/Copper
Outer dimensions	3.8 mm	5.0 mm	6.0 mm	5.8 mm	6.1 mm
Min. bending radius	18 mm	18 mm	35 mm	18 mm	35 mm
Temperature Range	-20°C to +65°C	-65°C to +250°C	-65°C to +250°C	-60°C to +180°C	-65°C to +250°C
Tensile Strength	150 N	350 N	950 N	70 N	n.a.
Application	Standard	Industrial	Heavy Industrial	Waterproof IP67	Industrial

Ordering Information

- ME** • flexible chrome-plated brass outer jacket, with hooked profile
- BX** • Heavy industrial stainless steel jacket, with fully interlocking profile
- MS** • stainless steel spiral jacket with glassilk and gray outer silicon rubber coating
- FX** • stainless steel jacket for rigid / fixated setups

Standard



-MS



-ME



-BX



-FX



Fiber-optic Probe properties

All Avantes fiber-optic cables and probes can be modified to customers request. Most materials we use in our fiber-optic assemblies can be replaced with others to improve specific chemical or thermal resistance or to enhance vacuum or pressure properties. Please contact our fiber design engineers with your specific request.

In the following paragraphs some of the most essential technical parameters are listed for the materials we use.

Thermal resistance

The thermal resistance of a fiber-optic assembly depends on some of the materials used:

1. Fiber: the standard fiber design has a polyimide buffer, covering a wide thermal range -190 to 400 °C. For higher temperatures metal clad coated (to 500 °C) fibers are recommended.
2. Jacketing: the standard jacketing is PVC based and has a small temperature range (-20 °C to 65 °C), for higher temperatures a flexible metal jacketing (-BX/ME) with silicone inner tubing (up to 250 °C) or stainless steel tubing (not flexible, to 750 °C) is recommended.
3. Probe ends: connectors and ferrules are standard made of metal and have a wide temperature range. For special plastics, like PVC, PEEK and Teflon a limited temperature range is applicable.
4. Bonding epoxy: the standard epoxy used is a heat curing bonding epoxy with a temperature range of -60 °C to 175 °C. The curing temperature is standard 100 °C, for high temperature ranges (order code -HT), the curing temperature is 200 °C. For the HTX (extreme high temperature) fibers and probes silver soldering is used, a process that can withstand temperatures up to 500 °C.

Technical Data

Temperature range	Fiber	Jacketing	Probe end	Bonding
-20 °C to $+65$ °C	Standard Polyimide	Standard PVC	Standard metal/ PVC/PEEK	Standard Epoxy
-30 °C to $+100$ °C	Standard Polyimide	Metal (-BX/ME) or silicone (-MS)	Standard metal/ PEEK	Standard Epoxy
-60 °C to $+200$ °C (HT)	Standard Polyimide	Metal (-BX/ME) or silicone (-MS)	Standard metal/ PEEK	High temperature curing epoxy
-100 °C to $+500$ °C (HTX)	Metal clad coated	BX/ME-jacket or none	Metal	Silver soldering

Ordering Information

-HT	• High Temperature version (up to 200 °C)
-HTX	• Extreme High Temperature version (up to 500 °C)

All fibers
are available with SMA,
ST and/or FC/PC connectors

Chemical resistance

The chemical resistance of a fiber-optic assembly depends on some of the materials used:

1. Fiber, the standard fiber design has a polyimide buffer, which normally will not be in contact with the sample; the quartz core provides good resistance against most solvents.
2. Jacketing, the standard jacketing is PVC based and has a relative good chemical resistance. The -BX stainless steel and -ME chrome plated brass jacketing also have a good chemical resistance, but are not waterproof. The Silicone metal jacketing (-MS) is recommended for waterproof environment, biomedical applications, etc. The PEEK and PTFE jacketing have the best chemical resistance.
3. Probe ends, connectors and ferrules are standard made of stainless steel (316) and are not very well suitable in corrosive environment. For most corrosive

environments PEEK or Hastelloy® C276 are recommended.

4. Bonding, the standard heat-curing two-component epoxy used is resistant to water, inorganic acids and salts, alkalis and many aggressive organic solvents and most petrochemical products, and an extended range of organic and inorganic environments.

The table below gives a summary for the chemical resistance for most materials used. It has been drawn up on the basis of relevant sources in accordance with the state of the art; no claim to completeness. The data constitutes recommendations only, for which no liability can be accepted. Please contact us if you have any doubt about the materials to use for your application.

Technical Data

Chemical environment	Fiber		Jacketing		Probe end		Epoxy
Acids weak	Standard Polyimide	±	-BX/ME	±	St. steel 316 PEEK Hastelloy® C276	-	+
			-MS	+		+	
Acids strong	Standard Polyimide	-	-PEEK	+	St. steel 316 PEEK Hastelloy® C276	+	±
			-PVC	±		+	
Bases weak	Standard Polyimide	±	-BX/ME	+	St. steel 316 PEEK Hastelloy® C276	+	+
			-MS	+		+	
Bases strong	Standard Polyimide	-	-PEEK	+	St. steel 316 PEEK Hastelloy® C276	+	+
			-PVC	+		+	
Aromatic carbons	Standard Polyimide	+	-BX/ME	+	St. steel 316 PEEK Hastelloy® C276	+	+
			-MS	+		+	
Alcohols	Standard Polyimide	±	-PEEK	+	St. steel 316 PEEK Hastelloy® C276	+	+
			-PVC	+		+	
Ketons/Ethers	Standard Polyimide	+	-BX/ME	+	St. steel 316 PEEK Hastelloy® C276	+	±
			-MS	-		+	
			-PEEK	+		+	
			-PVC	-		±	

+ = good resistance

± = conditional resistant

- = not resistant

Ordering Information

- PK • PEEK Probe material replaces Stainless Steel
- HY • Hastelloy® C276 Probe material replaces Stainless Steel

Fiber-optic Connectors

SMA connectors

We supply all of our standard fiber-optic cables, bundles and probes with SMA-905 connectors that easily fit into our complete range of spectrometers, light sources and accessories.

The SMA-905 connectors are screw-fitted and can be rotated over 360 degrees. The typical insertion loss for the connectors is 0.5 dB. The maximum filling diameter for bundles is 2.46 mm

FC/PC connectors

Optional FC/PC-connectors can be mounted to our fiber-optic products. The multi-mode FC/PC connectors have an extremely low insertion loss of < 0.2 dB. The FC/PC

connector cannot rotate, always mounts into the same fixed position and therefore has a high reproducibility.

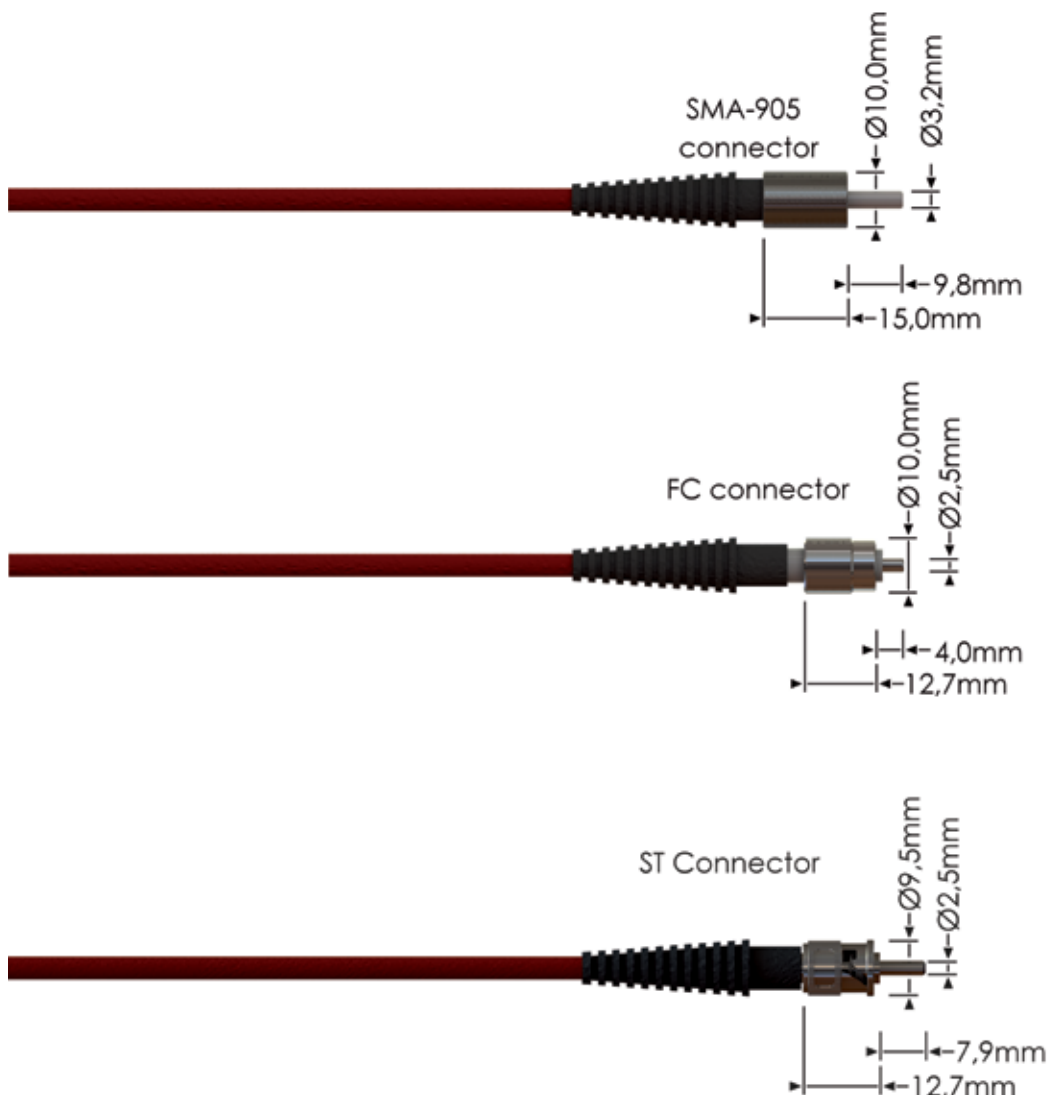
ST connectors

Optional ST-connectors can be mounted to our fiber-optic products.

ST-connectors easily mount with their bayonet type of fitting, and can therefore not rotate, i.e. they mount in a fixed position. The maximum filling diameter is 1.5 mm, typical insertion loss is 0.3 dB.

Ordering Information

-ST	• ST connector instead of standard SMA
-FC/PC	• FC/PC connector instead of standard SMA



Fiber-optic Cables

Avantes offers a wide range of fiber-optic cables, which can be made in a variety of lengths and configurations to meet your needs. For common applications, a 2 meter length is sufficient for this reason it is our standard fiber length.

Avantes offers SMA-905 or FC/PC connectors and these can be the same or different on both ends. For some applications, special round to linear fiber cables are recommended in which a bundle of fibers configured in a round pattern on one end and a linear array on the other end. The linear array (typically 1 mm in height) is aligned with the slit height of the spectrometer which is also 1 mm. This fiber configuration provides maximized light throughput for applications requiring high-sensitivity.

Fiber-optic cable types and diameters are recommended based upon the wavelength range being measured and the sensitivity required for a measurement. For the UV range high OH UV/VIS fiber is recommended. For customers working below 240 nm in the UV, special high OH UV/VIS fiber called solarization resistant fiber (SR)

is recommended. For longer wavelengths low OH VIS/NIR fiber is recommended. Best of both worlds can be achieved with our broadband fiber. This gives you the combined performance of the UV and IR fibers.

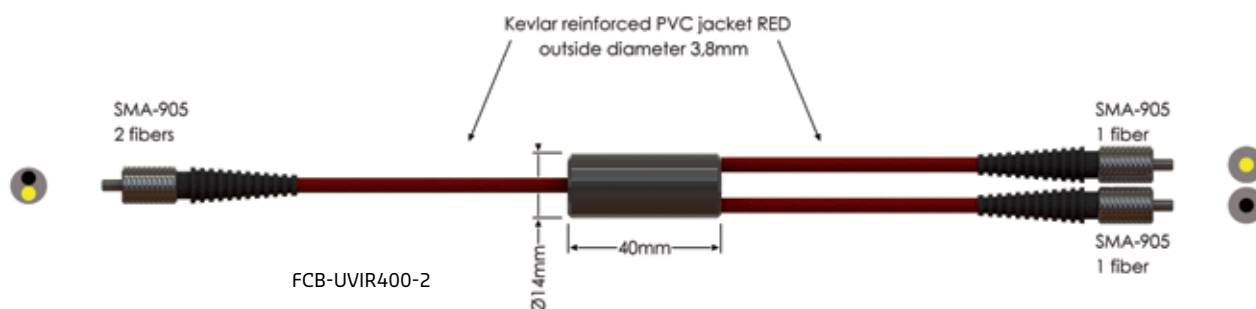
Avantes also offers a variety of jacketing options including Kevlar reinforced PVC sleeving with PTFE inner tubing (standard), chrome plated brass monocoil, stainless steel BX, silicone coated stainless steel monocoil and other special jacketings upon request.

For applications requiring high temperature resistance, special high temperature epoxy (HT) is available and should be specified at the time of order.

Recommended wavelengths for different cables:

- 180-800 nm: Solarization resistant (-SR)
 - 200-800 nm: UV/VIS (UV)
 - 350-2500 nm: VIS/NIR (IR)
 - 250-2500 nm: UV/VIS/NIR (UVIR)
- UV/IR available in core sizes 200, 400, 600 μm

Note: UVIR available in core sizes 200, 400 and 600 micron.



Ordering Information

FC-IR008-2	• Cable with 8 μm Fiber, 2 m length, SMA terminations
FC-xx050-2	• Cable with 50 μm Fiber, 2 m length, SMA terminations
FC-xx100-2	• Cable with 100 μm Fiber, 2 m length, SMA terminations
FC-xx200-2	• Cable with 200 μm Fiber, 2 m length, SMA terminations
FC-xx400-2	• Cable with 400 μm Fiber, 2 m length, SMA terminations
FC-xx600-2	• Cable with 600 μm Fiber, 2 m length, SMA terminations
FC-xx800-2*	• Cable with 800 μm Fiber, 2 m length, SMA terminations
FC-xx1000-2*	• Cable with 1000 μm Fiber, 2 m length, SMA terminations
FCB-xx050-2	• Bifurcated cable 2x50 μm , 2 m length, SMA terminations
FCB-xx100-2	• Bifurcated cable 2x100 μm , 2 m length, SMA terminations
FCB-xx200-2	• Bifurcated cable 2x200 μm , 2 m length, SMA terminations
FCB-xx400-2	• Bifurcated cable 2x400 μm , 2 m length, SMA terminations
FCB-xx600-2	• Bifurcated cable 2x600 μm , 2 m length, SMA terminations

Other lengths and fiber types are available. * 800-1000 μm with Acrylate buffer, black sleeving
Specify xx = UV for UV/VIS fiber cables, IR for VIS/NIR and UVIR for broadband UV/VIS/NIR

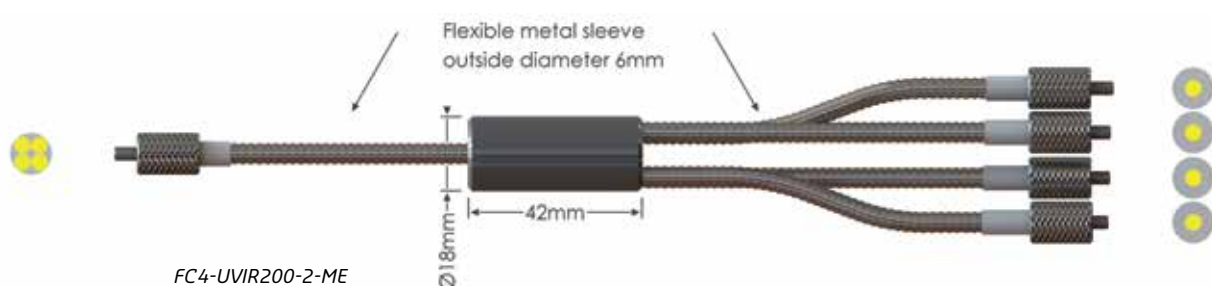
Multi-furcated Fiber-optic Cables

Simultaneous multi-point measurements and Avantes multi-channel spectrometers, require multi-furcated fiber-optic cables. These assemblies can function as a combiner or splitter of light as they have multiple legs on side which converge into a single connector on the opposite side. Avantes offers virtually any combination possible, which can be adapted to your requirements.

Typical setups that require multi-furcated cables are:

- One sampling point such as an integrating sphere, cosine corrector or collimating lens being measured with several spectrometers (individual AvaSpecs or Multi-channel).
- Multiple illumination fibers splitting out from one light source to different sampling points.

All types of connectors, jacketings and fiber sizes are available for these multi-furcated fiber cables. Contact us to configure and quote you on your specific needs.



FC4-UVIR200-2-ME

Ordering Information

FC4-xx200-2	• Four-furcated cable, 4x200 μm fibers, all legs SMA terminated, total 2 m long, splitting point in the middle
FC4-xx400-2	• As FC4-xx200-2, but with 4x400 μm fibers
FC4-xx600-2	• As FC4-xx200-2, but with 4x600 μm fibers
FC5-xx200-2	• Five-furcated cable, 5x200 μm fibers, all legs SMA terminated, total 2 m long, splitting point in the middle
FC5-xx400-2	• As FC5-xx200-2, but with 5x400 μm fibers
FC6-xx200-2	• Six-furcated cable, 6x200 μm fibers, all legs SMA terminated, total 2 m long, splitting point in the middle
FC6-xx400-2	• As FC6-xx200-2, but with 6x400 μm fibers
FC8-xx200-2	• Eight-furcated cable, 8x200 μm fibers, all legs SMA terminated, total 2 m long, splitting point in the middle
FC8-xx400-2	• As FC8-xx200-2, but with 8x400 μm fibers

Other lengths available on request

Specify xx = UV for UV/VIS fiber cables, IR for VIS/NIR and UVIR for broadband UV/VIS/NIR

Reflection Probes (Standard)



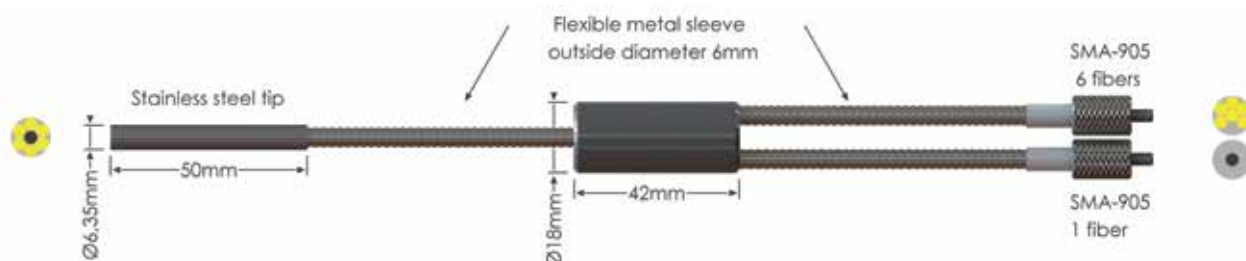
To obtain spectral information of the diffuse, or specular materials, reflection probes are used. The light from a light source is sent through six illumination fibers to the sample and the reflection is measured by a 7th fiber in the center of the reflection probe tip. The 7th fiber is coupled to a spectrometer configured to the appropriate wavelength range of interest. More illumination fibers can be added to get more energy from the light source and therefore increase the reflection signal level.

For measurements under an angle of 90°, the FCR-90-Option was developed. It's a special adapter with a mirror positioned at 45° and can be easily mounted on the tip of Avantes standard reflection probes.

The FCR-COL is an adjustable UV/VIS/ NIR collimating and focusing lens which enables focusing the measurement spot at an extended distance.

Technical Data

Fibers	7 fibers 200 mm or 400 mm core, 6 light-fibers, 1 read fiber, N.A.= 0.22. Standard 2 m length, splitting point in the middle.
Wavelength range	200-800 nm (UV/VIS), 350-2500 nm (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (2x)
Probe end	Stainless steel 316 cylinder, 50 mm long x 6.35 mm diameter. Optionally -PK for PEEK or -HY for Hastelloy® C276
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (BX, O.D. 6.0 mm) or chrome plated brass (ME, O.D. 5.0 mm) outer jacket. The jacketing also gives stress relieve.
Temperature	-30°C to 100°C. (-HT version 200 °C, -HTX version 500 °C)
Pressure	Probe head 50 bar @ 25 °C
Bending	Minimum bend radius: Short term (few seconds) 20-40 mm, long term: 120 -240 mm



Ordering Information

FCR-7xx200-2-BX/ME*	• Reflection probe, 7 x 200 µm fibers, 2 m length, SMA term.
FCR-7xx400-2-BX/ME*	• Reflection probe, 7 x 400 µm fibers, 2 m length, SMA term.
FCR-90-Option	• 90° Reflection add-on reflector for use with all ¼" reflection probes
FCR-COL	• Adjustable UV/VIS/NIR Collimating/focusing lens for FCR probes

* please specify jacket material

Options

-HT	• High Temperature version (up to 200°C)
-HTX	• Extreme High Temperature version (up to 500°C)
-PK	• PEEK Probe material replaces Stainless Steel
-HY	• Hastelloy® C276 Probe material replaces Stainless Steel

Reflection Probes with multiple legs

For some measurements, a reflection probe is needed that can be coupled to two spectrometers and a light source. A good example is a reflection measurement in the UV/VIS and NIR range. For these situations, Avantes offers our reflection probes with multiple legs.

The light from a light source is coupled into a fiber bundle, consisting out of 17 illumination fibers which transport the

light to the end of the probe. The reflected light is uniformly reflected into the two read fibers, each of which is connected to a spectrometer. In the example of a UV/VIS and NIR configuration a mix of high OH UV/VIS fiber and low OH VIS/NIR fibers are used for the respective light wavelengths and spectrometer types.

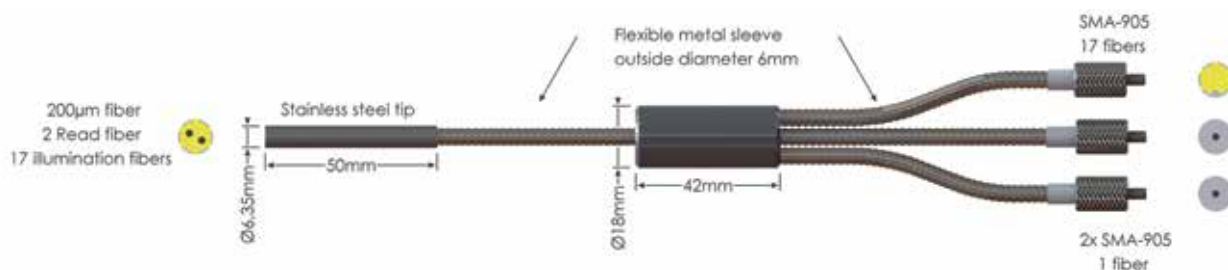
For measurements under a 90° angle, the FCR-90-Option has been developed. It is an

adapter with a mirror mounted at 45° and can be easily mounted to the tip of these reflection probes.

To accurately focus a small measurement spot from a higher distance, the FCR-COL adjustable US/VIS/NIR collimating/focusing lens is available and can be mounted to the tip of these probes.

Technical Data

Fibers	19 fibers 200 µm core, 17 light-fibers, 2 read fibers in 2 separate legs, N.A. = 0.22. Standard 2 m length, splitting point in the middle.
Wavelength range	200-800 nm (UV/VIS), 350-2500 nm (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (3x)
Probe end	Stainless steel 316 cylinder, 50 mm long x 6.35 mm diameter. Optionally -PK for PEEK or -HY for Hastelloy® C276
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (BX, O.D. 6.0 mm) or chrome plated brass (ME, 5.0 mm) outer jacket. The jacketing also gives stress relieve.
Temperature	-30°C to 100°C. (-HT version 200°C, -HTX version 500°C)
Pressure	Probe head 50 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm



Ordering Information

FCR-19UV200-2-BX/ME*	• Reflection probe UV/VIS, 17 x 200 µm UV/VIS illumination fibers, 2 read UV/VIS fibers in separate legs, 2 m length, 3 SMA term.
FCR-19IR200-2-BX/ME*	• As FCR-19UV200-2-BX/ME, but for VIS/NIR
FCR-19UVIR200-2-BX/ME*	• Reflection probe UV/VIS/NIR, 17 x 200 µm UV/VIS/NIR illumination fibers, 2 read UV/VIS/NIR fibers in separate legs, 2 m length, 3 SMA term.
FCR-90-Option	• 90° Reflection add-on reflector for use with all 1/4" reflection probes
FCR-COL	• Adjustable UV/VIS/NIR Collimating/focusing lens FCR probes

* please specify jacket material

Options

-HT	• High Temperature version (up to 200°C)
-HTX	• Extreme High Temperature version (up to 500°C)
-PK	• PEEK probe material replaces Stainless Steel
-HY	• Hastelloy® C276 Probe material replaces Stainless Steel

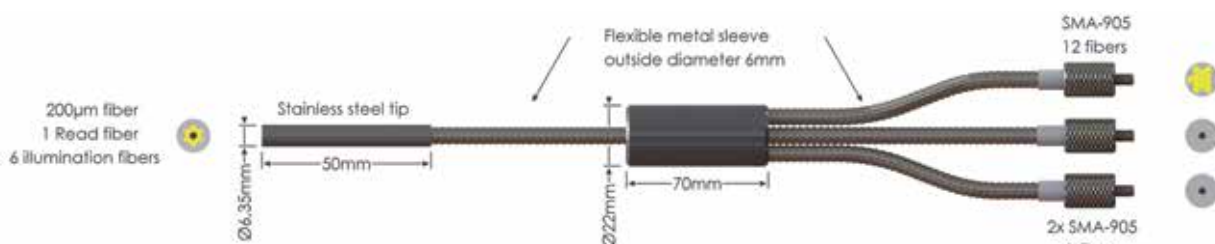
Reflection Probes with Reference

In order to correct fluctuations and drift from your light source, periodic referencing is required. To facilitate this, Avantes offers this series of reflection probes with a self-referencing feature. The light coming from the light source is bundled into 12 fibers, which are split into two 6 fiber bundles. One of these bundles is carried to the probe end for sample measurements and the other bundle of 6 are directed to a white reflection tile built into the probe

to provide a light source reference. This reference leg is connected to a slave spectrometer channel dedicated to light source referencing or may be routed to a single channel via a fiber-optic (contact a Sales Engineer about this special configuration). On the measurement side the probe end has a 7th fiber which reflects light back to the master spectrometer channel.

Technical Data

Fibers	14 fibers 200 µm core, 12 light-fibers, 2 x 1 read fiber, N.A.= 0.22. Standard 2 m length, splitting point in the middle.
Wavelength range	200-800 nm (UV/VIS), 350-2500 nm (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (3x)
Probe end	Stainless steel 316 cylinder, 50 mm long x 6.35 mm diameter . Optionally -PK for PEEK or -HY for Hastelloy® C276.
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (BX, O.D. 6.0 mm) or chrome plated brass (ME, 5.0 mm) outer jacket. The jacketing also gives stress relieve.
Temperature	-30°C to 100°C. (-HT version 200°C, -HTX version 500°C)
Pressure	Probe head 50 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm



Ordering Information

FCR-14xx200-2-REF-BX/ME*

• Reflection probe with reference, 14 x 200 µm fibers, 2 m length, SMA term.

Specify xx = UV for UV/VIS fiber cables, IR for VIR/NIR and UVIR for broadband UV/VIS/NIR

* please specify jacket material

Options

- HT** • High Temperature version (up to 200°C)
- HTX** • Extreme High Temperature version (up to 500°C)
- PK** • PEEK Probe material replaces Stainless Steel
- HY** • Hastelloy® C276 Probe material replaces Stainless Steel

Reflection Probes with Small Tips

For some medical and semiconductor applications, a (very) small tip is desired to do reflectance measurements. Avantes offers two standard diameters of small tip reflection probes, 1.5 and 2.5 mm and each tip is normally 100 mm long (custom lengths available).

The probe is configured with an illumination leg with six 200 µm fiber cables which connects to a fiber coupled light source and a single 200 µm read fiber cable to

measure the reflection via connection to a spectrometer.

A special angled fiber holder (AFH-15) is available for the 1.5 mm diameter reflection probe. This device enables reflection measurements under angles of 15, 30, 45, 60, 75 and 90 degrees. For more information, see 'reflection probe holders' at the end of this fiber-optics chapter.



Technical Data

Fibers	7 fibers 200 µm core, 6 light-fibers, 1 read fiber, N.A.= 0,22. Standard 2 m length, splitting point in the middle.
Wavelength range	200-800 nm (UV/VIS), 350-2500 nm (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (2x)
Probe end	Stainless steel cylinder, 100 mm long x 1.5 or 2.5 mm diameter.
Jacketing	The optical fibers are protected by a Kevlar reinforced PTFE jacket with PVC sleeving. OD: 3.8 mm
Temperature	-20°C to 65°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm



Ordering Information

FCR-7UV200-2-1.5x100	• Reflection probe, 1.5 mm tip, UV/VIS, 7 x 200 µm fibers, 100 mm long, 2 m length, SMA
FCR-7IR200-2-1.5x100	• As FCR-7UV200-2-1.5x100, but with VIS/NIR fibers
FCR-7UVIR200-2-1.5x100	• As FCR-7UV200-2-1.5x100, but with UV/VIS/NIR fibers
FCR-7UV200-2-2.5x100	• Reflection probe, 2.5 mm tip, UV/VIS, 7 x 200 µm fibers, 100 mm long, 2 m length, SMA
FCR-7IR200-2-2.5x100	• As FCR-7UV200-2-2.5x100, but with VIS/NIR fibers
FCR-7UVIR200-2-2.5x100	• As FCR-7UV200-2-2.5x100, but with UV/VIS/NIR fibers

For diffuse or specular reflection measurements, take a look at the RPH-1 reflection probe holder

Reflection Probes for Powders and Thick Fluids



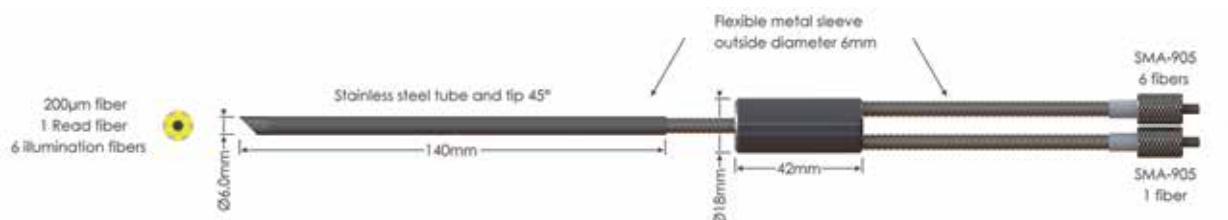
For effective measurement of reflection in powders and thick fluids, Avantes offers this specially designed series of reflection probes. The probes allow the user to simply dip the probe into the powder or thick fluids to do the measurements.

The illumination leg of the probe is connected to a light source and carries light to the sample via a bundle of six fibers. At

the probe tip, a 45 degree sapphire window illuminates the sample and collects the indirect reflections which are carried by a single fiber to the spectrometer. The 45 degree angle of the probe prevents the measurements of direct back reflection from the window, thus improving the dynamic range of your measurement.

Technical Data

Fibers	7 fibers 200 μ m core, 6 light-fibers, 1 read fiber, N.A.= 0.22. Standard 2 meter length
Wavelength range	200-800 nm (UV/VIS), 350-2500 nm (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (2x)
Probe end	Stainless steel 316 cylinder, 140 mm long x 6.0 mm diameter. The probe end contains a 5 mm diam. x 1 mm thick fused silica window. Waterproof. Optionally -PK for PEEK or -HY for Hastelloy® C276
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (BX, O.D. 6.0 mm) or chrome plated brass (ME, O.D. 5.0 mm) outer jacket. The jacketing also gives stress relieve.
Temperature	-30°C to 100°C. (-HT version 200°C)
Pressure	Probe head 10 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm



Ordering Information

FCR-7xx200-2-45-BX/ME*

- Reflection probe for powders and turbid fluids

Specify xx = UV for UV/VIS fiber cables, IR for VIR/NIR and UVIR for broadband UV/VIS/NIR

* please specify jacket material

Options

- HT** • High Temperature version (up to 200°C)
- PK** • PEEK Probe material replaces Stainless Steel
- HY** • Hastelloy® C276 Probe material replaces Stainless Steel

Did you know
Avantes is specialized
in custom made
fiber-optic cables?

1/2" Industrial Reflection Probes for Powders and Thick Fluids

For industrial applications that need reflection measured in thick liquids or powders, this probe is the ideal choice. The stainless steel cylinder and probe end make it withstand extreme situations. The tip is exchangeable and waterproof. Optionally PEEK or Hastelloy® C276 can be used as tip material.

The light enters from the light source through six bundled fibers to the probe end, where it lights the material to be analyzed through a silica window angled at 45 degrees. This angle prevents any light to be reflected from the window. The light is selectively reflected through the seventh fiber in the probe. This fiber leads to the connected spectrometer.



Technical Data

Fibers	7 fibers 200 µm core, 6 light-fibers, 1 read fiber, N.A.= 0.22, standard 2 meter length
Wavelength Range	200-800 nm (UV/VIS), 350-2500 nm (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (2x)
Probe End	Stainless steel cylinder, 120 mm long x 12.7 mm (1/2") diameter. The probe end contains a ca. 10 mm diam. x 1 mm thick sapphire window. The probe tip is exchangeable and waterproof. Optionally -PK for PEEK or -HY for Hastelloy® C276
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (BX, O.D. 6.0 mm) or chrome plated brass (ME, 5.0 mm) outer jacket. The jacketing also gives stress relieve.
Temperature	-40 °C to 100 °C. (-HT version 200°C)
Pressure	Probe head 10 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm

Ordering Information

FCR-7xx200-2-45-IND

- 1/2" Reflection probe for powders and turbid fluids

FCR-TIP45

- 1/2" Replacement tip with sapphire window for UV/VIS/NIR

Specify xx = UV for UV/VIS fiber cables, IR for VIR/NIR and UVIR for broadband UV/VIS/NIR

1/2" Industrial Fluorescence Probes

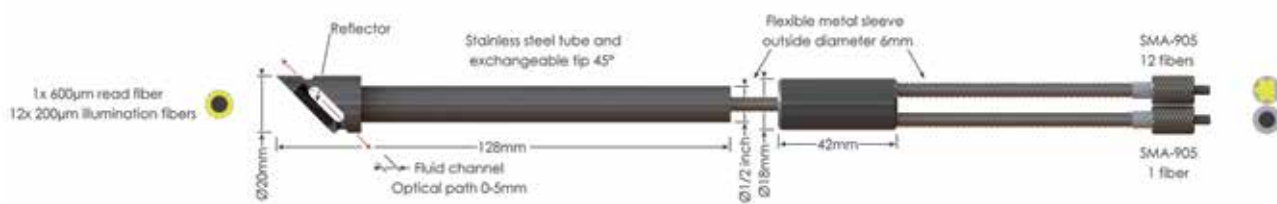


For effective measurement of fluorescence, Avantes offers this specially designed reflection probe. It features 12 excitation fibers of 200 μm around a 600 μm read fiber, which transports the fluorescence signal back to the spectrometer.

To turn the 45° reflection probe into a fluorescence probe, a special reflector accessory, FCR-FLTIP-IND, is attached to the probe end. It prevents ambient light to enter the probe and backscatters the excitation light. This increases the typically low fluorescence signal. The fluid channel path can be varied between 0 and 5 mm.

Technical Data

Fibers Illumination	12 fibers of 200 μm , UV/VIS
Fibers Detection	1 fiber 600 μm
Wavelength Range	200-800 nm (UV/VIS), 350-2500 nm (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)
Connector	2 x SMA-905
Probe End	Stainless steel 316 cylinder, 128 mm long x 12,7 mm ($\frac{1}{2}$ ") diameter. The probe end contains a ca. 10 mm diameter x 1 mm thick sapphire window with anti-reflection coating. The probe tip is exchangeable and waterproof. Optionally -PK for PEEK or -HY for Hastelloy® C276
Fluorescence Accessory	See drawing below
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (BX, O.D. 6.0 mm) or chrome plated brass (ME, 5.0 mm) outer jacket. The jacketing also gives stress relieve. Optionally a waterproof, steel reinforced, silicon jacket can be provided
Temperature	-30°C to 100°C. (-HT version 200°C)
Pressure	Probe head 10 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 60 mm, long term: 360 mm



Ordering Information

FCR-UV200/600-2-IND	• $\frac{1}{2}$ " Reflection Probe for fluorescence applications
FCR-FLTIP-IND	• Fluorescence Reflector Accessory for $\frac{1}{2}$ " FCR-UV200/600-2-IND probes

Options

-HT	• High Temperature version (up to 200°C)
-PK	• PEEK Probe material replaces Stainless Steel
-HY	• Hastelloy® C276 Probe material replaces Stainless Steel

For measurements in the lower UV-range, Avantes offers the -SR Solar Resistant fibers

Micro Transmission Dip Probes

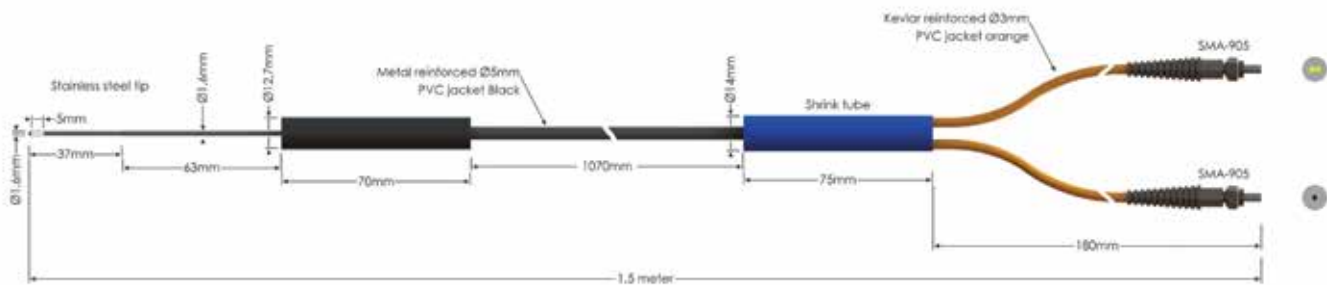
For micro-liter sampling, Avantes offers the micro transmission dip probe. It features a miniaturized tip which is 100 mm long x 1.6 mm in diameter to enable sampling in small vessels and all micro centrifuge tubes available on the market.

The micro transmission dip probe is available for UV measurements from 200 to 800 nm with solarization resistant (SR) fibers. The fixed optical pathlengths available are 2 mm, 5 mm or 10 mm.

The distance from the proximal end of the optical path to the distal end of the probe tip is 7 mm. The probe has two SMA connectors (FC/PC also available) for convenient coupling to the Avantes line of spectrometers and light sources. The probe features three UV/VIS fibers of 400µm: two for illumination and one for detection.

Technical Data

Fibers	2 illumination, 1 detection fiber, all 400 µm, UV/VIS-SR
Wavelength Range	200-800 nm (UV/VIS)
Connectors	2 x SMA-905
Probe End	Stainless steel cylinder, 37 mm long x 1.6 mm (1/16") diameter, then 63 mm x 1.8 mm. The probe end can be delivered with 3 different path lengths: 1 mm physical gap - 2 mm optical path, 2.5 mm physical gap - 5 mm optical path and 5 mm physical gap - 10 mm optical path
Jacketing	The optical fibers are protected by a metal reinforced PVC outer jacket. The tubing also gives stress relieve. OD: 5.0 mm. Total probe length 1.5 m
Temperature	0 °C to 65 °C.
Bending	Minimum bend radius: Short term (few seconds) 40 mm, long term: 240 mm



Ordering Information

FDP-UV-micro-1-SR	• 1/16" Micro Dip Probe, UV/VIS, 1 mm physical gap (2 mm optical path), 1.5 m
FDP-UV-micro-2.5-SR	• As FDP-UV-micro-1-SR, but 2.5 mm physical gap (5 mm optical path)
FDP-UV-micro-5-SR	• As FDP-UV-micro-1-SR, but 5.0 mm physical gap (10 mm optical path)

For the latest information,
go to www.avantes.com

Mini Transmission Dip Probes



For absorption measurements in miniaturized centrifuge tubes or vessels, Avantes offers the mini transmission dip probe. It features a miniaturized tip which is 130 mm long and 3.2 mm in diameter.

The mini transmission dip probe has a fixed 5 or 10 mm optical path length. It is available in three different versions: one for UV/VIS (200-800 nm) measurements, one for VIS/NIR (350-2500 nm) and one for UV/VIS/NIR (250-2500 nm). For best results below 240 nm, solarization resistant fiber (-SR) is recommended.

The probe features Avantes ME, chrome plated brass, jacketing.

Optionally the probe can be configured with a longer stainless steel or Hastelloy® tip, other jacketing options (MS, BX, or PVC). The probe has two SMA connectors (FC/PC also available) for convenient coupling to the Avantes line of spectrometers and light sources.

Please contact us for special requirements.

Technical Data

Fibers	1 illumination and 1 detection fiber, both 200 μ m, standard 2 meters length
Wavelength Range	200-800 nm (UV/VIS), 350-2500 nm (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)
Connectors	2 x SMA-905
Probe End	Stainless steel 316 cylinder, 130 mm long x 3.2 mm (1/8") diameter. The probe end contains 5 mm physical, 10 mm optical path, or a 2.5 mm physical gap (5 mm optical path). Optionally -HY for Hastelloy® C276
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (optional BX, O.D. 6.0 mm) or chrome plated brass (standard ME, 5.0 mm) outer jacket. The jacketing also gives stress relieve.
Temperature	-40 °C to 100 °C. (-HT version 200°C)
Pressure	Probe head 10 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm



Ordering Information

FDP-2xx200-2-2.5-mini

- 1/8" Mini Dip Probe, 2.5 mm path length (optical 5 mm), 2 m length

FDP-2xx200-2-5-mini

- 1/8" Mini Dip Probe, 5 mm path length (optical 10 mm), 2 m length

Specify xx = UV for UV/VIS fiber cables, IR for VIR/NIR and UVIR for broadband UV/VIS/NIR

Options

- BX** • Stainless steel jacket
- HT** • High Temperature version (up to 200°C)
- HY** • Hastelloy® C276 Probe material replaces Stainless Steel

Transmission Dip Probes

For online and inline absorbance measurements in fluids, transmission dip probes are used. When dipping or permanently mounting the probe end into the fluid, absorbance can be measured.

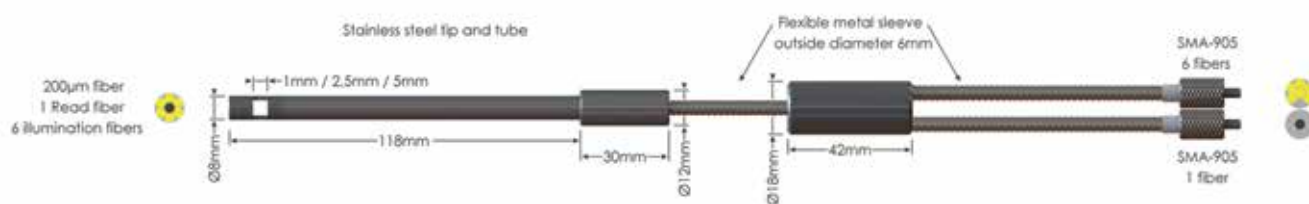
A standard SMA-905 connector is used to couple light into a fiber bundle, typically consisting out of six fibers (other configurations available upon request). The light is transmitted to the probe end, where it crosses the predetermined gap and is then reflected against a diffuse white reflective material back onto the receiving read fiber, which is coupled, to a spectrometer on the second leg of the probe.

The read fiber is placed in the center of the illumination fiber bundle to provide the best collection efficiency for the probe. Both bundles are housed in flexible stainless steel jacketing and the probe tip is also made of stainless steel. At the mid-point of the assembly a ferrule is used to split the fibers into their respective legs (illumination and read) which are terminated in SMA-905 connectors.

All Avantes fiber-optic probes can be customized to meet your specific requirements.

Technical Data

Fibers	6 illumination fibers, 1 detection fiber, all 200 µm, standard 2 meters
Wavelength range	200-800 nm (UV/VIS), 350-2500 (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (2x)
Tips	Replacement tips are available with 1, 2.5 and 5 mm spacing, i.e. an optical path of 2,5 and 10 mm and contain a 5 mm diam. x 1 mm thick fused silica window
Probe end	Stainless steel 316 cylinder, 100 mm long x 8,0 mm diameter. Waterproof, Optionally -HY for Hastelloy® C276
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (optional BX, O.D. 6.0 mm) or chrome plated brass (standard ME, 5.0 mm) outer jacket. The jacketing also gives stress relieve.
Temperature	-30°C to 100°C. (-HT version 200°C)
Pressure	Probe head 10 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm



Ordering Information

FDP-7xx200-2-yy	• Transmission Dip Probe, yy (1, 2.5, 5 mm) gap, 2 m length, SMA term.
FDP-TIP-yy	• Replacement tips, 1 mm, 2.5 mm, 5 mm gap for probe (fill in gap length for yy, note optical path = 2*yy)

Specify xx = UV for UV/VIS fiber cables, IR for VIR/NIR and UVIR for broadband UV/VIS/NIR

Options

-BX	• Stainless steel jacket
-HT	• High Temperature version (up to 200°C)
-HY	• Hastelloy® C276 Probe material replaces Stainless Steel

Transmission Dip Probes with Variable Path Length



For more flexibility during absorbance measurements in fluids, this fiber-optic probe features a variable and adjustable path length. The gap between the fiber and the diffuser can be set anywhere between 0.25 and 10 mm.

A standard SMA-905 connector is used to couple light into a fiber bundle, typically consisting out of six fibers (other configurations available upon request). The light is transmitted to the probe end, where it crosses the predetermined gap and is then reflected against a diffuse white reflective material back onto the receiving read fiber which is coupled to a spectrometer on the second leg of the probe.

The read fiber is placed in the center of the illumination fiber bundle to provide the best collection efficiency for the probe. Both bundles are housed in flexible stainless steel jacketing and the probe tip is also made of stainless steel. At the mid-point of the assembly a ferrule is used to split the fibers into their respective legs (illumination or read) which are terminated in SMA-905 connectors.

All Avantes fiber-optic cables can be customized to meet your specific requirements.

Technical Data

Fibers	6 illumination fibers, 1 detection fiber, all 200 μ m, standard 2 meters
Wavelength range	200-800 nm (UV/VIS), 350-2500 nm (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (2x)
Optical Path	0.25 - 10 mm physical gap, i.e. an optical path of 0.5-20 mm
Probe end	Stainless steel 316, 150-160 mm long x 12,7 mm (1/2") diameter. Waterproof. Optionally -PK for PEEK or -HY for Hastelloy® C276
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (optional BX, O.D. 6.0 mm) or chrome plated brass (standard ME, 5.0 mm) outer jacket. Optionally a waterproof, steel reinforced, silicon tubing can be provided (-MS)
Temperature	-30°C to 100°C. (-HT version 200°C)
Pressure	Probe head 10 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm



Ordering Information

- FDP-7xx200-2-VAR** • Transmission Dip Probe in stainless steel with variable tip length, 2 m length, SMA term.
- FDP-TIP-VAR** • Replacement Stainless Steel tip for Transmission dip probe with variable tip length

Specify xx = UV for UV/VIS fiber cables, IR for VIR/NIR and UVIR for broadband UV/VIS/NIR

Options

- BX** • Stainless steel jacket
- HT** • High Temperature version (up to 200°C)
- PK** • PEEK Probe material replaces Stainless Steel
- HY** • Hastelloy® C276 Probe material replaces Stainless Steel

Special Fiber Assemblies and Probes

For some applications a very specific fiber or probe is needed. Avantes has almost 20 years of experience in designing the custom probes for unique applications. Avantes has significant expertise in designing fiber-optics for high temperature (HTX), high pressure (HP), vacuum and other difficult conditions. Avantes wide variety of standard and custom materials can be configured to provide a fiber assembly which can meet the challenges of your environment.

Below are some examples of our special designs. Please contact us to discuss your needs.

High temperature UV/VIS/NIR probe with gas connection

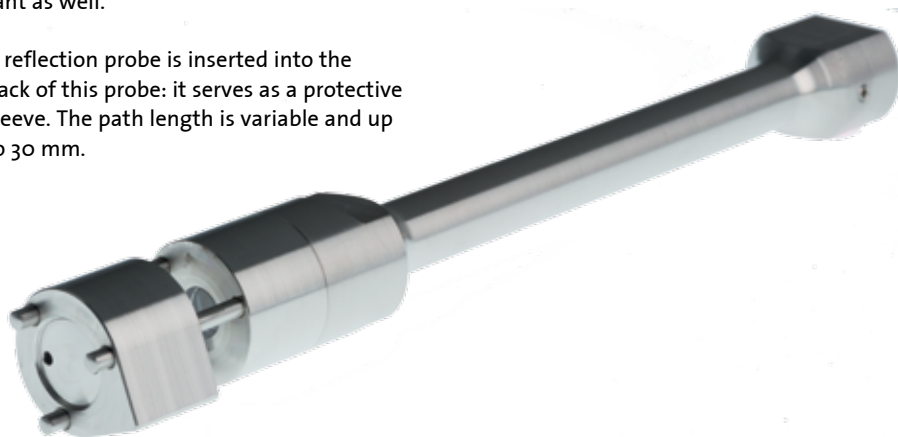
The universities of Bochum (Germany) and Utrecht (The Netherlands) approached us with a problem doing high temperature measurements at low pressure of dehydrogenation of propane: an ideal situation for the creation of cokes. Therefore every time the probe was contaminated with coke residue on the tip, meaning they could only do a single test after which they had to replace the probe.

Avantes responded by designing this high temperature probe. It's resistant to temperatures of 700 degrees centigrade or more and features a connection for gas insertion into the probe. So far, during one test the probe was used over 150 hours continuously, with temperatures of 550-600 degrees. The gas used was nitrogen. The result was a clean tip, re-usable probe and very happy customers.

Chemical resistant reflection probe

In chemical environments, standard reflection probes have a huge disadvantage: many chemicals interfere with the glue used to construct the probes. This version eliminates this disadvantage: all connections are mechanical, sapphire windows and o-rings are used. The material used is stainless steel 310, which is chemical resistant as well.

A reflection probe is inserted into the back of this probe: it serves as a protective sleeve. The path length is variable and up to 30 mm.



Collimating lens

COL-UV/VIS



Collimating lenses

To convert divergent beams of light into a parallel beam, a collimating lens is needed. Avantes collimating lenses are optimized for the UV/VIS/NIR range (200-2500 nm) and have anodized aluminum housings.

The COL-UV/VIS and COL-90-UV/VIS have a 6 mm diameter lens with a confocal length of 8.7 mm. The COL-90-UV/VIS is used when a 90-degree exit angle is needed. The focal point for the COL-UV/VIS and

COL-90-UV/VIS can be adjusted. The COL-UV/VIS can also be ordered with an FC/PC connector.

The COL-UV/VIS-25 is the big brother of the COL-UV/VIS. It has a lens diameter of 25 mm and a confocal length of 50 mm. This larger collimating lens is suitable for collection of light in free space.

COL-90-UV/VIS



Technical Data

	COL-UV/VIS	COL-90-UV/VIS	COL-UV/VIS-25
Lens Diameter	6 mm		25 mm
Lens confocal length	8.7 mm		50 mm
Lens Material	UV grade Fused Silica		
Wavelength range	200-2500 nm		
Fiber connection	SMA-905, UNS 1/4" (standard, FC/PC also possible)		
Mirror reflectivity	n.a.	>90% (200-1100 nm)	n.a.
Housing Material	Aluminum black anodized		
Thread	UNF 3/8"-24	n.a.	
Temperature range	-30°C to 100°C (-HT version 200°C)		

Ordering Information

COL-UV/VIS	• Collimating lens for UV/VIS/NIR, incl. SMA adapter and adj. focus
COL-UV/VIS-FCPC	• Collimating lens for UV/VIS/NIR, incl. FC/PC adapter, adj. focus
COL-90-UV/VIS	• Collimating lens under 90 degrees for UV/VIS/NIR, incl. SMA adapter
COL-UV/VIS-25	• Collimating lens 25 mm for UV/VIS/NIR, incl. SMA adapter and adj. focus

A collimating lens can be used to collect more light into a fiber cable

Cosine correctors

To collect light from a 180° angle, cosine correctors are used. This eliminates optical interface problems associated with the light collection sampling geometry inherent to other sampling devices such as bare fiber-optics, collimating lenses or integrating spheres.

Avantes offers four different models of cosine correctors: The CC-UV/VIS and CC-VIS/NIR have a 3.9 mm active area, and dimensions of 18 mm (L) X 6.5 mm (OD). The CC-UV/VIS is made of Teflon which especially suited for measurements in the 200-800 nm range, whereas the CC-VIS/NIR covers the full UV/VIS/NIR range of

200-2500 nm and is made of Radin Quartz.

The CC-UV/VIS/NIR-8MM works as the CC-VIS/NIR, but has an active area of 8.0 mm and dimensions of 29 mm (L) X 12 mm (OD). The specialized CC-UV/VIS/NIR-5.0 has a 20 mm active area is used for solar measurement applications requiring a 5° angular field of view has a 20 mm active area and is much larger than the other cosine correctors measuring 317 mm (L) X 38 mm (OD).

CC-VIS/NIR



Technical data

	CC-UV/VIS	CC-VIS/NIR	CC-UV/VIS/NIR-8MM	CC-UV/VIS/NIR-5.0
Active area	3.9 mm	3.9 mm	8.0 mm	20.0 mm
Diffusing material	Teflon (200-800 nm), ca. 1 mm thick	Radin Quartz (200-2500 nm), ca. 1.5 mm thick		
Dimensions	6.5 mm diameter, 18 mm long		12 mm diameter, 29 mm long	38 mm diameter, 317 mm long
Sampling geometry	Accepts light at/from 180° FOV			Accepts light at 5° FOV
Connector	SMA-905			
Temperature	-30 °C to +100 °C			

Ordering Information

CC-UV/VIS	• Cosine Corrector for UV/VIS, incl. SMA adapter
CC-VIS/NIR	• Cosine Corrector for UV/VIS/NIR, incl. SMA adapter
CC-UV/VIS/NIR-8MM	• Cosine Corrector for UV/VIS/NIR, 8 mm area, incl. SMA adapter
CC-UV/VIS/NIR-5.0	• Cosine Corrector for UV/VIS/NIR, 5.0° FOV, incl. SMA adapter

A cosine corrector collects light from an angle of 180°, ideal in situations with scattered light

Vacuum Feedthrough



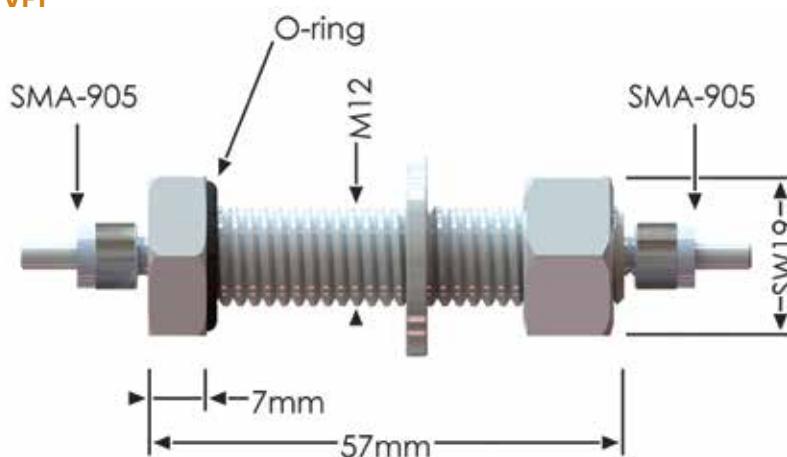
These feedthroughs are designed for the use with fiber-optics in vacuum chambers, such as for plasma and coating deposition monitoring. They can be used in chambers with wall thicknesses of 5-40 mm and vacuum levels up to 10^{-7} millibar.

The feedthrough assembly consists of an M12 housing with Viton® O-ring and two SMA fiber-optic interconnects to allow easy coupling to fiber-optic cables and probes. In order to connect these assemblies to fiber-optic cables inside/outside the chamber, two extra SMA fiber

interconnects (ME-FI-SM-MM) should be ordered separately.

The vacuum feedthrough can be delivered for all fiber diameters, from 50 μm up to 1000 μm for UV/VIS and VIS/NIR. Solarization resistant fiber (SR) for wavelengths <250 nm is also available. A high temperature version of the vacuum feedthrough(-HT) is also available enabling the device to withstand temperatures up to 200°C.

FC-VFT



Technical Data

Fibers	1 fiber, diameter 50 μm , 100 μm , 200 μm , 400 μm , 600 μm , 800 μm or 1000 μm
Wavelength range	200-800 nm (UV/VIS), 350-2500 (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)
Connectors	Standard SMA-905 connectors (2x)
Wall thickness of vacuum chamber	5-40 mm
Vacuum	Max. 10^{-7} mbar
Temperature	-40°C to 100°C (-HT version 200°C)

Ordering Information

FC-VFT-xx50	• Vacuum feedthrough for 50 μm fibers, incl. SMA adapter, needs 2 extra SMA interconnects
FC-VFT-xx100	• As FC-VFT-xx50, for 100 μm fibers
FC-VFT-xx200	• As FC-VFT-xx50, for 200 μm fibers
FC-VFT-xx400	• As FC-VFT-xx50, for 400 μm fibers
FC-VFT-xx600	• As FC-VFT-xx50, for 600 μm fibers
FC-VFT-xx800	• As FC-VFT-xx50, for 800 μm fibers
FC-VFT-xx1000	• As FC-VFT-xx50, for 1000 μm fibers
ME-FI-SM-MM	• SMA fiber interconnect, 2 pieces needed for each vacuum feedthrough

Specify xx = UV for UV/VIS fiber cables, IR for VIR/NIR and UVIR for broadband UV/VIS/NIR (only for 200, 400, 600)

Options

-HT	• High Temperature version (up to 200°C)
-SR	• Solarization resistant fibers for DUV <250 nm applications (in combination with 100-600 μm UV fibers only)

Fiber-optic Homogenizer

When connecting a multi-furcated fiber to a spectrometer or light source, light entering/exiting each of the fiber legs may or may not be uniform, so a fiber-optic homogenizer can be used to mix the signals to provide more uniform signal.

The compact MMA-UV/VIS-SMA fiber-optic homogenizer is made of anodized aluminum and has female SMA-905 connectors on both ends. Internally, a highly transmissive Suprasil-Rod with a diameter of 1 or

3 mm transmits the light from one end to the other (from bundle to single fiber) and perfectly mixes the modes.

The fiber-optic homogenizer can also be used as a mode stripper.

MMA-UV/VIS-SMA Homogenizer



Technical data

Wavelength Range	200-2000 nm
Optical Rod Diameter Stabdurchmesser	3 mm or 1 mm
Lens Material	Suprasil 1
Housing Material I	Aluminum anodized
Fiber Connection	SMA-905, UNS 1/4"
Dimensions	Length 47.5 mm, Diameter 14 mm
Temperature	-30 °C to +100 °C

Ordering Information

MMA1-UV/VIS-SMA	• Homogenizer / Modestripper 1 mm UV/VIS diameter for SMA Connectors
MMA3-UV/VIS-SMA	• Homogenizer / Modestripper 3 mm UV/VIS diameter for SMA Connectors

Fiber Microscope Adapters

To easily mount an Avantes fiber-optic spectrometer to a microscope, a C-mount adapter is available. It connects to an SMA or FC/PC fiber-optic cable and features an outside diameter of 38 mm, 35 mm long to

slide inside the tube of a microscope. A special adapter with C-mount 1 inch-32 thread is available as AVS-MFA-SMA to screw onto a microscope.



Technical Data

	AVS-MFA-SMA	AVS-CMOUNT-SMA	AVS-CMOUNT-FCPC
Fiber-optic connection	SMA	SMA	FC/PC
Microscope mount	1 inch-32 Cmount thread	38 mm diameter	38 mm diameter
Material	Black anodized aluminum		

Ordering Information

AVS-MFA-SMA	• C-mount adapter for Olympus, SMA connector
AVS-CMOUNT-SMA	• C-mount adapter, SMA connector
AVS-CMOUNT-FCPC	• C-mount adapter, FC/PC connector

Reflection Probe Holders



RPH-1 Reflection Probe Holder

The RPH-1 is to be used with our standard reflection probes, which are 6.5 mm in diameter. The holder enables positioning of the probe tip in two angles: 45 degrees for diffuse reflection measurements and 90 degrees (normal to sample) for specular reflection. This assembly is mostly used to facilitate color measurements.

A setscrew is included to mount the probe into position. The RPH-1 is a small device, measuring only 60 by 30 by 30 millimeters. It's made of black anodized aluminum.



AFH-15 Angled Fiber Holder

To do an angled measurement with a small 1.5 mm reflection probe or 1.5 mm stainless steel ferrule terminated fibers, the AFH-15 is the ideal accessory. Offering angles including 15°, 30°, 45°, 60°, 75° and 90°, reflection measurements with differing incident and collection angle can be easily

made with multiple, separate fibers for illumination and detection.

All 11 holes have a diameter of 1.6 mm and are equipped with a setscrew to mount the probes or fibers into position. The AFH-15 is made of black anodized aluminum.



AFH-Ocular

Measurements on a small spot (less than 0.5 mm) can be challenging but the AFH-Ocular makes the job easier. The ocular enables visual location of the measurement spot on your sample. The holder is used in conjunction with our miniaturized reflection probe (FCR-7UV100-2-1x25) which has 7 x 100 µm fibers in a 6 around

1 configuration and the tip is 1 mm in diameter x 25 mm long.

Please note that a black cover over the ocular (not included) should be used during measuring to prevent ambient light from reaching the measurement spot.

Ordering Information

RPH-1	• Reflection probe holder for 45/90 degree mounting of 6.5 mm reflection probes
AFH-15	• Angled fiber probe holder for measuring under different angles, needs 1.5 mm ferrule terminated fibers.
FC-UV200-2-1.5x40	• Fiber cable, 200 µm UV/VIS fiber, 2 m long, one end with SMA connector, other end with stainless steel ferrule, OD=1.5 mm x 40 mm length.
AFH-Ocular	• Angled fiber probe holder for precise measurements under 45 degrees incl. Ocular
FCR-7UV100-2-1x25	• Reflection probe with 7x100 µm UV/VIS fibers to 1x25 mm stainless steel ferrule, 2 meter long with PVC/Kevlar protection sleeve and 2 SMA connectors

Three years
limited warranty on all
Avantes spectrometers,
light sources and accessories

Transmission and Reflection Stage

For easy and accurate reflection and transmission measurements of glass and thinfilm, the Avantes Stage is the ideal companion. With a height of 420 mm and three individually adjustable devices, almost any measurement can be accomplished. The three devices are a rotatable entrance disc, with openings for an SMA fiber (with collimating lens) and different sizes reflection probes. The second and

third devices are sample holders, that are used for the transmission or reflection measurement. For scattering transmission measurements, an AvaSphere integrating sphere of 30 or 50 mm can be installed.



Ordering information

Transmission-stage

- Transmission and reflection stage, 420 mm high



Fiber Interconnects

To connect one fiber to another, a fiber interconnect is needed. They can be useful for coupling patch cords to fiber-optic probes and other devices, or for any multiple-fiber application where coupling of standard optical fibers and accessories is preferable to creating costly and complex fiber-optic assemblies.

Bulkheads

Avantes bulkhead adaptors for TO-5 and TO-18 packages are ideal for coupling an LED to a fiber-optic cable: the back side has space for an LED.

ME-FI-SM-MM SMA interconnect



ME-FI-FC/PC-MM FC/PC interconnect



ME-SM-BC SMA Bulkhead

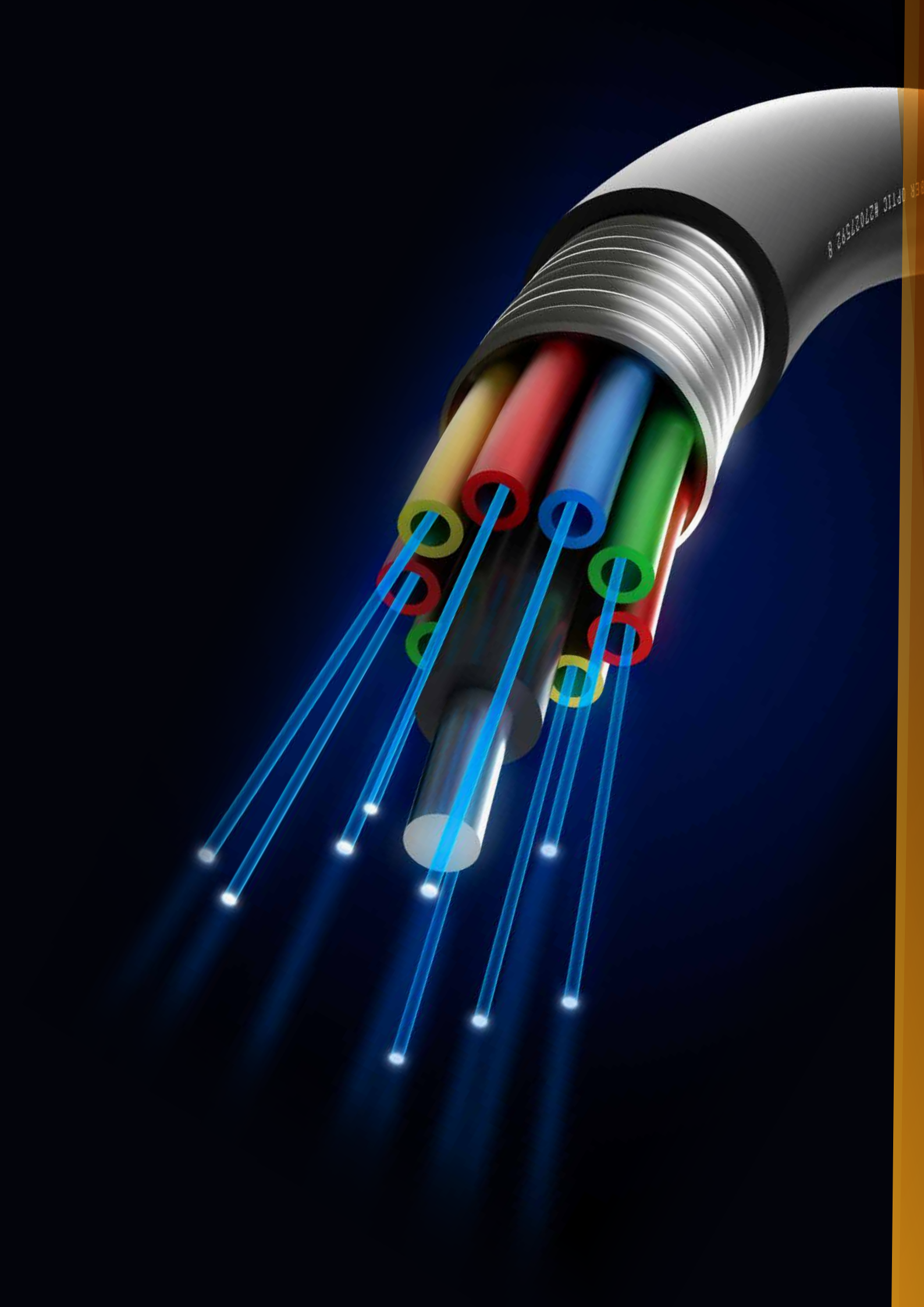


ME-FCPC-BC FC/PC Bulkhead



Ordering Information

ME-FI-SM-MM	• SMA Fiber interconnect, panel mountable
ME-FI-FCPC-MM	• FC/PC Fiber interconnect, panel mountable
ME-SM-BC	• SMA bulkhead adapter to TO-18
ME-SM-BC-S	• SMA bulkhead adapter to TO-5
ME-FCPC-BC	• FC/PC Bulkhead adapter



Accessories

100

INTRODUCTION

To facilitate easier and more accurate measurements during an experiment, Avantes offers a wide selection of high quality accessories. From integrating spheres to cuvette holders, filter holders and fiber-optic multiplexers Avantes has you covered for your fiber-optic accessory needs.

Avantes Accessories can be divided into several categories:

- USB to ethernet converter
- Cuvette holders. They are available in five different categories
 - 10 mm optical path, for UV/VIS/NIR absorbance measurements
 - 10 mm optical path, for UV/VIS fluorescence measurements
 - 10 mm optical path, for dual channel spectroscopy and fluorescence measurements
 - Variable length, from 10 to 100 mm for low absorption measurements
 - Direct-attached cuvette holders.
- Integrating spheres, available in three types:
 - Irradiance, for measuring radiometric and photometric quantities of LEDs and other light sources
 - Reflection, for measuring color parameters of object surfaces, such as L, a, b, hue, chromaticity
 - Reflection spheres with integrated light sources
- AvaTrigger external triggerbox device
- Inline or direct-attached filter holders and TTL-controlled shutters
- Inline or direct-attached fiber-optic attenuator
- Fiber-optic multiplexer, 1x16, 2x8 or 4x4 channels
- Optical table mounts for collimating lenses, as presented under fiber-optic accessories
- Flow cells for different types of applications:
 - Inline absorption measurements and process control 1/2" and 1/4" with 5 or 10 mm path length
 - Micro-flow cells for low volume, high pressure and HPLC applications
 - Long path flow cells for very low absorption measurements
- White and specular reflection tiles/standards to be used as a reference material for reflection measurements, such as color applications
- Power adapters and battery packs



AvaGigE: use your spectrometer on the network



USB cables have a maximum length of 5 meters. This means that controlling your spectrometer from a longer distance is difficult. This is why Avantes developed the AvaGigE: a USB to ethernet converter. Using a USB hub, you can connect the AvaGigE to up to 16 spectrometers with standard USB cables, connect the other side to the network and you're ready to go.

AvaSoft (version 7.7 and higher) and the GigE DLL interface enable connection and control of the spectrometer(s) as if they were right next to you. Data speeds are practically equivalent to a standard USB 2.0 connection. Setup can also be done via

a web-based configuration utility included with the AvaGigE.

Features:

- IP-based spectrometer control
- Field upgradable and network settings through web interface
- Can connect multiple AvaGigE to a single network
- No windows drivers needed: controlled directly through Avantes DLL with ethernet support
- Maximum network cable length 100 meters (CAT5E or better)

Technical Data

Power input	110-240VAC/50-60Hz Max. 20W
DC Consumption	5V/3.0A Max
Dimension	110 mm (L) X 69.5 mm (W) X 48.5 mm (H)
Communication input	1 Gigabit Ethernet 1 USB 2.0
Data transfer	160 spectra/sec (AvaSpec-2048-USB2 in network with AvaSoft) 300 spectra/sec (Avaspec-2048-USB2 through AvaGigE to PC)
Operating Temperature	0-40 °C
Storage Temperature	-25-70°C

Ordering Information

AvaGigE	• USB to Ethernet converter with controlling software
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Three years
limited warranty on all
Avantes spectrometers,
light sources and accessories

Cuvette Sample Holders

The CUV-UV/VIS, CUV-FL-UV/VIS and CUV-ALL-UV/VIS are especially designed for absorption and fluorescence measurements and should be used with standard 10x10 mm cuvettes. For non-standard cuvettes, adjustable ball-detents ensure repeatable placement and measurements at the same location. All cuvette holders have a 5 mm wide slit to hold filters and a cover to prevent ambient light from entering the light path.

The CUV-UV/VIS features two COL-UV/VIS collimating lenses with adjustable focus to maximize light throughput.

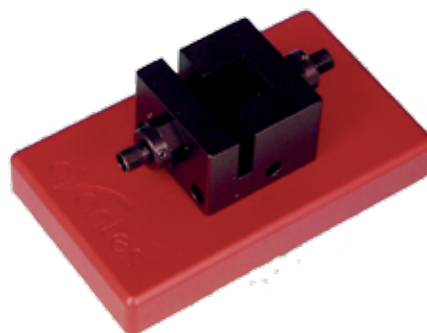
The CUV-FL-UV/VIS has the same specifications, but the collimating lenses are placed under an angle of 90 degrees for fluorescence measurements (to isolate excitation from emission wavelengths).

The other two ports on the CUV-FL-UV/VIS have SiO₂ coated aluminum mirrors (CUV-FL-MIRROR) to enhance the excitation and fluorescence signals.

The CUV-ALL-UV/VIS features four collimating lenses, all COL-UV/VIS, in two optical paths.

For UV measurement Avantes offers quartz cuvettes. The CUV-10-2 has two optical windows for absorption measurements. The CUV-10-4 features four optical windows, ideal for fluorescence with the CUV-FL-UV/VIS or dual path measurements with the CUV-ALL-UV/VIS.

CUV- UV/VIS



CUV-ALL-UV/VIS



Technical Data

	CUV-UV/VIS	CUV-FL-UV/VIS	CUV-ALL-UV/VIS
Cuvette Dimensions	10 x 10 mm		
Fiber connection	2 x COL-UV/VIS, SMA	2 x COL-UV/VIS, SMA, 2 mirrors	4 x COL-UV/VIS, SMA
Filter slot	Max 5 mm wide		
Overall dimensions	100 x 60 x 40 mm	100 x 100 x 40 mm	
Cover	Black anodized aluminum with black PE insert, 45 x 45 x 80 mm		

Ordering Information

CUV-UV/VIS	• Cuvette Holder, 10 mm path, incl. 2 UV/VIS/NIR lenses and cover
CUV-FL-UV/VIS	• Fluorescence Cuvette Holder, 10 mm path, incl. 2 UV/VIS/NIR lenses under 90°, 2 x SiO ₂ coated aluminum mirrors and cover
CUV-ALL-UV/VIS	• Cuvette Holder 10 mm path, 2 beams, 4 x UV/VIS/NIR lenses and cover
CUV-FL-MIRROR	• SiO ₂ coated aluminum mirror
CUV-10-2	• Quartz Cuvette 10 mm, 2 windows, 3.5 ml
CUV-10-4	• Quartz Cuvette 10 mm, 4 windows, 3.8 ml

Temperature Controlled Cuvette Holders

CUV-UV/VIS-TC



For extra stability during demanding measurements such as fluorescence, Avantes offers the CUV-UV/VIS-TC, a temperature controlled cuvette holder. The temperature can be set anywhere between -30°C and +105°C with an accuracy of 0.05°C.

Other features include magnetic stirring, slit attenuation kit and fused-silica lens systems with SMA fiber-optic connectors. It can be combined with any Avalight light source or AvaSpec spectrometer to create a powerful measurement system.

The CUV-UV/VIS-TC is available in fluorescence, absorption or combined fluorescence/absorption configurations. A special

direct-attached fluorescence configuration is available for coupling the Avalight-XE pulsed Xenon source for maximized fluorescence excitation energy.

Application areas enabled by the CUV-UV/VIS-TC series include DNA melting and annealing, protein thermodynamics, fluorophore characterization, enzyme kinetics and online thermocycling of biological particles.

Technical Data

Cuvette Dimensions	10 x 10 mm
Fiber connection	2 x COL-UV/VIS, SMA, 2 mirrors
Temperature control (Peltier)	-30°C to +105°C
TE control accuracy	± 0.05 °C
Stirring	Variable speed magnetic stirring
Overall dimensions	100 x 100 x 40 mm
Control unit	TE controller unit and circulation pump

Ordering Information

CUV-UV/VIS-TC-ABS	• Temperature controlled cuvette holder absorbance Kit, includes sample compartment, Temperature-Controller, two QIL-UV imaging lenses, BATH 100 submersible pump, QSLITS optical slits, cover with access cap, tubing, cables and a stir bar
CUV-UV/VIS-TC-FL	• Temperature controlled cuvette holder fluorescence Kit, same as CUV-UV/VIS-TC-ABS but with two QIL-UV imaging lens assemblies and two QMP mirror plugs
CUV-UV/VIS-TC-ABS/FL	• Temperature controlled cuvette holder fluorescence & absorbance kit, same as CUV-UV/VIS-TC-ABS, but with two QIL-UV imaging lens assemblies, two QCL-UV collimating lens assemblies, and two QMP mirror plugs
CUV-UV/VIS-TC-AVXE	• Base plate and support with AR-coated fused silica lens pair for excitation using the Avalight-XE pulsed Xe light sources

Accessories

CUV-TC-QCL-UV	• Extra AR-coated UV/VIS collimating lens for CUV-UV/VIS-TC
CUV-TC-QIL-UV	• Extra AR-coated UV/VIS imaging lens for CUV-UV/VIS-TC
CUV-TC-QMP	• Spherical mirror plate with steering plate for CUV-UV/VIS-TC
CUV-TC-QFH	• Filter holder for CUV-UV/VIS-TC
CUV-10-4	• Quartz Cuvette 10 mm, 4 windows, 3.8 ml

Direct-attach Accessories

Avantes offers a wide range of high quality direct-attach accessories, such as cuvette holders, filter holders and attenuators for the AvaLight series of light sources. In the table below an overview of direct-attach accessories for each light source can be found. For more information, please take a look at the following pages.

The last column is a combination of the attenuator, the cuvette holder and the filter holder in one easy to attach device.

CUV-ATT-DA



CUV-DA

Direct-attach accessories

Coupling to	Mounting	Round 1/2" Filter Holder	Cuvette Holder	Attenuator	Cuvette / Filter Holder / Attenuator
AvaLight-HAL-Mini	UNS thread	FH-DA-HAL-Mini	CUV-DA-HAL-Mini	ATT-DA-HAL-Mini	CUV-ATT-DA-HAL-Mini
AvaLight-DHS	Front plate	n/a	CUV-DA-DHS	n/a	n/a
AvaLight-DHc					
AvaLight-XE	SMA thread	FH-DA	CUV-DA	ATT-DA	CUV-ATT-DA
AvaLight-LED					
Fiber-optic	fiber	FH-INL	CUV-UV/VIS	ATT-INL-EXT	n/a

For the latest information,
go to www.avantes.com

Direct-attach variable In-Line Filter Holder

FH-DA



As part of the wide range of direct-attach accessories, Avantes offers the FH-DA series of filter holders. They can hold 0.5 inch filters of 1-8 mm thick.

The filter holders are equipped with two quartz collimating lenses for the UV/VIS/NIR range. Avantes offers a wide range of round 12 mm filters.

The FH-DA is available in two versions: the FH-DA for the AvaLight-XE, AvaLight-DHc and AvaLight-LED. The FH-DA-HAL is designed to work seamlessly with the AvaLight-HAL.

Technical Data

	FH-DA	FH-DA-HAL-Mini
Wavelength range	200-2500 nm	
Filter Dimensions	Round, 13 mm diameter, 1-8 mm thick	
Fiber connection	SMA-905 connector	
Light source	AvaLight-DHc/XE/LED	AvaLight-HAL-Mini
Light source mounting	SMA-905 thread	UNS thread (remove COL-UV/VIS)
Material	Black anodized aluminum	
Dimensions	44.5 x round 20 mm	37 x 40 x 41 mm

Separate round filters to install in FH-DA series

GL-WG305-12	Separate 12 x 3 mm long-pass filter > 305 nm
GL-KG3-12	Separate 12 x 3 mm band-pass filter, transparent > 325 nm and < 700 nm
GL-BG28-12	Separate 12 x 3 mm band-pass filter, transparent > 360 nm and < 500 nm
GL-GG385-12	Separate 12 x 3 mm long-pass filter > 385 nm
GL-GG475-12	Separate 12 x 3 mm long-pass filter > 475 nm
GL-OG515-12	Separate 12 x 3 mm long-pass filter > 515 nm
GL-OG550-12	Separate 12 x 3 mm long-pass filter > 550 nm
GL-OG590-12	Separate 12 x 3 mm long-pass filter > 590 nm
GL-NG9-1-12	Separate 12 x 1 mm Neutral Density filter, (transmission 10%, 400-1100 nm)
GL-NG9-2-12	Separate 12 x 2 mm Neutral Density filter, (transmission 1%, 400-1100 nm)
GL-NG9-3-12	Separate 12 x 3 mm Neutral Density filter, (transmission 0.1%, 400-1100 nm)

Ordering Information

FH-DA	• Direct-attach Filter Holder for 12 mm diameter filters, 1-8 mm thick, incl. one UV/VIS collimating lenses
FH-DA-HAL-Mini	• As FH-DA, meant for the AvaLight-HAL-Mini light source.

CUV Direct-attach Cuvette Holders

To mount a cuvette holder directly to your light source, Avantes offers a range of direct-attached cuvette holders. The CUV-DA connects to the AvaLight-DHc, -XE and -LED light sources, the CUV-DA-DHS to the AvaLight-DHS and AvaLight-DHS-BAL and the CUV-DA-HAL to the AvaLight-HAL. These devices can be used for either absorbance or fluorescence measurements.

All CUV-DA cuvette holders feature two 90-degree and one 180-degree threads that allow the COL-UV/VIS collimating lens to be connected for absorbance or fluorescence setups. Each of CUV-DA

series cuvette holders includes two SiO₂ aluminum mirrors to further enhance fluorescence signals. These are mounted at 90 degrees to the excitation source and emission output. The CUV-DA has a 5 mm wide filter slot.

For the AvaLight-HAL and the AvaLight-DHS the direct-attached cuvette holders can be mounted directly on the front panel of the light source by removing the standard filter holder.

CUV-DA



Technical Data

	CUV-DA			CUV-DA-DHS	CUV-DA-HAL-Mini
Lightsources	AvaLight-DHc	AvaLight-LED	AvaLight-XE	AvaLight-DH-S	AvaLight-HAL-Mini
Wavelength range	200-2500 nm				
Cuvette Dimensions	10 x 10 mm				
Light source connection	SMA thread incl col. lens			Mounting plate	UNS-thread (remove COL-UV/VIS)
Fiber connection	1 x COL-UV/VIS, SMA-905 connectors				
Fluorescence mirrors	2 x SiO ₂ coated aluminum mirrors				
Filter slit	Max. 5 mm wide				n.a.
Dimensions	60 x 43 x 28 mm			60x 50 x 50 mm	60x 35 x 35 mm

Ordering Information

CUV-DA	• Direct-attach 10 mm cuvette holder for AvaLight-DHc/XE/LED, incl. COL-UV/VIS lens and 2 mirrors
CUV-DA-DHS	• Direct-attach 10 mm cuvette holder for AvaLight-D(H)-S, incl. COL-UV/VIS lens and 2 mirrors
CUV-DA-HAL-Mini	• Direct-attach 10 mm cuvette holder for AvaLight-HAL(S)-Mini, incl. COL-UV/VIS lens and 2 mirrors
CUV-FL-MIRROR	• SiO ₂ coated aluminum mirror
CUV-10-4	• Quartz Cuvette 10 mm, 4 windows, 3.8 ml

Direct-attach Fiber-optic Attenuator

ATT-DA



When light intensity has to be reduced, the direct-attached attenuator is a great choice with your AvaLight series light sources. The attenuator helps in situations where detector saturation is an issue. It is attached to the light source and has a SMA connector to couple to other measurement devices and your spectrometer.

The ATT-DA series attenuators come in two versions: the ATT-DA is meant to be used with the AvaLight-DHc, the AvaLight-XE and AvaLight-LED. The ATT-DA-HAL is meant to be used with an AvaLight-HAL light source.

The attenuation can be set from 0-100%, which can be fixed with a set screws. It is supplied with a UV/VIS/NIR collimating lens.

Technical Data

	ATT-DA	ATT-DA-HAL-Mini
Wavelength range	200-2500 nm	
Attenuation	0-100%	
Iris aperture	0.0 – 12.0 mm	
Iris construction	2 x 5 leaves	
Fiber connection	SMA-905 connector	
Light source	AvaLight-DHc/XE/LED	AvaLight-HAL-Mini
Light source mounting	SMA-905 thread	UNS-thread (remove COL-UV/VIS)
Material	Black anodized aluminum	
Dimensions	27 mm round x 49 mm	37 x 41 x 57 mm

Ordering Information

ATT-DA	• Direct-attach Fiber-optic Attenuator, 0-100%, SMA connector
ATT-DA-HAL-Mini	• As ATT-DA, for AvaLight-HAL-Mini

Did you know
Avantes is specialized
in custom made
fiber-optic cables?

Cuvette holder with attenuator and filter holder

Have the most flexible setup with the combined cuvette holder, attenuator and filter holder. You can control the light throughput from 0-100%, which can be fixed with a set screw. Use the cuvette holder for any cuvette up to 10x10 mm and add half inch diameter (12-13 mm) filters of 1-8 mm thick.

The combined direct-attached accessory is available in two versions: the CUV-ATT-DA is used with the AvaLight-DHc (Deuterium and Halogen), AvaLight-XE (Xenon) and AvaLight-LED. The CUV-ATT-DA-HAL is meant for the AvaLight-HAL (Halogen) light source.



	Technical Data	
	CUV-ATT-DA	CUV-ATT-DA-HAL-Mini
Wavelength range	200-2500 nm	
Cuvette Dimensions	10 x 10 mm	
Attenuation	0-100%	
Filter slit	Max 5 mm wide	
Fiber connection	SMA-905 connector	
Fluorescence mirrors	2 x SiO ₂ coated aluminum mirrors	
Light source	AvaLight-DHc/XE/LED	AvaLight-HAL-Mini
Light source mounting	SMA-905 thread	UNS-thread (remove COL-UV/VIS)
Material	Black anodized aluminum	
Dimensions	42 x 34 x 85 mm	42 x 45 x 93 mm

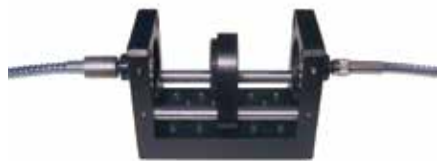
Ordering Information

CUV-ATT-DA	Combined direct-attach Fiber-optic Attenuator, Filter Holder and Cuvette Holder, SMA connector
CUV-ATT-DA-HAL-Mini	As CUV-ATT-DA, but for AvaLight-HAL-Mini light source



Variable In-Line Filter Holder

FH-INL-1"



FH-INL



When an in-line filter is needed, Avantes offers two types of in-line filter holders: the FH-INL-1" and the FH-INL. The FH-INL-1" is designed to hold one inch filters from 1-60 mm thick. The FH-INL is designed for 1/2" or 12-13 mm filters of 1-8 mm thick.

Both in-line filter holders come with two quartz collimating lenses for the UV/VIS/ NIR range. Avantes offers a wide range of round 12 mm filters (for FH-INL). For more specifications please see the table below.

Technical Data

	FH-INL	FH-INL-1"
Wavelength range	200-2500 nm	
Filter Dimensions	Round, 12-13 mm diameter, 1-8 mm thick	Round, max 1 inch (25.4 mm) diameter, 1-60 mm thick
Fiber connection	2 SMA-905 connectors	
Material	Black anodized aluminum	
Dimensions	round 20 x 50 mm	81 x 41 x 51 mm

Separate round filters to install in FH-INL

GL-WG305-12	Separate 12 x 3 mm long-pass filter > 305 nm
GL-KG3-12	Separate 12 x 3 mm band-pass filter, transparent > 325 nm and < 700 nm
GL-BG28-12	Separate 12 x 3 mm band-pass filter, transparent > 360 nm and < 500 nm
GL-GG385-12	Separate 12 x 3 mm long-pass filter > 385 nm
GL-GG475-12	Separate 12 x 3 mm long-pass filter > 475 nm
GL-OG515-12	Separate 12 x 3 mm long-pass filter > 515 nm
GL-OG550-12	Separate 12 x 3 mm long-pass filter > 550 nm
GL-OG590-12	Separate 12 x 3 mm long-pass filter > 590 nm
GL-NG9-1-12	Separate 12 x 1 mm Neutral Density filter, (transmission 10%, 400-1100 nm)
GL-NG9-2-12	Separate 12 x 2 mm Neutral Density filter, (transmission 1%, 400-1100 nm)
GL-NG9-3-12	Separate 12 x 3 mm Neutral Density filter, (transmission 0.1%, 400-1100 nm)

Ordering Information

FH-INL	• In-line Filter Holder for 12-13 mm diameter filters 1-8 mm thick, incl. UV/VIS collimating lenses and SMA connectors
FH-INL-1"	• Inline filterholder for 1" filters, max 60 mm optical path, incl 2 collimating lenses and SMA connectors.

In-line Fiber-optic Attenuator

For all UV-VIS-NIR applications and ATT-INL-EXT setups where light intensity has to be reduced, Avantes offers the inline fiber-optic attenuator (ATT-INL-EXT) and the direct attached fiber-optic attenuator (ATTDA). This device is an iris attenuator which controls light throughput to avoid detector saturation. The ATT-INL-EXT is coupled between two SMA terminated fiber-optic cables, whereas the ATT-DA can

be connected directly to the light source. Both devices consist of two UV/VIS/NIR collimating lenses mounted on either side of an adjustable iris. The attenuation can be set from 0-100% and can be fixed with a set screw.

ATT-INL-EXT



Technical Data

Wavelength range	200-2500 nm
Attenuation	0-100%
Iris aperture	0.0 – 12.0 mm
Iris construction	2 x 5 leaves
Fiber connection	2 SMA-905 connectors, incl. 2 COL-UV/VIS collimating lenses
Material	Black anodized aluminum
Dimensions	60 x Ø 25 mm

Ordering Information

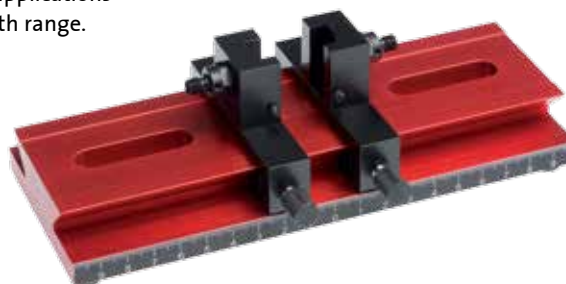
ATT-INL-EXT	• In-line Fiber-optic Attenuator, 0-100%, SMA connectors
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Variable Pathlength Cuvette Holder

For low absorption measurements and flow cell cuvettes, the CUV-VAR-UV/VIS cuvette holder is the ideal solution. It features a variable, adjustable path length, ranging from 10-160 mm, ensuring maximum flexibility. It can be used as a standard cuvette holder with a 10 mm path length, as a filter holder with 2 mm path length or any path length up to 160 mm.

This item is equipped with two COL-UV/VIS collimating lenses to support applications in the 200-2500 nm wavelength range.

CUV-VAR-UV/VIS



Technical Data

Base Dimensions (L x W x H)	200 x 80 x 25 mm
Fiber connection	2 x COL-UV/VIS, SMA connectors
Optical path	10-160 mm
Cuvette holder insert	Optical path 20 mm for 10 mm cuvettes
Focal height	15 mm from base plate
Overall dimensions (L x W x H)	200 x 96 x 62 mm

Ordering Information

CUV-VAR-UV/VIS	• Cuvette Holder with variable 0-100 mm path, incl. 2 COL-UV/VIS collimating lenses
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Integrating Spheres

AvaSphere 30-REFL



An integrating sphere works as a light collector. The light collected can be used as a diffuse illumination or measurement source. The basic principle is that light enters the sphere through the sample port, goes through multiple reflections on the highly reflective, Lambertian surface of the sphere and is scattered uniformly around the interior of the sphere. Behind a baffled port inside the sphere which is independent of the angular properties of the sample port, a fiber-optic cable collects a homogenized light signal and carries it to the spectrometer. The baffle is very significant as it prevents first reflections from entering the detection fiber.

The AvaSphere series integrating spheres are available with active diameters of 30, 50 and 80 mm and an SMA port at 90 degrees for collecting the irradiance and reflection signals. The reflection spheres feature an additional SMA-connector port at 8 degrees from normal (from sample port) for direct illumination. This port couples external light into the sphere through a fiber-optic cable connected to a COL-UV/VIS collimating lens. The sample port diameters are 6 mm for the AvaSphere-30, 10 mm for the AvaSphere-50 and 15 mm for the AvaSphere-80.

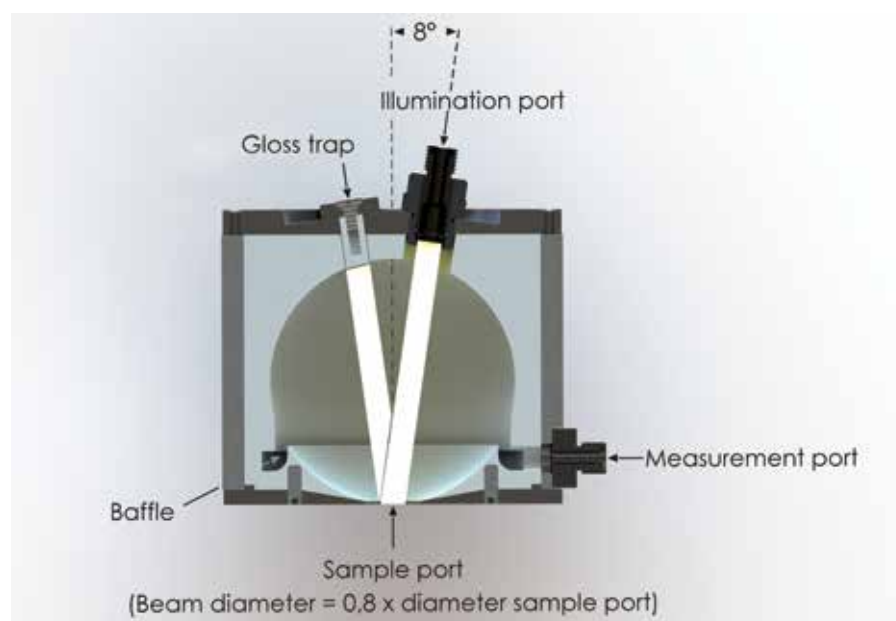
All sample ports are knife-edge, ensuring a near 180 degree field of view of the sample port. The irradiance version of the integrat-

ing sphere can be used for measurements of light sources, such as lasers, LEDs and incandescent sources. For irradiance measurements of 5 mm cylindrical LEDs, a special adapter is available for the AvaSphere-50/80-IRRAD. This adapter ensures correct and reproducible positioning of the LEDs inside the sphere.

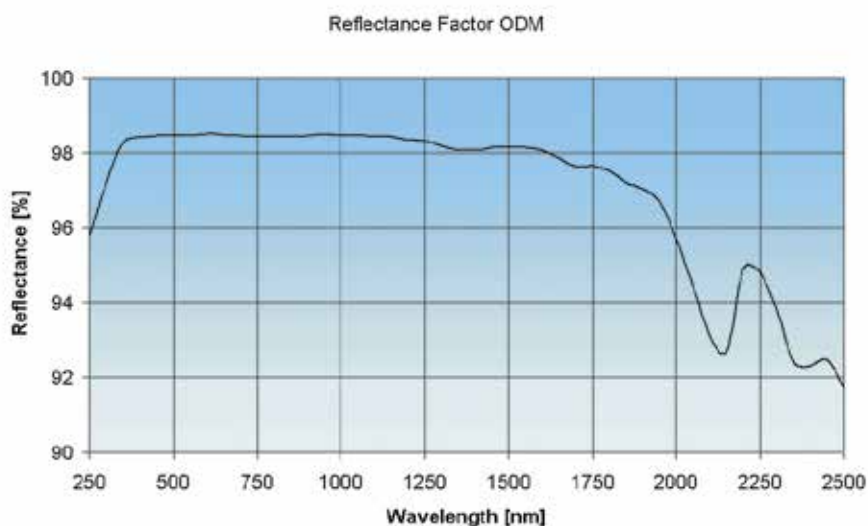
The AvaSphere reflection version is used for the measurement of total integrated reflectance of a surface, as well as for color measurements and fluorescence spectroscopy on solids/powders. The principle of measurement is based on direct illumination and indirect reflection.

The AvaSphere-50-LS-HAL with internal light source can be used as a uniform source and is available with an intensity calibration file.

The inside of the integrating spheres is made of a highly reflective diffuse PTFE material. This provides over 96% reflectance over a wide wavelength range of 250-2500 nm. For the AvaSphere-50-REFL a special black gloss-trap is available to exclude specular reflection in the measurement. Please order this option when ordering the sphere. In case specular reflection needs to be included, a white reflective part, which is standard on all AvaSphere-50-REFL, can be mounted in the position of the gloss-trap.



Reflection Integrating Sphere
Drawing for AvaSphere-50-REFL or 80-REFL



Reflection Curve AvaSphere

Technical Data

	AvaSphere-30	AvaSphere-50	AvaSphere-80
Internal diameter (mm)	30	50	80
Sample port diameter (mm)	6	10	15
External Dimensions	59.5 mm diameter 40 mm height	69.5 mm diameter 60 mm height	109 mm diameter 95 mm height

Ordering Information

AvaSphere-30-IRRAD	Integrating Sphere 30 mm for light measurements (250-2500 nm), Sample-port 6 mm
AvaSphere-50-IRRAD	Integrating Sphere 50 mm, Sample-port 10 mm
AvaSphere-80-IRRAD	Integrating Sphere 80 mm, Sample-port 15 mm
AvaSphere-30-REFL	Integrating Sphere 30 mm for reflection (250-2500 nm), Sample-port 6 mm, 2 SMA port
AvaSphere-50-REFL	Integrating Sphere 50 mm for reflection, Sample-port 10 mm
AvaSphere-80-REFL	Integrating Sphere 80 mm for reflection, Sample-port 15 mm
AvaSphere-50-LS-HAL	Integrating Sphere 50 mm for reflection, built-in halogen light source, sample-port 10 mm
AvaSphere-LED-ADR	Cylindrical Adapter to hold 3, 5, 8 mm LED's inside the AvaSphere-50-IRRAD
AvaSphere-LED-ADR-80	As AvaSphere-LED-ADR, but for AvaSphere-80-IRRAD
AvaSphere-GT50	Optional Gloss-trap for AvaSphere-50-REFL, coated with black absorbing material. Only in combination with AvaSphere-50-REFL.
AvaSphere-GT50-W	Gloss-trap coated with white material to include specular reflection. Standard included in AvaSphere-50-REFL.

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light sources and accessories

Integrating Sphere with internal halogen light source

AvaSphere-50-LS-HAL-12V



Providing up to 160 times more light on your sample for a reflection measurement relative to our standard reflectance integrating sphere, the AvaSphere-50-LS-HAL-12V is a valuable instrument for reflection applications. It is a combination of an integrating sphere and a halogen light source. The sphere provides diffused halogen light on your sample without the losses associated with fiber-optic coupling. It has a direct collimated SMA-port for collection of the reflection signal with any of our AvaSpec spectrometers.

It's mostly useful for dark or low reflecting materials and NIR spectral measurements

where signal strength can be limited. It is also very useful for measuring gem stones. In the application section of this catalog a complete gemology setup can be found.

The AvaSphere-50-LS-HAL-12V has an internal diameter of 50 mm, a sample port of 10 mm and an SMA terminated reference port. The 5W halogen lamp is stabilized and cooled with forced airflow. A 12V power supply is included.

The switch line makes it possible to remotely switch the light source on/off with a TTL signal.

Technical Data

Wavelength range	360-2500 nm
Internal diameter	50 mm
Sample port diameter	10 mm
Color temperature	2850 K
Stability/Drift	< 0.1% / h
Bulb life	4.000 hrs
Power requirement	12VDC, 1A
External Dimensions	70 mm diameter, 82,5 mm height

Ordering Information

AvaSphere-50-LS-HAL	Integrating sphere 50 mm for reflection (360-2500 nm), including 5W halogen light source, sample port 10 mm diam., 2 SMA ports (reflection and reference) and 12V power supply.
AvaLight-HAL-B-5W	Replacement 5W halogen bulb for AvaSphere-50-LS-HAL-12V
IC-DB26-AvaSphere-0,5	Interface cable to control switchline with AvaSpec
AvaSphere-50-HOLD	WS-2-GEM tile holder for AvaSphere-50-LS-HAL for gemology applications

Pre-configured spectrometers can be shipped within 24 hours

Large Integrating Spheres

For measurement of high powered LEDs and sources, Avantes offers the AvaSphere-100, -150 and -200. The number corresponds with the internal diameter of the spheres in millimeters.

The 100, 150 and 200 models come with three ports: at 0, 90 degrees and NP. The port of your choice is fitted with a baffled SMA-905 connector, please specify when ordering. Either of the other two ports can be used for illumination or sampling. The default sample port sizes are typically 25% of the sphere's diameter. Port plugs or reducers are available on request.

All spheres can be attached to spectrometers via fiber-optic cables and the entire system can be irradiance calibrated to measure total flux of a lamp under test.

Special sizes on request.



Technical Data

	AvaSphere-100	AvaSphere-150	AvaSphere-200
Wavelength range	400-1100 nm		
Internal diameter	102 mm	152 mm	203 mm
Port diameters	25.4 mm	38.1 mm	50.8 mm
Port Reducers	10 mm		
External Dimensions	118 mm	168 mm	218 mm

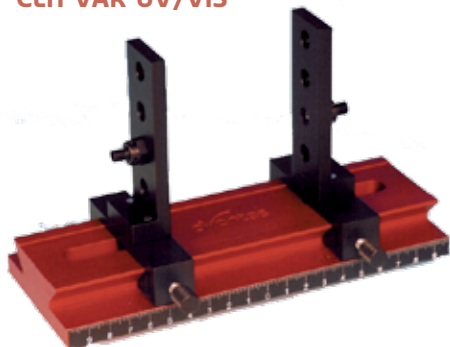
Ordering Information

AvaSphere-100	• Integrating Sphere, 100 mm, 3 ports (0,90,NP), 1 baffled SMA port, incl. Postmount
AvaSphere-100-SMA	• Additional SMA port for the AvaSphere-100
AvaSphere-100-PR10	• Port reducer for the AvaSphere-100 to 10 mm
AvaSphere-100-PP	• Port plug for unused ports for the AvaSphere-100
AvaSphere-150	• Integrating Sphere, 150 mm, 3 ports (0,90,NP), 1 baffled SMA port, incl. Postmount
AvaSphere-150-SMA	• Additional SMA port for the AvaSphere-150
AvaSphere-150-PR10	• Port reducer for the AvaSphere-150 to 10 mm
AvaSphere-150-PP	• Port plug for unused ports for the AvaSphere-150
AvaSphere-200	• Integrating Sphere, 200 mm, 3 ports (0,90,NP), 1 baffled SMA port, incl. Postmount
AvaSphere-200-SMA	• Additional SMA port for the AvaSphere-200
AvaSphere-200-PR10	• Port reducer for the AvaSphere-200 to 10 mm
AvaSphere-200-PP	• Port plug for unused ports for the AvaSphere-200

For the latest information,
go to www.avantes.com

Variable Collimating Lens Holder

CLH-VAR-UV/VIS



For transmission measurements of samples of various sizes and thicknesses, the variable collimating lens holder is the perfect tool. The vertical bars can be adjusted to samples up to 160 mm thick. The base is made of anodized aluminum and features adjustable mount bars. Each bar has four 3/8\"-24 threaded holes for COL-UV/VIS col-

limating lenses. Adjusting the bars is easy, simply loosen the screws and slide.

Two COL-UV/VIS collimating lenses are included with the variable collimating lens holder.

Technical Data

	Base	Mounting bars
Dimensions	200 x 80 x 25 mm, total height 120 mm	35 x 7 mm thick
Threads	n.a.	4 holes 3/8\"-24, 20 mm apart
Collimating Lenses	n.a.	2 COL-UV/VIS

Ordering Information

CLH-VAR-UV/VIS	• Variable Collimating Lens Holder, including 2 COL-UV/VIS lenses
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software for your AvaSpec
at www.avantes.com

AvaTripod

The AvaTripod is a flexible and versatile accessory, which is useable in various applications. The top of the tripod has an attachment head which features two holes; one measuring 6.8 mm in diameter to hold the barrel of a cosine corrector (CC-UV/VIS) or a reflection probe and a setscrew to hold the probe or cosine corrector in place. The second hole is a 3/8"-24 threaded hole for a COL-UV/VIS collimating lens.

The head can be fixed at any position, at any angle with an adjustable height of 200-300 mm.

AvaTripod



Technical Data

Dimensions	250 x 250 x 300 mm Max 75 x 75 x 200 mm (folded)
Threads	1 hole 3/8"-24 for COL-UV/VIS collimating lens 1 hole 6.8 mm diameter with setscrew for FCR probes and cosine correctors
Height adjustment	200-300 mm

Ordering Information

AvaTripod	• Tripod with COL-UV/VIS thread and 6.8 mm hole for FCR and CC-UV/VIS
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AvaTrigger External trigger box

We made it smaller and more sensitive... Introducing the new AvaTrigger. Designed for use with any AvaSpec-USB2 spectrometer, it enables two different external triggering methods: optical and manual.

The optical trigger is useful for measuring pulsed light sources, such as solar simulations. Your Avantes spectrometer can start integrating within 1.5 microseconds after receiving the signal from the AvaTrigger. Alternatively, you can specify a delay time if you are interested in measuring spectral output against time (temporal stability). The AvaTrigger has an SMA-905 connector to easily couple with any accessory or light

source from Avantes' extensive line-up.

The sensitivity of the optotrigger can be adjusted by a potentiometer at the front. A green indicator LED on the front panel of the AvaTrigger shows a short pulse when a TTL pulse is sent to your spectrometer.

The IC-DB26-2 interface cable required to connect the AvaTrigger with your Avantes spectrometer is included in the box.

AvaTrigger



Technical Data

Trigger Input	Opto	Pushbutton
Internal Delay time to TTL output	Ca. 300 ns*	20 µsec
Minimal pulse duration Trigger in	10 µsec	
Power consumption	5 mA @ 5VDC (internal)	
IO connector to AvaSpec	Pin 3 (5VDC), Pin 4 (hardware trigger to AvaSpec), pin 8 (enable trigger), pin 10 GND	
Dimensions	75 x 78 x 37 mm	
Weight	260 g	

*depending on the slew rate of the light source

Ordering Information

AvaTrigger-USB2	• External trigger source for all AvaSpec-USB2 spectrometers, incl. IC-DB26-2
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FOS-2-Inline

Fiber-optic Switch (FOS)

The fiber-optic switches (FOS) from Avantes are the ideal accessory to facilitate automatic shuttering of a spectrometer or to correct for light source drift. Automatic shuttering can be achieved with the FOS-1-Inline while light source drift correction requires the FOS-2-Inline. Both FOS designs can either be used automatically or operated electronically via a TTL pulse from an external source or AvaSpec spectrometer.

The FOS is coupled in the optical path between two SMA terminated fibers and features it two or four COL-UV/VIS collimating lenses (UV/VIS/NIR) and a filter holder for filters that are up to 5 mm thick. TTL signals can be provided by an external device or by an AvaSpec spectrometer connected through a cable (IC-DB26-2), ordered separately.

AvaSoft-Full spectroscopy software supports light source drift correction for a setup where one of the FOS-2-inline channels is connected to a reference measurement (such as a white tile, cuvette with blank) and the other channel is connected to the actual measurement. This provides for periodic switching to the reference channel and this updated reference data is used to correct the data measured at the sample channel.

A PS-24V/1.25A 24 volt DC power adapter is required for either of the FOS-series fiber-optic switches.

Technical Data

	FOS-1-inline	FOS-2-inline
Wavelength range	200-2500 nm	
Fiber connection	2 SMA-905 connectors, incl. 2 COL-UV/VIS collimating lenses	4 SMA-905 connectors, incl. 4 COL-UV/VIS collimating lenses
Filter slit	Max. 5 mm wide	
Shutter frequency	Max. 40 Hz	
Shutter delay	10 ms	
Shutter attenuation	60 dB	
Material	Black anodized aluminum	
Dimensions	130 x 65 x 65 mm	
Lifetime shutter	1.000.000 cycles (typical)	

Ordering Information

FOS-1-Inline	• In-line Fiber-optic Switch, one optical path, incl. 2 COL-UV/VIS
IC-DB26-2	• Interface cable AvaSpec-USB2 platform to FOS-1-inline, 2 m
FOS-2-Inline	• In-line Fiber-optic Switch, 2 optical path, incl. 4 COL-UV/VIS
IC-DB26-FOS2-2	• Interface Y-cable AvaSpec-USB2 platform to FOS-2 and AvaLight-S, 2 m
PS-24V/1.25A	• Power supply 100-240VAC/24VDC, 1.25A, necessary for FOS

Three years
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Avantes spectrometers,
light sources and accessories

Fiber-optic Multiplexer (FOM)

To configure systems which enable a single light source and spectrometer to make multi-point serial measurements, Avantes offers the FOM fiber-optic multiplexer. The device is available in three different configurations: 1 input to 16 outputs, 2 inputs to 8 outputs or 4 inputs to 4 outputs. The FOM consists of a precisely controlled stepper motor and a rotary block. The optical path is coupled through multiple COL-UV/VIS collimating lenses.

The fiber-optic multiplexer is controlled via a USB-connection to a PC. The FOM software enables full control over the switching order, switching time and delay time and operates as a stand-alone unit. To integrate the FOM with AvaSpec spectrometers and your own devices the FOM-DLL software development kit is available and should be ordered separately.

Applications for the FOM include process control, where multiple locations need to be measured with multiple probes, all with one spectrometer and/or light source.

FOM-UVIR400-2x8



Technical Data

	FOM-UVIR400-1x16	FOM-UVIR400-2x8	FOM-UVIR400-4x4
Multiplex Channels	1 x 16	2 x 8	4 x 4
Optical Throughput	> 60 % (based on 400 μ m fibers)		
Wavelength Range	250-2500 nm (UV/VIS/NIR)		
Fibers	Standard max. 400 μ m, different dimensions available on request		
Connectors	All SMA-905		
Optical Repeatability	> 99%		
Switching Time	< 60 ms between adjacent positions		
Interface	USB 2.0		
Power Requirement	100-230 VAC, 60VA		
Dimensions	244 x 144 x 354 mm		

Ordering Information

FOM-UVIR400-1x16	• Fiber-optic Multiplexer, 1 x 16 channels, 400 μ m fibers
FOM-UVIR400-2x8	• Fiber-optic Multiplexer, 2 x 8 channels, 400 μ m fibers
FOM-UVIR400-4x4	• Fiber-optic Multiplexer, 4 x 4 channels, 400 μ m fibers

Options

FOM-DLL	• Interface DLL package for Fiber-optic Multiplexer (FOM-UVIR400-1x16 and FOM-UVIR400-2x8, and FOM-UVIR400-4x4) for Windows XP through 8
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In-Line Flow cells

Flowcell-1/2"



For in-line absorbance or fluorescence measurements, Avantes offers the in-line flow cells. They are available for tubing diameters of 1/4, 1/2 and 1 inch. The flow cells consist of Swagelok union cross tube fittings and two UV/VIS/NIR collimating lenses.

The optical path depends on the size of the flow cell: the 1/4" version has an optical path of 5 mm, the 1/2" of 10 mm and the 1" version 20 mm. They feature SMA-905 connectors for easy coupling to any of our wide range of fiber-optic cables or bundles

All flow cells come with variable focusing to optimize light throughput over the spectral range.

All flow cells are also available in high temperature configurations (up to 200°C). Special gas flow cells are also available and are designed to withstand pressures up to 200 bar.

Technical Data

	1/4" flow cell	1/2" flow cell	1" flow cell
Optical path	5 mm	10 mm	20 mm
Sample volume	62 µl	124 µl	248 µl
Wavelength range	200-2500 nm		
Fiber connection	2 x SMA-905 connectors		
Collimating optics	Plano Convex, focal length 8.7 mm		
Max. Temperature	80°C (HT version till 200°C available on request)		
Max. Pressure	10 bar (Special Gasflowcell up to 200 bar)		
Material	Stainless steel for the fitting, black anodized aluminum for the SMA-905 connectors		
Overall dimensions	55 x 45 x 15 mm	72 x 50 x 22 mm	98 x 60 x 38 mm

Ordering Information

Flowcell-1/4"	• Flow cell 1/4" with variable SMA adapter, 5 mm path length, incl. 2 UV/VIS/NIR lenses
Flowcell-1/2"	• Flow cell 1/2" with variable SMA adapter, 10 mm path length, incl. 2 UV/VIS/NIR lenses
Flowcell-1"	• Flow cell 1" with variable SMA adapter, 20 mm path length, incl. 2 UV/VIS/NIR lenses
Flowcell-1/4"-FL	• Fluorescence Flow cell 1/4" with 2 SMA adapters, incl. 1 UV/VIS/NIR lens
Flowcell-1/4"-5-HPHT	• Flow cell for gasses and liquids, 1/4", 5 mm optical path length with SMA adapter, including 2 UV/VIS/NIR lenses, high pressure 200 bar, high temp 200°C.
Flowcell-1/4"-50-HPHT	• Flow cell for gasses and liquids, 1/4", 50 mm optical path length with SMA adapter, including 2 UV/VIS/NIR lenses, high pressure 200 bar, high temp 200°C.

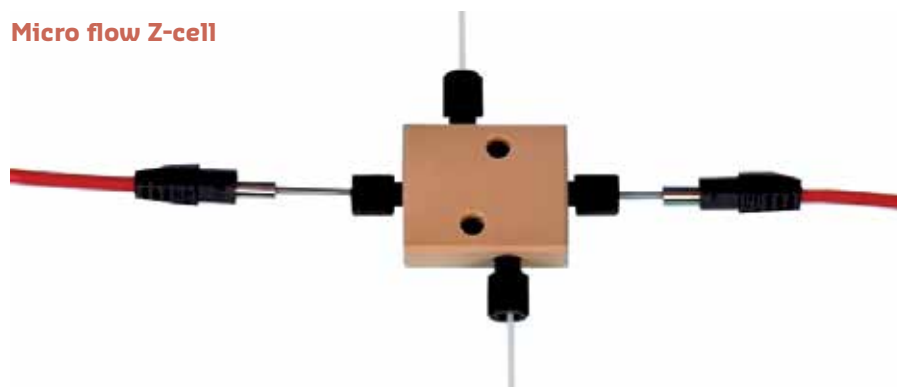
Option

-HT	• High temperatures up to 200°C
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Micro Flow Cell

For in-line measurements of low liquid volumes, Avantes offers our micro flow cells. The micro flow cells feature a Z-design and can easily be coupled to 1.5 mm PTFE tubing with 0.5 mm inner diameter. Typically these are used for absorption measurements and HPLC applications. Two special fiber-optic cables (FC part number terminating in FIA) are required for coupling with these micro flow cells. The special fiber-optic cable is the window for these flow cells.

Micro flow Z-cell



Technical Data

Flow Cell Type	Micro flow Z-cell -10	Micro flow cell -1.5
Wavelength Range	200-2500 nm	
Optical path length	10 mm	1.5 mm
Sample volume	18 µl	3 µl
Tubing OD connection	1.5 mm (1/16")	
Pressure rating	10 bar	
Fiber-optic coupling	1.6 mm ferrule	
Dimensions / material	32 x 38 x 13 mm / PEEK	

Ordering Information

FLOWCELL-Z-10	• Flow Z cell with 10 mm optical path
FLOWCELL-1.5	• Flow Z cell with 1.5 mm optical path
FC-UV400-1-FIA-SR	• Fiber cable 400 µm, UV/VIS, sol. Resistant for Flow Z cell 10/1.5

LPC series Long Path Flow Cells

LPC-FS-500 500 mm path length



When measurements need to be done in low-concentration fluids, the LPC series long path flow cells are the ideal choice. Available in 50 mm, 100 mm, 500 mm, 1 m and 2 m versions, they can be used to measure low-volume, low concentration (ppb-ppt) aqueous samples. They are suitable for discrete or continuous flow cell sampling.

The LPC long-pass flow cells consist of 550-micron inner-diameter fused silica capillary tubing with a low refractive index

polymer and an internal volume of 240µl/meter. The tubing has chromatography fittings for liquid flow. Coupling to a light source and spectrometer is easily done via SMA terminations.

These devices can be used in a wide variety of applications, such as liquid chromatography detection, drinking water analyses, as well as environmental and oceanographic monitoring systems.

Technical Data

Waveguide material	Fused silica tubing coated with low refractive index polymer
Optical Pathlength	50 mm, 100 mm, 500 mm, 1 m, 2 m
Inner Diameter	550 µm
Internal Volume	13-240 µl
Fiber input	400 µm
Max. Temperature	160 °C
Pressure Range	1.5 - 2000 PSI

Ordering Information

LPC-FS-50	• Long path flow cell fused silica tubing, 50 mm pathlength
LPC-FS-100	• As LPC-FS-50, 100 mm pathlength
LPC-FS-500	• As LPC-FS-50, 500 mm pathlength
LPC-FS-1000	• As LPC-FS-50, 1 m pathlength
LPC-FS-2000	• As LPC-FS-50, 2 m pathlength

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Reference Tiles

For diffuse reflection measurements, Avantes offers the WS-2 reference tile. For specular reflection measurements, the RS-2 is available.

The WS-2 reference tile is made out of a white diffuse PTFE based material, which is considered the highest grade reference material for diffuse reflectance. It is mostly used in colorimetric application where a reference signal has to be obtained during a reflection measurement.

The PTFE material is high purity and processed using exacting standards to an amorphous structure, so the tile reflects light from 350-1800 nm at circa 98% and from 250-2500 nm at more than 92%. The material offers long term stability, even in UV applications. The plastic is hydrophobic and chemically inert, so it is cleanable.

For gemology applications, the WS-2 is used in combination with a reflection integrating sphere. The gemstone is put on the middle of the tile with the integrating sphere over it.

The special WS-2-GEM is designed to facilitate holding and cooling a gemstone with liquid nitrogen, as it features a cavity and hole in the middle of the tile.

The WS-2-CAL is a NIST traceable calibrated white reference tile which includes an electronic calibration file covering 250-2500 nm.

The RS-2 is a mirror tile which can be used as a reference standard for specular reflection measurements.

The RS-2-CAL is a calibrated mirror tile which includes a NIST traceable calibration file, which is created using an 8° absolute specular reflectance measurement over the wavelength range from 250-2500 nm.

As with most Avantes products, these accessories can be delivered in a custom design. Contact us for more information.

WS-2 and WS-2-GEM



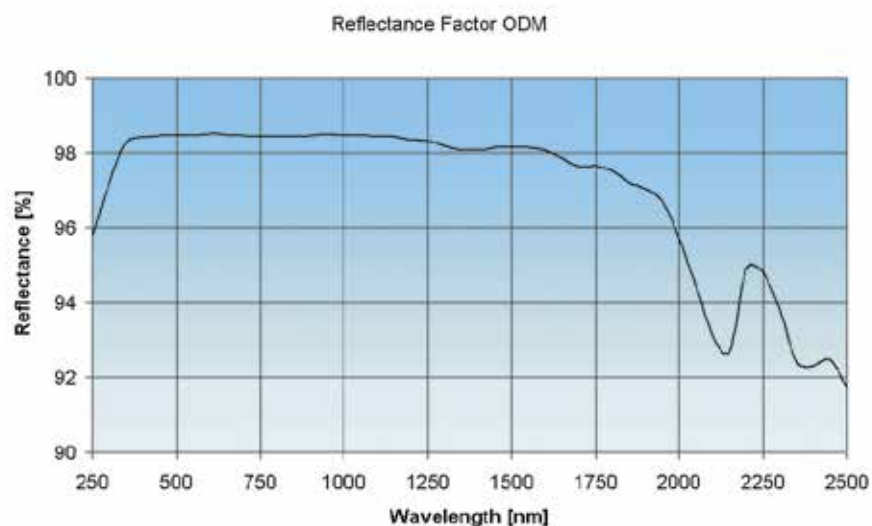
RS-2



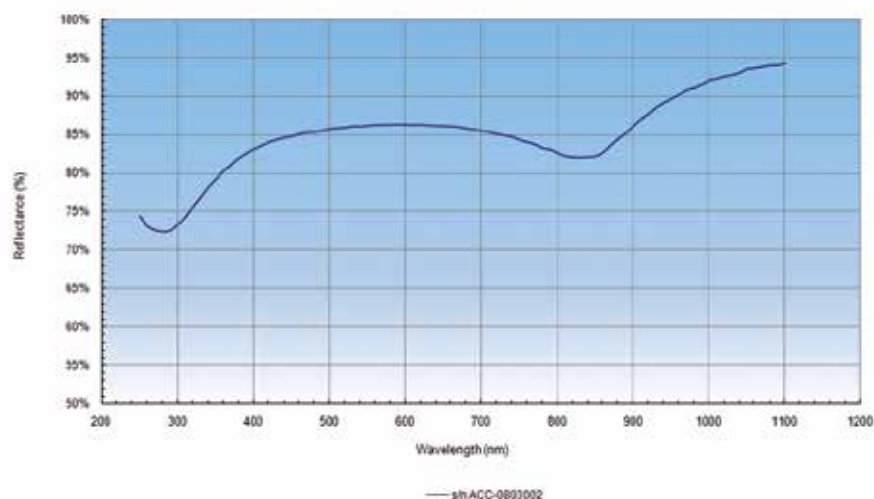
Technical Data

	WS-2	RS-2
Material	Diffuse PTFE material	BK7 with Al+MgF ₂ coating
Max. temperature	280°C	80°C
Dimensions tile	32 mm diameter / 10 mm thick	32 mm diameter / 1 mm thick
Housing	38 mm diameter, black PVC, cover red anodized	

For the latest information,
go to www.avantes.com



WS-2 curve



RS-2 curve

Ordering Information

WS-2	• White reference tile
WS-2-GEM	• White reference tile with cone, specially for Gemstone measurement
WS-2-CAL	• NIST traceable calibrated white reference tile with 8° hemispherical calibration, 250-2500nm
RS-2	• Specular Reflectance standard with Al+MgF ₂ , 250-2500 nm
RS-2-CAL	• NIST traceable calibrated Specular Reflectance standard with Al+MgF ₂ , 250-2500 nm

12 and 24 volts power adapters for spectrometer and light sources

Most AvaSpec spectrometers are USB powered, but some users prefer to externally power their instrument. Avantes PS-12V and PS-24V can be used to connect your AvaSpec spectrometer and AvaLight light sources to any 100-240V power connection.

The PS-12V has a maximum output of 1.0A and is used with all AvaSpec spectrometers and most light sources and accessories. The PS-24V is to be used with the AvaLight-HAL halogen light source and the FOS-inline

fiber-optic switch.

All power supplies are equipped with automatic thermal and overload cut-off circuitry. Please specify on the order which plug should be delivered based upon your geography: Euro, UK, USA or Australian plugs are available.

PS-12V Power adapter



Technical Data

	PS-12V/1.0A	PS-24V/1.25A
Power Input	100-240 VAC $\pm$ 10%/ 47-63 Hz	
Power consumption	400 mA	700 mA
Power Output	12 VDC $\pm$ 5%, depending on load	24 VDC $\pm$ 5%, depending on load
Output current (max.)	1.0 A	1.25 A
DC -Connector	5.5 mm OD, 2.1 mm ID, 11.5 mm long	3.5 mm OD, 1.3 mm ID, 10 mm long
Dimensions	92 mm x 40 mm x 28 mm	105 mm x 68 mm x 39 mm
Operating Temperature	0 - 45°C	
Cable length	2.0 m	

Ordering Information

PS-12V/1.0A	• Power supply 100-240VAC/12VDC, 1.0A
PS-24V/1.25A	• Power supply 100-240VAC/24VDC, 1.25A for FOS
PS-12V/1.1mm	• Power supply 100-240VAC/12VDC, 1.0A for AvaSpec-Mini
PS-12V/2.08A	• Power supply 100-240VAC/12VDC, for AvaLight-HAL-Mini

Euro plug standard, special power plug specify

-UK	• UK plug
-US	• USA plug
-AUS	• Australian plug

Did you know
Avantes is specialized
in custom made
fiber-optic cables?

Battery packs for portability of Avantes spectrometers and light sources

12V Battery pack



If you have a need for portability with our spectrometers or light sources, Avantes offers a range of battery packs to power our instruments in the field.

5+12V battery pack

The 5+12V battery pack was specifically designed for the AvaSpec-NIR series cooled spectrometers and the AvaSpec-TEC spectrometers that require a 5V-2A power supply for cooling. It has 5 NiMH batteries, with 13Ah capacity, enabling 6 hours of flawless operation.

12V battery pack

The 12V battery pack can be used with all our AvaSpec USB2-based spectrometers and most of our small form factor AvaLight illumination sources. It consists of 10 powerful NiMH batteries with a capacity of 1500mAh and allows you to use the spectrometers for up to eight hours without charging. It is suitable for all AvaSpec spectrometers and most small form factor light sources such as AvaLight-LED, AvaLight-XE, AvaLight-DHc and AvaLight-CAL, AvaLight-HAL-Mini.

Technical Data Battery Packs

	5+12V	12V
Power Input	5-9.6 VDC for loading	15-32 VDC/1.0A for loading
Input connector	4-pole Binder 719 male connector	3-pole Binder 719 male connector
Power Output	5 and 12 VDC	12 VDC
Output power	5 NiMH cells, 13 Ah	10 NiMH cells, 1500 mAh
Output -Connector	6-pole Hirose connector, 12 mm diameter x 55 mm	5.5 mm OD, 2.1 mm ID, 11.5 mm long
Dimensions	150 x 165 x 85 mm	100 x 110 x 44 mm
Operating Temperature	0 - 45°C	0 - 45°C

Three years
limited warranty on all
Avantes spectrometers,
light sources and accessories

1A Battery pack Charger



2.5A Battery pack Charger



Technical Data Battery Pack Chargers

	5V/ 2.5A	12V/1.0A
Power Input	100-240 VAC / 50-60 Hz	100-240 VAC $\pm$ 10% / 47-63 Hz
Power consumption	800 mA	700 mA
Power Output	4.8-9.6 VDC $\pm$ 5%	15-32 VDC $\pm$ 5%, depending on load
Output current (rapid charge)	2500 mA	950 mA
Output current (trickle charge)	n.a.	56 mA
DC -Connector	4-pole Binder 719 female connector	3-pole Binder 719 female connector, incl. temp feedback
Dimensions	110 mm x 53 mm x 32 mm	105 mm x 68 mm x 39 mm
Operating Temperature	0 - 40°C	0 - 40°C
Cable length	2.0 m	2.0 m

Ordering Information

Batterypack-5+12V/13Ah	• Battery pack 5 VDC and 12 VDC, 13 Ah
Batterypack-5+12V/13Ah-RM	• Battery pack 5 VDC and 12 VDC, 13 Ah, Rack-mounted version
Batterypack-12V/1.5Ah	• Battery pack 12 VDC, 1500 mAh
Batterypack-12V/1.5Ah-RM	• Battery pack 12 VDC, 1500 mAh, Rack-mounted version
Batterypack-charger-5V/2.5A-EUR	• Charger for battery pack 5 VDC, 2.5 A, Europlug standard, otherwise please specify -UK, -US, -AUS
Batterypack-charger-1.0A-EUR	• Charger for battery pack 12VDC, 1.0A, Europlug standard, otherwise please specify -UK, -USA, -AUS



Applications

INTRODUCTION

On the following pages we have listed some examples of the wide variety of solutions Avantes spectrometers are used for. From air pollution monitoring to measuring light effects on the biological clock of different organisms. And from LED measurements to real-time monitoring fertilizer concentration on crops.

Furthermore a number of example setups have been listed. LED, Irradiance, Thin Film and Color measurements are just some of the many possibilities. But the Avantes Spectrometers can be used in many more applications. Contact an application engineer to discuss your situation and the perfect spectroscopy solution for your needs.

Some of the markets our spectrometers are used in:

- Agriculture
- Astronomy
- Automobile industry
- Biology
- Biotechnology
- Chemistry
- Coating industry
- Colorimetry
- Construction
- Cosmetics
- Dairy industry
- Dental
- Dermatology
- Environmental
- Film industry
- Food
- Gas chromatography
- Gemology
- LCD industry
- Light industry
- Meteorology
- Medical
- Nanotechnology
- Narcotics
- Nuclear industry
- Optical filters
- Painting industry
- Paper industry
- Particle size analysis
- Pharmaceutical
- Photovoltaic industry
- Plasma etching
- Printing industry
- Pyrometry
- Radiometry
- Semiconductor industry
- Solar spectrum measurements
- Space research
- Sun glasses industry
- Textile industry

Avantes spectrometers: versatility worldwide

Finding fires with AvaSpec



Developed in Portugal, the Forest Fire Finder is an advanced fire detection and tracking system. The system consists of an individual or a series of towers which feature telescopic optics to measure spectra over forested areas. The system features an AvaSpec-ULS2048-USB2 spectrometer, a video camera, weather station, telescope, processing/controlling unit and communications unit. The telescope and the video camera scan the horizon non-stop, at an angle of 320 degrees. The telescope is connected to the spectrometer by means of a fiber and can collect spectra up to 15km away. These spectra are then processed and analyzed. The video camera takes pictures at pre-set intervals and can also be used to send real-time video. It is aligned with the telescope, to ensure what is measured.

Should the system detect a forest fire, automatically alerts are sent out through SMS, IP, GSM, etc. The alert contains needed information, such as fire location, detection time, weather conditions and an image of the detected fire. The weather conditions include wind speed and direction, temperature and humidity.

Environmental preservation in China has been closely examined in recent times, and there is increasing concern about reducing environmental pollution.

Industrial gas emissions have contributed enormously to the air pollution and must be monitored continuously. In China there are several companies which develop and manufacture CEMS (Continuous Emission Monitoring System). CEMS is used to do the air pollution measurement. These systems monitor the concentration of industrial gases and suspended particles emitted from air pollution sources.

UV spectrometers are integrated to the CEMS used for calculating the absorption of SO_x/NO_x. Over 200 CEMS systems do have 'Avaspec inside' and we expect this to be multiple in the future.

These AvaSpec spectrometers have high demands regarding stray light, optical resolution, stability and sensitivity.

The AvaSpecULS2048x16 has proven to be a very good choice for this application. This is because this device has a very high quantum efficiency and SNR(500:1) in the UV range, besides it has a lower stray light.

DOAS (Differential optical absorption spectroscopy) is one of the techniques which is used in these systems.

Application Note: CEMS Continuous Emission monitoring systems

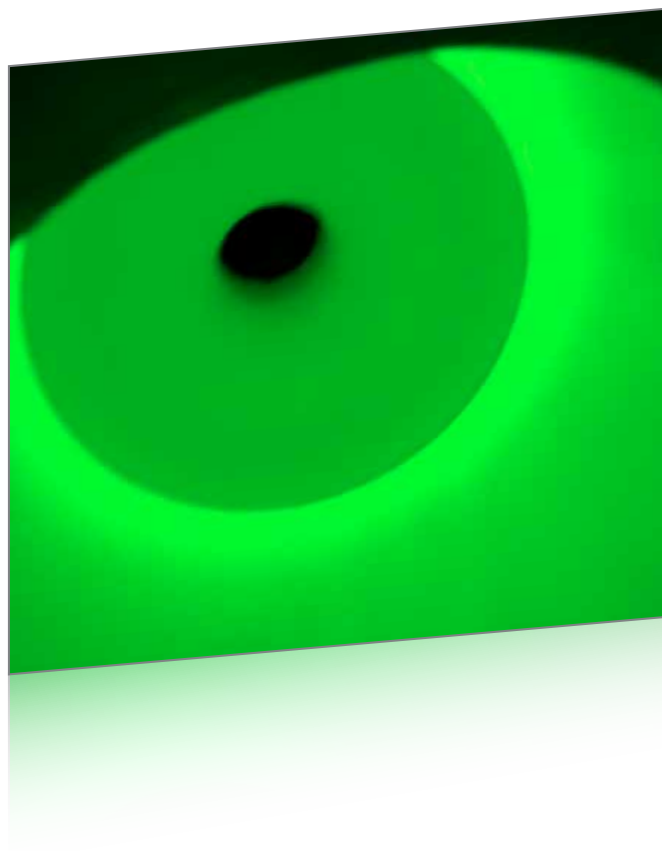


Application Note:

Light effects on the biological clock

Most organisms have a circadian clock which has evolved as a consequence of the rotation of the earth around its axis. The circadian clock resides in the suprachiasmatic nucleus and generates rhythms of about 24 hours. The suprachiasmatic nucleus adapts to daily changes in its environment. Light is the main synchronizer of the biological clock to the external light-dark cycle and is detected by ocular photoreceptors in the retina. Light information is then sent to the suprachiasmatic nucleus via the optic tract. In the suprachiasmatic nucleus light information leads to an enhancement in electrical activity of the neurons.

To determine the effects of light on the circadian clock in mice, in vivo electrophysiological recordings of neurons of the circadian clock were performed. Mice were exposed to three different wavelengths of light using monochromatic LEDs. The wavelengths of light used were UV (λ max 365 nm), blue (λ max 467 nm) and green (λ max 505 nm). During light exposure the extracellular activity of a group of neurons of the suprachiasmatic nucleus were recorded.



Integration of Avantes spectrometers in multi-element LIBS analysers



The Laser Induced Breakdown Spectroscopy (LIBS) gives information about the elemental composition within a small spot on a sample surface and, in addition, even low Z elements can be measured with good sensitivity. With the LIBS Software Suite (LSS) calibration (univariate or multivariate, PLS) and classification (PCA, NN) models for a wide range of analysis tasks can be created. The calibration models can be used for offline and online measurement. The SECOPTA GmbH in Berlin, Germany has integrated Avantes spectrometers in different FiberLIBS and MopaLIBS element analysers for industrial and laboratory applications.

To measure and apply the appropriate levels of fertilization on crops can be a time consuming activity. This is what the Yara system was designed to facilitate. Featuring a dual channel AvaSpec series spectrometer, fiber-optics and processing electronics mounted in a blue box on top of a tractor, the system makes real-time measurements of the optical appearance of crops and intelligently applies fertilizers accordingly.

Relevant for the fertilization is the level of nitrogen in a crop, which is measured by means of reflection spectroscopy. In the visible range (380-740 nm) the reflection is an indication of the leaf chlorophyll content, in the NIR range (700-1000 nm) reflectance is mainly affected by the crop's biomass.

Included with the Yara system is a terminal for real-time monitoring. A special viewing geometry and integrated irradiance correction guarantees accurate measurements. The system logs crop and GPS data on a on-board data card.

Monitoring fertilizer concentration on the go



Testing leakage of cooling water of (nuclear) power plant



In Japan there are many (nuclear) power plants and they are all build on a rocky based bottom. These rocks also have underground water streams, in case of an earthquake (not unrealistic in JAPAN) radioactive cooling water might leak through the rocks into these clear water streams and spread the radio- active radiation on to a greater area, which will be extremely dangerous for environment and all living creatures.

The idea is to drill several deep holes in a specific area around the power plant (aprox. 50 m deep) and measure fluorescence in the underground water stream. To the cooling water used in the coolwater system of the power plant a tracer is added, this tracer will cause a strong fluorescence signal when measured with the AVANTES system in a 50 meters deep well. When in case of an earthquake cooling water would leak it can be traced within a reasonable time as the distance from detection well to power plant is short.

For a company in Japan we developed a special flow cell with an integrated LED 480 nm, an AvaSpec with a backthinned detector (VB grating and SLIT 200) will detect the fluorescence in the control room. A 50 m powercable and a 50 m fiber was part of the solution as well.

High Dynamic-Range Time Intensity Measurement of Intense Femtosecond Laser Pulses

Ultrafast lasers are now broadly used in many research fields such as high intensity laser-matter interaction, femtochemistry, THz generation or time-resolved spectroscopy.

Characterization of femtosecond laser pulses has always been a difficult task, but with a new technique called Self-Referenced Spectral Interferometry, invented and patented by Fastlite (Paris, France), researchers can perform single-shot, calibration-free measurements with a simple and compact setup.

The Wizzler system, which includes an AvaSpec-2048L spectrometer, provides spectral intensity, spectral phase and coherent contrast measurements with an unprecedented dynamic range over 40dB, and is now becoming the reference tool in the field of femtosecond pulse measurements.

The included spectrometer covers a bandwidth ranging from 650 to 1080 nm and matches the full spectral bandwidth covered by the widely used Ti:Sapphire lasers. The hardware trigger allows single-shot acquisition up to 1kHz.



Just a small town in the English countryside, but it hosts a research facility that might change the world as we know it. The Joint European Torus, based in Oxfordshire, researches how to use fusion energy in daily life. Fusion offers the promise of energy that is environmental friendly, safe and available in almost unlimited quantities. Avantes spectrometers are used at the facility to measure changes during these plasma experiments.

Deputy leader Dr. Sebastijan Brezinsek of the JET-EFDA task force E2 is responsible for all spectrometers used at both the English and German facilities. When upgrading the torus, new miniature spectrometers were also needed. Mr. Brezinsek explains their choice:

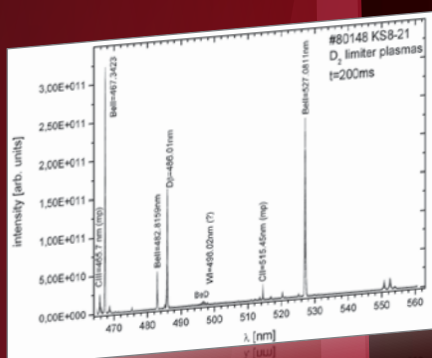
“we used a European Tender and the Avantes spectrometers offered the best quality for the best price. They are used to measure changes in the internal environment of the torus over time and they run 24 hours per day, for several years to come. This way we can measure the influence of the plasma on the internal environment of the torus. So far the quality of Avantes has proven itself.”

To prevent any influence from radiation, fiber cables guide the light to a facility 100 meters away from the torus building. There the 53 Avantes spectrometers work non-stop. For this application Avantes had to develop special systems, or as Klaas Otten, Avantes' technical sales manager, puts it:

“we are used to design custom made spectrometers for different applications. The systems used at JET-EFDA have special casing and low-noise detectors, to prevent any distortion. This system asked for individually triggered spectrometers, with fast data acquisition. Plasma is a fast changing substance and therefore fast repetition rate was one of the key requirements.”

Avantes supplies their spectrometers with high-performance measurement software, AvaSoft. For JET-EFDA, the DLL-package was used to control the instruments. According to Mr. Brezinsek:

"all our measurement systems connect to one central software solution, therefore we decided to use Avantes' DLL-files. This way we can combine all information into one view, thus enhancing the quality of our work." He concludes: "Thanks to Avantes, we can do our work better, faster and deliver better results. In France we are building a torus that should supply five times the energy we put into the system. This will really be the future of power supply in the world and Avantes helps to make it possible!".



Color measurements

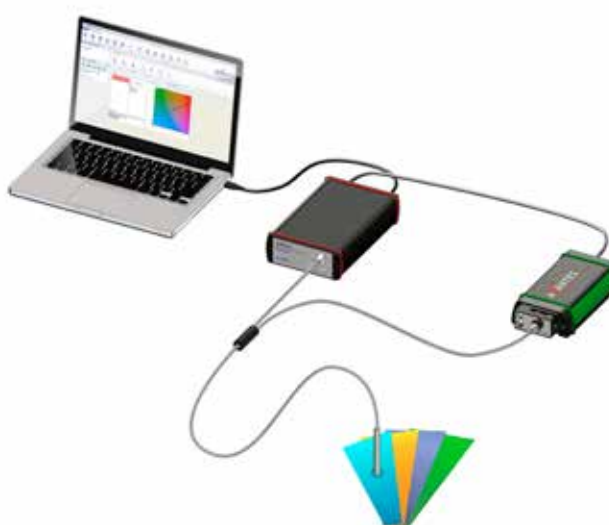
The human eye has a spectral sensitivity that peaks at around 555 nm, which means that the color green gives an impression of higher brightness than other colors. At 490 nm the sensitivity is only 20% compared to the sensitivity at 555 nm. Furthermore, the human eye can only distinguish about 10 million different colors which is actually quite limited relative to the needs of color measurement applications. Spectrometers are designed to measure exact wavelengths, and are therefore ideal for color measurements.

Visible light has a wavelength range of 390-750 nm, so generally color measurement systems are configured to cover the range from 380-780 nm with a spectral resolution of around 5 nm (FWHM).

To facilitate reflective color measurements a reflection probe or integrating sphere is typically required. In either case, a white continuous light source illuminates the surface to be measured and a white reflective

standard tile is needed for calibration. Color measurements may be applied to a variety of industrial applications such as color of textile, paper, fruit, wine, and bird feathers. Avantes has developed a variety

of custom probes to meet the specific demands of the color measurement application. Color measurements are manifested in the $L^*a^*b^*$ color model which includes parameters for brightness and hue.



Color measurement of small areas



Ideal for color measurements, this bundle features an AvaSpec-ULS2048 spectrometer, tuned for visible light. Furthermore a D65 halogen light source for illumination and a reflection probe together

with a reflection probe holder. Typical applications:

- In-line reproducibility
- Small spots & lines
- ... and many more

Order information: AvaSpec-Color-A

Spectrometer	AvaSpec-ULS2048-USB2	Grating BB (360-780nm) 200 μ m slit AvaSoft-Full & AvaSoft-Color
Light source	AvaLight-HAL-Mini	PS-12V/2.08A
Fiber optics	FCR-7UV200-2 reflection probe RPH reflection probe holder	
Included	WS-2 white reflection tile	

Color measurement of surfaces (total diffuse light)



Wide angle diffuse light from the sample is used to measure color. This uses a hand held 50 mm integrating sphere and a compact spectrometer. Measurement is free of the gloss specular component. The measurement optics are placed

under a 8° angle (D/8 SPIN). Typical applications:

- Rough surfaces
- Textile and printed paper
- Fruits
- ... and many more

Order information: AvaSpec-Color-B

Spectrometer	AvaSpec-ULS3648-USB2	Grating BB (360-780nm) 100 μ m slit AvaSoft-Full & AvaSoft-Color
Light source	AvaSphere-50-LS-HAL	
Fiber optics	FC-UV200-2-ME	
Included	WS-2 white reflection tile	

UV/VIS absorbance measurements

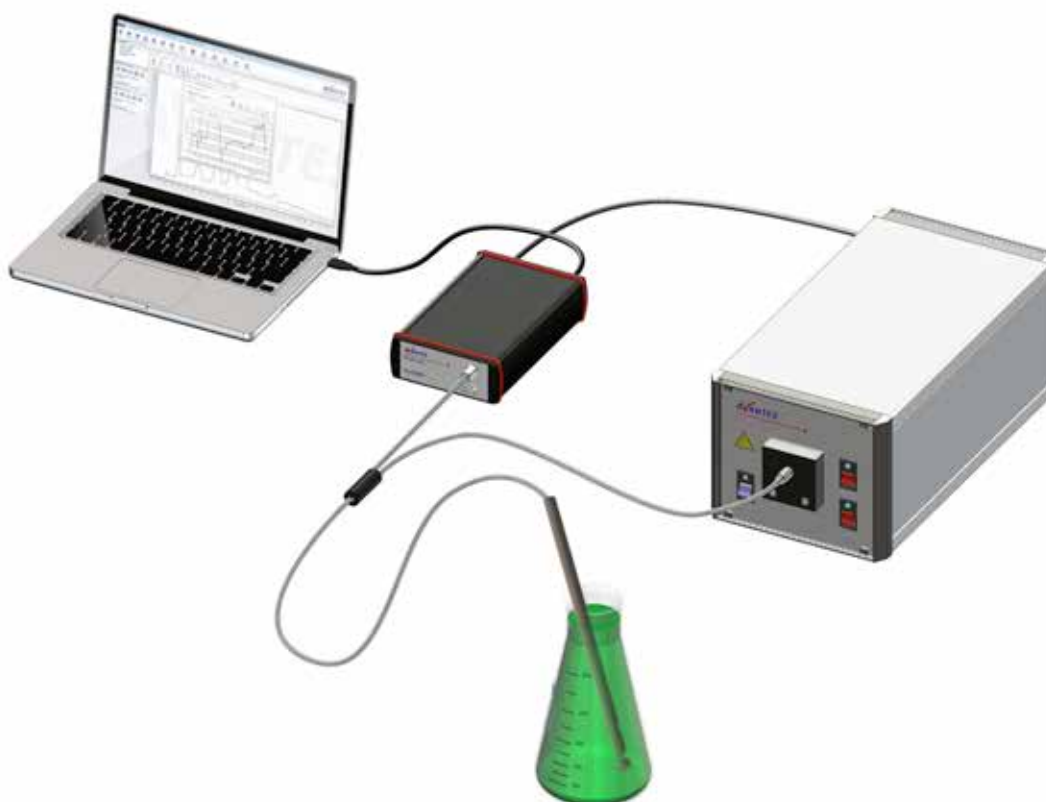
The absorbance (also called optical density) of a material is a logarithmic ratio of the radiation falling upon a material, to the radiation transmitted through a material. UV/VIS absorbance measurements encompass a wide variety of chemical and biochemical applications which involve many areas of research and industrial end uses. UV/VIS absorbance can be applied qualitatively and quantitatively in spectroscopic measurement applications ranging from blood parameters to chemical concentrations in process and reaction monitoring. Fiber-optic spectrometers offer a tremendous value proposition for UV/VIS measurements because of their relatively low cost, small size and ability to be introduced in harsh environments through the fiber interface. Combined with a fiber-optic transmission dip probe, inline flow cells or the more traditional cuvette cell, a fiber-optic spectrometer can accurately and repeatably measure over the range from 200-1100 nm.

Small Instruments Come of Age

Scientists who are largely familiar with more traditional bench top spectrophotometers may have the perception that fiber-optic instruments cannot provide the

resolution or stray-light rejection required for more demanding applications. In fact, fiber-optic spectrometer technology has come a long way and Avantes' instruments are on the leading edge for this technology. Our instruments are capable of measuring at resolutions as high as 0.05 nm in the UV. In terms of stray-light rejection, Avantes has developed a special optical bench called the ultra-low stray-light (ULS) optical bench to provide optimal performance for our customers. AvaSpec ULS spectrometers have stray-light levels as low as 0.04%.

Typically UV/VIS absorbance systems consist of a spectrometer, stabilized light source and fiber-optics, which are connected to some form of sampling accessory (probe or cuvette cell). Single fiber-optic spectrometers can be configured for broadband measurements (200-1100 nm) or narrow band (any range from 200-1100 nm) depending upon the desired wavelength range and resolution. Avantes UV/VIS instruments are also fully compatible with our AvaSpec NIRLine spectrometers, which enable spectroscopic measurements out to 2500 nm.



Common System Configurations

Avantes modular platform enables users to configure systems in a variety of ways and also allows the flexibility of changing the system configuration later to provide additional functionality. The typical UV/VIS absorbance system consists of an AvaSpec spectrometer, AvaLight fiber-optic light source, fiber cables and a cuvette cell holder. To the left this system configuration is shown with a cuvette cell holder above with a dip probe configuration below.

Our affordable AvaSpec-ULS2048-USB2 and AvaSpec-ULS2048L-USB2 provide excellent resolution (1.0 nm FWHM) over the entire range from 200-1100 nm, or higher resolution for a shorter-range configuration. For higher resolution (0.6 nm FWHM from 200-1100 nm) the AvaSpec-ULS3648-USB2 is recommended. Customers that demand higher signal-to-noise performance and higher sensitivity in the UV or NIR should consider Avantes SensLine instruments.

The AvaSpec-ULS2048XL has a high-performance back-thinned CCD detector and the AvaSpec-HS1024X58/122-TEC is Avantes highest sensitivity spectrometer with a thermo-electrically cooled CCD detector and a high numerical aperture optical bench. Any of Avantes' instruments can be combined with our AvaLight-DHS-BAL deuterium halogen source and a CUV-UV/VIS cuvette cell holder. The CUV-DA-DHS is a nice alternative, which enables directly coupling of the cuvette cell holder to the front plate of the light source to minimize the use of fiber-optics. This same system configuration can be integrated into a single housing (AVS-Desktop) to provide an integrated spectrophotometer module with a common power supply for the light source and spectro-meter.

Fiber-optics

One of the key value propositions to fiber-optic instruments is the ease with which measurements can be made inline

or in-process using a fiber-optic probe or accessory. Avantes offers a variety of sizes and configurations of fiber-optic transmission dip probes, which include special configurations for measurements in high temperatures (up to 500 °C), high pressure or vacuum. Also available are fiber-optic flow cells for standard and micro-fluidic applications.

Instrument Control Software

Avantes proprietary AvaSoft software is a Windows-based 32- and 64-bit compatible software package which enables full instrument control and includes a basic chemistry add-on module (AvaSoft-Chem). For customers requiring more sophisticated analytical software, which enables model development and multi-variate analysis, Avantes instruments are fully compatible with Panorama-Pro software from LabCognition.

UV/VIS/NIR Absorbance



Designed for broadband measurements, this UV/VIS absorbance bundle features a high power deuterium halogen light source with integrated shutter and a variable dip probe. A versatile bundle to measure absorbance in most situations.

Typical applications:

- Colorization of fluids
- In-line measurements
- Color of liquids in test tubes and flasks

... and many more

Order information: Ava-Absorbance

Spectrometer	AvaSpec-ULS2048-USB2	Grating UA (200-1100nm) 25 µm slit, DUV, DCL-UV/VIS OSC-UA Order Sorting Filter AvaSoft-Full
Light source	AvaLight-DH-S	
Fiber optics	FDP-7UV200-VAR Dip Probe	

The AvaAbsorb system was designed for those situations in which you would like to do consecutive sample and reference measurements in a controlled environment.

Irradiance measurements

Radiometry deals with the measurement of all optical radiation inclusive of the visible portion of this radiant energy. Irradiance is a parameter of radiometry. It describes the amount of radiant power impinging upon a surface per unit area. Irradiance measurements can be done in the UV, VIS and NIR wavelength ranges.

Avantes works with a variety of irradiance applications ranging from pulsed solar simulator characterization to free space measurements of radiant sources such as street lights. The AvaSpec line of instruments provides exceptional resolution and stray-light rejection to ensure the accuracy of these measurements. Typical system configurations involve one or more spectrometers configured for the appropriate range 200-400 nm for UV irradiance, 360-1100 nm for VIS irradiance and 1100-2500 nm for NIR irradiance. While broadband configurations covering 200-1100 nm are feasible with one spectrometer, optimal performance is achieved with dedicated UV (200-400 nm), VIS/NIR (400-1100 nm) channels.

The spectrometer or group of spectrometers is connected via fiber-optic cable to a diffuser with a known surface area and the entire system is calibrated against a NIST traceable source for irradiance. Avantes offers a variety of cosine diffusers and integrating spheres for irradiance applications. The calibrated system is shipped as an integrated system (connected together) and should remain in this configuration in order to ensure the integrity of the calibration. FC/PC connectors are recommended in lieu of the standard SMA, which enable repeatable disconnection and re-insertion of the fiber-optics, so the system may be disconnected for transportation.

Customers that wish to conduct their calibrations may consider one of Avantes' intensity calibration sources. The AvaLight-HAL-CAL is available for VIS/NIR wavelengths (360-2500 nm) and the AvaLight-DH-CAL is available for UV/VIS wavelengths (200-1100 nm).

The Avantes AvaSoft-IRRAD software module enables irradiance parameter measurements such as radiometric quantities - $\mu\text{Watt}/\text{cm}^2$, $\mu\text{Joule}/\text{cm}^2$, μWatt or μJoule , photometric quantities Lux or Lumen, color coordinates X, Y, Z, x, y, z, u, v, color rendering index and color temperature, and number of photons $\mu\text{Mol}/\text{s}\cdot\text{m}^2$, $\mu\text{Mol}/\text{m}^2$, $\mu\text{Mol}/\text{s}$ and μMol . AvaSoft-IRRAD software also facilitates the performance of irradiance intensity calibrations.



Irradiance / Spectroradiometry



Irradiance means measuring how much light reaches a specific place. This is why a cosine corrector is included: it collects light from a 180 degree angle.

The comprehensive AvaSoft-Irrad allows fully calibrated traceable radiometric and photometric measurements

Typical applications:

- Solar lighting
- Environmental & general lighting

... and many more

Order information: Ava-IRRAD-A

Spectrometer	AvaSpec-ULS2048-USB2 FC/PC	Grating UA (200-1100nm) 25 µm slit, DUV, DLC-UV/VIS OSC-UA Order Sorting Filter AvaSoft-Full & AvaSoft-Irrad Irrad-CAL-UV/VIS
Fiber optics	FC-UVIR200-2-ME-1FCPC	
Included	CC-VIS/NIR	

Download the latest
software for your AvaSpec
at www.avantes.com

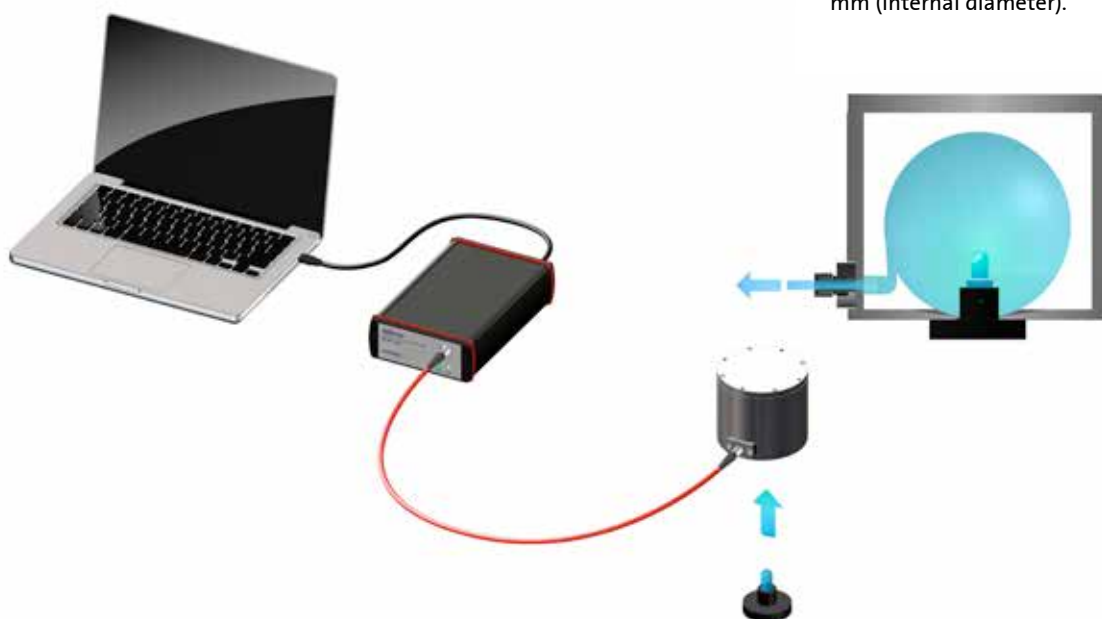
LED measurements

The measurement of LEDs presents unique application requirements for which Avantes has the appropriate instrumentation and applications experience to assist our customers in configuring a system. Avantes' many years of working with LED application has prompted us to develop a variety of system configurations that meets most LED metrology requirements. Light Emitting Diodes can be measured in a wide variety of colors and brightness. Accurate measurement of the LEDs therefore is essential. This can be done in two ways: photometry and radiometry.

Photometry relates to visible radiation alone, just as the response of the human eye. Radiometry goes beyond these limitations. In both photometry and radiometry, the LED can be characterized in emitted power or in intensity. Emitted power is all the power (flux) emitted from the LED in lumens or Watts, collected and measured without regards to the direction of the flux. The intensity is the ratio of the flux, leaving the source and propagating in the element of solid angle containing the given direction, and is expressed in candelas.

parameters and irradiance (excluding flux) a system is typically configured with the AvaSpec-ULS2048-USB2-FCPC spectrometers, a 25 or 50 μm slit and 300 line/mm grating covering the range from 360-1100 nm and provides 1.4 -2.4 nm full width half maximum (FWHM) resolution. A 2 meter fiber-optic cable (FC-UV200-2-FC-SMA) is mated to the instrument and terminated in a cosine function diffuser (CC-UV/VIS/NIR) which has 3.9 mm diameter surface area. The entire system is irradiance calibrated with an NIST source over the specified wavelength range for spectral irradiance ($\mu\text{W}/\text{cm}^2/\text{nm}$). This calibrated system can be operated using Avantes proprietary AvaSoft-IRRAD software which provides the following parameters: X, Y, Z, x, y, z, u, v, CRI, Color Temperature, Dominant Wavelength, Complementary Dominant Wavelength, FWHM, Centroid, Peak Wavelength & Purity. Additionally raw data in scope mode is displayed, as well as the X-Y chromaticity diagram. Optionally, the system can be configured with longer fiber lengths and the AvaTripod to hold the diffuser in place during measurement. The system can be controlled via Avantes dynamic linking library (DLL) interface through LabView, C#, C++ and a number of other programming environments.

For flux measurements the entire LED must be inserted into the port of an integrating sphere. Avantes offers a complete line of integrating spheres ranging from 30-200 mm (internal diameter).



For system calibrations, Avantes offers the AvaLight-HAL-CAL calibration sources which are offered in configurations that are compatible with cosine diffusers and small integrating spheres (30, 50, 80 mm). Avantes also offers two system configurations to enable the CIE Average LED Intensity (ALI) measurements which are specified in the CIE Publication No. 127. AvaSPEC-IRRAD-ILED-A and AvaSpec-IRRAD-ILED-B correspond to the condition A (316

mm measurement distance) and condition B (100 mm measurement distance) standards, respectively. The system is typically based upon the AvaSpec-ULS2048-USB2-FCPC spectrometers which are configured with a 25 or 50 μm slit and 300 line/mm grating covering the range from 360-1100 nm and provide 1.4-2.4 nm (FWHM) resolution. A fiber-optic cable (FC-UV200-2) is mated to the instrument and terminated in our AvaSphere-IRRAD-30 integrating sphere

which couples with the corresponding ILED-TUBE-A or ILED-TUBE-B. The system is irradiance calibrated with a NIST source over the specified wavelength range for spectral irradiance ($\mu\text{W}/\text{cm}^2/\text{nm}$). The ILED TUBE-A or ILED-TUBE-B is coupled with the AvaLED-Holder-5 mm (LED holder for 5 mm/ $T_1 \frac{3}{4}$ LEDs) which is coupled with a current stabilized power supply.

LED light measurements



More and more countries ban incandescent lamps from being sold, hugely boosting LED sales. Avantes supplies the needed tools for photometric and radiometric measurements.

The spectrometer is irradiance calibrated to obtain absolute values.

Typical applications:

- Irradiance
- Illuminance
- Radiometric & photometric flux
- Luminous intensity
- Color coordinates

... and many more

Order information: Ava-LED

Spectrometer	AvaSpec-ULS2048-USB2 FC/PC	Grating VA (350-1000nm) 25 μm slit, DLC-UV, OSC AvaSoft-Full & AvaSoft-Irrad Factory-calibrated system for irradiance IRRAD-CAL-VIS
Fiber optics	FC-UVIR600-2-ME-1FCPC	
Included	AvaSphere-50-IRRAD AvaSphere LED adapter	

LED ILED-A/B



The widely used recommendation for LED bulb luminous intensity measurements is CIE's Publication 127. This set contains everything you need: an irradiance calibrated spectrometer, with FC/PC connector for reproducible setups, with a fiber cable and ILED-A & ILED-B tubes.

Typical applications:

- Luminous intensity
- Radiant intensity
- Low & medium powered LEDs

... and many more

Order information: Ava-ILED-A/B

Spectrometer	AvaSpec-ULS2048-USB2 FC/PC	Grating VA (350-1000nm) 25 μm slit, DCL-UV/VIS, OSC AvaSoft-Full & AvaSoft-IRRAD IRRAD-CAL-VIS
Fiber optics	FC-UVIR600-2-ME-1FCPC	
Included	ILED-A & ILED-B tube, 5 mm LED adapter	

For the latest information,
go to www.avantes.com

Thin Film Metrology

Optical thickness of a coating is determined by white light interference and the pattern is translated into optical thickness through mathematical calculations.

Thin film metrology involves the use of these mathematical calculations to the presence and thickness of coatings which have been deposited on a substrate material using a variety of processes. The techniques available for this measurement range from profilometry to ellipsometry, spectroscopic reflectometry and x-ray analysis. Avantes instruments and fiber-optic sampling tools enable spectroscopic reflectometry measurements to support applications in a variety of industries from semiconductor to solar and optical coating measurements. Avantes thin film solutions provide measurement systems for single and multi-layer thin films on a number of substrates.

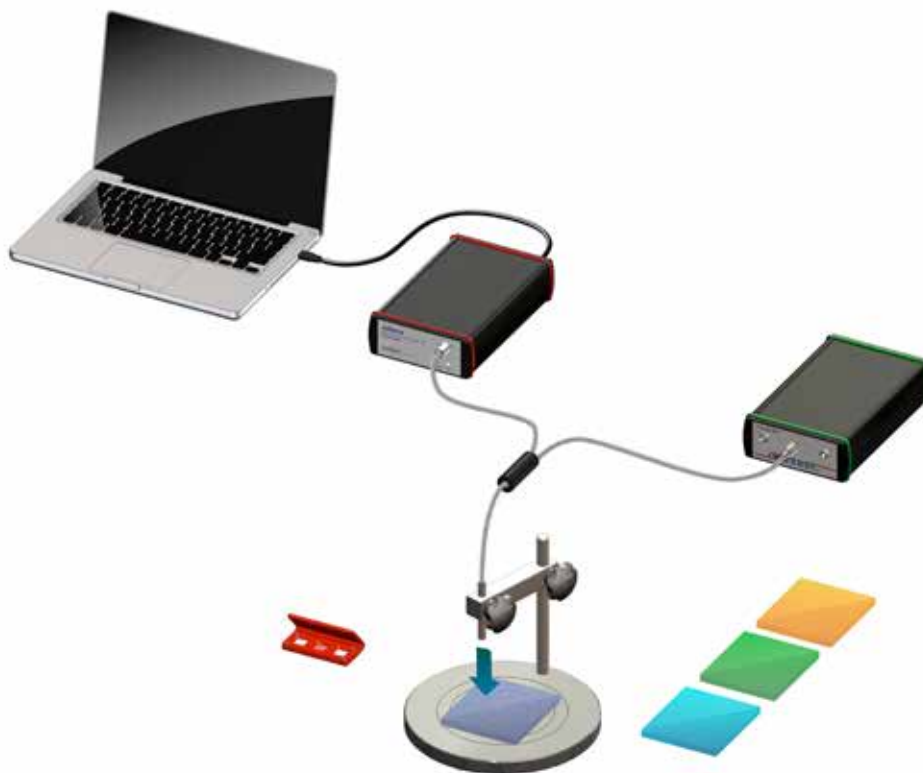
Thin Film Quality Control

Thin film deposition processes require regular monitoring and quality control particularly as new recipes are implemented and optimized in a coating facility. Typical applications require regular quality control

inspection during the initial phases requiring a high-speed offline measurement system to validate film thickness. Avantes thin film solutions enable high-speed spot measurements which can facilitate thin film presence and thickness validation.

Thin Film Reflectometry

Spectroscopic reflectometry involves illuminating samples with a white light (typically tungsten halogen or deuterium-halogen) at an incident angle which is normal to the sample and then measuring the reflectance and interference from the same geometry. Depending upon the nature of the coating ultra-violet, visible or near infrared wavelength measurements may be necessary to obtain an optimum fitting of the measured curve relative to the theoretical reflectance curve. The theoretical curve is developed from a database of optical constants (n and k). The “ n ” value is the refractive index and “ k ” is the extinction coefficient. The sampling process initially involves measuring a reference uncoated substrate followed by the sample measurement using the same conditions. Characteristics about the substrate (thickness and material) are inputs



for the software along with characteristics of the thin film layers (material, thickness). Reflectance spectra are captured and analyzed by software algorithms which compare the measured data to theoretical calculated values derived from the database of optical constants. The software provides a calculated thickness value along with a measure of goodness of fit relative to the theoretical curve.

Single-layer Thin Film Metrology

Avantes' single-layer thin film metrology system consists of our AvaSpec-ULS2048-USB2 fiber-optic spectrometer, AvaLight-DHc/AvaLight-DH-S deuterium-halogen light source or AvaLight-HAL tungsten halogen light source, the FCR-7UV200-2-ME (optional FCR-7UV400-2-ME for higher throughput) fiber-optic reflection probe and our Thin Film Stage. The software that drives the single layer system is Avantes' AvaSoft-ThinFilm which is a 32 or 64-bit application which supports single layer measurements of thin films ranging from 10 nm-50 µm with 1 nm resolution. AvaSoft-ThinFilm supports UV/VIS and NIR wavelength measurements from 200-1100 nm. The system is available with an optional thin film standard which provides samples of uncoated and coated substrates for validation purposes. For most specular surface UV measurements, the AvaLight-DHc compact deuterium halogen source is adequate, but for more diffuse coated surfaces, the higher power AvaLight-DH-S is recommended.

Multi-layer Thin Film Metrology

Avantes' multi-layer thin film metrology system consists of our AvaSpec-ULS2048-USB2 fiber-optic spectrometer, AvaLight-DHc/AvaLight-DH-S deuterium halogen light source or AvaLight-HAL tungsten halogen light source, the FCR-7UV200-2-ME (optional FCR-7UV400-2-ME for higher throughput) fiber-optic reflection probe and our Thin Film Stage. The software which drives the multi-layer system is TFProbe 2.0 which is developed by Angstrom Sun Technologies and is fully compatible with Avantes spectrometers. This sophisticated application supports up to five layer measurements and supports a variety of methods including nk constants, dispersion, and effective media approximation (EMA). TFProbe provides a user-friendly graphical user interface to input layer structure parameters. The system can include an optional thin-film standard which provides sample uncoated and coated substrates for validation purposes. TFProbe supports UV/VIS and NIR wavelengths from 200-1700 nm and enables the connection of multiple spectrometers to support this broadband wavelength measurement capability. For most specular surface UV measurements, the AvaLight-DHc compact deuterium halogen source is adequate, but for more diffuse coated surfaces, the higher power AvaLight-DH-S is recommended.

Thin Film



For single layer thin film measurements, this system provides the needed tools. It includes a reflection probe and a stage. It can measure thin films ranging from 10 nm to 50 µm with a resolution of 1 nm. It supports UV/VIS and NIR measurements from 200 - 1100 nm.

Typical applications:

- Semi-conductor industry
- Solar panels
- Coating

... and many more

Order information: Ava-ThinFilm

Spectrometer	AvaSpec-ULS2048-USB2	Grating UA (200-1100nm) 100 µm slit, DCL-UV/VIS, DUV coating OSC-UA AvaSoft-ThinFilm
Light source	AvaLight-DHc	PS-12V/1.0A
Fiber optics	FCR-7UV200-2-ME reflection probe	
Included	ThinFilm stage & standard	

Monitoring Coating Processes in Vacuum Chambers

Layer thickness, composition, surface finish, light transmission, reflectance, polarization ability: these are some of the important parameters that need to be monitored during coating processes. They all are facilitated by spectroscopy and spectroscopic interferometry. Fiber-optics provide a versatile tool to measure in remote vacuum and clean room chambers.

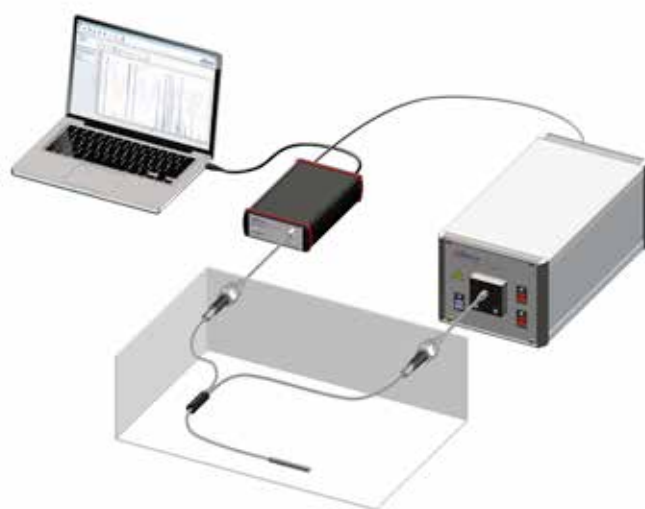
The illumination and detection can be organized at different fiber positions relative to the coating: to allow specular

reflection, diffuse reflection, transmission, polarization, interference, fluorescence and even Raman scattering to be measured. Fiber-optics can be arranged to either monitor several positions or to measure at different spatial positions or masking conditions simultaneously.

For on-line production environments, several fiber-optic sensors can be placed to monitor a production run. Ionic sources, such as plasma sources, can be monitored for spectral emission to confirm their con-

ditional efficiency during the operating process.

A typical application for a vacuum chamber system is monitoring an on-line coating process on a web. For this type of system a vacuum feed-through is used to transfer light into the vacuum area and then passes to the reflectance probe. The reflected light is passed through another vacuum feed-through to a spectrometer, AvaSpec-ULS2048-USB2 or SensLine instrument. The reflectance probe can be easily disconnected using the SMA interconnects. To compensate for fluctuations in the light source, a second channel can be added for light source reference measurements.



Vacuum



Two vacuum feed-throughs are included in this bundle: one with a 200 μm fiber cable and one with a 600 μm diameter. Also the needed reflection probe and a deuterium halogen light source.

The AvaSpec ULS2048L is the ideal companion for this setup.

Typical applications:

- Coating
- Plasma

... and many more

Order Information: Ava-Vacuum

Spectrometer	AvaSpec-ULS2048-USB2 Grating UA (200-1100 nm), 50 μm slit , DUV coating, DCL-UV/VIS, OSC-UA
Software	AvaSoft-Full and XLS or PROC add-on
Lightsource	AvaLight-DH-S-BAL Balanced deuterium-halogen light source
Fiber-optics	FCR-7UV200-2-ME reflection probe UV/VIS, 2 m, SMA FC-UV600-2 and FC-UV200-2
Vacuum Feedthrough	FC-VFT-UV200 and FC-VFT-UV600

Plasma Measurements

Plasmas are known for many emission peaks, located closely together. To separate these peaks, Avantes has developed multichannel spectrometers, featuring much higher resolution than a stand-alone device. For plasma monitoring, Avantes has made two bundles, with everything you need to measure plasma.

Typical applications:

- Semi-conductor
- Solar cells
- Razor blades
- Fusion reactors
- Glass & coating

... and many more



High resolution Plasma measurement

This 200 to 1030nm quad-channel spectrometer boasts an optical resolution of 0.18-0.22 nm, four times better than a standard AvaSpec-ULS2048 covering the same range. In AvaSoft Spectroscopy Software, the four channels are combined as if you were working with only one spectrometer.

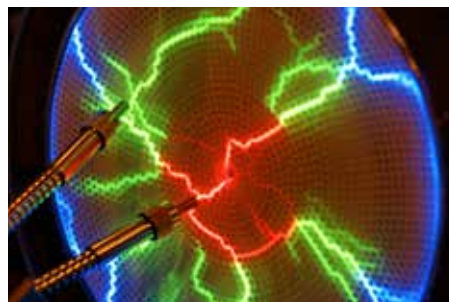
Order information: Ava-Plasma-A		
Spectrometers	4-channel desktop housing 4 x AvaSpec-ULS2048-USB2	Gratings: • UC (200-458nm), 0.18 nm • VC (455-683nm), 0.19 nm • NC (680-874nm), 0.20 nm • NC (870-1030nm), 0.22 nm All channels with 10 µm slit, DCL-UV/VIS detector collection lens & OSF-600 order sorting filter (where needed)
Fiber optics	FC4-UVIR400-2 multifurcated fiber	
Included	AvaSoft-Full spectroscopy software SPECline-A analytical software	

Extreme high resolution Plasma measurement

For even higher resolution than the above-mentioned quad-channel spectrometer, this version features eight channels, with an optical resolution of up to 0.10 nm. The wavelength range is 200-1070 nm, which means it detects from ultraviolet, through

visible, up to near infrared light.

The system is delivered in a 19" rackmountable enclosure.



Order information: Ava-Plasma-B		
Spectrometers	8-channel 19" rackmountable enclosure 8 x AvaSpec-ULS2048-USB2	Gratings: • UE (200-320, 318-420 & 417-505 nm), 0.10 nm • VE (500-565 nm), 0.10 nm • VD (565-670), 0.12 nm • VD (668-750 nm), 0.14 nm • NC (745-930 nm), 0.20 nm • NC (920-1070 nm), 0.22 nm All channels with 10 µm slit, DCL-UV/VIS detector collection lens & OSF-600 order sorting filter (where needed)
Fiber optics	FC8-UVIR400-2 multifurcated fiber	
Included	AvaSoft-Full spectroscopy software SPECline-A analytical software	

Gemology measurements

The measurement needs of the Gemology industry are demanding for a series of reasons. Chief among these can be low signal measurement and the need for rapid measurement systems to handle the volume of gemstones measured. Avantes offers basic measurement tools as well as advanced systems to meet various gemological requirements. Measurements can be accomplished with fairly simple systems using either integrating spheres or reflection probes up to photoluminescence systems requiring lasers and TE-cooled spectrometers.

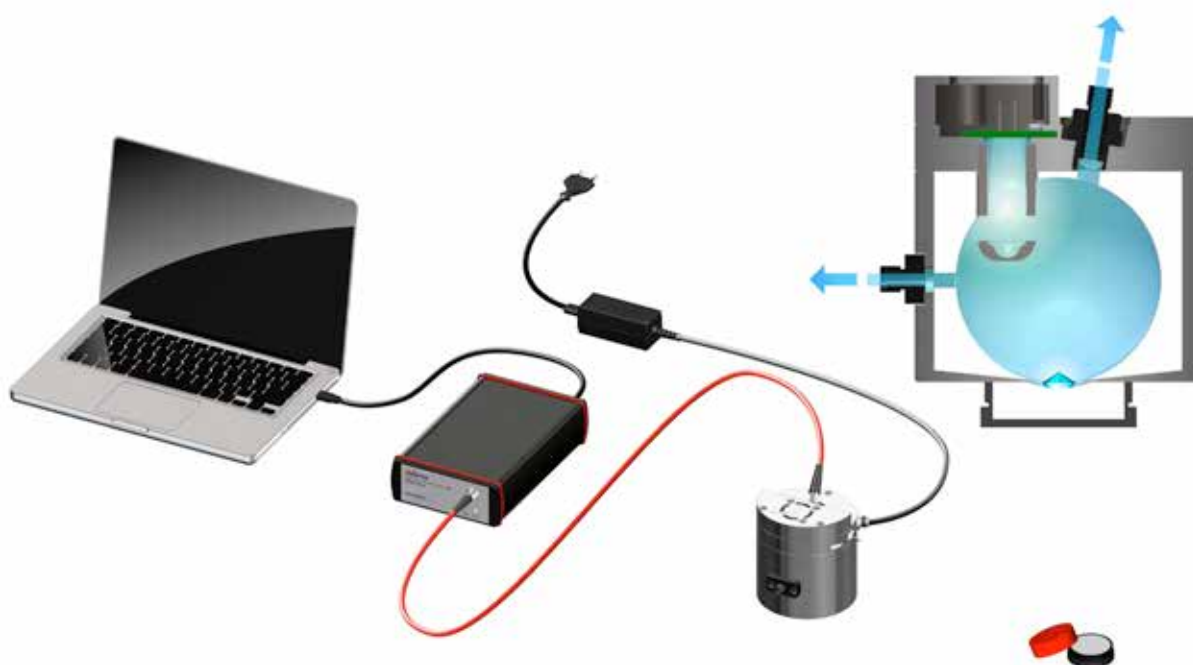
Basic Gemology Measurement

Gemologists often have two basic questions, "What are the characteristics of the stone I'm asked to measure?", and "Are these characteristics natural?" This is because the industry has developed multiple methods to "enhance" stones to improve color and hide imperfections. Methods employed include heat treating, irradiating, resin filling, laser drilling and even simple surface medications such as petroleum product treatments.

A typical basis system consists of an AvaSpec-ULS2048-USB2 spectrometer, a WS-2-GEM, white reference tile for gemology, and either an FCR-7UV200-2-BX fiber-optic reflection probe and AvaLight-HAL halogen light source or an AvaSphere-50-LS-HAL, reflection integrating sphere with Halogen illumination included. Although there are a number of possible applications, the measurement of the main chromium peaks (692.8 nm & 694.2 nm) in rubies or the determination of diamond types Ia or Ib status are frequently performed with this setup. Type Ia or colorless diamonds show strong nitrogen absorption peaks at 415 nm and 478 nm, whereas type Ib, yellow diamonds have wider distribution of nitrogen atoms eliminating these peaks. Other useful peaks are at 592 nm and 741 nm, peaks which indicate artificial coloring has occurred.

Advanced Gemology Measurements

Various entities report the use of photoluminescence systems to detect gemstone



characteristics. This technique most often makes use of a laser excitation source, sample chamber, and detection system. The laser wavelength depends on the feature(s) being sought. Most often, the chamber will include provisions for cryogenic cooling. The detection system can range from simple cameras to photomultiplier tubes. Avantes has provided systems with various lasers as well as the AvaSpec-ULS2048LTEC-USB (thermoelectrically cooled) spectrometer. An AvaRaman-Probe, fiber-optic Raman probe, is required as well to filter the excitation source out of the measured data.

One example of the usefulness of this technique is the detection of high-pressure, high-temperature treatment (HPHT).

HPHT is sometimes used to improve diamond color, for instance turning brown diamonds into green or yellow diamonds. Since many regulatory agencies require that all such treatments be disclosed, the chief concern is that stones could be misrepresented as natural or untreated stones. HPHT can be detected with an Avantes high-performance photoluminescence system as it leaves a trace peak at 694 nm.

Gemology



The easy way to answer two basic questions: “what are the characteristics of the stone I’m measuring?” and “are these characteristics natural?” is the Ava-GEM. It includes a sphere and a special gemology white reference tile to determine fast and without a doubt what your answers to the two questions will be.

Typical applications:

- Color
- Natural or artificial
- Artificial coloring

... and many more

Order information: Ava-GEM

Spectrometer	AvaSpec-ULS2048-USB2	Grating VA (360-1000nm) 25 µm slit, DCL-UV/VIS, OSC AvaSoft-Full
Fiber optics	FC-UV600-2 reflection probe	
Included	AvaSphere-50-LS-HAL AvaSphere-50-HOLD WS-2-GEM	PS-24V/1.25A

Three years
limited warranty on all
Avantes spectrometers,
light sources and accessories

Fluorescence measurements

Fluorescence spectroscopy, also known as fluorometry or spectrofluorometry, is a type of electromagnetic spectroscopy, which analyzes fluorescence from a sample. It involves using a beam of light that excites the electrons in molecules of certain compounds and causes them to emit light; typically, but not necessarily, visible light. It is a useful technique in many biological (chlorophyll and carotenoid), biochemical (fluorescence diagnosis of malignancies) and environmental applications. For most fluorescence applications the amount of fluorescence energy emitted is only 3% of the amount of excitation light energy. Fluorescence light has a lower energy (higher wavelength) than the excitation energy and is usually scattered light. This means it emits energy in all directions.

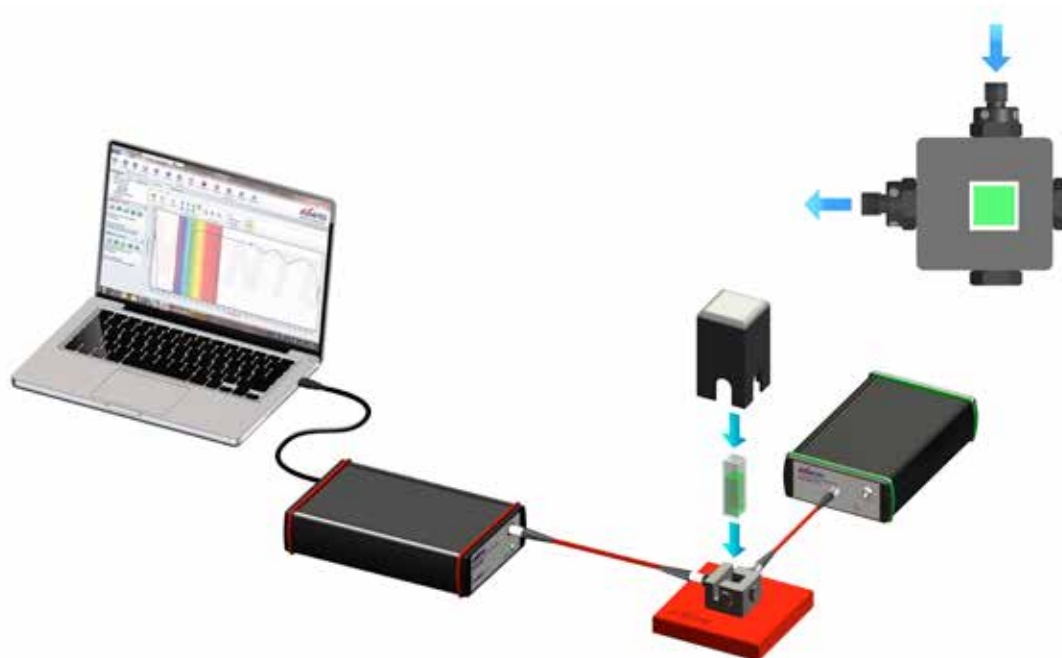
For optimal performance assuming the time acquisition window is not limited, Avantes recommends our AvaSpec-ULS2048LTEC spectrometer for this application, since it can support long integration times often exceeding 5 seconds. When higher-speed acquisition is required, Avantes recommends the AvaSpec-ULS2048XL back-thinned CCD spectrometer. For maximal sensitivity the top model of the SensLine, AvaSpec-HS1024x122-USB2 spectrometer is recommended.

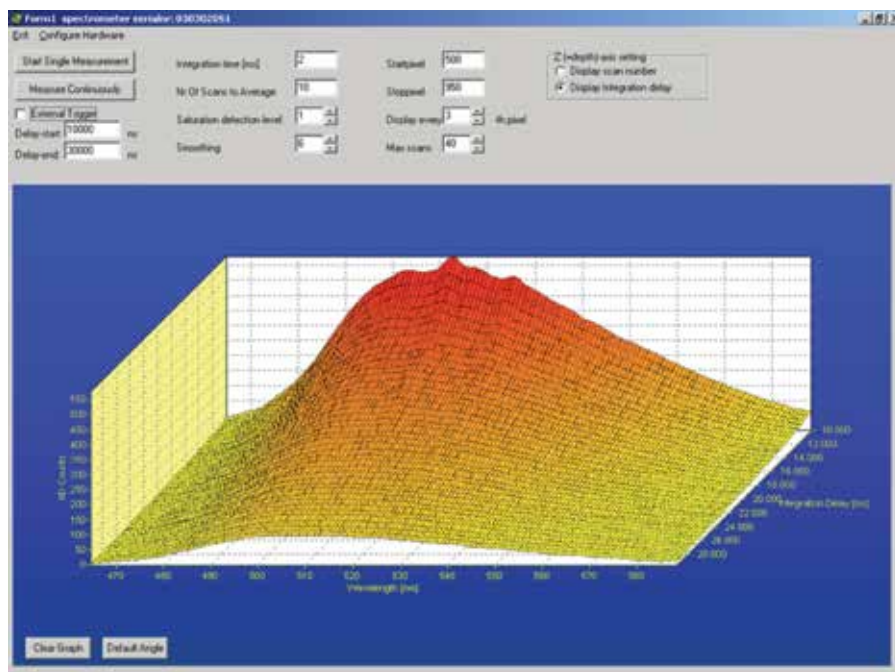
When configuring the measurement setup,

preventing excitation light from entering the spectrometer is an important issue.

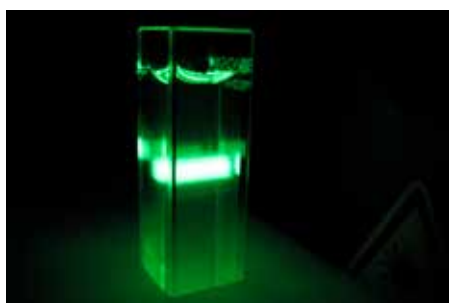
Possible methods to accomplish this, where one does not exclude the other, include:

- Make use of an AvaLight-LED light source which typically has a narrow bandwidth enabling the limitation of excitation to shorter wavelengths that are not part of the emission spectrum
- Use a broadband light source such as the AvaLight-HAL for high output in combination with an (interference) band-pass or low-pass filter.
- Make sure the optical path for excitation light and fluorescence are perpendicular. This means the excitation light will not enter the receiving fiber (use the CUV-UV/VIS-FL or the CUV-DA)
- Use the fluorescence decay time to separate excitation energy from the integration time start pulse. Use a pulsed light source to accomplish this (pulsed laser or AvaLight-XE Xenon flash)





Fluorescence



In spectroscopy fluorescence is one of the more challenging setups, due to the low fluorescent emission (about 3% of the excitation energy). The AvaSpec-2048L gives the highest sensitivity and the AvaLight-LED series provides excitation at the requested wavelength.

Typical applications:

- Dyes identification
- Fluorescent lamps
- Diagnosis of malignancies
- Fluorescent labeling

... and many more

Order information: Ava-Fluorescence

Spectrometer	AvaSpec-ULS2048L-USB2	Grating VA (350-1000nm) 200 µm slit, DCL-UV/VIS-200, OSC AvaSoft-Full
Light source	AvaLight-LEDxxx	Power supply
Fiber optics	FCR-UV200/600-2-IND FCR-FLTIP-IND	

Pre-configured
spectrometers can be shipped
within 24 hours

Biomedical applications

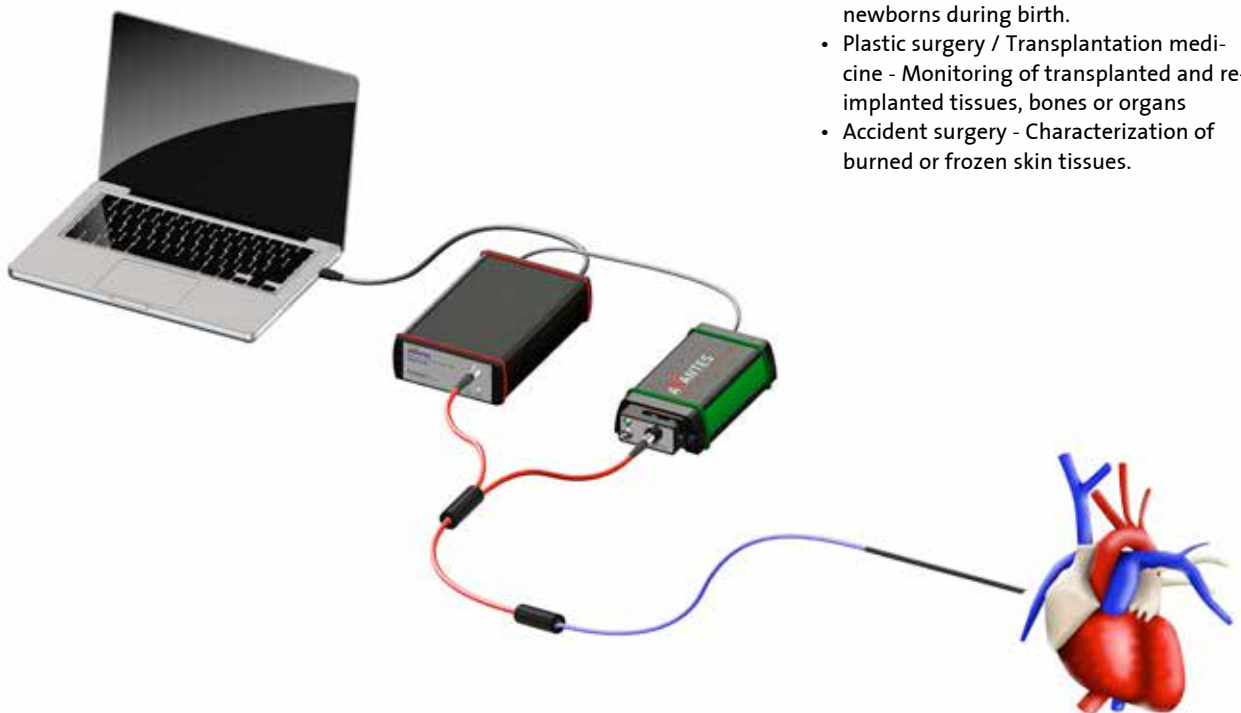
Avantes has extensive experience in the biomedical industry. Over the years, we have supported the development of both non-invasive and invasive spectrometry solutions for tissue and blood parameter measurements.

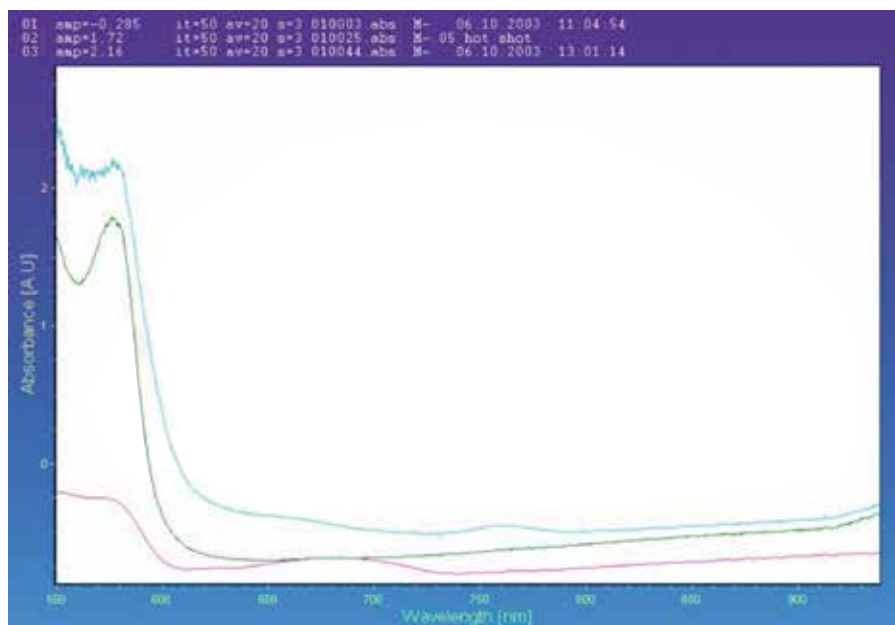
Some of the important medical indicators which Avantes has worked with include oxygen, hemoglobin, cytochrome and water concentration measurements in tissues and in the venous system. The AvaSpec-ULS2048-USB2 and our SensLine instruments are frequently recommended for these applications. The AvaLight-HAL tungsten halogen light source provides an excellent, high-stability VIS/NIR source for biomedical applications involving reflection

measurements. Avantes worked successfully with many customers to enable continuous measurements of oxygen saturation, concentration of total, oxygenated and deoxygenated hemoglobin.

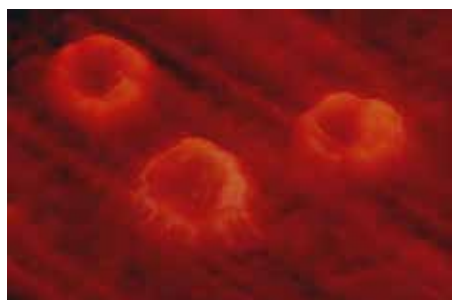
Some examples of implementations of Avantes solutions:

- Angiology / Pharmacology - Monitoring of the oxygen saturation after the application of vaso-active substances. Oxygen changes caused by Reynaud syndrome and microcirculation diseases in tissue.
- Dermatology - Detection of local -regional perfusion diseases, recurrence of melanomas.
- Diabetology - Micro-angiopathy, early detection of Endothelial dysfunction and ulceration.
- Cardio surgery - Oxygen consumption of the heart muscle during and after bypass operations.
- Neurosurgery / Oncology - Quantifying of oxygen consumption of (brain) tumors before/after radiation or operations.
- Pediatrics / Gynecology - monitoring of oxygen concentration of critically ill newborns during birth.
- Plastic surgery / Transplantation medicine - Monitoring of transplanted and re-implanted tissues, bones or organs
- Accident surgery - Characterization of burned or frozen skin tissues.





Biomedical



Spectroscopy helps achieving the goal of non-invasive measurement devices. This bundle non-invasively measures concentrations of unknown samples or changes in concentration over time. This bundle is meant for R&D usage.

Typical applications:

- Oxygen in blood
- Hemoglobin
- Microvascular circulation

... and many more

Order information: Ava-Biomedical

Spectrometer	AvaSpec-ULS2048-USB2	Grating NB (500-1000nm) 50 µm slit, OSF-475 AvaSoft-Full and AvaSoft-Chem
Light source	AvaLight-HAL-Mini	Power supply
Fiber optics	FCR-7IR200-2-MS-PK-S	
Included	WS-2	

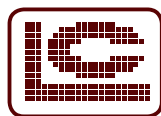
Did you know
Avantes is specialized
in custom made
fiber-optic cables?

Argentina**LASEROPTICS SA**

Lavalle 1634, 3er piso
C1048AAN Buenos Aires
Tel. (+54) 11-4374-6754
Fax (+54) 11-4372-7531
laser@laseroptics.com.ar

Australia**NewSpec Pty Ltd**

330 Glen Osmond Road
Myrtle Bank, SA 5064
Tel. (+61) 8 8463 1967
andrew.richardson@newspec.com.au

Austria**Laborchemie Gerätevertriebs GmbH**

Kanitzgasse 21
A-1230 Wien
Tel. (+43) 18882601
Fax (+43) 18892355
office@laborchemie.at

Benelux**Avantes BV**

Oude Apeldoornseweg 28
7333 NS Apeldoorn
Tel. (+31) 313-670160
Fax (+31) 313-670179
info@avantes.com

Brazil**MCI Photon Tech Ltda**

Rua Goitacazes, nr. 347 - sl 15
Sao Caetano do Sul
Bairro Centro - São Caetano do Sul - Sao Paulo
Tel. (+55) 11 4226-0304
mayara@mciphotontech.com.br

Canada**DELTA PHOTONICS****Delta Photonics**

A6-2285 St. Laurent Blvd, 1st fl.
Ottawa, ON K1G 4Z4
Tel. (+1) 613-688-3784
Fax (+1) 613-688-1370
Toll-Free (+1) 888-335-8241
sales@deltaphotonics.com

China**Avantes China**

Room 1209-1210, ULO Park,
No.601 apartment of Wangjing Yuan
Chaoyang District, Beijing, 1000102 P.R. China
Tel (+86) 10-84574045
Fax (+86) 10-84574017
info@avantes.com.cn
henry_zhang@avantes.com.cn
www.avantes.com.cn

Czech Republic, Slovak Republic**Measurement Technic Moravia Ltd.**

Babická 619
Zastávka, 664 84, CZ
Czech Republic
Tel. (+420) 513 034 408
dusan.novotny@mt-m.eu

Finland



Senveco OY

Nuijamiestentie 3 B 1.krs
FI-00400 Helsinki
Tel. (+358) 9-53066590
Fax (+358) 9-53066595
juhani.tiainen@senveco.fi

France



Optoprim

21- 23, Rue Aristide Briand
F 92170 Vanves
Tel. (+33) 1 41 90 61 80
Fax (+33) 1 41 90 61 89
info@optoprim.com

Germany North



Avantes BV

Oude Apeldoornseweg 28
7333 NS Apeldoorn
Tel. (+31) 313-670160
Fax (+31) 313-670179
FrankC@avantes.com

Germany South



Mountain Photonics GmbH

Robert-Bosch-Str. 10
Landsberg am Lech
Tel. (+49) 08191-985199-0
info@mp Photonics.de

Greece



Optronics Technologies S.A.

79-81 Thessalonikis str,
183 46 Moschato, Athens
Tel. (+30) 210-9837121
Fax (+30) 210-9834814
optronics@optronics.gr

Hungary



Joó Katalin Kereskedelmi és Szolgáltató Kft.

Alkotmány u.7
H-2131 Göd
Tel./Fax (+36) 27-334-360
joo.katalin@invitel.hu

India



New Age Instruments & Materials Pvt. Ltd.

1261, Sector-4, Gurgaon-122001 Haryana
Tel. (+91) 124- 4086513-16
Fax (+91) 124-2252647, 2331653
Sales@Newagein.com
Sameer@Newagein.com

Iran



Aryan Beris

Fourth Floor NO.37 Nobakht St.
South Sohrevardi Ave., 1578664935 Tehran
P.O.Box: 15875-1848
Tel. (+9821) 8301824-8846354
Fax (+9821) 8848523
Aryan@rayanchemie.com

Israel**Rosh Electroptics Ltd.**

20 Giborei Israel St
Entrance B, Floor 1, Office 97
Poleg Industrial Zone
Netanya 4250420
Tel. 972-9-8627401/3
mrubin@roshelop.co.il

Italy**Laser Point Srl.**

Via Burona, 51
I-20090 Vimodrone (MI)
Tel. (+39) 02-27400236
Fax (+39) 02-25029161
pellegrino@laserpoint.it

Italy**Optoprim Srl.**

Via Rota, 37
20900 Monza - Italy
Tel. (+39) 039 834977
Fax (+39) 039 2845269
info@optoprim.it

Japan**Phototechnica Corporation**

1-2-17 Minamiurawa
Minami-Ku Saitama-Shi
Saitama 336-0017
Tel. (+81) 48 871 0067
Fax (+81) 48 871 0068
tohyama@phototechnica.co.jp

Korea**JinYoung Tech**

Danammae Tower 1103, 22-1,
Doseon-dong, Seongdong-gu,
Seoul 133-882
Tel. (+82) 2-3280-7701
Fax (+82) 2-3280-7702
jinyoungtech@gmail.com

Latvia**SIA Doma**

Skanstes Str 13, Riga
LV-1013, Latvia
Tel. (+371) 7 37 62 89
fax (+371) 7 37 62 99
aldis.strods@domagroup.lv

Lithuania**VILDOMA, UAB**

Zirmunu 139
09120 Vilnius
Tel. (+370) 5 236 3657
Fax (+370) 5 236 3655
ginutis@vildoma.lt

Malaysia**ASEPTEC SDN BHD**

53-1, Jalan Equine 9, Taman Equine
Bandar Putra Permai, 43300 Seri Kembangan
Selangor, Malaysia
Tel. (+60) 3 8941 5634
Fax (+60) 3-8941 5635
info@aseptec.com.my

Poland



Spectro-lab

ul. Warszawska 100
05-092 Domianki
Tel. (+48) 22 675 25 67
marcin.guz@spectro-lab.pl

South Africa



Celtic Colour Consultants

16 Geduld Avenua
Beverley Gardens, Randburg
2194 Johannesburg
Tel. (+27) 11 326 4387
Fax 086 619 7165 (SA Only)
avantes@celticcolour.co.za
www.celticcolour.co.za

Romania



HISTERESIS SRL

Str G Enescu, Bl 251 Sc B ap 13
Vaslui
Tel. (+40) 761103687
constantin.sturza@histeresis.ro

Spain



Instrumatic Española, S.A.

Avda. de los Toreros, 5 1ºB
28231 - LAS ROZAS (Madrid)
Tel. (+34) 91-5558112
Fax (+34) 91-5971077
instrumatic@instrumatic.es

Russia (North-West)



LOKAMED Co. Ltd.

Popova str. 15/17
Saint-Petersburg
Tel. (+7) 912 936 2039
vlad@avantes.ru
avantes@rambler.ru
www.avantes.ru

Spain



ANTARES INSTRUMENTACIÓN, S.L.

c/ Escultores, 36 – 4ºA
28760 Tres Cantos (Madrid)
Tel. (+34) 0 91 803 32 29
ccarcedo@antaresinstrumentacion.com

Singapore



EINST Technology Pte Ltd

1092 Lower Delta Road #04-01
Singapore 169203
Tel. (+65) 6276 6928
Fax (+65) 6276 1558
sales@einstinc.com
www.einsttechnology.com

Sweden



A Z P E C T

Aspect Photonics AB

Balticvägen 3
SE-151 38 Södertälje
Tel. (+46) 8-55 44 24 91
Fax (+46) 8-55 44 24 99
inquiry@amstechnologies.com

Switzerland**Instrumentat SA**

Ch. de la Rueyre 116-118
CH-1020 Renens
Tel. (+41) 21 634 26 26
Fax (+41) 21 634 28 28
Francois.Maystre@instrumentat.ch

Taiwan**R&D Hi-Tech Corp**

1F, No. 307-2 Sec. 4 Chung Yang Rd Tu Cheng
23675 Taipei
Tel. (+886) 2-2269-6656
Fax (+886) 2-2269-3877
RND.Robin@msa.hinet.net

Taiwan**Protrustech Co., Ltd**

Tainan Office: Address: 3F.-1, No.293, Sec. 3, Dongmen
Rd. East District,
Tainan City 701 Taiwan
Tel. (+886)-6-2892081 / (+886)-2-29995339
sales@protrustech.com

Thailand**Spectral Technology Instrument Co.,Ltd.**

99/532 Ramkhamhaeng Rd., Saphansung
10240 Bangkok
Tel. (+66) 2-729 0927, 66 86-328 8289
Fax (+66) 2-729 1348
palakorn@spectralinstrument.com

Turkey**Global Analytical Laboratory Equipment Ltd.**

Camlica Bulvar Sitesi B Blok No 2
06800 Umitkoy – Ankara
Tel. (+90) 312 236 07 02
Fax (+90) 312 236 06 53
aksahin@globalanalitik.com.tr

Ukraine**TOV AVANTES**

Chkalov str., 215v, off. 72
54008 Nikolaev, Ukraine
Tel. (+38) 50 845 2677
Fax (+38) 512 584 237
avantes@mksat.net
www.avantes.net

United Kingdom



Avantes (UK) Ltd.

P.O. Box 409
Leatherhead, Surrey, KT22 2GS
United Kingdom
Tel. (+44) 1372363736
Fax (+44) 1372363736
infoUK@avantes.com

USA



Avantes Headquarters

Avantes Inc., 9769 W 119th Dr., Suite 4
Broomfield, CO 80021
Tel. (+1) 303-410-8668
Fax (+1) 303-410-8669
Toll free (+1) 866-678-4248
infoUSA@avantes.com

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**For product support or
questions, contact us at:**

Avantes Headquarters
Oude Apeldoornseweg 28
7333 NS Apeldoorn
The Netherlands
Tel: +31 (0)313 670 170
Fax: +31 (0)313 670 179
info@avantes.com
www.avantes.com

Avantes America
9769 W. 119th Dr. Suite 4
Broomfield, CO 80021
Tollfree: +1 (866)678 4248
Tel: +1 (303)410 8668
Fax: +1 (303)410 8669
infoUSA@avantes.com

Avantes China
Room 1209-1210, ULO Park
No. 601 apartment of Wangjing Yuan
Chaoyang District, Beijing
1000102 P.R. China
Tel: +86 10 84574045
Fax: +86 10 84574017
info@avantes.com.cn
www.avantes.com.cn

