Optical Bench Design

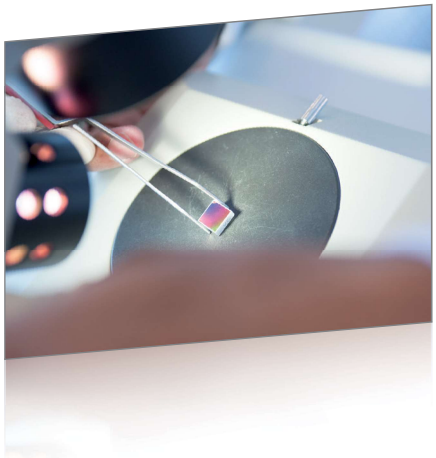
Avaspec-ULS Optical Bench Design: Symmetrical Czerny-Turner

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

The heart of most AvaSpec fiber-optic spectrometers is an optical bench with 37.5, 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-HS2048XL high-sensitivity spectrometers have a revolutionary 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 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.



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. For lesser range (approximately 500 nm) but higher resolution, you might consider a 600 lines/mm. Higher lines/mm gratings (1200, 1800, 2400, 3600) provide higher resolution for applications that require this (see Grating selection table in the spectrometer product section). 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.

Avantes offers a variety of different detector types, each with different sensitivity curves (see Figure 3a and 3b on page 20).
The AvaSpec instrument line is divided into multiple groups based on general requirements. The AvaSpec-Starline is comprised of general purpose UV/VIS instruments with low-cost CCD or CMOS detectors. The AvaSpec Sensline is comprised of higher performance back-thinned CCDs and thermo-electrically cooled CCD UV/VIS instruments. These instruments are particularly better in the UV and NIR range, compared to standard CCD and CMOS 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 that have a small form factor.

For high-speed applications, the 2048 pixel CMOS detectors in the AvaSpec-ULS2048CL from the StarLine are normally the best options. For low-light level applications such as fluorescence and Raman, the SensLine instruments may be the most appropriate. The AvaSpec NIRLine features 6 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, 1800, 2400, 3600), thus limiting the range of the instrument to a more narrow range. Additionally, it is advisable to consider a detector with 2048 or 4096 pixels and a small slit (10 or 5 µm). For the best resolution with all other criteria of lesser importance, the AvaSpec-ULS4096CL-EVO 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 larger slit 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-HS2048XL 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-HERO 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 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-HERO) 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 19) and Table 5 (page 21), the spectral sensitivity for each detector is depicted in Figures 3a and 3b.

b. Chemometric Sensitivity

To detect drastical 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-HERO 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-ULS2048CL-EVO spectrometers.
These instruments support high-speed data acquisition with the capability of starting an acquisition as fast as within 1.3 microseconds of receiving an external trigger. 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.

Table 1 Quick Reference Guide for Spectrometer Configuration

Application	AvaSpec model	Grating	WL range (nm)	Coating	Slit (µm)	FWHM resolution (nm)	DCL	OSF	OSC
Biomedical	ULS2048CL	NB	500-1000	-	50	1.2	-	475	-
Chemometry	ULS2048CL	UA	200-1100	-	50	2.3	-	-	OSC-UA
Color	ULS2048CL	BB	360-780	-	200	4.5	X/-	-	-
DOAS	ULS2048x64	UC	200-450	-	50	0.55	X	-	-
Fluorescence	ULS2048x64TEC ULS2048XL	VA, VB, UB	350-1100, 300-800	-	200	9.2 4.6	X	305	OSC
	HS2048XL	HS-500-0.33	200-1160	-	200	10.0	-	-	OSC
Fruit sugar	ULS2048CL	IA	800-1100	-	50	6.4	X	600	-
Gemology	ULS2048	VA	350-1100	-	25	1.2	X	-	OSC
High resolution	ULS2048CL	VD	600-700	-	10	0.12	-	550	-
	ULS4096CL	VD	600-700	-	10	0.05	-	550	-
High UV/NIR sensitivity	HS2048XL	HS-500-0.33	200-1160	-	200	10.0	-	-	OSC
Irradiance	ULS2048CL	UA	200-1100	DUV	50	2.3	X/-	-	OSC-UA
Laser diode	ULS4096CL	NC	700-800	-	10	0.18	-	600	-
LED	ULS2048CL	VA	350-1100	-	25	1.2	X/-	-	OSC
LIBS	ULS4096CL	D,E,F	200-900	DUV	10	0.09	-	-	-
Raman	ULS2048LTEC ULS2048x64TEC	NC	780-930	-	25	0.3	X	600	-
Solar	ULS2048XL	VA	300-1100		50	2.5		305	OSC
Thin films	ULS2048CL	UA	200-1100	DUV	100	4.6	X	-	OSC-UA
UV/VIS/NIR	ULS2048CL	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	-
	NIR256-2.5TEC	NIR100-2.5	1000-2500	-	50	15.0	-	1000	OSC-NIR

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, holo-graphic 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.

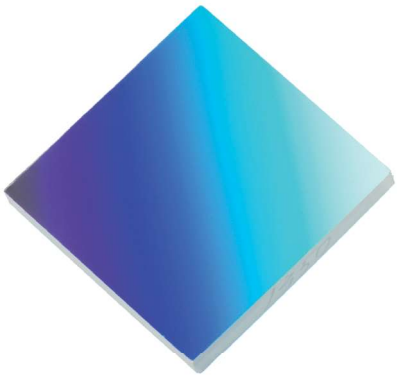
Avantes AvaSpec spectrometers come with a permanently installed grating that must be specified by the user. Additionally, the user needs to indicate what wavelength range needs to reach the detector. Sometimes the specified usable range of a grating is larger than the range that can be projected on the 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 2 on the following pages, 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 dual-blazed
grating is a 300 lines/mm broadband grating (covering 200-1100 nm) that has optimized efficiency in both UV and NIR.

Different diffraction gratings



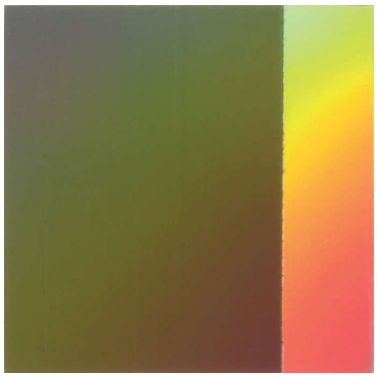


Table 2 Example of Spectral Range and Gratings

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

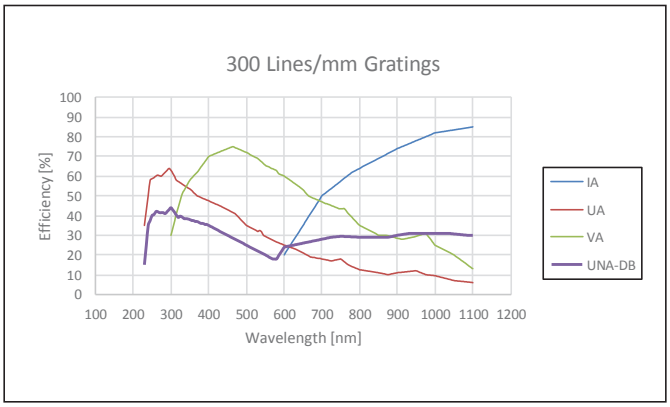
Please select Spectral range bandwidth from the useable Wavelength range, for example: grating UE (200-315 nm)
* the spectral range depends on the starting wavelength of the grating; the higher the wavelength, the smaller the range. For example: Grating UE (510-580 nm)

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)

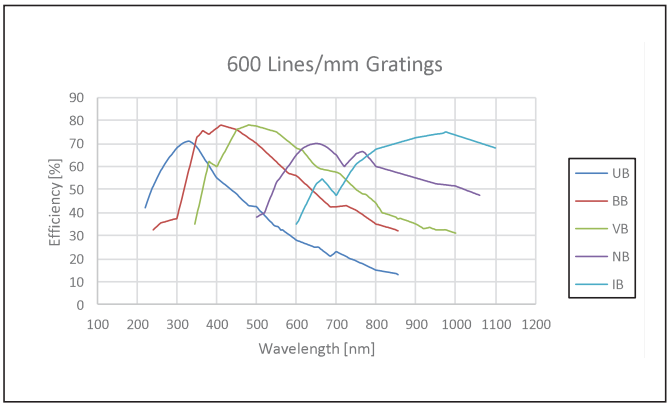
For newer types a different nomencla-ture is used stating the product line, lines/mm and blaze.

Figure 2 Grating Efficiency Curves

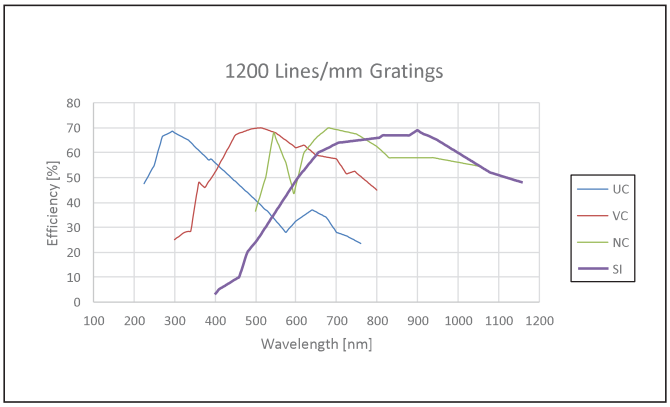
300 lines/mm gratings



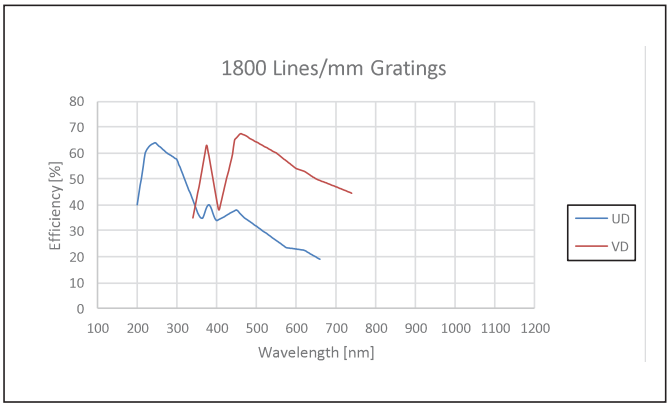
600 lines/mm gratings



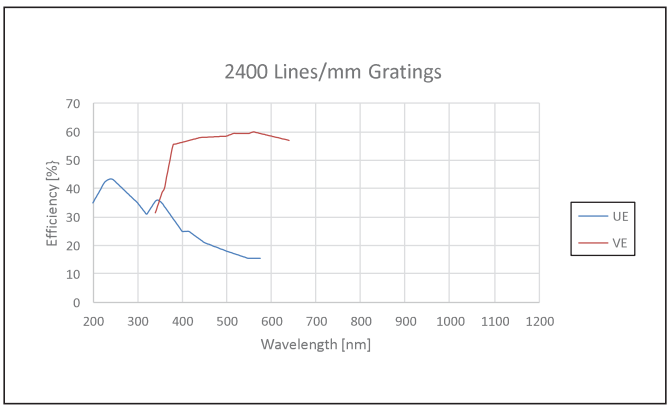
830 & 1200 lines/mm gratings



1800 lines/mm gratings



2400 lines/mm gratings



3600 lines/mm grating

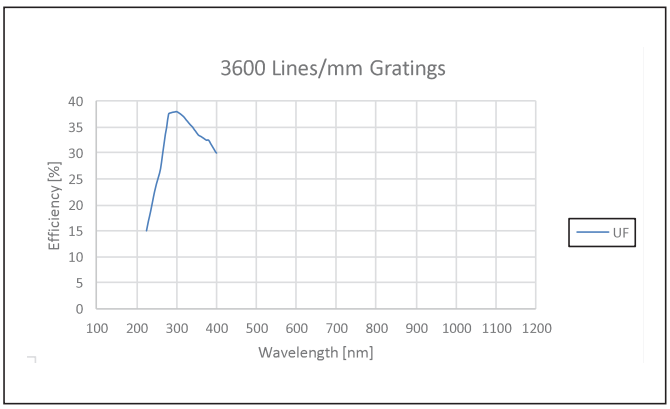
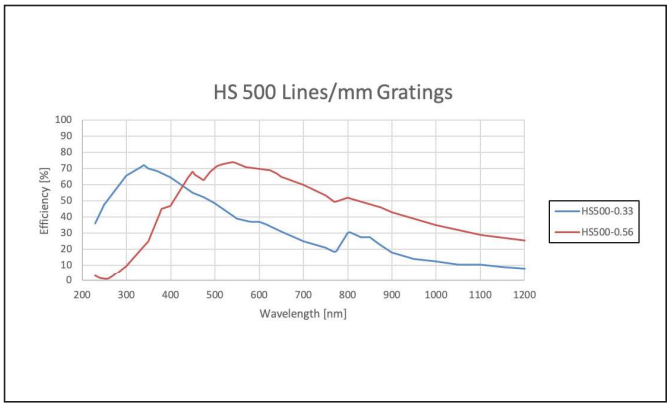
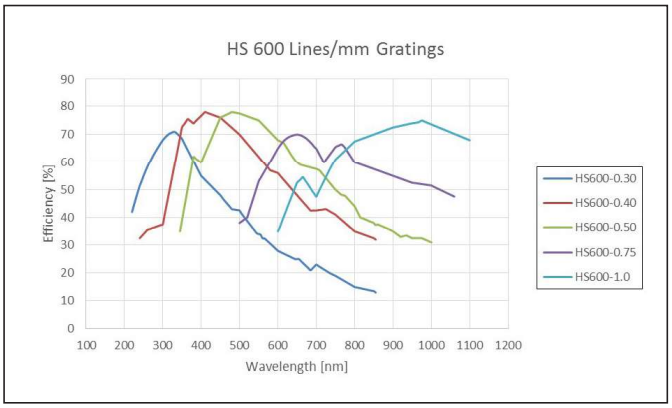


Figure 2 Grating Efficiency Curves

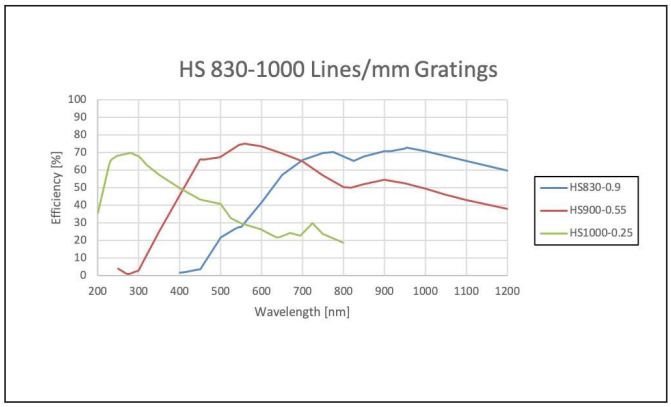
HS 500 lines/mm gratings



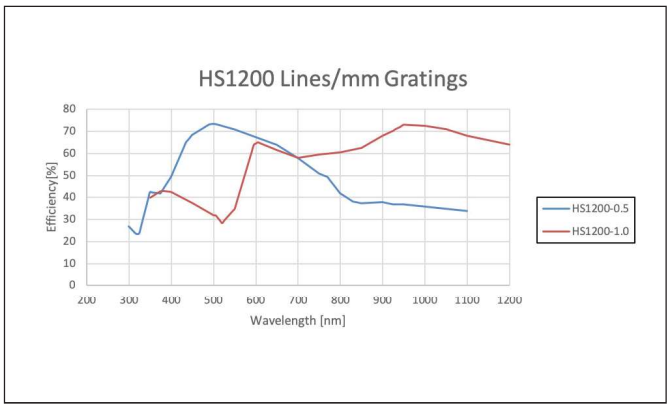
HS 600 lines/mm gratings



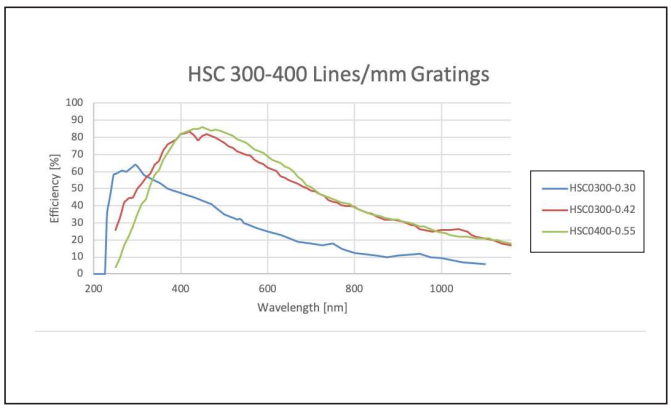
HS 830-1000 lines/mm gratings



HS 1200 lines/mm gratings



HSC 300-400 lines/mm gratings



HSC 600-830 lines/mm gratings

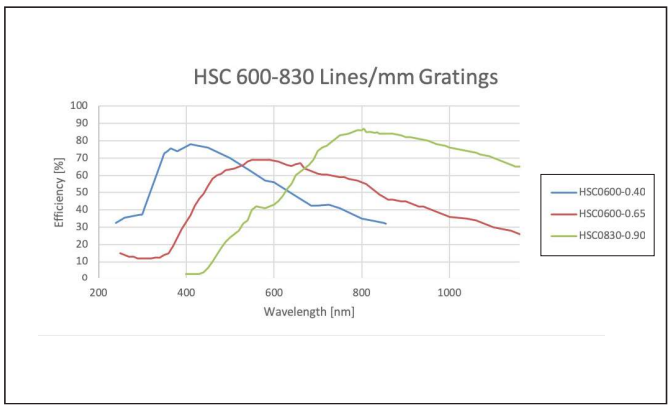
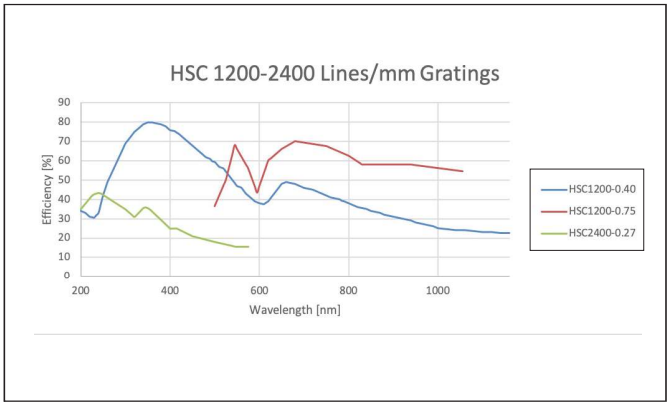
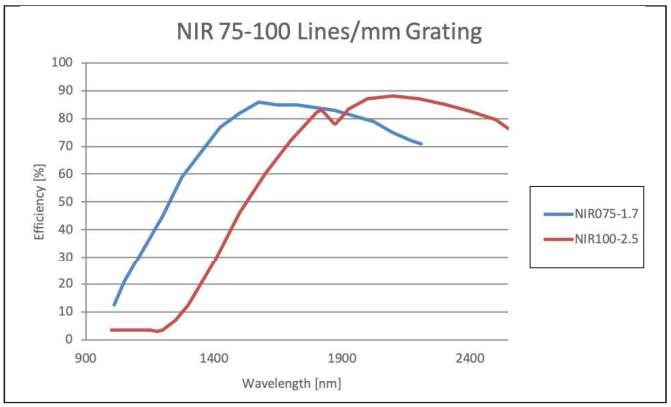


Figure 2 Grating Efficiency Curves

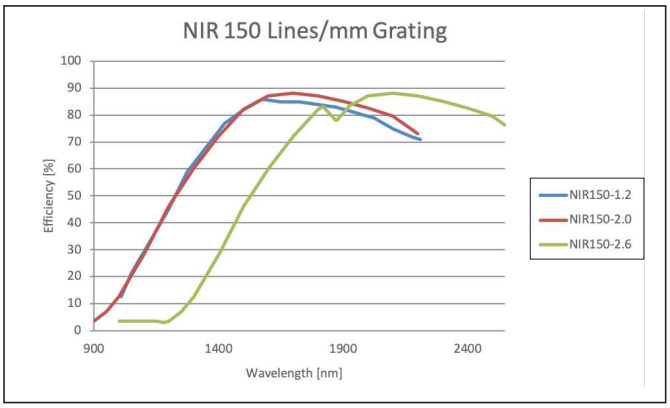
HSC 1200-2400 lines/mm gratings



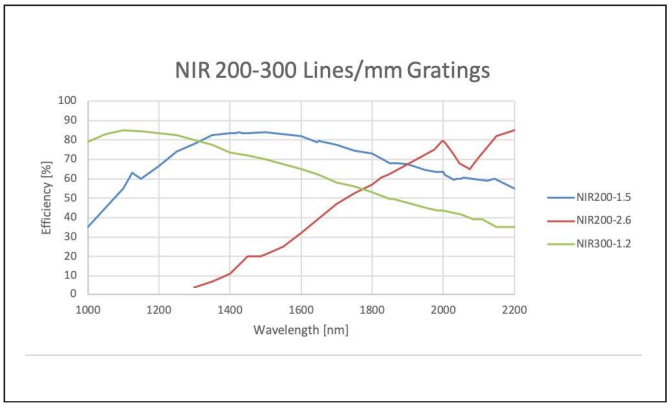
NIR 75-100 lines/mm gratings



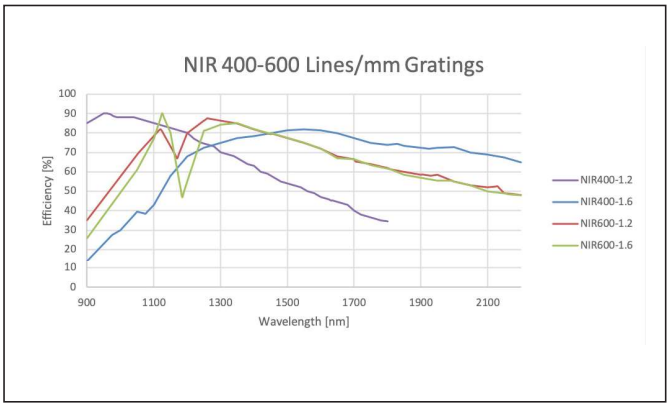
NIR 150 lines/mm gratings



NIR 200-300 lines/mm gratings



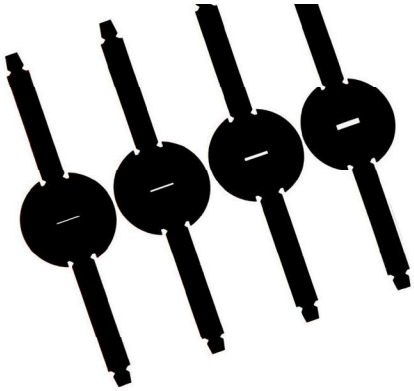
NIR 400-600 lines/mm gratings



Notes

How to Select the 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-ULS2048CL-EVO. 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.

For larger pixel-height detectors (3648, 2048L, 2048CL, 2048XL, 4096CL) 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 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).

Resolution Table (FWHM in nm) for AvaSpec-ULS2048CL-EVO

	Slit size (µm)					
Grating (lines/mm)	**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

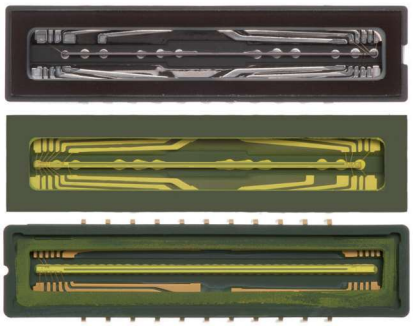
Detector Arrays

The AvaSpec line of spectrometers can be equipped with several types of detector arrays. Presently we offer silicon-based CCDs, back-thinned CCDs, and CMOS 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 our incoming goods inspection, before they are used in our instruments. Avantes offers full traceability on the following detector specifications:

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

StarLine and CompactLine CMOS Detectors (2048CL/4096CL)



Both CCD (charge-coupled device) and CMOS (complementary metal-oxide semiconductor) detectors start at the same point -- they convert light into electrons, only with different technologies. In the last years CMOS sensors has improved up to a point where they reach near parity with CCD devices.

Looking to the future the CMOS detectors seem to definitely take over the standard CCD technology in general purpose spectrometers. In general the CMOS detectors have a good UV response (without the need of using UV enhancement coatings and a higher response in the NIR region.

The overall sensitivity tends to be somewhat lower than with CCD technology.

SensLine Back-thinned CCD Detectors (2048XL/2048x64/1024x58)

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 effectivly 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.

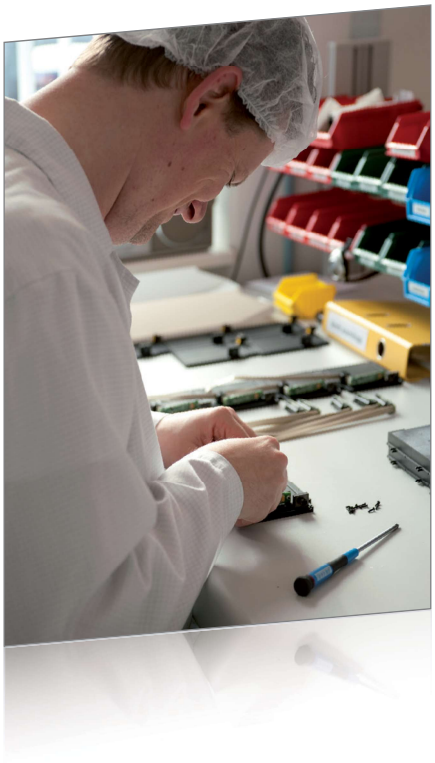
NIRLine InGaAs linear image sensors (AvaSpec-NIR256/512)

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 -2.5 µm all have 2- stage TE-cooling to reduce dark noise and are available in 256 and 512 pixel versions.

6 versions of detectors are available:

- 256/512 pixel non-cooled InGaAs detector for the 900-1750 nm range
- 256/512 pixel cooled InGaAs detector for the 900-1750 nm range
- 256/512 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 cylindrical detector collection lens (DCL) can be mounted directly on the detector array.

The DCL-UV/VIS-200 can be used for our spectrometers with larger pixel heights 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.
Our SensLine has the most sensitive detectors out of all of our instrument lines, as it includes back-thinned and thermoelectrically cooled detectors.

In Table 4 the UV/VIS detectors are depicted 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 (=√(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 (Pixel Well depth in electrons)/16-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, DCL if applicable, and 50 µm slit.

The measurement setup for 350-1100 nm has a 600 µm fiber connected to an AvaSpere-50-LS-HAL, equivalent to an optical power of 1.14 µW.

For the UV/VIS measurement at 220-1100 nm we connected the 600 µm fiber to an AvaLight-DHS through a CC-VIS/NIR diffuser, equivalent to 2.7 µW 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)

	StarLine			SensLine			
Detector	HAM-2048CL	HAM-4096CL	SONY-2048L	HAM-2048XL	HAM-1024x58	HAM-2048x64TEC	HAM-2048x64
Type	CMOS linear array	CMOS linear array	CCD linear array	Back-thinned CCD array	Cooled Back-thinned CCD array	Cooled Back-thinned CCD array	Back-thinned CCD array
# Pixels, pitch	2048, 14 µm	4096, 7 µm	2048, 14 µm	2048, 14 µm	1024x58, 24 µm	2048, 14 µm	2048, 14 µm
Pixel width x height (µm)	14 x 200	7 x 200	14 x 200	14 x 500	24 x 24 (total height 1.4 mm)	14 x 14 (total height 0.9 mm)	14 x 14 (total height 0.9 mm)
Pixel well depth (electrons)	80,000	80,000	90,000	200,000	1,000,000	300,000	200,000
Sensitivity Photons/ count @600 nm	2	2	2	4	16	6	4
Sensitivity in counts/µW per ms integration time	375,000 (AvaSpec-ULS2048CL)	218,000 (AvaSpec-ULS4096CL)	470,000 (AvaSpec-ULS2048L)	460,000 (AvaSpec-ULS2048XL)	445,000 (AvaSpec-HERO)	300,000 (AvaSpec-ULS2048x64 TEC)	650,000 (AvaSpec-ULS2048x64)
Peak wavelength	700 nm	700 nm	450 nm	650 nm	650 nm	600 nm	600 nm
QE (%) @ peak	80%	80%	40%	78%	92%	78%	78%
Signal/Noise	300:1	335:1	300:1	525:1	1200:1	550:1	450:1
Dark noise (counts RMS)	16	16	20	5	2	5	11.5
Dynamic Range	4000	4000	3300	13,700	40,000	19,000	6100
PRNU*	± 5%	± 5%	± 5%	± 3%	± 3%	± 3%	± 3%
Wavelength range (nm)	200-1100	200-1100	200-1100	200-1160	200-1160	200-1160	200-1160
Frequency	6 MHz	6 MHz	2 MHz	1 MHz	250 kHz	500 kHz	1.33 MHz

* Photo-Responsive Non-Uniformity

Figure 3a Sensitivity Curve StarLine

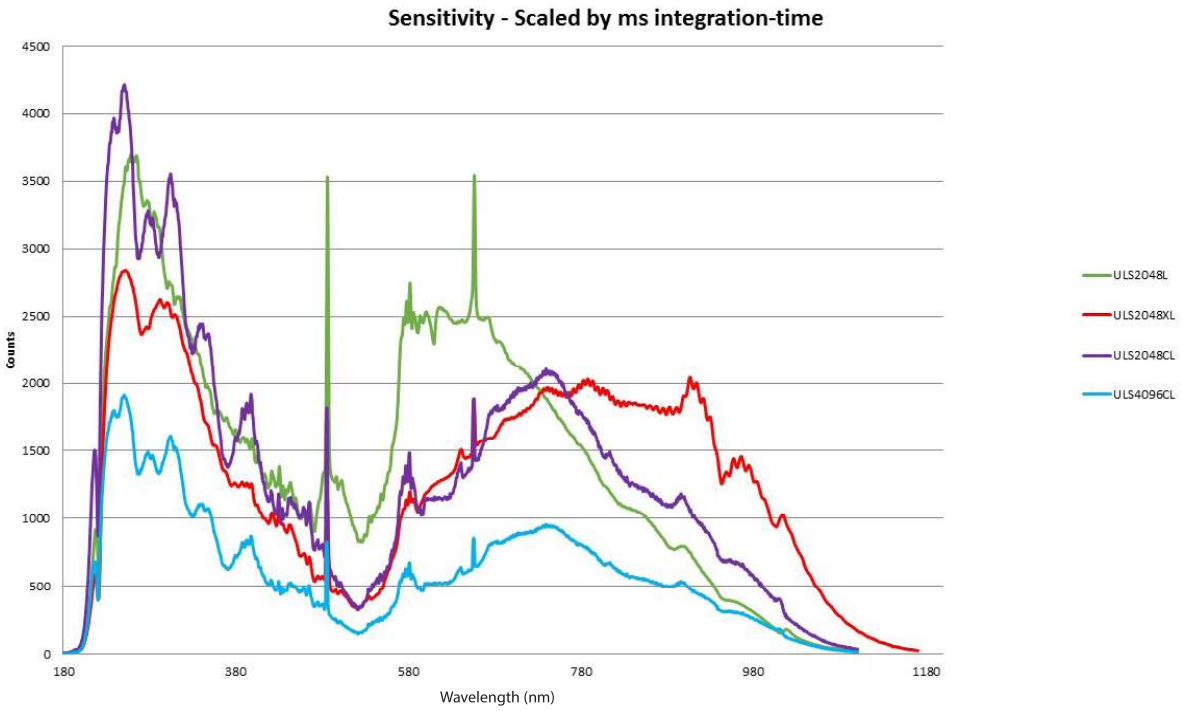
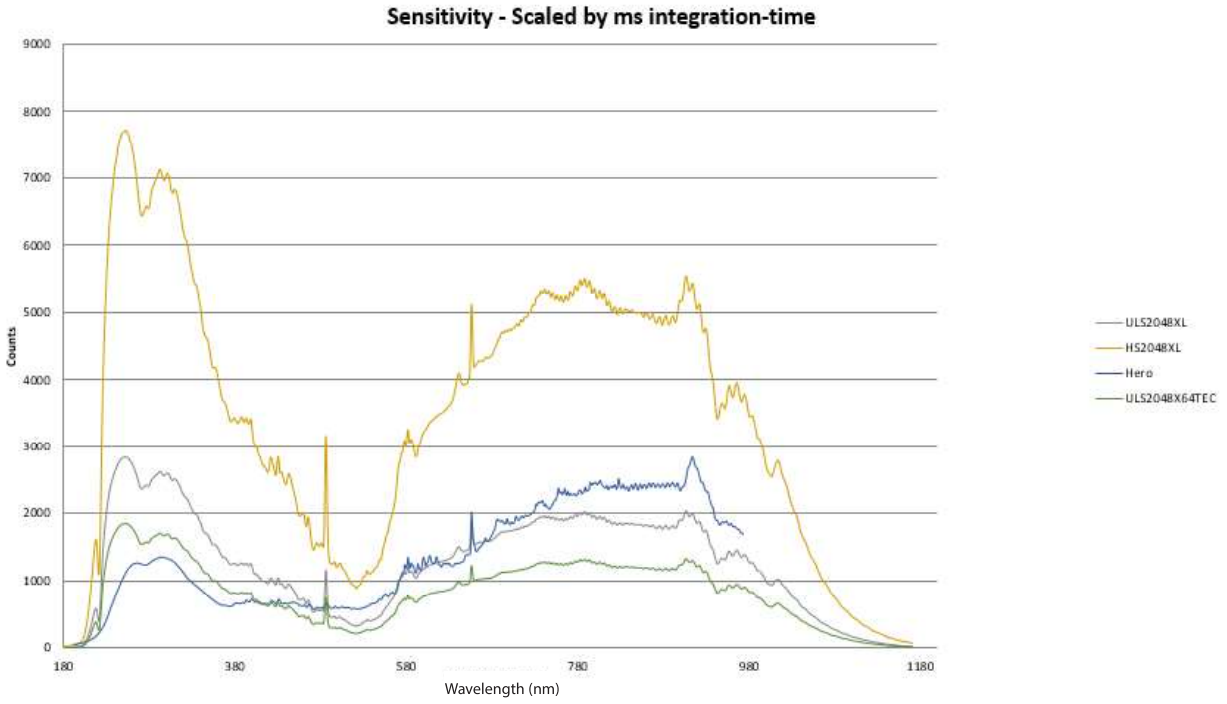


Figure 3b Sensitivity Curve SensLine



In Table 5 the specifications for the NIR spectrometers are given.

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 Detector Specifications (AvaSpec-NIR Models)

	NIRLine					
Detector	HAM-256-1.7	HAM-512-1.7	SU-256-1.7	SU-512-1.7	HAM-256-2.5	HAM-512-2.5
Type	Linear InGaAs array	Linear InGaAs array	Linear InGaAs array with 1-stage TE cooling	Linear InGaAs array with 1-stage TE cooling	Linear InGaAs array with 2-stage TE cooling	Linear InGaAs array with 2-stage TE cooling
# Pixels, pitch	256, 50 µm	512, 25 µm	256, 50 µm	512, 25 µm	256, 50 µm	512, 25 µm
pixel width x height (µm)	50 x 500	25 x 500	50 x 500	25 x 500	50 x 250	25 x 250
Sensitivity HS in counts/µW per ms	8,200,000 (integral 1000-1750 nm)	3,880,000 (integral 1000-170 nm)	4.800,000 (integral 1000-1750 nm)	2.500,000 (integral 1000-1750 nm)	990,000 (integral 1000-2500 nm)	480,000 (integral 1000-2500 nm)
Signal/Noise (HS)	1900:1	1900:1	1900:1	1900:1	1800:1	1900:1
Dark noise HS (counts RMS)	16	16	16	16	16	15
Dynamic Range HS	6000	6000	4900	4900	3500	4300
Sensitivity LN in counts/µW per ms	469,000 (integral 1000-1750 nm)	222,000 (integral 1000-1750 nm)	160,000 (integral 1000-1750 nm)	83,000 (integral 1000-1750 nm)	55,000 (integral 1000-2500 nm)	26,600 (integral 1000-2500 nm)
Signal/Noise (LN)	5000:1	5000:1	5000:1	5000:1	4000:1	3700:1
Dark noise LN (counts RMS)	12	12	12	12	12	13
Dynamic Range LN	9000	9000	7600	7600	4500	5100
Peak wavelength	1550 nm	1550 nm	1500 nm	1500 nm	2300 nm	2300 nm
QE (%) @ peak	90%	90%	70%	70%	65%	65%
PNRU**	±5%	±5%	10%	10%	±5%	±5%
Defective pixels (max)	0	0	0	0	12	26
Wavelength range (nm)	900-1750	900-1750	900-1750	900-1750	1000-2500	1000-2500
Frequency	500 kHz	500 kHz	1.2 MHz	1.2 MHz	500 kHz	500 kHz

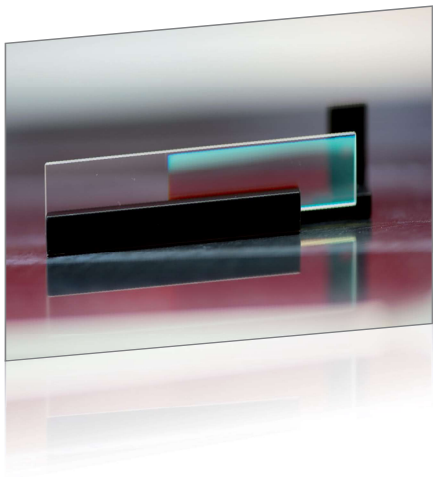
*** Photo-Response Non-Uniformity*

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 second-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 connector 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 the broad-band ULS configurations, Linear Variable Filters are used for even better suppression of the second-order effects.

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 second-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 back-thinned detectors, such as the 2048XL and 1024x58/122 we recommend an OSF-305 Filter, when the starting wavelength is 300 nm and higher.

Table 6 Filters Installed in AvaSpec Spectrometer Series

OSF-XXX	Permanently installed order-sorting filter @ XXX nm (XXX= 305, 395, 475, 515, 550, 600, 850)
OSC	Order-sorting coating with 600 nm long-pass filter for BB (>350 nm) and VB gratings
OSC-UA	Order-sorting coating with 350 and 600 nm long-pass filter for UA/VA gratings. Linear Variable Filter for ULS benches
OSC-UB	Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings
OSC-UC	Order-sorting coating with 300 nm long-pass filter for UC gratings
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-HSC300	Order-sorting coating for use with grating HSC0300-xx
OSC-HSC600	Order-sorting coating for use with grating HSC0600-xx
OSC-NIR	Order-sorting coating with 1400 nm long-pass filter for NIR100-2.5 and NIR150-2.0 gratings in AvaSpec-NIR256/512-2.5TEC

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-ULS2048CL-EVO), high-resolution instruments for demanding measurements like atomic emission (AvaSpec-ULS4096CL-EVO) and versatile instruments for common applications such as irradiance and absorbance chemistry (also AvaSpec-ULS2048CL-EVO). This instrument line offers an array of solutions for varied uses, while providing excellent price-to-performance ratios.

The AvaSpec-ULS2048CL/4096CL are based on CMOS arrays 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.

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 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 2048CL, 4096CL 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 when adequate volumes are needed. Therefore the CompactLine is especially well suited for OEM users wanting to integrate a spectrometer into their instrument.

The latest addition to our CompactLine is the AvaSpec-Mini-NIR. With this instrument it is now possible to measure up to 1750 nm in the same small form factor!

We offer three years limited warranty on all Avantes spectrometers, light sources (excl. bulbs) and accessories.

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 some feature high-performance thermoelectrically cooled detectors. The other models are based on standard CCDs, upgraded to high-performing instruments as a result of Avantes' unique 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), revolutionary High-Sensitivity (HS) and the optimal compromise (HSC) 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-NIR256/512-1.7 features an uncooled 256 or 512 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 product information and other updates, go to www.avantes.com.

AVANTES
MEMBER OF THE NYNOMIC GROUP

Preconfigured Spectrometers (In Stock)

For customers with urgent needs and general flexibility in their specifications, Avantes offers a variety of preconfigured spectrometers. We keep these spectrometers in stock so they are readily available, which makes for a significant decrease in shipping time.

Out of the seven available models, five are configured to be used for measurements in the UV-VIS-NIR range (200 to 1100 nm), one for the VIS-NIR range (360 to 1100 nm), and one just for the visible range (360 to 880 nm).

Several models are equipped with a replaceable slit (RS). All preconfigured spectrometers are available at discount pricing and include an upgrade to AvaSoft-Full. The full specifications are listed below.

Technical Data

Name	AvaSpec-ULS2048L-USB2-UA-RS	AvaSpec-ULS2048CL-EVO-RS-UA	AvaSpec-ULS2048XL-EVO-RS-UA	AvaSpec-ULS4096CL-EVO-UA-10	AvaSpec-ULS2048CL-EVO-UA-50	AvaSpec-ULS2048CL-EVO-VA-50	AvaSpec-ULS2048CL-EVO-RS-BB
Uses	UV/VIS/NIR					VIS/NIR	VIS
Range	200 - 1100 nm		200 - 1160 nm	200 - 1100 nm		360 - 1100 nm	360 - 880 nm
Slit/Connector	25 µm/SMA-RS			10 µm SMA-905	50 µm/SMA-905		25 µm/SMA-RS
Resolution (FWHM)	1.4 nm			0.5-0.7 nm	2.5 nm		0.7 nm
A/D Convertor	16 bit						
Interface	USB 2.0	USB 3.0/ETH					
Included options	Detector collecting lens, deep-UV coating, order-sorting coating, slit kit SMA	Detector collecting lens, order-sorting coating, slit kit SMA		Detector collecting lens, order sorting coating, slit			Detector collecting lens, order-sorting coating, slit kit SMA
Applications	Absorbance, emission, irradiance measurements		High-sensitivity applications (fluorescence, irradiance from very low intensity sources)	High-resolution measurements from high-intensity sources (lasers, powerful light sources, plasma)	Absorbance, emission, irradiance measurements	Color measurements, visible irradiance measurements	
AvaSoft-Full	Included						

Preconfigured spectrometers can be shipped within 24 hours.

Ordering Information

AvaSpec-ULS2048L-USB2-UA-RS	Ultra-low stray light fiber-optic UV/VIS/NIR spectrometer with replaceable slit, 2048 pixel/14x200 µm CCD detector, grating UA (200-1100 nm), DCL-UV/VIS-200, OSC-UA, DUV, USB2 powered, USB2 high speed interface. Includes AvaSoft-Full and slit kit SMA (slit 25-RS preinstalled; 50, 100 and 200 µm in box).
AvaSpec-ULS2048CL-EVO-RS-UA	Ultra-low stray light fiber-optic UV/VIS/NIR spectrometer with replaceable slit, 2048 pixel/14x200 µm CMOS detector, grating UA (200-1100 nm), DCL-UV/VIS-200, OSC-UA, USB3 powered, high speed USB3 and ETH interface. Includes AvaSoft-Full and slit kit SMA (slit 25-RS preinstalled; 50, 100 and 200 µm in box).
AvaSpec-ULS2048XL-EVO-RS-UA	Ultra-low stray light fiber-optic UV/VIS/NIR spectrometer with replaceable slit, 2048 pixel/14x500 µm back thinned CCD detector, grating UA (200-1100 nm), DCL-UV/VIS-200, OSC-UA, USB3 powered, high speed USB3 and ETH interface. Includes AvaSoft-Full and slit kit SMA (slit 25-RS preinstalled; 50, 100 and 200 µm in box).
AvaSpec-ULS4069CL-EVO-UA-10	Ultra-low stray light fiber-optic UV/VIS/NIR spectrometer, 4069 pixel CMOS detector, slit 10, grating UA (200-1100 nm), OSC-UA, DCL-UV/VIS-200, USB3 powered, high speed USB3 and ETH interface. Includes AvaSoft-Full.
AvaSpec-ULS2048CL-EVO-UA-50	Ultra-low stray light fiber-optic UV/VIS/NIR spectrometer, 2048 pixel CMOS detector, grating UA (200-1100 nm), slit 50, OSC-UA, DCL-UV/VIS-200, USB3 powered, high speed USB3 and ETH interface. Includes AvaSoft-Full.
AvaSpec-ULS2048CL-EVO-VA-50	Ultra-low stray light fiber-optic VIS/NIR spectrometer, 2048 pixel CMOS detector, grating VA (360-1100 nm), slit 50, OSC, DCL-UV/VIS-200, USB3 powered, high speed USB3 and ETH interface. Includes AvaSoft-Full.
AvaSpec-ULS2048CL-EVO-RS-BB	Ultra-low stray light fiber-optic VIS spectrometer, 2048 pixel CMOS detector, grating BB (360-880 nm), OSF-305, OSC, USB3 powered, high speed USB3 and ETH interface. Includes AvaSoft-Full and slit kit SMA (slit 25-RS preinstalled; 50, 100 and 200 µm in box).

AvaSpec-Mini2048CL
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 better than 3000:1, stray-light levels between 0.2 and 1% and weighs only 175 grams. Easy to take anywhere you like.

The AvaSpec-Mini2048CL is produced with the latest automated production technology, providing excellent unit-to-unit reproducibility and temperature stability.

These are key parameters for OEM customers for reliable integration into their products. Many areas of research can be covered with this device, such as light analysis, chemical research and Raman spectroscopy. The possibilities are endless.

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

Technical Data

Optical bench	Symmetrical Czerny-Turner, 75 mm focal length, MK II
Wavelength range	200 - 1100 nm
Stray light	0.2 - 1%
Sensitivity	337.500
Detector	HAM S11639 , CMOS linear array, 2048 pixels (14x200 µm)
Signal/noise	330:1
Dynamic range	3300
Dark noise	16 cnts
AD converter	16-bit, 6 MHz
Integration time	30 µs - 40 s
Interface	USB 2.0 (480 Mbps) / pigtailed (40 cm) USB-A
Sample speed with on-board averaging	3.0 ms/scan
Data transfer speed	4.6 ms/scan
I/O	5 bidirectional programmable I/O; 1 analog out; 1 analog in, 1x5V
Dimensions, weight	95 x 68 x 20 mm, 175 grams
Power supply	Default USB power, 500 mA
Temperature range	0-55°C

Grating selection table for AvaSpec-Mini*

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
2048CL					
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
UV/VIS/NIR	200-1100	900	300	300	MN 300-0.30
VIS/NIR	360-1100	720	300	500	MN 300-0.50

** Other gratings are available on request.*

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

	Slit size (µm)					
Grating (lines/mm)	**10**	**25**	**50**	**100**	**200**	**500**
	2048 CL					
300	1.00	1.30	2.40	4.80	9.20	22.00
600	0.40-0.53	0.70	1.20	2.40	4.60	11.00
1800	0.10-0.18	0.22	0.34-0.42	0.80	1.60	3.60
	** Typical values. Small deviations are possible.*					

Ordering information

AvaSpec-Mini2048CL	• Mini Fiber-optic Spectrometer, 75 mm focal length, 2048 pixel CMOS detector, USB 2 powered interface, including DCL
	Specify grating, wavelength range and options. Other gratings are available on request.

Options

SLIT-XX	• Slit size, please specify XX = 10, 25, 50, 100, 200 or 500 µm (5 µm possible on request)
OSC	• Order sorting coating for grating MN 600-0.50, recommended with OSF-305
OSC-UA	• Order sorting coating for grating MN 300-0.30
OSC-VA	• Order sorting coating for grating MN 300-0.50, recommended with OSF-305
OSF-YYY	• Order-sorting filter for reduction of 2nd order effects, please specify YYY= 305, 395, 457, 515, 550 or 600 nm, depends on range
	For non-OEM users a set of preconfigured models are available

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AvaSpec-Mini4096CL
Small and Powerful OEM spectrometer

This first-to-the-market, 4096 pixel CMOS array miniature spectrometer is the perfect combination of small size and high resolution (up to 0.09 nm)!

It's only the size of a deck of cards, yet delivers a dynamic range better than 3000:1, stray-light levels between 0.2 and 1% and weighs only 175 grams. Easy to take anywhere you like.

The AvaSpec-Mini4096CL is produced with the latest automated production technology, providing excellent unit-to-unit reproducibility and temperature stability. These are key parameters for OEM customers for reliable integration into their products.

Many areas of research can be covered with this device, such as light analysis, chemical research and Raman spectroscopy. The possibilities are endless.

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

Technical Data

Optical bench	Symmetrical Czerny-Turner, 75 mm focal length, MK II
Wavelength range	200 - 1100 nm
Stray light	0.2 - 1%
Sensitivity	261.000
Detector	HAM S13496 , CMOS linear array, 4096 pixels (7x200µm)
Signal/noise	300:1
Dynamic range	3300
Dark noise	16 cnts
AD converter	16-bit, 6 MHz
Integration time	30 µs - 50 s
Interface	USB 2.0 (480 Mbps) / pigtailed (40 cm) USB-A
Sample speed with on-board averaging	6.5 ms/scan
Data transfer speed	8.9 ms/scan
I/O	5 bidirectional programmable I/O; 1 analog out; 1 analog in, 1x5V
Dimensions, weight	95 x 68 x 20 mm, 175 grams
Power supply	Default USB power, 500 mA
Temperature range	0-55°C

Grating selection table for AvaSpec-Mini

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
4096CL					
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
UV/VIS/NIR	200-1100	900	300	300	MN 300-0.30
VIS/NIR	360-1100	720	300	500	MN 300-0.50

** Other gratings are available on request.*

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

	Slit size (µm)					
Grating (lines/mm)	**10**	**25**	**50**	**100**	**200**	**500**
	4096CL					
300	0.50-0.70	1.20-1.30	2.17	4.60	9.00	20.00
600	0.30-0.36	0.58-0.68	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-Mini4096CL	• Mini Fiber-optic Spectrometer, 75 mm focal length, 4096 pixel CMOS detector, USB 2 powered interface, including DCL
	Specify grating, wavelength range and options. Other gratings are available on request.

Options

SLIT-XX	• Slit size, please specify XX = 10, 25, 50, 100, 200 or 500 µm (5 µm possible on request)
OSC	• Order sorting coating for grating MN 600-0.50, recommended with OSF-305
OSC-UA	• Order sorting coating for grating MN 300-0.30
OSC-VA	• Order sorting coating for grating MN 300-0.50, recommended with OSF-305
OSF-YYY	• Order-sorting filter for reduction of 2nd order effects, please specify YYY= 305, 395, 457, 515, 550 or 600 nm, depends on range
	For non-OEM users a set of preconfigured models are available

NEW

AvaSpec-Mini-NIR
Small and Powerful OEM NIR Spectrometer

AvaSpec-Mini-NIR256-1.7

The latest addition to our CompactLine: the AvaSpec-Mini-NIR! The AvaSpec-Mini-NIR is a compact near-infrared spectrometer, based on a combination of our popular AvaSpec-NIR256-1.7 and Mini-series.

Like our other CompactLine spectrometers, this device is only the size of a deck of cards and USB powered, which makes it easy to integrate into other devices, including but not limited to OEM handheld applications.

Since the AvaSpec-Mini-NIR has no moving parts it is very robust and can be used virtually any environment!

Of course, the AvaSpec-Mini-NIR works seamlessly with our AvaSoft software and the Windows and Linux libraries we have available.

If size is not the most important factor for your application, we recommend the AvaSpec-Mini-NIR's bigger brother, the AvaSpec-NIR256-1.7-EVO (page 53) that is bigger in size but offers slightly higher sensitivity levels.

Technical Data

Optical bench	Symmetrical Czerny-Turner, 75 mm focal length, MK II
Wavelength range	900-1750 nm
Stray light	1%
Sensitivity HS in counts/µW per ms	665,000 (integral 1000-1750 nm)
Dynamic range HS	4750:1
Integration time HS	10 µs-300 ms
Signal/noise HS	1900:1
Dark noise HS	14 counts
Sensitivity LN in counts/µW per ms	38,000 (integral 1000-1750 nm)
Dynamic range LN	7500:1
Integration time LN	10 µs-5 seconds
Signal/noise LN	5000:1
Dark noise LN	9 counts
Detector	InGaAs array, 256 pixels
AD converter	16-bit, 500 kHz
Interface	USB2.0 (480 Mbps)/pigtailed (40 cm) USB-A
Sample speed with store to RAM	0.53 ms/scan
Data transfer speed	1.2 ms/scan
I/O	5 bidirectional programmable I/O: 1 analog out, 1 analog in, 1 x 5V
Power supply	Default USB power, 500 mA
Dimensions, weight	95 x 68 x 20 mm, 185 g
Temperature range	0-55ºC

Grating selection table for AvaSpec-Mini-NIR

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
NIR	900-1750	725	200	1550	NIR200-1.6
NIR	900-1495	330-320	400	1210	NIR400-1.2
NIR	1250-1700	315-310	400	1600	NIR400-1.6
NIR	900-1450	210-195	600	1280	NIR600-1.3
NIR	1350-1735	185-170	600	1669	NIR600-1.7

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

	Slit size (µm)			
Grating (lines/mm)	**50**	**100**	**200**	**500**
200	6	12	24	50
400	3	6	12	25
600	2	4	8	18
	** Typical values. Small deviations are possible.*			

Ordering information

AvaSpec-Mini-NIR256-1.7	• Miniature NIR fiber-optic spectrometer, 75 mm focal length, 256 pixel InGaAs detector, USB2 powered interface
	Specify grating, wavelength range and options. Other gratings are possible on request.

Options

SLIT-XX	• Slit size, please specify XX = 50, 100, 200 or 500 µm
	For non-OEM users, a preconfigured model will be available upon release

EVO Series, with CMOS Detector: StarLine AvaSpec-ULS2048CL-EVO Spectrometer

Using CMOS technology instead of the conventional CCD technology, this spectrometer offers you the latest technology.
New technologies like CMOS have evolved and become a suitable alternative.

In combination with our latest AS-7010 electronics it offers you a versatile device including USB3.0 communication with 10x higher speed compared to USB2, and a second communication port which offers Gigabit Ethernet for integration in your company network and possibility for long distance communication.

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.

Options include 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-2048CL 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.

The AvaSpec-ULS2048CL-EVO is also available as OEM unit, Bench only or Rackmount version.

AvaSpec-ULS2048CL

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	0.19-1.0%, depending on the grating
Sensitivity	375,000 counts/µW per ms integration time
Detector	CMOS linear Image Sensor
Signal/Noise	300:1
AD converter	16-bit, 6 MHz
Integration time	9 µs – 59s
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet 1 Gbps
Sample speed with on-board averaging	0.38 ms /scan
Data transfer speed	0.38 ms/scan (USB3), 1.0 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

Ordering Information

AvaSpec-ULS2048CL-EVO	• Fiber-optic Spectrometer, 75 mm AvaBench, 2048 pixel CMOS 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.
PS-12V/2.08A	• External power supply, needed for operation in ETH mode

Grating Selection Table for AvaSpec-ULS2048CL-EVO

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1100**	891**	300	300	UA
UV/VIS/NIR	200-1100**	891**	300	300/1000	UNA-DB
UV/VIS	200-850	515	600	300	UB
UV	200-750	247-218*	1200	250	UC
UV	200-650	163-143*	1800	UV	UD
UV	200-580	113-69*	2400	UV	UE
UV	200-400	69-45*	3600	UV	UF
UV/VIS	250-850	515	600	400	BB
VIS/NIR	300-1100**	800**	300	500	VA
VIS	360-1000	495	600	500	VB
VIS	300-800	247-218*	1200	500	VC
VIS	350-750	142-89*	1800	500	VD
VIS	350-640	74-49*	2400	VIS	VE
NIR	500-1050	495	600	750	NB
NIR	500-1050	218-148*	1200	750	NC
NIR	600-1100	346-297	830	800	SI
NIR	600-1100**	495**	300	1000	IA
NIR	600-1100	495	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-ULS2048CL-EVO

	Slit size (µm)					
Grating (lines/mm)	**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

Options

-RS	• Replaceable slit
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, 200 or 500 µm. Only in combination with AvaSpec-ULS2048CL-EVO-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, recommended with OSF-305
OSC-UA	• Order-sorting coating Linear Variable Filter for UA, VA gratings
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings
-FCPC	• FC/PC fiber-optic connector

EVO Series, with 4k CMOS Detector: StarLine AvaSpec-ULS4096CL-EVO

Another new member in our EVO series: the AvaSpec-ULS4096CL-EVO. Using CMOS technology instead of the conventional CCD technology, this spectrometer offers you the latest technology; ready for the next decade.

The dominant position of CCD detectors in the spectrometer field is fading and new technologies like CMOS have evolved and become a suitable alternative. The AvaSpec-ULS4096CL-EVO offers you this latest technology ensuring a spectrometer platform for the coming years.

In combination with our latest AS-7010 electronics it offers you a versatile device including USB3.0 communication with 10x higher speed compared to USB2, and a 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.

Options include 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-4096CL 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.

The AvaSpec-ULS4096CL-EVO is also available as OEM unit, Bench only or Rackmount version.
With the 4096 pixels these spectrometers are tailored for high resolution applications like Plasma and LIBS.

AvaSpec-ULS4096CL

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	0.19-1.0%, depending on the grating
Sensitivity	218.000 counts/µW per ms integration time
Detector	CMOS linear Image Sensor
Signal/Noise	335:1
AD converter	16-bit, 6 MHz
Integration time	9 µs – 40s
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet 1 Gbps
Sample speed with on-board averaging	0.70 ms /scan
Data transfer speed	0.70 ms/scan (USB3), 1.31 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, 532 mA Or 12VDC, 300 mA
Dimensions, weight	177 x 127 x 44,5 mm (1 channel), 1155 grams

EVOlutionary spectroscopy:
- Speed
- Network integration
- Multi-channel benefits

AVANTES
MEMBER OF THE NYNOMIC GROUP

Grating Selection Table for AvaSpec-ULS4096CL-EVO

Use	Usable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1100**	891**	300	300	UA
UV/VIS/NIR	200-1100**	891**	300	300/1000	UNA-DB
UV-VIS	200-850	515	600	300	UB
UV	200-750	247-218*	1200	250	UC
UV	200-650	163-143*	1800	UV	UD
UV	200-580	113-69*	2400	UV	UE
UV	200-400	69-45*	3600	UV	UF
UV/VIS	250-850	515	600	400	BB
VIS/NIR	300-1100**	792**	300	500	VA
VIS	360-1000	495	600	500	VB
VIS	300-800	247-218*	1200	500	VC
VIS	350-750	142-89*	1800	500	VD
VIS	350-640	74-49*	2400	VIS	VE
NIR	500-1050	495	600	750	NB
NIR	500-1050	218-148*	1200	750	NC
NIR	600-1100	346-297	830	800	SI
NIR	600-1100**	495**	300	1000	IA
NIR	600-1100	495	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 4096 pixels will be used for the useable range

Resolution Table (FWHM in nm) for AvaSpec-ULS4096CL-EVO

	Slit size (µm)					
Grating (lines/mm)	**10**	**25**	**50**	**100**	**200**	**500**
300	0.50-0.70	1.20-1.30*	2.17	4.6	9.00	20.0
600	0.30-0.36*	0.58-0.60	1.17	2.20	4.5	10.0
830	0.25	0.48	0.93	1.7	3.4	8.0
1200	0.14-0.18*	0.30	0.62	1.08	2.2	5.0
1800	0.09-0.11*	0.18	0.36-0.40*	0.78	1.5	3.7
2400	0.07-0.09*	0.13-0.15*	0.26-0.32*	0.40-0.64*	1.1	2.7
3600	0.05-0.06*	0.10	0.19	0.4	0.8	2.0

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution
**expected resolution gain with a 5 micometer slit will be a factor 0.8

Ordering Information

AvaSpec-ULS4096CL-EVO	• Fiber-optic Spectrometer, 75 mm AvaBench, 4096 pixel CMOS detector 7 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.
PS-12V/2.08A	• External power supply, needed for operation in ETH mode or with USB2 ports.

Options

-RS	• Replaceable slit
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-ULS4096CL-EVO-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, recommended with OSF-305
OSC-UA	• Order-sorting coating with Linear Variable Filter for UA, VA gratings
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings
-FCPC	• FC/PC fiber-optic connector

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 serie 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-ULS2048CL-EVO

AvaSpec-RS Spectrometer with Replaceable Slit

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 available on ULS Ultra-low Stray-light AvaSpecs. On our AvaSpec-HERO & NIR spectrometers this is standard. 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 or 500 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
SLIT-XX-RS	• Replaceable slit with SMA connector. Specify slit size XX=25, 50, 100, 200 or 500 µm, in combination with AvaSpec-ULS-RS spectrometers
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, 200 and 500 µm. Also included in the kit are the tools to easily change the slit in the spectrometer.

The Slit Kit is available in SMA (choice of 4 SMA slits), SMA/FCPC (combination of 2 SMA and 2 PCPC slits) and FC/PC (choice of 4 FCPC and/or SMA slits) versions.

All kits can be used on any spectrometer with the replaceable slit option installed. Slit sizes 5 and 10 um cannot be included in the kit , but can be ordered as a separate item (recalibration of spectrometer recommended).

Ordering Information

SLITKIT-SMA	• Slit kit containing of 4 SMA replaceable slits. Choice of 25, 50, 100, 200 and 500 µm slits (any combination), and the tools to replace the slit
SLITKIT-SMA/FCPC	• Slit kit containing of 2 SMA and 2 FCPC replaceable slits.. Choice of 25, 50, 100, 200 and 500 µm slits (any combination), and the tools to replace the slit
SLITKIT-FCPC	• Slit kit containing of 4 replaceable slits (FCPC and/or SMA). Choice of 25, 50, 100, 200 and 500 µm slits (any combination), and the tools to replace the slit.

When creating your setup, don't forget to order a fiber-optic cable!

AvaSpec-ULS2048XL-EVO SensLine High UV and NIR Sensitivity Back-Thinned CCD Spectrometer

AvaSpec-ULS2048XL-EVO

Combining exceptional quantum efficiency with high-speed is the value proposition of the AvaSpec-ULS2048XL-EVO spectrometer. Unlike many back-thinned CCD spectrometers, which have two dimensional arrays, the ULS2048XL-EVO 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-EVO 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-EVO uses the AS7010 electronics board offering USB3 (10 times faster than USB2), Gigabit Ethernet and better signal processing.

Connection to your PC is handled via a USB3-connection or Ethernet, delivering a scan every 2 milliseconds. The instrument 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 - 1160 nm
Resolution	0.09 –20 nm, depending on configuration (see table)
Stray-light	< 0.5%
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	525:1
AD converter	16-bit, 1 MHz
Integration time	2 µs – 20 seconds
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet 1 Gbps
Sample speed with store to RAM	2.44 ms /scan
Dark Noise	4.5 cnt RMS
Dynamic Range	13.700
Data transfer speed	2.44 ms /scan (USB3)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, synchronization
Power supply	Default USB power, 700 mA. Or external 12VDC, 360 mA
Dimensions, weight	175 x 127 x 44,5 mm (1 channel), 1180 grams

Grating Selection Table for AvaSpec-ULS2048XL-EVO

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	200-1160**	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-EVO

	Slit size (µm)					
Grating (lines/mm)	**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-EVO	• Ultra-low Stray-light Fiber-optic Spectrometer, 75 mm AvaBench, 2048 large 500 µm pixel back-thinned CCD detector, USB powered, high-speed USB3.0 and ETH interface, incl. AvaSoft-Basic, USB interface cable. Specify grating, wavelength range and options
PS-12V/2.08A	• External power supply, needed for use in ETH mode

Why is the XL so sensitive?
We're using back-illuminated detectors.
The electronics of these detectors are located on the back side, allowing more room for the light to be caught by the front side of the detector.

Options

-RS	• Replaceable slit
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, 200 or 500 µm. Only in combination with AvaSpec-ULS2048XL-EVO-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, 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, recommended with OSF-305
OSC-UA	• Order-sorting coating Linear Variable Filter for UA, VA gratings
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings
-FCPC	• FC/PC fiber-optic connector

Gratings can only be changed by Avantes.
Therefore, it is important to 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 multi-channel (e.g. AvaSpec-Dual) or rack-mountable versions,
you can create one virtual spectrometer with high-resolution
and high bandwidth. Contact us for more information and advice!

AvaSpec-HERO SensLine

The AvaSpec-HERO is the top of the line spectrometer!
Based on our High Sensitivity Compact (HSC) optical bench (f=100mm; NA=0.13) and a 1024x58 backthinned CCD detector, it offers the best of both worlds: high sensitivity and resolution!

The instrument is equipped with thermo-electric cooling, enabling long integration times in low light applications. In conjunction with our AS7010 electronics, including a high-end AD convertor, noise is kept to a minimum, which offers you an excellent Signal to Noise and Dynamic Range performance.
A selection of gratings and slits offers you the flexibility of configuring the instrument for a wide range of applications in the 200-1160 nm range.

From low light fluorescence applications to demanding Raman applications, the AvaSpec-HERO is your ideal companion.

With the high-speed USB3.0 and Gigabit Ethernet communication interface, the connection to your computer is fast and simple.

Of course the digital IO ports enabling external triggering, control of shutters, and pulsed light sources from the Avantes line of instruments are available as well.

The Avaspec-HERO is standard equipped for use with replaceable slits, offering optimal flexibility for a variety of applications. The combination of all the above makes the AvaSpec-HERO your ideal companion for all your spectroscopic measurements.

AvaSpec-HERO

Technical Data

Optical Bench	HSC Symmetrical Czerny-Turner, 100 mm focal length, NA: 0.13
Wavelength range	200-1160 nm
Resolution	0.2-7 nm, depending on configuration (see table)
Stray-light	0.5%, depending on the grating
Sensitivity	445,000 counts/µW per ms integration time
Detector	CCD array image sensor with one stage TE Cooled, 1024 pixels
Temperature cooled CCD	Max. ΔT = 30 °C versus ambient
Signal/Noise	1200:1
Dynamic Range	40.000
AD converter	16-bit, 250 kHz
Integration time	5.2 ms– 60 sec
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet 1 Gbps
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital bidirectional, trigger, sync., strobe, laser.
Sample speed with on-board averaging	5.2 ms/scan
Data transfer speed	5.2 ms/scan (USB3 and ETH)
Power supply	12VDC, 1.5A
Dimensions, weight	185 x 161 x 185mm, 3500 grams

The AvaSpec-HERO is the answer for those who are in need of high resolution ánd high sensitivity!

Grating Selection Table for AvaSpec-HSC1024x58TEC-EVO

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1160	770-760*	300	300	HSC0300-0.30
UV/VIS/NIR	250-1160	770-760*	300	420	HSC0300-0.42
VIS/NIR	250-1160	577-553	400	550	HSC0400-0.55
UV/VIS	250-850	373-340*	600	400	HSC0600-0.40
VIS/NIR	250-1160	373-340*	600	650	HSC0600-0.65
VIS/NIR	500-1160	268-220*	830	900	HSC0830-0.90
UV/VIS	200-1160	182-130*	1200	400	HSC1200-0.40
VIS/NIR	500-1050	182-130*	1200	750	HSC1200-0.75
UV/VIS	200-580	84-61*	2400	270	HSC2400-0.27

** 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 (FWHM in nm) for AvaSpec-HSC1024x58TEC-EVO

	Slit size (µm)					
Grating (lines/mm)	**10**	**25**	**50**	**100**	**200**	**500**
300	1.70	1.80	2.30	3.40	6.50	14.0
400	1.30	1.45	1.60	2.60	5.10	12.0
600	0.75	0.85	1.10	1.70	3.40	7.50
830	0.50	0.60	0.70	1.25	2.30	5.00
1200	0.32	0.40	0.48	0.80	1.45	3.50
2400	0.17	0.30	0.36	0.50	0.80	1.75

** Above values are average values. Due to optical properties resolution will be better in the lower wavelengths than in the higher wavelength range.*

Ordering Information

AvaSpec-HSC1024x58TEC-EVO	• AvaSpec-HERO; High sensitivity fiber optic spectrometer, HSC 100mm bench design, 1024x58 pixel back illum TE cooled CCD detector, high-speed USB 3.0 and ETH interface, including AvaSoft-Basic, USB interface cable, specify grating, wavelength range and options

Options

SLIT-XX-RS	• Replaceable slit with SMA connector, specificy slit size XX=10, 25, 50, 100, 200 or 500 µm.
SLIT-XX-RS-FCPC	• As SLIT-XX-RS, but with FC/PC connector
SLITKIT-SMA	• Slit kit containing 25, 50, 100, 200 or 500 µm slits, and the tools to replace the slit. SMA-connectors
SLITKIT-FCPC	• As SLITKIT-SMA, but with FC/PC connectors
OSF-YYY-3	• Order sorting filter for reduction of 2nd order effects, 3 mm thick, please specify YYY= 305, 395, 475, 515, 550, 600 nm
OSC-HSC300	• Order sorting coating for use with grating HSC0300-xx
OSC-HSC600	• Order sorting coating for use with grating HSC0600-xx and HSC0400-xx

NEW

AvaSpec-ULS2048x64TEC-EVO SensLine Thermoelectrically Cooled Fiber-Optic Spectrometer

The AvaSpec-ULS2048x64TEC-EVO is an updated version of our AvaSpec-ULS2048x64TEC spectrometer, with improved electronics and cooling.

This instrument enhances the Sensline series with its cooled, back-thinned detector. The back-thinned detecor 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 120 seconds with low-noise levels.

The instrument features Peltier cooling device integrated into our exclusive ultra-low stray light optical bench, which can reduce the temperature of the CCD chip to -30°C against ambient, improving the dark baseline and PRNU level significantly. The detector cooling also reduces the dark noise by a factor of 2-3.

The AvaSpec-ULS2048x64TEC-EVO uses a special low-noise version of the 2048x64 detector with integrated cooling.

All the features mentioned above make this instrument ideally suited for measuring low-light applications, such as fluorescence or low-light Raman measurements.

Optimal flexibility is guaranteed with the replaceable slit, making the instrument suitable for various kinds of applications.

The above mentioned qualities make the AvaSpec-ULS2048x64TEC-EVO 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.

AvaSpec-ULS2048x64TEC-EVO

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, integrated cooling
Temperature-cooled CCD	Max. ΔT = -30°C versus ambient. Optimal setting: 5°C
Signal/noise	550:1
AD converter	16-bit, 500 KHz
Dynamic range	19,000
Dark noise	5 cnts
Integration time	9.7 ms–120 s
Interface	USB 3.0 high speed, 5 Gbps Gigabit Ethernet 1 Gbps
Sample speed with on-board averaging	9.7 ms/scan
Data transfer speed	9.7 ms/scan (USB3) 9.7 ms/scan (ETH)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital bidirectional, trigger, sync., strobe, laser
Power supply	12 VDC, 1.5 A
Operating temperature	0-40°C
Cooling	30°C versus ambient
Dimensions, weight	185 x 145 x 185 mm, 3500 grams

Grating Selection Table for AvaSpec-ULS2048x64TEC-EVO

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

	Slit size (µm)					
Grating (lines/mm)	**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-EVO	Thermoelectrically cooled fiber-optic spectrometer, 75 mm ultra-low stray light AvaBench, 2048x64 pixel, TE-cooled and regulated low-noise CCD detector, USB3/ETH high-speed interface and replaceable slit, 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-RS	• Replaceable slit with SMA connector. Specify slit size XX= 10, 25, 50, 100, 200 or 500 µm
SLIT-XX-RS-FCPC	• As SLIT-XX-RS, but with FC/PC connector
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, recommended with OSF-305
OSC-UA	• Order-sorting coating with linear variable filter for UA, VA gratings
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings

AvaSpec-HS2048XL-EVO SensLine High UV and NIR Sensitivity Back-Thinned CCD Spectrometer

For high sensitivity applications where high resolution is not of paramount concern, the AvaSpec-HS2048XL-EVO 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.

The AvaSpec-HS2048XL-EVO uses the AS7010 electronics board offering USB3 (10 times faster than USB2), Gigabit Ethernet and better signal processing.

AvaSpec-HS2048XL-EVO

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 - 20 nm, depending on configuration (see table)
Stray-light	< 1 %
Sensitivity	1,250,000 counts/µW per ms int. time
UV Quantum efficiency	60% (200-300 nm)
Detector	Back-thinned CCD image sensor 2048 pixels
Signal/Noise	525:1
AD converter	16-bit, 1 MHz
Integration time	2 µs – 600 seconds
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet, 1 Gbps
Sample speed with on-board averaging	2.44 ms /scan
Dynamic Range	14.900
Data transfer speed	2.44 ms /scan (USB3)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, synchronization
Power supply	Default USB power, 700 mA. or external 12VDC, 360 mA
Dimensions, weight	175 x 165 x 85 mm, 1,950 kg

Grating Selection Table for AvaSpec-HS2048XL-EVO

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	600-1160	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-EVO

	Slit size (µm)					
Grating (lines/mm)	**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-EVO	• High-sensitivity fiber-optic Spectrometer, 2048 large 500 µm pixel back-thinned CCD detector, USB powered, high-speed USB3.0 and ETH interface, incl. AvaSoft-Basic, USB interface cable. Specify grating, wavelength range and options
PS-12V/2.08A	• External power supply, needed for use in ETH mode

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-EVO is ideally suited for diffuse reflection (UV, VIS, NIR) and fluorescence measurements.

NEW

AvaSpec-ULS2048x64-EVO SensLine High UV and NIR Sensitivity Spectrometer

Alongside the cooled AvaSpec-ULS2048x64TEC-EVO with low-noise detector, Avantes also offers the more cost-effective, uncooled AvaSpec-ULS2048x64-EVO. With its standard 2048x64 backthinned detector, this spectrometer is perfect for less demanding applications in the UV and NIR range.

For applications that require integration times lower than 2 seconds, the cooling option is often not needed. For example, this uncooled AvaSpec-ULS2048x64-EVO has an established track record in various DOAS applications all over the world because of its high UV response and 0.9 mm detector height that enables detecting the wavelengths of interest.

Options include an order-sorting filter, to reduce second-order effects and purge ports for deep-UV measurements. The AvaSpec-ULS2048x64-EVO comes with a wide range of slit sizes, gratings and can be configured with SMA or FC/PC fiber-optic entrance connectors.

The AvaSpec-ULS2048x64-EVO uses the AS7010 electronics board offering USB3 (10 times faster than USB2), Gigabit Ethernet and better signal processing.

Connection to your PC is handled via USB3-connection or Ethernet, delivering a scan every 2 milliseconds. The instrument comes complete with AvaSoft-basic software, USB cable and an extensive manual.

AvaSpec-ULS2048x64-EVO

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	650,000 counts/µW per ms int. time
Detector	Back-thinned CCD image sensor 2048x64 pixels (height: 0.89 nm)
Signal/noise	450:1
AD converter	16-bit, 1.33 MHz
Integration time	2.4 ms–25 seconds
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet 1 Gbps
Sample speed with on-board averaging	2.4 ms/scan
Dark noise	11.5 cnt RMS
Dynamic range	6100
Data transfer speed	2.4 ms/scan (USB3)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital bidirectional, trigger, sync., strobe, laser
Power supply	Default USB power, 885 mA. Or external 12VDC, 420 mA
Dimensions, weight	177 x 127 x 44,5 mm (1 channel), 1180 grams

Grating Selection Table for AvaSpec-ULS2048x64-EVO

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-ULS2048x64-EVO

	Slit size (µm)					
Grating (lines/mm)	**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-ULS2048x64-EVO	• Ultra-low Stray-light Fiber-optic Spectrometer, 75 mm AvaBench, 2048x64 pixel back-thinned CCD detector, USB powered, high-speed USB3.0 and ETH interface, incl. AvaSoft-Basic, USB interface cable. Specify grating, wavelength range and options

Options

-RS	• Replaceable slit
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, 200 or 500 µm. Only available for AvaSpec-ULS2048CL-EVO-RS
SLIT-XX-RS-FCPC	• As SLIT-XX-RS, but with FC/PC connector
OSF-YYY	• Order-sorting filter for reduction of second-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, recommended with OSF-305
OSC-UA	• Order-sorting coating with 350 and 600 nm linear variable filter for UA, VA gratings
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings
-FCPC	• FC/PC fiber-optic connector

AvaSpec-ULS2048LTEC SensLine Thermoelectrically Cooled Fiber-Optic Spectrometer

Long integration times in general are equivalent to higher dark noise. Avantes' thermoelectrically cooled (TEC) spectrometer systems overcome this problem by cooling the detector. These instruments are equipped with triple-stage cooling, keeping your detector at an 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.

AvaSpec-ULS2048LTEC

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 = -30°C versus ambient (optimal setting: 5°C)
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

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	600-1100	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-ULS2048LTEC

	Slit size (µm)					
Grating (lines/mm)	**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*	026-0.34*	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, recommended with OSF-305
OSC-UA	• Order-sorting coating with 350 and 600 nm long-pass filter for UA, VA gratings
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings
-FCPC	• FC/PC fiber optic connector
- RS	• Replaceable slit (recommended)

AvaSpec-NIR256/512-1.7-EVO
NIRLine Near-Infrared Fiber-Optic Spectrometer

For measurements in the near infrared range out to 1.7 µm, Avantes offers a new series of uncooled spectrometer configurations. The AvaSpec-NIR256-1.7-EVO and the AvaSpec-NIR512-1.7-EVO offer the same high sensitivity optical bench with the next generation of electronics. Both instruments deliver the same exceptional performance specifications such as a sample speed of only 0.53 ms/scan and integration times as fast as 20 µs, as the Avantes instruments you have come to trust.

For applications where resolution is key, or more datapoints for modelling is required, the 512 pixel detector will be the best choice.

The AvaSpec-NIR256/512-1.7-EVO spectrometers pair the same trusted InGaAs array detectors with our ultra low-noise electronics board featuring USB3 and Giga-Ethernet connection port. Digital and analog I/O ports enable external triggering and control over the shutter and pulsed lightsources and choose from two distinct software-controlled gain-setting modes, high-sensitivity mode (HS, default) and the low-noise (LN) mode.

These affordable uncooled instruments are USB powered and are available with a choice of four gratings and replaceable slits to match the bandwith and requirements fitting your application.

AvaSpec-NIR256-1.7-EVO

Technical Data

Spectrometer	AvaSpec-NIR256-1.7-EVO	AvaSpec-NIR512-1.7-EVO
Optical Bench	Symmetrical Czerny-Turner, 50 mm focal length,	
Wavelength range	900-1750 nm	
Resolution (slit & grating dependent)	2-50 nm	
Stray-light	<1%	
Sensitivity HS in counts /µW per ms	8,200,000 (integral 1000-1750 nm)	3,880,000 (integral 1000-1750 nm)
Dynamic Range HS	6000:1	
Integration time HS	10 µs–500 ms	
Signal/Noise HS	1900:1	
Sensitivity LN in counts /µW per ms	469,000 (integral 1000-1750 nm)	222,000 (integral 1000-1750 nm)
Dynamic Range LN	9000:1	
Integration time LN	10 µs–10 s	
Signal/Noise LN	5000:1	
Detector	InGaAs linear array, 256 pixels, 50 µm x 500 µm	InGaAs linear array, 512 pixels, 25 µm x 500 µm
AD converter	16-bit, 500 kHz	16-bit, 500 kHz
Interface	USB3.0 high speed, 5 Gbps, Gigabit Ethernet 1 Gbps	
Sample speed with store to RAM	0.53 ms/scan	
Data transfer speed	0.53 ms/scan (USB3)	
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital IO bi-directional, trigger, synchronization, strobe, laser	
Power supply	Default USB power, 600 mA or external 12VDC, 320mA (4W)	
Dimensions, weight	185 x 100 x 184 mm, 2.7 kg	

Grating Selection Table for AvaSpec-NIR256/512-1.7-EVO

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

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

	Slit size (µm)				
Grating (lines/mm)	**25***	**50**	**100**	**200**	**500**
200	6	8	12	22	50
400	2.5	3	6	12	25
600	n.a.	2	4	8	18

* only for AvaSpec-NIR512

Ordering Information

AvaSpec-NIR256-1.7-EVO	• Fiber-optic Spectrometer, 50 mm AvaBench, 256 pixel InGaAs detector, high-speed USB3 and ETH interface, with replaceable slit, incl. AvaSoft-Basic, USB interface cable, OSF-850/1000-3. Specify grating, wavelength range and slit
AvaSpec-NIR512-1.7-EVO	• Fiber-optic Spectrometer, 50 mm AvaBench, 512 pixel InGaAs detector, high-speed USB3 and ETH interface, with replaceable slit, incl. AvaSoft-Basic, USB interface cable, OSF-850/1000-3. Specify grating, wavelength range and slit
PS-12V/2.08A	• External power supply, needed for operation in ETH mode

Options

SLIT-XX-RS	• Replaceable slit with SMA connector, specify slit size XX=25*, 50, 100 or 200 µm
SLIT-XX-RS-FCPC	• as SLIT-XX-RS, but with FC/PC connector

** only for AvaSpec-NIR512*

Did you know the AvaSpec-NIR256-1.7-EVO has a little brother? Our new AvaSpec-Mini-NIR uses the same detector as the AvaSpec-NIR256-1.7-EVO, but in a much smaller package! This makes the AvaSpec-Mini-NIR perfect for OEM use and integration into handheld devices.
Check it out on page 31!

AVANTES
MEMBER OF THE NYNOMIC GROUP

AvaSpec-NIR256/512-1.7-HSC-EVO NIRLine Cooled Near-Infrared Fiber-Optic Spectrometer

For measurements in the near infrared range out to 1.7 µm, Avantes offers a new series of cooled spectrometer configurations. The AvaSpec-NIR256-1.7-HSC-EVO and the AvaSpec-NIR512-1.7-HSC-EVO offer the high sensitivity 100mm optical bench (HSC) with the next generation of electronics (EVO). Both instruments deliver exceptional performance specifications such as a high sample speed and integration times as fast as 20 µs, as the Avantes instruments you have come to trust.

For applications where resolution is key, or more datapoints for modelling is required, the 512 pixel detector will be the best choice.

The AvaSpec-NIR256/512-1.7-HSC-EVO spectrometers pair the same trusted InGaAs array detectors with our ultra low-noise electronics board featuring USB3 and Giga-Ethernet connection port. The instruments are standard equiped with a Replaceable Slit. Digital and analog I/O ports enable external triggering and control over the shutter and pulsed lightsources and choose from two distinct software-controlled gain-setting modes, high-sensitivity mode (HS, default) and the low-noise (LN) mode.

Cooling ensures optimal noise condition even at longer integration times. All NIR-1.7 instruments are available with a choice of four different gratings, making it possible to choose the bandwidth fitting your application.

AvaSpec-NIR256-1.7-HSC-EVO

Technical Data

Spectrometer	AvaSpec-NIR256-1.7-HSC-EVO	AvaSpec-NIR512-1.7-HSC-EVO
Optical Bench	Symmetrical Czerny-Turner, 100 mm focal length, 1 stage TE-cooled	
Wavelength range	900-1750 nm	
Resolution (slit & grating dependent)	1.9-32 nm	1.7-32 nm
Stray-light	<1%	
Sensitivity HS in counts /µW per ms	4.800.000 (integral 1000-1750 nm)	2.500.000 (integral 1000-1750 nm)
Dynamic Range HS	4900:1	
Signal/Noise HS	1900:1	
Integration time HS	20 µs–500ms	
Sensitivity LN in counts /µW per ms	160.000 (integral 1000-1750 nm)	83.000 (integral 1000-1750 nm)
Dynamic Range LN	7600:1	
Signal/Noise LN	5000:1	
Integration time LN	20 µs–20 s	
Detector	TE-cooled InGaAs linear array, 256 pixels, 50 µm x 500 µm	TE-cooled InGaAs linear array, 512 pixels, 25 µm x 500 µm
AD converter	16-bit, 1,2 MHz	16-bit, 1,2 MHz
Interface	USB3.0 high speed, 5 Gbps, Gigabit Ethernet 1 Gbps	
Sample speed with store to RAM	0.13 ms/scan	0.24 ms/scan
Data transfer speed	0.4 ms/scan (USB3)	0.53 ms/scan (USB3)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital IO bi-directional, trigger, synchronization, strobe, laser	
Power supply	12VDC, 12W	
Operating temperature	0-40ºC	
Cooling	25ºC versus ambient	
Dimensions, weight	185 x 160 x 184 mm, 3.6 kg	

Grating Selection Table for AvaSpec-NIR256/512-1.7-HSC-EVO

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
		256/512			
NIR	900-1700	790	150	1250	NIR150-1.2
NIR	900-1700	380-310*	300	1200	NIR300-1.2
NIR	900-1700	262-230*	400	1200	NIR400-1.2
NIR	960-1700	262-230*	400	1600	NIR400-1.6

*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 (FWHM in nm) for AvaSpec-NIR256/512-1.7 HSC- EVO

	Slit size (µm)				
Grating (lines/mm)	**25***	**50**	**100**	**200**	**500**
150	4.0	5.7	7.0	12.8	32
300	1.8	2.3	3.0	4.0	10
400	1.7	1.9	2.5	3.3	8.3

* only for AvaSpec-NIR512

Ordering Information

AvaSpec-NIR256-1.7-HSC-EVO	• Fiber-optic Spectrometer, 100 mm AvaBench, 256 pixel InGaAs detector with 1-stage TE cooling, high-speed USB3 and ETH interface with replaceable slit, incl. AvaSoft-Basic, USB interface cable, OSF-850/1000-3. Specify grating, wavelength range and slit.
AvaSpec-NIR512-1.7-HSC-EVO	• Fiber-optic Spectrometer, 100 mm AvaBench, 512 pixel InGaAs detector with 1-stage TE cooling, high-speed USB3 and ETH interface with replaceable slit, incl. AvaSoft-Basic, USB interface cable, OSF-850/1000-3 Specify grating, wavelength range and slit.

Options

SLIT-XX-RS	• Replaceable slit with SMA connector, specify slit size XX=25*, 50, 100 ,200 or 500 µm
SLIT-XX-RS-FCPC	• as SLIT-XX-RS, but with FC/PC connector

** only for AvaSpec-NIR512*

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

AvaSpec-NIR256/512-2.5-HSC-EVO
NIRLine Near-infrared Fiber-Optic Spectrometer

AvaSpec-NIR256-2.5-HSC-EVO

The new and improved versions of our NIR spectrometers offer more sensitivity, less weight and less size. They are based on a 100mm optical bench with a NA of 0.13 offering optimal balance between resolution and sensitivity.

The 2.5-HSC series feature 256 or 512 pixel InGaAs detectors and are available in multiple configurations. These instruments are perfect for grain, corn, wheat, soya, polymers but also for medical uses, process monitoring and other analysis. The 256 pixel detectors offer best sensitivity for most applications.

For applications where resolution is key, or more datapoints for modelling is required, the 512 pixel detector will be the best choice.

Also available on the –HSC is the userselectable 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 lowlight conditions. Analog and digital IO ports enable external triggering and control of shuttered and pulsed light sources from the AvaLight series.

The EVO instruments use the AS7010 electronics board offering USB3 (10 times faster than USB2), Gigabit Ethernet and better signal processing.

Technical Data

Spectrometer platform	AvaSpec-NIR256-2.5-HSC-EVO	AvaSpec-NIR512-2.5-HSC-EVO
Optical Bench	TE-cooled Symmetrical Czerny Turner, 100 mm focal length	
Wavelenght Range	1000-2500 nm	
Resolution (slit & grating dependent)	4.4-85.0 nm	2.6-85.0 nm
Pixel Dispersion (with NIR 075-1.7 grating)	6.2 nm	3.1 nm
Stray-light	<1.0%	
Sensitivity HS in counts / µW per ms (1000-2500 nm)	990,000	480,000
Signal/Noise HS	1800:1	1900:1
Integration time HS	10 µs-5 ms	
Sensitivity LN in counts / uW per ms (1000-2500nm)	55,000	26,600
Signal/Noise LN	4000:1	3700:1
Integration time LN	10 µs-100 ms	
Detector	inGaAs linear array with 2-stage TE-cooling, 256 pixel	inGaAs linear array with 2-stage TE-cooling, 512 pixel
Pixel size (WxH)	50 x 250 µm	25 x 250 µm
AD converter	16 bit, 500kHz	
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet 1 Gbps	
Sample speed with on-board averiging	0.54 ms/scan (USB3)	
Data transfer speed	1.11 ms/scan (USB3)	
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital bi-directional, trigger, sync, strobe, laser	
Power supply	12 V, 40W	
Operating Temperature range	0-40ºC	
Cooling	45ºC versus ambient	
Dimensions, weight	185 x 145 x 185 mm, 3.5 kg	

Grating Selection Table for AvaSpec-NIR 256/512-2.5-HSC-EVO

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
NIR	1000-2500	1500	75	1700	NIR075-1.7
NIR	1350-2500	1173-1150*	100	2500	NIR100-2.5
NIR	1000-2500	750-660*	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-NIR256/512-2.5-HSC-EVO

	Slit size (µm)				
Grating (lines/mm)	**25***	**50**	**100**	**200**	**500**
75	8.9	12.9	16.0	33.9	84.5
100	7.2	9.5	12.0	20.0	50.0
150	4.0	5.7	7.0	12.8	32.0
200	2.6	4.4	5.2	9.3	23.3

** Only for AvaSpec-NIR 512*

Ordering Information

AvaSpec-NIR256-2.5-HSC-EVO	• NIR Spectrometer, 100 mm Avabench, 256 pixel InGaAs detector 2stage TEC, high-speed USB 3.0 and ETH interface, incl. AvaSoft-Basic, USB cable, specify OSF-1000, NIR grating and wavelength range and Slit-xx-RS
AvaSpec-NIR512-2.5-HSC-EVO	• NIR Spectrometer, 100 mm Avabench, 512 pixel InGaAs detector 2stage TEC, high-speed USB 3.0 and ETH interface, incl. AvaSoft-Basic, USB cable, specify OSF-1000, NIR grating and wavelength range and Slit-xx-RS

Options

SLIT-XX-RS	• Slit size, please specify XX = 25, 50, 100, 200 or 500 µm

AvaSpec Dual-Channel Fiber-Optic Spectrometer

AvaSpec-ULS2048CL-2-EVO

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 or USB3.0/ETH 2 x DB26 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 (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 (ULS2048/ULS3648/ULS2048L/ULS2048XL), grating, wavelength range and options.
AvaSpec-EEEE-2-EVO	• Dual-channel AvaSpec-EVO Fiber-optic Spectrometer with 2 channels with the same detector in one housing, including synchronization cable. For both channels specify Detector type EEEE (ULS2048CL/ULS4096CL), grating, wavelength range and options.

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. For our USB2 version all channels are connected to the computer through a single USB2-cable.

For the EVO series a USB3 and a Ethernet version is available.
The Ethernet version (ETH) supports standard 4 channels. With the additional hub installed, it can handle up to 10 channels.

Benefits:

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

AVS-RACKMOUNT

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 (ULS2048/ULS3648/ULS2048L/ULS2048XL/NIR256/512), grating, wavelength range and options. Desktop/Rack-mount needs to be ordered separately
AVS-DESKTOP-USB3	• Desktop for USB3 platform multichannel AvaSpec-EVO, incl. channel synchronization, USB3-hub and 100-240VAC power supply, supports max. 4 Rack-mount spectrometer units.
AVS-DESKTOP-ETH	• Desktop for ETH platform multichannel AvaSpec-EVO, incl. channel synchronization, ETH-hub and 100-240VAC power supply, supports max. 4 Rack-mount spectrometer units.
AVS-RACKMOUNT-EVO-USB3	• 19" Rackmount for USB3 platform multichannel AvaSpec-EVO, including channel synchronization, USB3-hub, one DB26-IO connector and 100-240VAC power supply, supports max 10 rackmount unit spectrometer channels.
AVS-RACKMOUNT-EVO-ETH	• 19" Rackmount for ETH platform multichannel, including channel synchronization, 4 channel ETH-hub, one DB26-IO connector and 100-240VAC power supply, supports max. 10 rackmount unit spectrometer channels (needs AVS-RM-ADDON-5-10ETH).
AVS-RM-ADDON-5-10ETH	• Extra Industrial Hub for extension of AVS-RACKMOUNT-EVO-ETH to 5-10 channels
AvaSpec-EEEE-EVO-RM	• Rack-mount EVO Fiber-optic Spectrometer, incl. AvaSoft-Basic software, USB cable and sync cable, specify detector type EEEE (ULS2048CL/ULS4096CL/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.

Avantes Raman Bundles

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.

AvaRaman Bundle

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 occure (Integration time longer than 5 seconds) the thermo-electric-cooled (TEC) spectrometer is recommended. This is added in the Ava-Raman-B.
If very weak signals possibly together with fluorescence background the Ava-Raman-D using our new AvaSpec-HERO is recommended (Higher quantum efficiency in NIR and better signal to noise performance).

Ordering Information

AvaRaman-A *For basic applications.* *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 *For demanding applications.* *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-ULS2048LTEC-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-D *For the most challenging applications.* *This bundle uses the AvaSpec-Hero for detection. The High end cooled back-thinned detector, low-noise electronics and optical bench with high Numerical Aperture,* *results in excellent Signal to Noise and Dynamic Range*	• Replaces AvaRaman-C • Range : 100 cm-1 - 3000 cm-1 • Resolution: 10 cm-1 • Spectrometer based on an AvaSpec-HS1024x58TEC-EVO set for (788-1020nm), slit-25, FC-PC connector, replaceable. • Also including: AvaLaser785 (incl. probe) AvaRaman software: Panorama Light

Options

Ava-Raman-SH-785 Bundle	Light tight cuvette holder for Use with Raman probe of AvaLaser785 used with the Ava-Raman A/B/D bundles. Incl. adjustable gold coated mirror for signal collection
Ava-Raman-XYZ-785 Bundle	Manually Adjustable X-Y-Z Stage for use with Raman probe of AvaLaser785 used with the Ava-Raman A/B/D bundles

AvaRaman Fiber-Optic Raman System

AvaRaman

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 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.

Now the AvaSpec-HERO is integrated in a Raman system as well.
Because of the lower dark noise (only 2 counts) you'll have a much better performance. The superior Signal to Noise ratio (800:1) is important when you're dealing with small signals, which is typically the case in raman,. Also when small process changes need to be monitored in time, the HERO is superior as the small change process will lead to a small change in signal which can be clearly discriminated by the excellent SN ratio. The higher NA optical bench results in a better sensitivity (Twice as high as the ULS2048L). This will lead to more photons impinging on the detector. Temperature control is very important in raman measurements to create stable results in time. Cooling to -10 °C for lowest noise performance and very stable cooling control (+-0.1 °C accuracy) is delivering accurate and reproducible results.
This all together provides you with a combination that is suitable for the more demanding applications (low light, better signal to noise, low noise ratio).

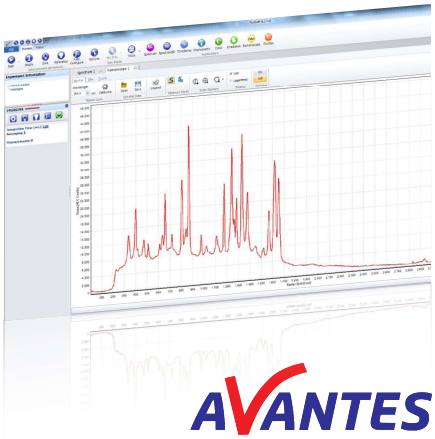
All AvaRaman systems are equipped with cooling systems. Cooling the detector down to -35°C cooling versus ambient, reduces the noise figures by a factor 2-3, enabling the usage of longer integration times to enhance the detection of small signals. All AvaRaman systems are delivered with special AvaSoft-Raman 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-FULL/Raman and Panorama-Pro, please check the software pages on the website.

Technical Data

	AvaRaman-532TEC	AvaRaman-532HERO-EVO	AvaRaman-785TEC
	Cooled	Cooled	Cooled
Signal to noise Ratio	200:1 for Benzene	800:1 for Benzene	300:1 for Benzene
Resolution*	10 cm^{-1}	10 cm^{-1}	7 cm^{-1}
Spectrometer	AvaSpec-ULS2048L-TEC with grating NC (535-752 nm), slit-25, DCL-UV/VIS TE-cooled	AvaSpec-HERO with HSC1200-0.75 (535-660nm), slit-25-FCPC, TE-cooled, Standard: replaceable slit	AvaSpec-ULS2048L-TEC with grating SI (785-1080 nm), slit-25, DCL-UV/VIS-200 TE-cooled
Raman Shift	100-5400 cm^{-1}	100-3650 cm^{-1}	100-3500 cm^{-1}
Laser output	532 nm, 50 mW	532 nm, 50 mW	785 nm, 500 mW, Class 3b
Laser Wavelength	532 nm	532 nm	785 nm
Laser Bandwidth	< 0.1 nm	< 0.1 nm	< 0.2 nm

** typical resolution: higher resolution possible on request*



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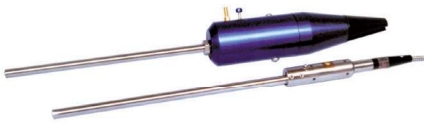
AvaRaman Probes

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 80ºC. Manual shutter included, 1.5 m fibers.
Specify XXX=excitation wavelength, laser and spectrometer connection type.

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 80ºC.
Specify XXX=excitation wavelength, laser and spectrometer connection type.

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 200ºC.
Specify XXX=excitation wavelength, laser and spectrometer connection type.



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 500ºC and 3000psi.
Specify XXX=excitation wavelength, laser and spectrometer connection type.

Ordering Information

AvaRaman-532TEC-USB2	Consisting of following elements: • Solid state 50 mW laser 532 nm, FWHM 0.1 nm, FC/PC connector • TE-cooled AvaSpec-ULS2048L-TEC-USB2 Spectrometer with 1200 lines/mm grating set 535-752 nm, 25 µm slit (SMA), DCL-UV/VIS-200 • AvaSoft-Raman software for the AvaRaman system, AvaRaman-GL-532 laser safety goggles
AvaRaman-532HERO-EVO	Consisting of following elements: • Solid state 50 mW laser 532 nm, FWHM 0.1 nm, FC/PC Connector • TE-cooled AvaSpec-HERO Spectrometer with 1200 lines/mm grating set for 535-660 nm, 25 µm slit (FC/PC) (replaceable) • AvaSoft-Raman software for the AvaRaman system, AvaRaman-GL-532 laser safety goggles
AvaRaman-785TEC-USB2	Consisting of following elements: • Solid state 500 mW laser 785 nm, FWHM 0.2 nm, FC/PC connector • TE-cooled AvaSpec-ULS2048L-TEC-USB2 Spectrometer with 830 lines/mm grating set 785-1080 nm, 25 µm slit (SMA), DCL-UV/VIS-200 • AvaSoft-Raman software for the AvaRaman system, AvaRaman-GL-785 laser safety goggles

Different Raman probes available, please see table above

Other Accessories

AvaRaman-SH-3/8"	• Rugged cuvette holder for secure positioning of 3/8" Raman probes
AvaRaman-SH-1/2"	• Rugged cuvette holder for secure positioning of ½" Raman probes
AvaRaman-Calibrationtile	• PTFE White tile in holder for 3/8" Raman probe

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 irradiance NIST traceable calibrations can be offered. Irradiance calibrations (µW/cm^2) are normally performed on a system with a fiber-optic cable and a cosine corrector or integrating sphere.

The irradiance 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 field 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, FC/PC connector recommended, incl. NL-calibration, needs AvaSoft-Full, AvaSoft-IRRAD and presolarized fibers (PRESOL)
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 (1100-2400 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, FC/PC connector recommended, incl. NL-calibration, needs AvaSoft-Full, AvaSoft-IRRAD and presolarized fibers (PRESOL) (calibration standardly performed without stray-light correction algorithm if applicable)

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
- 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 AvaSpec-DLL software development kit, enabling full control over the spectrometer in customer-designed software.

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 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 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 ºC
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

Detector Types

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

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 powerfull 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 convertors 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 Data

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 µs – 10 minutes (detector dependent)
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 ºC
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

Detector Types

- ILX511	for Sony ILX511B detectors (AvaSpec-ULS2048L-EVO)
- HAM11639	for Hamamatsu S11639 CMOS detectors (AvaSpec-ULS2048CL-EVO)
- HAM13496	for Hamamatsu S13496 CMOS detectors (AvaSpec-ULS4096CL-EVO)
- HAM2048XL	for Hamamatsu S11155 detectors (AvaSpec-ULS/HS2048XL-EVO), extra pcb incl.
- HAM1024x58	for Hamamatsu S7031 detectors (AvaSpec-HERO), extra pcb incl.
- HAM2048x64	for Hamamatsu 11071 or 11850 (AvaSpec-ULS2048x64(TEC)-EVO), extra pcb incl.
- NIR	for InGaAs NIR detectors (Specify model), extra pcb incl.

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-75-ULS (used in both StarLine and SensLine), AvaBench-75-MN (CompactLine), AvaBench-75-ULSTEC (SensLine) and AvaBench-37.5-HS and AvaBench-100-HSC (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.

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.

AvaBench-75-ULS

Technical Data

	AvaBench-75-ULS	AvaBench-75-MN	AvaBench-75-ULSTEC	AvaBench-37.5-HS	AvaBench-100-HSC
Implemented in	AvaSpec-ULS2048/3648/2048L/2048CL/4096CL 2048XL/2048x64(TEC)	AvaSpec-Mini2048CL /4096CL	AvaSpec-ULS2048LTEC	AvaSpec-HS1024x58 /2048XL	AvaSpec-HERO
Focal length	75 mm	75 mm	75 mm	37.5 mm asym.	100 mm
Numerical aperture	0.07	0.07	0.07	0.22	0.13
Wavelength range	200-1160 nm	200-1100 nm	200-1100 nm	200-1160 nm	200-1160 nm
Resolution (FWHM)	0.05-20 nm	0.05-20 nm	0.05-20 nm	1.2-20 nm	0.18-5.50 nm
Stray-light	0.04-0.1%	0.2-1%	0.04-0.1%	<1%	<1%
Gratings	Different	Different	Different	Different	Different
Slits	10, 25, 50, 100, 250, 500 µm	10, 25, 50, 100, 250, 500 µm	10, 25, 50, 100, 250, 500 µm	25, 50, 100, 200, 500 µm	25, 50, 100, 250, 500 µm
Detector	SONY 2048(L) / TOSHIBA 3648 /HAM 2048CL/4096CL 2048XL/2048x64	HAM 2048CL/4096CL	SONY 2048L	HAM 2048XL	HAM 1024x58
Detector lens	UV/VIS	UV/VIS-200	UV/VIS-200	n.a.	n.a.
Order-sorting filter	See options	See options	See options	See options	See options
Dimensions, weight	120 x 91 x 21 mm, 350 gr.	95 x 68 x 20 mm, 175 gr	120 x 91 x 62 mm, 760 gr.	95 x 152 x 42 mm, 722 gr	120 x 125 x 109 mm, 1500 gr

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

Ordering Information

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/U3	• OEM ultra-low stray-light optical bench, 75 mm focal length, 2048 pixel CCD detector. Specify grating, wavelength range and options.
AvaBench-75-ULS2048CL-U2/U3	• OEM ultra-low stray-light optical bench, 75 mm focal length, 2048 pixel CMOS detector. Specify grating, wavelength range and options.
AvaBench-75-ULS4096CL-U3	• OEM ultra-low stray-light optical bench, 75 mm focal length, 4096 pixel CMOS detector. Specify grating, wavelength range and options.
AvaBench-75-ULS2048XL-U2/U3	• 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-ULS2048x64-U3	• 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-ULS2048x64TEC-U3	• OEM ultra-low stray-light optical bench, 75 mm focal length, 2048x64 pixel back-thinned cooled CCD detector. Specify grating, wavelength range and options.
AvaBench-75-MN2048CL-U3	• OEM miniature optical bench, 75 mm focal length, 2048 pixel CMOS detector. Specify grating, wavelength range and options.
AvaBench-75-MN4096CL-U3	• OEM miniature optical bench, 75 mm focal length, 4096 pixel CMOS 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-37.5-HS2048XL-U2/U3	• OEM High-sensitivity optical bench, 37.5 mm focal length, 2048XL pixel back-thinned CCD detector. Specify grating, wavelength range and options.
AvaBench-100-HSC 1024x58TEC-U3	• OEM High-sensitivity optical bench, 100 mm focal length, 1024x58 pixel TE-cooled back-thinned CCD detector. Specify grating, wavelength range and options.

Gratings can only be changed by Avantes.
Therefore, it is important to 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 multi-channel (e.g. AvaSpec-Dual) or rack-mountable versions,
you can create one virtual spectrometer with high-resolution
and high bandwidth. Contact us for more information and advice!

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OEM spectrometer: AvaBench NIR Optical Bench

For OEM applications in the NIR range, Avantes 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-100TEC is developed for the NIR range from 1000-2500 nm with thermoelectric cooling. The AvaBench-100TEC supports two different TE-cooled detectors with 256 pixels and two TE-cooled detectors with 512 pixels. The 100 nm focal length optical bench provides the optimal balance between optical throughput and resolution. To keep the size as compact as possible, this bench features a unique folding mirror.
New in the NIR line of optical benches is the AvaBench-75-MN, offering a unique small form factor in the NIR range.

All AvaBench NIR optical benches have symmetrical Czerny-Turner designs with a fiber-optic entrance connector (standard SMA, other options available), collimating and a special designed focusing mirror and diffraction grating. A choice of different NIR gratings can be selected for all models.

Wavelength ranges, resolution tables, detector specifications and AvaBench options can be found on the pages 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 electronic 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 temparature sensor and power for the 2-stage Peltier cooling.

AvaBench-50

Technical Data

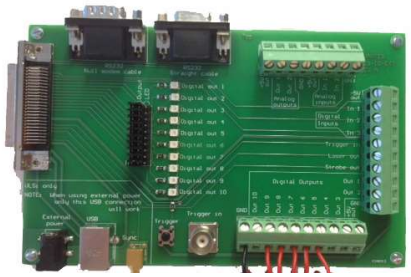
	AvaBench-50	AvaBench-75-MN	AvaBench-100TEC
Implemented in	AvaSpec-NIR256-1.7	AvaSpec-Mini-NIR	AvaSpec-NIR256-1.7TEC AvaSpec-NIR512-1.7TEC AvaSpec-NIR256-2.5-HSC-EVO AvaSpec-NIR512-2.5-HSC-EVO
Focal length	50 mm	75 mm	100 mm
Numerical aperture	0.24	0.07	0.14
Wavelength range	1000-1750 nm	900-1750 nm	1000-2500 nm
Resolution (FWHM)	2-50 nm	2-50 nm	1.5-90 nm
Stray-light	< 1%	< 1%	< 0.5%
Gratings	different	different	different
Slits	50, 100, 200, 500 µm	50, 100, 200, 500 µm	25, 50, 100, 250, 500 µm
Detector	HAM-NIR256-1.7	HAM-NIR256-1.7	SU-NIR256/512-1.7 HAM-NIR256-2.5 HAM-NIR512-2.5
TE Cooling	No	No	Yes
Order-sorting filter	OSF-850-3/OSF-1000-3	OSF-850-3/OSF-1000-3	OSF-1000-3 and OSC-NIR
Dimensions, weight	100 x 130 x 40 mm, 875 gr.	95 x 68 x 20 mm, 175 gr	185 x 145 x 185 mm, 3.5 kg.

Ordering Information

AvaBench-50-NIR256-1.7	• OEM optical bench, 50 mm focal length, 256 pixel InGaAs detector. Specify grating, wavelength range and slit, OSF-850-3 or OSF-1000-3.
AvaBench-Mini-NIR256-1.7	• OEM optical bench, 75 mm focal length, 256 pixel InGaAs detector. Specify grating, wavelength range and slit, OSF-850-3 or OSF-1000-3.
AvaBench-100-NIR256-1.7TEC	• OEM optical bench, 100 mm focal length, 256 pixel TE-cooled InGaAs detector. Specify grating, wavelength range and slit, OSF-850-3 or OSF-1000-3.
AvaBench-100-NIR512-1.7TEC	• OEM optical bench, 100 mm focal length, 512 pixel TE-cooled InGaAs detector. Specify grating, wavelength range and slit, OSF-850-3 or OSF-1000-3.
AvaBench-100-NIR256-2.5TEC	• OEM optical bench, 100 mm focal length, 256 pixel TE-cooled InGaAs detector 2.5 µm. Specify grating, wavelength range and slit, OSF-1000-3, OSC-NIR.
AvaBench-100-NIR512-2.5TEC	• OEM optical bench, 100 mm focal length, 512 pixel TE-cooled InGaAs detector 2.5 µm. Specify grating, wavelength range and slit, OSF-1000-3, OSC-NIR.

Developer Kits for Easy IO Access

Printed circuit board for AS5216 boards



Avantes Spectrometers feature great flexibility offering multiple Input / Output connections. These IO can be used with Avasoft 8 (Time Series) or with customized applications. The DEVKITs are intended to make life easier in the development-stage. Instead of fabricating or soldering a cable with the right connections now it is easy to connect using the screw terminals.

The AVS-DEVKIT-AS(C)5216 contains the PCB-IO-EXT-BES Printed Circuit Board. This board has several screw terminals for easy connectivity to the IO points, a BNC connector for the input trigger as well a push button for manual control. All outputs have a LED indicating their status (selectable with jumpers). Furthermore RS232 connectors are provided. For the ASC version a power, USB and SYNC connector are on the PCB. The PCB-IO-EXT-BES will be connected to the AvaSpec-ULS or AvaSpec-ULSi IO Connector with an interface cable.

Since the AS7010 and the AS5216 electronic boards share the same IO connections, the AVS-DEVKIT-AS5216 can also be used in combination with the AS7010.

The Developer Kit makes life easier in the development-stage. Connecting the screw terminals will enable you to get your application up and running in no-time!

Ordering Information

AVS-DEVKIT-AS5216	• Developer Kit consisting of: PCB-IO-EXT-BES Printed Circuit Board for connection to Avantes Spectrometers with AS5216 or AS7010 electronics boards, to easily control and connect signals to the IO connector. IC-IOEXT-DB26 connection cable to connect the board to DB26 connector.
Service-Mini-MKII-IO	• Service part: Set of mating connectors and wires for AvaSpec-MINI MKII IO connectors.(3 connectors/ 30 wires) This set consists: 3 x mating connector Wurth WTB series 665 010 113 322 and 30 x 150mm precrimped cable Wurth WTB series 665 010 130 115

OEM Spectrometer: Enclosures

For OEM (Original Equipment Manufacturer) customers, Avantes offers a line of enclosures for their spectrometers. There are multiple enclosures available for different combinations of AvaBenches and circuit boards.

AVS-HOUSING

AVS-HOUSING-EVO-ULS

AVS-HOUSING-DUAL

AVS-HOUSING-EVO-HSC

AVS-HOUSING-IND

AVS-HOUSING-DUAL-IND

AVS-HOUSING-HSC-OEM

AVS-HOUSING-NIR1.7-OEM

Ordering Information

AVS-HOUSING	• Aluminum housing to fit AvaBench-75 and AS-5216 board.
AVS-HOUSING-EVO-ULS	• Aluminum housing to fit AvaBench-75 and AS-7010 board.
AVS-HOUSING-DUAL	• Dual-channel aluminum housing to fit two AvaBench-75 and AS-5216/7010 boards.
AVS-HOUSING-EVO-HSC	• Aluminum housing to fit AvaBench-100 and AS-7010 board.
AVS-HOUSING-IND	• Neutral black aluminum housing to fit AvaBench-75 and AS-5216/7010 board with mounting ears
AVS-HOUSING-DUAL-IND	• Dual-channel neutral black aluminum housing to fit 2 AvaBench-75 and 2 AS-5216/7010 boards with mounting ears
AVS-HOUSING-HSC-OEM	• Stainless steel housing to fit AvaBench-100 and AS-7010 board.
AVS-HOUSING-NIR1.7-OEM	• Stainless steel housing to fit AvaBench-50 and AS-7010 board, with mounting ears.

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AvaSpec Spectrometer 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.

Interface cables

USB2/EVO 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
AvaLight-S/AvaLight-XE	IC-DB26-2	Interface cable AvaSpec-USB2/EVO 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/EVO platform to BNC plug External trigger, 2 m
External hardware trigger	IC-Extrig-USB2	Interface cable AvaSpec-USB2/EVO 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/EVO to External trigger pushbutton and AvaLight-S with shutter, 2 m
Other spectrometer	IC-COAX-SMB-0.25	Synchronization coax cable with 2 SMB connectors 0.25 m for AvaSpec-USB2/EVO platform