Embedded Spectrometer
SD1024X Series

With text display

With optional graphics display and keypad

Verity
INSTRUMENTS, INC.

Embedded Spectrometer SD1024X Series

Summary

SD2048XH™
- For demanding high resolution applications
- Scientific grade CCD
- Similar optics as SD1024XH

SD1024XH™
- For the most demanding applications
- Same as SD1024X, except:
  - Higher throughput optics
  - Lower system readout noise

SD1024X™
- For demanding applications
- Single or multi-fiber input
- Scientific grade CCD
- Low system readout noise

SD1024XM™
- For moderately demanding applications
- Single or multi-fiber input
- Mid-grade CCD
- Same optics as SD1024X

SD2048XM™
- For high resolution applications
- Single or multi-fiber input
- Mid-grade CCD
- Same optics as SD1024X

SD1024XL™
- For general purpose applications

SD2048XL™
- For high resolution applications
- Bright source emission required

Features and Benefits

- Does not require an applications computer for operation
  - » Minimizes problems associated with frequently changing computer components, peripherals, and operating systems
  - » Reduces space and cabling requirements
  - » Higher system reliability with integrated unit
- Modular approach: in event of a computer failure, only the chamber using the SD1024X Spectrometer is off-line; other chambers can continue in use.
- Windows™ 7 Embedded Operating System is more stable than other Windows non-embedded operating systems; Windows 7 to be supported until 2025.
- Monitor and Keyboard – the SD1024X supports direct connections to a keyboard via USB and monitor via a Mini DisplayPort™ Monitor Port
- SpectraView™ 7.2.00+ offers excellent functionality
- Optional Graphics Display with Keypad

Description

The SD1024X Series uses common electronics, application software and enclosures. The differences between the different spectrometer models are the charge coupled device (CCD), optical platform and embedded software parameters.

The **SD1024X** was designed for demanding semiconductor process applications. Its optical system employs a 1024-element, scientific-grade CCD array designed for multi-channel spectroscopy, offering high performance at a moderate cost. The advantages of the SD1024X include excellent ultraviolet (UV) response (down to 200nm), stability against degradation under UV exposure, high sensitivity, wide dynamic range and superior output linearity.

The **SD2048XH** is similar to the SD1024X. However, it uses a 2048-element high performance CCD, the “H” high optical throughput optics, a narrower slit, and reports spectral data in 0.25 nm increments.

The **SD1024XH** incorporates special high throughput optics and lower systematic noise as compared to the SD1024X. The optics used in the SD1024XH increase optical throughput by about 75%. The SD1024XH is recommended for applications that require maximum signal to noise, especially when measuring relatively low intensity signals (see performance data on next page).

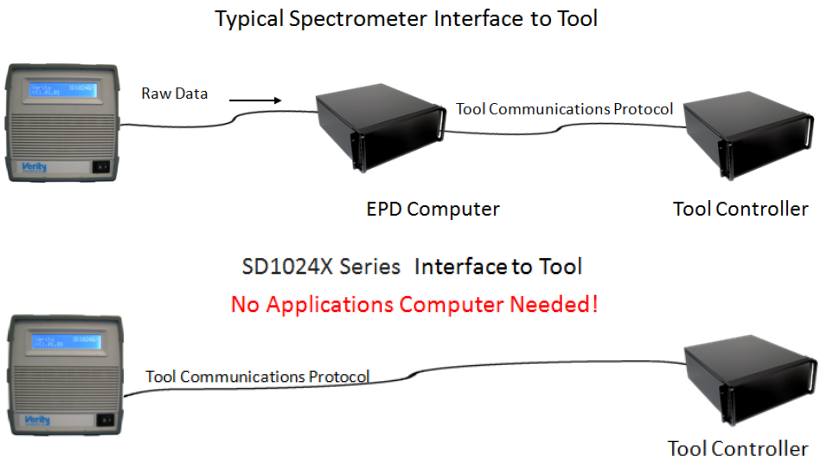
The **SD1024XM** is similar to the SD1024X. However, it uses a 2048 element mid-grade CCD. Since the CCD is 2 dimensional the SD1024XM can support multi fiber applications.

The **SD2048XM** is nearly identical to the SD1024XM, but reports spectral data in 0.25nm increments instead of 0.5nm readings as with the SD1024XM. Compared to the SD1024XM, the SD2048XM features a narrower inlet slit and modified embedded software parameters. Although the SD2048XM has better resolution than the SD1024XM, its sensitivity is significantly less.

The **SD1024XL** uses a general purpose CCD and was designed for general purpose semiconductor process applications.

The **SD2048XL** is nearly identical to the SD1024XL, but reports spectral data in 0.25nm increments instead of 0.5nm readings as with the SD1024X and SD1024XL. Compared to the SD1024XL, the SD2048XL features a narrower inlet slit and modified embedded software parameters. Although the SD2048XL has better resolution than the SD1024XL, its sensitivity is significantly less.

SD1024X Concept



Traditional Implementation

In a traditional implementation, the spectrometer is supported by an endpoint computer (EPD computer) which in turn is controlled by the tool controller.

SD1024X Implementation

Using the SD1024X, the EPD computer is no longer required. The SD1024X communicates directly with the tool controller, thereby eliminating the need for a dedicated endpoint computer.

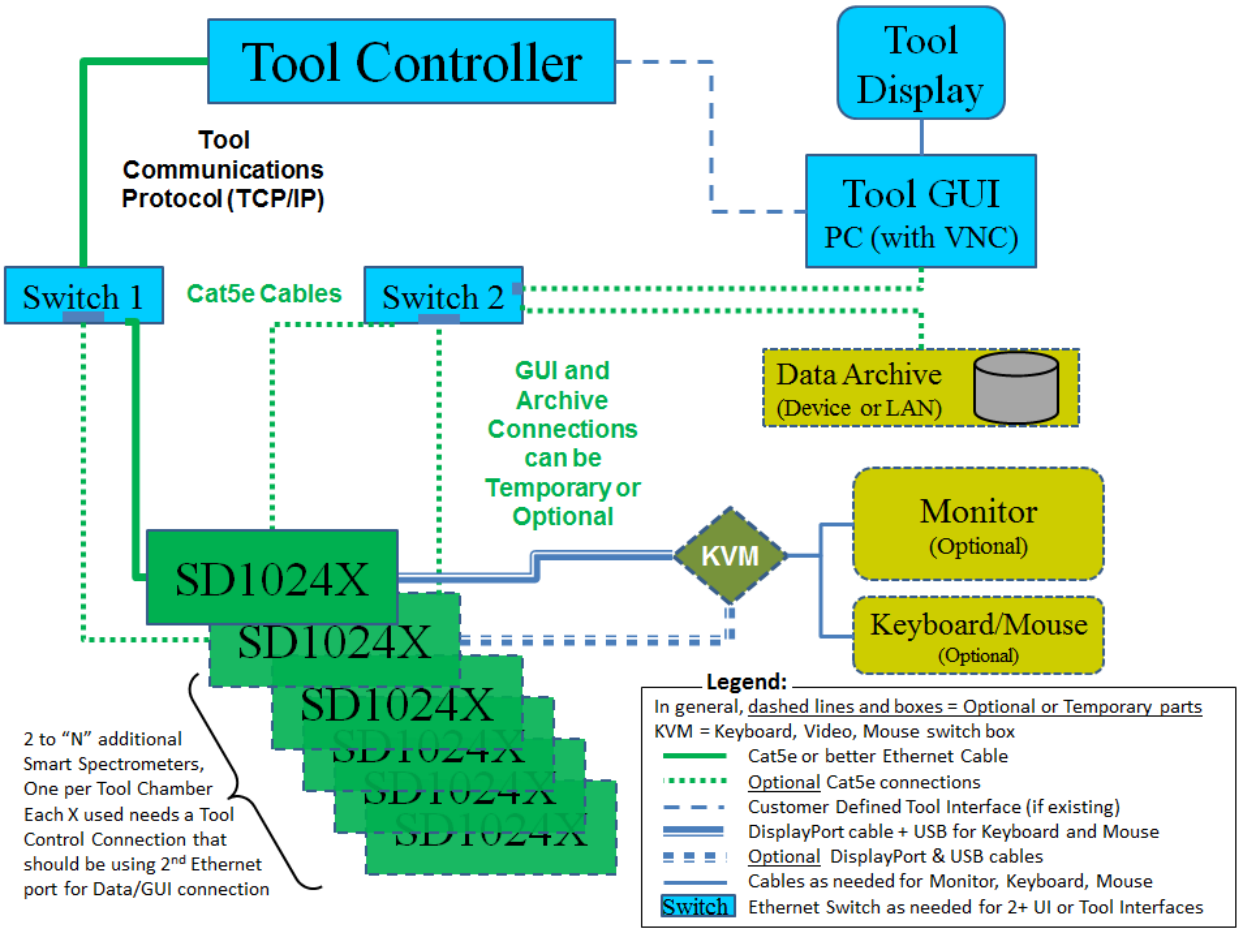
Detailed System Schematic

The SD1024X is accessed via VNC (Virtual Network Computing), alternatively a mouse and keyboard (with trackball) can be connected directly to the SD1024X. The tool GUI PC, or any other computer with an Ethernet connection to the SD1024X, with VNC loaded can be used to view and control the SpectraView software on the SD1024X. The SD1024X includes a simple LCD display for indicating instrument status. Optionally, a graphics display and keypad are available.

The SD1024X has two Ethernet ports to allow for control communications - one for a VNC connection and one for data archiving.

It is expected that an Ethernet switch might be used to allow for more than 2 connections to the SD1024X.

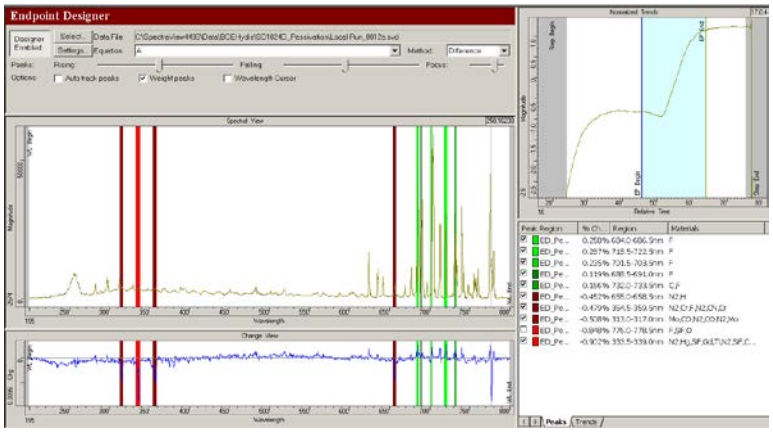
Tool Control is provided by an Ethernet or RS232 connection from the tool or chamber controller computer to the SD1024X. The SD1024X supports the Verity Communication Protocol over TCP/IP or RS232, as well as the flexible user- defined ASCII protocol over RS232. See Configuration Options on the last page of this brochure for RS232 and DIO option details.



SpectraView™ Software

The SD1024X runs SpectraView 7.2.00 or later version under a Windows 7 embedded operating system. This is the same version of SpectraView that can be used offline for reprocessing and recipe development. As compared to earlier versions of SpectraView, the 7.2.00 version provides many unique features including:

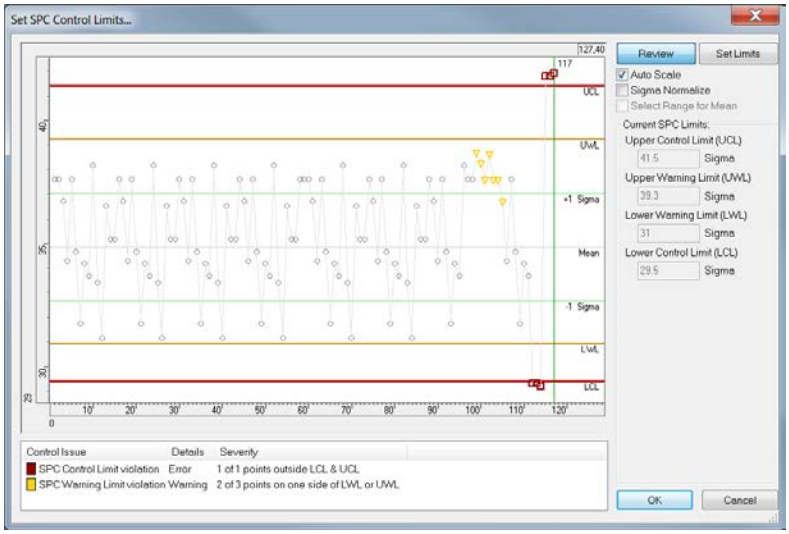
- EPdesigner™, for fast determination of endpoint trend lines
- Statistical Process Control support
- Support for broadband calibration
- New Smoothed Derivative function
- Auto Delete and Auto Archive enhancement
- "Save As" feature allowing to save a configuration into selected earlier formats for compatibility with older versions of SpectraView



EPdesigner

EPdesigner is used for the quick generation of endpoint trend lines. Once the "before endpoint" and "after endpoint" cursors are positioned, EPdesigner automatically generates an endpoint trend line based on the spectral changes between the after endpoint cursor and the before endpoint cursor. As part of this process, all endpoint regions and trend equations are generated.

In order to improve the endpoint trace signal to noise ratio, selected wavelengths that are used as part of the endpoint trend equation can be removed or added back. A materials database is included to confirm the selected peaks are consistent with the process chemistry.

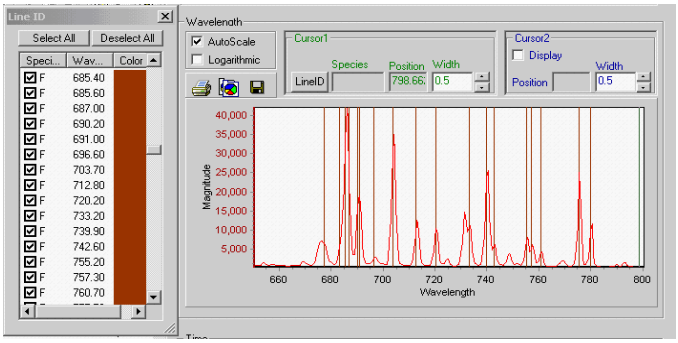


SPC Charting

SPC Charting allows the tracking of variables such as endpoint time over many wafer runs. Using SPC charting, Upper and Lower Control and Warning limits are entered and the selected data is tracked.

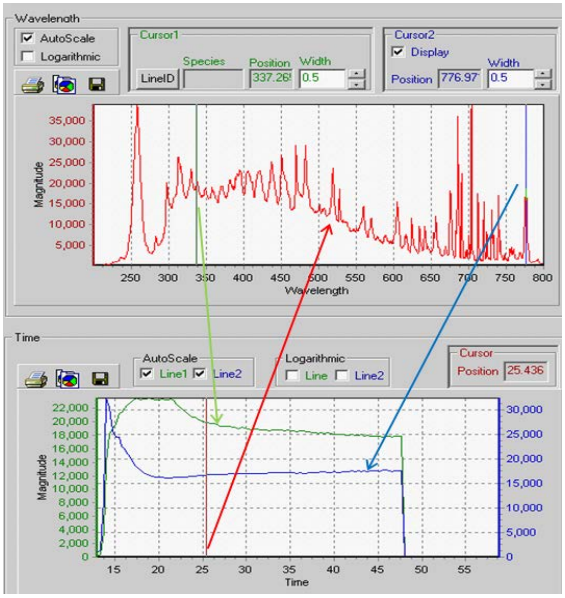
In the event of an excursion, the tool can be notified via Advanced Status Messaging (ASM) so that corrective action may be taken.

SpectraView™ Software



Line ID

Line ID functionality helps identify a gas species by examination of the optical spectrum at a wavelength or group of wavelengths. A default Library is included, and the user can define custom library entries.

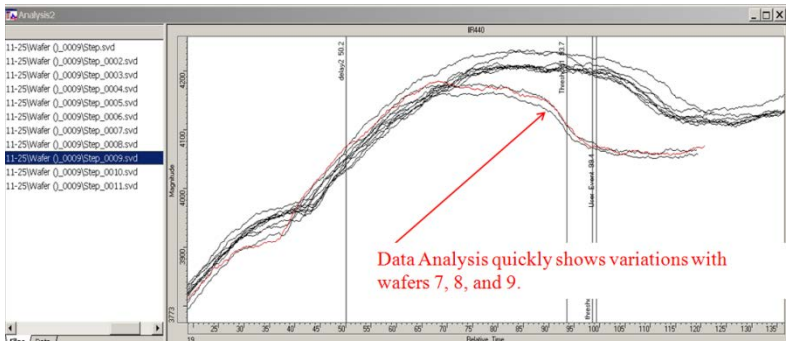


Spectral Viewer

Spectral Viewer consists of two windows, one of which is a spectral graph (intensity vs. wavelength at a selected point in time) and the other displays up to two trend lines (intensity vs. time for the selected trends).

This feature allows the user to view trend lines with dynamic updates based on the green and blue cursor's position in the spectral graph relative to wavelength.

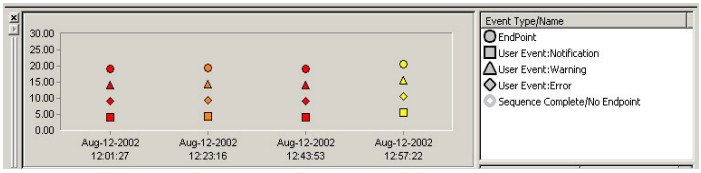
Additionally, if the red cursor in the trend graph is repositioned (relative to time), the spectral graph is immediately updated to reflect the spectrum at the point in time selected in the trend graph.



Data Analysis

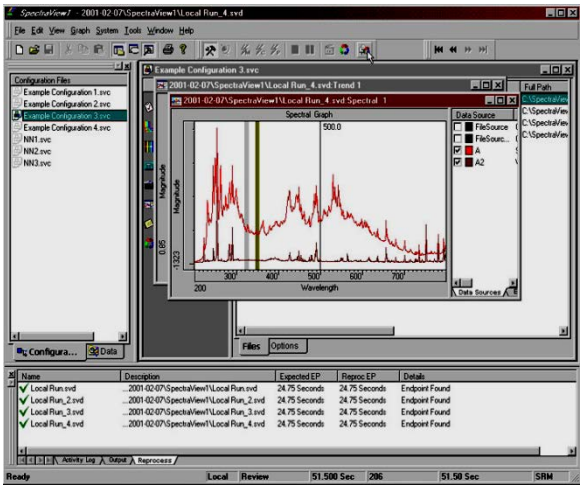
Data Analysis allows large numbers of files to be analyzed simultaneously. By contrasting results of data files against one another, a variety of equations and other parameters can be compared over time.

SpectraView™ Software



Event Statistics

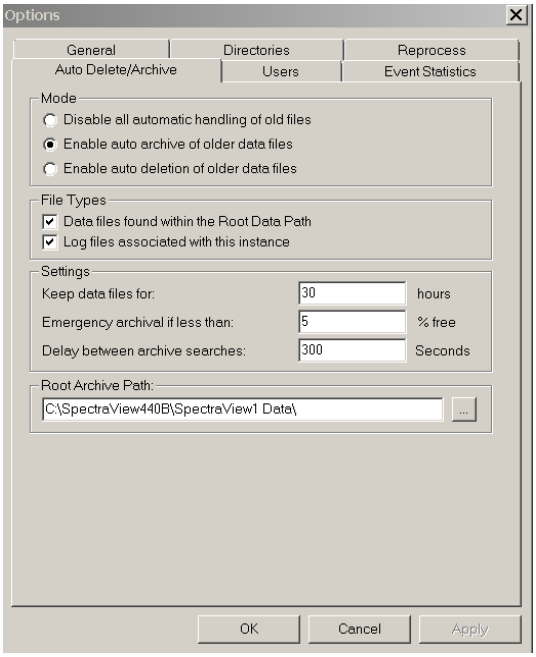
Event Statistics is useful for visually comparing multi-step processes on individual wafers over the entire production cycle.



Reprocess List

Reprocess List automatically tests several data files in a list against a configuration to see how each performs, relative to the selected configuration.

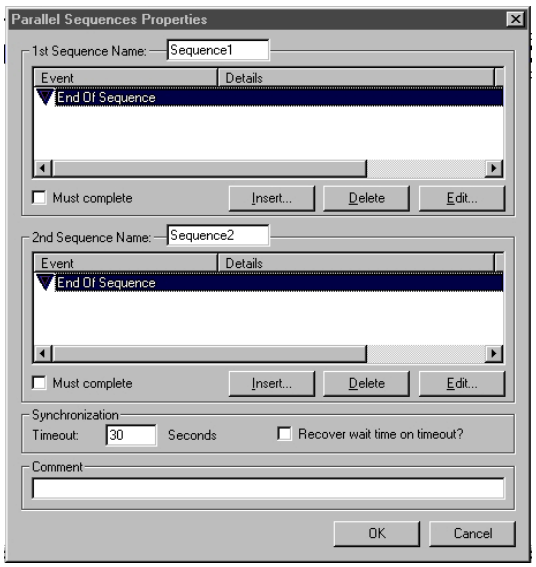
While reprocessing the data files, a notation is made in the form of a check mark or an X at the left of the file name, showing success or failure of the reprocess function.



Auto Delete/Auto Archive

Auto Delete/Auto Archive is a tool for managing and maintaining drive space. Auto Delete/Auto Archive operates in the background and is assigned the lowest CPU priority. This utility can be tailored to utilize extra disk space for archiving data, or to manage the most useful data files in a system with limited drive space.

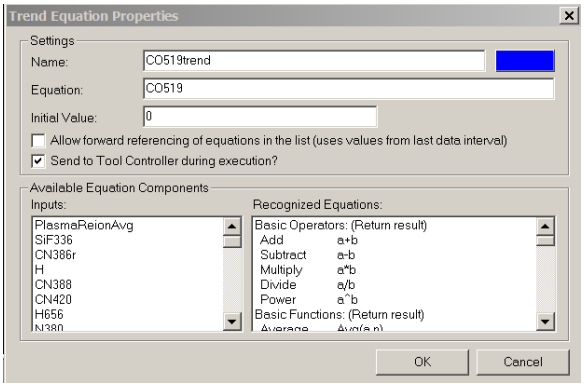
New in SpectraView version 6.0 is the addition of an “Auto-Copy” (not shown here) with delayed Auto Delete, which allows for immediate (when idle) copies of data and log files to be copied to a desired location. This new feature enables the prompt review of files without needing to access the tool computer.



Parallel Sequence

At any point in the list of sequence conditions, the user can insert a *Parallel Sequence* command to create two threads of concurrent processing. Each of these sequence threads will be executed concurrently after all the equations are completely processed following the receipt of each new spectrum.

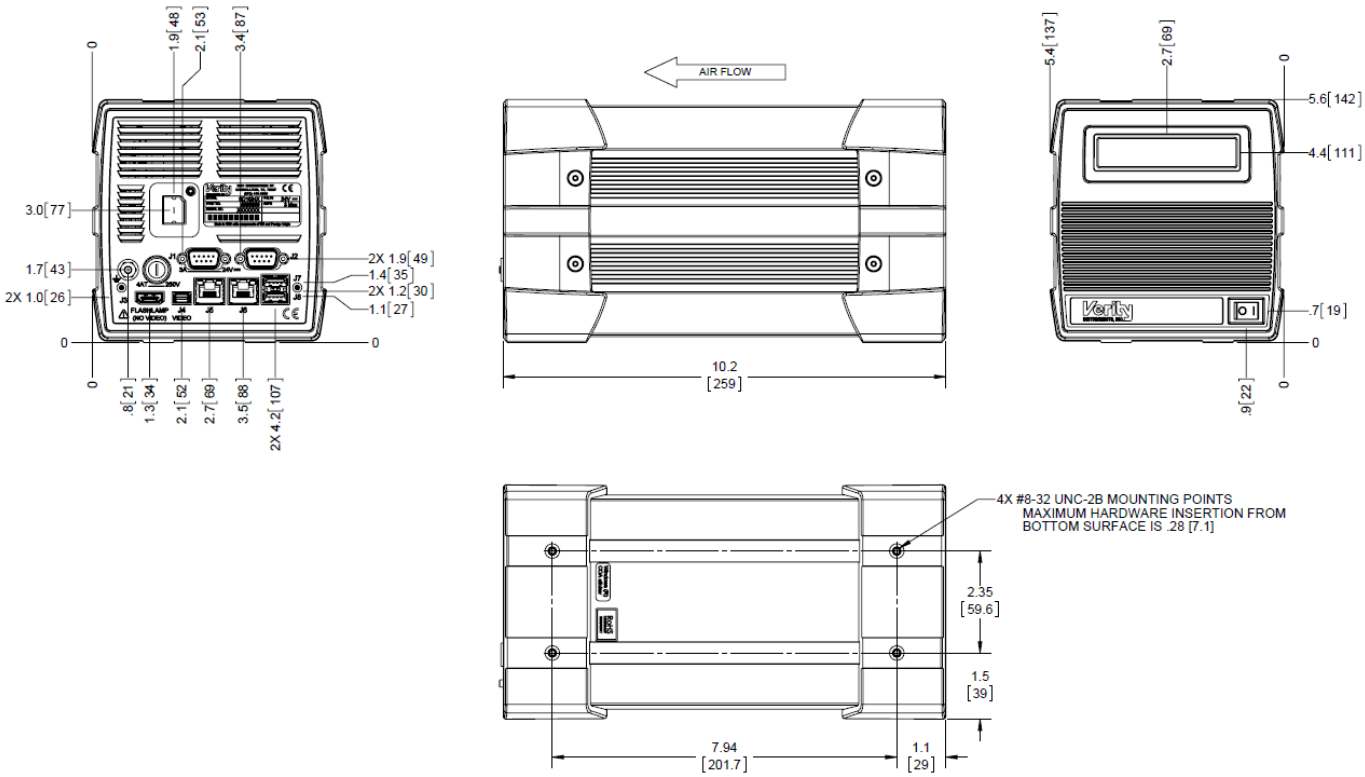
Parallel Sequences are used, for example, when it is desirable to monitor the chamber condition at the same time as monitoring for endpoint.



Trend Line Output

Using the Verity Standard Protocol (over Ethernet or RS232) or Verity ASCII Protocol (over RS232), selected trend lines can be sent to the tool controller. Of course, the receipt of this data must be planned for on the tool side.

Dimensions – SD1024X / SD1024XH/SD2048XH/SD1024XM/SD2048XM

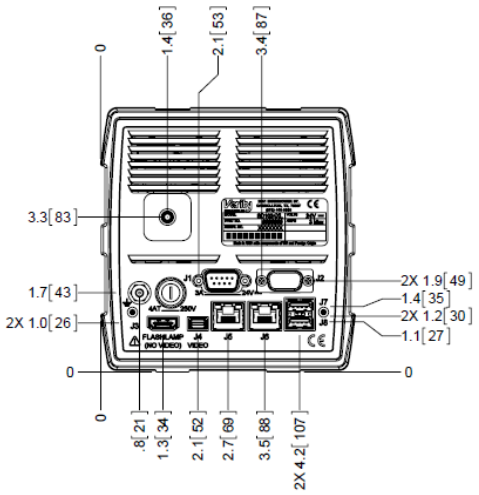


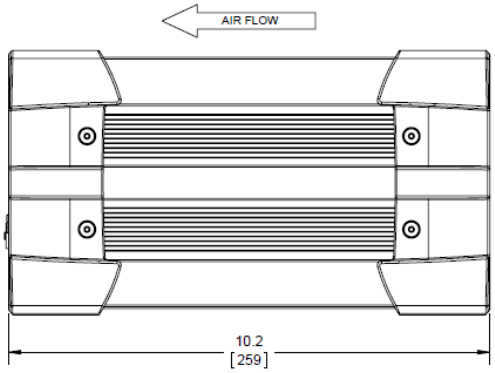
Rear Panel – SD1024X / SD1024XH/SD2048XH/SD1024XM/SD2048XM

With J2 configured for RS232 and Synchronization
(J2 is DB9 with external pins)

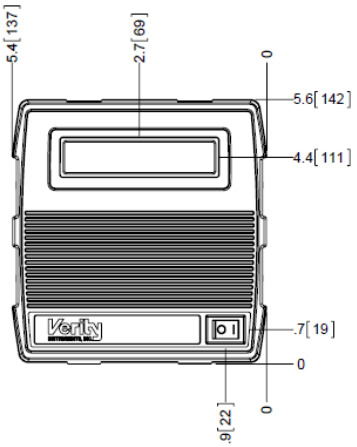
With J2 configured for
DIO & Synchronization and RS232 & DIO
(J2 is HD15 with internal sockets)

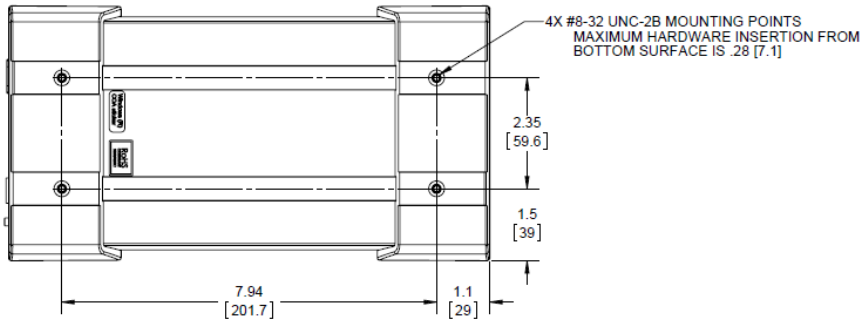
Dimensions – SD1024XL / SD2048XL





Front Panel with Text Display





Rear Panel – SD1024XL / SD2048XL

With J2 configured for RS232 and Synchronization
(J2 is DB9 with external pins)

Specifications

Model Number	SD2048XH	SD1024X/SD1024XH	SD1024XM	SD2048XM	SD1024XL	SD2048XL
Type	High Performance & High Resolution	High/Ultra Performance	Medium Performance	Medium Performance & High Resolution	General Purpose	High Resolution
Performance/Optics						
Detector	**Scientific Grade CCD Image Sensor 74 mm^2 TE cooled- low noise** Deep well - wide dynamic range UV sensitive- phosphor coating not required		**CCD Image Sensor 25 mm^2** Deep well-wide dynamic range UV Sensitive - phosphor coating not required		**CCD Linear Image Sensor 5.7 mm^2** Deep well-wide dynamic range UV Sensitive - phosphor coating not required	
Number of Pixels	2048 x 256	1024 x 128	2048 x 64 (read out as 1024)	2048 x 64	2048 (read out as 1024)	2048
Slit Width	17 microns	21 microns	21 microns	17 microns	50 microns	10 microns
Number of Channels	1-8	1-8	1-3	1-3	1	1
Range	200- 800 nm[5] 200-900 nm	200–800 nm[5] 200-900 nm	200- 800 nm[5] 200-900 nm	200- 800 nm[5] 200-900 nm	200–800 nm[3]	200–800 nm[3]
Resolution (FWHM)[1,7]	200-800 nm: 0.9 nm nominal 200-900 nm: 1.0 nm nominal	200-800 nm: 1.33 nm nominal <1.6 nm limit 200-900 nm: 1.55 nm nominal <1.87 nm limit	200-800 nm: 1.33 nm nominal <1.6 nm limit 200-900 nm: 1.55 nm nominal <1.87 nm limit	200-800 nm: 0.9 nm nominal 200-900 nm: 1.0 nm nominal	1.70 nm nominal <2.0 nm limit	0.80 nm nominal <1.0 nm limit
Wavelength Position Accuracy[1]	200 - 800 nm: < 0.1 nm nominal 0.15 nm limit 200 – 900 nm: <0.12 nm nominal 0.175 nm limit	200-800 nm: < 0.1 nm nominal 0.15nm limit 200-900 nm: <0.12 nm nominal 0.175 nm limit	200 - 800 nm: < 0.1 nm nominal 0.15 nm limit 200 - 900nm: <0.12 nm nominal 0.175 nm limit	200 - 800 nm: < 0.1 nm nominal 0.15 nm limit 200 – 900 nm: <0.12 nm nominal 0.175 nm limit	<0.1 nm nominal 0.15 nm limit	<0.1 nm nominal 0.15 nm limit
Saturation (counts)[2]	pending	50,000[4] to 65,536	≥ 65,000	≥ 65,000	≥ 65,000	≥ 65,000
Sensitivity Variation Outside the Calibrated Wavelength	pending	+/- 25% +/- 3% with broadband calibration[6]	pending	pending	pending	pending
Sensitivity, electrons[9]/uW/cm^2/ms (nominal, at 530 nm)	**51,000**	**37,000 (SD1024G) 54,000 (SD1024GH)**	**19,000**	**8900**	**4400**	**500**
Maximum Signal to Noise (2nm band) (nominal)[8]	200 - 800 nm: 3100 200 - 900 nm: 2900	200 - 800 nm: 3200 200 - 900 nm: 2960	1150	1150	1000	1000
Order Sorting Filter	Higher Order Suppression filter					
Minimum Integration Time (standard A/D)	7 ms	13 ms	2 ms	2ms	6 ms	
Minimum Integration Time (fast A/D)	2 ms	2 ms (SD1024G) 7 ms (SD1024GH)			2 ms	

Specifications – 2nd Page

Model Number	SD2048XH	SD1024X/SD1024XH	SD1024XM	SD2048XM	SD1024XL	SD2048XL
Mechanical & Integration						
Dimensions - inches (mm)	5.4” (137 mm) W x 10.2” (259 mm) L x 5.6” (142 mm) H					
Weight	6.6 lbs. (3 kg)				5.9 lbs. (2.7 kg)	
Fiber Optic Connection	Custom Design				SMA	
Power	20-28VDC, 75W max. User accessible 4A fuse					
Standards						
Compliance	EN 55022 RoHS	EN 55024 SEMI S8-0308	IEC 61010-1 SEMI S2-0310	Semi S10-0307		
SD1024X Computer Specifications						
Internal Storage Ethernet (Ports) / Speed User Interface	120 or 240 GB Solid State Drive (2) 10/100/1000 Ethernet to Windows, Linux, or Android VNC (Virtual Network Computing) Viewer (most vendors and versions will work)					
Environmental						
Operating Temperature Range	32°F (0°C) to 104°F (40°C)					
Storage Temperature Range	-4°F (-20°C) to 140°F (60°C)					
Maximum Humidity (Operation and Storage)	85% Non-condensing					

[1] Based on the average of several measurements taken across the spectrum at time of shipment.
[2] Saturation – based on using standard calibration method, consult factory for alternate calibration methods.
[3] Spectral Range - consult factory for range to 1100 nm.
[4] 50,000 is the minimum saturation for generic SD1024Xs, non-generic SD1024X’s have different saturation values. 65,000 is the minimum saturation value for all SD1024XHs.
[5] Optionally, 170-770 nm is available
[6] This specification is for the SD1024X, the specification for the SD1024XH is pending.
[7] For the SD2048XH models resolution is based on using SpectraView 7.2.02F08 or later
[8] Maximum signal to noise (S/N) is based on: SD1024X/XH and SD2048XH- the point at which the CCD output becomes non-linear; “high gain” calibrations will reduce the maximum S/N. With the SD1024XL and SD2048XL the maximum S/N is based on using our standard low gain calibration. The maximum S/N for the SD1024XM/SD2048XM is an estimate based on a typical calibration.
[9] Counts are converted to electrons using the photon transfer curve method.

Specifications are subject to change without notice.

Configurations

Options	Standard	Optional
Display	Text Display	Graphics Display with Keypad (as shown on first page of brochure)
Hard Drive	256 GB SSD Minimum	256 GB SSD Minimum
Rear Panel[2]	See three options at right	RS232[1] Communications and Synchronization (no DIO) Connector is DB9 with external pins Synchronization Input (1)[2] Synchronization Output (1)[2] DIO and Synchronization (no RS232) Connector is HD15 with internal sockets Digital Inputs – 2 (can be used for Start, Stop, Recipe)[2] Digital Outputs – 2 (can be used for Endpoint, Error, etc.)[2] Form C Synchronization Input (1)[2] Synchronization Output (1)[2] RS232 and DIO (no Synchronization) Connector is HD15 with internal sockets Digital Inputs – 2 (can be used for Start, Stop, Recipe)[2] Digital Outputs – 2 (can be used for Endpoint, Error etc.)[2] Form C RS232, DIO and Synchronization Connector is HD15 with internal sockets Digital Inputs – 2 (can be used for Start, Stop, Recipe)[2] Digital Outputs – 2 (can be used for Endpoint, Error etc.)[2] Form A Synchronization Input (1)[2] Synchronization Output (1)[2]

[1]- The pinout of the RS232 connector (for the RS232 and Synchronization configuration) is unchanged from the earlier revision of the SD1024X Series, except that the synchronization pins are now on this connector.
[2]- Consult Verity for software support implementation date

Verity INSTRUMENTS, INC.
2901 Eisenhower St.
Carrollton, TX. 75007
Phone: (972) 446-9990
Fax: (972) 446-9586
Email: Sales@verityinst.com
Web Address: http://www.verityinst.com