

iVac series Hardware Guide

Version 2.1 rev 17 Jun 2022



Covering iVac **316** & **324** models

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REVISION HISTORY

Version	Released	Description
1.0	15 Apr 2009	Initial Release.
1.1	15 Nov 2010	Updates throughout to align with software and general changes.
2.0	26 Jan 2017	Combined content for both 316 and 324 models. Aligned regulatory and compliance content to the latest. Updated the structure of the manual to the latest style and format. Software content removed as this is ket up to date in the separately supplied software (e.g. SDK2 or Solis).
2.1	17 Jun 2022	Added China RoHS table to appendix. Removed links to MyAndor. Updated packing list components. Removed old logo. Updated office addresses.

UPDATES TO THE MANUAL

Changes are periodically made to the product and these will be incorporated into new editions of the manual. Please check for new releases of the manual at andor.oxinst.com/downloads/. If you find an issue in this manual please contact your customer support representative (Section 1.1) with a description of the issue.

SAFETY AND WARNING INFORMATION



READ THIS INFORMATION FIRST

1. If the equipment is used in a manner not specified by Andor, the protection provided by the equipment may be impaired.
2. Before using the system, please follow and adhere to all warnings, safety, manual handling and operating instructions located either on the product or in this Hardware Guide.
3. Users must be authorised and trained personnel only; otherwise this may result in personal injury, and/ or equipment damage and impaired system performance.
4. There are no user-serviceable parts inside the product and the enclosure must not be opened. Only authorised service personnel may service this equipment.
5. Do not position this product so that it is difficult to operate the Mains disconnecting device. See SECTION 4.1 “Emergency Mains Disconnection” Section.
6. Protective earth is an integral part of the protection against electric shock in this product, and is provided via the earth pin of the external power supply. Ensure that this is plugged into the building earth system via the mains socket. Do not tamper with any of the earthing measures.
7. Only the correctly specified mains supply should be used.
8. Only the AC/DC external power supply provided with the product should be used.
9. Only the power supply cord provided with the product should be used. Should this not be correct for your geographical area, contact your local Andor representative.
10. Make sure the power supply cord is located so that it will not be subject to damage. If replacement of the detachable power supply cord is required, ensure replacement is of same type and rating.
11. Always disconnect the power supply from the product before replacing a fuse.
12. Replace fuse with fuse of same type and rating.
13. Performance of the system may be adversely affected by rapidly changing environmental conditions or operation outside of the operating conditions specified in APPENDIX A “TECHNICAL SPECIFICATIONS”
14. While running an experiment, try to keep temperature as stable as possible.
15. This equipment has not been designed and manufactured for the medical diagnosis of patients.
16. Electromagnetic Compatibility: This is a Class A product. In a domestic environment this product may cause electromagnetic interference, in which case the user may be required to take adequate measures.
17. This product has been designed and tested to perform successfully in a normal (basic) electromagnetic environment, e.g. a typical life science test laboratory, as per the EU EMC Directive. It is not designed to operate in a harsh electromagnetic environment, e.g. close to the following equipment: EMI/RFI generators, electrostatic field generators, electromagnetic or radioactive devices, plasma sources, arc welders, x-ray instruments, intense pulsed sources, or other similar sources of high energy fields whose emissions are not within the normal range expected under the EU EMC Directive.
18. Please note that this product is not designed to provide protection from ionising radiation. Any customer using this product in such an application should provide their own protection.
19. Your product is a precision scientific instrument containing fragile components. Always handle it with care.

-
20. Do not wet or spill liquids on the product, and do not store or place liquids on the product.
 21. If spillage occurs on the product, switch off power immediately, and wipe off with a dry, lint-free cloth.
 22. If any ingress of liquids has occurred or is suspected, unplug the mains cables, do not use, and contact Andor Customer Support.
 23. See SECTION 5.3, “Cleaning and Decontamination”.
 24. Do not expose the product to extreme hot or cold temperatures.
 25. Do not expose the product to open flames.
 26. Do not allow objects to fall on the product.
 27. Keep this Hardware Guide in a safe place for future reference.

WARNING AND SAFETY LABELS

The following are explanations of the safety symbols found on this product:



Caution, potential hazard



Caution, risk of electric shock

UNPACKING INFORMATION

Carefully unpack the unit and retain the packaging materials to transport or return equipment if required:

- If the equipment appears damaged in any way, return it to sales outlet in its original packaging.
- No responsibility for damage arising from the use of non-approved packaging will be accepted.
- Ensure all items and accessories specified at the time of ordering and as detailed on the packing list are present: if any items are missing, please contact your sales representative.

SECTION 1: INTRODUCTION

This manual includes a description of the main features of the iVac series, installation, routine operation and troubleshooting. It also provides a summary of some of the technical features of the iVac series. For further information on operation and control of the iVac refer to the relevant software guide e.g. Solis, or SDK2 and to the andor website for further technical information to help you get the best from your camera.



Figure 1: The iVac (316) spectroscopy camera

1.1 TECHNICAL SUPPORT

If you have any questions regarding the use of this equipment, please contact the representative* from whom your system was purchased, or:

Europe

Andor Technology Ltd.
7 Millennium Way
Springvale Business Park
Belfast
BT12 7AL
Northern Ireland
Tel. +44 (0) 28 9023 7126
Fax. +44 (0) 28 9031 0792

USA

Andor Technology
300 Baker Avenue
Suite # 150
Concord
MA 01742
USA
Tel. +1 (860) 290-9211
Fax. +1 (860) 290-9566

Asia-Pacific

Andor Technology (Japan)
5F IS Building
3-32-42 Higashi-Shinagawa
Tokyo 140-0002
Japan
Tel: +81 3 6732 8968
Fax: +81 3 6732 8939

China

Andor Technology (China)
Haitong Times Business Center,
Building B2 West,
No.11 West Third Ring North Road,
Haidian District,
Beijing,
100089
China
Tel: +86 (0) 10 5884 7900
Fax. +86 (0) 10 5884 7901

* The latest contact details for your local representative can be found on the [Contact and Support](#) page of our website.

1.2 DISCLAIMER

THE INFORMATION CONTAINED HEREIN IS PROVIDED “AS IS” WITHOUT WARRANTY, CONDITION OR REPRESENTATION OF ANY KIND, EITHER EXPRESS, IMPLIED, STATUTORY OR OTHERWISE, INCLUDING BUT NOT LIMITED TO, ANY WARRANTY OF MERCHANTABILITY, NON-INFRINGEMENT OR FITNESS FOR A PARTICULAR PURPOSE.

IN NO EVENT SHALL ANDOR BE LIABLE FOR ANY LOSS OR DAMAGE, WHETHER DIRECT, INDIRECT, SPECIAL, INCIDENTAL, CONSEQUENTIAL OR OTHERWISE HOWSOEVER CAUSED WHETHER ARISING IN CONTRACT, TORT OR OTHERWISE, ARISING OUT OF OR IN CONNECTION WITH THE USE OF THE INFORMATION PROVIDED HEREIN.

1.3 COPYRIGHT AND PROTECTIVE NOTICES

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The publication of information in this documentation does not imply freedom from any patent or proprietary right of Andor Technology Ltd. or any third party.

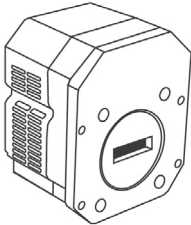
1.4 TRADEMARKS AND PATENT INFORMATION

Andor and the Andor logo are trademarks of Andor Technology Ltd. Andor Technology Ltd. is an Oxford Instruments company. All other marks are property of their owners.







iVac Manufacturers Information

Andor Technology Ltd., Belfast, BT12 7AL, UK.

1.5 SUPPLIED COMPONENTS

	Description	Quantity
	<p style="text-align: center;">iVac CCD Camera (model as ordered: refer to Section 1.5.1)</p>	1

* Any accessories (shown below) must be specified at time of ordering as the iVac is used in many OEM applications where the customer may not need either PSU, cables or other accessories:

	<p style="text-align: center;">Software electronic copy (Solis and SDK are ordered separately)</p>	*		<p style="text-align: center;">Hardware Guide in electronic format andor.oxinst.com/downloads/</p>	1
	<p style="text-align: center;">USB 2.0 Cable (2 m)</p>	*		<p style="text-align: center;">Quick Start Guide</p>	*
	<p style="text-align: center;">PSU</p>	*		<p style="text-align: center;">Performance Booklet</p>	1

An extensive range of products and optional accessories are available for spectroscopy and other applications - please contact your nearest Andor representative for further information.

1.5.1 iVAC MODEL OPTIONS

There are two models of iVac, based on either the “316” or the “324” sensor (see APPENDIX A: Technical Specifications or the iVac specifications sheet for more details).

iVac 316 Model

Sensor Type
Description
316 LDC-DD Back-Illuminated CCD, Deep-Depletion with anti-fringing, low dark current. 2000 x 256, 15 x 15 µm pixels



iVac 324 Model

Sensor Type
Description
324 FI Front illuminated, red enhanced CCD. Optimized sensor for Near IR applications. 1650 x 200, 16 x 16 µm



1.5.2 iVAC ACCESSORIES

The iVac may be ordered as a camera alone, or with a range of accessories is available for the iVac (see table below). The iVac is intended only for use with accessories supplied and recommended by Andor. Please contact your local Andor representative if further information is required.

Description	Code
+ 12V single line power supply	PS-12
High speed USB 2.0 cable, 3 metre, with fitted ferrite	ASE-01188
SMA to BNC triggering cable, 2 metre	ACC-CABL-BNC020SMA

1.5.3 SOFTWARE REQUIRED

Camera control software is required, e.g. Andor Solis or SDK2.

Description
SDK
Solis for Spectrography
Andor Driver Licence (ANDOR-DRV-LIC) Individual driver licence for Andor detectors & spectrographs. Required for integration into OEM bespoke product lines.

SECTION 2: PRODUCT OVERVIEW

This section provides an overview of the iVac. The iVac series is comprised of two models: the iVac 316 and the iVac 324. The iVac has been designed to serve as an optimum platform for a wide range of research benchtop, industrial process control, or spectrally-assisted medical diagnosis instruments. It is compact, robust, has UltraVac™ for effective and reliable cooling of a high performance sensor. It features a convenient USB 2.0 connection and is easily integrated into other instruments.

The **iVac 316** features a back illuminated Low Dark Current Deep-Depletion, 'LDC-DD' sensor which provides exceptionally slow background noise, high QE and anti-fringing.

The **iVac 324** features a front illuminated red enhanced sensor optimised sensor for the near IR.

Refer to Technical Specifications for further information.

2.1 EXTERNAL FEATURES OF THE iVAC

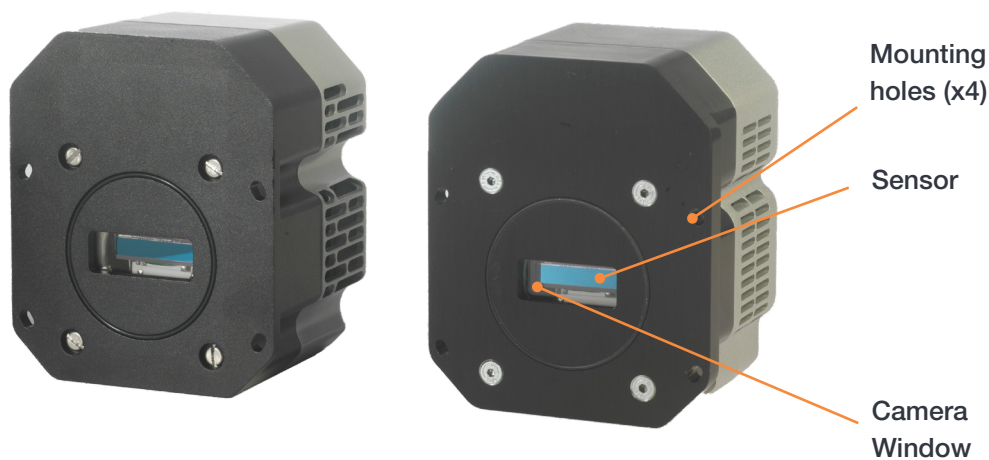


Figure 2: iVac 316 (left) and iVac 324 (right) (front view)

Mounting Flange (Mounting Holes)

The standard mounting flange has 4 x mounting holes 4 mm [0.16"] Ø thru. An O-ring helps provide a light tight seal against the mounting surface.

Sensor

The iVac features either the 316 back illuminated or 324 front illuminated sensor, and Andor's unique UltraVac™. UltraVac provides a permanent hermetically sealed enclosure for maximum QE and cooling performance over many years operation.

Camera Window

The iVac features a Single AR coated UV grade silica window for optimum transmission. For more information on camera windows please see [andor.oxinst.com/learning/view/article/camera-windows](https://www.andor-oxinst.com/learning/view/article/camera-windows).

2.2 REAR PANEL



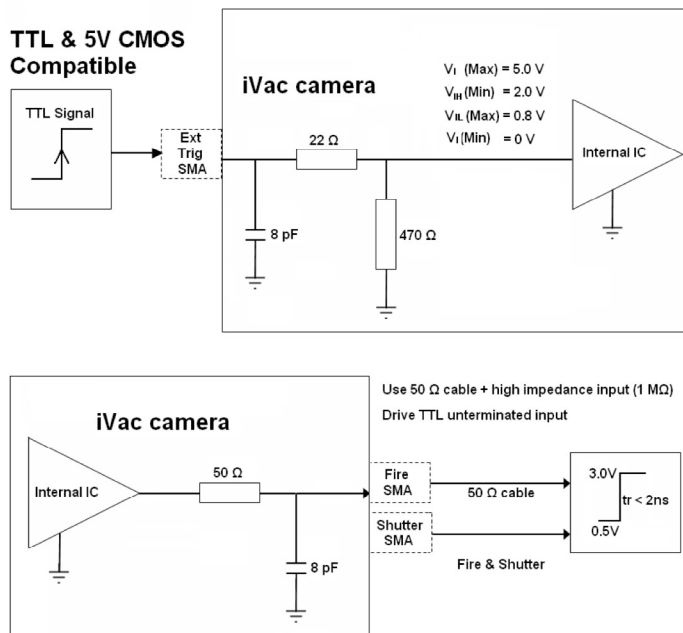
Figure 3: Rear Panel iVac 316 (left) and iVac 324 (right)

USB 2.0

Connects the iVac to the control PC via a USB 2.0 cable.

TTL / Logic

The TTL/Logic connection permit connection to other devices for synchronisation and control of fire, trigger and shutter operations. Connector type: SMA, provided with SMA - BNC cable Fire (Output), External Trigger (Input), Shutter (Output). These are used to send or receive Triggering and Firing signals. The SMA outputs (Fire & Shutter) are CMOS compatible & Series terminated at source (i.e. in the camera head) for 50Ω cable.



NOTE: The termination at the customer end should be high impedance (not 50Ω) as an incorrect impedance match could cause errors with timing and triggering. The SMA Ext Trig input is TTL level & CMOS compatible and has 470Ω impedance.

In the Solis Shutter control options, the TTL buttons, TTL Low & TTL High, let you instruct the system as to how it should control the opening and closing of the shutter.

- ▷ If you select TTL Low, the system will cause the output voltage from the iVac to go 'low' to open the shutter.
- ▷ If you select TTL High, the system will cause the output voltage from the iVac to go 'high' to open the shutter.

The documentation supplied by the shutter manufacturer will show whether your shutter opens at a high or a low TTL level.

Power

Power input connection for connection to a PSU. Refer to **Section 2.3**.

Cooling Fans

The iVac features TE cooling so that the sensor may be cooled to as low as -60°C. As the iVac is air cooled it is important that the cooling inlet and exhaust vents are kept clear of obstruction to ensure full cooling performance.

Notes:

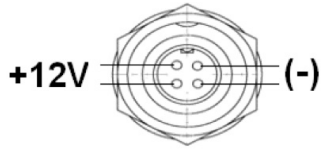
Minimum cable clearances required at rear of camera: 45 mm (right-angled USB cable), 60 mm (standard USB cable).

2.3 POWER REQUIREMENTS

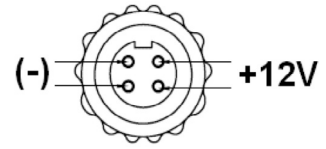
The PSU (if the PS-12 is not used) and power supply should meet the specifications outlined in this section.

Alternative Power Supply Unit Low Voltage Output Specifications	
Voltage	+ 12V ± 5%
Voltage Ripple	200 mV maximum
Steady State Current	2.1A minimum
In-rush Current Capability	42.2 A minimum into a 1 Ohm load (contact PSU manufacturer)
Overcurrent Protection	Current must be inherently limited to less than 8A, or there must be an overcurrent protection device that breaks after not more than 120 s when exposed to a current of 10.4 A or less
Certification	Certified by the relevant certification body, e.g. UL, TÜV, etc., to IEC 60950-1, or a similar appropriate safety standard
Output Connector	4 pin connection to iVac (see below)

2.3.1 CAMERA POWER CONNECTION PINOUTS



Camera input socket
Tyco Electronics Part # 6-1437719-4



Cable connector
Tyco Electronics Part # 3-1437719-3

NOTES:

1. In the UK (or other countries using UK standard electrical systems), the mains input into the PSU must be fitted with a 240V 5A fuse.
2. The power connector is keyed for correct orientation. The power connection should be made before connecting to the mains supply. Ensure the key is in the correct position before inserting as forcing in incorrectly may result in damage.

SECTION 3: INSTALLATION

WARNINGS:

- PRIOR TO COMMENCING INSTALLATION, THE USER SHOULD REFER TO THE SAFETY AND WARNING INFORMATION AND UNPACKING INSTRUCTIONS AT THE BEGINNING OF THIS MANUAL.
- TEMPERATURE AND HUMIDITY MUST MEET THE SPECIFICATIONS DEFINED IN TECHNICAL SPECIFICATIONS.
- AS PART OF THE SAFETY FEATURES OF THE IVAC SYSTEM, THE PRODUCT IS DESIGNED TO HAVE A PROTECTIVE EARTH CONNECTED VIA THE EARTH PIN ON THE MAINS PLUG. IT IS IMPORTANT TO ENSURE THAT THIS IS CONNECTED TO THE BUILDINGS PROTECTIVE EARTH SYSTEM
- THE EQUIPMENT SHOULD BE POSITIONED SO THAT THE MAINS SUPPLY PLUG/CORD CAN BE EASILY ACCESSED FOR DISCONNECTION

3.1 TRANSPORT AND STORAGE INFORMATION

The iVac is packed in normal protective transport packaging for shipping.

Storage

- Storage Temperature: -25°C to 50°C.
- Store in a cool dry place.

3.2 MOUNTING THE IVAC

To prevent damage to the iVac, other equipment and/or personnel the camera must be securely mounted before use. This can be using either the mounting flange or using the mounting hole on the base of the iVac.

- The 4-off through-holes in the front face of the camera (use with M3 or 6/32 screws)

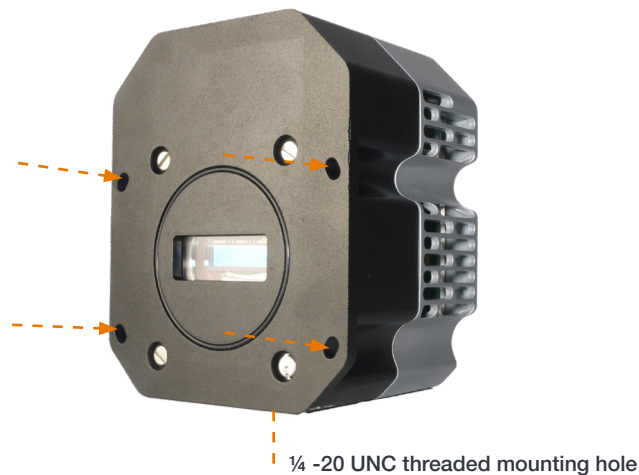


Figure 4: Mounting Holes located on the mounting flange

To mount this camera to an Andor Shamrock spectrograph, 4 off M3 x 10 or 6/32-1/2 UNC cap-head screws are required.

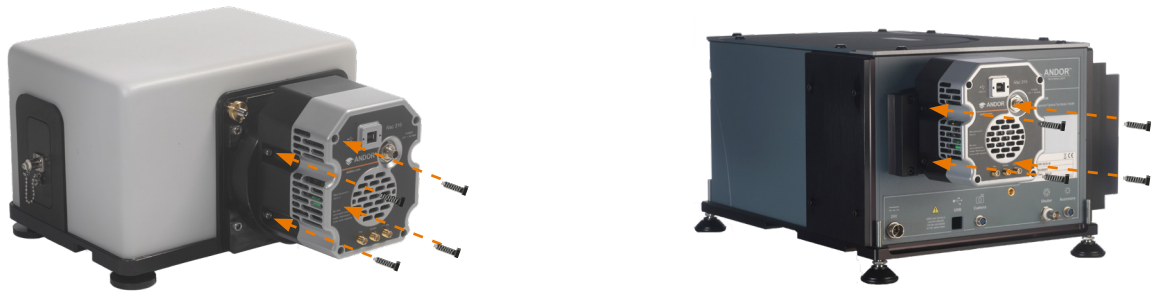


Figure 5: An iVac shown attached to a HoloSpec (left) and a Shamrock spectrograph (right) using the four mounting holes on the mounting plate.

3.3 SPECTROGRAPH COMPATIBILITY

The iVac series is fully compatible with Andor's Shamrock spectrograph (163 - 750 mm focal lengths) family and the HoloSpec. Spectrograph mounting flanges and software control are available for a wide variety of 3rd party spectrographs including, McPherson, JY/Horiba, PI/Acton, Chromex/Bruker, Oriel/Newport, Photon Design, Dongwoo, Bentham, Solar TII and others.

Andor produce a range of echelle spectrographs such as the Mechelle 5000 and provides integrated flanges for these spectrographs if required.

3.4 ATTACHING USING THE MOUNTING POST

- A ¼ -20 UNC threaded hole located on the underside/base of the unit- Refer to APPENDIX B.
- 10.0 mm [0.37] depth
- Note the iVac weighs approx 1.4 kg [3lbs 13 oz] ensure that the mounting is suitable to support the iVac if this mounting method is used.

3.5 CONNECTING THE iVAC TO THE PC

The iVac may be connected to the control PC via a USB 2.0 compatible cable.

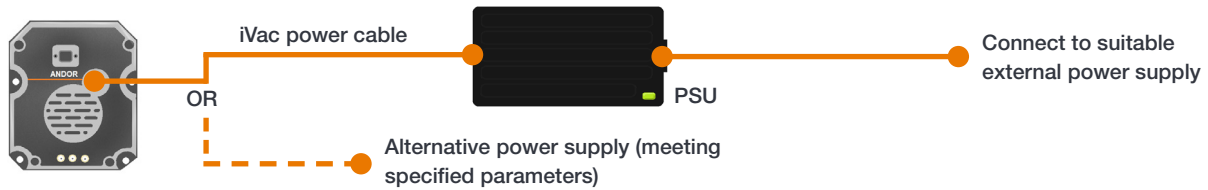
USB

- Connect the USB 2.0 cable from the iVac to a suitable USB slot on the control PC.



3.6 CONNECTING THE iVAC TO THE CAMERA CONTROL UNIT AND POWER SUPPLY

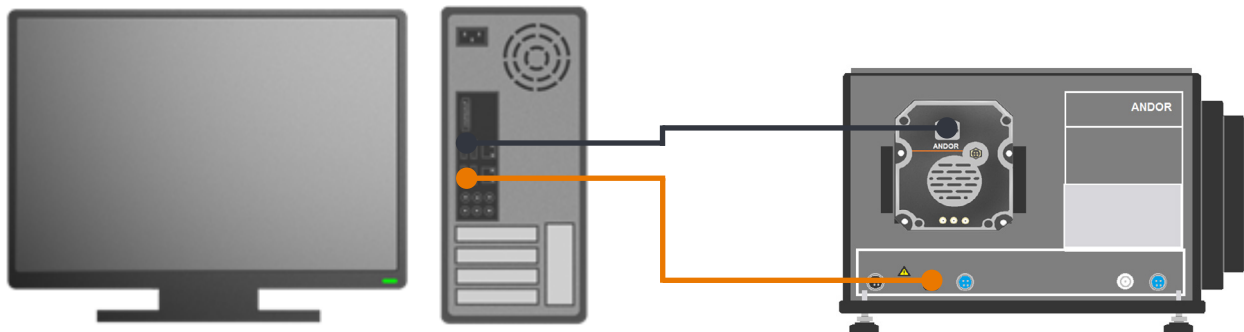
- Connect the power cable between the PSU (or suitable power source) and the Camera power input (rear panel).



- When using a PSU, connect the mains power cable between the PSU and the mains power supply.
- Ensure that any alternative power supply meets the required specifications outlined in Section 2.
- For connector and pin-out information please refer to Section 2.

3.7 CONNECTING OTHER DEVICES

Other devices should be connected to the control PC e.g. Spectrograph via a USB cable or other specified connection. Refer to the manual supplied with the device for further instructions.



3.8 INSTALLING SOFTWARE

Camera control software such as Andor Solis or SDK must be ordered separately. Solis and SDK provide simultaneous control of the Andor iVac, Shamrock, and Mechelle, as well as a range of 3rd party motorised spectrographs. The following guidelines are provided for Andor SDK software. Please refer to the instructions supplied with your software for further information.

3.8.1 MINIMUM COMPUTER REQUIREMENTS

- 3.0 GHz single core or 2.4 GHz dual or quad core processor
- 2 GB RAM
- 100 MB free hard disc to install software (at least 1 GB recommended for data spooling)
- USB 2.0 High Speed Host Controller capable of sustained rate of 40 MB/s
- Windows (8, 8.1 and 10) or Linux

3.8.2 INSTALLING SOLIS SOFTWARE AND USB DRIVERS

1. Terminate & exit any applications which are running on the PC.
2. Run the setup .exe from the supplied copy or the downloaded file: e.g. AndorSDK2Setup-<version>.exe
3. Select appropriate location for installation of software and drivers on your computer / network.
4. When prompted, select iVac.
5. Continue installation and restart your computer - when prompted - to successfully complete the installation.
6. The shortcut icon for Solis will appear on the desktop on re-start.
7. The iVac is now ready to be connected to a PC / laptop and powered on.

3.8.3 NEW HARDWARE WIZARD

When the iVac camera is connected to a PC for the first time, the **New Hardware Wizard** screen will appear.

1. Select the '**No, not this time only**' option then click **Next>**.
2. Select the '**Install from a list or specified location (Advanced)** option then click **Next>**.
3. Navigate to the directory where the Andor Solis software was installed to on the PC, then click **Next>** so that the **Installation Wizard can start**.
4. Click the **Finish** button to complete the installation.

Note: If the camera is connected to a different USB port, steps 1 – 4 will have to be repeated on the first connection only.

5. A system message will appear to indicate that the device has been successfully installed.

Note: You can check that the iVac is correctly recognized and installed by opening the Device Manager (Devices and printers) in Windows, Control Panel. The iVac will show under the Devices list.

SECTION 4: OPERATION

WARNINGS:

- IF THE EQUIPMENT IS USED IN A MANNER NOT SPECIFIED BY ANDOR OR ITS DISTRIBUTORS, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED.
- PLEASE READ THE USER GUIDES SUPPLIED WITH YOUR SYSTEM COMPONENTS AND CAMERA CONTROL SOFTWARE PRIOR TO USE.

4.1 EMERGENCY MAINS DISCONNECTION

In case of emergency, the disconnecting point of the equipment when using a PSU is the mains power cord connected to the external power supply, or the mains socket switch.

WARNING: SWITCH OFF THE POWER AT THE MAINS SOCKET AND REMOVE THE MAINS LEAD FROM THE EXTERNAL POWER SUPPLY.

4.2 POWER-UP SEQUENCE

1. Ensure that the iVac is powered on at the mains power supply.
2. Ensure that the USB cable is connected between the camera and the PC.
3. Start up the PC.
4. Launch your camera control software e.g. Solis or SDK2
5. The camera will now start up under control of the software and you are ready to use the camera.
6. Refer to your software manual for set-up and image acquisition information.

4.3 POWER-DOWN SEQUENCE

1. Exit the camera control software.
2. The camera will automatically turn off.
3. If not using for some time and the iVac is connected via a PSU, switch off and disconnect the cable from the mains power socket.

4.4 USING THE iVAC

Once set-up the iVac is controlled through the camera control software. Please refer to the information supplied with the camera control software (available separately) for further details e.g. **Andor Solis** or **SDK2**. For information on the features available with the iVac please refer to the **Appendix C Reference Information**.

SECTION 5: MAINTENANCE



THERE ARE NO USER-SERVICEABLE PARTS INSIDE THE CAMERA. DAMAGE CAUSED BY UNAUTHORISED MAINTENANCE OR PROCEDURES WILL INVALIDATE THE WARRANTY.

5.1 REGULAR CHECKS

- The state of the product should be checked regularly, especially the integrity of the PSU (if used) and the mains cable.
- Do not use equipment that is damaged.

5.2 ANNUAL ELECTRICAL SAFETY CHECKS

- It is advisable to check the integrity of the insulation and protective earth of the PSU (if used) on an annual basis, e.g. U.K. PAT testing.
- Do not use equipment that is damaged.

5.3 GENERAL CLEANING & DECONTAMINATION INFORMATION

- The camera body can be cleaned with a soft cloth and dampened by water or glass cleaner.
- Never spray liquids directly on the camera; apply cleaning solution to the cloth, then wipe the camera body with the dampened cloth.
- Do not use abrasive or other detergents to clean the camera.
- Dust may also collect on the cooling fans. From time to time, it may be necessary to clear away the dust with a small brush. The fans disperse heat from the unit. Should the airflow become blocked, the cooling performance may be impaired.

5.4 CLEANING THE CAMERA WINDOW

At some point, it may become necessary to clean debris that may have settled on the CCD imaging sensor window. Cleaning the camera window can provide effective results providing you carefully follow these step-by-step directions.

WARNINGS

- The glass is located very close to the CCD imaging sensor. Scratching the window may require the window to be replaced.
- Cleaning the window is done entirely at the customer's risk, window replacement is not covered under the warranty. It's better to under-clean than to over-clean.

5.4.1 TOOLS REQUIRED

- Compressed Air Can (or source of clean compressed air)
- Optics Brush

5.4.2 WINDOW CLEANING PROCEDURE

1. Remove the camera from your equipment and place it on a clean dry surface.

Guidelines for using Compressed Air

- If you are using a compressed air can always test-blast away from window before blowing air on the window. When you test-blast, you'll notice a spray of condensation shoot out from the can.
 - If condensation does form on the window, do not wipe it off. Allow it to fully dry before proceeding.
 - Always orient the compressed air can in an upright position before spraying.
 - A clean source of compressed air such as an can is recommended- do not use a compressor that may spray fine droplets of oil, or an unfiltered air supply that may spray dust particles onto the camera window.
2. Turn the camera on its side making it easier for particles to fall out of the camera head. Face the window toward you at the edge of a table.
 3. Give the window short blasts of compressed air to work dust particles out of the camera head.
 4. If there are still particles stuck on the window use an optics brush to very carefully dislodge them from the window surface. Then spray the dust particles out of the camera head with compressed air.

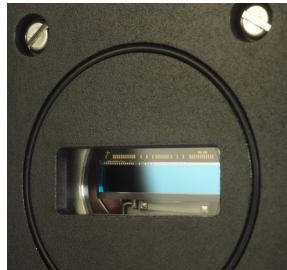


Figure 6: The camera window may be cleaned if it becomes contaminated by dust, however it is very delicate and the correct method and care must be taken

5.5 FUSE REPLACEMENT

In the U.K, Ireland and some other countries, the mains cable for the PSU (optional) has a BS 1363 (or Type G) plug that includes an integrated fuse. Only replace with fuse of the same type and rating for continued protection. The characteristics of a replacement fuse are as follows:

- **Rating:** 5 A 240 VAC
- **Type:** BS 1362, size: ¼ × 1" (6.3 × 25.4 mm) cartridge

SECTION 6: TROUBLESHOOTING

6.1 QUICK TROUBLESHOOTING GUIDE

Issue	Possible Cause	Action
Camera start-up tone does not sound on start-up	Camera not receiving power	<p>Check cable is connected between camera and PSU or power source</p> <p>Check power status of PSU or power source.</p> <p>Check PSU or DC power supply is receiving power from the mains supply.</p>
Camera is not recognized by PC	Communication issue	<p>Ensure the camera is switched on</p> <p>Check that the cables are connected between the camera and the PC</p>
Buzzer sounds continuously	This indicates that an “over temperature” condition has occurred within the camera	<p>Power the camera off and allow it to cool down</p> <p>Ensure fan vents are not obstructed</p> <p>Check the camera is operating within the specified environmental conditions</p>
Fan not operating as expected		<p>The fan is normally disabled if the camera heat-sink temperature is below 20°C</p> <p>To protect the internal electronics, the fan defaults to full speed if the camera heat-sink temperature exceeds 50°C. NOTE: The fan will continue to run even if the user has switched it off via software, until the correct heat-sink temperature has been reached.</p>
Camera does not cool to the required temperature		<p>Check that the camera is operating within the environmental conditions (Section 1.4) and the required temperature is consistent with the camera performance.</p> <p>NOTE: Allow sufficient head room for ambient temperatures fluctuations and camera performance, as the figures stated are typical.</p>

APPENDIX A: TECHNICAL SPECIFICATIONS

Performance Specifications Summary

Sensor	316			324			
Pixels	2000 x 256			1650 x 200			
Pixel size	15 x 15 μm			16 x 16 μm			
Image area	30 x 3.8 mm			26.4 x 3.2 mm			
Active area pixel well depth (typical)	150,000 e^-			120,000 e^-			
Output register Saturation	300,000 e^-			500,000 e^-			
Dark current ($e^-/\text{pixel}/\text{sec}$)							
@ -50°C	0.22			0.018			
@ -60°C	0.10			0.003			
Read noise (e^-)	130 kHz	400 kHz	1.48 MHz	35 kHz	130 kHz	400 kHz	1.48 MHz
Typical (maximum)	4.5 (5.5)	8 (10)	9 (11)	5.8 (10)	7.0 (11)	10.2 (13)	28.0 (32)

Refer to the iVac specifications sheet for further information: andor.oxinst.com/downloads/

General Specifications

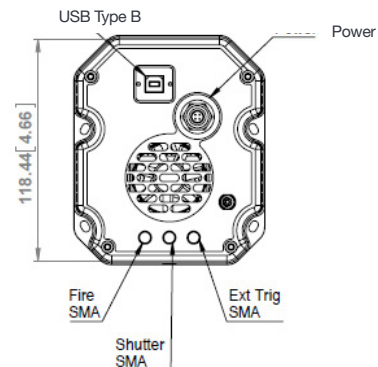
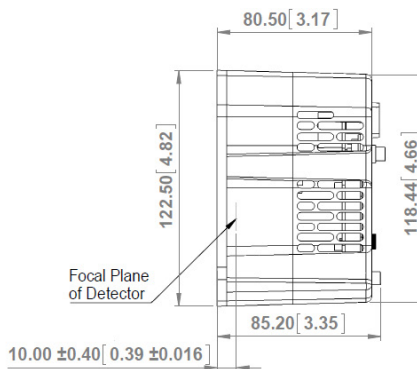
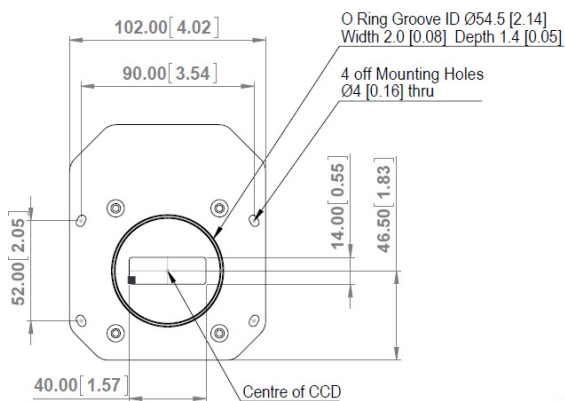
Minimum temperatures air cooled	-60°C @ +25°C ambient	
Blemish specification	Grade 1 sensor from supplier. Camera blemishes as defined by Andor Grade A andor.oxinst.com/learning/view/article/ccd-blemishes-and-non-uniformities	
Standard System window type	Fused silica, 'VIS-NIR Enhanced', wedged (AR coated on both sides, optimized at 900 nm)	UV-grade fused silica, 'Broadband VUV-NIR', unwedged
Digitization	16 bit	
Linearity	Better than 99%	
Weight	Weight: 1.4 kg [3 lb 13oz]	
Dimensions mm [inches]	See Appendix B "Mechanical Drawings"	

Environmental Specifications

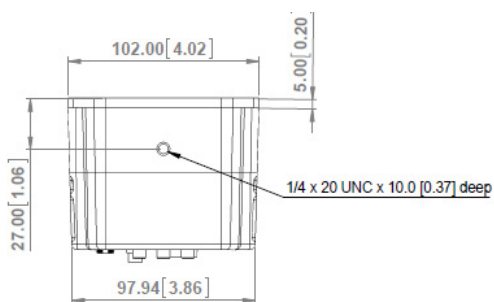
Usage	Indoor use only	
Operating Altitude	Up to 2000 m	
Operating Temperature	0°C to 40 °C ambient	
Storage Temperature	-25°C to 50 °C	
Operating Relative Humidity	<70% (non-condensing)	
Ingress Protection	IP20	
Overvoltage Category	CAT II. An overvoltage category of CAT II means that the equipment is designed to cope with transient voltages above the rated supply that would be experienced by any product connected to a mains socket in a building.	
Rated Pollution	Pollution Degree 2. Normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected.	
Ventilation Requirements	100 mm around vents	
Power Requirements	See Section 2.3	
Power Consumption		
@ -40°C	9 W	12.5 W
@ -60°C	24 W	20 W

APPENDIX B: MECHANICAL DRAWINGS

iVac 316

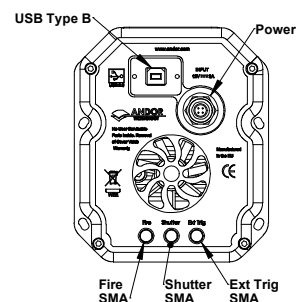
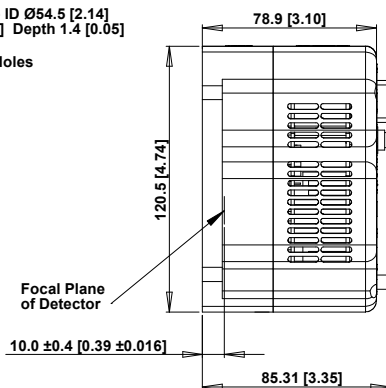
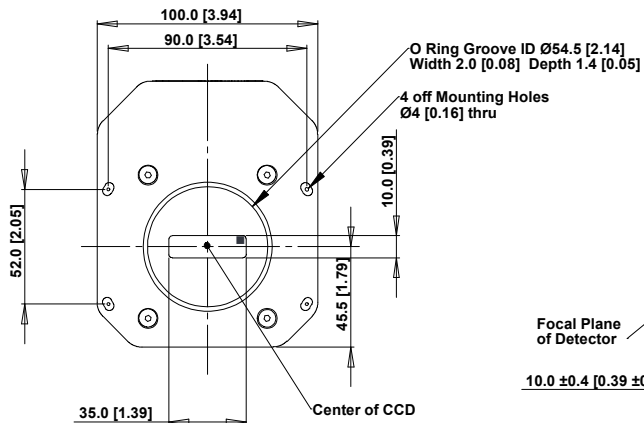


Rear connector panel

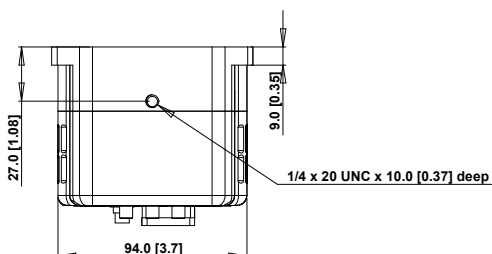


■ = position of pixel 1,1

iVac 324



Rear connector panel



■ = position of pixel 1,1

APPENDIX C: REFERENCE INFORMATION

ULTRAVAC™ TECHNOLOGY

UltraVac is Andor's proprietary vacuum technology that provides a permanent, hermetically sealed enclosure (without O-rings) for the sensor. This ensures maximum cooling performance, with a reliability proven through years of use in Andor cameras such as the iXon EMCCD, iKon and Newton series- the Mean Time Between Failure (MTBF) value is > 100 years.

Outgassing is minimized through assembly in a state of the art facility, with a stringent protocol and use of proprietary materials (Outgassing is the release of trapped gasses that would otherwise degrade cooling performance and potentially cause sensor failure). UltraVac also features a single camera window for the best optical performance. For more information about our UltraVac technology, please visit our website and view the technical article on [UltraVac](#).

TE COOLING

The CCD detector is cooled using a thermoelectric (TE) cooler. TE coolers are small, electrically powered devices with no moving parts, making them reliable and convenient. A TE cooler is actually a heat pump, i.e. it achieves a temperature difference by transferring heat from its 'cold side' (the CCD-chip) to its 'hot side' (the built-in heat sink). Therefore the minimum absolute operating temperature of the CCD depends on the temperature of the heat sink. The maximum temperature difference that a TE device can attain is dependent on the following factors:

- Heat load created by the CCD
- Number of cooling stages of the TE cooler
- Operating current.

The heat that builds up on the heat sink must be removed and this can be achieved in one of two ways:

1. **Air cooling:** a small built-in fan forces air over the heat sink.
2. **Water cooling:** external water is circulated through the heat sink using the water connectors on the top of the head.

The iVac supports the **air cooling** option which provides an effective and compact cooling option. Whichever method is being used, it is not desirable for the operating temperature of the CCD detector simply to be dependent on or vary with the heat sink temperature. Therefore a temperature sensor on the CCD, combined with a feedback circuit that controls the operating current of the cooler, allows stabilization of the CCD to any desired temperature within the cooler operating range.

AIR COOLING

Air cooling is the most convenient method of cooling. Even with a fan, a heat sink typically needs to be 10°C hotter than the ambient (room) temperature to transfer heat efficiently to the surrounding air. Therefore the minimum CCD temperature that can be achieved will be dependent on the room temperature.

NOTES:

1. The relationship between the air temperature and the minimum CCD temperature is not 1:1. This is because TE coolers become less efficient as they get colder
2. Systems are specified in terms of the minimum dark current achievable, rather than absolute temperature. For dark current specifications, please refer to the specification sheet for your camera
3. Cooling the CCD detector helps you reduce dark signal and its associated Shot Noise

FAN SETTINGS

The speed of the cooling fan can also be controlled, useful if working in experimental configurations which are extremely sensitive to vibration. The vast majority of applications, including optical microscopy, can be used with the default highest fan speed, since the vibrations from the fan are minimal. However some applications can be extremely sensitive to even the smallest of vibrations (such as when combining an optical set-up with patch clamp electrophysiology or atomic force microscopy) and it can be useful to either select a slower fan speed, or to temporarily turn off the fan altogether for the duration of the acquisition.

If the fan is being turned off altogether, depending on the cooling temperature selected and on the ambient temperature, the acquisition duration can be as long as 15 - 20 minutes before temperature begins to rise. Then the fan must be turned on again to give the head time to re-stabilize (dissipate built-up excess heat from the Peltier TE cooler) before the next acquisition begins.

SHUTTER AND TRIGGERING INFORMATION

For shutter and trigger mode operation information please refer to your camera control software e.g. SDK2.

APPENDIX D: GLOSSARY

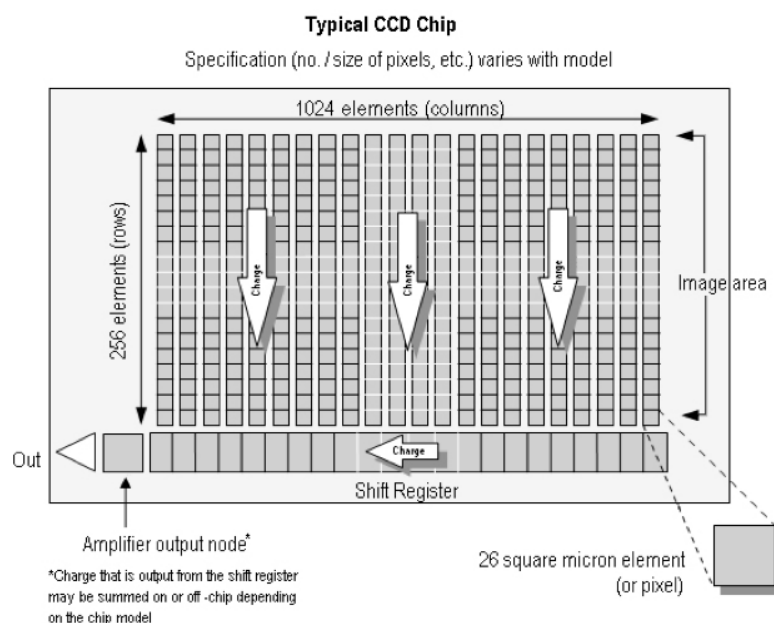
D1 - GLOSSARY

If this is the first time you have used Andor's CCD, the glossary that follows will help familiarize you with its design philosophy and some of its key terminology.

D1.1 - CCD

A Charge Coupled Device (CCD) is a silicon-based semiconductor chip bearing a two-dimensional matrix of photo-sensors, or pixels. This matrix is usually referred to as the 'image area'. The pixels are often described as being arranged in rows and columns (rows running horizontally, columns vertically). A typical CCD-chip may comprise 256 rows and 1024 columns, or 578 rows and 385 columns.

The CCD in your camera is a scientific slow scan device (in contrast to the fast scan CCD used in video cameras to capture moving images). An example of a typical layout is shown here:

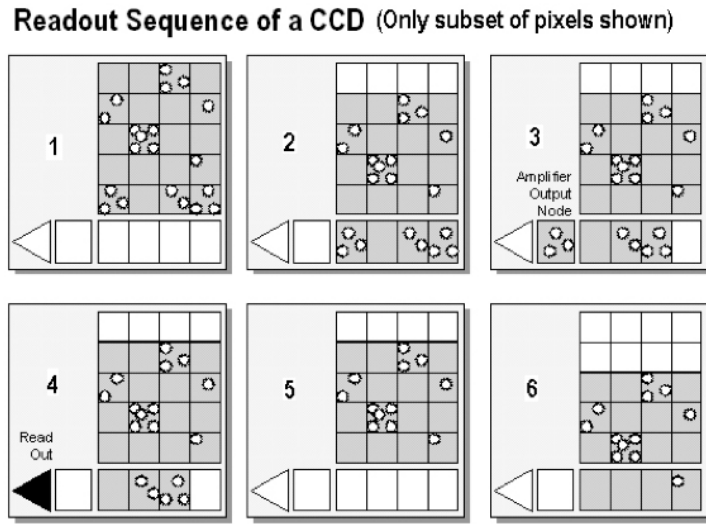


The **Shift Register** runs below and parallel to the light collecting rows. It has the same number of pixels as a light-collecting row, but is itself masked, so that no light can fall on it. When light falls on an element, electrons (photoelectrons) are produced and (in normal operation), these electrons are confined to their respective elements. Thus, if an image (or any light pattern) is projected on to the array, a corresponding charge pattern will be produced. To capture the image pattern into computer memory, the charge pattern must be transferred off the chip, and this is accomplished by making use of a series of horizontal (i.e. parallel to the rows/shift register) transparent electrodes that cover the array.

By suitable 'clocking', these electrodes can be used to shift (transfer) the entire charge pattern, one row at a time, down into the shift register. The shift register also has a series of electrodes (which are vertical, i.e. parallel to the columns) which are used to transfer the charge packets, one element at a time, into the output node of the 'on-chip' amplifier. The output of the amplifier feeds the **Analog-to-Digital (A/D)** converter, which in turn converts each charge packet into a 16-bit binary number.

D1.1.1 - Readout Sequence of a CCD

In the course of readout, charge is moved vertically into the shift register, and then horizontally from the shift register into the output node of the amplifier. The readout sequence illustrated below (which corresponds to the default setting of the **Full Resolution Image** binning pattern) allows data to be recorded for each individual element on the CCD-chip. Other binning patterns are achieved by summing charge in the shift register and/or the output node prior to readout (please see **Vertical Binning** and **Horizontal Binning**).



1	Exposure to light causes a pattern of charge (an electronic image) to build up on the frame (or 'image area') of the CCD-chip.
2	Charge in the frame is shifted vertically by one row, so that the bottom row of charge moves into the shift register.
3	Charge in the shift register is moved horizontally by one pixel, so that charge on the endmost pixel of the shift register is moved into the output node of the amplifier.
4	The charge in the output node of the amplifier is passed to the analog-to-digital converter and is read out.
5	Steps 3 & 4 are repeated until the shift register is emptied of charge.
6	The frame is shifted vertically again, so that the next row of charge moves down into the shift register. The process is repeated from Step 3 until the whole frame is read out.

D1.2 - Accumulation

Accumulation is the process by which data that have been acquired from a number of similar scans are added together in computer memory. This results in improved signal to noise ratio.

D1.3 - Acquisition

An Acquisition is taken to be the complete data capture process.

D1.4 - A/D Conversion

Charge from the CCD is initially read as an analog signal, ranging from zero to the saturation value. **A/D** (Analog to Digital) conversion changes the analog signal to a binary number which can then be manipulated by the computer.

D1.5 - Background

Background is a data acquisition made in darkness. It is made up of fixed pattern noise, and any signal due to dark current.

D1.6 - Binning

Binning is a process that allows charge from two or more pixels to be combined on the CCD-chip prior to readout (please see **Readout Sequence of a CCD**). Summing charge on the CCD and doing a single readout results in better noise performance than reading out several pixels and then summing them in the computer memory. This is because each act of reading out contributes to noise.

The two main variants of the binning process are vertical binning and horizontal binning, which are individually described in the pages that follow. In addition there are several binning patterns that tailor the main binning variants to typical application usage.

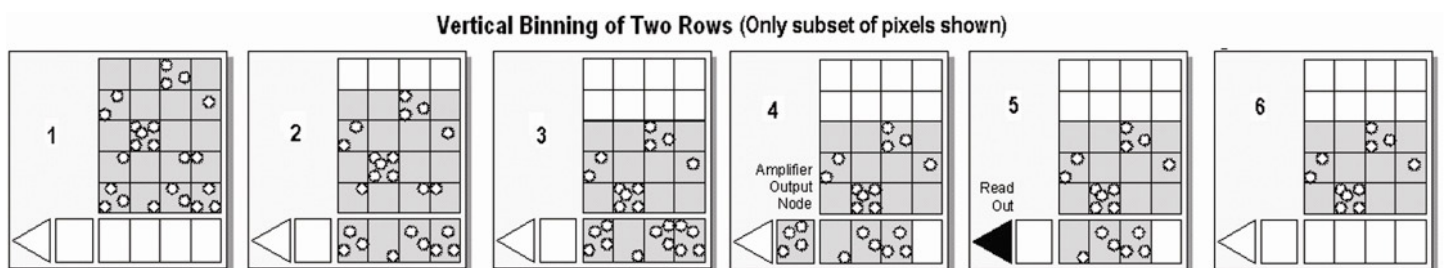
D1.6.1 - Vertical Binning

In Vertical Binning, charge from two or more rows of the CCD-chip is moved down into the shift register before the charge is read out. The number of rows shifted depends on the binning pattern you have selected. Thus, for each column of the CCD-chip, charge from two or more vertical elements is 'summed' into the corresponding element of the shift register. The charge from each of the pixels in the shift register is then shifted horizontally to the output node of the amplifier and read out.

Variants of Vertical Binning are used to affect a variety of binning patterns and they are as follows:

- **Single-Track:** charge is vertically binned and read out from a number of complete, adjacent rows of pixels on the CCD-chip. The rows form a single track across the full width of the CCD-chip. A value is taken for each column in the track.
- **Multi-Track:** Multi-Track mode differs from Single-Track in that you may now define two or more tracks from which to read out charge. In processing terms, each track is treated as in Single-Track above.
- **Full Vertical Binning (FVB):** charge from each complete column of pixels on the CCD is moved down and summed into the shift register and the charge is then shifted horizontally one pixel at a time from the shift register into the output node - in effect a value is read out for each complete column of the CCD-chip.

The example below illustrates readout of data from adjacent tracks, each track comprising two binned rows of the CCD-chip.



1	Exposure to light causes a pattern of charge (an electronic image) to build up on the frame (or Image Area) of the CCD-chip.
2	Charge in the frame is shifted vertically by one row, so that the bottom row of charge moves down into the shift register.
3	Charge in the frame is shifted vertically by a further row, so that the next row of charge moves down into the shift register, which now contains charge from two rows - i.e. the charge is vertically binned
4	Charge in the shift register is moved horizontally by one pixel, so that charge on the endmost pixel of the shift register is moved into the output node of the amplifier.
5	The charge in the output node of the amplifier is passed to the analog-to-digital converter and is read out.
6	Steps 4 & 5 are repeated until the shift register is empty. The process is repeated from Step 2 until the whole frame is read out.

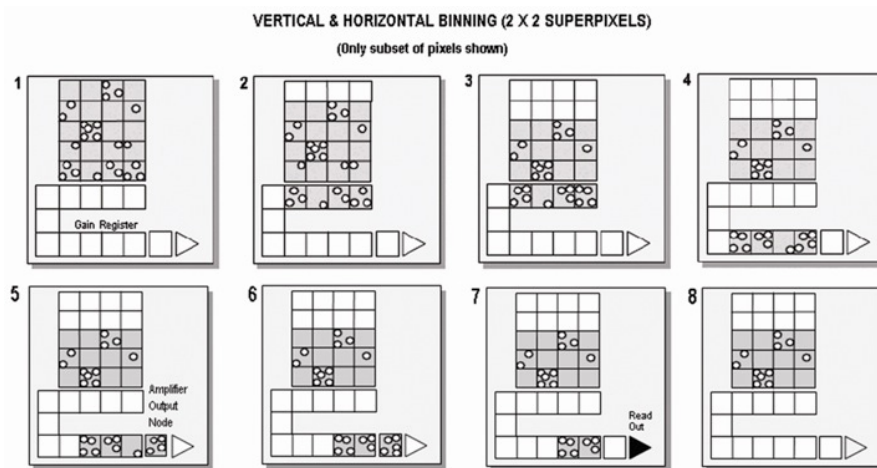
D1.6.2 - Horizontal Binning (Creating Superpixels)

Shifting the charge horizontally from several pixels at a time into the output node is known as horizontal binning.

Horizontal binning in combination with vertical binning allows you to define so-called superpixels that in Image Display Mode represent as a single picture element charge that has been binned from a group of pixels. For example, charge that is binned vertically from two rows and horizontally from two pixels before being read out is displayed as a superpixel of dimensions 2 x 2 pixels.

On the one hand, superpixels (by comparison with single pixels) result in a more coarsely defined image when the data are displayed in **Image** misplay mode. On the other hand, superpixels offer the advantages of summing data on-chip prior to readout. In the example below, where each superpixel is of dimensions 2 x 2 pixels, charge from two rows is first binned vertically into the shift register; then charge from two pixels of the shift register is binned horizontally into the output node of the amplifier. The effect of the combined binning processes is a summed charge equating to a 2 x 2 'superpixel'.

Since this example initially involves binning charge from two rows, the process begins in the same way as shown in **Steps 1 - 4** of **Vertical Binning of Two Rows** on then horizontal binning begins.



D1.7 - Counts

Counts refer to the digitization by the A/D conversion and are the basic unit in which data are displayed and processed. Depending on the particular version of the detection device, one count may, for example, be equated with a charge of 10 photoelectrons on a pixel of the CCD.

D1.8 - Dark Signal

Dark signal, a charge usually expressed as a number of electrons, is produced by the flow of dark current during the exposure time. All CCD's produce a dark current, an actual current that is measurable in (typically tenths of) milliamps per pixel. The dark signal adds to your measured signal level, and increases the amount of noise in the measured signal. Since the dark signal varies with temperature, it can cause background values to increase over time. It also sets a limit on the useful exposure time.

Reducing the temperature of the CCD reduces dark signal (typically, for every 7°C that temperature falls, dark signal halves). CCD readout noise is low, and so as not to compromise this by shot noise from the dark signal, it is important to cool the detector to reduce the dark signal. If you are using an exposure time of less than a few seconds, cooling the detector below 0°C will generally remove most of the shot noise caused by dark signal.

D1.9 - Detection Limit

The Detection Limit is a measure of the smallest signal that can be detected in a single readout. The smallest signal is defined as the signal whose level is equal to the noise accompanying that signal, i.e. a signal to noise ratio (S/N) of unity.

Sources of noise are:

- Shot noise of the signal itself
- Shot noise of any dark signal
- Readout noise

If the signal is small, we can ignore its shot noise.

Furthermore, if a suitably low operating temperature and short exposure time can be achieved, the lowest detection limit will equal the readout noise.

D1.10 - EXPOSURE TIME

Exposure Time is the period during which the CCD collects light prior to readout.

D1.11 - Noise

Noise is a complex topic, the full exploration of which is beyond the scope of this glossary. Noise may, however, be broken down into two broad categories as follows:

- Pixel Noise
- Fixed Pattern Noise

These two categories are described in the paragraphs that follow.

D1.11.1 - Pixel Noise

Let us first attempt to define pixel noise. Assume that a light signal is falling on a pixel of the CCD. If the charge on the pixel is read, and the read process is repeated many times, the noise may be taken as the variation in the values read. The Root Mean Square (r.m.s.) of these variations is often used to express a value for noise. As a rule of thumb, the r.m.s. is four to six times smaller than the peak to peak variations in the count values read from the pixel. Pixel noise has three main constituents:

- **Readout noise**
- **Shot noise from the dark signal**
- **Shot noise from the light signal itself**

Shot noise cannot be removed because it is due to basic physical laws. Most simply defined, shot noise is the square root of the signal (or dark signal) measured in electrons.

D1.11.2 - Readout Noise

Readout noise (which in our cameras is, in any case, low) is due to the amplifier and electronics: it is independent of dark signal and signal levels; it is only very slightly dependent on temperature; and it is present on every read, as a result of which it sets a limit on the best achievable noise performance.

Shot noise from the dark signal is dependent on the exposure time and is very dependent on the temperature; shot noise from the signal is additionally dependent on the signal level itself. If either the signal or the dark signal falls to zero, their respective shot noise also falls to zero.

The total pixel noise is not, however, simply the sum of the three main noise components (readout noise, shot noise from the dark signal, and shot noise from the signal).

Rather, the Root Sum Square (r.s.s.) gives a reasonable approximation - thus:

$$\text{total} = \text{sqrt}(\text{readnoise}^2 + \text{darkshot}^2 + \text{sigshot}^2)$$

where:

- **total** is the pixel noise
- **readnoise** is the readout noise
- **darkshot** is the shot noise of the dark signal
- **sigshot** is the shot noise of the signal

D1.11.3 - Shot Noise

Shot Noise is due to basic physical laws and cannot be removed. Any signal, whether it be a dark signal or a light signal, will have shot noise associated with it. This is most simply defined as:

If the signal or dark signal = **N** electrons, the shot noise is the square root of **N**.

You can do nothing about the shot noise of your signal, but by choosing minimum exposures and operating the CCD at suitably low temperatures, the dark signal, and hence the noise from the dark signal, can be reduced.

D1.11.4 - Fixed Pattern Noise

Fixed Pattern Noise (FPN) consists of the differences in count values read out from individual pixels, even if no light is falling on the CCD detector. These differences remain constant from read to read. The differences are due in part to a variation in the dark signal produced by each pixel, and in part to small irregularities that arise during the fabrication of the CCD.

Since fixed pattern noise is partly due to dark signal, it will change if the temperature changes, but because it is fixed, it can be completely removed from a measurement by background subtraction.

D1.13 - Pixel

A Pixel is an individual photosensor (or element) on a CCD.

D1.14 - Quantum Efficiency / Spectral Response

The glossary refers to signals as a number of electrons. More strictly speaking these are ‘photoelectrons’, created when a photon is absorbed. When a UV or visible photon is absorbed by the CCD detector it can at best produce only one photoelectron. Photons of different wavelengths have different probabilities of producing a photoelectron and this probability is usually expressed as **Quantum Efficiency (QE)** or **Spectral Response**.

QE is a percentage measure of the probability of a single photon producing a photoelectron, while spectral response is the number of electrons that will be produced per unit photon energy. Many factors contribute to the QE of a CCD, but the most significant factor is the absorption coefficient of the silicon that serves as the bulk material of the device

D1.15 - Readout

Readout is the process by which data are taken from the pixels of the CCD and stored in computer memory. The pixels, which are arranged in a single row, are read out individually in sequence. Readout involves amplifying the charge on each pixel into a voltage, performing an A/D conversion, and storing the data in computer memory. The time taken to perform this operation is known as the ‘read time’.

D1.16 - Saturation

Saturation is the largest signal the CCD can measure. A signal is measured in terms of the amount of charge that has built up in the individual pixels on the CCD-chip. A number of factors determine the maximum amount of charge that the CCD can handle.

D1.17 - Scan Types: Keep Clean & Acquired

The CCD is continually being ‘scanned’ to prevent its becoming saturated with dark current (see dark signal). If the Scan is being used simply to ‘clean’ the CCD (i.e. it is a keep-clean scan), the charge from the CCD is discarded.

In an acquired scan, however, the charge undergoes A/D conversion and is acquired into computer memory so that it can be used for subsequent processing and display: it is ‘read out’ (see **Readout** previously). In this User’s Guide ‘scan’ generally refers to an acquired scan - unless the context specifically indicates otherwise.

D1.18 - Signal to Noise Ratio

The **Signal to Noise Ratio** (commonly abbreviated as **S/N** or **SNR**) is the ratio between a given signal and the noise associated with that signal. Noise has a fixed component, and a variable component (shot noise) which is the square root of the signal. Thus, the SNR usually increases (improves) as the signal increases.

The maximum SNR is the ratio between the maximum signal (i.e. the saturation level) and the noise associated with that signal. At near saturation levels the dominant source of noise is the shot noise of the signal.

APPENDIX E: OTHER INFORMATION

E.1 TERMS AND CONDITIONS OF SALE AND WARRANTY INFORMATION

The terms and conditions of sale, including warranty conditions, will have been made available during the ordering process. The current version for the US is [available here](#), for all other regions (except Japan) please [click here](#).

E.2 EU/UK REACH REGULATION STATEMENT

Andor's EU/UK REACH Regulation statement is available at the [following link](#).

E.3 WASTE ELECTRONIC AND ELECTRICAL EQUIPMENT REGULATIONS 2006 (WEEE)

The company's statement on the disposal of WEEE can be found in the Terms and Conditions found on the Andor website, [WEEE Policy](#).



APPENDIX F: IVAC CHINA ROHS HAZARDOUS SUBSTANCES DECLARATION

Name and Content of Hazardous Substances in the Product
 产品中有害物质的名称及含量 产品中有害物质的名称及含量

Hazardous Substance: 有害物质						
Component Name 部件名称	Lead (Pb) 铅	Mercury (Hg) 汞	Cadmium (Cd) 镉	Chromium VI Compounds (Cr ⁶⁺) 六价铬化合物	Polybrominated Biphenyls (PBB) 多溴化联苯	Diphenyl Ethers (PBDE) 多溴联苯醚
Printed Circuit Board Assemblies (Surface-mount Resistors and Capacitors, and Brass Connectors) 电路板组件 电路板组件 (表面贴装电阻器和电容器, 以及黄铜连接器)	X	O	O	O	O	O
Hex Stand-offs (see image in table below) 六角隔撑	X	O	O	O	O	O
Screw Locks (see image in table below) 螺丝锁定	X	O	O	O	O	O
PS-12 External Power Supply (TT Electronics SW3605) Plug PS-12 外接电源 (TT Electronics SW3605) 插头	X	O	O	O	O	O
D.C. Power Socket on USB Board USB 板上的直流电源插座	X	O	O	O	O	O
All other parts 其余配件	O	O	O	O	O	O

This table was developed according to the provisions of SJ/T 11364

本表格依据SJ/T 11364 的规定编制

O - The content of such a hazardous substance in all homogeneous materials of such a component is below the limit required by GB/T 26572

O - 表示该有害物质在该部件所有均质材料中的含量均在GB/T 26572 规定的限量要求以下

X - The content of such a hazardous substance in a certain homogeneous material of such a component is above the limit required by GB/T 26572

X - 表示该有害物质至少在该部件的某一均质材料中的含量超出GB/T 26572 规定的限量要求

This table shows images for parts within the iVac.

Hex Stand-offs
六角隔撑
Screw Locks
螺丝锁定
PS-12 External Power Supply (TT Electronics SW3605) Plug
PS-12 外接电源 (TT Electronics SW3605) 插头
D.C. Power Socket on USB Board
USB 板上的直流电源插座

