System Performance

Technical Support for Andor Products at LOT-Oriel: Patrick Lindemann
phone +49/6151/8806-18
e-mail lindemann@lot-oriel.de

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CCD PERFORMANCE

System Overview

Description	Model						Serial Number
CCD Head ▽	D	U	9	34P	-	BR-DD-9JW	CCD-13535
TE Cooler performance (✔)					High		Ultra-high ✔
Accessories	Power Supply Unit (PS -24)						PS -25
	--						✔
	SO-		LM-			MFL-	
Serial/Batch Number							
Other							

▽ Sensor types are defined in Table 1 using the last two letters in box Model Number.

CCD Details

Manufacturer / Model No.		Pixels	Serial Number
E2V	CCD47-10	1024x1024, 13µm x 13µm	10041-09-21
E2V	CCD57-10	512x512, (FT), 13µm x 13µm	
E2V	CCD77-00	512x512, 24µm x 24µm	

Special Feature	(✔)		(✔)
NIMO	✔	AR coated Window (½° wedge)	✔
Fringe Suppression	✔	Custom Cables	
Shielded Anti-Blooming		Custom Mounting Flange	✔
MgF_2 Input			

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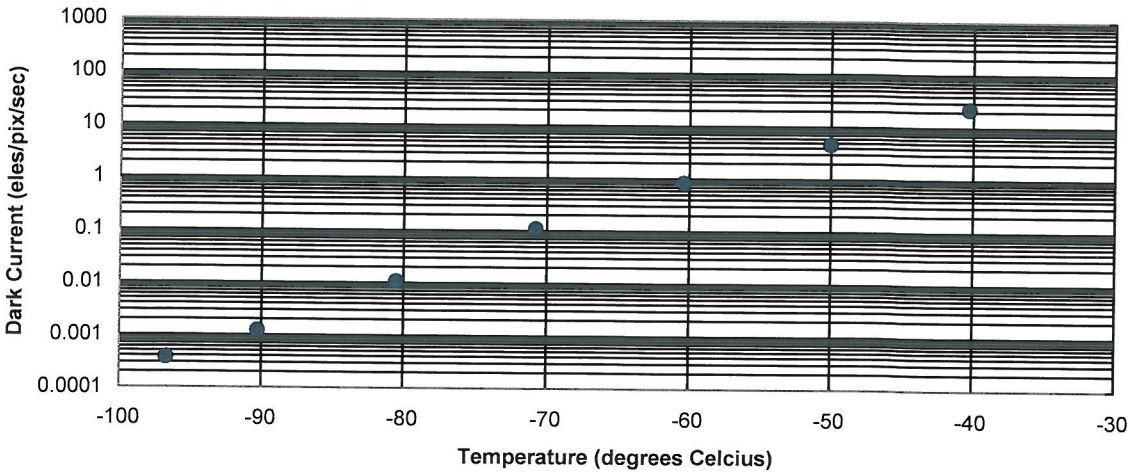
Summary of System Test Data

Readout Noise #1 and Base Mean Level

A/D Rate (MHz All 16 bit)	Preamp setting	CCD Sensitivity #3 eles per A/D count	Single Pixel Noise electrons	Full Vert Bin Noise electrons	Base Level #2 (Counts)
5	x1	6.7	33.8	34.0	1019
5	x2	3.4	18.7	19.2	1595
5	x4	1.6	13.7	13.7	3036
3	x1	5.7	18.7	18.1	1064
3	x2	3.0	12.6	12.6	2026
3	x4	1.4	10.1	10.1	3595
1	x1	5.2	10.8	10.4	835
1	x2	2.7	7.8	7.6	1699
1	x4	1.3	6.4	6.4	3487
0.05	x1	5.3	5.0	5.0	574
0.05	x2	2.8	4.0	4.2	1424
0.05	x4	1.3	3.6	3.6	3182
Saturation Signal per pixel			97177	Electrons/pixel	

CCD Dark Current



Minimum Dark Current Achievable #4	0.00037	electrons/pixel/sec	
@ Sensor Temperature of #5	-96.77	°C	16 °C cooling Water With PS-25
CCD Dark Current Uniformity better than #6	0.272689	electrons/pixel/sec	

Linearity and Uniformity

Linearity better than ♦7	1	% over 16 bits
Response Uniformity better than ♦8	2.08	%

Response Defects

White/Black Spots ♦9 (X, Y)

Centroid	Number of Pixels	Centroid	Number of Pixels
(X , X)	X	(,)	
(X , X)	X	(,)	
(,)		(,)	
(,)		(,)	
(,)		(,)	
(,)		(,)	

White/Black Columns ♦10	Column numbers indicated	X X X X
Trap ♦11	(X, Y)	(X , X)

Dark Current Defects

Hot Spots ♦12 (X, Y)

Centroid	Number of Pixels	Centroid	Number of Pixels
(X , X)	X	(,)	
(X , X)	X	(,)	
(,)		(,)	
(,)		(,)	
(,)		(,)	
(,)		(,)	

Hot Columns ♦13	Column numbers indicated	X X

Test Conditions

Readout Noise tested at	-80	°C with	16	°C water
Base Mean Level measured at	-80	°C with	16	°C water
Dark Current Uniformity tested at	-50	°C with	16	°C water
Blemishes tested at	-50	°C with	16	°C water

Custom Testing

780nm ½ degree wedge window fitted.

System Passed for Shipping

Signed P. SCOTT

Date 9TH JANUARY 2012

	HEADBOARD	FPGA
Hardware Version #	AB	20.24
	SOLIS	SDK
Shipping Software Version #	--	2.91.30000.0
Testing Software Version #	4.20.30003.13	2.92.30003.12

▽ Table 1; Key code to define the meanings of the last two letters in the Model Number

Sensor Options			
OE	Open electrode	BU2	Back Illuminated (BI) + 250nm UV optimised
FI	Front illuminated (FI)	BU	BI + UV (350nm) optimised
UV	FI+UV coating	BV	BI + VIS (550nm) optimised)
FO	FI + Fibre optic	BR-DD	BI + NIR +deepdepletion
FI-DD	FI + deep depletion	BN	BI with no AR coating

Performance Notes

*1 Readout Noise is measured for both single pixel (SP) and fully vertically binned (FVB) with the CCD in darkness at temperature indicated and minimum exposure time. Noise values will change with pre-amplifier gain selection [PAG].

*2 Average electronic DC offset for CCD in darkness at temperature indicated and minimum exposure time under dark conditions measured by single pixel (SP) for imaging systems and by (FVB) for spectroscopic systems.

*3 Sensitivity is calculated in photoelectrons per A/D count from measurements of the Photon Transfer Curve.

*4 Dark current falls exponentially with temperature. However, for a given temperature the actual dark current can vary by more than an order of magnitude from device to device. The devices are specified in terms of minimum dark current achievable rather than minimum temperature.

*5 Minimum temperature achieved for thermoelectric (TE) cooler set to maximum value with water cooling

*6 RMS (root mean square) deviation of dark current for fully binned operation for spectroscopic cameras, or full resolution image for imaging cameras, under dark conditions at temperature indicated (pixel/column defects not included). This variation is mainly cosmetic since it is fully subtractable without significant loss of performance.

*7 Linearity is measured from a plot of Counts vs. Signal over the 16 bit dynamic range. Linearity is expressed as a %age deviation from a straight line fit. This quantity is not measured on individual systems.

*8 RMS (root mean square) deviation from the average response of the CCD in full resolution image for imaging cameras, illuminated with uniform white light (defects not included).

*9 White/black pixels have signals >25% above/below the average (25% contrast) with uniform illumination across the sensor.

*10 A black column is defined as having ≥ 10 black pixels for imaging cameras.

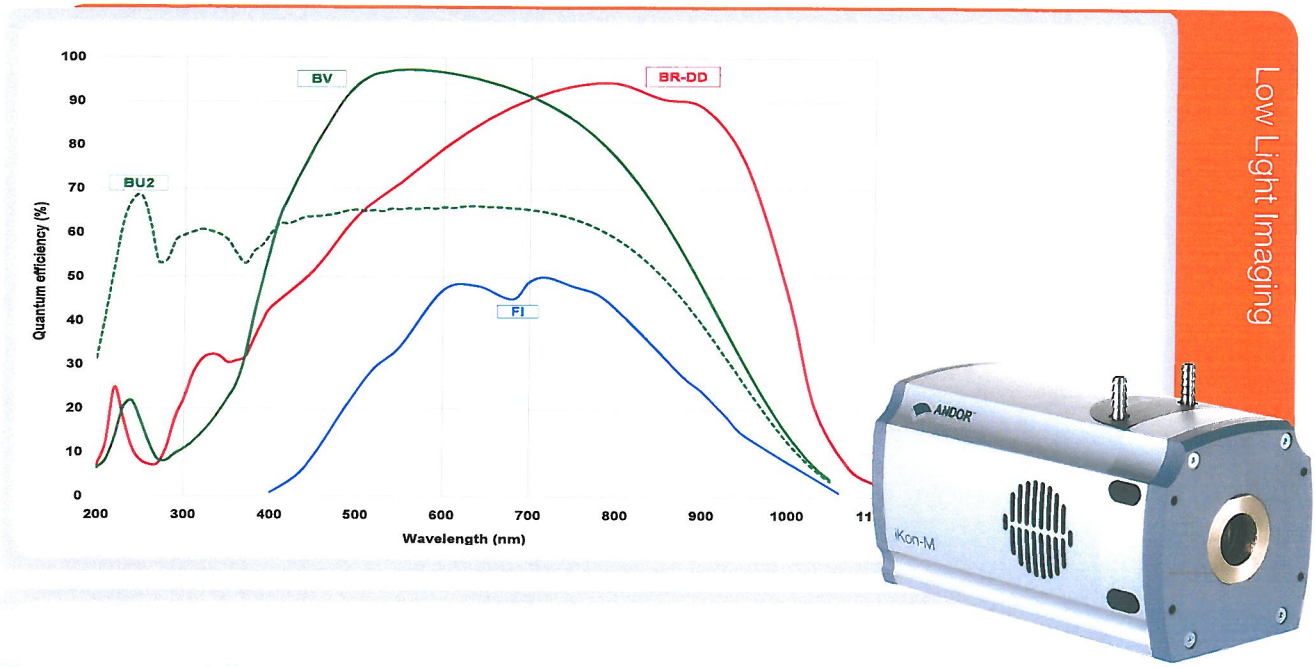
*11 Pixels which absorb charge as it is clocked through the defective area. When the light source is switched off, the signal from the trap appears to drop off more slowly than the signal from the surrounding pixels.

*12 Hot spots are counted if they exhibit >50 times the maximum specified dark current at the test temperature indicated.

*13 A column is considered defective if >10 pixels are affected, or if the column exhibits >2 times the maximum specified dark current at the test temperature indicated.

iKon-M 934 Series

1 Megapixel, -100°C, 5 MHz Imaging CCD



Features and Benefits

- **TE cooling to -100°C**
  Critical for elimination of dark current detection limit
- **QE_{max} 95% from back-illuminated sensor**
  Highest photon collection efficiency
- **Ultra low noise readout**
  Intelligent low-noise electronics offer the most 'silent' system noise performance available
- **Up to 5 MHz pixel readout**
  High frame rates achievable
- **UltraVac™ [1]**
  Critical for sustained vacuum integrity and to maintain unequalled cooling and QE performance, year after year
- **13 x 13 µm pixel size**
  Optimal balance of dynamic range and resolution
- **USB 2.0 connection**
  Simple Plug & Play connection
- **Integrated shutter**
  C-mount shutter as standard. Closed during readout to avoid vertical smear
- **Cropped Sensor Mode**
  Specialised acquisition mode for continuous imaging with fastest possible temporal resolution
- **Enhanced Baseline Clamp**
  Quantitative accuracy of dynamic measurements

Industry-Leading Ultra-Sensitive Imaging Technology

Andor's iKon-M 934 series cameras are designed to offer the ultimate in high-sensitivity, low noise performance, ideal for demanding imaging applications. These high resolution 1024 x 1024 CCD cameras boast up to 95% QE_{max}, high dynamic range, 13 µm pixels and exceptionally low readout noise. The iKon-M benefits from negligible dark current with industry-leading thermoelectric cooling down to -100°C.

The BR-DD 'Deep Depletion' sensor option offers ultimate performance for NIR applications, delivering > 90% QE beyond 800 nm and incorporating Fringe Suppression Technology™ to minimize etaloning effects. Rapid vertical shifts combined with fast kinetics acquisition mode, comprehensive trigger modes and custom coated wedge window render the BR-DD model an ideal solution for NIR optimized Bose Einstein Condensation applications.

Specifications Summary

Active pixels	**1024 x 1024**
Sensor size	**13.3 x 13.3 mm**
Pixel size (W x H)	**13 µm x 13 µm**
Active area pixel well depth	**100,000 e^-**
Pixel readout rates (MHz)	**5, 3, 1, 0.05**
Read noise	**2.9 e^-**
Maximum cooling	**-100°C**
Frame rate	**4.4 fps (full frame)**

System Specifications[*2]

Model number	DU934P	DU934P (Deep Depletion)
Sensor options	BU2: Back Illuminated CCD, UV-Enhanced, 250 nm optimized BV: Back Illuminated CCD, Vis optimized FI: Front Illuminated CCD	BR-DD: Back Illuminated CCD,Deep Depletion with fringe suppression. Optimum sensor for Near IR applications.
Active pixels	1024 x 1024	
Pixel size	13 x 13 µm	
Image area	13.3 x 13.3 mm with 100% fill factor	
Minimum temperatures [*3] Air cooled Coolant recirculator Coolant chiller, coolant @ 10°C, 0.75l/min	 -80°C -95°C -100°C	
Digitization	16 bit	
Blemish specifications	Grade 1 sensor	
System window type	Single quartz window; AR coated on both sides for BV & FI models. Custom coated windows can be ordered on request, e.g. 780 nm optimized for Rb BEC experiments	
Interface	USB 2.0	
Lens mount	C-mount	

Advanced Performance Specifications[*2]

Dark current, e^-/pixel/sec [*4] @ -80°C @ -100°C	 0.0003 0.00012	 0.017 0.00047
Pixel readout rates	5, 3, 1, 0.05 MHz	
Pixel well depth	100,000 e^-	
Read noise (e^-) [*5] 0.05 MHz 1 MHz 3 MHz 5 MHz	 2.9 6.6 11.6 18	 3.3 6.2 9.2 13.6
Linearity [*6]	Better than 99%	
Vertical clock speed	11.3 to 67.3 µs (software selectable)	4.25 to 64.25 µs (software selectable)

Frame Rates[*7]

50 kHZ				
Binning	Full Frame	512 x 512	256 x 256	128 x 128
1 x 1	0.04	0.1	0.2	0.4
2 x 2	0.2	0.2	0.4	0.8
4 x 4	0.6	0.6	0.9	1.5
8 x 8	2	1.2	1.7	2.8
16 x 16	5.1	2.3	3.2	5

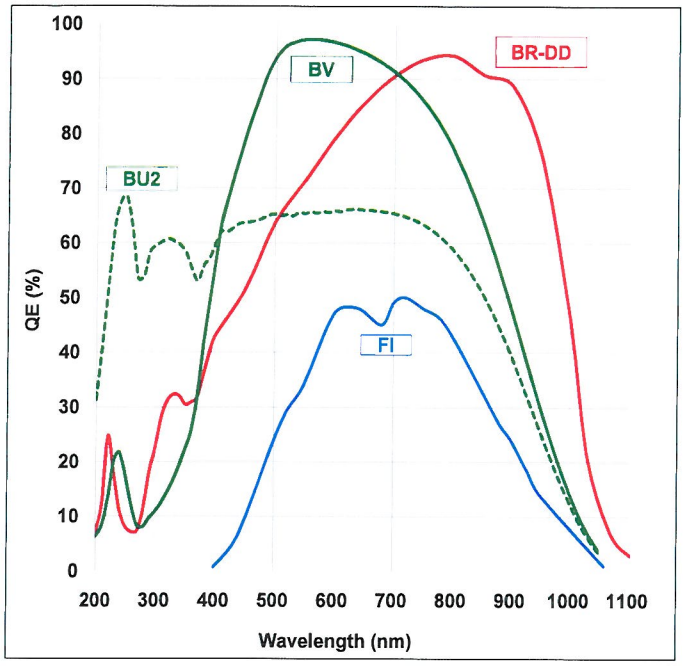
1 MHz				
Binning	Full Frame	512 x 512	256 x 256	128 x 128
1 x 1	0.9	1.8	3.5	6.9
2 x 2	2.9	4.3	7.5	13.5
4 x 4	7.9	9.4	14.8	24.6
8 x 8	18	18.2	26.6	40.7
16 x 16	33.4	31.6	43	59.8

3 MHz				
Binning	Full Frame	512 x 512	256 x 256	128 x 128
1 x 1	2.6	5.2	10	18.6
2 x 2	6.3	10.9	19.3	33.2
4 x 4	13.4	20.9	34.2	53.5
8 x 8	25.1	36.3	54.4	76.5
16 x 16	41.5	56.1	76.5	97.1

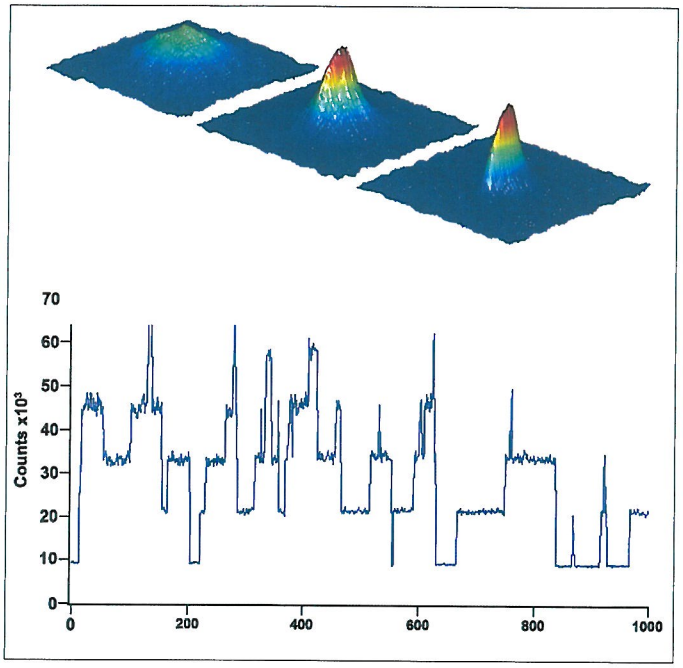
5 MHz Visualization mode				
Binning	Full Frame	512 x 512	256 x 256	128 x 128
1 x 1	4.4	8.5	16	28.8
2 x 2	8.4	15.9	28.5	47.6
4 x 4	15.6	28.1	47	70.8
8 x 8	27.3	45.8	69.4	93.5
16 x 16	43.6	66.9	91.2	111.5

Quantum Efficiency Curves [8]

20°C



Application Image



The top image shows surface plots of the transition from a thermal gas (left) to a Bose-Einstein condensate. The sharp, bimodal peak in the right figure is a signature of BEC. The graph below it shows fluorescence from a few-atom MOT v time, showing the discrete steps characteristic of single atoms entering and leaving the trap.
Courtesy of Prof. Michael Chapman, Georgia Institute of Technology, USA.

Have you found what you are looking for?

Need a larger sensor? The iKon-L 936 houses a 4 megapixel, back-illuminated CCD sensor (27.6 mm x 27.6 mm), cooling to -100°C, low noise performance and up to 5 MHz readout.

Need the ultimate in sensitivity? The iXon3 back-illuminated EMCCD series offers > 90% QE and single photon sensitivity, combined with fast frame rate performance.

Need faster frame rates? The 1 megapixel iXon3 885 EMCCD delivers 31 frames/sec (60 frames/s with 2 x 2 binning) with single photon sensitivity. Neo sCMOS delivers up to 100 frames/sec (full frame).

Need smaller pixels? Check out the iXon3 885 & Luca^{EM} EMCCDs, the Clara Interline CCD and the Neo sCMOS.

Need sensitive performance in the red/NIR with zero fringing (etaloning)? The iXon3 885 EMCCD cameras offer excellent QE across the red/NIR wavelength region with zero fringing, ideally suited to red-enhanced fluorophores and NIR applications, such as BEC of Rubidium.

Need a price/performance EMCCD? The Luca^{EM} R is a compact 1 Megapixel EMCCD USB 2.0 camera, offering high resolution and ultra-sensitivity at 12.4 frames/sec.

Need a customised version? Please contact us to discuss our Customer Special Request options.

Check out Andor's New Neo sCMOS. *Simultaneously* offering, ultra-sensitivity, high speed, high-resolution, large field of view & high dynamic range!

Creating The Optimum Product for You

How to customise the iKon-M 934:

Step 1.

The iKon-M 934 comes with 4 options for sensor types. Please select the sensor which best suits your needs.

Step 2.

Please indicate which software you require.

Step 3.

For compatibility, please indicate which accessories are required.

DU934P-BV
example shown

Step 1.

Choose sensor type

BR-DD: Back Illuminated. Deep Depletion CCD with fringe suppression
BU2: Back Illuminated CCD. AR coated for optimised performance in the 250 nm region
BV: Back Illuminated CCD. Vis optimised
FI: Standard front illuminated device

Step 2.

The iKon-M requires at least one of the following software options:

Solis for Imaging A 32-bit application compatible with 32 and 64-bit Windows (XP, Vista and 7) and Linux offering rich functionality for data acquisition and processing. AndorBasic provides macro language control of data acquisition, processing, display and export.

Andor SDK A software development kit that allows you to control the Andor range of cameras from your own application. Available as 32 and 64-bit libraries for Windows (XP, Vista and 7) and Linux.

Andor iQ A comprehensive multi-dimensional imaging software package. Offers tight synchronization of EMCCD with a comprehensive range of microscopy hardware, along with comprehensive rendering and analysis functionality. Modular architecture for best price/ performance package on the market.

Third party software compatibility
Drivers are available so that the iKon-M 912 range can be operated through a large variety of third party imaging packages. See Andor web site for detail: http://www.andor.com/software/

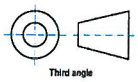
Step 3.

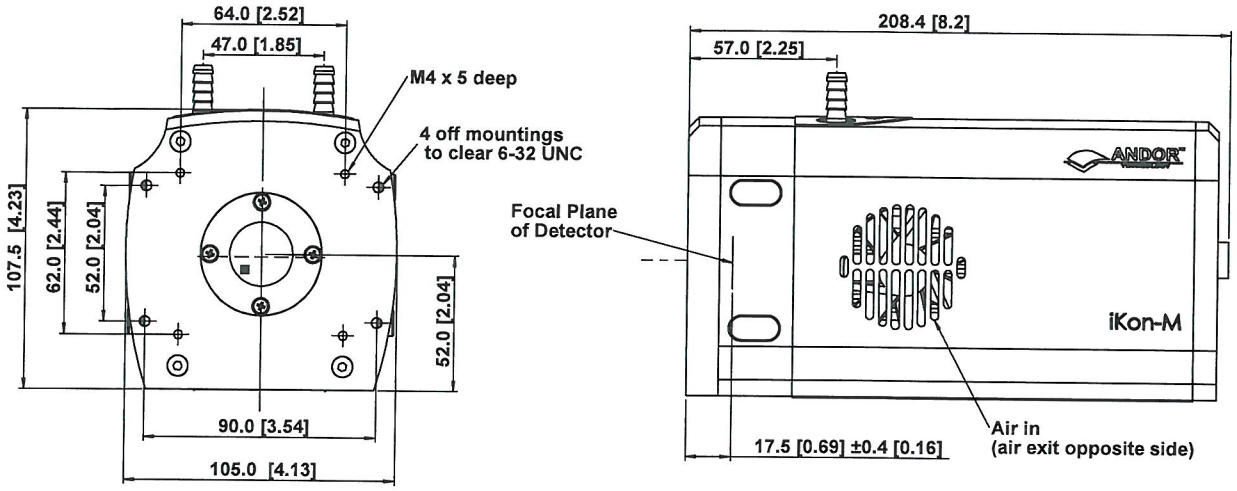
The following accessories are available:

XW-RECR Re-circulator for enhanced cooling performance
ACC-XW-CHIL-160 Oasis 160 Ultra compact chiller unit
OA-CCFM C-mount to Canon F-mount adapter
OA-CNAF C-mount to Nikon F-mount adapter
OA-COFM C-mount to Olympus F-mount adapter
OA-CTOT C-mount to T-mount adapter
OA-ECAF Auto ext. tubes (set of 3) for Canon AF
OA-ECMT Auto ext. tubes (set of 3) for C-mount
OA-ENAF Auto ext. tubes (set of 3) for Nikon AF
XU-RECR/TRANS USB 2.0 - Transmitter and Receiver, including 2 power supplies

Product Drawings

Dimensions in mm [inches]





■ = position of pixel 1,1

Weight: 2.2 kg [4 lb 13 oz]

Connecting to the iKon-M

Camera Control

Connector type: USB 2.0 with optional lockable connector

TTL / Logic

Connector type: SMB, provided with SMB - BNC cable

Fire (Output), External Trigger (Input), Shutter (Output)

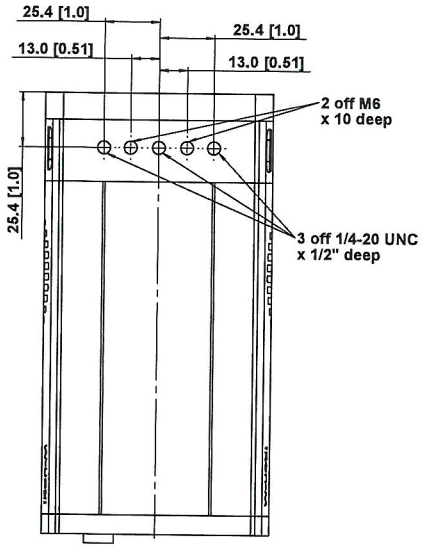
I²C connector

Compatible with Fischer SC102A054-130

Shutter (TTL), I²C Clock, I²C Data, +5 Vdc, Ground

Minimum cable clearance required at rear of camera

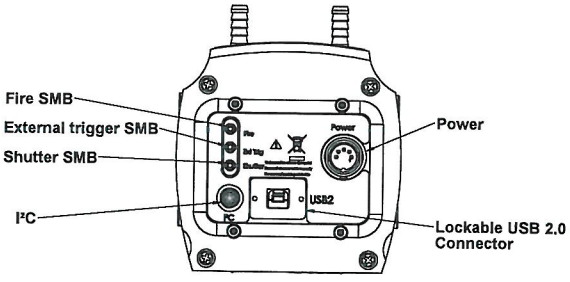
90 mm



Mounting hole locations

Typical Applications

- Bose-Einstein Condensation (BEC)
- Astronomy
- Bioluminescence/Chemiluminescence
- In-Vivo Imaging
- Photovoltaic Inspection (see the iKon-M PV Inspector Specification Sheet)
- Semiconductor Analysis
- Biochip Reading



Rear connector panel

Order Today

Need more information? At Andor we are committed to finding the correct solution for you. With a dedicated team of technical advisors, we are able to offer you one-to-one guidance and technical support on all Andor products. For a full listing of our regional sales offices, please see: www.andor.com/contact

Our regional headquarters are:

Europe
Belfast, Northern Ireland
Phone +44 (28) 9023 7126
Fax +44 (28) 9031 0792

Japan
Tokyo
Phone +81 (3) 3518 6488
Fax +81 (3) 3518 6489

North America
Connecticut, USA
Phone +1 (860) 290 9211
Fax +1 (860) 290 9566

China
Beijing
Phone +86 (10) 5129 4977
Fax +86 (10) 6445 5401

Items shipped with your camera

1x 2 m BNC - SMB connection cable
1x 3 m USB 2.0 cable Type A → Type B
1x Power supply with mains cable
1x Quick launch guide
1x CD containing Andor user guides
1x Individual system performance booklet

Footnotes: Specifications are subject to change without notice

1. Assembled in a state-of-the-art cleanroom facility, Andor's UltraVac™ vacuum process combines a permanent hermetic vacuum seal (no o-rings), with a stringent protocol to minimize outgassing, including use of proprietary material.
2. Figures are typical unless otherwise stated.
3. Specified minimum air cooled temperature assumes ambient temperature of 25°C. Specified minimum temperature with coolant assumes coolant temperature of 10°C.
4. The dark current measurement is averaged over the sensor area excluding any regions of blemishes.
5. Readout noise is for the entire system. It is a combination of sensor readout noise and A/D noise. Measurement is for Single Pixel readout with the sensor at a temperature of -80°C and minimum exposure time under dark conditions.
6. Linearity is measured from a plot of counts vs exposure time under constant photon flux up to the saturation point of the system.
7. The frame rates shown are for the BR-DD model, for a range of binning or array size combinations. All measurements are made with 4.25 µs vertical shift speed. It also assumes internal trigger mode of operation and minimum exposure time. Note: 5 MHz = Visualization mode only.
8. Quantum efficiency of the sensor at 20°C as measured by the sensor manufacturer.

Minimum Computer Requirements:

- 3.0 GHz single core or 2.4 GHz multi core processor
- 2 GB RAM
- 100 MB free hard disc to install software (at least 1GB recommended for data spooling)
- USB 2.0 High Speed Host Controller capable of sustained rate of 40MB/s
- Windows (XP, Vista and 7) or Linux

Operating & Storage Conditions

Operating Temperature 0°C to 30°C ambient
Relative Humidity < 70% (non-condensing)
Storage Temperature -25°C to 50°C

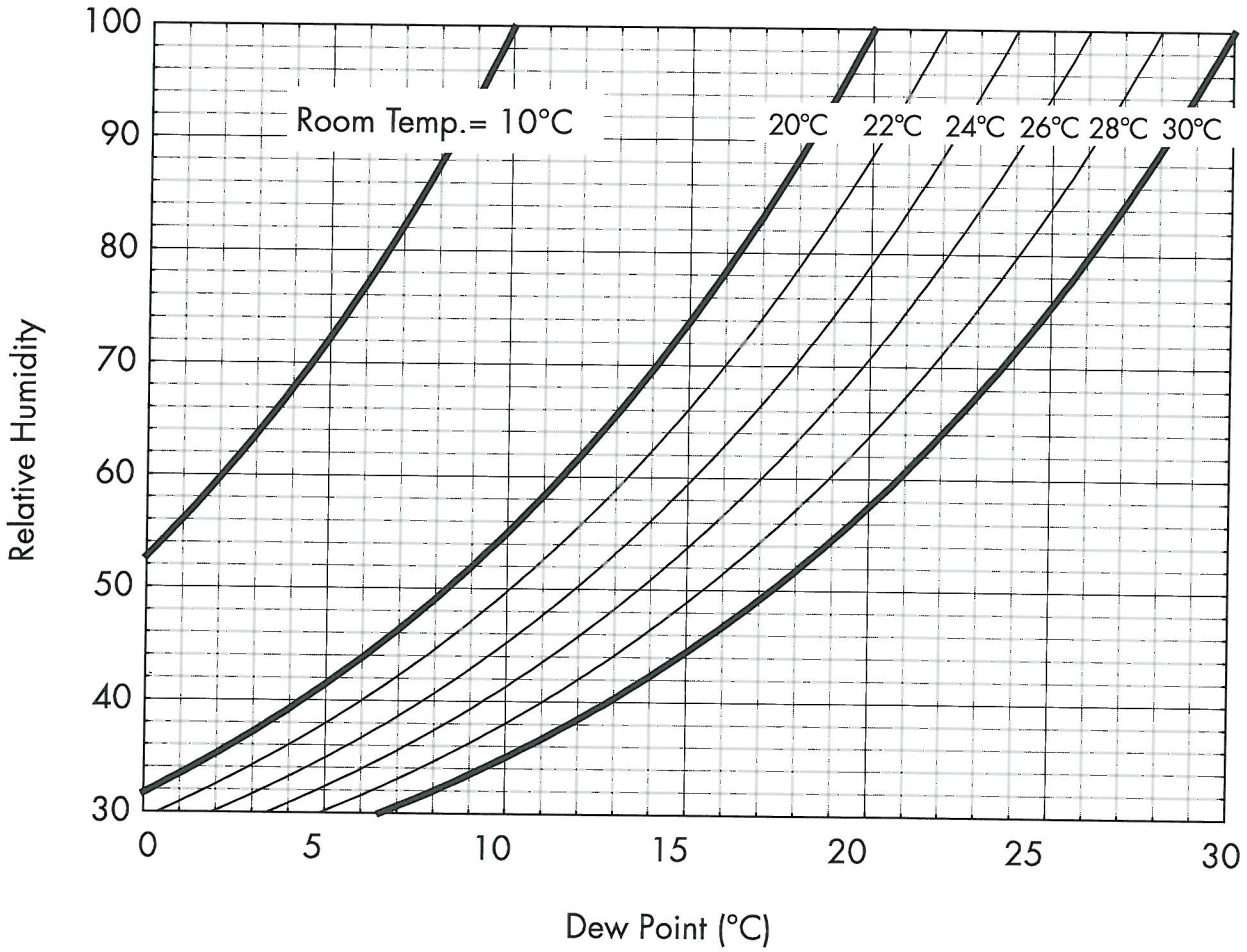
Power Requirements

110 - 240 VAC, 50 - 60 Hz

LiKonM934SS 0611 R2

Dew Point

To achieve ultimate cooling performance you need 10°C water. In humid conditions this will cause condensation and hence damage to the CCD head. Unfortunately in such con-ditions you will have to use warmer water. The following graph gives you a guideline to determine the dew point and select water temperature in humid conditions. For example if the room temperature is 24°C and relative humidity is 50%, the dew point can be determined from the graph to be 12°C. Therefore water temperature must be higher than dew point (i.e. >12°C). Typical water temperature should be 2°C higher than dew point (in this example ~14°C). This will limit the minimum CCD temperature (refer to the table in the manual).



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Please contact: Dr. Markus Wewer, phone: +49/6151/8806-754, eMail: wewer@lot-oriel.de
or Olaf Koschützke, phone: +49/6151/880643, eMail: koschuetzke@lot-oriel.de

LOT-Oriel Group Europe. Im Tiefen See 58. D-64293 Darmstadt. phone: +49/6151/8806-0. fax: +49/6151/896667. www.lot-oriel.com/de