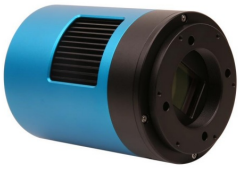
ATR294C Color Camera



ToupTek ATR294C Color Camera User Manual

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ToupTek ATR294C Color Camera

Description and Features

The ATR294C(ATR3CMOS10300KPA) camera is designed specifically for astrophotography. It is mainly used for deep sky photo shooting since the camera has cooled CMOS sensor, ultra-low readout noise, and low amp-glow. It can be also used for planetary photo shooting. Its extraordinary performance and extensive usage will give you a great astrophotography experience.

The features of ATR294C are listed below:

- IMX 294 Color CMOS Sensor
- Resolution: 4128 x 2808
- 4.63μm Square Pixel
- 4:3 Optical Format
- 14-bit ADC
- 512 Mbyte Memory
- Precise Temperature Regulation
- G Sensitivity: 419.02 mv with 1/30s
- Low Amp-Glow
- Ultra-Low Noise: 0.87 to 4.1e-
- Support High Frame Rate Mode (16.6 FPS at all Pixel Readout 14 bit)
- SNR Max: 48.0 dB
- Dynamic Range: 84.4 dB
- -35 C below ambient under short exposure/ -42 C under long exposure time (> 1s)

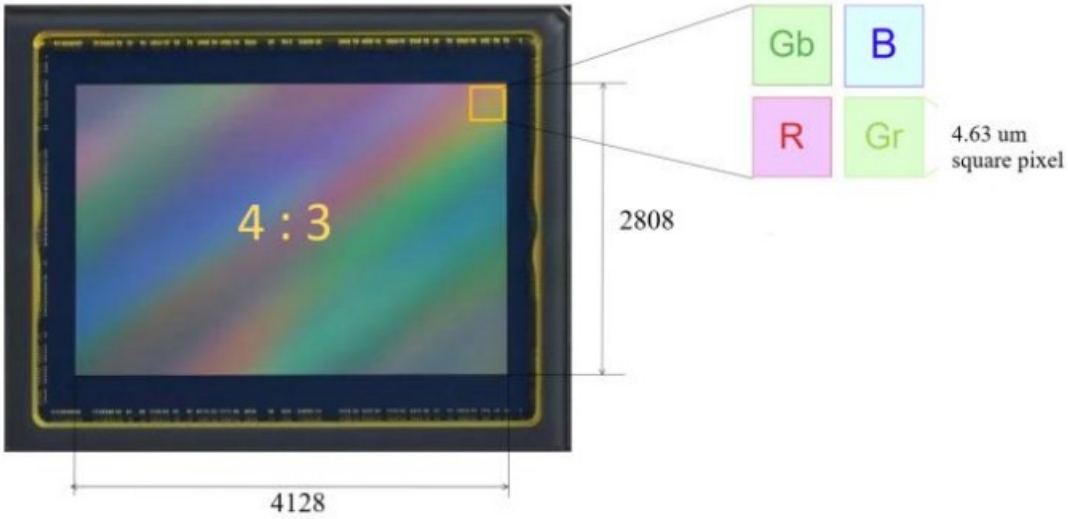


Figure 1 IMX294 Sensor and Its Pixel Structure

ATR294C Specifications and Performance

Camera Specifications

Table 1 ATR294C Technique Specifications.

Sensor	Sony IMX294 back-illuminated sensor	
Diagonal	23.1 mm	
Image Resolution	11.6 megapixels (4128*2808)	
Pixel Size	4.63mm ´ 4.63mm	
Image Area	19.1mm ´ 13.0mm	
Max FPS at Resolution (USB 3.0)	14bit	8bit
	16.6 FPS @ 4128*2808 19.3 FPS @ 4096*2160 69.5 FPS @ 2048*1080 96.0 FPS @ 1360*720	33.3 FPS @ 4128*2808 38.5 FPS @ 4096*2160 69.5 FPS @ 2048*1080 96.2 FPS @ 1360*720
Max FPS at Resolution (USB 2.0)	14bit	8bit
	1.9 FPS @ 4128*2808 2.0 FPS @ 4096*2160 7.6 FPS @ 2048*1080 16.7 FPS @ 1360*720	2.2 FPS @ 4128*2808 5.1 FPS @ 4096*2160 15.2 FPS @ 2048*1080 33.3 FPS @ 1360*720
Shutter Type	Rolling shutter	
Exposure Time	0.1ms – 3600s	
Gain	1x – 160x	
SNR	48.0 dB	
Dynamic Range	84.4 dB	
Read Noise	4.1 – 0.87 e-	
QE Peak	>80%	
Full Well	64ke-	
ADC	14bit	
DDR3 Buffer	512MB (4Gb)	
Connection Port	USB3.0/USB2.0	
Camera Adaptor	M42 ´ 0.75mm	

Protect Windows	IR-cut filter/AR-window
Spectral Range	380-690nm (with IR-cut filter)
Capture/Control SDK	Windows/Linux/macOS/Android Multiple Platform SDK (Native C/C++, C#/ VB.NET, Python, Java, DirectShow, Twain, etc.);
Recording System	Still picture and movie
Camera Dimensions	Diameter 80mm * height 107.1mm
Camera Weight	0.577kg
Back Focus Distance	17.5mm
Cooling:	Two-stage TEC
Effective Cooling Temp:	-35°C below ambient under short exposure/ -42°C under long exposure (> 1s)
Supported OS	Microsoft® Windows® XP / Vista / 7 / 8 / 10 / 11(32 & 64 bit) OS x (Mac OS X) Linux

Sony IMX294 Sensitivity

The sensor G Sensitivity of ATR294C is 419.02 mv with 1/30s 30s. Its spectral sensitivity is shown in Figure 2.

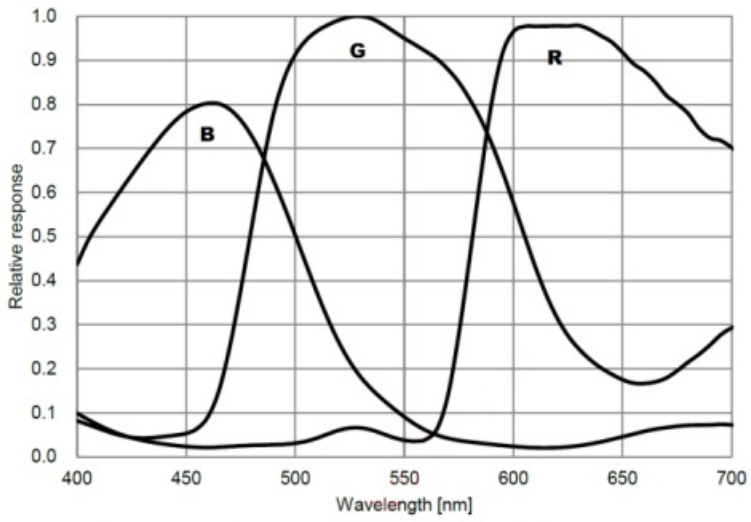


Figure 2 IMX294 Spectral Sensitivity Characteristic

14bit ADC and ROI

ATR294C has built-in 1 4-bit ADC. It also has 12-bit output mode for hardware binning and a smaller resolution. The camera also support s hardware ROI, and the smaller the ROI size is, the higher the frame rate is. Table 2 shows the frame rate of ATR294C in 1 4 8 b it mode, USB3.0 USB2.0 data transfer interface at different resolutions:

Table 2 ATR294C Frame Rate at Different Resolution/Data Bit/Data Transfer (USB3.0/ USB2.0)

Bit & Interface FPS Resolution	14bit ADC		8bit ADC	
	USB3.0	USB2.0	USB 3.0	USB 2.0
4128*2808	16.6	1.9	33.3	2.2
4096*2160	19.3	2.0	38.5	5.1
2048*1080	69.5	7.6	69.5	15.2
1360*730	96.0	16.7	96.2	33.3

DDR3 Buffer
The ATR294C camera has a 512MB (4Gb) DDR3 buffer, which helps maintain the stability of data transmission, and effectively reduces the amp-glow caused because image data can be temporarily buffered without being sent hastily to the receiver.

Binning
ATR294C supports digital binning from 1×1 to 8×8 in either the stacking or averaging method and hardware binning from 1×1 to 3×3 in the averaging method. Hardware pixel binning is much faster than software binning.

Conversion Gain Switch
ATR294C supports HCG and LCG mode switches. When HCG mode is toggled, the user could experience ultra-low noise results.

Power and Cooling System for Precise Temperature Regulation
Please remember that, the Camera can be powered only by a DC12V 3A power source. The cooling system of ATR294C is two-stage Thermoelectric Cooling (TEC) with a controllable electric fan assisting heat dissipation. The TEC system is controlled by the PID algorithm, which allows the TEC to be precisely regulated towards the target temperature with 0.1ºC deviation. The working temperature can be regulated to a specific number, and the effective temperature drop can be -42ºC from the ambient temperature. Such efficient cooling system guarantees the quality of the camera image.

Low Amp-Glow
ATR294C has been carefully designed and can achieve low amp-glow photo shooting. Figure 3 and Figure 4 show the different cameras at 20ºC and 5-minute exposure time with high amp glow and low amp glow. By comparison, the image captured by ATR294C shows low amp-glow.

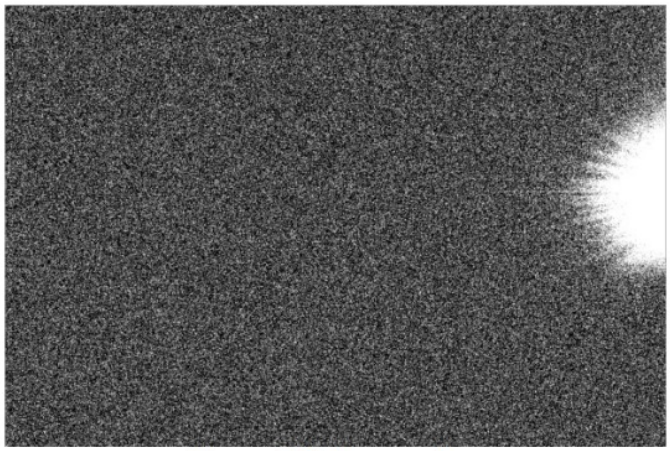


Figure 3 High amp-glow

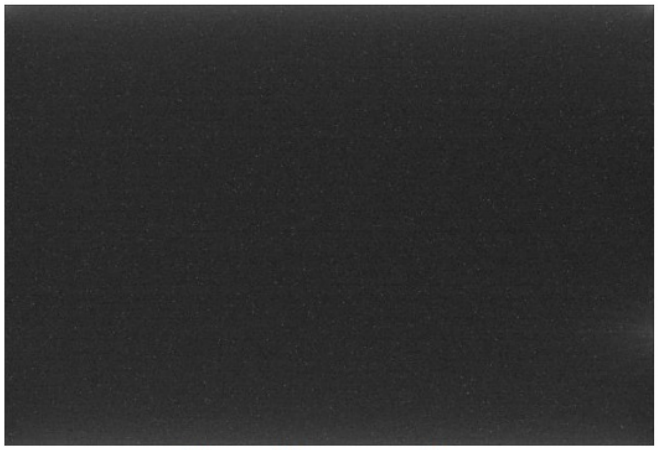


Figure 4 Low amp-glow

Camera Performance Analysis
Camera performance can be evaluated with e-/ADU, Read Noise, Full Well, and Dynamic Range.

e-/ADU: The sensors found in cameras used for vision applications have pixels that convert incoming photons into electrons. Gain on a CCD /CMOS camera represents the conversion factor from electrons (e-) into digital counts, or Analog-Digital Units (ADUs). Gain is expressed as the number of electrons that get converted into a digital number, or electrons per ADU (e-/ADU).

Read Noise: Read Noise is created within the camera electronics during the readout process as the electrons are subjected to the analog to digital conversion, amplification, and processing steps that enable an image to be produced. Read Noise is the most important reference to measure the performance of a camera. Lower read noise usually means better SNR and better quality of image.

Full Well: The electrons are held in each pixel and are converted into electrical charge which can be measured to show the amount of light that has fallen on each pixel. The maximum electrical charge possible is termed “full well capacity”. Under the same conditions such as noise and A/D converter quality, the greater the full well capacity a sensor has, the wider dynamic range the sensor has. As there is a limit to the depth to which pixels can be made, the full well capacity is often proportional to the frontal area of the light-gathering element of the pixel.

Dynamic Range: Dynamic Range is the ratio between the maximum output signal level and the noise floor at minimum signal amplification (noise floor which is the RMS (root mean square) noise level in a black image). The noise floor of the camera contains sensor readout noise, camera processing noise, and the dark current shot noise. The dynamic range represents the camera’s ability to display/reproduce the brightest and darkest portions of the image and how many variations in between. This is technically an intra-scene dynamic range. Within one image there may be a portion that is in complete black and completely saturated.

For the ATR series camera, the Gain Value is in xxx% mode. Here xxx is used as the x-axis (Gain Value) for the description of the camera performance

- ??? ????(??) = 20 ∗ ???10[???(???? ?????)/100]
- ???(???? ?????) = 100 × 10(??? ????(??)/20

All following data were acquired in SharpCap with ASCOM driver:
Camera setting used for HCG performance analysis is shown below:

- Full resolution
- RAW 14-bit mode
- Temperature: -10ºC

Figure 5 shows the curves of the camera analysis data in Table 3

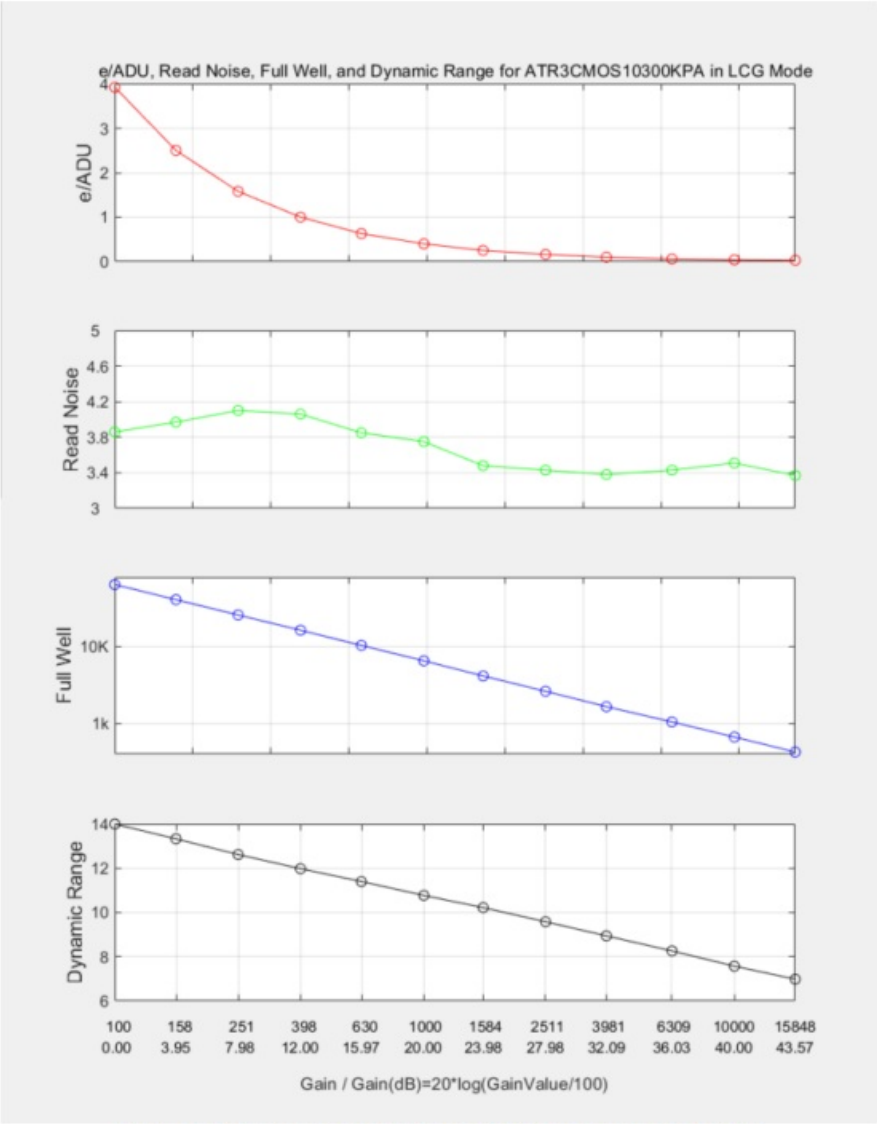


Figure 5 e/ADU, Read Noise, Full Well and Dynamic Range for ATR294C

The camera analysis data is shown in Table 3:

Table 3 Camera Analysis Data

SensorAnalysis Data												
Gain Value	**100**	**158**	**251**	**398**	**630**	**1000**	**1584**	**2511**	**3981**	**6309**	**10000**	**15848**
Rel Gain (dB)	**0**	**3.92**	**7.9**	**11.9**	**15.8**	**19.8**	**23.6**	**27.6**	**31.5**	**35.7**	**39.7**	**43.6**
e-/ADU	**3.92**	**2.5**	**1.58**	**1.00**	**0.63**	**0.40**	**0.25**	**0.16**	**0.1**	**0.06**	**0.04**	**0.03**
Read Noise (e-)	**3.86**	**3.97**	**4.1**	**4.06**	**3.85**	**3.75**	**3.48**	**3.43**	**3.38**	**3.43**	**3.51**	**3.37**
Full Well (ke-)	**64.2**	**40.9**	**25.8**	**16.4**	**10.4**	**6.6**	**4.2**	**2.6**	**1.7**	**1.05**	**0.67**	**0.43**
Dynamic Range (stop)	**14**	**13.3**	**12.6**	**12.0**	**11.4**	**10.8**	**10.2**	**9.58**	**8.94**	**8.26**	**7.57**	**6.98**

Camera setting used for LCG performance analysis is shown below:

- Full resolution

- RAW 14-bit mode
- Temperature: -10ºC

Figure 6 shows the curves of the camera analysis data in Table 4

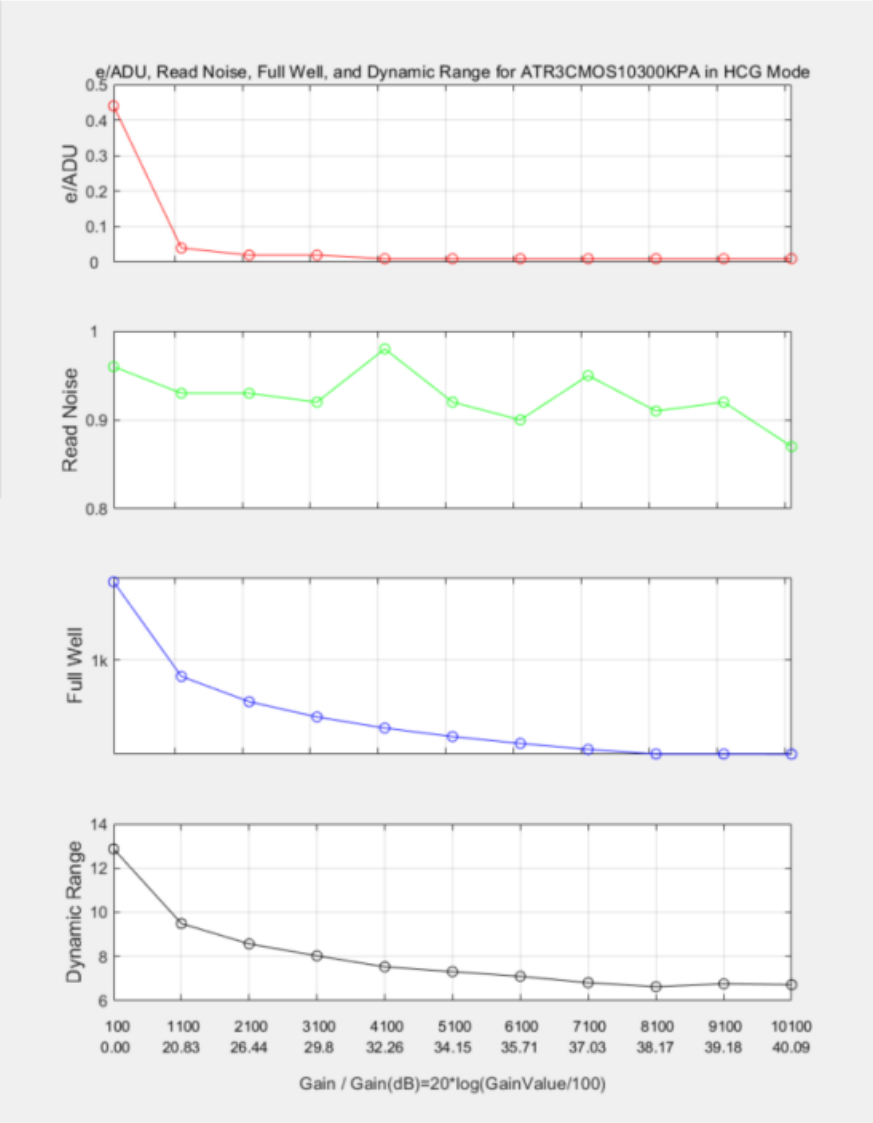


Figure 6 e/ADU, Read Noise, Full Well and Dynamic Range for ATR294C

The camera analysis data is shown in Table 4:

Table 4 Camera Analysis Data

SensorAnalysis Data											
Gain Value	**100**	**1100**	**2100**	**3100**	**4100**	**5100**	**6100**	**7100**	**8100**	**9100**	**10100**
Rel Gain (dB)	**0**	**20.66**	**26.19**	**29.52**	**31.95**	**33.81**	**35.31**	**36.61**	**37.61**	**37.61**	**37.65**
e-/ADU	**0.44**	**0.04**	**0.02**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
Read Noise (e-)	**0.96**	**0.93**	**0.93**	**0.92**	**0.98**	**0.92**	**0.9**	**0.95**	**0.91**	**0.92**	**0.87**
Full Well (ke-)	**7.2**	**0.67**	**0.35**	**0.24**	**0.18**	**0.15**	**0.12**	**0.11**	**0.09**	**0.09**	**0.09**
Dynamic Range (stop)	**12.87**	**9.49**	**8.57**	**8.03**	**7.53**	**7.31**	**7.1**	**6.81**	**6.63**	**6.76**	**6.72**

Product Package and Connections

Packing List

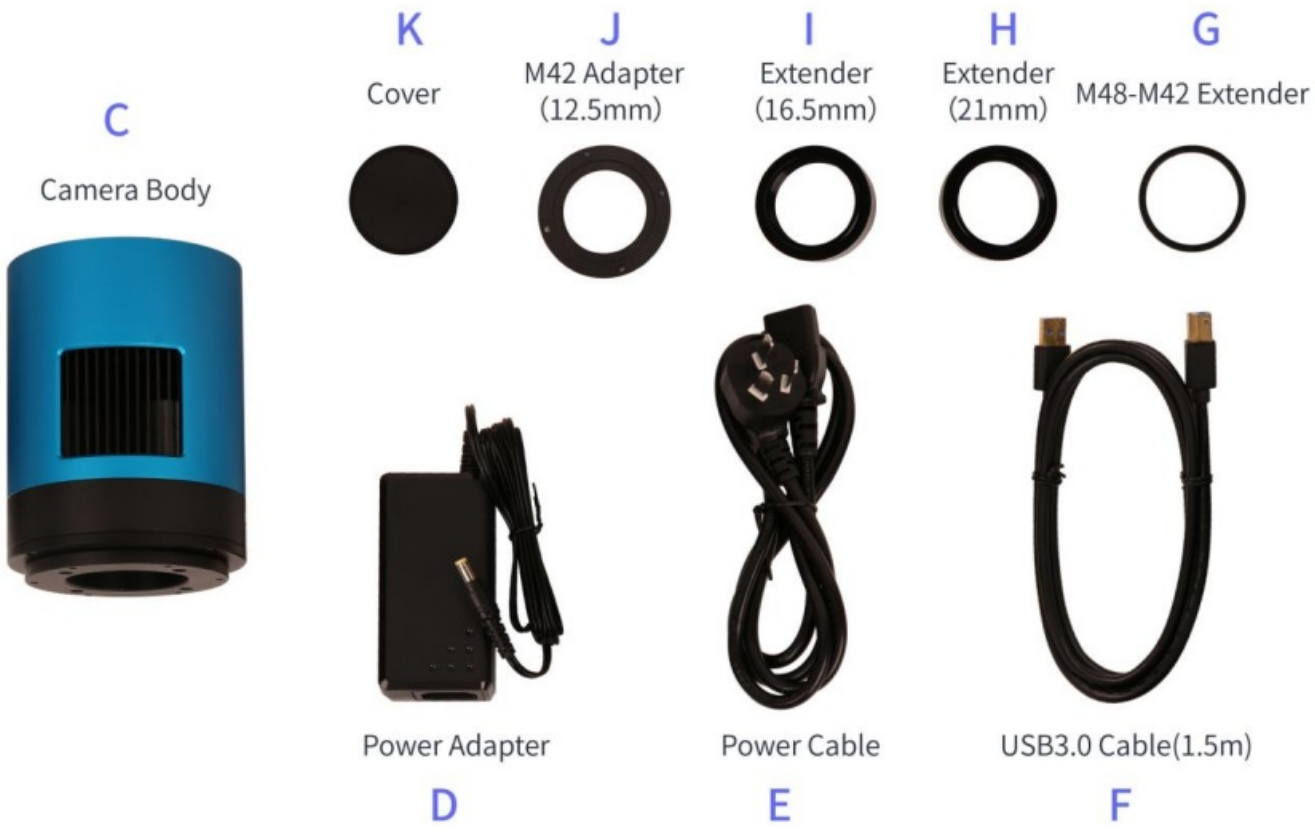


Figure 7 Packing Information of ATR294C

Table 5 ATR294C Packing List

Standard Package	
A	Carton L:50cm W:30cm H:30cm (20pcs, 12~17Kg/ carton, 0.045m3), not shown in the photo
B	3-A safety equipment case: L:28cm W:23cm H:15cm (1pcs, 3.9Kg/ box); carton size: L:28.2cm W:16.7cm H:25.5cm (**TBD**), not shown in the photo
C	ATR series camera (M42x0.75 Mount+2” adapter)
D	Power adapter: input: AC 100~240V 50Hz/60Hz, output: DC 12V 3.3A
E	Power cable
F	High-Speed USB3.0 A male to B male gold-plated connectors cable /1.5m
G	M48-M42 extender 0mm
H	M42M-M42F extender 21mm (**TBD**)
I	M48F – M42M extender 16.5mm (**TBD**)
J	M42M adapter 12.5mm
K	Cover

Camera Dimension and Its Mount

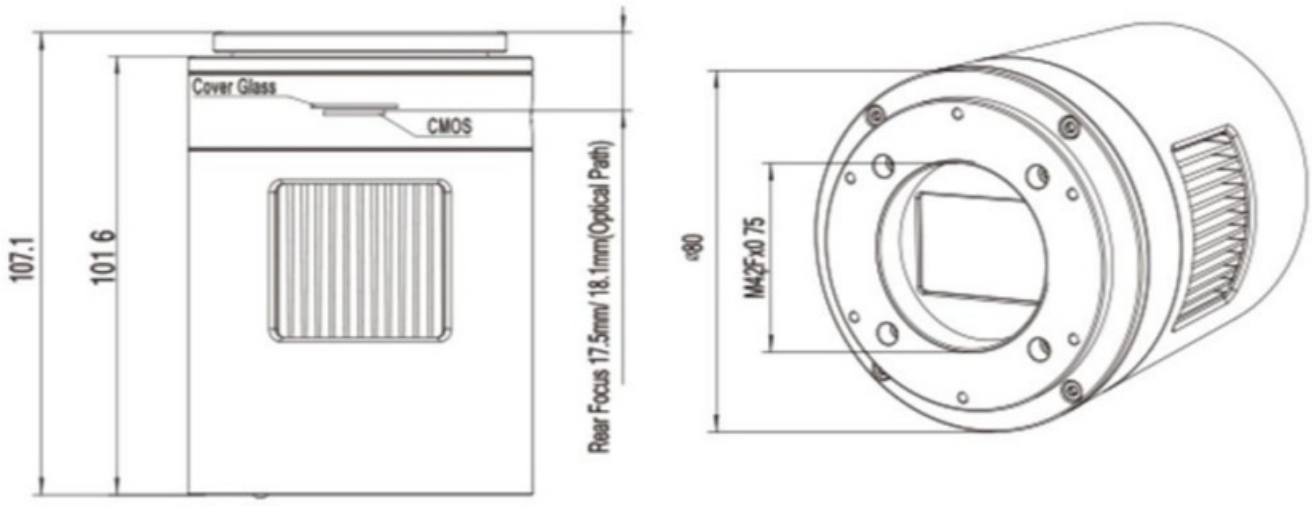


Figure 8 Dimension and Mount of ATR294C

Table 6 Dimension and Mount of ATR294C

Item	**Specification**
Diameter	Æ80mm
Height	107.1mm
Mount	M42Fx0.75mm

Camera Outline and Interface

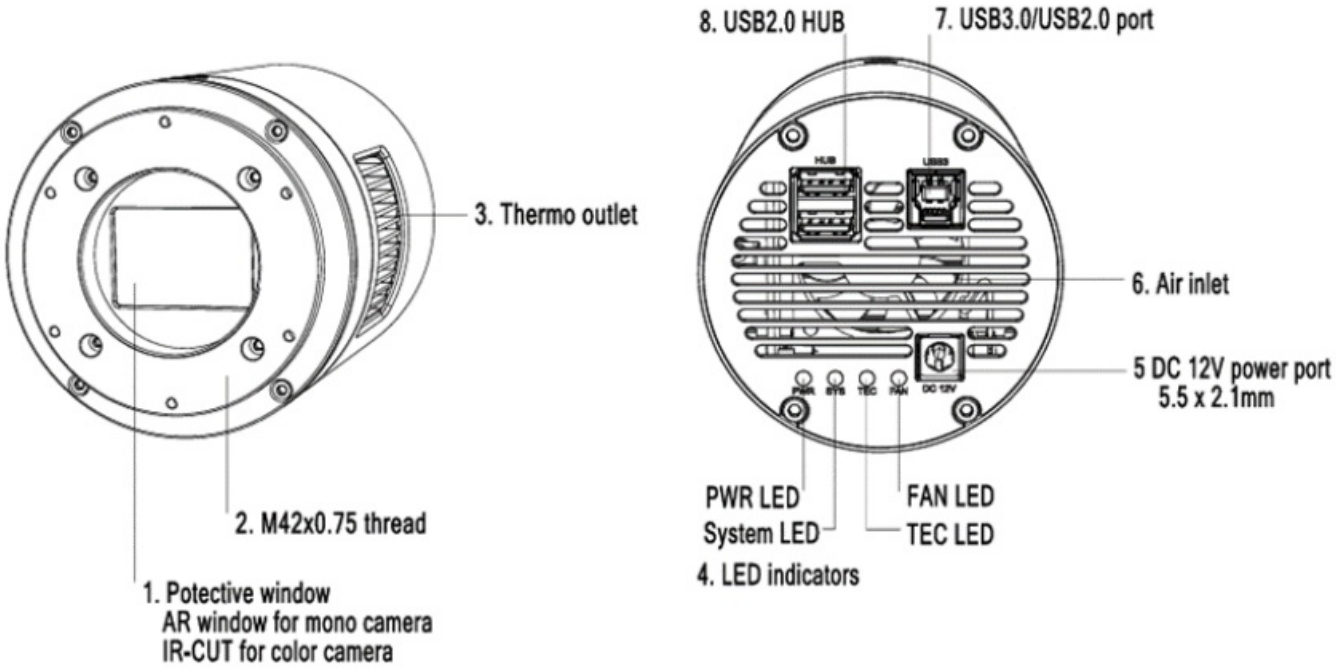


Figure 9 Camera Outline and Interface.

Table 7 Camera Outline and Interface List

Item	Specification
1	Protective window, AR window for mono camera, IR-cut filter for color camera
2	M42F ´ 0.75 thread
3	Thermal outlet or radiator
4	LED indicators: 1) Power LED. 2) System LED. 3)TEC LED. 4)Fan LED
5	DC 12V 3A power port, 5.5 ´ 2.1mm
6	Air inlet
7	USB 3.0/ USB 2.0 port
8	USB 2.0 HUB

Camera Mechanical Connection with Adapter

ATR294C can be connected to a telescope with a proper adapter, or the camera lens. The most common adapters are already included in the package, but we also provide some specific adaptors based on the requirement. The female flange to the sensor is 17.5mm. ATR294C comes with an M42x0.75 mount and can connect to the telescope with the M42x0.75 thread in a direct way. ATR294C can also connect to the telescope that uses 1.25” or 2” eyepieces by M42M-1.25” or M42M-2” adapter. Figure 10 shows the connection of the camera and the adapter. After the adapter is screwed into the camera, the camera can insert into the telescope’s eyepiece tube. Table 8 lists the details of the camera and adapter parameters.

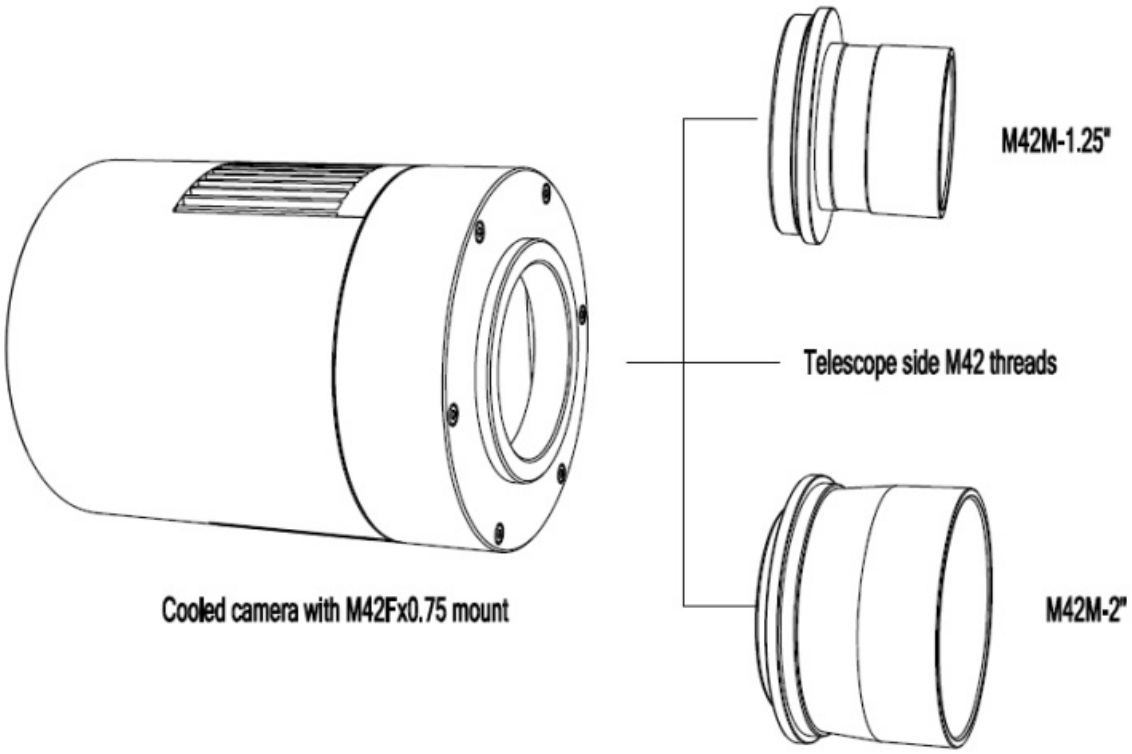


Figure 10 The Connection of the ATR Camera and Adapter

Item	Specification
Back Focal Distance	17.50mm
M42M-1.25” Adapter	M48M-1.25” adapter for 1.25” telescope
M42M-2” Adapter	M42M-2” adapter for 2” telescope

Camera Mechanical Connection with Lens

Figure 11 shows the connections between the ATR camera and the lens. Table 9 lists the connection’s parameters.

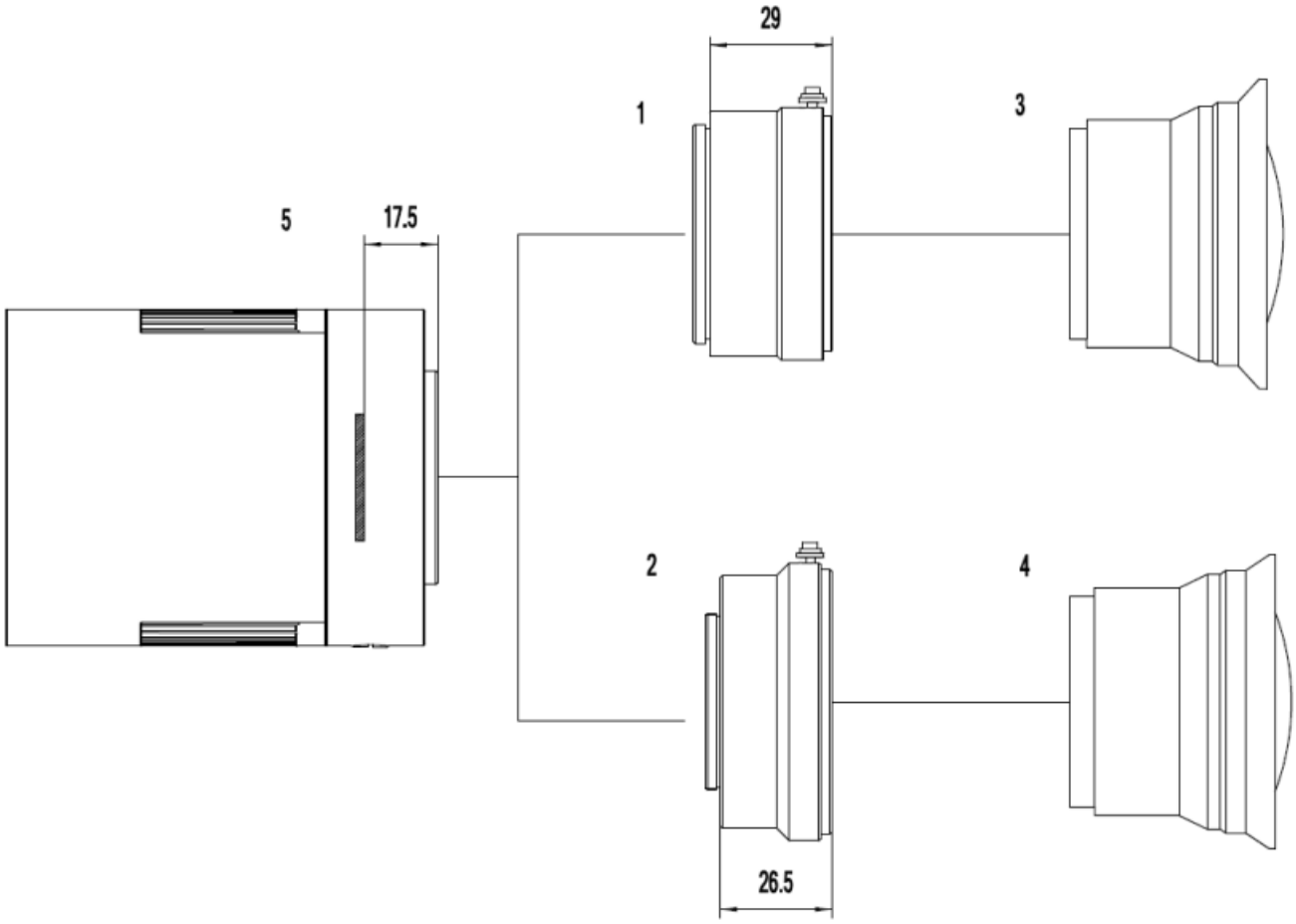


Figure 11 Nikon F/Canon EF Lens with ATR Camera

Table 9 Camera and Lens Connection

Item	Specification
1	Nikon F-M42 adapter (**TBD**)
2	EOS EF-M42 adapter
3	Nikon F-mount lens
4	Canon EF-mount lens
5	ATR camera with M42Fx0.75 mount

Camera Electric Connection with Accessories

On the back side of ATR294C, there are 3 connection ports: DC 12V/3A power port, USB3.0/ USB2.0 port, and USB-HUB. Due to the significantly larger power consumption of IMX294, ATR294C (including the cooling system) is now booted up only by a 12V/3A power supply. USB3.0 no longer works as a power source but only as a data communication method. The USB-HUB provides connection with other devices, which allows users to avoid the mess of cable management. Once another device is connected through the USB-HUB, it will be connected to the PC device through the USB3.0/USB2.0 port.

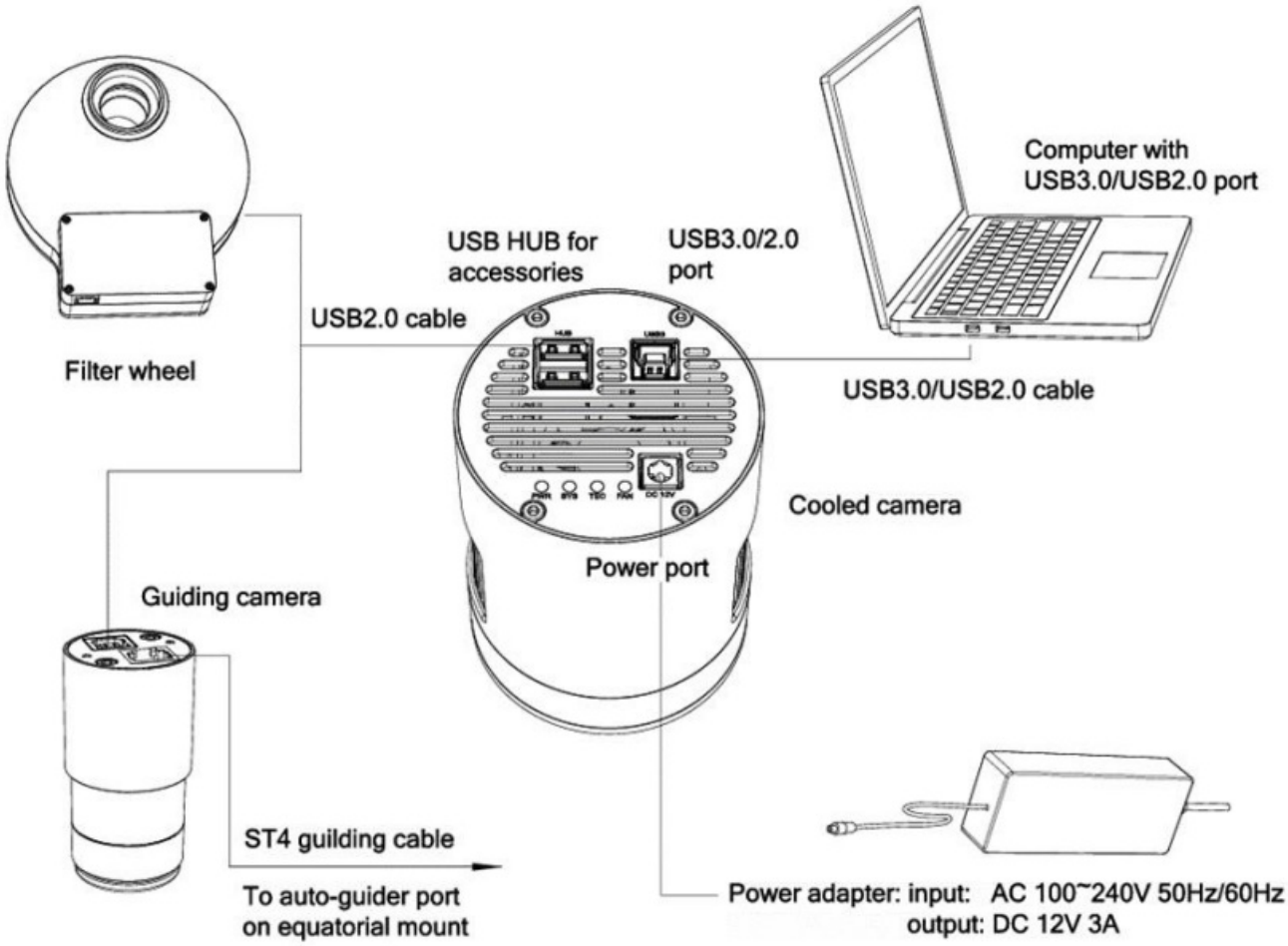


Figure 12 Camera Electric Connection

Table 10 Camera Electric Connection Details

Item	Specification
USB3.0/USb2.0 Port	To computer with USB3.0/USB2.0 cable
USB HUB for Accessories	To filter wheel with USB2.0 cable
	To guiding camera with USB 2.0 cable
Power Port	DC12V/3A

ATR294C and Its Software

Application Installation

For software, customers are welcomed to go to our software website: https://touptek-astro.com/downloads/, to download the latest ToupSky. The ATR can also be used with ASCOM, DirectShow SDK. If the third-party software is compatible with these SDK, customers can also download the software driver from our website and install the drivers into the third-party software. ToupSky is ToupTek astronomy camera's Windows application. ToupSky is a professional software integrated with camera control, image capture & process, image browse, and analysis functions. ToupSky is born with the following features:

Windows

- x86: XP SP3 or above; CPU supports SSE2 instruction set or above
- x64: Win7 or above

Features

- Full control of the camera
- Trigger mode and video mode support (raw format or RGB format)
- Automatic capture and quick record function
- Multi-language support
- Hardware ROI and digital binning function
- Extensive image processing functions, like image stitching, live stacking, flat field correction, dark field correction, etc.

Supported Camera:

- All ToupTek astronomy cameras

User-friendly UI Design

- Well-arranged menus and toolbars ensure quick operation;
- The unique design of 3 sidebars — Camera, Folders, Undo/Redo are orderly classified
- Convenient operating method (Double click or right-click context menu) as much as possible;
- Detailed help manual;

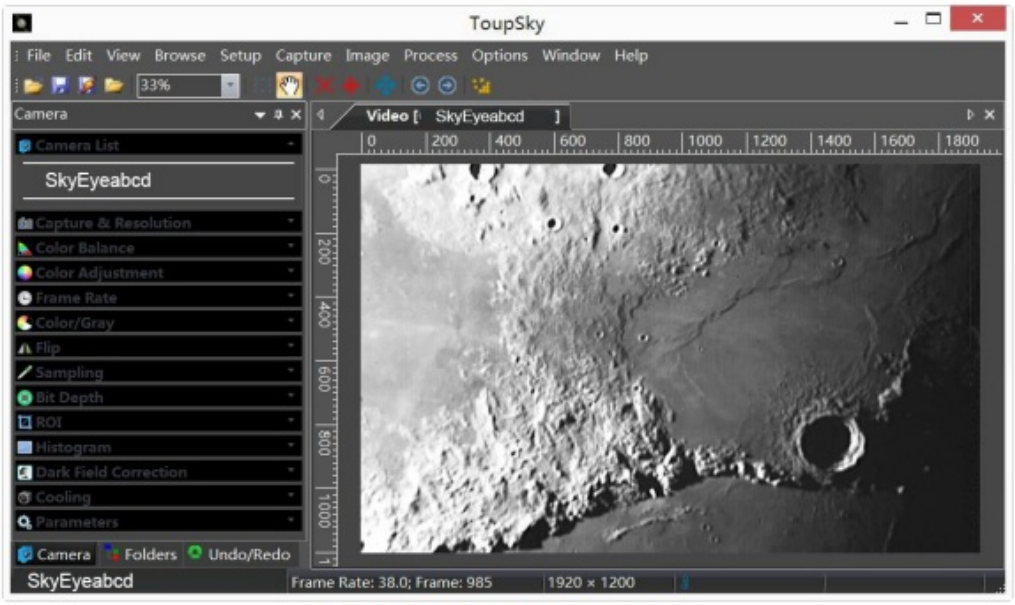


Figure 13 ToupSky and Its Video Window

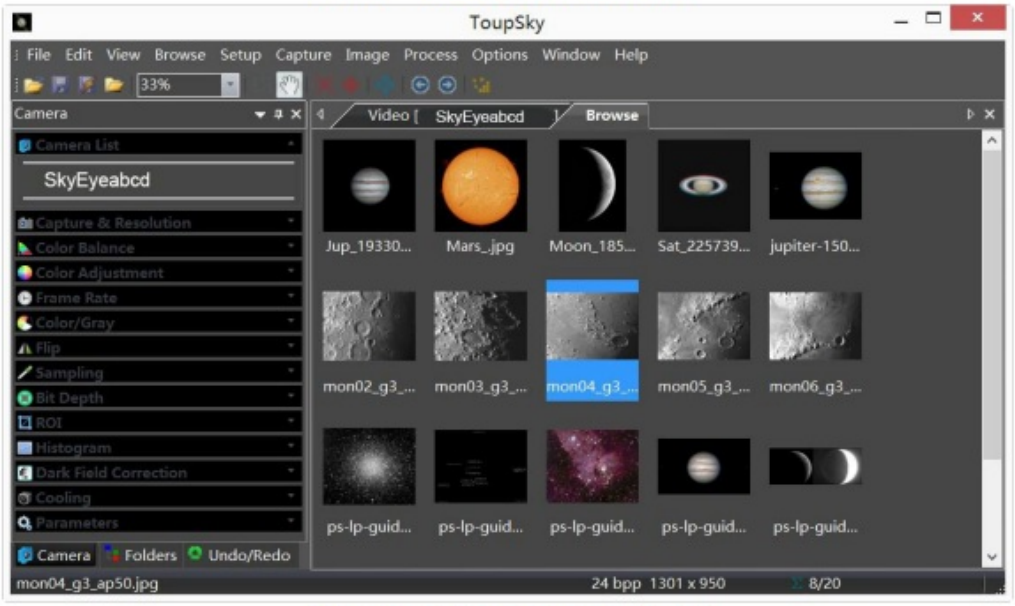


Figure 14 ToupSky and Its Browse Window

Professional Camera Control Panel

Capture & Resolution	Set the live and snap resolution and snap the image or record video;
Exposure & Gain	Auto exposure (exposure target preset) and manual exposure (exposure time can be inputted manually); Up to 5 times gain;
Color Balance	Advanced single-click intelligent white balance setting, temperature and tint can be manually adjusted;

Color Adjustment	Hue, saturation, brightness, contrast, gamma initialization adjustment;
Frame Rate	Adjustment of frame rate available for different computer configurations;
Flip	Check the “horizontal” or “vertical” option to correct the sample direction;
Sampling	Bin mode can obtain low noise video stream; Skip mode obtains sharper and smoother vi deo stream. Support video stream histogram extension, Negative and positive switching, Gray calibration, Clarity factor for focusing etc.
Bit Depth	Switch between 8 bits and 14 bits. 8 bits is the basic Windows image format. 14 bits will h ave higher image quality but moderate FPS.
ROI	ROI, Region of interest. This function can set the ROI on the video window. When the RO I group is expanded, a dotted rectangle with “Handles” will appear around the video window that will let you alter the RO I. Use the mouse button to adjust the ROI size. If ROI is ok, click Apply will set the video t o ROI size, and Defaults will return to the original size.
Dark Field Correcti on	To Enable the Dark Field Correction, one should capture the dark field image first. After th e images are captured, the Enable button will be clickable. Checking the Enable button will enable the Dark Field corr ection. Unchecking it will disable the Dark Field Correction.
Cooling	Set the TE-Cooling target temperature and set the fan On/Off;
Parameters	Load, save, overwrite, import, and export self-defined parameters of the camera control p anel (including calibration information, exposure and color setting information);

Practical Functions with Good Results

Video functions	Various professional functions: Video broadcast; Time lapse capture; Video recording; Vi deo stream grid; Image stitch; Video scale bar, date etc.
Image Processing and Enhancement	Control and adjust image by denoise, sharpen, color toning deinterlace, all kinds of filterin g algorithms and mathematical morphology algorithm, range, binary, pseudo color, surfac e plot and line profile ital..
Image Stacking	Image stacking adopts advanced image-matching technology. With the recorded video, re gardless of shifting, rotation, or scaling, the high-fidelity image can be stacked to decreas e the image noise.

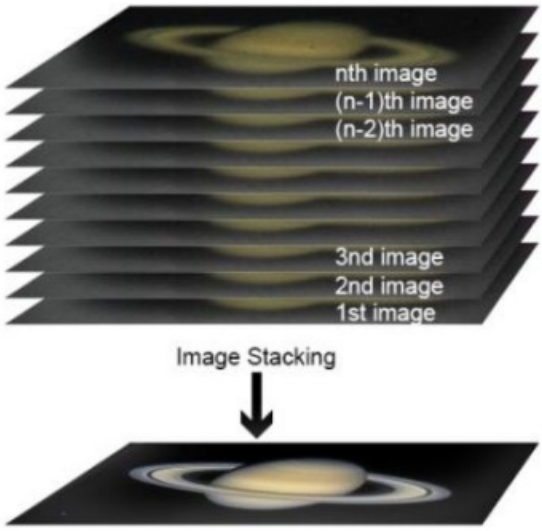


Figure 15 Image Stacking

Powerful Compatibility

- **Video Interface** Support Twain, DirectShow, SDK Package Native C++ C#/VB.NET
- **Operating System** Compatible with Microsoft® Windows® XP / Vista / 7 / 8 / 10 / 11 (32 & 64 bit), Mac OSX, Linux
- **Language Support** Unlimited language support, currently available in Simplified Chinese, Traditional Chinese, English, Russian, German, French, Polish and Turkish

Hardware Requirement

PC Requirements

- **CPU:** Intel Core 2 2.8GHz or higher
- **Memory:** 2GB or more
- **USB port:** USB3.0/USB2.0 port
- **Display**:17” or larger
- CD-ROM

ATR294C and Dshow
DshowAstro is an interface driver providing Dshow standard support for the ToupTek USB astronomy camera
Supported OS: Windows:

- x86: XP SP3 or above; CPU supports SSE2 instruction set or above
- x64: Win7 or above

Supported Camera:

- All ToupTek astronomy cameras

ATR294C and the 3rd Party Software

Support Software

No.	Software	Version	WDM	ASCOM	Native
1	PHD Guiding	2.3.0(2014)	√	√	√
2	Nebulosity	3.2.2(2014)	√	×	
3	MaxIm DL	5.23(2013)	√	×	
4	SharpCap	2.1(2014)	√	×	
5	MetaGuide	5.2.0(2014)	√		
6	FireCapture	2.4.05(2014)	√		
7	Astroart	5.0(2014)	√	×	

N.I.N.A
Powerful open-source astronomy equipment management system for deep sky photo shooting, free.

INDI
A popular third-party driver software for astronomy devices, often used on Linux and MacOS.

ASCOM Platform
All AstroCam telescope camera drivers request to install the ASCOM platform, for free. **http://www.ascomstandards.org/index.htm**

You can download the ASCOM package from:**http://ascomstandards.org/Downloads/Index.htm**

PHD Guiding
A popular free guide software: **http://openphdguiding.org/** ToupTek's telescope camera supports Native/ASCOM/WDM driver to run the video.

Nebulosity
A popular cooled camera control/image process software directly supported via ASCOM.

MetaGuide
Autoguiding software with a novel method to avoid atmospheric agitation. The latest version supports GCMOS01200KPB and the guide port: **http://www.astrogeeks.com/Bliss/MetaGuide/**

MAXIMAL
Famous full-functional CCD Control/Image Process software. PoPopularlysed in the US.

AstroArt
Famous full-functional CCD Control/Image Process software. Popularly used in Europe.

FireCapture
Great free planetary capture software. Support part of AstroCam series telescope camera.

SharpCAP
A nice free planetary capture software supports WDM cameras including the AstroCam series telescope camera.

Registax

A popular free planetary stacking and processing software.

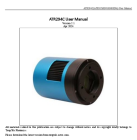
AstroStack
Ap planetary stacking and process software.

DeepSky Stacker
A free deep sky image stack and process software.

Service

For software upgrades, please refer to “Download” on our official website website: **https://touptekastro.com//** For customers who purchase the cameras from local dealer, please contact your dealer for more inquiry. For technical support, please contact e mail address: **astro@touptek.com**.

Documents / Resources

	**ToupTek ATR294C Color Camera** [pdf] User Manual ATR3CMOS10300KPA, ATR294C Color Camera, ATR294C, ATR294C Camera, Color Camera, Camera

References

- **Download Center**
- **ToupTek | Astronomical camera | Astronomy camera**
- **VB Shop**
- **ASCOM - Standards for Astronomy**
- **astrogeeks.com/Bliss/MetaGuide/**
- **ToupTek | Astronomical camera | Astronomy camera**
- **ToupTek | Astronomical camera | Astronomy camera**
- **ToupTek Astro: Electric filter wheel & Astronomical Cameras | Pro Astrophotography Equipment**
- **User Manual**