G3M664C User Manual

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1 Description and Features

G3M664C camera possesses an exceptionally strong capability to capture infrared light (with a high QE value at 550nm). It also has a large full well capacity, high dynamic range, high sensitivity, and low readout noise among other advantages. This results in outstanding performance in autoguiding, planetary photography, as well as in solar and lunar photography.

The features of G3M664C are listed below:

- IMX 664 Color CMOS sensor
- Resolution: 2688 x 1520
- 2.9 um Square Pixels
- 1/1.8-inch Optical Format
- 12-bit ADC
- Built-in Frame Buffer
- G Sensitivity: 5970 mV @ 1/30 s
- Low Noise: 0.76 to 2.61e-
- Frame Rate: 91 FPS at all Pixel Readout 8 bit
- SNR Max: 45.8 dB
- Dynamic Range: 75.8 dB

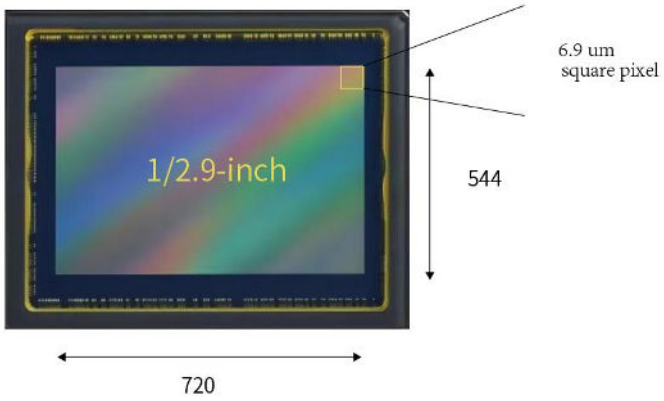


Figure 1 IMX664 Sensor and Its Pixel Structure

2 G3M664C Specifications and Performance

2.1 Camera Specifications

Table 1 G3M664C Technique Specifications.

Sensor	Sony IMX664 back illuminated sensor	
Diagonal	9.02 mm	
Image Resolution	4.08 mega pixels (2688*1520)	
Pixel Size	2.9μm × 2.9μm	
Image Area	7.84mm × 4.45mm	
Max FPS at Full Resolution (USB 3.0)	12bit	8bit
	45 FPS @ 2688*1520 63 FPS @ 1344*760	91 FPS @ 2688*1520 126 FPS @ 1344*760
Max FPS at Full Resolution (USB 2.0)	12bit	8bit
	5 FPS @ 2688*1520 6 FPS @ 1344*760	9 FPS @ 2688*1520 12 FPS @ 1344*760
Shutter Type	Rolling shutter	
Exposure Time	0.1ms – 1000s	
Gain	1x – 500x	
SNR	45.8 dB	
Dynamic Range	75.8 dB	
Read Noise	6.2 – 2.67 e-	
QE Peak	>91%	
Full Well	38ke-	
ADC	12bit	
Frame Buffer	Built-in	
Connection Port	USB3.0/USB2.0	
Camera Adaptor	Standard 1.25'' for telescope connection, and standard C adapter for industrial lens	
Optical Window	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 37mm * height 72.4mm	
Camera Weight	70 grams	
Back Focus Distance	Back Focus Distance is 8.5mm, 17.5mm with C adapter, 12.5 with CS adapter	
Cooling:	Passive cooling	
Supported OS	Microsoft® Windows® XP / Vista / 7 / 8 /10 /11 (32 & 64 bit) OS x (Mac OS X) Linux	

2.2 Sony IMX664 Sensitivity

The sensor G Sensitivity of G3M664C is 5970 mV with 1/30s. Its spectral sensitivity is shown in Figure 2. The sensitivity is measured with a purple excitation LED light source with a color temperature of 2850 K, an IR cut filter CM700(t =1.0 mm) is placed between the LED light source and the sensor receiving surface to irradiate substantially parallel light.

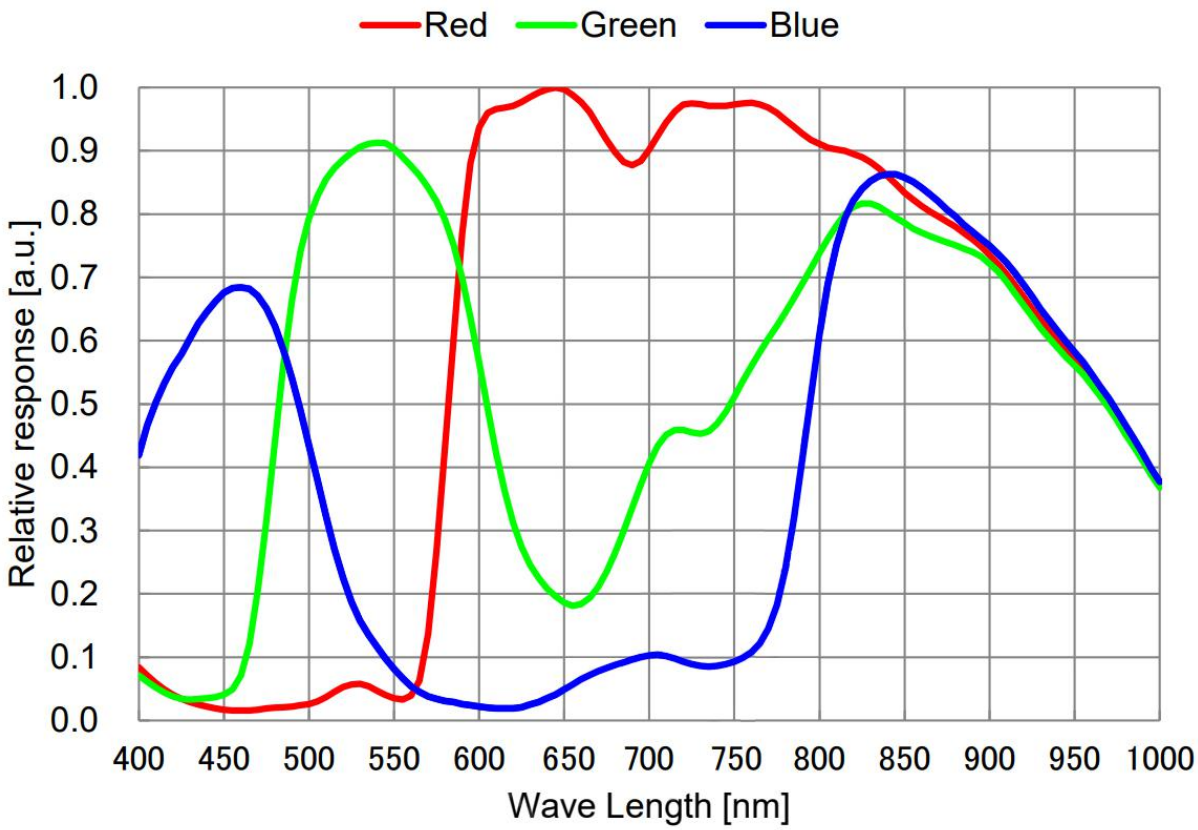


Figure 2 IMX664 Spectral Sensitivity Characteristic

2.3 12bit ADC and ROI

G3M664C has built in 12bit ADC. It also has 12bit output mode for software binning and smaller resolution. The camera also supports hardware ROI, and the smaller the ROI size is, the higher the frame rate is.

Table 2 shows the frame rate of the G3M664C in 12/8bit mode, USB3.0 / USB2.0 data transfer interface at different resolutions:

Table 2 G3M664C Frame Rate at Different Resolution/Data Bit/Data Transfer (USB3.0/ USB2.0)

Bit & Interface / FPS / Resolution	12bit ADC		8bit ADC	
	USB3.0	USB2.0	USB 3.0	USB 2.0
2688 * 1520	45	5	91	9
1344*760	126	12	63	6

2.4 Frame Buffer

G3M664C camera has a built-in frame buffer, which helps maintain the stability of data transmission, and effectively reduce the amp-glow caused because image data can be temporarily buffered without being sent hastily to the receiver. Ensure that each camera can still achieve its maximum frame rate when multiple cameras are operating simultaneously.

2.5 Binning

The G3M664C supports software binning from 1×1 to 8×8, but the frame rate does not increase due to binning.

2.6 Conversion Gain Switch

G3M664C support HCG 、LCG 、HDR mode switch.

2.7 Power System

The camera operates via a USB 3.0 interface. Upon establishing a connection with the host system using the USB 3.0 cable, the device is primed for operation.

2.8 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 the most important reference to measure the performance of a camera. Lower read noise usually means better SNR and better quality of image. 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.

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 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 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. 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 intra-scene dynamic range. Within one image there may be a portion that is in complete black and a portion that is completely saturated.

For the GPM 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

$$Rel\,Gain(dB) = 20 * log_{10}[xxx(Gain\,Value)/100]$$

$$xxx(Gain\,Value) = 100 \times 10^{(Rel\,Gain(dB)/20}$$

Camera setting used for performance analysis is shown below:

- HCG
- Full resolution
- RAW 12-bit mode

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

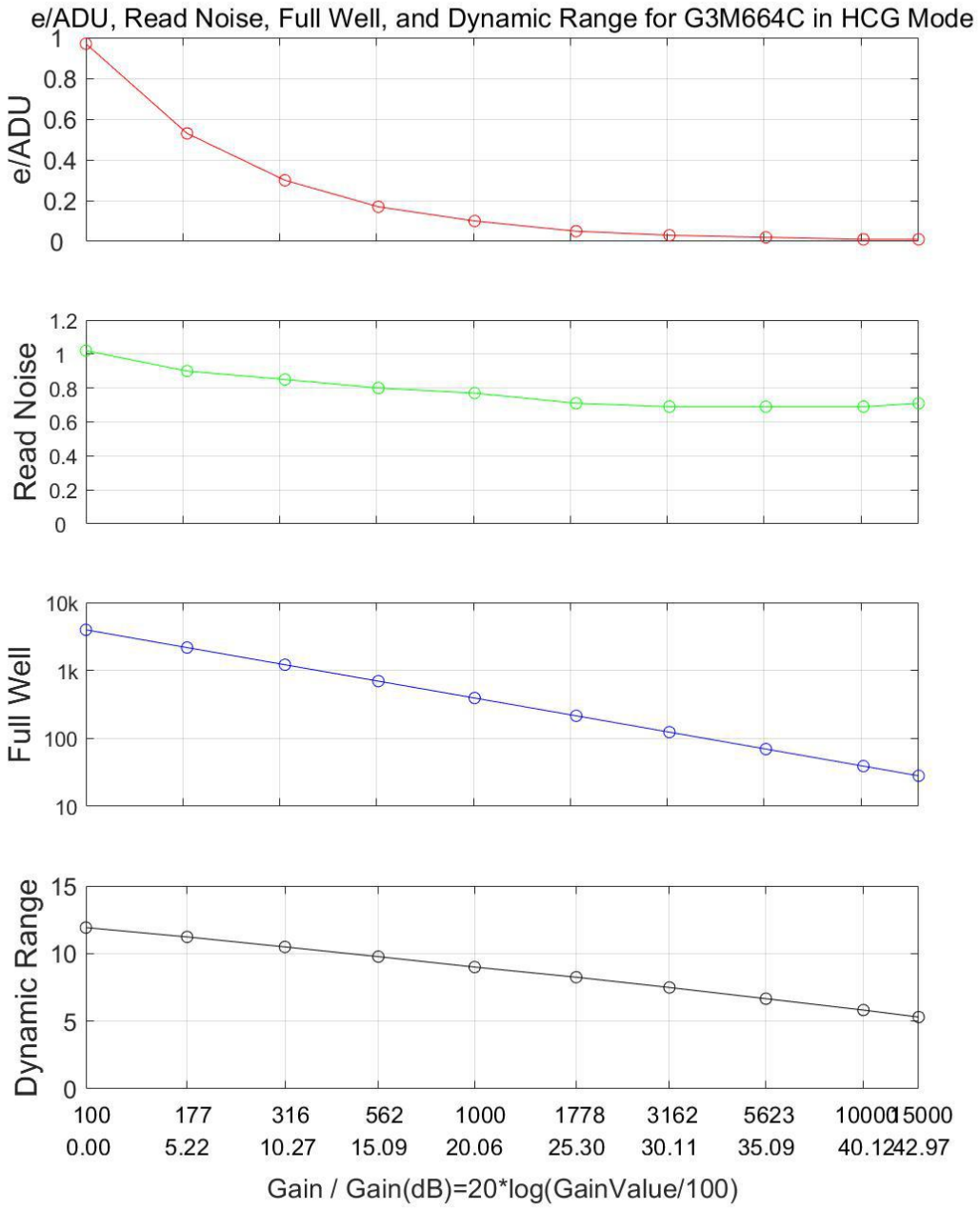


Figure 4 e/ADU, Read Noise, Full Well and Dynamic Range for G3M664C

The camera analysis data is shown in Table 3:

Table 3 Camera Analysis Data

Sensor Analysis Data										
Gain Value	100	177	316	562	1000	1778	3162	5623	10000	15000
Rel Gain (dB)	0.00	5.22	10.27	15.09	20.06	25.3	30.11	35.09	40.12	42.97
e^- /ADU	0.97	0.53	0.3	0.17	0.1	0.05	0.03	0.02	0.01	0.01
Read Noise (e-)	1.02	0.9	0.85	0.8	0.77	0.71	0.69	0.69	0.69	0.71
Full Well (ke-)	4.0	2.2	1.2	0.7	0.4	0.2	0.1	0.07	0.04	0.03
Dynamic Range (stop)	11.92	11.23	10.49	9.77	9	8.25	7.49	6.66	5.82	5.3

Camera setting used for performance analysis is shown below:

- LCG
- Full resolution
- RAW 12-bit mode

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

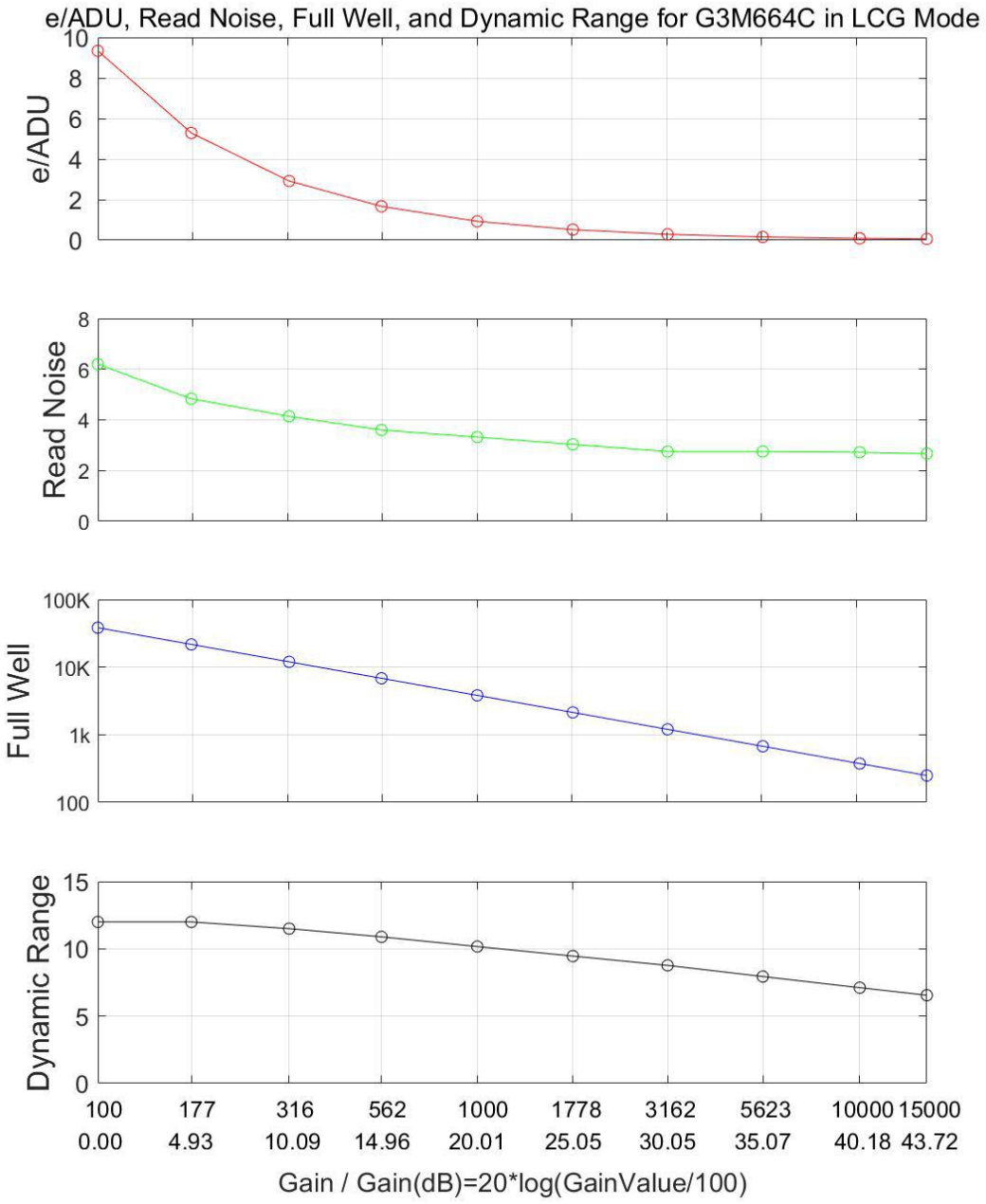


Figure 5 e/ADU, Read Noise, Full Well and Dynamic Range for G3M664C

The camera analysis data is shown in Table 4:

Table 4 Camera Analysis Data

Sensor Analysis Data										
Gain Value	100	177	316	562	1000	1778	3162	5623	10000	15000
Rel Gain (dB)	0.00	4.93	10.09	14.96	20.01	25.05	30.05	35.07	40.18	43.72
e^- /ADU	9.34	5.29	2.92	1.67	0.93	0.52	0.29	0.16	0.09	0.06
Read Noise (e-)	6.2	4.83	4.14	3.6	3.32	3.03	2.75	2.75	2.72	2.67
Full Well (ke-)	38.3	21.7	12.0	6.8	3.8	2.1	1.2	0.7	0.4	0.2
Dynamic Range (stop)	12	12	11.5	10.89	10.17	9.46	8.77	7.94	7.11	6.55

3 Product Package and Connections

3.1 Packing List



Figure 6 Packing Information of G3M664C

Table 5 G3M664C Packing List

Standard Camera Packing List	
A	Carton L:50cm W:30cm H:30cm (20pcs, 12~17Kg/ carton, 0.045m3), not shown in the photo
B	Gift box L:15cm W:15cm H:10cm (0.8~1.0Kg/ box)
C	One G3M series USB3.0 camera with 1.25” interface(outer) and C-Mount(inner)
D	High-speed USB3.0 A male to B male gold-plated connectors cable /2.0m
E	2.0m guide cable
F	1.25-inch nosepiece
G	CD (Driver & utilities software, Ø12cm)
Optional Accessory	
H	CS-mount ring

3.2 Camera Dimension and Its Mount

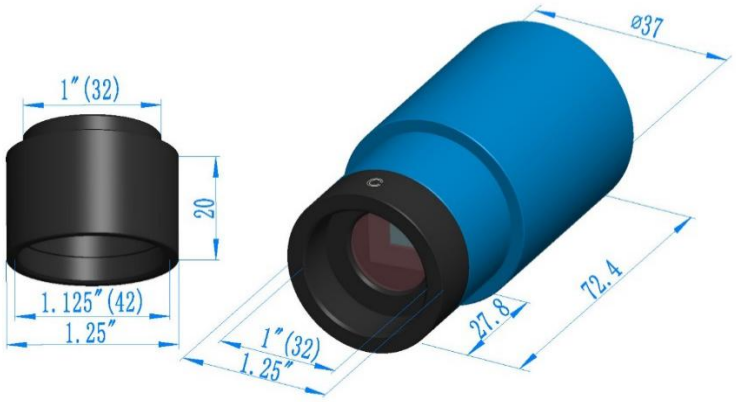


Figure 7 Dimension and Mount of G3M664C and 1.25” extender

The G3M series body, made from tough, alloy, ensures a heavy duty, workhorse solution. The camera is designed with a high-quality IR-CUT or AR to protect the camera sensor and block the IR elimination & the reflection light. No moving parts included. These measures ensure a rugged, robust solution with an increased lifespan when compared to other industrial camera solutions.

Table 6 Adapter of G3M664C

Item	Specification
1	Directly with 1.25” telescope;
2	G3M + 1.25” extender with 1.25” telescope
3	Standard C adapter connects to industrial C-mount adapter lens.

3.3 Camera Outline and Interface

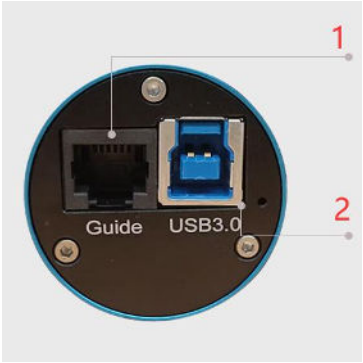


Figure 8 Camera Outline and Interface.

Table 7 Camera Outline and Interface List

Item	Specification
1	A built-in ST4 auto guider port for the easy connection of the auto guider.
2	USB3.0 interface.

4 G3M664C and Its Software

4.1 Application Installation

For software, customers are welcomed to go to our software website: https://touptek-astro.com/downloads/, to download the latest ToupSky. The GPM 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

4.1.1 User-friendly UI Design

- Well-arranged menus and toolbars ensure quick operating;
- 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;

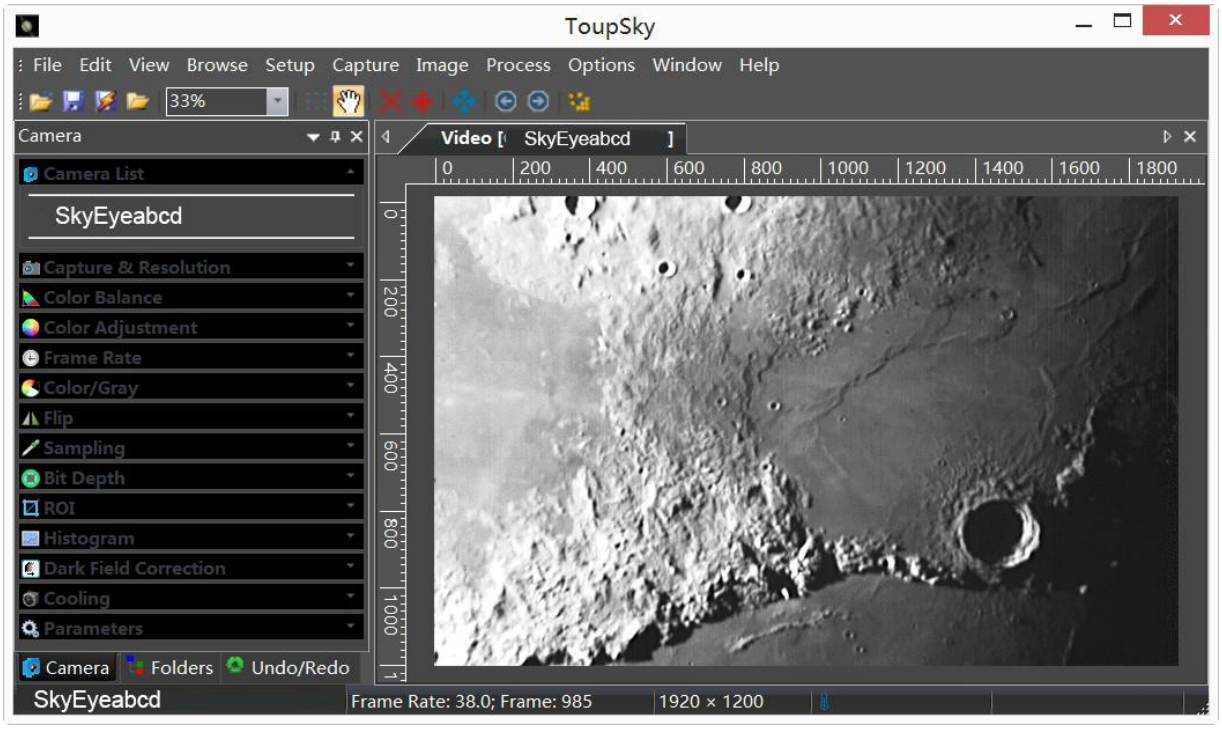


Figure 9 ToupSky and Its Video Window

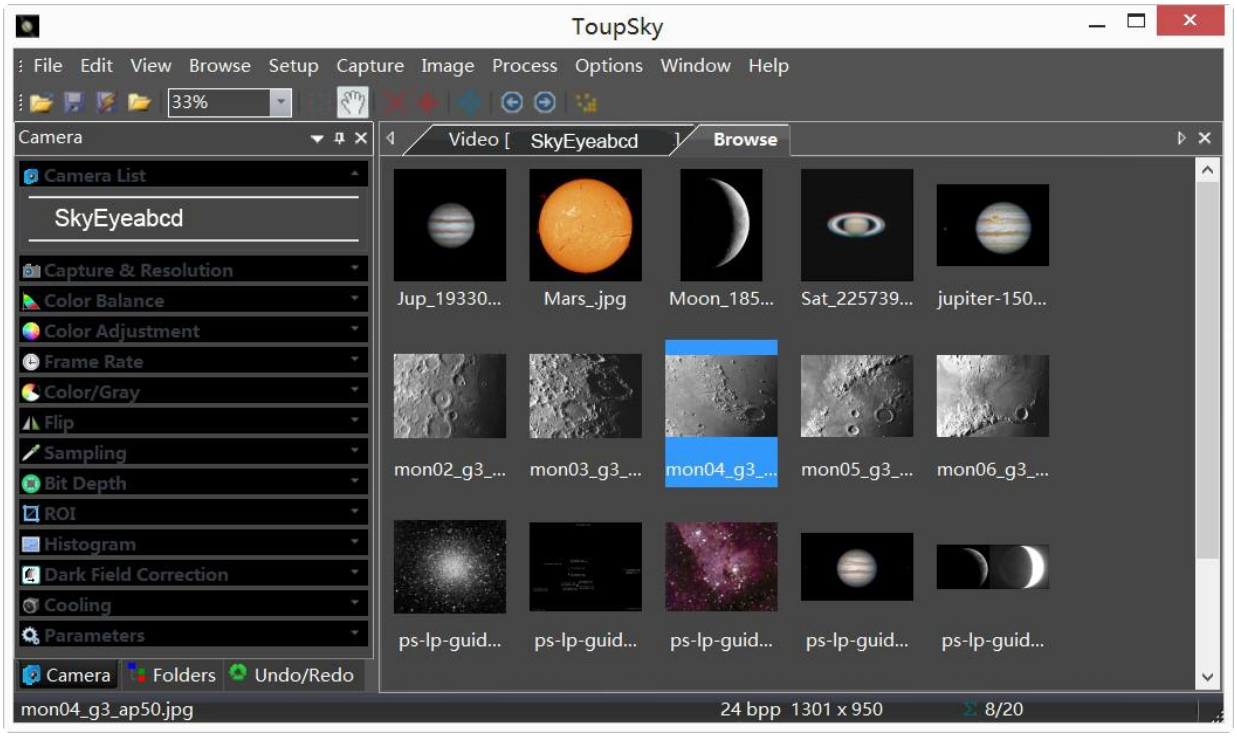


Figure 10 ToupSky and Its Browse Window

4.1.2 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 video stream. Support video stream histogram extension, Negative and positive switching, Gray calibration, Clarity factor for focusing etc.
Bit Depth	Switch between 8 bits and 12 bits. 8 bits is the basic Windows image format. 12bits will have higher image quality but moderate FPS.
ROI	ROI, Region of interest. This function can set the ROI on the video window. When the ROI group was expanded, a dotted rectangle with "Handles" will appear around the video window that will let you alter the ROI. Use mouse button to adjust the ROI size. If ROI is ok, click Apply will set the video to ROI size, Defaults will return to the original size.
Dark Field Correction	To Enable the Dark Field Correction, one should capture the dark field image first. After the images are captured, the Enable button will be clickable. Checking the Enable button will enable the Dark Field correction. 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, export self-defined parameters of camera control panel (including calibration information, exposure and color setting information);

4.1.3 Practical Functions

Video functions	Various professional functions: Video broadcast; Time lapse capture; Video record; Video 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 filtering algorithm and mathematical morphology algorithm, range, binary, pseudo color, surface plot and line profile ital..
Image Stacking	Image stacking adopts advanced image matching technology. With the recorded video, regardless of shifting, rotation, scaling, the high-fidelity image can be stacked to decrease the image noise.

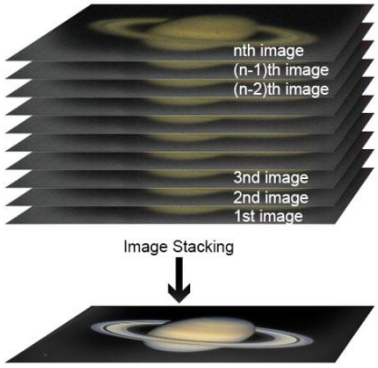


Figure 11 Image Stacking

4.1.4 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	Multiple-language support, currently available in Simplified Chinese, Traditional Chinese, English, Russian, German, French, Polish and Turkish

4.1.5 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

4.2 G3M664C and Dshow

ToupTekDshowAstroSetup (Click the left blue link to download)

DshowAstro is an interface driver providing Dshow standard support for 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

4.3 G3M664C and the 3rd Party Software

4.3.1 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)	√	×	/

4.3.2 N.I.N.A

Powerful open source astronomy equipment management system for deep sky photo shooting, free.

4.3.3 INDI

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

4.3.4 ASCOM Platform

All AstroCam telescope camera drivers request to install ASCOM platform, free.

http://www.ascom-standards.org/index.htm

You can download the ASCOM package from : http://ascom-standards.org/Downloads/Index.htm

4.3.5 PHD Guiding

A popular free guide software: http://openphdguiding.org/

ToupTek's telescope camera support Native/ASCOM/WDM driver to run the video.

4.3.6 Nebulosity

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

4.3.7 MetaGuide

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

4.3.8 MAXIMDL

Famous full functional CCD Control/Image Process software. Popular used in US.

4.3.9 AstroArt

Famous full functional CCD Control/Image Process software. Popular used in Europe.

4.3.10 FireCapture

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

4.3.11 SharpCAP

A nice free planetary capture software support WDM cameras includes AstroCam series telescope camera.

4.3.12 Registax

A popular free planetary stacking and processing software.

4.3.13 AstroStack

A planetary stacking and process software.

4.3.14 DeepSky Stacker

A free deep sky image stack and process software.

5 Service

For software upgrades, please refer to “Download” on our official website: www.touptek-astro.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.