

External filter wheels for G2, G3 and G4 CCD cameras



User's Manual



Version 2.2

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Introduction

Thank you for choosing of the External Filter Wheel for Gx CCD cameras. The ability to capture individual exposures through various filters is one of the key features of the cooled CCD cameras, regardless if being used for scientific research in astronomy or biology, for measurements and testing and other engineering applications or for astronomical photography. This is why the Gx CCD cameras were designed to include the filter wheel inside the camera head and to integrate filter wheel control into camera control from the beginning.

But number of filter positions is limited due to restricted space inside the camera head. G4 series of CCD cameras, employing large 36×36 mm detectors requiring 50×50 mm square filters, cannot use filter wheel inside the camera head at all because the filter wheel has to be too large. When more than 5 or 6 filters are necessary or the filter wheel has to be used with G4 camera, using of External filter wheel is the only option.



Illustration 1: Internal filter wheels for G2 (left) and G3 (center) cameras offer five filter positions, external filter wheel offers seven positions (right)

When there is no filter wheel inside the camera head, all electronics and firmware, intended to control it, stays idle. These components can be utilized to control external filter wheel with only little changes. Also the camera front shell can be manufactured thinner, the space for filter wheel is superfluous. The G2 and G3 camera design, allowing attaching of the external filter wheel,

differs from the variant with internal filter wheel in two points:

- Digital electronics PCB is not equipped with internal connectors for filter wheel control, but all necessary signals are routed to single 8-pin RJ-45 connector. This connector is placed between power and USB connectors on the bottom side of the camera shell.
- Camera front shell is 12.5 mm thinner compared to shell for cameras with internal filter wheel. Back focal distance measured from camera front plane is lowered from 29 mm to 16.5 mm.

Controlling of the external filter wheel with electronics already present in the camera head eliminates the necessity to connect the external filter wheel to the host PC (with separate USB or serial cable) as well as to plug in a separate power supply. Only single short 8-wire cable connects the external filter wheel with the camera head.



Illustration 2: G2 CCD camera with internal filter wheel (left) and a variant with thinner front shell and attached external filter wheel (right)

Another advantage of this design is full compatibility with all software for Gx camera control. External and internal filter wheels are indistinguishable from the software point of view (besides the fact, that external wheel often offers more positions). The SIPS camera control software and also other programs using supplied drivers (MaxIm DL, AstroArt or ASCOM compatible programs) control external and internal wheels the same way using the same drivers. When the camera is connected over the Ethernet interface, naturally it is possible to control also the external filter wheel through the TCP/IP protocol.

External filter wheel types

External filter wheels are manufactured in several sizes, depending on the camera series and also on the number and size of filters.

All external filter wheels has the same 17 mm thickness (the distance between the shell back side and the front plate, to which the telescope adapters are mounted). So the distance from the front plate to detector is 33.5 mm.

Sometimes the thickness of the front side of filter wheel shell is increased from the mechanical reasons and the resulting shell thickness is then 19 mm. But 17 mm distance between the telescope adapter plate and the back shell side remains the same.

The shell diameter and wheel weight depend on the type:

XS series (for G2 cameras):

- diameter 172 mm
- weight 0.70 kg

S series (for G2 and G3 cameras):

- diameter 212 mm
- weight 0.85 kg

M series (for G4 cameras):

- diameter 216 mm
- weight 0.90 kg

L series (for G3 and G4 cameras):

- diameter 252 mm
- weight 1.20 kg

Note the stated weights include filter wheel and the shell, but do not include the filters.

External filter wheels for G2 cameras



Type: **EFW-2XS-8**
Positions: 8
Filter type: Threaded cells 1.25 inch
Unmounted Ø31 mm



Type: **EFW-2XS-7**
Positions: 7
Filter type: Unmounted Ø36 mm



Type: **EFW-2S-12**
Positions: 12
Filter type: Threaded cells 1.25 inch
Unmounted Ø31 mm



Type: **EFW-2S-10**
Positions: 10
Filter type: Unmounted Ø36 mm



Type: **EFW-2S-7**
Positions: 7
Filter type: Threaded cells 2 inches
Unmounted Ø50 mm
Unmounted Ø2 inches (50.8 mm)

External filter wheel for G3 cameras



Type: **EFW-3S-7**
Positions: 7
Filter type: Threaded cells 2 inches
Unmounted Ø50 mm
Unmounted Ø2 inches (50.8 mm)
EFW-2S-7 and EFW-3S-7 are identical, types are distinguished only to assign wheel to camera type.



Type: **EFW-3L-7**
Positions: 7
Filter type: Square filters 50×50 mm



Type: **EFW-3L-9**
Positions: 9
Filter type: Threaded cells 2 inches
Unmounted Ø50 mm
Unmounted Ø2 inches (50.8 mm)
“L” external filter wheel on G3 camera cannot be used with G3-OAG.

External filter wheels for G4 cameras



Type: **EFW-4M-5**
Positions: 5
Filter type: Square filters 50×50 mm



Type: **EFW-4M-7**
Positions: 7
Filter type: Threaded cells 2 inches
Unmounted Ø50 mm
Unmounted Ø2 inches (50.8 mm)

Round filters can cause vignetting (shade detector edges) depending on the type of used optics.



Type: **EFW-4L-7**
Positions: 7
Filter type: Square filters 50×50 mm



Type: **EFW-4L-9**
Positions: 9
Filter type: Threaded cells 2 inches
Unmounted Ø50 mm
Unmounted Ø2 inches (50.8 mm)

Round filters can cause vignetting (shade detector edges) depending on the type of used optics.

Mounting of external filter wheels

External filter wheels are attached to the camera head the same way like telescope or lens adapters – using four M3 screws in the corners of a square around the light entrance to the camera head. Distances of the threaded holes depend on the camera type:

- G2 and G3 cameras use four M3 screws in the corners of the 44 mm square. The single external filter wheels type can be used on both camera models.
- G3 cameras use four M3 screws in the corners of the 52 mm square.

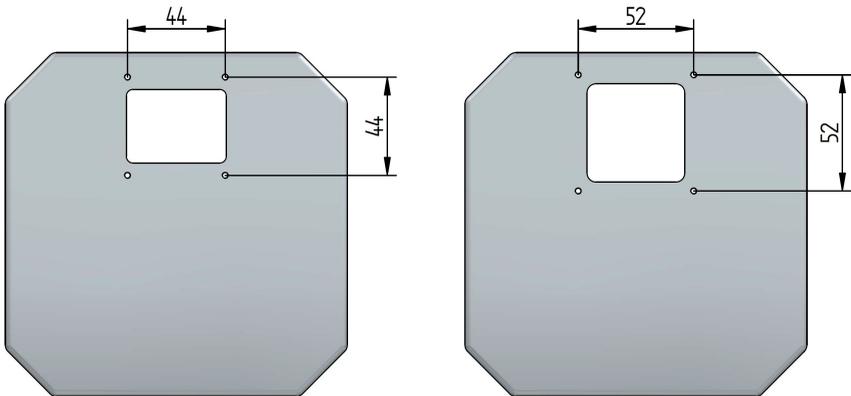


Illustration 3: Distances of the threaded mounting holes for adapters and filter wheels on the G3 and G2 cameras (left) and G4 cameras (right)

Although external filter wheels for G2 and G3 cameras are compatible, in reality the different filter size is the limiting factor. CCD detectors up to 24×36 mm are used in G3 cameras and any other filters than Ø50 mm (or 2 inches) cover corner parts of the chip. On the other side using such large filters for relatively small detectors, used in G2 cameras, is superfluous and it is more effective to use cheaper Ø36 mm or Ø31 mm filters. What's more, more positions are available for smaller filters.

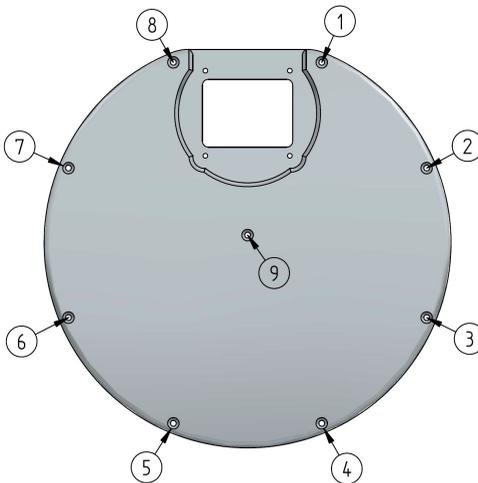
The external filter wheel housing thickness is always the same regardless of the number of positions, filter size and camera type.

The distance of the filter wheel housing front plate from the detector is 4.5 mm greater than in the case of camera with internal filter wheel. (33.5 mm compared to 29 mm). All available adapters for telescopes and lenses, which require preserving of the back focal distance, are designed to reflect this distance. Adapters keep the defined back focal distance if mounted 33.5 mm from the CCD. When these adapters have to be used on camera with internal filter wheel, it is necessary to use 4.5 mm thick spacer.

Also Off-Axis Guider (OAG) for G2 cameras is designed to preserve 55 mm back focal distance when mounted to external filter wheel housing. If it is used on camera with internal filter wheel, spacer supplied with the OAG must be used.

Installation procedure is as follows:

1. External filter wheel has to be attached directly to the camera head. If there is some camera adapter mounted to the head, it must be removed first.
2. The filter wheel housing front side must be unscrewed first. The front side is held on place with 8 M3 screws close to the outer edge and one central screw. So 9 screws must be removed in total.



If there is an adapter on the external filter wheel housing front side, it is not necessary to remove it.

3. The filter wheel itself, located inside the housing, can be freely removed after removing of the front side. The wheel is fixed in place by the central screw, going through the front side.

Attention – the filter wheel position is determined by the optical bar on the wheel side. One sensor of a pair is located above the filter wheel and care must be taken when removing the wheel not to damage this sensor. Wheel must be slightly pulled and then slid. Opposite movement must be applied when mounting the wheel back.

4. There are four countersunk holes in the wheel housing back shell. The filter wheel is fixed to the camera head using four M3 screws going through these holes.



Attention – always use the screws supplied with the filter wheel. (M3×6 screw with countersink head). Longer screws may extend inside the camera head and may interfere with the camera shutter.

It is also necessary to connect the filter wheel with the camera head using the supplied short 8-wire cable with RJ45 connectors.



Illustration 4: G2 and G4 CCD cameras with "S" and "L" series external filter wheels

Attached filter wheel configuration

Type of actually connected filter wheel (number of positions) is stored in the camera permanent memory and changing number of filter wheel positions requires updating of this information. Storing of filter wheel configuration in camera permanent memory significantly shortens the camera startup time. Camera firmware needs not to check whether some filter wheel is present and if the filter wheel is found, it is not necessary to count the positions on each startup.

If a certain type of filter wheel, identified by number of filter positions, is stored in the camera permanent memory and the filter wheel is missing, the only problem is prolonged camera startup. Firmware starts to search for filter wheel zero position and if it does not succeed within defined time interval, it continues working as if no filter wheel is present. Added startup time is approx. 10 seconds.

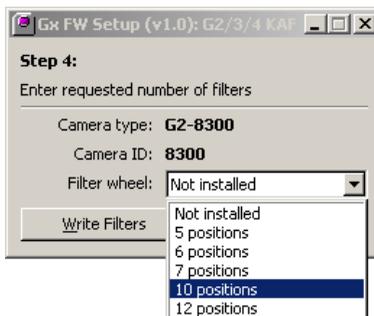
But if camera permanent memory contains some number of filters and a wheel with different number of positions is used, camera firmware successfully finds the wheel origin. Subsequent attempts to set some filter position may lead to usage of different filter, because filter wheel motion optimization calculates with different number of filters (Gx camera firmware always searches the shortest path to the new filter, still it is designed to place filter exactly to the same position, regardless of the direction from which the particular filter position is approached). Here comes the new tool, which allows every user to change the number of filter positions stored in the camera permanent memory.

The 'gxfw.exe' utility together with supporting libraries can be downloaded from the Download section of the <http://www.gxccd.com/> server.

The tool is designed to guide user through the process in several steps. First step requires connection of the configured camera.



The tool then guides the user to disconnect and connect the camera again (this sequence is necessary because of some technical reasons). Step 4 finally allows to pick up desired number of filter positions used or to deactivate filter wheel support.



When the information is finally written to the camera permanent memory, it is again necessary to unplug the camera and plug it so the camera firmware can perform startup sequence with the updated memory content.



Configuration tool, as well as all other software, does not distinguish between internal and external wheels. Only number of positions is important from the software point of view and it is not necessary to distinguish internal and external wheels also during configuration.

Caution – The utility needs to run with Administrative privileges. It is necessary to have access to Administrator account credentials on the particular PC. No other G2, G3 or G4 camera can be connected to the PC during configuration process.

Changing of individual filters

Filters are always located in the filter wheel in such way that the aperture in the direction of incoming light is clear and well defined (a circle in the case of round filters or a square in the case of large G4 filters). Otherwise the light reflected and/or scattered on filter edges, filter cells and fixing screws often create light artifacts, especially when a bright star is projected to the filter facet. In reality the first aperture must be created by the machined portion of the filter wheel and the filter itself is located from the opposite side relative to the direction of incoming light (which means from the CCD side of the filter wheel).

The filter wheel is mounted to the front camera shell in the case of the cameras with internal filter wheel. When the front shell is removed, the filter wheel side, where filters are mounted, is then directly accessible without the necessity to remove the wheel from the housing.

However, the situation is different in the case of external filter wheels – filter wheel is located in the back shell of the external filter wheel housing, so if it is necessary to change filters, filter wheel must be removed from the housing.

The procedure of removing of the filter wheel from the housing is otherwise identical to the steps 2 and 3 of the procedure of attaching of the filter wheel to the camera body.