



DIFFRACTION LIMITED

# ***SBIG<sup>®</sup> AFW Series*** *Filter Wheel*



## User's Manual

Version 1.03 – June 16, 2021

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

**Industry Canada Compliance Statement**

This Class A digital apparatus complies with Canadian ICES-003.

**European Union**

This product has been tested and found to comply with the limits for Class A Information Technology Equipment according to CISPR 22/European Standard EN 55022. Warning: This equipment is compliant with Class A of CISPR 32. In a residential environment this equipment may cause radio interference.

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# ***SBIG Advanced Filter Wheel User's Manual***

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# 1 – The SBIG AFW Advanced Filter Wheels

Diffraction Limited' SBIG AFW series filter wheels are designed to consume the minimum back focus distance while providing fast and quiet operation.

The AFW series wheels are designed to directly interface to all SBIG cameras that utilize the “STX” style accessory mounting. This includes all Aluma AC models as well as legacy STX and STXL models.

Currently two varieties are available:

- AFW-10-50SQ – ten slots accommodating 50 mm square filters, and
- AFW-12-50R – twelve slots accommodating 50 mm round filters.

A double-stack kit is available for all AFW wheels. This allows for two wheels to be stacked, providing additional filter slots.

The AFW can be used with the StarChaser SC-3 SHORT, which provides self-guiding in front of the filters. In conjunction with the StarChaser it is also compatible with the SBIG AO-X adaptive optics unit.



All power and control signals for the wheel is provided by a single DB-9 style connector, which connects directly to the main camera using the supplied cable. No other connections are required.

**Note:** The DB-9 connector is not a serial port. It can only be connected to an SBIG camera AUX connector.

The AFW design allows the filter wheel mounting screws to be accessed without removing filters or the carousel. This makes installation and removal very quick and easy.

## 2 – Supplied components

Observe proper handling procedures for sensitive electronic equipment and unpack your SBIG Advanced Filter Wheel and accessories carefully in a clean, dry, static-free area. Inspect the contents to ensure all components are present and in good order. You should find the following:

- AFW-10-50SQ or AFW-12-50R Filter Wheel
- DB-9 Male-Female cable, 2.5 foot
- 6-32 x 5/16" Torx wrench
- 5/64" Hex wrench
- 1/16" Hex wrench
- Qty 2 – 6-32 x 5/16" Torx flat-head screws

The included wrenches are used to install the filters and mount the filter wheel onto the camera.

The DB-9 cable is a high-quality cable with large gauge wiring to provide adequate power and control signals to the wheel.

**Warning:** Do not substitute a low-quality or longer cable as this *will* cause control problems, including intermittent wheel operation.

### 3 – Installing the Filter Wheel

Please follow these steps carefully to ensure correct installation.

#### Filter Installation

1. Lay the filter wheel down on a flat book or similar object so the protruding screws and motor cover do not touch the tabletop.



2. Using the 5/64" Hex wrench, remove the 5 screws attaching the cover, and set the cover aside.

- Each filter is retained by screws with fiber washers that help prevent damage to the glass filter. Using the 1/16" Hex wrench, remove the screws and washers for each slot.

➡ **CAUTION:**

**Be gentle! Apply only LIGHT vertical pressure to the retention screws.**

The filter carousel is intentionally very thin, to provide the minimum possible impact on back focus distance.

If significant vertical pressure is applied to the screws, the carousel may be warped, which could affect filter wheel operation.

- Each filter slot will contain a plastic spacer. Remove the spacer, and set it aside for now. The spacer is used when mounting thinner filters.



- Install the filters in the slots, in the desired order (typical order is Luminance, Red, Green, Blue, H-Alpha, S-II, O-III). The slots are labelled starting at 1, which will match the slot numbers in your software.
- Reinstall the spacers as follows:
  - If your filters are 3 mm thick, do not install the spacer.
  - If your filters are 2 mm thick, orient the spacer so the small cutouts align with the washers. The cutout is 1 mm deep, so this effectively reduces the thickness of the spacer to 1mm.
  - If your filters are 1 mm thick, orient the spacer so the washers do *not* align with the cutouts. You can flip the spacer over to do this.
- Reinstall the fiber washers and retention screws. If you are using 2 mm thick filters, make sure the washer nests into the cutout in the spacer.

## Attach the Filter Wheel to the Camera

The next step is to attach the wheel to the camera. The wheel base including carousel, circuit board, and motor attaches directly to the camera. The lid of the filter wheel will be facing the telescope.

**Note:** The DB-9 connector on the filter wheel is not a serial port. It can only be connected to an SBIG camera AUX connector.

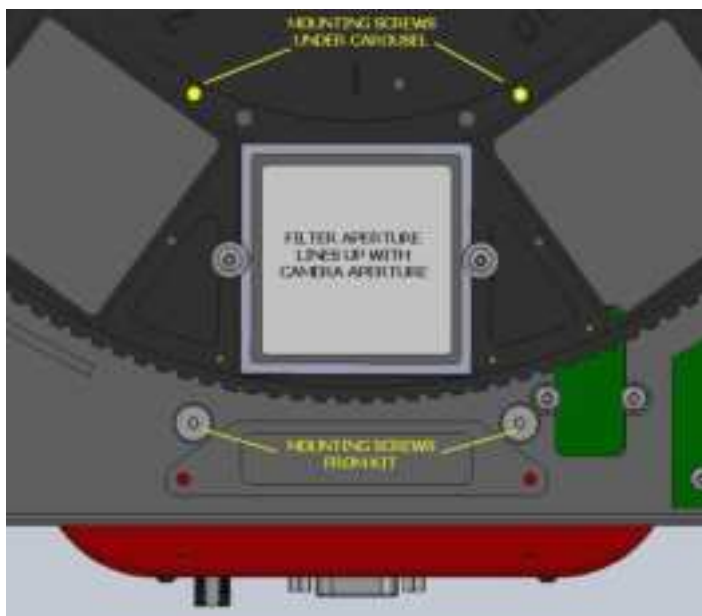
1. Ensure that the power into the camera is disconnected.

### **CAUTION:**

Never “hot plug” cables into or from units. This is especially important for the AUX connector. Always disconnect power before connecting or disconnecting accessories or cables.

2. Remove the adapter plate from the front of the camera. Note the location of any shim washers under the screws (the camera package should include a “shim sheet” showing the shim locations, if any).
3. Remove any additional mounting screws from the front of the camera (some camera models have additional mounting screws for different accessories).
4. Place the filter wheel on top of the camera, with the open filter aperture directly on top of the camera’s sensor aperture.

**Note:** For the next series of steps, you will need two 6-32 x 3/8” Torx flat head screws. They are included with the wheel in a small plastic bag. There are also two identical screws already installed in the wheel; they are captive under the carousel.



5. Note that two of the filter wheel mounting screws are under the carousel. They can be accessed by rotating the carousel by hand to align the hole.





AFW filter wheel attached to an Aluma AC series camera

6. Carefully position the filter wheel over the camera, so the two “captive” screws that are under the carousel line up with the mounting holes on the camera. Make sure the AUX connector is oriented close to the camera’s connector panel.
7. Manually rotate the carousel to line up an access hole with one of the screws.



8. Using the supplied Torx wrench, thread in the first screw but do not tighten.
9. Manually rotate the carousel to line up with the second screw and use the Torx wrench to thread in the screw, but do not tighten.
10. Install two 6-32 x 3/8" Torx flat head screws in the remaining two mounting holes. These are included with the filter wheel in a small plastic bag.
11. Now tighten all four screws. You will need to manually rotate the carousel as required to access the two captive screws.

## **Final Assembly**

The AFW filter wheel can be used in conjunction with the StarChaser SC-3-SHORT, which provides self-guiding in front of the filters. It is also compatible with the SBIG AO-X adaptive optics unit.

1. Reattach the filter wheel cover using the five screws removed in Filter Installation Step 1.
2. If you are planning to use a StarChaser SC-3 SHORT, it will be installed directly on top of the filter wheel. Please consult the StarChaser manual for details.
3. If you are planning to use an AO-X, it attaches directly on top of the StarChaser SC-3 SHORT. Please consult the AO-X manual for details.
4. Attach the mounting plate from the camera to the top of the assembly. Be sure to install the shims, if supplied, in the same locations relative to the camera. If you are unsure of the correct locations, please refer to the Shim Sheet included with the camera.
5. Connect the supplied DB-9 cable from the filter wheel's connector to the AUX connector on the camera. Be sure to tighten the thumbscrews on both ends.

## **Dual Wheel Assembly**

If you are planning on using the Dual Wheel option, you will need two identical filter wheels, plus the AFW-DUAL Dual Filter Wheel Adapter.

The adapter comes with a customized cable, which allows you to connect two wheels to the AUX port on the camera. One connector on the cable has a specially designed low-profile back shell, which allows it to fit between the two wheels with minimal impact on back focus distance.



### AFW-DUAL Dual Filter Wheel Adapter

Installing dual wheels requires following the same steps as installing a single wheel, except for a few additional steps. Please refer to the above instructions as required.

1. Install the first wheel onto the camera normally.
2. Install the filters normally. Usually, the last slot in the wheel is left empty, to allow filters in the second wheel to be used with no filter present in the first wheel.
3. Install the lid normally.
4. Install the thinner segment of the adapter to the top cover of the first wheel, using four 6-32 x 1/4" socket head cap screws.
5. Now attach the thicker segment of the adapter to the first segment, using four 6-32 x 1/4" socket head cap screws.
6. Remove the cover from the second filter wheel.
7. Locate the filter wheel ADDRESS switch on the edge of the control board.



Address Switch  
Up (0) for Filter Wheel 1  
Down (1) for Filter Wheel 2

8. Switch the ADDRESS to 1 for the second wheel only. (If only a single wheel is in use, the ADDRESS must be 0.)
9. Install the dual wheel AUX cable onto the second wheel. The connector with the custom round back shell *must* be attached to the second wheel prior to further assembly. This connector does not require thumbscrews; the first wheel holds it in place.



Install AUX cable as shown on second wheel

10. Install the filters in the second wheel.

11. Now attach the second wheel to the adapter. The wheels need to be installed at right angles, so the motor cover clears.



Dual Wheel Orientation (viewed from camera side)

12. Attach the cover on the second wheel, and finish mounting the nosepiece adapter and/or StarChaser and AO-X per the standard instructions.
13. Finally, plug the remaining two connectors on the AUX cable into the first filter wheel and the camera, and tighten the thumbscrews.

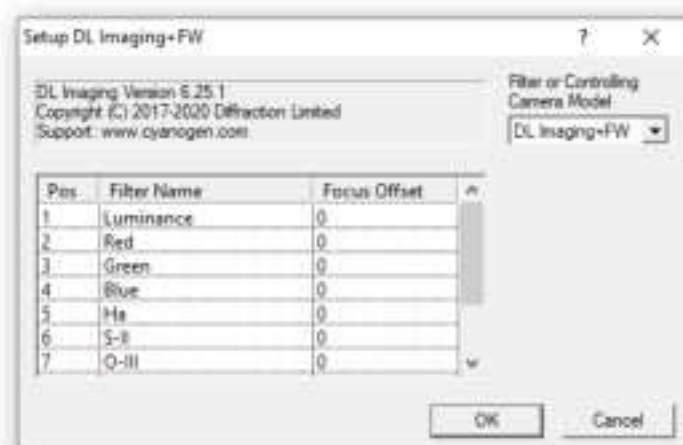
## 4 – Setting up the Filter Wheel

The following instructions assume you are using the MaxIm LT software, which is included with all modern SBIG cameras, or MaxIm DL Pro.

If you are using other software the steps will be similar; however, please consult the user manual for the software being used.

### Single Filter Wheel

1. Start MaxIm LT and open the Camera Control Window.
2. Following the instructions in the camera user manual, configure the software for Camera 1.
3. Now under Camera 1 click Setup Filter.
4. Set Filter or Controlling Camera Model to DL Imaging+FW.



**Note:** If you are using an SBIG STX or STXL camera, you will have to select a different option. If you are using SBIG Universal for the camera, you need to select SBIG Universal for the filter wheel. If you are using SBIG w/AO for the camera, you will need to select SBIG AO w/FW.

5. Rename the filter slots if required. Double-click on the filter names and enter a new value.
6. Click OK.
7. Click OK.
8. Click Connect.

Your filter wheel is now ready for use.


## Dual Filter Wheels

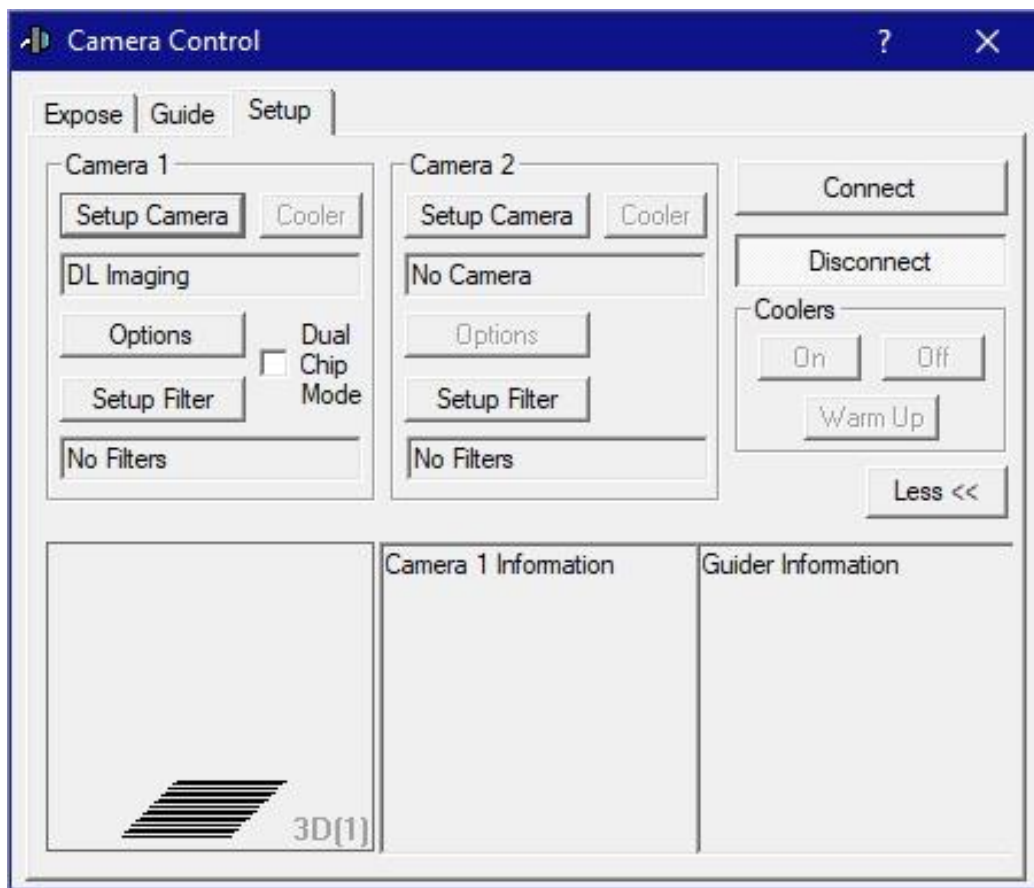
If you have installed dual wheels, some additional configuration is required. The following instructions are for the included MaxIm LT software. You can also use a current version of MaxIm DL Pro.

### DL Imaging – Aluma CCD, Aluma AC, STC Series

Follow these instructions for newer cameras that use the DL Imaging driver. See below for SBIG Universal based cameras.

The first time after installing the dual wheels the following steps must be followed:

1. Power up the camera with the dual wheels plugged into the AUX port and allow it to initialize.
2. Open MaxIm LT. Click the Camera Control icon  or press Ctrl-W to open the Camera Control form and click the Setup tab.



3. **Re-select your camera**, even if you have done so previously without the dual wheel installed. This is necessary so the software knows you have a Dual Wheel. The full procedure is in the camera manual; however, a brief summary follows:

Open the MaxIm LT Camera Control window, under Camera 1 click Setup Camera and set the Camera Model to DL Imaging. Next click Advanced. In the DL::Config dialog (shown below) click on your camera model under Devices, then click OK. Click OK again.

**DL::Config**

**Devices:**  
AC4040M-1271531-4095 [USB]

**Camera Info:**  
 Serial Number: AC4040M-1271531-4095  
 FPGA Rev: 1    WiFi Rev:   
 Connection: USB: handle=3688041  
 Firmware:   
 Update:   
 Main Sensor: ☒    Ext Sensor: ☐

**Network Config:**  
 Mode:    
 SSID:    
 Passphrase:    
 Update:   
 Settings:

**Main Sensor:**  
 ID:     Cooler Min:    
 R/O Model:     Cooler Max:    
 Frame Type:     eGain:    
 Model:     Substrate V:    
 Exp Precision:     Min Exp Length:    
 Filter Type:     Flag:    
 Settings:

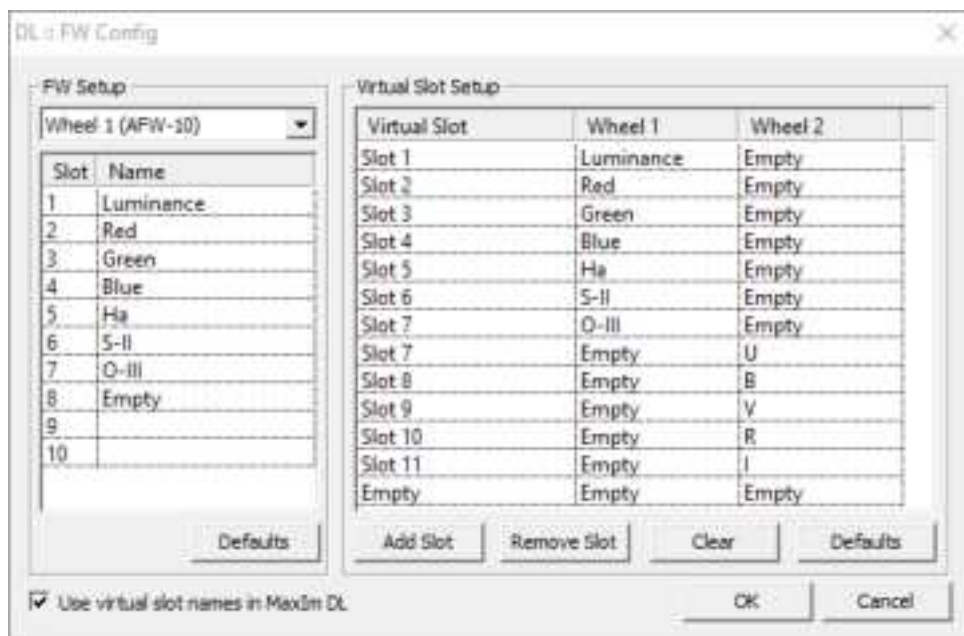
Dimension	X	Y	
Max Binning	2	2	...
Pixel Count	4128	4096	...
Pixel Size	9.00 um	9.00 um	...

R/O M...	G...	O...
Channel 1	N/A	N/A
Channel 2	N/A	N/A
Channel 3	N/A	N/A
Channel 4	N/A	N/A

Refresh   
 OK Cancel

- Next, under Camera 1 click **Setup Filter**. Set **Filter or Controlling Camera Model** to **DL Imaging+FW**.
- Click **Advanced**. The following form appears:





6. The first filter wheel is “Wheel 1” and the second wheel is “Wheel 2”.
7. Under FW Setup, choose Wheel 1. If you wish, click Defaults to load the default set of filter names (shown above).
8. To customize the filter slot names, double-click on each Name and enter a new name for the filter slot. The ID corresponds to the numbers printed on the carousel.
9. As suggested previously, when loading the filters the last slot in each wheel should be left empty. It is recommended that the last slot be labelled “Empty”.
10. Now under FW Setup, click Wheel 2.
11. Again, change the slot names as required for the installed filters. As before it is recommended that the last slot be “Empty”.
12. Once both Wheel 1 and Wheel 2 have been set up, configure the Slot Setup.

Slot Setup lets you configure “virtual” filter wheel slots, which map to specific positions for each of the two wheels.

In addition to the Add Slot, Remove Slot, and Clear buttons, you can right-click on a slot for a context menu. The Default button will automatically try to organize the filters using an “Empty” or “Blank” slot on the opposing wheel.

Example: Primary (wheel 1) has Luminance, Red, Green, Blue, Ha, S-II, O-III, Empty. Secondary (wheel 2) has U, B, V, R, I, Empty. You can

configure your “virtual wheel” to show:

Virtual Slot	Wheel 1	Wheel 2
Luminance	Luminance	Empty
Red	Red	Empty
Green	Green	Empty
Blue	Blue	Empty
Ha	Ha	Empty
S-II	S-II	Empty
O-III	O-III	Empty
U	Empty	U
B	Empty	B
V	Empty	V
R	Empty	R
I	Empty	I

13. In this example, when you select the Luminance filter, the primary wheel will go to Slot 1 for Luminance, and the secondary wheel will go to the last slot for Empty. If you select I, the first wheel will go to the Empty slot and the second wheel will go to the I band photometric filter.
14. To save yourself re-entering the slot names in the main configuration dialog box, turn on the **Use slot map names in MaxIm DL** checkbox. You will not need to reenter the slot names in the Setup DL Imaging+FW dialog box.
15. Click OK to save your changes. Click OK again on the Setup DL Imaging+FW dialog box.
16. The slot names will automatically appear when you connect to the camera.
17. Connect to the camera and verify that each slot selects the correct filters.

### SBIG Universal – STX, STXL Series

For STX and STXL cameras, you will need to use either the SBIG Universal or SBIG w/AO driver.

When using the **SBIG Universal** driver for the main camera, the filter wheel must be also set to **SBIG Universal**.

When using the **SBIG w/AO** driver for the main camera (required when using the AO-X Adaptive Optics unit), the filter wheel must be set to **SBIG AO w/FW**.

First, decide on the names of your “virtual slots”, which will map to slots in wheel 1 and wheel 2. See the table above for an example.

To set up

1. Configure the camera and filter wheel normally, then connect to the camera. This ensures that the settings file is created. You will be modifying that file manually.

2. Disconnect. This step is mandatory before you make any manual changes to the settings file.
3. If you are using SBIG Universal, open Windows Explorer and navigate to:

`Documents\MaxIm DL 6\Settings\CCDPlugSBIG`

4. If you are using SBIG w/AO, open Windows Explorer and navigate to:

`Documents\MaxIm DL 6\Settings\CCDPlugAO7`

5. Double-click the file `Settings.txt` – this will open it in Notepad.
6. Add the `FWSlotMap` to the bottom of the file. This is a string containing a list of virtual slots and the corresponding slots for wheel 1 and wheel 2. Following the example from the previous section, and using a 10 slot wheel with the last slot empty, the string will be:

```
FWSlotMap "Luminance:1:10;Red:2:10;Green:3:10;Blue:4:10;Ha:5:10;SII:6:10;OIII:7:10;U:10:1;B:10:2;V:10:3;R:10:4;I:10:5;"
```

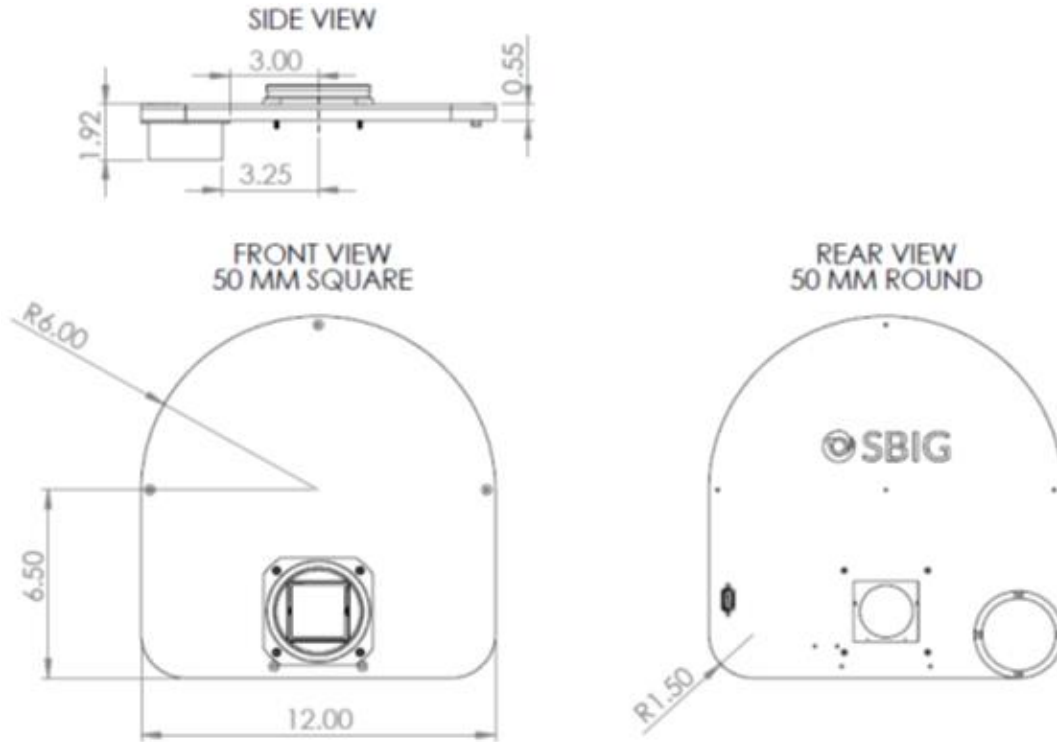
**7. Notes:**

- The whole text string must be one line (turn off the Word Wrap feature in Notepad if required).
- The beginning and ending quotes must be included.
- Each filter is defined as `Name:Wheel1:Wheel2;` – that is the filter name, the corresponding slot for wheel 1, and the corresponding slot for wheel 2. The name and wheel slots are separated by colons (:), and the slot definition is terminated with a semicolon (;).
- The last semicolon before the closing quote is mandatory.

8. Save the file and close Notepad.
9. Connect to the camera in MaxIm LT and verify correct filter wheel operation. Check each slot to ensure the correct filter is selected.

## 5 – Specifications

All AFW series filter wheels have the same external mechanical dimensions.



AFW mechanical layout – dimensions in inches.

Model	Feature	Specification
All AFW Models	Power	Via SBIG Camera AUX Port
	Control	Via SBIG Camera AUX Port
	Thickness	0.55" (14 mm)
AFW-10-50SQ	Number of Slots	10
	Filter Size	50 mm Square
	Filter Thickness	1 mm, 2 mm, or 3 mm
	Typical Camera	Aluma AC4040, STX
AFW-12-50R	Number of Slots	12
	Filter Size	50 mm Round
	Filter Thickness	1 mm, 2 mm, or 3 mm
	Typical Camera	Aluma AC2020, STXL



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