

Optec Filter Wheel

1.0.0

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Introduction

Optec manufactures several different filter wheel models with different feature sets. All models offer the same core features including computer control, automatic wheel ID recognition and easily changeable wheels.

The IFW wheel is 6 inches in diameter and is rotated on the center axis by a small stepper motor. The wheel has a precision bearing in the middle and uses a Neoprene O-ring for the drive. Each filter position uses tabs and spaces to hold the different types of filters. Supported filters are 2" (50mm) for 5 position wheels, 1" (25mm) for 8 and 1.5" (36mm) for 9 position wheels.

The shaft of the stepper motor makes friction contact with a Neoprene O-ring that is secured to the circumference of the wheel. It takes approximately 2000 steps of the stepper motor to complete one rotation of the wheel. For the original IFW it takes approximately 16 seconds for one complete wheel rotation. The new High Speed models can complete a rotation in around 2 seconds. One filter position change takes approximately 3.2 seconds for a low speed and around 1 second for a high speed.

Small magnets are inserted into each wheel opposite the filters, which indicate to the electronics the current wheel ID and filter position. Hall effect sensors detect the magnets and are read by the micro controller. The filter numbers are marked near the corresponding filter.

Another set of holes, only one of which contains a magnet, are used to identify the wheel and are referred to as the wheel ID. These holes are marked with the letters A, B, C, D, and E for the 5-position wheels, F, G and H for the 8-position wheels and I, J and K for the 9-position wheels. As the wheel rotates during the HOME procedure, the lettered ID hole with the magnet will pass over a second Hall effect sensor initiating a control pulse. The number of steps from this control pulse to the next signal pulse by the position magnet (filter position number 1) determines the wheel ID and position number 1. After the home is complete the wheel will stop at filter 1 and wait for further commands.

A lightweight, 6061 aluminum alloy is used for all machined parts. All parts are machined from solid aluminum blocks for optimum strength. In addition, all aluminum parts are bright dip and black anodized for maximum corrosion protection.

Models

Optec has offered several different filter wheel products. The current production models are the IFW 2 and HSFW filter wheels. All models support the same wheels, these include 5 position 55mm wheels, 8 position 25mm wheels and 7 position 36mm wheels. All models are able to read the wheel id and store unique identifiers for each filter position. High Speed models take around 2 seconds to home and .8 seconds to switch to an adjacent filter. See below for differences between the different models.

2.1 IFW 2

The IFW 2 is the latest model in the lineup. It is the first High Speed IFW that supports a serial connection. The IFW 2 supports hardware RS 232 serial, USB CDC (virtual serial over USB) and an optional hand controller. The IFW 2 is the first model to support field firmware updates without requiring an upgrade chip. The IFW 2 is fully backwards compatible with the original IFW serial commands.



2.2 HSFW

The HSFW is the first High Speed Filter Wheel from Optec. It can move and home substantially faster than the original IFW. The HSFW supports USB HID communication. Most software is written to use the C# .Net and native C libraries rather than direct commands.



2.3 IFW

The Intelligent Filter Wheel is the first filter wheel from Optec. It has a required external hand control box. It supports hardware RS 232 serial. The original IFW has been superseded by the IFW 2.



Software

Development

First Time Setup

1. Unpack the kit and verify the contents against your order.



2. Install your filters.
3. Install your wheel into the housing.
4. Connect 12v power to the housing.
5. Connect the USB, Serial or Hand Controller to the wheel.
6. Run the software or use the Hand Controller to home and move the wheel.
7. Set Filter Names from the software.

Install or Replace a Filter

The tab mounting filter wheels allow easier insertion of filters. The black delrin tabs and spacers will hold filters from 1 to 5 mm in thickness.

Spacer rings with thickness of 0.75 and 1.50 mm are stacked first in the filter wheel so that the filter's top surface is just above the level of the tab. The tab is then inserted and held in place with the supplied Phillips pan head screws (4-40 x 3/16 long) so that there is a small amount of pressure on the filter and the delrin tab is slightly bent. Delrin is very resilient and it will not be deformed easily even if the bend is steep. Don't tighten the three pan head screws until all the tabs are mounted and in contact with the filter. Then tighten each one slightly until the pan head screw is fully seated and the head is not above the surface of the filter wheel.



Replace a Wheel

The IFW filter wheel can easily be removed from the IFW system without tools or removal from the telescope. A hinged door is secured by a single captive thumbscrew. Once opened, the wheel can be extracted and another inserted in its place. The entire process takes only a few seconds. Hitting the HOME switch on the hand control or invoking the HOME function in the operating program will set the wheel to position one and bring up the available filter names for that wheel.

The wheel is held in place by a center shaft which is spring loaded and can be pulled from the wheel by use of a small pull knob on the back of the wheel housing. Rotating the pull knob counter clockwise will allow the spring shaft to retract from the wheel. At that point, the door can be opened and the wheel removed by hand. A different wheel is inserted and the pull knob turned clockwise until the shaft falls into the wheel center bearing. Proper operation of the wheel is dependent on the friction for the O-ring and motor shaft. If the pressure is too light or too heavy, or if there is oil or grease on the O-ring, the wheel will not rotate properly and an error condition will occur. Usually, cleaning the O-ring will solve this problem. See Section 6.0 for troubleshooting information. It is a common mistake to put the filter wheel in backwards. If this is done the filter wheel will not rotate. Make sure the numbers and markings on the filter wheel face the telescope when inserting the wheel.

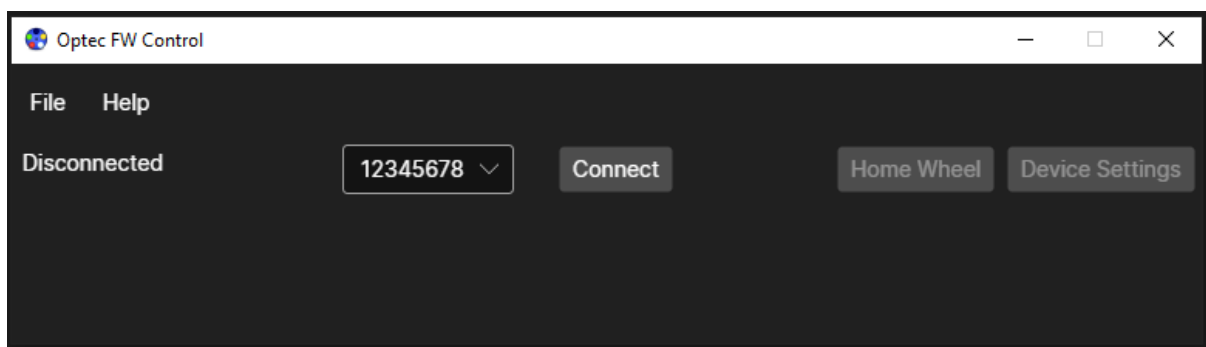
All models of Optec filter wheels use the same methods for removing and replacing the wheels.

Replace O-ring

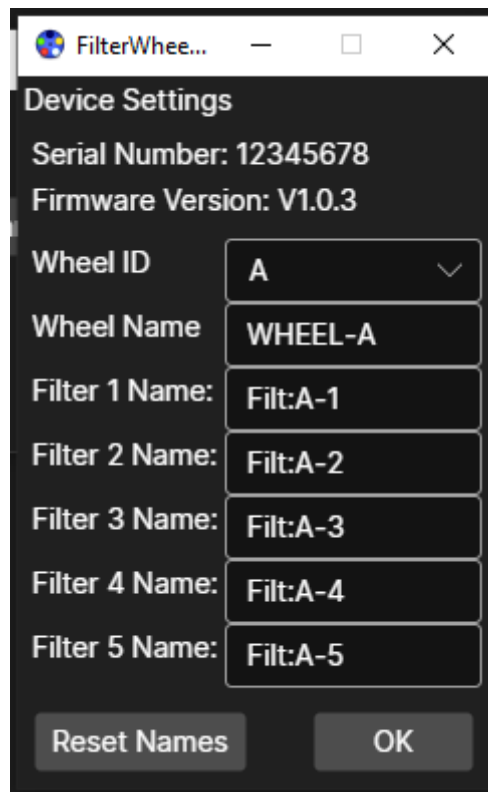
Over time, the O-ring will degrade and slipping can become a problem. These O-rings are easy to replace and a 3-pack replacement (#17575) can be purchased from Optec. To install the O-ring, wet with a small amount of mineral spirits to provide some lubrication and mount over the wheel. It sometimes helps to have an extra pair of hands. Use your finger to even out any high spots and make sure the O-ring is completely in the groove. Wipe the O-ring with a clean paper towel and allow the mineral spirits to dry before using.

Set Filter Names

1. Open the FW Control Software



2. Select the connection method for your FilterWheel and Connect
3. Click Device Settings
4. Set the new names and then press OK



The screenshot shows a software window titled "FilterWhee..." with standard Windows window controls. The window contains a "Device Settings" section with the following information:

- Serial Number: 12345678
- Firmware Version: V1.0.3
- Wheel ID: A (selected from a dropdown menu)
- Wheel Name: WHEEL-A
- Filter 1 Name: Filt:A-1
- Filter 2 Name: Filt:A-2
- Filter 3 Name: Filt:A-3
- Filter 4 Name: Filt:A-4
- Filter 5 Name: Filt:A-5

At the bottom of the window, there are two buttons: "Reset Names" and "OK".

Update IFW 2 firmware

The IFW 2 supports in field firmware updates. This can be done via the new FilterWheel software or manually.

10.1 Via Software

10.2 Manually

Definitions

11.1 Error Codes

Error codes are reported by the device firmware. For serial devices they come as ER=x and for HID as a number. These can be used for trouble shooting. Most Optec Software will report additional information based on the Error Code that is received.

11.2 Filter ID

Each filter slot has an ID magnet. These are used to position the wheel correctly.

11.3 Hand Controller

An external controller that allows the wheel to be controlled without a computer. Only supported by the IFW 2. Requires the internal hand controller power jumper to be set to on.

11.4 Homing

Optec Filter Wheels determine the number of filters and the wheel ID by homing the wheel. This is done automatically on power up and should be triggered manually by the user if a wheel is swapped or manually moved.

11.5 USB CDC

USB CDC (communication device class) is a USB communication type that emulates serial. It operates driverless on Windows 10+, most modern Linux distributions, and macOS. The IFW 2 supports USB CDC on its USB port.

11.6 Wheel ID

The Filter Wheel identifies the wheel by reading the wheel ID off the magnets. The wheel ID tells the controller how many filters are available. The filter wheel stores a unique name for every filter and wheel id combination. Currently valid wheel IDs are A-K

Error Codes

12.1 IFW Serial Protocol Error Codes

1. ER=1 Wheel rotation exceeds 2500 steps
2. ER=2 SBIG pulse is not within range (Astronomy models only)
3. ER=3 Invalid Wheel ID received
4. ER=4 Wheel is stuck in position
5. ER=5 Improper position received from PC
6. ER=6 Position change exceeds 800 steps
7. ER=7 8-position command for 5-position wheel
8. ER=8 12v power is disconnected (IFW 2 only)

12.2 HSFW HID Error Codes

0. No error has occurred. (cleared state)
1. The 12VDC power has been disconnected from the device.
2. The device stalled during a Home of Move procedure.
3. An invalid parameter was received during communication with the host(PC).
4. An attempt to Home the device was made while the device was already in motion.
5. An attempt to change filter positions was made while the device was already in motion.
6. An attempt to change filter positions was made before the device had been homed.
7. Optec use only
8. Unknown critical error

Hand Control

Only the IFW 2 supports a hand controller. The IFW 2 Hand Controller connects to the serial port. It allows filters to move and wheel homes to be triggered. After the Hand Controller finishes its startup the Home button is used to dismiss the version number.



