FLI
Finger Lakes Instrumentation

Engineering Excellence

Because Your Image Depends On It

High Speed Filter Wheel User's Guide

Welcome

Thank you for purchasing an FLI High Speed Filter Wheel. We know that your accessory will bring you years of enjoyment and excellent imaging results.

This User's Guide is intended as a reference tool for you to use with our High Speed Filter Wheels. Please read it and follow the procedures to ensure trouble-free installation of your hardware and software.

If you have any questions about your purchase, please contact us.

Contact Information

Finger Lakes Instrumentation, LLC
7287 West Main Street
Lima, New York 14485

Web: www.flicamera.com
Email: support@flicamera.com
Fax: 585-624-9879
Phone: 585-624-3760

If you are not aware of the FLI Yahoo Group you might want to look it up at http://tech.groups.yahoo.com/group/FLI_Imaging_Systems. This forum is for members wishing to: discuss FLI imaging systems, share imaging experiences, techniques and results, and discuss imaging solutions and problem solving.

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Check your Shipment

Please ensure that all the accessories and related components have arrived safely. In the unlikely event of a missing or damaged component, immediately notify FLI or your FLI dealer.

A High Speed Filter Wheel order should include the following items:

- High Speed Filter Wheel(s) (HS-10)
- RS-232 cable
- Power supply
- 10 Filter retaining rings (to hold 32 mm or 25 mm Filters in the Wheel)
- User's Guide

If you ordered other items, these items should be included. Please check that your order is complete.

Product Safety

This High Speed Filter Wheel is shipped with a 24 Volt power supply. Do not use any other power supply with this System or use the power supply in a way other than described in this Guide as it may cause damage to the High Speed Filter Wheel that will not be covered under the warranty.

If you are concerned about lightning strikes in the area in which you use your High Speed Filter Wheel, you may want to take safety precautions as electrical surges can damage electrical equipment. We recommend that when your High Speed Filter Wheel is not in use that you unplug it from power and unplug the USB cable from it.

High Speed Filter Wheel Overview

High Speed Filter Wheels (HSFW) use high-performance servo motors featuring rare earth magnets coupled with backlash-free power transfer to provide ultimate torque which translates to ultimate speed. Filter exchange rates under 30 milliseconds are possible.

An additional benefit of servo motors is the use of encoder feedback resulting in reliable operation compared to a stepper-motor-based open-loop approach where step skipping may occur. However, the advantages of servo motors come at a cost of increased circuitry and controller complexity. This is addressed with state-of-the-art semiconductor components, a high-performance DSP (Digital Signal Processor), and a sophisticated control algorithm.

The control system not only optimizes the trajectory to result in maximum speed with minimum vibration, it also adapts to the changes in load. When filters are added or removed, the controller parameters must be adjusted in order to maintain peak performance. A built-in adaptation mechanism takes care of these adjustments providing optimum performance under any operating conditions.

Specifications

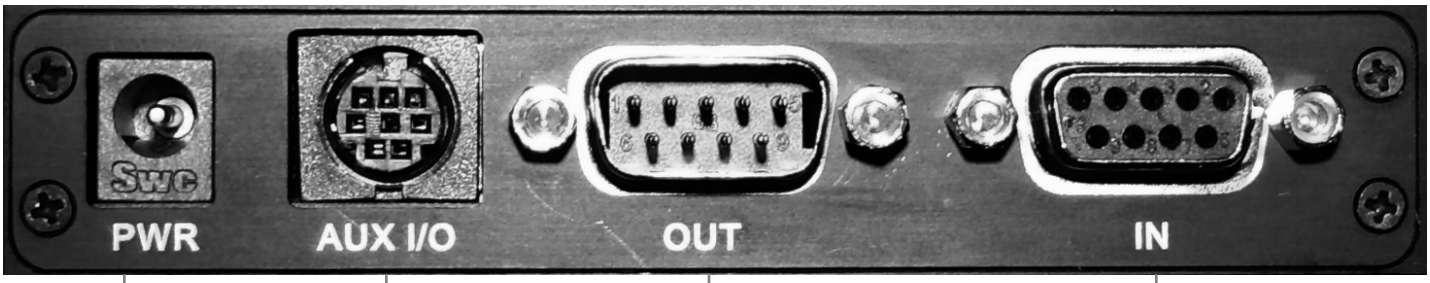
Voltage:	24 V DC
Power:	120 W
PC connection:	RS-232
Number of filter positions:	10
Filter pocket diameter:	32 mm or 25 mm
Adjacent filter transition:	30 ms
Longest distance (5 filter positions or 180 degree wheel turn):	90ms
Shutter open pulse:	24 V
Shutter open hold:	4 V
Dimensions:	6.25” × 7.25” × 1” (excluding motor)
Motor length:	3.5”
Weight:	3.2 lbs

Filter Information

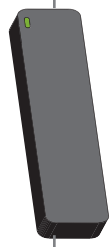
Three High Speed Filter Wheels are available.

- The HS-625 can accommodate 25 ± 0.4 mm filters with a thickness of 1 mm - 9 mm.
- The HS-1025 is designed to accommodate 25 ± 0.1 mm mm filters with a thickness of 1 mm - 9 mm.
- The HS-1032 can accommodate 32 mm filters with a thickness of 1 mm - 9 mm. With a 25mm Filter Insert Adapter the HS-1032 can accommodate 25 mm filters.

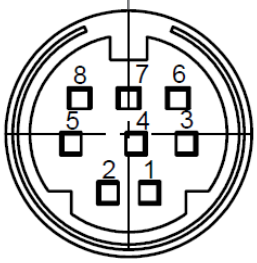
High Speed Filter Wheel Connections



24V DC Power In From Adapter



Connect the leads of an approved shutter between pins 4 and 7



RS-232 to additional Filter Wheels

Wheel A

Wheel C

Using standard RS-232 cables you can control up to three High Speed Filter Wheels by daisy chaining the devices.

RS-232 to Computer

Commands

Get Filter Wheel Status

Byte 1: **0xCC**

7	6	5	4	3	2	1	0
1	1	0	0	1	1	0	0

Response:

When requesting the wheel status, the device responds with the received command (CC hexadecimal) immediately and requests configuration information from a daisy-chained wheel. The status information of the whole chain is returned after a 1/4s timeout.

Bytes 0-10

0	1	2	3	4	5	6	7	8	9	10
0xCC	WAST	WBST	-	WCST	SAST	SBST	SAMOD	-	SBMOD	**0x0D**

Byte 0: 0xCC

Bit	7	6	5	4	3	2	1	0
Name	1	1	0	0	1	1	0	0

Byte 1: WAST (Wheel A Speed and Position)

Bit	7	6	5	4	3	2	1	0
Name	0	SPD2	SPD1	SPD0	POS3	POS2	POS1	POS0

Description		Wheel speed 000 (0) Speed = 0 001 (1) Speed = 1 010 (2) Speed = 2 011 (3) Speed = 3 100 (4) Speed = 4 101 (5) Speed = 5 110 (6) Speed = 6 111 (7) Speed = 7	Wheel position (0 – 9) 0000 (0) Position = 0 0001 (1) Position = 1 0010 (2) Position = 2 0011 (3) Position = 3 0100 (4) Position = 4 0101 (5) Position = 5 0110 (6) Position = 6 0111 (7) Position = 7 1000 (8) Position = 8 1001 (9) Position = 9

Byte 2: WBST (Wheel B Speed and Position)

Bit	7	6	5	4	3	2	1	0
Name	1	SPD2	SPD1	SPD0	POS3	POS2	POS1	POS0
Description		Wheel speed 000 (0) Speed = 0 001 (1) Speed = 1 010 (2) Speed = 2 011 (3) Speed = 3 100 (4) Speed = 4 101 (5) Speed = 5 110 (6) Speed = 6 111 (7) Speed = 7			Wheel position (0 – 9) 0000 (0) Position = 0 0001 (1) Position = 1 0010 (2) Position = 2 0011 (3) Position = 3 0100 (4) Position = 4 0101 (5) Position = 5 0110 (6) Position = 6 0111 (7) Position = 7 1000 (8) Position = 8 1001 (9) Position = 9			

Byte 4: WCST (Wheel C Speed and Position)

Bit	7	6	5	4	3	2	1	0
Name	1	SPD2	SPD1	SPD0	POS3	POS2	POS1	POS0

Description		Wheel speed 000 (0) Speed = 0 001 (1) Speed = 1 010 (2) Speed = 2 011 (3) Speed = 3 100 (4) Speed = 4 101 (5) Speed = 5 110 (6) Speed = 6 111 (7) Speed = 7	Wheel position (0 – 9) 0000 (0) Position = 0 0001 (1) Position = 1 0010 (2) Position = 2 0011 (3) Position = 3 0100 (4) Position = 4 0101 (5) Position = 5 0110 (6) Position = 6 0111 (7) Position = 7 1000 (8) Position = 8 1001 (9) Position = 9

Byte 5: SAST (Shutter A State)

Bit	7	6	5	4	3	2	1	0
Name	1	0	1	0	1	SHST2	SHST1	SHST0
Description						Shutter state 010 (1) Open 011 (2) Open on ext. trigger 100 (3) Closed		

Byte 6: SBST (Shutter B State)

Bit	7	6	5	4	3	2	1	0
Name	1	0	1	1	1	SHST2	SHST1	SHST0
Description						Shutter state 010 (1) Open 011 (2) Open on ext. trigger 100 (3) Closed		

Byte 7: SAMOD (Shutter A Mode)

Bit	7	6	5	4	3	2	1	0
Name	1	1	0	1	1	SHMOD2	SHMOD1	SHMOD0
Description						Shutter Mode 011 (3)Not Connected 100 (4) Normal operation		

Byte 9: SBMOD (Shutter B Mode)

Bit	7	6	5	4	3	2	1	0
Name	1	1	0	1	1	SHMOD2	SHMOD1	SHMOD0

Description						Shutter Mode 011 (3)Not Connected 100 (4) Normal operation

Get Filter Wheel Configuration

Byte 1: 0xFD

7	6	5	4	3	2	1	0
1	1	1	1	1	1	0	1

Response:

When requesting the wheel configuration, the device responds with the received command (FD hexadecimal) immediately and requests configuration information from a daisy-chained wheel. The configuration information of the whole chain is returned after a 1/4s timeout.

Bytes 0 – 4

0	1	2	3	4
0xFD	‘1’	‘0’	‘-’	‘3’

Bytes 5 – 9

5	6	7	8	9
‘W’	‘A’	‘:’	WHLACFG	
			Wheel A configuration ‘NC’ Not Connected ‘ER’ Error ‘25’ 25mm ‘32’ 32mm	

Bytes 10 – 14

10	11	12	13	14
‘W’	‘B’	‘:’	WHLBCFG	

			Wheel B configuration 'NC' Not Connected 'ER' Error '25' 25mm '32' 32mm

Bytes 15 – 19

15	16	17	18	19
'W'	'C'	':'	WHLCCFG	
			Wheel B configuration 'NC' Not Connected 'ER' Error '25' 25mm '32' 32mm	

Bytes 20 – 24

20	21	22	23	24
'S'	'A'	':'	SHATYP	
			Shutter A Type 'VS' Vincent Shutter	

Bytes 25 – 29

25	26	27	28	29
'S'	'B'	':'	SHBTYP	
			Shutter B Type 'VS' Vincent Shutter	

Byte 30

30
FRM
Firmware revision

Set Wheel Position

Byte 1: 0xFC (Note: Byte 1 only present for wheel C configuration, omitted if wheel A or B selected)

7	6	5	4	3	2	1	0
1	1	1	1	1	1	0	0

Byte 2:

Bit	7	6	5	4	3	2	1	0
Name	WHL	SPD2	SPD1	SPD0	POS3	POS2	POS1	POS0

Description	Wheel selection 0 Wheel A, C 1 Wheel B	Wheel speed 000 (0) Speed = 0 001 (1) Speed = 1 010 (2) Speed = 2 011 (3) Speed = 3 100 (4) Speed = 4 101 (5) Speed = 5 110 (6) Speed = 6 111 (7) Speed = 7	Wheel position (0 – 9) 0000 (0) Position = 0 0001 (1) Position = 1 0010 (2) Position = 2 0011 (3) Position = 3 0100 (4) Position = 4 0101 (5) Position = 5 0110 (6) Position = 6 0111 (7) Position = 7 1000 (8) Position = 8 1001 (9) Position = 9

Response:
Byte 1: command byte as received, returned immediately
Byte 2: 0x0D after task completion

Set Shutter State

	Open	Open on Ext. Trig	Close
Wheel A	0xAA	0xAB	0xAC
Wheel B	0xBA	0xBB	0xBC

Byte 1:

Bit	7	6	5	4	3	2	1	0
Name	1	0	WHL1	WHL0	1	SHFUN2	SHFUN1	SHFUN0
Description			Wheel selection 10 (2) wheel A 11 (3) wheel B			Shutter state 010 (2) open 011 (3) open on ext. trigger 100 (4) close		

Response:
Byte 1: command byte as received, returned immediately
Byte 2: 0x0D after task completion

Reset

Byte 1: 0xFB

7	6	5	4	3	2	1	0
1	1	1	1	1	0	1	1

Response: 0x0D

Examples

Binary	Hexadecimal	Decimal	Functionality
00000000	00	0	Wheel A moves to position ‘0’ at maximum speed
10000000	80	128	Wheel B moves to position ‘0’ at maximum speed
11111100 00000000	FC 00	252 0	Wheel C moves to position ‘0’ at maximum speed
00110110	36	54	Wheel A moves to position ‘6’ at speed 3
10101010	AA	170	Shutter A opens
10101100	AC	172	Shutter A closes
10111010	BA	186	Shutter B opens

Appendix A - Warranty for FLI Products

Unless otherwise noted, the standard statement of warranty described below applies to customers who purchase this product. This warranty may not apply in special circumstances in which prior arrangements have been made and separate documentation has been supplied prior to, or with, the product.

This warranty applies to all FLI Products.

All products and services are FOB Lima, NY. The customer is responsible for shipping and insurance to and from FLI.

The product is warranted against defects in materials and workmanship for a period of one (1) year after delivery to the original purchaser.

A CCD array is warranted by the CCD manufacturer for one (1) year.

In the event of a CCD array failure or malfunction, FLI will assist in testing, replacement, shipping and required communications with the CCD manufacturer in order to facilitate a resolution of the problem.

The internal environment of a camera is warranted to remain moisture free for a period of one (1) year when used under normal conditions.

Damage arising from ESD (electrostatic discharge) events, exposure to the elements, mechanical shock, over-voltage, reverse polarity connections, or other environmental hazards is not covered under warranty.

FLI will be the sole judge of what constitutes defects vs. normal performance.

FLI application software is supplied for demonstration purposes only. The software carries no warranty of fitness for any purpose. FLI supplies the necessary information, drivers, and libraries, for users and 3rd party vendors to develop software for their specific purposes.

FLI works to maintain compatibility with many 3rd party software vendors, however FLI cannot guarantee operation with non-FLI software. FLI is not responsible for changes, upgrades, or errors in 3rd party programs.

Incidental and consequential damages resulting from the use of FLI products, malfunction or failure to perform, or lack of fitness for a particular purpose, are not the responsibility of FLI and are hereby excluded both for property damage and to the extent permitted by law, for personal injury damage.

FLI products are not authorized for use as critical components in life support or medical diagnostic applications where failure to perform could result in injury, faulty diagnosis, or other risk to patients or personnel.

FLI products are not authorized for use in robotic control systems where malfunction or failure could cause system motions hazardous to personnel.

This warranty applies to the original purchaser.

Appendix B - FLI Return Procedure

If you need to return a product, please follow the instructions outlined below.

1. Obtain authorization to return the camera/product in advance by phone or email contact with FLI and:
    a. If you are outside the United States, contact your Customs Authority to register the merchandise to be returned to the United States for warranty repair or refund. Use the Harmonized Code number 9801.00.1012 on your shipping documentation. The monetary value you place on the item should be stated for insurance purposes. Clearly state that the "Value is for Customs purposes ONLY." When FLI returns the repair item to you, we will use the same monetary value.
    b. For all customers, prepare a Pro Forma invoice to accompany the shipment with the following statement:
        - For Equipment not covered under warranty: "American goods returned for repair only with NO Commercial Value. Temporary return only"
        - For Equipment covered under warranty: "American goods returned for Warranty Repair only with NO Commercial Value. Temporary return only"
    c. For all customers, if you are requesting service under warranty or a return, a copy of your original receipt.
    d. For you records, make a copy of these documents.
    e. Prepare a large shipping label with the appropriate return address (FLI or distributor) and for shipments from outside the U.S., include the Harmonized Code number.
2. Locate the original shipping boxes in which your item(s) was packaged. These boxes are designed to protect the products.

    OR:

    If you do not have the original shipping boxes, obtain a rigid box that is at least 3" (7.5 cm) larger in all dimensions than the items. A smaller box will not allow appropriate cushioning. Tape the side and bottom seams to secure the box.
3. If you have the original packing materials, place the item(s) in the original plastic bag(s) and place the bagged item in the appropriate foam cutout in the proper orientation. Insert other items into their appropriate compartments.

    OR:

    If you do not have the original bag, place the item(s) in a plastic bag and seal it. Wrap the bagged item(s) with at least two layers of bubble wrap or two bubble wrap bags. Wrap other items in the same manner. Into the bottom of the box, place two inches of packing material (Styrofoam peanuts or additional bubble wrap). Place the item(s) on the bottom layer with space around each. Add additional packing material around the sides of each item(s) and on top of the item(s).
4. Write a letter that includes the following: reason the item is being returned to FLI or distributor, your complete contact information (name, phone number(s), email address, return shipping address), and if appropriate, payment method and information. On top of the item(s) in the box, add the required paperwork described in step 1 and the letter described in step 4. Seal the box with packing tape. Tape the top flaps and label the box with the shipping label prepared in step 1.
5. Contact a shipper for pickup or bring it to a reliable carrier. As noted in step 1, use the appropriate value on shipping forms. FLI is not responsible for damage to any item or items when they are in the possession of a carrier.

Return Addresses by Carrier

UPS and Fed Ex Returns

Finger Lakes Instrumentation
Att. Greg Terrance
7287 West Main St.
Lima, N.Y. 14485

USPS Returns

Finger Lakes Instrumentation
Att. Greg Terrance
P.O. Box 19A
7298 West Main St.
Lima, N.Y. 14485