Handbook for the Starlight Xpress Universal Filter Wheel

Thank you for your purchase of a Starlight Xpress Universal Filter Wheel. We hope that you will enjoy using this advanced SX unit, which offers many unique features. This handbook will help you to put it into operation and to understand its capabilities. Please read it carefully.

Description:

The SX Universal Filter Wheel has several important advantages over older and less sophisticated designs:

1) The wheel uses an internal sub-miniature DC motor drive to turn the filter plate. This consumes far less power than the more typical stepper motor and allows wheel operation directly from the USB input, thus eliminating the cumbersome power supply and extra power cable. The DC drive also produces a quiet and vibration-free filter translation and eliminates a significant amount of bulk and weight.

2) The filter locations are encoded by 3 Hall-effect magnetic sensors, which permit up to 7 unique filter positions to be defined. The control software can specify a particular filter without prior knowledge of the location of 'position 1' – so the filters can never get out of sequence. The lack of any infrared

optical sensors also prevents stray infrared light from entering the CCD camera and causing strange image artefacts.

3) Although USB operation is the normal mode, the extra RJ12 socket also permits serial port control or 'handbox' manual control. The Universal Filter Wheel truly is 'Universal'!

4) The input and output adaptors are both removable and also may be oriented at any rotational angle to set the wheel and camera into optimum positions. The standard 'T' thread adaptors may be replaced with other versions for 'SCT' thread etc. simply by unscrewing three fixing bolts.

5) Two interchangeable filter plates are available – one with seven x 32.5mm filter positions and the other with five x 48mm filter locations. These are easily swapped by removing 6 'thumbscrew' fixings and simply dropping the plate into place. There are no gears or belt drives to engage and the plate drops directly into contact with the motor drive drum. Easily done, even by flashlight!

6) The ultra-slim design of the SXUFW minimises the loss of optical back focal distance to only 29mm overall (including the T thread adaptors).

Here is a simplified cross-sectional view of the filter wheel
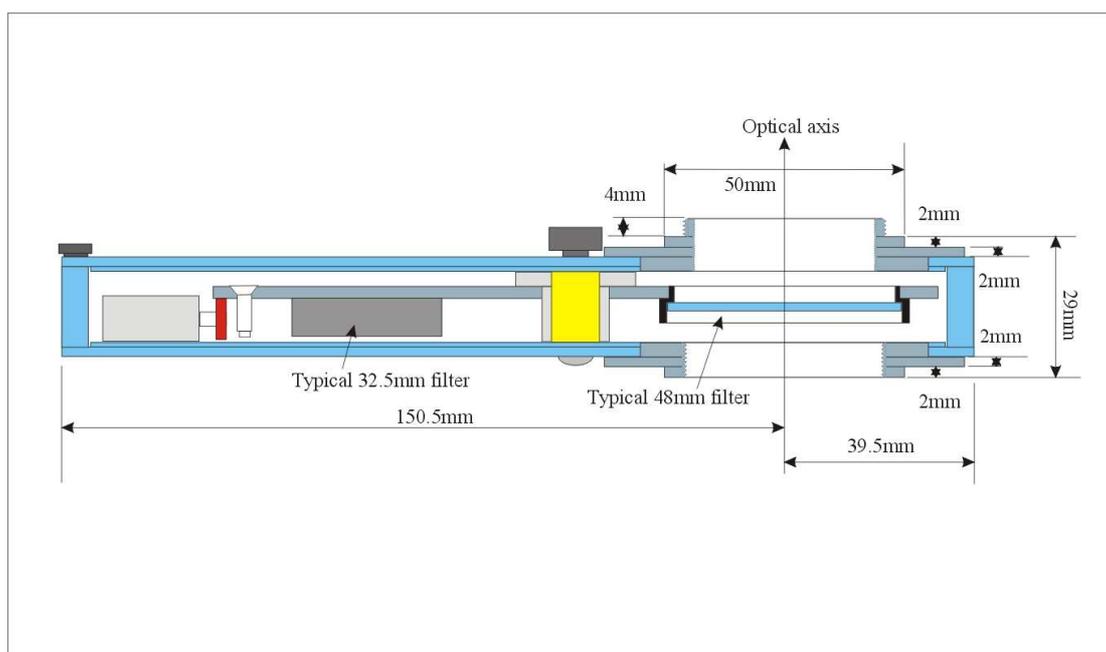
Loading the filters:
Open the wheel by unscrewing the 5 small thumbscrews from around the periphery of the wheel chamber and the single large thumbscrew from the central pillar. Carefully lift off the side wall and put it in a safe place. You will now see the filter plate and you can lift it off the centre bearing and place it down with the magnet screws facing upwards. Your filters may now be screwed into the plate from the magnet screw side, placing them in the desired numerical order according to the engraving on the plate. Assemble the wheel by reversing the sequence of operations above.

Installing the software:

No drivers are required for the SXUFW. The USB input is an 'HID' device which Windows recognises automatically, and the serial input does not use a special driver. Popular third-party software, such as AstroArt and MaximDL include the command sets for the SXUFW, and the latest SX software can be used with the wheel. You may also use a simple Windows 'Console' program, which is provided on the CD ROM. This program, 'SX Filter Wheel.exe', may be copied into a folder on your computer and will display a filter wheel control panel when executed. It may be found useful for both testing the wheel and operating it when the camera software does not support the SX wheel protocols.

Connecting up the wheel:

USB control:
If you are using USB control, then the only connection required is that between the USB port on the wheel and a USB output on your computer. You may, of course, use a USB hub, if necessary – a powered hub is recommended to ensure that the wheel motor has sufficient torque to operate reliably. When the wheel is first connected, Windows will display a message about 'New hardware found' followed by 'SX filter wheel'. Shortly afterwards, the wheel will rotate twice as it calibrates and determines the number of filter positions available. It is now in position 1 and ready to use.

Serial control:
The SXUFW requires a special RJ12 cable that must be used to connect via the serial port. This is available from Starlight Xpress dealers, if you wish to use serial control. The serial port of a PC cannot supply sufficient power to operate the filter wheel motor and so the cable is modified to allow the connection of a small 9v battery at the PC end. Just clip a 9v radio battery (PP3 or R22) to the snap connectors and then connect the serial socket to the PC serial port. No power will be taken until the RJ12 plug is inserted into the wheel socket. Disconnect the cable when not in use, or the battery will be drained in a few hours.

Serial control does not require any special drivers. Just determine the correct COM port number and operate the wheel using the control interface provided by the software in use.

Manual Control:
A manual control box is available from Starlight Xpress dealers. The kit includes an RJ12 cable to connect to the serial port of the wheel with the other end plugged into the manual control box. The box contains a 'AAA' size battery clip for 4 cells and a 10 position thumb-operated rotary switch (switch positions higher than the maximum number of filters will default to the highest number available – i.e. switch positions 8 and 9 give filter 7 on a 7 aperture filter wheel). To install the batteries, unscrew the four cross-head screws in the rear panel of the hand controller and lift it off. The battery holder may then be lifted out and fitted with four AAA cells.
Please be sure to disconnect the hand controller when it is not in use, or the battery pack will be discharged.

Starlight Xpress Universal Filter Wheel Communication Protocols

Interfaces available:
>   (a) USB: 1.1 or 2.0
>   (b) Serial Port: 9600 baud, 8 data bits, no parity, 1 stop bit.
>   (c) Manual Switch: Select filter using digital switch box.

General parameters:
>   Total Filters: This is the number of filters fitted on the wheel, and is currently 5 or 7.
>   Filter number: This is any number from 1 to <Total Filters>
>   (If a Filter Number higher than Total Filters is requested then the Filter Number is set to <Total Filters>)

USB Protocol:
>   The SX filter wheel uses a simple "Human Interface Device" protocol, so no special driver needs to be installed. The driver is an integral part of the Windows PC operating system.
>   Communications between the PC & filter wheel is by input and output reports (referenced to the PC). These reports are both of a fixed length of two bytes. The PC sends the output report and the filter wheel, about 1ms later, will send an input report in response.

The output report data is formatted thus:

Description	1st byte	2nd byte
Select Filter	New Filter number	Zero (0)
Request current filter number	Zero	Zero
Get Filter Total	Zero	One (1)

The input report data is formatted thus:

Response To:	1st byte	2nd byte
Select New Filter	New Filter number or Zero = filters moving	Total filters
Request current filter number	Current Filter number	Total filters

	or Zero = filters moving	
Get Filter Total	Current Filter number or Zero = filters moving	Zero

NB: The 'Get Filter Total' command responds straight away with a "filters moving" message. However there is a delay of several seconds before the Total Filters data is available to the "Request Current Filter Number" command. This is the time taken for the wheel to complete between one and two complete rotations. During this period the Total Filters will be reported as zero. When this command is completed filter 1 is automatically selected.

Serial Port Protocol:

The SX filter wheel implements a four-character format, which has just three commands thus:

Notes: Checksum is 8 bit addition of Header + Command + Data
0xA5 is the hexadecimal number = decimal number 165
0x20 is the hexadecimal number = decimal number 32

Output Command / Data from PC

Description	Header (1)	Command (2)	Data (3)	Checksum (4)
Select Filter	0xA5	1	0x20	4 = 1+2+3
Request Current Filter	0xA5	2	0x20	4 = 1+2+3
Get Filter Total	0xA5	3	0x20	4 = 1+2+3

Input Data to PC

Description	Header (1)	Response (2)	Data (3)	Checksum (4)
Select Filter	0xA5	0x81	New Filter Number	4 = 1+2+3
Request Current Filter	0xA5	0x82	Filter Number + 0x30	4 = 1+2+3
Get Filter Total	0xA5	0x83	Total Filters + 0x30	4 = 1+2+3

Examples, (all characters expressed in hexadecimal):

Select Filter Number 3:
PC -> Filter Wheel,   0xA5, 0x01, 0x03, 0xA9
Filter Wheel -> PC,   0xA5, 0x81, 0x03, 0x29

Request Current Filter (which is 2):
PC -> Filter Wheel,   0xA5, 0x02, 0x20, 0xC7
Filter Wheel -> PC,   0xA5, 0x82, 0x32, 0x59

Get Filter Total (which is 7):
PC -> Filter Wheel,   0xA5, 0x03, 0x20, 0xC8
Filter Wheel -> PC,   0xA5, 0x83, 0x37, 0x2F (after delay)

Note: The 'Get Filter Total' command has a delay of several seconds before the response is sent back. This is the time taken for the wheel to complete between one and two rotations. When completed, filter 1 is selected. Do not send any new requests until the response is received. Any data sent during this period would be read but then discarded.