FW102C

Motorized Filter Wheel

Operating Manual

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Part 1. Description

The FW102C is a high-precision, motor-driven filter wheel used for a host of applications, including color CCD photography, fluorescence microscopy, and photometry.

The unit consists of a control unit, a filter wheel housing, and a removable Ø4" filter wheel. The filter wheel accommodates up to six Ø1" filters or optics. Filter selection can be made manually from the push button controls on the display panel or remotely from a USB 2.0 interface, a serial port, or a TTL level active low (BNC) input. The FW102C contains an active display to indicate the selected filter and two separate aperture openings at the top of unit and at 210° degrees (See Figure Figure 8 on page 15).

Features

- Automated Computer Control Capability (Application Software Provided)
- Holds Six Ø1" Filters
- External Trigger In (Increment Control)
- External Trigger Out (Provisioned from Software)
- Bidirectional Controls
- 700 ms Typical Access Time
- Selectable Aperture Openings at 0° and 210°
- Dimmable Display

The FW102C is designed to ensure an accuracy of greater than ±1°. The FW102C easily mounts to our lens tube systems and optical instruments via two SM1 (1.035"-40) threaded mounts. Adapters are available to interface to other popular camera, microscope, and telescope thread sizes. The filter wheel is also compatible with Thorlabs' 30 mm cage systems, each port has the required four 4-40 tapped holes to mount the cage rods. The FW102C also features #8 and M6 tapped holes for mounting to steel posts. Two 1/4"-20 and M6 tapped holes allow the filter wheel to be mounted to a plate. The flexible mounting system makes the FW102C ideal for both instrument and laboratory applications.

The device comes with a CD-ROM that contains a Windows[TM1]-based, standalone application program. In addition, an OCX is provided to allow easy integrated instrumentation software development. Sample code is provided for LabVIEW[TM2] and C++ code development. The filter wheel can also be controlled via a set of command line prompts using terminal server software, allowing users to create scripts in their own programs.

The unit is powered via a 12 VDC input (converter supplied with unit).

New Design

The FW102C features a new, more robust design compared to the older FW102B. The filter wheel is turned using a powerful and reliable stepper motor and worm gear. This design will provide millions of wheel changes over its life time.

> **Due to play in the gears, some noise can be heard during operation and when moving or shaking the device. There are virtually no small parts that can come loose inside the device. This noise is normal and not indicative of a problem.**

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[1] Windows[TM] is a registered trademark of Microsoft Corporation.
[2] LabVIEW[TM] is a registered trademark of National Instruments Corporation.

Shipping Inventory

The FW102C is shipped with the following:

Quantity	Description
1	Controller with Filter Housing
1	FW102C Filter Wheel
1	12 Volt DC Converter
1	Power Cord
1	USB Cable
2	SM1CP2 End Caps
6	SM1RR Retaining Rings

Figure 1   Filter Wheel System

Part 2.   Basic Operation

The following sections describe the basic operation of the motorized filter wheel and application software.

2.1.   Changing and Removing Filters

WARNING
Prior to changing filters, ensure that the power is off and the unit is disconnected from the DC source.

The filters can be changed by first removing the filter wheel cover, which is held in place with a single thumbscrew. Filters can then be inserted into the desired locations. The filters are secured to the wheel via SM1RR-1CT retaining rings, which are included with the unit. For easy access, the entire filter wheel can be lifted out of the filter wheel housing. Please note that the rear edge of the threaded filter holes contain a retaining lip that secures one edge of a Ø1" filter. Some filters with a Ø25 mm may need to be mounted between two SM1RR-1CT retaining rings.

When replacing the filter wheel in the housing, slip the wheel over the shaft and turn slightly to allow the gears to mesh. Replace the cover and tighten the thumb screw. It is not necessary to return the wheel to any particular orientation, since the unit will reorient automatically when the power is turned on.

2.2.   Mounting

The base of the unit contains an array of mounting holes for attaching to steel posts or directly to other mounting plates. See the figure below for hole sizes and locations:
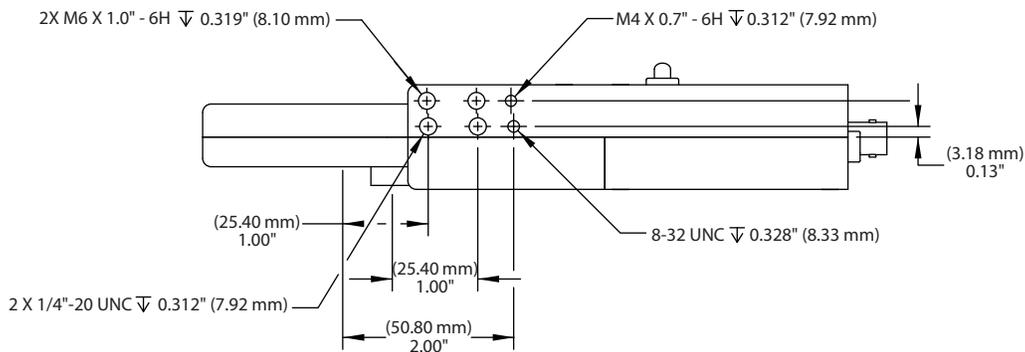
Figure 2   Filter Wheel Mounting Holes

The filter wheel cover contains SM1 threads for attaching lens tubes or for mounting the unit directly to cameras, microscopes, and telescopes. The filter wheel can be attached directly to Thorlabs' 30 mm cage systems via four 4-40 tapped holes that surround each port.

2.3.   Power

The unit comes with an AC wall adapter to supply 12 VDC to the unit. Plug the 2.1 mm plug from the AC adapter into the DC input jack on the unit. The ON/OFF (0/1) switch is located on the side of the

unit. Upon power up, the unit will display the filter number that is located at the selected aperture. If the wheel is not located at a valid location, it will rotate to the closest valid position.

2.4. Aperture

The unit has two aperture locations labeled "A" and "B" for the 0° and 210° positions, respectively (see Figure 3 below). The A/B switch on the side of the unit selects the aperture.
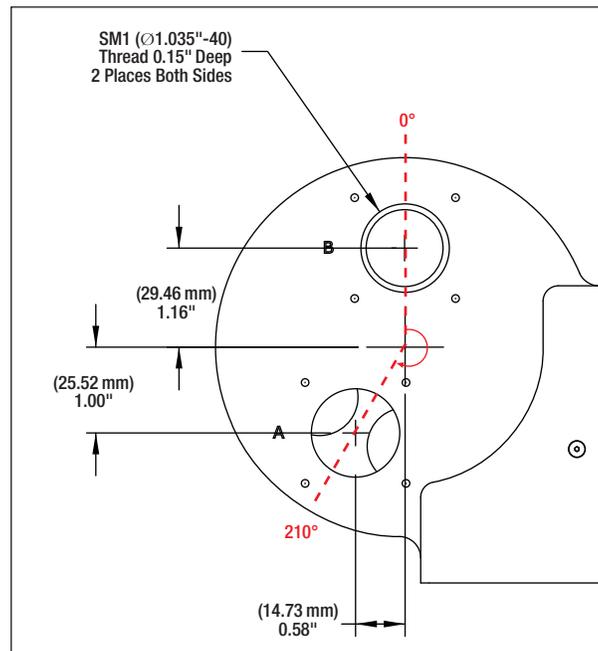

Figure 3   Filter Wheel Apertures

2.5. Manual Control

Pushing the ▲ / ▼ arrow buttons on the top of the unit will adjust the filter location. The arrows indicate the direction of the wheel's rotation, and the display will indicate the filter selection. The display brightness can be adjusted using a small screwdriver at the hole marked DIM.

2.6. External Trigger

The unit may be remotely triggered to advance to the next position. This is done by applying an active low pulse to the BNC trigger input. The input is TTL compatible and should not exceed 5 V. Because the input is internally pulled up, the trigger will operate with a passive connection to ground. The trigger mode defaults on power up to an input mode. Software provisioning can, however, change the trigger mode to an output mode. In the output mode, the unit generates an active high 10 ms pulse (TTL level) to indicate that the wheel has completed its rotation to the selected position. This pulse may be used to activate other equipment. The trigger can be changed to the output mode from the application software or by sending the command "Trig=1" over the USB interface.

Part 3. Software Control

3.1. Application Software Operation

The FW102C comes with a CD-ROM that contains application software to control the unit using USB 2.0, or RS232, from a PC. After installing the software, apply power to the unit. Connect a USB cable between the FW102C and a PC. To execute the FW102C standalone application, select *Programs > Thorlabs > FW102C* from the **Start menu**.

The initial screen will appear as shown below:
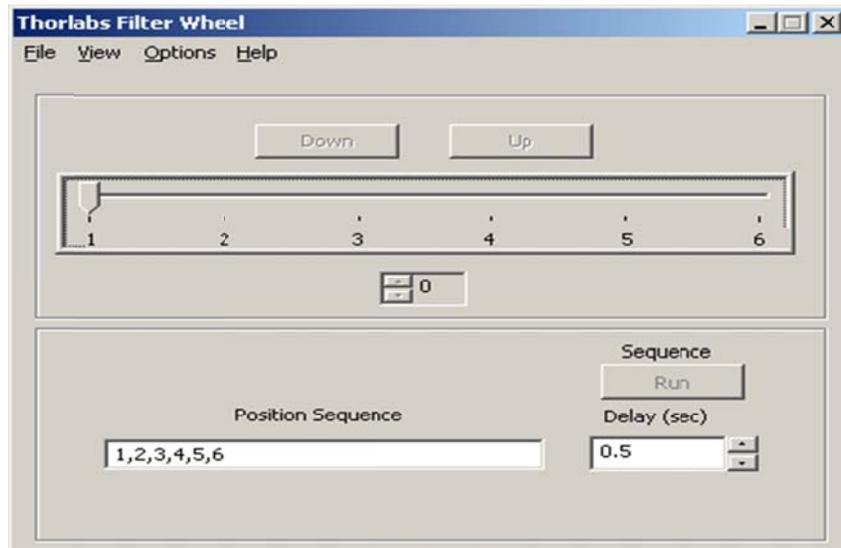
Figure 4   Software Screen Shot: Initial Startup Screen

Establishing Communications with FW102C

To operate the filter wheel, you must first establish a connection with the FW102C. The FW102C uses a USB driver that emulates a serial port and, when installed, will add a new COM port to the PC. Use the *Options > Serial Connection > Com Port* menu to select the new COM port.
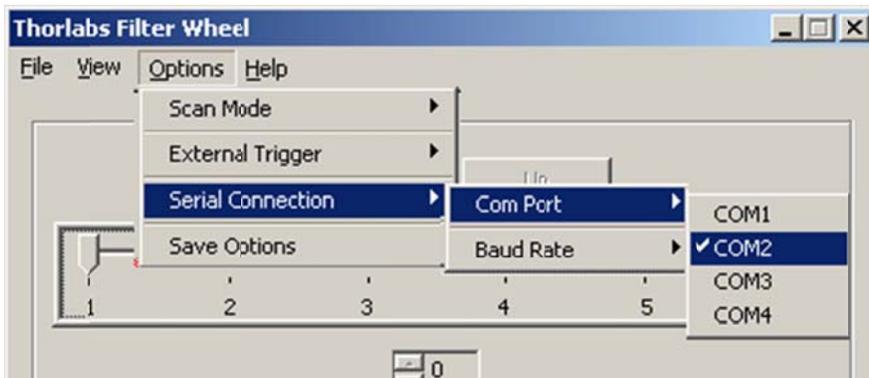
Figure 5   Software Screen Shot: Setting the COM Port

After selecting the proper COM port, select "Open Connection" from the **File Menu**.

The unit is now ready to operate either from the application software or from the front panel controls on the unit. The "Save Options" menu item will save the selected options for future sessions.

Filter Positions can be changed in any of the following ways:

- Pushing the ▲ / ▼ buttons on the top of the unit

- Dragging the slide bar to the desired position

- Using the increment / decrement arrows in the position window
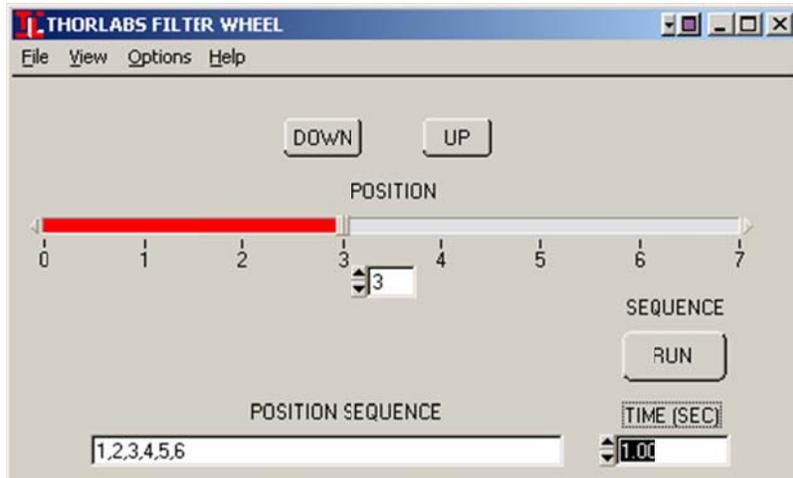
Figure 6   Software Screen Shot: Changing the Filter Position

Programmed Sequence Operation (Scan Mode)

The application software also contains the capability to control the filter wheel in a programmed sequence.

To operate in this mode, enter the filter number(s) of the desired sequence into the *POSITION SEQUENCE* box. A comma should separate each entry (See Figure 6 above). The *TIME (SEC)* box sets the delay between filter changes.

The programmed sequence may be set to run a single even or to run in a continuous mode. To choose the sequence mode, select *Options > Scan Mode*. Begin the sequence by clicking on the *RUN* button.

Help Menu

The *Help* menu contains a synopsis of the command line language for those who need to generate a scripting program to control the FW102C.

Minimum PC Requirements

The application program requires a minimum of a Pentium-class machine running Windows 98, 2000, NT, XP, Vista, or Windows 7.

3.2. Command Line Interface

The FW102C can also be controlled by a command line language through the USB or RS232 ports. This is offered to enable operation through a terminal interface or for those who may want to write their own program to control the wheel. Prior to running the command line interface, the unit should be powered, and a USB or RS232 cable should be connected between the FW102C and the host. The terminal emulator should be configured as follows:

Parameter	Setting
Baud Rate	115.2K Bits Per Second
Data Bits	8
Parity	None
Stop Bits	1
Flow Control	None

If the connection is correct, you will see the following message after pushing the *Enter* key:

Command error CMD_NOT_DEFINED

This message will be followed immediately by the prompt:

>

The basic structure of the interface is a keyword followed by either an equals sign "=" or a question mark "?". The "=" or "?" will determine if the string is a command or a query. All strings (commands and queries) must be terminated by a carriage return (CR) or pressing the ENTER key on the computer.

Command Structure

Keyword = argument (CR)

Here, *keyword* defines the function, and *argument* is a numerical value followed by a carriage return (*CR*).

Query Structure

Keyword? (CR)

Keyword defines the function, and the question mark (?) indicates a query. The string is terminated with a carriage return (*CR*). Exceptions to this and unique shortcut keys are given in the table on page xxx.

The prompt symbol ">" will appear on power-up and after a command is accepted by the FW102C and indicates that the FW102C is ready to receive another command line.

Keywords (Commands and Queries)

The following table describes all of the available commands and queries:

Command	Syntax[3]	Description
Get ID	*idn?	Returns the model number and firmware version
Set Position	pos=n	Moves the wheel to filter position n
Set Position Count	pcount=n	Sets the wheel type where n is 6 or 12
Get Position Count	pcount=?	Returns the wheel type
Set Trigger Mode	trig=0	Sets the external trigger to the input mode
	trig=1	Sets the external trigger to the output mode
Get Trigger Mode	Trig?	Returns the trigger mode
Set Speed Mode	speed=0	Sets the move profile to slow speed
	speed=1	Sets the move profile to high speed
Get Speed Mode	speed?	Returns the move profile mode
Set Sensor Mode	sensors=0	Sensors turn off when wheel is idle to eliminate stray light
	sensors=1	Sensors remain active
Get Sensor Mode	sensors?	Returns the sensor mode
Set Baud Rate	baud=0	Sets the baud rate to 9600
	baud=1	Sets the baud rate to 115200
Get Baud Rate	baud?	Returns the baud rate where 0 = 9600 and 1 = 115200
Save Settings	save	This will save all the settings as default on power up

If the keyword, format, or argument are incorrect or out of range, the unit will return an error string.

In addition to the commands given above, there is also special functionality added to the arrow keys of the computer's keyboard:

Key	Description
Up Arrow	Increments the filter position by 1
Down Arrow	Decrements the filter position by 1

3.3. ActiveX Control

An ActiveX control, FW102.ocx, is installed with the software. This feature can also be used to control the wheel from an environment that supports ActiveX. The methods and properties supported by the ActiveX control are described below:

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[3] *All Commands and queries are in lower case letters.*

Methods	Description
AboutBox	Displays a dialog box with information about Thorlabs
SelectComPort	Displays a dialog box to select the com port that the filter wheel is connected to
SelectBaudRate	Displays a dialog box to select the desired baud rate for communications
ShowDialog	Displays a dialog box to control the filter wheel
OpenPort	Opens the com port
ClosePort	Closes the com port
IncrementPosition	Advances the wheel one position clockwise
DecrementPosition	Advances the wheel one position counterclockwise
SaveCalibrationData	Saves the current motor parameters
GetCommands	Lists the available commands

Properties	Description
ID	Gets the product name and firmware version of the filter wheel
ComPort	Sets/Gets the com port for communications with the filter wheel
BaudRate	Sets/Gets the baud rate for communications with the filter wheel
PortOpen	Gets the status of the com port
Position	Gets/Sets the current filter position
MaxVelocity	Gets/Sets the maximum velocity
Acceleration	Gets/Sets the acceleration rate
PositionCount	Gets/Sets the number of filter position in the wheel
SensorsAlwaysOn	Gets/Sets a flag to indicate if optical sensors should remain on after move
TriggerType	Gets/Sets trigger mode to input or output
MinVelocity	Gets/Sets the minimum velocity
CalibrationPassword	Sets the calibration password for saving motor parameters
ElapsedTime	Gets the time last move took in milliseconds
StatusWord	Gets the result of the last move
SpeedProfile	Gets/Sets the current speed profile

Part 4.   Troubleshooting and Maintenance

Dust or debris can sometimes set into the filter wheel housing and block the sensors. This will result in the filter wheel failing to move to the desired position. To prevent this, periodically remove the filter wheel and use compressed air to clear away any contaminants.

Removing Filter Holder

The filter holder maybe tight and difficult to remove. To make the wheel release with the minimal of force, grab it on the right side (by filter position 5 in image below) and pull the wheel out and to the left as depicted by the large red arrow.

When reinserting the wheel, push the filter holder onto the post jiggling the holder clockwise and counterclockwise to help align the gears.
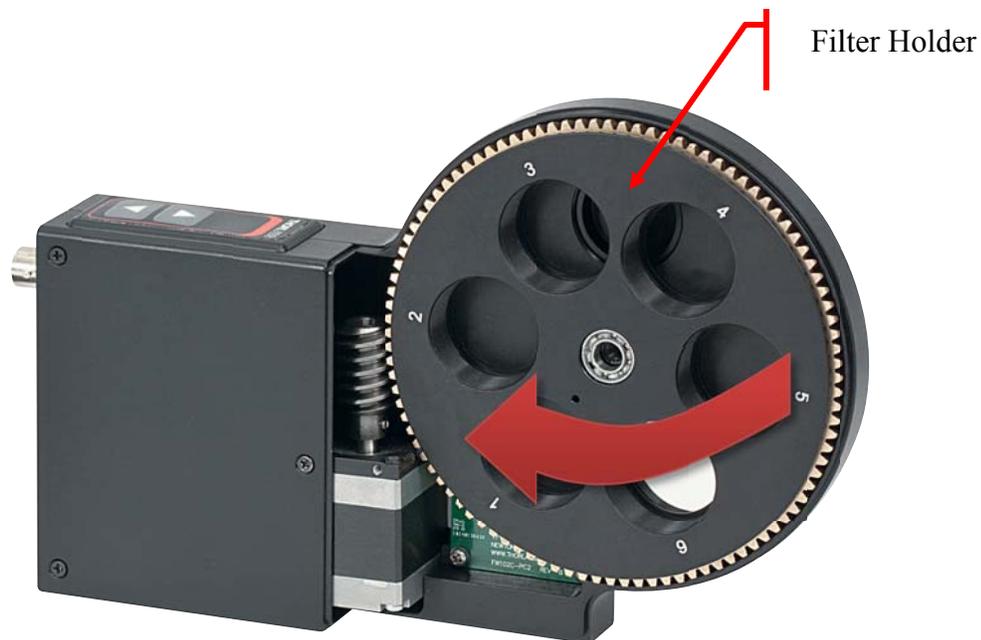

Filter Holder

Figure 7   Open Filter Wheel

Part 5. Specifications

5.1. Performance

Parameter	Min	Typical	Max
Access Time (Adjacent Locations)	-	900 ms	-
Access Time (Other Locations)	-	2500 ms	-
Accuracy/Repeatability	-	±0.5°	±1°
Expected Cycles	1.5×10^6	-	-

5.2. Electrical

Parameter	Min	Typical	Max
BNC Input Trigger			
Max Rate	-	-	0.5 pulses/sec
Minimum Pulse Width	1.0 ms	-	-
BNC Input Trigger[4]			
Input High	3.3 V	4.5 V	5.3 V
Input Low	0.3 V	0.0 V	1.0 V
BNC Output Trigger			
Output Pulse Width	9.0 ms	10.0 ms	11.0 ms
Output High[5]	2.5 V (1 KΩ)	3.3 V (1.95 KΩ)	5.0 V (Hi Z)
Output Low[4]	0.0 V	0.0 V	1.0 V
Power (DC Input, 1 A)	11.75 VDC	12 VDC	12.25 VDC
Operating Temperature	0 °C	-	60 °C

5.3. Physical Characteristics and Interface

Parameter	Description
Trigger Jack	BNC Female
Power Jack	Male 2.1 MM
USB Connector	Mini B
Mounting	(2) 1/4"-20, 8-32, (2) M6, M4, (2) SM1 Thread
Filter Diameter	1" (25.4 mm)
Max Planar Filter Width	0.25" (6.35 mm)
Dimensions (L x W x H)	5.44" x 1.85" x 4.39" (138 mm x 47 mm x 112 mm)
Weight (Without Power Supply)	1.65 lbs. (0.75 kg)

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[4] The BNC input trigger is an active low input. The input has an internal 1 KΩ input resistor. Grounding the center conductor of the jack will activate the trigger.
[5] When operating as an output, the unit output driver is configured in series with a 1 KΩ resistor.

Part 6.   Mechanical Drawings

Front

SM1 (⌀1.035"-40)
Thread 0.15" Deep
2 Places Both Sides

8 X4-40 UNC ⤵ 0.100" (2.54 mm)
For 30 mm Cage Plate

(⌀56.36 mm)
⌀2.22"

(135.41 mm)
5.33"

B

(29.46 mm)
1.16"

(25.52 mm)
1.00"

A

(70.14 mm)
2.76"

(14.73 mm)
0.58"

(130.78 mm)
5.15"

(90.39 mm)
3.56"

FW102C
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Side

In/Out Trigger

Serial Port

USB Port

Power

Bottom

2X M6 X 1.0" - 6H ⤵ 0.319" (8.10 mm)

(50 mm)
1.97"

(25 mm)
0.98"

M4 X 0.7" - 6H ⤵ 0.312" (7.92 mm)

(10.80 mm)
0.43"

(25 mm)
0.98"

(18.67 mm)
0.74"

(15.56 mm)
0.61"

(31.12 mm)
1.23"

(3.18 mm)
0.13"

(25.40 mm)
1.00"

8-32 UNC ⤵ 0.328" (8.33 mm)

(25.40 mm)
1.00"

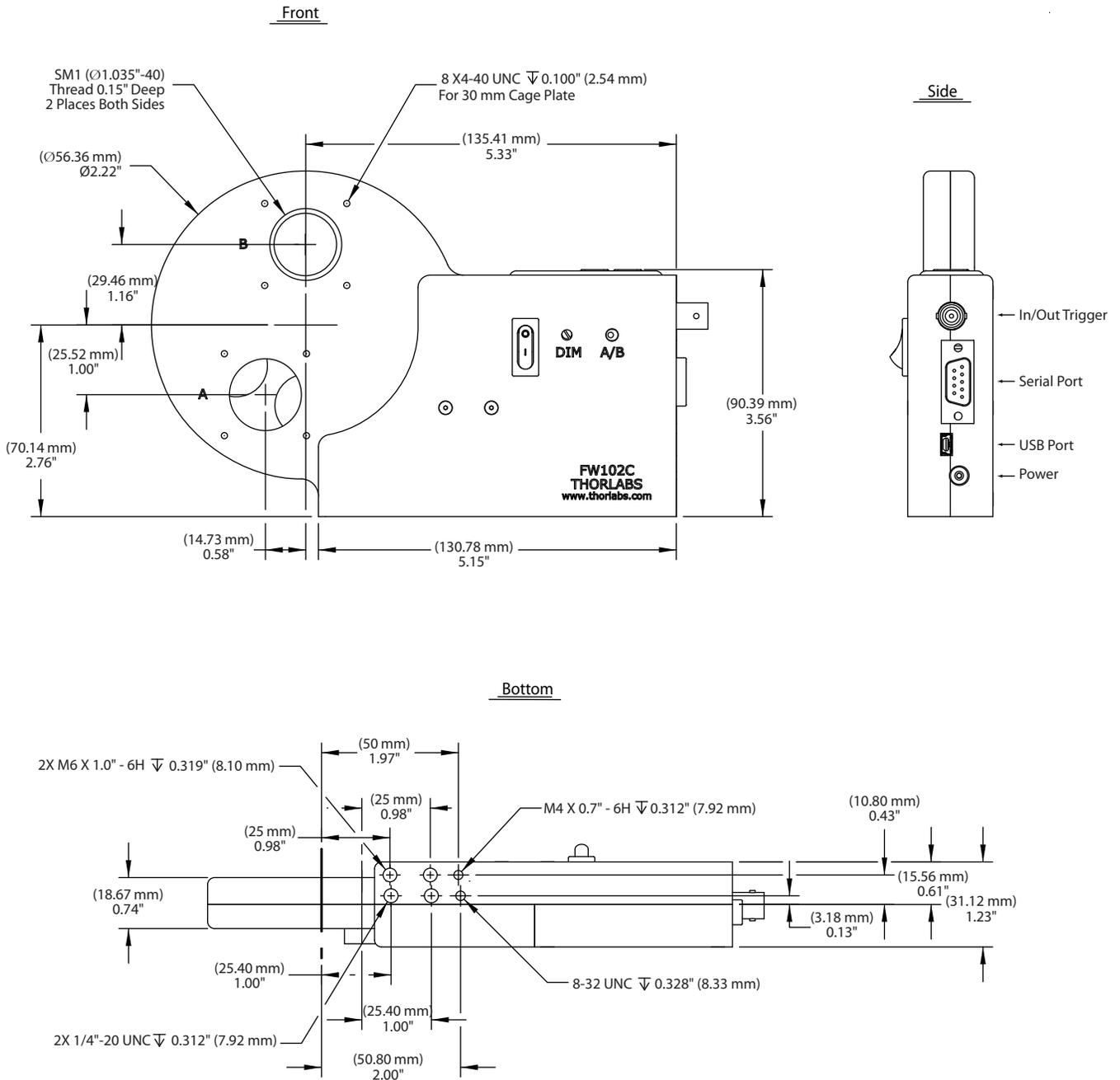2X 1/4"-20 UNC ⤵ 0.312" (7.92 mm)

(50.80 mm)
2.00"

Figure 8   Mechanical Drawing

Part 7. Regulatory

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs offers all end users in the EC the possibility to return "end of life" units without incurring disposal charges.

- This offer is valid for Thorlabs electrical and electronic equipment:
- Sold after August 13, 2005
- Marked correspondingly with the crossed out "wheelie bin" logo (see right)
- Sold to a company or institute within the EC
- Currently owned by a company or institute within the EC
- Still complete, not disassembled and not contaminated

ı Logo

As the WEEE directive applies to self-contained operational electrical and electronic products, this end of life take back service does not refer to other Thorlabs products, such as:

- Pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- Components
- Mechanics and optics
- Left over parts of units disassembled by the user (PCB's, housings etc.).

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

7.1. Waste Treatment is Your Own Responsibility

If you do not return an "end of life" unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

7.2. Ecological Background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of life products will thereby avoid negative impacts on the environment.

Part 8.   Thorlabs Worldwide Contacts

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