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# TABLE OF CONTENTS

PRODUCT OVERVIEW........................................................................................................... 1  
ScopeLED® F-Series Illuminator Overview........................................................................ 1  
Models & Naming Rule........................................................................................................ 1  
Included Hardware & Accessories.................................................................................... 3  
Safety Instruction................................................................................................................ 4  
HARDWARE SETUP............................................................................................................. 5  
Illuminator Mounting Installation..................................................................................... 5  
Installation Recommendations......................................................................................... 9  
MANUAL OPERATION.......................................................................................................... 11  
  Manual Controller........................................................................................................... 11  
  Basic Operation............................................................................................................... 11  
SOFTWARE OPERATION via USB...................................................................................... 12  
  ScopeLED® F-Series Software for Windows overview.................................................. 12  
  ScopeLED® USB Communications Adapter .................................................................. 18  
  Micro-Manager.............................................................................................................. 18  
EXTERNAL INPUT CONNECTOR......................................................................................... 19  
  External Input Connector Overview............................................................................... 19  
  External Trigger Mode Operation.................................................................................... 20  
APPLICATION NOTE......................................................................................................... 22  
  Optical Configuration of the Filter Set ........................................................................... 22  
  Step by Step Filter Set Design......................................................................................... 25  
  ScopeLED® F-Series Wavelength Information............................................................... 30  
TROUBLE SHOOTING......................................................................................................... 31  
SPECIFICATIONS.............................................................................................................. 32  
  Absolute Maximum Ratings............................................................................................ 32  
  Optical Specifications...................................................................................................... 32  
  Mechanical Dimensions................................................................................................ 32  
  Mechanical Drawings...................................................................................................... 33  
Programming Operation..................................................................................................... 34  
  Writing Software for the F-Series Illuminator.............................................................. 34  
  Low Level Interface........................................................................................................ 35  
  Message Structure.......................................................................................................... 37
PRODUCT OVERVIEW

This product must be installed in accordance with the applicable installation code by a person familiar with the construction and operation of the product and hazards involved.

ScopeLED® F-Series Illuminator Overview

ScopeLED® F-series offers high brightness, tunable wavelength and adjustable intensity in a compact, flexible, and convenient package. The advanced thermal design provides vibration free fan-less cooling with high intensity optically stable light output. Different colored LED chips packed into DiCon's Dense Matrix LED™ Array provides high efficiency and ultimate performance to replace conventional mercury arc lamp sources used for fluorescence microscopy applications.

ScopeLED® F-series design offers a nice small lamphouse type form factor, directly coupling to the microscope's epi-fluorescence illumination port and the smallest desktop footprint available in the industry. ScopeLED® F-series offers wavelengths from 390nm to 740nm in single, dual or quadruple wavelength models. It is the bright solution for wide-filed fluorescence applications, and with its affordable, efficient and environmentally friendly advantage will work best for your system.

ScopeLED® F-series also provide versatile operations that can be readily adjustable to most systems. It can be simply controlled manually or can be automated and synchronized with other hardware via USB or External triggering, making it a great fit for automated production lines and robotics.

The ScopeLED® F-series combine optical power, flexibility, and usability in a compact form and is a great choice for your application.

Models & Naming Rule

The ScopeLED® F-series has three models

F110
F120
F140

Please reference the laser-engraving label at the side of the unit to confirm that you are using one of these models. If not, contact the manufacturer for the proper user manual.
Available wavelength for ScopeLED® F-series product

<table>
<thead>
<tr>
<th>#</th>
<th>Nominal Wavelength (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>390</td>
</tr>
<tr>
<td>2</td>
<td>420</td>
</tr>
<tr>
<td>3</td>
<td>440</td>
</tr>
<tr>
<td>4</td>
<td>470</td>
</tr>
<tr>
<td>5</td>
<td>525</td>
</tr>
<tr>
<td>6</td>
<td>540</td>
</tr>
<tr>
<td>7</td>
<td>560P (Phosphors excited)</td>
</tr>
<tr>
<td>8</td>
<td>595</td>
</tr>
<tr>
<td>9</td>
<td>640</td>
</tr>
<tr>
<td>10</td>
<td>660</td>
</tr>
<tr>
<td>11</td>
<td>740</td>
</tr>
</tbody>
</table>

**NOTE:** A customized wavelength may be available upon special request.

Naming Rule for ScopeLED® F-series family product (and naming example)

```
Device
SLF  Fluorescence Illuminator

Control
110  Single Labeling (No Movement)
120  Dual Labeling (Single Axis)
140  Quadruple Labeling (Dual Axes)

Wavelength Specification*
LX   L1 through LC for F110
PX   P1 through PC for F120
GX   G1 through GC for F140
```
The ScopeLED® F-series quadruple wavelength models with wavelengths 390nm(λ1), 470nm(λ2), 560nm(λ3) and 640nm(λ4) and microscope mounting adapter for Nikon E600 will be named as:  
\[ F140-390-470-560P-640-N3 \]  
\( (F140-\lambda_1- \lambda_2- \lambda_3- \lambda_4-N3) \)

For adapters list please see [Microscope Mounting Adapters List](#)

**Included Hardware & Accessories**

- Illuminator x 1
- Microscope Mounting Adapter x 1 (See [Microscope Mounting Adapters List](#))
- AC/DC Power Adapter x 1
- AC Power Cord x 1
- B-Series Manual Controller x1
- RJ12-6 Cable x1
- USB to Mini-USB Cable Cord x 1
- Quick Start Guide x 1
- Additional microscope mounting adapters (Optional see [Microscope Mounting Adapters List](#))
- Foot Switch (Optional, PN: SLAF-FOOT)
- Analog to Digital Communication Cable: 4-Pin to 2-BNC Male Cable (Optional, PN: SLAF-2BNC)
Safety Instruction

Warnings

- Never look directly at the light output port.
- Inappropriate usage of ScopeLED® F-Series products could result in eye damage.
- Installation of the product onto readily available microscopes should always be performed according to the written guidelines.

Attention (also see Installation Recommendations & Absolute Maximum Ratings)

- The statements regarding safety of operation of the F-Series will apply only when the product is operated correctly.
- Any installation or attachment of microscope mounting adapter to the F-Series illuminator should always be performed with power adapter and other cables disconnected.
- When attaching to or removing from the microscope port, the F-Series illuminator ON/OFF rocker switch should always be set to OFF.
- The F-Series must not be operated in explosion prone environments. The F-Series products must always be operated with shielded cables.
HARDWARE SETUP

Illuminator Mounting Installation

1. Turn the Manual Controller ON/OFF Rocker Switch to “OFF” position

2. The illuminator comes with the mounting adapter installed; however, if for any reason the installed microscope adapter needs to be changed, use a 1.5mm allen wrench to loosen the M3 set screws located on the bottom of the front of the illuminator housing. Then take out of the adapter.

3. Place the desired adapter on the illuminator mounting port, and tighten the setscrews to secure the adapter.
4. Attach the ScopeLED F-Series Illuminator with the microscope mounting adapter to the microscope’s transmitted or reflected light lamp-house port.

5. Connect the RJ12-6 cable one end to the illuminator and the other end to the manual controller unit.

6. Connect the AC/DC power adapter to the illuminator at the DC power input port.

7. Plug the AC power cord into the power supply and then into the wall socket.

NOTE:
The illuminator mounting installation procedure uses F120/F140 model as the illustration. The F110 model mounting installation procedure is the same as shown above.
F110 Controls (Illuminator only)

A Microscope Mounting Adapter
B Focusing Lens
C Heat Sink
D RJ12
E External Trigger Connector
F Power Indicator
G Mini USB
H DC Power Jack
F120/F140 Controls (Illuminator only)

Manual Controller (Both F110/F120/F140 share the same manual controller)
Installation Recommendations

Mounting

The ScopeLED® F-series illuminator is available as F110 unit, F120 unit, or as a F140 unit. Consider your system and select the unit that works best for your application.

The mounting adapter is microscope model dependable. Please follow the table to choose the right adapter to attach on your microscope.

<table>
<thead>
<tr>
<th>Mounting Adapter Name</th>
<th>Microscope Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>N1</td>
<td>Nikon std fluor illuminator Bayonette mount</td>
</tr>
<tr>
<td>N2</td>
<td>Nikon fluor illuminator E200</td>
</tr>
<tr>
<td>O1</td>
<td>Olympus std fluor illuminator – IX, BX, MX</td>
</tr>
<tr>
<td>O2</td>
<td>Olympus BH fluor illuminator</td>
</tr>
<tr>
<td>L1</td>
<td>Leica DM fluor illuminator</td>
</tr>
<tr>
<td>L3</td>
<td>Leitz fluor illuminator old style with locking ring</td>
</tr>
<tr>
<td>Z1</td>
<td>Zeiss fluor illuminator</td>
</tr>
<tr>
<td>VWR1</td>
<td>VWR Vista Vision</td>
</tr>
<tr>
<td>AR2</td>
<td>Auxiliary Ring, F to B Series</td>
</tr>
</tbody>
</table>

Environment

The illuminator is not suited for wet or damp locations. Be sure to protect all electronics from moisture.

Do not mount or locate the unit in an explosive environment near combustible material.

Air Volume

Do not encase or bury the unit in any way that restricts airflow.

Orientation

The unit is unidirectionally installed to the microscope. Be sure that do not install the unit upside down to allow the best work performance.

Power Adapter

The output connector of the power adapter must be a female barrel connector for direct compatibility with the B-series Illuminator.

Though the fitting between the output connector of the power supply and input connector of the
Microscope Illuminator may be snug, the connection will not be able to support the weight of the Illuminator. Do not use the power supply as its own hanging device.
MANUAL OPERATION

Manual Controller

To manually operate the F-series illuminator, two knobs are available for wavelength tuning and intensity levels. The manual controller is identical for F110, F120 and F140.

F110 / F120 / F140 control knobs labels

![Diagram of knobs showing wavelength and intensity with labels λ1, λ2, λ3, λ4 on the left and 0, 20, 40, 60 on the right.]

Basic Operation

1. Follow **HARDWARE SETUP** to properly install the B-series illuminator onto your application system.

2. Press the ON/FF Rocker switch on the control panel to the “ON” position to turn the illuminator on.

   **NOTES:**
   The illuminator is now on with a shutter closed. You may see or hear the unit working when you switch the wavelength. However, no light output will be observed now unless you turn the shutter on.

3. Toggle on the LED Shutter Button - **Green** light signal will illuminate on the button when the shutter is open. The illuminator will operate at the setting indicated by the control knob.

4. Use the Wavelength Tuning knob to select the desired wavelength. These knob settings are wavelength dependable, please also see **Naming Rule for ScopeLED® F-series family product (and naming example)** for reference.

5. The Intensity knob is used to manually adjust the intensity or brightness of the modes without changing its color parameters. Turning the knob fully clockwise results in maximum brightness of the selected mode. Turning the knob fully counter-clockwise results in dimming the selected mode to zero output.
SOFTWARE OPERATION via USB

ScopeLED® F-series illuminator can be controlled using various software via USB. Software such as ScopeLED® F-series Software for Windows, ScopeLED® USB Communications Adapter or Micro-Manager can be easily downloaded from the website. Before software operation, please reference USB Software Operation to connect the device first.

NOTES: When controlling the unit via software, it is not necessary to connect the manual controller.

ScopeLED® F-Series Software for Windows overview

ScopeLED® F-series Software for Windows is a software application designed to control the preset color through the USB interface on the Microscope Illuminator. Before installation, be sure that your computer is equipped with ScopeLED® USB Communications Adapter (Available at: http://www.scopeled.com/resources/downloads.php) and the Microsoft .NET Framework 3.5 or higher. If you need external trigger operation, please refer to EXTERNAL INPUT CONNECTOR to connect the necessary items to your device.

Installation

No installation is required. To start the software please download from the ScopeLED® website http://www.scopeled.com/resources/downloads.php. After the download is complete, unzip the folder and double click “B_F_series.exe” executable file in the folder. By default, when you connect the F-Series illuminator to your computer it will scan the model you connect to the computer. You will see the information of your device. (If not, please see HARDWARE SETUP & Basic Operation for connections check.)
Features

- **Index**: Intensity control attribute from 0~255. (8 bit)
- **DAC**: Digital to Analog Converter. Intensity control attribute from 0~4095. (12 bit)
- **Min DAC**: Minimum DAC value, which means the lowest intensity attribute to turn on the individual channel.
- **Shutter**: The opening control of each channel. If the shutter is off, light is off. If the shutter is open and the intensity value is more than zero (under index control) or more than min DAC (under DAC control), you will see light on.

  - **Shutter Controls “ON”**: All channels are off, to click “ON” to turn the shutter on. You can choose to turn all the channels on by clicking the left control button under the “Shutter” or turn individual channels on by clicking the right three control buttons under the “Shutter.”
- **Shutter Controls “OFF”:** All channels are on, to click “OFF” to turn the shutter off. You can choose to turn all the channels off by clicking the left control button under the “Shutter” or turn individual channels off by clicking the right three control buttons under the “Shutter.”

![Shutter status diagram](image)

- **Shutter Status (example):** Channel 1 and channel 2 shutters are off; channel 3 shutter is on.

![Shutter status diagram](image)

- **Intensity:** Individual channel intensity control from index 0 ~ index 255 or DAC 0 ~ DAC 4095. Under Mixed RGB model type, CH1 Color = Red, CH2 color = Blue, CH3 color = Green. Under Single Color model type, CH1 Color = CH2 color = CH3 color. Before you do the channel(s) controls, make sure your shutter(s) corresponding to the channel(s) are in the “ON” status.

- **Intensity Controls “ON”:** All channels intensity is zero, to click “ON” to turn the channel intensity to complete on. You can choose to turn all the channels complete on by clicking the left control button under the “Intensity” or turn individual channels complete on by clicking the right three control buttons under the “Intensity.” You can also drag the bar to control the individual channel’s intensity you desire.
- **Intensity Controls “OFF”**: All channels intensity is not zero, to click “OFF” to turn the channel intensity to complete off. You can choose to turn all the channels complete off by clicking the left control button under the “Intensity” or turn individual channels complete off by clicking the right three control buttons under the “Intensity.”

![Channel Control Diagram]

- **Intensity Status (example)**: Channel 1 and channel 2 shutters are on and with intensity index of 193 and 208, respectively. If this is a Mixed RGB model, you might see a light combination of Red (CH1) and Blue (CH2), which could be pink, purple or magenta light.

![Channel Control Diagram]

- **Color Control**: An alternative control of manual controller, which controls preprogrammed color mode and light intensity.
- **Shutter Source**: By USB or TTL (See *external trigger Mode Operation*).
- **Intensity Source**: By USB or Analog (See *external trigger Mode Operation*).
**Color Control Operation:** To control the preprogrammed color mode operation

1. Open ScopeLED ® B-series Software for Windows program

2. Turn the shutter(s) on.
3. Choose the color you want (Mixed RGB only). Select the shutter source. If you select TTL shutter source, please control from your signal source.

4. Select the intensity source. If USB, then control with the intensity bar. If by Analog, please control the external signal source from **0 to 5 volts**.
ScopeLED® USB Communications Adapter

ScopeLED® USB command adapter provides an easy interface between the ScopeLED® HID (human Interface Device) illuminators and the lower level communication with windows. Once installed, it will check to see if the device is connected and recognized by windows and report back the model and serial number in a hyper terminal window. Commands sent via the USB communication port to the device will be interfaced to Windows OS through this program. The software is available at: http://www.scopeled.com/resources/downloads.php

A more detailed information about ScopeLED® USB command adapter please also see Programming Operation

Micro-Manager

ScopeLED® F-Series can be controlled by micro-manager software and integrated with camera and other microscopy accessories to become a completed, automated and powerful microscopy system.

More details about the micro-manager Open Source Microscopy Software are available at https://micro-manager.org/. Before install the micro-manager software, be sure that your computer is equipped with ScopeLED® USB command adapter (Available at: http://www.scopeled.com/resources/downloads.php). Other ScopeLED® operation properties, type and functions information under the micro-manager is available at https://www.micro-manager.org/wiki/ScopeLED
EXTERNAL INPUT CONNECTOR

External Input Connector Overview

The external input connector operates through a 4-pin interface depicted in figure below. Pin references are listed in Table 1. Pin 2 is for Transistor-Transistor Logic (TTL) signal input. Pin 1 to is for Analog control. Pin 3 and Pin 4 is ground.

![Diagram of external input connector]

Table 1: External Input Pin Configuration for Mode Control

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
<th>Input Signal Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Analog</td>
<td>Analog (0-5V)</td>
</tr>
<tr>
<td>2</td>
<td>TTL</td>
<td>TTL (0-3V or 0-5V)</td>
</tr>
<tr>
<td>3</td>
<td>Ground</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Ground</td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
- Ground connection pulled to each Analog and TTL BNC cable.
- The response time from the high voltage trigger to the output response of the Microscope Illuminator can be less than 2 us. (TTL shutter switch time). The channel to channel switching time can be less than 35 ms. (us = micro second, ms = mini second)
External Trigger Mode Operation

Simple TTL control: Uses Manual Controller to Set Channel Intensity

1. Follow **HARDWARE SETUP** to properly install the B-series illuminator onto your application system.

2. Connect the 4-Pin to 2-BNC Male Cable to the 4-Pin connector on the LED illuminator. (Optional Cable - a paired 4-pin connector comes with the illuminator for use with pin out table for users desiring to make their own cables)

3. Press the ON/FF Rocker switch on the control panel to the “on” position to turn the illuminator on.

   **NOTES:**
   The illuminator is now on with a shutter closed. No light output will be observed now unless you turn the shutter on.

4. Toggle on the LED Shutter Button - **Green** light signal will illuminate on the button when the shutter is open. The illuminator will operate at the setting indicated by the control knob.

5. Use the Wavelength Tuning knob to select the desired wavelength. These knob settings are wavelength dependable, please also see **Naming Rule for ScopeLED® F-series family product (and naming example)** for reference.

6. The Intensity knob is used to manually adjust the intensity or brightness of the modes without changing its color parameters. Turning the knob fully clockwise results in maximum brightness of the selected mode. Turning the knob fully counter-clockwise results in dimming the selected mode to zero output.

7. Connect the Male BNC connectors to a BNC breakout box or TTL signal generator for the Channel or Channels desired to be triggered

8. Toggle the LED Shutter Button Closed – LED shutter must be closed for TTL to trigger the shutter Open

9. Send TTL signal to the desired channel for TTL triggering.

10. The intensity Dial will work during the TTL triggering and intensities can be changed during trigger generation for illumination control.
Use of TTL and Analog Control for Triggering and Channel Intensity

2. Connect the desired Channels TTL and Analog BNC connectors to BNC break out box or to a TTL signal generator and a power supply output.
3. Turn the On/Off Rocker Switch on Manual Controller to “OFF” position. (OR Disconnect the Manual Controller from the illuminator by unplugging the RJ12-6 connection cable.)
4. Set the desired Analog Channel from 0-5 Volts for minimum to maximum intensity levels
5. Trigger the desired channels with TTL signal generator

USB Software Operation by ScopeLED® F-series Software for Windows

1. Follow Illuminator Mounting Installation to STEP 4 to properly install the f-series illuminator onto your application system.
2. Connect the AC/DC power adapter to the illuminator at the DC power input port.
3. Plug the AC power cord into the power supply and then into the wall socket.
4. Connect the 4-Pin to 2-BNC Male Cable to the 4-Pin connector on the LED illuminator (if TTL or Analog control is necessary.)
   
   (Optional Cable- a paired 4-pin connector comes with the illuminator for use with pin out table for users desiring to make their own cables)
5. Connect the desired Channels TTL and Analog BNC connectors to BNC break out box or to a TTL signal generator and a power supply output (if TTL or Analog control is necessary.)
6. Connect USB to Mini-USB Cable Cord to the operation computer and the illuminator.
7. Follow ScopeLED® F-Series Software for Windows overview to control the unit.

NOTES: You do not need the manual controller to do the operation. It does not matter if you connect it or not.
APPLICATION NOTE

Fluorescence microscope illumination is widely used in the field of biology and medical science. This section gives some information and basic knowledge of the fluorescence microscope and how-to tips of application of ScopeLED® F-Series illuminator.

Optical Configuration of the Filter Set

In fluorescence microscopy, the reflected optical light path gives a better result. Fluorescence microscopy requires intense, near-monochromatic illumination like high-powered LEDs. This optical configuration is shown in the figures below.

Basically there are three important components in a filter set that determine your illumination result: **Excitation filter, Emission filter** and **Beam Splitter (Dichromatic mirror)**. Only a properly selected filter set configuration, when combined with one of ScopeLEDs wavelengths can provide the best result for your application.
The light from the illuminator (\(\lambda_1\)) goes through the excitation filter, which filters out the unwanted spectral wavelength. The excitation filter band pass center should correspond to the excitation (absorption) peak of the dye and LED wavelength to obtain the best excitation efficiency. The light after the excitation filter (\(\lambda_2\)) then reflects from the beam splitter (\(\lambda_3\)) to the dye. The dye absorbs the light, becomes in an ‘excited’ state, and fluoresces with a longer wavelength light (\(\lambda_4\)) than the incident light. The fluorescence light goes through the beam splitter (\(\lambda_5\)) to filter out the excitation light that is not absorbed by the dye and reflects to the filter cube. The emission filter blocks the undesired wavelengths after passing through the beam splitter then the emission light (\(\lambda_6\)) goes to the detector. Likely, the emission filter band pass center should correspond to the emission peak of the dye to obtain the best excitation efficiency.
Illustration of Spectrum Progress Comparison of ScopeLED® F-Series & Mercury Lamp

<table>
<thead>
<tr>
<th>Spectrum Progress</th>
<th>λ1</th>
<th>λ2</th>
<th>λ3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excitation Filter (480nm / 40nm)</td>
<td>Before</td>
<td>After</td>
<td>After</td>
</tr>
<tr>
<td>Beam Splitter (&lt;500nm, &lt;4.0 T%)</td>
<td>Before</td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>(&gt;520nm, &gt;97.0 T%)</td>
<td>After</td>
<td>After</td>
<td>After</td>
</tr>
</tbody>
</table>

**Note:** Spectrum intensities are not scaled. Only relative intensities are shown to illustrate the step-by-step movement of the spectrum.
Step by Step Filter Set Design

A proper filter set selection determines the result of the fluorescence observation. ScopeLED® recommends that you follow the instruction to choose your filter set to obtain the best result of your application.

1. Dye Spectrum Characterization

Draw your dye's excitation / emission spectrum. Find out the excitation / emission peak of the dye.

2. ScopeLED® F-Series Wavelength Selection

Follow ScopeLED® F-Series Wavelength Information to find the LED wavelength that works for you. Usually, the one that is closest to your dye's excitation peak wavelength is the best choice.
3. Excitation Filter

To obtain the optimal excitation result, the excitation filter band pass should be centered at the excitation peak of the dye. The closer the band pass filter centers at the excitation peak, the better the signal as more light passes through the filter.

Typically, a successful dye excitation is a combination of correct selection of LED wavelength, excitation filter band pass and beam splitter band pass.

4. Emission Filter

The selection of emission filter is similar to the selection of excitation filter.
5. Beam Splitter (Dichromatic Mirror)

Because dyes emit light at a different wavelength than they excite, the purpose of the beam splitter is to allow excitation wavelengths to pass through in one direction, and then mission wavelengths to pass through the same filter in the opposite direction. The band pass of each direction should not overlap with the other and should capture as much of the light as possible in each direction.
6. Interferences of the Filter Set Consideration

To maximize the fluorescence signal, one can move the excitation / emission band pass center close to the excitation / emission peak of the dye. In addition, increasing the band pass is another way to achieve higher fluorescence signal. However, this may cause the overlap of the filter band pass, which results in a chromatic overlap. (Both excitation & emission signals go to the detector.) A wise choice is to widen the band pass but avoiding the interference / overlap of the individual peaks.
Overlap!!

- **Excitation (%)**
- **Emission (%)**
- **Emission Filter**
- **Excitation Filter**

Relative Intensity (%) vs. Wavelength (nm)
# ScopeLED® F-Series Wavelength Information

The table lists most common used dye and the corresponding ScopeLED® F-Series’ LED wavelength. If your dye is not listed on this table, please find the LED wavelength that is closest to your dye’s excitation peak or contact us: scopeled@scopeled.com

<table>
<thead>
<tr>
<th>Available LED Wavelength (nm)</th>
<th>Reference to the Common Fluorophores</th>
</tr>
</thead>
<tbody>
<tr>
<td>390</td>
<td>DAPI, Hoechst, Calcofluor White</td>
</tr>
<tr>
<td>420</td>
<td>DEAC</td>
</tr>
<tr>
<td>440</td>
<td>CFP</td>
</tr>
<tr>
<td>470</td>
<td>FITC, GFP, Alexa488</td>
</tr>
<tr>
<td>525</td>
<td>YFP, Alexa514, Alexa532</td>
</tr>
<tr>
<td>540</td>
<td>Rhodamine, Alexa 532, Eosin, Propidium Iodide</td>
</tr>
<tr>
<td>560P (Phosphors excited)</td>
<td>TRITC, DsRed, Alexa 555, dTomato, Alexa 546</td>
</tr>
<tr>
<td>595</td>
<td>mCherry, Alexa 568, Texas Red, Cy3.5</td>
</tr>
<tr>
<td>640</td>
<td>Cy5, Mitotracker Red, Alexa 633</td>
</tr>
<tr>
<td>660</td>
<td>Cy5, Alexa 647, Cy5.5</td>
</tr>
<tr>
<td>740</td>
<td>Cy7</td>
</tr>
</tbody>
</table>
## TROUBLE SHOOTING

<table>
<thead>
<tr>
<th>Problem</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illuminator does not turn on</td>
<td>Check that the green light on the power adapter is on and verify that all of the connections to the adapter and the Microscope Illuminator are properly connected. Turn the rock switch and the green shutter button to &quot;ON&quot;. Turn the Intensity knob to maximum intensity and cycle through the different modes using the color-tuning knob. The color-tuning knob can be in a custom mode position where the custom mode has not been programmed.</td>
</tr>
<tr>
<td>Light output only appears red</td>
<td>Make sure that the protective dust cover on the end cap has been removed.</td>
</tr>
<tr>
<td>Illuminator is not emitting all of the colors (Not applicable to F110)</td>
<td>Turn the intensity knob to maximum intensity, then cycle through each preset mode using the color-tuning knob. If any of the colors appear unusually dim, please contact the manufacturer.</td>
</tr>
<tr>
<td>Illuminator is flickering</td>
<td>Flickering is often a result of the driver not receiving a high enough DC voltage. Verify that the 12V DC output from the power supply is correct. Shorten the line from the power supply to the Microscope Illuminator. Never exceed more than a 15 ft length from the power supply. Power cycle the Microscope Illuminator by shutting off the power to the power supply and restarting.</td>
</tr>
<tr>
<td>Illuminator has shut down and is hot</td>
<td>Check to make sure the fan is operating properly and the device is being used within its environmental temperature range (see Installation Recommendations &amp; Absolute Maximum Ratings). Make sure there is nothing obstructing the airflow to the Microscope Illuminator. It is required that a minimum of eight cubic feet of airspace is provided around the device.</td>
</tr>
</tbody>
</table>
SPECIFICATIONS

Absolute Maximum Ratings

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>24VDC</td>
</tr>
<tr>
<td>Input Current</td>
<td>1.25A Max</td>
</tr>
<tr>
<td>Operating Temp</td>
<td>0ºC to 40ºC (32ºF to 104ºC)</td>
</tr>
<tr>
<td>Storage Temp</td>
<td>-40ºC to 75ºC (-40ºF to 167ºF)</td>
</tr>
<tr>
<td>Humidity</td>
<td>10% to 90%</td>
</tr>
<tr>
<td>F110 Power Consumption</td>
<td>&lt; 10W</td>
</tr>
<tr>
<td>F120 Power Consumption</td>
<td>&lt; 24W</td>
</tr>
<tr>
<td>F140 Power Consumption</td>
<td>&lt; 30W</td>
</tr>
<tr>
<td>F110 Model Weight</td>
<td>0.61 KG (1.35lbs)</td>
</tr>
<tr>
<td>F120 Model Weight</td>
<td>1.12 KG (2.45lbs)</td>
</tr>
<tr>
<td>F140 Model Weight</td>
<td>1.16 KG (2.56lbs)</td>
</tr>
</tbody>
</table>

Optical Specifications

Typical Optical Characteristics

<table>
<thead>
<tr>
<th>Peak Wavelength</th>
<th>Radiant Flux (mW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>390±5</td>
<td>600</td>
</tr>
<tr>
<td>420±5</td>
<td>850</td>
</tr>
<tr>
<td>440±5</td>
<td>600</td>
</tr>
<tr>
<td>470±5</td>
<td>550</td>
</tr>
<tr>
<td>525±5</td>
<td>270</td>
</tr>
<tr>
<td>540±5</td>
<td>200</td>
</tr>
<tr>
<td>560P (Phosphors excited)</td>
<td>420</td>
</tr>
<tr>
<td>595±5</td>
<td>110</td>
</tr>
<tr>
<td>640±5</td>
<td>420</td>
</tr>
<tr>
<td>660±5</td>
<td>350</td>
</tr>
<tr>
<td>740±5</td>
<td>170</td>
</tr>
</tbody>
</table>

Mechanical Dimensions

*Mechanical Dimensions for all Microscope Illuminator models*

<table>
<thead>
<tr>
<th>Model</th>
<th>Dimensions (Illuminator only, unit in mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F110</td>
<td>96 (L) x 85 (W) x 110 (H)</td>
</tr>
<tr>
<td>F120/F140</td>
<td>106 (L) x 85 (W) x 152 (H)</td>
</tr>
</tbody>
</table>
Mechanical Drawings

F110 Model

F120 / F140 Model
Programming Operation

The ScopeLED F-Series illuminator communicates to a host computer through USB. The B-Series illuminator is configured to be a *Human Interface Device* (HID). HID is a *standard class* within the USB specification. By using a standard class within the USB specification, the F-Series illuminator is able to use widely available device drivers and software for communicating with computers and software applications.

Writing Software for the F-Series Illuminator

Microsoft Windows provides a default HID device driver and therefore the F-Series illuminator does not need any additional devices drivers to communicate with a Windows software application.

There are three options for developing an application that communicates to the F-Series illuminator:

1. One option is to interface directly with the Windows HID device driver. Windows provides a set of low-level functions to find, connect to, and read and write to HID devices. This option potentially has the fewest run-time dependencies. In order to use these functions to develop an application for your device, you will need to use the Windows Driver Kit (WDK). The WDK is available from Microsoft.

2. Another option is to use the ScopeLED® USB Communications Adapter. While the low-level Windows functions are powerful and flexible, they are also difficult to use. ScopeLED® provides a USB Communication Adapter at no additional cost that simplifies the development process. The USB Communication Adapter is a middle layer (an adapter!) between your software and the Windows functions, providing a simpler, cleaner programming interface for controlling the B-Series illuminator.

   - The ScopeLED® USB Communications Adapter is available as a native Win32 DLL and as a .NET Framework Assembly, so it is compatible with most Windows development environments.

   - To receive a copy of the ScopeLED® USB Communications Adapter at no additional cost, please visit ScopeLED® resource center website at [http://www.scopeled.com/resources/downloads.php](http://www.scopeled.com/resources/downloads.php) or contact ScopeLED® at scopeled_support@diconlighting.com

   - ScopeLED® strongly recommends using the ScopeLED® USB Communications Adapter for developing your software. Unless you are an expert at Windows USB/HID device programming, you will be able to develop software applications for the B-Series illuminator much faster using the ScopeLED® USB Communications Adapter

The ScopeLED® USB Communications Adapter provides the following technical advantages:

- Manages device discovery. Using your device’s USB Vendor ID and Product ID (and optionally the serial number), connecting to your device is a simple, one-
step process. There's no need to use low-level Windows functions, or to create enumerations.

- Eliminates the complexity of USB/HID implementation details. You don't have to worry about reports, end points, or descriptors. Communicating to your device is as simple as reading and writing to a file.
- Parses the device data stream. The B-Series illuminator sends a steady stream of data, even when idle. The ScopeLED® USB Communications Adapter reliably reads and parses the incoming data stream. It extracts and separates meaningful messages and buffers them for you to read when you are ready. You don't have to waste time implementing your own stream parser, and you don't have to worry about missing portions of the data stream.
- Available as a .NET Assembly (for .NET Framework applications): Many of the low-level Windows functions require unmanaged memory, which is inconvenient and undermines many of the advantages of using the .NET Framework. The ScopeLED® USB Communications Adapter is available as a .NET assembly, where all of the memory management is taken care for you.

3. A third option is to use a third-party HID communications library. There are several such libraries available, some at no cost, however ScopeLED® cannot make recommendations or offer support for these third-party libraries.

**Low Level Interface**

**USB Reports**
In USB communication, data is sent in fixed-length blocks called reports. The B-Series illuminator expects reports 33 bytes long in both communication directions. The first byte of each report is the Report ID, which must always be 0 for the B-Series illuminator. The remaining 32 bytes are the data portion of the report.

The data portion of every report must be padded with NULL bytes to fill the full, required length. The NULL byte is the value 0x1F.

USB reports are completely independent from device messages.

- USB reports are a fixed size; device messages are variable size.
- Device messages may begin at any point within a report.
- A single report may contain more than one device message, or no messages at all (i.e. all NULL bytes).
- Device messages may span over more than one report.

**Host to Device Communication**
The F-Series illuminator uses the default Control Transfer pipe to receive data from the host.

**Device to Host Communication**
The B-Series illuminator uses Interrupt Transfers to send data to the host. In Interrupt Transfers, the HID device is continuously polled for data by the host at regular intervals. The polling interval is configured by the device itself, but the host is responsible for performing the polling operation.
Typically, the device driver stores the reports in an input queue of limited size. Applications may retrieve the reports from the input queue.

**Caution:** If the device driver input queue fills completely, the oldest report is discarded to make room for a new report. Therefore, an application may lose data from the B-Series illuminator if it cannot keep up with the continuous device polling.

Most of the time, an HID device will not have any new, meaningful data to send. In this case, the F-Series illuminator will send a full report of NULL bytes (0x1F).
**Message Structure**

The message format is the same in both the send and receive directions. Each message starts with a sentinel Start byte followed by a message length byte, and ends with a checksum byte and sentinel Stop byte. The message length value excludes the checksum byte and the start and stop bytes. The checksum value is the negative two’s complement of the sum of all the data in the message including the length byte, but excluding the Start and Stop bytes.

The value of the Start byte is **0xA9**, and the value of the Stop byte is **0x5C**.

The drawing below illustrates the message format for the B-Series illuminator.

<table>
<thead>
<tr>
<th>Byte Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Start Byte. This sentinel value signals the beginning of a message. The value is <strong>0xA9</strong>.</td>
</tr>
<tr>
<td>2</td>
<td>Message length. This value is the count of all of the bytes, excluding the Start byte, checksum, and Stop byte. The length includes the length byte itself. In the illustration above, the length value is <strong>(N-3)</strong>.</td>
</tr>
<tr>
<td>3</td>
<td>Command byte. This value is the command code for the message.</td>
</tr>
<tr>
<td>4 to N-2</td>
<td><strong>Messages to the device</strong>&lt;br&gt;Parameter data. This is optional data for possible command argument parameters.&lt;br&gt;&lt;br&gt;<strong>Messages from the device</strong>&lt;br&gt;In messages from the device to the host, byte <strong>B:4</strong> will contain the command result code. Refer to Section 6 for the meaning of the result code.&lt;br&gt;&lt;br&gt;The remaining data, bytes <strong>B:5 to B:N-2</strong>, is optional reply data. For example, the answer data to a query command would be included here.</td>
</tr>
<tr>
<td>N-1</td>
<td>Checksum. The checksum is the negative sum of all the data in the message including the length byte, but excluding the Start and Stop bytes. In the illustration above, it would be the negative sum of bytes <strong>B:2 to B:N-2</strong>.</td>
</tr>
<tr>
<td>N</td>
<td>Stop Byte. This sentinel value signals the end of a message. The value is <strong>0x5C</strong>.</td>
</tr>
</tbody>
</table>
USB Vendor ID and Product ID
The USB Vendor ID for the F-Series illuminator is 0x24C2 (decimal 9410).
The USB Product ID for the F-Series illuminator is 0x1305 (decimal 4869).

Commands
Naming Rule:
SAVE_xxxxxxx : Saves data to non-volatile memory (such as EEPROM, Flash... etc).
READ_xxxxxxx : Returns data from non-volatile memory (such as EEPROM, Flash... etc).
SET_xxxxxxx : Sets data to volatile memory (such as RAM... etc).
GET_xxxxxxx : Returns data from volatile memory (such as RAM... etc).

The following firmware command codes are currently defined: (The ‘X’ means that doesn’t support)

<table>
<thead>
<tr>
<th>Value</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>SET MASTER ENABLE</td>
</tr>
<tr>
<td>42</td>
<td>GET MASTER ENABLE</td>
</tr>
<tr>
<td>11</td>
<td>GET FW TYPE</td>
</tr>
<tr>
<td>12</td>
<td>GET FW VERSION</td>
</tr>
<tr>
<td>65</td>
<td>GET HW REVISION</td>
</tr>
<tr>
<td>9</td>
<td>GET SERIAL NUMBER</td>
</tr>
<tr>
<td>10</td>
<td>SET SERIAL NUMBER</td>
</tr>
<tr>
<td>55</td>
<td>SAVE AVAILABLE CHANNELS</td>
</tr>
<tr>
<td>31</td>
<td>GET AVAILABLE CHANNELS</td>
</tr>
<tr>
<td>54</td>
<td>SAVE WAVELENGTH</td>
</tr>
<tr>
<td>30</td>
<td>GET WAVELENGTH</td>
</tr>
<tr>
<td>39</td>
<td>SET CONTROL MODE</td>
</tr>
<tr>
<td>38</td>
<td>GET CONTROL MODE</td>
</tr>
<tr>
<td>56</td>
<td>SET ANALOG INTENSITY</td>
</tr>
<tr>
<td>57</td>
<td>GET ANALOG INTENSITY</td>
</tr>
<tr>
<td>69</td>
<td>GET TEMPERATURE</td>
</tr>
<tr>
<td>73</td>
<td>SET DAC</td>
</tr>
<tr>
<td>74</td>
<td>GET DAC</td>
</tr>
<tr>
<td>75</td>
<td>SAVE MIN DAC</td>
</tr>
<tr>
<td>76</td>
<td>GET MIN DAC</td>
</tr>
<tr>
<td>1</td>
<td>SET COLOR</td>
</tr>
<tr>
<td>24</td>
<td>PLAY PRESET MODE</td>
</tr>
<tr>
<td>23</td>
<td>GET PRESET MODE</td>
</tr>
<tr>
<td>14</td>
<td>OVERWRITE PRESET MODE</td>
</tr>
<tr>
<td>77</td>
<td>PLAY PRESET LUMENS</td>
</tr>
<tr>
<td>78</td>
<td>SET COLOR LUMENS</td>
</tr>
</tbody>
</table>

Note: All parameter and reply values are in big-endian format. The most significant byte is first, and the least significant byte is last.

SET MASTER ENABLE (command = 41)
Command Parameters: Master LED enable flag (1 byte)
0 = disable
1 = enable
Function | Turns all LEDs ON or OFF. When the LEDs are enabled, they will return to their previous intensity levels.

**GET MASTER ENABLE STATUS (command = 42)**

Command Parameters | None.
Reply Data | Master LED enable flag (1 byte)
0 = disable
1 = enable

Function | Returns the status of the master LED enable flag.

**GET FIRMWARE TYPE (command = 11)**

Command Parameters | None
Reply Data | Firmware type string. The type string is variable length and it is not null-terminated.

Function | Returns the device’s firmware type string.

**GET FIRMWARE VERSION (command = 12)**

Command Parameters | None
Reply Data | The device firmware version (4 bytes)

Function | Returns the device’s firmware version.

**GET HARDWARE REVISION (command = 65)**

Command Parameters | None
Reply Data | The device hardware revision (2 bytes).

Function | Returns the device’s hardware revision.

**GET SERIAL NUMBER (command = 9)**

Command Parameters | None
Reply Data | Serial Number String. The serial number string is variable length and it is not null-terminated.

Function | Returns the device’s serial number string.

**SET SERIAL NUMBER (command = 10)**

Command Parameters | Serial Length (1 byte)
Serial Number (<31 bytes)

Function | Saves the device’s serial number string.

**SAVE AVAILABLE CHANNELS (command = 55)**

Command Parameters | Channel count (1 byte)

Function | Saves number of channels on LED array

**GET AVAILABLE CHANNELS (command = 31)**

Command Parameters | None
Reply Data | Channel count

Function | Returns number of channels on LED array

**SAVE CHANNEL WAVELENGTH (command = 54)**

Command Parameters | Channel number (1 byte)
Channel wavelength in nanometers (2 bytes)

Function | Saves the wavelength for the given channel number

**GET CHANNEL WAVELENGTH (command = 30)**

Command Parameters | Channel number (1 byte)
Reply Data | Channel wavelength in nanometers (2 bytes).

Function | Returns the wavelength for the given channel number.
SET CONTROL MODE (command = 39)
Command Parameters Operating mode (1 byte)
  1 = normal control
  2 = analog control
  3 = TTL control
Function Sets the remote operating mode of the device.

GET CONTROL MODE STATUS (command = 38)
Command Parameters None.
Reply Data Operating mode (1 byte)
  1 = normal control
  2 = analog control
  3 = TTL control
Function Returns the remote operating mode of the device.

SET ANALOG TRIGGER INTENSITY (command = 56)
Command Parameters Analog intensity in 0.1 percent (2 bytes). For example, 1000 mean 100%. The acceptable range is from 0% to 100%.
Function Sets the intensity scaling factor for analog control. When using analog control, the intensity of the active channels will be scaled by this value.

GET ANALOG TRIGGER INTENSITY (command = 57)
Command Parameters None.
Reply Data Analog intensity in 0.1 percent. (2 bytes). For example, 1000 mean 100%.
Function Returns the intensity scaling factor for analog control.

GET TEMPERATURE (command = 69)
Command Parameters None
Reply Data Temperature in 0.1 degrees Celsius (2 bytes).
Function Returns the temperature measured on the LED array.

SET DAC (command = 73)
Command Parameters 12 bit DAC values, 2 bytes per channel
Function Set DAC values for all channels
GET DAC (command = 74)
Command Parameters None
Reply Data DAC values for all channels, 2 bytes per channel
Function Returns DAC values for all LED channels

SAVE MIN DAC (command = 75)
Command Parameters Channel number (1 byte)
  DAC value (2 bytes)
Function Saves minimum DAC value that LEDs turn on to EEPROM

GET MIN DAC (command = 76)
Command Parameters Channel number (1 byte)
  DAC value (2 bytes)
Function Returns minimum DAC value that LEDs turn on from EEPROM

SET COLOR (command = 1)
Command Parameters Channel 1 intensity from 0 to 255 (1 byte)
  Channel 2 intensity (1 byte)
  Channel 3 intensity (1 byte)
  Channel 4 intensity (1 byte)
Function Set intensity for all LED channels
PLAY PRESET MODE (command = 24)
Command Parameters
- Preset number (1 byte)
- Brightness level (1 byte)
Function
- Shows the preset color at specified brightness level.
- Brightness scale is proportional to optical power output.

GET PRESET MODE (command = 23)
Command Parameters
- Preset number (1 byte)
Reply Data
- Channel intensity (1 byte per channel, 4 total)
Function
- Returns a preset’s 8 bit intensity value of each channel

OVERWRITE PRESET MODE (command = 14)
Command Parameters
- Preset number (1 byte)
- Channel intensity (1 byte per channel, 4 total)
Function
- Saves preset mode color in 8-bit channel values

PLAY PRESET LUMENS (command = 77)
Command Parameters
- Preset number (1 byte)
- Lumens Brightness Level (1 byte)
Function
- Shows the preset color at the specified brightness level.
- Light output measured in lumens should be close to increasing linearly.

SET COLOR LUMENS (command = 78)
Command Parameters
- Ch1 intensity (1 byte)
- Ch2 intensity (1 byte)
- Ch3 intensity (1 byte)
- Ch4 intensity (1 byte)
Function
- Sets intensity for all four channels.
- Light output measured in lumens should be close to increasing linearly.
**Error Codes**
The command result codes will be one of the following values:

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No error.</td>
</tr>
<tr>
<td>1</td>
<td>Unknown command</td>
</tr>
<tr>
<td>2</td>
<td>Illegal command</td>
</tr>
<tr>
<td>3</td>
<td>Not enough Command Parameters</td>
</tr>
<tr>
<td>4</td>
<td>Too many Command Parameters</td>
</tr>
<tr>
<td>5</td>
<td>The message checksum is incorrect</td>
</tr>
<tr>
<td>6</td>
<td>The message length is incorrect.</td>
</tr>
<tr>
<td>7</td>
<td>The message is malformed.</td>
</tr>
<tr>
<td>8</td>
<td>A command argument is invalid</td>
</tr>
<tr>
<td>9</td>
<td>A command argument is out of range</td>
</tr>
<tr>
<td>100</td>
<td>Illegal EPROM address</td>
</tr>
<tr>
<td>101</td>
<td>Illegal EPROM data length</td>
</tr>
<tr>
<td>102</td>
<td>EPROM is busy</td>
</tr>
</tbody>
</table>