SeaChanger
4-Channel
Installation and Operation Manual

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FCC Information

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Important Safety and Warranty Notices

Safety Information

Please read all instructions prior to assembling, mounting, and operating this equipment.

Product Modification Warning

Ocean Optics products are designed and manufactured to meet the requirements of United States and International safety regulations. Modifications to the product could affect safety and render the product noncompliant to relevant safety standards.

Warranty Information

Limited Warranty

Unless otherwise stated, your *product unit* is covered by a one-year parts and labor limited warranty. Dichroic filters are not guaranteed against breakage or scratches to coating. It is the owner's responsibility to furnish receipts or invoices for verification of purchase, date, and dealer or distributor. If purchase date cannot be provided, date of manufacture will be used to determine warranty period.

Returning an Item Under Warranty for Repair

It is necessary to obtain a Return Material Authorization (RMA) number from your dealer or point of purchase BEFORE any units are returned for repair. The manufacturer will make the final determination as to whether or not the unit is covered by warranty. Lamps are covered by the lamp manufacturer's warranty.

All product units or parts returned to Ocean Optics must be packaged in a suitable manner to ensure the protection of such product units or parts. This packaging must be clearly and prominently marked to indicate that the package contains returned product units or parts and must also display its RMA number. Accompany all returned product units or parts with a written explanation of the alleged problem or malfunction. Ship returned product units or parts to: Ocean Optics, 8060A Bryan Dairy Road, Largo, Florida, 33777.

Note

Freight damage claims are invalid for fixtures shipped in non-factory boxes and packing materials.

Freight

All shipping charges will be paid by the purchaser. Items under warranty shall have return shipping paid by the manufacturer only in the continental United States. Under no circumstances will freight collect shipments be accepted. Prepaid shipping does not include rush expediting such as air freight. Air freight can be sent customer collect in the continental United States.

REPAIR OR REPLACEMENT AS PROVIDED FOR UNDER THIS WARRANTY IS THE EXCLUSIVE REMEDY OF THE CONSUMER. OCEAN OPTICS, INC. MAKES NO WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO ANY PRODUCT, AND OCEAN OPTICS SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Warranty is void if the product is misused, damaged, modified in any way, or for unauthorized repairs or parts. This warranty gives you specific legal rights; you may also have other rights, which vary from state to state.

Table of Contents

About This Manual

Document Purpose and Intended Audience

This document provides you with an installation section to get your SeaChanger up and running.

What's New in This Document

This version of the SeaChanger Installation and Operation Manual contains updated contact information.

Document Summary

Chapter	Description
Chapter 1: *Features*	Provides a list of product features.
Chapter 2: *Setup and Configuration*	Contains instructions for unpacking, installing and configuring the SeaChanger.
Chapter 3: *Operation*	Contains instructions for using the SeaChanger.
Appendix A: *SeaChanger Specifications*	Provides product specifications.
Appendix B: *Maintenance*	Provides for cleaning the SeaChanger dichroics.

Product-Related Documentation

You can access documentation for SeaChanger by visiting our website at **www.SeaChangerOnline.com**.

Upgrades

Occasionally, you may find that you need Ocean Optics to make a change or an upgrade to your system. To facilitate these changes, you must first contact Customer Service and obtain a Return Merchandise Authorization (RMA) number. Please contact Ocean Optics for specific instructions when returning a product.

Chapter 1

Features

SeaChanger Color Engine

The SeaChanger Color Engine is an innovative dichroic color-mixing accessory for the ETC Source Four® ellipsoidal fixture. SeaChanger gives you the freedom to mix any color as well as perform live fades from one color to another smoothly, silently, and cleanly.

SeaChanger attaches between the rear housing assembly and the front barrel assembly of the Source Four, and does not interfere with the gate area. You can still use patterns, irises, gobo changers, and all the usual accessories with your Source Four fixture.

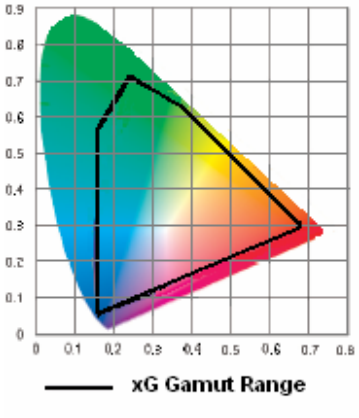
SeaChanger uses dichroic borosilicate glass, which will not fade or change color. So, the color you create during rehearsals is the same color you will see a week, a month, or a year later. And, there are no gel scrolls to burn out or replace.

SeaChanger is available in the standard “xG” configuration (order code SEA-XG), which features a multiband trichroic RGB filter in addition to the cyan, magenta and yellow filters, and in the optional “DM” configuration (order code SEA-DM), with a patterned aluminum douser in place of the “xG” filter.

SeaChanger Features

Your SeaChanger Color Engine offers the following features:

- Amazing color gamut provided by the “Extreme Green” xG* multiband trichroic filter, which, when used in concert with the CMY filters provides deep blues, rich reds, vivid greens, enhanced overtones and incredible tonal balance and control
- High-efficiency dichroics – Less light loss with dichroic color than with a gel, and unlike gels, will never fade or wash out
- No interference with Source Four optics – Can be used with any lens type
- Smooth color mixing – Includes pastel and saturated colors
- Installs in seconds with quick bayonet mounting to your Source 4
- Onboard drive electronics feature adaptive speed response algorithms giving full control over color mixing from smooth, stepless movement to rapid color snaps and bumps
- Silent operation – Contains no fans
- Live color fading from one color to another at any speed with no strange, intermediate colors
- No interference with Source Four’s gobos, irises, or gobo rotators
- Operates on four DMX channels: Cyan, Magenta, Yellow, and xGRB . (CMY and douser for the SEA-DM model)



SeaChanger Color Gamut

* Throughout this manual, the “Extreme Green” xG filter wheel is noted as “xGRB” as a reminder that the filter has red and blue passbands in addition to the photopically dominant green passband.

Chapter 2

Setup and Configuration

Unpacking the Products

Unpack your SeaChanger products and verify that they are undamaged. If there is no damage, continue with the rest of the setup procedure (see ***SeaChanger Setup***). If there is damage, notify both the shipping agent and the sales agent immediately.

Save the shipping carton and packing materials. The carton and packing materials are specifically designed to protect the product during transport. Return a product for repair in its original shipping carton and packing materials. Ocean Optics assumes no responsibility for products that are damaged during transport. Before returning anything to the factory, call for a Return Material Authorization (RMA) number. Ocean Optics cannot accept any goods shipped without an RMA number. See ***Returning an Item Under Warranty for Repair***.

Package Contents

The SeaChanger Color Engine ships with the following items:

- User manual
- Safety cable

Optional Accessories

The following accessories are available from Ocean Optics:

- Extended Yoke for down lighting or FOH installations (Part No. ME451-59)

SeaChanger Setup

Setting up the SeaChanger involves installing the proper power cord cap and setting the DMX start channels.

Installing a Power Cord Cap

Your SeaChanger ships with a power cord that must be connected to a standard cord cap. Different locations may require a different power cord cap to connect the fixture to a power source. Because of the variety of power cord caps used worldwide, Ocean Optics, Inc. cannot make specific recommendations for the power cord cap. Contact a local authority for the type of power cord cap needed.

The SeaChanger has a universal power supply onboard that allows for connection to a wide variety of main power sources. Refer to the Specifications section for details.

When installing the power cord cap, note that the cores in the mains lead are colored in accordance with the following code:

Color	Function
Green with Yellow stripe	Ground
Blue	Neutral
Brown	Live

WARNING

The SeaChanger is Class 1 equipment. This equipment must be connected to an earth ground.

Note

Maximum total color- changer cable length per SeaChanger should not exceed 600 ft. (182.9 m).

Mounting the SeaChanger on a Source Four Ellipsoidal Fixture

The SeaChanger requires no tools to install. It fits between the lamp and the lens module of the Source Four Ellipsoidal fixture. Perform this procedure *before* you connect the fixture to power.

WARNING

INTENSE HEAT. AVOID CONTACT BY PERSONS AND MATERIALS.

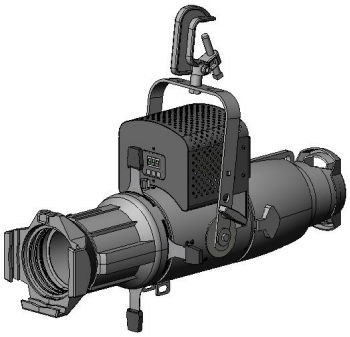
► *Procedure*

To install a SeaChanger Color Engine in a Source Four ellipsoidal fixture,

1. Remove the Source Four from the yoke assembly, setting aside the screws to use in Step 2.
2. Using the same screws, attach the SeaChanger as shown in the figure below. Adjust the SeaChanger to the desired orientation.

3. Remove the front barrel assembly of the Source Four ellipsoidal fixture by loosening the thumbscrew and the Philips set screw located above and beneath the lens barrel. Rotate the barrel assembly until it releases from the mounting tabs located in the rear housing assembly.
4. Insert the SeaChanger into the Source Four rear housing assembly by aligning the mounting tabs into the rear-locking ring of the SeaChanger. You must rotate the rear housing until the Source Four mounting tabs are captured in the SeaChanger locking ring channels. Tighten the thumbscrew and Philips set screw to lock the module onto the Source Four fixture.
5. Insert the front barrel assembly onto the front locking ring of the SeaChanger, engaging the barrel assembly into the locking ring channels.
6. Adjust the front barrel assembly to the desired orientation and tighten the thumbscrew and Philips set screw to lock the front barrel assembly to the SeaChanger.
7. Mount the unit using safety cable at the mounting location.

The installed SeaChanger can be oriented in either the “in-yoke” or “below-yoke” configurations as shown below:



Optimizing Performance

Soft Edge Beam

For optimum performance from SeaChanger and the Source Four when you need a soft edge, always move the lens tube out (away from the lamp housing) from the focus point, not towards.

Determining a Valid DMX Base Address

The DMX base address (start channel) identifies each fixture on a link for the DMX controller. There are 512 available channels on each DMX link. These 512 channels are divided among *all* the devices on a particular link. The number of channels a fixture requires is called the fixture's channel range. The DMX base address assigned to a particular fixture is the first channel available to a fixture in its channel range. The fixture's channel range must not overlap any other device's channel range on the link. When two devices on the same DMX link have overlapping channel ranges, one or both devices will be disabled or behave erratically.

Remember the following criteria when determining a valid base address:

- The base address is the number of the first channel in a consecutive block of channels assigned to an individual fixture.
- If you want two or more fixtures to respond to controller commands in exactly the same way, you can assign them the same base address. In that case, those fixtures must be the same type and must share the *entire* channel range.
- A fixture can be assigned the second block of DMX channels on a link without physically being the second fixture on the link.
- To avoid overlapping channels, place the start channel at the beginning of a range of available channels large enough to accommodate that fixture type.
- Every channel in the link does not need to be assigned.
- The channel range required for a fixture differs depending on the fixture type. The SeaChanger uses a DMX block of 4 contiguous channels.

Setting the Base DMX Address

The SeaChanger is a four channel DMX device, and requires that a contiguous block of four DMX addresses be available. The display panel or RDM input is used to enter the DMX base address of the fixture. Channel 1 is assigned to this base address, and Channels 2 through 4 are assigned the next three DMX addresses.

Chapter 3

Operation

Overview

The SeaChanger can be operated by a DMX512 controller, RDM (Remote Device Management) device, or from the front panel display.

Power and DMX Connections

The SeaChanger has a self-contained universal AC/DC power supply, permitting connection to single-phase power sources with a voltage range of 110 – 240 VAC, at a frequency of 50 – 60 Hz.

The DMX I/O connectors are 5-pin XLR type, and are connected in a pass-through arrangement to enable daisy chaining of multiple fixtures. Either connector can function as an input or output. An external terminator plug (not supplied) is recommended for the last fixture in a DMX cable run.

SeaChanger Display and Control Buttons

The SeaChanger features a 3-digit LED display and corresponding panel buttons for numeric entry. Each button push increments the corresponding digit by 1, and from 9 back to 0. Addresses and functions programmed via the display panel take effect after a 3 second delay.

DMX Signal Indicator

The SeaChanger display will show a decimal point if a DMX signal is present. The decimal point will go out when signal is not present or removed.

Display Blanking

The SeaChanger display will blank the digits after a 5-minute delay. The DMX signal indicator (decimal point) will remain on as long as a DMX signal is present. The display can be powered on by pushing any of the display buttons once while blanked.

USITT DMX512-A Manufacturer ID

All Ocean Optics DMX512 addressable fixtures have an ESTA registered Manufacturer's ID of ASCII "SC" (decimal 83 & 67, or 53h 43h in hex).
See ***http://www.esta.org/tsp/working_groups/CP/mfctrIDs.php***.

DMX Control

When connected to a suitable DMX controller, the SeaChanger can be operated via four DMX channels. The channels are assigned as in Table 1 below:

Table 1 – SeaChanger DMX Channel Map

Channel	Name	Parameter	Percent Range	DMX Range	Hex Range	Reset Default Percent Value
1	Cyan	Color Saturation	0 – 100%	0 – 255	0 – FF	0% Full clear
2	Magenta	Color Saturation	0 – 100%	0 – 255	0 – FF	0% Full clear
3	Yellow	Color Saturation	0 – 100%	0 – 255	0 – FF	0% Full clear
4	xGRB (Model SEA-XG)	Color Saturation	0 – 100%	0 – 255	0 – FF	0% Full clear
	Optional Douser (Model SEA-DM)	Brightness	0 – 100%	0 – 255	0 – FF	0% Full Dark

Reset from DMX Console

When connected to a suitable DMX controller, the SeaChanger filter wheel positions can be reset from the console by a two step dwell and snap as shown in Table 2 below:

Table 2 – SeaChanger Reset Procedure

Channel	Name	Dwell (+3 sec) (% / DMX / hex)	Snap (% / DMX / hex)	Reset Default Percent Value
1	Cyan	100% / 255 / FF	0% / 0 / 0	0% Full clear
2	Magenta	100% / 255 / FF	0% / 0 / 0	0% Full clear
3	Yellow	100% / 255 / FF	0% / 0 / 0	0% Full clear
4	xGRB (Model SEA-XG)	0% / 0 / 0	0% / 0 / 0	0% Full clear
	Optional Douser (Model SEA-DM)	0% / 0 / 0	0% / 0 / 0	0% Full Dark

Keypad Control

The SeaChanger keypad and LED display provides another interface to set the fixture base address, select the operating mode, and program settings. Settings take effect after a three second delay. These parameters are shown in Table 3.

RDM Control

The SeaChanger is RDM (Remote Device Management) compliant to ANSI E1.20-2006, "Entertainment Technology--Remote Device Management over USITT DMX512". RDM allows the SeaChanger base DMX address to be remotely set, and the operating mode or fixture settings to be changed. Available functions are listed in Table 3a for the Seachanger xG and in Table 3b for the SeaChanger DM (optional patterned aluminum douser wheel).

Table 3a – SeaChanger xG (xGRB Filter) Keypad / RDM Control Functions

Keypad / RDM Input	Function	Type
001 - 509	Set Fixture Base Address	Modal
700	Unassigned	-
701	Display Orientation Normal	Action
702	Display Orientation Inverted	Action
800	Start Demo Mode	Modal
900	All Out (Clear)	Modal
901	Cyan Full	Modal
902	Magenta Full	Modal
903	Yellow Full	Modal
904	All In (Full Dim)	Modal
905	Red (M + Y + xGRB) Full	Modal
906	Green (xGRB) Full	Modal
907	Roscolux #82 Surprise Blue	Modal
908	Roscolux #03 Dark Bastard Amber	Modal
909	Roscolux #158 Deep Orange	Modal
910	Roscolux #45 Rose	Modal
911	Roscolux #60 No Color Blue	Modal
912	Roscolux #51 Surprise Pink	Modal
913	Roscolux #94 Kelly Green	Modal
914	Roscolux #08 Pale Gold	Modal
915	L-341 Plum	Modal
916	L-162 Bastard Amber	Modal
917	L-113 Magenta	Modal
918	L-103 Straw	Modal
919	L-124 Dark Green	Modal
920	L-166 Pale Red	Modal
921	L-004 Medium Bastard Amber	Modal
922	Roscolux #310 Daffodil	Modal
923	Roscolux #46 Magenta	Modal
924	Roscolux #99 Chocolate	Modal
925	Roscolux #62 Booster Blue	Modal
990	Reset All Home Position	Action
991	Reset Cyan Home Position	Action
992	Reset Magenta Home Position	Action
993	Reset Yellow Home Position	Action
994	Reset xGRB Home Position	Action

Modal functions remain in effect until another is selected. Actions return to the current mode after execution.
Gel Match functions 901 – 903 and 905 - 925 are based on Osram HPL750/115 lamp.
Functions take effect after a 3 second delay.

Table 3b – SeaChanger DM (Optional Douser) Keypad / RDM Control Functions

Keypad / RDM Input	Function	Type
001 - 509	Set Fixture Base Address	Modal
700	Unassigned	-
701	Display Orientation Normal	Action
702	Display Orientation Inverted	Action
800	Start Demo Mode	Modal
900	All Out (Clear)	Modal
901	Cyan Full	Modal
902	Magenta Full	Modal
903	Yellow Full	Modal
904	All In (Full Dim)	Modal
905	L-079 Just Blue	Modal
906	L-110 Middle Rose	Modal
907	L-104 Deep Amber	Modal
908	L-105 Orange	Modal
909	L-164 Flame Red	Modal
910	L-322 Soft Green	Modal
911	Roscolux #60 No Color Blue	Modal
912	Roscolux #51 Surprise Pink	Modal
913	Roscolux #21 Golden Amber	Modal
914	Roscolux #82 Surprise Blue	Modal
915	Roscolux #04 Medium Bastard Amber	Modal
916	L-142 Pale Violet	Modal
917	Roscolux #02 Bastard Amber	Modal
918	Roscolux #46 Magenta	Modal
919	Roscolux #59 Indigo	Modal
920	L-136 Pale Lavender	Modal
921	L-035 Light Pink	Modal
922	L-158 Deep Orange	Modal
923	L-248 Half Minus Green	Modal
924	Roscolux #05 Rose Tint	Modal
925	L-162 Bastard Amber	Modal
990	Reset All Home Position	Action
991	Reset Cyan Home Position	Action
992	Reset Magenta Home Position	Action
993	Reset Yellow Home Position	Action
994	Reset Douser Home Position	Action

Modal functions remain in effect until another is selected. Actions return to the current mode after execution.
Gel Match functions 901 – 903 and 905 - 925 are based on Osram HPL750/115 lamp.
Functions take effect after a 3 second delay.

Demo Mode

The SeaChanger demo mode provides for color changing without a DMX controller attached. Selection of "800" via RDM or keypad starts the demo mode. The fixture will sequence through the colors in Table 4a for the SeaChanger xG or as in Table 4b for the SeaChanger DM (optional patterned aluminum douser wheel) below, with a four second dwell time at each color. Custom demo color tables are available at the time of order; please contact Ocean Optics for more information.

Table 4a – SeaChanger xG (xGRB Filter) Demo Sequence

Sequence Number	Function	RDM / Keypad Equivalent
1	Cyan Full	901
2	Magenta Full	902
3	Yellow Full	903
4	Red (M + Y + xGRB)	905
5	Extreme Green (xGRB)	906
6	Roscolux #82 Surprise Blue	907
7	Roscolux #03 Dark Bastard Amber	908
8	Roscolux #158 Deep Orange	909
9	Roscolux #45 Rose	910
10	Roscolux #60 No Color Blue	911
11	Roscolux #51 Surprise Pink	912
12	Roscolux #94 Kelly Green	913
13	Roscolux #08 Pale Gold	914
14	L-341 Plum	915
15	L-162 Bastard Amber	916
16	L-113 Magenta	917
17	L-103 Straw	918
18	L-124 Dark Green	919
19	L-166 Pale Red	920
20	L-004 Medium Bastard Amber	921
21	Roscolux #310 Daffodil	922
22	Roscolux #46 Magenta	923
23	Roscolux #99 Chocolate	924
24	Roscolux #62 Booster Blue	925
Gel Match demo colors 1 - 24 are based on Osram HPL750/115 lamp. To cancel demo mode, select a DMX base address between 1 and 509 via RDM or keypad.		

Table 4b – SeaChanger DM (Optional Douser) Demo Sequence

Sequence Number	Function	RDM / Keypad Equivalent
1	Cyan Full	901
2	Magenta Full	902
3	Yellow Full	903
4	L-079 Just Blue	905
5	L-110 Middle Rose	906
6	L-104 Deep Amber	907
7	L-105 Orange	908
8	L-164 Flame Red	909
9	L-322 Soft Green	910
10	Roscolux #60 No Color Blue	911
11	Roscolux #51 Surprise Pink	912
12	Roscolux #21 Golden Amber	913
13	Roscolux #82 Surprise Blue	914
14	Roscolux #04 Medium Bastard Amber	915
15	L-142 Pale Violet	916
16	Roscolux #02 Bastard Amber	917
17	Roscolux #46 Magenta	918
18	Roscolux #59 Indigo	919
19	L-136 Pale Lavender	920
20	L-035 Light Pink	921
21	L-158 Deep Orange	922
22	L-248 Half Minus Green	923
23	Roscolux #05 Rose Tint	924
24	L-162 Bastard Amber	925
Gel Match demo colors 1 - 24 are based on Osram HPL750/115 lamp. To cancel demo mode, select a DMX base address between 1 and 509 via RDM or keypad.		

Appendix A

SeaChanger Specifications

Specification	Value
Mechanical	
Height	292 mm (11.5 in.)
Width	178 mm (7.0 in.)
Length	259 mm (10.2 in.) without ETC Source Four 750 mm (29.5 in.) with ETC Source Four Model 426 (26°)
Shipping Weight	6.4 kg (14 lbs.)
Actual Product Weight	5.4 kg (12 lbs.)
Electrical	Non-dimming circuit 100/240 VAC, 50/60 Hz (auto-sensing) 1.5 Amps @ 110 VAC, 0.7 Amps @ 240 VAC Onboard internal 5VDC, 50W switching mode power supply Fuse: Bussmann P/N S501-3.15A or equivalent (IEC60127-2, 5x20mm ceramic tube, fast acting, high breaking current, 250 volts AC, 3.15 amps)
Environmental	
Maximum Ambient Temperature	45 °C (113 °F)
Minimum Ambient Temperature	0 °C (32 °F)
Maximum Exterior Surface Temperature*	200 °C (392 °F)
Cooling	Fanless, convection cooling
Lamp	
Type*	575W or 750W HPL incandescent lamp; can be used with Source 4 HID (high intensity discharge) fixtures

Specification	Value
Control, Cabling and Terminator	
SeaChanger Data Link	8 bit DMX512 male and female 5-Pin XLR with DMX signal passthrough for daisy-chaining Remote Device Management (RDM) per ANSI E1.20-2006 DMX start address can be set via RDM or onboard display
Maximum Recommended Cable Length	182.9 m (600 ft.)
Compatible Terminator	120 ohms
SeaChanger Onboard Keypad / Display	Three button shielded membrane keypad with three digit, seven segment LED display and DMX signal indicator
Operating Features	
Color Filter Type, Range and Control	Channel 1 - Cyan: 0-95% saturation Channel 2 - Magenta: 0-95% saturation Channel 3 - Yellow: 0-95% saturation Channel 4 - standard – xG(RGB) filter: 0-99% saturation optional - patterned Al douser: 0-99% dimming custom – dichroic filters Dichroic patterned CMY and xG(RGB) coatings on optical glass substrates, BBAR coated, in-band transmission > 98% Patterned aluminum douser (SEA-DM model) with dielectric enahancement, on optical glass substrate
Speed	0.3 sec average clear to full saturation Onboard drive electronics with adaptive speed response
Accessory Compatibility	Preserves all ETC Source Four beam characteristics and compatibility with all beam-shaping ETC Source Four accessories such as gobos; gobo rotators; gobo changers; and 10,14,26,36,50,70 and 90 degree field-of-view barrels; and other beam shaping devices
Mounting	Suspension on Source Four yoke from mounting points; Bayonet mount to fixture -- Adaptable to Source Four tungsten or HID fixtures
Maintenance	Easy color engine removal for periodic cleaning
Safety	Safety cable ring, 3’ safety cable included
* *For more information, see the documentation for the ETC™ Source Four fixture.*	

Appendix B

Maintenance

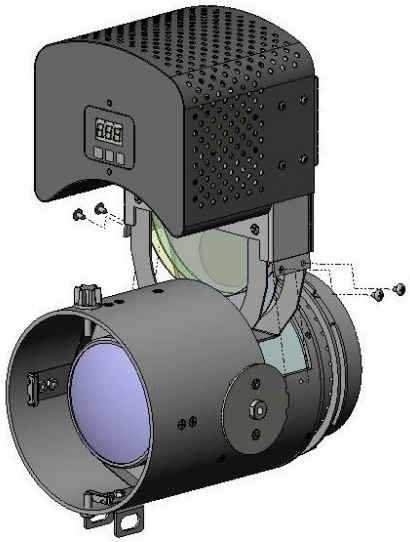
Cleaning the SeaChanger Dichroics

WARNINGS

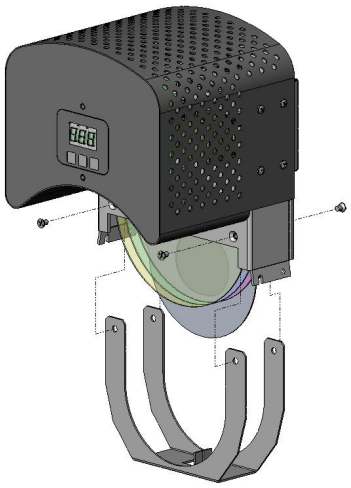
Disconnect power and turn power switch off before servicing.

Equipment surfaces may reach temperatures up to 67° C (153° F). Allow the fixture to cool before handling.

Remove the SeaChanger color engine from the lens tube assembly by removing (4) Philips screws and extracting the color engine as shown:



The filters can be easily accessed by removing (4) Philips screws and pulling the protective cage away from the color engine as shown below:



Clean the dichroic glass filters using a mild glass cleaner (containing no ammonia) and a soft, lint-free cotton cloth or swab.

Reverse the above steps for reassembly. When reassembling, ensure that the cage is oriented in the same direction as it was removed; the cage has a retaining slot for the aperture stop that will bend the aperture stop out of position if installed incorrectly.

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