Ocean Optics' SeaChanger xG

By Mike Wood

This month, we're departing slightly from our usual format and looking at a fixture accessory rather than a full lighting unit. The SeaChanger xG from Ocean Optics is designed to address a specific, long-identified need in providing full color dichroic mixing capability to the ubiquitous ETC Source Four ellipsoidal. There have been other attempts to meet this need, both with dichroics—the High End Systems' ColorMerge immediately springs to my mind, of course—and with gel, in the case of the Wybron CXI. Can the SeaChanger compete with these and hit the sweet spot for performance, price, usability, and size?

Figure 1 - Fixture as tested

Ocean Optics is well known as a manufacturer of thin-film coatings and optical test equipment, such as spectrometers. The move to manufacture the SeaChanger is, on the surface, a major departure from the company's normal business. However, it makes sense; that same expertise in thin-film coatings and dichroics gives the company a leg up with a product like SeaChanger, where accurate, smooth color is critical. The requirements for a color-mixing unit for a Source Four are subtly different than for a moving light. The theatrical community uses more subtle, pastel shades than in the moving light industry; it needs something that can run side by side with existing gels. Noise is a major concern to this sector, but speed of change may not be.

How do you make a dichroic color changer work in a Source Four, which was never originally designed with this kind of product in mind? The first thought is to make a product that fits in the gel frame runners, as you would with a scroller. It's a great spot to homogenize the color, as you are a long way away from the focal plane. Well, that works for gel and scrollers, but may not make as much sense for dichroics. The beam diameter at the gel frame slot is large, and would need correspondingly large, expensive dichroics; the slot also varies in size from lens tube to lens tube, meaning you would have to make more than one model. Most problematically, the size of the beam passing through that gel slot aperture varies as you move the lenses and change the focus of the fixture. If you were to use a typical gradient dichroic wheel in that position, the portion of the wheel that the beam passes through would change as the fixture lens was adjusted. This would change the effective color of the beam, so the color projected would depend not only on wheel position but also on the fixture focus—which is clearly unacceptable. Fixture focus must have no effect on color.

A better location is the gate; the beam here is always the same size and ETC serendipitously provides a means to access this area through the interchangeable lens tube system. Separate the two and you can put something in between, which is exactly what Ocean Optics does. You can't just drop a large color changer in here, though, and change the spacing of the reflector to the gate—or you would really mess up the optics of the Source Four. To deal with this, the SeaChanger isn't just dichroic. Inside the barrel there is a sophisticated optical system, which corrects the beam so the gate and lens tube see exactly the same light pattern that they'd see without the SeaChanger and its added length.

As I said earlier, we can't follow our usual review format. However, the goal remains the same: to lay out measurements and details in as complete and objective a manner as possible, leaving the reader in a position to form his or her own conclusions.

For the main series of tests, the SeaChanger xG was fitted to a Source Four 750W unit using an HPL 750W 115V 300-hour lamp and a standard-resolution 26° lens. Both the fixture and the SeaChanger were run at 115V, 60Hz; however, the SeaChanger is fitted with an auto-sensing universal power supply rated for 100/240VAC 50/60Hz, so it can be run from any local supply (Figure 1: Fixture as tested; Figure 2: SeaChanger xG). Although the demo unit supplied had no electrical rating or approval plates, Ocean Optics tells me that it has ETL and CE approval.

Assembly

Fitting the SeaChanger to the Source Four is pretty simple. First, the Source Four lens and yoke are removed. You then attach the yoke to the SeaChanger instead (Figure 3). This ensures that the fairly heavy SeaChanger is kept near the center of gravity, so you can still balance, adjust tilt, and lock off the unit easily. I found a minor problem here, in that the yoke mounting bosses didn't protrude through the Source Four yoke as much as they should. The protrusion is so you can securely tighten the fixing bolts without locking tilt in position. This needs to be addressed, as leaving those bolts loose, as I had to, is a safety concern.

Finally, refit the Source Four lamp house and lens to the SeaChanger using the normal ETC bayonets and you're in business. You retain all the lens rotation and other operational features of the Source Four unaltered.

Note that the SeaChanger can be fitted either way round—with the main housing either up or down. For these tests, I ran it in the worst-case position for heat—upwards, as shown in Figure 1—but, if you can, I would recommend having it downwards to keep it as cool as possible.

Optics

As mentioned in the introduction, the SeaChanger embodies some serious optics. Figure 4 shows the view from the rear and Figure 5 from the front. There is a single large lens in the rear and a three-element lens system in the front. All lens surfaces have a high efficiency anti-reflection coating to prevent light loss from all this glass. As this is one of Ocean's specialties, the results are extremely impressive. I measured an overall insertion efficiency in open white of 83%, or 17% loss, which is about as good as you can possibly imagine for a unit of this type.

This is made even more impressive when you consider that the four dichroic wheels (more on those later) are in the light path at all times; that makes a grand total of 16 glass/air surfaces (two surfaces for each of the four lenses and four dichroics). To get an 83% overall transmission means that each of those surfaces has a transmission efficiency of around 99%. Suffice to say that you won't notice any loss in light output in operation.

So the optics don't affect light output significantly—what about the field? Here, there was a slight change—I found that adding in the SeaChanger made the unit slightly "peakier" and it would be necessary to tweak the Source Four lamp adjust slightly to get back to a flat field. If this is important to you, it might be worth setting up the system on the bench with the SeaChanger attached rather than trying to adjust it in the rig later. After adjustment, the system behaved as you would expect.

The measured beam angle from the 26° lens was unchanged by the SeaChanger with effectively no change to the useful beam.

I also tested the SeaChanger with a number of other Source Four lenses including the 19°, 36°, and 50° standard definition, and the 19°, 26°, 36° and 50° EDLT lenses. I was concerned in case the EDLT lenses showed increased patterning from the dichroic wheels, but none was apparent, and performance with all lenses looked similarly good. I was not able to test with either the zoom lenses or the large diameter narrow angle lenses.

Color system

As already mentioned, the SeaChanger uses a familiar style of patterned dichroic wheel using tapered fingers of color (Figure 6). However, it doesn't just use cyan, magenta, and yellow, and they aren't completely normal wheels. In the SeaChanger xG, Ocean Optics adds in a fourth wheel, an "extreme green." The name is, to my mind, somewhat confusing. Although it looks to be green, it is in fact a complex blend, with peaks in the red, green, and blue. It only looks green to the human eye because green is where our color vision is most sensitive. You can see

Left: Figure 2 - SeaChanger xG
Below: Figure 3 - Yoke Mounting

Left: Figure 4 - Rear of unit

the complexity by playing with it and mixing some colors. Add it to an already mixed green and it does, indeed, make it "greener." However, add it to an orange and you can get into an area of the color chart that simply adding green just wouldn't do. You're able to mix some of those interesting shades which, up until now, have been the sole purview of the gel manufacturers. It's difficult to put this into words—we don't have the language to subtly describe colors—but the delicate control you can get is worthwhile and interesting.

The only operational downside, at least to me, is that the control of the "extreme green" wheel is non-intuitive. Like a lot of people in our business, I've gained good experience of operating CMY systems and can quickly mix a result close to where I want to be. Adding in the fourth wheel is a new skill to learn. I found the best results by ignoring it initially, getting close to my desired shade with CMY, and then adding it slowly to see what it did. This then requires some slightly iterative tweaking of the CMY to optimize the result. It's definitely something you want to use color palettes for. I'd like to see a conversion chart from gel numbers to the relevant CMYX values as a programming aid.

The dichroic wheels have one more trick up their sleeves. With those four wheels you have eight air/glass interfaces and, in open white, you could lose a lot of light just traversing all those boundaries. An uncoated air/glass or glass/air boundary will typically lose around 4% of output due to reflection at the boundary (often known as Fresnel losses)—put eight in a series with no coatings and you lose a very significant 28%. This is why you often see color mixing wheels with a physical hole cut in the glass at the open white point—a hole has no loss! However, a problem with a hole is that you then have to pass an edge of the glass over the aperture to get into the color. Depending on the optical system, that edge can be visible, and here, in the SeaChanger, you are so close to the focal plane of the Source Four that this would be a big problem. Ocean Optics neatly avoids the whole issue by coating the uncolored surfaces of the glass with a high-quality anti-reflection or AR coating, which reduces the losses to less than 1% per surface. This isn't easy to do, as you want to AR-coat only the areas which are not already coated with the dichroic to avoid affecting the color; you cannot just AR-coat the whole surface. Ocean Optics has a background in making the RGB color disks that spin at high speed in many single-chip video projectors and was able to use that same selective coating technology in this product. It gives impressive results. The company doesn't coat the whole surface and then etch off what it doesn't need, as most vendors do; instead it masks and just coats where needed. This technology allows Ocean Optics to make multiple runs and accurately place different coatings in different areas on the glass.

Figure 7 shows the mechanical system used for the color wheels. This is very conventional, with belt drives from stepper motors. Figure 8 shows the four wheels in the assembly.

The color mixing is generally excellent—a remarkable result, given the position of the system in the optical train. The only time I saw any evidence of uneven colors was with some mid-tones mixing cyan and magenta, where there was evidence of a redder outside edge to the beam with a bluer center. I also occasionally saw some zebra stripe reflections just outside the main beam, but these were at a very low level. The range of colors available is particularly strong, with good performance in the critical pale blues and straws and some excellent aquas, lavenders, and ambers through use of the xG wheel. The range of colors shows the unit's intended use in theatrical applications.

Figure 5 - Front of unit

Figure 6 - Dichroics

Figure 7 - Motors

Figure 8 - Dichroic Wheels

Color mixing

Color	Cyan	Magenta	Yellow	Red	Green	Blue	xGreen
Transmission	30%	5.5%	81%	5%	10%	1.3%	57%

Color change speed – worst case	1.6 sec

The transmission readings show that Ocean Optics has selected a very highly saturated and fairly narrow magenta to help reach those deep blues and reds. This is slightly surprising, given that it's an incandescent unit and, actually, the saturated colors aren't that strong—but the

Figure 9 - Display

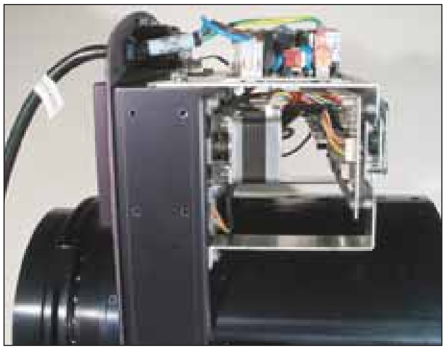

Figure 10 - Electronics

Above: Figure 11 - Connectors

Left: Figure 12 - Chassis

intermediate mix values are smooth enough that it's not really an issue.

The color change speed from open to full color is pretty slow at 1.6 seconds. Plan your color change cues carefully as snap changes aren't possible. Ocean Optics is aware of this and has profiled the color change moves so that they reach a position close to the final target as quickly as possible and then decelerate to reach the final target accurately to speed up the "perceived" change speed. You'd need to try it to see if this works for your requirements. Movement was smooth and step free at all speeds.

Power consumption as tested at 115V

	Max current	Power Factor
Electronics, Initializing	0.4A	0.6
All Colors Moving	.37A	0.66

Noise

Of course, that slow speed is just what you need from a noise point of view. The unit has no fans, so it's completely silent when not changing colors. Even with all four wheels moving, the noise level doesn't rise much; I measured a peak level of 38.2dBA at 1m, as compared with my test room's ambient floor noise of under 35dBA. That makes the SeaChanger one of the quietest fixtures around.

Electrical parameters

Clearly, the power supply is not power-factor corrected. At only 30W (45VA), this isn't really a problem.

Homing/initialization time is four seconds from a cold start, and four seconds with a DMX512 "reset" command.

Electronics and control

The "power bulge" on the SeaChanger contains the electronics, power supply, and control. All are fairly standard and functional. DMX512 address selection is through a three-character display, each with its own selector button. Each button increments the associated digit—a very straightforward system. As well as DMX512 control, the unit also offers preset fixed colors selectable from a wide range of gel colors. (Figure 9 – Display; Figure 10 – Electronics.) I'm pleased to see that the unit also offers RDM control. I wasn't able to test this, but you should be able to remotely set the unit DMX512 addressing through RDM control.

Construction

It's a slightly mixed bag—the construction of the optical barrel and lenses is very neat and elegant, but I feel the power bulge and its aesthetics let it down slightly. To my eye, having three different shades of black and three different surface finish textures doesn't make it hang together visually as one unit and tends to overemphasize its size. The positioning of the DMX512 connectors worried me—if you install the unit in the "power bulge up" configuration, these are right above the lamp house and get extremely hot. I'm particularly concerned about the DMX512 cabling in this mode; data cabling usually doesn't have the same high temperature rating as power cords. If you run it in this orientation, dress the data cables up and away from the lamp house (Figure 11).

However, whatever my concerns on the outside of the unit, the appearance has no effect on the performance; the internal systems are fine, neat and tidy (Figure 12).

Conclusions

So, there it is: the SeaChanger xG from Ocean Optics. With a list price of $1,995, it's costlier than a color scroller, but it does a lot more than a color scroller. Is it right for you? That's not for me to say, but hopefully you now have enough information to make up your own mind.

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