Clay Paky A.LEDA B-EYE K20

By: Mike Wood

Fig. 1: Fixture as tested.

Folks are starting to get pretty inventive with their LED luminaires. We are past the point of asking the question, "Are these bright enough to replace my regular lights?" and can move on with the more interesting question: "What new things can I do with these light sources?"

No longer are LED products just being asked to emulate and replace their conventional sourced predecessors; instead, we are starting to see brand-new classes of luminaire that simply weren't achievable with prior technology. This is much more exciting! Yes, I know it's a great thing to replace a large-wattage incandescent light with a low-wattage LED where you want it to look exactly the same, but it's much more interesting to do something completely different.

We've seen a few lights that fall into this category in this column already, and in this issue I'm testing a brand-new product from one of the more successful companies in the field of automated lighting, Clay Paky. It was a relatively late mover into the LED arena, and its first products were fairly conservative. This time around, however, Clay Paky has moved far away from the conservative, and, spurred on no doubt by the success of the Sharpy range, has produced a new range of LED products capable of narrow beam and wash effects. The product under review is the Clay Paky A.LEDA B-EYE K20 (which, if you'll forgive me, I'm going to abbreviate to B-EYE K20).

The origin of the B-EYE name is clear as soon as you look at the product (Figure 1): Thirty-seven slightly bug-eyed lenses stare out at you, arranged in four concentric rings of 18, 12, six, and one. Actually, only the center lens is a hive-shaped hexagon—the rest are pentagons or quadrilaterals—but I think we can give Clay Paky the benefit of the doubt with the evocative name! We'll come back to those lenses later on and explain what their purpose is.

This review follows my usual format, starting with the light sources and working through, measuring everything as objectively as possible, ending with the light output. For this review, all data comes from tests I carried out on a single unit supplied to me as typical by Clay Paky. Please bear in mind, as I always say when we are looking at effects or beam lights, that the figures don't tell you everything with this kind of light. They are a start, giving you a frame of reference, but the success, or otherwise, in any particular case has as much to do with good lighting design, positioning, and integration into the overall show. The B-EYE K20 can be run on all voltage from 100-240V 50/60Hz; for these tests, it was run on a nominal 115V 60Hz supply. Quiescent current draw, with no LEDs running, was 0.62A, 70W.

LEDs

The B-EYE K20 uses 37 of the 15W Osram Ostar RGBW die. Each is capable of being run independently, so there are 37 x 4 = 148 drivers to go with those LEDs. That's a lot of power (37 x 15 = 555W), and a lot of drivers. Figure 2 shows a close-up of a single four-color die on one of the many circuit boards in the head. The LEDs are mounted two to a board, so there are 19 of these small boards in total (the center LED is on its own). As you can perhaps see in the photograph, the LED is mounted directly to a metal-backed circuit board for good heat conduction, and is in direct contact with the bottom end of a square plastic light pipe. Figure 3 shows the rear of the unit, and the main circuit board with 19 ribbon cables around the edge leading out to

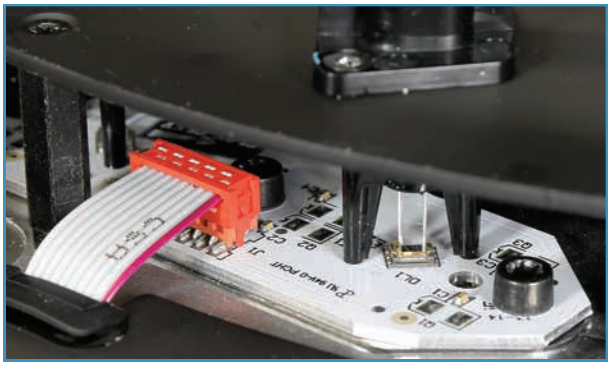

Fig. 2: LEDs.

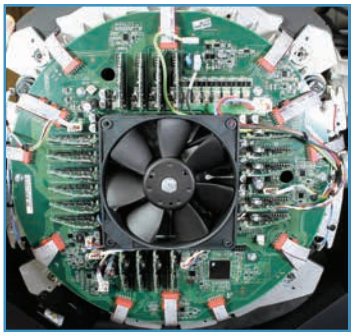

Fig. 3: Main circuit board.

the LED boards. This board also has 19 vertically mounted daughter boards, each of which contains the drivers for one of those LED boards. There's a lot of circuitry in a small space here. The whole thing is cooled by the large thermostatically controlled fan you can see in the center of Figure 3.

Optics

I mentioned the light pipes above; each four-color LED couples into its own light pipe, which serves to homogenize the four colors (red, green, blue, and white) and transfer the light output to an exit lens. Figure 4 shows the array of light pipes as they emerge through the backing plate. Each one is about 50mm long, and the light looks a little like a strange optical hedgehog at this point. On the top of each light pipe

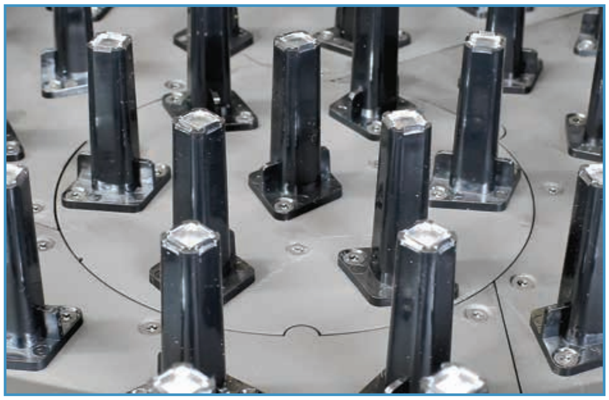

Fig. 4: Light pipes.

Fig. 5: Light pipe output.

is a small square output lens that, I assume, acts both as a collimator and final diffuser to ensure the light is thoroughly mixed (Figure 5). The reason for the length of these light pipes, and the way they are arranged, is twofold. First, the longer a light pipe, the better job it does of mixing and homogenizing the light passing through it. (As a rule of thumb, the pipe length should be at least three times the diameter of the source, preferably more.) Secondly, in the B-EYE K20 these light pipes protrude up into a lens array that provides the beam angle control and the rotation (of which more later).

Figure 6 shows the lens array that gives the product its name. There are 37 large lenses, one for each light pipe. They are identical optically, but differ in external shape to allow them to be fitted as closely together as possible in the concentric rings. If you look closely, you can see that there are seven variants of shape: six different ones in each of the six pie-shaped wedges, three in the outer ring, two in the middle ring, one in the inner, and a single center lens. Only the center lens is fully symmetrical; the rest are complex, irregular shapes. This entire array is mounted on a metal ring that can move backwards and forwards along the optical axis, and rotate around it. Figure 7 shows one of the three linear actuators and slides that control the backwards and forwards motion. As these move, the ring, with all 37 lenses on, moves, carrying each lens toward or away from its associated light pipe, behaving as a simple single-lens zoom system and changing the beam angle of each emitter individually. So far, this is nothing unusual; we've seen many products that do something similar. However, the difference here is that this ring can also rotate and move the lens across the top of the light pipe. Figure 8 shows the rotate motor and gear that engages with a ring gear running round the outer circumference of the lens array.

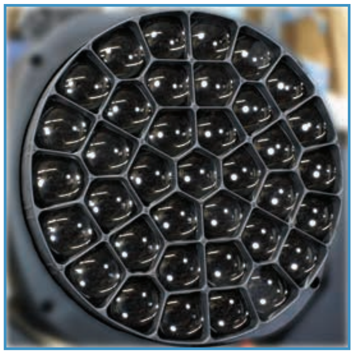

Fig. 6: Lenses.

Fig. 7: Zoom motor.

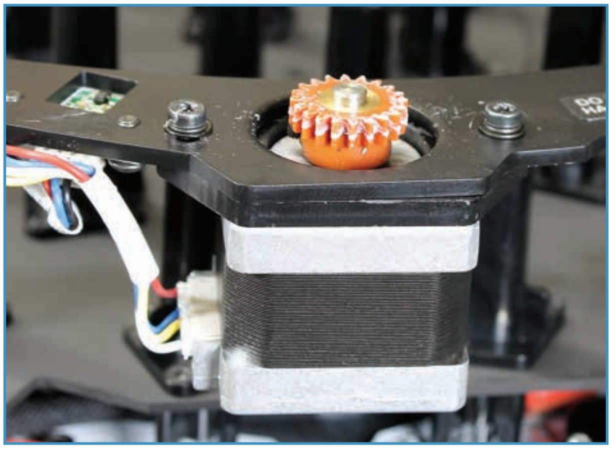

Fig. 8: Lens rotate.

Now you understand why the light pipes are so long and narrow, and the lenses are large. The large front lens can be moved from side to side in front of the light pipe exit without the light pipe moving past the edge of the much larger lens. The result of that is to direct the light sideways, with the output lens acting as a prism in a controlled manner. The further you turn the lens ring, the further you move each lens off center, and the more the light is deflected sideways. Notice I keep emphasizing that the light beam is moved sideways, tangential to the concentric rings; this is an important point to keep in mind, as the final result doesn't look like that! Instead, as these 37 beams angle sideways, your brain tells you that they are angling outwards, radially, and increasing the zoom angle of the unit. Indeed, that is the overall result, and it's only if you follow a single beam that you realize the direction in which it is really moving! One minor limitation of the system is that, when the lenses are moved back closer to the light pipes, the lens ring cannot be rotated very much; otherwise, it would shear off all the light pipes as it turned. Thus the rotate effect is only possible at the narrower beam angles when the lens ring is forward and the light pipes are clear of the back of it. At the wide end, the small amount of rotation possible provides a slightly enhanced maximum zoom.

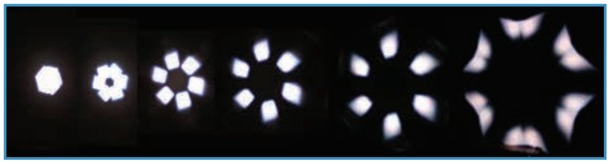

Fig. 9: B-Eye effect.

Figure 9 shows a montage of photographs of the output from just the inner, six-LED ring as the lens ring is rotated. On the left, the lenses are aligned centrally above the light pipes and the beam passes straight through without sideways deflection. As the lens ring is progressively turned so, the deflection of each of the six beams increases, which separates them farther and farther apart. Note that this off-axis projection also distorts the shape of the projected beams somewhat. Finally, on the right side of Figure 9, you see the lenses rotated to a position that's exactly halfway between the adjacent light pipes. Now each lens can see two light pipes and you get two images from each light pipe, one through each of two lenses. If we continued to turn, we would see the pattern reverse, as the next lens moves across the light pipe, finally ending up centered again. With the six-LED ring, this cycle of in and out will repeat six times in a full rotation of the ring. Similarly, it will repeat 12 times for the middle ring and 18 times for the outer ring. This result is that each circle of light beams moves in and out in the 3:2:1 ratio of the rings. As these beams are tight and narrow, the result is an elegant gavotte of the 37 beams.

It isn't really a true zoom effect, because each individual light beam doesn't change in beam angle, but the overall envelope of beams does zoom. It took me some time to get my head around what was going on here, so taking some time to experiment with the B-EYE K20 if you are going to use them is essential. Clay Paky has provided a large number of pre-programmed macros on a DMX channel to help get you started with picking good combinations of LEDs, zoom, and lens rotation, and I recommend trying those out to get a feel for what is possible. Figure 10 shows a sample of a macro in which emitter color and rotation are synchronized to create an effect.

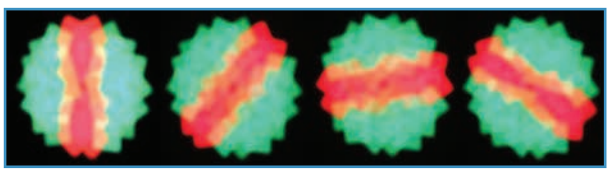

Fig. 10: Macro patterns.

I measured zoom as taking a minimum of one second to move from narrow to wide. The rotate function took 1.5 seconds to move from one static position to the next static position that produces the same effect (i.e. 60° apart), and it is capable of continuous rotation at speeds up to 7rpm.

Output

Now, back to more understandable and measurable concepts: I measured the output of the B-EYE K20 with all emitters running at full, when it was in wide (normal) zoom and the lenses were fully back, at just over 9,900 lumens with a field angle of 54°. Thermal droop was fairly small; I saw a drop to 93% of initial cold output over 15 minutes of running at full power, and output then stabilized.

Output at the narrow angle end of the range is difficult to measure; the individual beams start to separate, and to get out of the near field into the far field area where the inverse square law works correctly would require a longer throw than I have available. Probably 50' would be necessary. The beam angle is measurable at between 5° and 7.5°, varying with the rotational position of the front lenses; I estimate the total output to be about 50% of that in wide angle.

The B-EYE K20 allows the setting of the color temperature of white light output; this table shows the reduction of light output at each color temperature and the actual measured color temperature versus the setting. The lower color temperatures were very close to their rated levels, while the higher ones were a little too high. (I measured these with a spectrometer. Don't waste your time with a tri-stimulus color meter; they are useless for LEDs.)

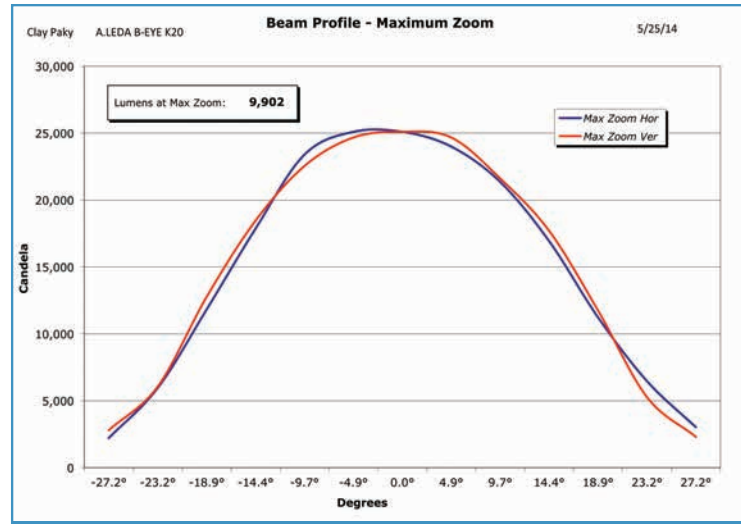

Fig. 11: Beam profile - max.

SETTING	OUTPUT	MEASURED CCT	CRI	CQS
All emitters	100%	12,177K	75	86
2,500K	43%	2,530K	19	55
3,200K	57%	3,268K	41	68
4,000K	76%	4,152K	57	78
5,000K	84%	5,376K	60	79
5,600K	89%	6,209K	62	80
6,000K	93%	6,618K	64	81
7,000K	97%	8,297K	67	83
8,000K	97%	9,522K	70	84
White only	54%	7,866K	76	74

Dimming

Figure 12 shows the dimming curve of the B-EYE K20, when set to its default setting. It also offers a number of other dimmer curves, as well as options for incandescent lamp emulation where the dimming time is slowed to match the time taken by an incandescent lamp to warm up and cool down. I measured possible strobe rates from 1 - 25Hz. Dimming with 16-bit fading was, as you would expect, very smooth. There was minimal color shift while dimming, with a slight shift towards green over the bottom few percent. I measured the PWM frequency at 1.15kHz split across two phases on different emitters, effectively 2.3kHz.

Color

Color mixing is as you would expect from a familiar RGBW LED system. I measured the wavelengths of the emitters at blue 450nm, green 523nm, and red 645nm. The colors are chosen for effect, rather than pastels, thus the blue is quite deep and doesn't read well on a light meter. To the eye, the output appearance of the blue is much better than these figures suggest.

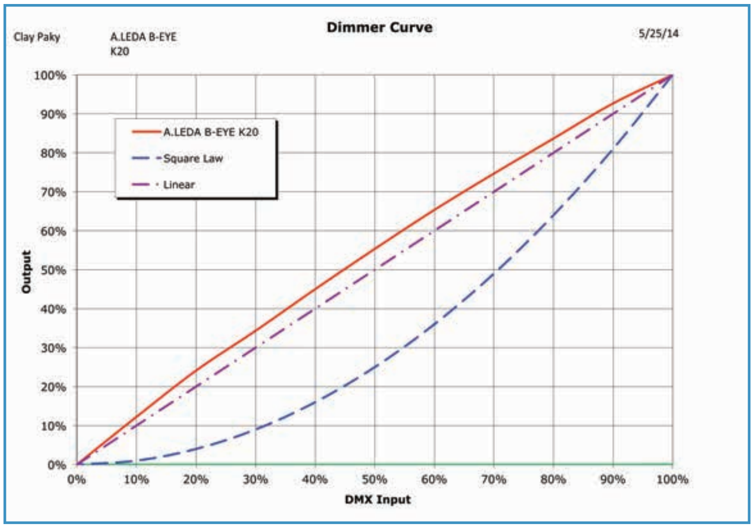

Fig. 12: Dimmer curve.

COLOR MIXING							
Color	Red	Green	Blue	Cyan	Magenta	Yellow	White
Transmission	17%	45%	4.8%	47%	18%	57%	54%

Pan and tilt

The B-EYE K20 has full pan and tilt ranges of 540° and 207°, respectively. I measured pan speed over the full 540° at three seconds and 1.8 seconds for 180°. In tilt, the figures were 1.6 seconds for 207° and 1.5 seconds for 180°. Both pan and tilt have optical encoders to reposition the fixture if it is knocked out of place. I measured hysteresis, or repeatability, at 0.25° for pan and 0.12° for tilt, which is about 1" and 0.5" respectively at a 20' throw (44mm and 22mm at 10m). Movement was smooth and clean, with no objectionable wobble or overshoot.

Noise

The cooling fan provides the predominant constant noise from the B-EYE K20. Zoom rotate was the noisiest moving element with some noticeable resonances at some speeds.

SOUND LEVELS	
Ambient	<35 dBA at 1m
Stationary	44.5 dBA at 1m
Homing/Initialization	49.3 dBA at 1m
Pan	46.5 dBA at 1m
Tilt	46.1 dBA at 1m
Zoom	45.4 dBA at 1m
Zoom Rotate	47.5 dBA at 1m

Homing/initialization time

The B-EYE K20 took 64 seconds to complete a full initialization from first powering up, and 55 seconds to perform a system reset while running. The unit was well-behaved on reset with slow fades in and out of the LEDs before and after all movement.

Power, electronics, and control

In operation on a nominal 115V 60Hz supply, the unit consumed 5.3A when stationary at full output with all emitters on. This equated to a power consumption of 622W with a power factor of 0.98.

Figure 13 shows the yoke arm that contains the drivers and control for the pan-and-tilt motors. (The pan motor is visible at the bottom of the photograph). It looks like Clay Paky uses a separate slave processor for this system. This makes sense, it can likely be used on a range of different products. We've already looked at LED drivers in the head, so the only other circuitry is the main input system. This is in the top box and provides DMX512 and Ethernet connectivity to the rest of the system as well as driving the LCD display and menu system (Figures 14 and 15). As with other recent Clay Paky products the menu system has a battery, allowing operation before the unit is powered up.

Fig. 13: Yoke arm.

The products offer various options of level of control. You can either (as I did) choose a lower channel count, which gives you access to global colors from the emitters plus a large range of macros that use individual colored beams, or, if you have the channel space available and the time to program, you can opt for total individual control of every LED and pixel-map the unit.

Fig. 14: Input electronics.

Fig. 15: Menu.

Fig. 16: Connectors.

Fig. 17: Power supply.

The connector panel is familiar (Figure 16) and offers five-pin DMX-512 XLRs and three-pin XLR connectors, as well as power via Powercon and Ethernet on an Ethercon. The final element in the top box is the power supply (Figure 17).

Construction and serviceability

Clay Paky expects you to take the head apart to clean the lenses, and gives instructions in the manual on how to do it, which I did to take the photographs you see here. Like many LED-based units, it and the circuit boards are probably about the only components that are designed to be user-serviceable. Construction is clean and tidy. I also have a more general comment about construction that applies not only to the B-EYE K20, but also to many other units I've seen recently. I'm seeing a generally much-improved tooling level in automated lights. Instead of fabricated parts, there are many more fully tooled or molded components. I'm very happy to see this, as fully tooled parts usually lead to higher reliability and consistency. I'm not sure that increased sales volume is the reason; instead, I suspect the availability of less-expensive tooling. Whatever the reason, it's a good thing and the B-EYE K20 demonstrates it well.

That's about it for the Clay Paky A.LEDA B-EYE K20; as I said at the beginning, it's exciting to see manufacturers start to explore the new results they can get with solid-state lighting. But don't take my word for it; if this data sounds interesting then try it out for yourself.

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