Philips Vari-Lite VL4000 Spot

By: Mike Wood

It was almost like old times when the delivery truck containing the Philips Vari-Lite VL4000 Spot Luminaire showed up. No namby-pamby LEDs; instead, a large road case containing Vari-Lite's latest offering was wheeled (not carried) up to the workshop door. That's not to say that the VL4000 Spot is old-fashioned; far from it. This is the latest offering from what is perhaps the best-known brand name in automated lighting. The VL4000 Spot is clearly intended as the new flagship spot product for Philips Vari-Lite, containing as it does a very wide range of color and beam effects, including framing shutters, all driven by a short-arc 1,200W HID lamp. Vari-Lite has crammed a lot into this 83lb (38kg) package, in particular an impressively specified multi-element zoom lens system and some complex mechanics, but more of that later. Vari-Lite may be the best-known brand, but the world of automated lighting is a very competitive place these days, so how does the VL4000 Spot perform? As always, I've tried to test and measure everything I can, from power input to light output, reporting the raw data so you have information to help make your own determination.

Figure 1: As tested.

The results presented here are based on the testing, with the fixture operating on a nominal 230V 60Hz supply, of a single VL4000 Spot unit supplied to me by Philips (Figure 1).

Lamp and lamp access

The VL4000 Spot uses the now-very-familiar Philips MSR Gold 1200 FastFit lamp. It has a rated nominal output of 95,000lm at 1,200W from its 5.5mm arc (Figure 2). Interestingly however, Philips Vari-Lite offers two modes of operation for the lamp, Standard and Studio; Standard mode runs the lamp at a higher 1,400W, thus producing more output. You might think this is overrunning the lamp, but it isn't really. If you ran an incandescent lamp at 17% higher than its rated power, you would clearly have a significant problem with lamp life. However, the same isn't true of an HID lamp. As long as you keep the lamp envelope within its correct operating temperature range, then there is much more leeway to change the operating power without adversely affecting the life. Accurate temperature control is the key.

Fig. 2: Lamp change.

The MSR Gold 1200 uses the Fast-Fit lamp base, which allows an easy lamp change from the rear of the unit through the reflector without having to remove any major parts (just a small rear cover).

The lamp is enclosed in a separately ventilated lamphouse structure, capped with the usual hot mirror. This entire structure is cooled by a large tangential fan pressurizing the lamphouse and venting out the rear of the unit. Figure 3 shows the fan and main lamphouse air vent. It's a little unusual to see a large tangential fan used in this application, but it is a good choice; it is very efficient and produces relatively low noise levels for the volume of air it moves.

Fig. 3: Lamp cooling

The VL4000 Spot optical train consists of three main structural blocks—dimming and color control, beam modifiers, and lenses—the center one of which, beam modifiers, moves back and forwards to provide focus control. We'll go through these block by block.

Dimmer and strobe shutters

The dimming and strobe systems are mounted immediately after the hot mirror. The dimmer is a simple patterned glass system that you might expect would cause uneven dimming, but there's an homogenizing field lens further downstream which helps to provide smooth dimming, flat across the field. The dimmer curve was a little too steep at the top end for my liking (Figure 3), but is similar to that of the VL880 and may be the way Vari-Lite likes it. The design of the strobe blades is very simple—effectively, flat blades with concave edges forming a rough iris across the beam. In strobe mode, the VL4000 Spot provided a measured range of crisp strobe speeds from 0.5Hz up to 10.6Hz.

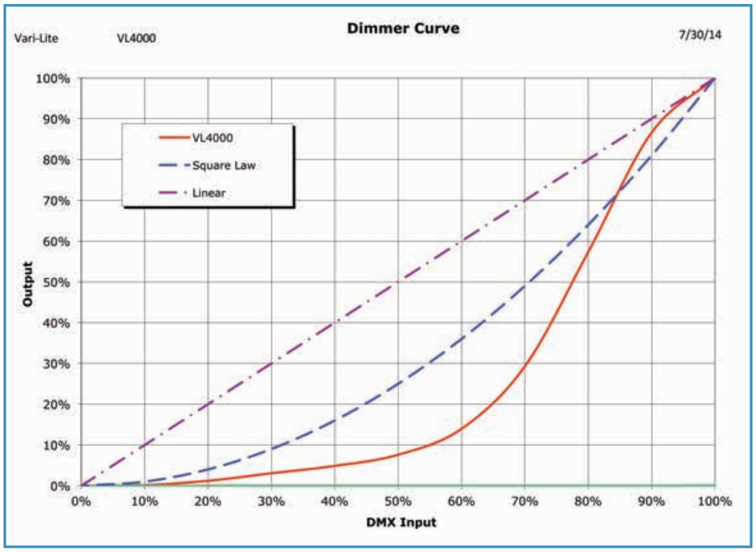

Fig. 4: Dimmer law.

Color systems

The VL4000 Spot provides both color wheel and color-mixing systems. First in line are the color-mixing filters. These are arranged as four sets (cyan, magenta, yellow, and CTO) of two etched dichroic filters, each of which run on their own linear track and open and close across the beam like a pair of curtains. We are still before the homogenizing field lens in the optical train, which helps enormously in smoothing out the colors across the field and removing the moiré effects you sometimes see with this kind of system. That being said, I did see distinct colored edges in some positions, particularly from the yellow filter. Philips Vari-Lite has chosen quite a dark yellow, which tends to overpower the paler cyan when trying to mix aquas and gives those colors somewhat green edges. The other two pastel mixed colors

Fig. 5: Color mixing.

that are always tricky for dichroic color mixing systems, lavender (magenta plus cyan) and amber (magenta plus yellow), were much cleaner. I think I'd use the fixed color wheel in preference to the color mixing to make aquas with the VL4000 Spot (Figure 5).

COLOR MIXING

Color	Cyan	Magenta	Yellow	Red	Green	Blue
Transmission	19%	10%	65%	8.5%	2.4%	1.2%
Color change speed – worst case				0.2 sec		

The CTO wheel smoothly adjusted the color temperature from the native, unfiltered 6,140K down to 2,822K.

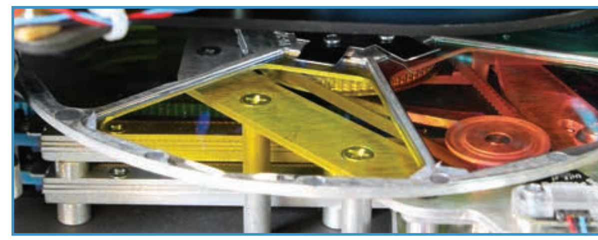

Fig. 6: Color wheel.

Immediately after the color mix system are the two fixed color wheels (Figure 6). Each contains five trapezoidal dichroic filters and an open slot. As can be seen in the photograph, the colors look to be interchangeable, but also have two blobs of silicone adhesive in the corners to keep them in place, so I didn't try to remove them. The aluminum spokes between colors are very narrow and produced excellent half colors with no gap. The two wheels contain colors that are either more saturated (such as reds, ambers, and blues) or difficult to mix well (such as Kelly Green) than those available on the color-mixing system.

COLOR WHEEL 1

Color	Red	Fuchsia	Orange	Kelly Green	Congo Blue
Transmission	2.1%	2.5%	9%	14%	0.2%

COLOR WHEEL 2

Color	Blue	Green	Minus Green	Lavender	Amber
Transmission	1.0%	45%	88%	10%	18%

COLOR WHEEL SPEED

Color change speed – adjacent	0.2 sec
Color change speed – worst case	0.4 sec
Maximum wheel spin speed	1.4 sec/rev = 43 rpm

These are quite large heavy filters, so the movement speed was a little slower than some other units, although still quite snappy. My test unit didn't have final shipping software, so didn't offer varying wheel rotation speed. Vari-Lite tells me that the shipping unit will, of course, have this.

Mounted between these two color wheels is the homogenizing field lens I've already mentioned. It looks to me as if this also acts as an aperture stop, further cleaning up the beam. Figure 7 shows this lens in place.

We now move into the beam modifier block, containing

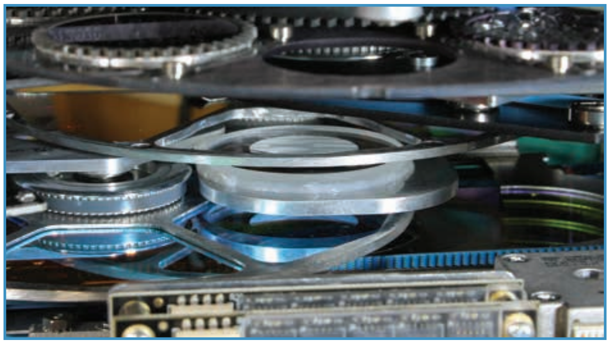

Fig. 7: Lens and field stop.

animation wheels, gobo wheels, iris, and framing shutters. This whole structure is mounted on tracks and lead screws and is moved backwards and forwards along the optical path to allow the lens system to focus on the desired element. Philips Vari-Lite calls this function “edge” as opposed to the more normal name “focus.”

Animation wheels

The VL4000 Spot provides two separate replaceable animation wheels, each of which can be independently moved from out of the optical path across the beam. One wheel comes in from the left side of the beam, and the other from the right. Once in position across the beam, the wheels can be rotated and the position of the center of rotation can be moved through 90°. The first wheel can have its center of rotation anywhere from the top of the beam to the right side, while the second moves from the bottom also to the right side. When they are both positioned on the right side, the two wheels are concentric, which gives further effect possibilities.

Fig. 8: Animation wheels.

Figure 8 shows the two wheels (one black and white patterned and the other a multi-colored dichroic) superimposed in this manner. You wouldn’t normally use them in focus like this, but it’s a clearer way to illustrate them. It took approximately one second to insert or remove either of the wheels. Once in place, they can be rotated at speeds from a maximum of 0.84sec/rev (71rpm) down to an extremely slow speed that takes more than an hour to rotate fully.

Gobo wheels

The VL4000 Spot has two rotating gobo wheels, each of which has seven replaceable gobos (glass gobos only) and an open slot. Figure 9 shows a close-up of the first gobo wheel and the adjacent animation wheel. As has become the norm, the gobos themselves are mounted in carriers

Fig. 9: Gobo wheel and animation wheel.

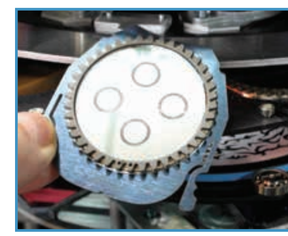

Fig. 10: Gobo change.

that are easily removed and replaced into the wheel assembly. Figure 10 shows a carrier with gobo ready to be inserted back into the wheel. One new feature on the VL4000 Spot is the provision of alignment marks that allow you to get a gobo back in exactly the same rotational position as when you removed it. It isn't often that this is a problem, but it's good that there is a solution in case the need arises. Figure 11 shows the system for alignment: You have to rotate the central gear until the gear tooth marked with a machined

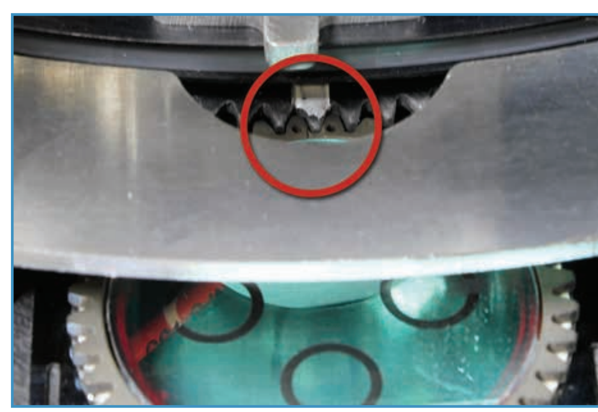

Figure 11: Gobo alignment marks.

slot is in the center of the gobo aperture you are replacing. You then line up the two holes on the gobo carrier with that silver slot as you insert it. I've highlighted the alignment marks in a red circle in Figure 11 to make it clearer. It takes longer to describe than to do; it's a fairly simple, although somewhat fiddly, process.

ROTATING GOBO SPEEDS

Gobo change speed – adjacent	0.3 sec
Gobo change speed – worst case	0.9 sec
Maximum gobo spin speed	3.7 sec/rev = 16 rpm
Minimum gobo spin speed	616 sec/rev = 0.1 rpm
Maximum wheel spin speed	1.4 sec/rev = 43 rpm
Minimum wheel spin speed	1440 sec/rev = 0.04 rpm

Positioning and rotation were both smooth with a good range of rotation speeds. Movement was clean when changing direction with acceptable hysteresis. I measured the accuracy at 0.25° of hysteresis error, which equates to 1.1" at a throw of 20' (45mm at 10m). All wheels use a quick-path algorithm to minimize change times.

Fig. 12: Gobo focus.

Figure 12 shows the typical focus (edge) quality achievable with very acceptable edge to center difference and color fringing. Figure 13 shows the effect of pulling focus (adjusting edge, in Vari-Lite speak) from one gobo wheel to the other (Figures 12 and 13).

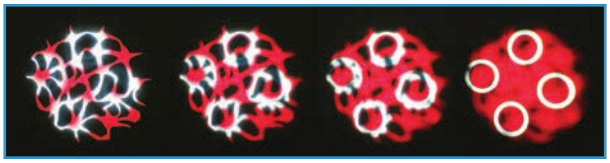

Fig. 13: Gobo morph.

Framing shutters

Next in our beam modifier block are the four blade-framing shutters. The four orthogonal blades are mounted in two opposing pairs, each pair running in a single slot for focus. Each blade has two thin stepper motors (Figure 14), one on

Fig. 14: Framing motors.

each of the lower edges. This system allows each blade to travel almost to the center of the aperture (no overlap is achievable from opposing blades) with a maximum useful tilt angle range for each blade of approximately 20° either side of center. (The blades can tilt slightly further than this to approximately 27°, but if you do so the corner of the blade comes into view). In addition, the entire framing system can be rotated 50° in either direction. Each blade can be moved through its full travel in 0.5 seconds. Focus quality on the blades was good, but, as with many other automated lights using similar fast optical systems, there is inevitably some focus difference between the shutter and gobos. However, at narrower angles it is possible to get a reasonable focus match between gobo wheel two and the

shutter blades. At the wider beam angles, optical aberrations mean that the image of the straight shutter blades gets somewhat curved.

Iris

The last focusable component is the iris. The fully closed iris reduces the aperture size to 23% of its full size, which gives equivalent field angles of 2.3° at minimum zoom and 10.4° at maximum zoom. I measured the opening/closing time at around 0.2 seconds.

Frost and prism

We now move into the final optical block of the VL4000 Spot, which comprises lenses, frost, and prism. This is a mechanically complex structure using four primary lens groups. Numbering from the back (closest to the iris), the first and third lens groups move to provide zoom, while the second and fourth, final output, lens groups are fixed. The real complexity comes in when you consider the frost and prism arms. These are both mounted on lead screws and can track forward and backwards with the lenses. Depending on the current zoom setting—and thus the positions of the four lens groups—when you issue the command to position the frost or prism across the beam, they will either be inserted between lens groups two and three, or between groups three and four. Once in place, they will move with the lenses as zoom is altered. This flexibility gives good results for the prism in particular, but it also leads to two natural consequences that you can treat as features or foibles, as you prefer. Firstly, once the frost or prism is inserted, the zoom range is reduced; the extra component in the optical path inevitably limits the travel of the lens groups. Secondly, and somewhat non-obviously, if you want to adjust zoom and insert the prism (or frost) in the same cue, it makes a difference whether you insert the prism before you zoom, or first zoom, then insert, the prism. One choice might result in the prism being inserted between lens groups two and three, while the other could result in the prism being inserted between lens groups three and four. Once the prism is inserted, it won't move to the other slot unless it is removed fully from the beam, so the zoom position chosen during insertion will affect the potential range for the zoom until the prism is removed again. This is something that is very hard to describe in words, but you will need to spend some time experimenting with the interaction between frost/prism and zoom to get the best from the system.

The prism is a single three-facet unit that can be inserted or removed in approximately 1.1 seconds and, once inserted, can be rotated at speeds ranging from glacially slow up to 1 sec/rev (60pm). The image separation from the prism is reasonable, and focus quality is maintained well. Interestingly, the VL4000 Spot offers an extra DMX channel

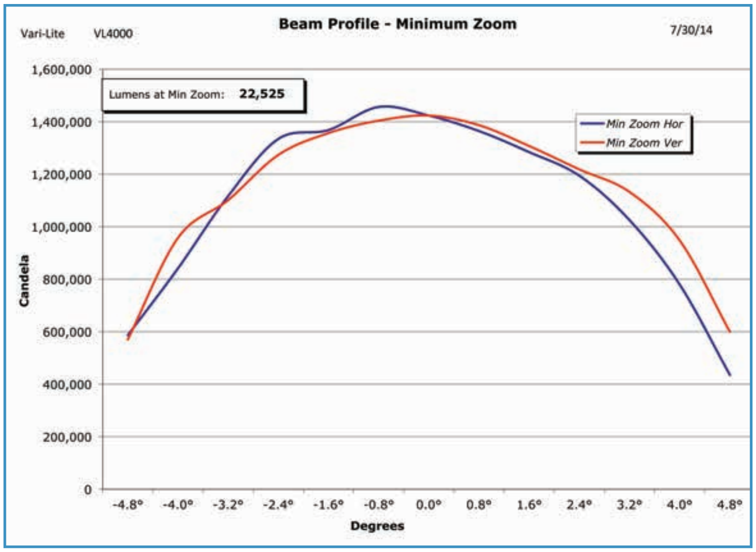

Fig. 15: Minimum beam profile.

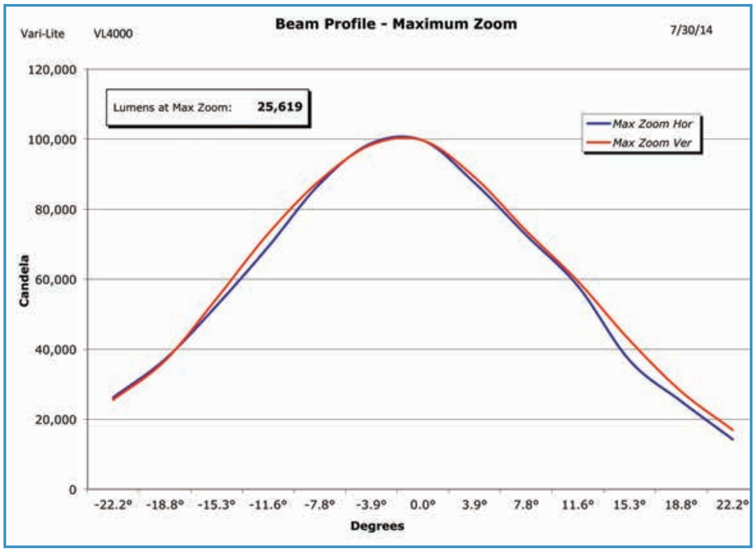

Fig. 16: Maximum beam profile.

called "Divergence," which allows you to alter the separation of the three images without changing the overall zoom. It does this by altering the relative positions of the prism and lens groups one and three.

The frost flag is similar and provides a variable wash type of frost rather than an edge softening. Frost insertion or removal took 1.2 seconds. The insertion and removal times for both prism and frost are quite long, because of the complexity of the system having to move the selected flag to the correct point forwards and backwards to find the gap between the chosen lens groups. You couldn't therefore use the frost as a strobe effect.

Lenses and output

We've already discussed the four final lens groups. These, taken with the prior field lens mounted in the color system, provide a 12-element, five-group optical system. I measured zoom as taking 1.1 seconds to move end-to-end, while focus (which is really the movement of the entire center section containing gobos and framing, not just a couple of lenses) took 2.6 seconds.

I measured the optical system in the VL4000 Spot as providing a nearly 5:1 range of zoom with field angles ranging from 9.7° — 44.5°. The output for an open beam in sharp focus at the widest zoom angle in Standard lamp mode was 25,600 field lumens, ramping down to 22,500 field lumens at the narrow angle end. In Studio mode, where the lamp power is reduced, these figures dropped by 18%. Figures 15 and 16 show the output curves.

Pan and tilt

The pan and tilt range of the VL4000 Spot are 540° and 270°, respectively. A full-range 540° pan move took six seconds to complete, while a more typical 180° move finished in four seconds. Tilt took 3.8 seconds for a full 270° move and 3.5 seconds for 180°. All movements were good and smooth, with no visible steppiness. I measured hysteresis on pan at 0.15°, equivalent to 0.6" at 20', while tilt hysteresis was 0.1°, equivalent to 0.4" at 20'. Both axes have optical encoders to reset position if the unit is knocked.

Noise

In Standard lamp mode, the lamp-cooling fan provides the background noise level with most motor functions quieter than the fan noise. Focus (edge) was the noisiest movement function.

SOUND LEVELS

	Normal Mode
Ambient	<35 dBA at 1m
Stationary	52.9 dBA at 1m
Homing/Initialization	59.4 dBA at 1m
Pan	53.5 dBA at 1m
Tilt	54.1 dBA at 1m
Color	52.9 dBA at 1m
Gobo	52.9 dBA at 1m
Gobo rotate	52.9 dBA at 1m
Zoom	53.5 dBA at 1m
Focus	54.6 dBA at 1m
Strobe	52.9 dBA at 1m
Animation wheel	52.9 dBA at 1m
Iris	52.9 dBA at 1m
Frost	52.9 dBA at 1m
Prism	52.9 dBA at 1m

Switching the lamp to Studio mode made a very significant difference to these figures, with the stationary noise level dropping over 9dB from 52.9dBA — 43.5dBA.

Electrical parameters and homing/initialization time

I measured power consumption in Standard lamp mode at 7.7A from a 233.5V 60Hz supply; that's equivalent to just under 1,800W. Full initialization took quite a long time, at around 112 seconds from either a cold start or a DMX512 reset command. However, quicker options, where just some functions are reset, are available through the control channel. Homing is very well behaved in that the fixture fades out smoothly, resets, and keeps its shutter closed before fading up again after all reset movement is finished.

Construction

The VL4000 Spot is somewhat modular in its construction, with the various optical components removable after connectors and wiring are removed. Figure 17 shows a view of the main head with the major optical components in view. Head covers are quickly and easily removable, with reasonable access to change gobos. The yoke mechanics are solid, with both pan and tilt fitted with manual locking systems accessible from either side of the unit for transportation.

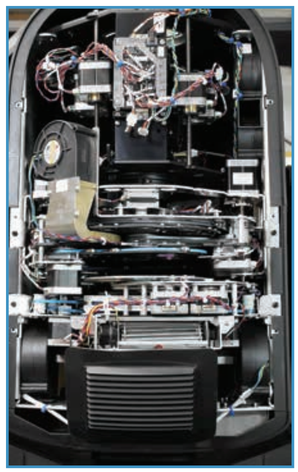

Fig. 17: Head side view.

Electronics and control

As is the norm these days, the motor drive electronics are distributed throughout the luminaire, with all sharing a common data bus. Figure 18 shows one of the many identical five-channel motor driver and sensor boards in the VL4000 Spot; the DIP switches (circled in red on the figure) address

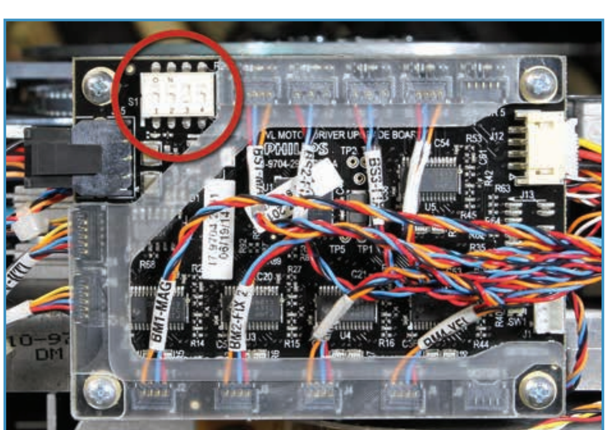

Fig. 18: Modular driver board.

Fig. 19: Yoke with tilt.

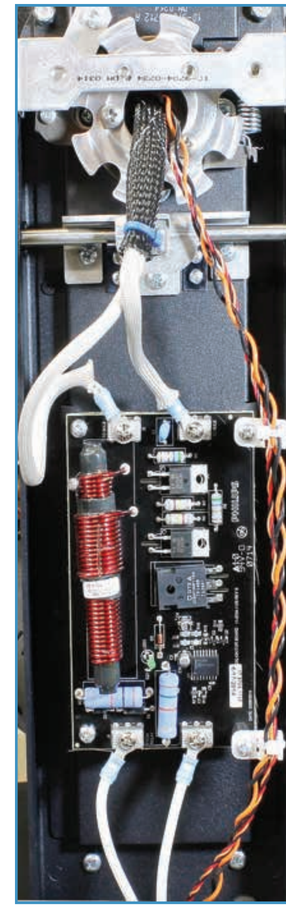

Fig. 20: Yoke with ignitor.

Fig. 21: Top box.

the different boards, depending on their specific function. The one exception in the head is the framing system, which has its own dedicated motor driver and sensor board as part of the framing assembly.

The yoke arms contain the larger, more powerful, pan-and-tilt drivers and the lamp ignitor (Figures 19 and 20) while the top box holds the communication and main control electronics along with lamp and motor power supplies (Figure 21).

The VL4000 Spot has a large color LCD panel providing

Fig. 22: Menu.

access to the comprehensive menu and setup system using a conventional six-button control panel. This system is battery-powered for operation when the unit is in the road case (Figure 22). Finally, the connector panel contains the new-style Neutrik powerCON True1 for power input along with standard five-pin DMX512 connections and a USB socket for diagnostic and service access (Figure 23). Philips tells me that the shipping version of the product will

Fig. 23: Connectors.

have RDM capability; unfortunately, the version I had did not have this enabled, so I was unable to test functionality.

Well, there you have it; the Philips Vari-Lite VL4000 Spot. It's clearly a complex unit with many features and a comprehensive range of functions and good light output. Does it meet your needs or could it fill a slot in your next rig? I've tried to give you the raw facts and figures to help you make a decision, but ultimately, as always, it's you who gets to decide.

Mike Wood provides design, research and development, technical, and intellectual property consulting services to the entertainment technology industry. He can be contacted at mike@mikewoodconsulting.com.