BenQ W1700
UHD AV projector

BenQ's W1700 breaks the pricing paradigm for UHD projection with some very 'flash' new technology...

Four corners

SUMMARY

BenQ W1700
Price: $2499

+ True Ultra-HD resolution
+ Excellent value for money
+ Long lamp life
- Cadence issues due to 60 hertz lock

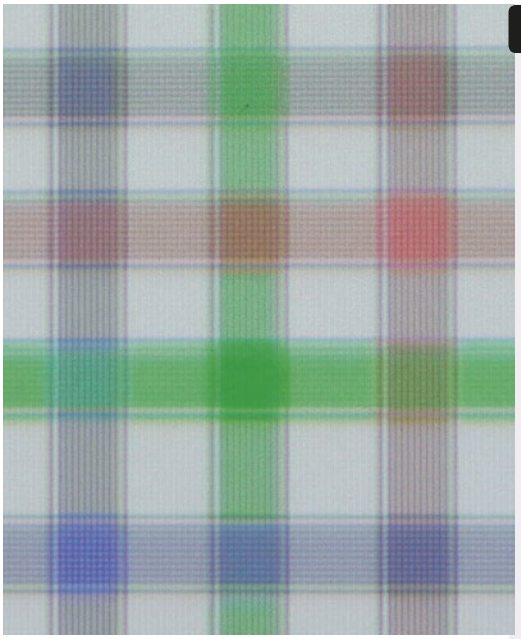
The disappointing thing about Ultra High Definition is how long it has taken to become available at a reasonable price in the application for which it provides the greatest benefit — the large front projection screen. Several companies have been nibbling at the edges of affordability, including BenQ with its W11000 Ultra-HD projector. But now it's jumped right in with the W1700, a projector which claims to deliver true Ultra-HD resolution. The price? Just $2499.

Equipment

This is a much smaller projector than the W11000 (or the X12000), and it weighs a modest 4.2kg. Inside it achieves the 3840 × 2160 pixel resolution of Ultra High Definition by means of pixel shifting a very small (0.47 inches, or just under 12mm) full-HD Digital Micromirror Panel to four different positions for each frame. Obviously that's something we'll be looking at very closely as we get further into the review.

A conventional 240-watt lamp powers the projector, but BenQ rates this one with a lamp life of at least 4000 hours. The low output mode bumps this up to 10,000 hours, and a 'LampSave' mode delivers, says BenQ, some 15,000 hours of life.

BenQ has also designed the projector to produce 96% coverage of the Rec.709 colour space, which is the standard high-definition colour specification. The contrast ratio is rated at 10,000:1 and the maximum brightness at 2200 lumens.



ABOVE: a detail from a photographic image of single-pixel lines in a UHD test pattern (see main copy), as displayed by the BenQ W1700. Note the lines are individually reproduced — not entirely cleanly, and not quite as brightly in colour at the pixel level as when they are reinforced by neighbours, but certainly pixel-for-pixel Ultra High Definition.

On DMDs, screen-door effects and creating 4K...

In the body of this review I indicated that the problem with much pixel shifting technology is that the pixels are just too big. If a pixel is shifted a half-pixel width to its right, most of its left side will overlap the position where it previously was, and most of its right side will overlap the pixel which was previously to its right. (The previous pixels are no longer being displayed, but the persistence of vision in your eyes will make it look like they are still there. DLP projectors do everything over time, rather than simultaneously, and can only work due to this property of human vision.)

Yet with this projector, as our test photo (left) shows, there is clearly resolution down to the UHD level, even if it's not all that clean. Let's try to explain this at the tech level.

The Digital Micromirror Device used in this projector appears to be the Texas Instruments DLP470TE, a 0.47-inch model with 1920 x 1080 resolution. It has a pixel pitch (the distance from an edge of one pixel to the equivalent edge on the next) of 5.4 micrometres, or thousandths of a metre. As it happens, this appears to be a 'cut down' version of the DLP660TE DMD, the 0.66-inch '4K' model, which also has a pixel pitch of 5.4µm. (It doesn't really have 4K's worth of pixels, but 2716 by 1528 pixels, which it displays twice.)

The DLP470TE chip is newly developed; indeed it isn't yet (as we write) fully listed on the site of the manufacturer Texas Instruments. But it shares its size with the 1080p DLP470LE, while TI's other 1080p DMD model is the DLP650NE, a 0.65-inch model with a pixel pitch of 7.6 micrometres, nearly 41% larger.

Which brings us to the 'screen door' effect. Since 1080p projectors appeared, this hasn't been much of an issue in home theatre. But with 720p and earlier, sometimes the grid pattern of the pixels would be visible, with thin black lines around each pixel. (The name came from the similarity with looking through fly wire.) These days the pixel density is so high one really can't see the inter-pixel boundaries unless unrealistically close to the screen.

Now consider what happens when you use a 0.47-inch DMD at 1080p instead of a 0.65-inch one. The pixels are smaller of course, but are the spaces between them smaller as well? Remember, a 1080p Digital Micromirror Device has on its surface more than two million tiny mirrors. They are slightly under 7.6µm wide for a 0.65-inch DMD, and slightly under 5.4µm wide for a 0.47 inch DMD. Are the gaps less wide? My guess is no, or almost no. Some clearance tolerance must be provided, and there's little reason to think the tolerances could be reduced. If a powerful enough lens were used to display the image at 1080p to the same size as with the larger DMD, it would likely have a more noticable screen-door effect.

That problem at 1080p lends it to effective use with pixel shifting, since it *reduces* overlap between standard and shifted pixels. The pixels are smaller, which is just what you want. ***SD***

There are two HDMI inputs on the projector, with one supporting HDCP2.2 and UHD signals, rendering it suitable for use with Ultra-HD Blu-ray players. It also supports High Dynamic Range (HDR) signals. The other HDMI input could be readily used for a Chromecast dongle or similar, since the projector also has a USB socket for providing power. It could also be used with BenQ's own wireless HDMI system.

There is no lens shift function here. There is automatic vertical keystone, which I'd recommend switching off so that you don't accidentally have it reducing your display resolution because of a slight departure from an exact level. There's a 1.2:1 zoom range. For a 100-inch screen, a range of between 3.25 metres and 3.9 metres is required.

The projector also has a built-in speaker with a 5W amp, though we would, of course, recommend enjoying your large-screen projection with a rather larger external sound system.

Performance

The first question to be answered, even before getting to the broader question of picture quality, is whether this projector actually delivers the resolution of Ultra High Definition. I confess I had my doubts. The problem with pixel shifting technology isn't anything to do with the general concept. Of course pixels can be shifted, and amazingly they can be shifted by such tiny amounts that they can be moved mere halves of pixel widths. The problem has been the size of the individual pixels. A 1080p panel would presumably use pixels large enough to almost entirely fill each pixel's space in the grid, otherwise the screen-door effect would be intolerable. Which means that each pixel, on being shifted, would be overlapping — by a long way — on top of what was supposed to be the UHD pixel next to it (see above).

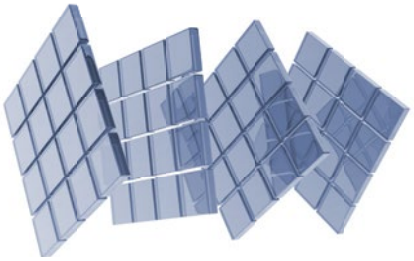
That was my concern, and it seemed to be largely the case with earlier 1080p pixel shifters we've looked at. There are ways of getting around that, of course. The first would be to make the pixels smaller so that they don't overlap as much, if at all. That would require the projector to be locked into UHD mode all the time in order to avoid that massive screen door effect. Possibly, as an alternative, the pixel-shifting tech could somehow focus the pixels down to tighter dots. Despite getting some information from Tecas Instruments (see overleaf) which makes the Digital Micromirror technology (see above) within this BenQ, we can't be certain exactly howthey have done it — but the fact is that this projector is indeed capable of resolving Ultra-HD resolutions to the screen. (The box above goes into this in wonderful, nerdy, depth.)

I confirmed this by using my standard UHD test pattern — coloured and black and white lines with one UHD pixel of separation sent to the projector. A photo of the centre part of the image, where the lines cross, is reproduced above. Each set of lines consists of ten lines, one pixel wide each, with a one-pixel-wide line between them. Then there's a two-pixel-wide white space to the sides of the ten, with a further coloured line outside of that. As you can see, they are all reproduced. Not cleanly, and not quite as brightly in colour at the pixel level as when they are reinforced by neighbours, but nonetheless, there they are.

I took those photos with the projector in the default 'User 1' picture mode. After watching a little, I found it useful to advance the overall colour saturation by a few notches because the picture seemed to lack some richness. That fixed things nicely, bringing to the picture a colour intensity that seemed to enhance clarity.

I had, after all, come to this projector after spending some weeks with a 65-inch OLED TV. Getting the colour up was essential.

Also by comparison, the black levels were rather brighter than the infinite black available from OLED. This projector is not in the top rank for projectors of deep blacks. But it



was able to produce them deeply enough to achieve the all-important effect of being subjectively convincing, especially when absorbed in the program, rather than seeking to examine the technical aspects of picture delivery.

I general I prefer to run projectors at one of the eco lamp settings, but with this one I found it better to stick with 'Normal'. That allowed highlights to really punch out of black backgrounds in certain scenes, albeit at the slight loss of some dark picture detail.

As it happens, I've been systematically going through the Harry Potter movies in order. I'd watched the first six on 65-inch OLED, and the seventh on this projector. It is a visually dark movie in many parts, and once or twice there was indeed a loss of low light detail. But apart from those couple of high contrast moments, the black levels did not detract from enjoyment.

Which raised the question as to which was better for watching a Harry Potter movie on Ultra HD, this projector or a $7K 65-inch OLED? There were pros and cons both ways. Yes, colour and blacks were obviously better on the OLED. But what it could not deliver was a scale to match the DTS:X sound field produced by the movie. The sheer size of the picture became part of the experience with this projector.

I used the test pattern on a Sony Ultra-HD Blu-ray — dial 7669 on your remote when the main menu is displayed — and paid close attention to the last few chapters of this. These show calibrated grey-scale brightness levels for HDR. They go all the way up to 10,000 nits, something no home display can produce. All HDR capable displays map the various signal levels to what they consider to be suitable output levels to achieve the best effect. For example, if the display tops out at 1000 nits the display may be designed to map, say, 1500 nits to the maximum output. Everything above 1500 nits is crushed down to that. The levels below 1500 nits are then scaled appropriately between full black and the maximum.

With this projector the continuous black-to-white grey scale at the bottom of the screen showed no visible steps, just a perfectly smooth graduation in brightness. The marked levels on the larger stepped patterns showed a barely perceptible difference between 800 and 900 nits, with a 1000 and above all matching 900 nits. At the other end of the scale, I could not distinguish between 0.000, 0.001 and 0.005 nits, but the next step to 0.010 nits was visible.

How about performance with lesser material? The projector did a very good job of delivering full-HD material with a sharpness and clarity that didn't disappoint by comparison with Ultra HD. Even my old DVD test clips seemed surprisingly watchable, thanks to the resolution enhancement provided by the projector. It manages to pull this off with little in the way of ghosting, so it remained watchable.

But the same problem that afflicted the X12000 and W11000 projector remained: the internal display engine is locking in a 60 hertz display sequence. I found myself quite sensitive to the resulting cadence issues. The A B C D frame sequence of 24p movies was converted to A A B B B C C D D D, producing marked judder in just about all camera pans, and sometimes even in the movement of characters across the screen. This was somewhat more marked with 50 hertz material, such as HDTV, SDTV and Australian DVDs. For those, it seems that every fifth frame was repeated to turn 50 into 60. So judder abounded.

That was offset a little by significantly improved 576i/50 and 1080i/50 deinterlacing. The auto film/video detection was not perfect, but acceptable, with normal material being competently handled, and about half of my trickiest film clips properly handled.

Conclusion

So there you have it. BenQ has managed to produce a full resolution Ultra-HD projector for just $2499. It's a projector that is able to deliver the scale that really makes Ultra HD worthwhile. ⊣ *Stephen Dawson*

SPECS

BenQ W1700 $2499

Projection technology: 12mm FHD Digital Micromirror Device with 4x pixel shifting technology

Resolution: 3840 by 2160 pixels

Aspect ratio: 16:9

Lamp: 240 watts

Lamp life: Normal 4000 hrs, Economic 10,000 hrs, SmartEco 8000 hours, LampSave 15,000 hrs

Contrast ratio: 10000:1

Brightness: 2200 ANSI Lumens

Inputs: 2 x HDMI (1 with UHD support), 1 x D-SUB15, stereo audio (3.5mm)

Outputs: stereo audio (3.5mm)

Other: 1 x RS-232C, 1 x USB-B (1.5 amp power), 1 x USB Mini-B (firmware upgrades), 1 x 12 volt trigger

Dimensions (whd): 353mm x 135mm x 272mm

Weight: 4.2kg

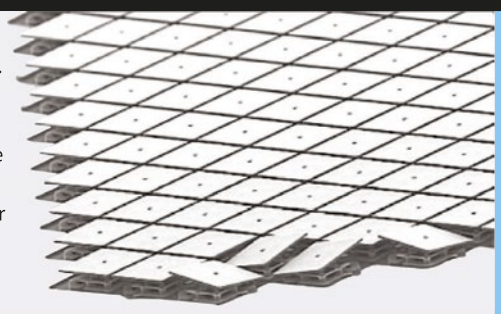
Warranty: Two years on-site pick up and return (Lamp: the earlier of 6 months or 750 hours use)

Contact: BenQ Australia

Telephone: 1300 130 336

Web: www.benq.com.au

FLASH FORMATIONS: a brief conversation with Texas Instruments



It sounds easy enough — use four flashes of 1920 x 1080 to make the UHD resolution of 3840 x 2160. The numbers are easy. But the geometry is less obvious. After significant debate between author and Editor over the possible implementations, we came up with three potential answers.

The first is the simplest. The DMD could deliver 1920 x 1080 to four entirely separate quarters of the screen. But this would require moving the entire DMD around significant angles, and might also create borders or potential time-smearing as the separate sections appeared. So unlikely.

Second: the pixels on the DMDs might occupy only a quarter of the micromirror area, so they can be shifted half a mirror in each direction to deliver four adjacent pixels. But this would make the pixels tiny, potentially affecting brightness.

Or third, full-size pixels (filling most of each micromirror) are delivered to four separate positions that overlap. This would seem to require image processing of each frame prior to delivery (to calculate and negate the effects of overlapping), but then this geometry is the only way to make sense of previous DMDs which doubled 2716 x 1528 to make 4K.

We contacted Texas Instruments, creators of the miraculous DMD chips. "*The DLP470TE and DLP470TP 4K UHD chipsets display four pixels on the screen per micromirror*", they said, and when we asked for further clarification, they replied that: "*The DLP470TE uses a 1920x1080 array of micromirrors, which switch on the order of microseconds, to create four distinct addressable pixels on the screen during every frame to deliver full 4K UHD resolution... The complete set of pixels are oversampled and processed by unique TI image processing algorithms leading to a crisp, colorful & detailed full 8-megapixel 4K UHD display.*"

Can you confirm that the addressable pixel spaces overlap each other? Is the image processing required to predict the overlap effects?

"I appreciate your interest in how our newest 4K UHD technology works," replied our correspondent, "but the DLP image processing algorithms are proprietary and I'm afraid I can't go into any more detail."

But from that, together with a diagram from BenQ, we reckon it's option 3 — oversampling and pre-processing, then 240Hz flashing to four clockwise-adjacent positions, with overlaps. ***JF***