

# Choosing the correct pixel pitch for your application

White paper

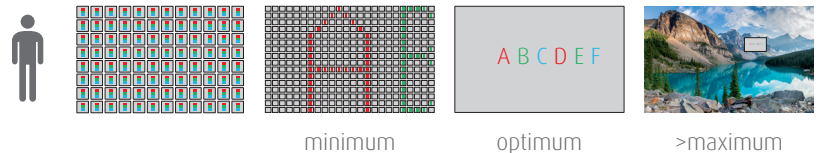
## 1 Definitions

**Minimum Viewing Distance (MVD)** – Relates to a single pixel. The minimum viewing distance is the distance at which all LED dyes in a single pixel merge into a single colored pixel.

**Optimal Viewing Distance (OVD)** – Relates to LED characteristics and pitch placement. The optimal viewing distance is the distance at which the viewer can no longer distinguish individual pixels.

**Maximum Reading Distance (MRD)** – Relates to pixel pitch. MRD is defined as the maximum distance at which the minimum character size is still readable. Since a character is at least 7 px in height, MRD is the subjective distance at which the human eye can distinguish letters.

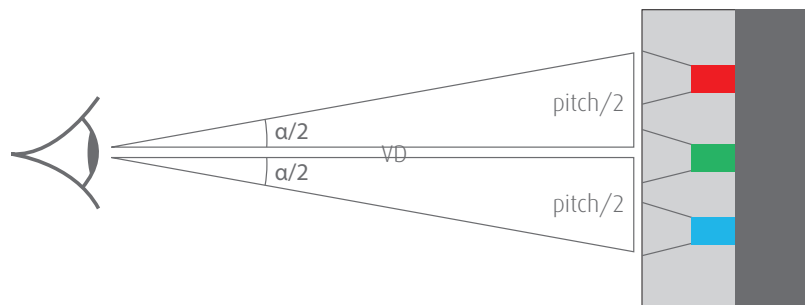
**Fill factor** – The fill factor of the LED itself is an often forgotten but important contributing factor in selecting the right product. The better the diffusion of the LED light within the LED, the better the fill factor. A better fill factor will positively impact all types of viewing distances.



## 2 Theoretical approach

### 2.1 Human Visual Acuity

The best possible human visual acuity is normally taken to be 0.6 arc minute (0.6/60th of a degree) for a typical viewer; an object can be perceived as long as it is larger than 1 arc minute. Observing pixelization, or seams, requires the human eye to see 2 pixels and the space between the 2 pixels: the point at which the colors of the three dyes of one LED merge so that a **uniform colored pixel** appears (MVD) / pixels start merging so that a uniform image appears (OVD). Human Visual Acuity for both MVD and OVD calculations is standardized at 2.4 arc minutes.



$$\text{Human Visual Acuity} = \alpha = 2 \text{ arc minutes} = \frac{2.4}{60^\circ} = 0.000698132 \text{ radians}$$

**BARCO**

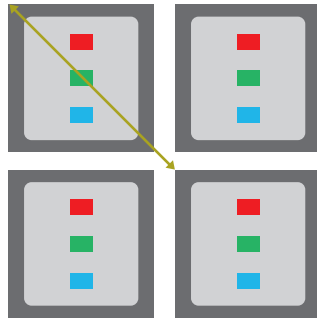
Visibly yours

## 2.2 Pitch

LED display manufacturers typically specify and name their product pixel pitch using the smallest measurement between 2 pixels on the stuffed LED board. For example, a product with Horizontal spacing of 1.67 mm and Vertical spacing of 1.89 mm will result in a commercial spec of 1.67 mm.

However, for the human eye, the largest spacing between the pixels must be taken into account – in all cases, the largest spacing is diagonal spacing:

E.g.



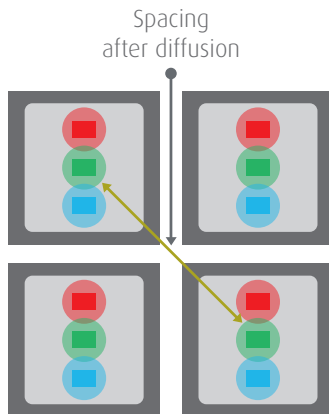
$$\text{Pitch} = \sqrt{(\text{Horizontal pitch}^2 + \text{Vertical pitch}^2)}$$

$$\text{Pitch} = \sqrt{(12 \text{ mm}^2 + 12.8 \text{ mm}^2)} = 17.55 \text{ mm}$$

## 2.3 Fill factor/diffusion

In addition to the obvious main characteristic – LED (dye) spacing – fill factor/diffusion of the LED's lens can have a big influence.

E.g.



$$\text{Diffused Pitch} = \sqrt{(\text{Horizontal pitch}^2 + \text{Vertical pitch}^2)} - \text{dye diffusion diameter}$$

$$\text{Diffused Pitch} = \sqrt{(12 \text{ mm}^2 + 12.8 \text{ mm}^2)} - 0.6 \text{ mm} = 16.95 \text{ mm}$$

## 2.4 Optimal Viewing Distance

$$\text{OVD (mm)} = \frac{\frac{\text{diffused pitch}}{2}}{\tan \frac{\alpha}{2}} \text{ Human Visual Acuity}$$

OVD of the 12 mm LED product **without** diffusion:

$$\text{OVD} = \frac{\frac{17.55 \text{ mm}}{2}}{\tan \frac{\alpha}{2}} = 25138.51 \text{ mm} = 25.14 \text{ m}$$

OVD of the 12 mm LED product **with** diffusion:

$$\text{OVD} = \frac{\frac{16.95 \text{ mm}}{2}}{\tan \frac{\alpha}{2}} = 24279 \text{ mm} = 24.28 \text{ m}$$

### 3 OVD in practice

The rule of thumb for defining the OVD of an LED product is **VERY** simple:

$$\text{OVD (in m)} = 2 * \text{commercial pitch (in mm)}$$

### 4 Conclusion

The human eye is not capable of perceiving resolution beyond the OVD. Because the cost of the LED/drivers on a product is about 75% of the BOM cost of a final product, and the LED density relates exponentially to the LED pitch, there is no justification for over-specifying the LED pitch.

When choosing the LED product and its pitch, it is crucial to know where the spectators will (most likely) be – as a pitch that is too high might also result in an unacceptable MRD. Furthermore, diffusion can help reduce the cost of a project substantially.

A reference list of Barco products and their respective OVDs:

Product	Commercial pitch	Diffused pitch	OVD
X1.6	1.66mm	2.35mm	3.36m
X1.9	1.92mm	2.72mm	3.89m
X2	2.77mm	3.92mm	5.61m
V4i	4.00mm	5.66mm	8.10m
V4e	4.50mm	6.36mm	9.12m
V6i	6.00mm	8.49mm	12.15m
R7	7.22mm	10.21mm	14.63m
C8s	8.33mm	11.78mm	16.87m
T8	8.33mm	11.78mm	16.87m
T10	10.00mm	14.14mm	20.26m
R10	10.83mm	15,32mm	21.94m
V16	16.00mm	22.63mm	32.41m