Quality Viewing Metric

Measuring the total image quality of your display technology

Published by Clarity's Product Marketing Department

In today's audio/visual industry, image quality for projection displays is defined by a myriad of individual performance specifications. These include screen brightness, lumen output of the projector, contrast ratio, etc. For the consumer, it can be difficult to make sense of how these all relate to the overall displayed image quality.

What would be helpful is a single, simple metric for evaluating image quality. Yet it should be noted that image quality is highly subjective. Therefore the ultimate test of any image quality metric is how well it correlates to *perceived* image quality.

Many display characteristics are interrelated in their contributions to perceived image quality. The human ability to resolve fine detail is influenced primarily by both the brightness and the contrast of the image. Thus, simply selecting the brightest display with the highest native resolution is not always the best choice for overall perceived image quality. While brightness is important to *capture attention*, contrast performance is most critical for *conveying information*.

In its ongoing research, Clarity has found a simple method for comparing display image quality. It is based on information widely specified by display manufacturers and exhibits a strong correlation to perceived image quality. This proposed metric, the Quality Viewing Metric (QVM), is the product of screen brightness multiplied by contrast in ambient light.

QVM = Brightness (FtL) x Contrast Ratio

(ie. 400:1 @ 40fc ambient light)

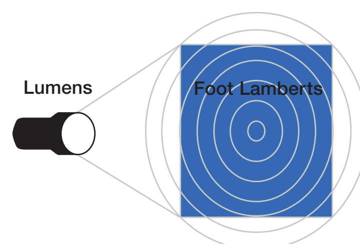
The building blocks of QVM

Contrast

Contrast ratio is continually gaining recognition as one of the most distinguishing characteristics used to differentiate display brands and technologies. And yet it is still often under-emphasized by industry consumers, even though it has a tremendous effect on perceived image quality. A high contrast ratio display accentuates both bright colors and dark lines or shadows. Poor contrast ratio usually means the system exhibits bright colors but a poor black level performance. This is characterized as either an inability to display dark enough blacks – resulting in "washed out" and "grayed out" images – or a loss of fine detail in the dark areas of the image. Poor contrast ratios will greatly diminish perceived image quality.

Brightness

Brightness is one of the most accepted determinants of perceived image quality in the industry. Clarity recognizes the importance of the brightness of the displayed image, as opposed to only the brightness of the optical engine inside. Brightness specifications measured in ANSI lumens provide the brightness of the *display engine*, yet neglect to specify the brightness of the *actual image* displayed on the screen. Although the displayed image brightness is related to the lumen output of the display engine, other factors such as the image size and screen characteristics also have an affect. The actual image brightness is measured in units of foot Lamberts (lumens/square foot), or nits (candelas/square meter). The QVM measurement specifically uses foot Lamberts (ftL) as a multiplier.



The brightness of a surface, measured in foot Lamberts, depends on many factors. Among these are the intensity of the light source (lumens), the distance from the source to the surface, and the reflectance properties of the surface.

Screen choice

The screen design converts raw lumens at the output of the projection lens into perceivable levels of brightness and contrast. Different screen options result in different combinations of brightness and contrast. Accordingly, different screens result in different QVM levels. For a detailed look at the advantages and disadvantages of different screen types, refer to the application note "Rear Projection Screen Technology: Optimizing Your Display Performance".[1]

Ambient light

Incorporating the effects of ambient light on the contrast ratio of the displayed image is key. In all real world applications of projection systems there is some level of ambient light. Therefore QVM uses the contrast ratio *in ambient light* for its calculation. QVM is calculated using a contrast ratio in ambient light of 40 foot-candles – the high end of most command and control applications.

How the display's screen handles ambient light has a large impact on overall contrast ratio. Higher reflectance from a screen, such as a UCS Acrylic screen (4.8 percent diffuse reflectance), will add to the displayed black levels and decrease the effective contrast ratio significantly. Lower reflectivity levels from a screen, such as a black glass screen (0.4 percent diffuse reflectance), will protect the native contrast ratio of the engine output, improve the quality of the displayed image, and increase the QVM level accordingly.

Note: *The photo above left demonstrates the contrast differences between the high reflectivity UCS Acrylic screens and the low reflectivity black glass screen on the bottom center of the display.*

Calculating QVM

The Quality Viewing Metric (QVM) combines the level of brightness with the level of contrast to provide a metric that measures total image quality.

Definitions

W = peak *white* level, or the brightness specification of the display in ftL
C = dark room *contrast* ratio specification of the display
A = *ambient* light level, which is assumed to be 40fc
R = diffuse *reflectance* specification of the screen in %

Calculations

1. First calculate the black level specification:
   $B = W/C$
2. Next calculate the black level and white level performance in ambient light:
   $Ba = B + A \ast R$ $\quad$ $Wa = W + A \ast R$
3. Contrast in ambient light is then:
   $Ca = Wa/Ba$
4. Finally, QVM is calculated as:
   $QVM = Wa \ast Ca$

Example *(Clarity Wildcat display with acrylic UCS screen)*

W = 110ftL (screen brightness) C = 1500:1 (dark room contrast)
A = 40fc (assumed ambient light) R = 4.8% (screen diffuse reflectance)

$B = 110/1500 = 0.073$ftL
$Ba = 0.073+40 \ast .048 = 1.993$ftL
$Wa = 110+40 \ast .048 = 112$ftL
$Ca = 112/1.993 = 56$

QVM = 112ftL x 56 (contrast ratio @ 40fc) = 6272.

[1] Clarity Visual Systems (September 2001), Rear Projection Screen Technology: Optimizing Your Display Performance

Clarity Wildcat QVM comparison									
Display	Tech	Screen Size	Screen Type	Brightness	Dark Room Contrast	Contrast in 40fc	QVM @ 0° View (100%)	% QVM @ 30° View	% QVM @ 50° View
Wildcat S	AP/LCD	40"	Wide-View glass	25 ftL	1500	141	**3,500**	56%	24%
Wildcat S	AP/LCD	40"	High-Contrast glass	42 ftL	1500	225	**9,500**	41%	4%
Wildcat S	AP/LCD	40"	High-Gain acrylic	110 ftL	1500	56	**6,300**	18%	3%

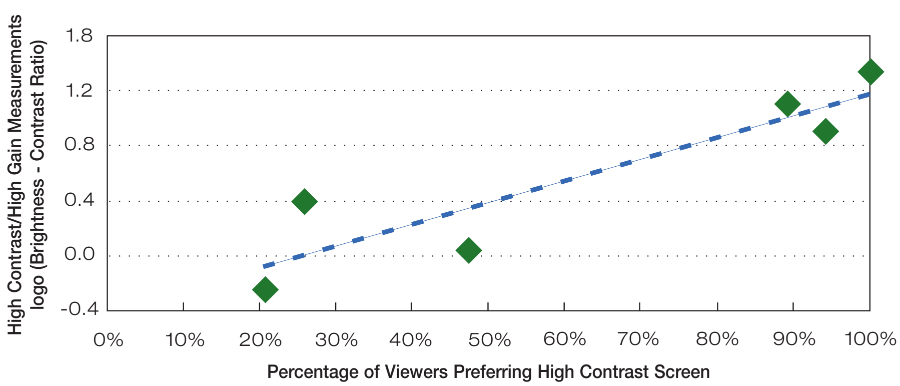
QVM over viewing angles

The table above reveals that a QVM declines over increasing viewing angles. What is important to understand is that different screens produce different rates of diminishing QVMs. The Wide-View glass screen produces the least percentage of difference in QVM from 0 to 50°. This screen is the most appropriate for most large wall applications that require consistent levels of QVM over wide viewing angles. For applications that maintain a controlled viewing angle, the High-Contrast glass screen may be a more appropriate choice because the increased drop in QVM over viewing angles will not be consequential over a ± 30° viewing angle.

A subjective look at QVM

To quantify a link between perceived image quality and the QVM, subjective comparisons of the High-Gain screen and the High-Contrast screen have been conducted. The goal here was to determine whether there was a correlation between the measured QVM rating and subjective perception of image quality. A series of images with varying brightness and contrast content were displayed side-by-side on the two screens. Viewers were asked to vote for the "better" display under the same viewing angle and ambient light conditions as in the objective tests. Viewers were asked to choose which display was preferred. The graph below plots the objective measurements versus the subjective test results.

The test results show us that as the objective measurements of the QVM of the displays increased, so did the subjective perception of the good image quality. In this case, over varying viewing angles and ambient light conditions, as the QVM for the High-Contrast screen increased greater than the High-Gain QVM value, the percentage of viewers preferring the High-Contrast over the High-Gain increased also. Hence, the display with a higher QVM level correlated to a higher level of perceived image quality to the subjective viewer.



Clarity Visual Systems, Incorporated
9025 S.W. Hillman Court, Suite 3122
Wilsonville, Oregon, 97070, USA
Phone: 503-570-0700
Fax: 503-682-9441
http://www.clarityvisual.com

Printed in U.S.A. 15064-W 09/02