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ANSI Lumens, Foot Lamberts, And Image Luminance

Dave Rodgers

Arguably, the most important element of creating a great projected visual display is in the combination of a projector's brightness and a screen's ability to adequately reflect light. The overall result is known as Image Luminance. Simply put, if you want a good projected image, the image needs to be bright enough to be easily seen. It sounds simple enough, but there are various rules of physics that must be followed in order to get that perfect image. In order to successfully acquire the right projector and projection surface, you need to be familiar with these basic concepts:

- Projector Brightness (Lumens)
- Screen Reflectivity (Gain)
- Screen Size
- Atmospheric or Room Lighting (Ambient Light)

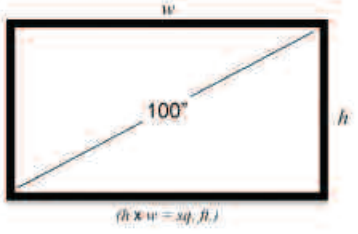
When these four basic elements of the equation are identified, the next step is to understand the basic properties of each, as well as how we can calculate these variables into creating a projection system that best works for you.

(ANSI) Lumens

The American National Standards Institute (ANSI) averaged multiple readings of visible light from various angles to determine a standardized unit of measure known as ANSI Lumens. Lumens are the units of measure for the amount of light that a projector is reportedly able to produce. More specifically, it is a measurement of light intensity as specified by the International System of Units as "a unit of luminous flux equal to the light emitted in a unit solid angle by a uniform point source of one candle intensity." Mathematically, it is a measurement of one candela of visible light per squared radian (1 candela * sr) Symbol = lm.

To put it into easier perspective, a candela is about the equivalent of the light of one candle. The candela actually replaces the obsolete measurement of the "Candlepower (cp)" and is equivalent to 1.02 cp units of measured visible light.

1,000 ANSI Lumen Projector



*1,000 ANSI Lumens / 30sq. ft. = **33 foot-Lamberts***

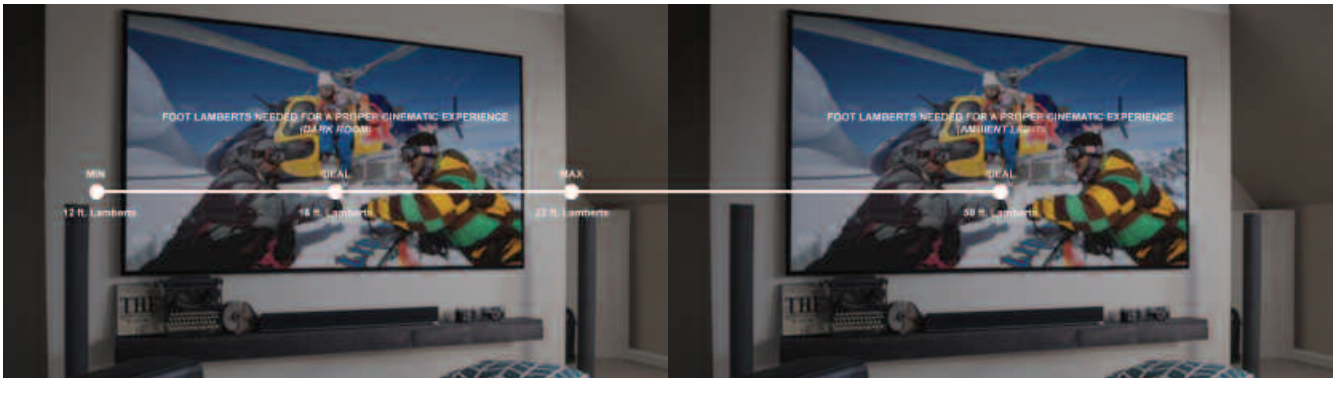
Foot Lamberts

A Foot Lambert is a measurement of visible light that equals 1 circular candela per square foot, or 3.426 candela per square meter. The symbol for Foot Lamberts is Lv (aka fL).

Foot Lamberts are the measured brightness of a projector's output spread over the surface of your projection screen. Its standardized measurement was established by the Society of Motion Picture & Television Engineers. SMPTE, as they are more commonly known, developed a standard for determining the amount of light necessary for proper cinematic playback in a darkened room.

Why Foot Lamberts are Important

Since Foot Lamberts essentially describe the projector screen's brightness, it is important to know how many Foot Lamberts are needed to get a clear, visible projected



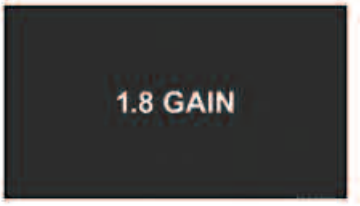


image in a darkened room. For that matter, they are also essential to determine how much more brightness would be required with the presence of ambient light as well. As seen in the left-hand side of the picture, ambient light can wash out an image if the overall luminance is insufficient. While using the same projector and a more reflective surface on the right-hand side, the projected image is clear and easily visible.

According to SMPTE, the target amount of light necessary for proper cinematic playback in a darkened room is "SMPTE 196M." This means that the ideal setting is 16 fL, running the projector in "open gate" (no film) or 14 fL running the projector with film (typical base density of 0.05 yields peak white of 14 Lv). In other words, the range of Foot Lamberts for a darkened room would be 12 Foot Lamberts for the minimum, 22 Foot Lamberts for the maximum, and 16 Foot Lamberts as the ideal output for home theatres and commercial cinemas.

When projecting in a room with ambient light, it is recommended that 50 Foot Lamberts should prove ideal, but be prepared to increase or decrease output as home lighting levels tend to vary.

Image luminance is found by multiplying the Foot Lamberts times the projection screen's reflectivity or gain. The image luminance is the overall image brightness created by the combination of projector output and screen reflectivity. Projection screens vary in their reflective properties. The reflective, neutral, matte-white screen is typically 1.0 gain but can vary as high as 1.4 in its reflectivity. Negative gain projection screens are designed to enhance contrast levels at the expense of having less reflectivity. They are typically measured between 0.5 to 0.9 gain. Ambient Light Rejecting or ALR projection screens typically perform in the realm positive gain, or anything higher than 1.0 to 1.8 gain. These screens are known for superior brightness and image saturation, however, they can also be negative gain, as heavy contrast layers are incorporated to enhance darkness levels for superior image quality.

How to Calculate Foot Lamberts

Step 1. Determine the area of your projection screen.

- Divide the inch measurements by 12 and then multiply the width times the height.
- For this exercise, assume you have a 100-inch (16:9) screen.
- (Area = h*w) or approximately (Area = 4.1*7.25 feet ≈ 29.725 ft^2).
- Round to the nearest whole or half number and you should have an area of 30 square feet.

Step 2. Divide your projector's lumens by the screen's area from step 1.

- For simplicity, assume that the projector has a 1000 lumens output.
- 1000 lumens divided by 30 ft^2 = 33 Foot Lamberts.

Step 3. Find the Image Luminance

- Whichever screen you have, find out what its gain is and then multiply it times the Foot Lamberts calculated from step 2. Pretend the examples are for 100-inch 16:9 screens.
- Example 1: 33 Foot Lamberts times 1.0 gain has 33 candelas per ft^2 .
- Example 2: 33 Foot Lamberts times 1.5 gain has 49.5-50 candelas per ft^2.
- Example 3: 33 Foot Lamberts with a negative gain 0.5 is only 16.5 candelas per ft^2.

Determining Which Screen Is Right For You

The table below presents a hypothetical model for a 1000 lumens projector used with variable screen sizes from 100 to 200 inches and a variety of reflective materials.

The numbers are estimated to give an approximate measurement.

Looking at the top row, it shows that a 0.5 to 1.0 gain material on a 100-inch (16:9) projector screen will have acceptable screen luminance for use with a 1000 lumens projector in a darkened environment. A 1.5 gain material on a 100" (16:9) projector screen is required to achieve acceptable screen luminance using a 1000 lumens projector in a brightly lit living room and will require about 50 Foot Lamberts.

The formula is simple. You need a certain level of screen brightness to present superb picture clarity, and it corresponds directly with the amount of atmospheric light that you are presenting in. The factors of projector brightness and your screen's ability to adequately reflect light are key in helping you get the big picture. **WSR**

Dave Rodgers, Marketing Manager for Elite Screens Inc. (www.elitescreens.com), has 20 years of experience in the AV and wireless communications industries. He has made numerous television, radio, and editorial appearances, providing installers and do-it-yourselfers with easy solutions toward creating larger-than-life big screen applications.

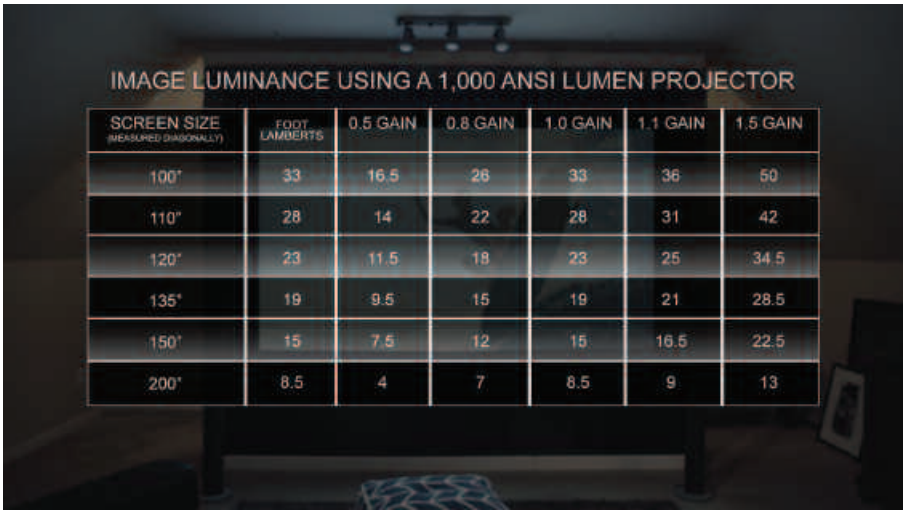


IMAGE LUMINANCE USING A 1,000 ANSI LUMEN PROJECTOR

SCREEN SIZE (MEASURED DIAGONALLY)	FOOT LAMBERTS	0.5 GAIN	0.8 GAIN	1.0 GAIN	1.1 GAIN	1.5 GAIN
100"	33	16.5	26	33	36	50
110"	28	14	22	28	31	42
120"	23	11.5	18	23	25	34.5
135"	19	9.5	15	19	21	28.5
150"	15	7.5	12	15	16.5	22.5
200"	8.5	4	7	8.5	9	13