Landmark Technology

LMG203-121SN01 - 12.1"

VHB LCD Module with LED Backlight

Introduction

The LMG203-121SN01 is a 12.1" sunlight readable LCD module. The module consists of an AUO G121SN01 TFT color LCD panel and a VHB (very high brightness) LED backlight. At the full brightness setting, the LCD screen lumiannce can reach about 1,600 Cd/m^2 (nits). At this level, the total backlight power consumption is only 12 Watts, which is about half the power required of a CCFL backlight at the same screen brightness.

With 1,600 nits screen brightness, the display is highly readable under bright ambient lighting, including direct outdoor sunlight. Also, the AUO G121SN01 is an industrial LCD with a wide operating temperature range, from -10 to $+65^oC$, making this LCD module specifically suitable for demanding outdoor applications.

Characteristics (Note 1, 2)

Parameters	Typical Value	Units	Conditions
LCD Screen Luminance	1,600	Cd/m^2	LCD in OFF state (normally White)
Luminance Uniformity	20% or better		Note 3
Backlight Power Consumption	12	Watts	Total power to the LED driver board
Screen Luminance Dimming Ratio	20:1		With LD200 LED driver board
Typical LCD Contrast Ratio	500:1		White vs. Black (measured in the dark along the normal direction)
Typical Viewing Angles			
3:00 direction	70	Degrees	Contrast ratio ≥ 10
9:00 direction	70	Degrees	Contrast ratio ≥ 10
6:00 direction	60	Degrees	Contrast ratio ≥ 10
12:00 direction	60	Degrees	Contrast ratio ≥ 10
LCD Screen Chromaticity (x, y)			
White	(0.288, 0.307)		Measured at the normal direction
Red	(0.587, 0.377)		Measured at the normal direction
Green	(0.319, 0.593)		Measured at the normal direction
Blue	(0.144, 0.093)		Measured at the normal direction
Response Speed			
Rise time	10	msec	White to Black, 10% - 90% transition
Fall time	25	msec	Black to White, 10% - 90% transition
LCD Module Weight	850	Grams	

Note 1: Please refer to AUO G0121SN01 LCD Specification for detailed electrical specifications and general precautions.

Note 2: All data is measured at $25^o C \pm 2^oC$ ambient temperature.

Note 3: Uniformity = $(L_{max} - L_{min}) / (L_{max} + L_{min})$ where L_{max} (L_{min}) is the maximum (minimum) luminance measured using a 10 mm diameter meter aperture over the LCD active area, except the last 10 mm area from the edges.

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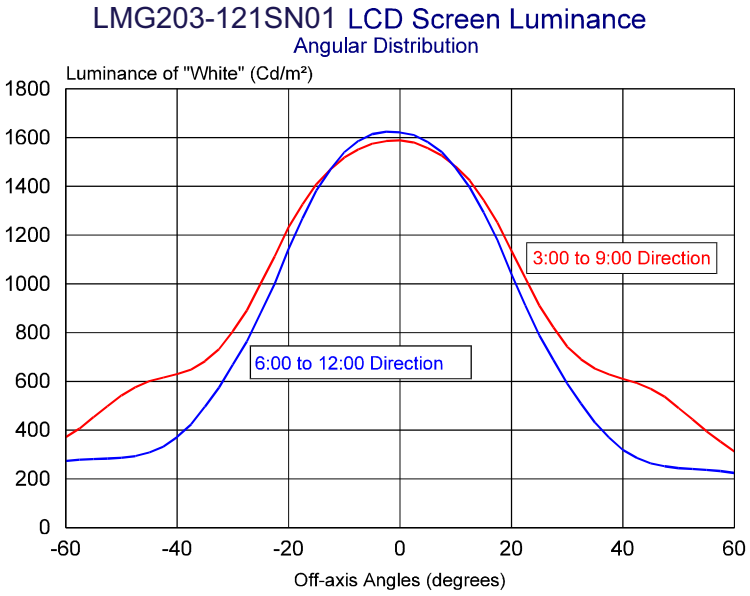
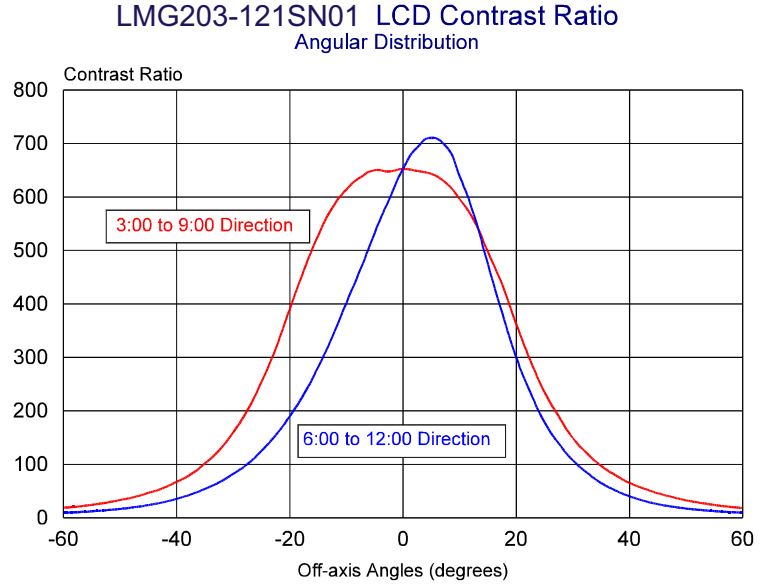
LCD Module Optical Performances

Luminance & Contrast Ratio

The typical LMG203-121SN01 LCD module screen luminance and contrast ratio are shown in the figures below:

At the best viewing direction, this module delivers a very high screen luminance of about 1,600 Cd/m^2. Since this module is a normally white LCD, the screen luminance is measured with the LCD in the "Off" state (i.e. the pixels are not energized). This is the "white" state that provides the maximum possible luminance. The "white" color displayed on the screen when the video signal is applied may have a lower luminance which can be caused by the improper settings of the graphics card and/or the LCD controller. When the LCD is properly driven, the measured luminance of the "white" color displayed on the screen should be within 10% of the specified value.





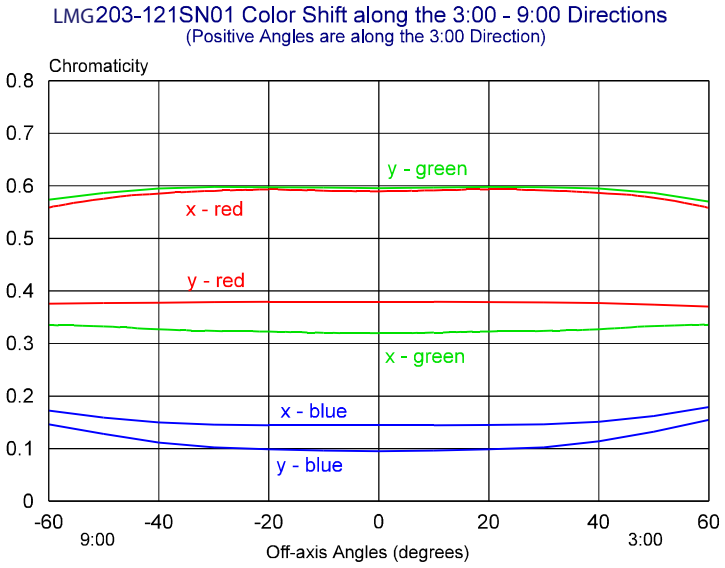
The LMG203-121SN01 LCD module also has a high contrast ratio (CR) of about 600:1 measured on axis. At the best viewing angle, the CR value exceeds 700:1. These values are the inherent CR, which is the luminance ratio between the "White" and the "Black" states measured in a dark room. Under ambient lighting, particularly in bright outdoor environments, the CR value of the display drops significantly due to the reflection and glare caused by the strong ambient illumination.

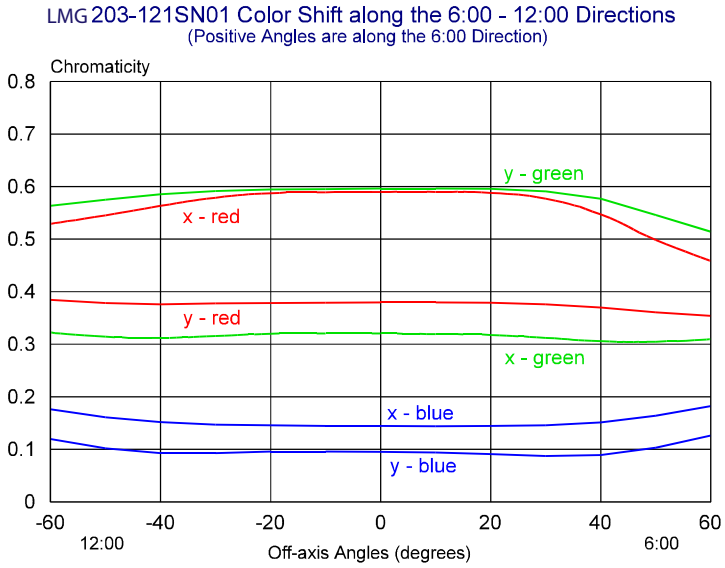
Chromaticity

The figures on the next page present the chromaticity (x, y) data of the R, G, B primary colors displayed on the screen.

Along the 3:00 to 9:00 (horizontal) directions, the chromaticity values of the Red and Green primary colors do not change significantly. Only the Blue primary color shows some color shift at very large off-axis angles. Therefore, the color shift along the horizontal direction is small.

Along the 6:00 to 12:00 (vertical) directions, the chromaticity value changes are mostly small except at large off-axis angles along the 6:00 direction. Therefore, the image displayed on the screen shows color shift toward the white at large off-axis viewing angles along the 6:00 direction.





LED Backlight Driving Specifications

The LMG203 LCD module has a VHB backlight with two LED lamp strips. Each LED lamp has 48 white LEDs that are electrically connected into 6 branches in parallel. Each branch has 8 LEDs connected in series.

Each LED lamp strip is terminated with a JST 2-pin connector, BHRS-02VS-1. The JST mating connector part number is SM02-BHSS-1-TB.

The driving voltage and current for each LED branch in the LED lamp are listed below:

LED driving voltage	19.2	Vdc
LED driving current	50	mA

At this driving condition, the backlight delivers 1,600 Cd/m^2 of LCD screen luminance. With a high efficiency LED driver board, the total power consumption (with the driver board losses) at this brightness level is about 12 Watts.

Thermal Management

The maximum backlight power consumption of the LMG203 LCD module is only 12 Watts. At this level, the thermal management issues are similar to those of LCDs with a regular brightness of 300 - 500 nits. However, the temperature characteristics of an LED lamp are quite differenct from those of a CCFL.

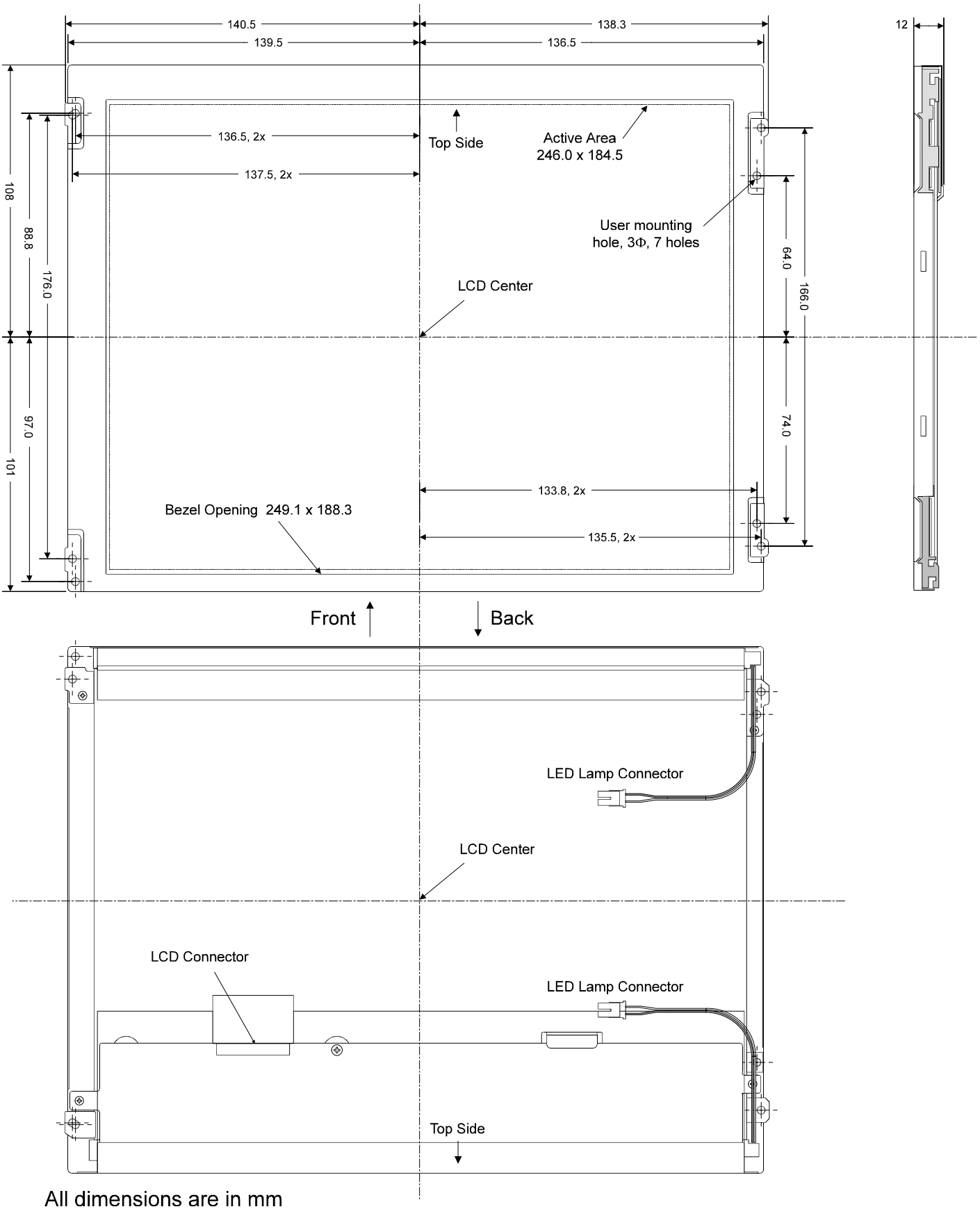
The efficiency of an LED in Lumens per Watt decreases as temperature increases. In order to keep the efficiency up and maintain the LCD screen brightness, it is necessary to keep the LED lamps cool. Therefore, as the LCD temperature increases, it is necessary to implement cooling measures to maintain the optimal operating condition.

For outdoor display applications where the LCD may be subject to direct sunlight exposure, the major source of heat usually comes from sunlight. LCDs are suitable for outdoor applications because they have low reflective, black front surfaces. However, a black surface is a good solar absorber. For example, if strong sunlight shines on the display at a perpendicular direction, the LMG203 LCD module can absorb up to 50 Watts of solar power. This is more than four times the power consumption of the LED backlight including the driver board losses. As a result, the LCD temperature can rise very quickly, approaching or even exceeding its maximum tolerance level.

Thermal Management (continue)

In general, since the LMG203-121SN01 LCD has a wide operating temperature range from -10 to 65^{o}C, the thermal management issue is not difficult to resolve unless the LCD module is subjected to very strong, direct sunlight exposure. For a detailed description of the thermal impact caused by direct sunlight exposure, please refer to Technote 1199 on Landmark's web site.

LMG203-121SN01 Mechanical Dimensions



All dimensions are in mm