PRELIMINARY RESULTS

Landmark Technology

LMG213-121S1-L01 - 12.1"

VHB LCD module with LED backlight

Introduction

LMG213-121S1-L01 is a 12.1" sunlight readable, wide viewing angle LCD module. The module consists of a CHI MEI G121S1-L01 TFT color LCD panel and a Landmark (very high brightness) backlight. The module is mechanically compatible to Landmark's LM207-121X1-L01 sunlight readable LCD module.

At the maximum backlight power of 13 watts, the LMG213-121S1-L01 module delivers a screen luminance of about 1,300 CD/m^2 (nits). At this brightness level, the display is highly readable under bright amient lighting, including direct outdoor sunlight. Also, the CHI MEI G121S1-L01 is an industrial LCD with a wide operating temperature range, from -30 to +70C, making this LCD module specifically suitable for demanding outdoor applications.

Characteristics (Note 1, 2)

Parameters	Typical Value	Units	Conditions
LCD Screen Luminance	1,300	Cd/m^2	LCD displays the brightest White
Luminance Uniformity	20% or better		Note 3
Backlight Power Consumption	13	Watts	Total Power to LED Driver
Screen Luminance Dimming Ratio	20:1		With LD200A LED Driver
Screen Luminance Dimming Ratio	150: 1 (analog) and >250:1 (PWM)		With LD208C LED Driver
Typical LCD Contrast Ratio	1,000:1		White vs. Black (measured in the dark along the normal direction)
Typical Viewing Angles			
3:00 - 9:00 directions	89	Degrees	Contrast ratio ≥10
6:00 - 12:00 directions	89	Degrees	Contrast ratio ≥10
LCD Screen Chromaticity (x, y)			
White	(0.353, 0.381)		Measured at the normal direction
Red	(0.623, 0.358)		Measured at the normal direction
Green	(0.316, 0.566)		Measured at the normal direction
Blue	(0.147, 0.146)		Measured at the normal direction
Response Speed			
Rise time	18	msec	White to Black, 10% - 90% transition
Fall time	17	msec	Black to White, 10% - 90% transition
Operating Temperature Range	-30 to 70	Degree C	
LCD Module Weight	850	Grams	

Note 1: Please refer to "CHI MEI G121S1-L01 LCD Specification" for detailed electrical specifications and general precautions.

Note 2: All data is measured at 25^{o} C ± 2^{o}C 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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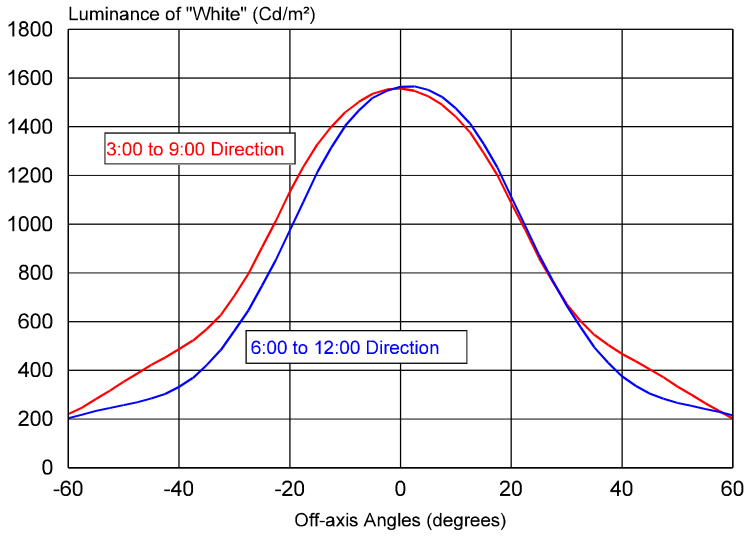
LCD Module Optical Performance

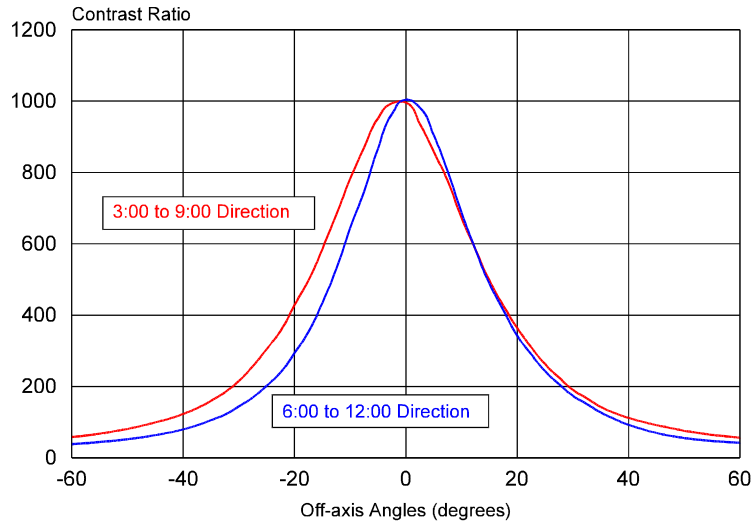
Luminance & Contrast Ratio

The typical LMG213-121S1-L01 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 1,300 Cd/m^2. Since this module is a normally black, wide viewing angle LCD, the screen luminance is measured with the LCD displaying the brightest White color. Therefore, it is necessary to adjust the video signal and the OSD settings on the LCD controller to achieve the brightest White color supported by the LCD. When the graphics card and the LCD controller are adjusted properly, the measured luminance of the "white" color displayed on the screen should be within 10% of the specified value.

LMG213-121S1-L01 LCD Screen Luminance
Angular Distribution



LMG213-121S1-L01 LCD Contrast Ratio
Angular Distribution



The LMG213-121S1-L01 LCD module has a very high contrast ratio (CR) of about 1,000:1 measured on axis. For all the practical viewing angles, the CR value exceeds 100:1. 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.

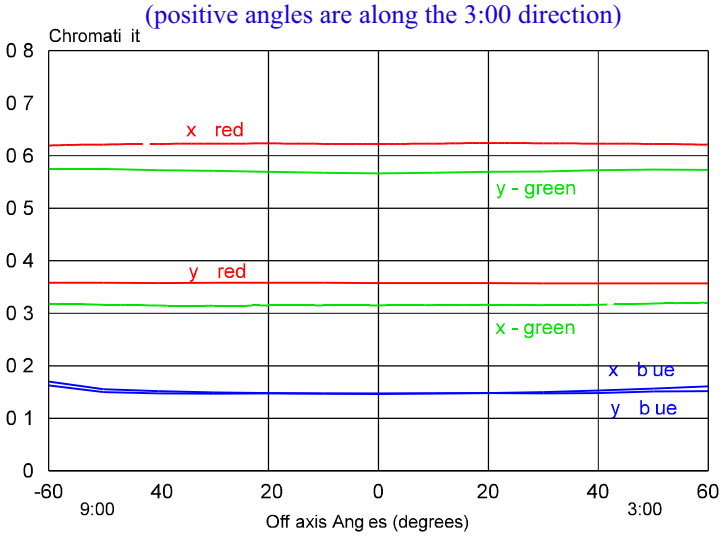
Chromaticity

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

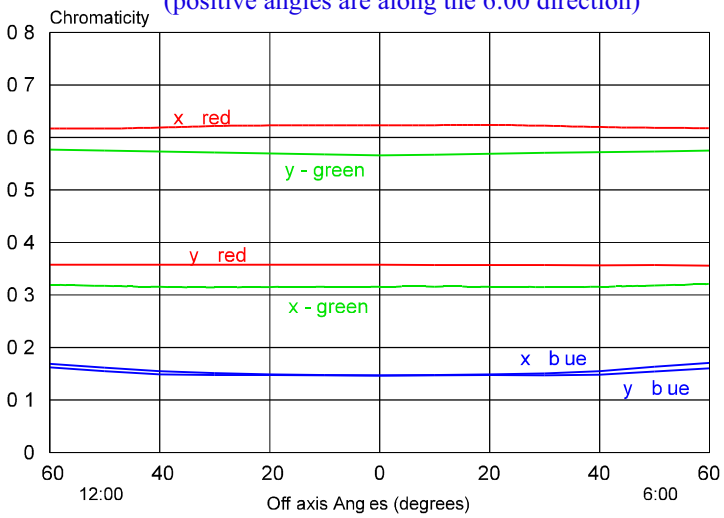
The LMG213-121S1-L01 is a normally black, wide viewing angle LCD. There is virtually no color shift at any off-axis viewing angles.

As the viewing direction moves to large off-axis angles, the brightness and the contrast ratio of the image on the screen reduces, but with no noticeable color shifts.

LMG213-121S1-L01 Color Shift Along The 3:00-9:00 Directions
(positive angles are along the 3:00 direction)



LMG213-121S1-L01 Color Shift Along The 6:00-12:00 Directions
(positive angles are along the 6:00 direction)



LED Backlight Driving Specifications

The LMG213-121S1-L01 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	35	mA

At this driving condition, the backlight delivers 1,300 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 13 Watts.

Thermal Management

The maximum backlight power consumption of the LMG213 module is only 13 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 different from those of 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 measure 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 LMG213 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 LM213-121X1-L01 LCD has a wide operating temperature range from -30 to 70C, 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 website.

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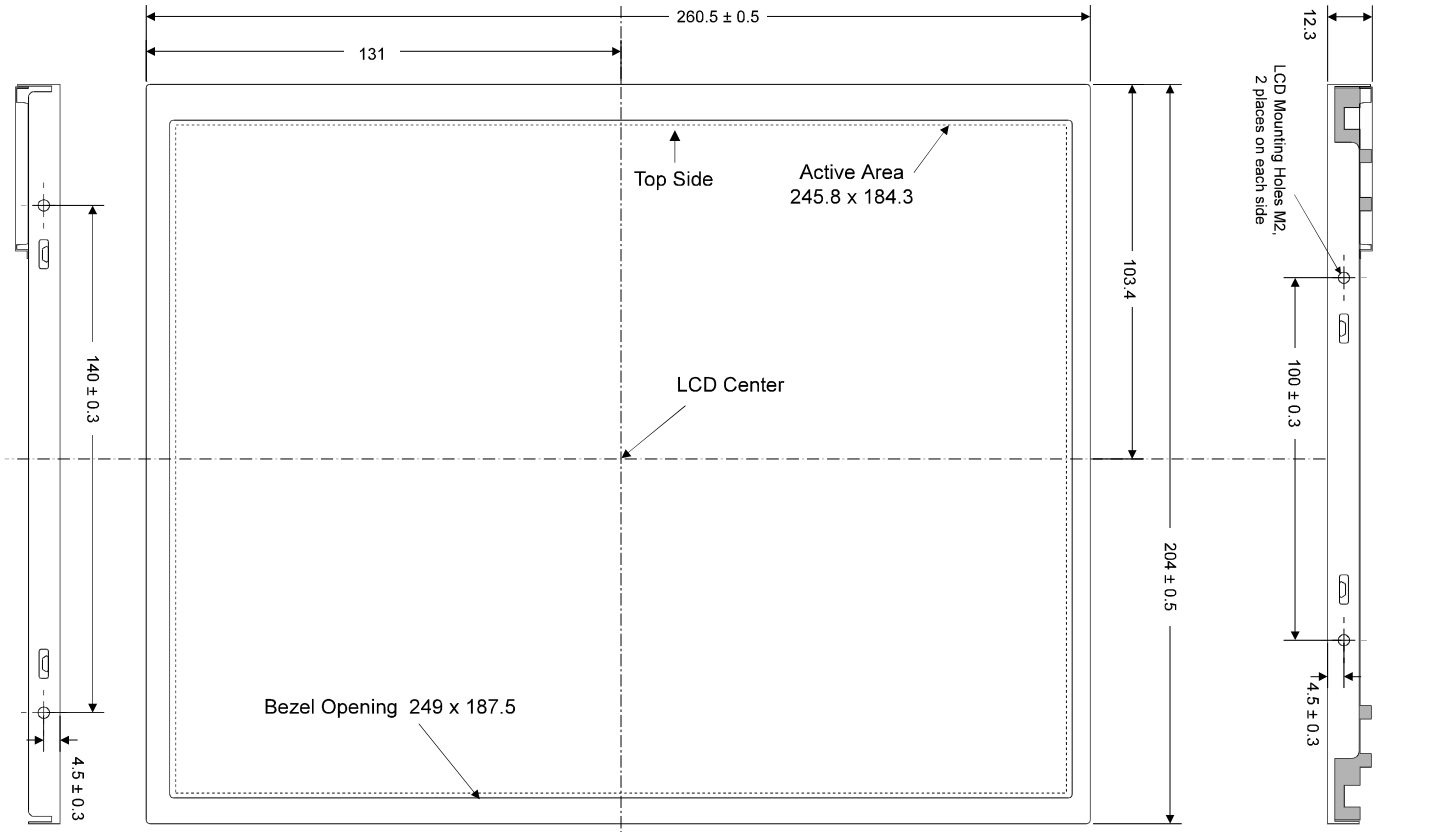
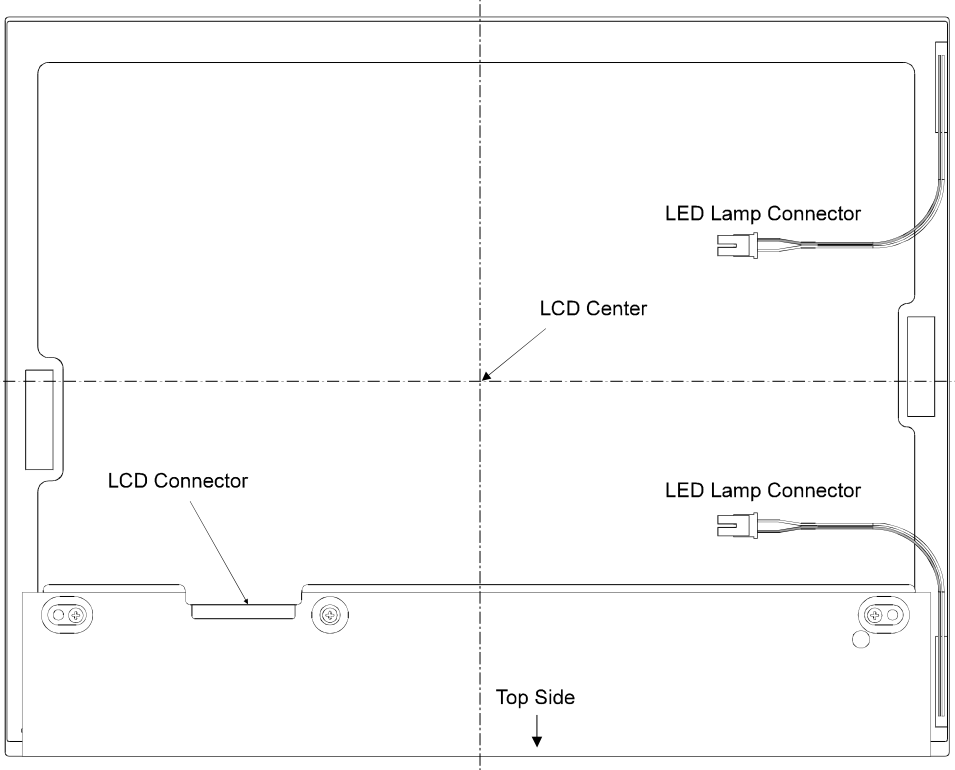
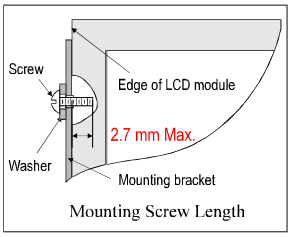
LMG213-121S1-L01 Mechanical Dimensions





Warning: using a mounting screw longer than shown below or tighten it with a torque exceeding 2.0 Kg-cm will severely damage the LCD module.



Max. torque - 2.0 Kg-cm

All dimensions are in mm