Landmark Technology

LMG229-065J - 6.5" Sunlight Readable LCD with LED Backlight

Introduction

LMG229-065J is a 6.5" sunlight readable LCD module. The module consists of an Optrex T51750GD065J-FW TFT color LCD panel and a Landmark VHB (very high brightness) LED backlight. The Optex LCD is available with anti-reflective (AR) and anti-glare (AG) front polarizers. The current LMG229-065J uses the Optrex LCD with an AR front polarizer.

At an LED backlight power about 6 Watts, the LMG229-065J module displays a VGA (640 x 480) image at an extremely high screen luminance of 2,400 Cd/m^2. At this brightness level and with the AR front polarizer, the display is highly readable under bright ambient lighting including direct outdoor sunlight. With the Landmark LD200A LED driving board, the screen luminance can be adjusted down to about 120 Cd/m^2. For night display viewing that may require lower brightness, a PWM dimming LED driving board should be used.

Characteristics (Note 1, 2)

Parameters	Typical Value	Units	Conditions
LCD Screen Luminance	2,400	Cd/m^2	LCD in OFF state (normally White)
Luminance Uniformity	20% or better		(Note 3)
Backlight Power Consumption	6	Watts	Excluding LED drive board losses
LCD Contrast Ratio	>450:1		At the optimum viewing direction
	~150:1		At the viewing direction $\perp$ to LCD.
Typical Viewing Angles			
3:00 to 9:00 directions	± 60	Degrees	Contrast ratio ≥ 5
6:00 direction	60	Degrees	Contrast ratio ≥ 5
12:00 direction	40	Degrees	Contrast ratio ≥ 5
LCD Screen Chromaticity (x, y)			
White	(0.327, 0.383)		Measured at the direction perpendicular to the LCD
Red	(0.534, 0.372)		
Green	(0.353, 0.592)		
Blue	(0.155, 0.164)		
LCD Module Weight	255	Grams	

Note 1: Please refer to Optrex T51750GD065J-FW LCD data sheets for detailed LCD 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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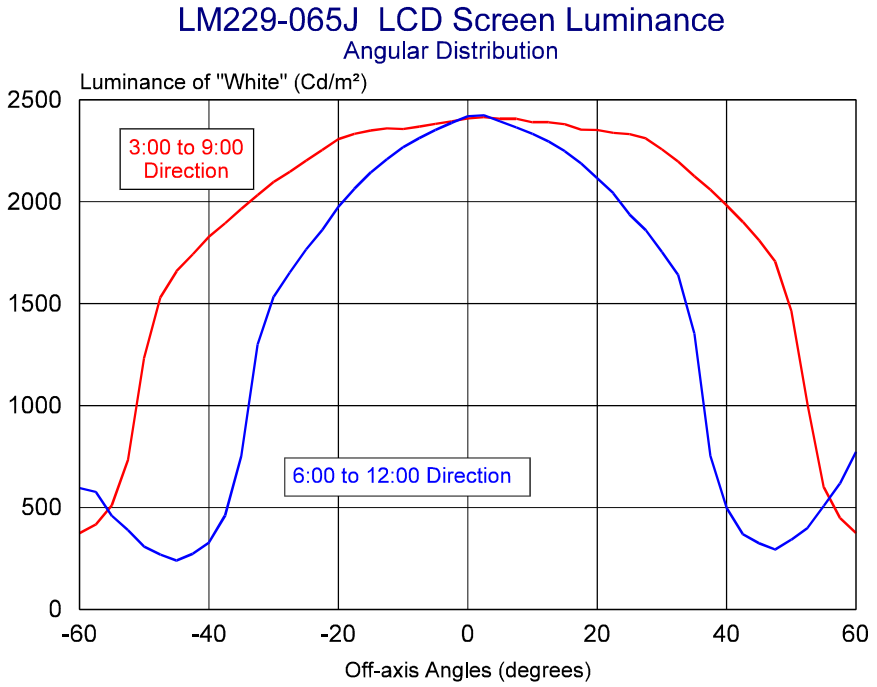
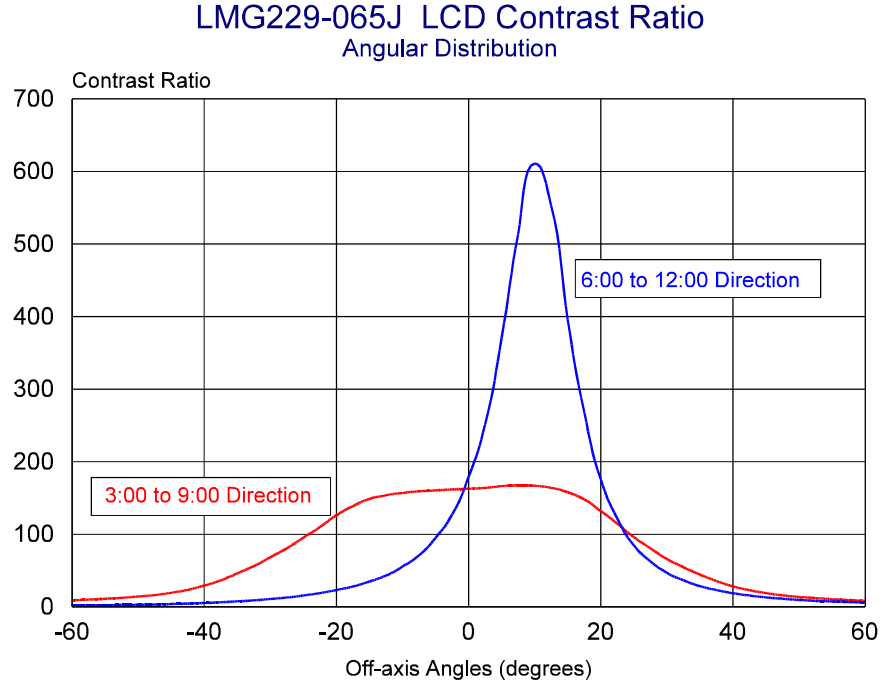
LCD Module Optical Performances

Luminance & Contrast Ratio

The typical LMG229-065J LCD module screen luminance and contrast ratio are shown in the figures below. Since this is a normally white LCD module, the screen luminance is measured with the LCD in the "Off" state (i.e. the pixels are not energized). This is the "white" state with the maximum possible luminance. The "white" color displayed on the screen when the video signal is applied may have a slightly lower luminance. The difference can be caused by 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.





At the optimal viewing direction, the LMG229-065J LCD module has a very high contrast ratio (CR) of about 600:1. Along the normal direction, the CR value is about 150:1. This is the inherent CR which is the luminance ratio between the "White" state and the "Black" state measured in a totally 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 ambient illumination.

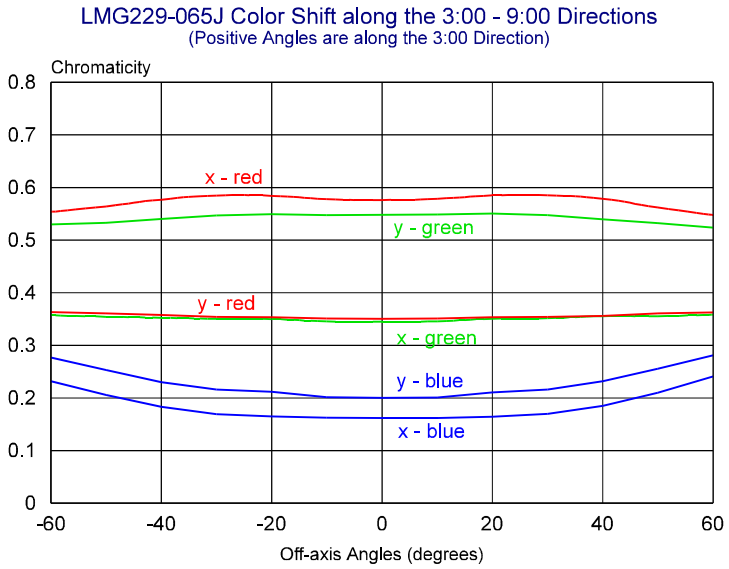
Chromaticity

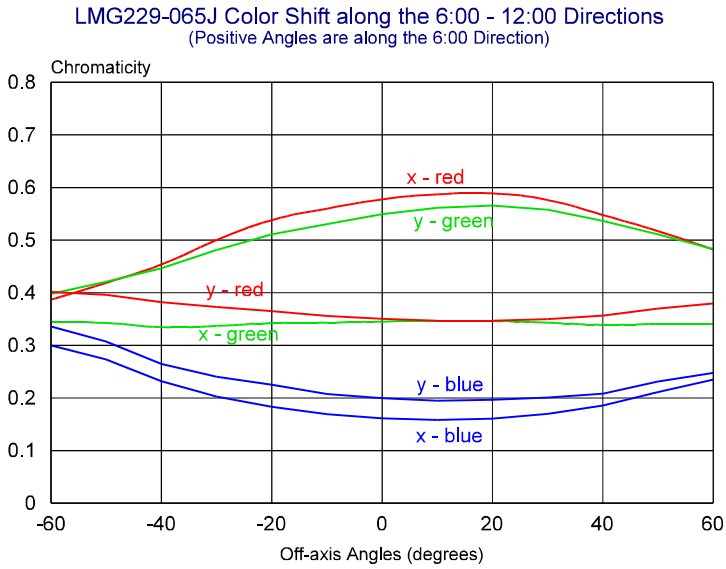
The 1931 CIE chromaticity coordinates of the R, G, B primary colors measured at the normal direction are presented in the table on page 1.

For a TN LCD, the LMG229-065J LCD module has good viewing angles with relatively small color shifts. The figures on the next page present the chromaticity (x, y) data of the R, G, B primary colors as a function of the viewing angles

Along the 3:00 to 9:00 directions, the chromaticity values of the red and green primary colors have small changes at large off-axis viewing angles. However, the blue primary color has larger chromaticity changes at viewing angles of 40 degrees and beyond

Along the 6:00 direction, the color shifts are small but slightly larger than those along the 3:00 and 9:00 directions. Along the 12:00 direction, all the primary colors have significant chromaticity shifts toward the white. Therefore, as the viewer moves to large off-axis angles, the colors tend to be more and more washed out





Backlight Connections & Driving Conditions

The backlight uses a total of 108 LEDs in a backlit mode.. The LEDs are organized in 2 groups. Each group has 6 LED strings with each string having 9 LEDs connected in series.

The 6 LED strings in a group are connected in parallel and terminated with a JST 2-pin connector. Thus, the backlight has two connectors. The details of the connector, wiring colors, and the mating connector are listed on the right side.

LED backlight connector:

JST BHSR-02VS-1 or equivalent

Mating connector:

JST SM02(4.0)B-BHS-1-TB or equivalent

Connector wiring color:

LED Anode Connection Wire	Red
LED Common Connection Wire	White

The driving conditions of the LED backlight at the maximum screen brightness of 2,400 nits are listed below:

LED Current (each string)	17.3	mA
LED Current per group (6 strings)	104	mA
Total LED current (12 strings)	208	mA
LED string Voltage (typical)	29.7	V

At these driving conditions, the power consumption of the backligth is about 6 Watts.

The LCD screen brightness can be adjusted down by reducing the LED current. This can be done by either reducing the DC current going through the LEDs or by pulse width modulating (PWM) the LED current.. For PWM, the screen brightness is proportional to the average LED strip current.

Landmark's LD200A is a driving board that provides a DC LED strip current. As the screen brightness is adjusted down, the DC current going through the LED strip reduces. It has a conversion efficiency of about 85%. Thus, the 12V DC power input to the LD200A is about 7 Watts. For detailed information, please refer to the LD200A driving board data sheet.

Thermal Management

The VHB backlight in the LMG229-065J LCD module consumes only 6 Watts at full brightness. As a result, the effect to the LCD screen temperature due to the VHB backlight is quite small and there are few thermal management issues to contend with.

If the LMG220-065J LCD module is placed in outdoor environments with direct sunlight exposure, then thermal management considerations must be implemented to avoid LCD overheating. The front surface of an LCD is a good solar energy absorber, the direct sunlight exposure can heat up the LCD module far more seriously than the heat produced from the VHB LED backlight alone. For more information on LCD sunlight heating issues, please refer to Technical note TK1199 at www.landmarktek.com/html/lm_faqs.html.

Backlight Life & Handling Precautions

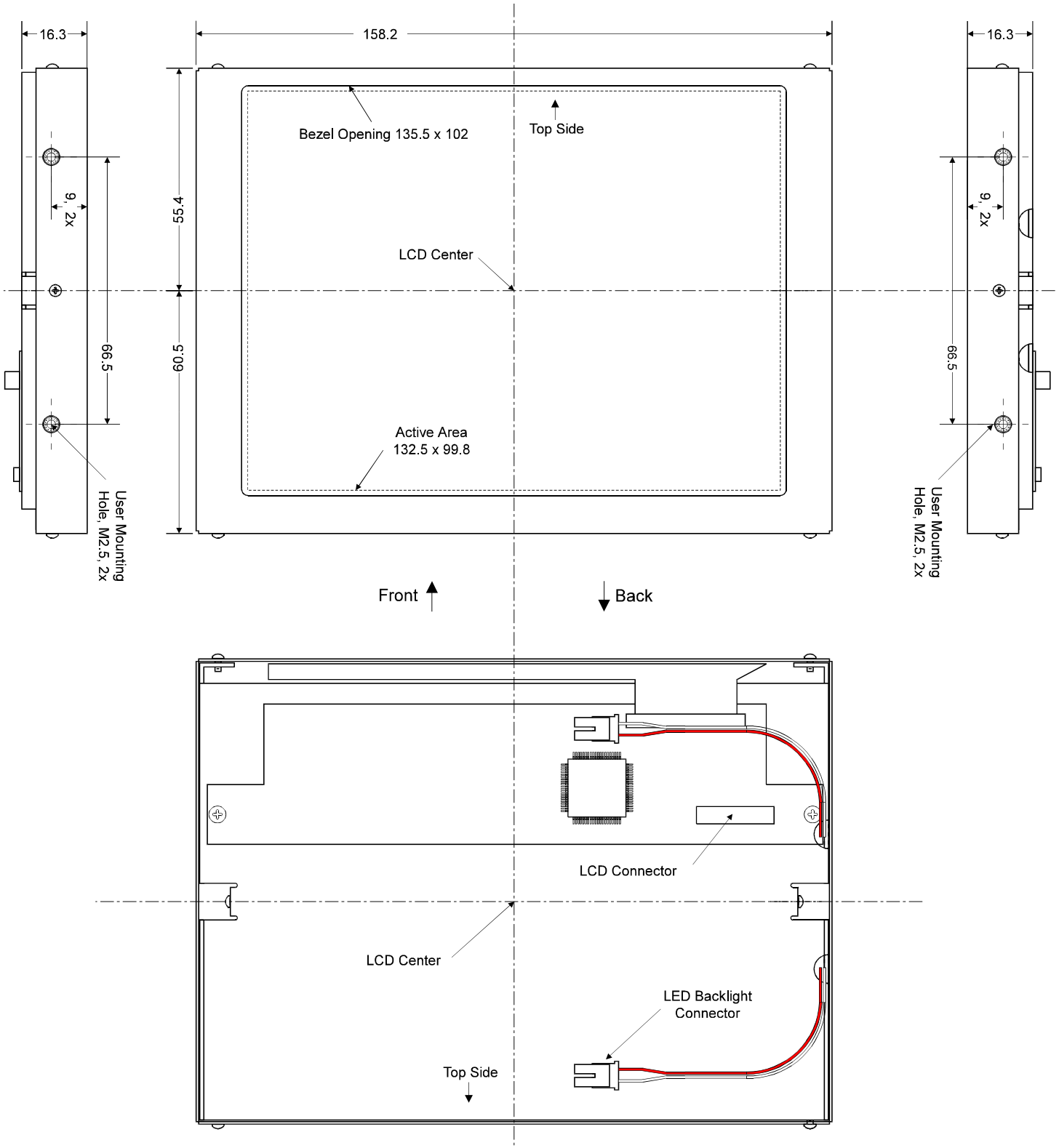
The general life specification for LEDs is at 50,000 to 100,000 hours. However, since LED backlights are relativly new, there is no real test data up to 50,000 hours. At Landmark Technology, we have tested our LMG203 LED backlight up to 20,000 hours. During this 2.2 years period, the LMG203-121S1-L0 LCD screen brightness decays by about 7%. This decay is significantly less than the test results with the CCFL backlights.

The LCD backlight life is usually specified in the number of operating hours before the backlight brightness drops to 50% of its initial value. From the trend of the brightness decay curve with the LMG203 LED backlight, it is expected that the half brightness life of the LED backlight in LMG203 will be at 50,000 hours or more.

In actual LCD applications, the luminance of a very bright display will likely be adjusted down in dimly lit environments. This reduces the LED current, which increases the life of the LED significantly. Therefore, the practical operating lifetime of the VHB LED backlight in the LMG229-065J LCD module can be expected to reach 40,000 to 50,000 hours.

On the other hand, LEDs are sensitive to static electricity and voltage spikes. It is necessary to operate and handle the LED backlights carefully. For example, before removing the LED backlight connectors from the drive board, the DC power input to the drive board must be turned off. Fail to do so will most likely demage the LED backlight.

LCD Module Dimensions



All dimensions are in mm