Landmark Technology

LM171A-065J - 6.5" Sunlight Readable LCD Module

Introduction

LM171A-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) backlight. The module is in an edge mount, semi-ruggedized case. There are two models available. The LM171A-065J-AR has an anti-reflective front polarizer, and the LM171A-065J-AG has a regular anti-glare front polarizer.

At a backlight power of about 11.5 Watts, the LM171A-065J-AG module displays a VGA (640 x 480) image at an extremely high screen luminance of 2,150 Cd/m^2. At this brightness level, the display is highly readable under bright ambient lighting including direct outdoor sunlight. With the Landmark BI206D inverter, the screen luminance can be adjusted down to about 10 Cd/m^2 for night viewing. In addition, the color tone of the white matches closely to the color of normal sunlight.

Characteristics (Note 1, 2)

Parameters	Typical Value	Units	Conditions
LCD Screen Luminance			
LM171A-065J-AG	2,150	Cd/m^2	LCD in OFF state (normally White)
LM171A-065J-AR	1,850	Cd/m^2	LCD in OFF state (normally White)
Luminance Uniformity	20% or better		(Note 3)
Backlight Power Consumption	11.5	Watts	Excluding inverter losses
LCD Contrast Ratio	>450:1		At the optimum viewing direction
	~150:1		At the viewing direction ⊥ 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	(0.360, 0.380)		With LM171A-065J-AR,
Red	(0.581, 0.347)		measured at the normal direction
Green	(0.344, 0.541)		
Blue	(0.161, 0.187)		
LCD Module Weight	250	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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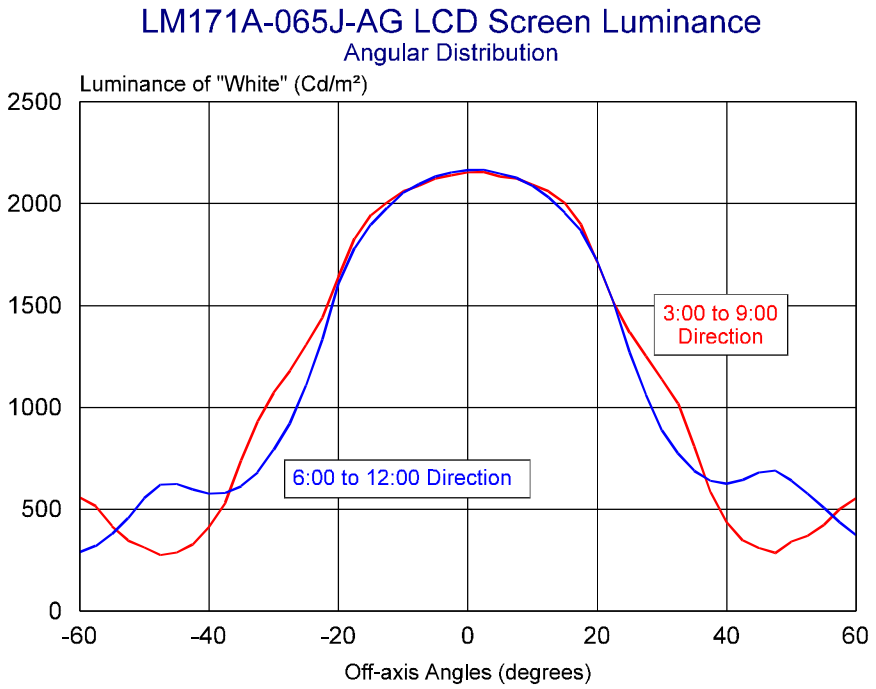
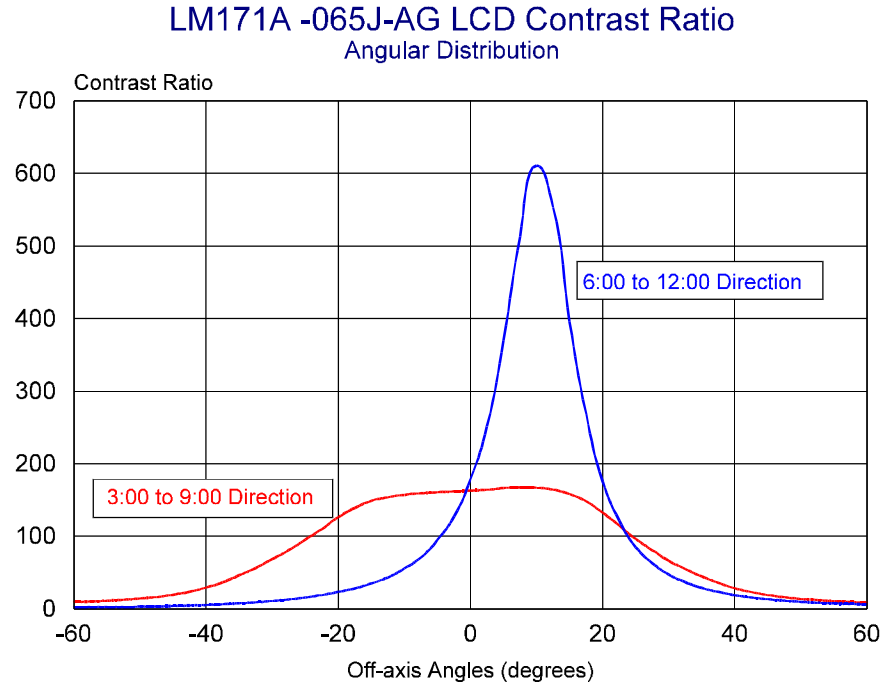
LCD Module Optical Performances

Luminance & Contrast Ratio

The typical LM171A-065J-AG 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 LM171A-065J-AG 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.

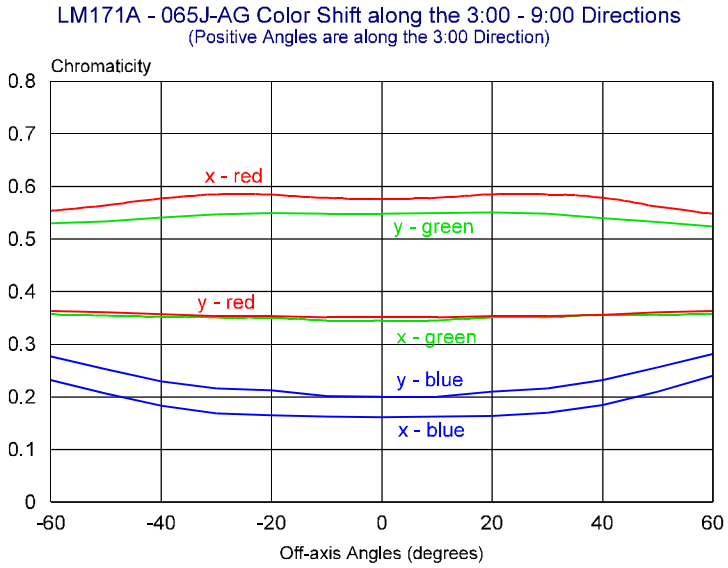
Chromaticity

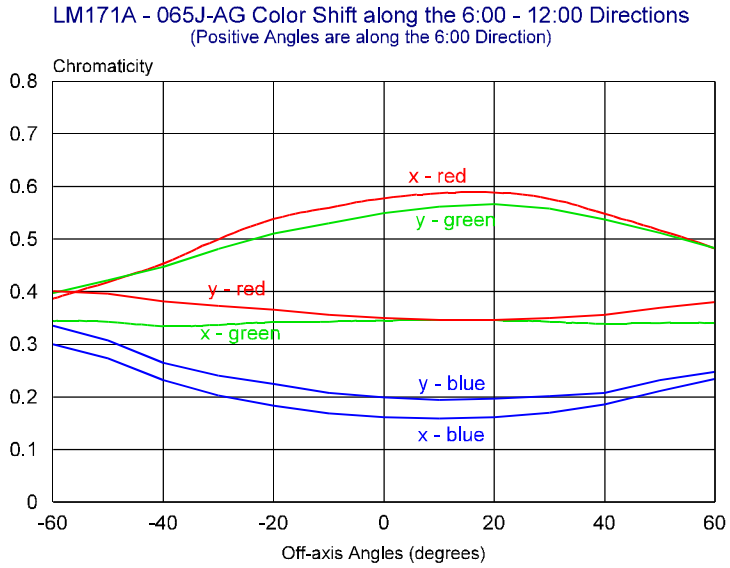
The 1931 CIE chromaticity coordinates of the R, G, B primary colors measured at the normal direction are presented in the table on page 1.

For a TN LCD, the LM171A-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

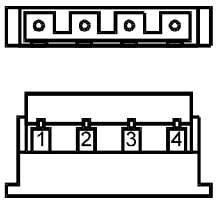
Along the 6:00 direction, the color shifts are small but slightly larger than those along the 3:00 and 9:00 directions. Along the 12:00 direction, all the primary colors have significant chromaticity shifts toward the white. Therefore, as the viewer moves to large off-axis angles, the colors tend to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





Backlight Lamp Connections

The LM171A-065J-AG LCD module uses a total of 6 cold cathode fluorescent lamps (CCFLs). The lamps are oriented in the horizontal direction and are electrically connected into two groups through two JST 4-pin connectors. The figure below shows the connector pin out assignments.



Connector: JST BHR-04VS-1, two connectors per module

Mating connector: JST SM04 (4.0)B-BHS-1-TB

Lamp wiring color:

Lamp #1 to #6	White
Lamp Common #1, #2	Gray

Group #1 Connector		Group #2 Connector	
Pin #	To	Pin #	To
1	Lamp #1	1	Lamp #4
2	Lamp #2	2	Lamp #5
3	Lamp #3	3	Lamp #6
4	Common 1	4	Common 2

Backlight Driving Conditions

It is recommended that an inverter with about 1300 Vrms starting voltage be used to run the VHB backlight on the LCD module. The lamp voltage and current at full LCD screen luminance are listed below:

Lamp Voltage	370	V_{rms}
Lamp Current	5.0	mArms

At this level, the LCD screen luminance reaches about 2,100 Cd/m^2 for LM171A-065J-AG. The backlight power consumption is about 11 Watts. Since most inverters have an efficiency between 75 - 80%, the DC power input to the inverter will be about 13.8 to 14.7 Watts.

Landmark BI206D inverters are specially tuned to drive the VHB backlight in the LM171A-065J LCD module. The inverter has a PWM (pulse width modulation) dimming circuit that provides a 200:1 screen luminance adjustment range. For detailed information, please refer to the BI206D inverter data sheets.

Thermal Management

The VHB backlight in the LM171A-065J LCD module consumes approximately 11 Watts at full brightness. As a result, the LCD screen temperature will be higher than normal. With the LCD running in normal room temperature without forced air cooling, the backlight aluminum box temperature reaches about 55^{o} C. This is about the maximum backlight box temperature before the LCD screen luminance starts to drop below the specified value. Therefore, when the LCD module is housed in a case, please make sure that the backlight Al box temperature is maintained at 55^{o} C or lower by using a small cooling fan or some type of thermal dissipation device.

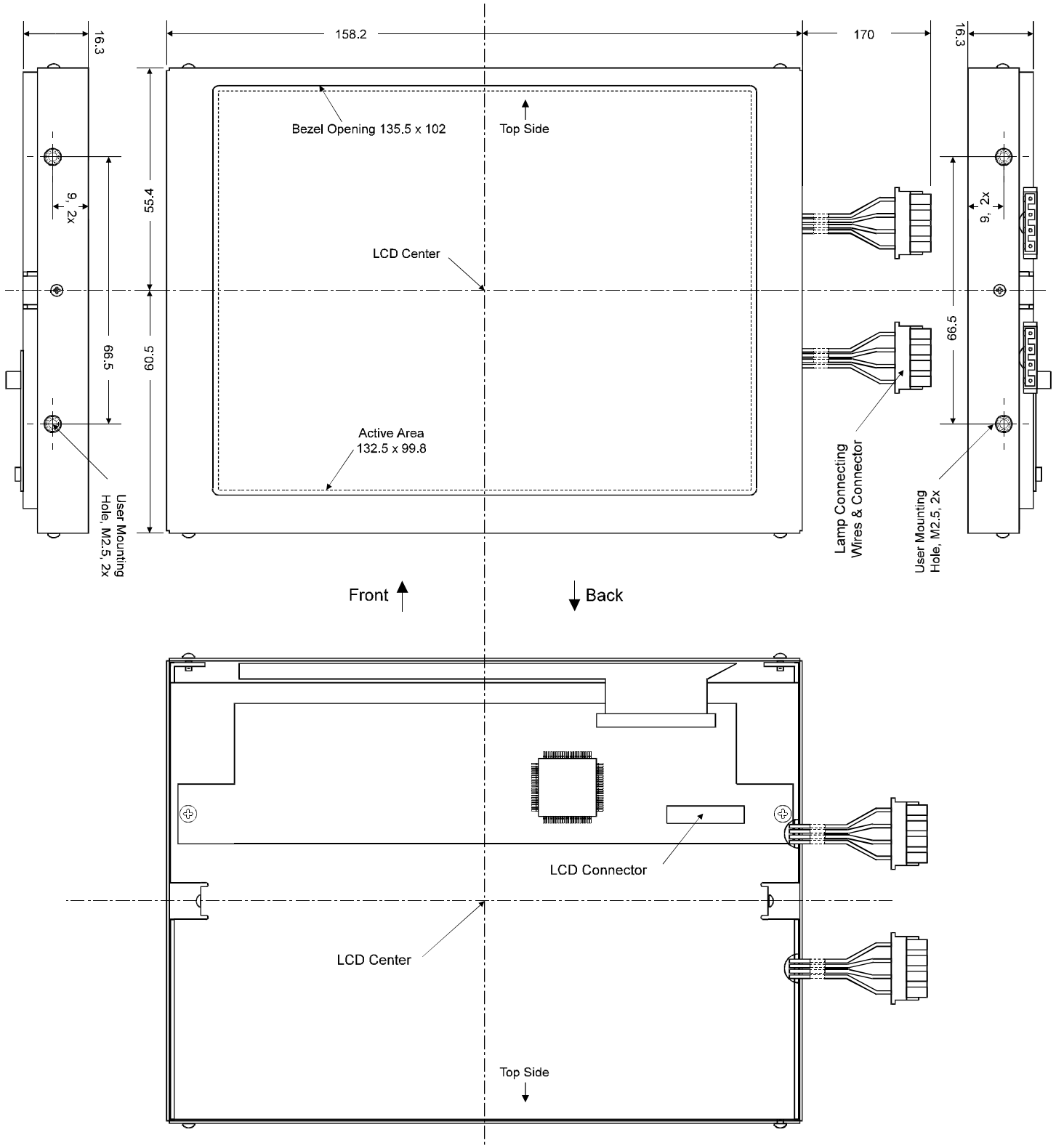
If the LM171A-065J LCD module is placed in outdoor environments with direct sunlight exposure, extra thermal management considerations must be implemented to avoid LCD over heating. The front surface of an LCD is a good solar energy absorber, the direct sunlight exposure can heat up the LCD module far more seriously than the heating from the VHB backlight alone. For more information on the sunlight heating issues on LCDs, please refer to Technical note TK1199 - www.landmarktek.com/html/lm_faqs.html.

Backlight Life

With the BI206D Inverter operating the LM171A-065J module at full screen luminance, the half brightness life of the CCFLs in the VHB backlight is about 25,000 hours. The half brightness life is the number of operating hours before the CCFL surface luminance drops down to 50% of its initial value.

In general, the luminance of a backlight decays slightly faster than that of a CCFL. This is due to the aging of other materials in the backlight. However, in actual applications, the luminance of a very bright display will likely be adjusted down in dimly lit environments. This reduces the lamp current, which increases the half brightness life of the lamps. Therefore, in practical applications, the operating lifetime of the VHB backlight in this extremely bright LCD module can be expected to reach beyond 25,000 hours. For detailed descriptions on backlight life issues and actual test data on Landmark Technology VHB backlights, please refer to Technical Note TK801 - www.landmarktek.com/html/lm_faqs.html

LCD Module Dimensions



All dimensions are in mm