

Introduction

LM161-104SN02 is a 10.4" VHB (Very High Brightness) LCD module. The module consists of an AUO B104SN02 TFT color LCD glass panel and a Landmark VHB backlight. It displays a very bright image with SVGA resolution.

At the maximum backlight power of 19 Watts, the LM161-104SN02 module delivers 1500 Cd/m² (nits) of LCD screen luminance. At this brightness level, the display is highly readable under bright ambient lighting, including direct outdoor sunlight. It is recommended that the Landmark BI200A or BI200AT inverter be used to operate the backlight in this LCD module. With this inverter, the LCD screen luminance can be adjusted down to about 8 Cd/m² for night viewing.

Characteristics (Note 1, 2)

Parameters	Typical Value	Units	Conditions
LCD Screen Luminance	1500	Cd/m ²	LCD displaying the brightest white
Luminance Uniformity	20% or better		Note 3
Backlight Power Consumption	19	Watts	Excluding inverter losses
Screen Luminance Dimming Ratio	200:1		With LMT BI330C inverter
Typical LCD Contrast Ratio	470:1		White vs. Black (measured in the dark along the normal direction)
Typical Viewing Angles			
3:00 direction	60	Degrees	Contrast ratio ≥ 10
9:00 direction	60	Degrees	Contrast ratio ≥ 10
6:00 direction	50	Degrees	Contrast ratio ≥ 10
12:00 direction	35	Degrees	Contrast ratio ≥ 10
LCD Screen Chromaticity (x, y)			
White	(0.338, 0.349)		Measured at the normal direction
Red	(0.589, 0.322)		Measured at the normal direction
Green	(0.317, 0.542)		Measured at the normal direction
Blue	(0.154, 0.149)		Measured at the normal direction
Response Speed			
Rise time	15	msec	Black to White, 10% - 90% transition
Fall time	10	msec	White to Black, 10% - 90% transition
LCD Module Weight	600	Grams	

Note 1: Please refer to AUO B104SN02 LCD Specification for detailed electrical specifications and general precautions.

Note 2: All data is measured at 25^o C ± 2^o C ambient temperature.

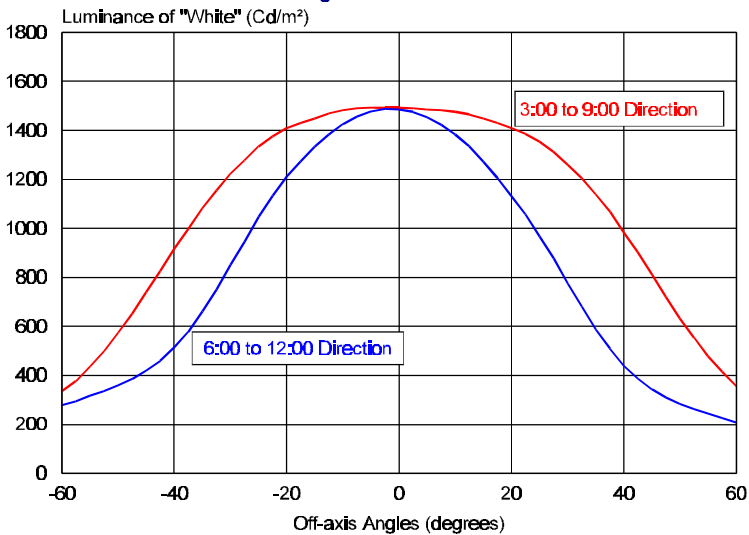
Note 3: Uniformity = (L_{max} - L_{min}) / (L_{max} + L_{min}) where L_{max} (L_{min}) is the maximum (minimum) luminance measured using a 10 mm diameter meter aperture over the LCD active area, except for the last 10 mm area from the edges.

LCD Module Optical Performances

Luminance & Contrast Ratio

The typical LM161-104SN02 LCD module screen luminance and contrast ratio are shown in the figures below. Since this 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 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 brightest “White” should be within 10% from the specified value.

LM161-104SN02 LCD Screen Luminance
Angular Distribution



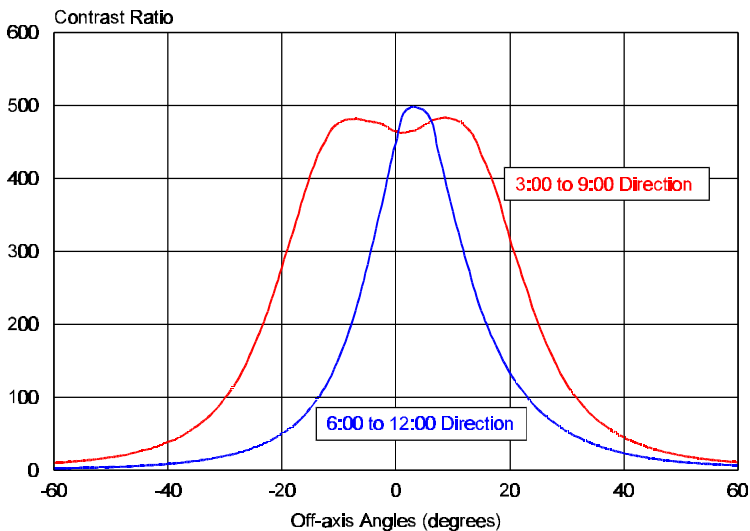
At the optimal viewing directions, the LM161-104SN02 LCD module has a high contrast ratio (CR) exceeding 450:1. This is the inherent CR, which is the luminance ratio between the “White” and the “Black” states measured in a dark room. Under ambient lighting, particularly in bright outdoor environments, the CR value of the display drops significantly due to the reflection and glare caused by the strong ambient illumination.

Chromaticity

The AUO B104SN02 is a film compensated TN LCD. The viewing angle of the LM161-104SN02 module is quite good and the amount of color shift at large viewing angles are relatively small.

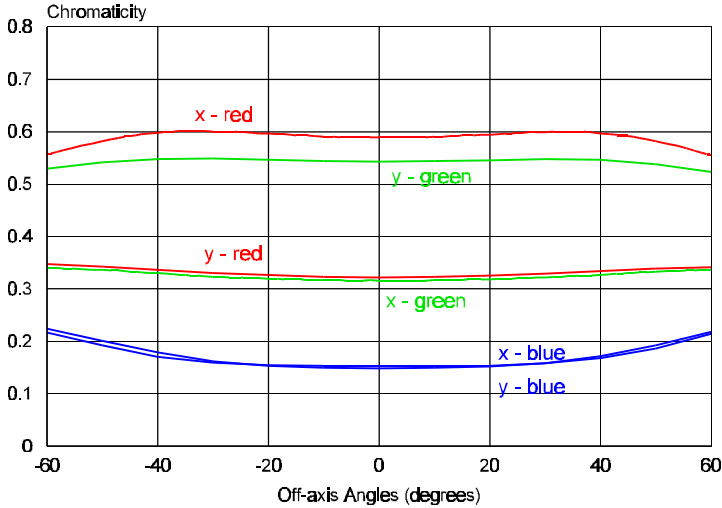
The figures on the next page present the chromaticity (x, y) data of the R, G, B primary colors displayed on the screen.

LM161-104SN02 LCD Contrast Ratio
Angular Distribution

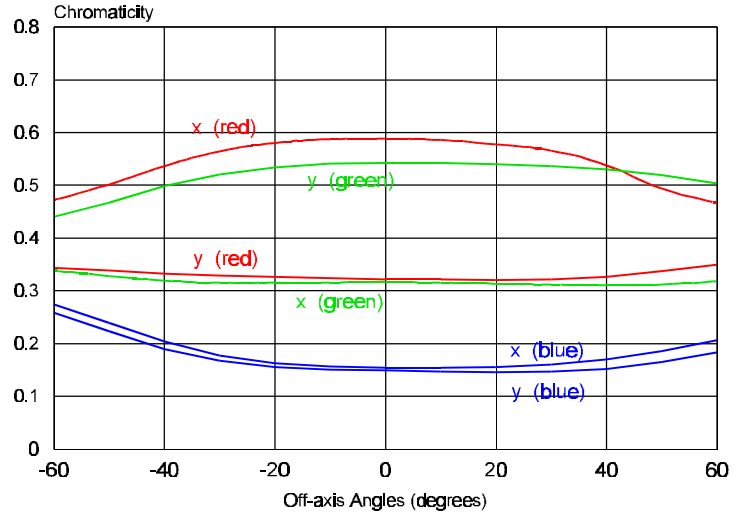


Along the 3:00 to 9:00 (horizontal) direction, the chromaticity values of the R, G, B primary colors do not change too much until the viewing angles exceed $\pm 45^\circ$. Along the 6:00 to 12:00 (vertical) directions, the color shifts are more significant. In particular, along the 12:00 direction, all the R, G, B primary colors show the typical white shift of a film compensated TN LCD. However, the overall color shifts of this LCD module at large off-axis viewing angles are small.

LM161-104SN02 Color Shift along the 3:00 - 9:00 Directions
(Positive Angles are along the 3:00 Direction)



LM161-104SN02 Color Shift along the 6:00 - 12:00 Directions
(Positive Angles are along the 6:00 Direction)



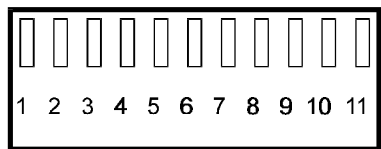
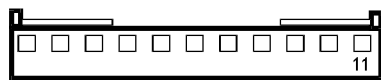
Backlight Lamp Driving Specifications

LM161-104SN02 VHB LCD has a VHB backlight with 8 cold cathode fluorescent lamps (CCFLs). The lamps are electrically connected into two groups through two 11-pin Molex connectors. The figure below shows the connector pin out assignments.

It is recommended that an inverter with lamp starting voltage equal or higher than 1,200 V_{rms} be used to operate the VHB backlight on the LM161-104SN02 module. The lamp voltage and current at full LCD screen brightness are as follows:

Operating Voltage 400 V_{rms}
Lamp Current 6 mA_{rms}

At this driving condition, the backlight delivers about 1,500 Cd/m^2 LCD screen brightness with a power consumption of about 19 Watts. Since most inverters have an efficiency level between 75 - 80%, the total DC power input to the inverter is about 23.8 to 25 Watts. When the backlight is dimmed down, the power consumption decreases.



Connector (Housing) Molex 22-01-3117
Two connectors per
backlight

Mating Header: Molex 22-23-2111

Group 1 Connector		Group 2 Connector	
Pin #	To	Pin #	To
1	NC	1	NC
2	NC	2	NC
3	Lamp #1	3	Lamp #5
4	NC	4	NC
5	Lamp #2	5	Lamp #6
6	NC	6	NC
7	Lamp #3	7	Lamp #7
8	NC	8	NC
9	Lamp #4	9	Lamp #8
10	NC	10	NC
11	COMMON 1	11	COMMON 2

Landmark BI200A and BI200AT inverters are designed to drive the 8-CCFL backlight in the LM161-104SN02 module. Both inverters have a PWM (pulse width modulation) circuit that provides a 200:1 screen luminance adjustment (i.e. from 1500 to 8 Cd/m²). For detailed information, please refer to the BI200A and BI200AT data

Backlight Life

When the lamps in the LM161-104SN02 backlight are operating at the recommended current for full LCD screen luminance, they are rated at 25,000 hours of half brightness life. 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 VHB display will likely be adjusted down in dimly lit environments. Since the half brightness life increases rapidly when lamps are operated at reduced current levels for lower LCD screen luminance, the actual operating lifetime of the backlight in this 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 backlights, please refer to Technical Note TK801

Thermal Management

The backlight power consumption of the LM161-104SN02 LCD module is approximately 19 Watts at full brightness. As a result, the LCD screen temperature will be higher than normal. It is necessary to dissipate the backlight heat such that the LCD temperature stays within the temperature specifications of the AUO B104SN02 LCD.

The exact increase in screen temperature depends on the installation of the LCD module in the equipment. For example, with the LM161-104SN02 operating at full brightness in open air with no air flow (still air), the average temperature of the LCD front surface is about 15 to 20 °C above the ambient air temperature. The highest temperature rise usually occurs if the LCD is placed horizontally. If the LCD is placed vertically, a portion of the heat may rise and dissipate into the air without heating up the LCD. When the LCD is mounted on a heat conducting bezel or a cooling fan is used, the screen temperature rise can be significantly reduced.

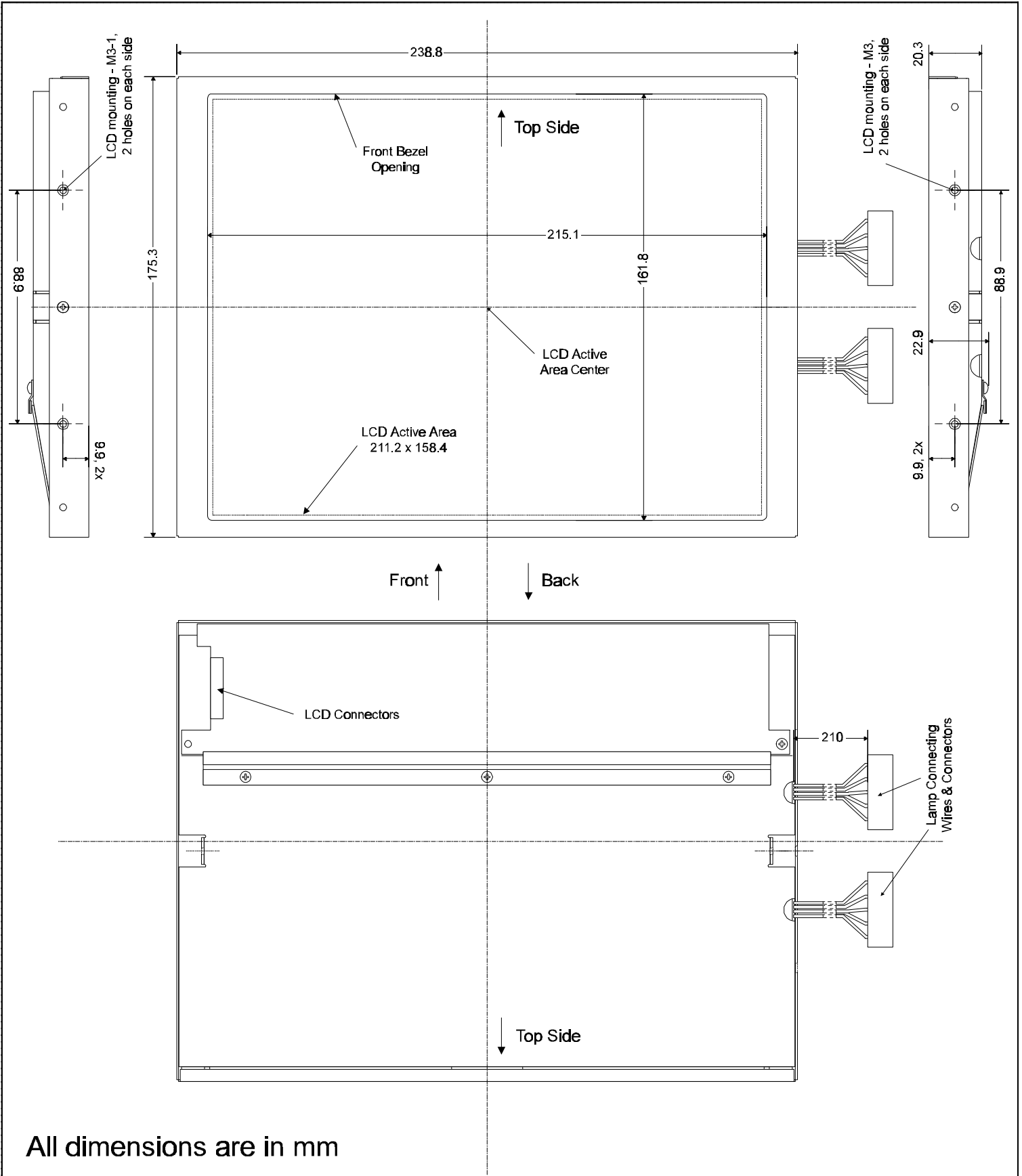
It is recommended that the LCD screen temperature be measured at full brightness in the equipment under actual operating environments. The cooling measure should then be designed accordingly. Please make sure that the specified maximum LCD temperature is not exceeded.

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LCD Module Mechanical Dimensions



All dimensions are in mm