

Introduction

LM143C-201SN02 is a 20.1" sunlight readable LCD module. The module consists of an AUO A201SN02 TFT color LCD panel and a Landmark VHB (very high brightness) backlight. The module has the same foot print and uses the same mounting holes as the original A201SN02 LCD.

At the maximum backlight power of 55 Watts, the LM143C-201SN02 module delivers 1,500 Cd/m² (nits) of LCD screen luminance. At this brightness level, the display is highly readable under bright ambient lighting including direct outdoor sunlight. The backlight requires the Landmark BI330C inverter, which can adjust the LCD screen luminance down to 8 Cd/m² for night viewing.

Characteristics (Note 1, 2)

| Parameters | Typical Value | Units | Conditions |
|--------------------------------|------------------|-------------------|--|
| LCD Screen Luminance | 1,500 | Cd/m ² | LCD in OFF state (normally White) |
| Luminance Uniformity | 20% or better | | Note 3 |
| Backlight Power Consumption | 55 | Watts | Excluding inverter losses |
| Screen Luminance Dimming Ratio | 200:1 | | With LMT BI330C inverter |
| Typical LCD Contrast Ratio | 650:1 | | White vs. Black (measured in the dark) |
| Typical Viewing Angles | | | |
| 3:00 direction | > 70 | Degrees | Contrast ratio ≥ 10 |
| 9:00 direction | > 70 | Degrees | Contrast ratio ≥ 10 |
| 6:00 direction | > 55 | Degrees | Contrast ratio ≥ 10 |
| 12:00 direction | > 70 | Degrees | Contrast ratio ≥ 10 |
| LCD Screen Chromaticity (x, y) | | | |
| White | (0.345, 0.348) | | Measured at the normal direction |
| Red | (0.655, 0.335) | | Measured at the normal direction |
| Green | (0.283, 0.619) | | Measured at the normal direction |
| Blue | (0.140, 0.069) | | Measured at the normal direction |
| Display Color | 16.7 M (24 bits) | | |
| Response time | 16 | msec | t _r + t _f , between White & Black, 10% to 90% transition or vice versa |
| LCD Interface | TTL one port | | |
| LCD Module Weight | 3000 | Grams | |

Note 1: Please refer to AUO A201SN02 LCD Product Specification for detailed LCD electrical specifications and general precautions

Note 2: All the optical data are measured at 25° C ± 2° C ambient temperature along the normal direction.

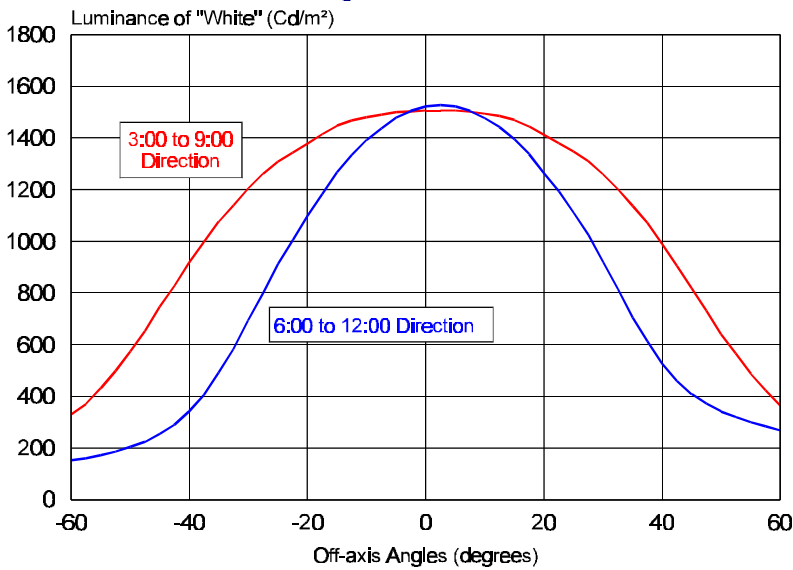
Note 3: Uniformity = (L_{max} - L_{min}) / (L_{max} + L_{min}) where L_{max} (L_{min}) is the maximum (minimum) luminance measured using a 10 mm diameter meter aperture over the LCD active area, except the last 10 mm area from the edges.

LCD Module Optical Performances

Luminance & Contrast Ratio

The typical LM143C-201SN02 LCD module screen luminance and contrast ratio are shown in the figures below: Since this module is a normally white LCD, the screen luminance at 1,500 nits 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 slightly lower luminance. Which 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% to the specified value.

LM143C-201SN02 LCD Screen Luminance
Angular Distribution



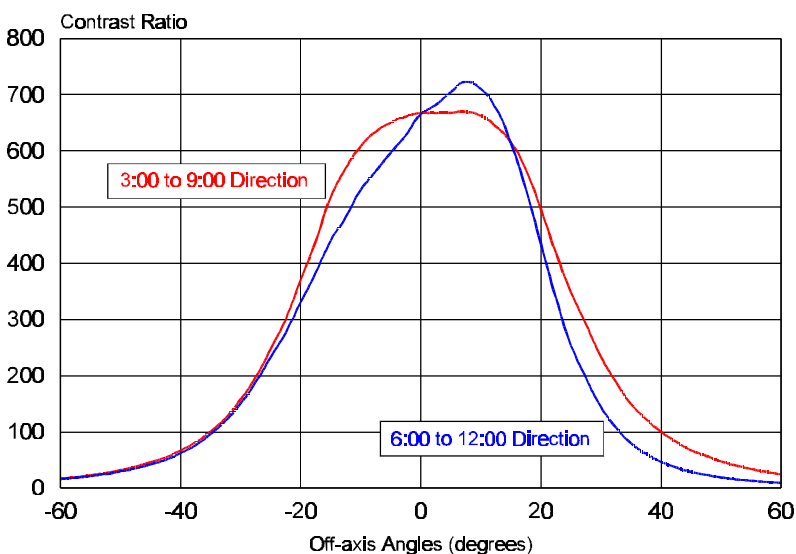
At a viewing direction perpendicular to the display, the LM143C-201SN02 LCD module has a contrast ratio (CR) about 650:1. This is the inherent CR, which is the luminance ratio between the “White” and the “Black” states measured in a totally dark room. Under ambient lighting, particularly in bright outdoor environments, the CR value of the display drops significantly due to the reflection and glare caused by the strong ambient illumination.

Chromaticity

LM143C-201SN02 is a normally white, film compensated TN LCD. Yet it has a very wide viewing angle with small color shift at off axis angles

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

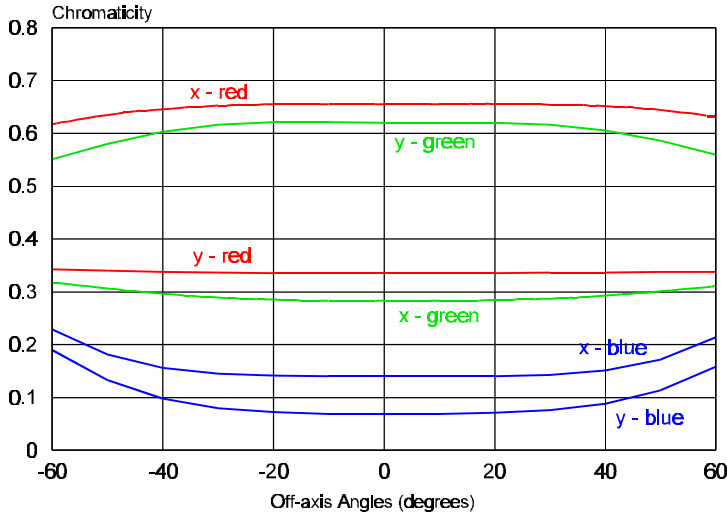
LM143C-201SN02 LCD Contrast Ratio
Angular Distribution



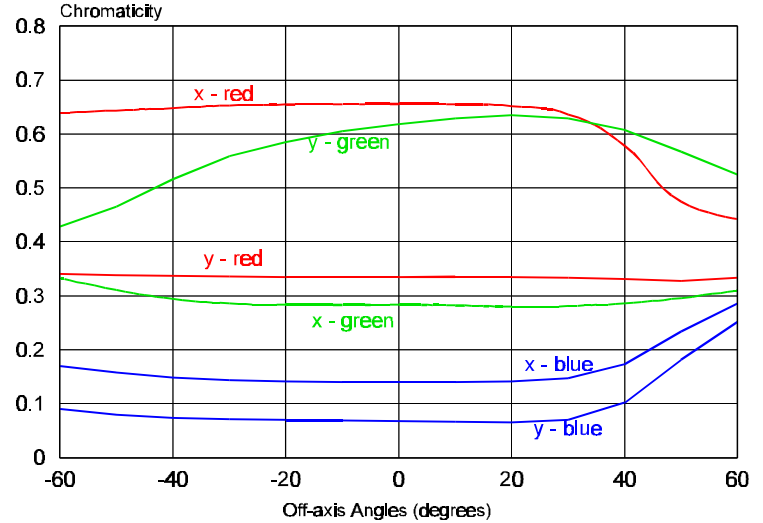
Along the 3:00 to 9:00 (horizontal) directions, there are not much changes in chromaticity until the viewing angle reaches $\pm 45^\circ$ off axis. Therefore, the color shift along the horizontal direction is small.

Along the vertical side, at 6:00 direction, the chromaticity values of the R, G, B primary colors change significantly at off-axis viewing angles beyond 40° . On the other hand, along the 12:00 direction, the changes are only significant for the Green primary color.

LM143C-201SN02 Color Shift along the 3:00 - 9:00 Directions
(Positive Angles are along the 3:00 Direction)



LM143C-201SN02 Color Shift along the 6:00 - 12:00 Directions
(Positive Angles are along the 6:00 Direction)



Backlight Lamp Driving Specifications

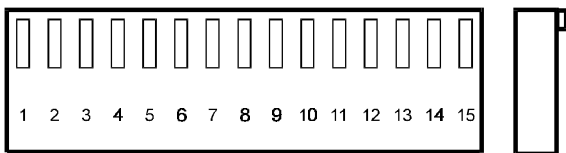
LM143C-201SN02 VHB LCD has a VHB backlight with 15 cold cathode fluorescent lamps (CCFLs). The lamps are electrically connected into three groups through three 15-pin Molex connectors. The figure below shows the connector pin out assignments.

voltage and current at full LCD screen luminance are listed below:

| | | |
|--------------|-----|------------|
| Lamp Voltage | 730 | V_{rms} |
| Lamp Current | 5.0 | mA_{rms} |

It is recommended that an inverter with a minimum of 1700 V_{rms} starting voltage be used to run the VHB backlight on the LM143C-201SN02 module. The lamp

At this driving condition, the backlight delivers 1,500 Cd/m^2 of LCD screen luminance with a power consumption of about 55 Watts.



| Connector #1 | | Connector #2 | | Connector #3 | |
|--------------|----------|--------------|----------|--------------|----------|
| Pin # | To | Pin # | To | Pin # | To |
| 1 | Lamp #1 | 1 | Lamp #6 | 1 | Lamp #11 |
| 2 | NC | 2 | NC | 2 | NC |
| 3 | Lamp #2 | 3 | Lamp #7 | 3 | Lamp #12 |
| 4 | NC | 4 | NC | 4 | NC |
| 5 | Lamp #3 | 5 | Lamp #8 | 5 | Lamp #13 |
| 6 | NC | 6 | NC | 6 | NC |
| 7 | Lamp #4 | 7 | Lamp #9 | 7 | Lamp #14 |
| 8 | NC | 8 | NC | 8 | NC |
| 9 | Lamp #5 | 9 | Lamp #10 | 9 | Lamp #15 |
| 10 | NC | 10 | NC | 10 | NC |
| 11 | NC | 11 | NC | 11 | NC |
| 12 | NC | 12 | NC | 12 | NC |
| 13 | NC | 13 | NC | 13 | NC |
| 14 | NC | 14 | NC | 14 | NC |
| 15 | Common 1 | 15 | Common 2 | 15 | Common 3 |

Connector (Housing) Molex 22-01-3157
Three connectors per LCD Module

Mating Header: Molex 22-05-3151

Lamp wiring color:

Lamp#1 to Lamp #15 White
Commons 1, 2, 3 Gray

Since most inverters have an efficiency level between 75 - 80%, the DC power input to the inverter is about 69 to 74 Watts. When the LCD luminance is adjusted down, the power consumption decreases.

Landmark BI330 inverter is designed to drive the 15-CCFL backlight in the LM153A-213U4 module. The inverter has 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 BI330 data sheet.

Backlight Life

When the lamps in the LM143C-201SN02 backlight are operating at the recommended current for full LCD screen luminance, they are rated at 50,000 hours 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 50,000 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 LM143C-201SN02 LCD module is approximately 55 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 A201SN02 LCD.

The exact increase in screen temperature depends on the installation of the LCD module in the equipment. For example, with the LM143C-201SN02 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.

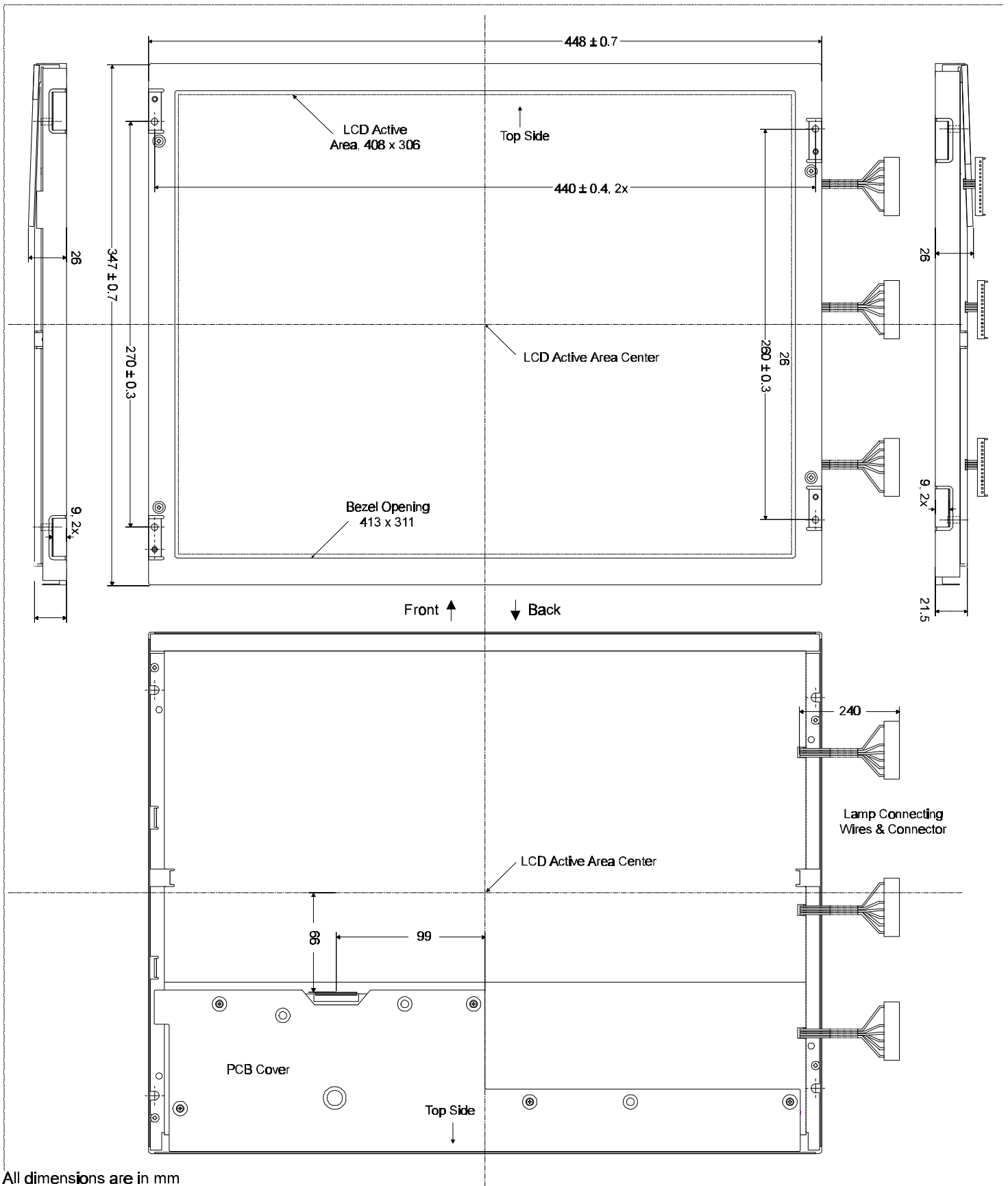
It is recommended that the LCD screen temperature be measured at full brightness in the equipment under actual operating environments. The cooling measure should then be designed accordingly. Please make sure that the specified maximum LCD temperature is not exceeded.

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LCD Module Mechanical Dimensions



All dimensions are in mm

