Landmark Technology

LM222-170EG01 - 17"

Sunlight Readable LCD Module

Introduction

LM222-170EG01 is a 17" sunlight readable LCD module. The module consists of an AUO G170EG01 TFT color LCD panel and a Landmark VHB (very high brightness) backlight. The module is fully compatible, mechanically and electrically, to Landmark LM177-170EG01 sunlight readable LCD module.

At the maximum backlight power of 37 Watts, the LM222-170EG01 module delivers 1,300 Cd/m^2 (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 BI320A inverter be used to operate the backlight in this LCD module. With this inverter, the LCD screen luminance can be adjusted down to 7 Cd/m^2 for night viewing.

Characteristics (Note 1, 2)

Parameters	Typical Value	Units	Conditions
LCD Screen Luminance	1,300	Cd/m^2	LCD in OFF state (normally White)
Luminance Uniformity	20% or better		Note 3
Backlight Power Consumption	39	Watts	Excluding inverter losses
Screen Luminance Dimming Ratio	200:1		With LMT BI320A inverter
Typical LCD Contrast Ratio	1,000:1		White vs. Black (measured in the dark at the normal direction)
Typical Viewing Angles			
3:00 direction	> 70	Degrees	Contrast ratio ≥ 10
9:00 direction	> 70	Degrees	Contrast ratio ≥ 10
6:00 direction	> 70	Degrees	Contrast ratio ≥ 10
12:00 direction	> 70	Degrees	Contrast ratio ≥ 10
LCD Screen Chromaticity (x, y)			
White	(0.347, 0.375)		Measured at the normal direction
Red	(0.644, 0.345)		Measured at the normal direction
Green	(0.280, 0.617)		Measured at the normal direction
Blue	(0.141, 0.078)		Measured at the normal direction
Response Speed			
Rise time	3.5	msec	White to Black, 10% - 90% transition
Fall time	1.5	msec	Black to White, 10% - 90% transition
LCD Module Weight	1,700	Grams	

Note 1: Please refer to AUO G170EG01 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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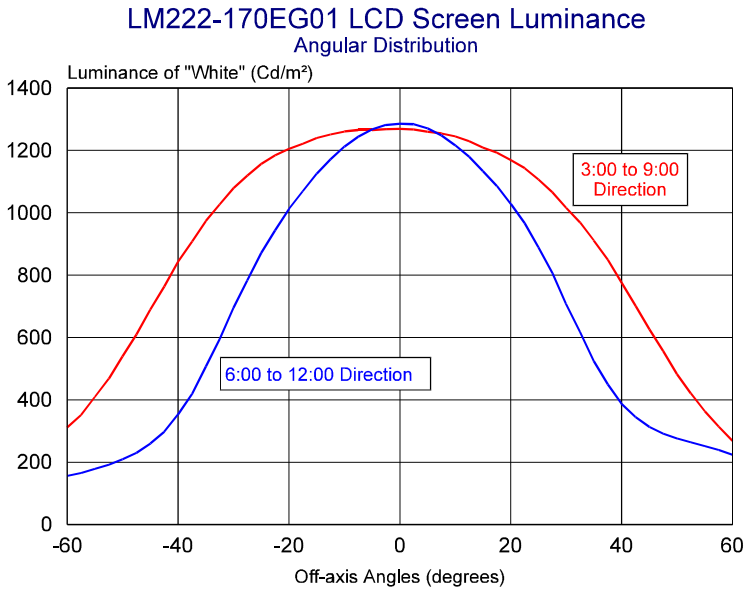
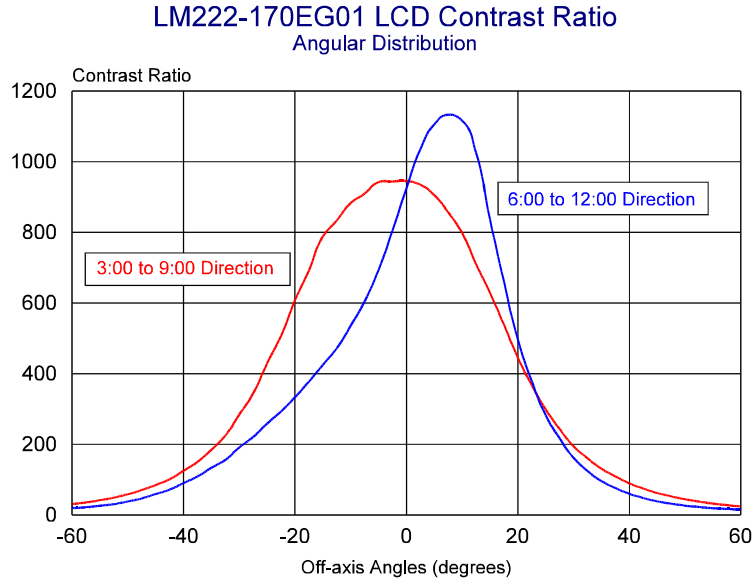
LCD Module Optical Performances

Luminance & Contrast Ratio

The typical LM222-170EG01 LCD module screen luminance and contrast ratio are shown in the figures below. Since this module 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 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 improper settings of 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.





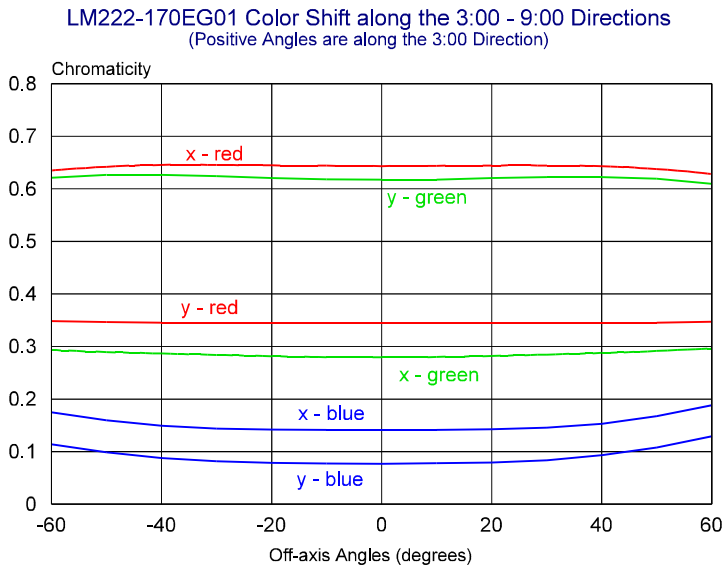
At the optimal viewing directions, the LM222-170EG01 LCD module has a very high contrast ratio (CR) of about 1,000:1. This is the inherent CR, which is the luminance ratio between the "White" and the "Black" states measured in a dark room. Under ambient lighting, particularly in bright outdoor environments, the CR value of the display drops significantly due to the reflection and glare caused by the strong ambient illumination.

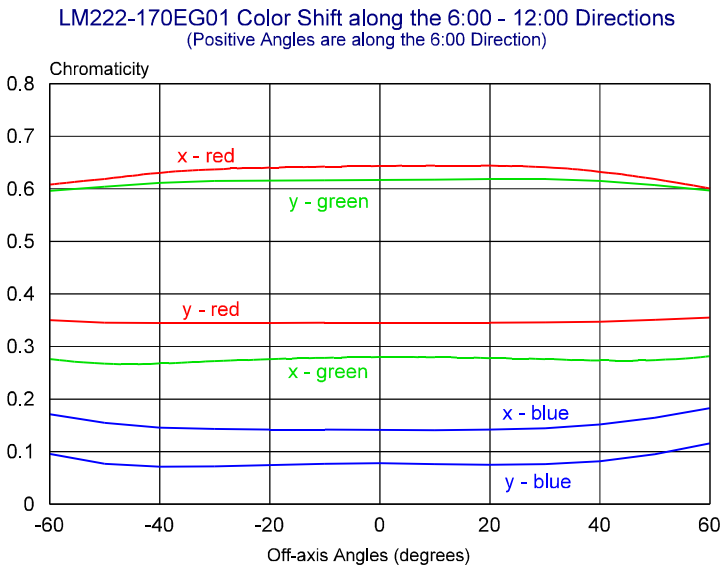
Chromaticity

The LM222-170EG01 is a normally white, film compensated TN LCD, yet it has a very wide viewing angle with almost no color shift.

The figures on the next page present the chromaticity (x, y) data of the R, G, B primary colors displayed on the screen along the 3:00 to 9:00 (horizontal) and the 6:00 to 12:00 (vertical) directions.

The Red & Green primary colors have virtually no chromaticity shifts for all the viewing angles. Only the Blue primary color shows some chromaticity shifts at the large off axis angles of 50 degrees and beyond.





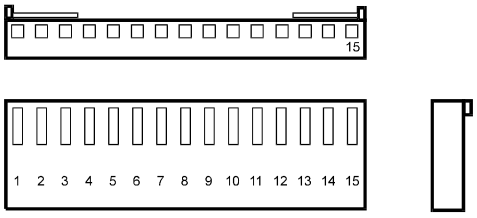
Backlight Lamp Driving Specifications

The LM222-170EG01 VHB LCD has a VHB backlight with 12 cold cathode fluorescent lamps (CCFLs). The lamps are electrically connected into two groups through two 15-pin Molex connectors. The figure on the next page shows the connector pin out assignments.

It is recommended that an inverter with a minimum of 1700 V_{rms} starting voltage be used to run the VHB backlight on the LM222-170EG01 module. The lamp voltage and current at full LCD screen luminance are listed below:

Lamp Voltage	595	V_{rms}
Lamp Current	5.5	mA_{rms}

At this driving condition, the backlight delivers 1,300 Cd/m^2 of LCD screen luminance with a power consumption of about 39 Watts.



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

Connector (Housing)	Molex 22-01-3157 Two connectors per backlight
Mating Header:	Molex 22-23-2151

Since most inverters have an efficiency level between 75 - 80%, the DC power input to the inverter is about 49 to 52 Watts. When the LCD luminance is adjusted down, the power consumption decreases.

The Landmark BI320A inverter is designed to drive the 12-CCFL backlight in the LM222-170EG01 module. The inverter has a PWM (pulse width modulation) circuit that provides a 200:1 screen luminance adjustment (i.e. from 1,300 to 7 Cd/m^2). For detailed information, please refer to the BI320A data sheet.

Backlight Life

When the lamps in the LM222-170EG01 backlight are operating at the recommended current for full LCD screen luminance, they are rated at 25,000 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 25,000 hours. For detailed discriptions 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 LM222-170EG01 LCD module is approximately 39 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 G170EG01, V0 LCD.

The exact increase in screen temperature depends on the installation of the LCD module in the equipment. For example, with the LM222-170EG01 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 ^{o}C above the ambient air temperature. Thus, the LCD module can be operated at 1,300 nits in open air without any cooling. However, when it is installed in a case, some type of cooling measure should be implemented.

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 a low reflective, black front surface. However, a black surface is also a good solar energy absorber. For example, if strong sunlight shines on the LM222-170EG01 LCD module at a perpendicular direction, the LCD module can absorb up to 100 Watts of solar power. This is about twice the total power consumption of the VHB backlight plus the inverter loss. As a result, the LCD temperature can rise very quickly beyond its maximum tolerance level. Please refer to Landmark Technote TK1199 for more details.

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.

Caution:

LM222-170EG01 is a side mount LCD module. Please use screws of proper size and length for LCD mounting. Excessively long screws can cause severe damage to the LCD module. Please follow the drawing on page 6 for the proper screw length.

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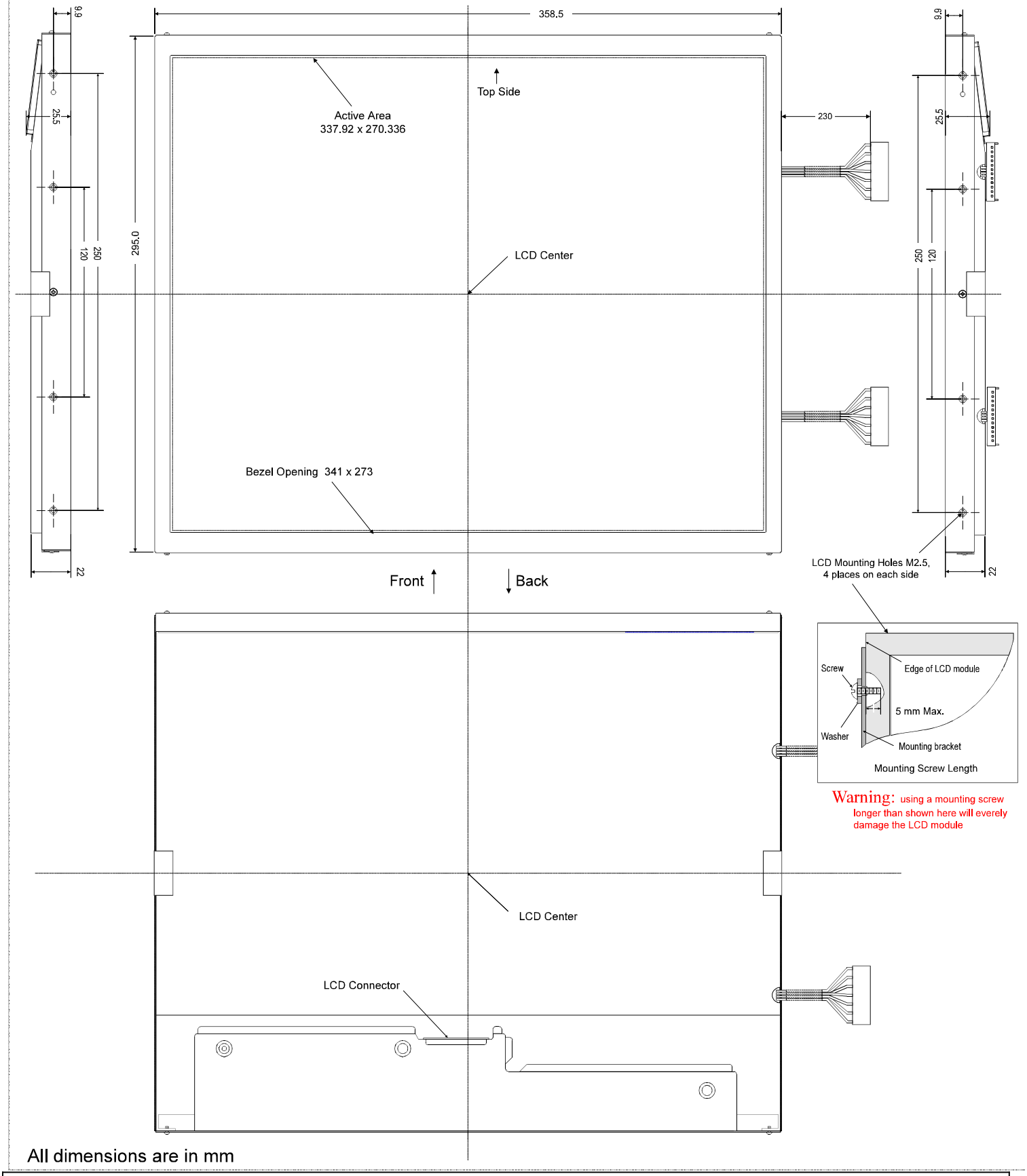
LCD Module Mechanical Dimensions



Warning: using a mounting screw longer than shown here will everely damage the LCD module

All dimensions are in mm