

#### Introduction

LM170-150X1LGN2A is a 15" Sunlight Readable LCD module. The module consists of a Sharp LQ150X1LGN2A TFT color LCD panel and a Landmark VHB (very high brightness) backlight. The LM170-150X1LGN2A module is mechanically compatible to Landmark LM140-150DG16 and LM152C-150XH04 LCD modules.

At the maximum backlight power of 35 Watts, the LM170-150X1LGN2A module delivers 1,800 Cd/m<sup>2</sup> (nits) of LCD screen brightness. At this brightness level, the display is highly readable even under direct sunlight. In addition, the color tone of the "White" displayed on the LCD screen closely matches the color of normal sunlight. With a wide dimming range inverter, the screen brightness can be adjusted down to less than 10 Cd/m<sup>2</sup>.

#### Characteristics (Note 1, 2)

Parameters	Typical Value	Units	Conditions
LCD Screen Luminance	2,000	Cd/m <sup>2</sup>	LCD displays the brightest white
Luminance Uniformity	20% or better		Note 3
Backlight Power Consumption	35	Watts	Excluding inverter losses
Screen Dimming Ratio	200:1		With LMT BI224A inverter
Typical LCD Contrast Ratio	500:1		White vs. Black (measured in the dark at the normal direction)
Typical Viewing Angles			
3:00 to 9:00 direction	> ± 60	Degrees	Contrast ratio ≥ 10
6:00 to 12:00 direction	> ± 55	Degrees	Contrast ratio ≥ 10
3:00 to 9:00 direction	> ± 60	Degrees	Screen brightness ≥ 200 Cd/m <sup>2</sup>
6:00 to 12:00 direction	> ± 55	Degrees	Screen brightness ≥ 200 Cd/m <sup>2</sup>
LCD Screen Chromaticity (x, y)			
White	(0.343, 0.352)		Measured at the normal direction
Red	(0.628, 0.341)		Measured at the normal direction
Green	(0.296, 0.586)		Measured at the normal direction
Blue	(0.144, 0.103)		Measured at the normal direction
LCD Module Weight	1,200	Grams	
Display Resolution	1,024 x 768		
LCD Interface	LVDS		

Note 1: Please refer to the Sharp LQ150X1LGN2A data sheet for detailed LCD electrical specifications and general precautions.

Note 2: All data are measured at 25<sup>o</sup> C ± 2<sup>o</sup> C ambient temperature.

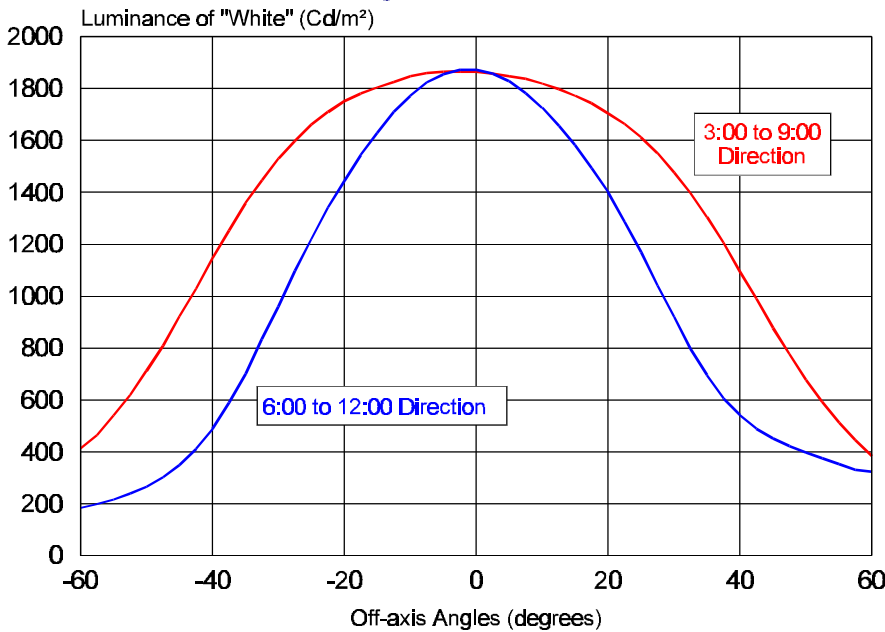
Note 3: Uniformity = (L<sub>max</sub> - L<sub>min</sub>) / (L<sub>max</sub> + L<sub>min</sub>) where L<sub>max</sub> (L<sub>min</sub>) is the maximum (minimum) luminance measured with a 10 mm diameter meter aperture over the LCD active area except for the last 10 mm area from the edges.

## LCD Module Optical Performances

### Luminance & Contrast Ratio

The typical LM170-150X1LGN2A LCD module screen luminance and contrast ratio are shown in the figures below: Since the Sharp LQ150X1LGN2A 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.

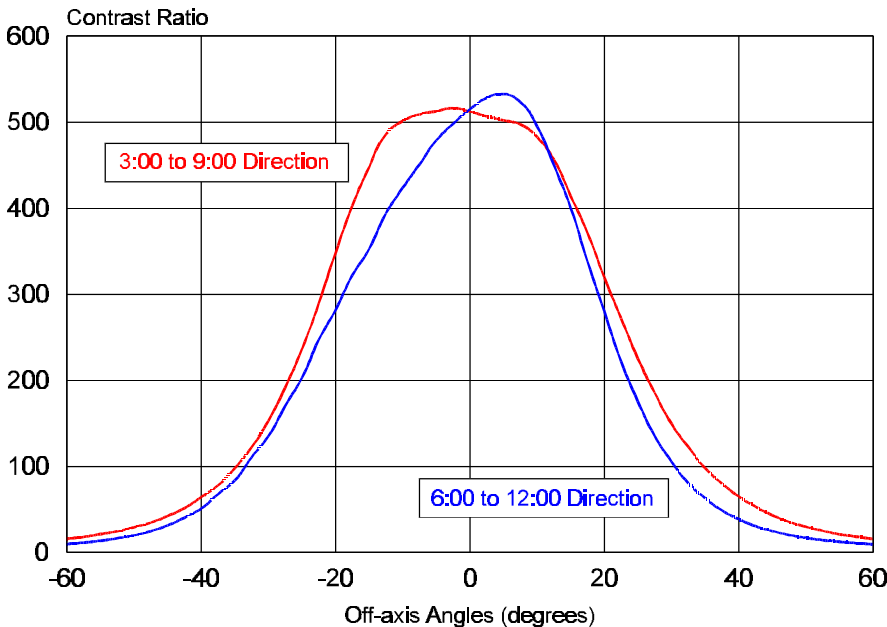
**LM170-150X1LGN2A LCD Screen Luminance**  
Angular Distribution



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.

The LM170-150X1LGN2A LCD module has a very high contrast ratio (CR) over 500:1 along the normal direction. 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.

**LM170-150X1LGN2A LCD Contrast Ratio**  
Angular Distribution



### Chromaticity

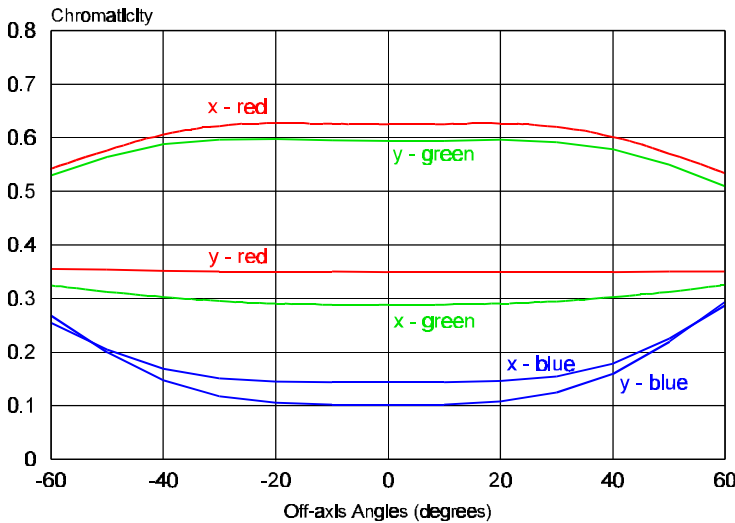
The 1931 CIE chromaticity coordinates of the R, G, B primary colors are presented in the table on page 1. The color gamut is quite wide. Therefore, at the normal viewing direction, the colors displayed on the screen are quite good.

The Sharp LQ150X1LGN2A is a film compensated TN LCD, yet it has a very wide viewing angle with 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

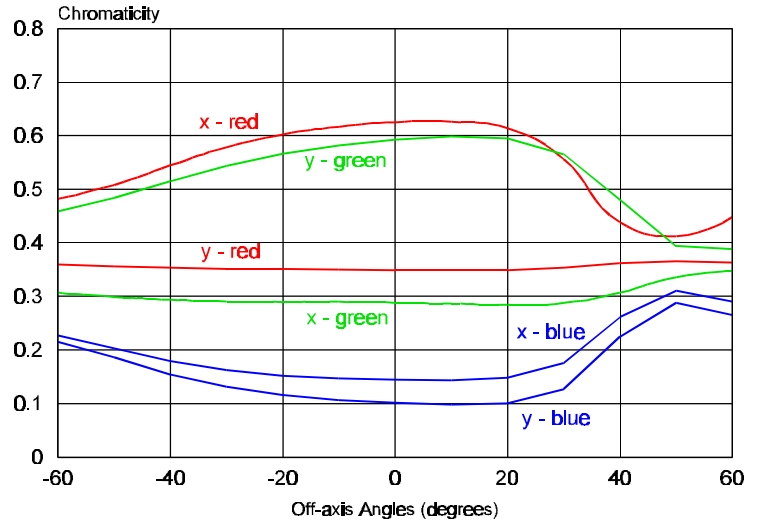
Along the 3:00 to 9:00 (horizontal) directions, the chromaticity changes of the primary colors are small until the viewing angles reach  $\pm 50^\circ$  and beyond. Therefore, the display image has virtually no color shifts over  $\pm 45^\circ$  viewing angles. Beyond that, a minor color shift toward the “White” is observed.

Along the 6:00 to 12:00 (vertical) directions, all the primary colors have significant chromaticity changes at viewing angles beyond  $40^\circ$ , in particular, along the 6:00 direction. As the viewer moves to large off-axis angles, the color shifts along the 6:00 direction become noticeable.

LM170-150X1LGN2A Color Shift along the 3:00 - 9:00 Directions  
(Positive Angles are along the 3:00 Direction)

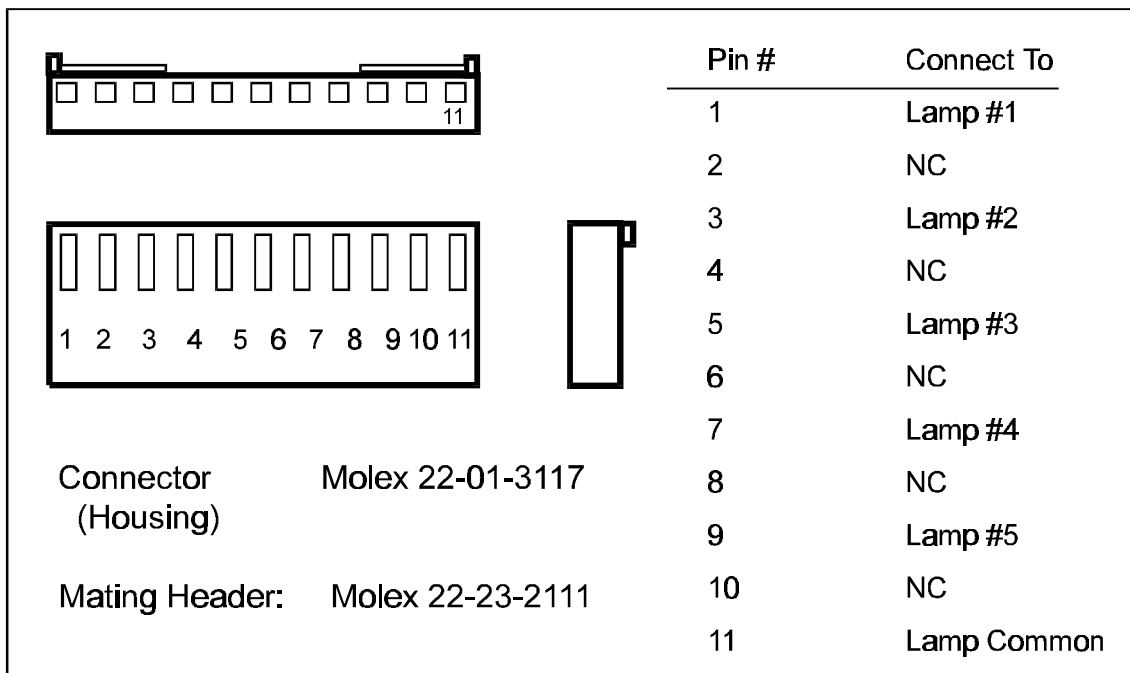


LM170-150X1LGN2A Color Shift along the 6:00 - 12:00 Directions  
(Positive Angles are along the 6:00 Direction)



### Backlight Lamp Connections

LM170-150X1LGN2A VHB LCD module uses a total of 12 cold cathode fluorescent lamps to achieve the required screen luminance. The lamps are oriented in the horizontal direction and are electrically connected into two groups through two 13-pin Molex connectors. The figure below shows the connector pin out assignments.



## Backlight Lamp Driving Specifications

It is recommended that an inverter with about 1300 V<sub>rms</sub> starting voltage be used to run the VHB backlight on the LM170-150X1LGN2A module. The lamp voltage and current at full LCD screen brightness are listed below:

Operating Voltage	515	V <sub>rms</sub>
Lamp Current	5.6	mA <sub>rms</sub> / lamp

At this driving condition, the backlight delivers 1,800 Cd/m<sup>2</sup> of LCD screen brightness with a power consumption of about 35 Watts. Since most inverters have an efficiency between 75 - 80%, the total DC power input to the inverter is about 44 to 47 Watts. When the backlight is dimmed down, the power consumption decreases.

Landmark BI224A inverters are specifically tuned to drive the backlight in the LM170-150X1LGN2A module. The inverter has a PWM (pulse width modulation) circuit that provides a 200:1 screen luminance adjustment (i.e. from 1,800 to 9 Cd/m<sup>2</sup>). For detailed information, please refer to the BI224A inverter data sheets.

It is quite difficult to measure the lamp current accurately, So, if you intend to run the LM170-150X1LGN2A VHB backlight with other inverters, please measure the screen brightness to double check the lamp driving condition. To accomplish this, turn on the inverter and set the brightness of the “white” state on the LCD screen to the maximum. Make sure that the room temperature is about 25 °C and run the backlight for at least 30 minutes before measuring the screen brightness. If the measured screen brightness differs from the specified value by a significant margin, for example more than ±15%, the lamps are either under-driven or over-driven. Significantly over-driving the lamps can cause a reduction in backlight life.

## Thermal Management

The backlight power consumption of the LM170-150X1LGN2A LCD module is approximately 35 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 Sharp’s temperature specifications for the LQ150X1LGN2A LCD.

The exact degree of screen temperature rise depends on the installation of the LCD module in the equipment. For example, with the LM170-150X1LGN2A 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 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.

If the thermal issue becomes difficult to resolve, it is possible to run the LM170-150X1LGN2A module at a lower brightness to reduce the backlight power. For example, if the PWM dimming circuit of the BI224A Inverter is set at 70% duty cycle, the LCD screen brightness is about 1,260 nits and the backlight power will be reduced by about 30%. As a result, the thermal related issues are reduced proportionally.

## Backlight Life

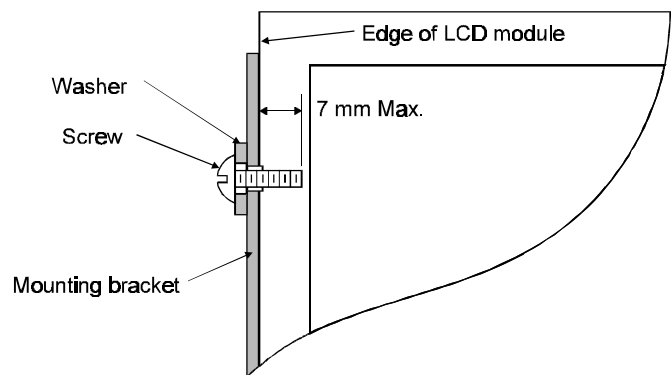
The half brightness life of the VHB backlight in the LM170-150X1LGN2A sunlight readable module is rated at 25,000 hours. The half brightness life is the number of operating hours before the backlight luminance (so as the LCD luminance) drops down to 50% of its initial value.

For a well made backlight, its life is mainly determined by the lamp life. Lamp life depends strongly on the lamp current. The recommended lamp current for full LM170-150X1LGN2A LCD screen brightness is 5.6 mA. At this level, the half brightness life of the backlight is rated at 25,000 hours.

In actual applications, a VHB display is likely adjusted down under dim ambient lighting conditions. For example, if the LM170-150X1LGN2A LCD module is dimmed down to half of its full level, the lamp current decreases to 2.8 mA and the lamp life increases to about 50,000 hours. Therefore, the actual operating lifetime of the VHB backlight in the LM170-150X1LGN2A module is expected to exceed 25,000 hours under most practical situations. For more detailed descriptions on backlight life issues and actual test data on Landmark Technology backlights, please refer to Technical Notes TK801

### Caution:

LM170-150X1LGN2A 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 the right as the guideline for the proper screw length.



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