

Introduction

LM154-150LW71N is a 15" Sunlight Readable LCD module. The module consists of a Sharp LQ150X1LW71N TFT color LCD panel and a Landmark VHB (very high brightness) backlight. The LM154-150LW71N module is mechanically compatible to the Landmark LM140-150DG16, and LM152C-150XN04 LCD modules.

At the maximum backlight power of 36 Watts, the LM154-150LW71N module delivers 1,150 Cd/m² (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 6 Cd/m².

Characteristics (Note 1, 2)

Parameters	Typical Value	Units	Conditions
LCD Screen Luminance	1,150	Cd/m ²	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	550:1		White vs. Black (measured in the dark at the normal direction)
Typical Viewing Angles			
3:00 to 9:00 direction	± 85	Degrees	Contrast ratio ≥ 10
6:00 to 12:00 direction	± 85	Degrees	Contrast ratio ≥ 10
3:00 to 9:00 direction	> ± 60	Degrees	Screen brightness ≥ 150 Cd/m ²
6:00 to 12:00 direction	> ± 60	Degrees	Screen brightness ≥ 150 Cd/m ²
LCD Screen Chromaticity (x, y)			
White	(0.341, 0.354)		Measured at the normal direction
Red	(0.653, 0.335)		Measured at the normal direction
Green	(0.286, 0.618)		Measured at the normal direction
Blue	(0.142, 0.095)		Measured at the normal direction
Display Resolution	1,024 x 768		
LCD Interface	LVDS		
LCD Module Weight	1,200	Grams	
LCD Module Dimensions	See P. 6		

Note 1: Please refer to the Sharp LQ150X1LW71N data sheet for detailed LCD electrical specifications and general precautions.

Note 2: All data are 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 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

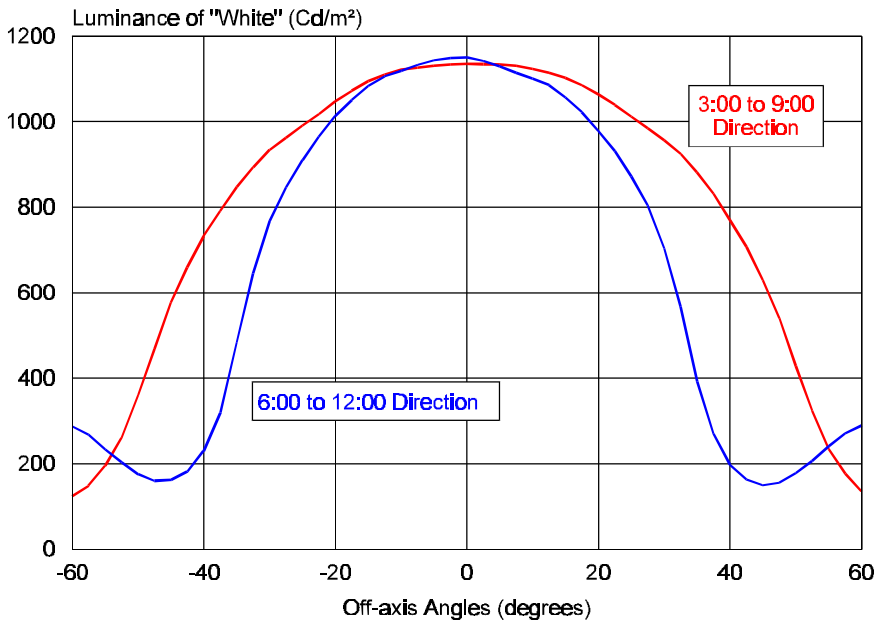
Luminance & Contrast Ratio

The typical LM154-150LW71N LCD module screen luminance and contrast ratio are shown in the figures below: Since the Sharp LQ150X1LW71N is a normally black, wide viewing angle LCD, the screen luminance is measured with the LCD displaying the brightest “White” state. Therefore, the measured screen luminance may depend on the

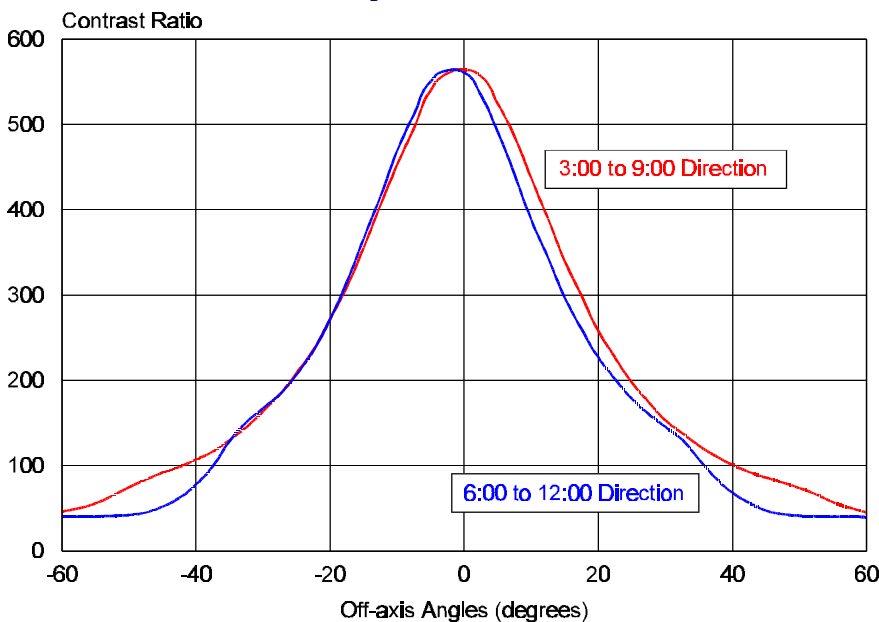
graphics card, the LCD controller, and the OSD settings. When the LCD is properly driven, the measured luminance of the brightest “White” displayed on the screen should be within 10% of the specified value.

The LM154-150LW71N 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.

LM154-150LW71N LCD Screen Luminance
Angular Distribution



LM154-150LW71N LCD Contrast Ratio
Angular Distribution

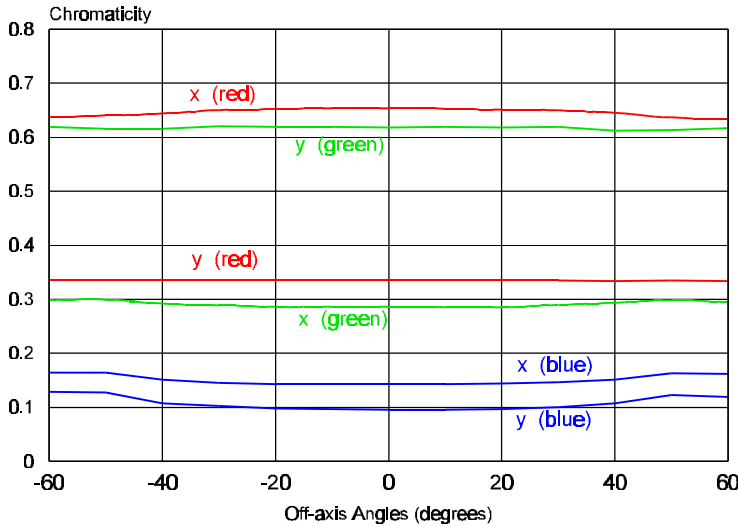


Color and Chromaticity

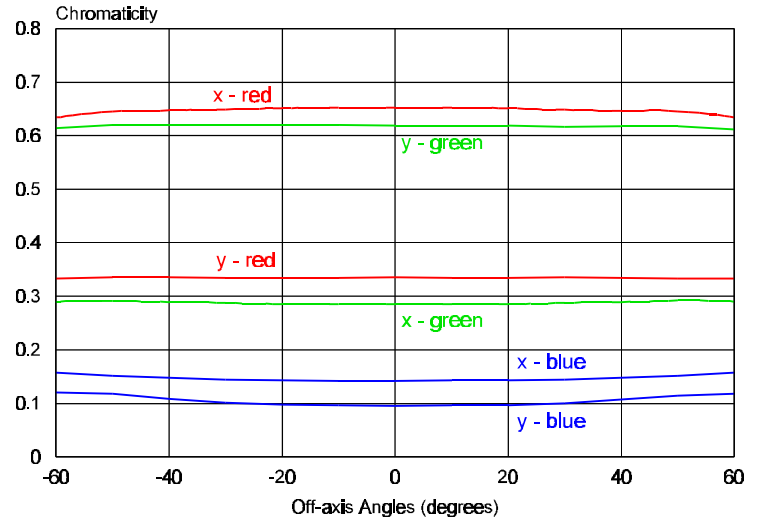
The 1931 CIE chromaticity coordinates of the R, G, B primary colors are listed in the table on page 1. The color gamut is exceptionally wide. In addition, the LCD reproduces images in 24-bit colors and gray scales. Therefore, the image quality is superb.

The following figures show the chromaticity (x, y) data of the R, G, B primary colors as a function of the viewing angles. It is obvious that there is virtually no color shift at off-axis viewing angles.

LM154-150LW71N Color Shift along the 6:00 - 12:00 Directions
(Positive Angles are along the 6:00 Direction)

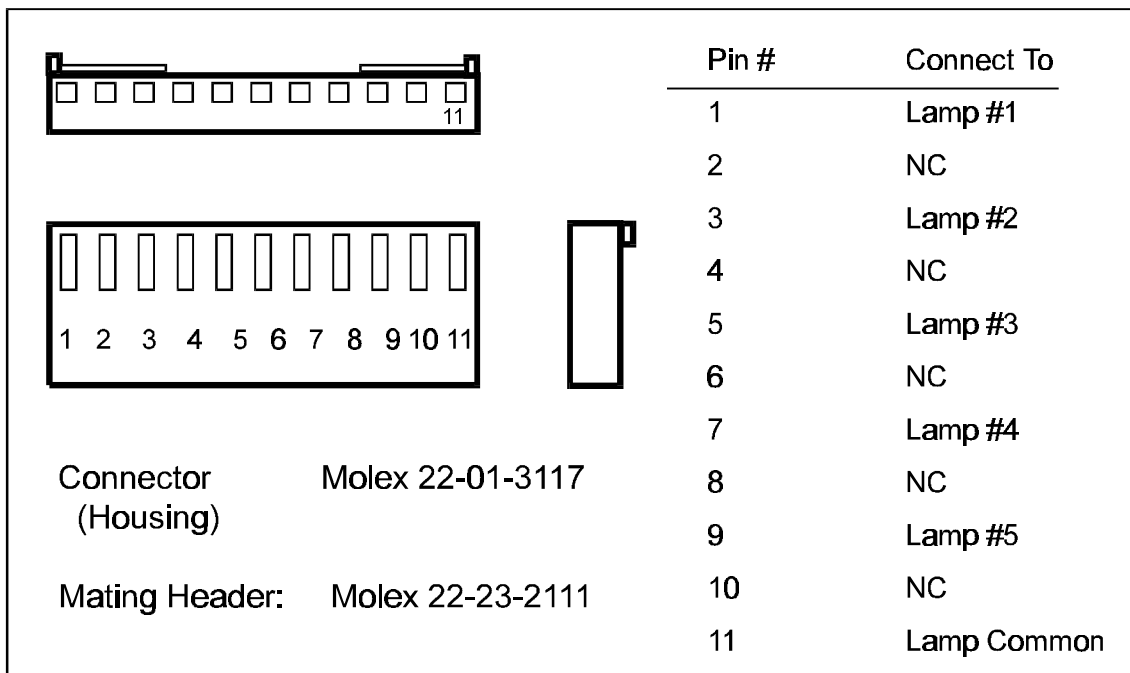


LM154-150LW71N Color Shift along the 3:00 - 9:00 Directions
(Positive Angles are along the 3:00 Direction)



Backlight Lamp Connections

LM154-150LW71N 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_{rms} starting voltage be used to run the VHB backlight on the LM154-150LW71N module. The lamp voltage and current at full LCD screen brightness are listed below:

Operating Voltage	515	V_{rms}
Lamp Current	5.6	mA_{rms} / lamp

At this driving condition, the backlight delivers 1,150 Cd/m^2 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 LM154-150LW71N module. The inverter has a PWM (pulse width modulation) circuit that provides a 200:1 screen luminance adjustment (i.e. from 1,150 to 6 Cd/m^2). 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 LM154-150LW71N 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 $\pm 15\%$, 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 LM154-150LW71N 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 LQ150X1LW71N LCD .

The exact degree of screen temperature rise depends on the installation of the LCD module in the equipment. For example, with the LM154-150LW71N 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 LM154-150LW71N module at a lower brightness to reduce the backlight power. For example, if the PWM dimming circuit of the BI320A inverter is set at 70% duty cycle, the LCD screen brightness is about 800 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 LM154-150LW71N sunlight readable module is rated at 25,000 hours. The half brightness life is the number of operating hours before the backlight luminance (and the LCD luminance) drops down to 50% of its initial value.

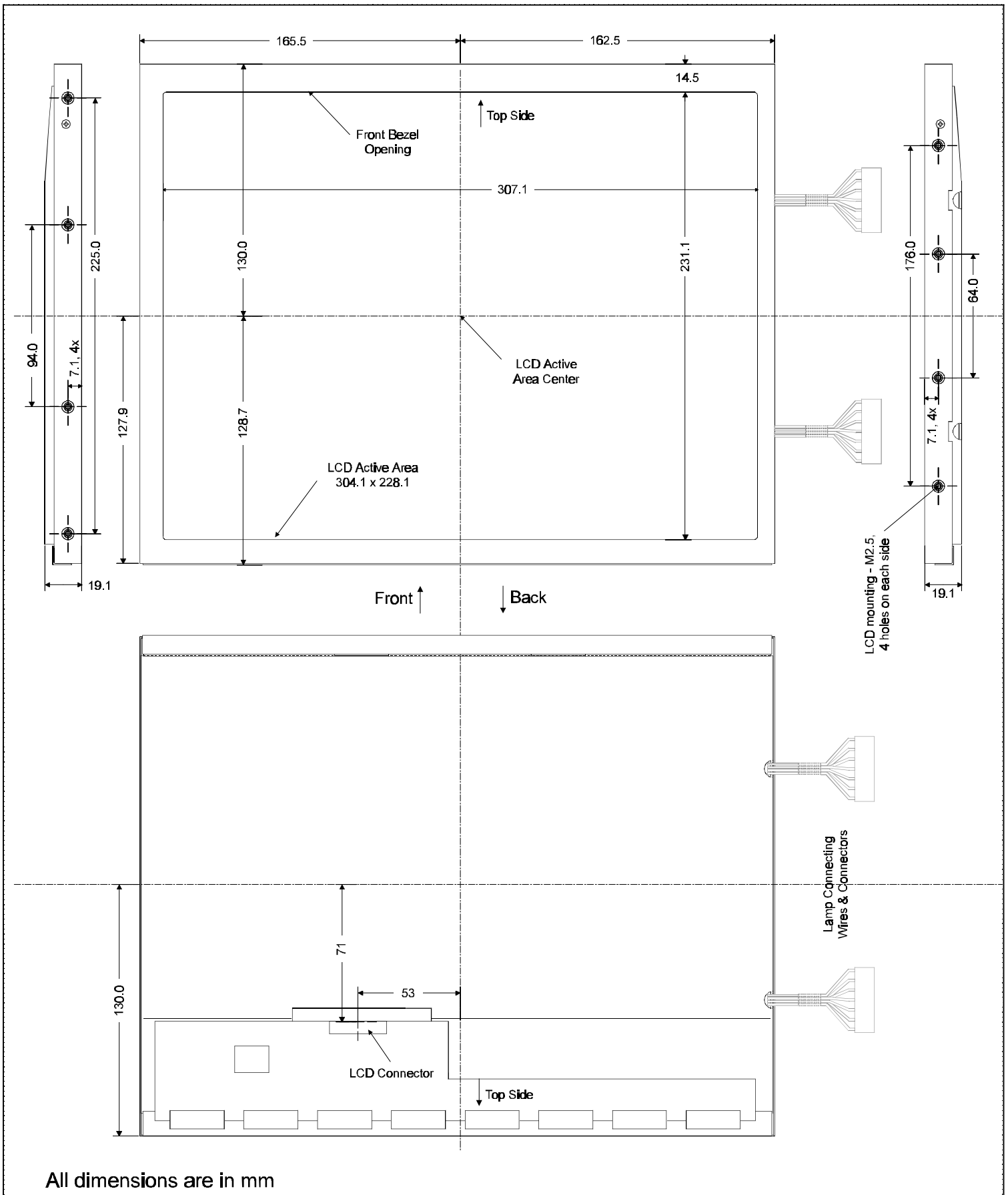
For a well made backlight, its life is mainly determined by the lamp life. Lamp life depends strongly on the lamp current. The recommended lamp current for full LM154-150LW71N LCD screen brightness is 5.6 mA. At this level, the half brightness life of the backlight is rated at 25,000 hours.

In actual applications, a VHB display is likely adjusted down under dim ambient lighting conditions. For example, if the LM154-150LW71N 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 65,000 hours. Therefore, the actual operating lifetime of the VHB backlight in the LM154-150LW71N 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

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All dimensions are in mm