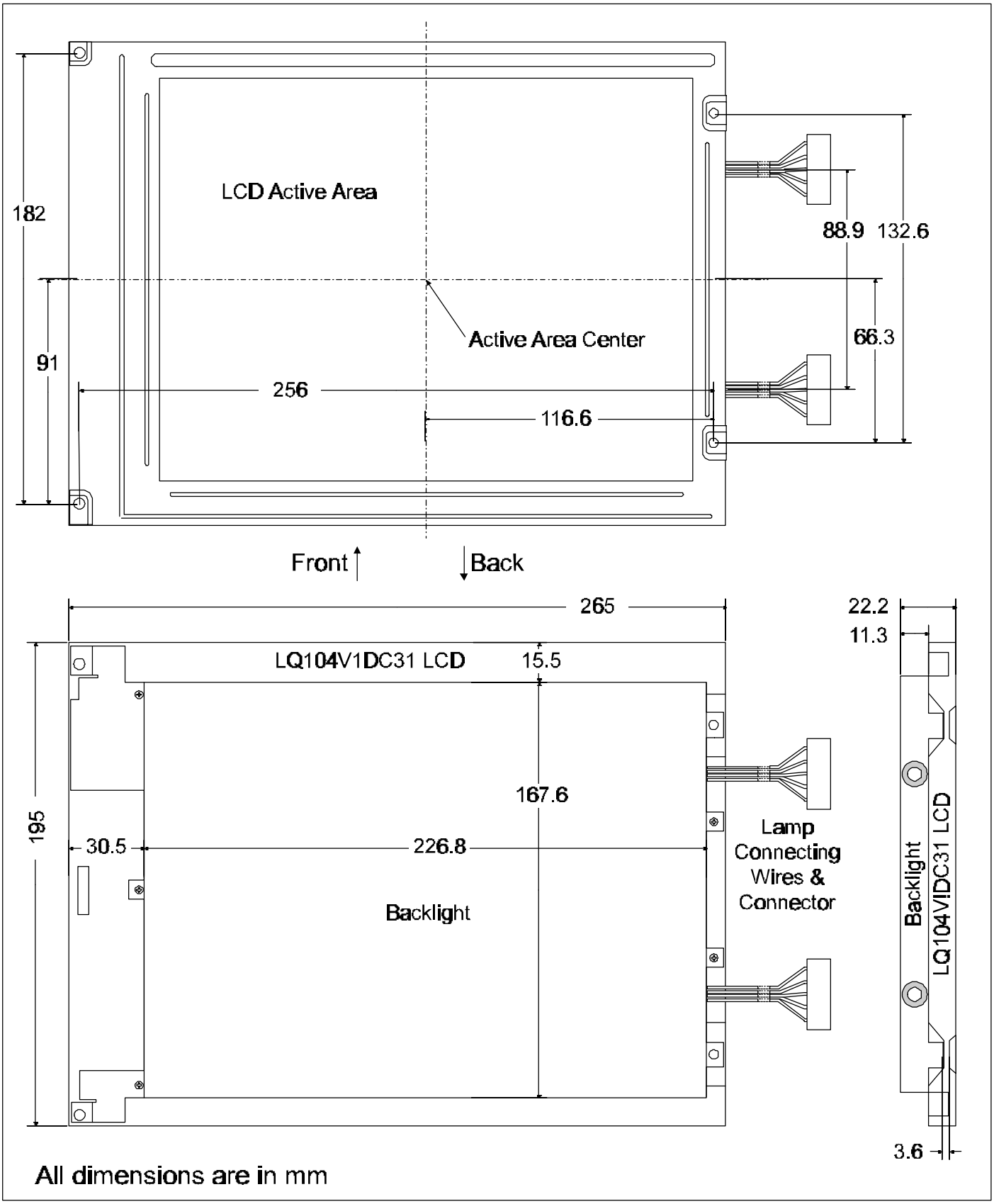
Landmark Technology

LM073A-DC31 — Sunlight Readable 10.4" LCD Module



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Introduction

LM073A-DC31 is a 10.4", high efficiency sunlight readable LCD module. The module consists of a Sharp LQ104V1DC31 TFT color LCD and a Landmark very high brightness (VHB) backlight mounted onto the back of the LCD. The entire module is about 0.9" thick and has the same foot print as the LQ104V1DC31 LCD.

The Sharp LQ104V1DC31 LCD is a high contrast, wide viewing-angle LCD, and a 0 to 70^{o}C extended operating temperature range. In the normal mode operation, the LM073A-DC31 module delivers 1,400 Cd/m^2 (nits) LCD screen brightness at a backlight power of 19 Watts. With a dimming inverter, the module can be operated in a reduced brightness mode, for example at 1,000 nits, with lower power consumption and longer lamp life. In both modes, the display is highly readable under direct sunlight. In addition, the color tone of the "White" displayed on the LCD screen is closely matched to the color of normal sunlight.

With a wide dimming range inverter, the LM073A-DC31 LCD module presents a surperb color image at 640 x 480 resolution over ambient illumination levels from full bright sunshine to total darkness, making it highly suitable for various outdoor applications.

Characteristics (Notes 1, 2)

Parameters	Typical Value	Units	Conditions
LCD Screen Max. Luminance	1,400	Cd/m^2	White (LCD in off state)
Luminance Uniformity	20% or better		Note 3
Screen Dimming Ratio	200:1		With LMT BI200A-73 inverter
LCD Contrast Ratio & Viewing angles	220 See P. 3		White vs. Black (measured in dark)
LCD Screen Chromaticity			
White (LCD in off state)	x = 0.336, y = 0.361		At normal direction
Red	x = 0.497, y = 0.339		At normal direction
Green	x = 0.303, y = 0.509		At normal direction
Blue	x = 0.199, y = 0.203		At normal direction
Backlight Power Consumption	19	Watts	At 1,400 Cd/m^2 brightness
LCD Module Weight	740	Grams	
Backlight Life	20,000	Hours	50% initial luminance
Number of CCFLs	8		
LCD Module Dimensions	See P. 1		

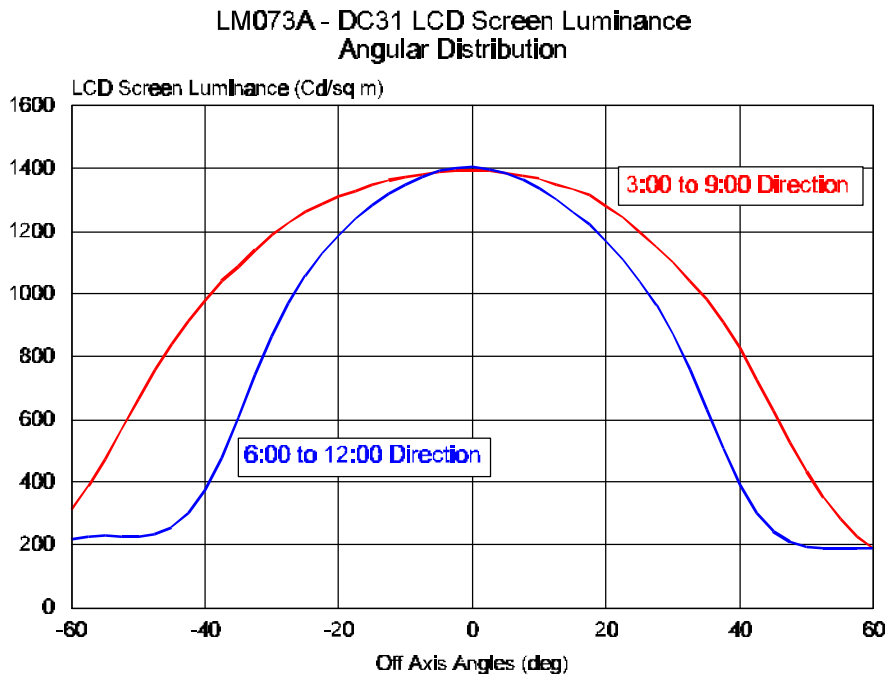
Note 1: Please refer to Sharp LQ104V1DC31 specification for other electrical and optical informaiton.

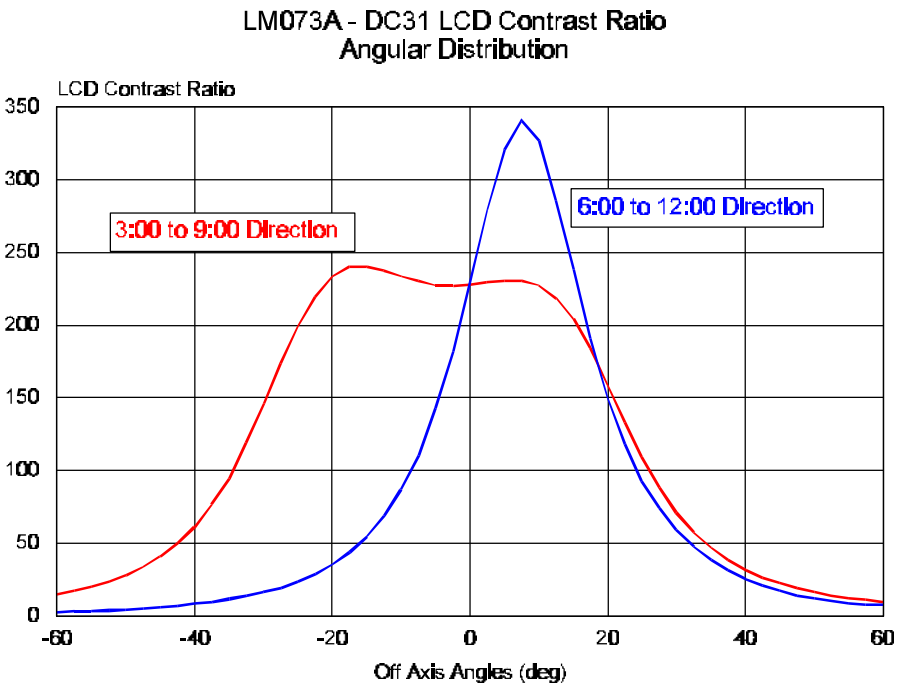
Note 2: All data are measured at 25 ^{o}C ± 2 ^{o}C ambient temperature.

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

LCD Module Optical Performances

The typical LM073A-DC31 LCD module screen luminance and contrast ratio are shown in the figures below:





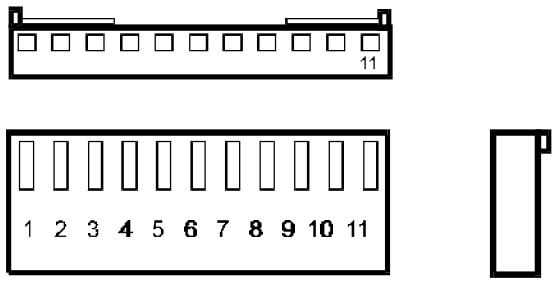
The LCD screen luminance is measured with the LCD in the "Off" state (i.e. the pixels are not energized). This is the "White" state with the maximum luminance. Quite often, this "Off" state is brighter than the "White" displayed on the screen after the LCD is turned on. The difference may be caused by the graphics card and/or on the LCD controller card driving the display. When the LCD is driven properly, the luminance difference between the "Off" state and the "White" color should be less than 10%.

The inherent contrast ratio (CR) of the LCD is the luminance ratio between the "White" and the "Black" states measured in a dark room. In outdoor environments, the contrast ratio of the display drops significantly due to the surface reflections and glare caused by the ambient illumination at the front surface of the LCD and other surfaces such as touch screen or the protective window.

Backlight Lamp Connections

The very high brightness (VHB) backlight in the LM073A-DC31 module uses a total of 8 cold cathode fluorescent lamps to achieve the required luminance. The lamps are electrically connected in two separate groups. Group 1 contains lamps #1, #3, #5, and #7 and group 2 contains lamps #2, #4, #6, and #8. The lamps are oriented in the horizontal direction with the #1 lamp at the top side of the LCD.

The lead wires connecting the lamps are terminated with two Molex connectors. The following are the connector pin out assignments.



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 #2
4	NC	4	NC
5	Lamp #3	5	Lamp #4
6	NC	6	NC
7	Lamp #5	7	Lamp #6
8	NC	8	NC
9	Lamp #7	9	Lamp #8
10	NC	10	NC
11	COMMON 1	11	COMMON 2

Backlight Lamp Driving Specifications

It is recommended to use an inverter with a 1200 V_{rms} starting voltage to run the VHB backlight in the LM073A-DC31 module. For the normal operation, the lamp voltage and current at maximum LCD screen brightness are listed below:

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

At this driving condition, the backlight delivers the specified maximum LCD screen brightness with a power consumption about 19 Watts. Since most inverters used to drive CCFLs have an efficiency between 75 - 80%, the total DC power input to the inverter is about 23.8 to 25.3 Watts.

When the backlight is dimmed down, the power consumption decreases and in the meantime, the lamp half brightness life increases. Please refer to Landmark BI200A-73 Inverter data sheet for the power versus LCD screen brightness relationship. Please also refer to Landmark Technical Note TK801 for issues on backlight and lamp life.

Thermal Management

For normal mode operation at maximum screen brightness, the backlight power consumption is about 19 Watts. As a result, the LCD temperature will be higher than normal. It is necessary to dissipate the backlight heat such that the LCD temperature maintains within the Sharp specification for LQ104V1DC31.

The exact amount of screen temperature increase depends on the installation of the LCD module in your equipment. For example, with LM073A-DC31operating at full brightness in open air with no air flow (still air), the temperature of the LCD is about 12 to 16 ^{o}C above the ambient air temperature depending on whether the LCD is placed vertically (12 ^{o}C) or horizontally (16 ^{o}C). When the LCD is mounted onto a heat conducting bezel or a small cooling fan (such as a CPU fan) is attached to the backlight, the screen temperature rise can be significantly reduced.

It is recommended to measure the LCD screen temperature at full brightness in the equipment under actual operating environments (for example, in a summer day with full sunshine) and then design the cooling measure accordingly. Please refer to Sharp LQ104V1DC31 data sheet for the thermal specifications. Make sure that the specified maximum LCD temperature is not exceeded.

Backlight Life

The half brightness life of the VHB backlight in LM073A-DC31 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 LCD screen brightness is 6 mA. At this level, the half brightness life of the backlight is rated at 20,000 hours.

In actual applications, a very bright sunlight readable display will most likely be dimmed down during dusk and night times. For example, if the LM073A-DC31 LCD module is dimmed down to 500 Cd/m^2, the lamp current decreases to about 2 mA and the lamp life increases to well above 100,000 hours. Therefore, the actual operating lifetime of the VHB backlight in the LM073A-DC31 module is expected to exceed 20,000 hours under most practical situations. For more detailed descriptions on backlight life issues and actual test data on Landmark backlights, please refer to Technical Notes TK801

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