Landmark Technology

LM191-104X01 - 10.4"

Sunlight Readable LCD Module

Introduction

LM191-104X01 is a 10.4" sunlight readable LCD module. The module consists of a Hydis HV104X01-100 TFT color LCD panel and a Landmark VHB (very high brightness) backlight. The module is in a universal package that is the standard for Landmark's 10.4" sunlight readable LCD modules.

At a backlight power of 19 Watts, the LM191-104X01 module delivers a screen luminance of about 1,550 Cd/m^2 (nits). At this brightness level, the display is highly readable under bright ambient lighting, including direct outdoor sunlight. Also, the Hydis HV104X01-100 is an industrial LCD with a wide operating temperature range, from -20 to $+70^oC$, making this LCD module specifically suitable for demanding outdoor applications.

Characteristics (Note 1, 2)

Parameters	Typical Value	Units	Conditions
LCD Screen Luminance	1,550	Cd/m^2	LCD in OFF state (normally White)
Luminance Uniformity	20% or better		Note 3
Backlight Power Consumption	20	Watts	Excluding inverter losses
Screen Luminance Dimming Ratio	200:1		With LMT BI200A inverter
Typical LCD Contrast Ratio	600:1		White vs. Black (measured in the dark along the normal direction)
Typical Viewing Angles			
3:00 direction	89	Degrees	Contrast ratio ? 10
9:00 direction	89	Degrees	Contrast ratio ? 10
6:00 direction	89	Degrees	Contrast ratio ? 10
12:00 direction	89	Degrees	Contrast ratio ? 10
LCD Screen Chromaticity (x, y)			
White	(0.329, 0.363)		Measured at the normal direction
Red	(0.600, 0.352)		Measured at the normal direction
Green	(0.314, 0.550)		Measured at the normal direction
Blue	(0.149, 0.149)		Measured at the normal direction
Response Speed			
Rise time + Fall time	28	msec	Luminance transition, 10% - 90% for rise time, 90% - 10% for fall time
LCD Module Weight	580	Grams	

Note 1: Please refer to "Hydis HV104X01-100 LCD Specification" for detailed electrical specifications and general precautions.

Note 2: All data is measured at 25^o C ± 2^oC 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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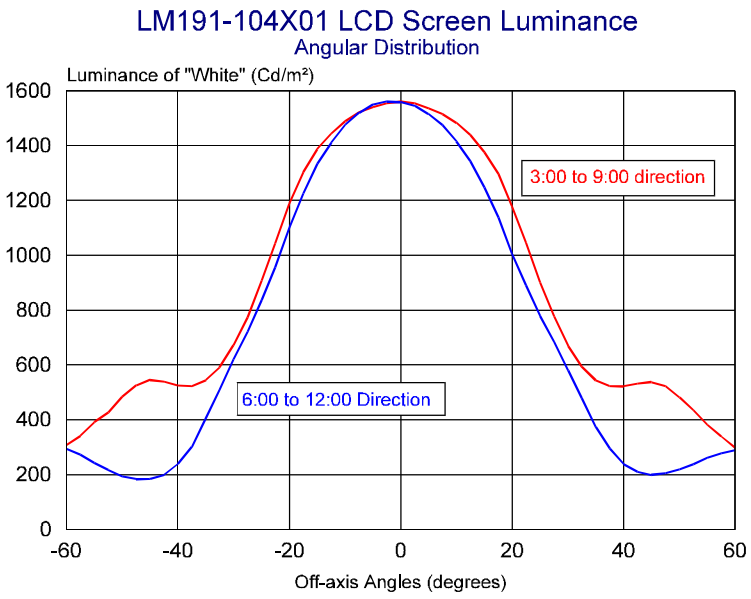
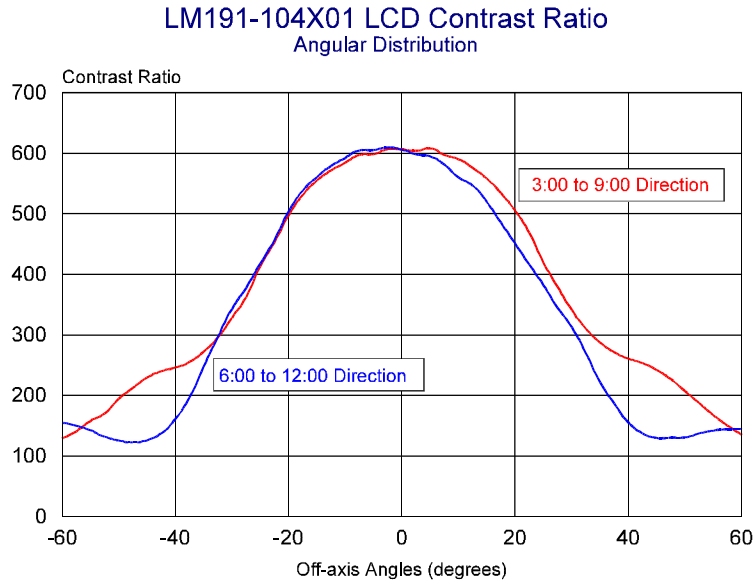
LCD Module Optical Performance

Luminance & Contrast Ratio

The Hydis HV104X01-100 is a superb, new type of LCD that provides not only extremely wide viewing angles but also a high optical transmission similar to those of the TN LCDs. These desirable features result in an extremely good optical performance for the LM191-104X01.

The typical LM191-104X01 LCD module screen luminance and contrast ratio are shown in the figures below. At the best viewing direction, this module delivers a very high screen luminance of about 1,550 Cd/m^2. Since this module is a wide viewing angle, normally black LCD, the screen luminance is measured with the LCD displaying the "white" color. The LCD controller is carefully adjusted to provide the best image quality on the screen. If this is not done properly, then the luminance of the color "white" displayed on the screen may become significantly lower than 1,550 nits. Readjusting the graphics card and the LCD controller carefully will bring the luminance to within 5% of this specified value.

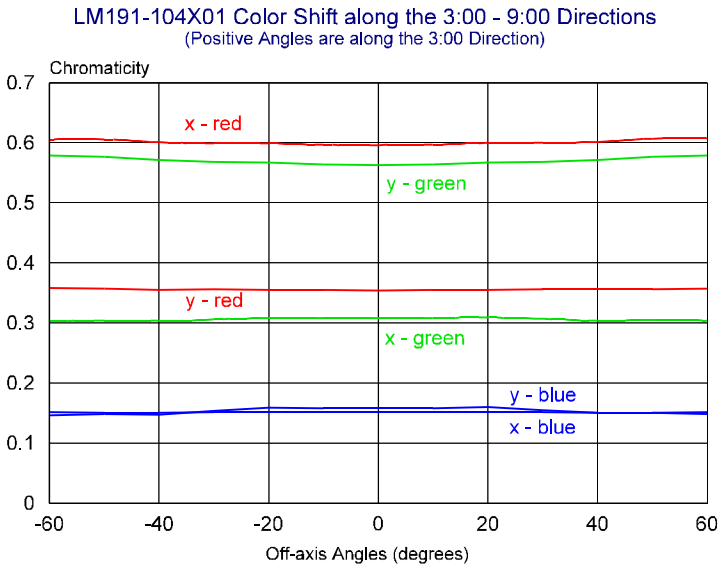


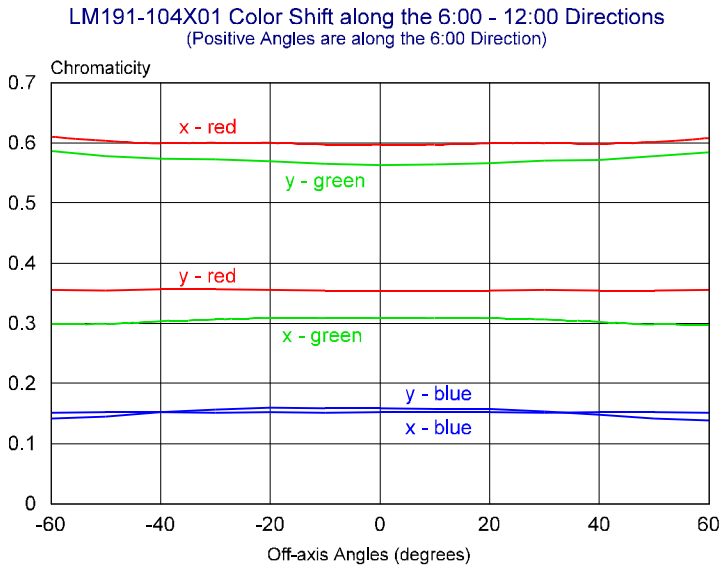


The LM191-104X01 LCD module also has a very high contrast ratio (CR) of about 600:1 measured on axis. For all practical viewing angles, the CR value is well above 100:1. These values are the inherent CR, which is the luminance ratio between the "White" and the "Black" states measured in a dark room. 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

Since the Hydis HV104X01-100 is a normally black wide viewing angle LCD, there is almost no color shift when viewing it at off-axis angles. This is indicated by the figures on the next page which show the chromaticity (x, y) data of the R, G, B primary colors displayed on the screen viewing at various off-axis angles along the 3:00 to 9:00 direction and along the 6:00 to 12:00 directions. There are virtually no changes in chromaticity values.





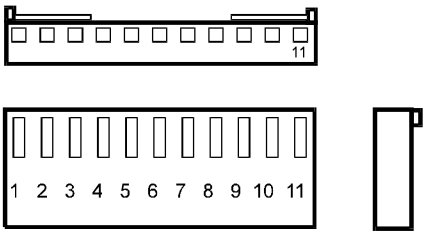
Backlight Lamp Driving Specifications

The LM191-104X01 VHB LCD has a VHB backlight with 8 cold cathode fluorescent lamps (CCFLs). The lamps are electrically connected into two groups through two 11-pin Molex connectors. The figure below shows the connector pin out assignments.

It is recommended that an inverter with a minimum of 1300 V_{rms} starting voltage be used to run the VHB backlight on the LM191-104X01 module. The lamp voltage and current at full LCD screen luminance are listed below:

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

At this driving condition, the backlight delivers 1,550 Cd/m^2 of LCD screen luminance with a power consumption of about 19 Watts.



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

Since most inverters have an efficiency level between 75 - 80%, the DC power input to the inverter is about 23.8 to 25 Watts. When the LCD luminance is adjusted down, the power consumption decreases.

Landmark BI200A inverter is designed to drive the 8-CCFL backlight in the LM191-104X01 module. The inverter has a PWM (pulse width modulation) circuit that provides a 200:1 screen luminance adjustment (i.e. from 1,550 to about 8 Cd/m^2). For detailed information, please refer to the BI200A data sheet.

Backlight Life

The LM191-104X01 LCD module uses the latest long life CCFLs. When the lamps 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. That reduces the lamp current and increases the lamp life. So, the actual operating lifetime of the backlight can be expected to reach beyond 50,000 hours. For detailed descriptions of the actual test data on Landmark Technology backlights, please refer to Technical Note TK801.

Thermal Management

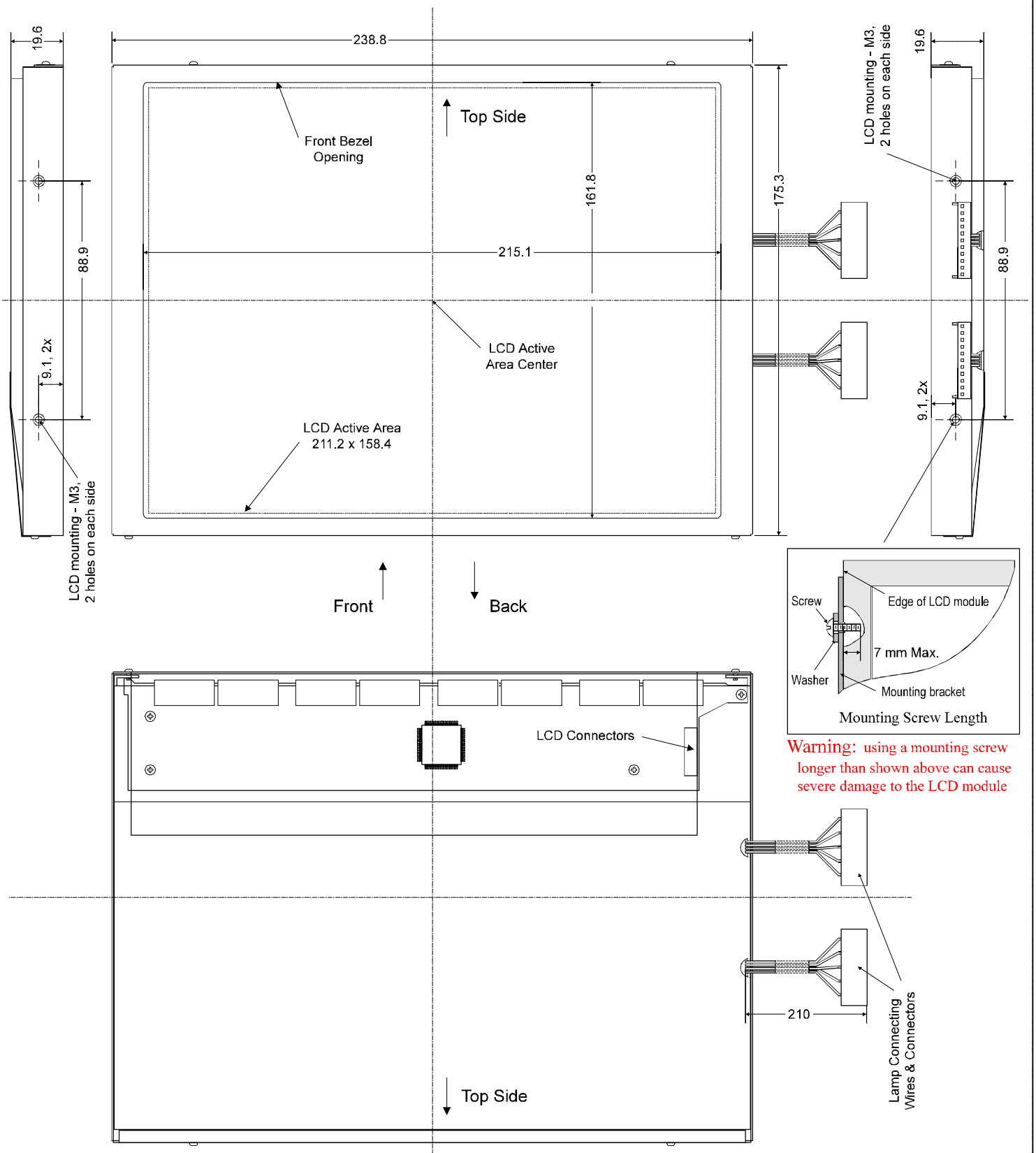
The backlight power consumption of the LM191-104X01 LCD module is approximately 19 Watts at full brightness. As a result, the LCD screen temperature will be higher than normal. It is necessary to dissipate the backlight heat such that the LCD temperature stays within the temperature specifications of the Hydis HV104X01-100 LCD.

The exact increase in screen temperature depends on the installation of the LCD module in the equipment. For example, with the LM191-104X01 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. The highest temperature rise usually occurs when 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.

Since the LM191-104X01 has a wide operating temperature range from -20 to 70^{o}C, the thermal issue is generally not difficult to resolve unless the LCD module is subjected to very strong, direct sunlight exposure. For a detailed description of the thermal impact caused by direct sunlight exposure, please refer to Technote 1199 on Landmark web site.

LCD Module Mechanical Dimensions



Warning: using a mounting screw longer than shown above can cause severe damage to the LCD module

All dimensions are in mm