

Introduction

LM184-213U6 is a 21.3" sunlight readable LCD module to replace the LM153A-213U4. The module consists of a Samsung LTM213U6-L01 TFT color LCD glass panel and a Landmark VHB (very high brightness) backlight in a package that has the same foot print and uses the same mounting holes as the LM153A-213U4.

At the maximum backlight power of 60 Watts, the LM184-213U6 module delivers 750 Cd/m² (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 BI330 inverter be used to operate the backlight in this LCD module. With this inverter, the LCD screen luminance can be adjusted down to 4 Cd/m² for night viewing.

Characteristics (Note 1, 2)

Parameters	Typical Value	Units	Conditions
LCD Screen Luminance	750	Cd/m ²	LCD displaying the brightest white
Luminance Uniformity	20% or better		Note 3
Backlight Power Consumption	60	Watts	Excluding inverter losses
Screen Luminance Dimming Ratio	200:1		With LMT BI330C inverter
Typical LCD Contrast Ratio	940:1		White vs. Black (measured in the dark along the normal direction)
Typical Viewing Angles			
3:00 direction	85	Degrees	Contrast ratio ≥10
9:00 direction	85	Degrees	Contrast ratio ≥10
6:00 direction	85	Degrees	Contrast ratio ≥10
12:00 direction	85	Degrees	Contrast ratio ≥10
LCD Screen Chromaticity (x, y)			
White	(0.320, 0.352)		Measured at the normal direction
Red	(0.641, 0.345)		Measured at the normal direction
Green	(0.270, 0.615)		Measured at the normal direction
Blue	(0.140, 0.073)		Measured at the normal direction
Response Speed			
On/Off (TR + TF)	16	msec	10% - 90% transition
Gray to Gray (TG - G) _{avg}	8	msec	Gray to Gray, average
LCD Module Weight	2,500	Grams	

Note 1: Please refer to Samsung LTM213U6-L01 LCD Specification for detailed electrical specifications and general precautions.

Note 2: All data is measured at 25^o C ± 2^o C ambient temperature.

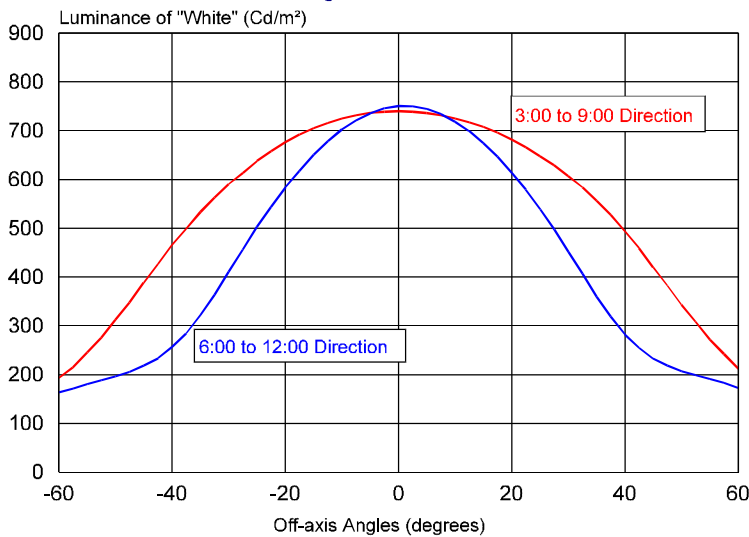
Note 3: Uniformity = (L_{max} - L_{min}) / (L_{max} + L_{min}) where L_{max} (L_{min}) is the maximum (minimum) luminance measured using a 10 mm diameter meter aperture over the LCD active area, except for the last 10 mm area from the edges.

LCD Module Optical Performances

Luminance & Contrast Ratio

The typical LM184-213U6 LCD module screen luminance and contrast ratio are shown in the figures below. Since this module is a wide viewing angle, normally “black” display, the screen luminance is measured with the LCD driven to the brightest “White” color. 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” should be within 10% from the specified value.

LM184-213U6 LCD Screen Luminance
Angular Distribution



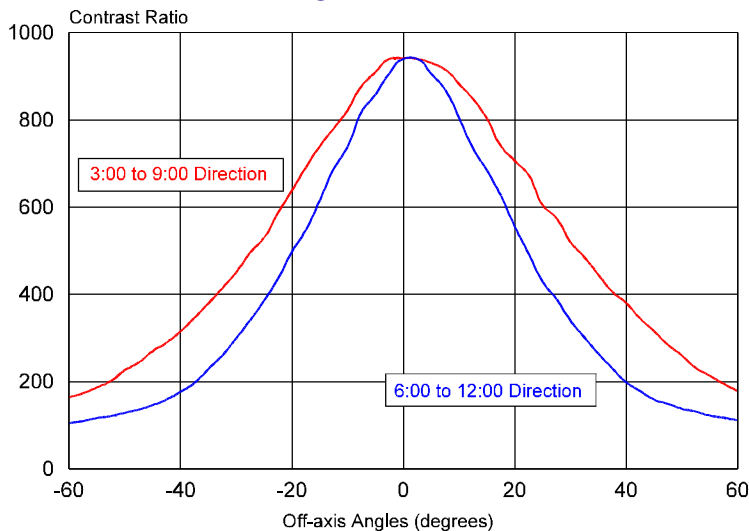
At the optimal viewing directions, the LM184-213U6 LCD module has a contrast ratio (CR) exceeding 900:1. This is the inherent CR, which is the luminance ratio between the “White” and the “Black” states measured in a dark room. Under ambient lighting, particularly in bright outdoor environments, the CR value of the display drops significantly due to the reflection and glare caused by the strong ambient illumination.

Chromaticity

LM184-213U6 is an LCD module that has a very wide viewing angle with virtually no color shift.

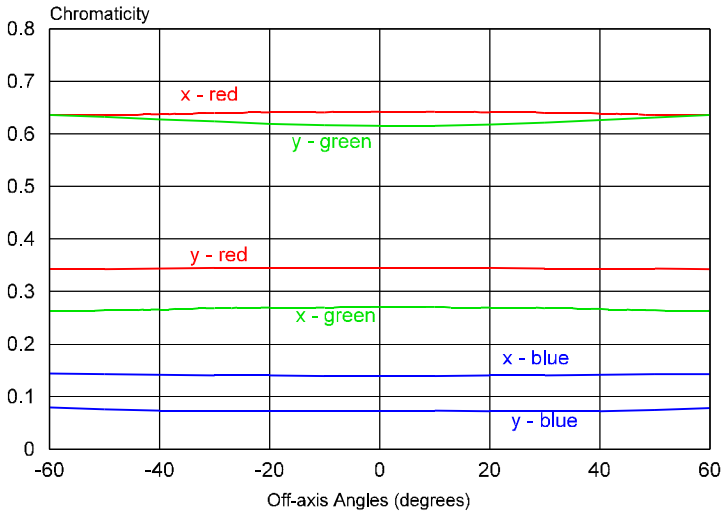
The figures on the next page present the chromaticity (x, y) data of the R, G, B primary colors displayed on the screen.

LM184-213U6 LCD Contrast Ratio
Angular Distribution

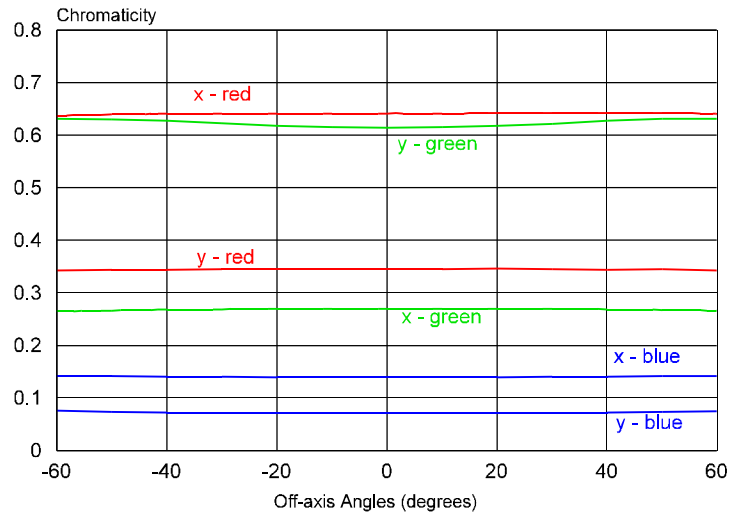


It is obvious that alone either the 3:00 to 9:00 (horizontal) directions or the 6:00 to 12:00 (vertical) directions, the chromaticity values of the R, G, B primary colors do not change. Only the green primary color shows a very slight variation in the chromaticity y.

LM184-213U6 Color Shift along the 6:00 - 12:00 Directions
(Positive Angles are along the 6:00 Direction)



LM184-213U6 Color Shift along the 3:00 - 9:00 Directions
(Positive Angles are along the 3:00 Direction)



Backlight Lamp Driving Specifications

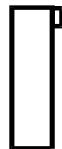
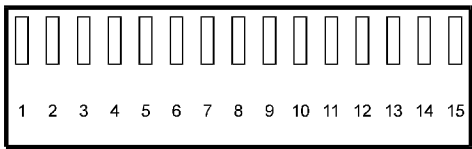
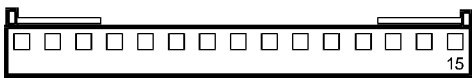
LM184-213U6 VHB LCD has a VHB backlight with 15 cold cathode fluorescent lamps (CCFLs). The lamps are electrically connected into two groups through three 15-pin Molex connectors. The figure below shows the connector pin out assignments.

voltage and current at full LCD screen luminance are listed below:

Lamp Voltage	700	V_{rms}
Lamp Current	5.7	mA_{rms}

It is recommended that an inverter with a minimum of 1700 V_{rms} starting voltage be used to run the VHB backlight on the LM184-213U6 module. The lamp

At this driving condition, the backlight delivers 750 Cd/m^2 of LCD screen luminance with a power consumption of about 59 Watts.



Connector (Housing) Molex 22-01-3157
Three connectors per LCD Module

Mating Header: Molex 22-05-3151

Lamp wiring color:

Lamp#1 to Lamp #15 White
Commons 1, 2, 3 Gray

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

Since most inverters have an efficiency level between 75 - 80%, the DC power input to the inverter is about 73 to 78 Watts. When the LCD luminance is adjusted down, the power consumption decreases.

Landmark BI330 inverter is designed to drive the 15-CCFL backlight in the LM184-213U6 module. The inverter has a PWM (pulse width modulation) circuit that provides a 200:1 screen luminance adjustment (i.e. from 750 to 4 Cd/m²). For detailed information, please refer to the BI330 data sheet.

Backlight Life

When the lamps in the LM184-213U6 backlight are operating at the recommended current for full LCD screen luminance, they are rated at 50,000 hours of 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 50,000 hours. For detailed descriptions 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 LM184-213U6 LCD module is approximately 60 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 Samsung LTM213U6-L01 LCD.

The exact increase in screen temperature depends on the installation of the LCD module in the equipment. For example, with the LM184-213U6 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 air 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.

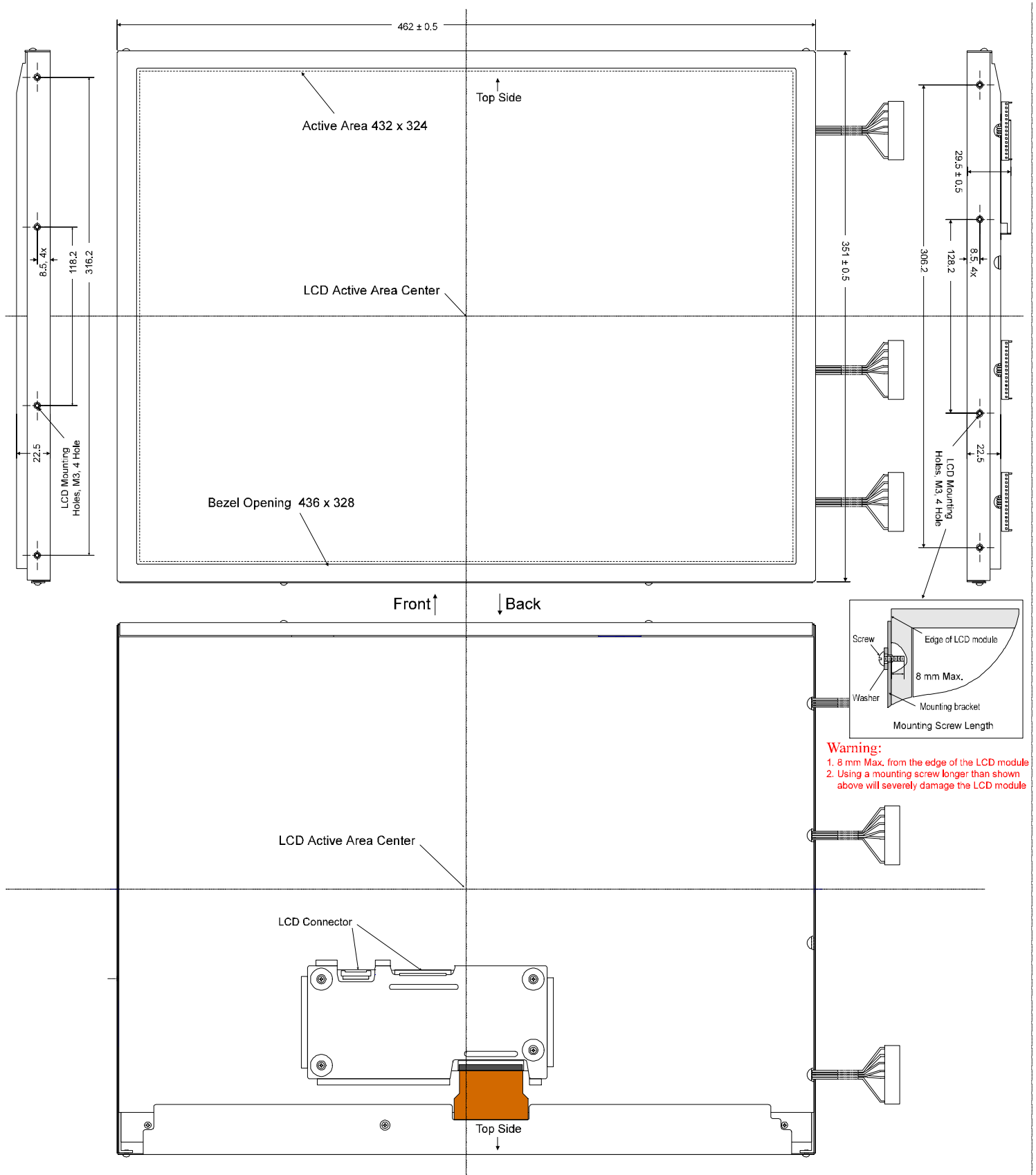
It is recommended that the LCD screen temperature be measured at full brightness in the equipment under actual operating environments. The cooling measure should then be designed accordingly. Please make sure that the specified maximum LCD temperature is not exceeded.

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LCD Module Mechanical Dimensions



All dimensions are in mm