Upgrading to LQ150X1LG91 from CCFT-Backlit Modules

Sharp Microelectronics of the Americas

INTRODUCTION

Many manufacturers of LCD modules are moving to LED-backlit units, and Sharp is a leader, responding to increasing Customer demand for LED-backlit modules. LED backlights offer several advantages over CCFTs, with the primary reason being power savings, followed by the absence of mercury and superior low-temperature operation.

Moving a product from a CCFT-backlit module to an LED-backlit module raises a number of concerns for the designer:

- Overall compatibility
- Mechanical compatibility
- Optical compatibility
- Colorimetry compatibility
- Revision control
- Long-term availability

This Application Note will cover the upgrade path to LQ150X1LG91 from these modules:

- LQ150X1LG45
- LQ150X1LG55
- LQ150X1LG71
- LQ150X1LG81

LED Backlight Lifetime Concerns

Backlight longevity comes up frequently when Designers are discussing the transition to LED, and the extreme ends of the temperature specification was where this concern originated. The rule-of-thumb used to be, “Hot - CCFT, Cold - LED,” but no longer.

In the past, the LED’s shortened lifetime at higher temperatures was a reason to reject an LED-backlit module for a high-temperature application. However, LED technology continues to evolve, allowing them to become better-suited for higher temperature applications.

Modern LED backlights feature higher-efficacy emitters, meaning in a watts-per-lumen sense they are not being operated nearly as close to the upper end of their performance envelope as in times past. They also feature adequate heatsinking so that all generated heat is dissipated properly. Figure 1 shows how the backlight assembly is bonded to the frame member for heatsinking.

Figure 1. Closeup of LED Backlight Assembly

Meanwhile, by testing all modules to the maximum limit of their Specifications, Sharp guarantees their modules will perform to Specifications at those published extremes. So even though the target application may involve higher ambient temperatures, as long as the design maintains the module within its published *Absolute Maximum Values*, you can have confidence that a Sharp module will perform to its lifetime specifications. Often the LED-backlit upgrade module will have the same *Absolute Maximum Values* specified.

MAKING THE TRANSITION

Fortunately, companies like Sharp are working hard to ease the transition, by introducing upgrade LCD modules that are as close to a “drop-in replacement” for their CCFT-counterparts as possible.

Whenever Sharp is forced to discontinue a CCFT-backlit module and replace it with an LED-backlit one, extensive research is performed to properly map form, fit, and function issues between the discontinued module and its upgrade.

Often, the upgraded module will be slightly thinner and slightly lighter due to the LED strip requiring less space and less mechanical reinforcement. While most customers do not find this a drawback, designers should always be aware of these differences and how they may affect their particular design.

Optically, there may sometimes be slight differences in view angle (typically around 10° total when they do occur) due to the different films used with LED backlights; it's up to the Designer to determine if this is an impact to the final product.

In all cases where there are differences in the upgraded module, these differences will be called out in Sharp's Product Change Notice document.

These items are also reviewed for compatibility:

- Electrical - the connectors will be exactly the same and have exactly the same functions, unless otherwise stated.
- Hardware-based display functions - such as Display Invert and Display Reverse are typically supported, using the same combinations of pin voltages.
- Driver availability - many driver manufacturers have built replacement backlight drivers to be 'drop-in' replacements for existing CCFT driver units; these units are made to utilize the same power supplies with no modifications to the existing design.
- Built-in LED Drivers - Sharp is building many modules (many as upgrades) with built-in LED backlight drivers, so Designers need not consider the expense of replacing a standalone CCFT driver with a standalone backlight driver. Sharp's upgrade modules come with a built-in advantage in backlight drivers that are designed to be compatible with common CCFT driver supply voltages, Backlight ON/OFF signals, and PWM dimming signals.

Drive Circuitry Compatibility

If your current design uses a PWM for dimming, many drive schemes are compatible with the drive circuitry in the upgrade panel. Generally, Sharp's LED backlight drive circuits are made to be compatible with existing PWM and DC dimming schemes already in use for CCFT drivers.

UPGRADING A DESIGN TO LQ150X1LG91

Sharp is upgrading several parts to the LQ150X1LG91. As of this Application Note's publication date, these other parts are being phased out because the CCFT backlights are no longer being manufactured. The LQ150X1LG91 is a similar part, but with the backlight structure and films modified to incorporate LED backlighting; plus a built-in backlight driver circuit. The following sections will make direct comparisons to allow you to assess the similarities.

Comparing Form and Fit Differences

MECHANICAL

Table 1 compares Form and Fit through the Mechanical Specifications for these modules.

Note how the mechanical dimensions as shown by the Specifications match closely with the LQ150X1LG91, and its mass is somewhat less (as expected).

MOUNTING AND CONNECTORS

Let's look next at the mounting schemes. See the mechanical drawings in Figure 2 through Figure 6 for a comparison.

Table 1. Mechanical Specifications

Parameter	LQ150X1LG91 (UPGRADE)	LQ150X1LG45	LQ150X1LG55	LQ150X1LG71	LQ150X1LG81
Display size (diagonal)	15-inch (38 cm)	15-inch (38 cm)	15-inch (38 cm)	15-inch (38 cm)	15-inch (38 cm)
Active area	304.1 × 228.1 mm	304.1 × 228.1 mm	304.1 × 228.1 mm	304.1 × 228.1 mm	304.1 × 228.1 mm
Pixel format	1024 × 768	1024 × 768	1024 × 768	1024 × 768	1024 × 768
Number of colors	16 M	16 M	16 M	16 M	16 M
Pixel pitch	0.297 × 0.297 mm	0.297 × 0.297 mm	0.297 × 0.297 mm	0.297 × 0.297 mm	0.297 × 0.297 mm
Display mode	Normally White	Normally White	Normally White	Normally White	Normally White
External Dimensions	326.5 × 253.5 × 9.6 mm	326.5 × 253.5 × 11.2 mm	326.5 × 253.5 × 11.2 mm	326.0 × 252.0 × 11.2 mm	326.0 × 252.0 × 11.2 mm
Mass (MAX.)	950 g	1000 g	1000 g	1000 g	1000 g
Surface treatment	Anti-glare and 3H hard-coating	Anti-glare and 3H hard-coating	Anti-glare and 3H hard-coating	Anti-glare and 3H hard-coating	Anti-glare and 3H hard-coating

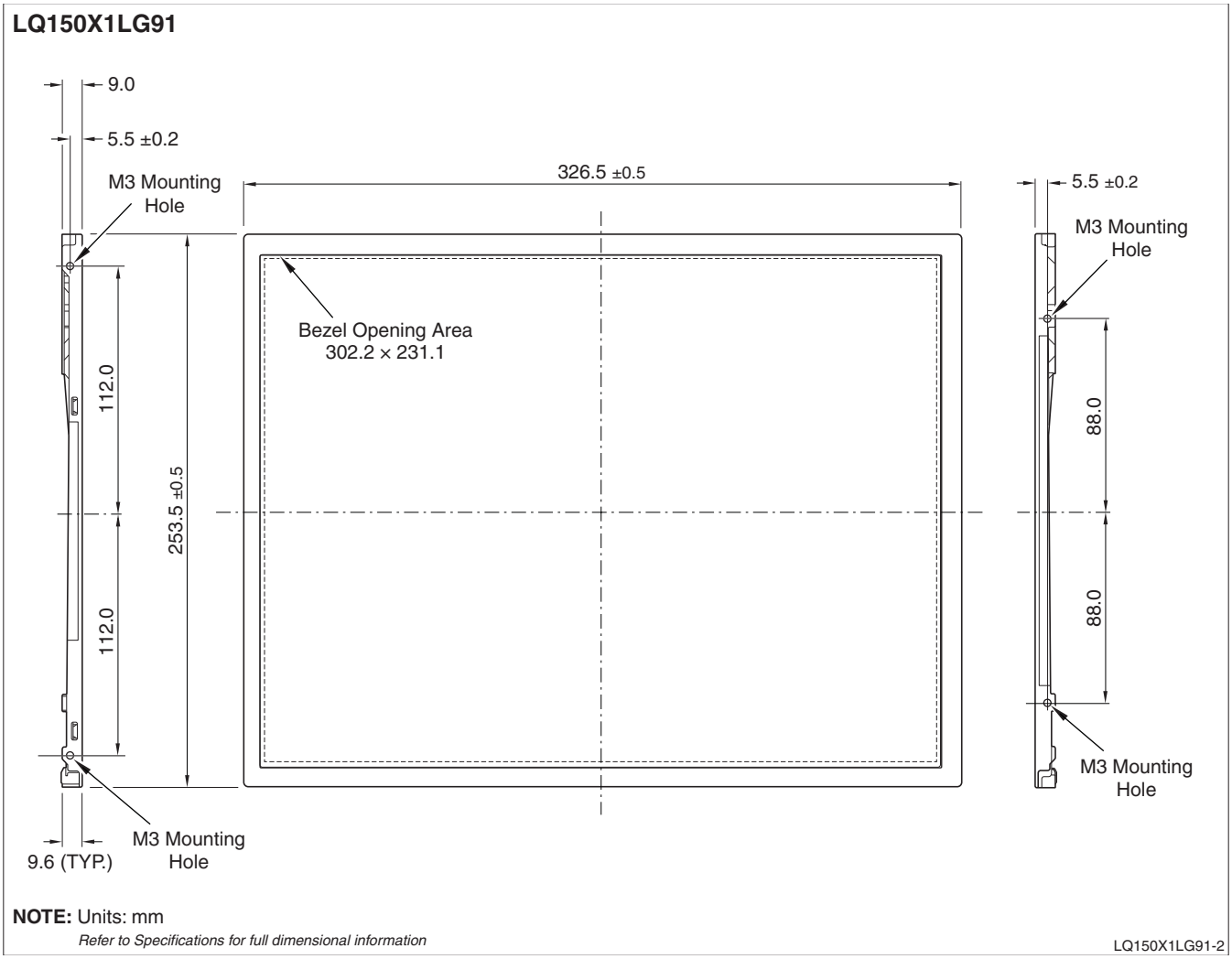


Figure 2. Mounting Dimensions for LQ150X1LG91

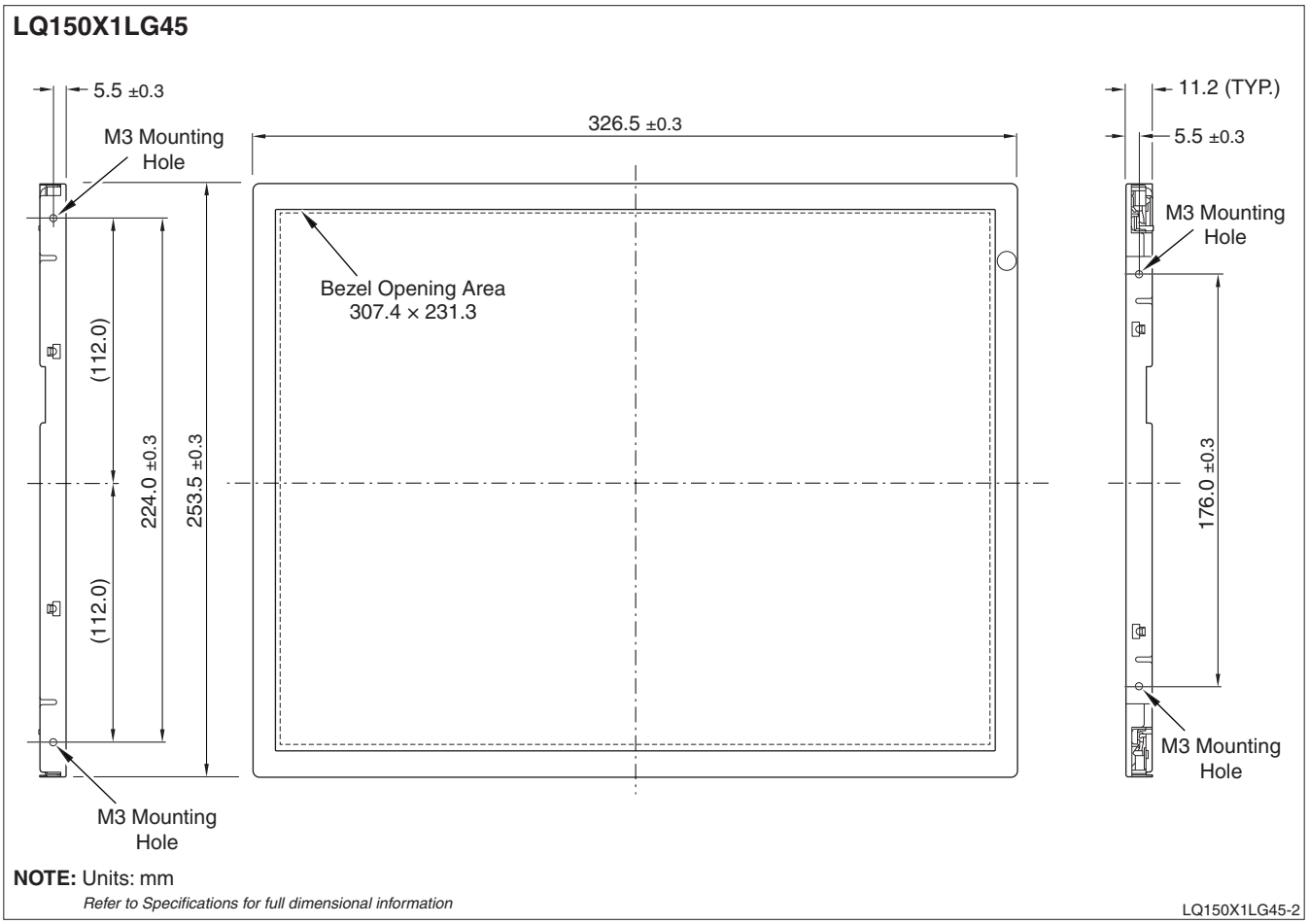
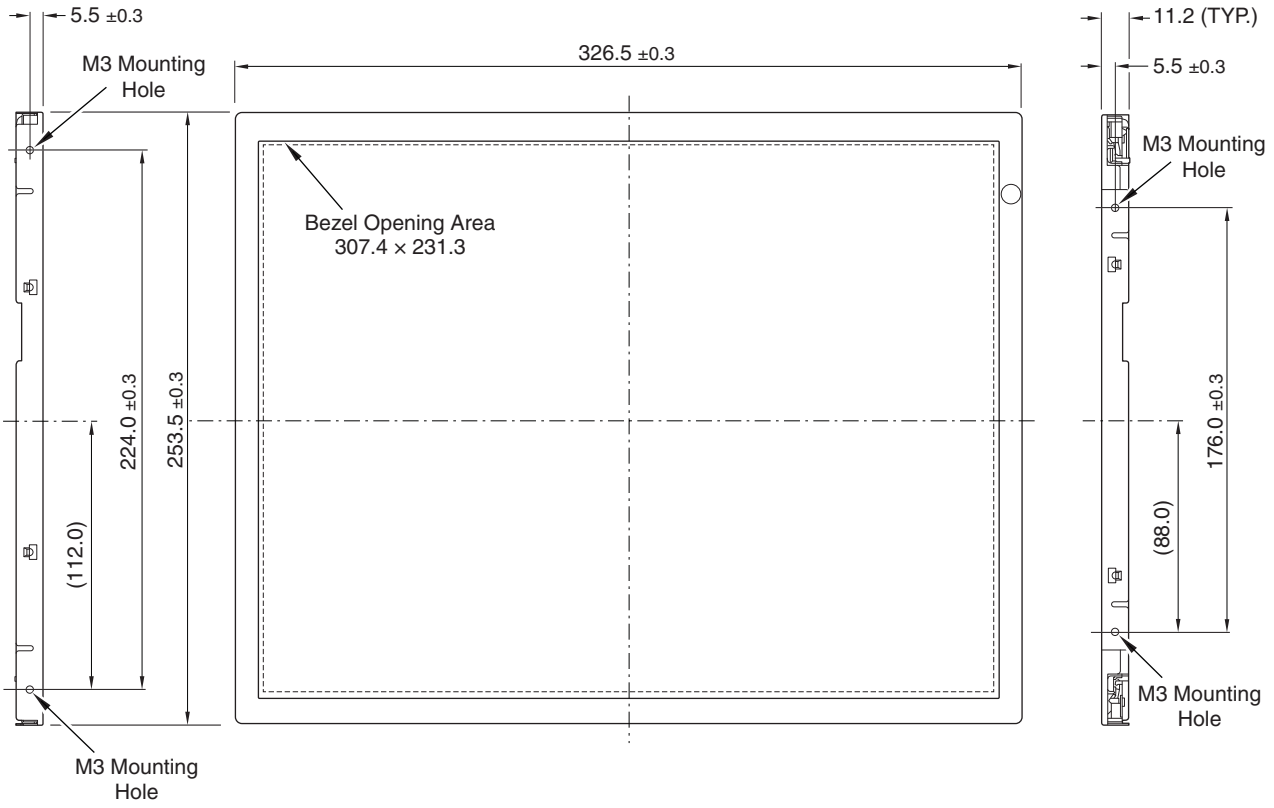


Figure 3. Mounting Dimensions for LQ150X1LG45

LQ150X1LG55



NOTE: Units: mm

Refer to Specifications for full dimensional information

LQ150X1LG55-2

Figure 4. Mounting Dimensions for LQ150X1LG55

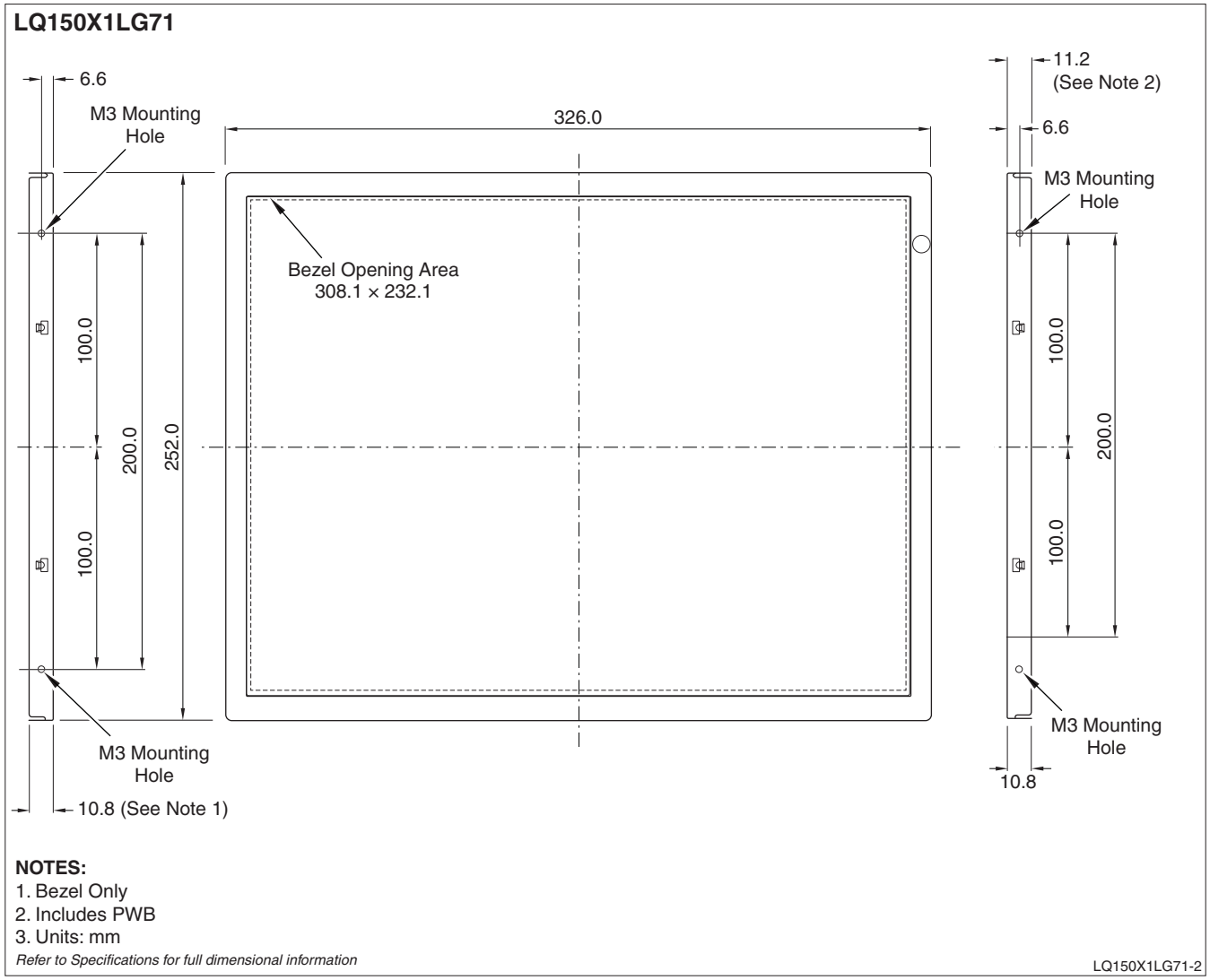
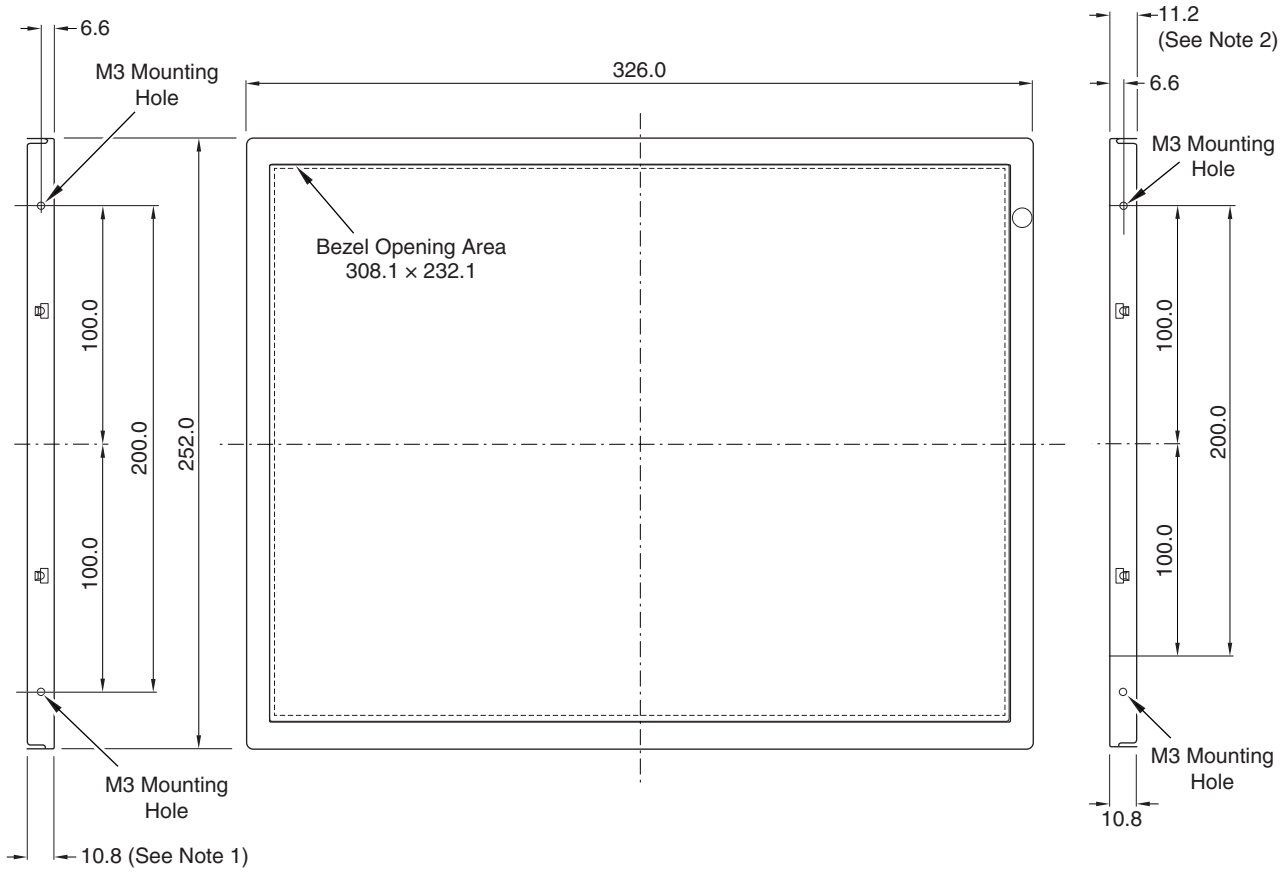


Figure 5. Mounting Dimensions for LQ150X1LG71

LQ150X1LG81



NOTES:
1. Bezel Only
2. Includes PWB
3. Units: mm

Refer to Specifications for full dimensional information

LQ150X1LG81-2

Figure 6. Mounting Dimensions for LQ150X1LG81

The next four illustrations superpose the LQ150X1LG91 with each of the upgrade panels.

Note how when superposing theLQ150X1LG71 and LQ150X1LG81, that the dimensions are slightly different, and the mounting screw positions are quite different and so warrant attention.

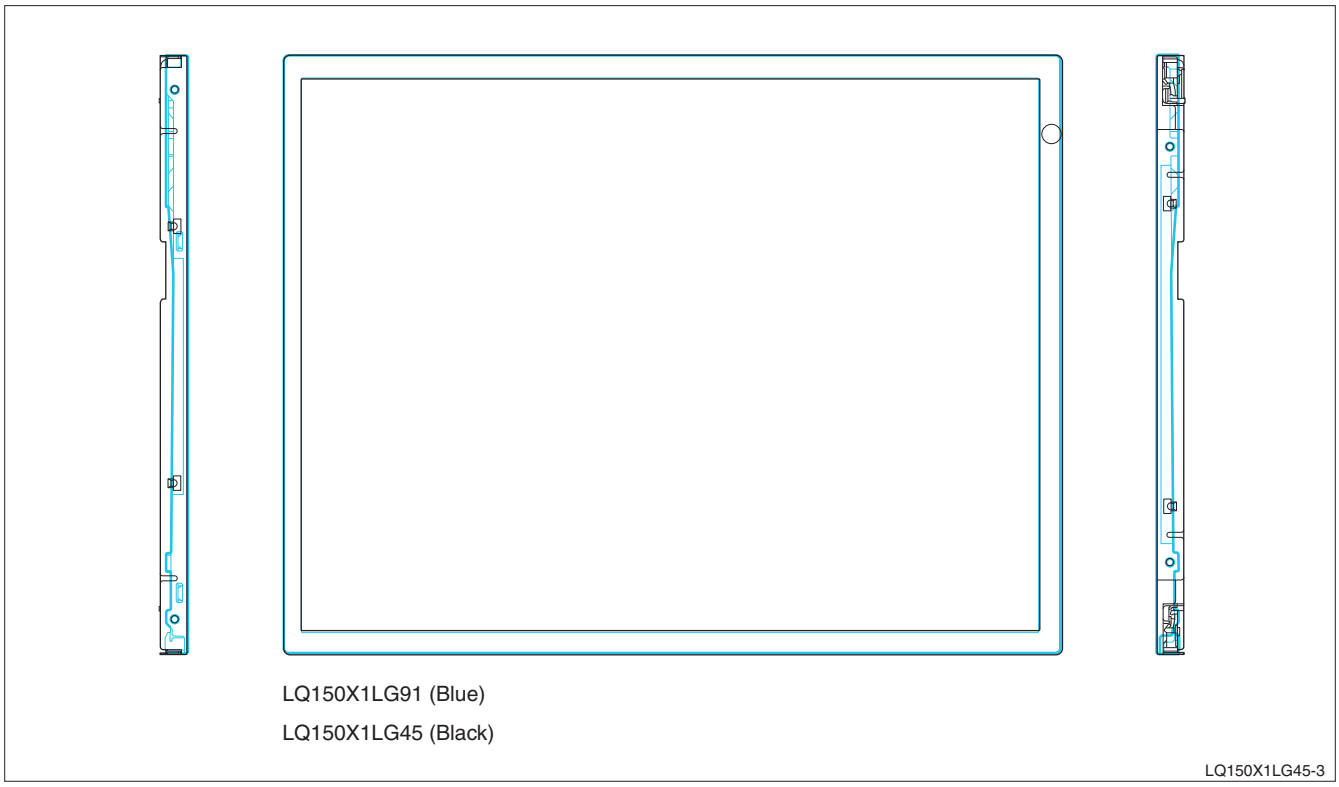


Figure 7. Superposition of LQ150X1LG91 and LQ150X1LG45

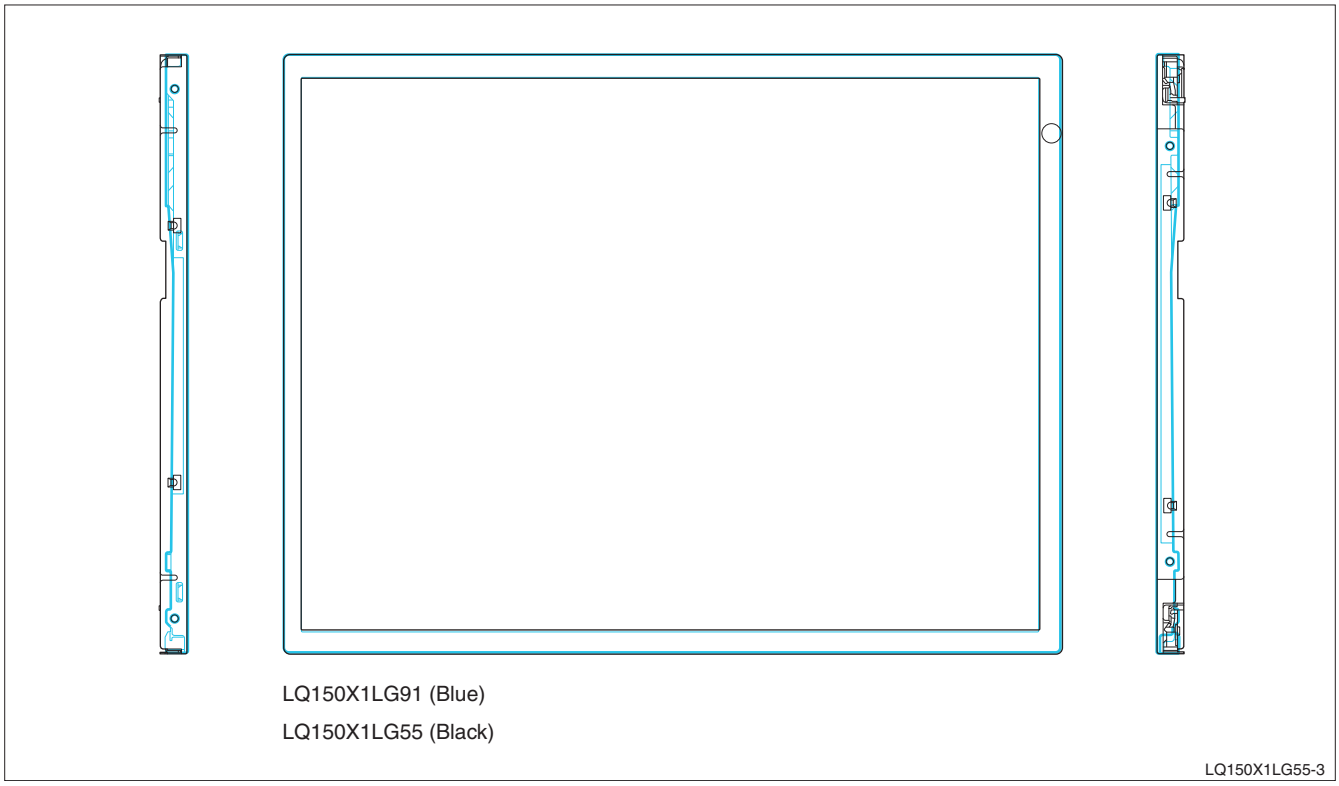


Figure 8. Superposition of LQ150X1LG91 and LQ150X1LG55

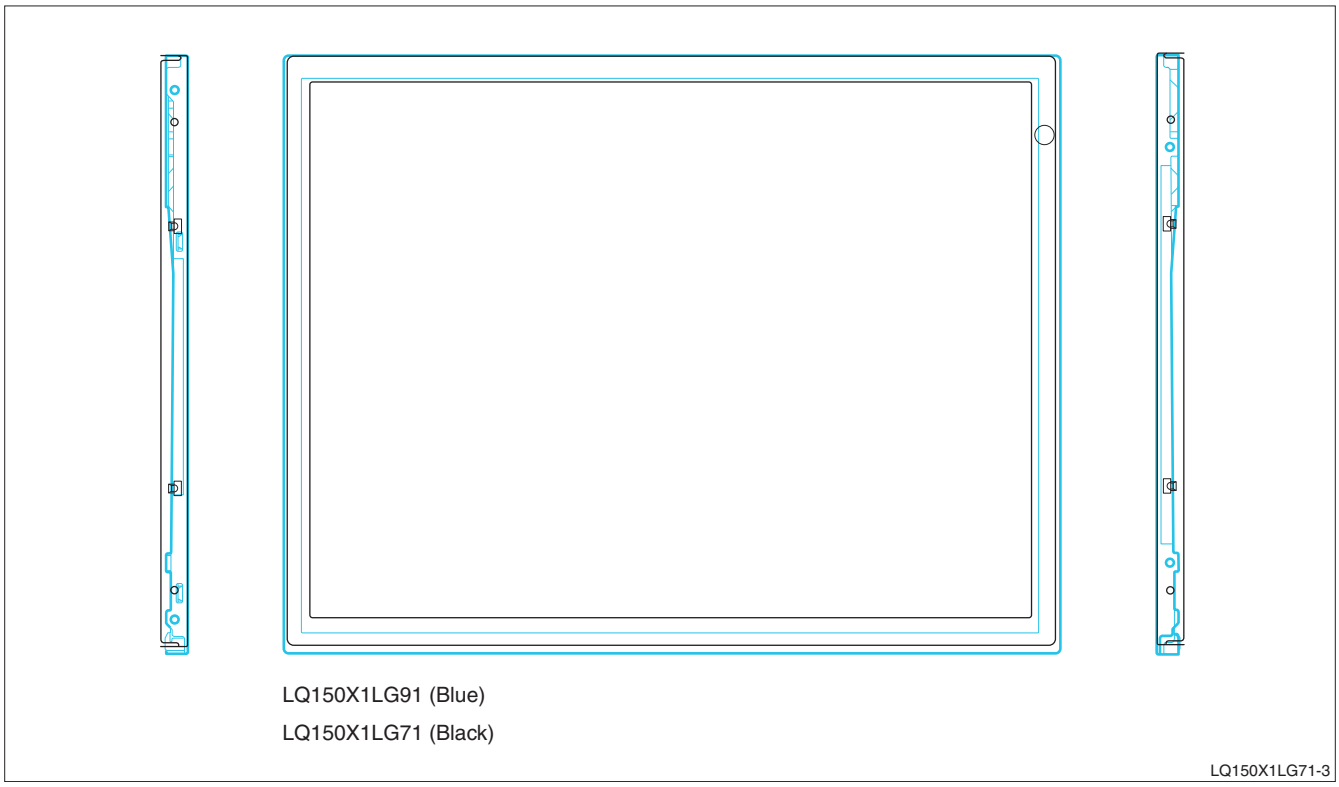


Figure 9. Superposition of LQ150X1LG91 and LQ150X1LG71

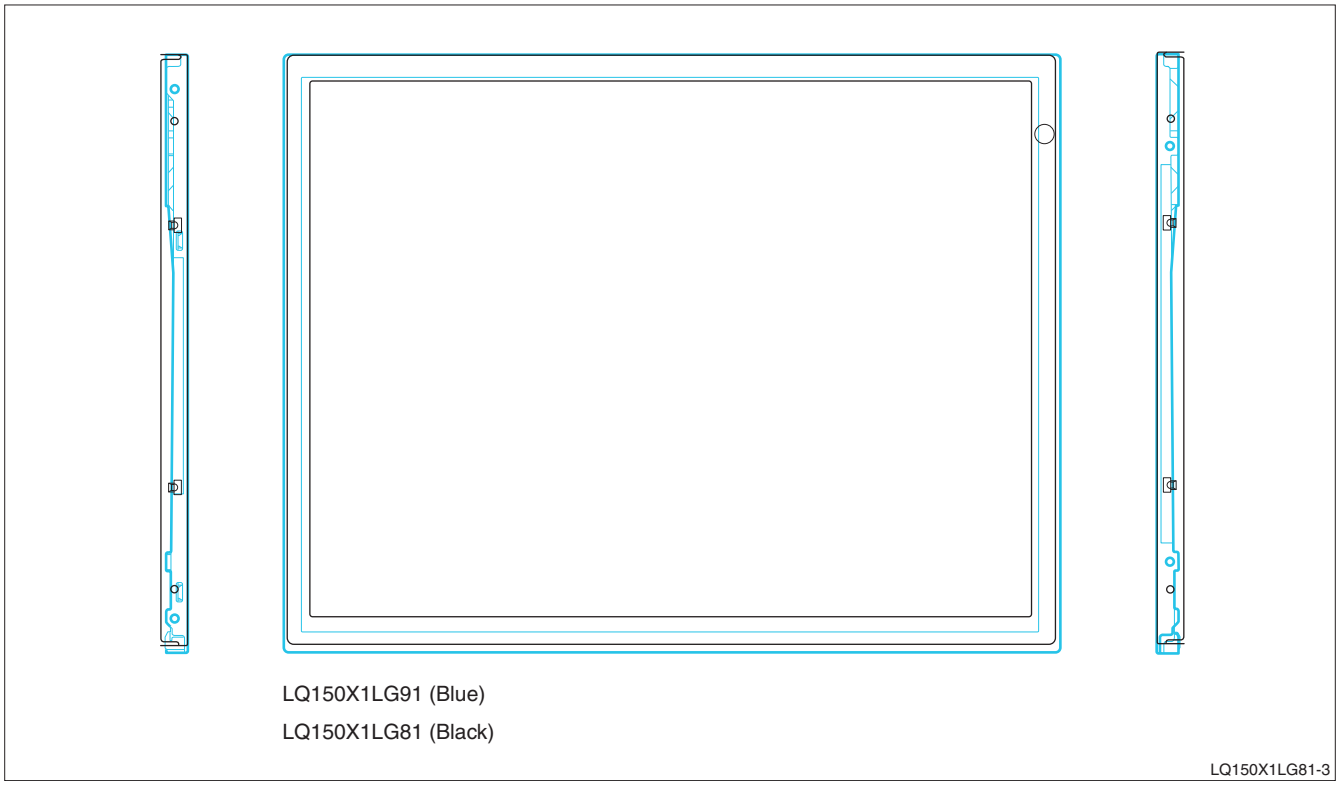


Figure 10. Superposition of LQ150X1LG91 and LQ150X1LG81

INTERFACE CONNECTOR

Let's also consider the interface connector location; to keep from having to change or modify any existing cabling within the original design. Again referring to the mechanical drawings of Figure 2 through Figure 6, we can see they match.

See Table 2 for a comparison of mating connectors for the LQ150X1LG91 main interface (panel and power) versus the panels being upgraded.

Functional Differences

When looking at the functional differences between a module and its upgrade, it is often asked, "Can this upgrade withstand the same environment?" The Absolute Maximum Values table provides a *yes* answer.

Table 2. Main Interface Connector Types

LQ150X1LG91 (UPGRADE)	LQ150X1LG45	LQ150X1LG55	LQ150X1LG71	LQ150X1LG81
DF14-20S-1.25C (Hirose)	DF14-20S-1.25C (Hirose)	DF14-20S-1.25C (Hirose)	DF14-20S-1.25C (Hirose)	DF14-20S-1.25C (Hirose)

Table 3. Absolute Maximum Ratings (Conditions Ta = 25°C unless otherwise noted)

Parameter	LQ150X1LG91 (UPGRADE)	LQ150X1LG45	LQ150X1LG55	LQ150X1LG71	LQ150X1LG81
V_{CC} Supply Voltage	-0.3 V to + 4.0 V	-0.3 V to + 4.0 V	-0.3 V to + 4.0 V	-0.3 V to + 4.0 V	-0.3 V to + 4.0 V
Input voltage VI1, V2 (RXIN, CK IN; R/L, U/D, SEL_LVDS)	-0.3V to Vcc+0.3V	-0.3V to Vcc+0.3V	-0.3V to Vcc+0.3V	-0.3V to Vcc+0.3V	-0.3V to Vcc+0.3V
Storage temperature (Tstg)	-30°C to +70°C	-25°C to +60°C	-25°C to +60°C	-25°C to +60°C	-25°C to +60°C
Operating temperature (Topa)	-20°C to +70°C	0°C to +60°C	0°C to +60°C	0°C to +60°C	0°C to +60°C

NOTE: Storage humidity: 95% RH (MAX.) at Ta ≤ 40°C; Maximum wet-bulb temp at 39°C or less at Ta > 40°C; non-condensing.

Electrical Interface Matching

With the mechanical connector and functional differences settled, we can begin looking into the electrical match.The pinouts are as shown in Table 4.

Table 4. Interface Connectors

LQ150X1LG91 (UPGRADE)		LQ150X1LG45	LQ150X1LG55	LQ150X1LG71	LQ150X1LG81	FUNCTION
PIN NO.	SYMBOL	SYMBOL	SYMBOL	SYMBOL	SYMBOL	
1	VCC	VCC	VCC	VCC	VCC	+3.3V power supply
2	VCC	VCC	VCC	VCC	VCC	+3.3V power supply
3	GND	GND	GND	GND	GND	
4	GND	GND	GND	GND	GND	
5	RXIN0-	RXIN0-	RXIN0-	RXIN0-	RXIN0-	Negative Data Input, CH 0
6	RXIN0+	RXIN0+	RXIN0+	RXIN0+	RXIN0+	Positive Data Input, CH 0
7	GND	GND	GND	GND	GND	
8	RXIN1-	RXIN1-	RXIN1-	RXIN1-	RXIN1-	Negative Data Input, CH 1
9	RXIN1+	RXIN1+	RXIN1+	RXIN1+	RXIN1+	Positive Data Input, CH 1
10	GND	GND	GND	GND	GND	
11	RXIN2-	RXIN2-	RXIN2-	RXIN2-	RXIN2-	Negative Data Input, CH 2
12	RXIN2+	RXIN2+	RXIN2+	RXIN2+	RXIN2+	Positive Data Input, CH 2
13	GND	GND	GND	GND	GND	
14	RXCLK IN-	RXCLK IN-	RXCLK IN-	RXCLK IN-	RXCLK IN-	Negative Clock Input
15	RXCLK IN+	RXCLK IN+	RXCLK IN+	RXCLK IN+	RXCLK IN+	Positive Clock Input
16	GND	GND	GND	GND	GND	
17	RXIN3-	RXIN3-	RXIN3-	RXIN3-	RXIN3-	Negative Data Input, CH 3
18	RXIN3+	RXIN3+	RXIN3+	RXIN3+	RXIN3+	Positive Data Input, CH 3
19	RL/UD	RL/UD	RL/UD	RL/UD	RL/UD	Display Mode Select
20	SEL_LVDS	SEL_LVDS	SEL_LVDS	SEL_LVDS	SEL_LVDS	LVDS Mode Select

NOTE: All clock and Data signal inputs are differential, or balanced, input.

SIGNAL FUNCTIONS AND TIMING

The next things to check are signal functions and timing. Since these panels use LVDS (Low Voltage Differential Signaling), it's important to know their compatibility with possible transmitters in the host application. See Table 5 for a comparison of 8-bit and 6-bit data mapping between all parts.

Table 5. Data Mapping Comparison

LQ150X1LG91 (UPGRADE)					LQ150X1LG45, LQ150X1LG55, LQ150X1LG71, LQ150X1LG81		
8-BIT				6-BIT*	8-BIT		6-BIT*
TRANSMITTER		SET_LVDS			SET_LVDS		
PIN	DATA	LOW	HIGH	HIGH	LOW	HIGH	HIGH
51	TA0	R0 (LSB)	R2	R0 (LSB)	R0 (LSB)	R2	R0 (LSB)
52	TA1	R1	R3	R1	R1	R3	R1
54	TA2	R2	R4	R2	R2	R4	R2
55	TA3	R3	R5	R3	R3	R5	R3
56	TA4	R4	R6	R4	R4	R6	R4
3	TA5	R5	R7 (MSB)	R5 (MSB)	R5	R7 (MSB)	R5 (MSB)
4	TA6	G0 (LSB)	G2	G0 (LSB)	G0 (LSB)	G2	G0 (LSB)
6	TB0	G1	G3	G1	G1	G3	G1
7	TB1	G2	G4	G2	G2	G4	G2
11	TB2	G3	G5	G3	G3	G5	G3
12	TB3	G4	G6	G4	G4	G6	G4
14	TB4	G5	G7 (MSB)	G5 (MSB)	G5	G7 (MSB)	G5 (MSB)
15	TB5	B0 (LSB)	B2	B0 (LSB)	B0 (LSB)	B2	B0 (LSB)
19	TB6	B1	B3	B1	B1	B3	B1
20	TC0	B2	B4	B2	B2	B4	B2
22	TC1	B3	B5	B3	B3	B5	B3
23	TC2	B4	B6	B4	B4	B6	B4
24	TC3	B5	B7 (MSB)	B5 (MSB)	B5	B7 (MSB)	B5 (MSB)
27	TC4	(HS)	(HS)	(HS)	(HS)	(HS)	(HS)
28	TC5	(VS)	(VS)	(VS)	(VS)	(VS)	(VS)
30	TC6	DE	DE	DE	DE	DE	DE
50	TD0	R6	R0 (LSB)	GND	R6	R0 (LSB)	GND
2	TD1	R7 (MSB)	R1	GND	R7 (MSB)	R1	GND
8	TD2	G6	G0 (LSB)	GND	G6	G0 (LSB)	GND
10	TD3	G7 (MSB)	G1	GND	G7 (MSB)	G1	GND
16	TD4	B6	B0 (LSB)	GND	B6	B0 (LSB)	GND
18	TD5	B7 (MSB)	B1	GND	B7 (MSB)	B1	GND
25	TD6	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)

NOTE: SET_LVDS = LOW has no effect when in 6-bit mode.

LED Backlight Connection

The LQ150X1LG91 has an onboard backlight driver and that driver utilizes typical power supplies and signals.

The connector requires a n SHLP-06V-S-B (JST) for its mating connection. Pinout is as shown in Table 6.

Pins 5 and 6 operate at logic levels and have a 10k Ω pull-down resistor. Setting pin 5 HIGH will enable the backlight, and a PWM signal with a frequency of between 200 Hz and 1k Hz and a duty cycle of 10% to 100% will control dimming. A duty cycle of 100% is 'ON full' or no dimming.

Table 6. Backlight Connector (CN2)

PIN NO.	SYMBOL	FUNCTION
1	VDD	+12V power supply
2	VDD	+12V power supply
3	GND	GND
4	GND	GND
5	XSTABY	Backlight ON/OFF signal*
6	VBR	PWM signal*

NOTE: Pins 5 and 6 are logic level.

Optical Comparisons

Table 7 compares the Optical Characteristics using the Typical values from the Specifications:

Note that all viewing angles are significantly better in all directions, while contrast is much higher. Brightness remains unchanged, so the upgrade module will appear similar. However, the contrast is much better; and the eye tends to perceive this as clarity, so the upgrade module will appear sharper than the one it replaces.

CONCLUSION

In this Application Note, we've shown how the Specifications compare between the LQ150X1LG91 and these modules:

- LQ150X1LG45
- LQ150X1LG55
- LQ150X1LG71
- LQ150X1LG81

The LQ150X1LG91 is a mechanical drop-in replacement for LQ150X1LG45 and LQ150X1LG55, but not an exact fit LQ150X1LG71 and LQ150X1LG81 (due to mounting screw differences).

Electrically, the Main Interfaces are the same.

The main change for the Designer will be the LED backlight, but Sharp uses standard signals and voltages to ease the transition.

Table 7. Optical Comparison (Typical Values)

PARAMETER	LQ150X1LG91 (UPGRADE)	LQ150X1LG45	LQ150X1LG55	LQ150X1LG71	LQ150X1LG81
Horizontal Viewing angle	160	120	160	120	120
Vertical Viewing angle (12 o'clock)	80	45	80	45	45
Vertical Viewing angle (6 o'clock)	80	55	80	55	55
Contrast ratio	800	550	650	550	550
Response time (Rise/Fall, ms)	30	8	8	8	8
White Chromaticity (x)	0.305	0.313	0.313	0.313	0.313
White Chromaticity (y)	0.325	0.329	0.329	0.329	0.329
White Luminance (nits)	350	250	350	250	350

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

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