Upgrading to the LQ150X1LW12/LW94 (LED-Backlit) from the LQ150X1LW73 (CCFT-Backlit) Module

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 LQ150X1LW12 (or the LQ150X1LW94 as a side-mount version) from the LQ150X1LW73.

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.

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. (The LQ150X1LW12 and LQ150X1LW94 have a backlight lifetime specification of 50,000 hours.) Often the LED-backlit upgrade module will have the same *Absolute Maximum Values* specified.

Figure 1. Closeup of LED Backlight Assembly

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 cases where there are differences in the upgraded module, these differences will be noted 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 LQ150X1LW12 OR LQ150X1LW94

Sharp is upgrading the LQ150X1LW73 to the LQ150X1LW12 and providing the LQ150X1LW94 as a side mount version. As of this Application Note's publication date, the LQ150X1LW73 is being phased out because the CCFT backlight is no longer being manufactured. The LQ150X1LW12 and LQ150X1LW94 are similar parts, 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 LQ150X1LW12 is a perfect match in height and width for the LQ150X1LW73.

Table 1. Mechanical Specifications

Parameter	LQ150X1LW73	LQ150X1LW12 (UPGRADE)	LQ150X1LW94 (UPGRADE)
Display size (diagonal)	15-inch (38 cm)	15-inch (38 cm)	15-inch (38.1 cm)
Active area	304.1 × 228.1 mm	304.1 × 228.1 mm	304.1 × 228.1 mm
Pixel format	1024 × 768	1024 × 768	1024 × 768
Number of colors	16 M	16 M	16 M
Pixel pitch	0.297 × 0.297 mm	0.297 × 0.297 mm	0.297 × 0.297 mm
Display mode	Normally Black	Normally Black	Normally Black
External Dimensions	331.6 × 254.76 × 12.5 mm	331.6 × 254.76 × 9.3 mm	326.5 × 253.5 × 9.0 mm
Mass (MAX.)	1450 g	950 g	950 g
Surface treatment	Anti-glare, Low Reflection, and hard-coating	Anti-glare and 2H hard-coating	Anti-glare and 3H hard-coating

Mounting and Connectors

Let's look next at the mechanical interchange, including mounting schemes.

At first glance, it appears the LQ150X1LW12 is a good mechanical match with the LQ150X1LW73. See the mechanical drawings on the next pages for a comparison.

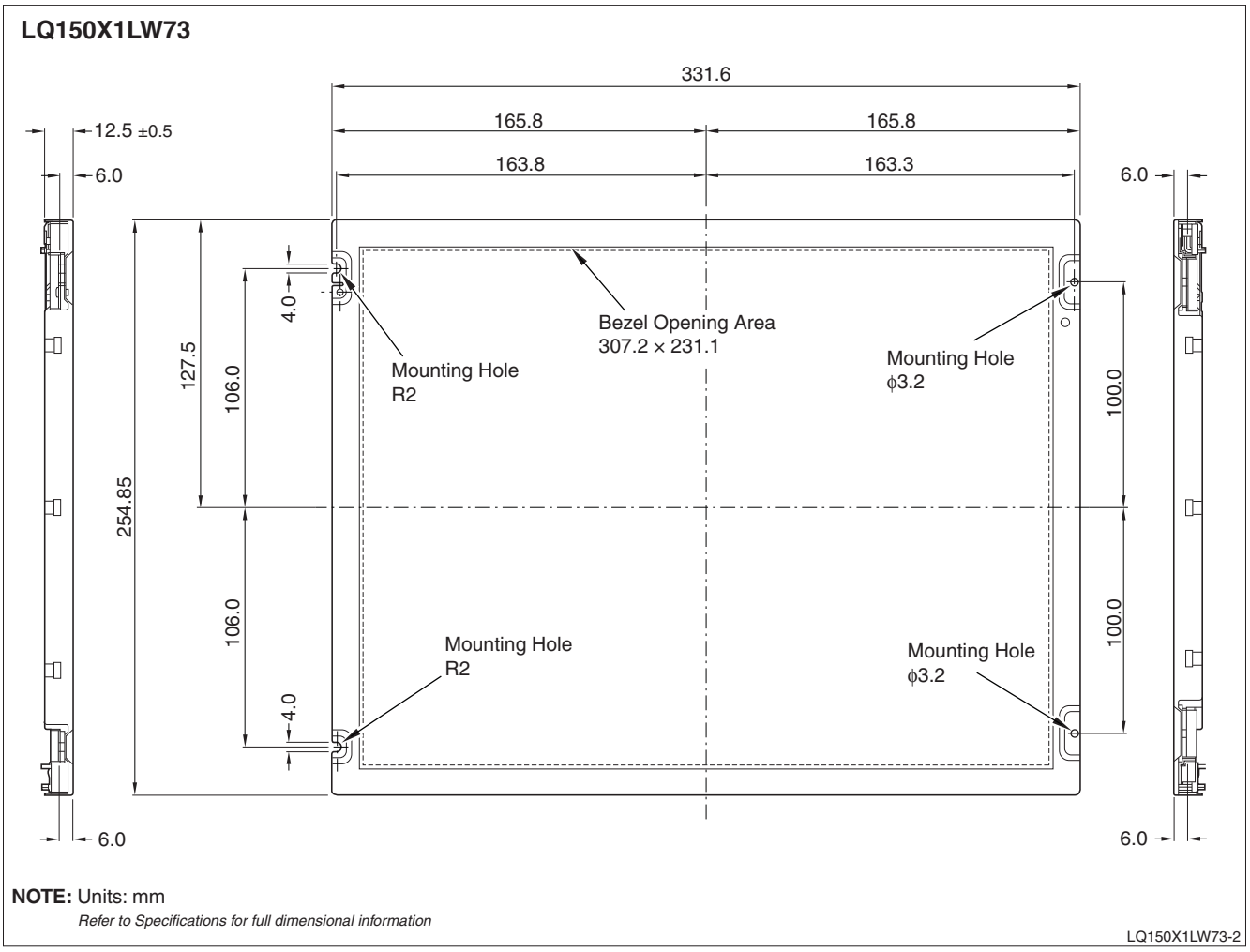

Figure 2. Mounting Dimensions for LQ150X1LW73

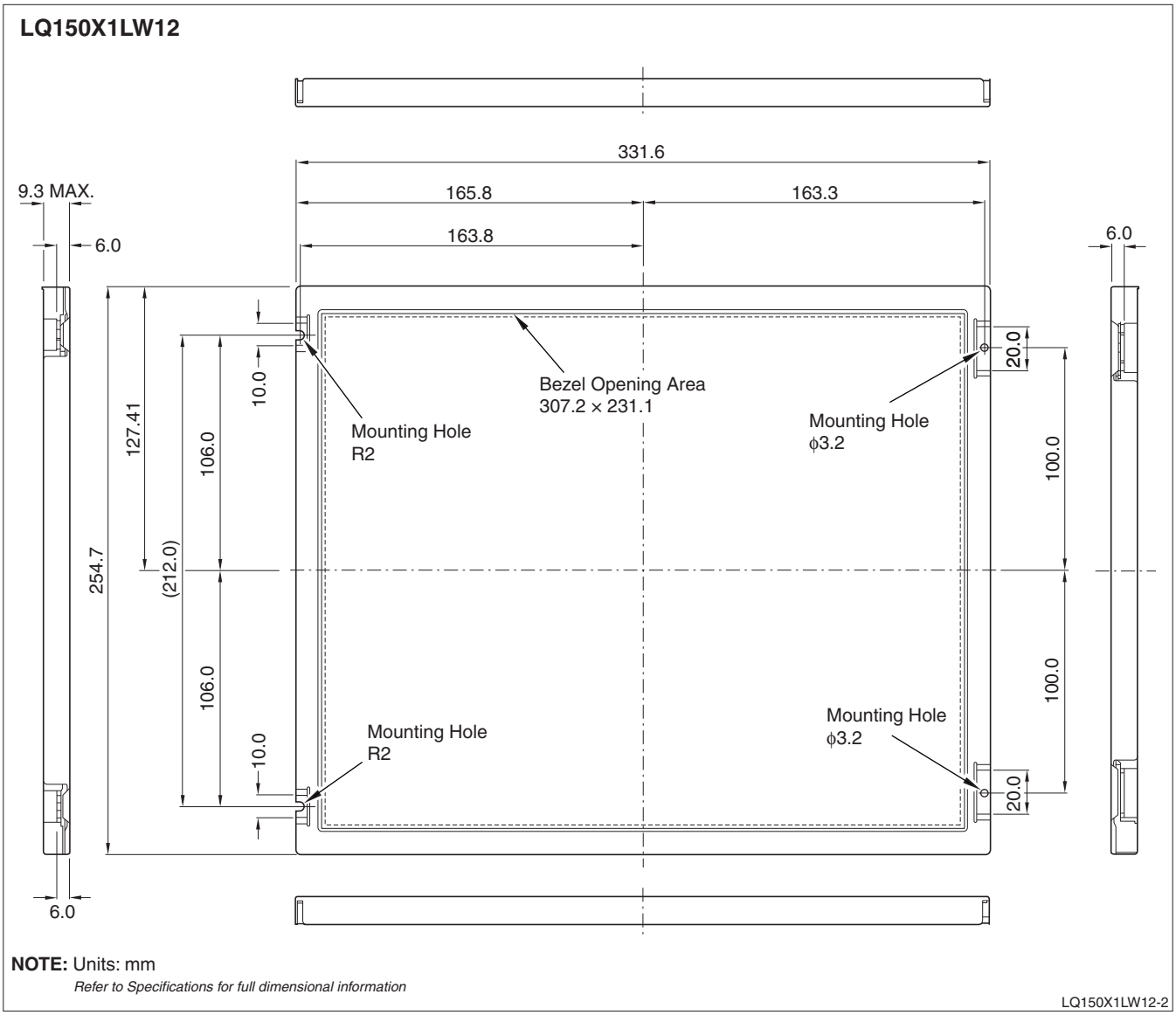

Figure 3. Mounting Dimensions for LQ150X1LW12 (Upgrade)

Figure 4 superposes the LQ150X1LW12 with the LQ150X1LW73. The slight differences are exaggerated for clarity. However, we can see that the mechanical match is still quite good.

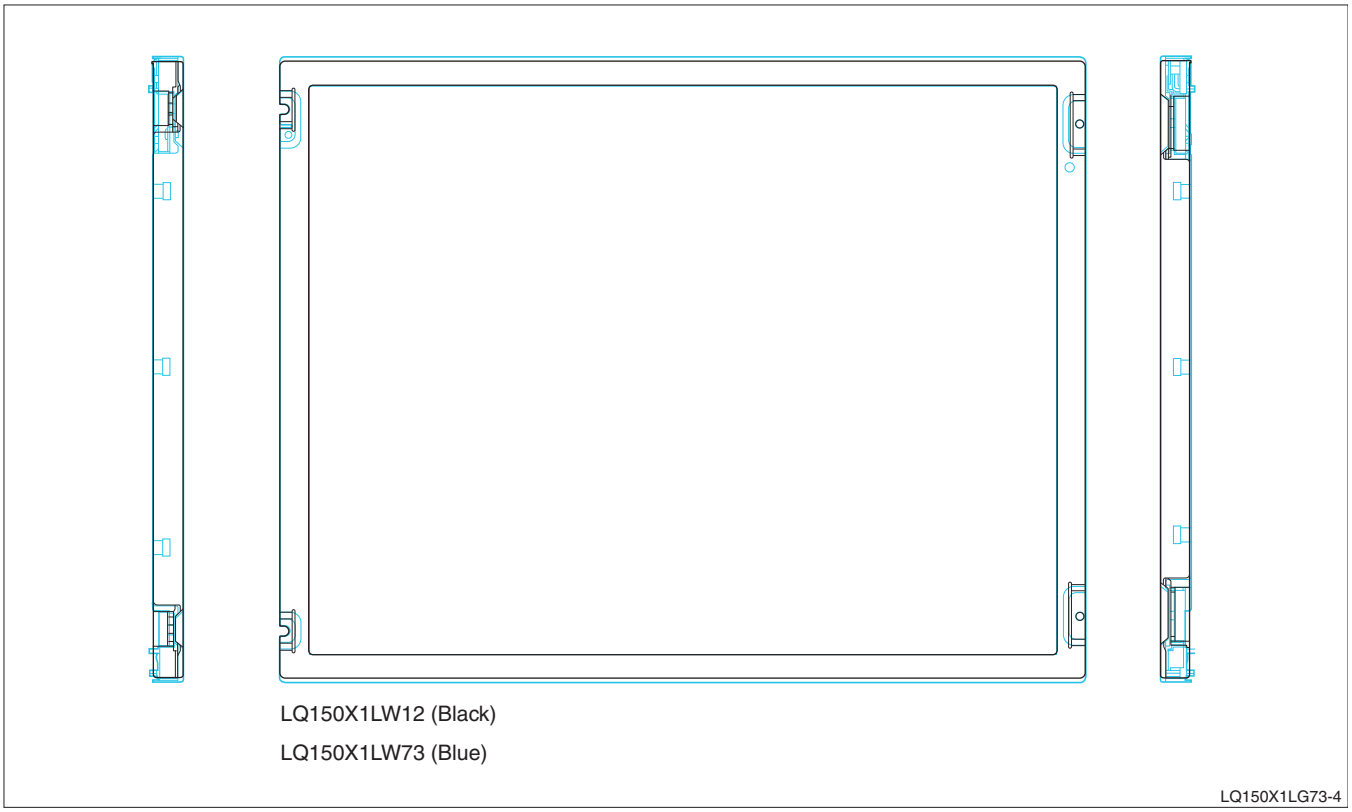

Figure 4. Superposition of LQ150X1LW12 (Upgrade) and LQ150X1LW73

The LQ150X1LW94 uses side mounts instead of mounting tabs. See the mechanical drawings on the next pages for a comparison.

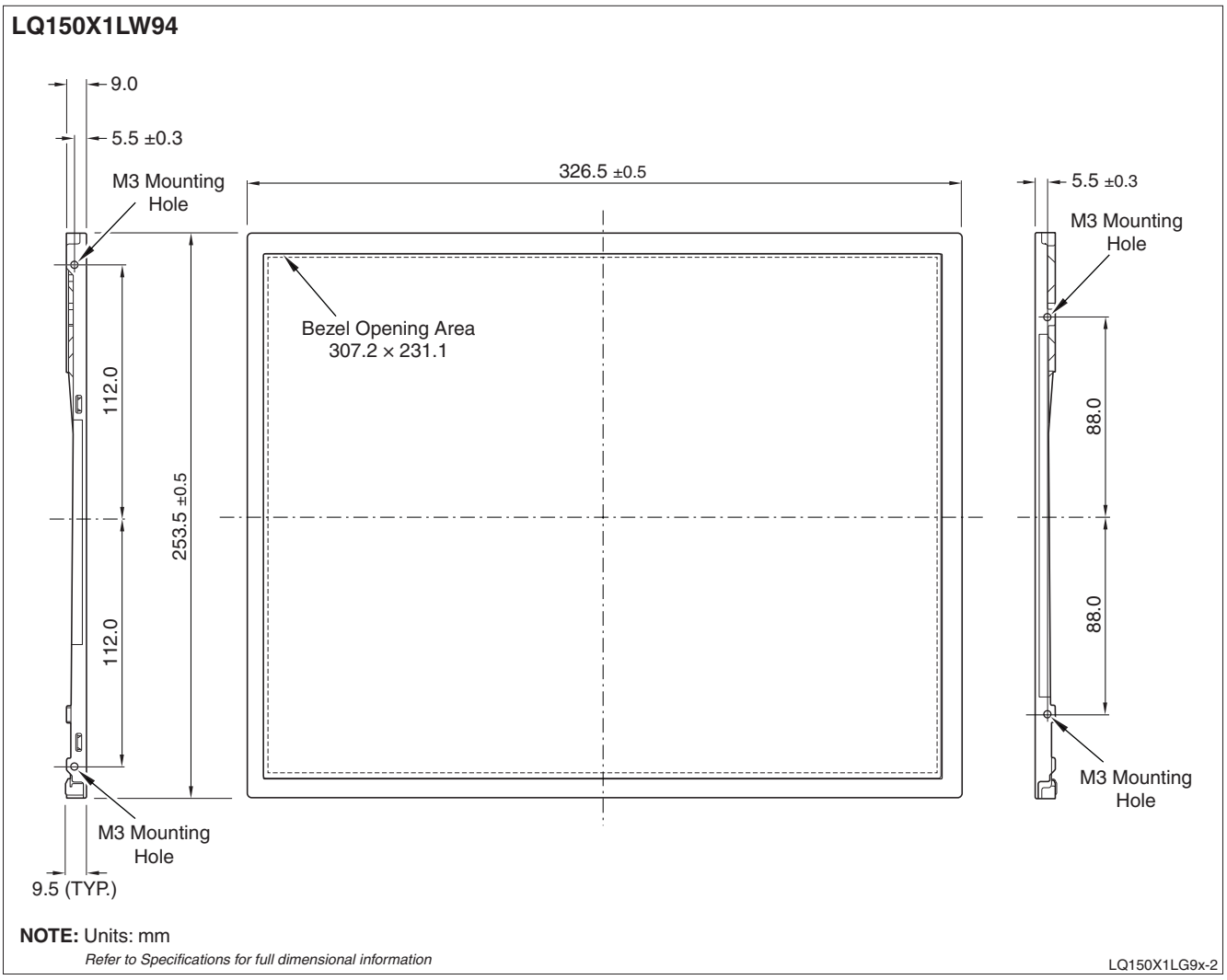

Figure 5. Mounting Dimensions for LQ150X1LW94 (Upgrade)

Figure 6 superposes the LQ150X1LW94 with the LQ150X1LW73. Note how there is a visible difference in the mounting scheme and the mechanical dimensions.

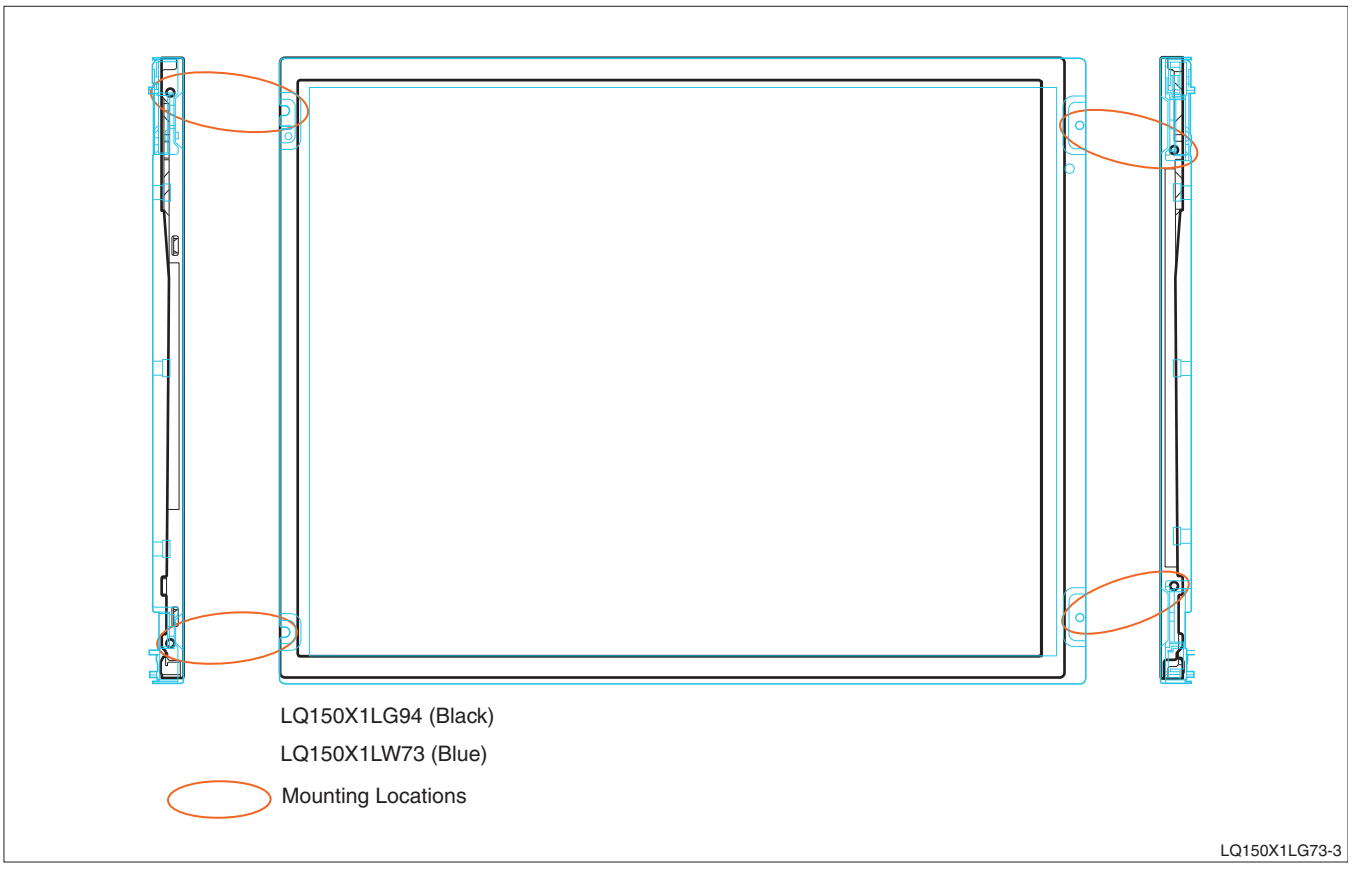

Figure 6. Superposition of LQ150X1LW94 (Upgrade) and LQ150X1LW73

INTERFACE CONNECTOR

Table 2 compares the Main Interface connectors for the LQ150X1LW94 (panel and backlight) versus the LQ150X1LW73.

Table 2. Main Interface Connector Types

LQ150X1LW73	LQ150X1LW12 (UPGRADE)	LQ150X1LW94 (UPGRADE)
DF14H-20P-1.25H (Hirose)	DF14H-20P-1.25H (56) (Hirose)	DF14-30P-1.25(56) (Hirose)

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

Parameter	LQ150X1LW73	LQ150X1LW12 (UPGRADE)	LQ150X1LW94 (UPGRADE)
V_{CC} Supply Voltage	0 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)	Not Specified	-0.3 V to Vcc+0.3 V	-0.3 V to Vcc+0.3 V
Storage temperature (Tstg)	-25°C to +65°C	-25°C to +65°C	-25°C to +65°C
Operating temperature (Topa)	0°C to +60°C	0°C to +65°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.

By checking the pinouts in Table 5, we can see the differences in the panels’ main interfaces. The LQ150X1LW12 is an exact match, pin-for-pin, with LQ150X1LW73.

When it comes to the LQ150X1LW94, on the surface of things, the main interface appears to be both electrically and mechanically incompatible as it includes the backlight power-and-control pins.

However, in looking through Table 5 (see next page), it can be seen that the LQ150X1LW94 requires the same voltage and signal connections as the LQ150X1LW73; but on different pins. However, it uses the same LVDS transmitter as the LQ150X1LW73 as shown in Table 4:

Table 4. Required LVDS Transmitters

LQ150X1LW73	LQ150X1LW12 (UPGRADE)	LQ150X1LW94 (UPGRADE)
THC63LVDM83R (THine)	THC63LVDM83D (THine)	THC63LVDM83R (THine)

Table 5. Interface Connectors

LQ150X1LW73			LQ150X1LW12 (UPGRADE)			LQ150X1LW94 (UPGRADE)		
PIN NO.	SYMBOL	FUNCTION	PIN NO.	SYMBOL	FUNCTION	PIN NO.	SYMBOL	FUNCTION
1	VCC	+3.3 V power supply	1	VCC	+3.3V power supply	1	GND	GND
2	VCC	+3.3 V power supply	2	VCC	+3.3V power supply	2	GND	GND
3	GND		3	GND		3	VDD	+12 V Backlight Power supply
4	GND		4	GND		4	VDD	+12 V Backlight Power supply
5	RXIN0-	Negative Data Input, CH 0	5	RXIN0-	Negative Data Input, CH 0	5	GND	GND
6	RXIN0+	Positive Data Input, CH 0	6	RXIN0+	Positive Data Input, CH 0	6	XSTABY	Backlight ON/OFF signal
7	GND		7	GND		7	VBR	PWM signal
8	RXIN1-	Negative Data Input, CH 1	8	RXIN1-	Negative Data Input, CH 1	8	GND	GND
9	RXIN1+	Positive Data Input, CH 1	9	RXIN1+	Positive Data Input, CH 1	9	VCC	+3.3V Power supply
10	GND		10	GND		10	VCC	+3.3V Power supply
11	RXIN2-	Negative Data Input, CH 2	11	RXIN2-	Negative Data Input, CH 2	11	GND	GND
12	RXIN2+	Positive Data Input, CH 2	12	RXIN2+	Positive Data Input, CH 2	12	GND	GND
13	GND		13	GND		13	RXIN0-	Negative Data Input, CH 0
14	RXCLK IN-	Negative Clock Input	14	RXCLK IN-	Negative Clock Input	14	RXIN0+	Positive Data Input, CH 0
15	RXCLK IN+	Positive Clock Input	15	RXCLK IN+	Positive Clock Input	15	GND	GND
16	GND		16	GND		16	RXIN1-	Negative Data Input, CH 1
17	RXIN3-	Negative Data Input, CH 3	17	RXIN3-	Negative Data Input, CH 3	17	RXIN1+	Positive Data Input, CH 1
18	RXIN3+	Positive Data Input, CH 3	18	RXIN3+	Positive Data Input, CH 3	18	GND	GND
19	RL/UD	Display Mode Select	19	RL/UD	Display Mode Select	19	RXIN2-	Negative Data Input, CH 2
20	SET_LVDS	LVDS Mode Select	20	SET_LVDS	LVDS Mode Select	20	RXIN2+	Positive Data Input, CH 2

Table 5. Interface Connectors (Continued)

LQ150X1LW73			LQ150X1LW12 (UPGRADE)			LQ150X1LW94 (UPGRADE)		
PIN NO.	SYMBOL	FUNCTION	PIN NO.	SYMBOL	FUNCTION	PIN NO.	SYMBOL	FUNCTION
						21	GND	GND
						22	RXCLK IN-	Negative Clock Input
						23	RXCLK IN+	Positive Clock Input
						24	GND	GND
						25	RXIN3-	Negative Data Input, CH 3
						26	RXIN3+	Positive Data Input, CH 3
						27	GND	GND
						28	RL/UD	Display Mode Select
						29	SET_LVDS	LVDS Mode Select
						30	GND	GND

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

The data mapping works out the same for all modes (see Table 6). So the upgrade panel can be used, but will require some attention to the interface connection scheme.

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 6 for a comparison of 8-bit and 6-bit data mapping between all parts.

Table 6. Data Mapping Comparison

TRANSMITTER		LQ150X1LW73			LQ150X1LW12 (UPGRADE)			LQ150X1LW94 (UPGRADE)		
		8-BIT		6-BIT*	8-BIT		6-BIT*	8-BIT		6-BIT*
		SET_LVDS			SET_LVDS			SET_LVDS		
PIN	DATA	LOW	HIGH	HIGH	LOW	HIGH	HIGH	LOW	HIGH	HIGH
51	TA0	R0 (LSB)	R2	R0 (LSB)	R0 (LSB)	R2	R0 (LSB)	R0 (LSB)	R2	R0 (LSB)
52	TA1	R1	R3	R1	R1	R3	R1	R1	R3	R1
54	TA2	R2	R4	R2	R2	R4	R2	R2	R4	R2
55	TA3	R3	R5	R3	R3	R5	R3	R3	R5	R3
56	TA4	R4	R6	R4	R4	R6	R4	R4	R6	R4
3	TA5	R5	R7 (MSB)	R5 (MSB)	R5	R7 (MSB)	R5 (MSB)	R5	R7 (MSB)	R5 (MSB)
4	TA6	G0 (LSB)	G2	G0 (LSB)	G0 (LSB)	G2	G0 (LSB)	G0 (LSB)	G2	G0 (LSB)
6	TB0	G1	G3	G1	G1	G3	G1	G1	G3	G1
7	TB1	G2	G4	G2	G2	G4	G2	G2	G4	G2
11	TB2	G3	G5	G3	G3	G5	G3	G3	G5	G3
12	TB3	G4	G6	G4	G4	G6	G4	G4	G6	G4
14	TB4	G5	G7 (MSB)	G5 (MSB)	G5	G7 (MSB)	G5 (MSB)	G5	G7 (MSB)	G5 (MSB)
15	TB5	B0 (LSB)	B2	B0 (LSB)	B0 (LSB)	B2	B0 (LSB)	B0 (LSB)	B2	B0 (LSB)
19	TB6	B1	B3	B1	B1	B3	B1	B1	B3	B1
20	TC0	B2	B4	B2	B2	B4	B2	B2	B4	B2
22	TC1	B3	B5	B3	B3	B5	B3	B3	B5	B3
23	TC2	B4	B6	B4	B4	B6	B4	B4	B6	B4

Table 6. Data Mapping Comparison (Continued)

TRANSMITTER		LQ150X1LW73			LQ150X1LW12 (UPGRADE)			LQ150X1LW94 (UPGRADE)		
		8-BIT		6-BIT*	8-BIT		6-BIT*	8-BIT		6-BIT*
		SET_LVDS			SET_LVDS			SET_LVDS		
PIN	DATA	LOW	HIGH	HIGH	LOW	HIGH	HIGH	LOW	HIGH	HIGH
24	TC3	B5	B7 (MSB)	B5 (MSB)	B5	B7 (MSB)	B5 (MSB)	B5	B7 (MSB)	B5 (MSB)
27	TC4	(NA)	(NA)	(NA)	(HS)	(HS)	(HS)	(HS)	(HS)	(HS)
28	TC5	(NA)	(NA)	(NA)	(VS)	(VS)	(VS)	(VS)	(VS)	(VS)
30	TC6	DE	DE	DE	DE	DE	DE	DE	DE	DE
50	TD0	R6	R0 (LSB)	GND	R6	R0 (LSB)	GND	R6	R0 (LSB)	GND
2	TD1	R7 (MSB)	R1	GND	R7 (MSB)	R1	GND	R7 (MSB)	R1	GND
8	TD2	G6	G0 (LSB)	GND	G6	G0 (LSB)	GND	G6	G0 (LSB)	GND
10	TD3	G7 (MSB)	G1	GND	G7 (MSB)	G1	GND	G7 (MSB)	G1	GND
16	TD4	B6	B0 (LSB)	GND	B6	B0 (LSB)	GND	B6	B0 (LSB)	GND
18	TD5	B7 (MSB)	B1	GND	B7 (MSB)	B1	GND	B7 (MSB)	B1	GND
25	TD6	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)	(NA)

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

LQ150X1LW12 LED BACKLIGHT

The LQ150X1LW12 has an onboard backlight driver which utilizes typical power supplies and signals. It utilizes a separate connector, CN2. The mating connector is a J.S.T. SHLP-06V-S-B. The pins are shown in Table 7.

Table 7. Backlight Pins, LQ150X1LW12

PIN NO.	SYMBOL	FUNCTION
1	VDD	+12 V Power supply
2	VDD	+12 V 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.

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 on pin 6 with a frequency of between 50 Hz and 1 kHz and a duty cycle of 1% to 100% will control dimming. A duty cycle of 100% is 'ON full' or no dimming.

LQ150X1LW94 LED BACKLIGHT

The LQ150X1LW94 has an onboard backlight driver which utilizes typical power supplies and signals. It shares the connector with the main interface, thereby making the main interface connection incompatible with the LQ150X1LW73. The Main Interface pins for the backlight are highlighted in Table 8.

Table 8. Backlight Pins, LQ150X1LW94

PIN NO.	SYMBOL	FUNCTION
3	VDD	+12 V Power supply
4	VDD	+12 V Power supply
5	GND	GND
6	XSTABY	Backlight ON/OFF signal
7	VBR	PWM signal

NOTE: Pins 6 and 7 are logic level.

Pins 6 and 7 operate at logic levels and have a 10k Ω pull-down resistor. Setting pin 6 HIGH will enable the backlight, and a PWM signal on pin 7 with a frequency of between 50 Hz and 1 kHz and a duty cycle of 1% to 100% will control dimming. A duty cycle of 100% is 'ON full' or no dimming.

OPTICAL COMPARISONS

Table 9 compares the Optical Characteristics using the Typical values from the Specifications:

Table 9. Optical Comparison (Typical Values)

PARAMETER	LQ150X1LW73	LQ150X1LW12 (UPGRADE)	LQ150X1LW94 (UPGRADE)
Horizontal Viewing angle	170	170	170
Vertical Viewing angle (12 o'clock)	85	85	85
Vertical Viewing angle (6 o'clock)	85	85	85
Contrast ratio	600	1000	1500
Response time (Rise/Fall, ms)	35	35	35
White Chromaticity (x)	0.313	0.300	0.300
White Chromaticity (y)	0.329	0.325	0.325
White Luminance (nits)	350	350	300

Note that all viewing angles are the same in all directions, while contrast is much higher for both replacements. The LQ150X1LW12 is an excellent match in all areas, but the image will look considerably ‘crisper’ because of its much higher contrast.

Brightness for the LQ150X1LW94 is slightly less, so the upgrade module will appear slightly darker if viewed side by side with the one it replaces. However, the contrast more than double; and the eye tends to perceive this as clarity, so the upgrade module will appear much sharper than the one it replaces.

CONCLUSIONS

This Application Note has considered the upgrade path from the LQ150X1LW73, by comparing the Specifications between the LQ150X1LW12, and the LQ150X1LW94.

LQ150X1LW12

The LQ150X1LW12 is a simple upgrade path, to the point of being mechanically and electrically drop-in compatible with the LQ150X1LW73.

Visually, the LQ150X1LW12 will appear much ‘crisper’ due to its much greater contrast capability.

The backlight may require attention from the Designer for compatibility with existing circuitry; however Sharp has made the task as easy as possible by making the onboard LED backlight driver compatible with common CCFT driver supply voltages and signals.

LQ150X1LW94

Upgrading to the LQ150X1LW94 will require the Designer’s attention to both the mechanical fit and the connections at the Main Interface.

The LQ150X1LW94 is not a direct mechanical drop-in replacement for LQ150X1LW73, as it uses side mounts instead of tab mounts.

The Main Interface is also mechanically incompatible, due to the inclusion of the backlight control and power pins.

Electrically, the panel’s signals and power requirements are the same (including LVDS signals and timing), but the pinouts do not match, ëbecause the backlight power and control pins are included in the main interface connector for the LQ150X1LW94. Other extra pins are taken up with ground connections for greater reliability.

Signal-wise, the LQ150X1LW94 is a good match; an upgrade will require attention to the Main Interface connector design, to include the backlight power and drive signals. Sharp has made this job easier through the use of industry-standard voltages and signals for the backlight.

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