

Upgrading to LQ104V1DG81 from CCFT-Backlit Modules

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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 LQ104V1DG81 from these modules:

- LQ10D36A
- LQ104V1DG5A
- LQ104V1DG21
- LQ104V1DG61

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 LQ104V1DG81

Sharp is upgrading several parts to the LQ104V1DG81. 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 LQ104V1DG81 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.

With the exception of the LQ104V1DG21, the mechanical dimensions as shown by the Specifications match closely with the LQ104V1DG81, and its mass is somewhat less (as expected).

Mounting and Connectors

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

Table 1. Mechanical Specifications

Parameter	LQ104V1DG81 (UPGRADE)	LQ10D36A	LQ104V1DG5A	LQ104V1DG21	LQ104V1DG61
Display size (diagonal)	10.4-inch (26 cm)	10.4-inch (26 cm)	10.4-inch (26 cm)	10.4-inch (26 cm)	10.4-inch (26 cm)
Active area	211.2 × 158.4 mm	211.2 × 158.4 mm	211.2 × 158.4 mm	211.2 × 158.4 mm	211.2 × 158.4 mm
Pixel format	640 × 480	640 × 480	640 × 480	640 × 480	640 × 480
Number of colors	262,144	262,144	262,144	262,144	262,144
Pixel pitch	0.33 × 0.33 mm	0.33 × 0.33 mm	0.33 × 0.33 mm	0.33 × 0.33 mm	0.33 × 0.33 mm
Display mode	Normally White	Normally White	Normally White	Normally White	Normally White
External Dimensions	246.5 × 179.4 × 12.5 mm	246.5 × 179.4 × 11 mm	246.5 × 179.4 × 15.5 mm	265.0 × 195.0 × 11.5 mm	246.5 × 179.4 × 13.7 mm
Mass (MAX.)	500 g	520 g	620 g	700 g	620 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

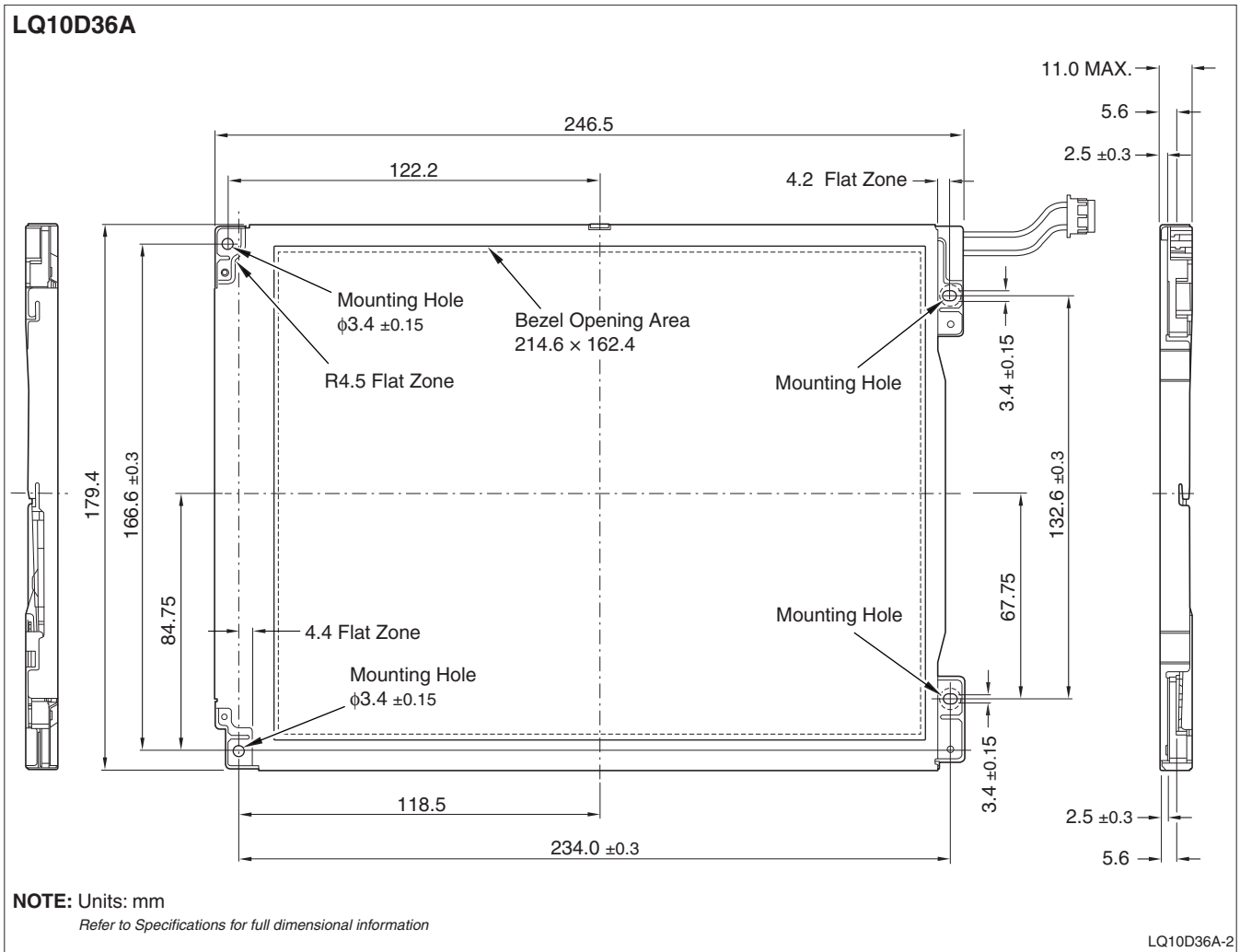


Figure 3. Mounting Dimensions for LQ10D36A

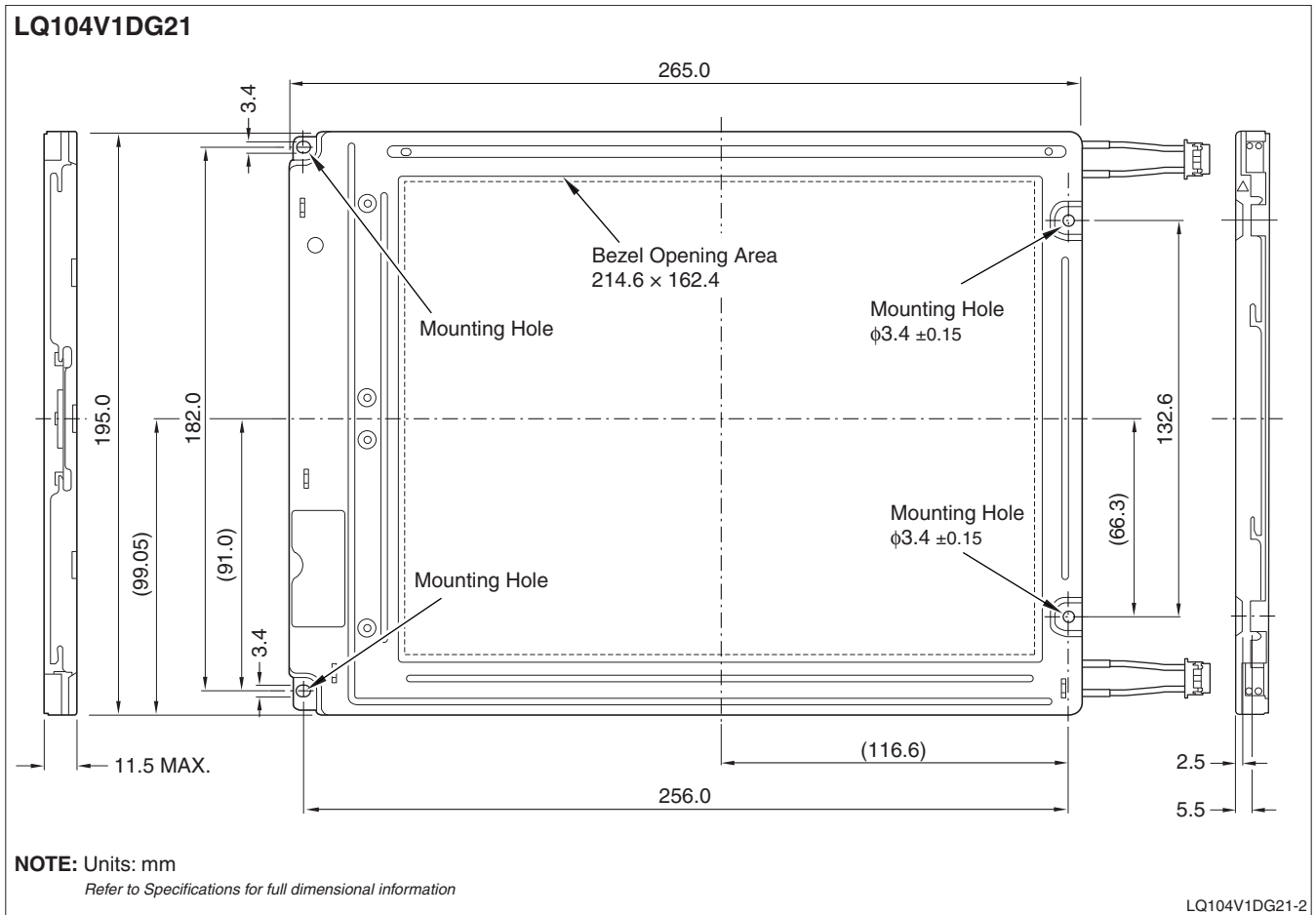


Figure 5. Mounting Dimensions for LQ104V1DG21

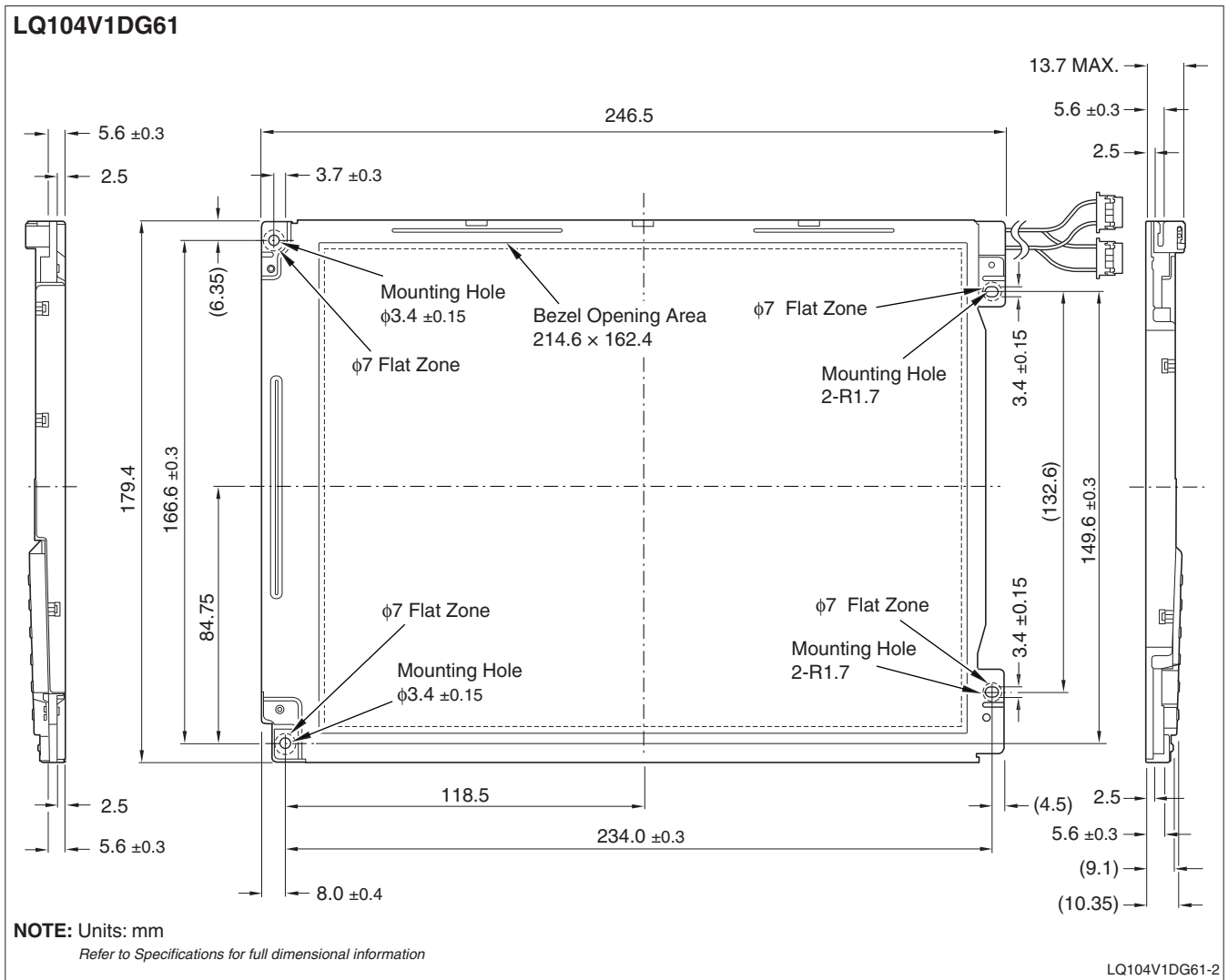


Figure 6. Mounting Dimensions for LQ104V1DG61

The next four illustrations superpose the LQ104V1DG81 with each of the upgrade panels.

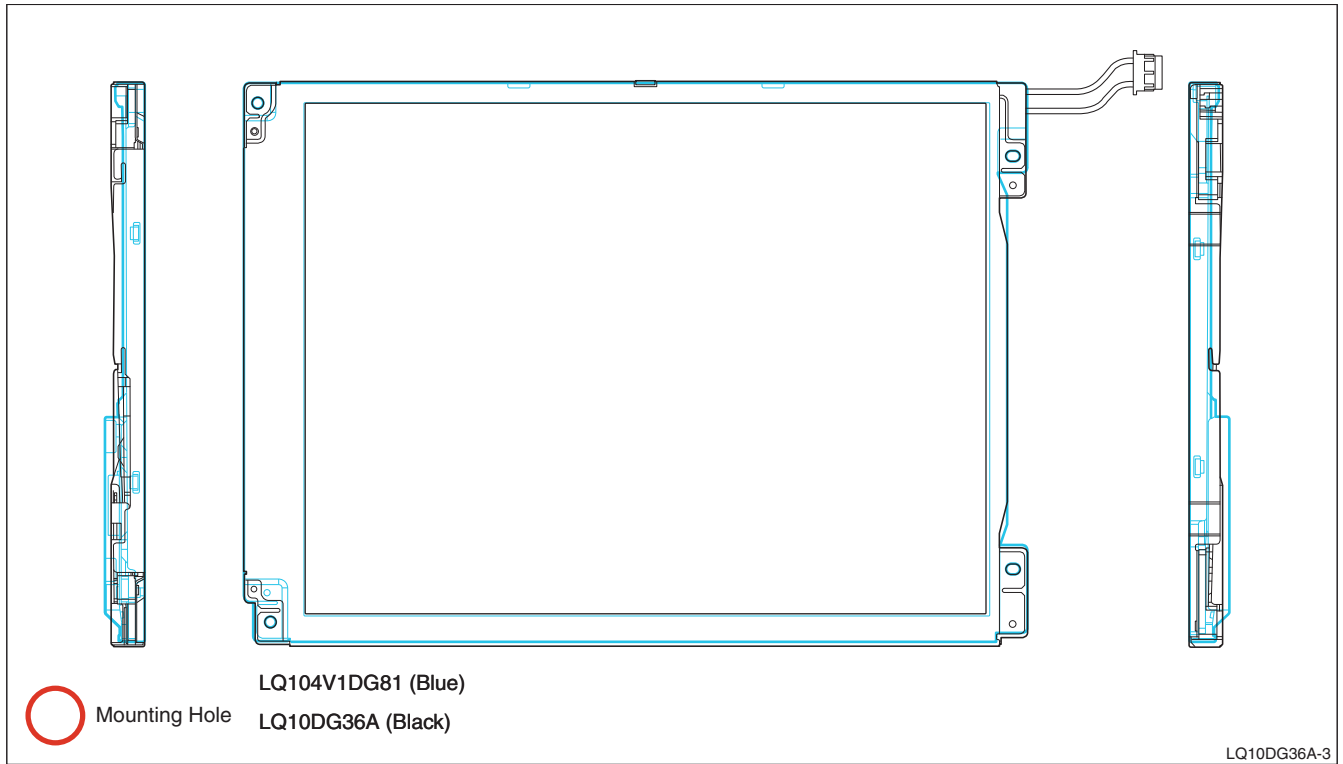


Figure 7. Superposition of LQ104V1DG81 and LQ10D36A

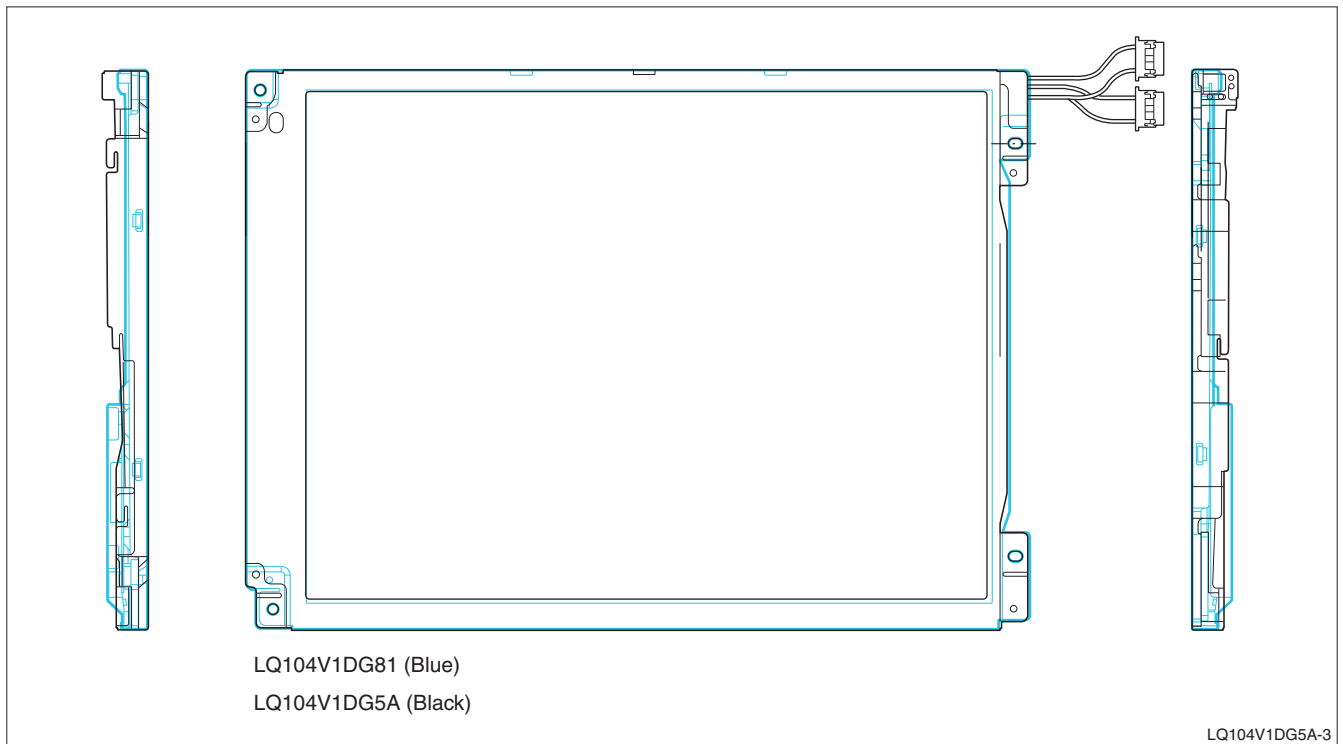


Figure 8. Superposition of LQ104V1DG81 and LQ104V1DG5A

INTERFACE CONNECTOR

See Table 2 for a comparison of mating connectors for the LQ104V1DG81 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 qualified yes'; note that the maximum input voltage tolerance for the LQ104V1DG81 is lower.

Table 2. Main Interface Connector Types

LQ104V1DG81 (UPGRADE)	LQ10D36A	LQ104V1DG5A	LQ104V1DG21	LQ104V1DG61
DF9MA-31P-1V(32) or DF9B-31P-1V(32) (Hirose) or 20026-231x-x1F (I-PEX)	DF9MA-31P-1V(32) (Hirose)	DF9MA-31P-1V(32) (Hirose)	DF9MA-31P-1V(32) (Hirose)	DF9MA-31P-1V(32) (Hirose)

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

Parameter	LQ104V1DG81 (UPGRADE)	LQ10D36A	LQ104V1DG5A	LQ104V1DG21	LQ104V1DG61
V _{CC} Supply Voltage	-0.3 V to + 4.0 V	-0.3 V to + 6.0 V	-0.3 V to + 6.0 V	-0.3 V to + 6.0 V	-0.3 V to + 6.0 V
Input voltage VI1, V2 (RXIN, CK IN; R/L, U/D, SEL_LVDS)	-0.3V to V _{cc} +0.3V	-0.3V to V _{cc} +0.3V	-0.3V to V _{cc} +0.3V	-0.3V to V _{cc} +0.3V	-0.3V to V _{cc} +0.3V
Storage temperature (T _{stg})	-30°C to +80°C	-30°C to +70°C	-30°C to +70°C	-30°C to +70°C	-30°C to +80°C
Operating temperature (T _{opa})	-30°C to +80°C	-10°C to +65°C	-10°C to +65°C	-10°C to +65°C	-30°C to +80°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.

Note that the LQ104V1DG81 supports only a 3.3 V power supply instead of the 3.3 V/5 V supply of the modules it supersedes. The display mode reversal for the upgrade panel performs both a right/left and up/down reversal, rather than each direction being individually selectable.

Table 4. Interface Connectors

LQ104V1DG81 (UPGRADE)		LQ10D36A	LQ104V1DG5A	LQ104V1DG21	LQ104V1DG61	FUNCTION
PIN NO.	SYMBOL	SYMBOL	SYMBOL	SYMBOL	SYMBOL	
1	GND	GND	GND	GND	GND	GND
2	CK	CK	CK	CK	CK	Data Clock
3	Hsync	Hsync	Hsync	Hsync	Hsync	Horizontal sync
4	Vsync	Vsync	Vsync	Vsync	Vsync	Vertical sync
5	GND	GND	GND	GND	GND	GND
6	R0	R0	R0	R0	R0	RED data (LSB)
7	R1	R1	R1	R1	R1	RED data
8	R2	R2	R2	R2	R2	RED data
9	R3	R3	R3	R3	R3	RED data
10	R4	R4	R4	R4	R4	RED data
11	R5	R5	R5	R5	R5	RED data (MSB)
12	GND	GND	GND	GND	GND	GND
13	G0	G0	G0	G0	G0	GREEN data (LSB)
14	G1	G1	G1	G1	G1	GREEN data
15	G2	G2	G2	G2	G2	GREEN data
16	G3	G3	G3	G3	G3	GREEN data
17	G4	G4	G4	G4	G4	GREEN data
18	G5	G5	G5	G5	G5	GREEN data (MSB)
19	GND	GND	GND	GND	GND	GND
20	B0	B0	B0	B0	B0	BLUE data (LSB)
21	B1	B1	B1	B1	B1	BLUE data
22	B2	B2	B2	B2	B2	BLUE data
23	B3	B3	B3	B3	B3	BLUE data
24	B4	B4	B4	B4	B4	BLUE data
25	B5	B5	B5	B5	B5	BLUE data (MSB)
26	GND	GND	GND	GND	GND	GND
27	ENAB	ENAB	ENAB	ENAB	ENAB	Horizontal line start pulse
28	Vcc	Vcc	Vcc	Vcc	Vcc	+3.3 V power supply
29	Vcc	Vcc	Vcc	Vcc	Vcc	+3.3 V power supply
30	NC	R/L	R/L	R/L	R/L	Display mode select
31	SCAN	U/D	U/D	U/D	U/D	Horizontal/Vertical display mode select

LED Backlight Connection

The LQ104V1DG81 has an onboard backlight driver and that driver utilizes typical power supplies and signals.

The connector is an SM06B-SHLS-TF (JST). Pinout is as shown in Table 5.

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 5. 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 6 compares the Optical Characteristics using the Typical values from the Specifications:

Table 6. Optical Comparison (Typical Values)

PARAMETER	LQ104V1DG81 (UPGRADE)	LQ10D36A	LQ104V1DG5A	LQ104V1DG21	LQ104V1DG61
Horizontal Viewing angle	160	140	140	120	140
Vertical Viewing angle (12 o'clock)	65	50	50	40	50
Vertical Viewing angle (6 o'clock)	80	60	60	70	60
Contrast ratio	800	500	500	300	600
Response time (Rise/Fall, ms)	35	35	35	60	35
White Chromaticity (x)	0.300	0.313	0.313	0.313	0.313
White Chromaticity (y)	0.320	0.329	0.329	0.329	0.329
White Luminance (nits)	450	200	350	350	450

Note that all viewing angles are significantly better in all directions, while contrast is much higher. Brightness is significantly higher than three of the superceded modules, so the upgrade module will appear brighter. 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 LQ104V1DG81 and:

- LQ10D36A
- LQ104V1DG5A
- LQ104V1DG21
- LQ104V1DG61

The LQ104V1DG81 is a mechanical drop-in replacement for most applications (except for LQ104V1DG21, where it is 19 mm narrower and 21 mm shorter). Applications using the LQ104V1DG21 will require rework for size and mechanical mounting.

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.

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

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