



## TFT DISPLAY MODULE DATA SHEET



*(FPC Folded)*

**Datasheet Release 2015-12-02**

**for:**

[CFAF320480C4-035T](#)

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### CFAF320480C4-035T Datasheet Revision History

Datasheet Release: 2015-12-02

- Removed all information for the discontinued CFAF320480C4-035T-TS. This discontinued display has been replaced by the [CFAF320480C5-035T-TS](#).
- Minors changes were made to text, formatting, and module outline illustrations to match the improved current datasheet template. Revised sections include [CARE AND HANDLING PRECAUTIONS \(Pg. 21\)](#) and [QUALITY ASSURANCE STANDARDS \(Pg. 24\)](#). Specifications for the CFAF320480C4-035T have not changed.
- Removed sample code appendix. Sample Code is now available under the Datasheets & Files tab for this display.
- Removed controller datasheet appendix. The [Himax HX8357-B](#) controller datasheet is available as a free download on our website.

Datasheet Release: 2014-09-15

- Added statement “About Volatility” on this page.
- Removed information about kit that included the CFAF320480C4-035T(without touch screen). Kit is available that includes the CFAF320480C4-035T-TS (with touch screen).
- Corrected depth specifications in Physical Characteristics section. Depths are slightly less than previously stated. Updated text, formatting, and module outline illustrations to match improved Datasheet template.

Data Sheet Release: 2013-05-06

Improved information in OPTICAL SPECIFICATIONS and LED Backlight Characteristics. Modules have not changed.

Data Sheet Release: 2013-05-03

First Data Sheet for the new CFAF320480C4-035T and CFAF320480C5-035T-TS display modules.

### Product Change Notifications

To check for Product Change Notifications for this display module, see the Product Notices tab on a product's web page:  
<https://www.crystalfontz.com/product/cfaf320480c4035t-lcd-tft-320x480-display-module#pcn>

Product pages without a Product Notices tab do not have Product Change Notifications.

### About Variations

We work continuously to improve our products. Because display technologies are quickly evolving, these products may have component or process changes. Slight variations (for example, contrast, color, or intensity) between lots are normal. If you need the highest consistency, whenever possible, order and arrange delivery for your production runs at one time so your displays will be from the same lot.

### About Volatility

This display module has volatile memory.



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## GENERAL CHARACTERISTICS

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### MAIN FEATURES

- Full-color (262K) 320xRGBx480 display consists of a TFT panel, integrated controller, an FPC (Flexible Printed Circuit) tail, and a white LED backlight.
- Module dimensions
  - Active Area
    - Diagonal is 88.90 millimeters  
Inches = 3.5-inches
    - Active area width and height is 48.96 (W) x 73.44 (H) millimeters.  
Inches = 1.93" (W) x 2.89" (H).
  - Display Module Overall:
    - FPC *unfolded* is 55.50 (W) x 127.55 (H) mm (Shape and length of FPC may vary slightly.)  
Inches = 2.185" (W) x 5.022" (H)
    - FPC *folded* is 55.50 (W) x (H) 85.96 mm  
Inches = 2.185" (W) x 3.384" (H).
  - Overall module depth:
    - Millimeters: 2.55 mm (D) excluding the molded plastic alignment pin.
    - Inches = 0.100" (D) excluding the molded plastic alignment pin
- The integrated [Himax HX8357-B](#) controller datasheet is available as a free download on our website.
- Requires only a single source 3.0v for both power supply and logic.
- Interface modes to host:
  - 8-bit, 9-bit, 16-bit or 18-bit parallel.
  - 16-bit or 18-bit "DOTCLK" RGB.
  - 3- or 4-wire SPI.
- The 50-pin FPC mates with standard 0.5mm ZIF sockets such as [HFJ150CT-ND](#) and [HFK150CT-ND](#) from Digi-Key.
- Transmissive display with edge-lit LED backlight (6 white LEDs). The white LED backlight has anode (A,+) and cathode (K -) pins brought out on the FPC.
- 6:00 o'clock viewing angle (polarizer viewing direction).
- Temperature range for operation is from -20°C to +70°C.
- This display can be purchased mounted on a carrier board or as part of a complete development kit. These are available under the "Additional Options" heading on the display's web page.
- This display is RoHS compliant.
- CrystalFontz America, Incorporated is ISO 9001:2008 certified.



## EXPLANATION OF PART NUMBER CODES IN THIS DATASHEET

<u>CFA</u>	<u>F</u>	<u>320</u>	<u>480</u>	<u>C4</u>	-	<u>035</u>	<u>T</u>
①	②	③	④	⑤		⑥	⑦

①	<b>Brand</b>	CrystalFontz America, Inc.
②	<b>Display Type</b>	F – TFT
③	<b>Number of Pixels (Width)</b>	320 pixels
④	<b>Number of Pixels (Height)</b>	480 pixels
⑤	<b>Model Identifier</b>	C4
⑥	<b>Diagonal Dimension</b>	035 – 3.5-inch diagonal
⑦	<b>Backlight Type &amp; Color</b>	T – white LED backlight



## MECHANICAL SPECIFICATIONS

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### PHYSICAL CHARACTERISTICS

ITEM	SPECIFICATION
Number of Pixels	320 x RGB x 480 pixels
Pixel Pitch	0.051 (W) x 0.051 (H) mm
Active Area	
Active Area Diagonal	Millimeters: 88.90 mm Inches: 3.500"
Active Area Width and Height	Millimeters: 48.96 (W) x 73.44 (H) mm Inches: 1.927" (W) x 2.891" (H)
Module Outline Dimensions	
Overall module width and height with FPC unfolded*	Millimeters: 55.50 (W) x 127.55 (H) mm Inches: 2.185" (W) x 5.022" (H)
Overall module width and height with FPC folded	Millimeters: 55.50 (W) x 85.96 (H) mm Inches: 2.185" (W) x 3.384" (H)
<i>*For reference only. Shape and length of FPC may vary slightly.</i>	
Module depth excluding the molded plastic alignment pin	Millimeters: 2.55 (D) mm Inches: 0.100" (D)
FPC Bend Radius	>R.95 mm
Weight	19 grams



# MODULE OUTLINE DRAWINGS

Figure 1. Module Outline Drawing, Front And Side View

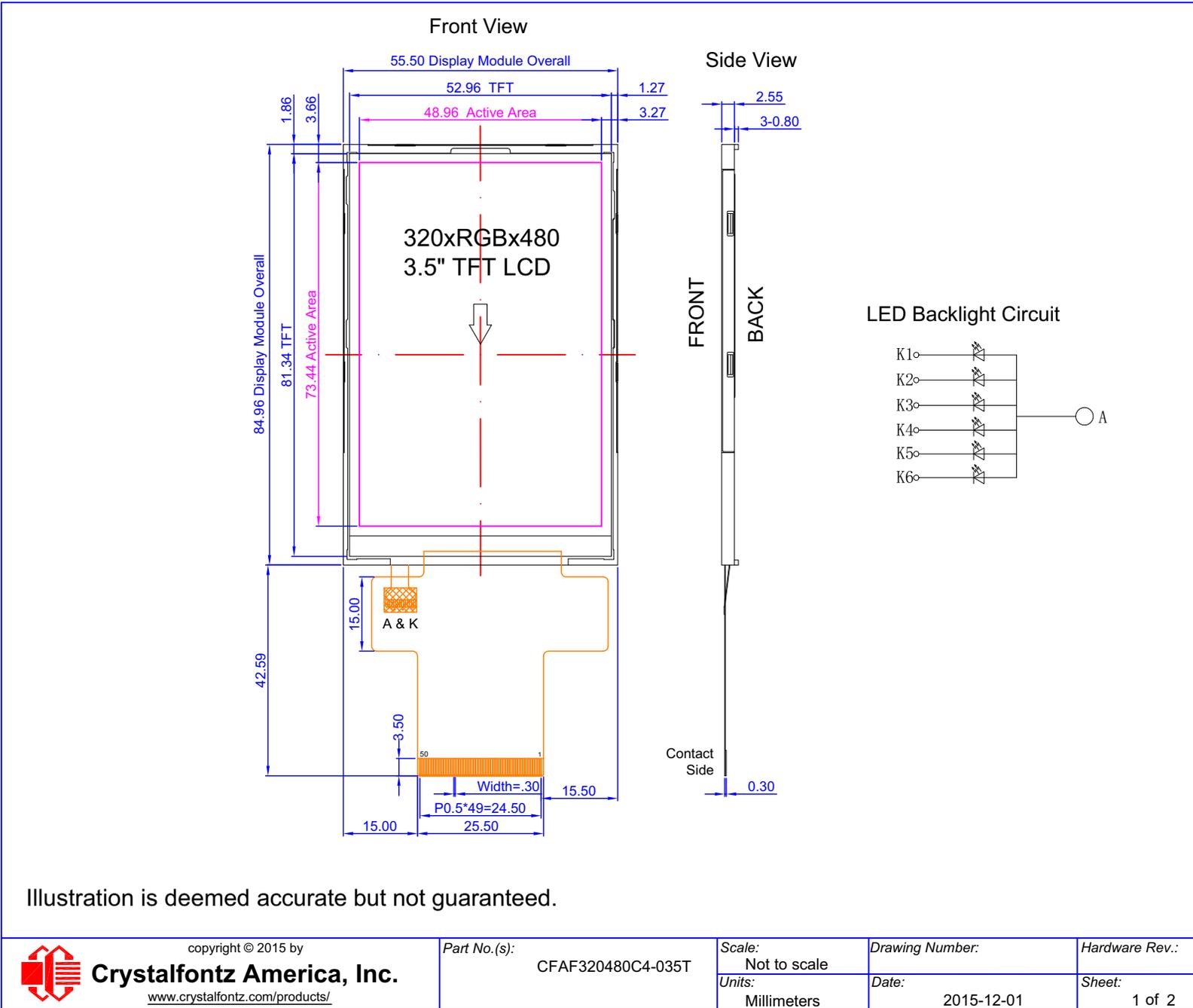




Figure 2. Module Outline Drawing, Back View

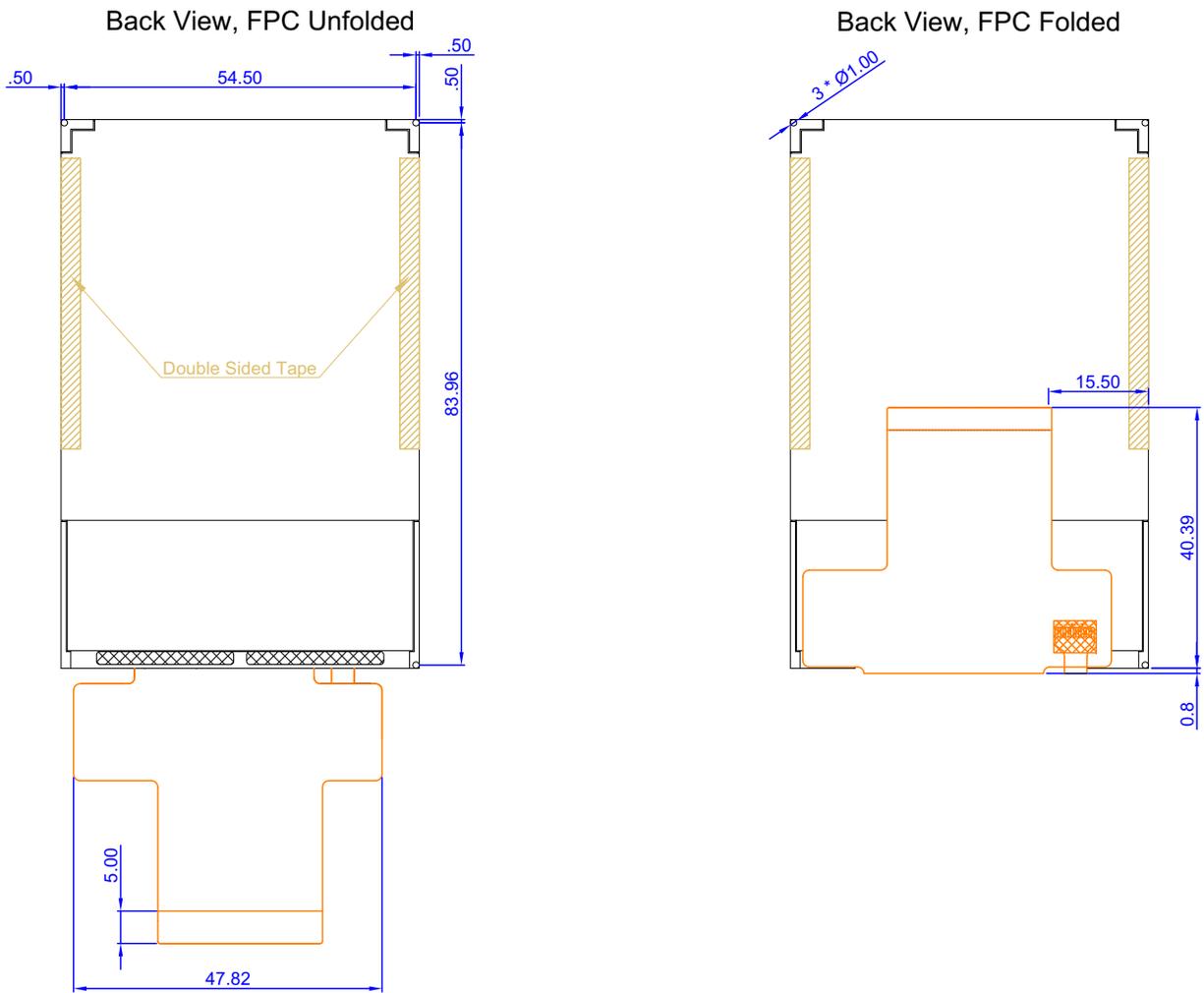


Illustration is deemed accurate but not guaranteed.

 <b>Crystalfontz America, Inc.</b> <a href="http://www.crystalfontz.com/products/">www.crystalfontz.com/products/</a>	copyright © 2015 by	Part No.(s): CFAF320480C4-035T	Scale: Not to scale	Drawing Number:	Hardware Rev.:
	Units: Millimeters		Date: 2015-12-01		



## ELECTRICAL SPECIFICATIONS

### ABSOLUTE MAXIMUM RATINGS

Ambient Temperature (Ta) = 25°C			
Absolute Maximum Ratings	Symbol	Minimum	Maximum
Digital Logic Supply and Input/Output Supply	V <sub>LOGIC I/O</sub>	-0.3v	+4.6v
Analog Supply	V <sub>ANALOG</sub>		
Operating Temperature*	T <sub>OP</sub>	-20°C	+70°C
Storage Temperature*	T <sub>ST</sub>	-30°C	+80°C
Humidity	RH	0%	90%
Input voltage	V <sub>IN</sub>	-0.3v	V <sub>LOGIC I/O</sub> +0.3v
<b>Caution</b> <i>These are stress ratings only. Functional operation of the module at these or any other conditions beyond those listed under <a href="#">Recommended DC Characteristics (Pg. 11)</a> is not implied.</i>  <i>Extended exposure to the absolute maximum ratings listed above may affect device reliability. Stresses beyond those listed above can cause permanent damage.</i>			



## RECOMMENDED DC CHARACTERISTICS

RECOMMENDED DC CHARACTERISTICS	SYMBOL	MINIMUM	TYPICAL	MAXIMUM
Digital Logic Supply and Input/Output Supply	$V_{\text{LOGIC I/O}}$	+1.7v	+1.8v / +3.3v	+3.3v
Analog Supply	$V_{\text{ANALOG}}$	+2.5v	+3.3v	
Current consumption for Normal Operation	$V_{\text{OP}}$	—	10 mA	15 mA
Input High Voltage	$V_{\text{IH}}$	$+0.7v * V_{\text{LOGIC I/O}}$ for $V_{\text{LOGIC I/O}} = +1.8v$ $V_{\text{IH}} = +0.7v * +1.8v = +1.26v$  for $V_{\text{LOGIC I/O}} = +3.3v$ $V_{\text{IH}} = +0.7v * +3.3v = +2.31v$	—	$V_{\text{LOGIC I/O}}$
Input Low Voltage	$V_{\text{IL}}$	0v (GND)	—	$+0.3v * V_{\text{LOGIC I/O}}$ for $V_{\text{LOGIC I/O}} = +1.8v$ $V_{\text{IL}} = +0.3v * +1.8v = 0.54v$  for $V_{\text{LOGIC I/O}} = +3.3v$ $V_{\text{IL}} = +0.3v * +3.3v = +0.99v$
Output High Voltage @0.1mA	$V_{\text{OH}}$	$+0.8v * V_{\text{LOGIC I/O}}$ for $V_{\text{LOGIC I/O}} = +1.8v$ $V_{\text{OH}} = +0.8v * +1.8v = +1.44v$  for $V_{\text{LOGIC I/O}} = +3.3v$ $V_{\text{OH}} = +0.8v * +3.3v = +2.64v$	—	$V_{\text{LOGIC I/O}}$
Output Low Voltage @0.1mA	$V_{\text{OL}}$	0v (GND)	—	$+0.2v * V_{\text{LOGIC I/O}}$ for $V_{\text{LOGIC I/O}} = +1.8v$ $V_{\text{OL}} = +0.2v * +1.8v = 0.36v$  for $V_{\text{LOGIC I/O}} = +3.3v$ $V_{\text{OL}} = +0.2v * +3.3v = +0.66v$

*This is a summary of the module's major operating parameters. For detailed information see the [Himax HX8357-B](#) controller datasheet.*



## DETAILS OF INTERFACE PIN FUNCTION

PIN	SIGNAL	LEVEL	DIRECTION	DESCRIPTION																																																		
1	GND	0v		Ground. Must be connected to an external ground.																																																		
2-3	V <sub>LOGIC I/O</sub>	1.65v to 3.3v	I	Digital Logic Supply and Input/Output Supply																																																		
4-5	V <sub>ANALOG</sub>	+2.5v to +3.3v	I	Analog supply,																																																		
6	IM0		I	<table border="1"> <thead> <tr> <th>IM2</th> <th>IM1</th> <th>IM0</th> <th>Interface Mode</th> <th>DB Pins In Use</th> </tr> </thead> <tbody> <tr> <td colspan="5"><i>Parallel (also known as DOTCLK or DPI) Interface</i></td> </tr> <tr> <td>0</td> <td>0</td> <td>0</td> <td>18-bit RGB / DPI</td> <td>DB17-BD0</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>9-bit RGB / DPI</td> <td>DB8-DB0</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> <td>16-bit RGB / DPI</td> <td>DB15-DB0</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> <td>8-bit RGB / DPI</td> <td>DB7-DB0</td> </tr> <tr> <td colspan="5"><i>3 or 4-wire SPI</i></td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> <td>3-wire, 9-bit SPI</td> <td>SDI, SCL, CS</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> <td>4-wire, 8-bit SPI</td> <td>SDI, SCL, CS, RS</td> </tr> <tr> <td colspan="5">Note: If pin is not used, tie to GND or make no connection.</td> </tr> </tbody> </table> <p><b>DPI</b> is Display Pixel Interface.</p>	IM2	IM1	IM0	Interface Mode	DB Pins In Use	<i>Parallel (also known as DOTCLK or DPI) Interface</i>					0	0	0	18-bit RGB / DPI	DB17-BD0	0	0	1	9-bit RGB / DPI	DB8-DB0	0	1	0	16-bit RGB / DPI	DB15-DB0	0	1	1	8-bit RGB / DPI	DB7-DB0	<i>3 or 4-wire SPI</i>					1	0	1	3-wire, 9-bit SPI	SDI, SCL, CS	1	1	1	4-wire, 8-bit SPI	SDI, SCL, CS, RS	Note: If pin is not used, tie to GND or make no connection.				
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1	0	1	3-wire, 9-bit SPI	SDI, SCL, CS																																																		
1	1	1	4-wire, 8-bit SPI	SDI, SCL, CS, RS																																																		
Note: If pin is not used, tie to GND or make no connection.																																																						
7	IM1																																																					
8	IM2																																																					
9	$\overline{\text{RST}}$	L	I	Reset signal. <i>Low:</i> Display controller is reset. The $\overline{\text{RST}}$ pin should be pulsed low shortly after power is applied. <i>High:</i> The $\overline{\text{RST}}$ pin should be brought <i>high</i> (V <sub>LOGIC I/O</sub> ) for normal operation.																																																		
10	V <sub>SYNC</sub>		I	Vertical and Horizontal frame synchronizing signal used for RGB / DPI mode. The pin should be pulled <i>high</i> (V <sub>LOGIC I/O</sub> ) when not in use.																																																		
11	H <sub>SYNC</sub>																																																					
12	P <sub>CLK</sub>	H/L	I	Pixel Clock Signal for RGB / DPI mode. The pin should be pulled <i>low</i> when not in use.																																																		
13	DE	H/L	I/O	Data Enable signal for RGB / DPI mode. The pin should be pulled <i>low</i> when not in use.																																																		



PIN	SIGNAL	LEVEL	DIRECTION	DESCRIPTION (Continued)
14-31	DB17-DB0	H/L	I/O	<p><i>In MIPI databus interface mode, DB7-DB0 are used like:</i>            18-bit bidirectional data bus.            8-bit bus: use DB7-DB0            9-bit bus: use DB8-DB0            6-bit bus: use DB15-DB0            8-bit bus: use DB17-DB0</p> <p><i>In MIPI DPI interface mode, DB17-DB0 are treated as 18-bit bus</i></p> <p><i>RGB data bus</i>            6-bit bus: use DB5-DB0            16-bit bus: use DB15-DB0            18-bit bus: use DB17-DB0            If not used: please connect to V<sub>SSD</sub>.</p> <p><b>MIPI</b> is <b>Mobile Industry Processor Interface</b>. See <a href="#">MIPI Alliance</a>.</p>
32	GND	0v		Ground. Must be connected to an external ground.
33	MISO		O	SPI data signal: <b>Master In Slave Out</b> . If unused, leave disconnected / floating.
34	MOSI		I	SPI data signal: <b>Master Out Slave In</b> . The data is received on the rising edge of the SCK signal. If unused, tie to V <sub>SSD</sub> .
35	$\overline{RD}$		I	DBI Type-B: Serves as a read signal and read data at the low level. If unused, tie to V <sub>LOGIC I/O</sub> .
36	$\overline{WR\_SCK}$		I	DBI Type-B: Serves as a write signal and write data at the low level. DBI Type-C: Serves as SCK (Serial Clock). If unused, tie to V <sub>LOGIC I/O</sub> .
37	D/ $\overline{C}$	H/L	I	Data/Command control. Determines whether data bits are data or command. 1 – High: Addresses the data register. 0 – Low: Addresses the command register. If unused, tie to V <sub>LOGIC I/O</sub> .
38	$\overline{CS}$	H/L	I	Chip select input. Low: Controller chip is selected. Communications with host is possible. High: Controller chip is not selected. Host interface signals are ignored by the controller.
39-42	See description column			<p>CFAF320480C4-035T (no touch screen): No Connection.</p> <p>CFAF320480C5-035T-TS (with touch screen):            XR(X+): right            YD(Y-): down            XL(X-): left            YU(Y+): up</p>



PIN	SIGNAL	LEVEL	DIRECTION	DESCRIPTION (Continued)
43	A1 (LED +)			Common supply pin for LEDs. "A" (anode) or "+" of LED backlight.
44-49	LEDK1-LEDK6 (LED -)			Individual supply pins for LED. "K" (cathode or kathode for German and original Greek spelling) or "-" of LED backlight.
50	GND			Ground.

*For backlight connections, please refer to [LED Backlight Characteristics \(Pg. 17\)](#).*

## ESD (ELECTRO-STATIC DISCHARGE)

The circuitry is industry standard CMOS logic and is susceptible to ESD damage. Please use industry standard antistatic precautions as you would for any other static sensitive devices such as expansion cards, motherboards, or integrated circuits. Ground your body, work surfaces, and equipment.



# OPTICAL SPECIFICATIONS

Ambient Temperature (Ta) = 25°C, Maximum 75% Relative Humidity						
ITEM	SYMBOL	ADDITIONAL TEST CONDITIONS	MINIMUM	TYPICAL	MAXIMUM	
Color Depth				262K		
Contrast Ratio (CR) <sup>1</sup>		$\theta = \phi - 0^\circ$		500		
TFT Response Time <sup>2</sup>	Tr			5 ms		
	Tf			15 ms		
Red Chromaticity	Rx			0.611	0.641	0.671
	Ry			0.290	0.320	0.350
Green Chromaticity	Gx			0.270	0.300	0.330
	Gy			0.536	0.566	0.596
Blue Chromaticity	Bx			0.104	0.134	0.164
	By			0.098	0.128	0.158
White Chromaticity	Wx			0.267	0.297	0.327
	Wy		0.301	0.331	0.361	
Viewing Angle, Horizontal	$\theta_{x+}$	Center CR $\geq$ 10		70 degrees		
	$\theta_{x-}$			70 degrees		
Viewing Angle, Vertical	$\theta_{y+}$			60 degrees		
	$\theta_{y-}$			60 degrees		
Viewing Direction				6:00		

<sup>1</sup> Contrast Ratio = (brightness with pixels light)/(brightness with pixels dark).  
<sup>2</sup> Response Time: The amount of time it takes a pixel to change from active to inactive or back again. Tr = T rise, Tf = T fall.



### Definition of Vertical and Horizontal Viewing Angles ( $CR \geq 2$ )

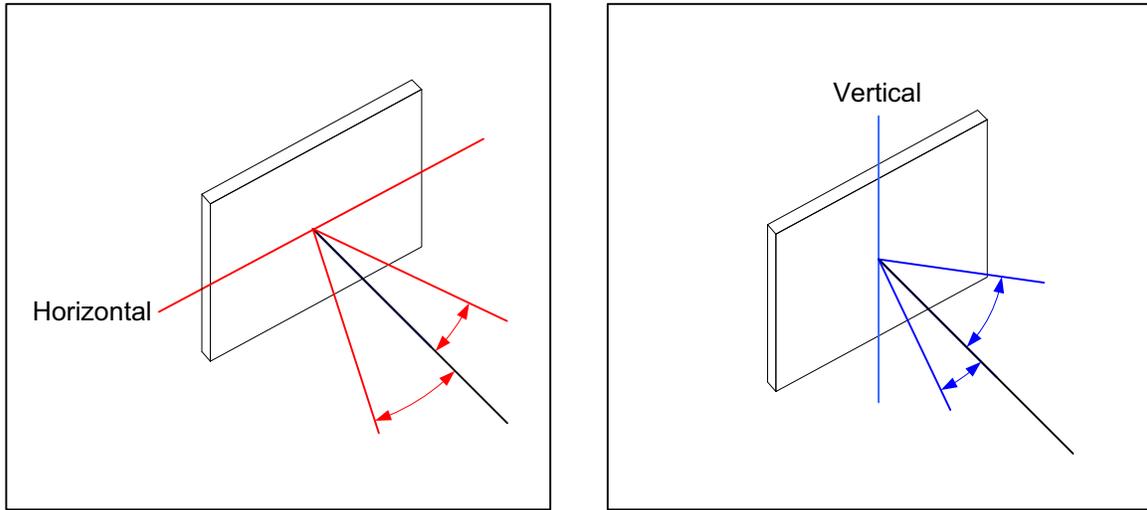


Figure 3. Definition Of Horizontal And Vertical Viewing Angles ( $CR > 2$ )

### Definition of 6 O'Clock and 12:00 O'Clock Viewing Angles

This display module has a 6:00 o'clock viewing angle.

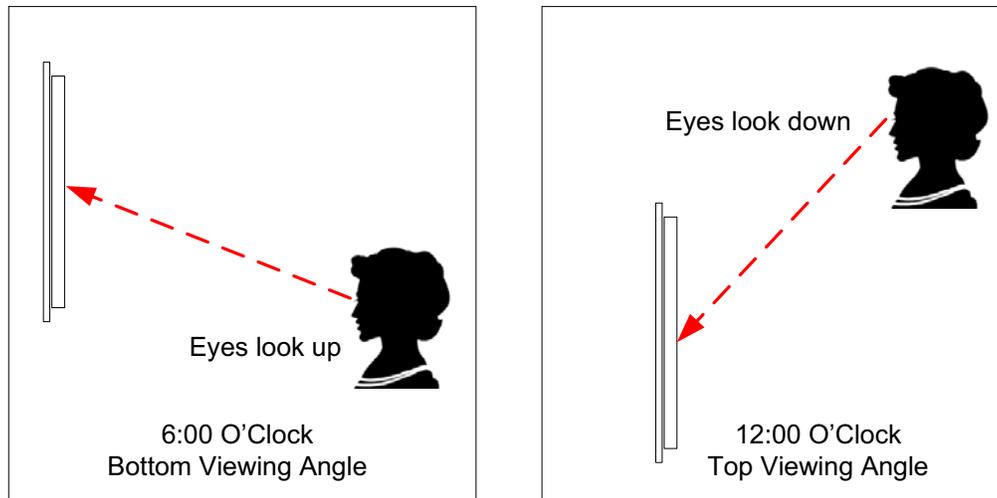


Figure 4. Definition Of 6:00 O'Clock And 12:00 O'Clock Viewing Angles



## LED BACKLIGHT CHARACTERISTICS

This display module uses an LED backlight. LED backlights are easy to use, but they are also easily damaged by abuse.

### **CAUTION**

Do not connect +5v directly to the backlight terminals. This will ruin the backlight. Ensure that you have proper current and voltage control for your backlight before connecting the backlight circuit.

### **NOTE**

We recommend that the LED backlight be dimmed or turned off during periods of inactivity to conserve its lifetime.

LEDs are “current” devices. The important aspect of driving an LED is the current flowing through it, not the voltage across it. Ideally, a current source would be used to drive the LEDs. In practice, a simple current limiting resistor in line from a voltage source will work well in most applications and is much less complex than a current source.



## How to Calculate the Value of $R_{LIMIT}$

You need to know what the forward voltage of the LEDs is so you can calculate the current limiting resistor ( $R_{LIMIT}$ ). The forward voltage will vary slightly from display to display.

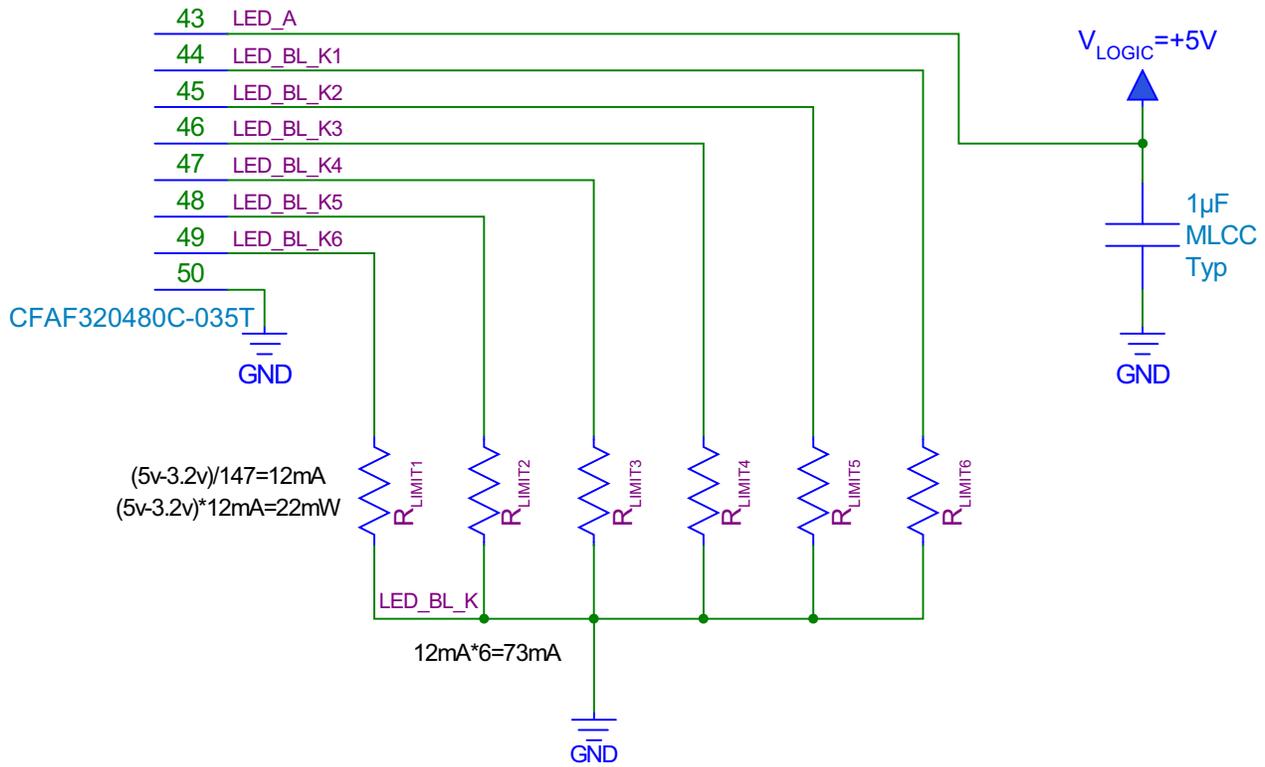


Figure 5. Typical LED Backlight Connections For “Always On”

The general equation to calculate  $R_{LIMIT}$  is:

$$R_{LIMIT} = \frac{V_{LOGIC} \text{ (Supply Voltage)} - V_{LED} \text{ (Typical LED Forward Voltage)}}{I_{LED} \text{ (Typical LED Forward Current, Single LED)}}$$

The specific  $R_{LIMIT}$  calculation for these display modules at  $V_{LOGIC} = +5.0v$  is:

$$R_{LIMIT} = \frac{5.0v - 3.2v}{0.015A} = 120 \Omega \text{ (minimum — use next larger standard size)}$$

## How to Calculate the Power Rating of the Resistor

The general equation to calculate the power rating of the resistor is:

$$P = IE$$

where

**P** = Power. Measured in Watts (W).

**I** = Current. Measured in amperes (A). "I" is from the outdated term “Intensity”.

**E** = Voltage. Measured in volts (v). “E” is from the outdated term “Electromotive force”.



The specific power rating calculation for these display modules is:  
 $P = 0.015A \times (5.0v - 3.2v) = 0.0027W = 2.7mW$

Please select a resistor that can safely dissipate 2.7 mW while keeping its temperature at an acceptably low value for your application.

### PWM Dimming

The backlight may be dimmed by PWM (Pulse Width Modulation). The typical range for the PWM frequency is from 100 to 300 Hz.

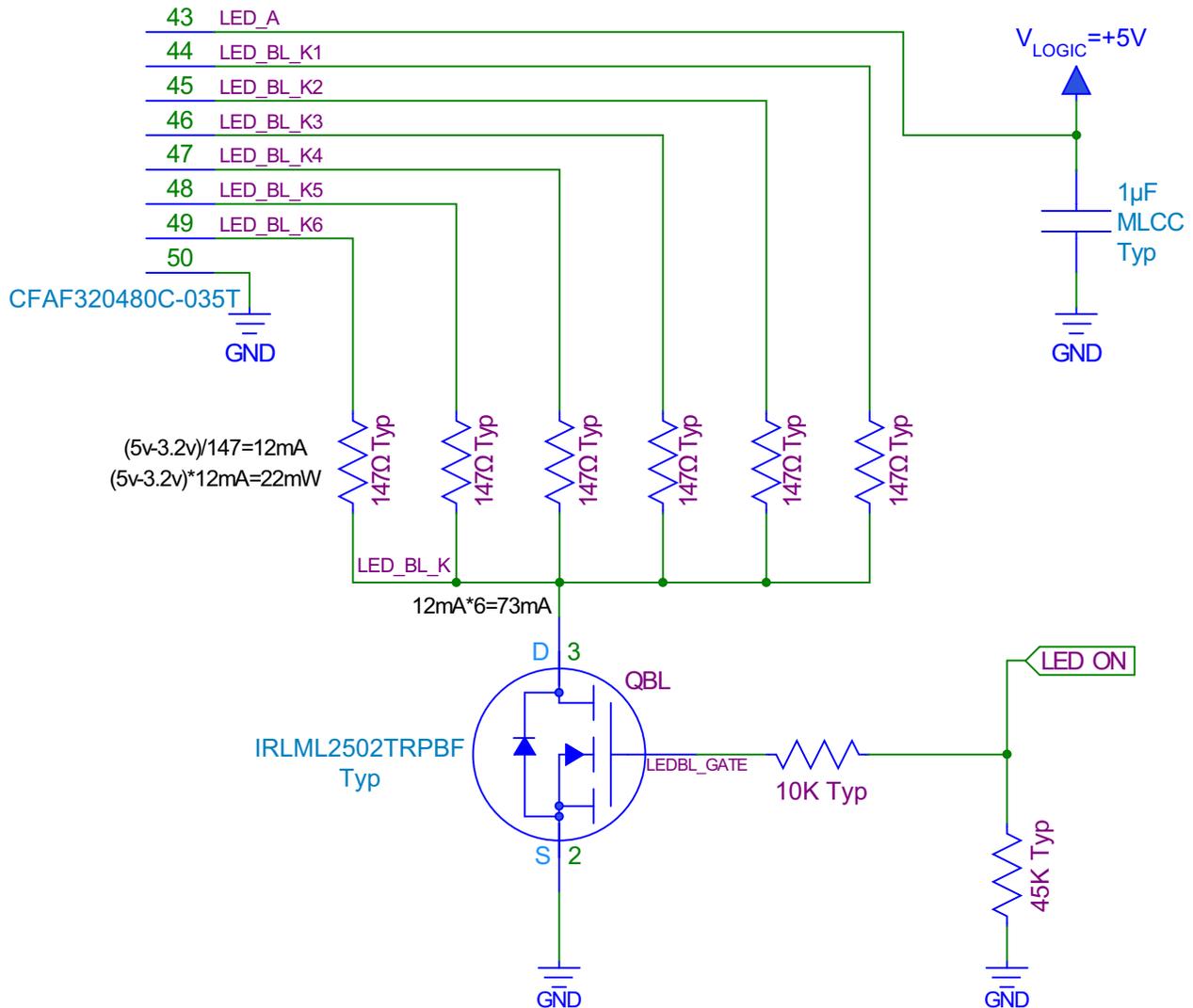


Figure 6. Typical LED Backlight Connections For PWM Dimming



## MODULE RELIABILITY AND LONGEVITY

CFAF320480C4-035T LED Backlight Characteristics Edge-lit with six LEDs in parallel. Ambient temperature: $T_A = 25^\circ\text{C}$			
PARAMETER	MINIMUM	TYPICAL	MAXIMUM
Forward Current ( $I_{LED}$ )	—	90 mA 15mA per LED 15mA x 6 = 90 mA	
<i>Caution: Driving the backlight above 90 mA may shorten its lifetime.</i>			
Forward Voltage ( $V_{LED}$ )	—	+3.2v	—
Luminous Intensity* (IV) when $I_{LED} = 90\text{ mA}$ Includes TFT panel.	—	110 cd/m	—
<i>The backlight is measured through the LCD. Direct backlight measurement is significantly brighter.</i>			
Uniformity (minimum/maximum x 100%)	80%	—	—

## MODULE RELIABILITY

PART NUMBER	SPECIFICATION
CFAF320480C4-035T	Brightness will be >50% of a new module's initial brightness for at least 50,000 hours of operation when supply to each LED is below 90 mA.
<i>Under operating and storage temperature specification limitations, humidity noncondensing) RH up to 65%, and no exposure to direct sunlight. Value listed above is approximate and represents typical lifetime.</i>	
<i>The white LEDs dim over time, especially if driven with high currents. The dimming may not be noticeable when a single display is installed. However, if a new display is installed next to a display that has been on continuously for a very long time, you will see the difference. To preserve the lifetime of white LEDs, we recommend that white LED backlights are dimmed or turned off when not needed. Also, please do not use more current than you need to achieve your brightness requirements.</i>	



## MODULE LONGEVITY (EOL/REPLACEMENT POLICY)

CrystalFontz is committed to making all of our modules available for as long as possible. For each module we introduce, we intend to offer it indefinitely. We do not pre-plan a module's obsolescence. The majority of modules we have introduced are still available.

We recognize that discontinuing a module may cause problems for some customers. However, rapidly changing technologies, component availability, or low customer order levels may force us to discontinue ("End of Life" EOL) a module. For example, we must occasionally discontinue a module when a supplier discontinues a component or a manufacturing process becomes obsolete. When we discontinue a module, we will do our best to find an acceptable replacement module with the same fit, form, and function.

In most situations, you will not notice a difference when comparing a "fit, form, and function" replacement module to the discontinued module. However, sometimes a change in component or process for the replacement module results in a slight variation, perhaps an improvement, over the previous design.

Although the replacement module is still within the stated Datasheet specifications and tolerances of the discontinued module, changes may require modification to your circuit and/or firmware. Possible changes include:

- *Backlight LEDs.* Brightness may be affected (perhaps the new LEDs have better efficiency) or the current they draw may change (new LEDs may have a different VF).
- *Controller.* A new controller may require minor changes in your code.
- *Component tolerances.* Module components have manufacturing tolerances. In extreme cases, the tolerance stack can change the visual or operating characteristics.

Please understand that we avoid changing a module whenever possible; we only discontinue a module if we have no other option. We will post Part Change Notices on the product's web page as soon as possible. If interested, you can subscribe to future part change notifications.

## CARE AND HANDLING PRECAUTIONS

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For optimum operation of the display module and to prolong its life, please follow the precautions below.

Excessive voltage will shorten the life of the display module. You must drive the display module within the specified voltage limit. See [Absolute Maximum Ratings \(Pg. 10\)](#).

## HANDLING CAUTION FOR DISPLAY MODULES SHIPPED IN TRAYS

If you receive display modules packed in trays, handle trays carefully by supporting the entire tray. Trays were made to immobilize the display modules inside their packing carton. Trays are not designed to be rigid. Do not carry trays by their edges; trays and display modules may be damaged.

## ESD (ELECTRO-STATIC DISCHARGE)

The circuitry is industry standard CMOS logic and is susceptible to ESD damage. Please use industry standard anti-static precautions as you would for any other static sensitive devices such as expansion cards, motherboards, or integrated circuits. Ground your body, work surfaces, and equipment.



## DESIGN AND MOUNTING

- The controller/driver maintains its internal operating modes until something happens to change it. Excessive external noise can change these internal modes. In your packaging and system design, suppress or prevent the noise from influencing the controller. Also, refresh the operating modes periodically to prevent the effects of unanticipated noise.
- The exposed surface of the “glass” is actually a polarizer laminated on top of the glass. To protect the soft plastic polarizer from damage, the display module ships with a protective film over the polarizer. Please peel off the protective film slowly. Peeling off the protective film abruptly may generate static electricity.
- The polarizer is made out of soft plastic and is easily scratched or damaged. When handling the display module, avoid touching the polarizer. Finger oils are difficult to remove.
- To protect the soft plastic polarizer from damage, place a transparent plate (for example, acrylic, polycarbonate, or glass) in front of the display module, leaving a small gap between the plate and the display surface. We use Lexan, which is readily available and works well.
- Do not disassemble or modify the display module.
- The display module can be mounted vertically onto a front panel using a variety of methods. If the enclosure is plastic, it can be molded to have the display module snap into place. A metal enclosure can use a milled faceplate with mounting tabs to secure the display module. Adhesives can be used, as long as they are not similar to “super-glue” because these emit vapors that can damage the display module over time.
- Do not reverse polarity to the power supply connections. Reversing polarity will immediately ruin the display module.
- Use care to keep the exposed terminals clean.
- Repeated sharp bends can damage the FPC/FFC tail. (FPC = Flexible Printed Circuit, FFC = Flat Flex Cable) As long as the FPC/FFC bend stays within the FPC/FFC elastic region, it can be bent multiple times. To tell if a bend is completely elastic, the FPC/FFC will return 100% to its pre-bent state. Typically this is around a 5mm radius, or 10mm from side-to-side for a 180° bend. You may bend the FPC/FFC more sharply. For instance, to pass the tail through a slot in a PCB. However these sharper bends will force the FPC/FFC into its plastic region, where it will not return to its pre-bent state on its own. The key is to make sharper bends only once and leave them. Repeatedly bending and unbending the FPC/FFC through its plastic region will cause it to fatigue and eventually fail.

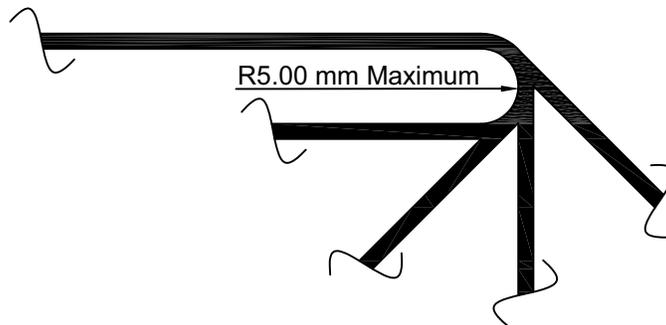


Figure 7. Example Of Minimum Plastic Bend Radius For FPC/FFC

- For easy connection, the 50-pin FPC mates with standard 0.5mm ZIF sockets such as [HFJ150CT-ND](#) and [HFK150CT-ND](#), both available from Digi-Key.

## AVOID SHOCK, IMPACT, TORQUE, OR TENSION

- Do not expose the display module to strong mechanical shock, impact, torque, or tension.
- Do not drop, toss, bend, or twist the display module.
- Do not place weight or pressure on the display module.



## CAUTION

All electronics may contain harmful substances. Avoid contamination by using care to avoid damage during handling. If any residues, gases, powders, liquids, or broken fragments come in contact with your skin, eyes, mouth, or lungs, immediately contact your local poison control or emergency medical center.

## HOW TO CLEAN

1. Turn display module off.
2. Use the removable protective film to remove smudges (for example, fingerprints) and any foreign matter. If you no longer have the protective film, use standard transparent office tape (for example, Scotch® brand “Crystal Clear Tape”).
3. If the polarizer is dusty, you may carefully blow it off with clean, dry, oil-free compressed air.
4. If you must clean with a liquid, never use glass cleaners, as they may contain ammonia or alcohol that will damage the polarizer over time. Never apply liquids directly on the polarizer. Long contact with moisture may permanently spot or stain the polarizer. Use filtered water to slightly moisten a clean lint-free microfiber cloth designed for cleaning optics. (For example, use a cloth sold for cleaning plastic eyeglasses.)
5. The plastic is easily scratched or damaged. Use a light touch as you clean the polarizer. Wipe gently.
6. Use a dry microfiber cloth to remove any trace of moisture before turning on the TFT.
7. Gently wash the microfiber cloths in warm, soapy water and air dry before reuse.

## OPERATION

- We do not recommend connecting this display module to a PC's parallel port as an end product. This display module is not “user friendly” and connecting it to a PC's parallel port is often difficult, frustrating, and can result in a “dead” display module due to mishandling. For more information, see our forum thread at <http://www.crystalfontz.com/forum/showthread.php?s=&threadid=3257>.
- Your circuit should be designed to protect the display module from ESD and power supply transients.
- Observe the operating temperature limitations, non-condensing with minimal fluctuations. Operation outside of these limits may shorten life and/or harm the display module. Changes in temperature can result in changes in contrast.
  - At lower temperatures of this range, response time is delayed.
  - At higher temperatures of this range, display becomes dark. (You may need to adjust the contrast.)
- Operate away from dust, moisture, and direct sunlight.

## STORAGE AND RECYCLING

- Store in an ESD-approved container away from dust, moisture, and direct sunlight, fluorescent lamps, or any strong ultraviolet radiation.
- Observe the storage temperature limitations with minimal fluctuations. Rapid temperature changes can cause moisture to form, resulting in permanent damage.
- Do not allow weight to be placed on the display modules while they are in storage.
- Please recycle your outdated Crystalfontz display modules at an approved facility.



# QUALITY ASSURANCE STANDARDS

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## INSPECTION CONDITIONS

- Environment
  - Temperature: 25±5°C
  - Humidity: 30~85% RH (non-condensing)
- For visual inspection of active display area
  - Source lighting: two 20-Watt or one 40-Watt fluorescent light
  - Display adjusted for best contrast
  - Viewing distance: 30±5 cm (about 12 inches)
  - Viewing angle: inspect at 45° angle of vertical line right and left, top and bottom

## COLOR DEFINITIONS

We try to describe the appearance of our modules as accurately as possible. For the photos, we adjust for optimal appearance. Actual display appearance may vary due to (1) different operating conditions, (2) small variations of component tolerances, (3) inaccuracies of our camera, (4) color interpretation of the photos on your monitor, and/or (5) personal differences in the perception of color.

## DEFINITION OF VIEWING AREA AND ACTIVE AREA

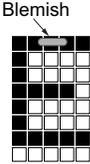
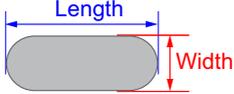
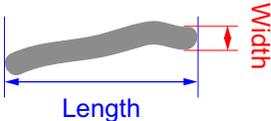
## DEFECTS CLASSIFICATION

Defects are defined as:

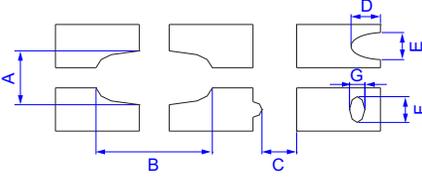
- Major Defect: results in failure or substantially reduces usability of unit for its intended purpose.
- Minor Defect: deviates from standards but is not likely to reduce usability for its intended purpose.



## ACCEPTANCE STANDARDS

#	DEFECT TYPE	ACCEPTANCE STANDARDS CRITERIA			MAJOR/ MINOR	
1	Electrical defects	1. No display, display malfunctions, or shorted segments. 2. Current consumption exceeds specifications.			Major	
2	Viewing area defect	Viewing area does not meet specifications).			Major	
3	Contrast adjustment defect	Contrast adjustment fails or malfunctions.			Major	
4	Blemishes or foreign matter on display segments		<i>Defect Size (mm)</i>	<i>Acceptable Qty</i>	Minor	
			≤0.3	3		
			≤2 defects within 10 mm of each other			
5	Other blemishes or foreign matter outside of display segments	Defect size = (A + B)/2 	<i>Defect Size (mm)</i>	<i>Acceptable Qty</i>	Minor	
			≤0.15	Ignore		
			0.15 to 0.20	3		
			0.20 to 0.25	2		
			0.25 to 0.30	1		
6	Dark lines or scratches in display area		<i>Defect Width (mm)</i>	<i>Defect Length (mm)</i>	<i>Acceptable Qty</i>	Minor
			≤0.03	≤3.0	3	
			0.03 to 0.05	≤2.0	2	
			0.05 to 0.08	≤2.0	1	
			0.08 to 0.10	≤3.0	0	
			≥0.10	>3.0	0	
7	Bubbles between polarizer film and glass		<i>Defect Size (mm)</i>	<i>Acceptable Qty</i>	Minor	
			≤0.20	Ignore		
			0.20 to 0.40	3		
			0.40 to 0.60	2		
			≥0.60	0		



#	DEFECT TYPE	ACCEPTANCE STANDARDS CRITERIA (Continued)	MAJOR / MINOR								
8	Display pattern defect	 <table border="1"> <thead> <tr> <th>Dot Size (mm)</th> <th>Acceptable Qty</th> </tr> </thead> <tbody> <tr> <td><math>((A+B)/2) \leq 0.2</math></td> <td rowspan="5"> <math>\leq 3</math> total defects  <math>\leq 2</math> pinholes per digit         </td> </tr> <tr> <td><math>C &gt; 0</math></td> </tr> <tr> <td><math>((D+E)/2) \leq 0.25</math></td> </tr> <tr> <td><math>((F+G)/2) \leq 0.25</math></td> </tr> <tr> <td></td> </tr> </tbody> </table>	Dot Size (mm)	Acceptable Qty	$((A+B)/2) \leq 0.2$	$\leq 3$ total defects $\leq 2$ pinholes per digit	$C > 0$	$((D+E)/2) \leq 0.25$	$((F+G)/2) \leq 0.25$		Minor
Dot Size (mm)	Acceptable Qty										
$((A+B)/2) \leq 0.2$	$\leq 3$ total defects $\leq 2$ pinholes per digit										
$C > 0$											
$((D+E)/2) \leq 0.25$											
$((F+G)/2) \leq 0.25$											
9	Backlight defects	<ol style="list-style-type: none"> <li>1. Light fails or flickers.*</li> <li>2. Color and luminance do not correspond to specifications.*</li> <li>3. Exceeds standards for display's blemishes or foreign matter (<a href="#">see test 5, Pg. 25</a>), and dark lines or scratches (<a href="#">see test 6, Pg. 25</a>).</li> </ol> <p><i>*Minor if display functions correctly. Major if the display fails.</i></p>	Minor								
10	COB defects	<ol style="list-style-type: none"> <li>1. Pinholes <math>&gt; 0.2</math> mm.</li> <li>2. Seal surface has pinholes through to the IC.</li> <li>3. More than 3 locations of sealant beyond 2 mm of the sealed areas.</li> </ol>	Minor								
11	PCB defects	<ol style="list-style-type: none"> <li>1. Oxidation or contamination on connectors.*</li> <li>2. Wrong parts, missing parts, or parts not in specification.*</li> <li>3. Jumpers set incorrectly.</li> <li>4. Solder (if any) on bezel, LED pad, zebra pad, or screw hole pad is not smooth.</li> </ol> <p><i>*Minor if display functions correctly. Major if the display fails.</i></p>	Minor								
12	Soldering defects	<ol style="list-style-type: none"> <li>1. Unmelted solder paste.</li> <li>2. Cold solder joints, missing solder connections, or oxidation.*</li> <li>3. Solder bridges causing short circuits.*</li> <li>4. Solder balls.</li> </ol> <p><i>*Minor if display functions correctly. Major if the display fails.</i></p>	Minor								







## APPENDIX A: TFT MODULE TERMS AND SYMBOLS

Crystalfontz Term / Symbol	Equivalent	Equivalent	Equivalent	Description
A (LED +)				Supply pin for LED. "A" (anode) or "+" of LED backlight. If more than one, may be labeled as A <sub>1</sub> , A <sub>2</sub> , ...
cd/m <sup>2</sup>	lumen	nits		Candela per square meter. A unit of measurement used to measure Luminous Intensity. cd/m <sup>2</sup> = 1 lumen.
$\overline{CS}$	CS#	CSX		Chip select input. <i>Low</i> : Controller chip is selected. Communications with host are possible. <i>High</i> : Controller chip is not selected. Host interface signals are ignored by the controller.
COF				Chip On Flex. Controller is on the FPC. Similar in appearance to "TAB". The flex circuit on COF is typically much thinner than the flex of a "flex tail".
COG				Chip On Glass. Controller is on the glass panel.
DB0 ~ DBn	D0 ~ Dn			Parallel databus.
D/ $\overline{C}$	RS or DCX	A0	CD or D/C#	Data/Command control. Determines whether data bits are data or command. <i>1 – High</i> : Addresses the data register. <i>0 – Low</i> : Addresses the command register.
DE				Data Enable signal for RGB / DPI mode.
DPI	DOTCLK	parallel		Displays Pixel Interface
ESD				Electro-Static Discharge. Sudden and brief electrical current that flows between two objects. ESD between a human and a TFT module can cause permanent damage.
FPC				Flexible Printed Circuit. Also called "flex tail". Typically much thicker than the "flex" film of COF (Chip On Flex).
GND	V <sub>SS</sub>			Ground. Must be connected to an external ground.
H <sub>SYNC</sub>				Horizontal frame synchronizing signal used for RGB mode.
I <sub>DD</sub>				Typical power supply current for TFT. Total electrical current (I) in the Drains of a CMOS circuit



Crystalfontz Term / Symbol (Continued)	Equivalent	Equivalent	Equivalent	Description
I <sub>LED</sub>				Current used by LED backlight.
I <sub>OP</sub>	V <sub>CCI</sub>			Current for normal OPERATION, typically measured in milliamperes (mA). 1 mA = 0.001A (Ampere)
I <sub>ST</sub>				Current for STandby mode, typically measured in microampere (μA). 1 μA = 0.000001A (Ampere)
I/O	IO			Input/Output
K (LED -)				Supply pin for LED. “K” (cathode or kathode for German and original Greek spelling) or “-” of LED backlight. If more than one, may be labeled as K <sub>1</sub> , K <sub>2</sub> , ...
MIPI				Mobile Industry Processor Interface. See <a href="#">MIPI Alliance</a> .
MISO	D <sub>OUT</sub>			SPI data signal: Master In Slave Out.
MOSI	DINI_SDA			SPI data signal: Master Out Slave In.
mm				Millimeter or millimetre. Unit of length equal to one thousandth of a meter. 1 millimeter = 0.0394 inches.
mW				Milliwatt is equal to one thousandth of a Watt. Watts = Volts x Amps.
NC	nc			No Connection.
P <sub>CLK</sub>				Pixel clock signal for RGB / DPI mode.
PWM				Pulse Width Modulation is a way to simulate intermediate levels by switching a level between full on and full off. PWM is typically used to control the brightness of LED backlights, relying on the natural averaging by the human eye.
$\overline{RD}_{8080}$	$\overline{RD}$ (E)	E ( $\overline{RD}$ )	E or RDX	Host interface input. <i>8080 Host</i> : Active low. Signal on the databus is latched at the rising edge of $\overline{RD}$ .
RGB				Typically used to indicate that Red, Green, and Blue are combined to produce a broad array of colors.
RH	Rh			Relative Humidity



Crystalfontz Term / Symbol (Continued)	Equivalent	Equivalent	Equivalent	Description
RoHS				Restriction of Hazardous Substances Directive, an environmental standard.
$\overline{\text{RST}}$	$\overline{\text{RES}}$	RST#	RES#	Reset signal. <i>Low:</i> Display controller is reset. The $\overline{\text{RST}}$ pin should be pulsed low shortly after power is applied. <i>High:</i> The RST pin should be brought high for normal operation.
SCK	SCL			Serial Clock
Ta	TA			"Ambient temperature" is the temperature of the air that surrounds a component.
Tf				Unit of measurement for TFT response time. f = falling edge.
TFT				Thin-Film Transistor fabricated directly on the display substrate.
T <sub>OP</sub>				OPERating Temperature.
Tr				Unit of measurement for TFT response time. r = rising edge.
T <sub>ST</sub>	T <sub>STG</sub>			STorage Temperature.
V <sub>ANALOG</sub>	V <sub>CI</sub>			Analog supply,
V <sub>IH</sub>	V <sub>ICH</sub>			High level input voltage.
V <sub>IL</sub>	V <sub>LCH</sub>			Low level input voltage.
V <sub>IN</sub>	V <sub>T</sub>			Input voltage
V <sub>LED</sub>				Forward voltage for LED backlight.
V <sub>LOGIC</sub>	V <sub>CC</sub>	V <sub>DD</sub>		Power supply input. Must be connected to an external source.
V <sub>LOGIC I/O</sub>	V <sub>CCIO</sub>	IO <sub>VCC</sub>		Digital Logic Supply and Input/Output Supply
V <sub>OH</sub>	V <sub>OHC</sub>			High level output voltage.
V <sub>OL</sub>	V <sub>OLC</sub>			Low level output voltage.
V <sub>SSD</sub>				Digital ground.



Crystalfontz Term / Symbol (Continued)	Equivalent	Equivalent	Equivalent	Description
$V_{\text{SYNC}}$				Vertical frame synchronizing signal used for RGB mode.
$\overline{\text{WR}}_{8080}$	R/ $\overline{\text{W}}$ ( $\overline{\text{WR}}$ )	$\overline{\text{WR}}$ (R/ $\overline{\text{W}}$ )	R/W#	Host interface input. <i>8080 Host:</i> Active low. Signal on the databus is latched at the rising edge of $\overline{\text{WR}}$ signal.
$\overline{\text{WR\_SCK}}$				<i>DBI Type-B:</i> Serves as a write signal and write data at the low level. <i>DBI Type-C:</i> it serves as SCK (Serial Clock). If unused, tie to $V_{\text{LOGIC I/O}}$ .