



## TFT DISPLAY MODULE DATA SHEET



(FPC Folded)

Datasheet Release 2016-09-14

for:

[CFAF320480C5-035T-TS](#)

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#### CFAF320480C5-035T-TS Datasheet Revision History

Datasheet Release: 2016-09-14  
In [Details Of Interface Pin Function \(Pg. 12\)](#), pins 14-31, corrected from:  
6-bit bus: use DB15-DB0  
8-bit bus: use DB17-DB0  
to  
16-bit bus: use DB15-DB0  
18-bit bus: use DB17-DB0

Datasheet Release: 2015-12-02  
First Datasheet for the CFAF320480C5-035T-TS display module. This display is the replacement for the discontinued [CFAF320480C4-035T-TS](#).

#### 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/cfaf320480c5035ts-touchscreen-graphic-tft-display-module-320x480-lcd#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, an integrated 4-wire analog touch screen, 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: 3.75 mm (D) excluding the molded plastic alignment pin.
    - Inches = 0.148" (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 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>C5</u>	-	<u>035</u>	<u>T</u>	-	<u>TS</u>
①	②	③	④	⑤		⑥	⑦		⑧

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
⑧	<b>Configuration Codes</b>	TS – with touch screen



# 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: 3.50"
Active Area Width and Height	Millimeters: 48.96 (W) x 73.44 (H) mm Inches: 1.93" (W) x 2.89" (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 Maximum excluding the molded plastic alignment pin	Millimeters: 3.75 (D) mm Inches: 0.148" (D)
FPC Bend Radius	>R.95 mm
Weight	28 grams



# MODULE OUTLINE DRAWINGS

Figure 1. Module Outline Drawing, Front And Side View

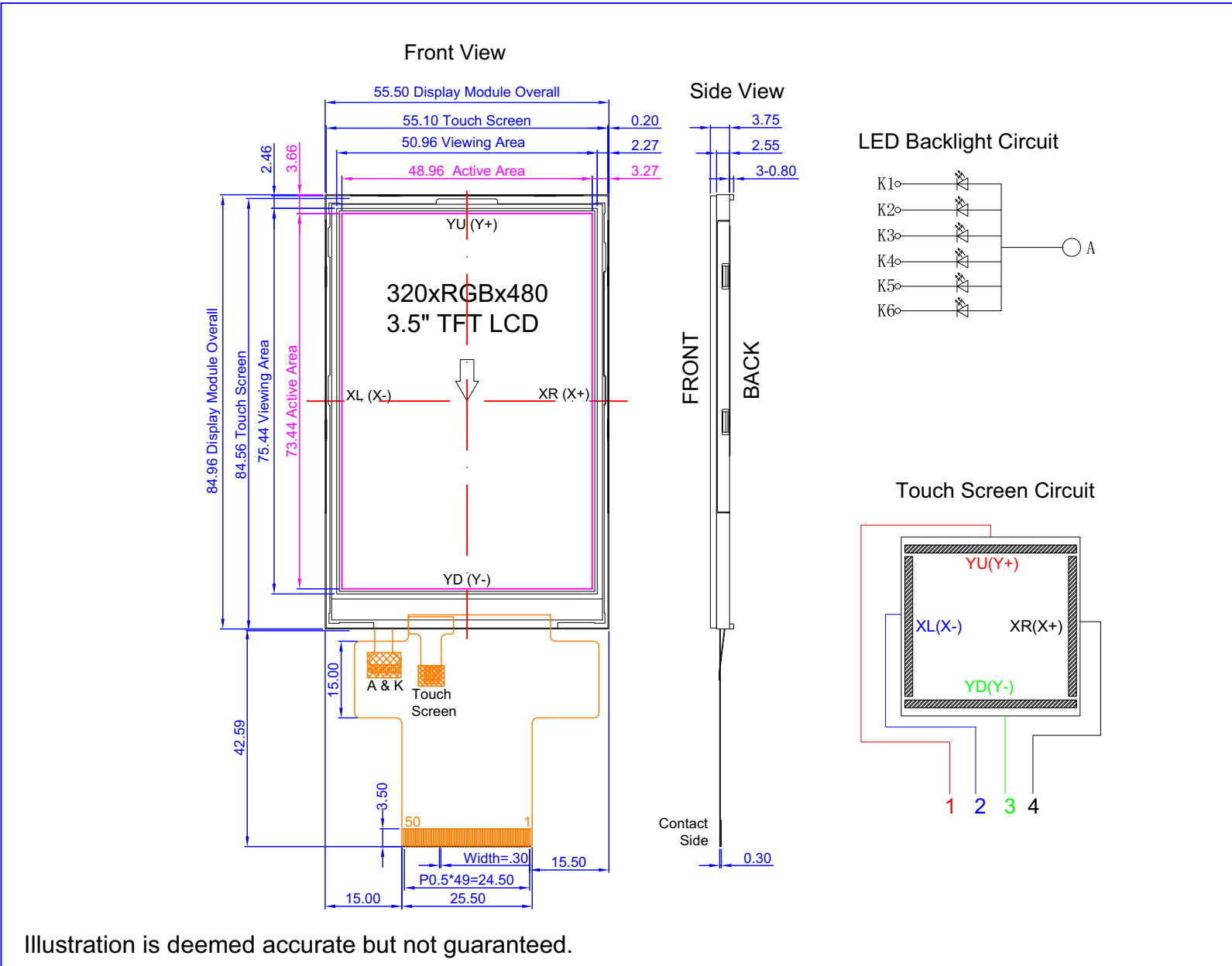


Illustration is deemed accurate but not guaranteed.



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Part No.(s):  
CFAF320480C5-035T-TS

Scale:  
Not to scale  
Units:  
Millimeters

Drawing Number:  
Date:  
2015-12-01

Hardware Rev.:  
Sheet:  
1 of 2





Figure 2. Module Outline Drawing, Back View

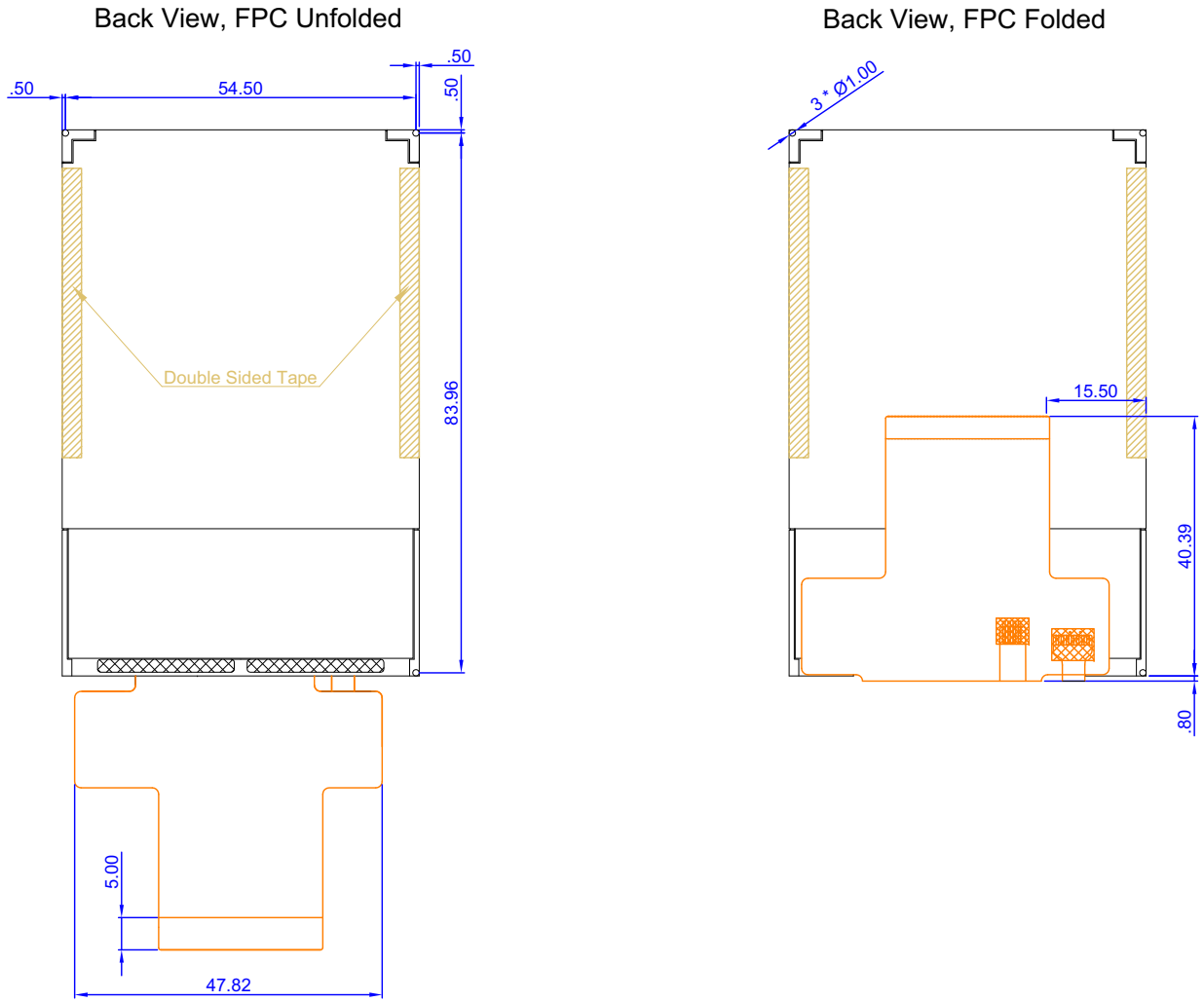



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 <b>Crystalfontz America, Inc.</b> <a href="http://www.crystalfontz.com/products/">www.crystalfontz.com/products/</a>	copyright © 2015 by	Part No.(s): CFAF320480C5-035T-TS	Scale: Not to scale	Drawing Number:	Hardware Rev.:
			Units: Millimeters		Date: 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
<p><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></p> <p><i>Extended exposure to the absolute maximum ratings listed above may affect device reliability. Stresses beyond those listed above can cause permanent damage.</i></p>			



## 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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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            16-bit bus: use DB15-DB0            18-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 \(Pg. 18\)](#).*

## ABOUT THE 4-WIRE ANALOG RESISTIVE TOUCH SCREEN

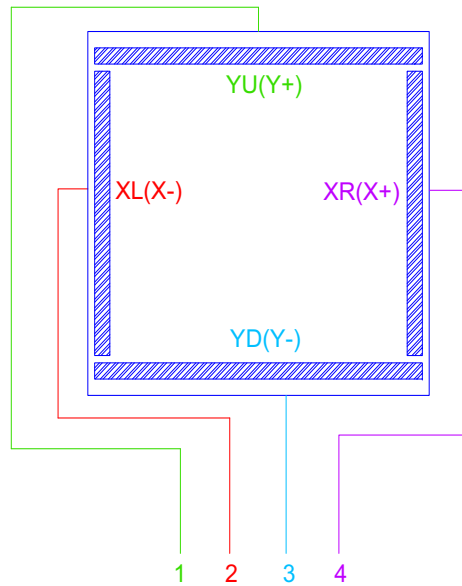


Figure 3. Touch Screen Connections For CFAF320480C5-035T-TS



The touch screen must be driven in one direction, then read in the other direction.

- ❑ Typically, the kind of micro-scontroller that supports the RGB / DPI interface (ARM9, etc) will also have ADC pins that can be used directly to read the touch screen.
- ❑ TI (Texas Instruments) makes I2C / SPI and low level touch screen controllers. Typical:  
[www.ti.com/product/tsc2046e](http://www.ti.com/product/tsc2046e).
- ❑ Some micro-controllers have analog inputs that may work directly. [TSHARC \(www.tsharc.com\)](http://www.tsharc.com) makes a high-level controller from a preprogrammed PIC micro-controller.

## Basic Concept

Put a gradient across one set of electrodes. Set both electrodes as digital outputs, driving one high and the other one low. Look at either of the *other* set of electrodes (both set as inputs, at least one analog). The analog input will pick up the voltage of the gradient at the contact point. To read the other channel, rotate the whole process 90 degrees.

You may need to address other factors, including references, calibration, drift, non-contact, detecting "taps", and "double-taps".

## More Information

- ❑ A comparison of three types of touch screens:  
[www.howstuffworks.com/question716.htm](http://www.howstuffworks.com/question716.htm).
- ❑ Source for resistive touch screen construction:  
<http://www.ti.com/lit/an/slyt209a/slyt209a.pdf>.

## 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 ( $CR \geq 2$ )

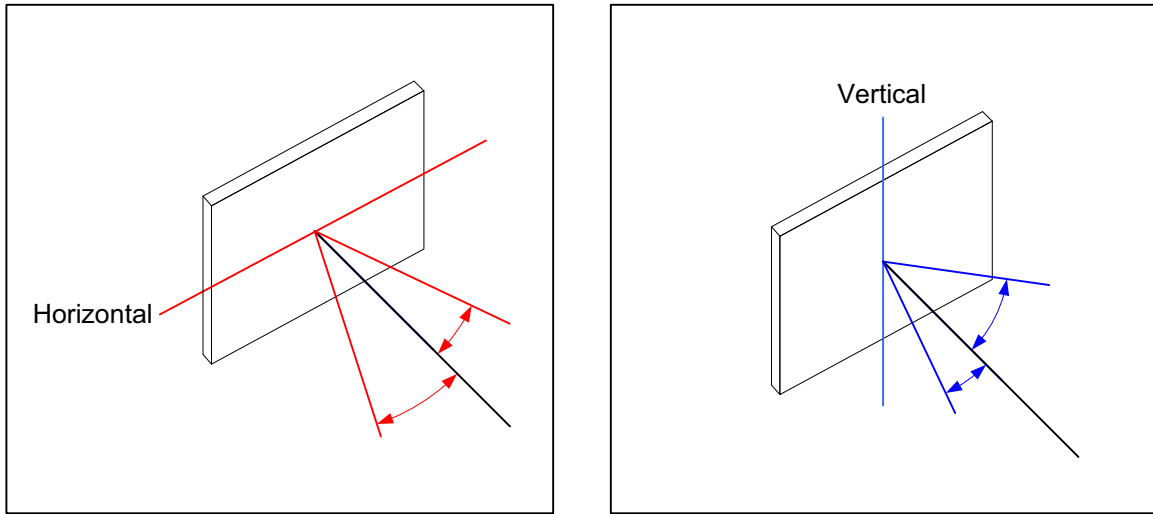


Figure 4. Definition Of Horizontal And Vertical Viewing Angles ( $CR > 2$ )

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

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

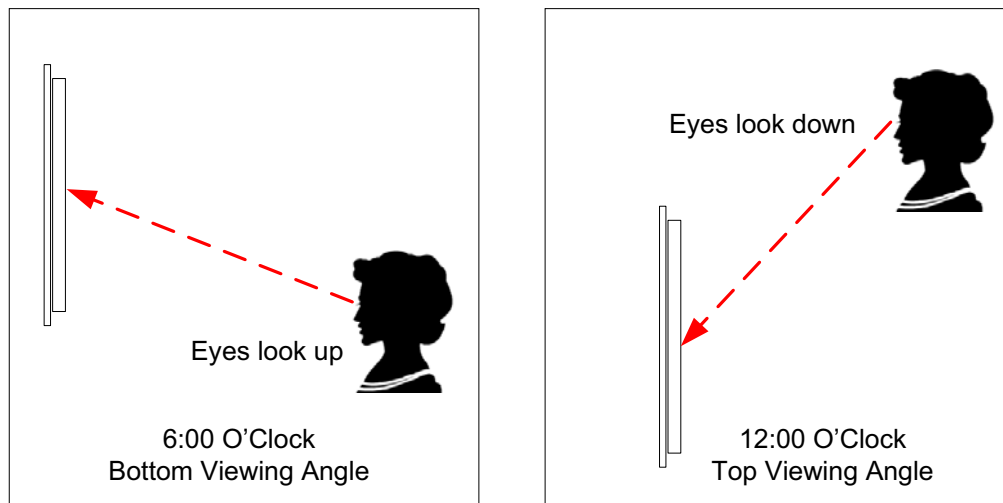


Figure 5. Definition Of 6:00 O'Clock And 12:00 O'Clock Viewing Angles



## LED BACKLIGHT CHARACTERISTICS

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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.

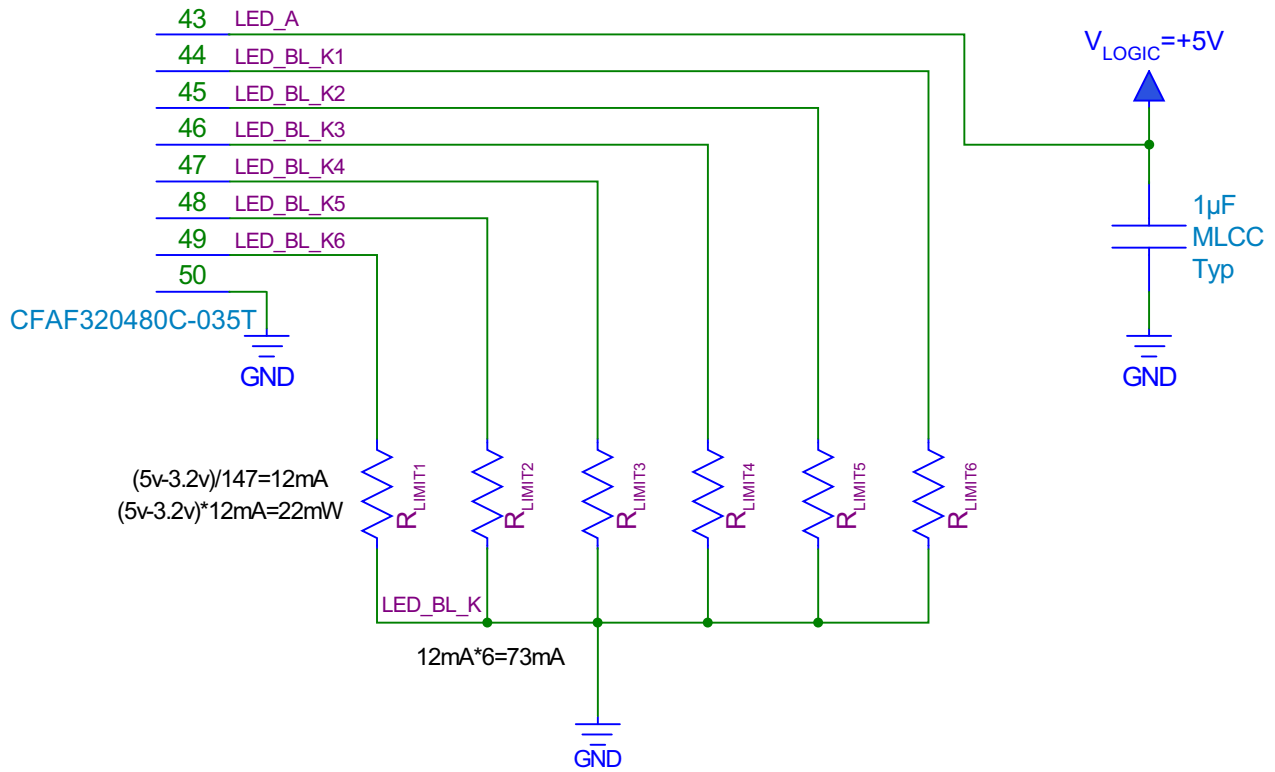


Figure 6. Typical LED Backlight Connections For “Always On”

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.

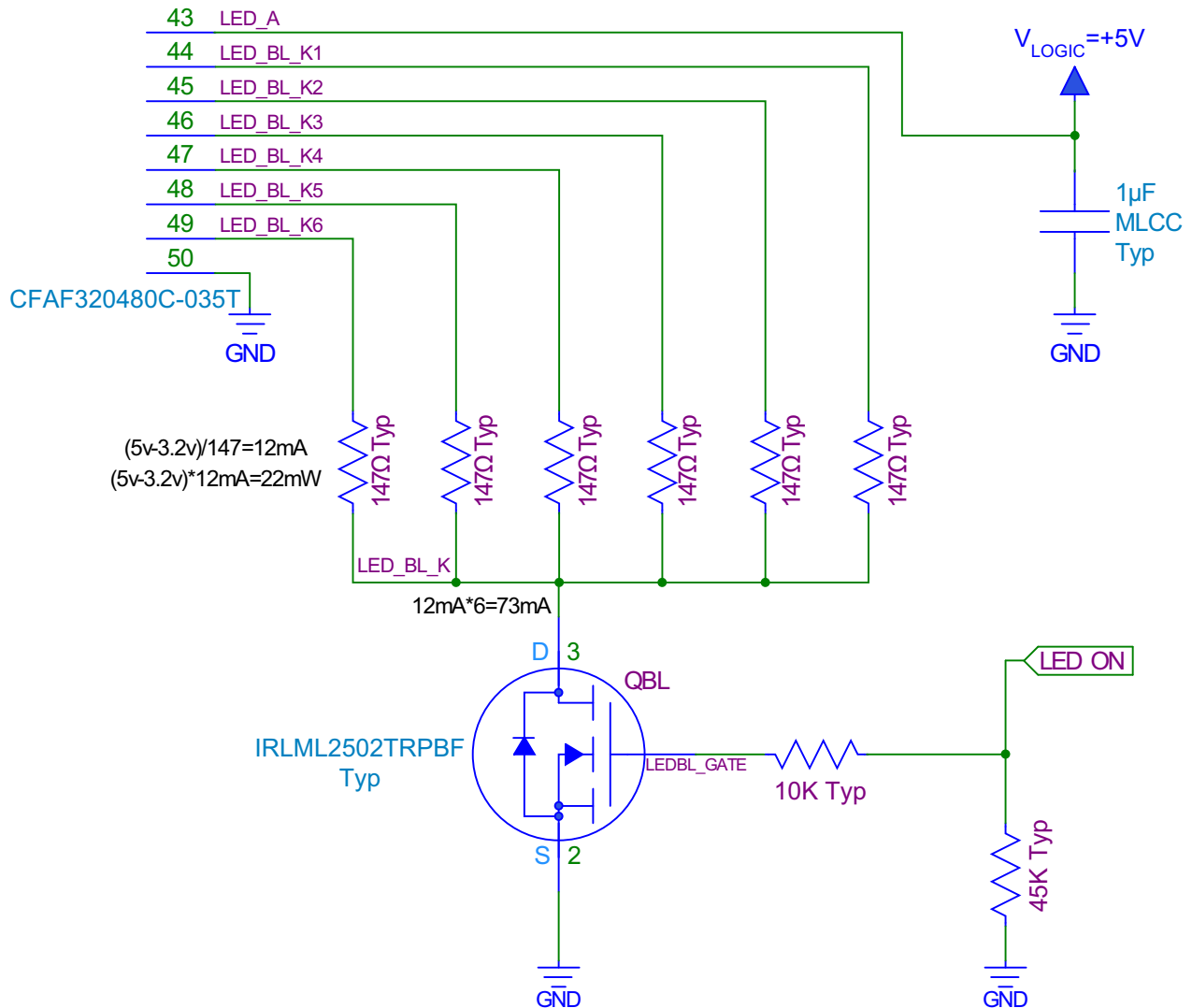


Figure 7. Typical LED Backlight Connections For PWM Dimming



CFAF320480C5-035T-TS LED Backlight Characteristics <i>Edge-lit with six LEDs in parallel.</i>			
<i>Ambient temperature: TA = 25°C</i>			
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 $I_{LED} = 90$ mA Includes TFT panel and touch screen.	—	85 cd/m <sup>2</sup>	—
<i>The backlight is measured through the LCD. Direct backlight measurement is significantly brighter.</i>			
Uniformity (minimum/maximum x 100%)	80%	—	—

## MODULE RELIABILITY AND LONGEVITY

### MODULE RELIABILITY

PART NUMBER	SPECIFICATION
CFAF320480C5-035T-TS	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.
<p><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></p> <p><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></p>	



## 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.