3.5” TFT DISPLAY MODULE
WITH EVE GRAPHICS ACCELERATOR

DATASHEET

CFAF320240F-035T-A1-1

Datasheet Release: 2019/08/21

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1. General Information

Datasheet Revision History
Datasheet Release: 2019/08/21 Datasheet for the CFAF320240F-035T-A1-1 display module.

Product Change Notifications
You can check for or subscribe to Part Change Notices for this display module on our website.

Variations
Slight variations between lots are normal (e.g., contrast, color, or intensity).

Volatility
This display module has volatile memory.

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2. Introduction

The Crystalfontz CFAF320240F-035T-A1-1 is a revolutionary new accelerated display for embedded systems based on the FTDI/BridgeTek FT810 EVE (Embedded Video Engine) graphics accelerator.

Traditionally, to connect a TFT to an embedded system, you either had to choose a very powerful processor that supports a frame buffer and RBG interface or write directly to the frame buffer on the TFT's controller. Either of these methods relies on software rendering of graphics primitives. To make a simple, non-antialiased, may take hundreds or thousands of write operations. Sometimes read-modify-write operations are required, which increases the again by double or more—further slowing the display performance.
Additionally, either of these methods use a lot of GPIO or GPIO configured as the RGB interface, often requiring you to choose a larger processor package. There are examples of using SPI to control small TFT LCDs, but even on small displays the performance is often dismal.

Another hurdle with traditional TFT implementations is text. Fonts can use up a lot of memory to store, and rendering them to the frame buffer can be complex—especially if they need to be rotated or antialiased. Typically, the compromise of having only a couple of bitmapped, non-antialiased fonts rendered at only horizontal and vertical is used. Angle a font at 45° to put labels on some data? Not without a very complete and complex (also typically big and slow) graphic library.

Imagine if there was a display that accepted high-level commands. Writing just a few instructions would completely describe a line. As long as we are imagining, why not further imagine that the line was fully anti-aliased, and any width you could want? What if writing a few more commands could render beautiful, anti-aliased text from a wide selection of fonts at any angle?
The FTDI/BridgeTek FT810 EVE graphics accelerator at the heart of the CFAF320240F-035T-A1-1 display solves all these problems and more.

Embedded systems based on simple 8-bit processors can now have beautiful, responsive, multi-touch enabled user interfaces that do not tax the host processor.
Want proof? Our demo for the CFAF320240F-035T-A1-1 was intentionally written to fit nicely on a Seeeduino v4.2 (this is a 3.3v version of the Arduino Uno). And as always, we freely supply all the source code.

3. Key Features

3.1. Module Features

- 3.5-inch 320x240 TFT LCD panel
- FTDI/BridgeTek FT810 EVE graphics accelerator
- SPI Single or Quad host interface
- Compact 30-position 0.5mm flat-cable ZIF host connection
- Threaded mounting standoffs for simple mechanical design
- Compact form-factor, overall size is no larger than LCD
- Single +3.3V power supply (backlight supply can be 3.3v to 6v)

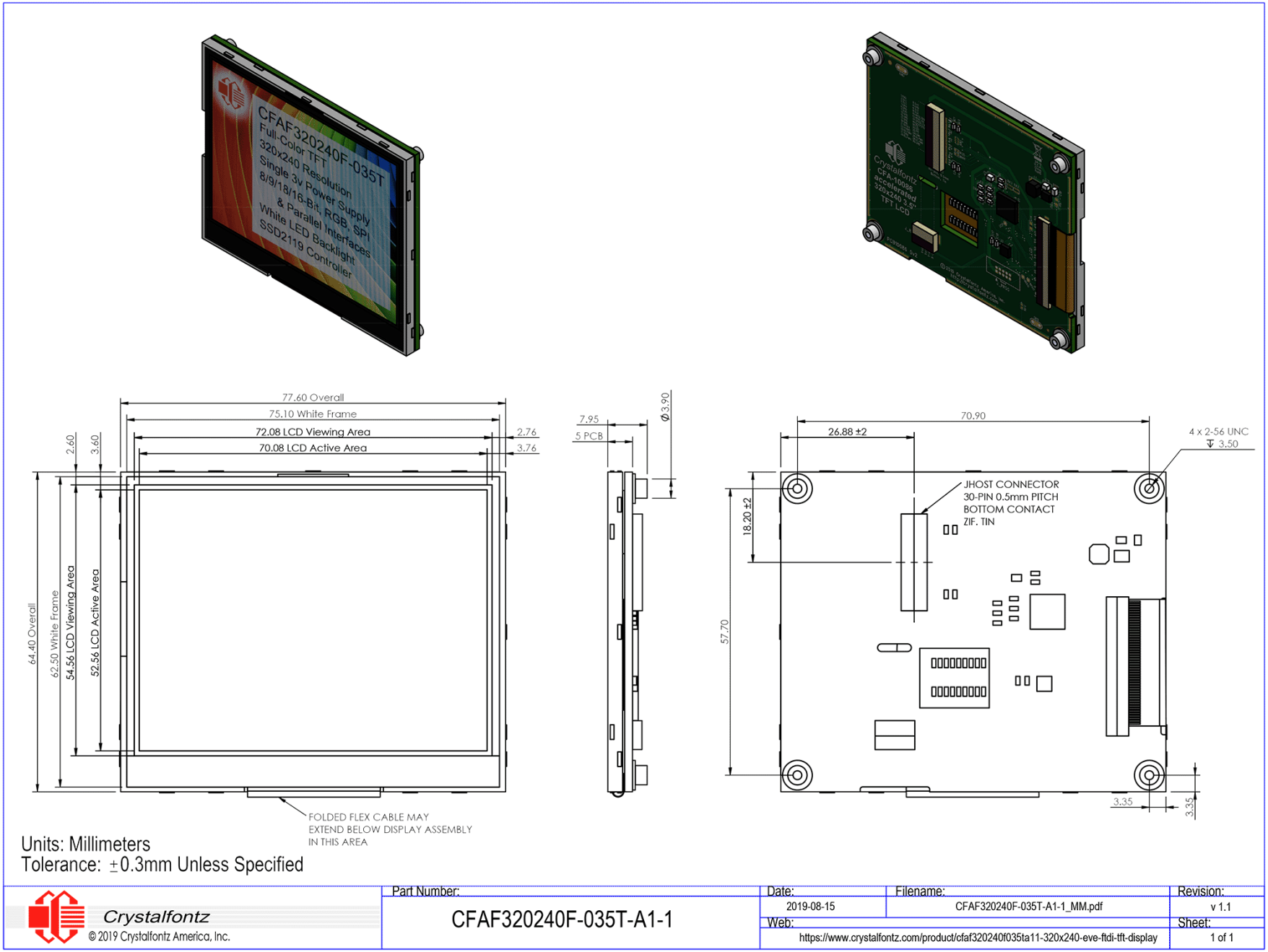
3.2. EVE Graphics Accelerator Features

- Support multiple widgets for simplified design implementation
- User interface design software (PC) simplifies the design process
- Enhanced sketch processing
- Anti-aliasing of primitive displayed objects for higher-quality graphics
- Assorted graphical effects such as alpha-blending, shadows, transitions, wipes, etc.
- Programmable interrupt controller provides interrupts to host MCU
- Support playback of motion-JPEG encoded AVI videos
- Mono audio channel output with wave playback and built-in sound synthesizer
- PWM output for display backlight dimming control

4. Mechanical Data

Item	Specification (mm)	Specification (inch)
Overall Module Dimension	77.60 (W) x 64.40 (H) x 7.95 (D)	3.06 (W) x 2.54 (H) x 0.31 (D)
Viewing Area	72.08 (W) x 54.56 (H)	2.84 (W) x 2.15 (H)
Active Area	70.08 (W) x 52.56 (H)	2.76 (W) x 2.07 (H)
Dot Pitch	0.219 (W) x 0.219 (H)	0.0086 (W) x 0.0086 (H)
Weight (Typical)	52.3 grams	1.845 ounces

5. Mechanical Drawings



6. Module Details

6.1. General Information

The CFAF320240F-035T-A1-1 is a 3.5-inch TFT display module based around a FTDI/BridgeTek FT810 Embedded Video Engine (EVE).

All display, backlight control and audio features are controlled via the Embedded Video Engine which appears to the host MCU as a memory-mapped SPI device. The host MCU sends commands and data over the EVE SPI serial protocol.

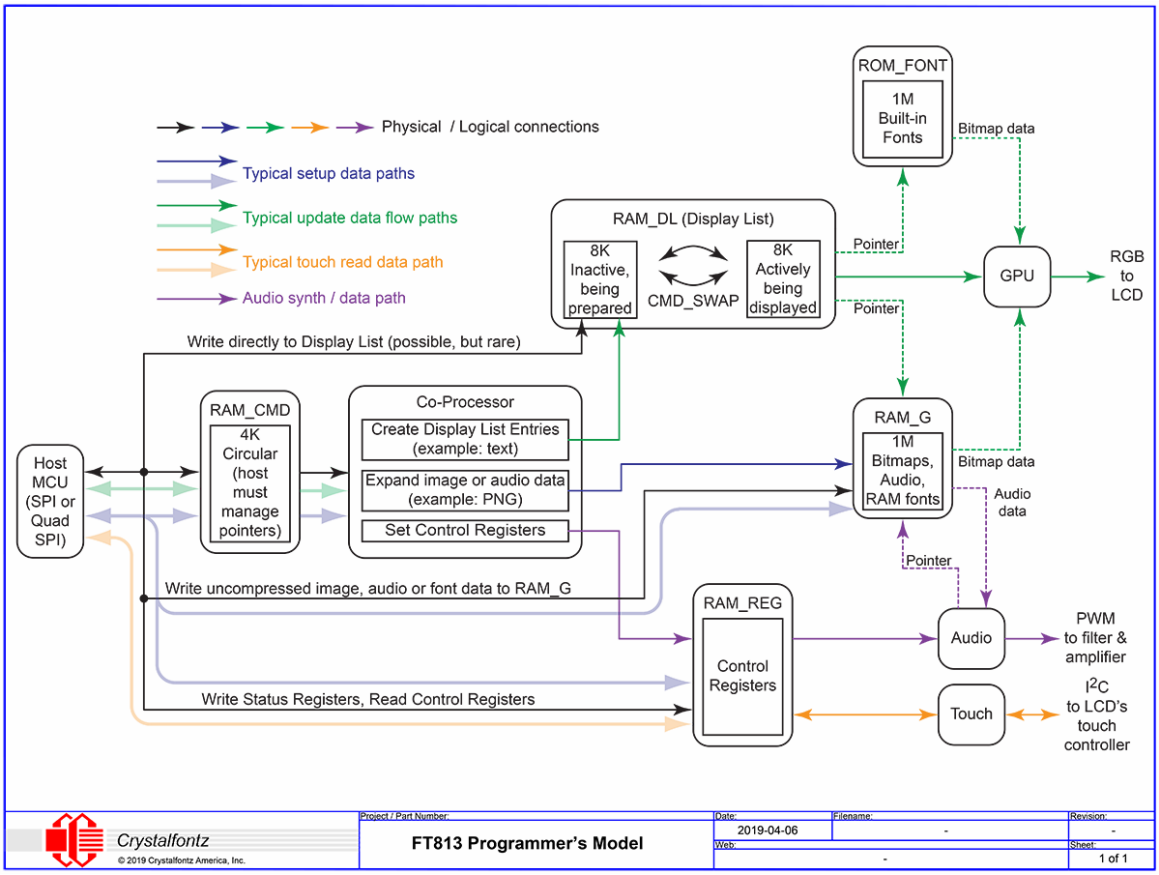
For detailed BridgeTek datasheets and other development information, see the Embedded Video Engine Documentation / Resources section below.

6.2. Embedded Video Engine Documentation / Resources

- BridgeTek FT810 Datasheet: https://brtchip.com/ft81x/
- BridgeTek Application Notes: https://brtchip.com/application-notes/
- BridgeTek Screen Designer Software: https://brtchip.com/eve-toolchains/
- BridgeTek Forum: http://www.brtcommunity.com/index.php?board=7.0
- FTDI FT810 Datasheets: https://www.ftdichip.com/Products/ICs/FT81X.html
- FTDI Application Notes: https://www.ftdichip.com/Support/Documents/AppNotes.htm
- FTDI C232HM USB-SPI cable: https://www.ftdichip.com/Products/Cables/USBMPSSE.htm

6.3. Embedded Video Engine Programmer's Model

The diagram below is a basic overview of the EVE programming model showing data flow paths to and from the SPI host interface to the memory and processing blocks of the embedded video engine.



6.4. Interface Pin Function

Host data connection and power supply is achieved via a single 30 pin flat-cable connector (labled J_HOST) on the rear of the module. Any 30 pin FFC-FPC ZIF cable with a 0.5mm pitch and bottom contacts will be compatible with this module.

J_HOST Connection			
Pin	**Symbol**	**Signal Direction**	**Function**
1	GND		Ground (1)
2	3V3		Logic Power Supply (1)
3	3V3		Logic Power Supply (1)
4	GND		Ground (1)
5	3V3		Logic Power Supply (1)
6	3V3		Logic Power Supply (1)
7	GND		Ground (1)
8	SCK	Input	SPI Clock
9	GND		Ground (1)
10	MOSI / D0	Input	SPI Single Mode: SPI MOSI SPI Dual/Quad Mode: SPI Data Line 0
11	GND		Ground (1)
12	MISO / D1	Output	SPI Single Mode: SPI MISO SPI Dual/Quad Mode: SPI Data Line 1
13	GND		Ground (1)
14	GPIO0 / D2	Input / Output	SPI Single/Dual Mode: General Purpose IO0 SPI Quad Mode: SPI Data Line 2
15	GND		Ground (1)
16	GPIO1 / D3	Input / Output	SPI Single/Dual Mode: General Purpose IO1 SPI Quad Mode: SPI Data Line 3
17	GND		Ground (1)
18	nCS	Input	SPI Slave Chip-Select
19	GND		Ground (1)
20	nINT	Output	Interrupt to Host
21	GPIO2		General purpose IO2
22	nPD	Input	Chip Power Down Mode
23	AUDIO PWM	Output	Audio PWM
24	GND		Ground (1)
25	BLPWR		Backlight Power Supply (1)
26	BLPWR		Backlight Power Supply (1)
27	GND		Ground (1)
28	BLPWR		Backlight Power Supply (1)
29	BLPWR		Backlight Power Supply (1)
30	GND		Ground (1)

Notes:

1. *It is recommended that these pins are all connected to their respective power source. Not doing so may produce unpredicable results or damage the display module.*

6.5. Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Unit
Logic Power Supply	3V3	0.0	4.0	V
Backlight Power Supply	BLPWR	0.0	6.0	V
Operating Temperature	T_{OP}	-20	+70	°C
Storage Temperature	T_{ST}	-30	+80	°C

Notes:

- *These are stress ratings only. Extended exposure to the absolute maximum ratings listed above may affect device reliability or cause permanent damage.*
- *Temp. ≦60°C, 90% RH Maximum Temp.＞60°C Absolute humidity < 90% RH at 60°C*

6.6. Electrical Characteristics

Item	Symbol	Min	Typ	Max	Unit
Logic Power Supply	3V3	2.97	3.30	3.63	V
Input Logic High	VIH	2.0	-	3V3	V
Input Logic Low	VIL	0	-	0.8	V
Logic Supply Current	I3V3	--	133	-	mA

6.7. Backlight Characteristics

Item	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	BLPWR		2.7	3.3	5.5	V
Supply Current	IBLPWR	BLPWR=5V	-	78	86	mA
		BLPWR=3.3V	-	120	132	mA
Luminance	L	at 100% brightness	175	200	225	cd/m^2
LED Lifetime		at 100% brightness	-	10,000	-	hours

6.8. Optical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit
Response Time	T_r	25°C	-	8	12	ms
	T_f		-	17	23	ms
Contrast Ratio	(CR)	θ=0°	320	400	-	-
Red Chromaticity	Wx	Backlight at 100% brightness	0.627	0.647	0.667	ms
	Wy		0.316	0.336	0.356	ms
Green Chromaticity	Wx		0.116	0.136	0.156	ms
	Wy		0.556	0.576	0.596	ms
Blue Chromaticity	Wx		0.116	0.136	0.156	ms
	Wy		0.109	0.129	0.149	ms
White Chromaticity	Wx		0.285	0.305	0.325	ms
	Wy		0.314	0.334	0.354	ms
Viewing Direction	6 o'clock					

7. Getting Started

7.1. Getting started with the CFAF320240F-035T-A1-2 kit

Components Required:

- Crystalfontz the CFAF320240F-035T-A1-1 display module
- Crystalfontz CFA10098 EVE adapter board
- Appropriate flat-flex-cable (6" WR-FFC-Y50 & 12" WR-FFC-Y51)
- 0.1" female-to-female jumper wires (Crystalfontz WR-JMP-Y40)
- Seeeduino v4.2 (Crystalfontz CFAPN15062)
- USB Cable (Crystalfontz WR-USB-Y27)
- Bench supply set to 3.3v, rated for at least 1000mA

Hardware Procedure:

- Following the Example Connection Diagrams below, connect the components.
- Supply 3.3v from a bench supply (rated for at least 1000mA) to the CFA10098
- Connect the USB cable to your PC

Firmware Procedure:

- Download and install Arduino IDE software.
- Download the example sketch available on GitHub, and open it in the Arduino IDE.
- Build and upload the sketch to the Seeeduino

7.2. Getting started with the CFAF320240F-035T-A1 and a Windows PC

Components Required:

- Crystalfontz the CFAF320240F-035T-A1-1 display module
- Crystalfontz CFA10098 EVE adapter board
- Appropriate flat-flex-cable (6" WR-FFC-Y50 & 12" WR-FFC-Y51)
- FTDI C232HM-DDHSL-0 USB to SPI cable
- Bench supply set to 3.3v, rated for at least 1000mA

Hardware Procedure:

- Connect the CFA10098 to the CFAF320240F-035T-A1-1 using the FFC (see the 7.5 below)
- Connect the CFA10098 to the C232HM-DDHSL-0 USB adapter
- Connect 3.3v from a bench supply (rated for at least 1000mA) to the CFA10098
- Connect the USB to SPI cable to your Windows PC

Software Procedure:

- Download and install the FTDI PC demonstration application from this website.
- Download, open, build and run the example EVE application available on GitHub.

In order to modify and compile the FTDI PC demonstration program, you will need to download Visual Studio. You can use the free version but you may need to register with Microsoft.

7.3. Getting started, hardware, with CFAF320240F-035T-A1 and your PCB

Components Required:

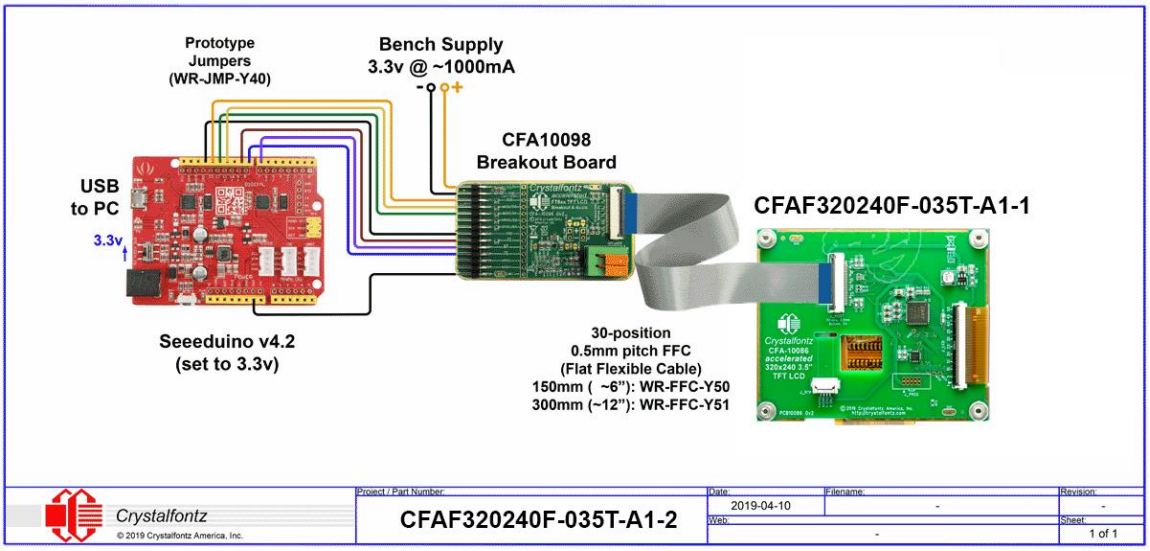
- Crystalfontz CFAF320240F-035T-A1-1 display module
- Appropriate ZIF connector: 30-position, 0,5mm pitch, tin contact mounted to your custom PCB
- Appropriate flat-flex-cable (6" WR-FFC-Y50 & 12" WR-FFC-Y51)

Procedure:

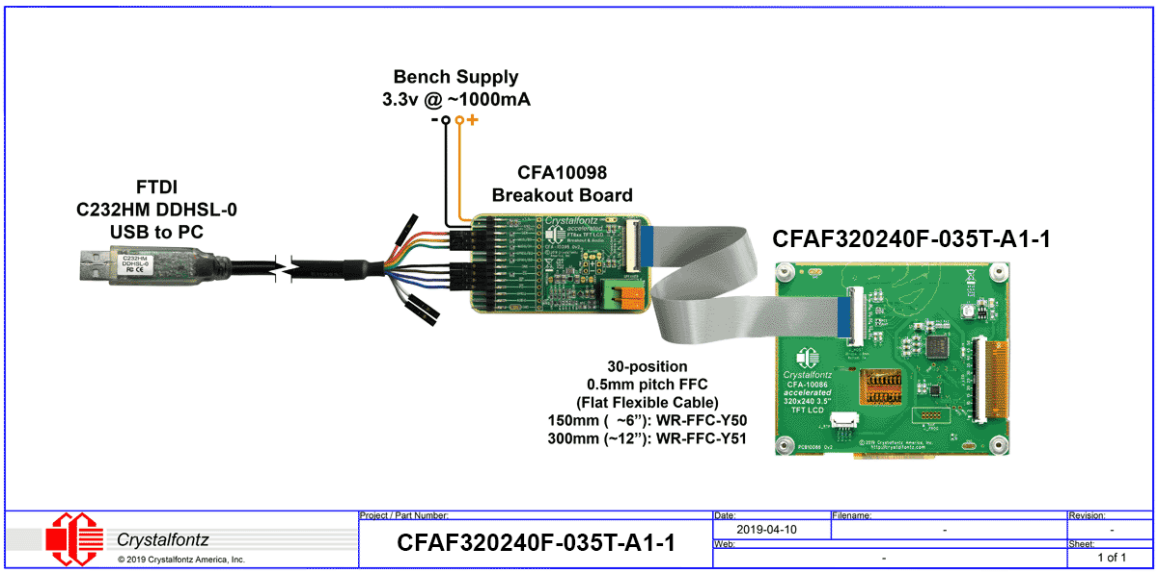
- Connect the FFC to the ZIF connector on your PCB
- Connect the FFC to the ZIF connector on the CFAF320240F-035T-A1-1 FFC (see the 7.5 below)

Note that your power supply must be able to supply enough current to drive the backlight.

7.4. Example Connection Diagrams



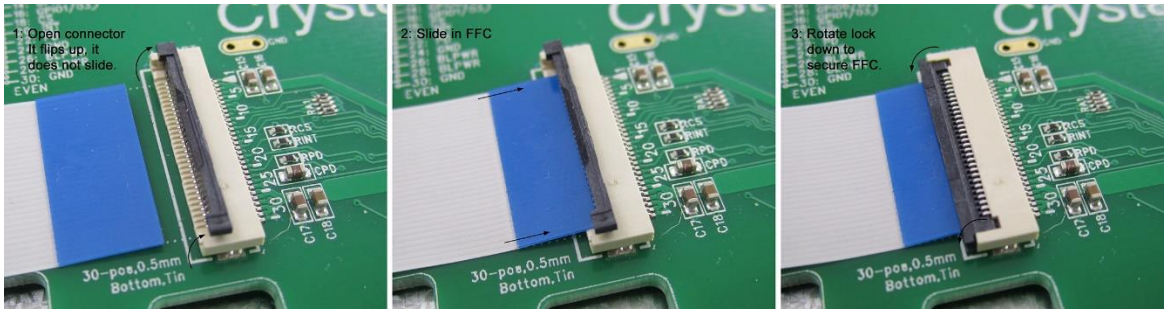
CFAF320240F-035T-A1- CFA10098 – Seeeduino



CFAF320240F-035T-A1 - CFA10098 - USB to PC

7.5. ZIF Connector Use With Flat-Flex-Cable (FFC)

Please take note of the orientation of the flat-flex-cable, and use of the locking clip in the following photos.



8. Care and Handling Precautions

For optimum operation of the CFAF320240F-035T-A1-1 is and to prolong its life, please follow the precautions described below.

8.1. ESD (Electrostatic Discharge)

If present, the USB D+ & D- lines have enhanced ESD protection following industry standard USB2 practice.

The remainder of this circuitry is industry standard CMOS logic and 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.

8.2. Design and Mounting

- The exposed surface of the display is either a touch-sensitive panel, or a polarizer laminated on top of the glass. To protect the surface from damage, the module ships with a protective film over the display. Please peel off the protective film slowly. Peeling off the protective film abruptly may generate static electricity.
- If the display does not have a touch-sensitive panel, to protect the soft plastic polarizer from damage, place a transparent plate (for example, acrylic, polycarbonate or glass), in front of the module, leaving a small gap between the plate and the display surface.
- Do not disassemble or modify the module.
- Do not modify the six tabs of the metal bezel or make connections to them.
- Do not reverse polarity to the power supply connections. Reversing polarity will immediately ruin the module.

8.3. Mechanical Shock, Impact, Torque, or Tension

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

8.4. LCD Panel Breakage

- If the LCD panel breaks, be careful to not get the liquid crystal fluid in your mouth or eyes.
- If the liquid crystal fluid touches your skin, clothes, or work surface, wash it off immediately using warm soapy water.

8.5. Cleaning

- The display surface can easily be scratched or become hazy, so use extra care when you clean it.
- Do not clean the display surface with liquids.
- If the display surface becomes dusty, carefully blow it off with clean, dry, oil-free compressed air.

- 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”).
- If the above methods are not adequate, gently wipe using a very soft, clean, dry, lint free cloth (such as a microfiber towelette).
- Contact with moisture may permanently spot or stain the polarizer.

8.6. Operation

- Protect the module from ESD and power supply transients.
- Observe the operating temperature limitations: a minimum of -20°C to a maximum of +70°C with minimal fluctuation. Operation outside of these limits may shorten life and/or harm display.
- 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.
- Adjust backlight brightness so the display is readable, but not too bright.
- Dim or turn off the backlight during periods of inactivity to conserve the backlight lifetime.

8.7. Storage and Recycling

- Store in an ESD-approved container away from dust, moisture, and direct sunlight.
- Observe the storage temperature limitations: -30°C minimum, +80°C maximum with minimal fluctuation. Rapid temperature changes can cause moisture to form, resulting in permanent damage.
- Do not allow weight to be placed on the module while in storage.
- Please recycle your outdated Crystalfontz modules at an approved facility.