3.9” TFT DISPLAY MODULE
WITH EVE GRAPHICS ACCELERATOR
DATASHEET

CFAF480128A0-039TC-A1-1

Datasheet Release: 2020-02-18

Revision A1

Crystalfontz America, Inc.
12412 East Saltese Avenue
Spokane Valley, WA 99216-0357
Phone: 888-206-9720
Fax: 509-892-1203
Email: support@crystalfontz.com
URL: www.crystalfontz.com

Table of Contents

1. General Information ____ *3*
2. Introduction ____ *4*
3. Key Features ____ *5*
4. Mechanical Data ____ *5*
5. Mechanical Drawings ____ *6*
6. Module Details ____ *8*
7. Getting Started ____ *11*
8. Care and Handling Precautions ____ *12*

1. General Information

Datasheet Revision History
Datasheet Release: 2020-02-18 Datasheet for the CFAF480128A0-039TC-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.

Disclaimer
Certain applications using Crystalfontz America, Inc. products may involve potential risks of death, personal injury, or severe property or environmental damage (“Critical Applications”). CRYSTALFONTZ AMERICA, INC. PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. Inclusion of Crystalfontz America, Inc. products in such applications is understood to be fully at the risk of the customer. In order to minimize risks associated with customer applications, adequate design and operating safeguards should be provided by the customer to minimize inherent or procedural hazard. Please contact us if you have any questions concerning potential risk applications. Crystalfontz America, Inc. assumes no liability for applications assistance, customer product design, software performance, or infringements of patents or services described herein. Nor does Crystalfontz America, Inc. warrant or represent that any license, either express or implied, is granted under any patent right, copyright, or other intellectual property right of Crystalfontz America, Inc. covering or relating to any combination, machine, or process in which our products or services might be or are used. All specifications in datasheets on our website are, to the best of our knowledge, accurate but not guaranteed. Corrections to specifications are made as any inaccuracies are discovered. Company and product names mentioned in this publication are trademarks or registered trademarks of their respective owners. Copyright © 2020 by Crystalfontz America, Inc.,12412 East Saltese Avenue, Spokane Valley, WA 99216 U.S.A.

2. Introduction

The Crystalfontz CFAF480128A0-039TC-A1-1 is a revolutionary new accelerated display for embedded systems based on the FTDI/BridgeTek FT81x EVE (Embedded Video Engine) graphics accelerator.

There are two traditional options for connecting a TFT to an embedded system: first to choose a very powerful processor that could support a frame buffer and RGB interface or second, to write directly to TFT controller's frame buffer. Both of these methods rely on software to render graphics primitives. A simply non-anti-aliased image may take hundreds or even thousands of write operations. Sometimes, read-modify-write operations are required which doubles (or more) the necessary number of commands- further slowing the display performance.

Additionally, these methods require a lot GPIO or GPIO configured as the RGB interface, often requiring a larger processor package. There are examples of using SPI to control small TFT LCDs, but even on small displays the performance suffers.

Text poses another problem for traditional implementations of TFTs. Fonts require a lot of memory to store and rendering them to the frame buffer can be complex- especially if they need to be anti-aliased or rotated. The traditional solution is to support just a few bitmapped, non-anti-aliased fonts rendered only on the horizontal and vertical. Need to angle a font to put labels on some data? Not without a very complete and complex (and typically big and slow) graphic library.

Now image a display that solves the problems with traditional TFTs. One that accepts high-level commands, so writing just a few instructions completely describes a line. As long as we're imagining- what if that line was fully anti-aliased and adjustable in width? How about writing just a few more commands and rendering beautiful anti-aliased text from a wide selection of fonts at any angle?

This daydream is now a reality with the CFAF480128A0-039TC-A1-1 thanks to the FTDI/BridgeTek FT811 EVE graphics accelerator at the heart of the module. Embedded systems with 8-bit processors can now have beautiful and responsive displays and touch support that do not tax the host processor.

Ready to live the dream? Our demo code for the CFAF480128A0-039TC-A1-1 was written to fit on the Seeeduino v4.2 (a 3.3v version of the Arduino Uno). As always, our source code is freely supplied and our displays are fully supported.

3. Key Features

3.1. Module Features

- 3.9-inch 480x128 TFT LCD panel
- Capacitive touch sensing screen
- FTDI/BridgeTek FT811 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, height and width no larger than LCD
- Single +3.3V power supply (backlight supply can be 3.3v to 6v)

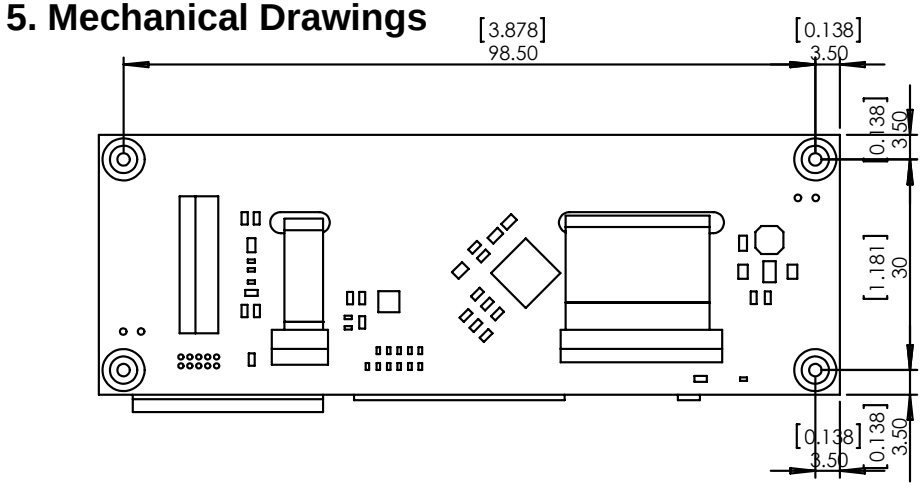
3.2. EVE Graphics Accelerator Features

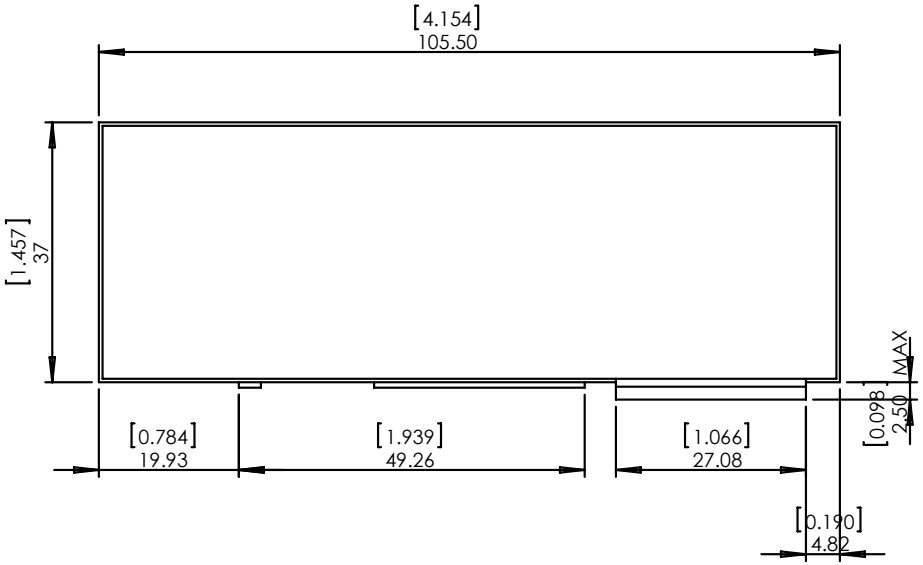
- Support multiple widgets for simplified design implementation
- User interface design software (PC) simplifies the design process
- Hardware engine can recognize touch tags and track touch movement
- Enhanced sketch processing
- Anti-aliasing of primitive displayed objects for higher-quality graphics
- 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

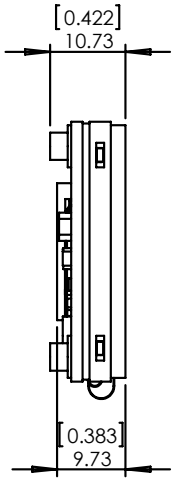
4. Mechanical Data

Item	Specification (mm)	Specification (inch)
Overall Module Dimension	105.5 (W) x 37.0 (H) x 10.73 (D)	4.154 (W) x 1.457 (H) x 0.422 (D)
Viewing Area	97.04 (W) x 32.34(H)	3.82 (W) x 1.27 (H)
Active Area	95.04 (W) x 25.34 (H)	3.74 (W) x 1.00 (H)
Dot Pitch	0.066 (W) x 0.198 (H)	0.0026 (W) x 0.0078 (H)
Weight (Typical)	59.6 grams	2.10 ounces

5. Mechanical Drawings







Pin	Fuction
1	GND
2-3	3v3
4	GND
5-6	3v3
7	GND
8	SCK
9	GND
10	MOSI/D0
11	GND
12	MISO/D1
13	GND
14	GPIO0/D2
15	GND
16	GPIO1/D3
17	GND
18	FT_CS
19	GND
20	INT
21	GPIO2
22	PD
23	FT_AUDIO
24	GND
25-26	BLPWR
27	GND
28-29	BLPWR
30	GND

Units: [Inches]
Millimeters

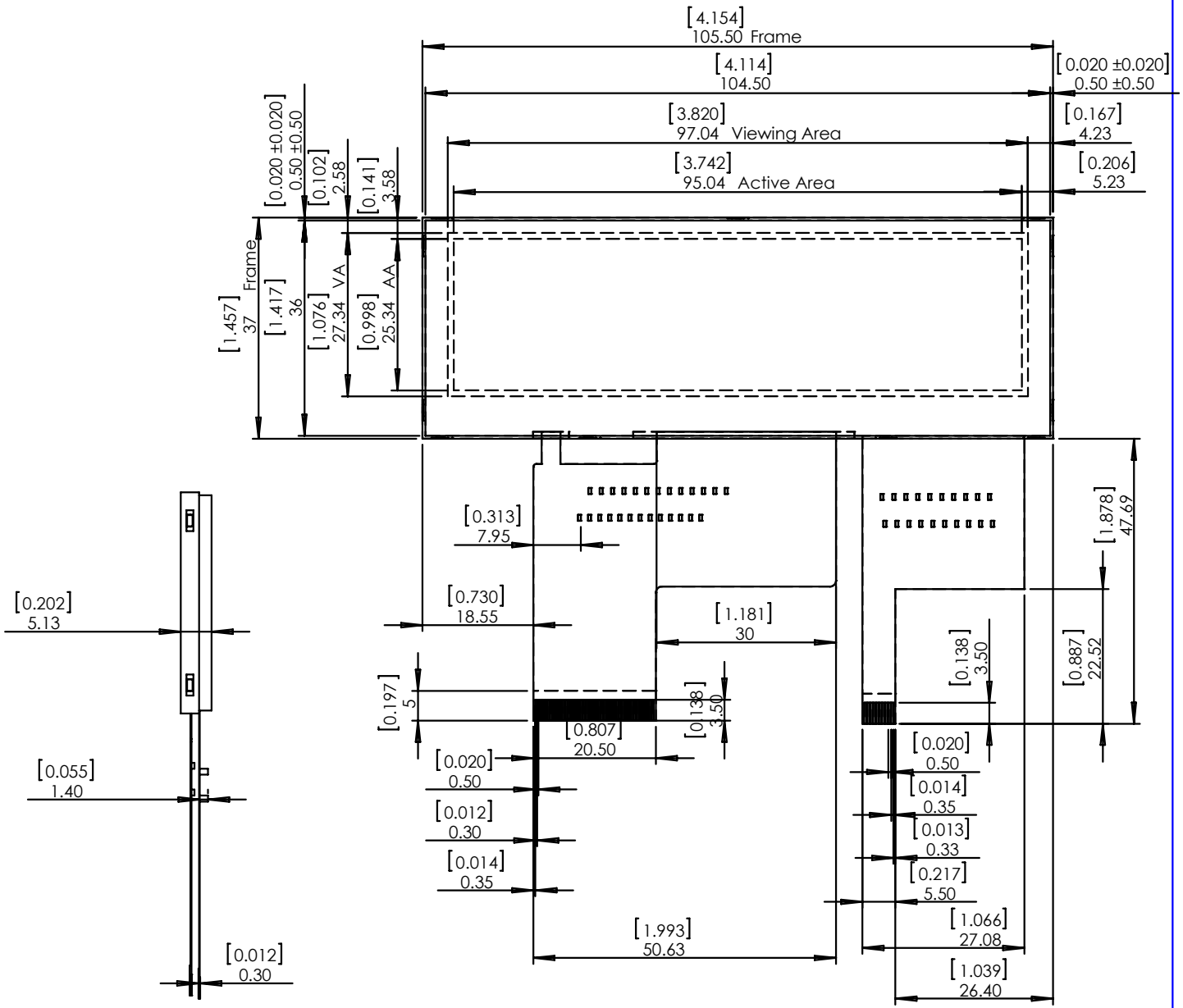
Tolerance: [0.0118]
0.3

Crystalfontz

Part Number:	Date:	Filename:	Revision:
CFAF480128A0-039TC-A1-1	2020-02-06	CFAF480128A0-039TC-A1-1.pdf	v 1.0
	Web: www.crystalfontz.com/product/cfaf480128a0039tca11		Sheet: 1 of 1

Pin	Function
1	VLED-
2	VLED+
3	GND
4	VCC
5-12	R0-R7
13-20	G0-G7
21-28	B0-B7
29	GND
30	DCLK
31	DISP
32	HSYNC
33	VSYNC
34-35	NC
36	GND
37-40	NC

Touch Pin	Function
1	VSS
2	VDDT
3	SCL
4	NC
5	SDA
6	NC
7	/RST
8	NC
9	/INT
10	VSS



Units: [Inches] Millimeters

Tolerance: [0.0118] 0.3

Crystalfontz

Part Number:	Date:	Filename:	Revision:
CFAF480128A0-039TC	2020-02-06	CFAF480128A0-039TC drawing.pdf	v1.1
	Web: www.crystalfontz.com/product/cfaf480128A0039TC		Sheet: 1 of 1

6. Module Details

6.1. General Information

The CFAF480128A0-039TC-A1-1 is a 3.9-inch TFT display module based around a FTDI/BridgeTek FT811 Embedded Video Engine (EVE).

All display, touch sensing, 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.

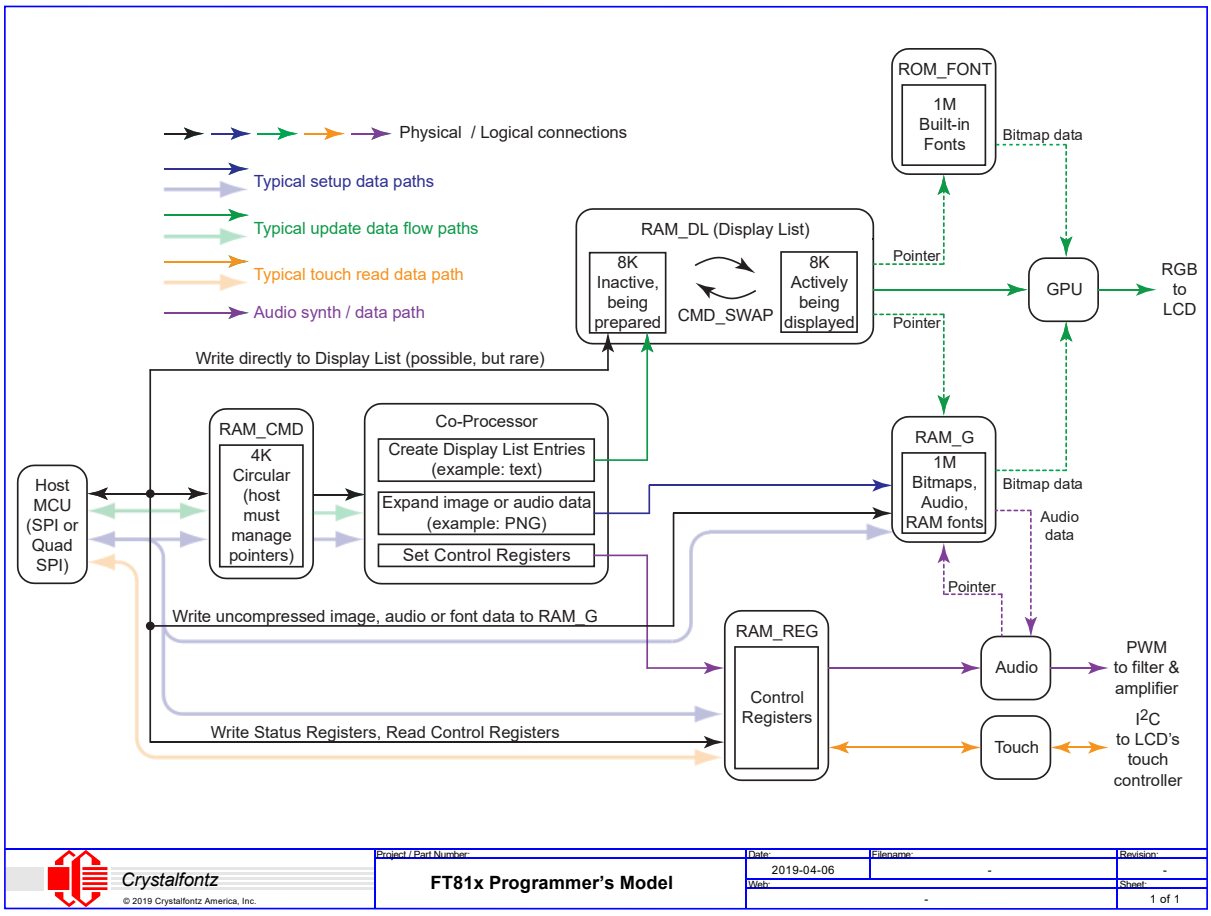
For detailed BridgeTek datasheets and other development information, see the Embedded Video Engine Documentation / Resources section below.

6.2. Embedded Video Engine Documentation / Resources

- Bridgetek FT81x 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 FT81x 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	/CS	Input	SPI Slave Chip-Select
19	GND		Ground (1)
20	/INT	Output	Interrupt to Host
21	GPIO2		General purpose IO2
22	/PD	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	-	-	V
Input Logic Low	VIL	-	-	0.8	V

6.7. Backlight Characteristics

Item	Symbol	Min	Typ	Max	Unit
Forward Current	I_{LED}	-	40	-	mA
Forward Voltage	V_{LED+}	14	15	17	V
LED Lifetime	Hr.	-	50K	-	Hr.

6.8. Optical Characteristics

Item		Symbol	Condition	Min	Typ	Max	Unit
Response Time		T_r	θ=0°, Φ=0	-	10	-	ms
		T_f		-	15	-	ms
Contrast Ratio		(CR)	At Optimized Viewing Angle	-	500	-	-
White Chromaticity		Wx	θ=0°, Φ=0	0.269	0.319	0.369	ms
		Wy		0.273	0.323	0.373	ms
Viewing Angle	Horizontal	θL	CR≧10 Ta=25±2°C I_{LED}=40mA	-	65	-	Degree
		θR		-	65	-	
	Vertical	θT		-	65	-	
		θB		-	50	-	
Brightness		-	-	-	500	-	cd/m^2
Viewing Direction		6 o'clock					

7. Getting Started

7.1. Getting started with the CFAF480128A0-039TC-A1-2 kit

Components Required (included in -2 kit):

- Crystalfontz the CFAF480128A0-039TC-A1-1 display module
- Crystalfontz CFA10098 EVE adapter board
- Appropriate flat-flex-cable (6" WR-FFC-Y50 or 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 (not included)

Hardware Procedure:

- Connect the components:
  - Use the FFC to connect the CFA10098 to the CFAF480128A0-039TC-A1-1 display module
  - Connect the CFA10098 to the Seeeduino following the table below
- 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

Seeeduino	Color	CFA10098
3v3	Orange	Pin1: 3.3V
GND	Black	Pin2: GND
D13	White	Pin3: SCK
D11	Yellow	Pin4: MOSI
D12	Green	Pin5: MISO
D9	Brown	Pin9: $\overline{CS}$
D7	Violet	Pin10: $\overline{INT}$
D8	Blue	Pin11: $\overline{PD}$
GND	Grey	GND

7.2. Getting started with the CFAF480128A0-039TC-A1-1and a Windows PC

Components Required:

- Crystalfontz the CFAF480128A0-039TC-A1-1 display module
- Crystalfontz CFA10098 EVE adapter board
- Appropriate flat-flex-cable (6" WR-FFC-Y50 or 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 CFAF480128A0-039TC-A1-1 using the FFC (see the 7.4 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 the product page.

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 CFAF480128A0-039TC-A1-1 and your PCB

Components Required:

- Crystalfontz CFAF480128A0-039TC-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 or 12" WR-FFC-Y51)

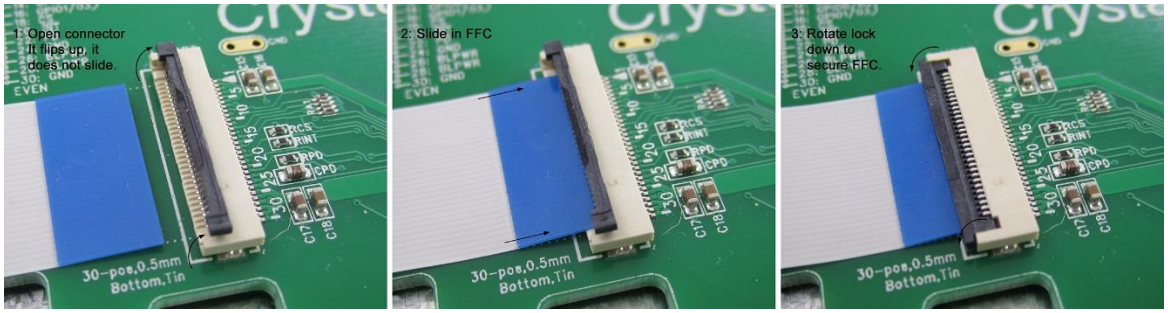
Procedure:

- Connect the FFC to the ZIF connector on your PCB
- Connect the FFC to the ZIF connector on the CFAF480128A0-039TC-A1-1 FFC

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

7.4. 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 CFAF480128A0-039TC-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.