Crystalfontz

TFT DISPLAY MODULE DATA SHEET

CFAF320240F-035T-TS

Crystalfontz

Full-Color TFT 320xRGBx240 pixels

18/16/9/8 bit parallel, RGB, SPI interface

Single 3v power supply and logic voltages

White LED backlight Controller on-board

Touch Screen Included!

AD35396E   G5/3

CFAF320240F-035T-TS shown above

Data Sheet Release Date 2014-12-24
for
CFAF320240F-035T without Touch Screen
CFAF320240F-035T-TS with Touch Screen

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Data Sheet Revision History

Data Sheet Release Date: 2014-12-24
- Combined the CFAF320240F-035T and CFAF320240F-035T-TS Data Sheets into one and updated formatting to match current standards.
- Wherever listed, changed viewing angle (polarizer viewing direction) from "12 o'clock" to "6 o'clock".
- Wherever listed, changed Color Depth from "16.7M" to "262K".
- Added a notice About Volatility (page 4).
- In Physical Characteristics: (Pg. 10), changed weight from 22 grams to 24 grams for CFAF320240F-035T and 38 grams for CFAF320240F-035T-TS. This difference is due to using a more accurate, calibrated scale. The physical weight of the modules has not changed.
- In Module Outline Drawings (Pg. 12), removed version number. This product is not under Crystalfontz version control. Also removed tolerance specification and added note "Illustration deemed accurate but not guaranteed". Touch Screen dimensions for CFAF320240F-035T-TS changed. A detailed illustration of the touch screen is added.
- Wherever listed, increased accuracy of dimension specifications from one point after the decimal to two points.
- In Absolute Maximum Ratings (Pg. 18), added a new caution note in the specifications table.
- In Recommended DC Characteristics (3.0v Operation) (Pg. 19), added specification for Power Supply Current for TFT.
- Added LCD Duty And Bias (Pg. 18) specifications.
- Updated SOURCES FOR DRIVER LIBRARIES AND SAMPLE CODE (Pg. 30).
- In Module Reliability and Longevity, added Reliability Test Results (Pg. 31).
- In Module Reliability (Pg. 32), corrected from 50,000 hours >50% of Initial Brightness (New Module) to 10,000 hours.
- In Care and Handling, added If TFT Panel Breaks (Pg. 34) and How to Clean (Pg. 34).

Data Sheet Release Date: 2012/07/18
- Wherever described, clarified module dimensions. Module has not changed.
- Updated Data Sheet formatting to match current standards.

Data Sheet Release Date: 2012/04/11
- Updated Interface Pin Usage Table.
- Added reference to TFT module available mounted on a carrier board (part number CFAF320240F-035T-CB and CFAF320240F-035T-TS-CB).
- Added Solomon Systech SSDD2119 controller RGB information as APPENDIX D: SOLOMON SYSTECH SSD2119 RGB INTERFACE.
Publish Data Sheet Release Date instead of Data Sheet version number.

Data Sheet Release Date: 2011/08/15
Data Sheet version: v1.0
No changes except the module part number. Previous part number was CFAF320240F-T and CFAF320240F-T-TS.

Data Sheet Release Date: 2010/08/24
For CFAF320240F-T and CFAF320240F-T-TS (previous part number)
Data Sheet version: v1.2
In Additional Information on Interface Types section, corrected text in third bullet from
 "what should be done with pins DB17-DB8 (pins 19-28)?"
to
"what should be done with pins DB9-DB0 (pins 27-36)?"

Data Sheet Revision History (Continued)

Data Sheet Release Date: 2010/07/09
For CFAF320240F-T and CFAF320240F-T-TS (previous part number)
Current Data Sheet version: v1.1
Improved information in LED Backlight Characteristics specifications.

CFAF320240F-T: Specifications for luminous intensity were direct measurement of backlight (*not* through the TFT). Specifications are now *through* the TFT. Luminous intensity has not changed.

For CFAF320240F-T-TS*:* Specifications for luminous intensity were direct measurement of backlight (*not* through the TFT and touch screen). Specifications are now *through* the TFT and touchscreen. Luminous intensity has not changed.

Data Sheet Release Date: 2010/07/09
For CFAF320240F-T and CFAF320240F-T-TS (previous part number)
Since last Data Sheet (Preliminary, no version number):
- Moved information from preliminary Data Sheet into this v1.0 Data Sheet. This Data Sheet uses the standard Graphic TFT template.
- If and how the module's FFC (Flat Flex Cable) and CFAF320240F-T-TS touch screen's FFC are folded or unfolded affects the overall module dimensions. Wherever listed in this Data Sheet v1.0, module width and height dimensions have been changed to define (1) module excluding FFCs and (2) module including FFCs unfolded. Actual width and height dimensions have not changed.
  - For CFAF320240F-T: Expanded "Module Dimension" depth description. Nominal depth is still "3.10" millimeters. Maximum depth of "3.30" millimeters was added. Actual module dimensions have not changed.
  - For CFAF320240F-T-TS: Added "Module Dimension" Nominal depth of "4.10" millimeters. Maximum depth of "3.10" millimeters was changed to "4.45" millimeters. This increase is because the thickness of the touch screen is now added to the total thickness for the module. Actual module dimensions have not changed.
  - For CFAF320240F-T: "Active Area/Viewing Area" width changed from "70.08" millimeters to "70.07" millimeters. "Active Area/Viewing Area" height changed from "52.56" millimeters to "52.55" millimeters.
  - For CFAF320240F-T-TS: "Active Area/Viewing Area" *width* changed from "69.92" millimeters to "70.07" millimeters. "Active Area/Viewing Area" *height* changed from "52.55" millimeters to Active Area remaining at "52.55" millimeters but Viewing Area to "55.65" millimeters.
- In Physical Characteristics, added specifications for Module Connector Pitch, FFC Bend Radius, Weight, Touch Screen Connector Pitch (for CFAF320240F-T-TS), and resources for ZIF connectors.
- Improved Module Outline Drawings and System Block Diagram.
- In the preliminary Data Sheet, temperatures under section "1 General Specifications" were listed correctly. In Absolute Maximum Ratings section of preliminary Data Sheet, previous specifications were for controller SSD2119 only and did not include the module. In this Data Sheet v1.0,
  - Operating Temperature changed *minimum* from "-40°C" to "-20°C" and *maximum* from "+85°C" to "+70°C".
  - Storage Temperature changed *minimum* from "-65°C" to "-30°C" and *maximum* from "+150°C" to "+80°C". Actual module temperature ranges have not changed.
- The previous DC Characteristics specifications were for the controller SSD2119. The DC Characteristics section in this Data Sheet are for the module.
- In Details of Interface Pin Function, used Crystalfontz standard terms for signals and improved descriptions.

Data Sheet Revision History (Continued)

Data Sheet Release Date: 2010/07/09
For CFAF320240F-T and CFAF320240F-T-TS (previous part number)
- New sections include:
  - MAIN FEATURES.
  - To improve explanation of how pins are used for the various interfaces, added Photo Reference for Pin Functions, Interface Pin Usage Table, and Additional Information on Interface Types.
  - For CFAF320240F-T-TS, About the Touch Screen section includes resources for learning more about touch screens.
  - ESD (Electro-Static Discharge). Please read this caution.
  - Some OPTICAL SPECIFICATIONS are now available.
  - LED Backlight Characteristics includes information on how to step up a +3.3v power supply for the backlight and describes typical connections as well as a complete list of specifications.
  - SOURCES FOR DRIVER LIBRARIES AND SAMPLE CODE.
  - MODULE RELIABILITY AND LONGEVITY.
  - CARE AND HANDLING PRECAUTIONS.
  - APPENDIX A: QUALITY ASSURANCE STANDARDS.
  - APPENDIX B: TFT MODULE TERMS AND SYMBOLS.
  - APPENDIX C: SOLOMON SYSTECH SSD2119 TFT DRIVER. Controller specifications are added for your convenience.
- Deleted information from the preliminary Data Sheet that was copied from the controller specifications. The controller specifications are appended to this v1.0 Data Sheet.

Data Sheet Release Date: 2010/01/19
For CFAF320240F-T and CFAF320240F-T-TS (previous part number)
Data Sheet version: Preliminary, no version number
New Data Sheet.

Hardware Updates

To check for update notices for this display module, look up the part number here on our website.

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.

The Fine Print

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CONTENTS

LIST OF FIGURES

MAIN FEATURES

FEATURES

The *CFAF320240F-035T-TS* is identical to the *CFAF320240F-035T* except that it has a four-wire analog touch screen.

❑ Full-color (262K) 320 x RGB x 240 TFT consists of a TFT panel, a driver IC, an FFC (Flat Flexible Cable), a touch screen (CFAF320240F-035T-TS only), and an LED backlight.

❑ Active Area is 3.5" diagonal, 70.08 (W) x 52.56 (H) mm (2.76" (W) x 2.07" (H)). For more dimension details, see Module Outline Drawings (Pg. 12).

❑ Interface modes to host:
   ● 8-bit, 9-bit, 16-bit, and 18-bit parallel (8080 or 6800).
   ● 16-bit or 18-bit "DOTCLK" RGB.
   ● 3- or 4-wire SPI.

❑ Integrated Solomon Systech SSD2119 or compatible driver. See Display Controller Datasheets on our website.

❑ Transmissive display with LED backlight. White edge-lit with two parallel rows of LEDs, three LEDs in each row, six LEDs total. Display light pixels on a dark colored area (any color combination) or invert for dark colored pixels (any color combination) on a light area.

❑ Requires only a single source 3.3v for both power supply and logic.

❑ Built-in for DC-DC converter for panel voltage.

❑ The display module's 50-pin FFC mates with standard 0.5 mm ZIF connectors such as HFJ150CT-ND and HFK150CT-ND available from Digi-Key.

❑ 6:00 o'clock viewing angle (polarizer viewing direction). Use in portrait or landscape orientation.

❑ Temperature operation is from -20°C to +70°C.

❑ The display modules are available mounted on a carrier boards (CFAF320240F-035T-TS-CB and CFAF320240F-035T-CB).

❑ Free downloadable sample code is on our website under the CFAF320240F-035T or CFAF320240F-035T-TS DATASHEETS & FILES tabs.

❑ RoHS compliant. Factory is ISO certified.

MODULE CLASSIFICATION INFORMATION

CFA	F	320	240	F	-	035	T	-	*
❶	❷	❸	❹	❺		❻	❼		❽

❶	**Brand**	Crystalfontz America, Inc.
❷	**Model Identifier**	F – TFT
❸	**Number of Pixels (Width)**	320 pixels
❹	**Number of Pixels (Height)**	240 pixels
❺	**Model Identifier**	F
❻	**Diagonal Dimension**	035 – 3.5-inch diagonal
❼	**Backlight Type & Color**	T – White LED Backlight
❽	**Special Code ***	(blank) – No Touch Screen TS – Touch Screen (on CFAF320240F-035T-TS)

MECHANICAL SPECIFICATIONS

PHYSICAL CHARACTERISTICS:

ITEM	SPECIFICATION
Pixels	
Number of Pixels	320 x 480 = 153,600 pixels
Pixel Size	0.063 (W) x 0.209 (H)
RGB Pixel Pitch	0.219 (W) x 0.219 (H) mm
TFT Active Area	
Active Area Diagonal	Inches: 3.5" (3.44 inches)
Active Area Width	Millimeters: 70.08 (W) mm Inches: 2.76" (W)
Active Area Height	Millimeters: 52.56 (H) mm Inches: 2.07" (H)
Viewing Area	*CFAF320240F-035T:* Same as Active Area *CFAF320240F-035T-TS* *Touch Screen Viewing Area:* Millimeters: 72.08 (W) x 54.56 (H) mm Inches: 2.84" (W) x 2.15" (H)
Display Module Outline Dimensions	
Overall Display Module Width Without Module's FFC	Millimeters: 77.60 (W) mm Inches: 3.06" (W) mm
Overall Display Module Height with Module's FFC unfolded and *CFAF320240F-035T-TS* Touch Screen Unfolded*	*CFAF320240F-035T:* Millimeters: 106.80 (H) mm Inches: 4.20" (H) mm *CFAF320240F-035T-TS* Millimeters: 119.60 (H) mm Inches: 4.71" (H) mm
Overall Display Module Height with FFC folded and *CFAF320240F-035T-TS* Touch Screen Folded*	*CFAF320240F-035T:* Millimeters: 65.38 (H) mm Inches: 2.57" (H) mm *CFAF320240F-035T-TS* Millimeters: 67.50 (H) mm Inches: 2.66" (H) mm
*For reference only. Shape and length of FPC may vary.	

ITEM (Continued)	SPECIFICATION

Module Depth	*CFAF320240F-035T:*
	  Millimeters: 3.10 (D) mm
	  Inches: 0.12" (D)
	
	CFAF320240F-035T-TS:
	  Millimeters: 4.45 (D) mm
	  Inches: 0.18" (D)

Weight	*CFAF320240F-035T*
	  24 grams
	
	CFAF320240F-035T-TS:
	  38 grams

FFCs	
Module Connector Pitch	0.5 mm
CFAF320240F-035T-TS Touch Screen Connector Pitch	1.0 mm
FFC Bend Radius	>R.5.0 mm

FFC Notes:
The display module's 50-pin FFC mates with standard 0.5mm ZIF connectors such as HFJ150CT-ND and HFK150CT-ND available from Digi-Key.

See "No Bend Area" detail on sheet 4 of Module Outline Drawings (Pg. 12).

The CFAF320240F-035T-TS touch screen FFC mates with 1.00 mm pitch spaced ZIF sockets such as 609-1883-1-ND or 609-1886-1-ND from Digi-Key.

Front View

77.60 Overall Display Module Without FFC

70.08 Active Area / Viewing Area

1.25

3.37

64.40 Overall Display Module Without FFC

52.56 Active Area / Viewing Area

106.80 Overall Display Module With FFC Unfolded

320 x RGB x 240

See Pixel
Detail 'A'
Page 4

See Contact Side
Detail 'C'
Page 3

1.25

3.76

See FFC
No Bend Area
Detail 'B'
Page 4

42.40 FFC

1

50

5.00

33.90

64.40 FFC

87.72 Overall Display Module With FFC Unfolded

R-10

Side Views

3.10

65.38 OverallDisplay Module With FFC Folded

.30

Figure 1. Module Outline Drawings (4 pages)

Note:
1. Illustration deemed accurate but not guaranteed.
2. FFC = Flat Flex Cable mates with ZIF connector.
3. Diagonal = 3.5" (3.44 inch)

Part No.(s):	Scale:	Drawing Number:	
CFAF320240F-035T (No Touch Screen)	Not to scale	CFAF320240F-035T	
	Units: Millimeters	Date: 2014-12-18	Sheet: 1 of 5

CFAF320240F-035T And CFAF320240F-035T-TS Graphic TFT Display Modules
Data Sheet Release 2014-12-24

Front View

77.60 Display Module Without Module's FFC
72.08 Touch Screen Viewing Area
71.08 Touch Screen Active Area
70.08 TFT Active Area

320 x RGB x 240

Side Views

4.45
1.10 Touch Screen

67.50 Overall Display Module With Module's FFC and Touch Screen's FFC Folded

63.80 Touch Screen Overall
54.56 Touch Screen Viewing Area
53.56 Touch Screen Active Area
52.56 TFT Active Area

See Pixel Detail 'A' Page 4

119.60 Overall Display Module With Touch Screen FFC Unfolded

1.25
3.76

See Contact Side Detail 'C' Page 3

42.40 FFC

1

50

5.00
33.90

See FFC No Bend Area Detail 'B' Page 4

55.30 FFC

R-10

1   4

See Touch Screen Pin Detail 'D' Page 5

.30

.10

87.72 Overall Display Module With FFC Unfolded

Note:
1. Illustration deemed accurate but not guaranteed.
2. FFC = Flat Flex Cable mates with ZIF connector.
3. Diagonal = 3.5" (3.44 inch)

Part No.(s):	CFAF320240F-035T-TS (With Touch Screen)	Scale: Not to scale	Drawing Number: CFAF320240F-035T	
		Units: Millimeters	Date: 2014-12-22	Sheet: 2 of 5

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See Contact Side Detail 'E' (below)

50   1

5.00

3.50

W=.30

P0.50 X (50-1) = 24.50

25.50

Contact Side Detail 'C'

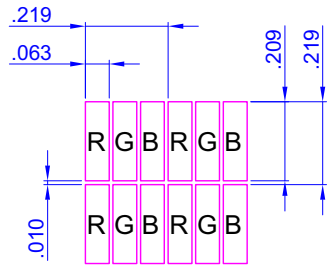| Pin	Signal
50	K₁(LED₁-)
49	A₁(LED₁+)
48	A₂(LED₂+)
47	K₂(LED₂-)
46	NC
*45	V$_{LOGIC}$
*44	V$_{LOGIC}$
43	GND
42	GND
41	NC
40	DCLK
39	VSYNC
38	HSYNC
37	DEN
36	DB0
35	DB1
34	DB2
33	DB3
32	DB4
31	DB5
30	DB6
29	DB7
28	DB8
27	DB9
26	DB10
25	DB11
24	DB12
23	DB13
22	DB14
21	DB15
20	DB16
19	DB17
18	PS0
17	PS1
16	PS2
15	PS3
14	WR$_{8080}$ (R/W$_{6800}$)
13	D/C̄
12	SDI
11	SCL
10	CS
9	RST
8	SD0
7	RD$_{8080}$ (E$_{6800}$)
6	GND
5	GND
4	GND
3	NC
2	NC
1	GND

* Both V$_{LOGIC}$ pins (44,45)
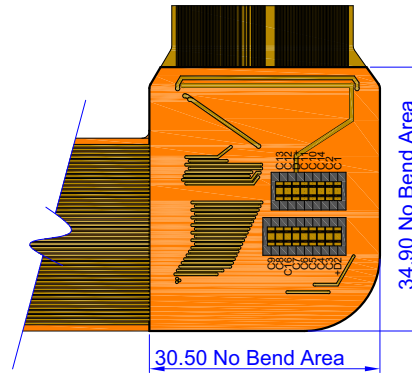need to be connected.

Contact Side Detail 'E'

Note:
1. Illustration deemed accurate but not guaranteed.
2. FFC = Flat Flex Cable mates with ZIF connector.
3. Diagonal = 3.5" (3.44 inch)

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Part No.(s):	Scale:	Drawing Number:	
CFAF320240F-035T and CFAF320240F-035T-TS	Not to scale	CFAF320240F-035T	
	Units: Millimeters	Date: 2014-12-18	Sheet: 3 of 5

.219

.063

.209

.219

| R | G | B | R | G | B |

| R | G | B | R | G | B |

.010

Pixel Detail 'A'

34.90 No Bend Area

30.50 No Bend Area

FFC No Bend Area
Detail 'B'

Note:
1. Illustration deemed accurate but not guaranteed.
2. FFC = Flat Flex Cable mates with ZIF connector.
3. Diagonal = 3.5" (3.44 inch)

| Part No.(s): CFAF320240F-035T and CFAF320240F-035T-TS | Scale: Not to scale | Drawing Number: CFAF320240F-035T | |
| | Units: Millimeters | Date: 2014-12-18 | Sheet: 4 of 5 |

Front View

77.60 Touch Screen Overall
72.08 Touch Screen Viewing Area
71.08 Touch Screen Active Area

2.76
3.26

63.80 Touch Screen Overall
54.56 Touch Screen Viewing Area
53.56 Touch Screen Active Area

Y+(YU)

X- (YL)

X+ (XR)

Y- (YD)

6.82
7.32

Black Screen

14 40

2.00

0.1 Backing

55.30

23.15

6.00

3.00

1 4

.70

0.6+0.4=Pitch 1.00

5.00

Side View

1.1

Front ITO Film 0.188

Back ITO Tempered Glass 0.7

0.1 Backing

6.00

3.00

.30

Y+

Front View

X-

Y-

X+

1 2 3 4

Touch Screen
Detail "D"

Description
1. Structure: Film+Glass+DST+FPC
   Film: Matte anti-glare 0.188mm
   Glass: 500Ω/□ (0.7mm)
   Tail: FFC (Pitch=1.0mm)
   Total Thickness：1.1
2. Operating Voltage：5.0v
3. Circuit Rating：DC 5v 1mA
4. Insulation Resistance：≥20MΩ (25v DC)
5. Linear：≤1.5%
6. Transmittance: >80%
7. Operating Pressure：80-150g
8. Work Environment：-20°C~+70°C，≤90%RH
9. Storage Environment：-25°C~+75°C，≤90%RH

Part No.(s):
Touch Screen Detail
For
CFAF320240F-035T-TS

Scale:
Not to scale

Drawing Number:
CFAF320240F-035T

Units:
Millimeters

Date:
2014-12-22

Sheet:
5 of 5

ELECTRICAL SPECIFICATIONS

SYSTEM BLOCK DIAGRAM

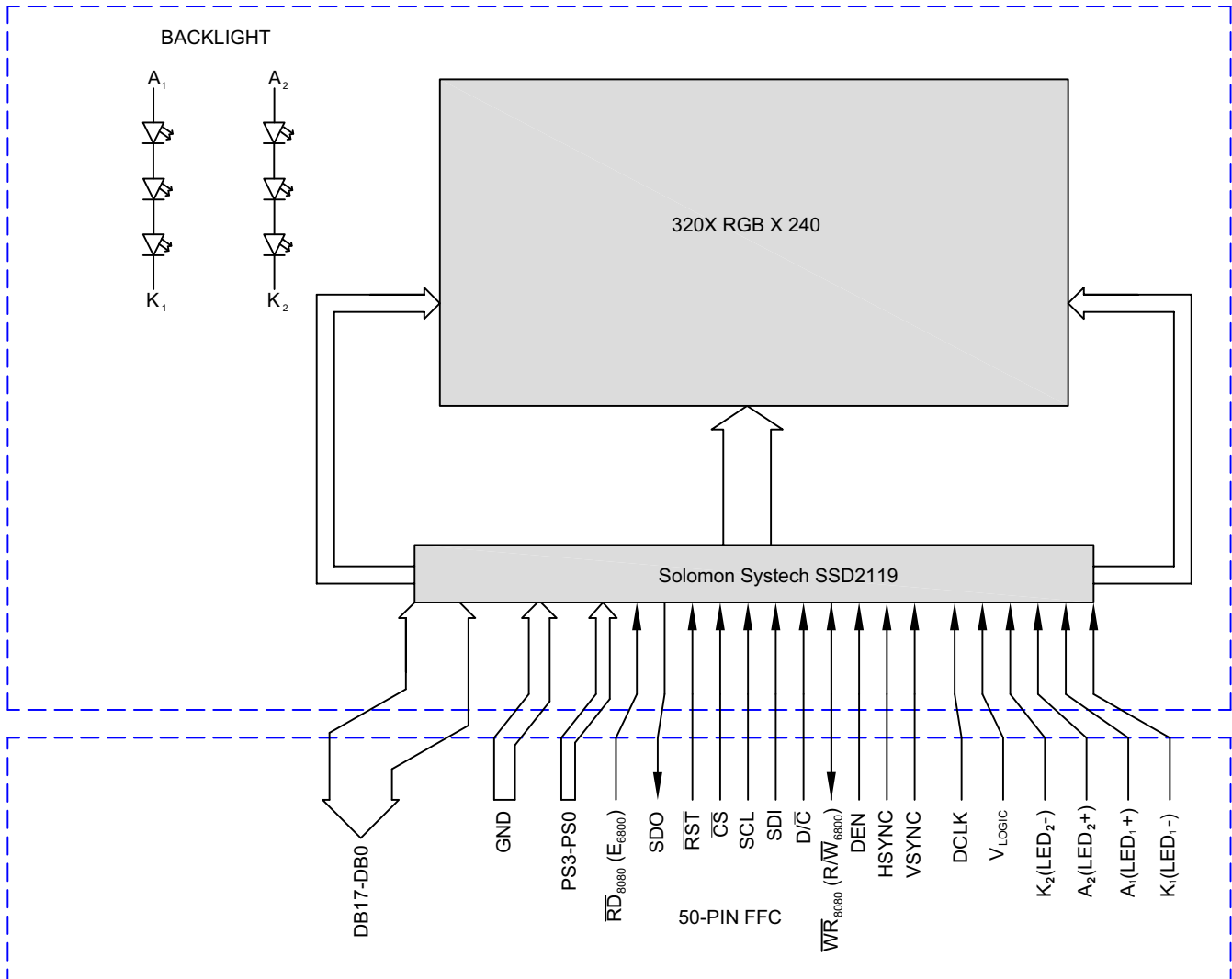Note: Selected interface will affect which pins are actually used.

Figure 2. System Block Diagram

LCD DUTY AND BIAS

DRIVING METHOD	SPECIFICATION
Duty[1]	240
Bias[2]	1/16

[1]The duty cycle, also known as duty ratio or multiplex rate, is the fraction of total frame time that each row of the LCD is addressed.

[2]The drive bias, also known as voltage margin, is related to the number of voltage levels used when driving the LCD. Bias is defined as 1/(number of voltage levels-1). The more segments driven by each driver(1), the higher number of voltage levels are required. There is a direct relationship between the bias and the duty.

ABSOLUTE MAXIMUM RATINGS

ABSOLUTE MAXIMUM RATINGS	SYMBOL	MINIMUM	MAXIMUM
Supply Voltage	$V_{LOGIC\ I/O}$	-0.3v	+4.0v
Logic Supply Voltage	V_{LOGIC}	-0.3v	+4.0v
Operating Temperature	T_{OP}	-20°C	+70°C
Storage Temperature*	T_{ST}	-30°C	+80°C
Humidity	RH	0%	90%

Caution
These are stress ratings only. Functional operation of the module at these or any other conditions beyond those listed under Recommended DC Characteristics (3.0v Operation) (Pg. 19) *is not implied.*

Extended exposure to the absolute maximum ratings listed above may affect device reliability. Stresses beyond those listed above can cause permanent damage.

RECOMMENDED DC CHARACTERISTICS (3.0V OPERATION)

This is a summary of the module's major operating parameters. For detailed information see the Solomon Systech SSD2119 driver datasheet at controller datasheets *on our website.*

DC CHARACTERISTICS	TEST CONDITION	SYMBOL	MINIMUM	TYPICAL	MAXIMUM
Logic Supply Voltage[*]	T_{OP} = -20°C to +70°C	V_{LOGIC}	+2.5	+3.0v	+3.6v
Supply Voltage for I/O signals	T_{OP} = -20°C to +70°C	$V_{LOGIC\ I/O}$	+1.4v	+3.0v	+3.6v
Input High Voltage		V_{IH}	+0.8v x V_{Logic} For V_{Logic} = +3.0v V_{OH}= +0.8v x +3.0v = +2.4v		V_{Logic}
Input Low Voltage		V_{IL}	0v (GND)		+0.2v x V_{Logic} For V_{Logic} = +3.0v V_{IL} = +0.2v x +3.0v = +0.6v
Output High Voltage	I_{OUT} = 100µA 3.3MHz	V_{OH}	+0.9v x V_{Logic} For V_{Logic} = +3.0v V_{OH}= +0.9v x +3.0v = +2.7v		V_{Logic}
Output Low Voltage	I_{OUT} = 100µA 3.3MHz	V_{OL}	0v (GND)		+0.1v x V_{Logic} For V_{Logic} = +3.0v V_{OL}= +0.1v x +3.0v = +0.3v
Power Supply Current for TFT		I_{DD}		43 mA	
Current for Normal Operation		I_{OP}	0.05 mA		
Current for Standby Mode		I_{ST}	0.03 mA		0.2 mA

[*]If you use a +3.3v supply, you will need to step up the power supply for the LED backlight because it requires +9.9v. For information on how to do this, see How to Use Current Feedback LED Driver (Pg. 29).

DETAILS OF INTERFACE PIN FUNCTION

Note: Pins depends on choice of 8-bit, 9-bit, 16-bit, and 18-bit parallel (8080 or 6800), RGB, or SPI interface. Click here
to see Interface Pin Usage Table.

PIN	SIGNAL	LEVEL	DIRECTION	DESCRIPTION
1	GND	L		Power supply and signal ground. Must be connected to an external ground.
2-3	NC			No Connection
4-6	GND	L		Ground. Must be connected to an external ground.
7	$\overline{RD}_{8080}$ (E_{6800})	H/L	I	Host interface input. *8080 Host:* Active low. Signal on the databus is latched at the rising edge of $\overline{RD}$. *6800 Host:* Enable control signal input active high. E = *High:* Read or Write operation is active. E = *Low:* No operation
8	SDO	H/L	O	Data output pin in serial interface. (Serial Data Out/MISO)
9	$\overline{RST}$	H/L	I	Reset signal. *Low:* Display controller is reset. The $\overline{RST}$ pin should be pulsed low shortly after power is applied. *High:* The $\overline{RST}$ pin should be brought high for normal operation.
10	$\overline{CS}$	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.
11	SCL	H/L	I	Serial clock input.
12	SDI	H/L	I	Data input pin in serial interface. (Serial Data In/MOSI)
13	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.
14	$\overline{WR}_{8080}$ (R/$\overline{W}_{6800}$)	H/L	IO	Host interface input. *8080 Host:* Active low. Signal on the databus is latched at the rising edge of $\overline{WR}$ signal. *6800 Host:* Read/Write control signal output. R/$\overline{W}$ = High: Read (Host←Module) R/$\overline{W}$ = Low: Write (Host→Module)
15-18	PS3-PS0	H/L		Notice the descending order. Click here to see Interface Pin Usage Table.
19-36	DB17-DB0	H/L	IO	Parallel databus. Notice the descending order.
37	DEN	H/L	I	Display enable pin from controller. (RGB interface only.)
38	HSYNC	H/L	I	Line synchronization input. (RGB interface only.)
39	VSYNC	H/L	I	Frame/RAM write synchronization input. (RGB interface only.)

PIN	SIGNAL	LEVEL	DIRECTION	DESCRIPTION (Continued)
40	DCLK	H/L	I	Dot-clock signal and oscillator source. A non-stop external clock must be provided to that pin even at front or back porch non-display period.
41	NC			No Connection.
42-43	GND	L		Ground. Must be connected to an external ground.
44-45	V_{LOGIC}	H	I	Power supply input. Must be connected to an external source. **Note: Both pins must be connected.**
46	NC			No Connection.
47	K_2 (LED_2 -)	L		Supply pin for LED. "K" (cathode or kathode for German and original Greek spelling) or "-" of LED backlight.
48	A_2 (LED_2 +)	H		Supply pin for LED. "A" (anode) or "+" of LED backlight.
49	A_1 (LED_1 +)	H		Supply pin for LED. "A" (anode) or "+" of LED backlight.
50	K_1 (LED_1 -)	L		Supply pin for LED. "K" (cathode or kathode for German and original Greek spelling) or "-" of LED backlight.
For backlight connections, please refer to LED Backlight (Pg. 27).				

PHOTO REFERENCE FOR PIN FUNCTIONS

Note: Both V_{LOGIC} pins (44 and 45) must be connected.

(1) GND
(2) NC
(3) NC
(4) GND
(5) GND
(6) GND
(7) $\overline{RD}_{8080}(E_{6800})$
(8) SDO
(9) $\overline{RST}$
(10) $\overline{CS}$
(11) SCL
(12) SDI
(13) D/$\overline{C}$
(14) $\overline{WR}_{8080}(R/\overline{W}_{6800})$
(15) PS3
(16) PS2
(17) PS1
(18) PS0
(19) DB17
(20) DB16
(21) DB15
(22) DB14
(23) DB13
(24) DB12
(25) DB11
(26) DB10
(27) DB9
(28) DB8
(29) DB7
(30) DB6
(31) DB5
(32) DB4
(33) DB3
(34) DB2
(35) DB1
(36) DB0
(37) DEN
(38) HSYNC
(39) VSYNC
(40) DCLK
(41) NC
(42) GND
(43) GND
(44) V_{LOGIC}
(45) V_{LOGIC}
(46) NC
(47) K_2 (LED$_2$ -)
(48) A_2 (LED$_2$ +)
(49) A_1 (LED$_1$ +)
(50) K_1 (LED$_1$ -)
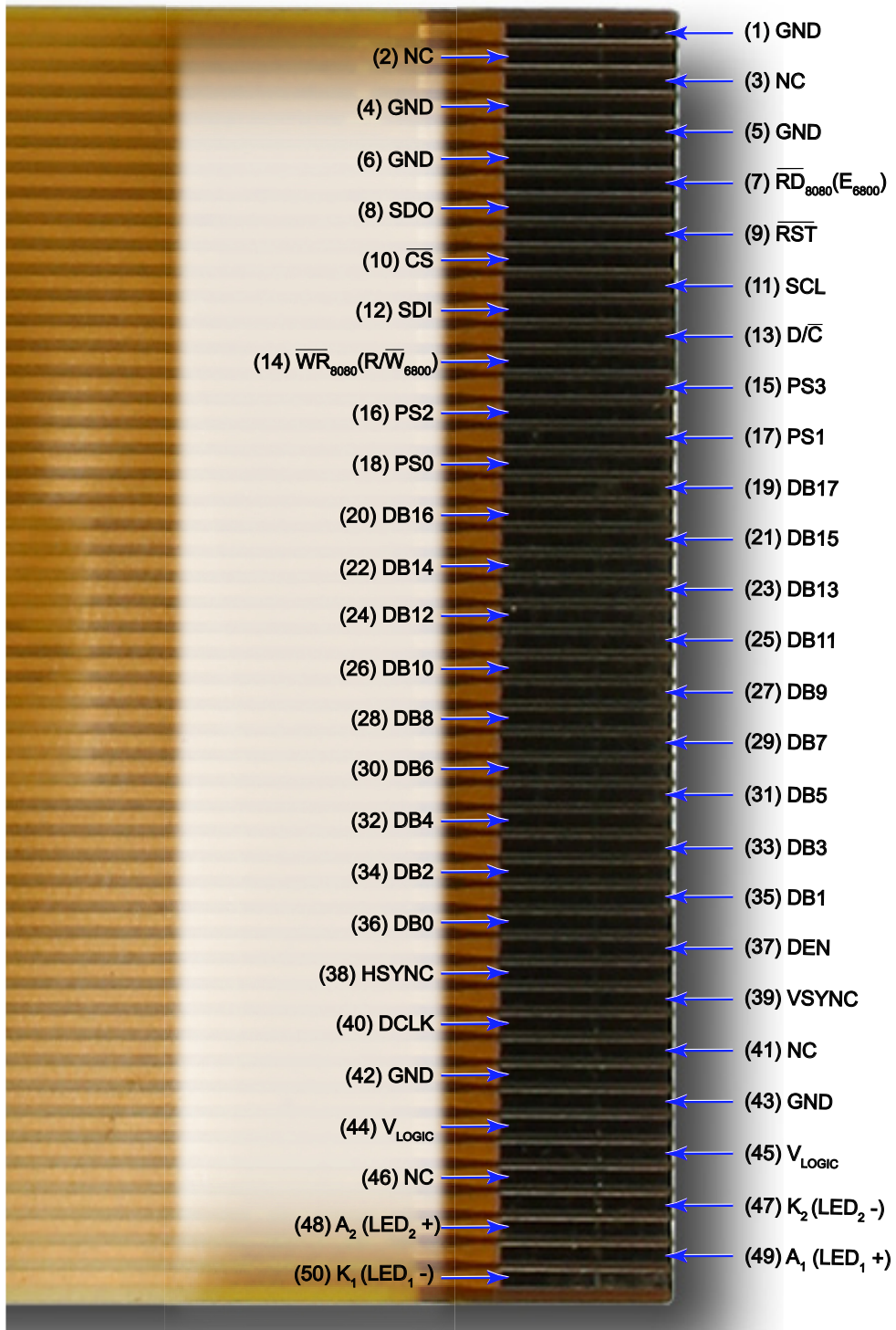
Figure 3. Back View of FFC (Pins Labeled)

INTERFACE PIN USAGE TABLE

Click here to view a full size PDF file of the table below.

CFAF320240F Series Connections
1v1

Label	Pin	6800 – 8 Bit	6800 – 9 Bit	6800 – 16 Bit	6800 – 18 bit	8080 – 8 Bit	8080 – 9 Bit	8080 -16 Bit	8080 – 18 Bit	SPI – 4 Wire	SPI – 3 Wire	RGB - 262K	RGB – 64K
Vss	1	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
NC	2	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect
NC	3	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect
Vss	4	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
Vss	5	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
Vss	6	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
RD	7	Enable	Enable	Enable	Enable	Read Strobe	Read Strobe	Read Strobe	Read Strobe	Ground	Ground	Ground	Ground
SDO	8	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect
Reset	9	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset	Chip Reset
CS	10	Chip Select	Chip Select	Chip Select	Chip Select	Chip Select	Chip Select	Chip Select	Chip Select	Serial Chip Select	Serial Chip Select	Serial Chip Select	Serial Chip Select
SCL	11	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	Serial Clock Input	Serial Clock Input	Serial Clock Input	Serial Clock Input
SDA	12	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	Data Input	Data Input	Data Input	Data Input
RS	13	Data / Command	Data / Command	Data / Command	Data / Command	Data / Command	Data / Command	Data / Command	Data / Command	Serial Data / Command	No Connect	No Connect	No Connect
RW	14	Read / Write	Read / Write	Read / Write	Read / Write	Write / Read	Write / Read	Write / Read	Write / Read	No Connect	No Connect	Ground	Ground
PS3	15	0	1	0	1	0	1	0	1	1	1	0	0
PS2	16	0	0	0	0	0	0	0	0	1	1	1	1
PS1	17	0	0	0	0	1	1	1	1	1	1	1	0
PS0	18	1	1	0	0	1	1	1	0	1	1	0	1
DB17	19	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	RR5	RR4
DB16	20	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	RR4	RR3
DB15	21	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	RR3	RR2
DB14	22	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	RR2	RR1
DB13	23	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	RR1	RR0
DB12	24	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	RR0	GG5
DB11	25	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	GG5	GG4
DB10	26	x	x	x	x	x	x	x	x	NC or Gnd	NC or Gnd	GG4	GG3
DB9	27	NC or Gnd	x	NC or Gnd	x	NC or Gnd	x	NC or Gnd	x	NC or Gnd	NC or Gnd	GG3	NC or Gnd
DB8	28	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	GG2	GG2
DB7	29	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	GG1	GG1
DB6	30	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	GG0	GG0
DB5	31	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	BB5	BB4
DB4	32	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	BB4	BB3
DB3	33	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	BB3	BB2
DB2	34	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	BB2	BB1
DB1	35	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	x	x	NC or Gnd	NC or Gnd	BB1	BB0
DB0	36	NC or Gnd	NC or Gnd	NC or Gnd	x	NC or Gnd	NC or Gnd	NC or Gnd	x	NC or Gnd	NC or Gnd	BB0	NC or Gnd
DEN	37	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Data Enable	Data Enable
HSYNC	38	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Line Sync	Line Sync
VSYNC	39	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Frame / RAM Sync	Frame / RAM Sync
DCLK	40	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Dot Clock	Dot Clock
NC	41	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect
Vss	42	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
Vss	43	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground	Ground
Vcc	44	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v
Vcc	45	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v	+3v
NC	46	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect	No Connect
K2	47	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -
A2	48	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +
A1	49	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +	Backlight +
K1	50	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -	Backlight -
Label	Pin	6800 – 8 Bit	6800 – 9 Bit	6800 – 16 Bit	6800 – 18 bit	8080 – 8 Bit	8080 – 9 Bit	8080 -16 Bit	8080 – 18 Bit	SPI – 4 Wire	SPI – 3 Wire	RGB – 262K	RGB – 64K

ADDITIONAL INFORMATION ON INTERFACE TYPES

❑ I want to display video. Which interface is faster, SPI or parallel?

The SPI interface is a clocked interface. Each command or data bit is clocked. With the 18-bit parallel interface, you are able to pass 18 bits of command or data at a time. Using the same controller at the same clock speed, the parallel interface will always be faster.

❑ What if I need RS-232 serial interface?

Three-wire or four-wire SPI interface is not RS-232 but does not require the control lines that the 8-, 9-, of 16-bit interfaces do.

❑ Using the 8-bit 8080 interface, what should be done with pins DB9-DB0 (pins 27-36)? Tie them to ground, pull them up, or let them float?

Leave unused pins floating.

ABOUT THE CFAF320240F-035T-TS TOUCH SCREEN

For touch screen pins, see page 5 of the Module Outline Drawings (Pg. 12).

The touch screen must be driven in one direction, then read in the other direction.
❑ TI (Texas Instruments) makes a low-level part that has the drivers and ADC built into one part. See hyperlinks under "Additional Information" on the following page.
❑ Some microcontrollers have analog inputs that may work directly. TSHARC (www.tsharc.com) makes a high-level controller from a pre-programmed PIC microcontroller.
❑ Microchip has some high level touch screen support available. See www.microchip.com/en_us/technology/mtouch.

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".

Additional Information

❑ A comparison of three types of touch screens: www.howstuffworks.com/question716.htm.
❑ An introductory explanation of how four-wire resistive touch screens work: www.elotouch.com/Technologies/AT4/howitworks.asp.
❑ Information on the structure of a resistive touch screen: www.dmccoltd.com/english/tecnical/logs/tec20041126_a.asp.
❑ IDT clock/timing devices: www.idt.com/?catID=18690836&source=ICSTcom.
❑ Texas Instruments ADS7843 and TSC2003 4-wire touch screen controllers: http://focus.ti.com/docs/prod/folders/print/ads7843.html and http://focus.ti.com/docs/prod/folders/print/tsc2003.html.

ESD (ELECTRO-STATIC DISCHARGE)

The 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.

OPTICAL SPECIFICATIONS

OPTICAL CHARACTERISTICS

Ambient Temperature (Ta) = 25°C, Maximum 75% Relative Humidity					
ITEM	**SYMBOL**	**ADDITIONAL TEST CONDITIONS**	**MINIMUM**	**TYPICAL**	**MAXIMUM**
Color Depth				262K	
Transmittance	T	with polarizer	5.7%	6.76%	
Contrast Ratio (CR)[1]			320	400	
TFT Response Time[2]	Tr			8 ms	12 ms
	Tf			17 ms	23 ms
Red Chromaticity	x		0.627 ms	0.647 ms	0.667 ms
	y		0.316 ms	0.336 ms	0.356 ms
Green Chromaticity	x	$\theta = \varphi - 0°$	0.116 ms	0.136 ms	0.156 ms
	y		0.556 ms	0.576 ms	0.596 ms
Blue Chromaticity	x		0.116 ms	0.136 ms	0.156 ms
	y		0.109 ms	0.129 ms	0.149 ms
White Chromaticity	x		0.285 ms	0.305 ms	0.325 ms
	y		0.314 ms	0.334 ms	0.354 ms
Viewing Direction (O'Clock)				6:00	

[1]Contrast Ratio = (brightness with pixels light)/(brightness with pixels dark).

[2]Response Time is 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 RESPONSE TIME (TR, TF)
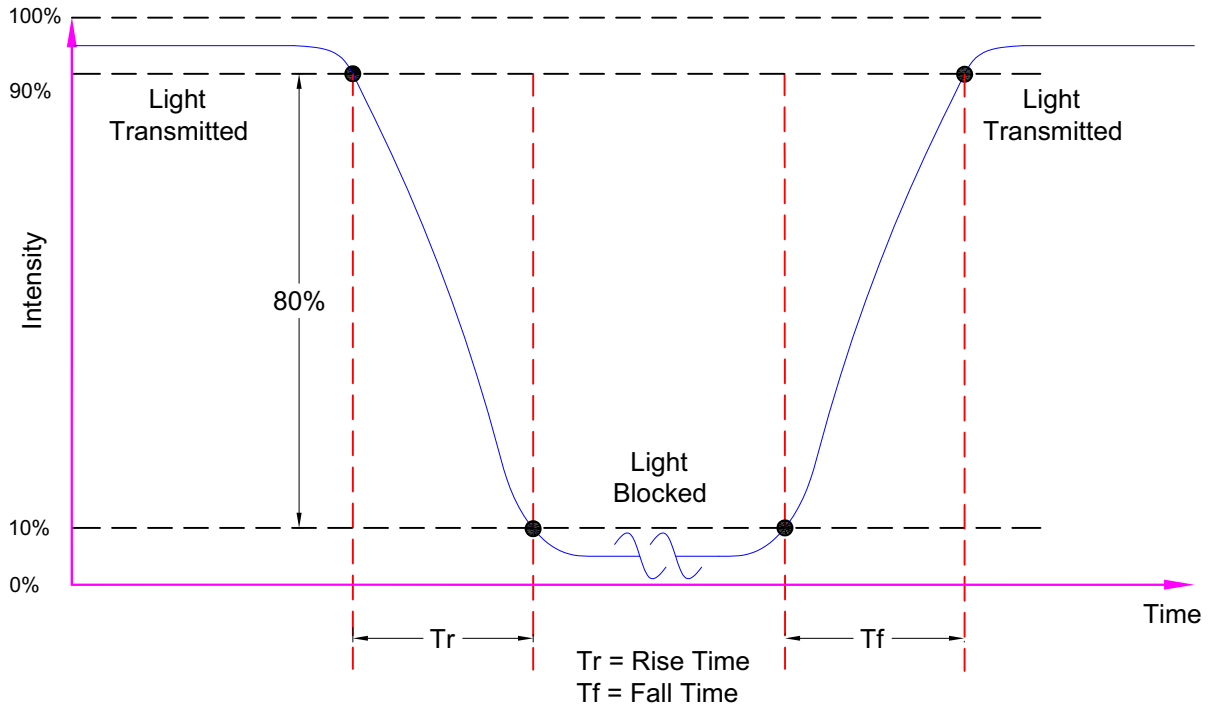
Figure 4. Definition of Response Time (Tr, Tf)

DEFINITION OF VERTICAL AND HORIZONTAL VIEWING ANGLES (CR≥2)
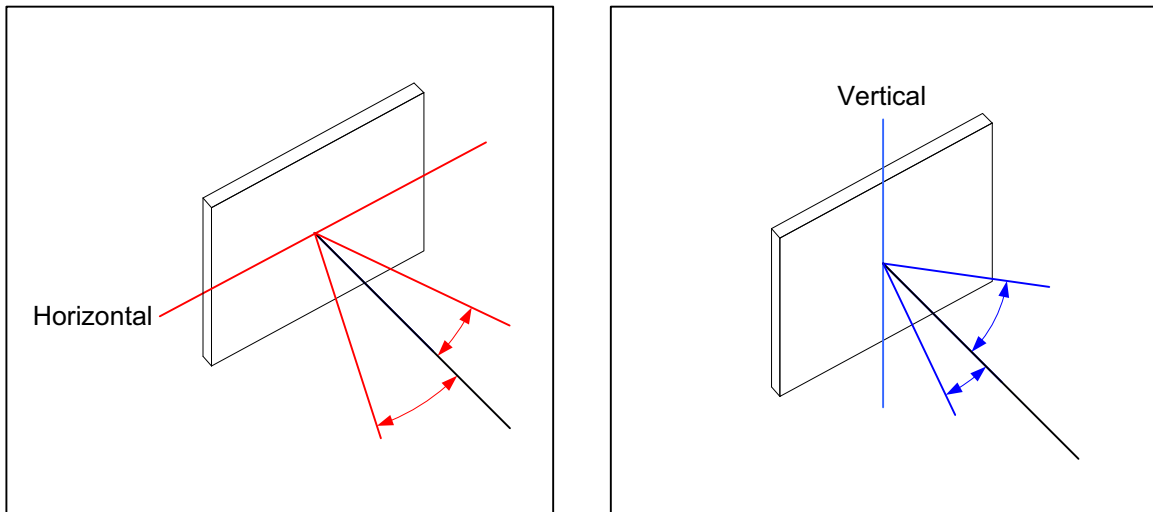
Figure 5. Definition of Horizontal and Vertical Viewing Angles (CR>2)

DEFINITION OF 6 O'CLOCK AND 12:00 O'CLOCK VIEWING ANGLES

This module has a 6:00 o'clock viewing angle. A 6:00 o'clock viewing angle is a bottom viewing angle like what you would see when you look at a cell phone or calculator. A 12:00 o'clock viewing angle is a top viewing angle like what you would see when you look at the gauges in a golf cart or airplane.
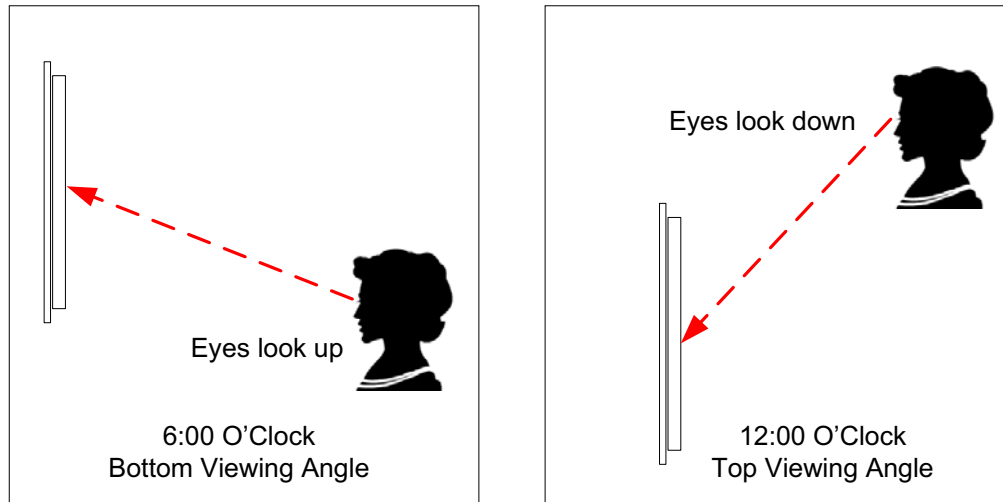
Figure 6. Definition of 6:00 O'Clock and 12:00 O'Clock Viewing Angles

LED BACKLIGHT

These TFT display modules use an LED backlight. LED backlights are easy to use, but they are also easily damaged by abuse.

> 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.

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.

"Always On" Backlight Connections

Backlight V_{LED} = +9.6v, 12.5mA per side

V_{LED} = Forward Voltage

A_1 (LED +) A_2 (LED +)

LED Backlight

K_1 (LED -) K_2 (LED -)

R_{LIMIT1} R_{LIMIT2}

GND
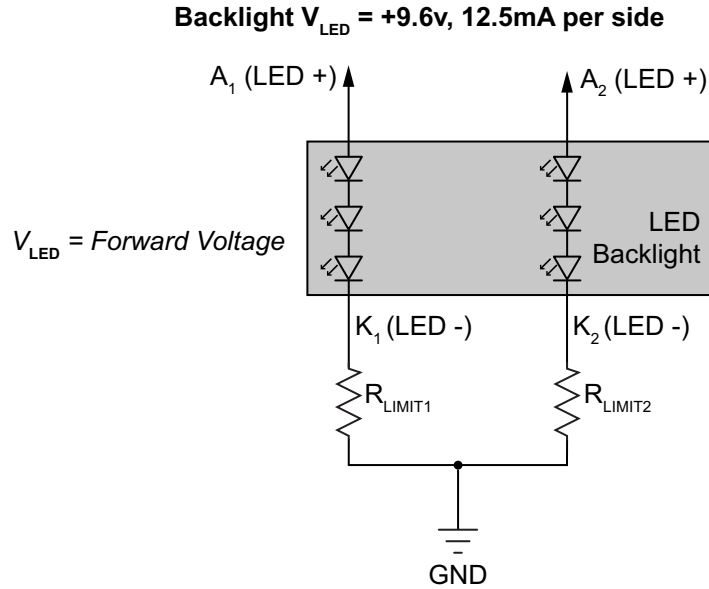
Figure 7. Typical LED Backlight Connections For "Always On"

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.

Backlight V_{LED} = +9.6v, 12.5mA per side

V_{LED} = Forward Voltage

A_1 (LED +) A_2 (LED +)

LED Backlight

K_1 (LED -) K_2 (LED -)

R_{LIMIT1} R_{LIMIT2}

PWM signal from microcontroller   IRLML2502 (typical)

GND
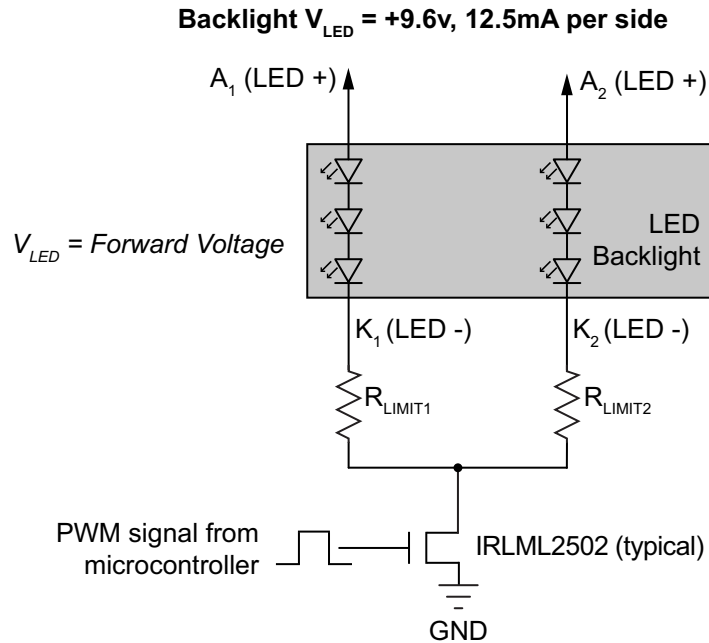
Figure 8. Example of LED Backlight Connections For PWM Dimming

Backlight Characteristics

Ambient temperature: $T_A = 25°C$			
Backlight Characteristics *White edge-lit with two parallel rows of LEDs, three LEDs in each row, six total LEDs.* *White LED backlight displays light pixels on a dark colored area (any color combination) or invert for dark colored pixels (any color combination) on a light area.*			
PARAMETER	**MINIMUM**	**TYPICAL**	**MAXIMUM**
Forward Current (I_{LED})	10mA per row 10mA x 2 rows = 20mA	12.5mA per row 12.5mA x 2 rows = 25mA	20mA per row 20mA x 2 rows = 40mA
Driving the backlight above 25mA will shorten its lifetime.			
Forward Voltage (V_{LED})	+8.4v	+9.6v	+10.2v
Luminous Intensity* (I_V) $I_{LED} = 25mA$	*CFAF320240F-035T*: 175 cd/m^2 *CFAF320240F-035T-TS*: 115 cd/m^2	*CFAF320240F-035T*: 200 cd/m^2 *CFAF320240F-035T-TS*: 150 cd/m^2	*CFAF320240F-035T*: 225 cd/m^2 *CFAF320240F-035T-TS*: 185 cd/m^2
CFAF320240F-035T: The backlight is measured through the TFT. Direct backlight measurement is significantly brighter. *CFAF320240F-035T-TS:* The backlight is measured through the TFT and touch screen.			
Reverse Voltage (VR)			15v
Wavelength ($I \lambda$) $I_{LED} = 25mA$	x=0.25 y=0.25		x=0.29 y=0.29
Uniformity (minimum/maximum x 100%)	80%		

How to Use Current Feedback LED Driver

The maximum forward voltage is +9.6v. For lifetime reliability, we do not recommend pushing more than the 12.5 mA through the LEDs.

If you have only +3.3v available and need to step up the power supply for the LED backlight, use a current feedback LED driver such as the Fairchild Semiconductor FAN5333 (www.fairchildsemi.com/pf/FA/FAN5333B.html). One source for the FAN5333 is here: http://search.digikey.com/scripts/DkSearch/dksus.dll?Cat=2556628&k=FAN5333. The FAN5333 is good to +30v. Many similar drivers are available. By using a driver, you do not need a current limiting resistor. Here is the example circuit from the FAN5333 datasheet:
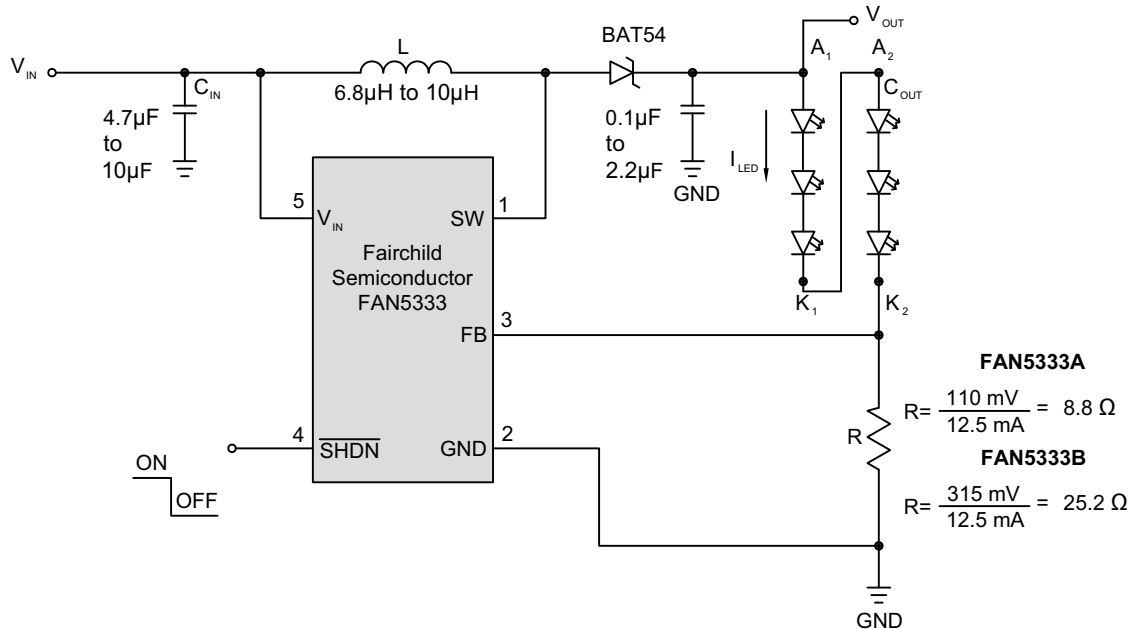
Figure 9. Circuit Example Using Feedback LED Driver

SOURCES FOR DRIVER LIBRARIES AND SAMPLE CODE

SOURCES FOR DRIVER LIBRARIES

Graphic LCD driver libraries may save you a lot of time and help you develop a more professional product. Possible library sources are easyGUI, en.radzio.dxp.pl, RAMTEX, and Segger emWin.

SOURCE FOR SAMPLE CODE

Free downloadable sample code is on our website under the CFAF320240F-035T or CFAF320240F-035T-TS DATASHEETS & FILES tabs.

MODULE RELIABILITY AND LONGEVITY

RELIABILITY TEST RESULTS

RELIABILITY TEST RESULTS			
TEST	CONDITION	SAMPLE SIZE	TEST RESULT
Low Temperature	-20°C, 96 Hours	3 displays	Pass
Thermal Humidity	70°C, 90% RH, 96 Hours		Pass
Temperature Cycle On/Off	-20°C, 70°C, On/Off, 20 Cycles On cycle: >10 seconds Off cycle: <10 seconds		Pass
High Temperature Storage	80°C, 96 Hours		Pass
Low Temperature Storage	-30°C, 96 Hours		Pass
ESD	150pF, 330Ω, ±6KV(Contact)/± 8KV(Air), 5 points/panel, 10 times/point		Pass
Thermal Shock Resistance	See test description.	3 displays	Pass

One test cycle is:
1. Test Low for 30 minutes.
2. Normal temperature for 5 minutes.
3. Test High for 30 minutes.
4. Normal temperature for 5 minutes.
5. Take out and dry at Normal temperature and allow to stand for 24 hours.

Repeat these steps for a total of 5 cycles.

MODULE RELIABILITY

PART NUMBER	SPECIFICATION*
CFAF320240F-035T CFAF320240F-035T-TS	10,000 hours >50% of Initial Brightness (New Module)
*Under operating and storage temperature specification limitations, humidity RH 45+20%, and no exposure to direct sunlight.	

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.*

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 preplan 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 Data Sheet specifications and tolerances of the discontinued module, changes may require modification to your circuit and/or firmware. Possible changes include:

- *Controller/Driver.* A new controller/driver 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.
- *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 webpage as soon as possible. If interested, you can subscribe to future part change notifications.

CARE AND HANDLING PRECAUTIONS

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

ESD (ELECTRO-STATIC DISCHARGE)

The 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.

DESIGN AND MOUNTING

● The integrated Solomon Systech SSD2119 driver maintains its internal registers until something happens to change it (host sends a command, etc.). Excessive external noise (EMI, RFI) can change these internal registers. In your application and system design, suppress or prevent the noise from influencing the driver and your product. One method of mitigating this problem is to periodically re-initialize the driver to help prevent the effects of unanticipated noise.

● *CFAF320240F-035T:*

■ 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 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 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 module, leaving a small gap between the plate and the display surface. We use GE HP-92 Lexan, which is readily available and works well.

● *CFAF320240F-035T-TS*:

■ To protect the touch screen from damage, CFAF320240F-035T-TS ships with a protective film over the touch screen. Please peel off the protective film slowly. Peeling off the protective film abruptly may generate static electricity.

■ The touch screen is made out of plastic and can be scratched or damaged. Please handle carefully.

■ To avoid damage, your bezel must be smooth where it touches the touch screen. Your bezel should not apply undue force to the touch screen.

■ To avoid shorting, your mounting bezel should be at least 3 mm from the Active Area of the touch screen.

● Do not disassemble or modify the module.

● Do not modify the tab of the metal holder or make connections to it.

● Do not reverse polarity to the power supply connections. Reversing polarity will immediately ruin the module.

● Use care to keep the exposed terminals clean. Contamination, including fingerprints, may make soldering difficult and the reliability of the soldered connection poor.

- Sharp bends can damage the module and touch screen FFCs (Flat Flex Cables). Do not crease FFC. Do not bend FFC tightly against the edge of the TFT panel. Do not repeatedly bend the FFC beyond its elastic region. Limit bend radius to at least R5.00 mm.

R5.00 mm Maximum
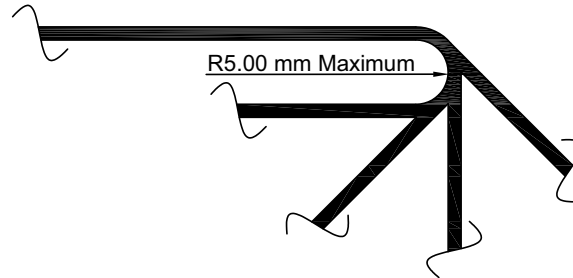
Figure 10. Limit Bend Radius of FFC

- Excessive over-bending and/or creasing of the FFC can also cause stress to the bonding between the glass and the FFC. This causes displays problems such as distortion and partial display.

AVOID 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.

IF TFT PANEL BREAKS

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 touch screen or polarizer over time. Never apply liquids directly on the touch screen or 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 touch screen or 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 module to a PC's parallel port as an "end product." This 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 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 module from ESD and power supply transients.
- Observe the operating temperature limitations: from -20°C minimum to +70°C maximum with minimal fluctuations. Operation outside of these limits may shorten the life and/or harm the display.
- 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 strong ultraviolet radiation.
- Observe the storage temperature limitations: from -30°C minimum to +80°C maximum with minimal fluctuations. Rapid temperature changes can cause moisture to form, resulting in permanent damage.
- Maximum storage life is 10 years within storage temperature limitations and normal humidity.
- Do not allow weight to be placed on the modules while they are in storage.
- Please recycle your outdated Crystalfontz modules at an approved facility.

APPENDIX A: QUALITY ASSURANCE STANDARDS

INSPECTION CONDITIONS

- Environment
  - Temperature: 25±5°C
  - Humidity: 30~85% RH (noncondensing)
- 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 ACTIVE AREA AND VIEWING AREA

CFAF320240F-035T:
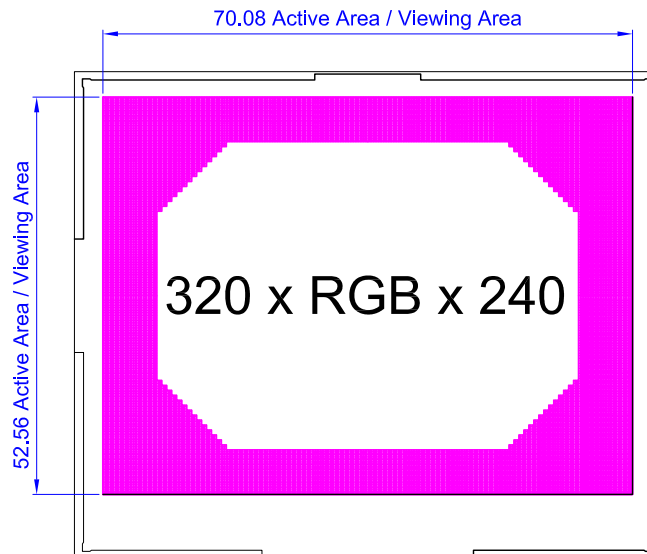
CFAF320240F-035T-TS:
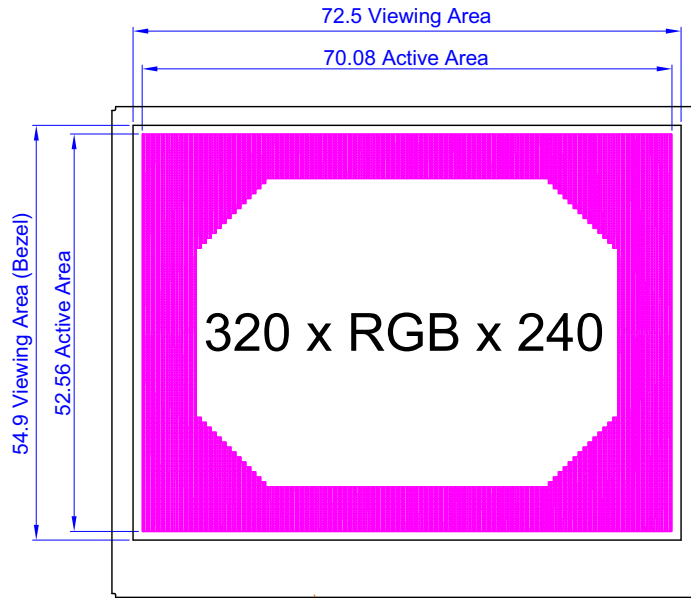
ACCEPTANCE SAMPLING

Defect Type	AQL*
Major	≤.65%
Minor	<1.0%
* Acceptable Quality Level: maximum allowable error rate or variation from standard	
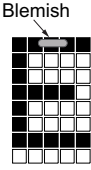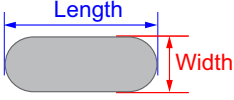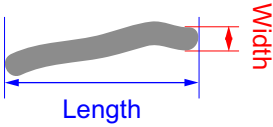
DEFECTS CLASSIFICATION

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	Blemish	*Defect Size (mm)*	*Acceptable Qty*	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 Length Width	*Defect Size (mm)*	*Acceptable Qty*	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 Width Length	*Defect Width (mm)*	*Defect Length (mm)*	*Acceptable Qty*	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	*Defect Size (mm)*	*Acceptable Qty*		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	 | *Dot Size (mm)*	*Acceptable Qty* | |---|---| | ((A+B)/2)≤0.2 | | | C>0 | ≤3 total defects | | ((D+E)/2)≤0.25 | ≤2 pinholes per digit | | ((F+G)/2)≤0.25 | |	Minor
9	Backlight defects	1. Light fails or flickers.* 2. Color and luminance do not correspond to specifications.* 3. Exceeds standards for display's blemishes or foreign matter (see test 5, Pg. 38), and dark lines or scratches (see test 6, Pg. 38). *Minor if display functions correctly. Major if the display fails.*	Minor
10	COB defects	1. Pinholes >0.2 mm. 2. Seal surface has pinholes through to the IC. 3. More than 3 locations of sealant beyond 2 mm of the sealed areas.	Minor
11	PCB defects	1. Oxidation or contamination on connectors.* 2. Wrong parts, missing parts, or parts not in specification.* 3. Jumpers set incorrectly. 4. Solder (if any) on bezel, LED pad, zebra pad, or screw hole pad is not smooth. *Minor if display functions correctly. Major if the display fails.*	Minor
12	Soldering defects	1. Unmelted solder paste. 2. Cold solder joints, missing solder connections, or oxidation.* 3. Solder bridges causing short circuits.* 4. Solder balls. *Minor if display functions correctly. Major if the display fails.*	Minor

APPENDIX B: TFT MODULE TERMS AND SYMBOLS

Symbol	Description
A (LED +)	Supply pin for LED. "A" (anode) or "+" of LED backlight. If more than one, may be labeled as A_1, A_2, ...
cd/m^2 lumen	Candela per square meter. A unit of measurement used to measure Luminous Intensity. cd/m^2 = 1 lumen
$\overline{CS}$ CS#	Chip select input. *Low:* Controller chip is selected. Communications with host are possible. *High:* 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 A0 CD D/C#	Data/Command control. Determines whether data bits are data or command. *1 – High:* Addresses the data register. *0 – Low:* Addresses the command register.
DCLK	Dot-clock signal and oscillator source. A non-stop external clock must be provided to that pin even at front or back porch non-display period. RGB interface only.
DEN	Display enable pin from controller. RGB interface only.
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.
FFC	Flat Flexible Cable. Also called "flex tail" or "pigtail". Typically thinner than the "flex" film of COG (Chip On Glass).
FPC	Flexible Printed Circuit. Also called "flex tail" or "pigtail". Typically much thicker than the "flex" film of COF (Chip On Flex).
GND V$_{SS}$	Power supply and signal ground. Must be connected to an external ground.
HSYNC	Line synchronization input. RGB interface only.
I$_{DD}$	Typical power supply current for LCD. Total electrical current (I) in the Drains of a CMOS circuit.
I$_{LED}$	Current used by LED backlight.
IMn	Interface mode select pin. (Where n is the corresponding number.)
I$_{OP}$	Current for normal Operation, typically measured in milliamperes (mA). 1 mA = 0.001A (Ampere)
I$_{ST}$	Current for STandby mode, typically measured in microampere (µA). 1 µA = 0.000,001A (Ampere)

Symbol	Description (Continued)
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_1, K_2, ...
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	Make no connection.
PSn-PS0	(see table below)

PS3	PS2	PS1	PS0	Interface Mode
0	0	0	0	16-bit 6800 parallel interface. (if available)
0	0	0	1	8-bit 6800 parallel interface. (if available)
0	0	1	0	16-bit 8080 parallel interface.
. . . .				
0	0	1	1	8-bit 8080 parallel interface. (if available)

Symbol	Description (Continued)
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.
$\overline{RD}_{8080}$ (E_{6800}) $\overline{RD}$ (E) E ($\overline{RD}$) E	Host interface input. *8080 Host:* Active low. Signal on the databus is latched at the rising edge of $\overline{RD}$. *6800 Host (if available):* Enable control signal input active high. E = *High:* Read or Write operation is active E = *Low:* No operation
RGB	Typically used to indicate that Red, Green, and Blue are combined to produce a broad array of colors.
RoHS	Restriction of Hazardous Substances Directive, an environmental standard.
$\overline{RST}$ $\overline{RES}$ RST# RES RESET#	Reset signal. *Low:* Display controller is reset. The $\overline{RST}$ pin should be pulsed low shortly after power is applied. *High:* The $\overline{RST}$ pin should be brought high for normal operation.
SCL	Serial clock input.
SDO MISO	Data output pin in serial interface. (Serial Data Out)

Symbol	Description (Continued)
SI SDI MOSI	Data input pin in serial interface. (Serial Data In)
Ta TA	"Ambient temperature" is the temperature of the air that surrounds a component.
Tf	Unit of measurement for LCD response time. f = falling edge. See Definition of Response Time (Tr, Tf) (Pg. 26).
TFT	Thin-Film Transistor fabricated directly on the display substrate.
T_{OP}	Operating temperature.
Tr	Unit of measurement for LCD response time. r = rising edge. See Definition of Response Time (Tr, Tf) (Pg. 26).
T_{ST} T_{STG}	Storage temperature.
V_{IH} V_{ICH}	High level input voltage.
V_{IL} V_{LCH}	Low level input voltage.
V_{LED}	Forward voltage for LED backlight.
V_{LOGIC} V_{CC} V_{DD} V_{CI}	Power supply input. Must be connected to an external source.
$V_{LOGIC\ I/O}$ V_{CCIO}	Supply voltage for I/O signals.
V_{OH} V_{OHC}	High level output voltage.
V_{OL} V_{OLC}	Low level output voltage.
VSYNC	Frame/RAM write synchronization input. RGB Interface only.

$\overline{WR}_{8080}$ ($R/\overline{W}_{6800}$)
$R/\overline{W}$ ($\overline{WR}$)
$\overline{WR}$ (R/W)
R/W#
	Host interface input.
	
	8080 Host: Active low. Signal on the databus is latched at the rising edge of $\overline{WR}$ signal.
	
	6800 Host (if available): Read/Write control signal output.
	    R/$\overline{W}$ = High: Read (Host←Module)
	    R/$\overline{W}$ = Low: Write (Host→Module)

APPENDIX C: SOLOMON SYSTECH SSD2119 RGB INTERFACE

Solomon Systech SSD2119 *RGB INTERFACE,* 2009, (4 pages) follows.

SSD2119

RGB Interface

SOLOMON
SYSTECH

RGB Interface

SSD2119 supports RGB interface. RGB interface unit consists of D[17:0], HSYNC, VSYNC, DOTCLK and OE signals for display moving pictures. When the RGB interface is selected, the display operation is synchronized with external control signals (HSYNC, VSYNC and DOTCLK). Data is written in synchronization with the control signals when DEN is enabled for write operation in order to avoid flicker or tearing effect while updating display data.

Mode Selection Pins

Name	Type	Connect to	Function	Description					When not in use
				PS3	PS2	PS1	PS0	Interface Mode	
PS[3:0]	I	V_{DDIO} or V_{SS}	Interface Selection	0	1	0	0	9-bit generic D[8:0] (262k colour) + 3-wire SPI If 65K color, D3 shorts to D8 internally	-
				0	1	0	1	16-bit generic (262k colour) + 3-wire SPI	
				0	1	1	0	18-bit generic (262k colour) + 3-wire SPI	
				0	1	1	1	6-bit generic D[8:3] (262k colour) + 3-wire SPI	

SSD2119 init Code for RGB

Comment	Data[7:4]	Data[3:0]	Description
28	00	06	
00	00	01	Turn Oscillator On
01	30	EF	
02	06	00	
11	46	70	DFM[1:0] : 262k Color Mode DenMode = 0 : RGB interface controlled by HSYNC, VSYNC pin and HBP, VBP WMode = 1 : Write RAM from Generic RGB data (POR, if PS:00xx) Nosync=1 : Dmode change immediately Dmode=0 : Display engine will be clocked by DOTCLK pin and onchip oscillator will be off (POR, if PS:00xx)
10	00	00	
07	00	33	
0C	00	05	
30	0	0	
31	3	2	
32	4	7	
33	3	3	
34	0	0	
35	6	3	Gamma Setting
36	7	7	
37	6	0	
3A	10	0	
3B	10	3	
0D	0	0d	
0E	31	0	
15	0	58	

All Solomon Systech Products complied with six (6) hazardous substances limitation requirement per European Union (EU) "Restriction of Hazardous Substance (RoHS) Directive (2002/95/EC)" and China standard "电子信息产品污染控制标识要求 (SJ/T11364-2006)" with control Marking Symbol . Hazardous Substances test report is available upon requested.

http://www.solomon-systech.com