TFT DISPLAY MODULE DATA SHEET

Datasheet Release 2015-09-21 for
CFAF240320A-032T-TS and CFAF240320A-032T

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Datasheet Revision History

CFAF240320A-032T and CFAF240320A-032T-TS Datasheet Release: 2015-09-21
In section LED BACKLIGHT CHARACTERISTICS (Pg. 28), corrected from
"The backlight is edge-lit with 4 white LEDs in **parallel**."
to
"The backlight is edge-lit with 4 white LEDs in **series**."
and corrected from
"Forward Current ($I_{LED)}$ **= 80 mA"**
to
"Forward Current ($I_{LED)}$ **= 20 mA"**

CFAF240320A-032T and CFAF240320A-032T-TS Data Sheet Release 2015-03-13

- Combined the CFAF240320A-032T preliminary data sheet published 2012-05-04 and the CFAF240320A-032T-TS data sheet published 2015-01-23 into this one updated data sheet.
- Expanded information to match current data sheet standards.
- Minor corrections to ELECTRICAL SPECIFICATIONS.

Data Sheet Release 2015-01-23 for CFAF240320A-032T only:

- Removed "Preliminary" watermark on Data Sheet.
- On this page, notices About Variations and About Volatility were added.
- Display module weight is added to Mechanical Specifications (Pg. 7) (23 grams).
- See important note added at the bottom of Display Module Outline Drawing (Pg. 8). This drawing shows the TFT with the touch screen (CFAF240320A-032T-TS). Except for the "TP" dimensions and the overall depth, all other dimensions are identical. The depth for CFAF240320-032T listed in the preliminary Data Sheet under Mechanical Specifications (Pg. 7) was correct and has not changed.
- Operating and storage temperature range was corrected in Absolute Maximum Ratings (Pg. 10). The temperature range now matches what was previously stated in Physical Characteristics (Pg. 6).
- In Details Of Interface Pin Functions (Pg. 12), changed touch panel (touch screen) pins to NC (No Connect.) The CFAF240320A-032T has no touch screen. However, we do sell a touch screen version of this TFT module CFAF240320A-032T-TS.
- In addition to Reliability Test Results, additional information was added in new section RELIABILITY AND LONGEVITY (Pg. 20). Box drop test results was removed.
- Text for cautions and handling precautions was rewritten in new section CARE AND HANDLING PRECAUTIONS (Pg. 22).

Preliminary Data Sheet Release: 2012-04-25
New product.

Hardware Updates

To see update notices, check the Product Notices tab on the product page. Product pages without a tab do not have product notices.

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

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.

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All specifications in Data Sheets and on our website are, to the best of our knowledge, accurate but not guaranteed. Corrections to specifications are made as any inaccuracies are discovered.

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CONTENTS

MAIN FEATURES

- These display modules have a full color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching device.
- The 240 x RGB x 320 (262K) display modules are composed of a transmissive TFT an integrated driver IC, an FFC/FPC flexible cable, and a white LED backlight unit.
  - The *CFAF240320A-032T-TS* has a 4-wire analog resistive touch screen.
  - The *CFAF240320A-032T* does not have a touch screen.
- Active Area for both display modules is 3.2" diagonal, 48.60 (W) x 64.80 (H) millimeters (1.91" (W) x 2.55" (H)).
- Host interface choices:
  - 8-bit, 9-bit 8-bit, 16-bit, 18-bit parallel
  - 3 wire & 4 wire SPI
  - DOT-CLK interface / Generic RGB
- Requires only a single source 3.3v for both power supply and logic.
- For interface information and other details on the integrated ILITEK ILI9325 or compatible driver, see controller data-sheets on our website.
- The display module's 45-pin FFC/FPC flexible cable mates with standard 0.5 mm ZIF sockets such as 609-1196-1-ND available from Digi-Key.
- Transmissive display with edge-lit LED backlight (4 white LEDs). The white LED backlight has anode (A,+) and cathode (K -) pins brought out on a separate flexible tail.
- 9:00 o'clock viewing angle (polarizer viewing direction). Use in portrait or landscape orientation.
- Temperature operation range is from -20°C to +70°C.
- To get you started, free downloadable sample code is under the DATASHEETS & FILES tab on the display module's website page.
- RoHS compliant. Crystalfontz America and factory are ISO certified.
- To make prototyping quick and easy, we offer these display modules mounted on carrier boards (CFAF240320A-032T-CB and CFAF240320A-032T-TS-CB.The carrier boards support a current driver for the LED backlight of the display.

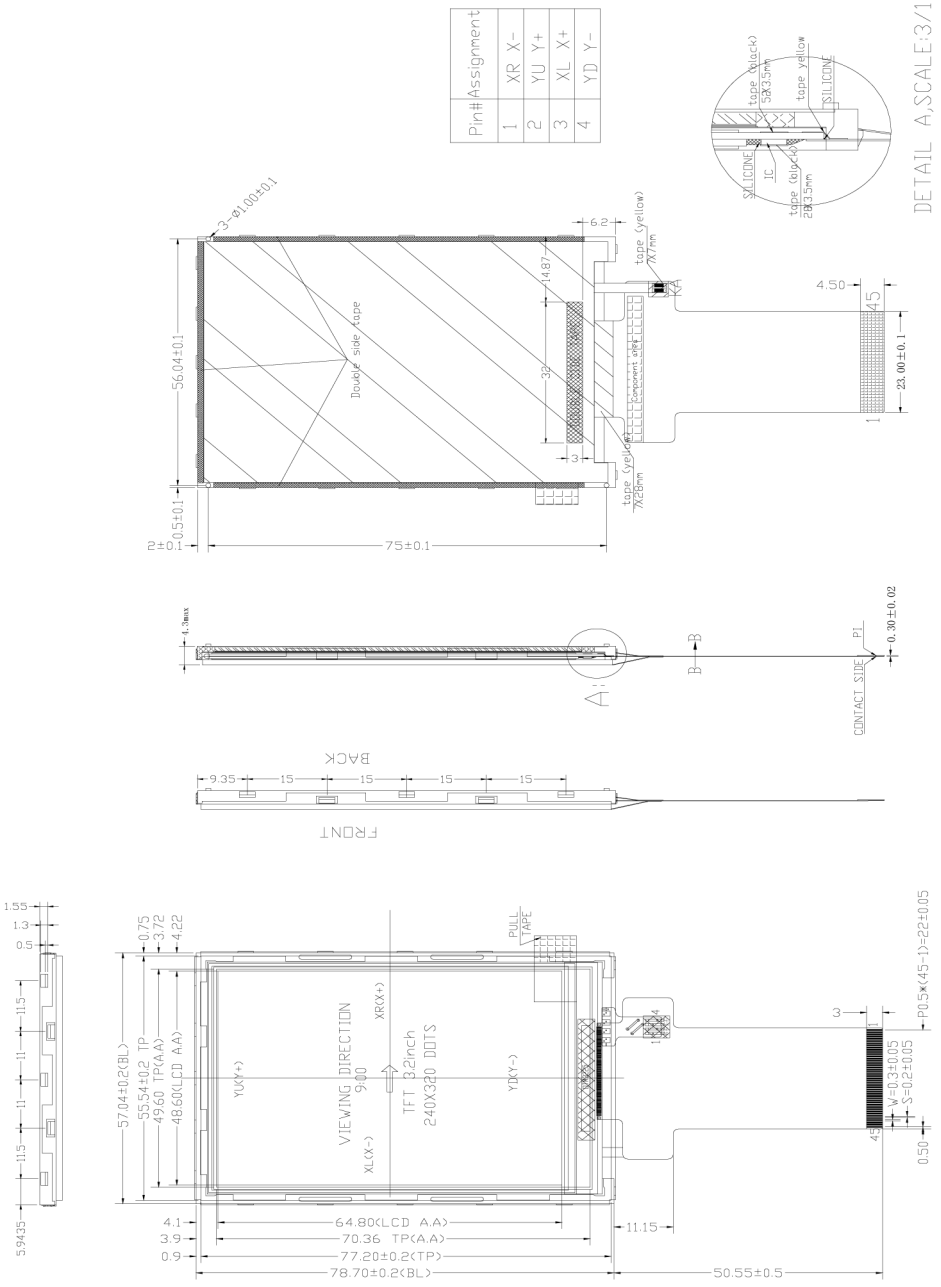
MECHANICAL SPECIFICATIONS

PHYSICAL CHARACTERISTICS

ITEM	SPECIFICATION
Active Area	
Active Area Diagonal	Inches: 3.2"
Active Area Width	Millimeters: 48.60 (W) mm Inches: 1.91" (W)
Active Area Height	Millimeters:64.80 (H) mm Inches: 2.55" (H)
Viewing Area	*CFAF240320A-032T:* Millimeters: 50.60 (W) x 66.80 (H) mm Inches: 1.99" (W) x 2.62" (H) *CFAF240320A-032T-TS* Touch Screen Viewing Area is same as Active Area.
Display Modules Outline Dimensions	
Overall Modules Width	Millimeters: 57.04 (W) mm Inches: 2.25" (W) mm
Overall Module Height With FFC/FPC Flexible Tails Unfolded*	Millimeters: 129.25 (H) mm Inches: 5.19" (H) mm
Overall Module Height Without FFC/FPC Flexible Tails	Millimeters: 78.70 (H) mm Inches: 3.09" (H) mm
**For reference only. Shape and length of tail may vary.*	
Module Depth	*CFAF240320A-032T:* Millimeters: 3.10 (D) mm Inches: 0.12" (D) *CFAF240320A-032T-TS:* Millimeters: 4.3 (D) mm Inches: 0.17" (D)
Weight	*CFAF240320A-032T* 23 grams *CFAF240320A-032T-TS:* 33 grams
FFC/FPC Flexible Tail	
FPC/FFC Tail Connector Pitch	0.5 mm

ITEM (Continued)	SPECIFICATION
CFAF240320A-032T-TS Touch Screen Connector Pitch	1.0 mm
Tails Bend Radius	>R.5.0 mm
Tail Notes: *The display module's 45-pin FFC/FPC flexible cable mates with standard 0.5 mm ZIF sockets such as 609-1196-1-ND available from Digi-Key.* *The CFAF240320A-032T-TS touch screen FFC/FPC flexible tail mates with 1.00 mm pitch spaced ZIF sockets such as 609-1883-1-ND or 609-1886-1-ND from Digi-Key.*	

DISPLAY MODULE OUTLINE DRAWING



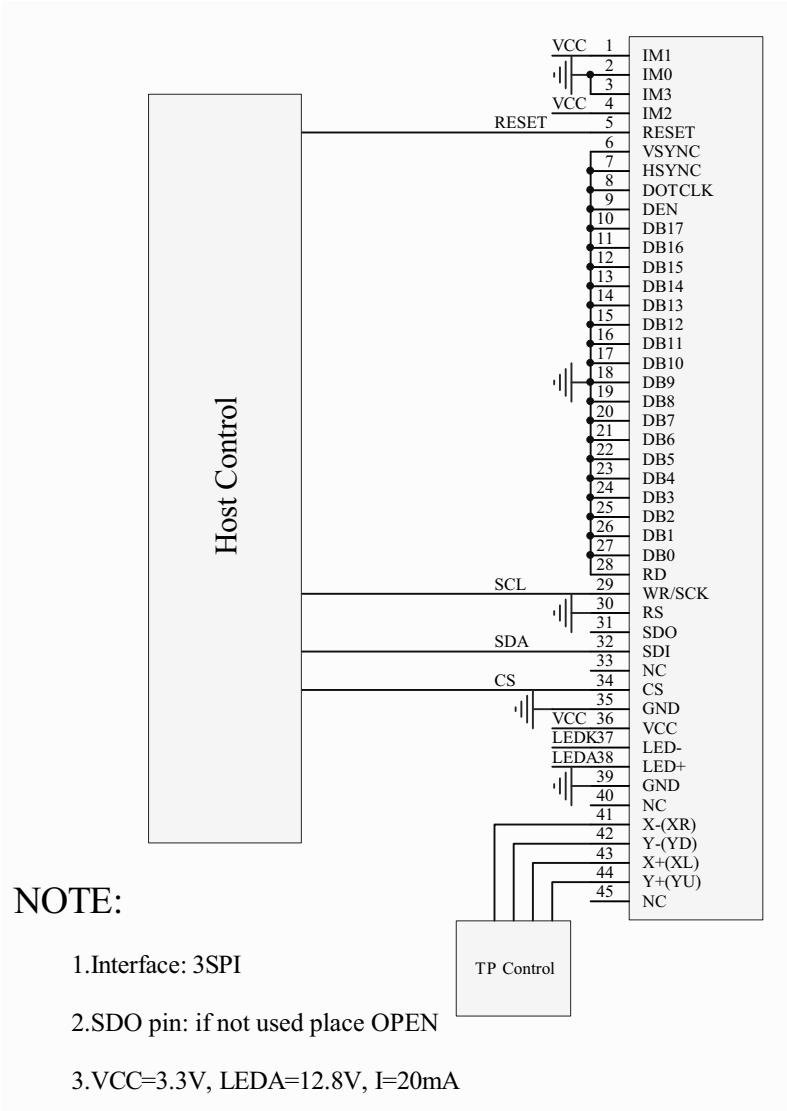
This drawing shows the touch screen (TP) on CFAF240320A-032T-TS. The CFAF240320A-032T has identical dimensions except it has no touch screen. Without the touch screen, depth is 3.1 mm.

Drawing deemed accurate but not guarranteed.

SYSTEM BLOCK DIAGRAMS

Pin descriptions are shown for the various interfaces below. These diagrams are for the *CFAF240320A-032T-TS*, which has a touch screen. For the *CFAF240320A-032T* (no touch screen), pins 41-44 are "NC". Make no connection.

3-Wire SPI



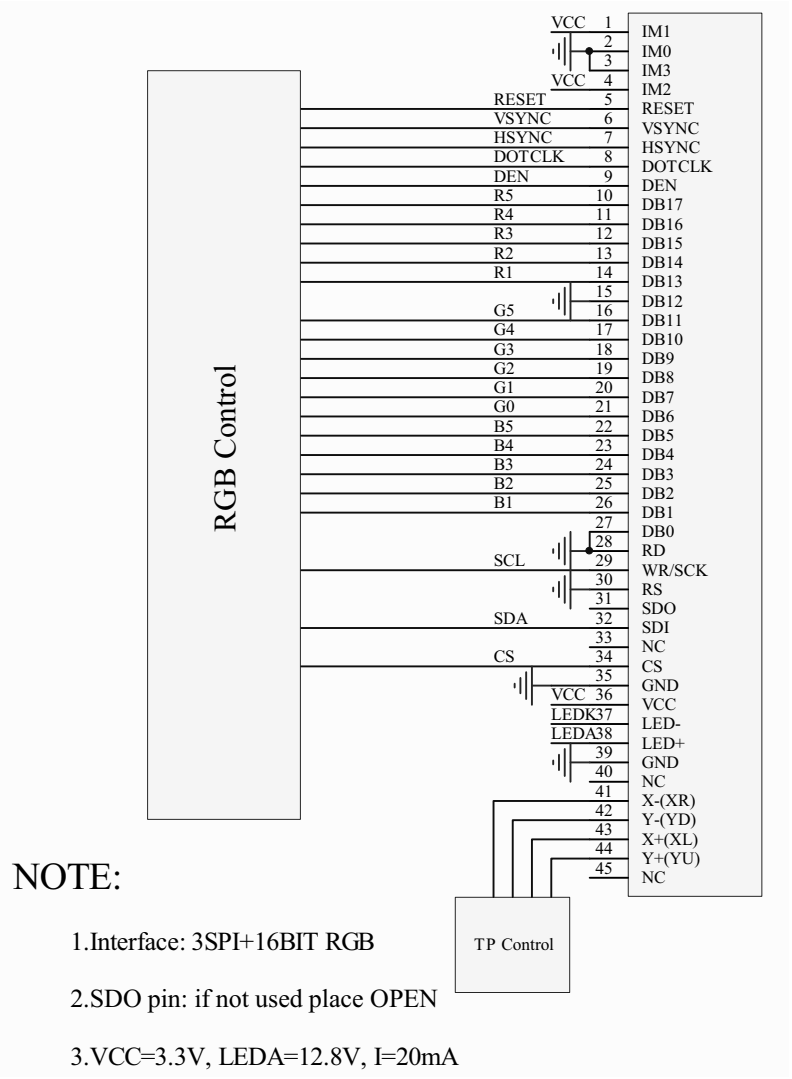
NOTE:

1.Interface: 3SPI

2.SDO pin: if not used place OPEN

3.VCC=3.3V, LEDA=12.8V, I=20mA

3-Wire SPI + 16-Bit RGB



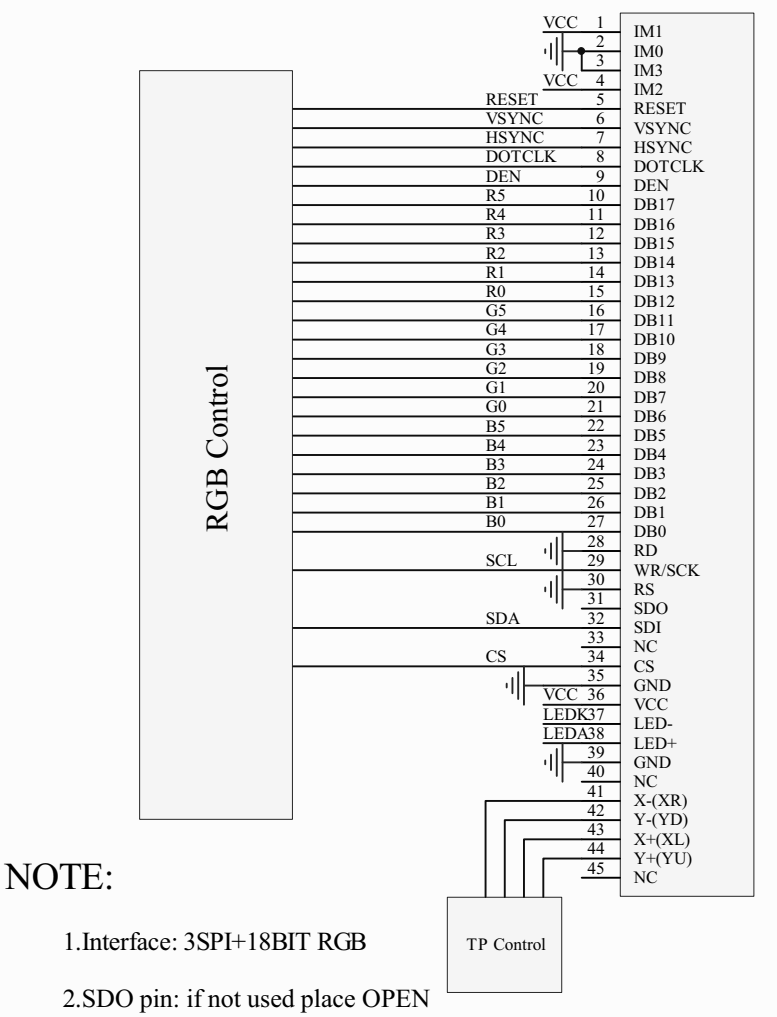
NOTE:

1.Interface: 3SPI+16BIT RGB

2.SDO pin: if not used place OPEN

3.VCC=3.3V, LEDA=12.8V, I=20mA

3-Wire SPI + 18-Bit RGB



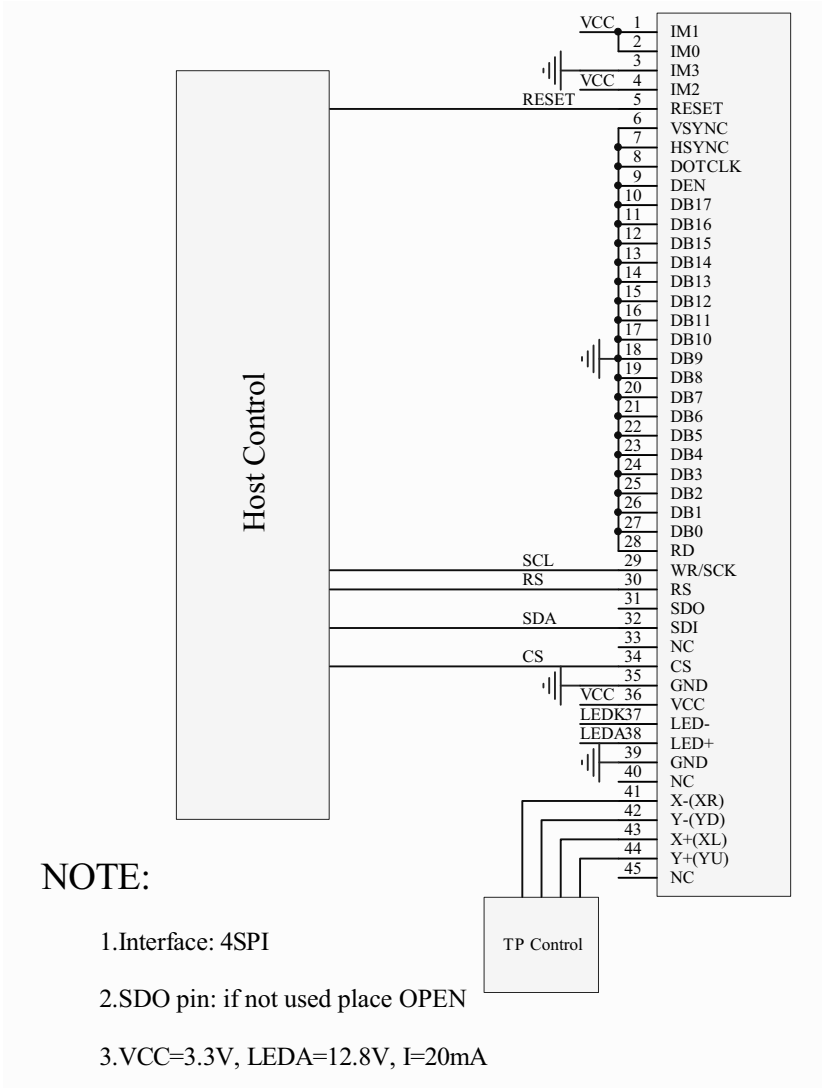
NOTE:

1.Interface: 3SPI+18BIT RGB

2.SDO pin: if not used place OPEN

3.VCC=3.3V, LEDA=12.8V, I=20mA

4-Wire SPI



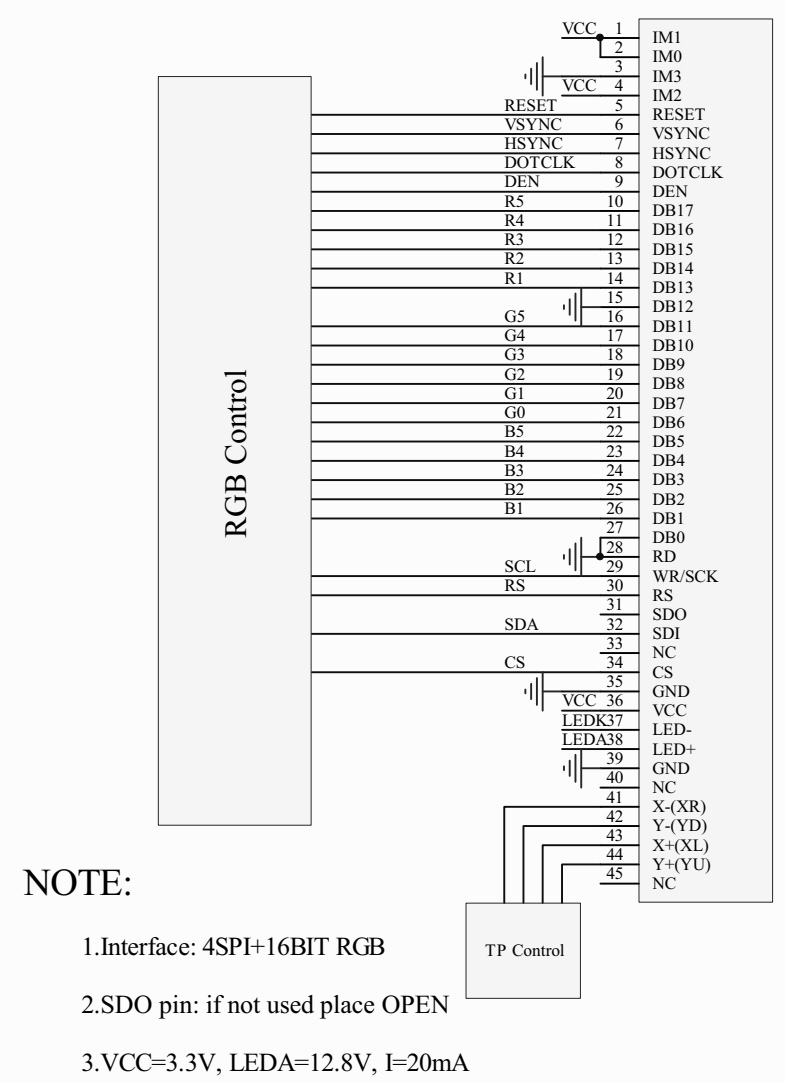
NOTE:

1.Interface: 4SPI

2.SDO pin: if not used place OPEN

3.VCC=3.3V, LEDA=12.8V, I=20mA

4-Wire SPI + 16-Bit RGB



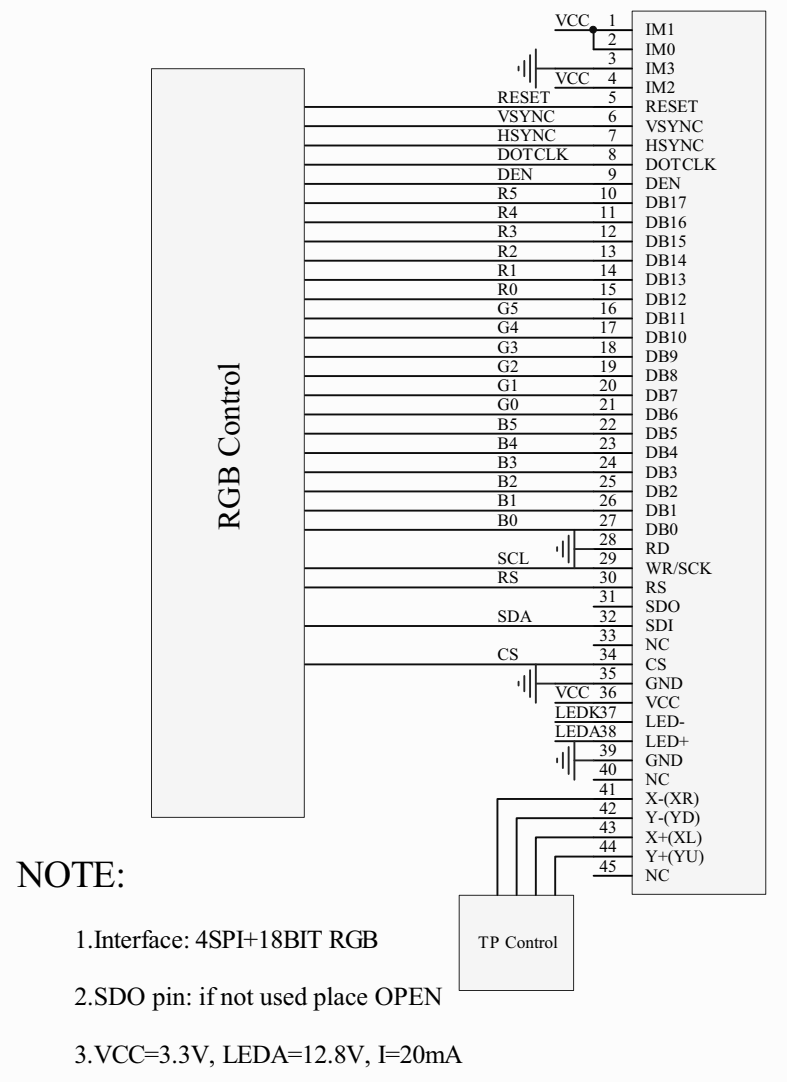
NOTE:

1.Interface: 4SPI+16BIT RGB

2.SDO pin: if not used place OPEN

3.VCC=3.3V, LEDA=12.8V, I=20mA

4-Wire SPI + 18-Bit RGB



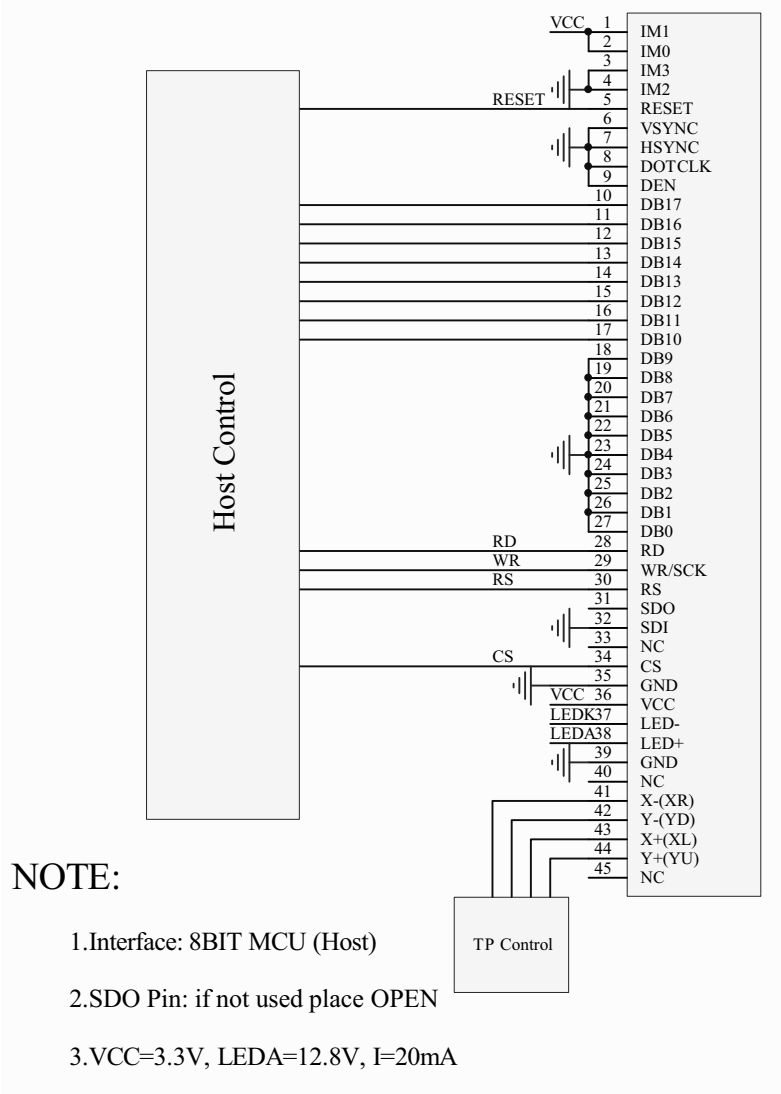
NOTE:

1.Interface: 4SPI+18BIT RGB

2.SDO pin: if not used place OPEN

3.VCC=3.3V, LEDA=12.8V, I=20mA

8-Bit Parallel



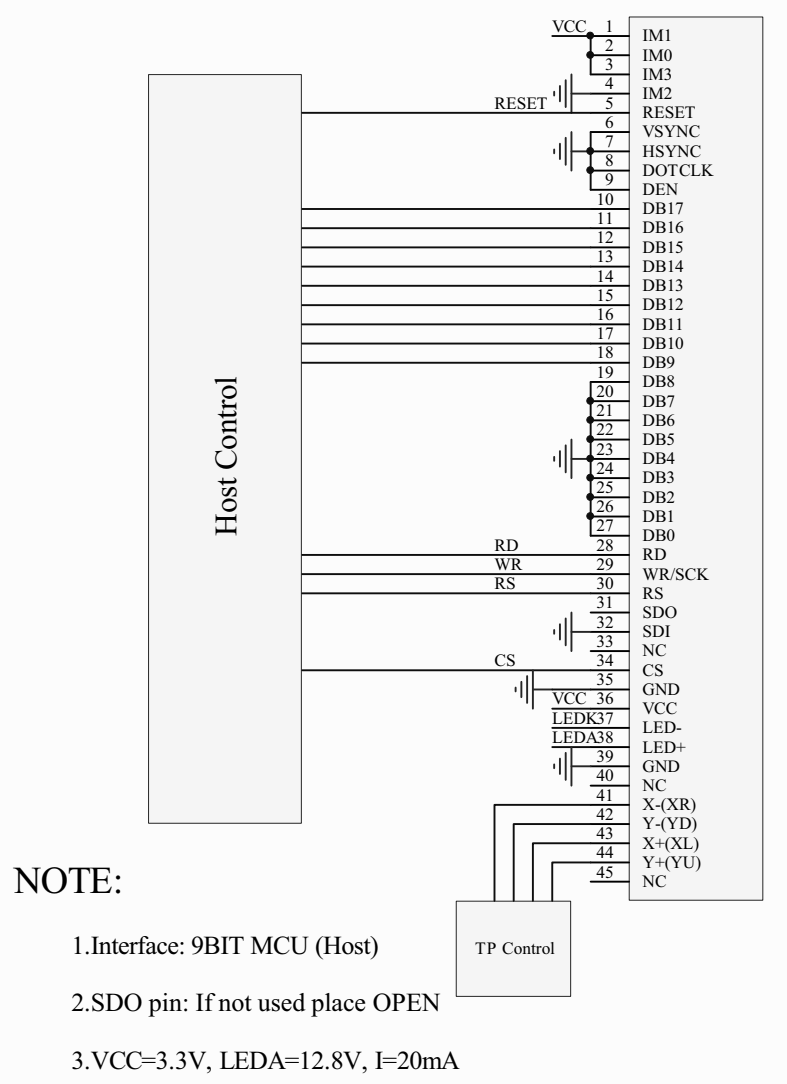
NOTE:

1.Interface: 8BIT MCU (Host)

2.SDO Pin: if not used place OPEN

3.VCC=3.3V, LEDA=12.8V, I=20mA

9-Bit Parallel



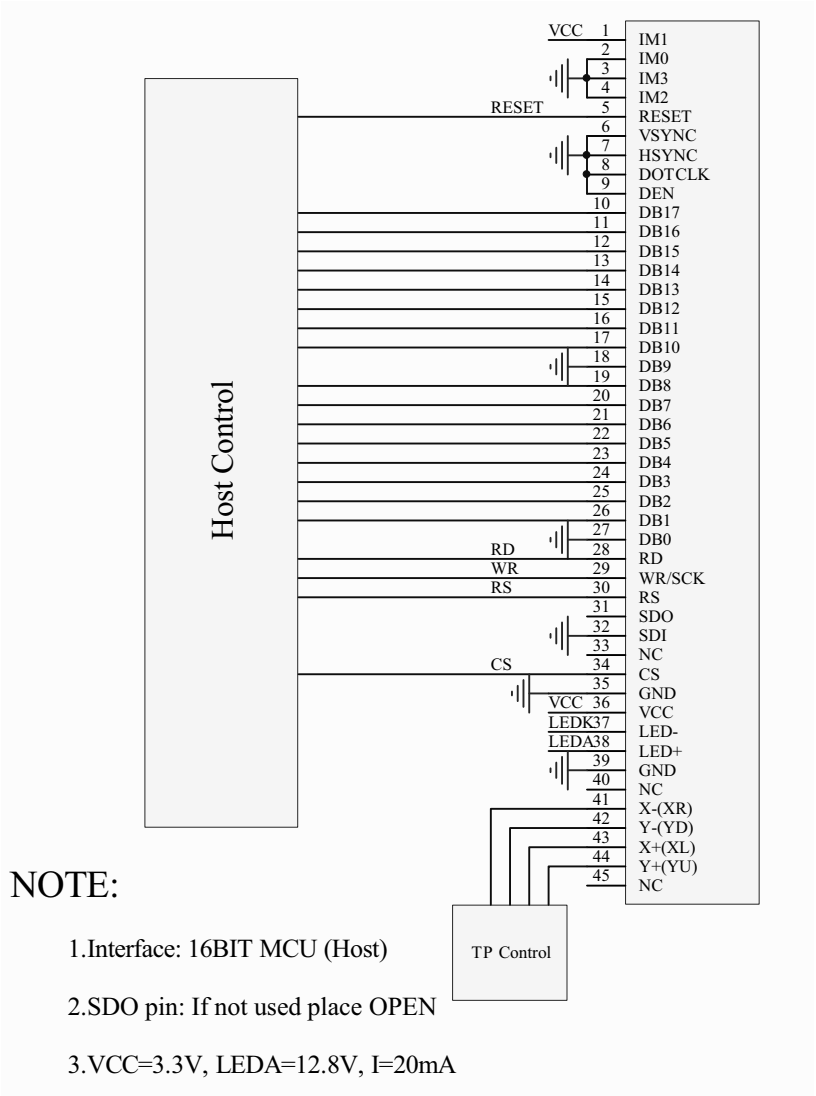
NOTE:

1.Interface: 9BIT MCU (Host)

2.SDO pin: If not used place OPEN

3.VCC=3.3V, LEDA=12.8V, I=20mA

16-Bit Parallel



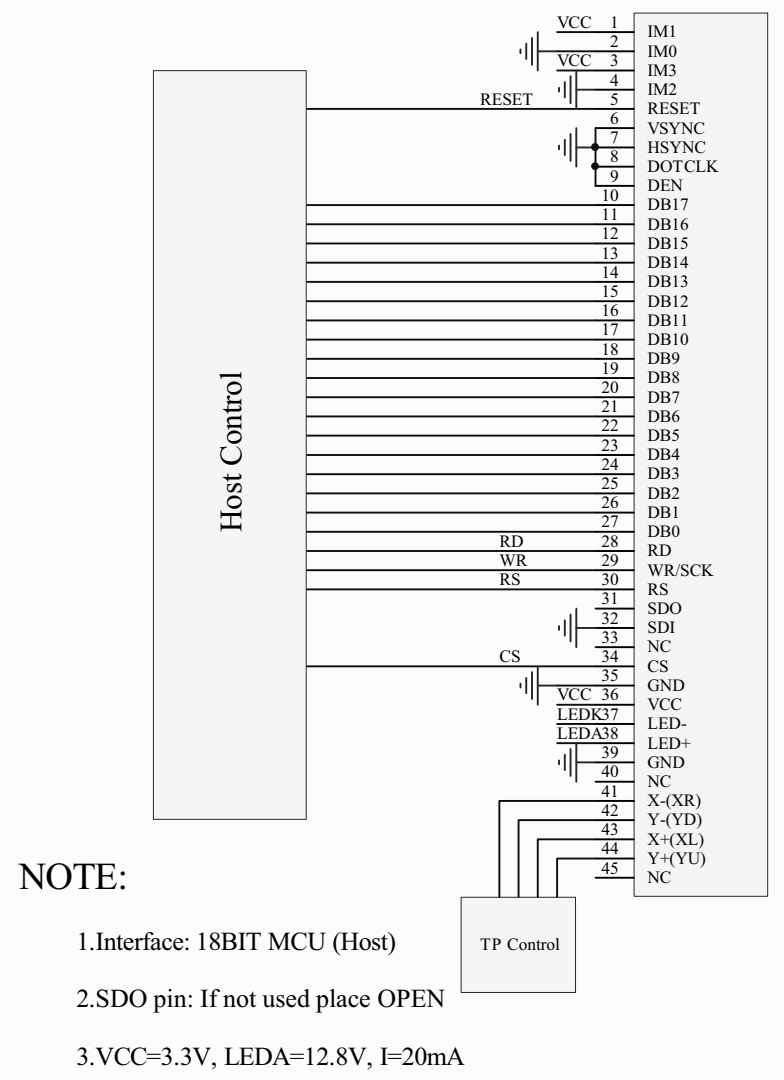
NOTE:

1.Interface: 16BIT MCU (Host)

2.SDO pin: If not used place OPEN

3.VCC=3.3V, LEDA=12.8V, I=20mA

18-Bit Parallel



LCD DUTY AND BIAS

DRIVING METHOD	SPECIFICATION
Duty[1]	1/320
Bias[2]	1/18

[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.

ELECTRICAL SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

Ambient Temperature (Ta) = 25°C			
Absolute Maximum Ratings	**Symbol**	**Minimum**	**Maximum**
Supply Voltage For Logic	V_{CC}	-0.3v	+3.3v
Logic Signal Input Voltage	V_{IN}	-0.3v	V_{CC}+0.3v
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 display module at these or any other conditions beyond those listed under Recommended DC Characteristics (3.0v Operation) (Pg. 20) 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.

Background color changes slightly depending on ambient temperature. This phenomena is reversible.

RECOMMENDED DC CHARACTERISTICS (3.0V OPERATION)

This is a summary of the two display modules' major operating parameters. For detailed information, see the ILITEK ILI9325 driver datasheet at controller datasheets on our website.

RECOMMENDED DC CHARACTERISTICS	SYMBOL	MINIMUM	TYPICAL	MAXIMUM
Supply Voltage For Logic	V_{CC}	+2.7v	+2.8	+3.3v
Current Consumption	V_{OP}	—	8 mA	—
Input High Voltage	V_{IH}	+0.7v * V_{CCI} for V_{CC}= +2.8v V_{IH} = +0.7v * +2.8v = +1.96v	—	V_{CCI}
Input Low Voltage	V_{IL}	0v (V_{SS}/GND)	—	+0.3v * V_{CC} for V_{CC} = +2.8v V_{IL} = +0.3v * +2.8v = 0.84v
Output High Voltage	V_{OH}	+0.8v * V_{CCI} for V_{CC}= +2.8v V_{IH} = +0.7v * +2.8v = +2.24v	—	V_{CCI}
Output Low Voltage	V_{OL}	0v (GND)	—	+0.2v * V_{CC} for V_{CC} = +2.8v V_{IL} = +0.3v * +2.8v = 0.56v

DETAILS OF INTERFACE PIN FUNCTIONS

<table>
<tr><th>NO.</th><th>SYMBOL</th><th>DISCRIPTION</th><th>I/O</th></tr>
<tr><td>1
2
3
4</td><td>IM1
IM0
IM3
IM2</td><td>
<table>
<tr><th>IM3</th><th>IM2</th><th>IM1</th><th>IM0/ID</th><th>Interface Mode</th><th>DB Pin</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>Setting invalid</td><td></td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>Setting invalid</td><td></td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td>i80-system 16-bit interface</td><td>DB[17:10], DB[8:1]</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td><td>i80-system 8-bit interface</td><td>DB[17:10]</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>ID</td><td>Serial Peripheral Interface (SPI)</td><td>SDI, SDO (DB[1:0])</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>0</td><td>9-bit 3 wires Serial Peripheral Interface</td><td>SDA, SCL, nCS</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1</td><td>8-bit 4 wires Serial Peripheral Interface</td><td>SDA, SCL, nCS, RS (D/CX)</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>Setting invalid</td><td></td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td>Setting invalid</td><td></td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>0</td><td>i80-system18-bit interface</td><td>DB[17:0]</td></tr>
</table>
</td><td>I</td></tr>
<tr><td>5</td><td>RESET</td><td>Reset pin. Setting either pin low initializes the LSI. Must be resetafter power is supplied.</td><td>I</td></tr>
<tr><td>6</td><td>VSYNC</td><td>Frame synchronizing signal for RGB interface operation.
fix this pin at VCI or GND when not in use.</td><td>I</td></tr>
<tr><td>7</td><td>HSYNC</td><td>Line synchronizing signal for RGB interface o peration.
fix this pin at VCI or GND when not in use.</td><td>I</td></tr>
<tr><td>8</td><td>DOTCLK</td><td>Dot clock signal for RGB interface operation.
Fix this pin at VCI or GND when not in use.</td><td>I</td></tr>
<tr><td>9</td><td>DEN</td><td>Data enable signal for RGB interface peration.
fix this pin at VCI or GND when not in use.</td><td>I</td></tr>
<tr><td>10-27</td><td>DB17-DB0</td><td>Data bus .
Fix to GND level when not in use.</td><td>I/0</td></tr>
<tr><td>28</td><td>RD</td><td>Serves as a read signal and MCU read data a t the rising edge.
fix this pin at VCI or GND when not in use</td><td>I</td></tr>
<tr><td>29</td><td>WR/SCK</td><td>Write strobe signal in DBI type B operation</td><td>I</td></tr>
<tr><td>30</td><td>RS</td><td>Display data/ command selection pin</td><td>I</td></tr>
<tr><td>31</td><td>SDO</td><td>SPI interface output pin.-The data is output on the falling edge of the SCL signal.-If not used, let this pin open.</td><td>I</td></tr>
<tr><td>32</td><td>SDI</td><td>Data lane in 1 data lane serial interface.
The data is latched on the rising edge of the SCL signal.</td><td>I</td></tr>
<tr><td>33</td><td>NC</td><td>NC</td><td></td></tr>
<tr><td>34</td><td>CS</td><td>Chip select input pin (“Low” enable).
fix this pin at VCI or GND when not in use.</td><td>I</td></tr>
</table>

35	GND	Ground.	P
36	VCC	Supply voltage(3.3V).	P
37	LED−	Cathode pin OF backlight	P
38	LED+	Anode pin of backlight	P
39	GND	Ground.	P
40	NC	NC	
41*	X−	Touch panel Right Glass Terminal	A/D
42 *	Y−	Touch panel Bottom Film Terminal	A/D
43 *	X+	Touch panel Left Glass Terminal	A/D
44 *	Y+	Touch panel Top Film Terminal	A/D
45	NC	NC	

* Pin descriptions 41-44 in table above are for *CFAF240320A-032T-TS* (with touch screen). Pins 41-44 for *CFAF240320A-032T* (no touch screen) are "NC". Make no connection.

ESD (ELECTRO-STATIC DISCHARGE)

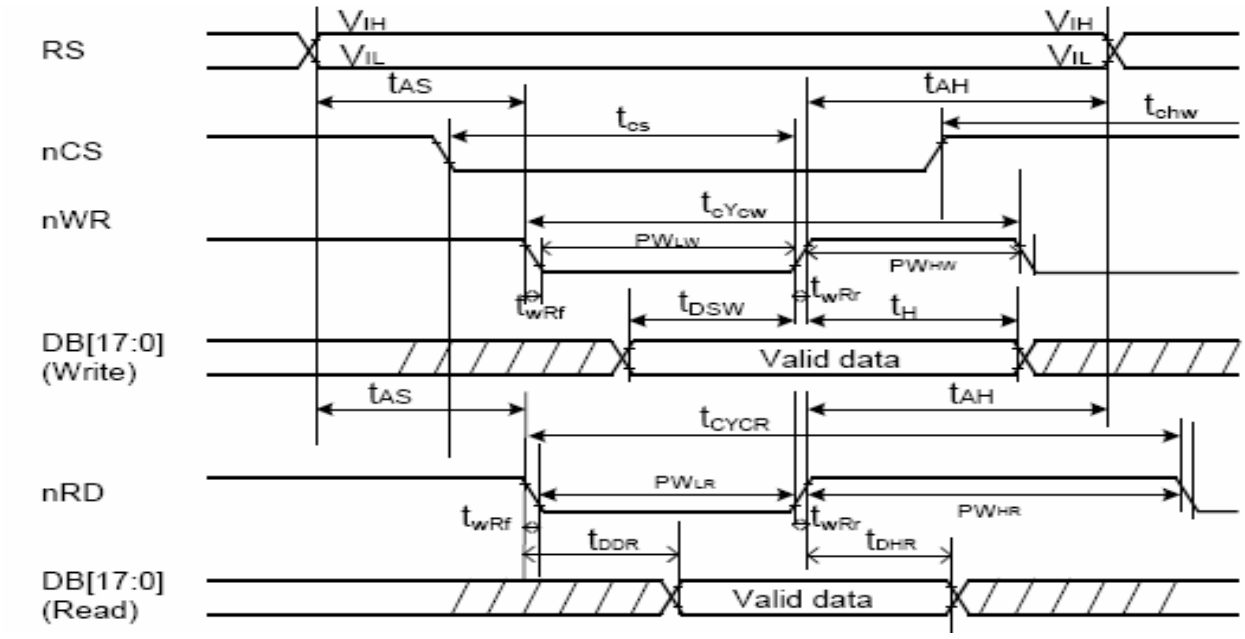
The circuitry is industry standard CMOS logic and is susceptible to ESD damage. Please use industry standard anti-static precautions as you would for any other static sensitive devices such as expansion cards, motherboards, or integrated circuits. Ground your body, work surfaces, and equipment.

AC CHARACTERISTICS

DISPLAY PARALLEL 18/16/9/8-BIT INTERFACE TIMING CHARACTERISTICS (8080 SYSTEM)

Normal Write Mode (IOVCC = 1.65~3.3V)

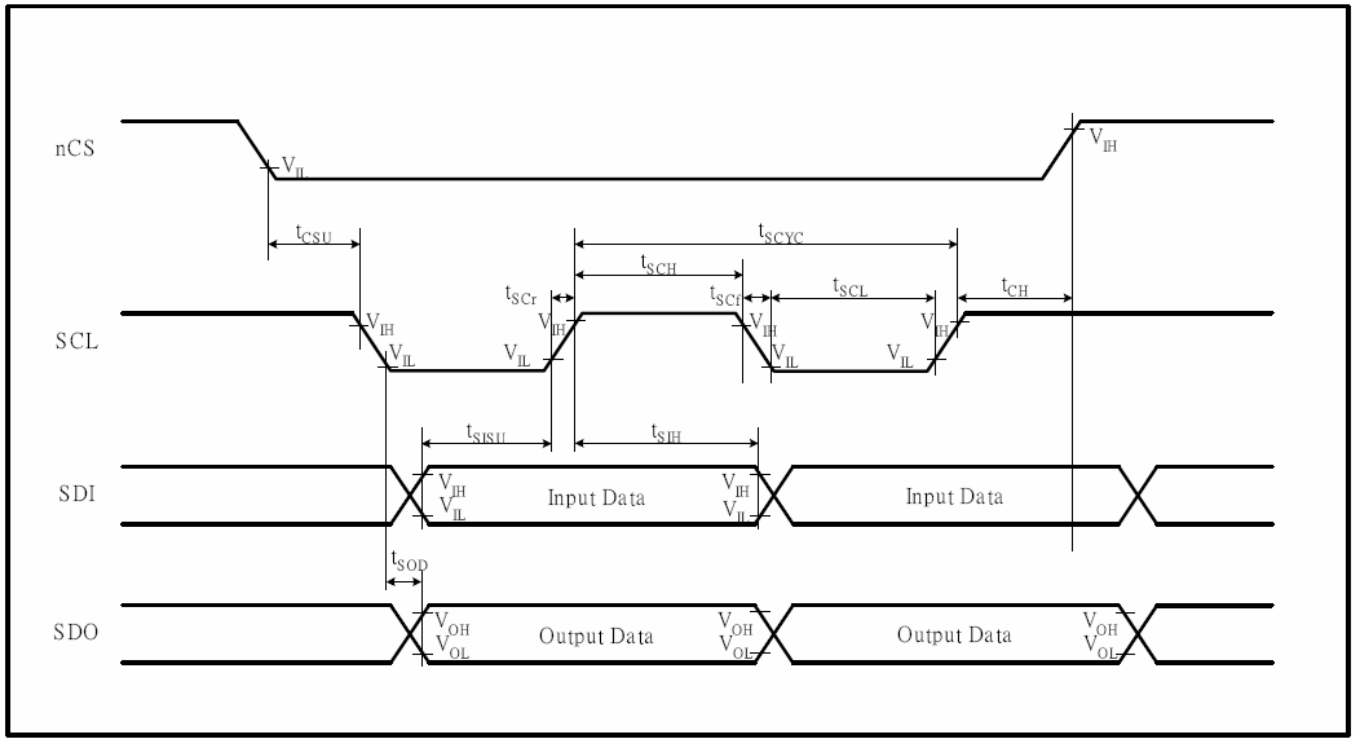
Item		Symbol	Unit	Min.	Typ.	Max.	Test Condition
Bus cycle time	Write	t_{CYCW}	ns	80	-		-
	Read	t_{CYCR}	ns	300	-	-	-
Write low-level pulse width		PW_{LW}	ns	50	-	500	-
Write high-level pulse width		PW_{HW}	ns	15	-	-	-
Read low-level pulse width		PW_{LR}	ns	150	-	-	-
Read high-level pulse width		PW_{HR}	ns	150	-	-	
Write / Read rise / fall time		t_{WRr}/t_{WRf}	ns	-	-	25	
Setup time	Write (RS to nCS, E/nWR)	t_{AS}	ns	10	-	-	
	Read (RS to nCS, RW/nRD)			5	-	-	
Address hold time		t_{AH}	ns	5	-	-	
Write data set up time		t_{DSW}	ns	10	-	-	
Write data hold time		t_H	ns	15	-	-	
Read data delay time		t_{DDR}	ns	-	-	100	
Read data hold time		t_{DHR}	ns	5	-	-	



SERIAL DATA TRANSFER INTERFACE TIMING CHARACTERISTICS

(IOVCC= 1.65 ~ 3.3V)

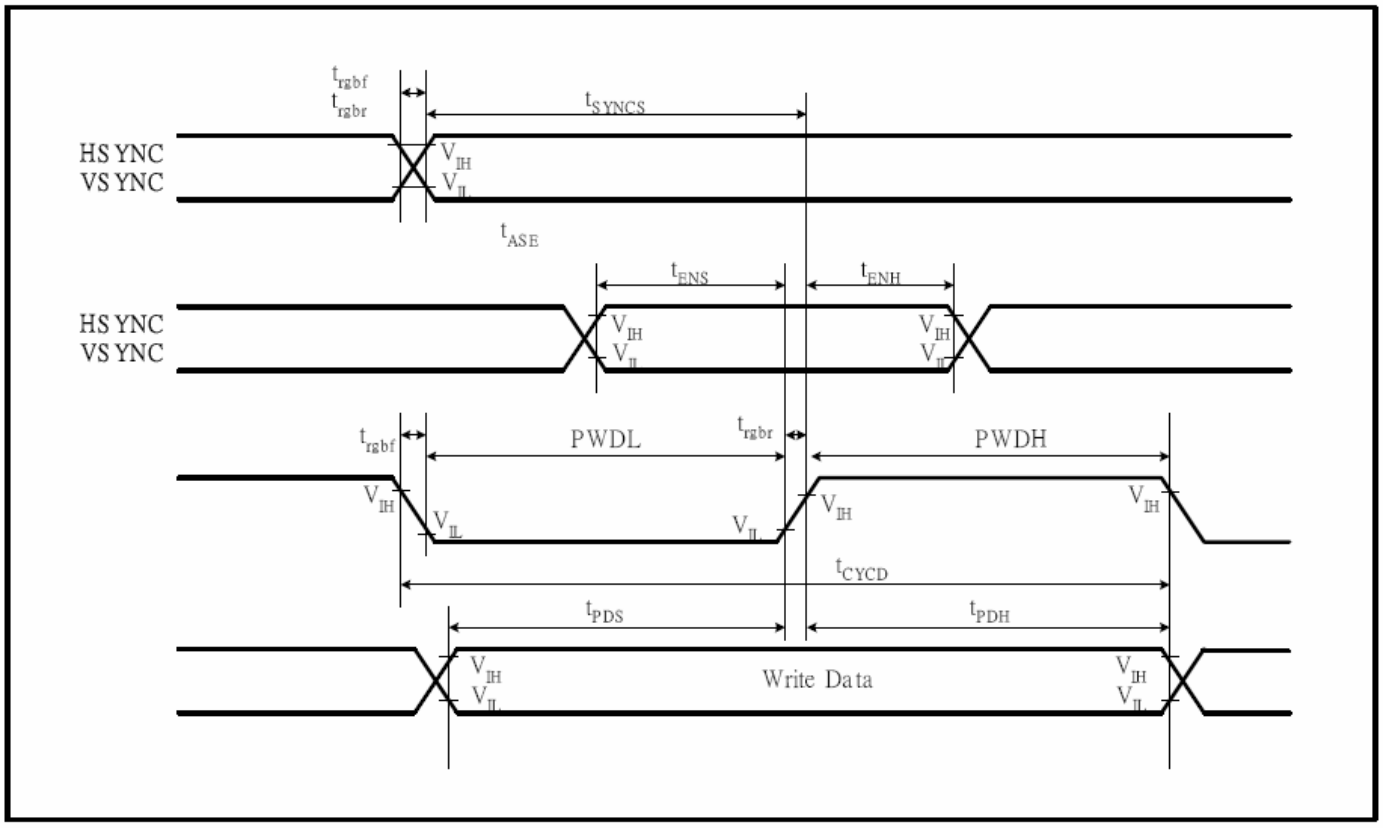
Item		Symbol	Unit	Min.	Typ.	Max.	Test Condition
Serial clock cycle time	Write (received)	t_{SCYC}	Ns	100	-	-	
	Read (transmitted)	t_{SCYC}	ns	200	-	-	
Serial clock high – level pulse width	Write (received)	t_{SCH}	ns	40	-	-	
	Read (transmitted)	t_{SCH}	ns	100	-	-	
Serial clock low – level pulse width	Write (received)	t_{SCL}	ns	40	-	-	
	Read (transmitted)	t_{SCL}	ns	100	-	-	
Serial clock rise / fall time		t_{SCr}, t_{SCf}	ns	-	-	5	
Chip select set up time		t_{CSU}	ns	10	-	-	
Chip select hold time		t_{CH}	ns	50	-	-	
Serial input data set up time		t_{SISU}	ns	20	-	-	
Serial input data hold time		t_{SIH}	ns	20	-	-	
Serial output data set up time		t_{SOD}	ns	-	-	100	
Serial output data hold time		t_{SOH}	ns	5	-	-	



RGB INTERFACE TIMING CHARACTERISTICS

18/16-bit Bus RGB Interface Mode (IOVCC = 1.65 ~ 3.3V)

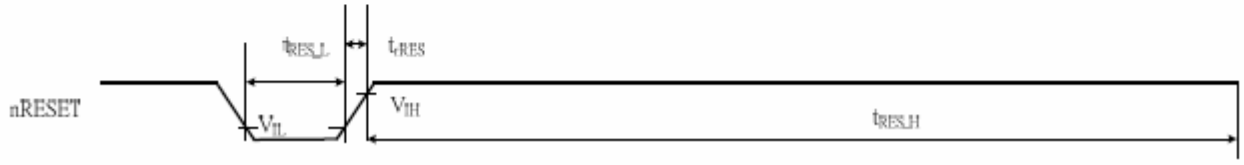
Item	Symbol	Unit	Min.	Typ.	Max.	Test Condition
VSYNC/HSYNC setup time	t_{SYNCS}	ns	0	-	-	-
ENABLE setup time	t_{ENS}	ns	10	-	-	-
ENABLE hold time	t_{ENH}	ns	10	-	-	-
PD Data setup time	t_{PDS}	ns	10	-	-	-
PD Data hold time	t_{PDH}	ns	40	-	-	-
DOTCLK high-level pulse width	PWDH	ns	40	-	-	-
DOTCLK low-level pulse width	PWDL	ns	40	-	-	-
DOTCLK cycle time	t_{CYCD}	ns	100	-	-	-
DOTCLK, VSYNC, HSYNC, rise/fall time	t_{rghr}, t_{rghf}	ns	-	-	25	-



RESET TIMING

Reset Timing Characteristics (IOVCC = 1.65 ~ 3.3 V)

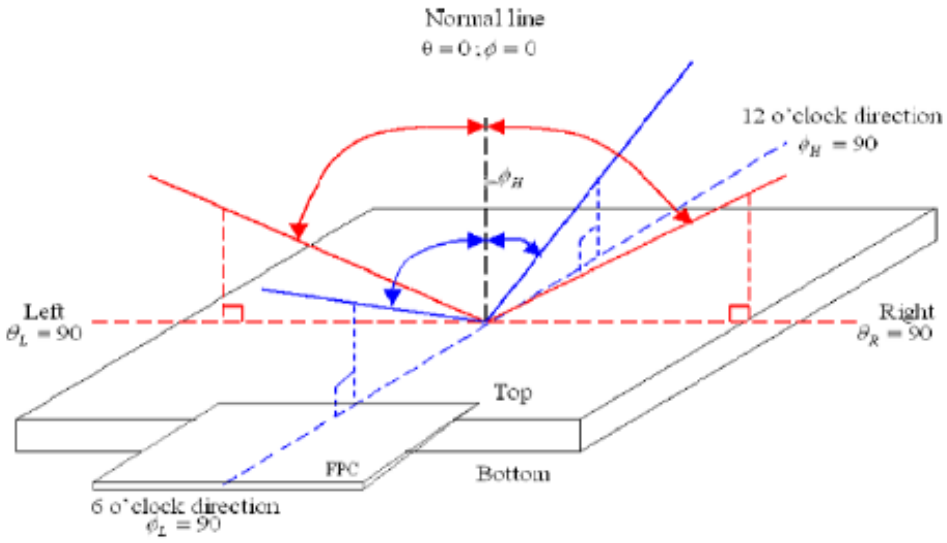
Item	Symbol	Unit	Min.	Typ.	Max.
Reset low-level width	t_{RES_L}	ms	1	-	-
Reset rise time	t_{rRES}	µs	-	-	10
Reset high-level width	t_{RES_H}	ms	50	-	-



OPTICAL SPECIFICATIONS

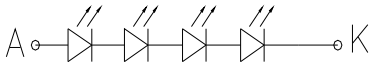
The following items are measured under stable conditions. The optical characteristics are measured in a dark room with measuring equipment: LCD-7200, BM-5A, BM-7, PR-650, EZ-Contrast.

ITEM	SYMBOL	ADDITIONAL TEST CONDITIONS	MINIMUM	TYPICAL	MAXIMUM
Red Chromaticity	Rx	θ = φ - 0°	0.621	0.641	0.661
	Ry		0.327	0.347	0.367
Green Chromaticity	Gx		0.284	0.304	0.324
	Gy		0.553	0.573	0.593
Blue Chromaticity	Bx		0.115	0.135	0.155
	By		0.101	0.121	0.141
White Chromaticity	Wx		0.292	0.312	0.332
	Wy		0.321	0.341	0.361
Viewing Direction				>9:00	



LED BACKLIGHT CHARACTERISTICS

The backlight is edge-lit with 4 white LEDs in series.



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

LED Backlight Characteristics **White Edge-lit *with 4 LEDs in series.*** ***Ambient temperature: TA = 25°C***			
PARAMETER	**MINIMUM**	**TYPICAL**	**MAXIMUM**
Forward Current (I_{LED})*		5 mA 5 mA per LED 5 mA x 4 = 20 mA	
Driving the backlight above 20 mA will shorten its lifetime.			
Forward Voltage (V_{LED})	+12.3v	+12.8v	+13.3v
Luminous Intensity* (I_V) I_{LED} = 20 mA		TBD cd/m^2	
Uniformity (minimum/maximum x 100%)	80%		

Caution

Ensure that you have proper current and voltage control for your backlight before connecting the backlight circuit.

Note

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

RELIABILITY AND LONGEVITY

DISPLAY MODULE RELIABILITY TEST RESULTS

RELIABILITY TEST RESULTS			
TEST	**CONDITION**	**SAMPLE SIZE**	**TEST RESULT**
Low Temperature	-20°C, 96 Hours	3 displays	Pass
Thermal Humidity	40°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
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.

DISPLAY MODULE RELIABILITY

PART NUMBER	SPECIFICATION
CFAF240320A-032T CFAF240320A-032T-TS	Brightness will be >50% of a new display module's initial brightness for at least 10,000 hours of operation when driving the backlight at or below 20 mA.

Under operating and storage temperature specification limitations, humidity non-condensing) RH up to 65%, and no exposure to direct sunlight. Value listed above is approximate and represents typical lifetime.

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.

DISPLAY MODULE LONGEVITY (EOL/REPLACEMENT POLICY)

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

We recognize that discontinuing a display 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 display module. For example, we must occasionally discontinue a display module when a supplier discontinues a component or a manufacturing process becomes obsolete. When we discontinue a display module, we will do our best to find an acceptable replacement display 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 display module to the discontinued display module. However, sometimes a change in component or process for the replacement display module results in a slight variation, perhaps an improvement, over the previous design.

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

- *Backlight LEDs.* Brightness may be affected (perhaps the new LEDs have better efficiency) or the current they draw may change (new LEDs may have a different VF).
- *Controller.* A new controller may require minor changes in your code.
- *Component tolerances.* Display 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 display module whenever possible; we only discontinue a display module if we have no other option. We will post Part Change Notices on the product's web page as soon as possible. If interested, you can subscribe to future part change notifications.

SOURCES FOR DRIVER LIBRARIES AND SAMPLE CODE

SOURCES FOR DRIVER LIBRARIES

Driver libraries may save you a lot of time and help you develop a more professional product. Possible library sources are easyGUI**,** RAMTEX, Micriμm, and Segger.

SOURCE FOR SAMPLE CODE

Free downloadable sample code is available under the Datasheets & File tab on the web pages for these display modules.

CARE AND HANDLING PRECAUTIONS

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

Excessive voltage will shorten the life of the display module. You must drive the display module within the specified voltage limit. See Absolute Maximum Ratings (Pg. 19).

HANDLING CAUTION FOR DISPLAY MODULES SHIPPED IN TRAYS

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

ESD (ELECTRO-STATIC DISCHARGE)

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

DESIGN AND MOUNTING

- The ILITEK ILI9325 or compatible driver maintains its internal operating modes until something happens to change it. Excessive external noise can change these internal modes. In your packaging and system design, suppress or prevent the noise from influencing the controller. Also, refresh the operating modes periodically to prevent the effects of unanticipated noise.
- *CFAF240320A-032T*: The exposed surface of the “glass” is actually a polarizer laminated on top of the glass.To protect the soft plastic polarizer from damage, the display module ships with a protective film over the polarizer. Please peel off the protective film slowly. Peeling off the protective film abruptly may generate static electricity.
- *CFAF240320A-032T-TS*: To protect the touch screen from damage, the display module 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.
- *CFAF240320A-032T:* The polarizer is made out of soft plastic and is easily scratched or damaged. When handling the display module, avoid touching the polarizer. Finger oils are difficult to remove.
- *CFAF240320A-032T:* To protect the soft plastic polarizer from damage, place a transparent plate (for example, acrylic, polycarbonate, or glass) in front of the display module, leaving a small gap between the plate and the display surface. We use GE HP-92 Lexan, which is readily available and works well.
- *CFAF240320A-032T-TS*: 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.
- *CFAF240320A-032T-TS*: 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 display module.
- The display module can be mounted vertically onto a front panel using a variety of methods. If the enclosure is plastic, it can be molded to have the display module snap into place. A metal enclosure can use a milled faceplate with mounting tabs to secure the display module. Adhesives can be used, as long as they are not similar to “super-glue” because these emit vapors that can damage the display module over time.
- Do not reverse polarity to the power supply connections. Reversing polarity will immediately ruin the display module.
- Use care to keep the exposed terminals clean.

- Sharp bends can damage the FPC/FFC cables. Do not crease the cables. Do not bend the cables tightly against the edge of the LCD panel. Do not repeatedly bend the cable beyond its elastic region. Excessive over-bending and/or creasing of the FFC/FPC flexible tail can cause stress to the bonding between the glass and the tail. This causes displays problems such as distortion and partial display. Limit bend radius to at least R5.00 mm.

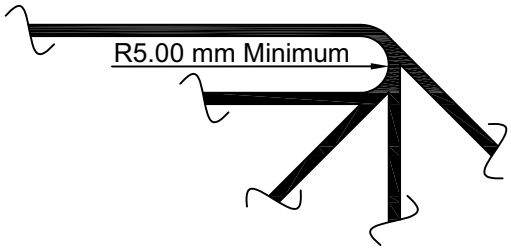


Figure 1. Limit Bend Radius Of Tails

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

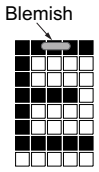
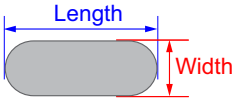
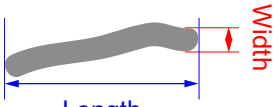
We try to describe the appearance of our modules as accurately as possible. For the photos, we adjust for optimal appearance. Actual display appearance may vary due to (1) different operating conditions, (2) small variations of component tolerances, (3) inaccuracies of our camera, (4) color interpretation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

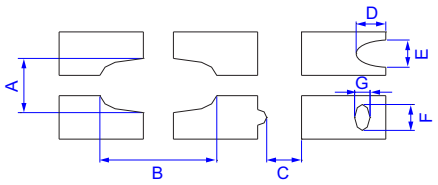
DEFECTS CLASSIFICATION

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		*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 	*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 	*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	

<table>
<tr><th>#</th><th>DEFECT TYPE</th><th>ACCEPTANCE STANDARDS CRITERIA (Continued)</th><th>MAJOR / MINOR</th></tr>
<tr><td>8</td><td>Display pattern defect</td><td> 

<table>
<tr><th>Dot Size (mm)</th><th>Acceptable Qty</th></tr>
<tr><td>((A+B)/2)≤0.2</td><td rowspan="4">≤3 total defects

≤2 pinholes per digit</td></tr>
<tr><td>C>0</td></tr>
<tr><td>((D+E)/2)≤0.25</td></tr>
<tr><td>((F+G)/2)≤0.25</td></tr>
</table></td><td>Minor</td></tr>
<tr><td>9</td><td>Backlight defects</td><td>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. 35), and dark lines or scratches (see test 6, Pg. 35).
*Minor if display functions correctly. Major if the display fails.</td><td>Minor</td></tr>
<tr><td>10</td><td>COB defects</td><td>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.</td><td>Minor</td></tr>
<tr><td>11</td><td>PCB defects</td><td>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.</td><td>Minor</td></tr>
<tr><td>12</td><td>Soldering defects</td><td>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.</td><td>Minor</td></tr>
</table>

APPENDIX B: TFT MODULE TERMS AND SYMBOLS

Term / 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 nits	Candela per square meter. A unit of measurement used to measure Luminous Intensity. cd/m^2 = 1 lumen.
$\overline{CS}$ CS# CSX	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 ~ DB*n* D0 ~ D*n*	Parallel databus.
D/$\overline{C}$ RS DCX 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.
DE DEN	Data Enable signal for RGB / DPI mode.
DPI DOTCLK parallel	Displays Pixel Interface
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.
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”. Typically much thicker than the “flex” film of COF (Chip On Flex).
GND V_{SS}	Ground. Must be connected to an external ground.
H_{SYNC}	Horizontal frame/RAM write synchronizing signal used for RGB mode only.

<table>
<tr><th>Term / Symbol</th><th>Description</th></tr>
<tr><td>I_{DD}</td><td>Typical power supply current for TFT.
Total electrical current (I) in the Drains of a CMOS circuit</td></tr>
<tr><td>I_{LED}</td><td>Current used by LED backlight.</td></tr>
<tr><td>IMn</td><td>Interface mode select pin where n is the corresponding number.</td></tr>
<tr><td>I_{OP}
V_{CCI}</td><td>Current for normal OPeration, typically measured in milliamperes (mA).
1 mA = 0.001A (Ampere)</td></tr>
<tr><td>I_{ST}</td><td>Current for STandby mode, typically measured in microampere (μA).
1 μA = 0.000001A (Ampere)</td></tr>
<tr><td>I/O
IO</td><td>Input/Output</td></tr>
<tr><td>K (LED -)</td><td>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, ...</td></tr>
<tr><td>MIPI</td><td>Mobile Industry Processor Interface. See MIPI Alliance.</td></tr>
<tr><td>MISO
SDO
D_{OUT}</td><td>Data output signal in serial SPI interface: Master In Slave Out. Serial Data Out.</td></tr>
<tr><td>MOSI
SDI
SI
DINI_SDA</td><td>Data output signal in serial SPI interface: Master Out Slave In. Serial Data In.</td></tr>
<tr><td>mm</td><td>Millimeter or millimetre. Unit of length equal to one thousandth of a meter.
1 millimeter = 0.0394 inches.</td></tr>
<tr><td>mW</td><td>Milliwatt is equal to one thousandth of a Watt.
Watts = Volts x Amps.</td></tr>
<tr><td>NC
nc</td><td>Make No Connection.</td></tr>
<tr><td>P_{CLK}</td><td>Pixel clock signal for RGB / DPI mode.</td></tr>
<tr><td>PSn-PS0</td><td>
<table>
<tr><th>PS3</th><th>PS2</th><th>PS1</th><th>PS0</th><th>Interface Mode</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>16-bit 6800 parallel interface. (if available)</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>8-bit 6800 parallel interface. (if available)</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td>16-bit 8080 parallel interface.</td></tr>
<tr><td colspan="5">. . . . . .</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td><td>8-bit 8080 parallel interface.
(if available)</td></tr>
</table>
</td></tr>
</table>

Term / Symbol	Description
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 RDX	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.
RH Rh	Relative Humidity
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.
SCK SCL	Serial Clock
Ta TA	“Ambient temperature” is the temperature of the air that surrounds a component.
Tf	Unit of measurement for TFT response time. f = falling edge.
TFT	Thin-Film Transistor fabricated directly on the display substrate.
T_{OP}	OPerating Temperature.
Tr	Unit of measurement for TFT response time. r = rising edge.
T_{ST} T_{STG}	STorage Temperature.
V_{ANALOG} V_{CI}	Analog supply,
V_{IH} V_{ICH}	High level input voltage.
V_{IL} V_{LCH}	Low level input voltage.

Term / Symbol	Description
V_{IN} V_T	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} IO_{VCC}	Digital Logic Supply and Input/Output Supply
V_O V_{ADJ}	Supply voltage for driving LCD (contrast adjustment).
V_{OH} V_{OHC}	High level output voltage.
V_{OL} V_{OLC}	Low level output voltage.
V_{SSD}	Digital ground.
V_{SYNC}	Vertical frame/RAM write synchronizing signal used for RGB mode only.
$\overline{WR}_{8080}$ R/$\overline{W}$ ($\overline{WR}$) $\overline{WR}$ (R/$\overline{W}$) 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)
$\overline{WR}$_SCK	*DBI Type-B:* Serves as a write signal and write data at the low level. *DBI Type-C:* it serves as SCK (Serial Clock). If unused, tie to $V_{LOGIC\ I/O}$.