TFT DISPLAY MODULE DATASHEET

Datasheet Release 2016-01-19
for
CFAF240400D-030T

Crystalfontz America, Incorporated

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Datasheet Revision History

Datasheet Release: 2016-01-19

- Added dimension details to the FPC/FFC flexible cable in Module Outline Drawings (Pg. 8).
- In Module Reliability (Pg. 19) section, lifetime specification was increased from *10,000* hours to *50,000* hours.
- Details on carrier board kit was removed. There are now two kits available. See descriptions under *Additional Options* on CFAF240400D-030T.
- Wherever listed, made a direct link to the Orise Tech OTM4001A datasheet on our website.
- Previous *Hardware Revision Notice* was replaced by *Product Change Notifications* immediately below this section.

Datasheet Release: 2014-12-11
Complete rewrite to meet current datasheet standards. Information that was previously missing in the preliminary Datasheet has been added.

- Added link to location of the Orise Tech OTM4001A controller datasheet on our website. Previous controller was Orise Tech SPFD5420A.
- Added link to CFAF240400D-030T-CB, an assembly of this TFT display module installed on a 2BM-10005 carrier board.

Preliminary Datasheet Release: 2014-07-31
Corrected inset table pin numbers in attached ORISE Technology controller datasheet, page 7, 5. Signal Descriptions, System Configuration Input Signal, IM2~1, IM0/D.

Preliminary Datasheet Release: 2011-08-09
No changes except the part number. Previous part number was CFAF240400D-T. Part number now includes diagonal dimension. For more information see Technical bulletin #10335 published 2011-03-29.

Preliminary Datasheet Release: 2010-08-05
Corrected pin names 9, 10, and 33 in section “3.1 Input Signal & Power”. Also replaced module drawing.

Preliminary Datasheet Release: 2009-5-6
First issue.

Product Change Notifications

To check for Product Change Notifications for this display module, see the Product Notices tab on a product’s web page:
https://www.crystalfontz.com/product/cfaf240400d030t

Product pages without a Product Notices tab do not have Product Change Notifications.

About Variations

We work continuously to improve our products. Because display technologies are quickly evolving, these products may have component or process changes. Slight variations (for example, contrast, color, or intensity) between lots are normal.

About Volatility

This display module has volatile memory.

The Fine Print

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All specifications in Datasheets 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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LIST OF FIGURES

MAIN FEATURES

- ❑ Full-color (65K/262K) 240xRGBx400 display module consists of a TFT panel, integrated controller, an FPC (Flexible Printed Circuit) tail, and a white LED backlight.
- ❑ Module dimensions
  - Active Area
    - Diagonal is 75.69 millimeters
      Inches = 2.98"
    - Active area width and height is 38.88 (W) x 64.80 (H) millimeters.
      Inches = 1.53" (W) x 2.55" (H).
  - Overall module width and height:
    - FPC *unfolded* is 45.04 (W) x 101.64 (H) millimeters. (Shape and length of FPC may vary.)
      Inches = 1.77" (W) x 4.00" (H).
    - FPC *folded* is 45.04 (W) x (H) 77.00 millimeters.
      Inches = 1.77" (W) x 3.03" (H).
  - Overall module depth:
    2.60 (D) millimeters
    Inches = 0.10" (D).
- ❑ Integrated Orise OTM4001A 720-channel 6-bit source driver or compatible controller. For Application Notes, see the Orise Tech OTM4001A datasheet on our website.
- ❑ Requires only a single source 3.3v for both power supply and logic.
- ❑ Interface modes: 8-bit, 9-bit, 16-bit or 18-bit parallel interface to host.
- ❑ This TFT is engineered for high volume production. It uses a "TAB" (tape automated bonding) or "COF" (chip on flex) style flex tail. The TAB connector is soldered directly to corresponding pads on your PCB using a hot-bar soldering machine. For more information, see Hot Bar Soldering Machine (Pg. 21).
- ❑ Transmissive display with edge-lit LED backlight (4 white LEDs). The backlight has one anode (A,+) and four cathode (K -) pins brought out on the FPC.
- ❑ 12:00 o'clock viewing angle (polarizer viewing direction).
- ❑ Temperature operation is from -20°C to +70°C.
- ❑ This TFT is RoHS compliant.
- ❑ Crystalfontz America, Incorporated is ISO 9001:2008 certified.
- ❑ This TFT can be ordered mounted on a carrier board. The carrier board supports a current drive for the LED backlight of the display. See descriptions under *Additional Options* on CFAF240400D-030T.

EXPLANATION OF PART NUMBER CODE

CFA	F	240	400	D	-	030	T
❶	❷	❸	❹	❺		❻	❼

❶	**Brand**	Crystalfontz America, Inc.
❷	**Display Type**	F – TFT
❸	**Number of Pixels (Width)**	240 pixels
❹	**Number of Pixels (Height)**	400 pixels
❺	**Model Identifier**	D
❻	**Diagonal Dimension**	030 – 3.0-inch diagonal
❼	**Backlight Type & Color**	T – white LED backlight

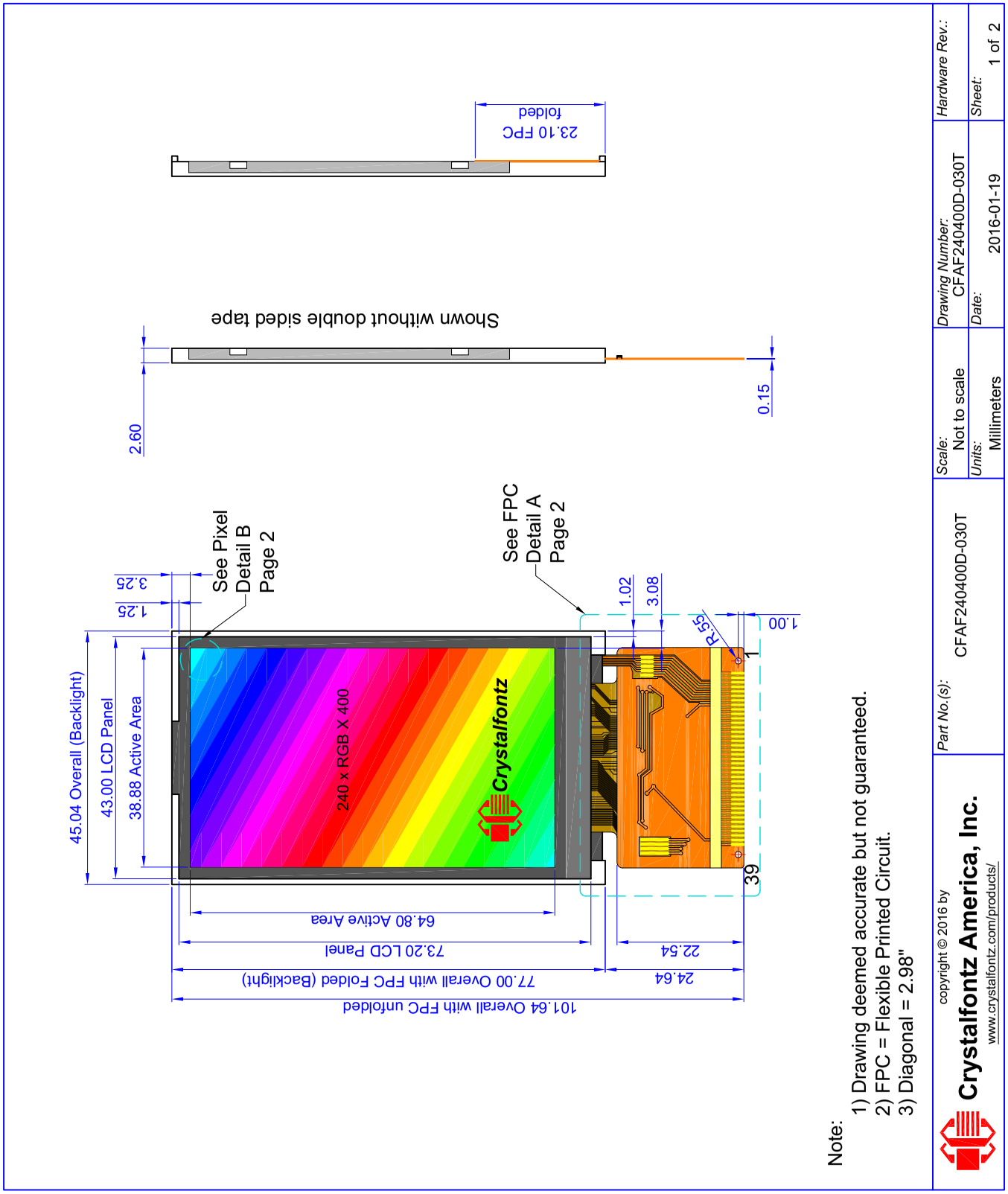
MECHANICAL SPECIFICATIONS

PHYSICAL CHARACTERISTICS

ITEM	SPECIFICATION
Number of Pixels	240 x RGB x 400 pixels
Pixel Pitch	0.162 (W) x 0.162 (H) mm
Active Area	
Active Area Diagonal	Millimeters: 75.569 mm Inches: 2.98" (referred to as 3.0")
Active Area Width	Millimeters: 38.88 (W) mm Inches: 1.53" (W)
Active Area Height	Millimeters: 64.80 (H) mm Inches: 2.55" (H)
Module Outline Dimensions	
Overall Module Width	Millimeters: 45.04 (W) mm Inches: 1.77" (W)
Overall Module Height with FPC unfolded*	Millimeters: 101.64 (H) mm Inches: 4.00" (H)
Overall Module Height with FPC folded	Millimeters: 77.00 (H) mm Inches: 3.03" (H)
**For reference only. Shape and length of FPC may vary.*	
Module Depth	Millimeters: 2.60 (D) mm Inches: 0.10" (D)
Weight	14 grams

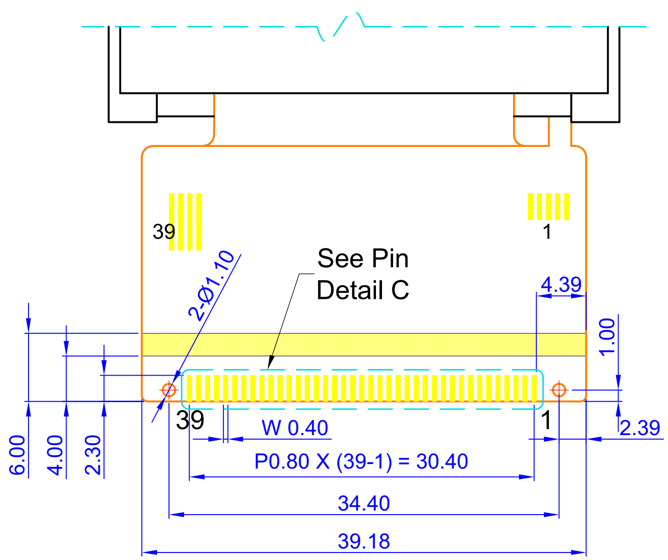
MODULE OUTLINE DRAWINGS

Figure 1. Module Outline Drawings (2 pages)

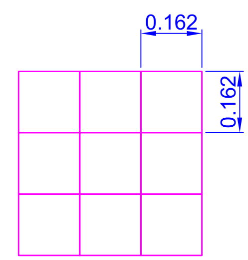


Pin	Signal
1	GND
2	NC
3	LEDK4
4	LEDK3
5	LEDK2
6	LEDK1
7	LEDA
8	RESET
9	IM0
10	IM1
11	DB-17
12	DB-16
13	DB-15
14	DB-14
15	DB-13
16	DB-12
17	DB-11
18	DB-10
19	DB-9
20	DB-8
21	DB-7
22	DB-6
23	DB-5
24	DB-4
25	DB-3
26	DB-2
27	DB-1
28	DB-0
29	RD
30	WR
31	RS
32	CS
33	NC
34	NC
35	NC
36	NC
37	NC
38	VDD
39	GND

Pin Detail C



FPC Detail A



Pixel Detail B

Note:

1) Drawing deemed accurate but not guaranteed.
2) FPC = Flexible Printed Circuit.
3) Diagonal = 2.98"

Part No.(s):	Scale:	Drawing Number:	Hardware Rev.:
CFAF240400D-030T	Not to scale	CFAF240400D-030T	
	Units: Millimeters	Date: 2016-01-19	Sheet: 2 of 2

ELECTRICAL SPECIFICATIONS

BLOCK DIAGRAM

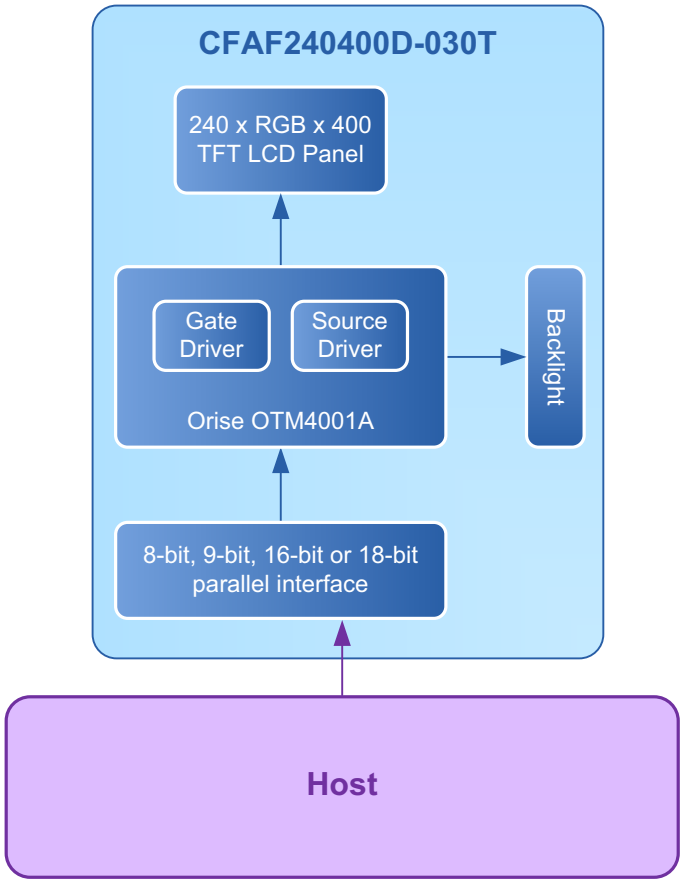


Figure 2. System Block Diagram / Circuit Example

LCD DUTY AND BIAS

DRIVING METHOD	SPECIFICATION
Duty[1]	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

Ambient Temperature (Ta) = 25°C			
Absolute Maximum Ratings	**Symbol**	**Minimum**	**Maximum**
Digital Logic Supply	V_{LOGIC}	-0.3v	+4.6v
Supply Voltage for IO Signal	$V_{LOGIC\ I/O}$		
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. 12) 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)

RECOMMENDED DC CHARACTERISTICS	SYMBOL	MINIMUM	TYPICAL	MAXIMUM
Digital Logic Supply	V_{LOGIC}	+2.4v	+2.8v	+3.3v
Supply Voltage for I/O Signals	$V_{LOGIC\ I/O}$	+1.65v		
Power Consumption	V_{OP}	—	12 mA	—
Input High Voltage	V_{IH}	+0.7v * $V_{LOGIC\ I/O}$ for $V_{LOGIC\ I/O}$ = +3.3v V_{IH} = +0.7v * +3.3v = +2.31v	—	$V_{LOGIC\ I/O}$
Input Low Voltage	V_{IL}	0v (GND)	—	+0.3v * $V_{LOGIC\ I/O}$ for $V_{LOGIC\ I/O}$ = +2.8v V_{IL} = +0.3v * +2.8v = 0.84v
Output High Voltage	V_{OH}	+0.8v * $V_{LOGIC\ I/O}$ for $V_{LOGIC\ I/O}$ = +3.3v V_{OH}= +0.8v * +3.3v = +2.64v	—	$V_{LOGIC\ I/O}$
Output Low Voltage	V_{OL}	0v (GND)	—	+0.2v * $V_{LOGIC\ I/O}$ for $V_{LOGIC\ I/O}$ = +3.3v V_{OL} = +0.2v * +3.3v = 0.66v
This is a summary of the module's major operating parameters. For details, see the Orise Tech OTM4001A datasheet on our website.				

ESD (ELECTRO-STATIC DISCHARGE)

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

DETAILS OF INTERFACE PIN FUNCTIONS

<table>
<tr><th>PIN</th><th>SIGNAL</th><th>DESCRIPTION</th></tr>
<tr><td>1</td><td>GND</td><td>Ground. Must be connected to an external ground.</td></tr>
<tr><td>2</td><td>NC</td><td>Make No Connection</td></tr>
<tr><td>3</td><td>K_4 (LED -)</td><td rowspan="4">Individual supply pins for LED. “K” (cathode or kathode for German and original Greek spelling) or “-” of LED backlight.</td></tr>
<tr><td>4</td><td>K_3 (LED -)</td></tr>
<tr><td>5</td><td>K_2 (LED -)</td></tr>
<tr><td>6</td><td>K_1 (LED -)</td></tr>
<tr><td>7</td><td>A (LED +)</td><td>Common supply pin for LEDs. “A” (anode) or “+” of LED backlight.</td></tr>
<tr><td>8</td><td>RESET</td><td>Reset signal.
Low: Display controller is reset. The RESET pin should be pulsed low shortly after power is applied.
High: The RESET pin should be brought high ($V_{DD\ I/O}$) for normal operation.</td></tr>
<tr><td>9</td><td>IM0</td><td rowspan="2">Interface mode select pins.
<table>
<tr><th>IM1</th><th>IM0</th><th>Interface Mode</th><th>DB Pins In Use</th></tr>
<tr><td>0</td><td>0</td><td>18-bit</td><td>DB17-BD0</td></tr>
<tr><td>0</td><td>1</td><td>9-bit</td><td>DB17-DB9</td></tr>
<tr><td>1</td><td>0</td><td>16-bit</td><td>DB17-DB10
DB8-D1</td></tr>
<tr><td>1</td><td>1</td><td>8-bit</td><td>DB7-DB10</td></tr>
</table></td></tr>
<tr><td>10</td><td>IM1</td></tr>
<tr><td>11-28</td><td>DB17~DB0</td><td>Parallel databus. If unused, connect to Ground.</td></tr>
<tr><td>29</td><td>$\overline{RD}$</td><td>Read control pin for the DBI interface. If unused, connect to $V_{DD\ I/O}$.</td></tr>
<tr><td>30</td><td>$\overline{WR}$</td><td>Write control pin for the DBI interface. If unused, connect to $V_{DD\ I/O}$.</td></tr>
<tr><td>31</td><td>RS
(D/$\overline{C}$)</td><td>Data/Command control. Determines whether data bits are data or command.
1 – High: Addresses the data register.
0 – Low: Addresses the command register.
If unused, connect to $V_{DD\ I/O}$.</td></tr>
<tr><td>32</td><td>$\overline{CS}$</td><td>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.</td></tr>
<tr><td>33-37</td><td>NC</td><td>Make No Connection</td></tr>
<tr><td>38</td><td>V_{DD}</td><td>Digital Logic Supply and Input/Output Supply</td></tr>
<tr><td>39</td><td>GND</td><td>Ground. Must be connected to an external ground.</td></tr>
<tr><td colspan="3">For backlight connections, please refer to LED Backlight Characteristics (Pg. 16).</td></tr>
</table>

OPTICAL SPECIFICATIONS

Ambient Temperature (Ta) = 25°C, Maximum 75% Relative Humidity					
ITEM	**SYMBOL**	**ADDITIONAL TEST CONDITIONS**	**MINIMUM**	**TYPICAL**	**MAXIMUM**
Color Depth				65K/262K	
Any one of the pixels can show any of the 16.7 million colors.					
Contrast Ratio (CR)[1]		θ = φ - 0°		250	
TFT Response Time[2]	Tr			30 ms	
	Tf			30 ms	
Red Chromaticity	Rx		0.633	0.653	0.673
	Ry		0.311	0.331	0.351
Green Chromaticity	Gx		0.291	0.311	0.331
	Gy		0.554	0.574	0.594
Blue Chromaticity	Bx		0.114	0.134	0.154
	By				
White Chromaticity	Wx		0.288	0.308	0.328
	Wy		0.322	0.342	0.362
Viewing Angle, Horizontal	θ_{X+}	Center CR≥10		130 degrees	
	θ_{X-}				
Viewing Angle, Vertical	θ_{Y+}			110 degrees	
	θ_{Y-}				
Viewing Direction				12:00	

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

[2] *Response Time: The amount of time it takes a pixel to change from active to inactive or back again. Tr = T rise, Tf = T fall.*

Optical Measuring Conditions

- ❑ Dark room, ambient temperature (Ta) = 25°C, and 15 minutes warm up time.
- ❑ Westar Display Technologies FPM520 display measurement system, SR-3 for chromaticity, and Topcon BM-5A luminance colorimeter for other optical characteristics.

Definition of Response Time (Tr, Tf)

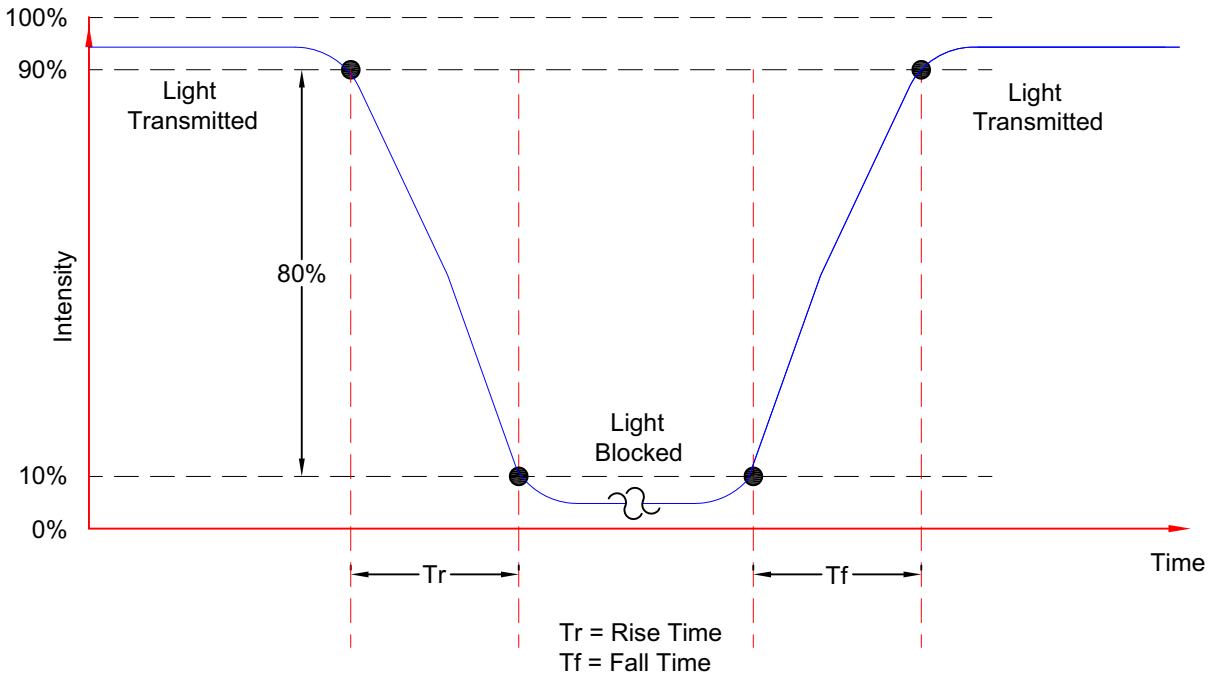


Figure 3. Definition of Response Time (Tr, Tf)

Definition of Vertical and Horizontal Viewing Angles (CR≥2)

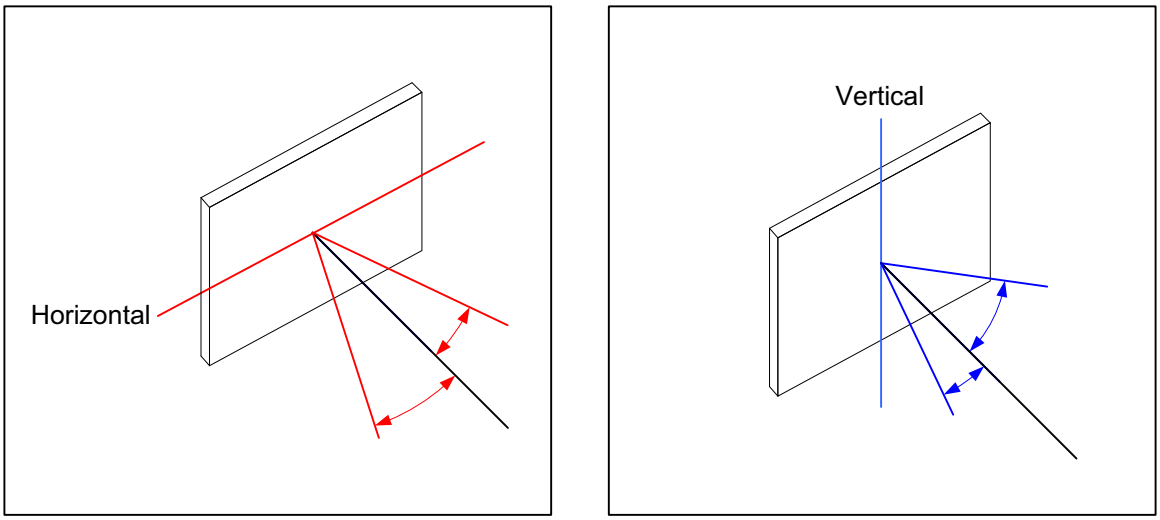


Figure 4. Definition of Horizontal and Vertical Viewing Angles (CR>2)

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

This module has a 12:00 o'clock viewing angle.

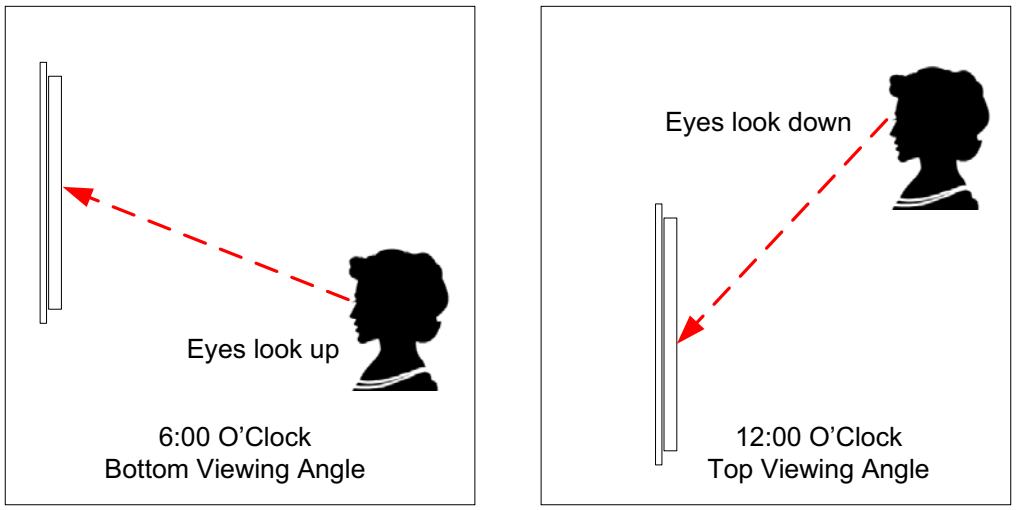


Figure 5. Definition of 6:00 O'Clock and 12:00 O'clock Viewing Angles

LED BACKLIGHT CHARACTERISTICS

LED Backlight Characteristics ***Edge-lit with 4 LEDs in parallel*** ***Ambient temperature: TA = 25°C***		
PARAMETER	**MINIMUM**	**TYPICAL**
Forward Current (I_{LED}) (V_{LED} = 3.2v)		60 mA* 15mA per LED 15mA x 4 = 60 mA
**Driving the backlight above 60 mA will shorten its lifetime.*		
Forward Voltage (V_{LED})		+3.2v
Luminous Intensity* (I_V) I_{LED} = 60 mA		TBD cd/m^2
Uniformity (minimum/maximum x 100%)	80%	

The CFAF240400D-030T uses an LED backlight. LED backlights are easy to use, but they are also easily damaged by abuse.

CAUTION

Do not connect +5v directly to the backlight terminals. This will ruin the backlight.

> **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 module to display module.

SOURCES FOR DRIVER LIBRARIES AND SAMPLE CODE

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.

SAMPLE CODE

Free downloadable sample code is on our website under the product’s DATASHEETS & FILES tab.

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	60°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 note below.	3 displays	Pass
Note: Five cycles of operation: Test L ow for 30 minutes -> normal temperature for 5 minutes -> Test High for 30 minutes -> normal temperature for 5 minutes, as one cycle then take it out and dry at normal temperature, and allow to stand for 24 hours.			

MODULE RELIABILITY

PART NUMBER	SPECIFICATION
CFAF240400D-030T	Brightness will be >50% of a new module's initial brightness for at least 50,000 hours of operation when supply to each LED is below 60 mA.

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

The white LEDs dim over time, especially if driven with high currents. The dimming may not be noticeable when a single display module is installed. However, if a new display module is installed next to a display module 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:

- *Backlight LEDs.* Brightness may be affected (perhaps the new LEDs have better efficiency) or the current they draw may change (new LEDs may have a different VF).
- *Controller.* A new controller may require minor changes in your code.
- *Component tolerances.* Module components have manufacturing tolerances. In extreme cases, the tolerance stack can change the visual or operating characteristics.

Please understand that we avoid changing a module whenever possible; we only discontinue a module if we have no other option. We will post Part Change Notices on the product's web page as soon as possible. If interested, you can subscribe to future part change notifications.

CARE AND HANDLING PRECAUTIONS

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

Excessive voltage will shorten the life of the module. You must drive the display module within the specified voltage limit.See Recommended DC Characteristics (3.0v Operation) (Pg. 12).

HANDLING CAUTION FOR MODULES SHIPPED IN TRAYS

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

This panel has sensitive components on the FPC. Handle the display modules carefully in to prevent damage.

ESD (ELECTRO-STATIC DISCHARGE)

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

DESIGN AND MOUNTING

- 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.
- Do not disassemble or modify the 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 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 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 panel Do not crease the cables.

TAB SOLDERING

This module uses a "TAB" (tape automated bonding) or "COF" (chip on flex) style flex tail mated with a "COG" (chip on glass) display controller. The TAB is soldered directly to corresponding pads on your PCB by using a hot-bar soldering machine. High volume contract manufacturers will be familiar with this type of construction and its assembly methods.

Hot-bar soldering machines designed for prototype, rework, or repair of TAB connections are available from equipment suppliers at reasonable cost. The TAB style connection requires no separate connector so the cost is very low and the ultrathin profile of the display is maintained.

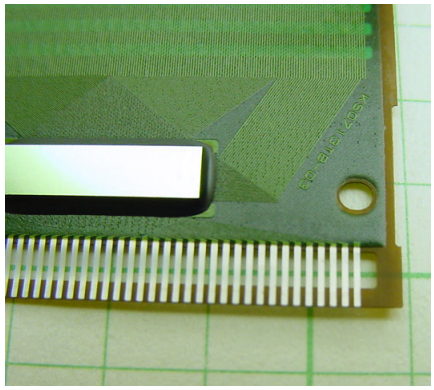


Figure 6. Typical Tab Solder Tail Construction

Hot Bar Soldering Machine

We have had good experience with the APE Bondmaster and their price is reasonable ($US4K in June 2009). Other possible solutions are:

http://www.fancort.com/hotbar/hotbar.html
https://www.manncorp.com/hot-bar-soldering/pbs-series/index.php?auto=done

The process is:

1. Pads on the PCB are tinned.
2. Tail is visually aligned to the PCB or by using the alignment holes.
3. Tail is held in place relative to the PCB with Kapton® tape.
4. Bondmaster head is lowered, applying pressure between the tail and the PCB.
5. Bondmaster is "cycled", which means it heats up to the point of melting the solder and then cools down.
6. Bondmaster head is raised.

Hand Soldering

For prototype work, hand soldering may be acceptable. Preset soldering iron to <260°C. Do not apply heat for more than 3 to 4 seconds. The FPC is quite fragile; use extreme care when soldering by hand. Great care must be taken since the conductors of the tail are completely exposed in the area where they are soldered. Solder only to the exposed terminals of the FPC connector. The use of Kapton® tape to help locate and secure the FPC may be useful.

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 THE DISPLAY PANEL

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 polarizer over time. Never apply liquids directly on the 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 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

- Do not connect or disconnect the display module when the host power is on.
- 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 module 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: a minimum of -20°C to a maximum of +70°C noncondensing with minimal fluctuation. Operation outside of these limits may shorten life and/or harm the display module. Changes in temperature can result in changes in contrast.
  - At lower temperatures of this range, response time is delayed.
  - At higher temperatures of this range, display becomes dark. (You may need to adjust the contrast.)
- Operate away from dust, moisture, and direct sunlight.

STORAGE AND RECYCLING

- Store in an ESD-approved container away from dust, moisture, and direct sunlight, fluorescent lamps, or any 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.
- It is recommended that the modules should be stored under a condition where no condensation is allowed. Condensation may cause an abnormal operation or a failure of the module.
- 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

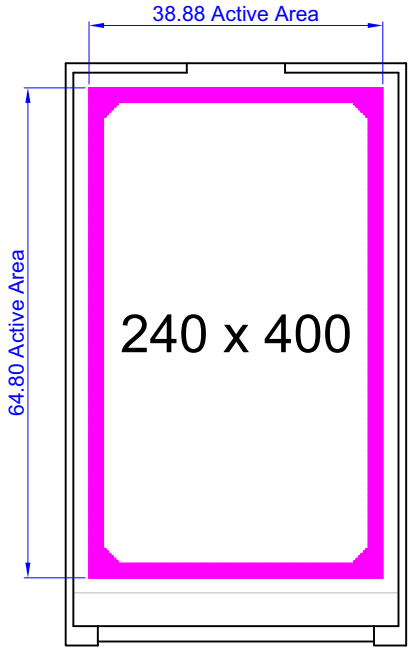
INSPECTION CONDITIONS

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



ACCEPTANCE SAMPLING

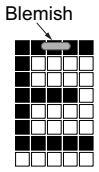
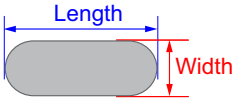
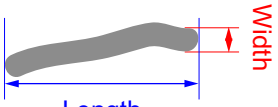
DEFECT TYPE	AQL*
Major	≤.65%
Minor	<1.0%
* Acceptable Quality Level: maximum allowable error rate or variation from standard	

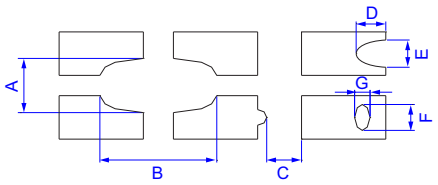
DEFECTS CLASSIFICATION

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		*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. 25), and dark lines or scratches (see test 6, Pg. 25).
*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.

Term / Symbol	Description
I_{DD}	Typical power supply current for TFT. Total electrical current (I) in the Drains of a CMOS circuit
I_{LED}	Current used by LED backlight.
IM*n*	Interface mode select pin where *n* is the corresponding number.
I_{OP} V_{CCI}	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 = 0.000001A (Ampere)
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, ...
MIPI	Mobile Industry Processor Interface. See MIPI Alliance.
MISO SDO D_{OUT}	Data output signal in serial SPI interface: Master In Slave Out. Serial Data Out.
MOSI SDI SI DINI_SDA	Data output signal in serial SPI interface: Master Out Slave In. Serial Data In.
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.
P_{CLK}	Pixel clock signal for RGB / DPI mode.
PS*n*-PS0	**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)

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. See Definition of Response Time (Tr, Tf) (Pg. 15).
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. See Definition of Response Time (Tr, Tf) (Pg. 15).
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/$\overline{W}$ (W$\overline{R}$) $\overline{WR}$ (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 $V_{LOGIC\ I/O}$.