



DISPLAY MODULE DATASHEET



Datasheet Release 2015-12-29
for
[CFAF240320E-022T](#)

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GENERAL INFORMATION

Datasheet Revision History

Datasheet Release: 2015-12-29
First datasheet for a new product, the CFAF240320E-022T TFT display module.

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/CFAF240320E022T>

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. 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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DISPLAY MODULE DESCRIPTION

GENERAL SPECIFICATIONS

This is a full color active matrix TFT (Thin Film Transistor) LCD (Liquid Crystal Display) that uses an amorphous silicon TFT as a switching device. This model is composed of a transmissive TFT-LCD Panel, driver circuit, and an LED backlight.

General Information Items	Specification	Unit	Note
	Main Panel		
Display area (AA)	33.84(H)*45.12(V) (2.2inch)	mm	-
Driver element	TFT active matrix	-	-
Display colors	65K	colors	-
Number of pixels	240*(RGB)*320	dots	-
Pixel arrangement	RGB vertical stripe	-	-
Pixel pitch	0.141(H)*0.141(V)	mm	-
Viewing angle	6:00	o'clock	-
Controller IC	ST7789V	-	-
Display mode	Transmissive/Normally White	-	-
Operating temperature	-20 +70	°C	-
Storage temperature	~ ~	°C	-

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal		41.70		mm	-
	Vertical(V)		56.16		mm	-
	Depth(D)		2.60		mm	-
Weight			10		g	-



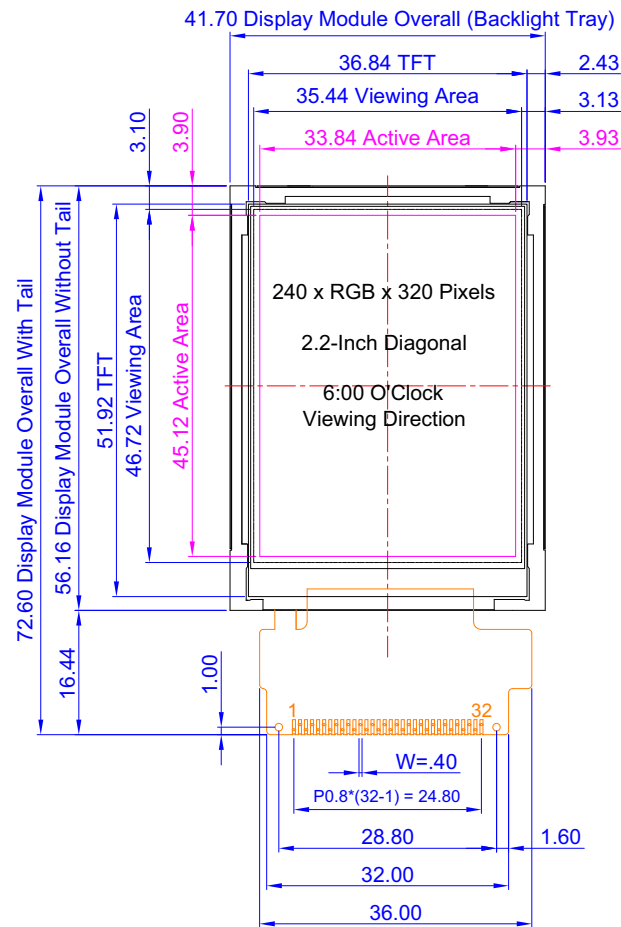
ADDITIONAL FEATURES

- ☐ The interface is 8-bit parallel.
- ☐ Sample code is available for download under the display's web page [Datasheets & Files](#) tab.
- ☐ The connector can be soldered directly to corresponding pads on your PCB with a hot-bar soldering machine.
- ☐ For additional communications information, see the [Sitronix ST7789V](#) controller datasheet on our website.
- ☐ This display is RoHS compliant.
- ☐ CrystalFontz America Incorporated is ISO 9001:2008 certified.

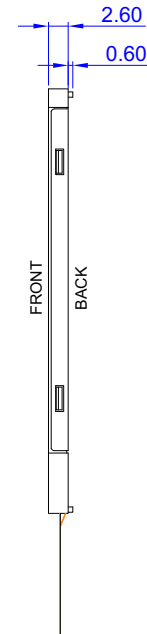


DISPLAY MODULE OUTLINE DRAWINGS

Front View



Side View



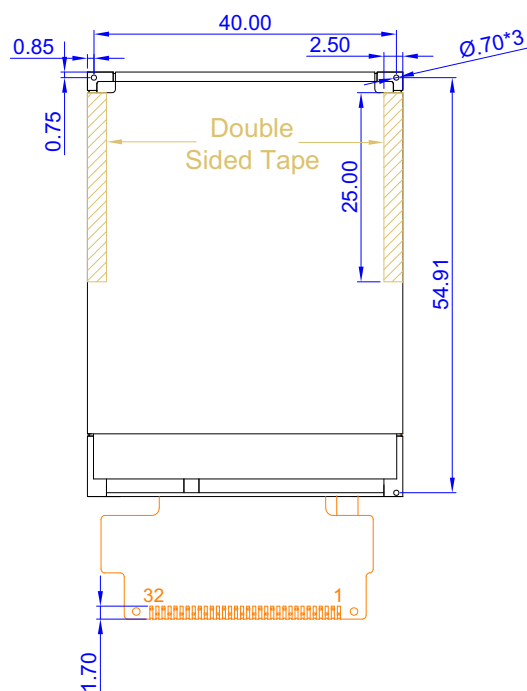
Notes:

1. Drawing is deemed accurate but not guaranteed.
2. Diagonal = 2.2"





Back View



Note:

1. Drawing is deemed accurate but not guaranteed.
2. Diagonal = 2.22"



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Part No.(s):

CFAF240320E-022T

Scale:

Not to scale

Units:

Millimeters

Drawing Number:

CFAF240320E-022T

Date:

2015-12-16

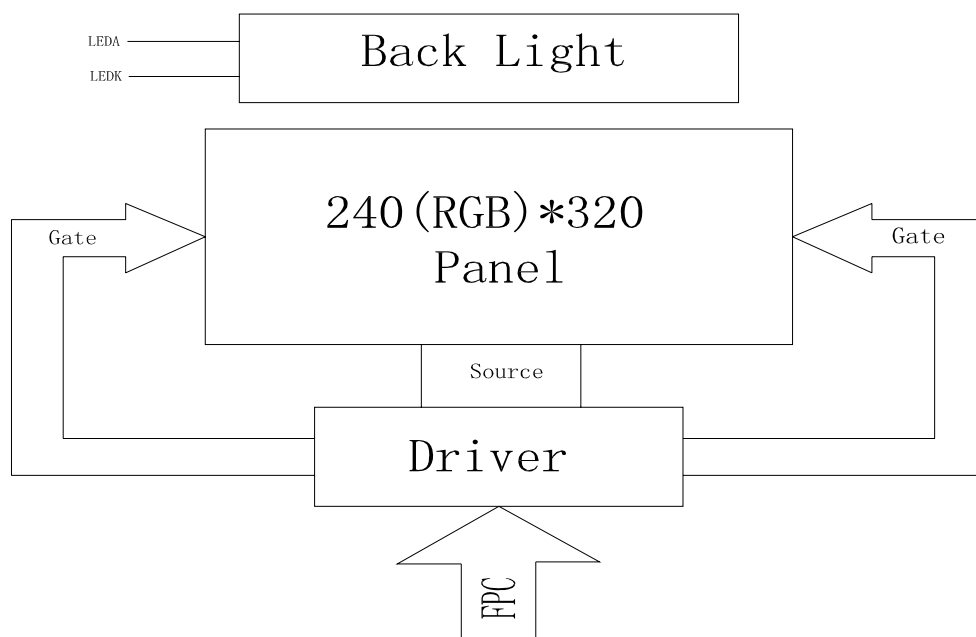
Hardware Rev.:

Sheet:

2 of 2



SYSTEM BLOCK DIAGRAM





ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

This display module uses an LED backlight. LED backlights are easy to use, but they are also easily damaged.

CAUTION

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

These are stress ratings only. Functional operation of the display module at these or any other conditions beyond those listed under Recommended DC Characteristics below is not implied. Stresses beyond those listed above can cause permanent damage.

Prolonged exposure at temperatures outside of the operating range may cause permanent damage to the module.

Characteristics	Symbol	Min.	Max.	Unit
Digital Supply Voltage	VDD	-0.3	4.6	V
Digital interface supply Voltage	VDDIO	-0.3	4.6	V
Operating temperature	TOP	-20	+70	°C
Storage temperature	TST	-30	+80	°C



RECOMMENDED DC CHARACTERISTICS

Characteristics	Symbol	Min.	Typ.	Max.	Unit	Note
Digital Supply Voltage	VDD	2.4	3.3	4.0	V	
Digital interface supply Voltage	VDDIO	1.65	3.3	4.0	V	
Normal mode Current consumption	IDD	--	7	--	mA	
Level input voltage	VIH	0.7VDDIO		VDDIO	V	
	VIL	GND		0.3VDDIO	V	
Level output voltage	VOH	0.8VDDIO		VDDIO	V	
	VOL	GND		0.2VDDIO	V	

LED BACKLIGHT CHARACTERISTICS

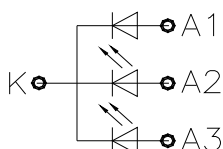
NOTE

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

The backlight is edge-lit with two white LEDs.

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Forward Current	IF	45	60	--	mA	
Forward Voltage	VF	--	3.2	--	V	
LCM Luminance	LV	--	TBD	TBD	cd/m2	If=60mA

Backlight Circuit:





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.

OPTICAL CHARACTERISTICS

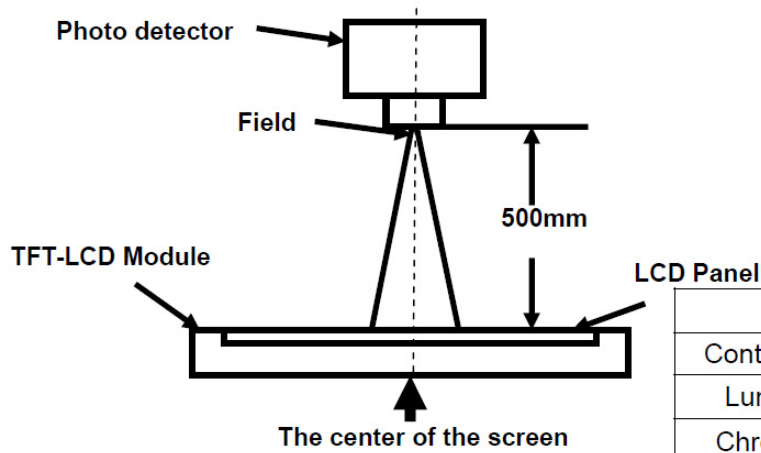
Measurements taken in a dark room, ambient temperature 25°C, with a 15 minute warm-up period. Chromaticity ([CIE 1931](#)) color coordinates measured at center point of LCD.

Item		Symbol	Condition	Min.	Typ.	Max.	Unit.
Transmittance (with Polarizer)		T(%)	--	5.5	6.0	--	%
Contrast Ratio		CR	$\theta=0$	250	350		%
Response time		T _{ON}	25°C	--	20	30	Ms
		T _{OFF}					
NTSC		S(%)		--	48	--	%
Color Filter Chromaticity	White	W _X	C-light	0.253	0.303	0.353	
		W _Y		0.309	0.359	0.409	
	Red	R _X		0.581	0.631	0.681	
		R _Y		0.265	0.315	0.365	
	Green	G _X		0.261	0.311	0.361	
		G _Y		0.478	0.528	0.578	
	Blue	B _X		0.081	0.131	0.181	
		B _Y		0.119	0.169	0.219	
Viewing angle	Hor.	θ_L	CR>10	40	45	--	
		θ_R		40	45	--	
	Ver.	θ_T		45	50	--	
		θ_B		15	20	--	
Option View Direction		6 O'clock					



OPTICAL MEASUREMENT SETUP

Westar Display Technologies FPM520 display measurement system using SR-3 for chromaticity and BM-7A for other optical characteristics.



Item	Photo detector	Field
Contrast Ratio	SR-3A	1°
Luminance		
Chromaticity		
Lum Uniformity		
Response Time	BM-7A	2°

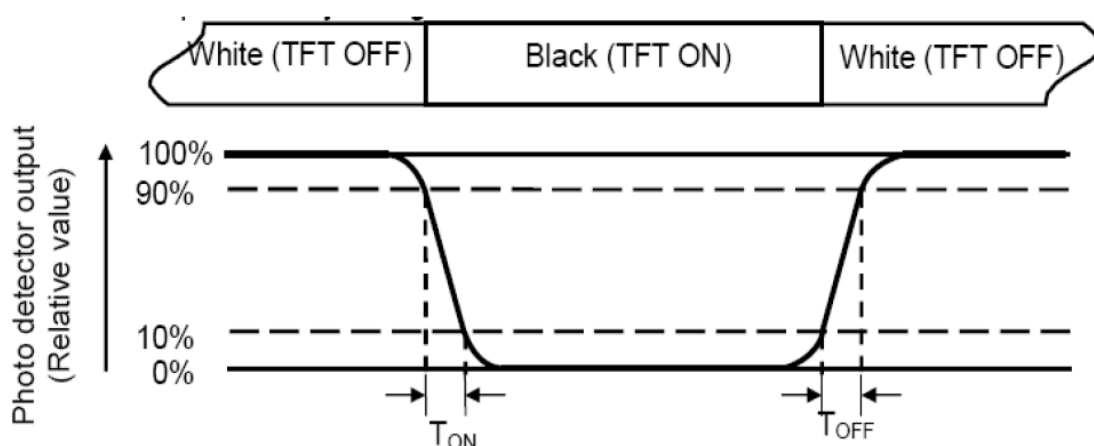


DEFINITION OF CONTRAST RATIO

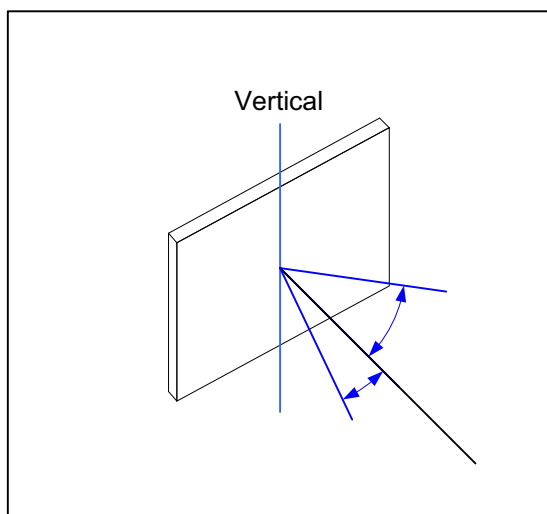
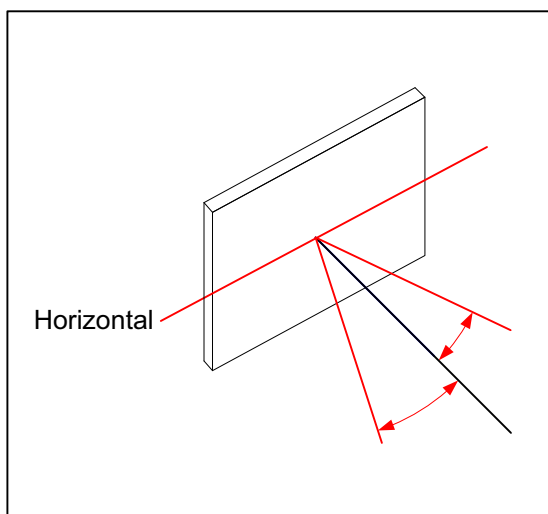
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance measured when LCD is on the "White" state}}{\text{Luminance measured when LCD is on the "Black" state}}$$

DEFINITION OF RESPONSE TIME (TON, TOFF)

The response time is defined as the LCD optical switching time interval between "White" state and "Black" state. Rise time (T_{ON}) is the time between photo detector output intensity changed from 90% to 10%. And fall time (T_{OFF}) is the time between photo detector output intensity changed from 10% to 90%.



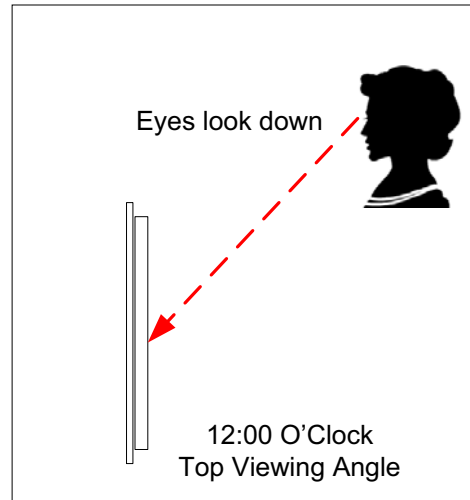
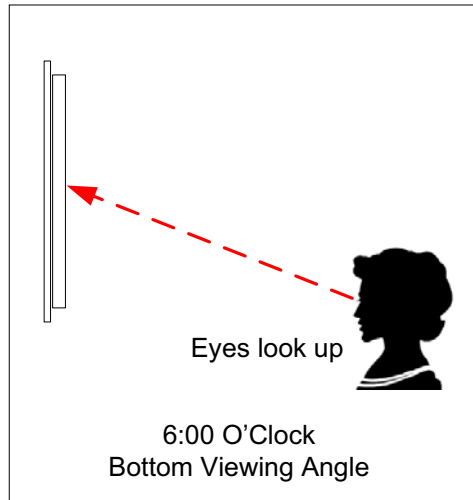
DEFINITION OF VERTICAL AND HORIZONTAL VIEWING ANGLES ($CR \geq 2$)





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

This display module has a **6:00 o'clock** viewing angle.





DETAILS OF INTERFACE PIN FUNCTIONS

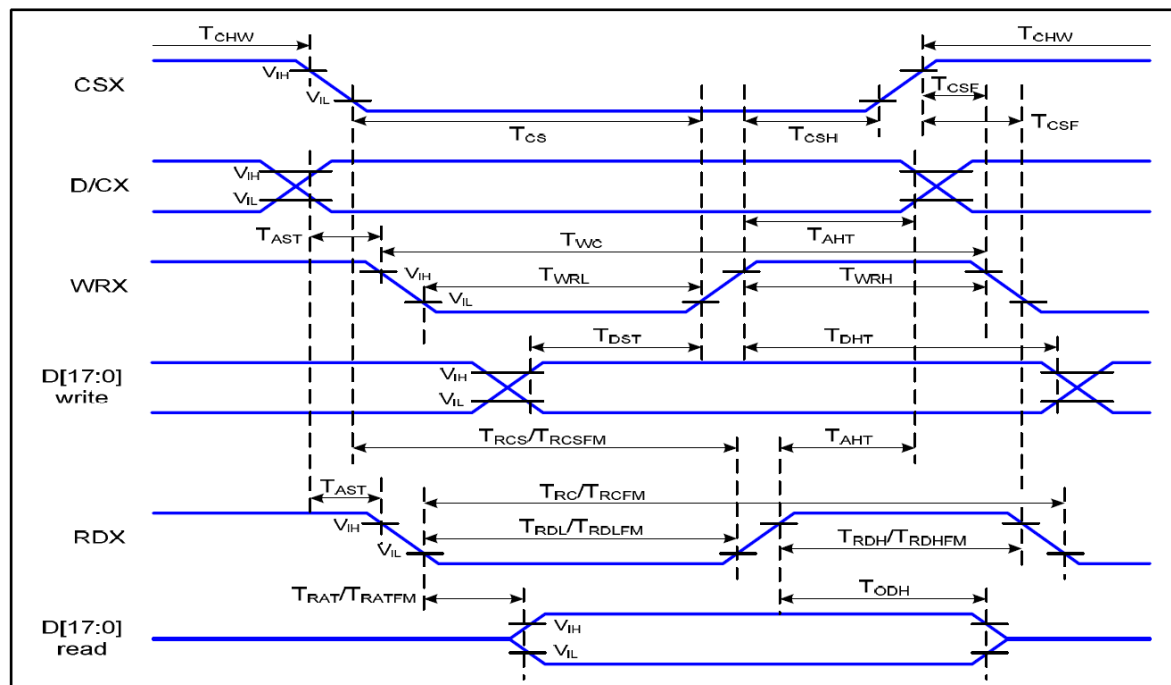
NO.	SYMBOL	DESCRIPTION	I/O
1	NC	Ground.	P
2	GND	Ground.	
3	IOVCC		
4	CS	-Chip select input pin ("Low" enable). -Fix this pin at VCI or GND when not in use.	
5	RS	-Display data/ command selection pin	
6	WR	-The MCU interface mode select.	I
7	RD	Read enable in 8080 MCU parallel interface. -If not used, please fix this pin at VDD.	
8	NC	NC.	
9	NC	NC.	
10	NC	NC.	I
11	NC	NC.	
12	NC	NC.	
13	LEDA1	Anode pin of backlight.	
14	LEDA2	Anode pin of backlight.	
15	LEDA3	Anode pin of backlight.	I/O
16	LEDK	Cathode pin of backlight.	
17	NC	NC	I/O
18	NC	NC	
19	NC	NC	I
20-27	DB0 - DB7	- 8-bit parallel bi-directional data bus for MCU interface mode. - Fix to GND level when not in use.	I
28	RESET	Reset pin. Setting either pin low initializes the LSI. Must be reset after power is supplied.	I
29	VCI	Supply Voltage(3.3V).	I
30	VCI	Supply Voltage(3.3V).	P



31	GND	Ground.	P
32	NC	NC.	p

AC CHARACTERISTICS

Parallel 8-bit interface timing characteristics (8080):

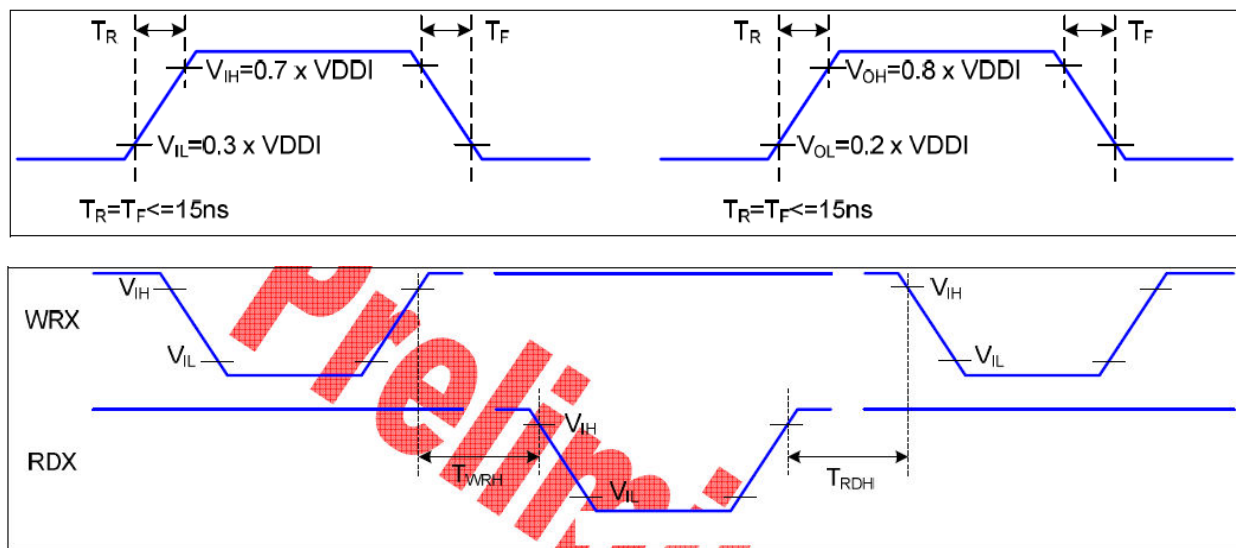


$VDDI=1.65$ to $3.3V$, $VDD=2.4$ to $3.3V$, $AGND=DGND=0V$, $T_a = -30$ to $70\text{ }^{\circ}C$

Signal	Symbol	Parameter	Min	Max	Unit	Description
D/CX	T _{AST}	Address setup time	0		ns	-
	T _{AHT}	Address hold time (Write/Read)	10		ns	
CSX	T _{CHW}	Chip select "H" pulse width	0		ns	-
	T _{CS}	Chip select setup time (Write)	15		ns	
	T _{RCS}	Chip select setup time (Read ID)	45		ns	
	T _{RCSFM}	Chip select setup time (Read FM)	355		ns	
	T _{CSF}	Chip select wait time (Write/Read)	10		ns	
	T _{CSH}	Chip select hold time	10		ns	
WRX	T _{WC}	Write cycle	66		ns	-
	T _{WRH}	Control pulse "H" duration	15		ns	
	T _{WRL}	Control pulse "L" duration	15		ns	



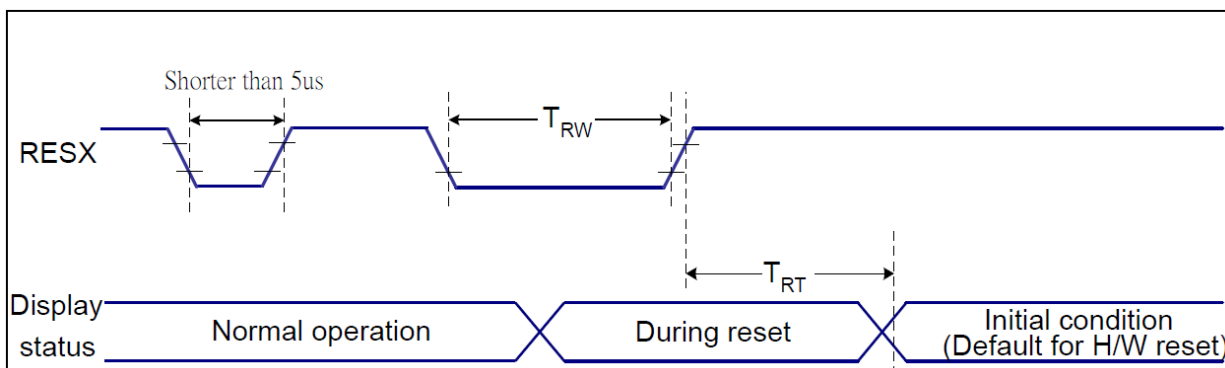
RDX (ID)	T_{RC}	Read cycle (ID)	160		ns	When read ID data
	T_{RDH}	Control pulse "H" duration (ID)	90		ns	
	T_{RDL}	Control pulse "L" duration (ID)	45		ns	
RDX (FM)	T_{RCFM}	Read cycle (FM)	450		ns	When read from frame memory
	T_{RDHFM}	Control pulse "H" duration (FM)	90		ns	
	T_{RDLFM}	Control pulse "L" duration (FM)	355		ns	
D[17:0]	T_{DST}	Data setup time	10		ns	For CL=30pF



Note: The rising time and falling time (T_r , T_f) of input signal and fall time are specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.



RESET TIMING CHARACTERISTICS



$V_{DDI}=1.65$ to $3.3V$, $V_{DD}=2.4$ to $3.3V$, $AGND=DGND=0V$, $T_a=-30 \sim 70^{\circ}C$

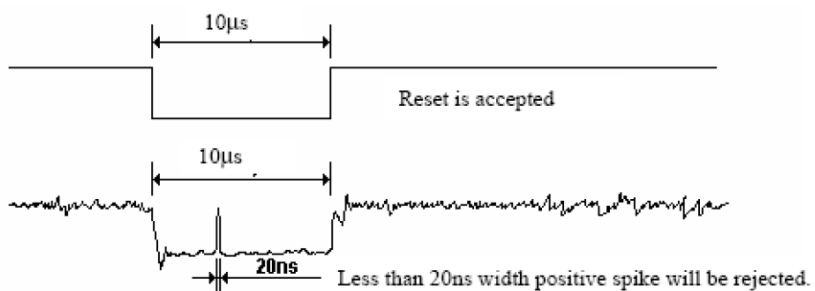
Related Pins	Symbol	Parameter	MIN	MAX	Unit
RESX	TRW	Reset pulse duration	10	-	us
	TRT	Reset cancel	-	5 (Note 1, 5)	ms
				120 (Note 1, 6, 7)	ms

Notes:

1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time (t_{RT}) within 5 ms after a rising edge of RESX.
2. Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below:

RESX	Action
Shorter than 5us	Reset Rejected
Longer than 9us	Reset
Between 5us and 9us	Reset starts

3. During the Resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep Out –mode. The display remains the blank state in Sleep In –mode.) and then return to Default condition for Hardware Reset.
4. Spike Rejection also applies during a valid reset pulse as shown below:



5. When Reset applied during Sleep In Mode.
6. When Reset applied during Sleep Out Mode.
7. It is necessary to wait 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec.



PRODUCT RELIABILITY AND LONGEVITY

DISPLAY MODULE RELIABILITY TEST RESULTS

Item	Condition	Sample Size	Test Result	Note
Low Temperature Operating Life test	-20°C, 96 HR	3ea	pass	-
Thermal Humidity Operating Life test	70°C90%RH, 96 HR	3ea	pass	-
Temperature Cycle ON/OFF test	-20°C ↔ 70°C, ON/OFF, 20 CYCLES	3ea	pass	(1)
High Temperature Storage test	80°C, 96 HR	3ea	pass	-
Low Temperature Storage test	- 30°C, 96 HR	3ea	pass	-
ESD test	150pF, 330Ω , ±6KV(Contact)/± 8KV(Air), 5 points/panel, 10 times/point	3ea	pass	
Thermal Shock Resistance	The sample should be allowed to stand the following 5 cycles of operation: TSTL for 30 minutes -> normal temperature for 5 minutes -> TSTH for 30 minutes -> normal temperature for 5 minutes, as one cycle, then taking it out and drying it at normal temperature, and allowing it stand for 24 hours	3ea	pass	
Box Drop Test	1 Corner 3 Edges 6 faces, 66cm(MEDIUM BOX)	1box	pass	-

Note (1) ON Time over 10 seconds, OFF Time under 10 seconds



DISPLAY MODULE RELIABILITY

We list the lifetime of white LEDs at 50,000 hours to emphasize that white LEDs do not have the extremely long lifetime typical of red, yellow-green, or blue LEDs. 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.

PART NUMBER	SPECIFICATION
CFAF240320E-022T	Brightness will be >50% of a new display module's initial brightness for at least 50,000 hours of operation when supply to each if LED is below 60 mA.
<i>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.</i>	

DISPLAY MODULE LONGEVITY (EOL / REPLACEMENT POLICY)

CrystalFontz is committed to making all of our display modules available for as long as possible. Occasionally, a supplier discontinues a component, or a process used to make the module becomes obsolete, or the process moves to a more modern manufacturing line. In order to continue making the module, we will do our best to find an acceptable replacement part or process which will make the “replacement” fit, form, and function compatible with its predecessor.

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 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 display module to the discontinued module it replaces. 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 display module is still within the stated datasheet specifications and tolerances of the discontinued module, changes may require modification to your circuit and/or firmware. Possible changes include:

- *LCD fluid, polarizers, or the LCD manufacturing process.* These items may change the appearance of the display, requiring an adjustment to V_O .
- *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 module if we have no other option. We publish Part Change Notices (PCN) as soon as possible.



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 \(Pg. 10\)](#).

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 controller/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.
- 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.
- 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.
- 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 Lexan, which is readily available and works well.
- 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.
- Repeated sharp bends can damage the FPC/FFC tail. (FPC = Flexible Printed Circuit, FFC = Flat Flex Cable) As long as the FPC/FFC bend stays within the FPC/FFC elastic region, it can be bent multiple times. To tell if a bend is completely elastic, the FPC/FFC will return 100% to its pre-bent state. Typically this is around a 5mm radius, or 10mm from side-to-side for a 180° bend. You may bend the FPC/FFC more sharply. For instance, to pass the tail through a slot in a PCB. However these sharper bends will force the FPC/FFC into its plastic region, where it will



not return to its pre-bent state on its own. The key is to make sharper bends only once and leave them. Repeatedly bending and unbending the FPC/FFC through its plastic region will cause it to fatigue and eventually fail.

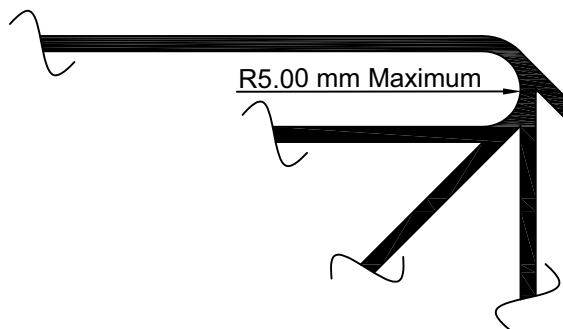


Figure 1. Example Of Minimum Plastic Bend Radius For FPC/FFC

AVOID SHOCK, IMPACT, TORQUE, OR TENSION

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

CAUTION

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 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

- We do not recommend connecting this display module to a PC's parallel port as an end product. This display 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 display module from ESD and power supply transients.



- Observe the operating temperature limitations, non-condensing with minimal fluctuations. 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 with minimal fluctuations. Rapid temperature changes can cause moisture to form, resulting in permanent damage.
- Do not allow weight to be placed on the display modules while they are in storage.
- Please recycle your outdated CrystalFontz display modules at an approved facility.



QUALITY ASSURANCE STANDARDS

INSPECTION CONDITIONS

- Environment
 - Temperature: $25\pm 5^{\circ}\text{C}$
 - 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

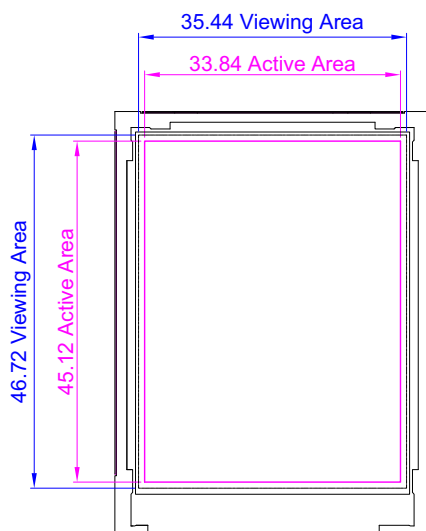
We try to describe the appearance of our modules as accurately as possible. For the photos, we adjust for optimal appearance. Actual display appearance may vary due to (1) different operating conditions, (2) small variations of component tolerances, (3) inaccuracies of our camera, (4) color interpretation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

DEFECTS CLASSIFICATION

Defects are defined as:

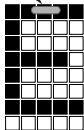
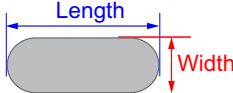
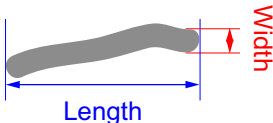
- Major Defect: results in failure or substantially reduces usability of unit for its intended purpose.
- Minor Defect: deviates from standards but is not likely to reduce usability for its intended purpose.

ACTIVE AREA AND VIEWING AREA LOCATIONS

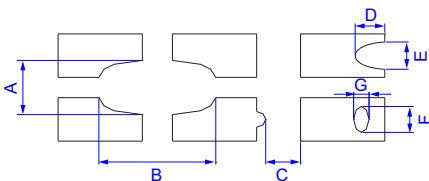




ACCEPTANCE STANDARDS

#	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	<div>Blemish</div> 	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	<div>Defect size = (A + B)/2</div> 	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		



#	DEFECT TYPE	ACCEPTANCE STANDARDS CRITERIA (Continued)	MAJOR / MINOR	
8	Display pattern defect		Minor	
		Dot Size (mm)		Acceptable Qty
		$((A+B)/2) \leq 0.2$		≤ 3 total defects ≤ 2 pinholes per digit
		$C > 0$		
		$((D+E)/2) \leq 0.25$		
		$((F+G)/2) \leq 0.25$		
9	Backlight defects	<div>1. Light fails or flickers.*</div> <div>2. Color and luminance do not correspond to specifications.*</div> <div>3. Exceeds standards for display's blemishes or foreign matter (see test 5, Pg. 28), and dark lines or scratches (see test 6, Pg. 28).</div> <div><i>*Minor if display functions correctly. Major if the display fails.</i></div>	Minor	
10	COB defects	<div>1. Pinholes > 0.2 mm.</div> <div>2. Seal surface has pinholes through to the IC.</div> <div>3. More than 3 locations of sealant beyond 2 mm of the sealed areas.</div>	Minor	
11	PCB defects	<div>1. Oxidation or contamination on connectors.*</div> <div>2. Wrong parts, missing parts, or parts not in specification.*</div> <div>3. Jumpers set incorrectly.</div> <div>4. Solder (if any) on bezel, LED pad, zebra pad, or screw hole pad is not smooth.</div> <div><i>*Minor if display functions correctly. Major if the display fails.</i></div>	Minor	
12	Soldering defects	<div>1. Unmelted solder paste.</div> <div>2. Cold solder joints, missing solder connections, or oxidation.*</div> <div>3. Solder bridges causing short circuits.*</div> <div>4. Solder balls.</div> <div><i>*Minor if display functions correctly. Major if the display fails.</i></div>	Minor	



APPENDIX A: 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.
$\overline{\text{CS}}$ CS# CSX	Chip select input. <i>Low</i> : Controller chip is selected. Communications with host are possible. <i>High</i> : 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.
$\overline{\text{D/C}}$ RS DCX A0 CD D/C#	Data/Command control. Determines whether data bits are data or command. <i>1 – High</i> : Addresses the data register. <i>0 – Low</i> : 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 <i>n</i> 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 -PS ₀	<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>	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)
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. <i>8080 Host:</i> Active low. Signal on the databus is latched at the rising edge of \overline{RD} . <i>6800 Host (if available):</i> Enable control signal input active high. E = <i>High</i> : Read or Write operation is active E = <i>Low</i> : 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. <i>Low:</i> Display controller is reset. The \overline{RST} pin should be pulsed low shortly after power is applied. <i>High:</i> 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}) $R/\overline{W}\#$	Host interface input. <i>8080 Host:</i> Active low. Signal on the databus is latched at the rising edge of \overline{WR} signal. <i>6800 Host (if available):</i> Read/Write control signal output. R/\overline{W} = High: Read (Host←Module) R/\overline{W} = Low: Write (Host→Module)
$\overline{WR_SCK}$	<i>DBI Type-B:</i> Serves as a write signal and write data at the low level. <i>DBI Type-C:</i> it serves as SCK (Serial Clock). If unused, tie to $V_{LOGIC\ I/O}$.