



DISPLAY MODULE DATASHEET



Datasheet Release 2016-09-19
for
[CFAF240320E-022T](#)

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GENERAL INFORMATION

Datasheet Revision History

Datasheet Release: 2016-09-19

Added a caution note to [LED Backlight Characteristics \(Pg. 12\)](#). Display specifications have not changed. Removed unnecessary sections.

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	-



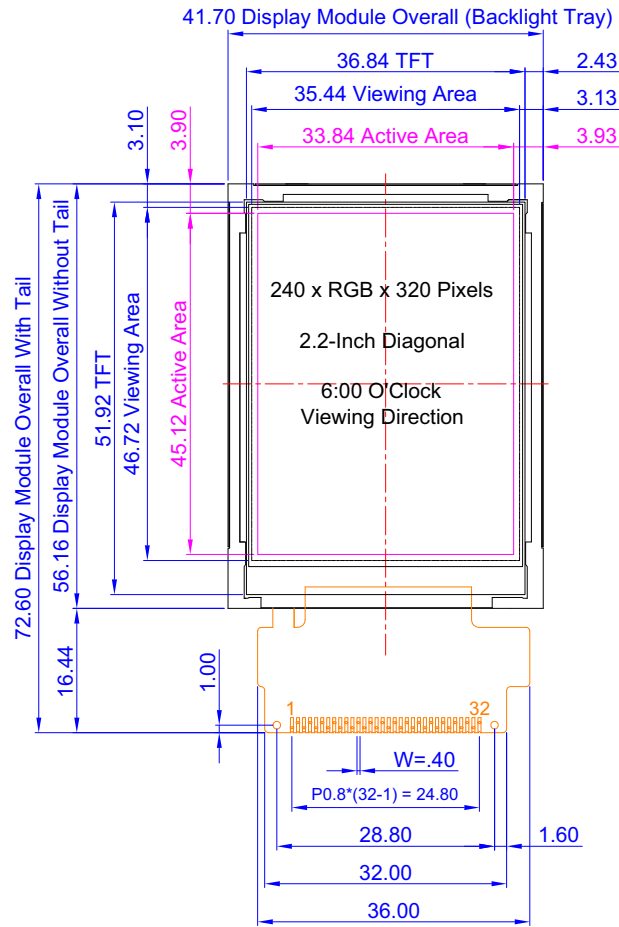
ADDITIONAL FEATURES

- 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.

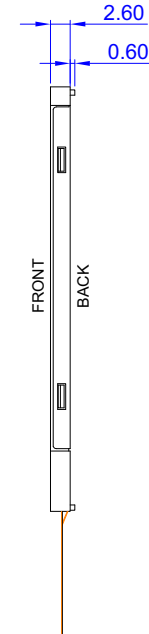


DISPLAY MODULE OUTLINE DRAWINGS

Front View



Side View



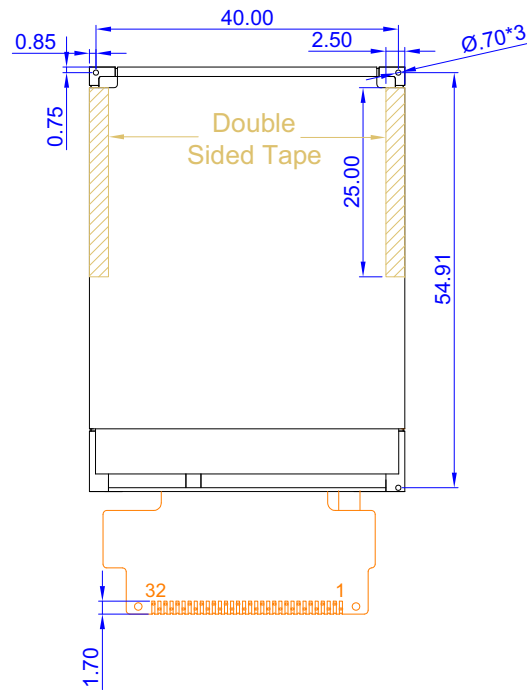
Notes:

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

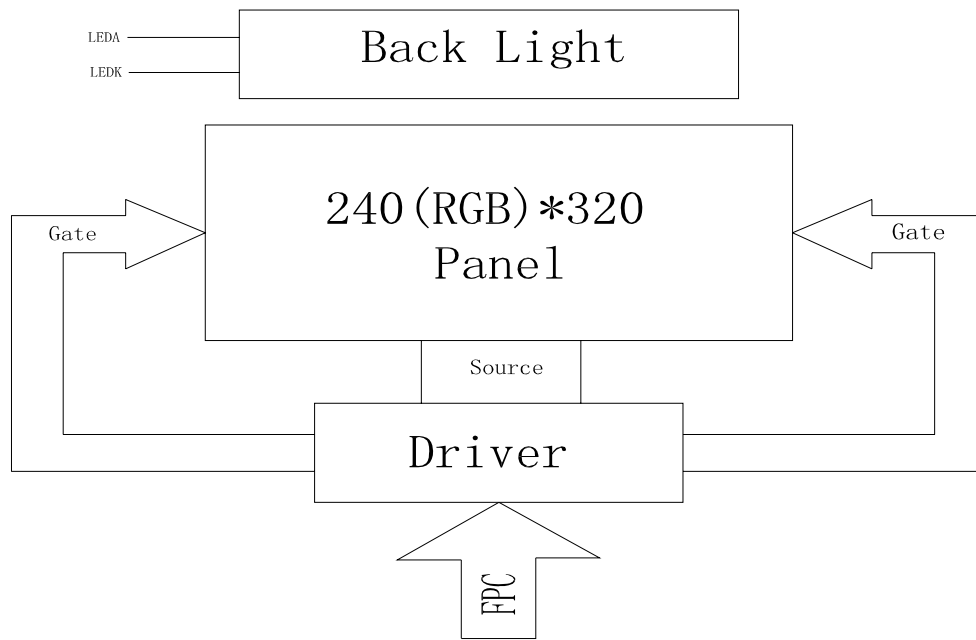
Hardware Rev.:

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

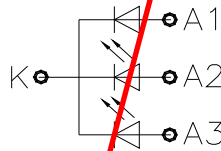
NOTE

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 three white LEDs in parallel.

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Forward Current	IF		45	60	mA	
Forward Voltage	VF	--	3.2 (Typ)	--	V	

Backlight Circuit:



CAUTION

Do not drive the LEDs at any current over their rated maximum of 20mA (15mA recommended for longer life). Be aware that the forward voltage of white LEDs can vary (LED to LED, batch to batch, and over time) by a significant amount. We recommend using a constant current LED power supply such as the AP3036, NCP5007, FAN5333, or similar to drive the LEDs. Do not use a constant voltage source to drive the LEDs.

This display module 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. 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.

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.



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

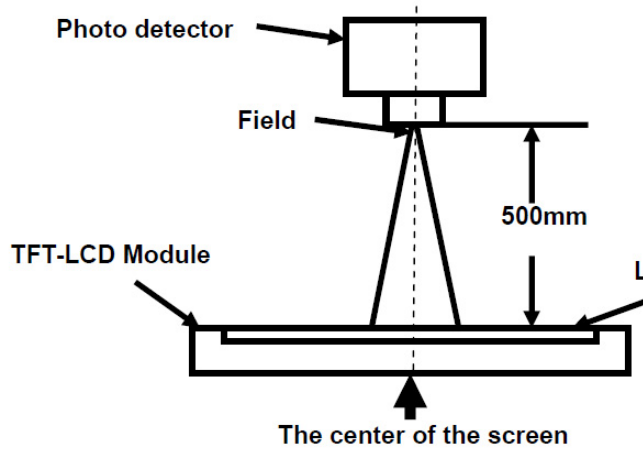
Measurements taken in a dark room, ambient temperature 25°C, with a 15 minute warm-up period. Chromaticity ([CIE 1931](#)) color coordinates measured at center point of LCD.

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°

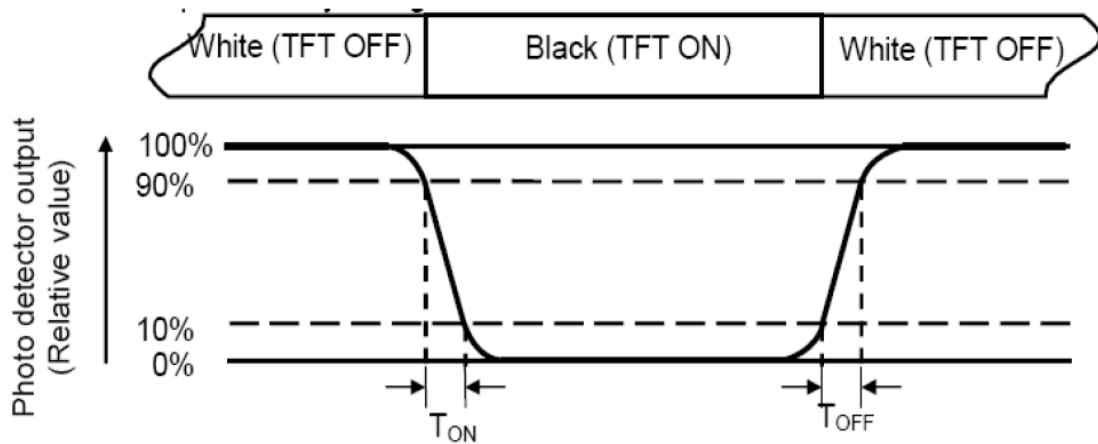


DEFINITION OF CONTRAST RATIO

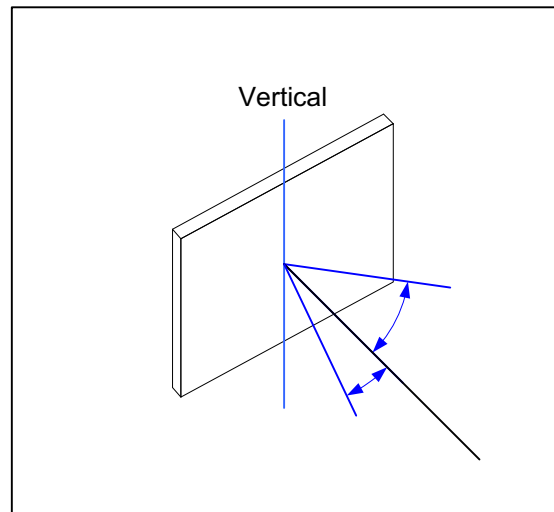
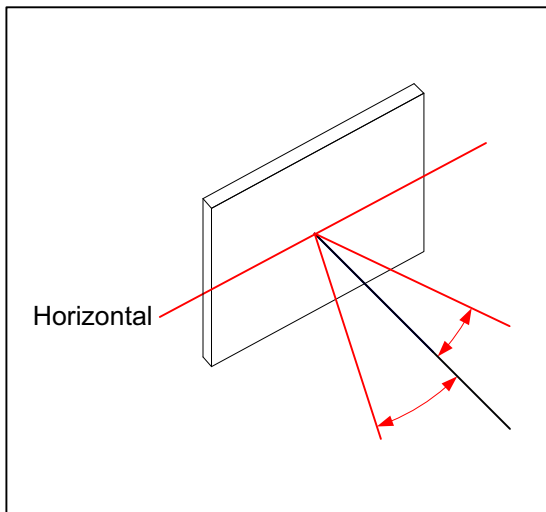
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance measured when LCD is on the "White" state}}{\text{Luminance measured when LCD is on the "Black" state}}$$

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%.



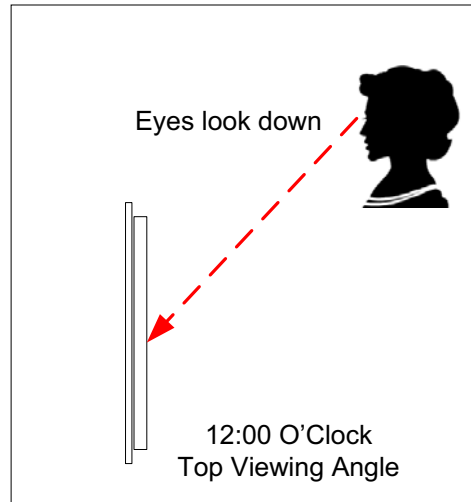
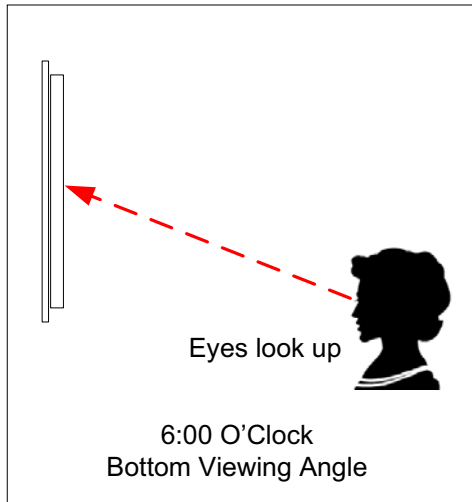
DEFINITION OF VERTICAL AND HORIZONTAL VIEWING ANGLES ($CR_{\geq 2}$)





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

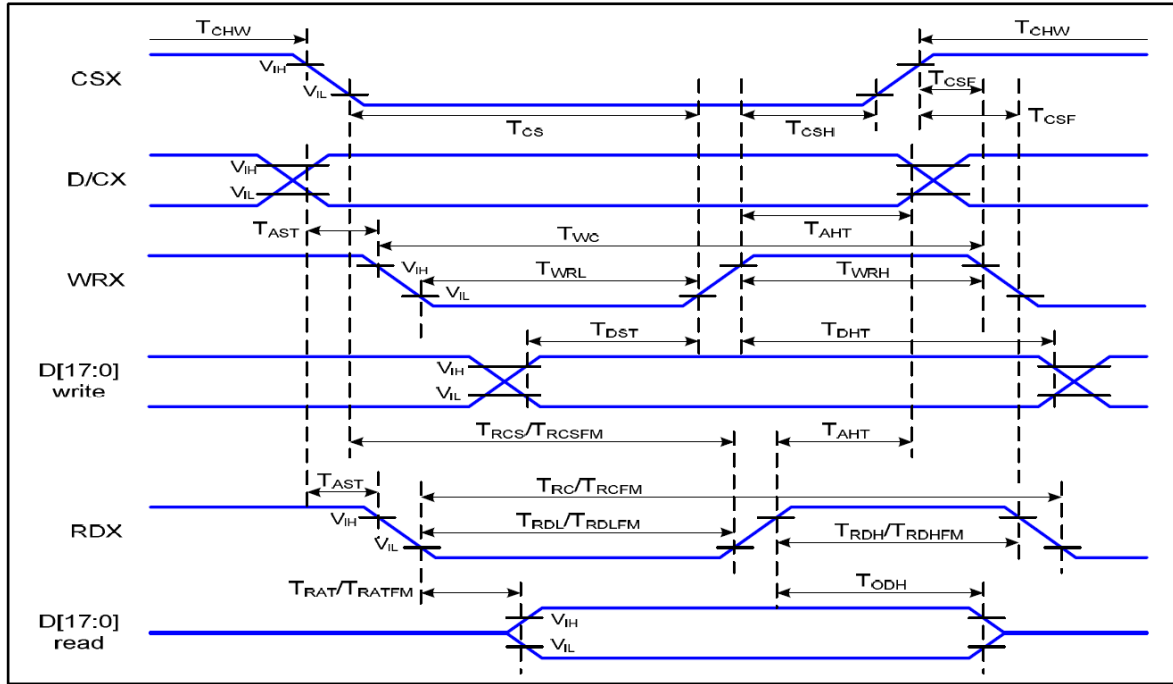


31	GND	Ground.	P
32	NC	NC.	p



AC CHARACTERISTICS

Parallel 8-bit interface timing characteristics (8080):

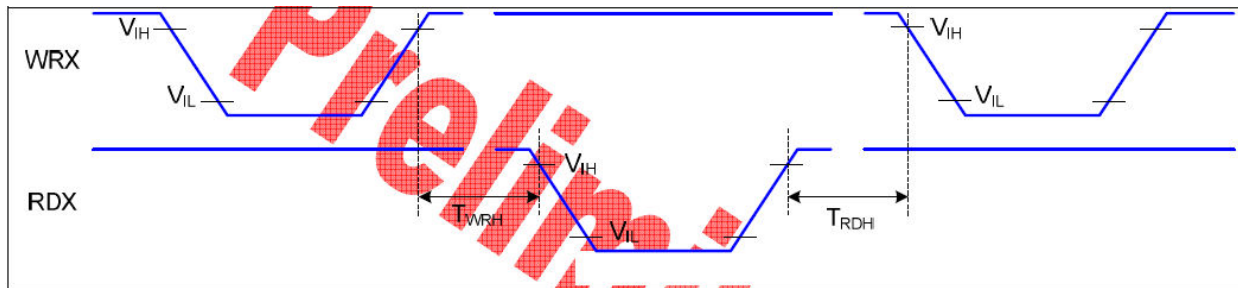
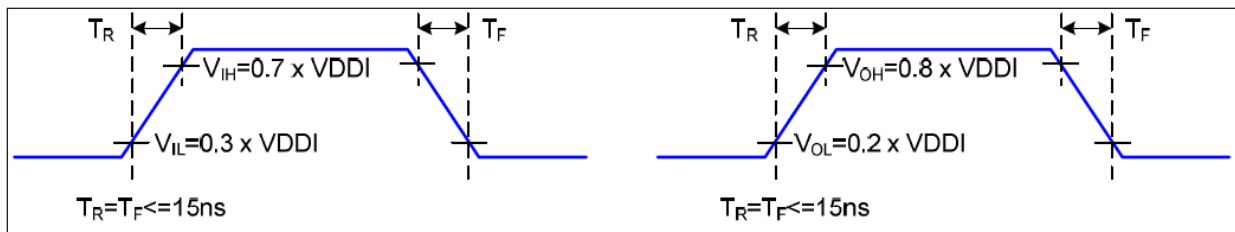


VDD=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta= -30 to 70 °C

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	



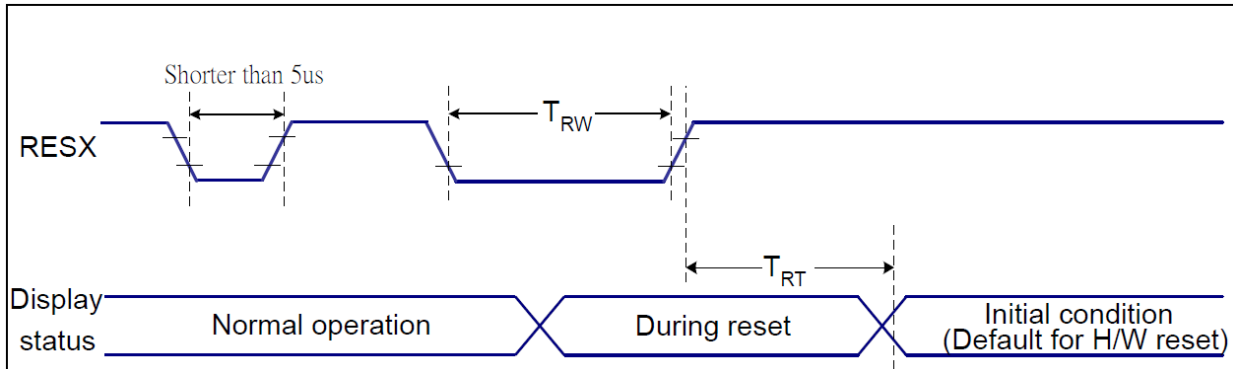
RDX (ID)	T_{RC}	Read cycle (ID)	160	ns	When read ID data
	T_{RDH}	Control pulse "H" duration (ID)	90	ns	
	$T_{RD L}$	Control pulse "L" duration (ID)	45	ns	
RDX (FM)	T_{RCFM}	Read cycle (FM)	450	ns	When read from frame memory
	T_{RDHFM}	Control pulse "H" duration (FM)	90	ns	
	$T_{RD LFM}$	Control pulse "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



VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=-30 ~ 70 °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:

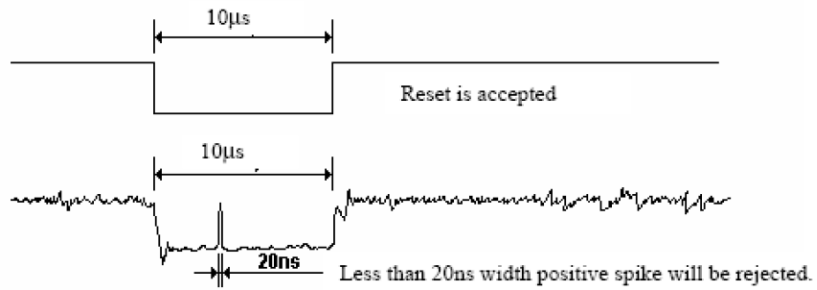
1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time (t_{RT}) within 5 ms after a rising edge of RESX.

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.