



ePAPER DISPLAY MODULE DATASHEET



Datasheet Release 2023-05-08
for
CFAP104212D1-0213

Crystalfontz America, Inc.

12412 East Saltese Avenue
Spokane Valley, WA 99216-0357
Phone: 888-206-9720
Fax: 509-892-1203
Email: support@crystalfontz.com
URL: www.crystalfontz.com

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1. General Information

Datasheet Revision History

Datasheet Release Date: **2023-05-08**
Datasheet for the CFAP104212D1-0213 ePaper display module.

Product Change Notifications

You can check for or subscribe to [Part Change Notices](#) for this display module on our website.

Variations

Slight variations between lots are normal (e.g., contrast, color, or intensity).

Volatility

This display module has volatile memory.

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2. Description Overview

This is a flexible ePaper display that supports partial updates. The 2.13" active area contains 104x212 pixels and has 1-bit white/black full display capabilities. Each display includes an integrated circuit containing a gate buffer, source buffer, interface, timing control logic, oscillator, DC-DC, SRAM, LUT, VCOM, and border.

This display uses the UC8151D controller. For information about commands, etc. please see the [UC8151D controller datasheet](#).

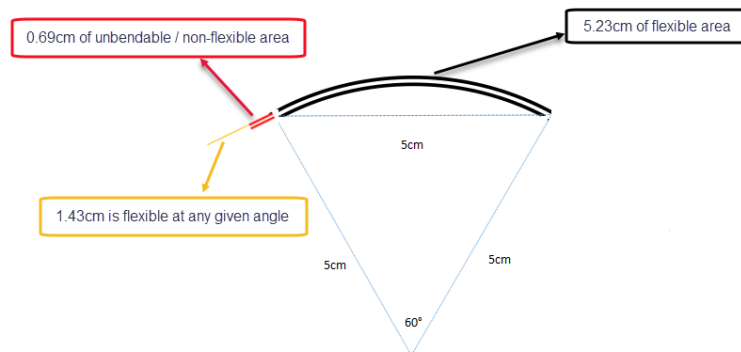
3. Features

- High Contrast, High Reflectance, Pure Reflective Mode
- Ultra-Wide Viewing Angle
- Ultra-Low Power Consumption
- Bi-Stable Display
- Commercial Temperature Range
- Landscape or Portrait Mode
- Antiglare Hard-Coated Front-Surface
- Low Current Deep Sleep Mode
- On-Chip Display RAM
- Waveform Stored in On-Chip OTP
- Serial Peripheral Interface Available
- On-Chip Oscillator, Booster and Regulator Control for Generating V_{COM} , Gate and Source Driving Voltage
- I²C Signal Master Interface to Read External Temperature Sensor
- Available in COG Package IC Thickness 180um

4. Mechanical Specifications

Parameter	Specifications	Unit	Remark
Screen Size	2.13	in	-
Display Resolution	212 (H) × 104 (W)	pixels	dpi: 111
Active Area	48.55 (H) × 23.71 (W)	mm	-
Pixel Pitch	0.229 × 0.228	mm	-
Pixel Configuration	Square	-	-
Outline Dimension	59.2 (H) × 29.2 (W) × 0.3 (D)	mm	-
Weight (typical)	0.6	g	-

5. Flexible Specifications



IMPORTANT: DO NOT TWIST. This module is bendable; it is not designed to be twisted.

6. Input/Output Terminals

6.1. Pin Out List

Pin #	Signal	Description
1	NC	No connection and do not connect with other NC pins. Keep Open
2	GDR	N-Channel MOSFET Gate Drive Control
3	RESE	Current Sense Input for the Control Loop
4	VGL	Negative Gate Driving Voltage
5	VGH	Positive Gate Driving Voltage
6	TSCL	I ² C Interface to Digital Temperature Sensor Clock Pin. Leave open if not used
7	TSDA	I ² C Interface to Digital Temperature Sensor Data Pin. Leave open if not used
8	BS1	Bus Selection Pin. Low for 4-wire SPI, High for 3-wire (9-bit) SPI
9	BUSY	Busy State Output Pin. Signal is low when display chip is busy. The operation of the chip should not be interrupted when the busy signal is low.
10	RES#	Reset signal input pin. Reset is active low.
11	D/C#	Data/Command Control Pin. When high, incoming data is interpreted as data. When low, incoming data is interpreted as a command
12	CS#	Chip Select Input Pin, active low
13	D0	Serial Clock Pin (SPI - SCL)
14	D1	Serial Data Pin (SPI - SDIN)
15	VDDIO	Power for Interface Logic Pins
16	VCI	Power Supply Pin for Chip
17	VSS	Ground
18	VDD	Core Logic Power Pin
19	VPP	Power Supply for OTP Programming
20	VSH	Positive Source Driving Voltage
21	PREVGH	Positive Supply Pin for VGH and VSH
22	VSL	Negative Source Driving Voltage
23	PREVGL	Power Supply Pin for VCOM, VGL, and VSL
24	VCOM	VCOM Driving Voltage

7. Electrical Characteristics

7.1. Absolute Maximum Rating

Parameter	Symbol	Rating	Unit
Logic Supply Voltage	V _{CI}	-0.3 to +6.0	V
Logic Input Voltage	V _{IN}	-0.3 to V _{CI} +2.4	V
Operating Temp. range	T _{OPR}	0 to +50	°C
Storage Temp. range	T _{STG}	-25 to +70	°C
Humidity Range	RH	40-70	%

IMPORTANT: It is recommended that you use a UV protective film when operating the module in direct sunlight.

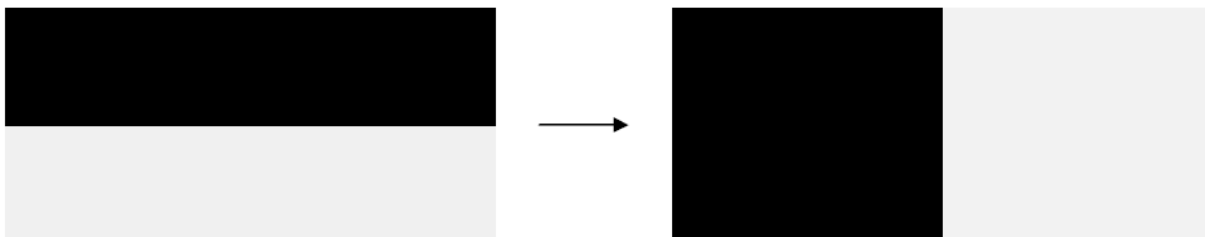
7.2. Panel DC Characteristics

The following specifications apply for: V_{SS} = 0V, V_{CI} = 3.3V, T_a = 25°C

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Signal Ground	V _{SS}	-	-	0	-	V
Logic Supply Voltage	V _{CI}	-	2.3	3.3	3.6	V
High Level Input Voltage	V _{IH}	Digital Input Pins	0.7V _{CI}	-	V _{CI}	V
Low Level Input Voltage	V _{IL}	Digital Input Pins	0	-	0.3V _{CI}	V
High Level Output Voltage	V _{OH}	Digital Input Pins, I _{OH} = 400uA	V _{CI} -0.4	-	-	V
Low Level Output Voltage	V _{OL}	Digital Input Pins, I _{OL} = -400uA	0	-	0.4	V
Image Update Current	I _{UPDATE}	-	-	8	10	mA
Standby Panel Current	I _{STANDBY}	-	-	-	5	uA
Power Panel (Update)	P _{UPDATE}	-	-	26.4	40	mW
Standby Power Panel	P _{STBY}	-	-	-	0.0165	mW
Operating Temperature	-	-	0	-	50	°C
Storage Temperature	-	-	-25	-	70	°C
Deep sleep mode current	I _{VCI}	DC/DC Off No Clock No Input Load Ram Data Not Retained	-	2	5	uA
Sleep mode current	I _{VCI}	DC/DC Off No Clock No Input Load Ram Data Retained	-	35	50	uA

The typical power consumption is measured with the following pattern transition: from horizontal 2 gray scale pattern to vertical 2 gray scale pattern, shown below.

Note: The standby power is the consumed power when the panel controller is in standby mode. The listed electrical/optical characteristics are only guaranteed under the controller & waveform provided by Crystalfontz. V_{COM} is recommended to be set in the range of assigned value ±0.1V.





7.3. Panel AC Characteristics

7.3.1. Oscillator Frequency

The following specifications apply for: $V_{SS} = 0V$, $V_{Cl} = 3.3V$, $T_a = 25^\circ C$

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Internal Oscillator Frequency	F_{osc}	$V_{Cl}=2.3$ to $3.6V$	-	1.625	-	MHz

7.3.2. MCU Interface Selection

This display can communicate with an MCU using either 4-wire or 3-wires SPI. The interface mode is set using the BS1 pin. When the BS1 pin is low, 4-wire SPI is selected. When BS1 is high, 3-wire SPI is selected.

Pin Name	Data/Command Interface		Control Signal		
Bus Interface	D1	D0	CS#	D/C#	RES#
SPI4	SDIN	SCLK	CS#	D/C#	RES#
SPI3	SDIN	SCLK	CS#	L	RES#

Note: L is connected to V_{SS} . H is connected to V_{Cl} .

7.3.3. MCU Serial Interface (4-Wire SPI)

The 4-wire SPI consists of serial clock SCLK, serial data SDIN, D/C#, and CS#. In SPI mode, D0 acts as SCLK, D1 acts as SDIN.

Function	CS#	D/C#	SCLK
Write Command	L	L	↑
Write Data	L	H	↑

Note: ↑ means rising edge of signal

SDIN is shifted into an 8-bit shift register in the order of D7, D6, ...D0. The data byte in the shift register is written to the Graphic Display Data RAM (RAM) or command register in the same clock. Under serial mode, only write operations are allowed.

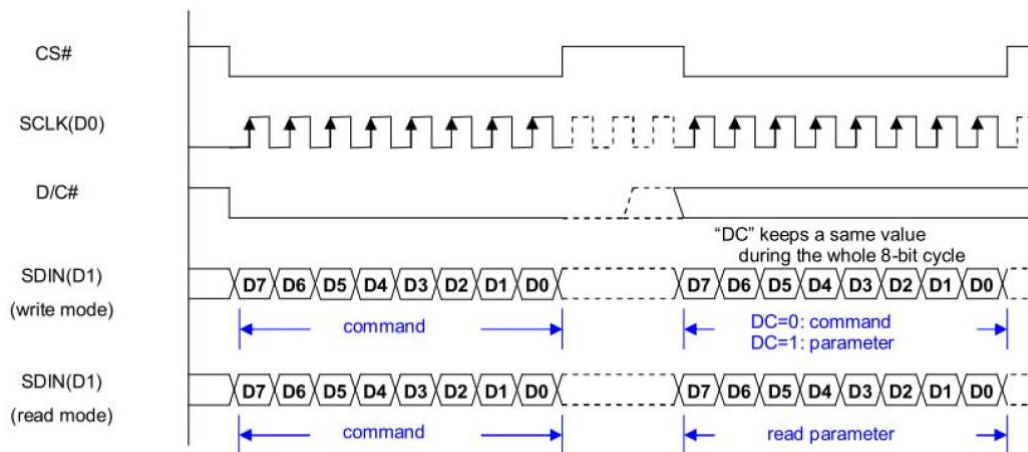


Figure 7-1: Write Procedure in 4-Wire Serial Peripheral Interface Mode



7.3.4. MCU Serial Interface (3-Wire SPI)

The 3-wire serial interface consists of serial clock SCLK, serial data SDIN and CS#.

In 3-wire SPI mode, D0 acts as SCLK, D1 acts as SDIN. The pin D/C# can be connected to an external ground.

The operation is similar to 4-wire serial interface except instead of using the D/C# pin, a D/C# bit is appended to the beginning of each byte. 9-bits are shifted into the shift register on every ninth clock in sequence: D/C# bit, D7 to D0 bit. The D/C# bit (first bit of the sequential data) will determine the following data byte in shift register is written to the Display Data RAM (D/C# bit = 1) or the command register (D/C# bit = 0). Under serial mode, only write operations are allowed.

Function	CS#	D/C#	SCLK
Write Command	L	Tie LOW	↑
Write Data	L	Tie LOW	↑

Table 7-3: Control Pins of 3-Wire Serial Peripheral Interface

Note: ↑stands for rising edge of signal

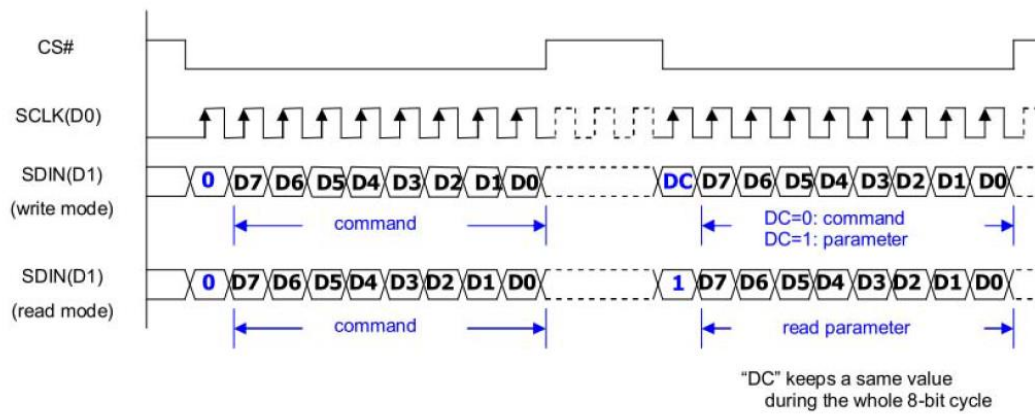
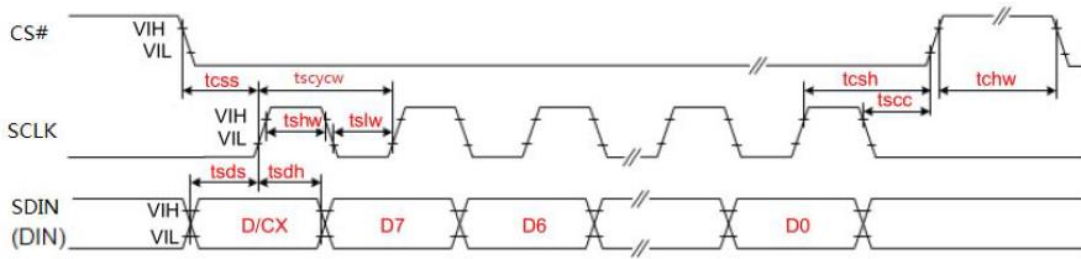


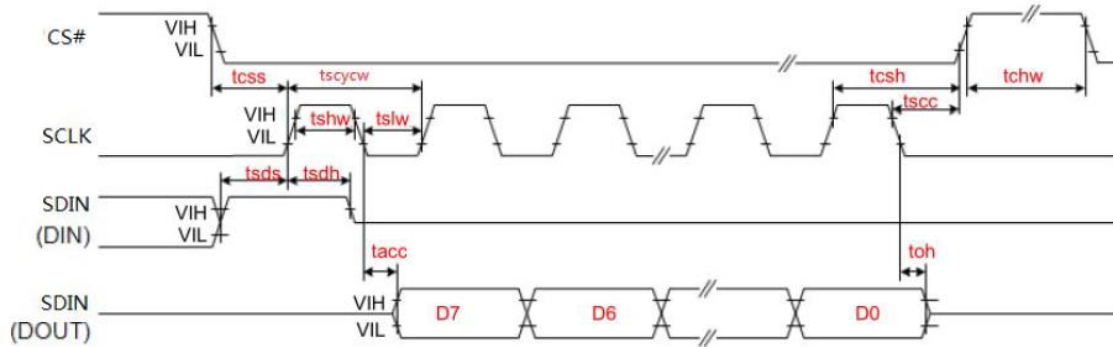
Figure 7-2: Write Procedure in 3-Wire Serial Peripheral Interface Mode



7.3.5. Timing Characteristics of Series Interface



3-wire Serial Interface – Write



3-wire Serial Interface – Read

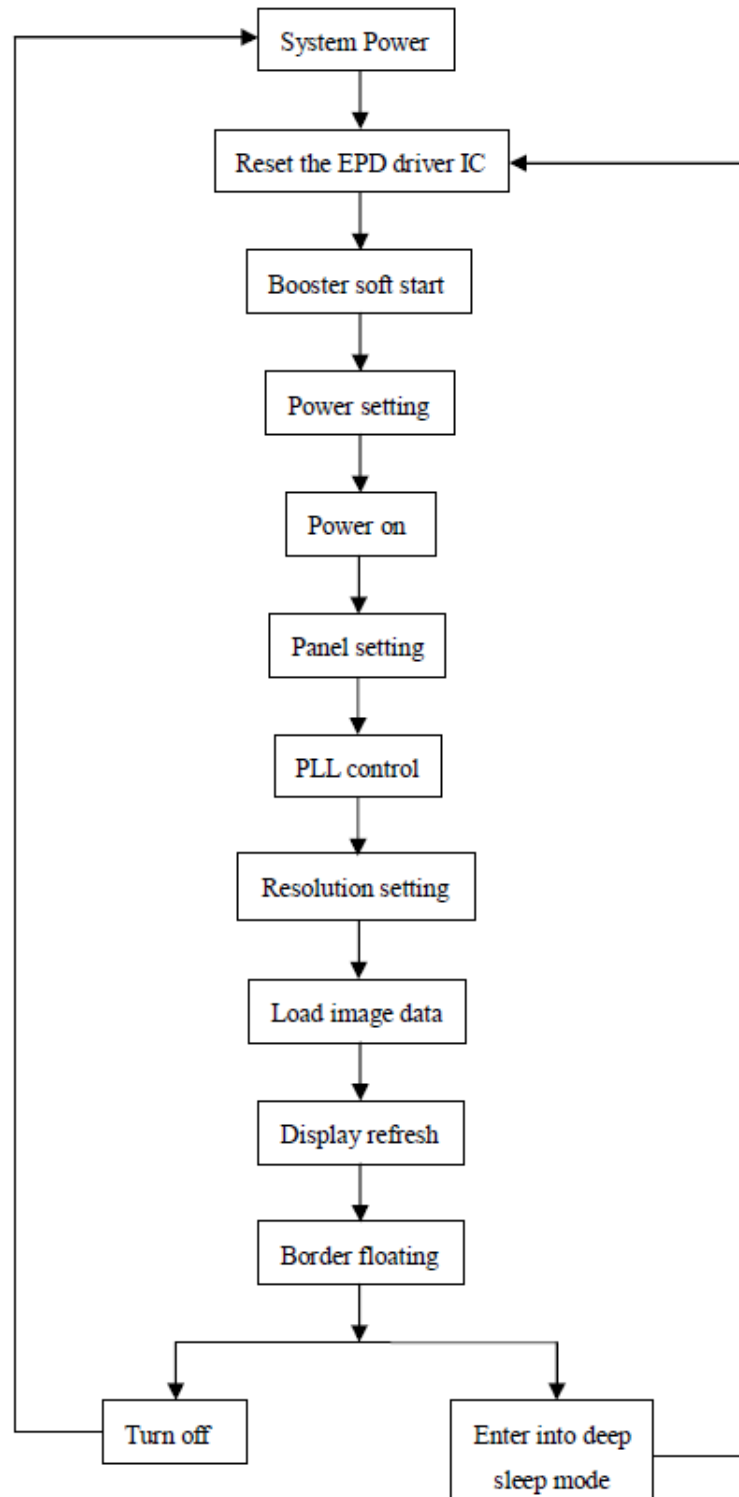
Symbol	Signal	Parameter	Min	Typ	Max	Unit
tcss	CS#	Chip Select Setup Time	60	-	-	ns
tcsh		Chip Select Hold Time	65	-	-	ns
tscch		Chip Select Setup Time	20	-	-	ns
tchwh		Chip Select Setup Time	40	-	-	ns
tscycw	SCLK	Serial Clock Cycle (Write)	100	-	-	ns
tshw		SCL "H" Pulse Width (Write)	35	-	-	ns
tslw		SCL "L" Pulse Width (Write)	35	-	-	ns
tscycr		Serial Clock Cycle (Read)	150	-	-	ns
tshr		SCL "H" Pulse Width (Read)	60	-	-	ns
tslr		SCL "L" Pulse Width (Read)	60	-	-	ns
tsds	SDIN (DIN) (DOUT)	Data Setup Time	30	-	-	ns
tsdh		Data Hold Time	30	-	-	ns
tacc		Access Time	-	-	10	ns
toh		Output Disable Time	15	-	-	ns

Parameter	Symbol	Conditions	TYP	Max	Unit	Remark
Panel Power Consumption During Update	-	25°C	26.4	40	mW	-
Power Consumption in Standby Mode	-	25°C	-	0.0165	mW	-

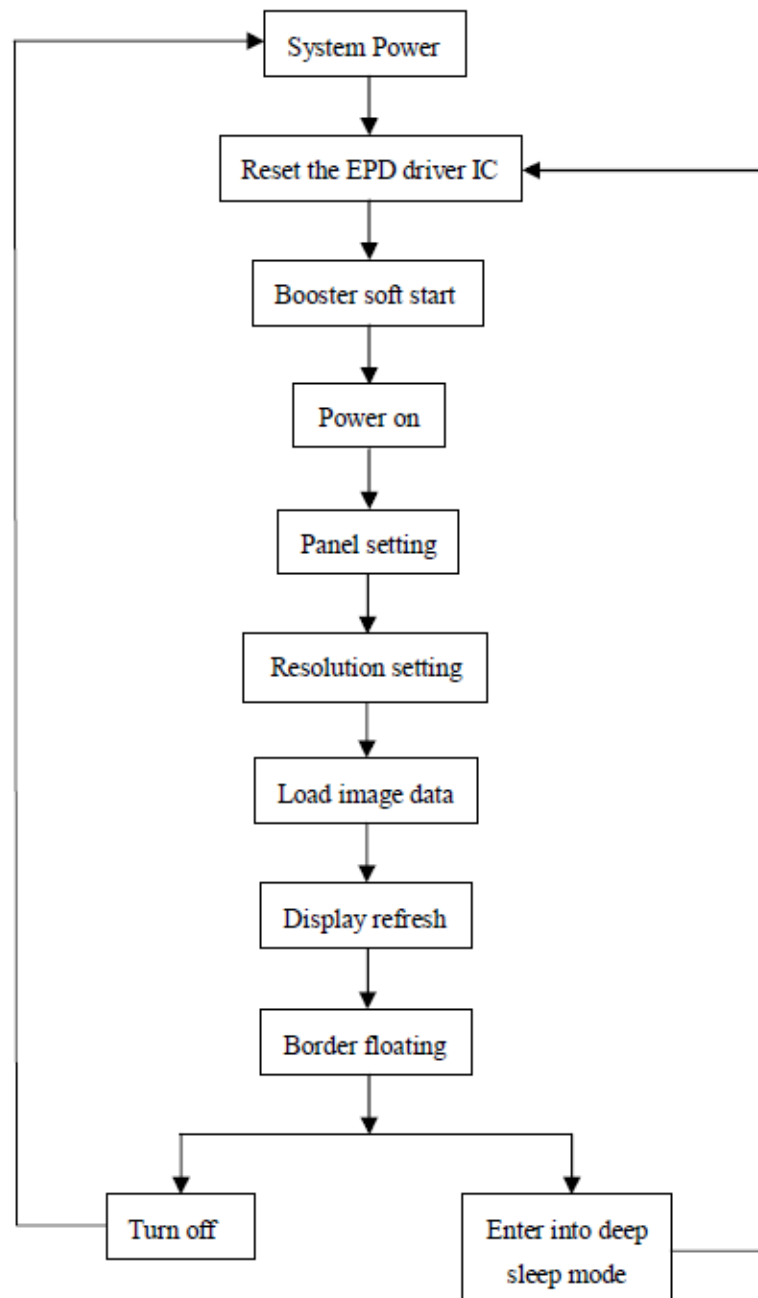
8. Typical Operating Sequence

8.1. Normal Operation Flow

8.1.1. BW Mode & LUT from Register



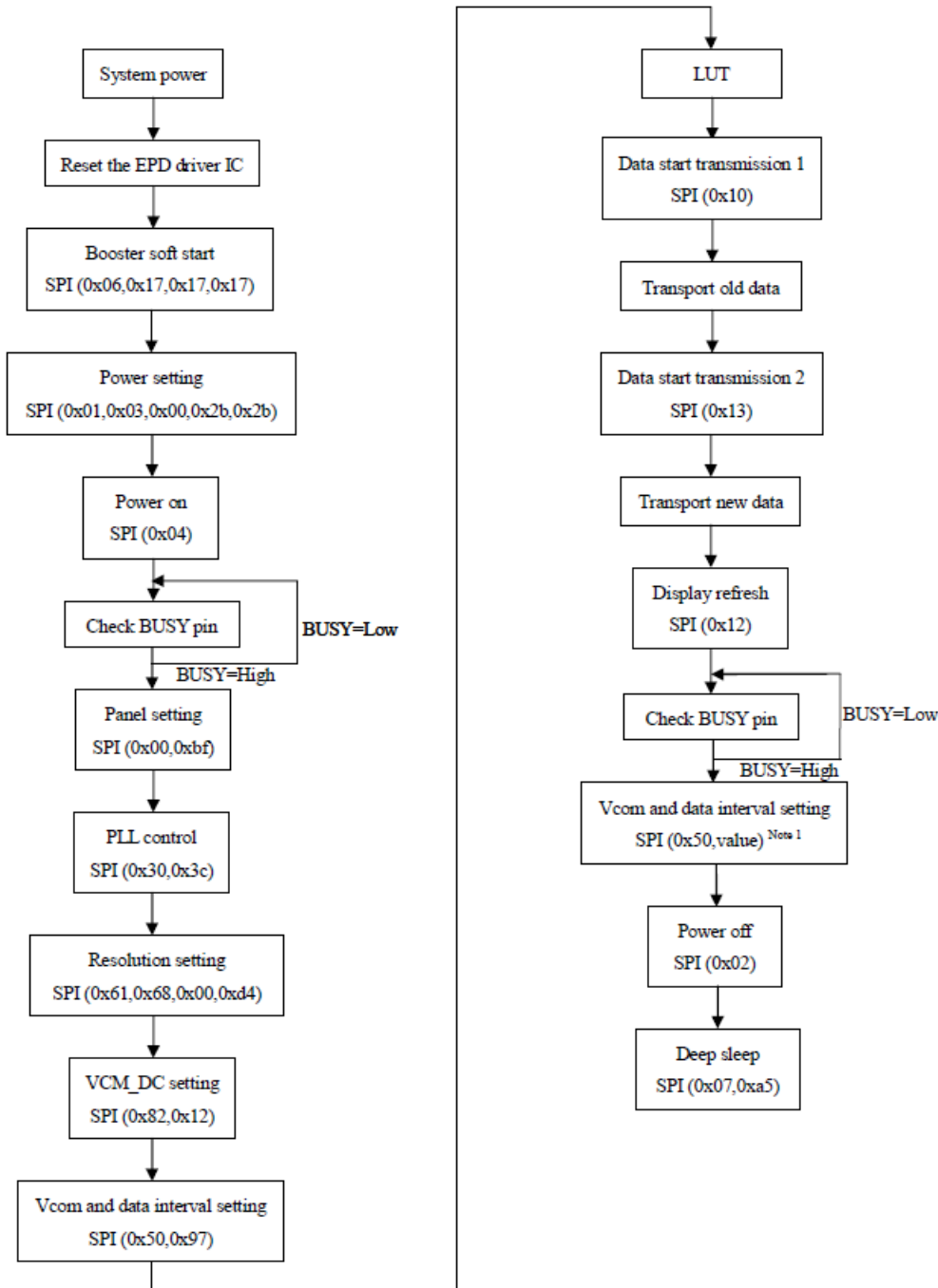
8.1.2. BW Mode & LUT from OTP





8.2. Reference Program Code

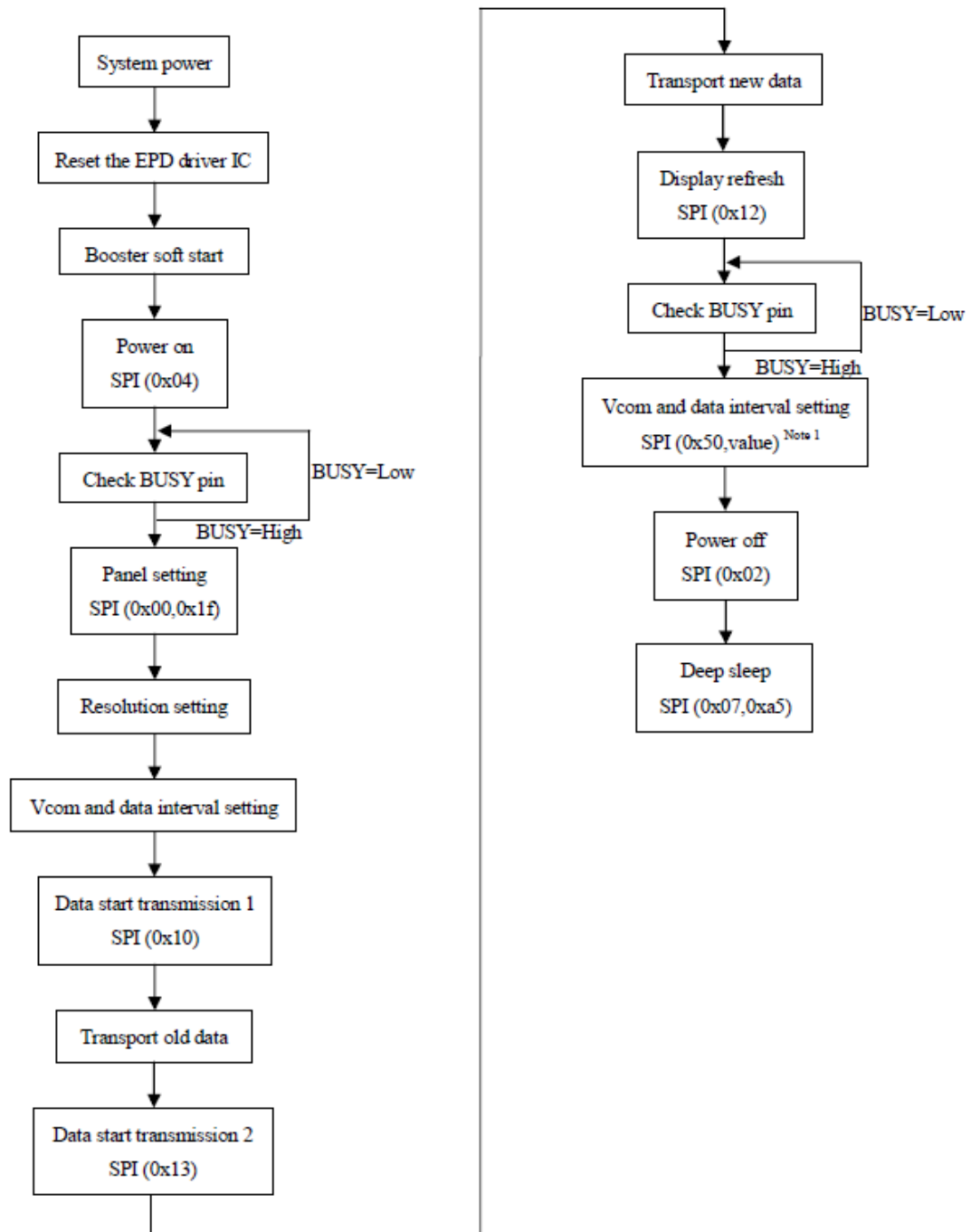
8.2.1. BW Mode & LUT from Register



Note 1: Set border to floating.



8.2.2. BW Mode & LUT from OTP



Note 1: Set border to floating.

9. Optical Characteristics

9.1. Specifications

Measurements are made with the illumination under an angle of 45 degrees, the detection is perpendicular unless otherwise specified.

T=25°C

Symbol	Parameter	Conditions	Min	Type	Max	Unit	Note
R	Reflectance	White	30	35	-	%	Note 10-1
Gn	2Gray Level	-	-	$DS + (WS - DS) \times n(m-1)$	-	L*	-
CR	Contrast Ratio	Indoor	8		-	-	-
Panel's Life	-	0°C~50°C	-	1,000,000 times or 5 years	-	-	Note 10-2

WS: White State, DS: Dark State

Gray State from Dark to White: DS, WS

m: 2

Note (10-1): Luminance meter: Eye – One Pro Spectrophotometer

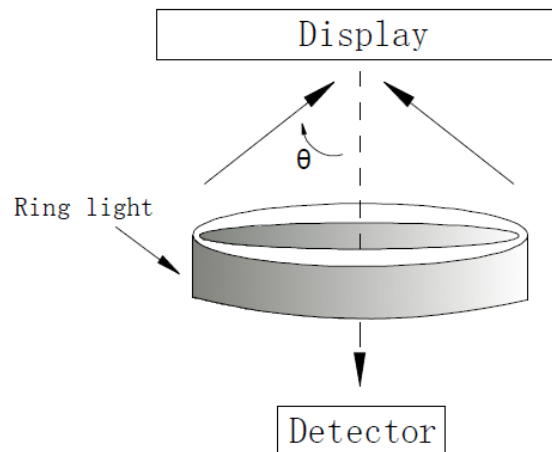
Note (10-2): Panel life is not guaranteed when worked in temperatures below 0 degrees or above 50 degrees. Each update interval time should be at a minimum of 180 seconds.

9.2. Definition of Contrast Ratio

The contrast ratio (CR) is the ratio between the reflectance in a full white area (R1) and the reflectance in a dark area (Rd) ():

R1: White Reflectance Rd: Dark Reflectance

$CR = R1/Rd$

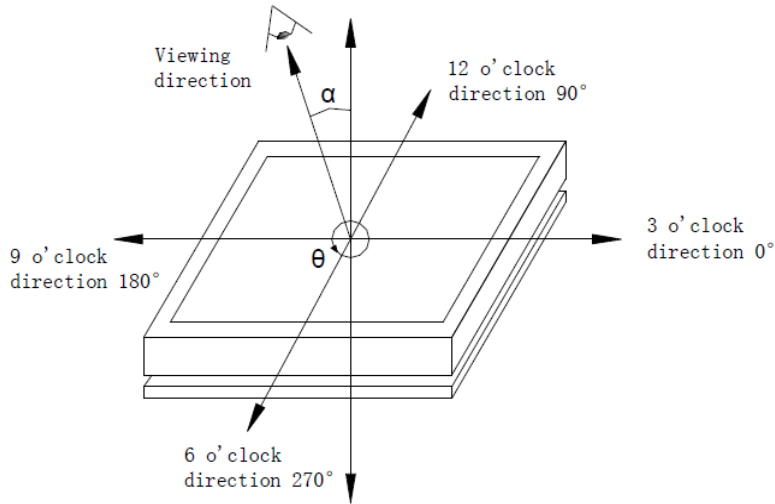


9.3. Reflection Ratio

The reflection ratio is expressed as:

$$R = \text{Reflectance Factor}_{\text{white board}} \times (L_{\text{CENTER}} / L_{\text{WHITE BOARD}})$$

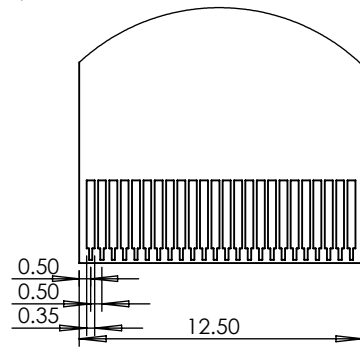
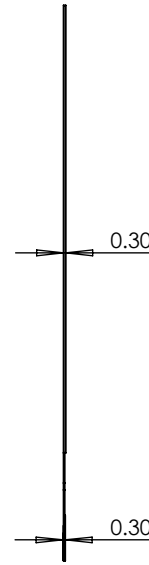
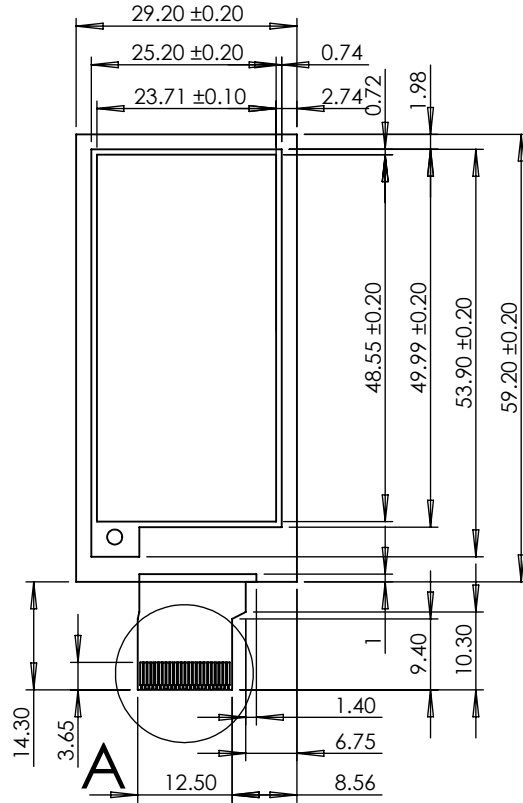
L_{CENTER} is the luminance measured at center in a white area ($R=G=B=1$). $L_{\text{WHITE BOARD}}$ is the luminance of a standard white board. Both are measured with equivalent illumination source. The viewing angle shall be no more than 2 degrees.



9.4. Bi-Stability

The Bi-Stability standard is as follows:

Bi-Stability	Result			
			AVG	MAX
24-Hour Luminance Drift	White state	ΔL^*	-	3
	Black state	ΔL^*	-	3



DETAIL A
SCALE 3 : 1

Display Controller	UC8151D
Viewing Direction	All
Operating Temperature	0-50°C
Voltage Levels	3.3v logic

Pin #	Signal
1	NC
2	GDR
3	RESE
4	VGL
5	VGH
6	TACL
7	TSDA
8	BS1
9	BUSY
10	RES#
11	D/C#
12	CS#
13	D0
14	D1
15	VDDIO
16	VCI
17	VSS
18	VDD
19	VPP
20	VSH
21	PREVGH
22	VSL
23	PREVGL
24	VCOM

Units: millimeters
Tolerance: ±0.15



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Part Number:

CFAP104212D1-0213

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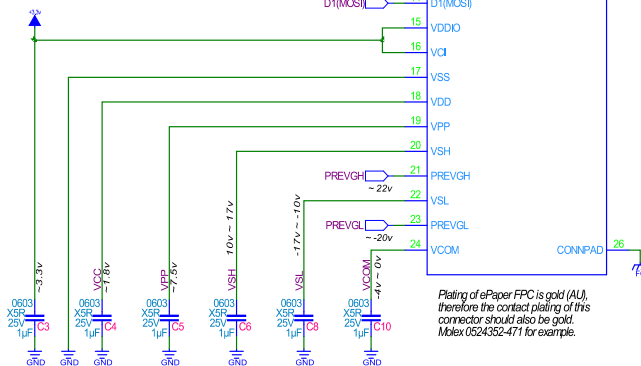
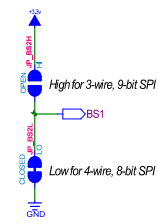
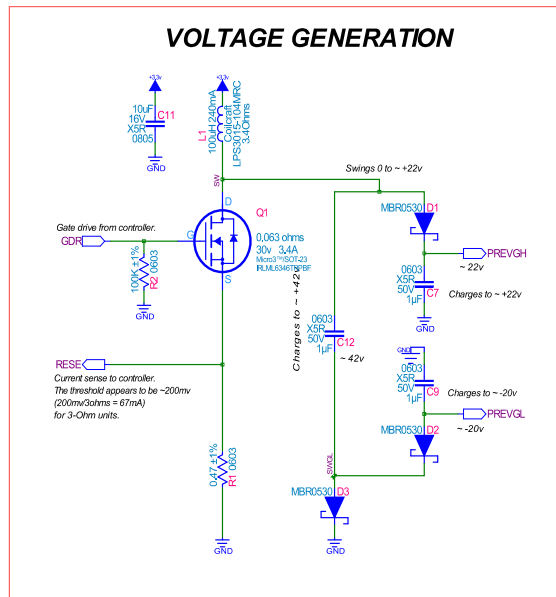
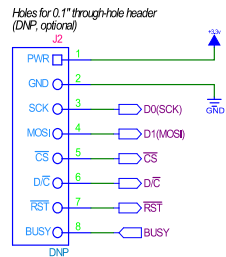
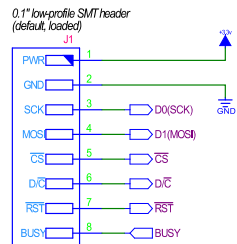
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11. ePaper Breakout Board Schematic



REV	ENGINEER	DATE	REMARKS
0v0	BAC	2018-04-04	Initial Creation
0v1	BAC	2018-05-17	Ind val, C12 val, JP_OP47 open, CN FPC
-	-	-	-
-	-	-	-
-	-	-	-



Plating of ePaper FPC is gold (Au), therefore the contact plating of this connector should also be gold. Molex 0224352-471 for example.

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CFA-10084: ePaper Adapter Board 24-pin (0.47 ohm)

Page 1 / 1: Schematic

PRODUCT NAME:	PRODUCT REVISION:	PCB NUMBER:	PCB REVISION:
CFA-10084	0v1	PCB-10084	0v1