



ePAPER DISPLAY MODULE DATASHEET



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for

CFAP200200A5-0154

Crystalfontz America, Inc.

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1. General Information

Datasheet Revision History

Datasheet Release Date: 2023-02-23
Datasheet for the CFAP200200A5-0154 ePaper Display Module 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

A square black-and-white 200x200 pixel ePaper display module, perfect for small, low power, long term display. Once an image is shown on the display, it remains visible while entirely disconnected from power. The display is an active matrix electrophoretic display (AMEPD).

Built-in voltage generation requires only a few external components. An integrated circuit contains a gate buffer, source buffer, interface, timing control logic, oscillator, DC-DC, SRAM, LUT, VCOM, and border. See the [CFA10084 ePaper breakout board](#) for an example of implementing this display.

3. Features

- 200x200 Pixels, 183 ppi
- High Contrast
- High Reflectance, Pure Reflective Mode
- Ultra-Wide Viewing Angle
- Ultra-Low Power Consumption, Bi-Stable Display, Low Current Deep Sleep Mode
- Commercial Temperature Range
- Antiglare Hard-Coated Front-Surface
- On-Chip Display RAM
- Serial Peripheral Interface (SPI)
- On-Chip Booster and Regulator Control for Generating VCOM, Gate and Source Driving Voltage
- I²C Signal Master Interface to Read External Temperature Sensor
- Full screen update time: 2 seconds
- Fast screen update time: 1.5 seconds (a full screen update is recommended once every 5 fast updates)
- Partial refresh time: 0.26 seconds
- Recommended time between updates: 180 seconds
- SSD1681 Controller chip

4. Mechanical Specifications

Parameter	Specifications (mm)	Specification (in)
Screen Size	39.1	1.54
Active Area	27.00 (H) × 27.00 (W)	1.06 x 1.06
Pixel Pitch	0.14 × 0.14	0.005 x 0.005
Outline Dimension	37.32 (H) × 31.80 (W) × 1.0 (D)	1.47 x 1.25 x 0.04
Weight (typical)	2.2 grams	0.07 ounces
Display Resolution	200 (H) × 200 (W)	

5. Pin Functions

Pin #	Type	Single	Description
1	NC	NC	No Connection and Do Not Connect with Other NC Pins
2	O	GDR	N-Channel MOSFET Gate Drive Control
3	I	RESE	Current Sense Input for the Control Loop
4	NC	NC	No Connection and Do Not Connect with Other NC Pins
5	C	VSH2	Positive Source Driving Voltage
6	O	TSCL	I ² C Interface to Digital Temperature Sensor Clock Pin <i>External pull-up resistor required</i>
7	I/O	TSDA	I ² C Interface to Digital Temperature Sensor Data Pin <i>External pull-up resistor required</i>
8	I	BS1	Bus Selection Pin – Low 4-Wire SPI, High 3-Wire SPI
9	O	BUSY	Busy State Output Pin – high when chip is busy
10	I	RES#	Reset Pin – active low
11	I	D/C#	Data /Command Control Pin – Data high, command low Tie low for 3-wire SPI
12	I	CS#	Chip Select Input Pin - active low
13	I	SCL	Serial Clock Pin (SPI)
14	I	SDA	Serial Data Pin (SPI)
15	P	VDDIO	Power for Interface Logic Pins. Connect to VCI
16	P	VCI	Power Supply Pin for the Chip
17	P	VSS	Ground
18	C	VDD	Core Logic Power Pin. This pin is regulated internally. Connect a capacitor between VDD and VSS
19	P	VPP	Power Supply for OTP Programming, leave open if not used
20	C	VSH1	Positive Source Driving Voltage
21	C	VGH	Positive Gate Driving Voltage
22	C	VSL	Negative Source Driving Voltage
23	C	VGL	Negative Gate Driving Voltage
24	C	VCOM	VCOM Driving Voltage

I – Input
 O – Output
 P – Power
 C – Capacitor
 NC – No connection, do not connect to other NC pins
 See Section 12: Reference Circuits

6. Maximum Ratings

6.1. Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Logic Supply Voltage	V _{CI}	-0.5 to +4.0	V
Operating Temp. Range	T _{OPR}	0 to +50	°C
Storage Temp. Range	T _{STG}	-25 to +70	°C

IMPORTANT: A UV protective film is recommended when operating the module in direct sunlight.

Recommended Storage temp is 23°C±2, and humidity of 55%RH±10

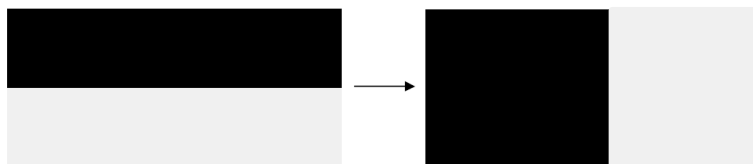
6.2. DC Characteristics

The following specifications apply for: V_{SS} = 0V, V_{CI} = 3.0V, T_{OPR} = 23°C

Parameter	Symbol	Conditions	Module Pin	Min	Typ	Max	Unit
Logic Supply Voltage	V _{CI}	-	V _{CI}	2.2	3.0	3.7	V
High Level Input Voltage	V _{IH}	-	SCL, SDA, CS#, D/C#, RES#, BS1	0.8V _{CI}	-	V _{CI}	V
Low Level Input Voltage	V _{IL}	-		-	-	0.2 V _{CI}	V
High Level Output Voltage	V _{OH}	I _{OH} = -100uA	BUSY	0.9 V _{CI}	-	-	V
Low Level Output Voltage	V _{OL}	I _{OL} = 100uA		-	-	0.1 V _{CI}	V
Module Operating Current	I _{UPDATE}	-	-	-	1.5	-	mA
Deep Sleep Mode	I _{SLEEP}	-	-	-	1	5	µA
Panel power consumption during Update	-	25°C	-	-	4.50	-	mW
Deep Sleep Mode	-	25°C	-	-	0.003	-	mW

The typical power consumption is measured with the following pattern transition: from horizontal pattern to vertical 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. MCU Interface

See the [SSD1681 datasheet](#) for more information.

7.1. MCU Serial Peripheral Interface (4-Wire SPI)

4-wire SPI consists of SCL (serial clock), SDA (serial data), D/C# and CS#. SDA is shifted into an 8-bit shift register in the order of D7, D6, ... D0 on the rising edge of the clock signal. The data byte in the shift register is written to the Graphic Display Data RAM (RAM) or command register in the same clock.

Function	CS# Pin	D/C# Pin	SCL Pin	SDA Pin
Write Command	L	L	↑	Command data
Write Data	L	H	↑	Data data

Note: ↑ indicates rising edge of signal

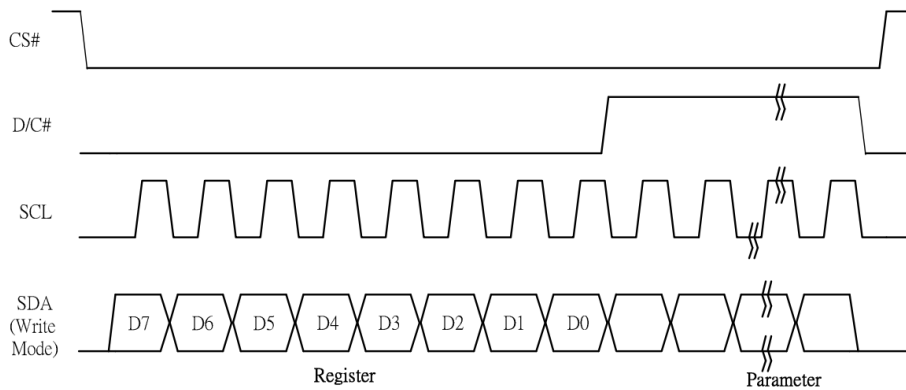


Figure: Write Procedure in 4-Wire SPI Mode

7.2. MCU Serial Peripheral Interface (3-Wire SPI)

The 3-wire serial interface consists of SCL (serial clock), SDA (serial data) and CS#. 3-wire SPI operation is similar to 4-wire, except instead of using the D/C# pin, a 9th bit is included to indicate Data or Command. The 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).

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

Note: ↑ stands for rising edge of signal

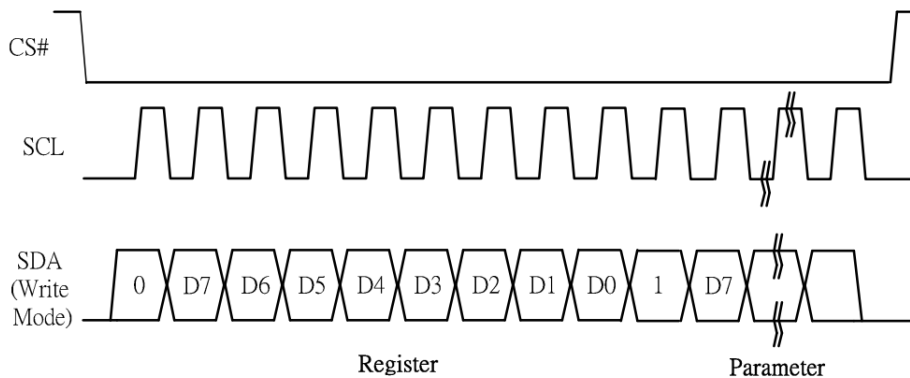


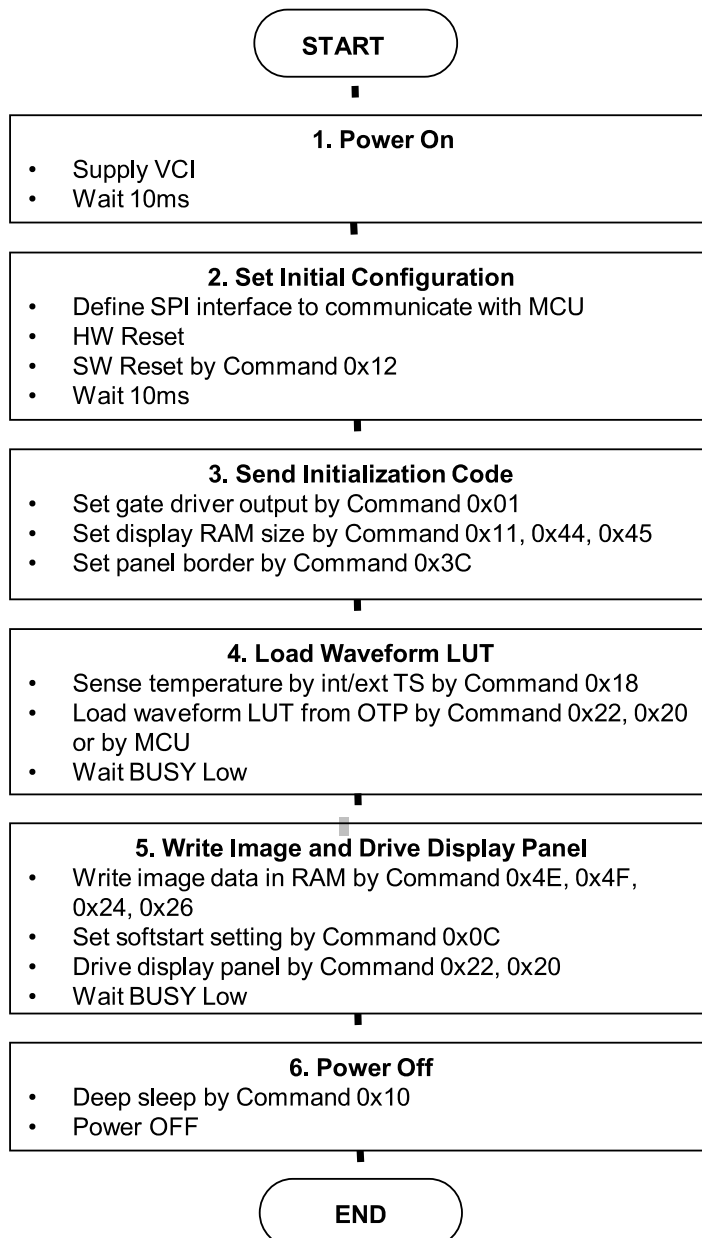
Figure: Write Procedure in 3-Wire SPI Mode

8. Serial Peripheral Interface Timing

The following specifications apply for: $V_{SS} = 0V$, $V_{CI} = 2.2V$ to $3.7V$, $T_{OPR} = 25^{\circ}C$, write mode. Timing given is from 20% to 80% of $V_{DDIO-V_{SS}}$

Symbol	Parameter	Min	Typ	Max	Unit
f _{SCL}	Clock Cycle Frequency	-	-	20	MHz
t _{CSSU}	Chip Select Setup Time	60	-	-	ns
t _{CSHLD}	Chip Select Hold Time	65	-	-	ns
t _{CSHIGH}	Chip Select HIGH	100	-	-	ns
t _{SCLLOW}	Clock Low Time	25	-	-	ns
t _{SCLHIGH}	Clock High Time	25	-	-	ns
t _{SDASU}	SDA Setup Time	10	-	-	ns
t _{SDAHLDD}	SDA Hold Time	40	-	-	ns

9. Typical Operating Sequence



10. Optical Characteristics

10.1. Specifications

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	Note
R	Reflectance	White	30	35	-	%	13-1
Gn	2Gray Level	-	-	$DS+(WS-DS) \times n (m-1)$	-	L*	13-2
CR	Contrast Ratio	Indoor	8	-	-	-	-
Panel Life	-	0°C~50°C	-	5 years 1,000,000 times	-	-	13-3

Note (13-1): Luminance meter: Eye – One Pro Spectrophotometer

Note (13-2): WS: White State, DS: Dark State, m: 2

Note (13-3): Panel life is not guaranteed when used outside of conditions described herein, or outside of the 45-70%RH. Display must be updated at least once per day.

10.2. 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

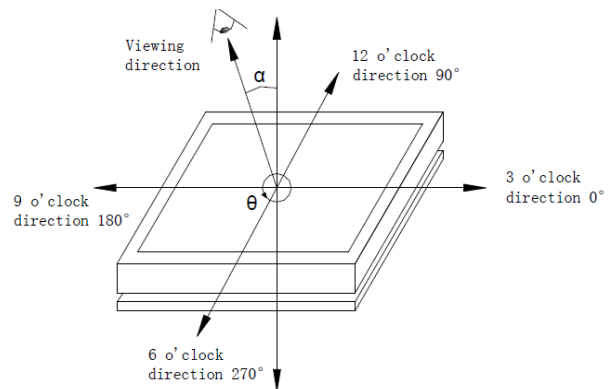
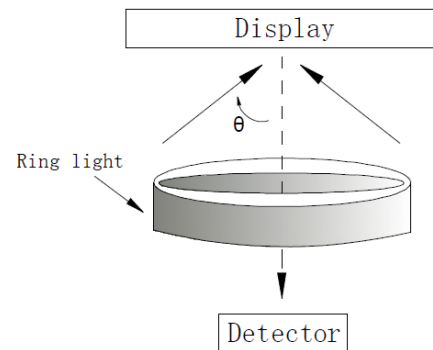
$$CR = R1/Rd$$

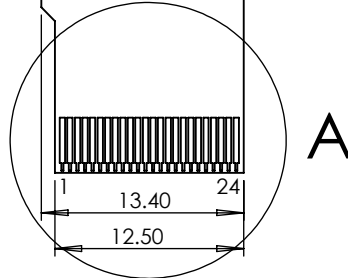
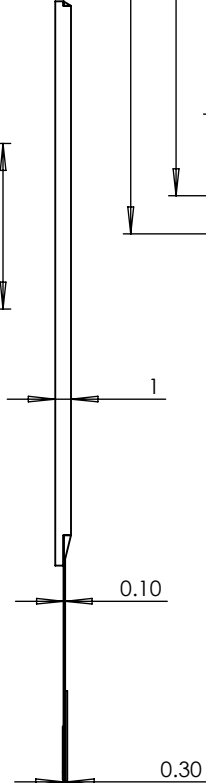
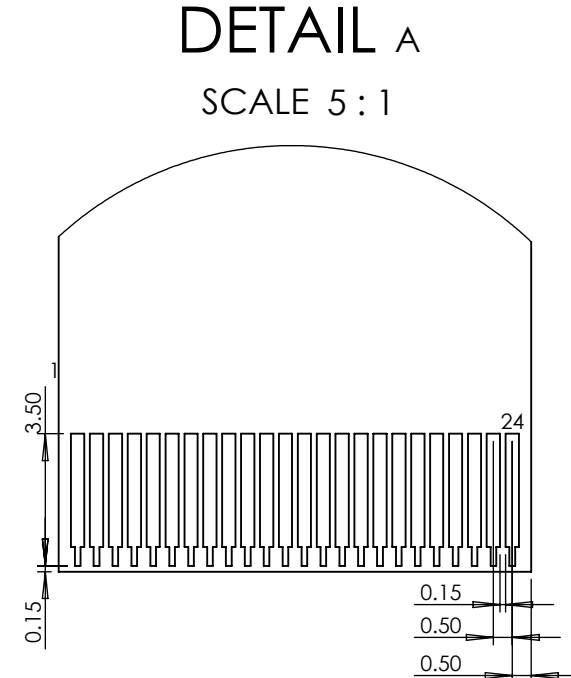
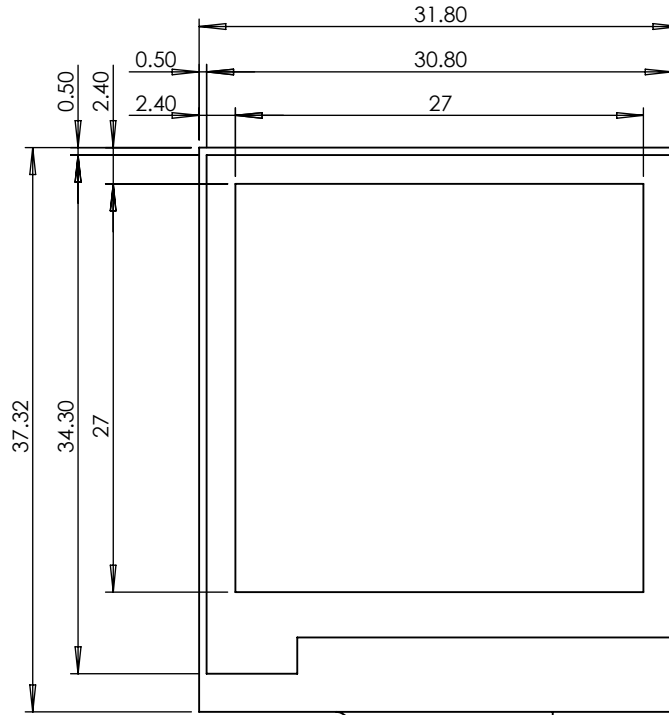
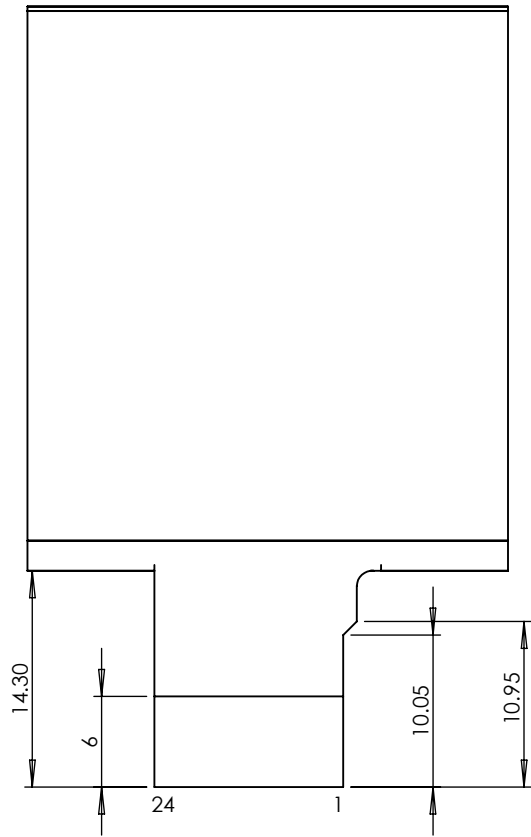
10.3. Reflection Ratio

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.





Pin	Function
1	NC
2	GDR
3	RESE
4	NC
5	VSH2
6	TSCL
7	TSDA
8	BS1
9	BUSY
10	RES#
11	D/C#
12	CS#
13	SCL
14	SDA
15	VDDIO
16	VCI
17	VSS
18	VDD
19	VPP
20	VSH1
21	VGH
22	VSL
23	VGL
24	VCOM

Controller	SD1681
Operating Temp	0-50°C

Units: millimeters
Tolerance: ±0.2



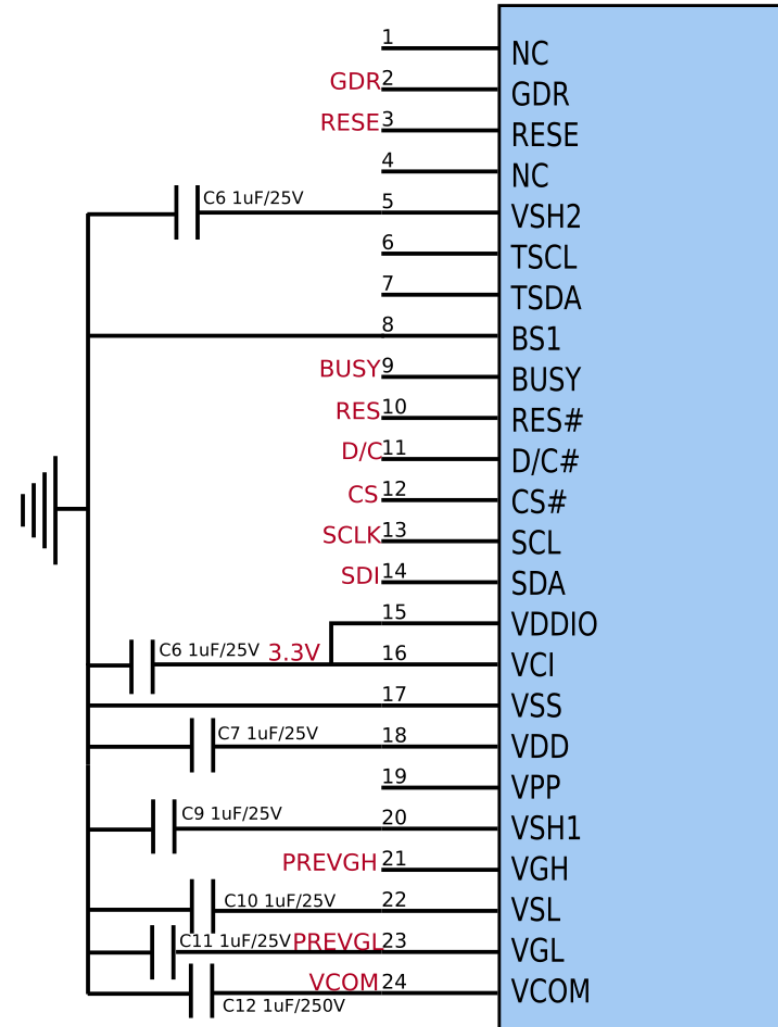
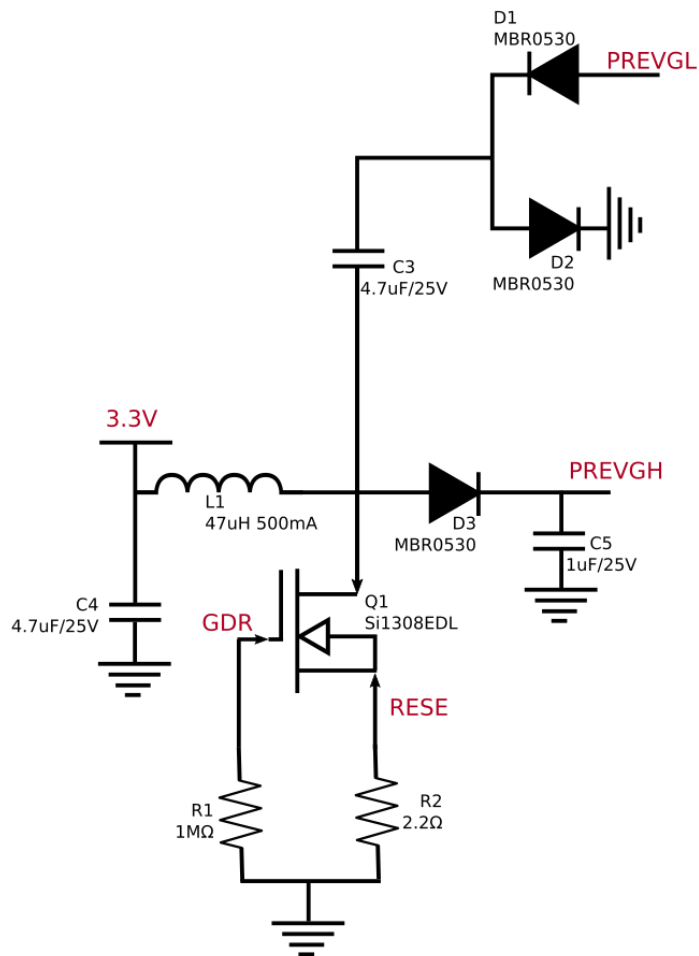
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12. Reference Circuits

12.1. General



12.2. ePaper Breakout Board Schematic

