Application Note

For

Pervasive Displays
BWRY 2.06” EPD

Description	**Elaborate how to refresh the Pervasive Displays BWRY 2.06” EPD**
Date	**2025/5/14**
Doc. No.	
Revision	**v01**

Pervasive Displays Confidential

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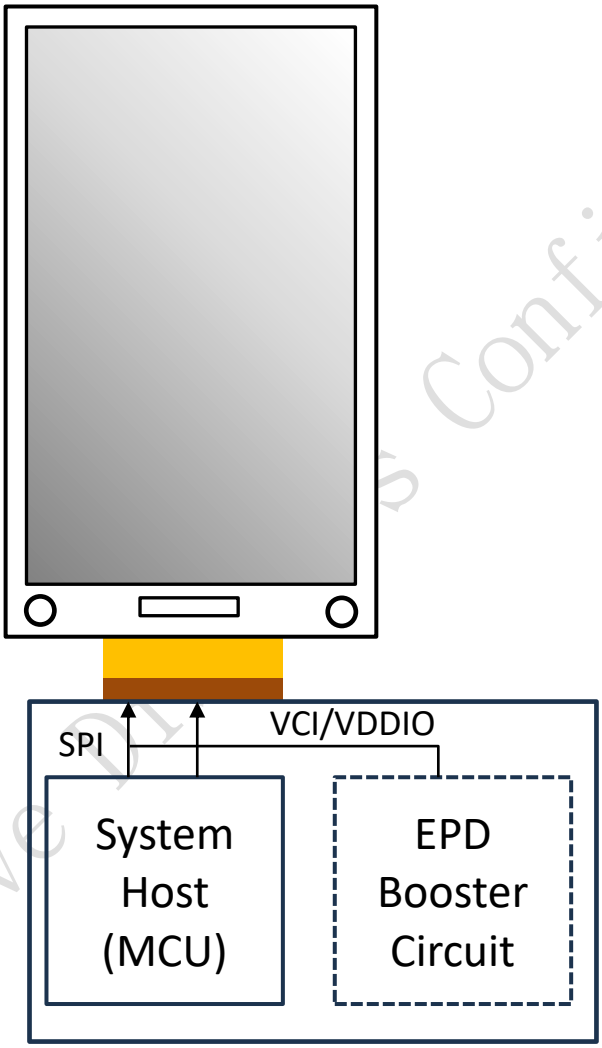
1. General Description

1.1 Overview

The document introduces how to drive the Pervasive Displays 2.06” BWRY EPD. The EPD has embedded the Tcon function. The driver's major control interface is SPI. The host sends the setting commands and the display image to the driver through the SPI bus.



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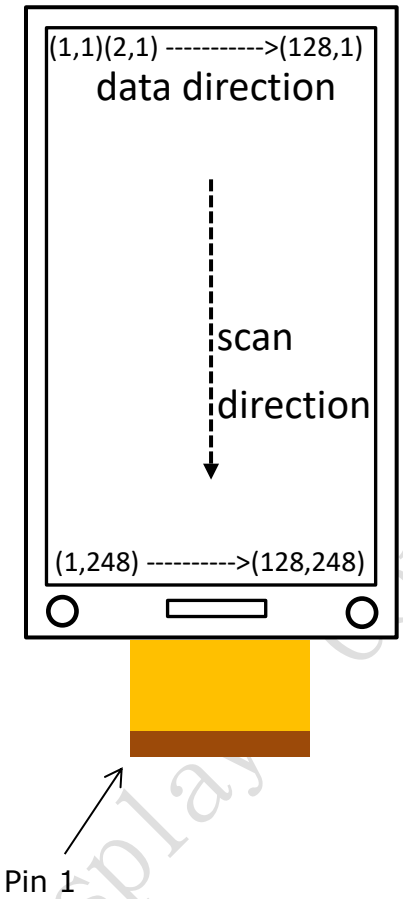
1.2 Panel drawing



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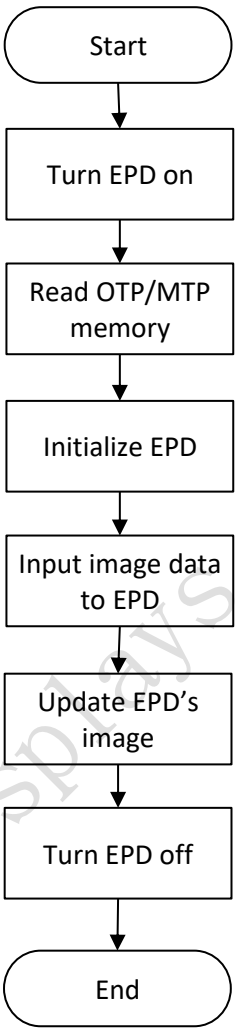
1.3 EPD Driving Flow Chart

The flowchart below provides an overview of the necessary actions to update the EPD. The steps below refer to the detailed descriptions in the respective sections.



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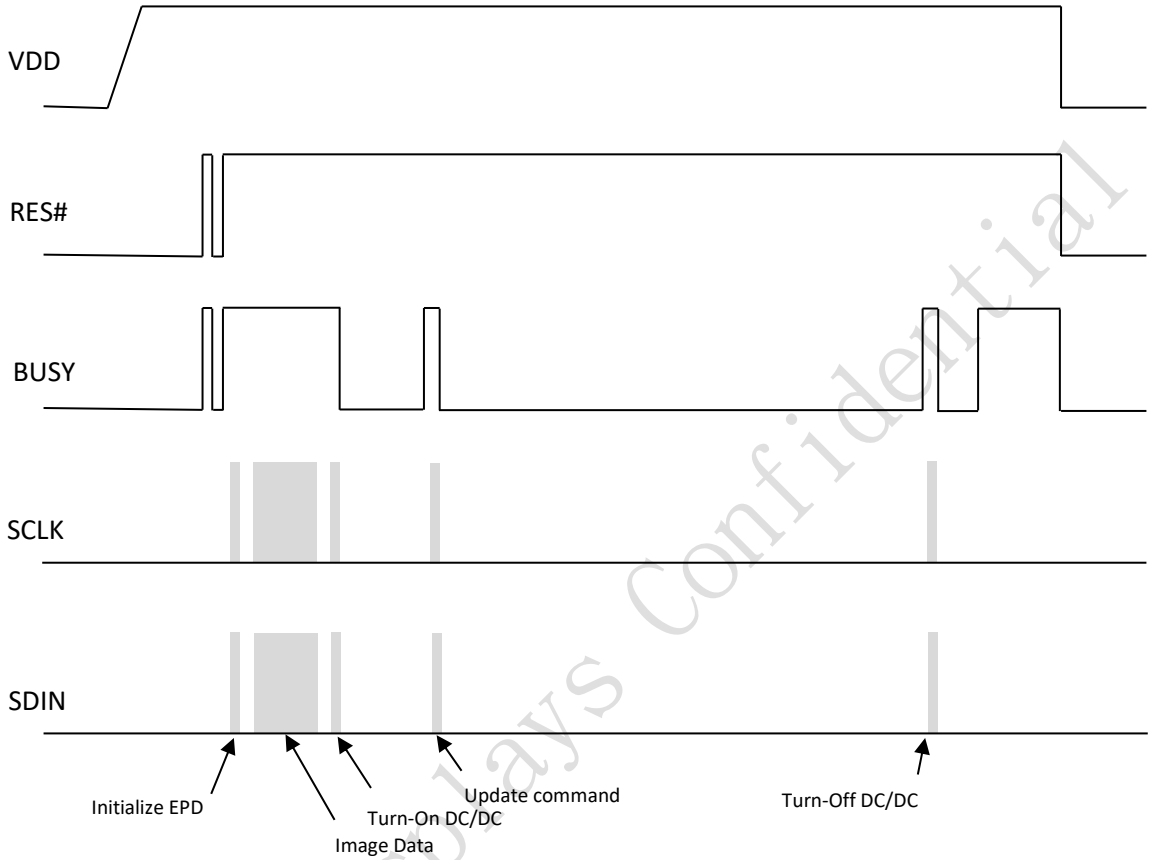
1.4 Overall Waveform

The diagram below provides an overview of signal control during an EPD update cycle.



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1.5 SPI Timing Format

SPI commands are used to communicate between the MCU and the COG Driver in EPD. The SPI format used differs from the standard. When setting up the SPI timing, Pervasive Displays recommends verifying both the SPI command format and SPI command timing in this section.

- SPI pins description:
  - SCLK : Serial communication clock.
  - SDIN : Serial communication data input/output

    When sending register index/data, the pin must be an output of the MCU.

    When reading data, the pin must be an input of the MCU.
  - D/C# : The pin is used to distinguish between the register index and data

    L : Register index. **H** : Data
  - CS# : Serial communication chip select.
- Below is a description of the SPI Format:

  SPI(0xI, 0xD_1, 0xD_2, …, 0xD_n)

  Where:

  I is the Register Index and the length is 1 byte
  $D_{1\sim n}$ is the Register Data. The Register Data length is varies.

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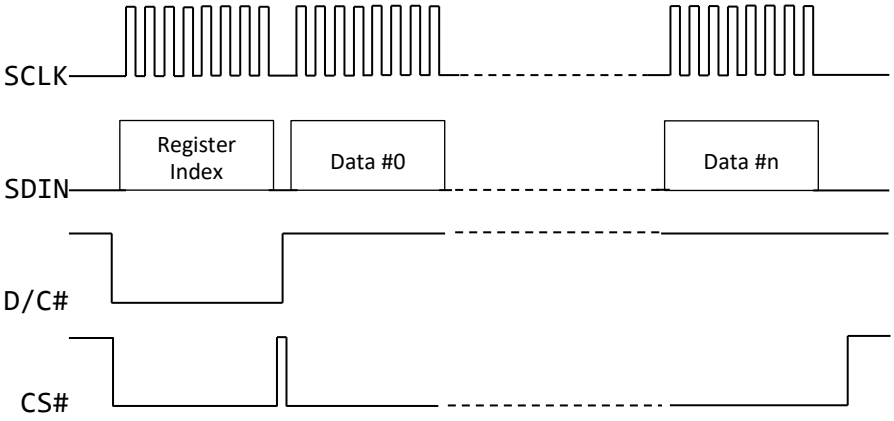
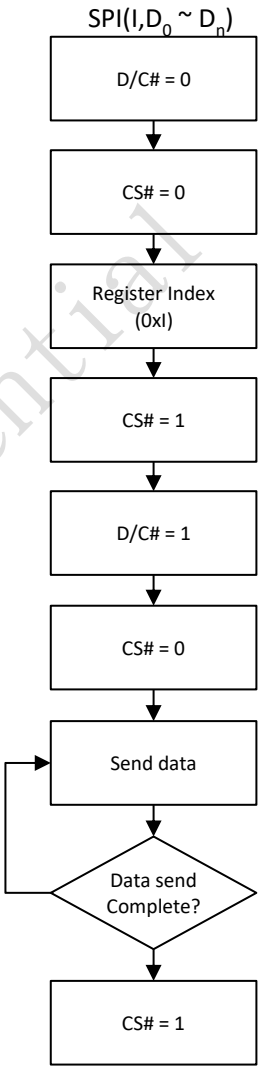
- SPI send command signals and flowchart:

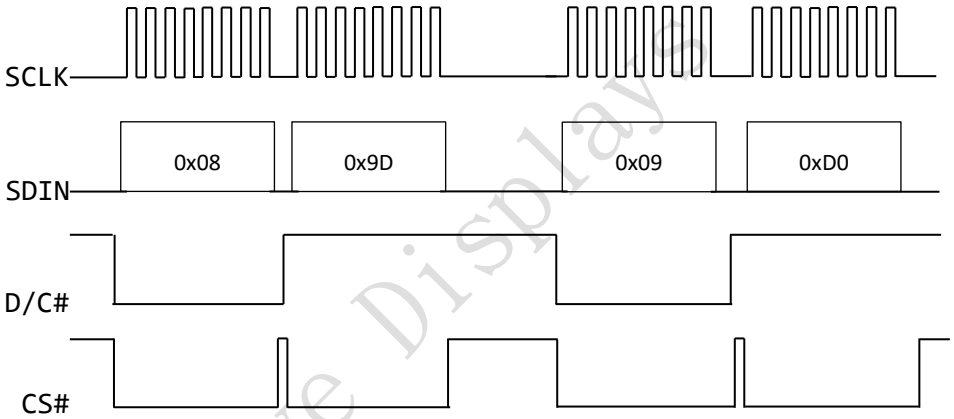




For example:

To send two SPI commands:

SPI(0x08,0x9D) and SPI (0x09,0xD0)



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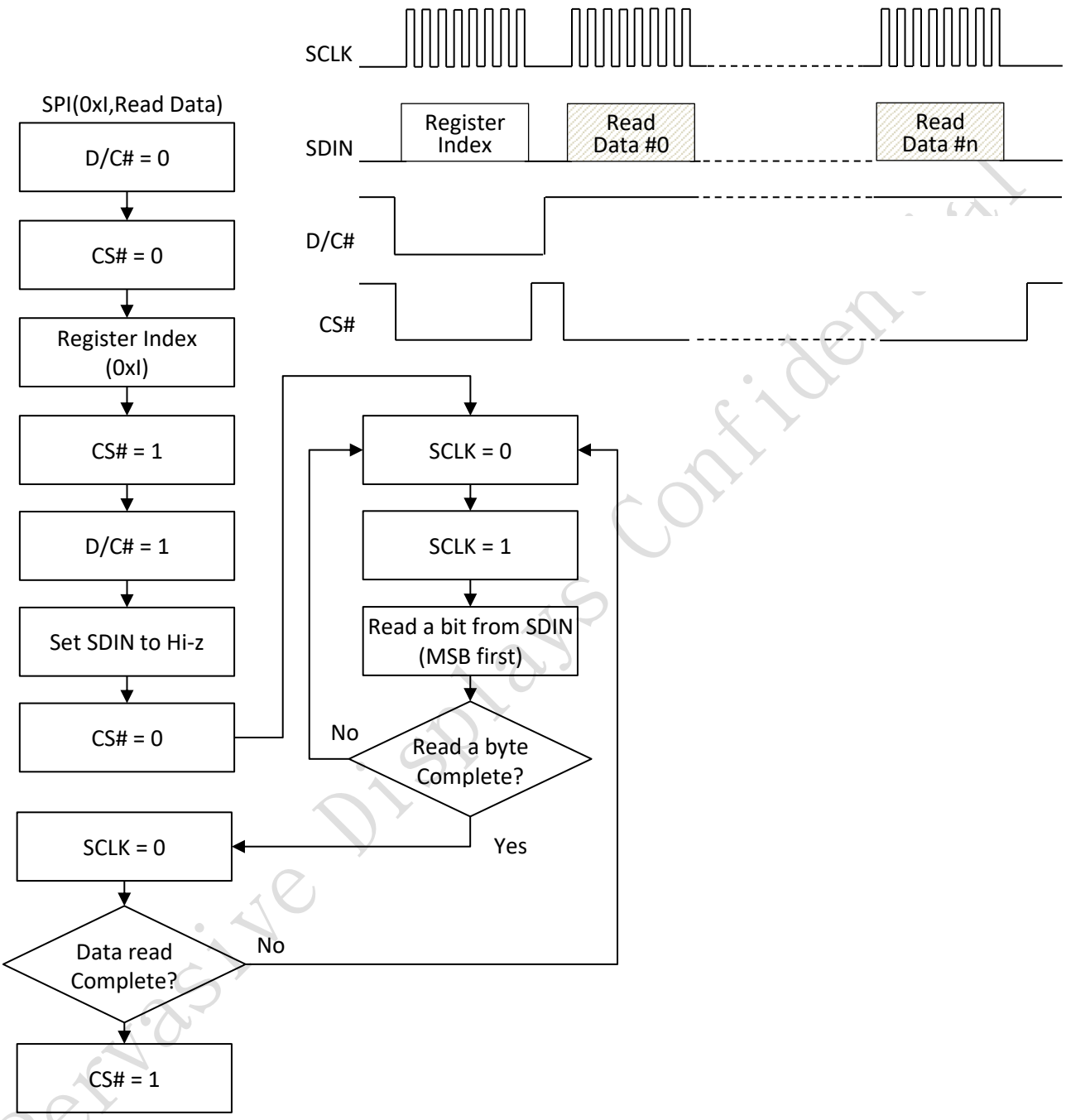
- SPI read command signals and flowchart:



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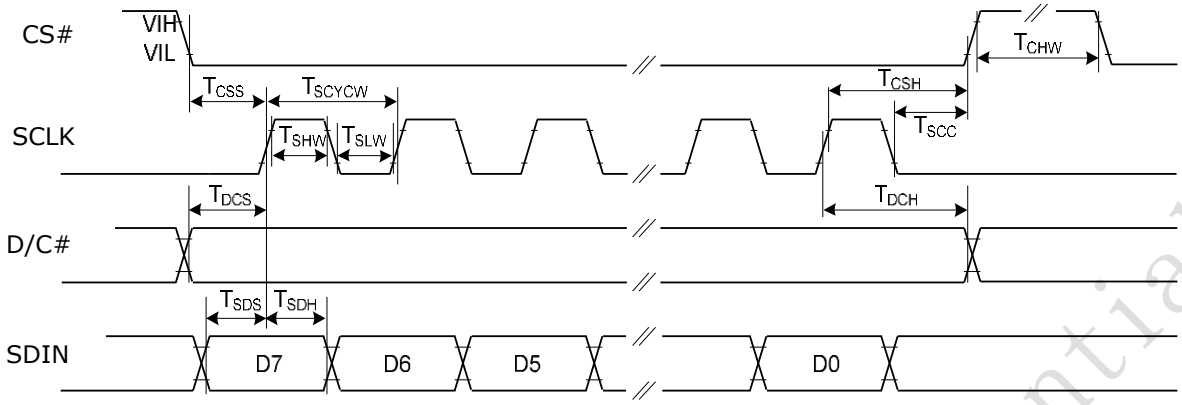
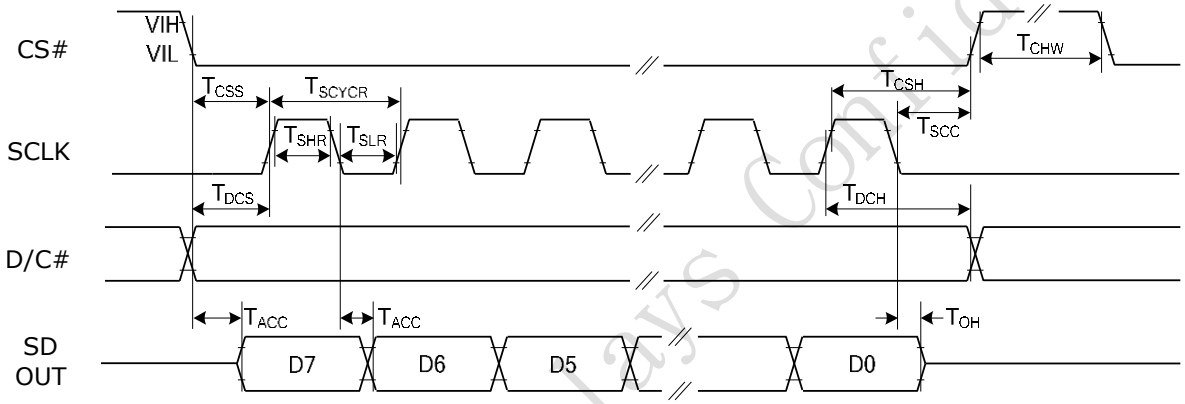
- SPI command timing



Write mode



Read mode

AC Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Chip Select Setup Time	t_{CSS}	60	-	-	ns	
Chip Select Hold Time	t_{CSH}	65	-	-	ns	
Chip Select Setup Time	t_{SCC}	25	-	-	ns	
Chip Select Setup Time	t_{CHW}	100	-	-	ns	
Serial Clock Cycle (Write)	t_{SCYCW}	50	-	-	ns	
SCLK "H" Pulse Width (Write)	t_{SHW}	25	-	-	ns	
SCLK "L" Pulse Width (Write)	t_{SLW}	25	-	-	ns	
Serial Clock Cycle (Read)	t_{SCYCR}	400	-	-	ns	
SCLK "H" Pulse Width (Read)	t_{SHR}	180	-	-	ns	
SCLK "L" Pulse Width (Read)	t_{SLR}	180	-	-	ns	
DC Setup Time	t_{DCS}	40	-	-	ns	
DC Hold Time	t_{DCH}	40	-	-	ns	
Data Setup Time	t_{SDS}	30	-	-	ns	
Data Hold Time	t_{SDH}	30	-	-	ns	
Access Time	t_{ACC}	-	-	100	ns	
Output Disable Time	t_{OH}	15	-	-	ns	

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1.6 Read MTP memory mapping data

There is memory layout in MTP that was programmed the User-defined data and the EPD initial data. This paragraph is going to describe the data format.

	ADDRESS	DATA	DESCRIPTION
MTP memory	0x000 | 0xD7F	Pervasive Displays Reserves	
	0xD80	Check code	This check code indicates whether the MTP data is valid. If so, it would be 0xA5.
	0xD81 | 0xD8F	Pervasive Displays Reserves	
	0xD90 | 0xDAF	COG initial data	The data of this sector is the necessary IC initial data. These data need to be read out for IC initialization.
	0xDB0 | ……	Pervasive Displays Reserves	

According to the table, there is memory mapping of user data. The "check code" is used to determine whether the MTP data is valid. Based on the following procedures for reading the user data, the data from **0xD80** to **0xDAF** will be stored to the array **data[0]** ~ **data[47]**

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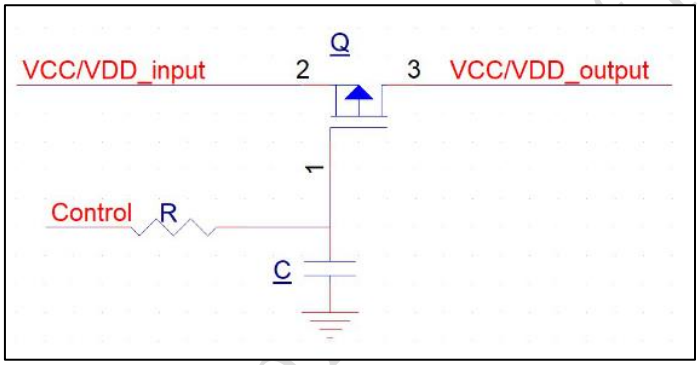
2. Turn on EPD

Turn on EPD processes

Step	Action / SPI instruction		
	Index	Data	Data size
1	Initial state *1		
2	Tune on EPD's VDD/VCC *2		
3	COG reset *3		

Note:

1. Initial state the VCC/VDD, RES#, CS#, SDIN, SCLK, BS, D/C# = 0
2. In order to the inrush current will cause other issue. It is recommended to add soft-start when VCC/VDD is turned on. (as the circuit below)
3. Please refer to next page for details



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- COG reset sequence

COG reset processes

Step	Action / SPI instruction		
	Index	Data	Data size
1	RES# = 0		
2	Delay 20ms		
3	RES# = 1		
4	Delay 10ms		
5	RES# = 0		
6	Delay 20ms		
7	RES# = 1		
8	Delay 10ms		
9	Waiting for the BUSY signal to be high level		
10	Delay 10ms		

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3. EPD initial

EPD initial processes [*1]

Step	Action / SPI instruction		
	Index	Data	Data size
1	Read out the Chip ID from the 0x70 register to make sure it's right EPD [*2]		
2	0xF0	0x0B	1
3	0x90 [*3]	-	0
4	Waiting for the BUSY signal to be high level		
5	0xA2	0x33	1
6	0xA0	-	0
7	Waiting for the BUSY signal to be high level		
8	0xF6	0x0D,0x80	2
9	Read out the user data from the 0x92 instruction [*4]		
10	COG Reset [*5]		
11	0xE0	0x02	1
12	0xE6	Environment Temperature [*6]	1
13	0xA5	-	0
14	Waiting for the BUSY signal to be high level		
15	0x01	data[16,17] [*7]	2
16	0x00	data[18,19]	2
17	Waiting for the BUSY signal to be high level		
18	0x61	data[20,21,22,23]	4
19	Waiting for the BUSY signal to be high level		
20	0x06	data[24,25,26,27]	4
21	0x03	data[30]	1
22	0xE7	data[33]	1
23	0x65	data[34,35,36,37]	4
24	0x30	data[38]	1
25	0x50	data[39]	1
26	0x60	data[40,41]	2
27	0xE3	data[42]	1
28	0x62	data[43,44]	2
29	0xE9	0x01	1

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NOTE:

1. Follow the end of the power on sequence
2. The 0x70 instruction can read out 2-byte data of the Chip ID that would be {0xC9,0x01}
3. This register does not have data, just send the index.
4. The first byte of readout is a dummy byte. According to the MTP mapping table, the necessary data is from 0xD80 ~ 0xDAF, so 48 bytes of data need to be read out and stored these data into the "**data**" array.
5. COG reset: please refer to the Ch.2

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6. The data is the temperature value and unit are degree of Celsius.
   The highest bit of the data represents positive/negative in temperature.
   if it's positive, the data = (temperature value)
   if it's negative, the data = (2's complement of temperature value)

   example:

temperature value	data
25°C	0x19
5°C	0x05
-5°C	0xFB

7. The command is with 2-byte data that would be read out from **0xD90~0xD91** of MTP memory, which is equivalent to **data[16~17]**

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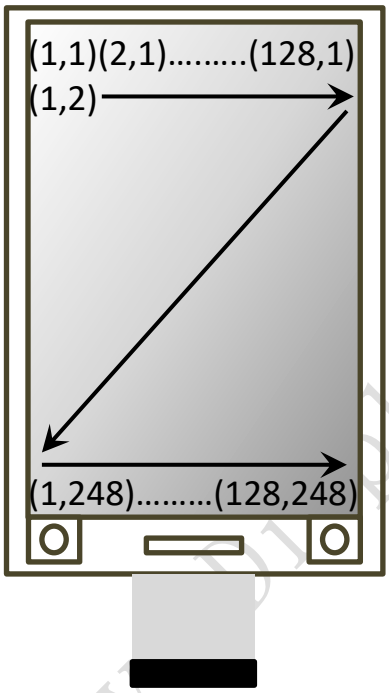
4. Input image data to the EPD

This section describes how to send image data into COG which will be displayed on the display. The register index of the image buffer is 0x10.

There is 2-bit data per pixel to define 4 colors. (e.g. the first byte represents the 1st ~ 4th pixels of the first line, the second byte represents the 5th ~ 8th pixels of the first line, …… and so on).

Data Byte	bit[7:6]	bit[5:4]	bit[3:2]	bit[1:0]
Pixel	pixel[n]	pixel[n+1]	pixel[n+2]	pixel[n+3]




```
Image data input sequence:
Line001:(1,1)>(2,1)>…>(128,1)
Line002:(1,2)>(2,2)>…>(128,2)
                :
                :
                :
Line248:.............(128,248)
Frame data : 2 x 128 x 248
           = 63,488 bits
           = 7,936 Bytes
```

The color definition of image data is as blow table,

data	color
00	black
01	white
10	Yellow
11	Red

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5. EPD Update command

Update command [*1]

Step	Action / SPI instruction		
	Index	Data	Data size
1	0x04	-	0
2	Waiting for the BUSY signal to be high level		
3	0x12	0x00	1
4	Waiting for the BUSY signal to be high level		

Note:

1. Follow the end of the sending image data to EPD

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6. Turn off EPD

EPD off processes [*1]

Step	Action / SPI instruction		
	Index	Data	Data size
1	0x02(POF)	0x00	1
2	Waiting for the BUSY signal to be high level		
3	0x07(DSLP)	0xA5	1
4	delay 50ms		
5	Set CS#, D/C, SDIN, SCLK and RES# pin to Hiz/floating		
6	delay 1000ms		
7	Cut Vdd/Vcc off		
8	delay 200ms [*2]		

Note:

1. Follow the end of the EPD update command sequence
2. Finished all steps for updating the EPD

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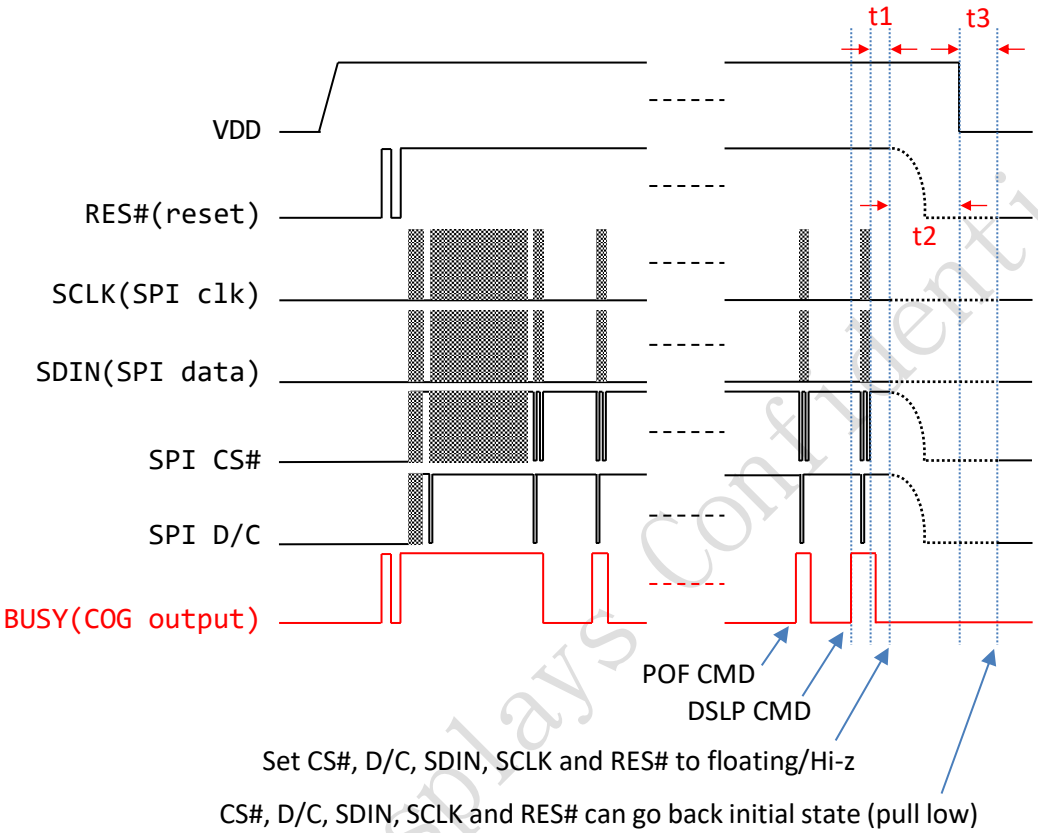
The power-off timing diagram is like the diagram below.

t1: must be more than 50ms.

t2: must be more than 1000ms.

t3: must be more than 200ms.



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Revision History

Version	Date	Page (New)	Section	Description
v01	2025/5/14			Initial version

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Glossary of Acronyms

EPD	Electrophoretic Display (e-Paper Display)
EPD Panel	EPD
TCon	Timing Controller
FPL	Front Plane Laminate (e-Paper Film)
SPI	Serial Peripheral Interface
COG	Chip on Glass
PDI, PDi	Pervasive Displays Incorporated

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