



12.48 inch  
**E-paper Display Series**



**GDEY1248Z51**

Dalian Good Display Co., Ltd.

# Product Specifications



<b>Customer</b>	<b>Standard</b>
<b>Description</b>	<b>12.48" E-PAPER DISPLAY</b>
<b>Model Name</b>	<b>GDEY1248Z51</b>
<b>Date</b>	2022/01/28
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## 1. Overview

The display is a TFT active matrix electrophoretic display, with interface and a reference system design. The 12.48 " active area contains  $984 \times 1304$  pixels, and has 1-bit white/black and 1-bit red full display capabilities. An integrated circuit contains gate buffer, source buffer, interface, timing control logic, oscillator, DC-DC, SRAM, LUT, VCOM, and border are supplied with each panel.

## 2. Features

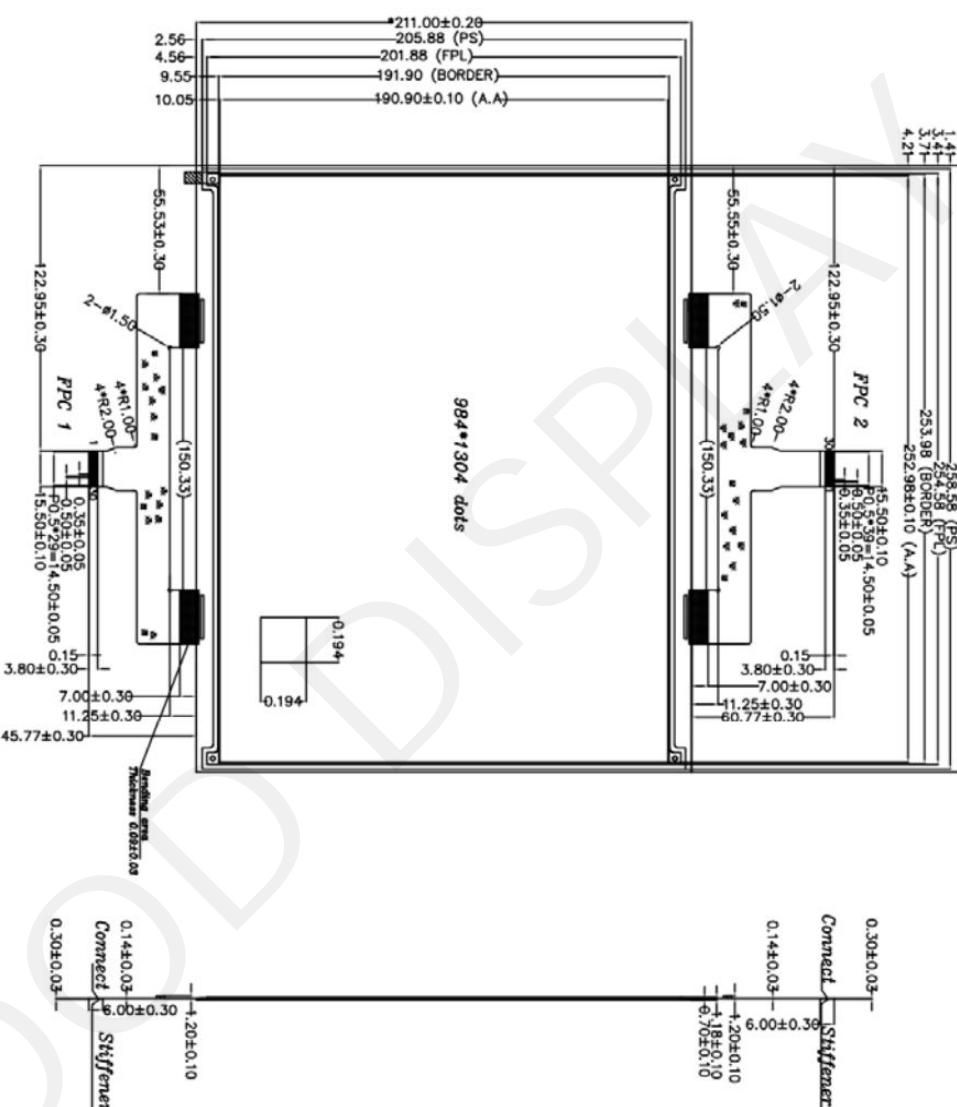
- $984 \times 1304$  pixels display
- High contrast High reflectance
- Ultra wide viewing angle Ultra low power consumption
- Pure reflective mode
- Bi-stable display
- Commercial temperature range
- Landscape portrait modes
- Hard-coat antiglare display surface
- Ultra Low current deep sleep mode
- On chip display RAM
- Waveform can stored in On-chip OTP or written by MCU
- Serial peripheral interface available
- On-chip oscillator
- On-chip booster and regulator control for generating VCOM, Gate and Source driving voltage
- I2C signal master interface to read external temperature sensor
- Built-in temperature sensor

## 3. Mechanical Specifications

Parameter	Specifications	Unit	Remark
Screen Size	12.48	Inch	
Display Resolution	$984(H) \times 1304(V)$	Pixel	Dpi:131
Active Area	$252.98 \times 190.90$	mm	
Pixel Pitch	$0.194 \times 0.194$	mm	
Pixel Configuration	Square		
Outline Dimension	$261.4(H) \times 211(V) \times 1.20(D)$	mm	
Weight	$129.23 \pm 0.05$	g	

## 4. Mechanical Drawing of EPD module

CUSTOMER'S APPROVED:		DATE:	PAGE: 1 / 1
FPC 2			
1	CSB_S2	1	CSB_M1
2	GDR_M2	2	GDR_M1
3	RESE_M2	3	RESE_M1
4	VSHR_M2	4	VSHR_M1
5	TSDA	5	TSCL
6	TSDA	6	TSCL
7	SCL	7	SCL
8	BUSY_M2	8	BUSY_M1
9	RST	9	RST
10	DC	10	DC
11	CSB_M2	11	CSB_S1
12	SCL	12	SCL
13	SDA	13	SDA
14	LSYNC_M2	14	LSYNC_M1
15	MN2_SYNC_M2	15	MN2_SYNC_M1
16	NEMI_SYNC_M2	16	NEMI_SYNC_M1
17	VDDIO_M2	17	VDDIO_M1
18	VDD_M2	18	VDD_M1
19	VSS_M2	19	VSS_M1
20	VDD_18V_M2	20	VDD_18V_M1
21	VOOTP_M2	21	VOOTP_M1
22	VSH_M2	22	VSH_M1
23	VGH_M2	23	VGH_M1
24	VSL_M2	24	VSL_M1
25	VGL_M2	25	VGL_M1
26	VCOM_M2	26	VCOM_M1
27	BUSY_S2	27	BUSY_S1
28	VSHR_S2	28	VSHR_S1
29	VSH_S2	29	VSH_S1
30	VSL_S2	30	VSL_S1
FPC 1			
1	CSB_M1	1	CSB_S2
2	GDR_M1	2	GDR_M2
3	RESE_M1	3	RESE_M2
4	VSHR_M1	4	VSHR_M2
5	TSCL	5	TSDA
6	TSCL	6	TSDA
7	SCL	7	SCL
8	BUSY_M1	8	BUSY_M2
9	RST	9	RST
10	DC	10	DC
11	CSB_S1	11	CSB_M2
12	SCL	12	SCL
13	SDA	13	SDA
14	LSYNC_M1	14	LSYNC_M2
15	MN2_SYNC_M1	15	MN2_SYNC_M2
16	NEMI_SYNC_M1	16	NEMI_SYNC_M2
17	VDDIO_M1	17	VDDIO_M2
18	VDD_M1	18	VDD_M2
19	VSS_M1	19	VSS_M2
20	VDD_18V_M1	20	VDD_18V_M2
21	VOOTP_M1	21	VOOTP_M2
22	VSH_M1	22	VSH_M2
23	VGH_M1	23	VGH_M2
24	VSL_M1	24	VSL_M2
25	VGL_M1	25	VGL_M2
26	VCOM_M1	26	VCOM_M2
27	BUSY_S1	27	BUSY_S2
28	VSHR_S1	28	VSHR_S2
29	VSH_S1	29	VSH_S2
30	VSL_S1	30	VSL_S2
REVISION RECORD			
NO.	REVISION RECORD	NAME	DATE
5	Modify FPC	DALIAN GOOD DISPLAY CO., LTD.	GDEY1248Z51
4	Modify IC	Drew	
3	Modify glass size	Chk	
2	Modify glass size	Unit:mm	
1	Modify glass,PS, FPL size	Apu	
	Initial version		



10 Dimensions with mark "\*" are important

## 5. Input /Output Pin Assignment

### 5-1) Pin out List

FPC-1 pin out list

No.	Single	Type	Description	Remark
1	CSB_M1	I	Serial communication chip select	Note 5-1
2	GDR_M1	O	This pin is N-MOS gate control	
3	RESE_M1	P	Current sense input for control loop	
4	VSHR_M1	P	Positive source voltage for Red	
5	TSCL	O	I <sup>2</sup> C clock for external temperature sensor	
6	TSDA	I/O	I <sup>2</sup> C data for external temperature sensor	
7	BS	I	Input interface setting. Select 3 wire/4 wire SPI interface	Note 5-5
8	BUSY_M1	O	This pin indicates the driver status	Note 5-4
9	RST	I	Global reset pin. Low reset	Note 5-3
10	DC	I	Serial communication Command/Data input	Note 5-2
11	CSB_S1	I	Serial communication chip select	Note 5-1
12	SCL	I	Serial communication clock input	
13	SDA	I/O	Serial communication data input	
14	LSYNC_M1	I/O	2+2 cascade sync signal	
15	M1M2_SYN_C_M1	I/O	2+2 cascade sync signal	
16	M2M1_SYN_C_M1	I/O	2+2 cascade sync signal	
17	VDDIO_M1	P	IO voltage supply	
18	VDD_M1	P	Digital/Analog power	
19	VSS_M1	P	Digital ground	
20	VDD_18V_M1	P	1.8V voltage input &output	
21	VOTP_M1	P	OTP program power (7.5V)	
22	VSH_M1	P	Positive source voltage	
23	VGH_M1	P	Positive gate voltage	
24	VSL_M1	P	Negative source voltage	
25	VGL_M1	P	Negative gate voltage	
26	VCOM_M1	O	VCOM output	
27	BUSY_S1	O	This pin indicates the driver status	
28	VSHR_S1	P	Positive source voltage for Red	
29	VSH_S1	P	Positive source voltage	
30	VSL_S1	P	Positive gate voltage	

## FPC-2 pin out list

No.	Single	Type	Description	Remark
1	CSB_S2	I	Serial communication chip select	Note 5-1
2	GDR_M2	O	This pin is N-MOS gate control	
3	RESE_M2	P	Current sense input for control loop	
4	VSHR_M2	P	Positive source voltage for Red	
5	TSCL	O	I <sup>2</sup> C clock for external temperature sensor	
6	TSDA	I/O	I <sup>2</sup> C data for external temperature sensor	
7	BS	I	Input interface setting. Select 3 wire/4 wire SPI interface	Note 5-5
8	BUSY_M2	O	This pin indicates the driver status	Note 5-4
9	RST	I	Global reset pin. Low reset	Note 5-3
10	DC	I	Serial communication Command/Data input	Note 5-2
11	CSB_M2	I	Serial communication chip select	Note 5-1
12	SCL	I	Serial communication clock input	
13	SDA	I/O	Serial communication data input	
14	LSYNC_M2	I/O	2+2 cascade sync signal	
15	M1M2_SYN_C_M2	I/O	2+2 cascade sync signal	
16	M2M1_SYN_C_M2	I/O	2+2 cascade sync signal	
17	VDDIO_M2	P	IO voltage supply	
18	VDD_M2	P	Digital/Analog power	
19	VSS_M2	P	Digital ground	
20	VDD_18V_M2	P	1.8V voltage input &output	
21	VOTP_M2	P	OTP program power (7.5V)	
22	VSH_M2	P	Positive source voltage	
23	VGH_M2	P	Positive gate voltage	
24	VSL_M2	P	Negative source voltage	
25	VGL_M2	P	Negative gate voltage	
26	VCOM_M2	O	VCOM output	
27	BUSY_S2	O	This pin indicates the driver status	
28	VSHR_S2	P	Positive source voltage for Red	
29	VSH_S2	P	Positive source voltage	
30	VSL_S2	P	Positive gate voltage	

Note 5-1: This pin (CSB) is the chip select input connecting to the MCU. The chip is enabled for MCU communication only when CSB is pulled Low.

Note 5-2: This pin (DC) is Data/Command control pin connecting to the MCU. When the pin is pulled HIGH, the data will be interpreted as data. When the pin is pulled Low, the data will be interpreted as command.

Note 5-3: This pin (RST\_N) is reset signal input. The Reset is active Low.

Note 5-4: This pin (BUSY\_N) is BUSY\_N state output pin. When BUSY\_N is low, the operation of chip should not be interrupted and any commands should not be issued to the module.

The driver IC will put BUSY\_N pin low when the driver IC is working such as:

- Outputting display waveform; or
- Programming with OTP
- Communicating with digital temperature sensor

Note 5-5: This pin (BS) is for 3-line SPI or 4-line SPI selection. When it is " Low" , 4-line SPI is selected. When it is " High" , 3-line SPI (9 bits SPI) is selected. Please refer to below Table.

Table: Bus interface selection

<b>BS</b>	<b>MCU Interface</b>
L	4-lines serial peripheral interface(SPI)
H	3- lines serial peripheral interface(SPI) - 9 bits SPI

## 6. Command Table

W/R: 0: Write Cycle 1: Read Cycle

C/D: 0: Command / 1: Data

D7~D0: -: Don't Care #: Valid Data

#	Command	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	Registers	Default
1	Panel Setting (PSR)	0	0	0	0	0	0	0	0	0	0	REG, KW/R, UD, SHL, SHD_N, RST_N	00H
		0	1	--	--	#	#	#	#	#	#		0FH
2	Power Setting (PWR)	0	0	0	0	0	0	0	0	0	1	BD_EN, VSR_EN, VS_EN, VG_EN	01H
		0	1	--	--	--	#	--	#	#	#		07H
		0	1	--	--	--	#	--	#	#	#	VCOM_SLEW, VG_LVL[2:0]	17H
		0	1	--	--	#	#	#	#	#	#	VDH_LVL[5:0]	3AH
		0	1	--	--	#	#	#	#	#	#	VDL_LVL[5:0]	3AH
		0	1	--	--	#	#	#	#	#	#	VDHR_LVL[5:0]	03H
3	Power OFF (POF)	0	0	0	0	0	0	0	0	1	0		02H
4	Power OFF Sequence Setting (PFS)	0	0	0	0	0	0	0	0	1	1	T_VDS_OFF[1:0]	03H
		0	1	--	--	#	#	--	--	--	--		00H
5	Power ON (PON)	0	0	0	0	0	0	0	0	1	0	0	04H
6	Power ON Measure (PMES)	0	0	0	0	0	0	0	1	0	1		05H
7	Booster Soft Start (BTST)	0	0	0	0	0	0	0	0	1	1	0	06H
		0	1	#	#	#	#	#	#	#	#	BT_PHA[7:0]	17H
		0	1	#	#	#	#	#	#	#	#	BT_PHB[7:0]	17H
		0	1	--	--	#	#	#	#	#	#	BT_PHC1[5:0]	17H
		0	1	#	--	#	#	#	#	#	#	PHC2_EN, BT_PHC2[5:0]	17H
8	Deep sleep (DSLP)	0	0	0	0	0	0	0	0	1	1	1	07H
		0	1	1	0	1	0	0	1	0	1	Check code	A5H
9	Display Start Transmission 1 (DTM1, White/Black Data) (x-byte command)	0	0	0	0	0	1	0	0	0	0	K/W or OLD Pixel Data (800x600):	10H
		0	1	#	#	#	#	#	#	#	#	KPXL[1:8]	-
		0	1	:	:	:	:	:	:	:	:	:	-
		0	1	#	#	#	#	#	#	#	#	KPXL[n-7:n]	-
10	Data Stop (DSP)	0	0	0	0	0	1	0	0	0	1		11H
		1	1	#	--	--	--	--	--	--	--		00H
11	Display Refresh (DRF)	0	0	0	0	0	1	0	0	1	0		12H
12	Display Start transmission 2 (DTM2, Red Data) (x-byte command)	0	0	0	0	0	1	0	0	1	1	Red or NEW Pixel Data (800x600):	13H
		0	1	#	#	#	#	#	#	#	#	RPXL[1:8]	-
		0	1	:	:	:	:	:	:	:	:	:	-
		0	1	#	#	#	#	#	#	#	#	RPXL[n-7:n]	-
13	Dual SPI	0	0	0	0	0	1	0	1	0	1		15H
		1	1	--	--	#	#	--	--	--	--	MM_EN, DUSPI_EN	00H
14	Auto Sequence (AUTO)	0	0	0	0	0	1	0	1	1	1		17H
		0	1	1	0	1	0	0	1	0	1	Check code	A5H
15	VCOM LUT (LUTC) (61-byte command, structure of bytes 2~7 repeated 10 times)	0	0	0	0	1	0	0	0	0	0		20H
		0	1	#	#	#	#	#	#	#	#	Level select-0~3[1:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-0[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-1[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-2[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-3[7:0]	-
		0	1	#	#	#	#	#	#	#	#	Times to repeat[7:0]	-
16	W2W LUT (LUTWW) (43-byte command, structure of bytes 2~7 repeated 7 times)	0	0	0	0	1	0	0	0	0	1		21H
		0	1	#	#	#	#	#	#	#	#	Level select-0~3[1:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-0[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-1[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-2[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-3[7:0]	-
		0	1	#	#	#	#	#	#	#	#	Times to repeat[7:0]	-

		0	0	0	0	1	0	0	0	1	0		
		0	1	#	#	#	#	#	#	#	#	Level select-0~3[1:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-0[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-1[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-2[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-3[7:0]	-
		0	1	#	#	#	#	#	#	#	#	Times to repeat[7:0]	-
17	K2W LUT (LUTKW / LUTR) (61-byte command, structure of bytes 2~7 repeated 10 times)	0	0	0	0	1	0	0	0	1	1		22H
		0	1	#	#	#	#	#	#	#	#	Level select-0~3[1:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-0[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-1[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-2[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-3[7:0]	-
		0	1	#	#	#	#	#	#	#	#	Times to repeat[7:0]	-
18	W2K LUT (LUTWK / LUTW) (61-byte command, structure of bytes 2~7 repeated 10 times)	0	0	0	0	1	0	0	0	1	1		23H
		0	1	#	#	#	#	#	#	#	#	Level select-0~3[1:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-0[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-1[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-2[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-3[7:0]	-
		0	1	#	#	#	#	#	#	#	#	Times to repeat[7:0]	-
19	K2K LUT (LUTKK / LUTK) (61-byte command, structure of bytes 2~7 repeated 10 times)	0	0	0	0	1	0	0	1	0	0		24H
		0	1	#	#	#	#	#	#	#	#	Level select-0~3[1:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-0[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-1[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-2[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-3[7:0]	-
		0	1	#	#	#	#	#	#	#	#	Times to repeat[7:0]	-
20	Border LUT (43-byte command, structure of bytes 2~7 repeated 7 times)	0	0	0	0	1	0	0	1	0	1		25H
		0	1	#	#	#	#	#	#	#	#	Level select-0~3[1:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-0[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-1[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-2[7:0]	-
		0	1	:	:	:	:	:	:	:	:	Number of frames-3[7:0]	-
		0	1	#	#	#	#	#	#	#	#	Times to repeat[7:0]	-
21	LUT option (LUTOPT)	0	0	0	0	1	0	1	0	1	0		2AH
		0	1	#	#	--	--	--	--	--	--	STATE_XON[9:8]	00H
		0	1	#	#	#	#	#	#	#	#	STATE_XON[7:0]	00H
22	KW LUT option (KWOPT)	0	0	0	0	1	0	1	0	1	1		2BH
		0	1	--	--	--	--	--	--	#	#	ATRED, NORED	00H
		0	1	#	#	--	--	--	--	--	--	KWE[9:8]	00H
		0	1	#	#	#	#	#	#	#	#	KWE[7:0]	00H
23	PLL control (PLL)	0	0	0	0	1	1	0	0	0	0		30H
		0	1	--	--	--	--	#	#	#	#	FRS[3:0]	06H
24	Temperature Sensor Calibration (TSC)	0	0	0	1	0	0	0	0	0	0		40H
		1	1	#	#	#	#	#	#	#	#	D[10:3] / TS[7:0]	00H
		1	1	#	#	--	--	--	--	--	--	D[2:0] / -	00H
25	Temperature Sensor Selection (TSE)	0	0	0	1	0	0	0	0	0	1		41H
		0	1	#	--	--	--	#	#	#	#	TSE, TO[3:0]	00H
26	Temperature Sensor Write (TSW)	0	0	0	1	0	0	0	0	1	0		42H
		0	1	#	#	#	#	#	#	#	#	WATTR[7:0]	00H
		0	1	#	#	#	#	#	#	#	#	WMSB[7:0]	00H
		0	1	#	#	#	#	#	#	#	#	WLSB[7:0]	00H
27	Temperature Sensor Read (TSR)	0	0	0	1	0	0	0	0	1	1		43H
		1	1	#	#	#	#	#	#	#	#	RMSB[7:0]	00H
		1	1	#	#	#	#	#	#	#	#	RLSB[7:0]	00H
28	Panel Break Check (PBC)	0	0	0	1	0	0	0	1	0	0		44H
		1	1	--	--	--	--	--	--	--	#	PSTA	00H
29	VCOM and data interval setting (CDI)	0	0	0	1	0	1	0	0	0	0		50H
		0	1	#	--	#	#	--	--	#	#	BDZ, BDV[1:0], DDX[1:0]	31H
		0	1	--	--	--	--	#	#	#	#	CDI[3:0]	07H

31	End Voltage Setting (EVS)	0 0 0 1 0 1 0 0 1 0	VCEND, BDEND[1:0]	52H 02H
32	TCON setting (TCON)	0 0 0 1 1 0 0 0 0 0	S2G[3:0], G2S[3:0]	60H 22H
33	Resolution setting (TRES)	0 0 0 1 1 0 0 0 0 1		61H
		0 1 -- -- -- -- # -- # #	HRES[9:8]	03H
		0 1 # # # # # 0 0 0	HRES[7:3]	20H
		0 1 -- -- -- -- -- # #	VRES[9:0]	02H 58H
34	Gate/Source Start setting (GSST)	0 0 0 1 1 0 0 1 0 1		65H
		0 1 -- -- -- -- -- # #	HST[9:8]	00H
		0 1 # # # # # 0 0 0	HST[7:3]	00H
		0 1 -- -- -- -- -- # #	VST[9:0]	00H 00H
35	Revision (REV)	0 0 0 1 1 1 0 0 0 0		70H
		1 1 # # # # # # # #	PROD_REV[23:16]	FFH
		1 1 # # # # # # # #	PROD_REV[15:8]	FFH
		1 1 # # # # # # # #	PROD_REV[7:0]	FFH
		1 1 # # # # # # # #	LUT_REV[23:16]	FFH
		1 1 # # # # # # # #	LUT_REV[15:8]	FFH
		1 1 # # # # # # # #	LUT_REV[7:0]	FFH
		1 1 # # # # # # # #	CHIP_REV[7:0]	0CH
36	Get Status (FLG)	0 0 0 1 1 1 0 0 0 1		71H
		1 1 -- # # # # # # #	PTL_FLAG, I <sup>2</sup> C_ERR, I <sup>2</sup> C_BUSYN, DATA_FLAG, PON, POF, BUSY_N	13H
37	Auto Measurement VCOM (AMV)	0 0 1 0 0 0 0 0 0 0		80H
		0 1 -- # # # # # # #	AMVT[1:0], XON, AMVS, AMV, AMVE	10H
38	Read VCOM Value (VV)	0 0 1 0 0 0 0 0 0 1		81H
		1 1 -- # # # # # # #	VV[6:0]	00H
39	VCOM_DC Setting (VDCS)	0 0 1 0 0 0 0 0 1 0		82H
		0 1 -- # # # # # # #	VDCS[6:0]	00H
40	Partial Window (PTL)	0 0 1 0 0 1 0 0 0 0		90H
		0 1 -- -- -- -- -- # #	HRST[9:8]	00H
		0 1 # # # # # 0 0 0	HRST[7:3]	00H
		0 1 -- -- -- -- -- # #	HRED[9:8]	03H
		0 1 # # # # # 1 1 1	HRED[7:3]	1FH
		0 1 -- -- -- -- -- # #	VRST[9:0]	00H
		0 1 # # # # # # # #		00H
		0 1 -- -- -- -- -- # #	VRED[8:0]	02H
		0 1 -- -- -- -- -- # #	PT_SCAN	57H 01H
41	Partial In (PTIN)	0 0 1 0 0 1 0 0 0 1		91H
42	Partial Out (PTOUT)	0 0 1 0 0 1 0 0 1 0		92H
43	Program Mode (PGM)	0 0 1 0 1 0 0 0 0 0		A0H
44	Active Programming (APG)	0 0 1 0 1 0 0 0 0 1		A1H
45	Read OTP (ROTP)	0 0 1 0 1 0 0 0 1 0		A2H
		1 1 # # # # # # # #	Data of Address = 000h	N/A
		1 1 : : : : : : : :	:	N/A
		1 1 # # # # # # # #	Data of Address = n	N/A
46	Cascade Setting (CCSET)	0 0 1 1 1 0 0 0 0 0		E0H
		0 1 -- -- -- -- -- # #	TSFIX, CCEN	00H
47	Power Saving (PWS)	0 0 1 1 1 0 0 0 1 1		E3H
		0 1 # # # # # # # #	VCOM_W[3:0], SD_W[3:0]	00H
48	LVD Voltage Select (LVSEL)	0 0 1 1 1 0 0 1 0 0		E4H
		0 1 -- -- -- -- -- # #	LVD_SEL[1:0]	03H
49	Force Temperature (TSSET)	0 0 1 1 1 0 0 1 0 1		E5H
		0 1 # # # # # # # #	TS_SET[7:0]	00H
50	Temperature Boundary Phase-C2 (TSBDRY)	0 0 1 1 1 0 0 1 1 1		E7H
		0 1 # # # # # # # #	TSBDRY_PHC2[7:0]	00H

**COMMAND DESCRIPTION**

**W/R:** 0: Write Cycle / 1: Read Cycle    **C/D:** 0: Command / 1: Data    **D7-D0:** -: Don't Care

**(1) PANEL SETTING (PSR) (REGISTER: R00H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Setting the panel	0	0	0	0	0	0	0	0	0	0	00H
	0	1	-	-	REG	KW/R	UD	SHL	SHD_N	RST_N	0FH

**REG:** LUT selection

**0: LUT from OTP. (Default)**  
1: LUT from register.

**KW/R:** Black / White / Red

**0: Pixel with Black/White/Red, KWR mode. (Default)**  
1: Pixel with Black/White, KW mode.

**UD:** Gate Scan Direction

0: Scan down. First line to Last line: Gn-1 → Gn-2 → Gn-3 → ... → G0  
1: **Scan up. (Default)** First line to Last line: G0 → G1 → G2 → ... → Gn-1

**SHL:** Source Shift Direction

0: Shift left. First data to Last data: Sn-1 → Sn-2 → Sn-3 → ... → S0  
1: **Shift right. (Default)** First data to Last data: S0 → S1 → S2 → ... → Sn-1

**SHD\_N:** Booster Switch

0: Booster OFF  
1: **Booster ON (Default)**

When SHD\_N becomes LOW, charge pump will be turned OFF, register and SRAM data will keep until VDD OFF.  
And Source/Gate/Border/VCOM will be released to floating.

**RST\_N:** Soft Reset

0: Reset. Booster OFF, Register data are set to their default values, all drivers will be reset, and all functions will be disabled. Source/Gate/Border/VCOM will be released to floating.

**1: No effect (Default).**

**(2) POWER SETTING (PWR) (R01H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Selecting Internal/External Power	0	0	0	0	0	0	0	0	0	1	01H
	0	1	-	-	-	BD_EN	-	VSR_EN	VS_EN	VG_EN	07H
	0	1	-	-	-	VCOM_SLEW	-	VG_LVL[2:0]			17H
	0	1	-	-	VDH_LVL[5:0]					3AH	
	0	1	-	-	VDL_LVL[5:0]					3AH	
	0	1	-	-	VDHR_LVL[5:0]					03H	

**BD\_EN:** Border LDO enable

**0 : Border LDO disable (Default)**

Border level selection: 00b: VCOM    01b: VDH

10b: VDL

11b: VDHR

**1 : Border LDO enable**

Border level selection: 00b: VCOM

01b: VBH(VCOM-VDL)

10b:VBL(VCOM-VDH)

11b: VDHR

**VSR\_EN:** Source LV power selection

**0 : External source power from VDHR pins**

**1 : Internal DC/DC function for generating VDHR. (Default)**

**VS\_EN:** Source power selection

**0 : External source power from VDH/VDL pins**

**1 : Internal DC/DC function for generating VDH/VDL. (Default)**

**VG\_EN:** Gate power selection

**0 : External gate power from VGH/VGL pins**

**1 : Internal DC/DC function for generating VGH/VGL. (Default)**

**VCOM\_SLEW:** VCOM slew rate selection for voltage transition. The value is fixed at "1".

**VG\_LVL[2:0]:** VGH / VGL Voltage Level selection.

VG_LVL[2:0]	VGH/VGL Voltage Level
000	VGH=9V, VGL= -9V
001	VGH=10V, VGL= -10V
010	VGH=11V, VGL= -11V
011	VGH=12V, VGL= -12V
100	VGH=17V, VGL= -17V
101	VGH=18V, VGL= -18V
110	VGH=19V, VGL= -19V
<b>111 (Default)</b>	VGH=20V, VGL= -20V

**VDH\_LVL[5:0]:** Internal VDH power selection for K/W pixel. (**Default value: 111010b**)

VDH_LVL	Voltage	VDH_LVL	Voltage	VDH_LVL	Voltage	VDH_LVL	Voltage
000000	2.4 V	010001	5.8 V	100010	9.2 V	110011	12.6 V
000001	2.6 V	010010	6.0 V	100011	9.4 V	110100	12.8 V
000010	2.8 V	010011	6.2 V	100100	9.6 V	110101	13.0 V
000011	3.0 V	010100	6.4 V	100101	9.8 V	110110	13.2 V
000100	3.2 V	010101	6.6 V	100110	10.0 V	110111	13.4 V
000101	3.4 V	010110	6.8 V	100111	10.2 V	111000	13.6 V
000110	3.6 V	010111	7.0 V	101000	10.4 V	111001	13.8 V
000111	3.8 V	011000	7.2 V	101001	10.6 V	<b>111010</b>	<b>14.0 V</b>
001000	4.0 V	011001	7.4 V	101010	10.8 V	111011	14.2 V
001001	4.2 V	011010	7.6 V	101011	11.0 V	111100	14.4 V
001010	4.4 V	011011	7.8 V	101100	11.2 V	111101	14.6 V
001011	4.6 V	011100	8.0 V	101101	11.4 V	111110	14.8 V
001100	4.8 V	011101	8.2 V	101110	11.6 V	111111	15.0 V
001101	5.0 V	011110	8.4 V	101111	11.8 V		
001110	5.2 V	011111	8.6 V	110000	12.0 V		
001111	5.4 V	100000	8.8 V	110001	12.2 V		
010000	5.6 V	100001	9.0 V	110010	12.4 V		

**VDL\_LVL[5:0]:** Internal VDL power selection for K/W pixel. (**Default value: 111010b**)

VDL_LVL	Voltage	VDL_LVL	Voltage	VDL_LVL	Voltage	VDL_LVL	Voltage
000000	-2.4 V	010001	-5.8 V	100010	-9.2 V	110011	-12.6 V
000001	-2.6 V	010010	-6.0 V	100011	-9.4 V	110100	-12.8 V
000010	-2.8 V	010011	-6.2 V	100100	-9.6 V	110101	-13.0 V
000011	-3.0 V	010100	-6.4 V	100101	-9.8 V	110110	-13.2 V
000100	-3.2 V	010101	-6.6 V	100110	-10.0 V	110111	-13.4 V
000101	-3.4 V	010110	-6.8 V	100111	-10.2 V	111000	-13.6 V
000110	-3.6 V	010111	-7.0 V	101000	-10.4 V	111001	-13.8 V
000111	-3.8 V	011000	-7.2 V	101001	-10.6 V	<b>111010</b>	<b>-14.0 V</b>
001000	-4.0 V	011001	-7.4 V	101010	-10.8 V	111011	-14.2 V
001001	-4.2 V	011010	-7.6 V	101011	-11.0 V	111100	-14.4 V
001010	-4.4 V	011011	-7.8 V	101100	-11.2 V	111101	-14.6 V
001011	-4.6 V	011100	-8.0 V	101101	-11.4 V	111110	-14.8 V
001100	-4.8 V	011101	-8.2 V	101110	-11.6 V	111111	-15.0 V
001101	-5.0 V	011110	-8.4 V	101111	-11.8 V		
001110	-5.2 V	011111	-8.6 V	110000	-12.0 V		
001111	-5.4 V	100000	-8.8 V	110001	-12.2 V		
010000	-5.6 V	100001	-9.0 V	110010	-12.4 V		

**VDHR\_LVL[5:0]:** Internal VDHR power selection for Red pixel. (**Default value: 000011b**)

VDHR_LVL	Voltage	VDHR_LVL	Voltage	VDHR_LVL	Voltage	VDHR_LVL	Voltage
000000	2.4 V	010001	5.8 V	100010	9.2 V	110011	12.6 V
000001	2.6 V	010010	6.0 V	100011	9.4 V	110100	12.8 V
000010	2.8 V	010011	6.2 V	100100	9.6 V	110101	13.0 V
<b>000011</b>	<b>3.0 V</b>	010100	6.4 V	100101	9.8 V	110110	13.2 V
000100	3.2 V	010101	6.6 V	100110	10.0 V	110111	13.4 V
000101	3.4 V	010110	6.8 V	100111	10.2 V	111000	13.6 V
000110	3.6 V	010111	7.0 V	101000	10.4 V	111001	13.8 V
000111	3.8 V	011000	7.2 V	101001	10.6 V	111010	14.0 V
001000	4.0 V	011001	7.4 V	101010	10.8 V	111011	14.2 V
001001	4.2 V	011010	7.6 V	101011	11.0 V	111100	14.4 V
001010	4.4 V	011011	7.8 V	101100	11.2 V	111101	14.6 V
001011	4.6 V	011100	8.0 V	101101	11.4 V	111110	14.8 V
001100	4.8 V	011101	8.2 V	101110	11.6 V	111111	15.0 V
001101	5.0 V	011110	8.4 V	101111	11.8 V		
001110	5.2 V	011111	8.6 V	110000	12.0 V		
001111	5.4 V	100000	8.8 V	110001	12.2 V		
010000	5.6 V	100001	9.0 V	110010	12.4 V		

**(3) POWER OFF (POF) (R02H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Turning OFF the power	0	0	0	0	0	0	0	0	1	0	02H

After the Power OFF command, the driver will be powered OFF. Refer to the POWER MANAGEMENT section for the sequence.

This command will turn off booster, controller, source driver, gate driver, VCOM, and temperature sensor, but register data will be kept until VDD turned OFF or Deep Sleep Mode. Source/Gate/Border/VCOM will be released to floating.

**(4) POWER OFF SEQUENCE SETTING (PFS) (R03H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Setting Power OFF sequence	0	0	0	0	0	0	0	0	1	1	03H
	0	1	-	-	T_VDS_OFF[1:0]	-	-	-	-	-	00H

**T\_VDS\_OFF[1:0]:** Source to gate power off interval time.

**00b: 1 frame (Default)**

01b: 2 frames

10b: 3 frames

11b: 4 frame

**(5) POWER ON (PON) (REGISTER: R04H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Turning ON the power	0	0	0	0	0	0	0	1	0	0	04H

After the Power ON command, the driver will be powered ON. Refer to the POWER MANAGEMENT section for the sequence.

This command will turn on booster, controller, regulators, and temperature sensor will be activated for one-time sensing before enabling booster. When all voltages are ready, the BUSY\_N signal will return to high.

**(6) POWER ON MEASURE (PMES) (R05H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Internal Bandgap Set	0	0	0	0	0	0	0	1	0	1	05H

This command enables the internal bandgap, which will be cleared by the next POF.

**(7) BOOSTER SOFT START (BTST) (R06H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Booster Software Start Set	0	0	0	0	0	0	0	1	1	0	06H
	0	1	BT_PHA[7:6]		BT_PHA[5:3]						17H
	0	1	BT_PHB[7:6]		BT_PHB[5:3]						17H
	0	1	-	-	BT_PHC1[5:3]						17H
	0	1	PHC2EN	-	BT_PHC2[5:3]						17H

**BT\_PHA[7:6]:** Soft start period of phase A.

**00b: 10mS**

01b: 20mS

10b: 30mS

11b: 40mS

**BT\_PHA[5:3]:** Driving strength of phase A

000b: strength 1  
100b: strength 5

001b: strength 2  
101b: strength 6

**010b: strength 3**  
110b: strength 7

011b: strength 4

111b: strength 8 (strongest)

**BT\_PHA[2:0]:** Minimum OFF time setting of GDR in phase A

000b: 0.27uS  
100b: 0.80uS

001b: 0.34uS  
101b: 1.54uS

010b: 0.40uS  
110b: 3.34uS

011b: 0.54uS

**111b: 6.58uS**

**BT\_PHB[7:6]:** Soft start period of phase B.

**00b: 10mS**

01b: 20mS

10b: 30mS

11b: 40mS

**BT\_PHB[5:3]:** Driving strength of phase B

000b: strength 1  
100b: strength 5

001b: strength 2  
101b: strength 6

**010b: strength 3**

110b: strength 7

011b: strength 4

111b: strength 8 (strongest)

**BT\_PHB[2:0]:** Minimum OFF time setting of GDR in phase B

000b: 0.27uS  
100b: 0.80uS

001b: 0.34uS  
101b: 1.54uS

010b: 0.40uS  
110b: 3.34uS

011b: 0.54uS

**111b: 6.58uS**

**BT\_PHC1[5:3]: Driving strength of phase C1**

000b: strength 1	001b: strength 2	<b>010b: strength 3</b>	011b: strength 4
100b: strength 5	101b: strength 6	110b: strength 7	111b: strength 8 (strongest)

**BT\_PHC1[2:0]: Minimum OFF time setting of GDR in phase C1**

000b: 0.27uS	001b: 0.34uS	010b: 0.40uS	011b: 0.54uS
100b: 0.80uS	101b: 1.54uS	110b: 3.34uS	<b>111b: 6.58uS</b>

**PHC2EN: Booster phase-C2 enable**

0: Booster phase-C2 disable  
Phase-C1 setting always is applied for booster phase-C.

1: Booster phase-C2 enable  
If temperature > temperature boundary phase-C2(RE7h[7:0]), phase-C1 setting is applied for booster phase-C.  
If temperature <= temperature boundary phase-C2(RE7h[7:0]), phase-C2 setting is applied for booster phase-C.

**BT\_PHC2[5:3]: Driving strength of phase C2**

000b: strength 1	001b: strength 2	<b>010b: strength 3</b>	011b: strength 4
100b: strength 5	101b: strength 6	110b: strength 7	111b: strength 8 (strongest)

**BT\_PHC2[2:0]: Minimum OFF time setting of GDR in phase C2**

000b: 0.27uS	001b: 0.34uS	010b: 0.40uS	011b: 0.54uS
100b: 0.80uS	101b: 1.54uS	110b: 3.34uS	<b>111b: 6.58uS</b>

**(8) DEEP SLEEP (DSLP) (R07H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Deep Sleep	0	0	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>
	0	1	1	0	1	0	0	1	0	1

07H

A5H

After this command is transmitted, the chip will enter Deep Sleep Mode to save power. Deep Sleep Mode will return to Standby Mode by hardware reset. The only one parameter is a check code, the command will be executed if check code = 0xA5.

**(9) DATA START TRANSMISSION 1 (DTM1) (R10H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Starting data transmission	0	0	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	0	1	Pixel1	Pixel2	Pixel3	Pixel4	Pixel5	Pixel6	Pixel7	Pixel8
	0	1	:	:	:	:	:	:	:	:
	0	1	Pixel(n-7)	Pixel(n-6)	Pixel(n-5)	Pixel(n-4)	Pixel(n-3)	Pixel(n-2)	Pixel(n-1)	Pixel(n)

10H

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This command starts transmitting data and write them into SRAM.

In KW mode, this command writes "OLD" data to SRAM.

In KWR mode, this command writes "K/W" data to SRAM.

In Program mode, this command writes "OTP" data to SRAM for programming.

**(10) DATA STOP (DSP) (R11H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Stopping data transmission	0	0	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>
	1	1	data_flag	-	-	-	-	-	-	-

11H

00H

Check the completeness of data. If data is complete, start to refresh display.

**Data\_flag:** Data flag of receiving user data.

0: Driver didn't receive all the data.

1: Driver has already received all the one-frame data (DTM1 and DTM2).

After "Data Start" (R10h) or "Data Stop" (R11h) commands and when data\_flag=1, the refreshing of panel starts and BUSY\_N signal will become "0".

**(11) DISPLAY REFRESH (DRF) (R12H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Refreshing the display	0	0	0	0	0	1	0	0	1	0	12H

While user sent this command, driver will refresh display (data/VCOM) according to SRAM data and LUT.

After Display Refresh command, BUSY\_N signal will become "0" and the refreshing of panel starts.

**(12) DATA START TRANSMISSION 2 (DTM2) (R13H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Starting data transmission	0	0	0	0	0	1	0	0	1	1	13H
	0	1	Pixel1	Pixel2	Pixel3	Pixel4	Pixel5	Pixel6	Pixel7	Pixel8	--
	0	1	:	:	:	:	:	:	:	:	--
	0	1	Pixel(n-7)	Pixel(n-6)	Pixel(n-5)	Pixel(n-4)	Pixel(n-3)	Pixel(n-2)	Pixel(n-1)	Pixel(n)	--

This command starts transmitting data and write them into SRAM.

In KW mode, this command writes "NEW" data to SRAM.

In KWR mode, this command writes "RED" data to SRAM.

**(13) DUAL SPI MODE (DUSPI) (R15H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Stopping data transmission	0	0	0	0	0	1	0	1	0	1	15H
	0	1	-	-	MM_EN	DUSPI_EN	-	-	-	-	00H

This command sets dual SPI mode.

**MM\_EN:** MM input pin definition enable.

0: MM input pin definition disable  
1: MM input pin definition enable.

**DUSPI\_EN:** Dual SPI mode enable.

0: Dual SPI mode disable (single SPI mode)  
1: Dual SPI mode enable

**(14) AUTO SEQUENCE (AUTO) (R17H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Auto Sequence	0	0	0	0	0	1	0	1	1	1	17H
	0	1	1	0	1	0	0	1	0	1	A5H

The command can enable the internal sequence to execute several commands continuously. The successive execution can minimize idle time to avoid unnecessary power consumption and reduce the complexity of host's control procedure. The sequence contains several operations, including PON, DRF, POF, DSPL.

AUTO (0x17) + Code(0xA5) = (PON → DRF → POF)

AUTO (0x17) + Code(0xA7) = (PON → DRF → POF → DSPL)

**(15) VCOM LUT (LUTC) (R20H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0							
Build Look-up Table for VCOM (61-byte command, structure of bytes 2~7 repeated 10 times)	0	0	0	0	1	0	0	0	0	0	20H						
	0	1	LEVEL SELECT-0		LEVEL SELECT-1		LEVEL SELECT-2		LEVEL SELECT-3		--						
	0	1	NUMBER OF FRAMES-0								--						
	0	1	NUMBER OF FRAMES-1								--						
	0	1	NUMBER OF FRAMES-2								--						
	0	1	NUMBER OF FRAMES-3								--						
	0	1	TIMES TO REPEAT								--						

This command stores VCOM Look-Up Table with 10 groups of data. Each group contains information for one state and is stored with 6 bytes (byte 2~7, 8~13, 14~19, 20~25, ...), while the sixth byte indicates how many times that phase will repeat.

**Bytes 2, 8, 14, 20, 26, 32, 38, 44, 50, 56:**

D[7:6], D[5:4], D[3:2], D[1:0]: Level Selection

- 00b: VCOM\_DC
- 01b: VDH+VCOM\_DC (VCOMH)
- 10b: VDL+VCOM\_DC (VCOML)
- 11b: Floating

**Bytes 3~6, 9~12, 15~18, 21~24, 27~30, 33~36, 39~42, 45~48, 51~54, 57~60:**

Number of Frames

- 0000 0000b: 0 frame
- : : :
- 1111 1111b: 255 frames

**Bytes 7, 13, 19, 25, 31, 37, 43, 49, 55, 61:**

Times to Repeat

- 0000 0000b: 0 time
  - : : :
  - 1111 1111b: 255 times
- If KW/R=0 (KWR mode), all 10 groups are used.  
If KW/R=1 (KW mode), only 7 groups are used.

**(16) W2W LUT (LUTWW) (R21H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0							
Build White Look-up Table for W2W (43-byte command, structure of bytes 2~7 repeated 7 times)	0	0	0	0	1	0	0	0	0	1	21H						
	0	1	LEVEL SELECT-0		LEVEL SELECT-1		LEVEL SELECT-2		LEVEL SELECT-3		--						
	0	1	NUMBER OF FRAMES-0								--						
	0	1	NUMBER OF FRAMES-1								--						
	0	1	NUMBER OF FRAMES-2								--						
	0	1	NUMBER OF FRAMES-3								--						
	0	1	TIMES TO REPEAT								--						

This command stores White-to-White Look-Up Table with 7 groups of data. Each group contains information for one state and is stored with 6 bytes (byte 2~7, 8~13, 14~19, 20~25, ...), while the sixth byte indicates how many times that phase will repeat.

**Bytes 2, 8, 14, 20, 26, 32, 38:**

Level Selection.

- 00b: GND
- 01b: VDH
- 10b: VDL
- 11b: VDHR

**Bytes 3~6, 9~12, 15~18, 21~24, 27~30, 33~36, 39~42:**

Number of Frames

- 0000 0000b: 0 frame
- : : :
- 1111 1111b: 255 frames

**Bytes 7, 13, 19, 25, 31, 37, 43:**

Times to Repeat

- 0000 0000b: 0 time
  - : : :
  - 1111 1111b: 255 times
- If KW/R=0 (KWR mode), LUTWW is not used.  
If KW/R=1 (KW mode), LUTWW is used.

**(17) K2W LUT (LUTKW / LUTR) (R22H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Build Look-up Table for K2W or Red (61-byte command, structure of bytes 2~7 repeated 10 times)	0	0	0	0	1	0	0	0	1	0	22H
	0	1	LEVEL SELECT-0	LEVEL SELECT-1	LEVEL SELECT-2	LEVEL SELECT-3					--
	0	1			NUMBER OF FRAMES-0						--
	0	1			NUMBER OF FRAMES-1						--
	0	1			NUMBER OF FRAMES-2						--
	0	1			NUMBER OF FRAMES-3						--
	0	1			TIMES TO REPEAT						--

This command stores White-to-White Look-Up Table with 10 groups of data. Each group contains information for one state and is stored with 6 bytes (byte 2~7, 8~13, 14~19, 20~25, ...), while the sixth byte indicates how many times that phase will repeat.

**Bytes 2, 8, 14, 20, 26, 32, 38, 44, 50, 56:**

Level Selection.

- 00b: GND
- 01b: VDH
- 10b: VDL
- 11b: VDHR

**Bytes 3~6, 9~12, 15~18, 21~24, 27~30, 33~36, 39~42, 45~48, 51~54, 57~60:**

Number of Frames

0000 0000b: 0 frame

: :  
: :

1111 1111b: 255 frames

**Bytes 7, 13, 19, 25, 31, 37, 43, 49, 55, 61:**

Times to Repeat

0000 0000b: 0 time

: :  
: :

1111 1111b: 255 times

If KW/R=0 (KWR mode), all 10 groups are used.

If KW/R=1 (KW mode), only 7 groups are used.

**(18) W2K LUT (LUTWK / LUTW) (R23H)**

This command builds Look-up Table for White-to-Black. Please refer to K2W LUT (LUTKW/LUTR) for similar definition details.

Regardless of KW/R=0 or KW/R=1, LUTWK/LUTW is used.

**(19) K2K LUT (LUTKK / LUTK) (R24H)**

This command builds Look-up Table for Black-to-Black. Please refer to K2W LUT (LUTKW/LUTR) for similar definition details.

Regardless of KW/R=0 or KW/R=1, LUTKK/LUTK is used.

## (20) BORDER LUT (LUTBD) (R25H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0							
Build Look-up Table for Border (43-byte command, Bytes 2~7 repeated 7 times)	0	0	0	0	1	0	0	1	0	1	25H						
	0	1	LEVEL SELECT-0		LEVEL SELECT-1		LEVEL SELECT-2		LEVEL SELECT-3		--						
	0	1	NUMBER OF FRAMES-0														
	0	1	NUMBER OF FRAMES-1														
	0	1	NUMBER OF FRAMES-2														
	0	1	NUMBER OF FRAMES-3														
	0	1	TIMES TO REPEAT														

This command stores White-to-White Look-Up Table with 7 groups of data. Each group contains information for one state and is stored with 6 bytes (byte 2~7, 8~13, 14~19, 20~25, ...), while the sixth byte indicates how many times that phase will repeat.

**Bytes 2, 8, 14, 20, 26, 32, 38:**

Level selection.

BD_EN=0:	00b: VCOM	01b: VDH	10b: VDL	11b: VDHR
BD_EN=1:	00b: VCOM	01b: VBH(VCOM-VDL)	10b: VBL(VCOM-VDH)	11b: VDHR

**Bytes 3~6, 9~12, 15~18, 21~24, 27~30, 33~36, 39~42:**

Number of Frames

0000 0000b:	0 frame
:	:
:	:
1111 1111b:	255 frames

**Bytes 7, 13, 19, 25, 31, 37, 43:**

Times to Repeat

0000 0000b:	0 time
:	:
:	:
1111 1111b:	255 times

Only 7 LUTBD groups are used in KW mode or KWR mode.

## (21) LUT OPTION (LUTOPT) (R2AH)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
LUT Option	0	0	0	0	1	0	1	0	1	0	2AH
	0	1	STATE_XON[9:8]		-	-	-	-	-	-	00H
	0	1	STATE_XON[7:0]								

This command sets XON control enable.

**STATE\_XON[9:0]:**

All Gate ON (Each bit controls one state, STATE\_XON [0] for state-1, STATE\_XON [1] for state-2 ....)

00 0000 0000b: no All-Gate-ON

00 0000 0001b: State-1 All-Gate-ON

00 0000 0011b: State-1 and State2 All-Gate-ON

## (22) KW LUT OPTION (KWOPT) (R2BH)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
KW LUT Option	0	0	0	0	1	0	1	0	1	1	2BH
	0	1	-	-	-	-	-	-	ATRED	NORED	00H
	0	1	KWE[9:8]	-	-	-	-	-	-	-	00H
	0	1			KWE[7:0]						00H

This command sets KW LUT mechanism option in KWR mode's LUT and only valid in K/W/R mode.

{ATRED, NORED}: KW LUT or KWR LUT selection control

ATRED	NORED	Description
0	0	KWR LUT always
0	1	KW LUT only
1	0	Auto detect by red data
1	1	KW LUT only

## KWE[9:0]:

KW LUT enable control bits. Each bit controls one state, KWE[0] for state-1, KWE[1] for state-2, ... .

At least 1 Enable Control bit should be set when KW LUT only is selected in KWR mode.

00 0000 0001b: KW LUT enable in State-1

00 0000 0011b: KW LUT enable in State-1 and State2

00 0000 1011b: KW LUT enable in State-1, State2 and State-4

## (23) PLL CONTROL (PLL) (R30H)

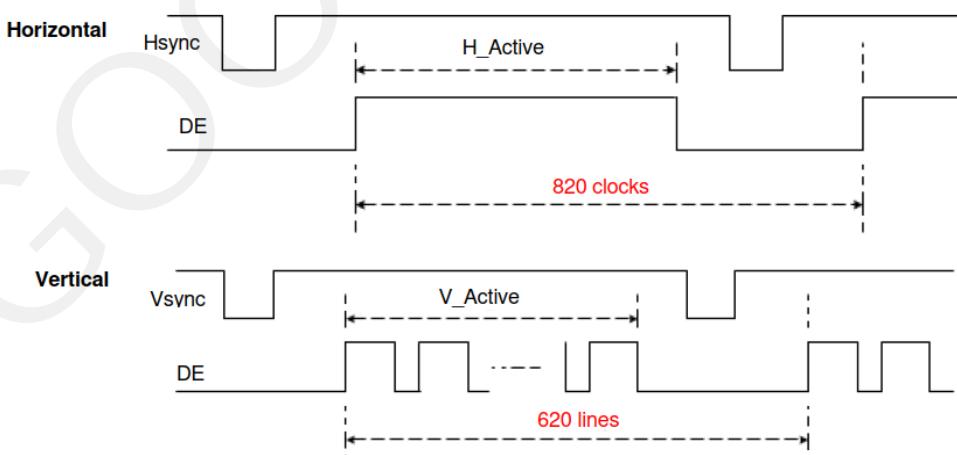
Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Controlling PLL	0	0	0	0	1	1	0	0	0	0	30H
	0	1	-	-	-	-	-	-	-	-	06H

The command controls the PLL clock frequency. The PLL structure must support the following frame rates:

FMR[3:0]: Frame rate setting

FRS	Frame rate
0000	5Hz
0001	10Hz
0010	15Hz
0011	20Hz
0100	30Hz
0101	40Hz
<b>0110</b>	<b>50Hz</b>
0111	60Hz

FRS	Frame rate
1000	70Hz
1001	80Hz
1010	90Hz
1011	100Hz
1100	110Hz
1101	130Hz
1110	150Hz
1111	200Hz



## (24) TEMPERATURE SENSOR CALIBRATION (TSC) (R40H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Sensing Temperature	0	0	0	1	0	0	0	0	0	0
	1	1	D10/TS7	D9/TS6	D8/TS5	D7/TS4	D6 / TS3	D5 / TS2	D4 / TS1	D3 / TS0
	1	1	D2	D1	D0	-	-	-	-	-

This command enables internal or external temperature sensor, and reads the result.

**TS[7:0]:** When TSE (R41h) is set to 0, this command reads internal temperature sensor value.

**D[10:0]:** When TSE (R41h) is set to 1, this command reads external LM75 temperature sensor value.

TS[7:0]/D[10:3]	Temp. (°C)
1110_0111	-25
1110_1000	-24
1110_1001	-23
1110_1010	-22
1110_1011	-21
1110_1100	-20
1110_1101	-19
1110_1110	-18
1110_1111	-17
1111_0000	-16
1111_0001	-15
1111_0010	-14
1111_0011	-13
1111_0100	-12
1111_0101	-11
1111_0110	-10
1111_0111	-9
1111_1000	-8
1111_1001	-7
1111_1010	-6
1111_1011	-5
1111_1100	-4
1111_1101	-3
1111_1110	-2
1111_1111	-1

TS[7:0]/D[10:3]	Temp. (°C)
0000_0000	0
0000_0001	1
0000_0010	2
0000_0011	3
0000_0100	4
0000_0101	5
0000_0110	6
0000_0111	7
0000_1000	8
0000_1001	9
0000_1010	10
0000_1011	11
0000_1100	12
0000_1101	13
0000_1110	14
0000_1111	15
0001_0000	16
0001_0001	17
0001_0010	18
0001_0011	19
0001_0100	20
0001_0101	21
0001_0110	22
0001_0111	23
0001_1000	24

TS[7:0]/D[10:3]	Temp. (°C)
0001_1001	25
0001_1010	26
0001_1011	27
0001_1100	28
0001_1101	29
0001_1110	30
0001_1111	31
0010_0000	32
0010_0001	33
0010_0010	34
0010_0011	35
0010_0100	36
0010_0101	37
0010_0110	38
0010_0111	39
0010_1000	40
0010_1001	41
0010_1010	42
0010_1011	43
0010_1100	44
0010_1101	45
0010_1110	46
0010_1111	47
0011_0000	48
0011_0001	49

## (25) TEMPERATURE SENSOR ENABLE (TSE) (R41H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Enable Temperature Sensor /Offset	0	0	0	1	0	0	0	0	0	1
	0	1	TSE	-	-	-			TO[3:0]	

This command selects Internal or External temperature sensor.

**TSE:** Internal temperature sensor switch

**0: Enable (default)**

**1: Disable; using external sensor.**

**TO[3:0]:** Temperature offset.

TO[3:0]	Calibration	
	0000 b	+0 (Default)
0001		+1
0010		+2
0011		+3
0100		+4
0101		+5
0110		+6
0111		+7

TO[3:0]	Calibration
1000	-8
1001	-7
1010	-6
1011	-5
1100	-4
1101	-3
1110	-2
1111	-1

**(26) TEMPERATURE SENSOR WRITE (TSW) (R42H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Write External Temperature Sensor	0	0	0	1	0	0	0	0	1	0
	0	1					WATTR[7:0]			
	0	1					WMSB[7:0]			
	0	1					WLSB[7:0]			

This command writes the temperature sensed by the temperature sensor.

**WATTR[7:6]:** I<sup>2</sup>C Write Byte Number

- 00b : 1 byte (head byte only)
- 01b : 2 bytes (head byte + pointer)
- 10b : 3 bytes (head byte + pointer + 1<sup>st</sup> parameter)
- 11b : 4 bytes (head byte + pointer + 1<sup>st</sup> parameter + 2<sup>nd</sup> parameter)

**WATTR[5:3]:** User-defined address bits (A2, A1, A0)

**WATTR[2:0]:** Pointer setting

**WMSB[7:0]:** MSByte of write-data to external temperature sensor

**WLSB[7:0]:** LSByte of write-data to external temperature sensor

**(27) TEMPERATURE SENSOR READ (TSR) (R43H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Read External Temperature Sensor	0	0	0	1	0	0	0	0	1	1
	1	1					RMSB[7:0]			
	1	1					RLSB[7:0]			

This command reads the temperature sensed by the temperature sensor.

**RMSB[7:0]:** MSByte read data from external temperature sensor

**RLSB[7:0]:** LSByte read data from external temperature sensor

**(28) PANEL GLASS CHECK (PBC)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Check Panel Glass	0	0	0	1	0	0	0	1	0	0
	1	1	-	-	-	-	-	-	-	PSTA

This command is used to enable panel check, and to disable after reading result.

**PSTA:** 0: Panel check fail (panel broken)

1: Panel check pass

**(29) VCOM AND DATA INTERVAL SETTING (CDI) (R50H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Set Interval between VCOM and Data	0	0	0	1	0	1	0	0	0	0
	0	1	BDZ	-	BDV[1:0]	N2OCP	-	DDX[1:0]		
	0	1	-	-	-	SDEND		CDI[3:0]		

This command indicates the interval of VCOM and data output. When setting the vertical back porch, the total blanking will be kept (20 Hsync).

**BDZ:** Border Hi-Z control

0: Border output Hi-Z disabled (default)

1: Border output Hi-Z enabled

**BDV[1:0]:** Border LUT selection

KWR mode (KW/R=0)

DDX[0]	BDV[1:0]	LUT
0	00	LUTBD
	01	LUTR
	10	LUTW
	11	LUTK
<b>1 (Default)</b>	00	LUTK
	01	LUTW
	10	LUTR
	11	LUTBD

KW mode (KW/R=1)

DDX[0]	BDV[1:0]	LUT
0	00	LUTBD
	01	LUTKW (1 → 0)
	10	LUTWK (0 → 1)
	11	LUTKK (0 → 0)
<b>1 (Default)</b>	00	LUTKK (0 → 0)
	01	LUTWK (1 → 0)
	10	LUTKW (0 → 1)
	11	LUTBD

**N2OCP:** Copy frame data from NEW data to OLD data enable control after display refresh with NEW/OLD in KW mode.

**0: Copy NEW data to OLD data disabled (default)**

**1: Copy NEW data to OLD data enabled**

**DDX[1:0]:** Data polarity.

Under KWR mode (KW/R=0):

DDX[1] is for RED data.  
DDX[0] is for K/W data,

DDX[1:0]	Data {Red, K/W}	LUT
00	00	LUTW
	01	LUTK
	10	LUTR
	11	LUTR
<b>01 (Default)</b>	00	LUTK
	01	LUTW
	10	LUTR
	11	LUTR

DDX[1:0]	Data {Red, K/W}	LUT
10	00	LUTR
	01	LUTR
	10	LUTW
	11	LUTK
<b>11</b>	00	LUTR
	01	LUTR
	10	LUTK
	11	LUTW

Under KW mode (KW/R=1):

DDX[1]=0 is for KW mode with NEW/OLD,  
DDX[1]=1 is for KW mode without NEW/OLD.

DDX[1:0]	Data {NEW, OLD}	LUT
00	00	LUTWW (0 → 0)
	01	LUTKW (1 → 0)
	10	LUTWK (0 → 1)
	11	LUTKK (1 → 1)
<b>01 (Default)</b>	00	LUTKK (0 → 0)
	01	LUTWK (1 → 0)
	10	LUTKW (0 → 1)
	11	LUTWW (1 → 1)

DDX[1:0]	Data {NEW}	LUT
10	0	LUTKW (1 → 0)
	1	LUTWK (0 → 1)
<b>11</b>	0	LUTWK (1 → 0)
	1	LUTKW (0 → 1)

**SDEND:** source driving ending

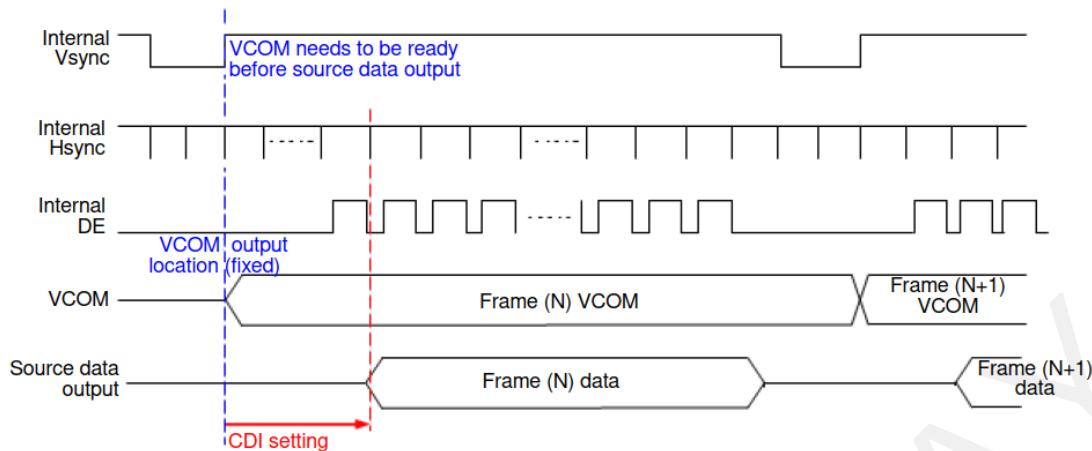
0: source driver channels output 2-frame 0V at the end

1: source driver channels keep the last state at the end

**CDI[3:0]:** VCOM and data interval

CDI[3:0]	VCOM and Data Interval
0000 b	17 hsync
0001	16
0010	15
0011	14
0100	13
0101	12
0110	11
<b>0111</b>	<b>10 (Default)</b>

CDI[3:0]	VCOM and Data Interval
1000	9
1001	8
1010	7
1011	6
1100	5
1101	4
1110	3
<b>1111</b>	<b>2</b>



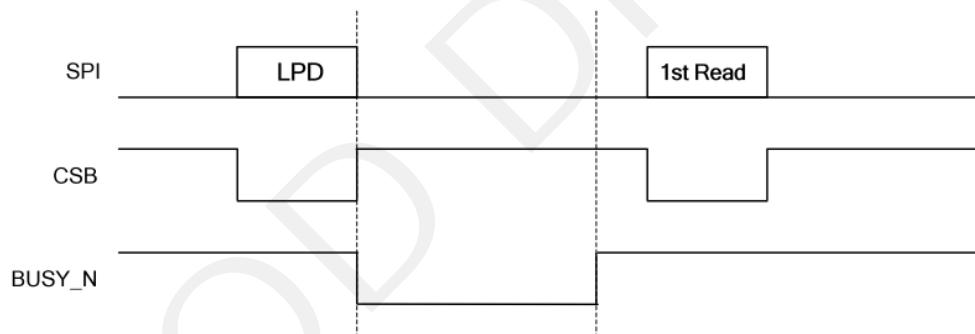
### (30) LOW POWER DETECTION (LPD) (R51H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Detect Low Power	0	0	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	51h
	1	1	-	-	-	-	-	-	-	-	01h

This command indicates the input power condition. Host can read this flag to learn the battery condition.

**LPD:** Internal Low Power Detection Flag

- 0: Low power input ( $V_{DD} < 2.5V, 2.4V, 2.3V$ , or  $2.2V$ , selected by LVD\_SEL[1:0] in command LVSEL)  
**1: Normal status (default)**



### (31) END VOLTAGE SETTING (EVS) (R52H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
End Voltage Setting	0	0	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	52h
	0	1	-	-	-	-	VCEND	-	BDEND[1:0]	-	02h

This command selects source end voltage and border end voltage after LUTs are finished.

**VCEND:** VCOM end voltage selection

**0b: VCOM\_DC**      1b: floating

**BDEND[1:0]:** Border end voltage selection

00b: 0V      01b: 0V      10b: **VCOM\_DC**      11b: floating

## (32) TCON SETTING (TCON) (R60H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Set Gate/Source Non-overlap Period	0	0	0	1	1	0	0	0	0	0
	0	1		S2G[3:0]			G2S[3:0]			

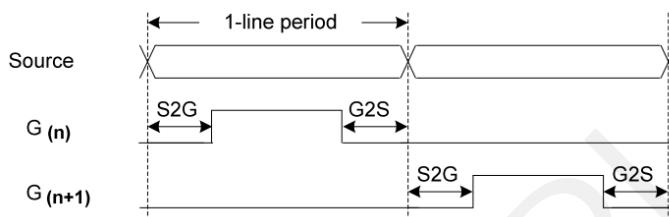
This command defines non-overlap period of Gate and Source.

**S2G[3:0] or G2S[3:0]:** Source to Gate / Gate to Source Non-overlap period

S2G[3:0] or G2S[3:0]	Period
0000 b	4
0001	8
<b>0010</b>	<b>12 (Default)</b>
0011	16
0100	20
0101	24
0110	28
0111	32

S2G[3:0] or G2S[3:0]	Period
1000 b	36
1001	40
1010	44
1011	48
1100	52
1101	56
1110	60
1111	64

Period Unit = 667 nS.



## (33) RESOLUTION SETTING (TRES) (R61H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Set Display Resolution	0	0	0	1	1	0	0	0	0	1
	0	1	-	-	-	-	-	-	-	HRES[9:8]
	0	1			HRES[7:3]			0	0	0
	0	1	-	-	-	-	-	-	-	VRES[9:8]
	0	1					VRES[7:0]			58h

This command defines resolution setting.

**HRES[9:3]:** Horizontal Display Resolution (Value range: 01h ~ 64h)

**VRES[9:0]:** Vertical Display Resolution (Value range: 001h ~ 258h)

Active channel calculation, assuming HST[9:0]=0, VST[9:0]=0:

Gate: First active gate = G0;  
Last active gate = VRES[9:0] - 1

Source: First active source = S0;  
Last active source = HRES[9:3]\*8 - 1

Example: 128 (source) x 272 (gate), assuming HST[9:0]=0, VST[9:0]=0

Gate: First active gate = G0,  
Last active gate = G271; (VRES[9:0] = 272, 272 - 1 = 271)

Source: First active source = S0,  
Last active source = S127; (HRES[9:3]=16, 16\*8 - 1 = 127)

## (34) GATE/SOURCE START SETTING (GSST) (R65H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Set Gate/Source Start	0	0	0	1	1	0	0	1	0	1
	0	1	-	-	-	-	-	-	-	HST[9:8]
	0	1			HST[7:3]			0	0	0
	0	1	-	-	-	-	-	-	-	VST[9:8]
	0	1				VST[7:0]				00h

This command defines resolution start gate/source position.

**HST[9:3]:** Horizontal Display Start Position (Source). (Value range: 00h ~ 63h)

**VST[9:0]:** Vertical Display Start Position (Gate). (Value range: 000h ~ 257h)

Example : For 128(Source) x 240(Gate)

HST[9:3] = 4 (HST[9:0] = 4\*8 = 32),  
VST[9:0] = 32

Gate: First active gate = G32 (VST[9:0] = 32),  
Last active gate = G271 (VRES[9:0] = 240, VST[9:0] = 32, 240-1+32=271)

Source: First active source = S32 (HST[9:0]= 32),  
Last active source = S239 (HRES[9:0] = 128, HST[9:0] = 32, 128-1+32=239)

## (35) REVISION (REV) (R70H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
LUT/Chip Revision	0	0	0	1	1	1	0	0	0	0	70h
	1	1									FFh
	1	1									FFh
	1	1									FFh
	1	1									FFh
	1	1									FFh
	1	1									0Ch
	1	1									
	1	1									

The command reads the product revision, LUT revision and chip revision.

**PROD\_REV[23:0]:** Product Revision. PROD\_REV[23:0] is read from OTP address 0x0BDD ~ 0X0BDF or 0x17DD ~ 0x17DF.

**LUT\_REV[23:0]:** LUT Revision. LUT\_REV[23:0] is read from OTP address 0x0BE0 ~ 0X0BE2 or 0x17E0.~ 0x17E2.

**CHIP\_REV[7:0]:** Chip Revision, fixed at 00001100b.

## (36) GET STATUS (FLG) (R71H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Read Flags	0	0	0	1	1	1	0	0	0	1	71h
	1	1	-	PTL_Flag	I <sup>2</sup> C_ERR	I <sup>2</sup> C_BUSYN	Data_Flag	PON	POF	BUSY_N	13h

This command reads the IC status.

**PTL\_Flag:** Partial display status (high: partial mode)

**I<sup>2</sup>C\_ERR:** I<sup>2</sup>C master error status

**I<sup>2</sup>C\_BUSYN:** I<sup>2</sup>C master busy status (low active)

**Data\_Flag:** Driver has already received all the one frame data

**PON:** Power ON status

**POF:** Power OFF status

**BUSY\_N:** Driver busy status (low active)

## (37) AUTO MEASURE VCOM (AMV) (R80H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Automatically measure VCOM	0	0	1	0	0	0	0	0	0	0	80h
	0	1	-	-	AMVT[1:0]	XON	AMVS	AMV	AMVE		10h

This command triggers auto VCOM sensing mechanism.

**AMVT[1:0]:** Auto Measure VCOM Time

00b: 3s  
10b: 8s

01b: 5s (default)  
11b: 10s

**XON:** All Gate ON of AMV

**0: Gate normally scan during Auto Measure VCOM period. (default)**  
1: All Gate ON during Auto Measure VCOM period.

**AMVS:** Source output of AMV

**0: Source output 0V during Auto Measure VCOM period. (default)**  
1: Source output VDHR during Auto Measure VCOM period.

**AMV:** Analog signal

**0: Get VCOM value with the VV command (R81h) (default)**  
1: Get VCOM value in analog signal. (External analog to digital converter)

**AMVE:** Auto Measure VCOM Enable (/Disable)

**0: No effect (default)**  
1: Trigger auto VCOM sensing.

**(38) VCOM VALUE (VV) (R81H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Automatically measure VCOM	0	0	1	0	0	0	0	0	0	1	81h
	1	1	-				VV[6:0]				00h

This command gets the VCOM value.

**VV[6:0]:** VCOM Value Output

VV [6:0]	VCOM Voltage (V)	VV [6:0]	VCOM Voltage (V)	VV [6:0]	VCOM Voltage (V)
000 0000b	-0.10	001 1011b	-1.45	011 0110b	-2.80
000 0001b	-0.15	001 1100b	-1.50	011 0111b	-2.85
000 0010b	-0.20	001 1101b	-1.55	011 1000b	-2.90
000 0011b	-0.25	001 1110b	-1.60	011 1001b	-2.95
000 0100b	-0.30	001 1111b	-1.65	011 1010b	-3.00
000 0101b	-0.35	010 0000b	-1.70	011 1011b	-3.05
000 0110b	-0.40	010 0001b	-1.75	011 1100b	-3.10
000 0111b	-0.45	010 0010b	-1.80	011 1101b	-3.15
000 1000b	-0.50	010 0011b	-1.85	011 1110b	-3.20
000 1001b	-0.55	010 0100b	-1.90	011 1111b	-3.25
000 1010b	-0.60	010 0101b	-1.95	100 0000b	-3.30
000 1011b	-0.65	010 0110b	-2.00	100 0001b	-3.35
000 1100b	-0.70	010 0111b	-2.05	100 0010b	-3.40
000 1101b	-0.75	010 1000b	-2.10	100 0011b	-3.45
000 1110b	-0.80	010 1001b	-2.15	100 0100b	-3.50
000 1111b	-0.85	010 1010b	-2.20	100 0101b	-3.55
001 0000b	-0.90	010 1011b	-2.25	100 0110b	-3.60
001 0001b	-0.95	010 1100b	-2.30	100 0111b	-3.65
001 0010b	-1.00	010 1101b	-2.35	100 1000b	-3.70
001 0011b	-1.05	010 1110b	-2.40	100 1001b	-3.75
001 0100b	-1.10	010 1111b	-2.45	100 1010b	-3.80
001 0101b	-1.15	011 0000b	-2.50	100 1011b	-3.85
001 0110b	-1.20	011 0001b	-2.55	100 1100b	-3.90
001 0111b	-1.25	011 0010b	-2.60	100 1101b	-3.95
001 1000b	-1.30	011 0011b	-2.65	100 1110b	-4.00
001 1001b	-1.35	011 0100b	-2.70	100 1111b	-4.05
001 1010b	-1.40	011 0101b	-2.75		

**(39) VCOM\_DC SETTING (VDCS) (R82H)**

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Set VCOM_DC	0	0	1	0	0	0	0	0	1	0	82h
	0	1	-				VDCS[6:0]				00h

This command sets VCOM\_DC value

**VDCS[6:0]:** VCOM\_DC Setting

VDCS [6:0]	VCOM Voltage (V)	VDCS [6:0]	VCOM Voltage (V)	VDCS [6:0]	VCOM Voltage (V)
000 0000b	-0.10	001 1011b	-1.45	011 0110b	-2.80
000 0001b	-0.15	001 1100b	-1.50	011 0111b	-2.85
000 0010b	-0.20	001 1101b	-1.55	011 1000b	-2.90
000 0011b	-0.25	001 1110b	-1.60	011 1001b	-2.95
000 0100b	-0.30	001 1111b	-1.65	011 1010b	-3.00
000 0101b	-0.35	010 0000b	-1.70	011 1011b	-3.05
000 0110b	-0.40	010 0001b	-1.75	011 1100b	-3.10
000 0111b	-0.45	010 0010b	-1.80	011 1101b	-3.15
000 1000b	-0.50	010 0011b	-1.85	011 1110b	-3.20
000 1001b	-0.55	010 0100b	-1.90	011 1111b	-3.25
000 1010b	-0.60	010 0101b	-1.95	100 0000b	-3.30
000 1011b	-0.65	010 0110b	-2.00	100 0001b	-3.35
000 1100b	-0.70	010 0111b	-2.05	100 0010b	-3.40
000 1101b	-0.75	010 1000b	-2.10	100 0011b	-3.45
000 1110b	-0.80	010 1001b	-2.15	100 0100b	-3.50
000 1111b	-0.85	010 1010b	-2.20	100 0101b	-3.55
001 0000b	-0.90	010 1011b	-2.25	100 0110b	-3.60
001 0001b	-0.95	010 1100b	-2.30	100 0111b	-3.65
001 0010b	-1.00	010 1101b	-2.35	100 1000b	-3.70
001 0011b	-1.05	010 1110b	-2.40	100 1001b	-3.75
001 0100b	-1.10	010 1111b	-2.45	100 1010b	-3.80
001 0101b	-1.15	011 0000b	-2.50	100 1011b	-3.85
001 0110b	-1.20	011 0001b	-2.55	100 1100b	-3.90
001 0111b	-1.25	011 0010b	-2.60	100 1101b	-3.95
001 1000b	-1.30	011 0011b	-2.65	100 1110b	-4.00
001 1001b	-1.35	011 0100b	-2.70	100 1111b	-4.05
001 1010b	-1.40	011 0101b	-2.75		

## (40) PARTIAL WINDOW (PTL) (R90H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Set Partial Window	0	0	1	0	0	1	0	0	0	0	90h
	0	1	-	-	-	-	-	-	-	HRST[9:8]	00h
	0	1	-	-	HRST[7:3]	-	-	-	0	0	00h
	0	1	-	-	-	-	-	-	-	HRED[9:8]	03h
	0	1	-	-	HRED[7:3]	-	-	-	1	1	1Fh
	0	1	-	-	-	-	-	-	-	VRST[9:8]	00h
	0	1	-	-	VRST[7:0]	-	-	-	-	-	00h
	0	1	-	-	-	-	-	-	-	VRED[9:8]	02h
	0	1	-	-	VRED[7:0]	-	-	-	-	-	57h
	0	1	-	-	-	-	-	-	-	-	PT_SCAN

This command sets partial window.

**HRST[9:3]:** Horizontal start channel bank. (Value range: 00h~63h)

**HRED[9:3]:** Horizontal end channel bank. (Value range: 00h~63h). HRED must be greater than HRST.

**VRST[9:0]:** Vertical start line. (Value range: 000h~257h)

**VRED[9:0]:** Vertical end line. (Value range: 000h~257h). VRED must be greater than VRST.

**PT\_SCAN:** 0: Gates scan only inside of the partial window.

1: Gates scan both inside and outside of the partial window. (default)

## (41) PARTIAL IN (PTIN) (R91H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Partial In	0	0	1	0	0	1	0	0	0	1	91h

This command makes the display enter partial mode.

## (42) PARTIAL OUT (PTOUT) (R92H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Partial Out	0	0	1	0	0	1	0	0	1	0	92h

This command makes the display exit partial mode and enter normal mode.

## (43) PROGRAM MODE (PGM) (RA0H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Enter Program Mode	0	0	1	0	1	0	0	0	0	0	A0h

After this command is issued, the chip would enter the program mode.

After the programming procedure completed, a hardware reset is necessary for leaving program mode.

## (44) ACTIVE PROGRAM (APG) (RA1H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Active Program OTP	0	0	1	0	1	0	0	0	0	1	A1h

After this command is transmitted, the programming state machine would be activated.

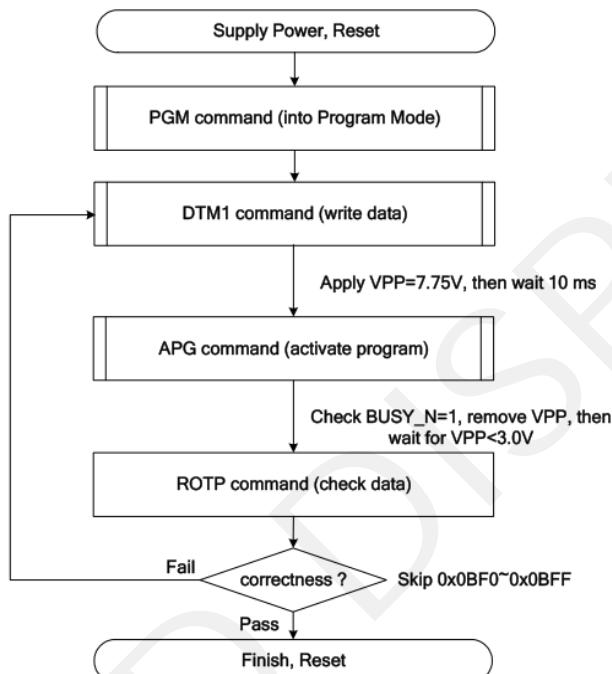
The BUSY\_N flag would fall to 0 until the programming is completed.

## (45) READ OTP DATA (ROTP) (RA2H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Read OTP data for check	0	0	1	0	1	0	0	0	1	0	A2h
	1	1									--
	1	1									--
	1	1							:		--
	1	1									--
	1	1									--

The command is used for reading the content of OTP for checking the data of programming.

The value of (n) is depending on the amount of programmed data, the max address = 0x17FF.



The sequence of programming OTP.

## (46) CASCADE SETTING (CCSET) (RE0H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Set Cascade Option	0	0	1	1	1	0	0	0	0	0	E0h
	0	1	-	-	-	-	-	-	-	TSFIX	CCEN 00h

This command is used for cascade.

**TSFIX:** Let the value of slave's temperature is same as the master's.

**0: Temperature value is defined by internal temperature sensor / external LM75. (default)**

1: Temperature value is defined by TS\_SET[7:0] registers.

**CCEN:** Output clock enable/disable.

**0: Output 0V at CL pin. (default)**

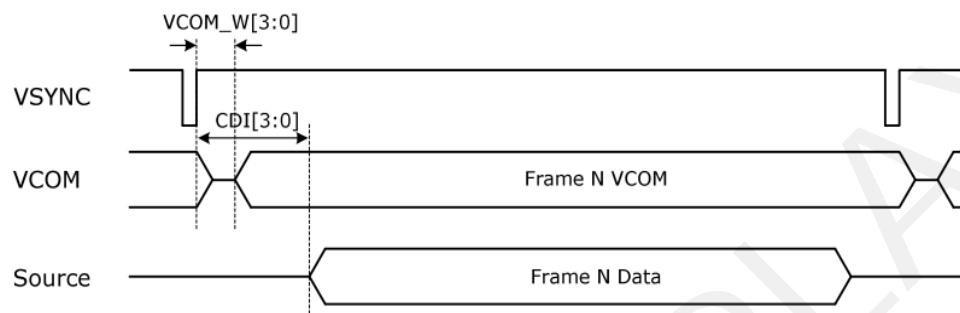
1: Output clock at CL pin to slave chip.

## (47) POWER SAVING (PWS) (RE3H)

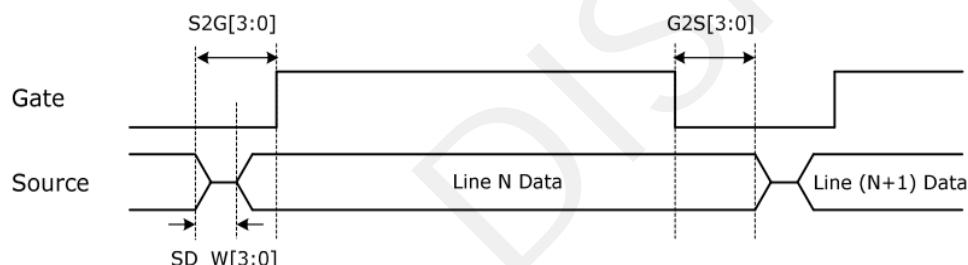
Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Power Saving for VCOM & Source	0	0	1	1	1	0	0	0	1	1	E3h
	0	1		VCOM_W[3:0]					SD_W[3:0]		00h

This command is set for saving power during refreshing period. If the output voltage of VCOM / Source is from negative to positive or from positive to negative, the power saving mechanism will be activated. The active period width is defined by the following two parameters.

**VCOM\_W[3:0]:** VCOM power saving width (Unit: line period)



**SD\_W[3:0]:** Source power saving width (Unit: 660nS)



## (48) LVD VOLTAGE SELECT (LVSEL) (RE4H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Select LVD Voltage	0	0	1	1	1	0	0	1	0	0	E4h
	0	1	-	-	-	-	-	-	-	-	03h

**LVD\_SEL[1:0]:** Low Power Voltage selection

LVD_SEL[1:0]	LVD value
00	< 2.2 V
01	< 2.3 V
10	< 2.4 V
11	< 2.5 V (default)

## (49) FORCE TEMPERATURE (TSSET) (RE5H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Force Temperature Value for Cascade	0	0	1	1	1	0	0	1	0	1	E5h
	0	1						TS_SET[7:0]			00h

This command is used for cascade to fix the temperature value of master and slave chip.

## (50) TEMPERATURE BOUNDARY PHASE-C2 (TSBDRY) (RE7H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	
Temperature Boundary Phase-C2	0	0	1	1	1	0	0	1	1	1	E7h
	0	1						TSBDRY_PHC2[7:0]			00h

This command is used to set the temperature boundary to judge whether booster phase-C2 is applied or not.

## 7. Electrical Characteristics

### 7.1. Absolute maximum rating

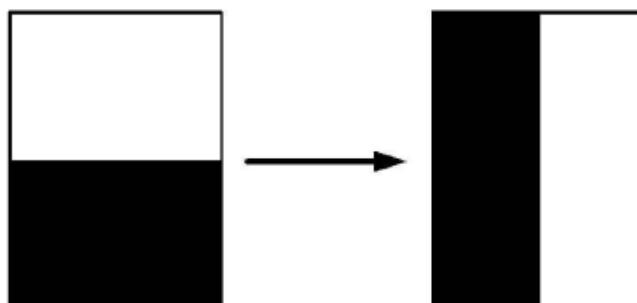
Parameter	Symbol	Rating	Unit
Logic supply voltage	VCI	-0.3 to +6.0	V
Logic Input voltage	VIN	-0.3 to VCI +0.3	V
Operating Temp range	TOPR	0 to +40	°C
Storage Temp range	TSTG	-25 to+60	°C
Optimal Storage Temp	TSTGo	23±2	°C
Optimal Storage Humidity	HSTGo	55±10	%RH

### 7.2. Display DC Characteristics

The following specifications apply for: VSS=0V, VCI=3.0V, TOPR =23°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Single ground	V <sub>SS</sub>	-	-	0	-	V
I/O supply Voltage	VCI	-	2.5	3.3	3.6	V
Digital/Analog supply voltage	VDD		2.5	3.3	3.6	
High level input voltage	VIH	-	0.7 VCI	-	-	V
Low level input voltage	VIL	-	0	-	-	V
High level output voltage	VOH	IOH = 400uA	VCI-0.4	-	-	V
Low level output voltage	VOL	IOL =-400uA	0	-	0.4	V
Image update current	I <sub>UPDATE</sub>			45		mA
Power panel (update)	P <sub>UPDATE</sub>			148.5		mW
Operating temperature	-	-	0	-	40	°C
Storage temperature	-	-	-25	-	60	°C
Image update time at 25 °C	-	-	-	25		sec
Deep sleep mode current	I <sub>VCI</sub>	DC/DC off No clock No input load Ram data not retain	-	2	5	uA

Notes: 1. The typical power is measured with following transition from horizontal 2 scale pattern to vertical 2 scale pattern.



2. The deep sleep power is the consumed power when the panel controller is in deep sleep mode.

3. The listed electrical/optical characteristics are only guaranteed under the controller & waveform provided by Good Display.

## 7.3. AC Characteristics

### 7.3.1. MCU Interface Selection

Provides 3-wire/4-wire serial interface for command and display data transferred from the MCU. The serial interface supports 8-bit mode. Data can be input/output by clocks while the chip is active (CSB =LOW). While input, data are written in order from MSB at the clock rising edge. When too many parameters are input, the chip accepts only defined parameters, and ignores undefined ones.

### 7.3.2. 3 Wire SPI Format

Data / Command is recognized with the first bit transferred. Data are transferred in the unit of 9 bits. To prevent malfunction due to noise, it is recommended to set the CSB signal to HIGH every 9 bits. (The serial counter is reset at the rising edge of the CSB signal.)

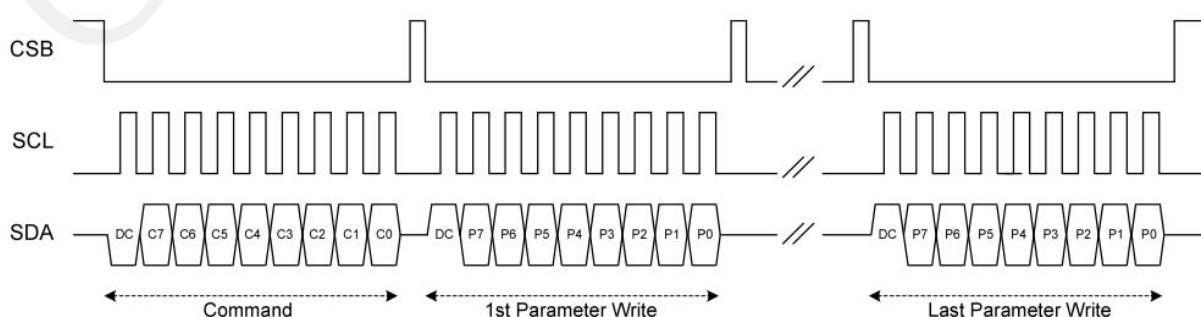


Figure: 3-wire SPI write operation

The MSB bit of data will be output at SDA pin after the 1st SCL falling edge, if the 1st input data at SDA is high.

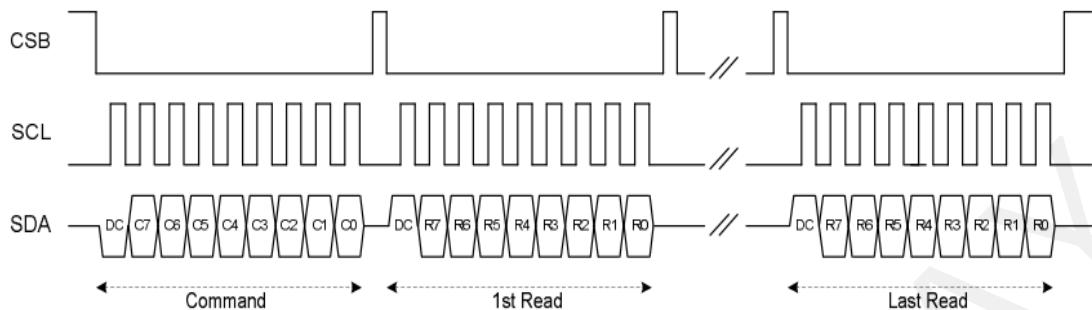


Figure: 3-wire SPI read operation

### 7.3.3. 4 Wire SPI Format

Data / Command is recognized with DC pin. Data are transferred in the unit of 8 bits. To prevent malfunction due to noise, it is recommended to set the CSB signal to HIGH every 8 bits. (The serial counter is reset at the rising edge of the CSB signal).

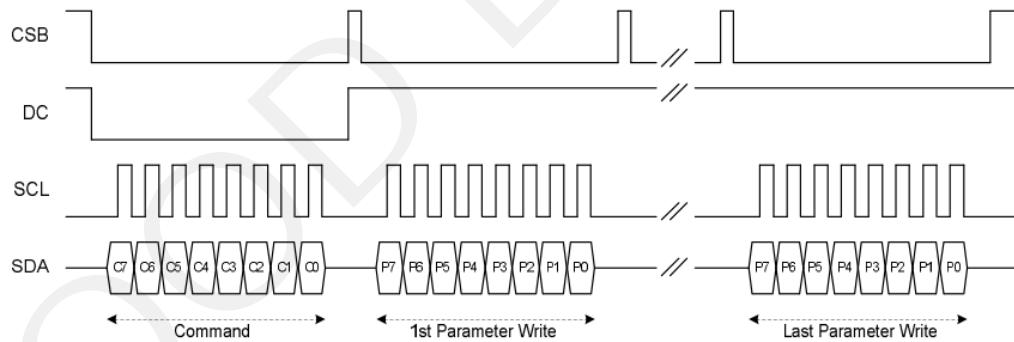


Figure: 4-wire SPI write operation

The MSB bit of data will be output at SDA pin after the CSB falling edge, if DC pin is High.

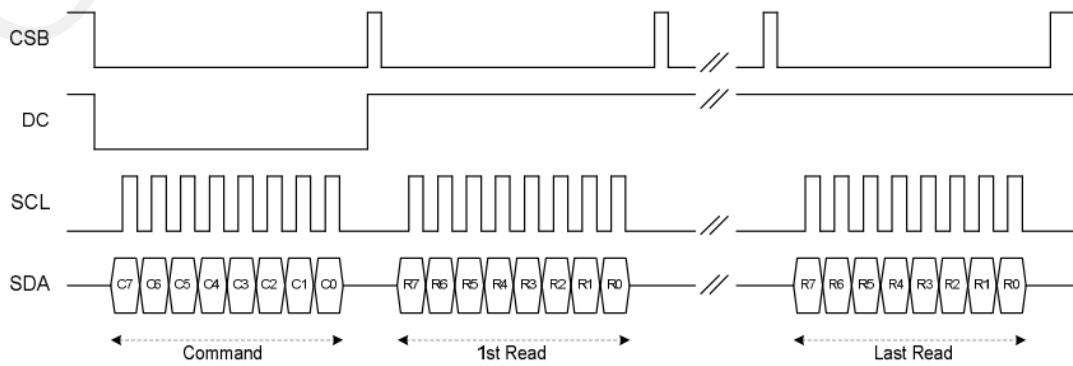
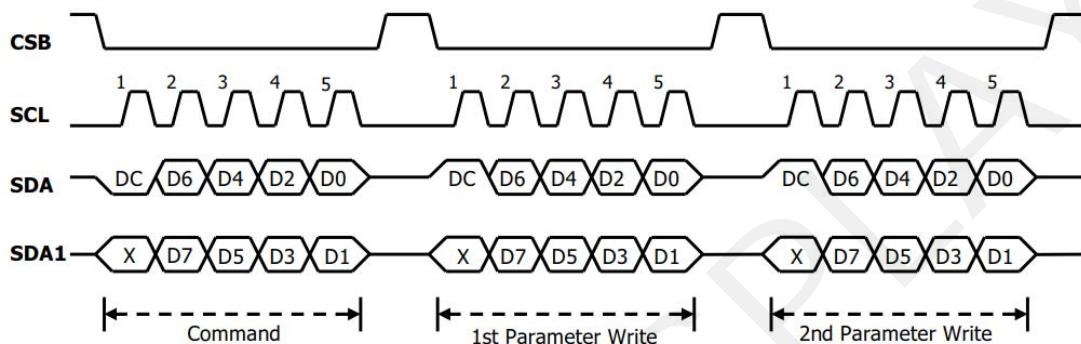


Figure: 4-wire SPI read operation

### 7.3.4. 3 Wire Dual SPI Format

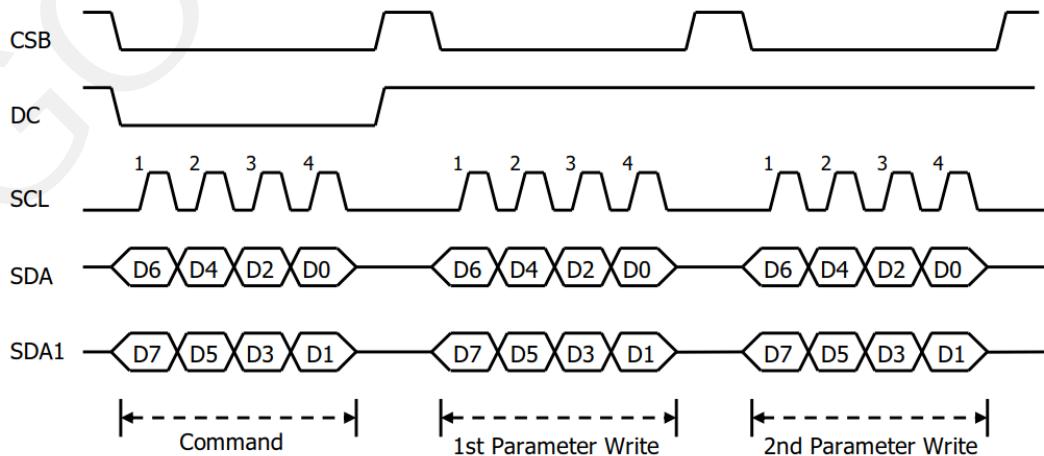
Data / Command is recognized with the first bit transferred at SDA. Data are transferred in the unit of 5 SPI clocks. To prevent malfunction due to noise, it is recommended to set the CSB signal to HIGH every 5 SPI clocks. (The serial counter is reset at the rising edge of the CSB signal.) In 3-wire dual SPI mode, SDA and SDA1 are only input mode for data write transmission.



**Figure:** 3-wire dual SPI write operation

### 7.3.5. 3 Wire Dual SPI Format

Data / Command is recognized with DC pin. Data are transferred in the unit of 4 SPI clocks. To prevent malfunction due to noise, it is recommended to set the CSB signal to HIGH every 4 SPI clocks. (The serial counter is reset at the rising edge of the CSB signal.) In 4-wire dual SPI mode, SDA and SDA1 are only input mode for data write transmission.



**Figure:** 4-wire dual SPI write operation

## 7.4. Timing Characteristics

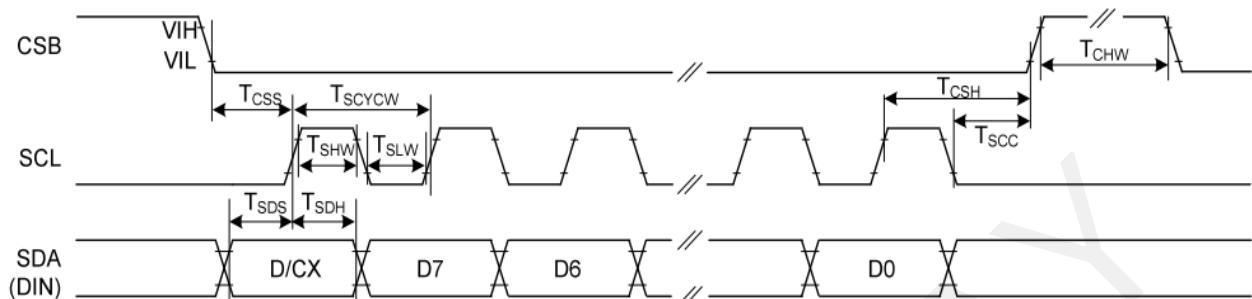


Figure: 3-wire Serial Interface Characteristics (Write mode)

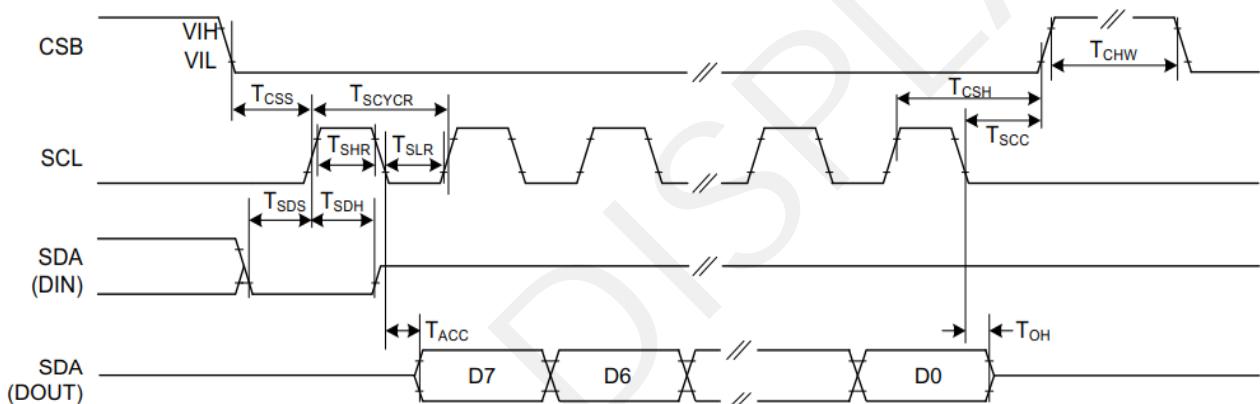


Figure: 3-wire Serial Interface Characteristics (Read mode)

Symbol	Signal / Parameter	Conditions	Min.	Typ.	Max.	Unit
T <sub>CS</sub>	CSB	Chip select setup time	60			ns
T <sub>CSH</sub>		Chip select hold time	65			ns
T <sub>SCC</sub>		Chip select setup time	20			ns
T <sub>CHW</sub>		Chip select setup time	40			ns
T <sub>SCYCW</sub>	SCL	Serial clock cycle (Write)	100			ns
T <sub>SHW</sub>		SCL "H" pulse width (Write)	35			ns
T <sub>SLW</sub>		SCL "L" pulse width (Write)	35			ns
T <sub>SCYCR</sub>		Serial clock cycle (Read)	230			ns
T <sub>SHR</sub>		SCL "H" pulse width (Read)	60			ns
T <sub>SLR</sub>		SCL "L" pulse width (Read)	60			ns
T <sub>SDS</sub>	SDA (DIN)	Data setup time	30			ns
T <sub>SDH</sub>		Data hold time	30			ns
T <sub>ACC</sub>	SDA (DOUT)	Access time			230	ns
T <sub>OH</sub>		Output disable time	15			ns

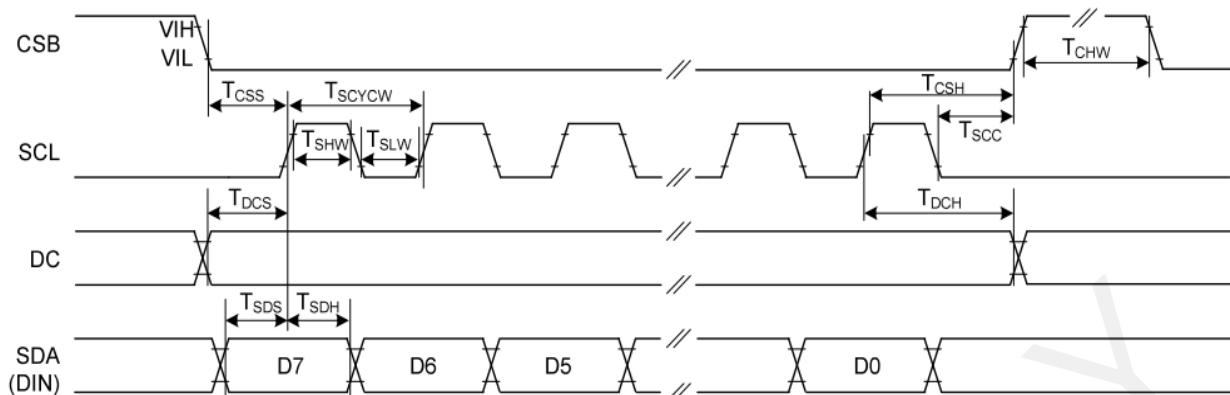


Figure: 4-wire Serial Interface Characteristics (Write mode)

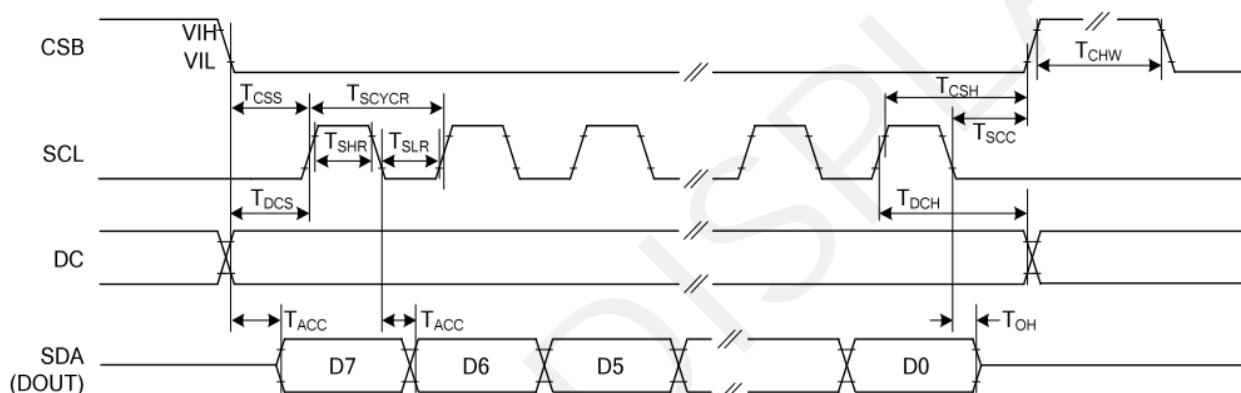


Figure: 4-wire Serial Interface Characteristics (Read mode)

Symbol	Signal / Parameter	Conditions	Min.	Typ.	Max.	Unit
T <sub>CS</sub> S	CSB	Chip select setup time	60			ns
T <sub>CSH</sub>		Chip select hold time	65			ns
T <sub>SCC</sub>		Chip select setup time	20			ns
T <sub>CHW</sub>		Chip select setup time	40			ns
T <sub>SCYCW</sub>	SCL	Serial clock cycle (Write)	100			ns
T <sub>SHW</sub>		SCL "H" pulse width (Write)	35			ns
T <sub>SLW</sub>		SCL "L" pulse width (Write)	35			ns
T <sub>SCYCR</sub>		Serial clock cycle (Read)	230			ns
T <sub>SHR</sub>		SCL "H" pulse width (Read)	60			ns
T <sub>SLR</sub>		SCL "L" pulse width (Read)	60			ns
T <sub>DCS</sub>	DC	DC setup time	30			ns
T <sub>DCH</sub>		DC hold time	30			ns
T <sub>SDS</sub>	SDA (DIN)	Data setup time	30			ns
T <sub>SDH</sub>		Data hold time	30			ns
T <sub>ACC</sub>	SDA (DOUT)	Access time			230	ns
T <sub>OH</sub>		Output disable time	15			ns

## 8. Typical Operating Sequence

### Normal Operation Flow

The flow chart below to update the EPD. The steps below refer to the flow chart in the respective sections.

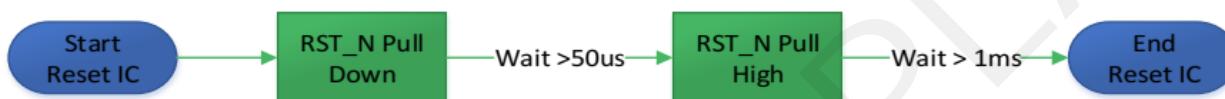
#### ➤ EPD Driving Flow Chart



**Start:** To supply 2.3V – 3.6V on VDD/VDDA/VDDIO then wait  $VDD = 95\% \times (2.3V \sim 3.6V)$  for at least > 1ms.

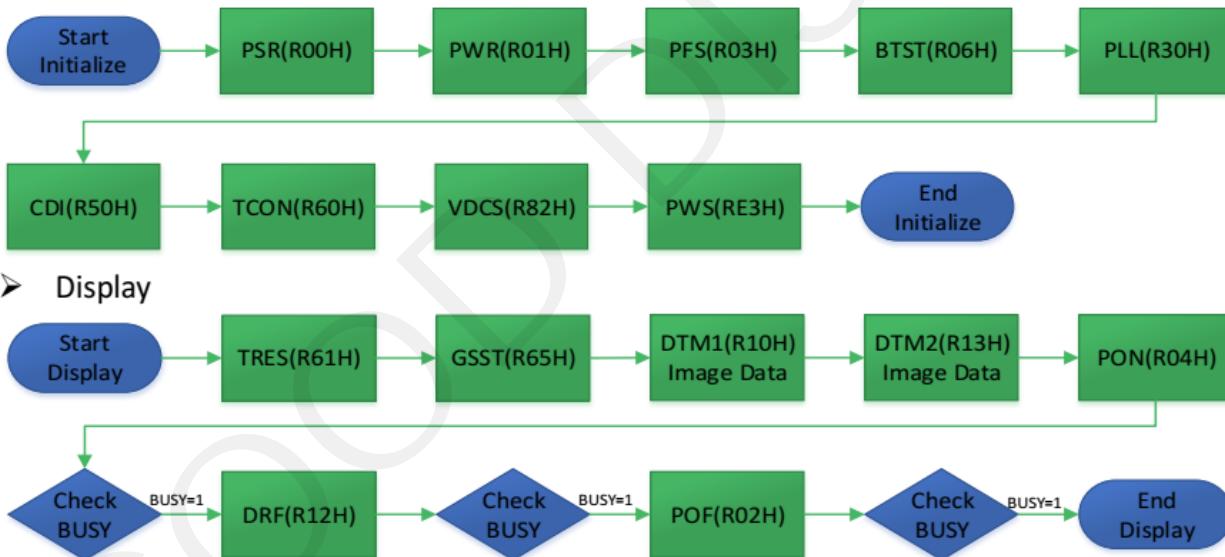
**End:** To remove 2.3V – 3.6V from VDD/VDDA/VDDIO to 0V.

#### ➤ Reset IC



**End Reset IC:** At this moment we will see RST\_N= High, BUSY= High and VDD current is less than or equal to 34uA.

#### ➤ Initialize IC



**End Display:** At this moment we will see VGH= VDD, VGL/VDH/VDHR/VDL=0V and VDD current is less than or equal to 34uA.

#### ➤ Deep Sleep



**End Deep Sleep:** At this moment we will see VDDDO is approximately equal to 0V and VDD current is less than or equal to 1.1uA. Control pins defined as input types cannot be floating.

## 9. Optical Characteristics

### 9.1. Specifications

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

Symbol	Parameter	Conditions	Min	Typ.	Max	Units	Notes
R	White Reflectivity	White	30	35	-	%	8-1
CR	Contrast Ratio	Indoor	8:1		-		8-2
GN	2Grey Level	-		DS+(WS-DS)*n(m-1)			8-3
T update	Image update time	at 25 °C		25	-	sec	
Life		Topr		1000000times or 5years			

Notes: 8-1. Luminance meter: Eye-One Pro Spectrophotometer.

8-2. CR=Surface Reflectance with all white pixel/Surface Reflectance with all black pixels

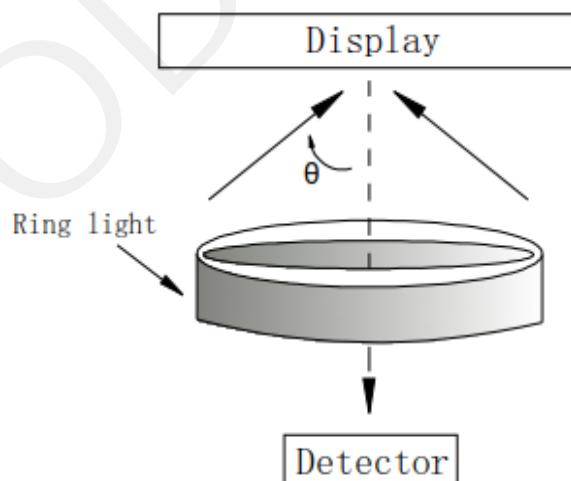
8-3 WS: White state, DS: Dark state

### 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

$$CR = R1/Rd$$

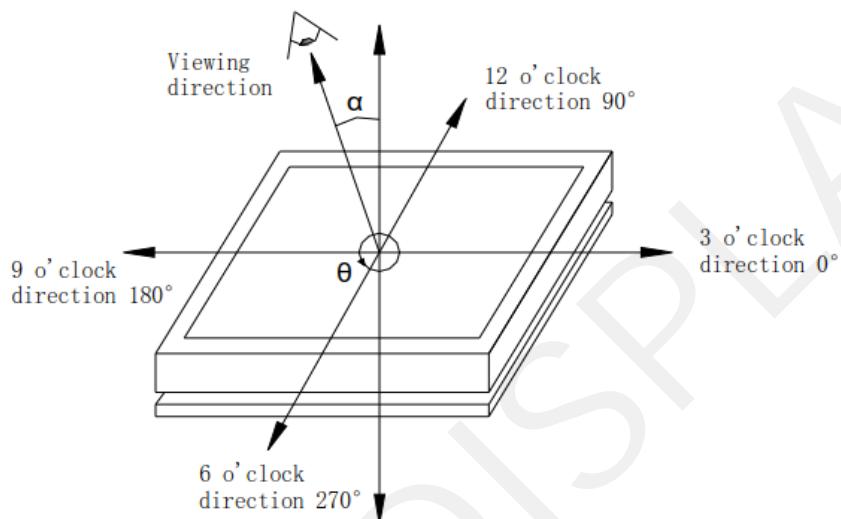


### 9.3. Reflection Ratio

The reflection ratio is expressed as :

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

$L_{\text{center}}$  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.

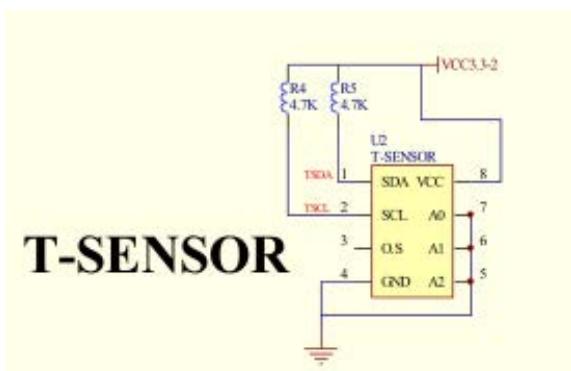
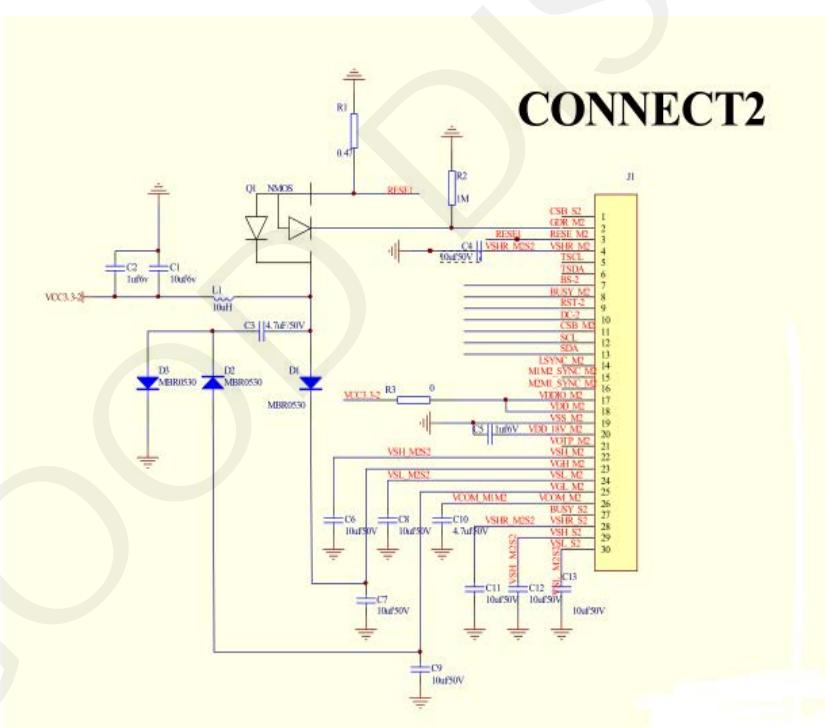
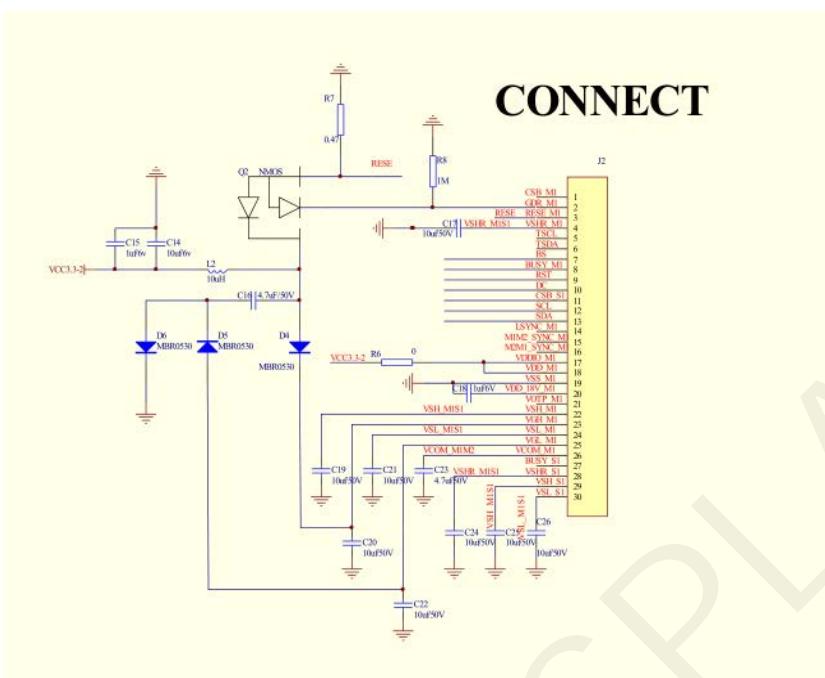


### 9.4. Bi-stability

The Bi-stability standard as follows:

Bi-stability	Result		
24 hours Luminance drift		AVG	MAX
	White state $\Delta L^*$	-	3
	Black state $\Delta L^*$	-	3

## 10. Reference Circuit



## 11. Handling, Safety and Environmental Requirements

### **WARNING**

The display glass may break when it is dropped or bumped on a hard surface. Handle with care.

Should the display break, do not touch the electrophoretic material. In case of contact with electrophoretic material, wash with water and soap.

### **CAUTION**

The display module should not be exposed to harmful gases, such as acid and alkali gases, which corrode electronic components.

Disassembling the display module can cause permanent damage and invalidate the warranty agreements.

Observe general precautions that are common to handling delicate electronic components. The glass can break and front surfaces can easily be damaged. Moreover the display is sensitive to static electricity and other rough environmental conditions.

#### **Data sheet status**

Product specification	The data sheet contains final product specifications.
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#### **Limiting values**

Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134).

Stress above one or more of the limiting values may cause permanent damage to the device.

These are stress ratings only and operation of the device at these or any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

#### **Application information**

Where application information is given, it is advisory and does not form part of the specification.

#### **Product Environmental certification**

RoHS
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## 12. Reliability Test

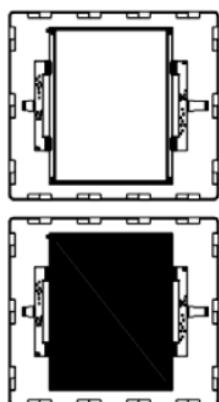
NO	Test items	Test condition
1	Low-Temperature Storage	T = -25°C, 240 h Test in white pattern
2	High-Temperature Storage	T=60°C, RH=40%, 240h Test in white pattern
3	High-Temperature Operation	T=40°C, RH=35%, 240h
4	Low-Temperature Operation	0°C, 240h
5	High-Temperature, High-Humidity Operation	T=40°C, RH=80%, 240h
6	High Temperature, High Humidity Storage	T=50°C, RH=80%, 240h Test in white pattern
7	Temperature Cycle	1 cycle:[-25 ° C 30min]→[+60 ° C 30 min] : 50 cycles Test in white pattern
8	UV exposure Resistance	765W/m <sup>2</sup> for 168hrs,40 °C Test in white pattern
9	ESD Gun	Air+/-15KV;Contact+/-8KV (Test finished product shell, not display only) Air+/-8KV;Contact+/-6KV (Naked EPD display, no including IC and FPC area) Air+/-4KV;Contact+/-2KV (Naked EPD display, including IC and FPC area)

Note: The protective film must be removed before temperature test.

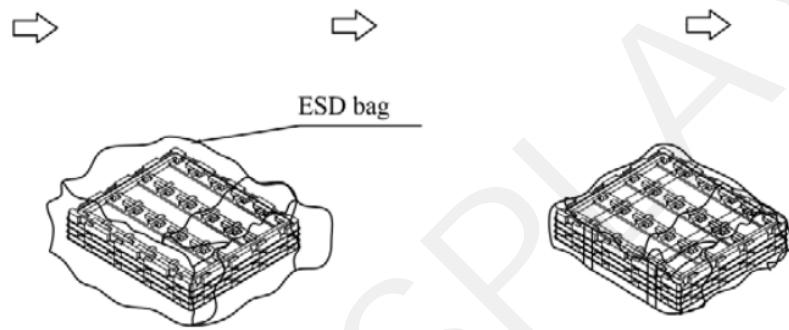
## 13. Packing

### PACKLING ORDER:

1) Putting 1 pcs Modules on each PET tray. And cover a dedicated EPE film.

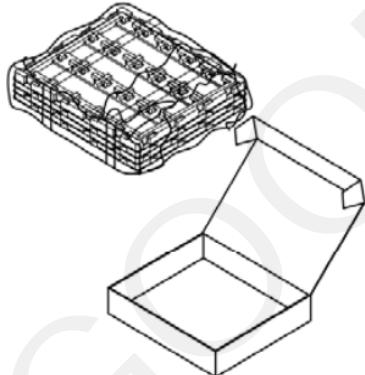


2) Putting 9 pcs PET trays together with 1 empty tray on the top of PET tray. Insert in the ESD bag, add desiccant in the ESD bag.

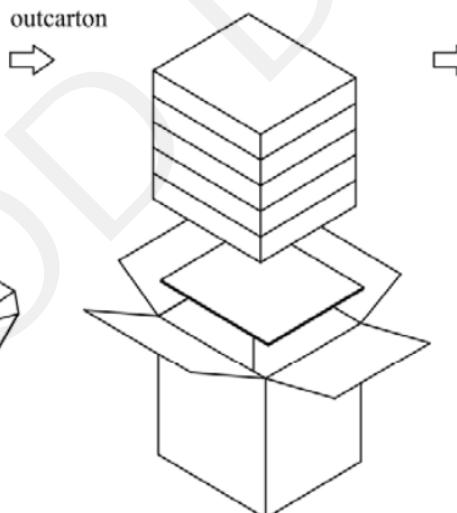


3) the tray together with rubber band

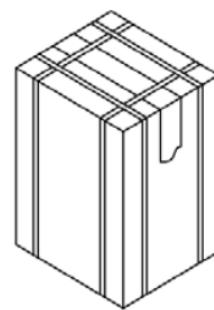
4) Putting in the inner small carton



5) Putting 5 small cartons into one outcarton



6) Packing finished



Note: 1 pcs in a tray, 9 trays in a inner carton, 5 inner cartons in a out carton, so  $1 \times (10-1) \times 5 = 45$  pcs/Outcarton

Dimension (Small carton): 385\*325\*87mm

Dimension (Out carton): 394\*344\*470mm

## 14. Precautions

- (1) Do not apply pressure to the EPD panel in order to prevent damaging it.
- (2) Do not connect or disconnect the interface connector while the EPD panel is in operation.
- (3) Do not touch IC bonding area. It may scratch TFT lead or damage IC function.
- (4) Please be mindful of moisture to avoid its penetration into the EPD panel, which may cause damage during operation.
- (5) If the EPD Panel / Module is not refreshed every 24 hours, a phenomena known as "Ghosting" or "Image Sticking" may occur. It is recommended to refreshed the ESL / EPD Tag every 24 hours in use case. It is recommended that customer ships or stores the ESL / EPD Tag with a completely white image to avoid this issue
- (6) High temperature, high humidity, sunlight or fluorescent light may degrade the EPD panel's performance. Please do not expose the unprotected EPD panel to high temperature, high humidity, sunlight, or fluorescent for long periods of time.