

KOE

JDI Group

Kaohsiung Opto-Electronics Inc.

FOR MESSRS : _____

DATE : Aug. 4th, 2017

CUSTOMER'S ACCEPTANCE SPECIFICATIONS

TX31D203VM0EAB

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ACCEPTED BY : _____

PROPOSED BY : John Chou

2. RECORD OF REVISION

DATE	SHEET No.	SUMMARY

3. GENERAL DATA

3.1 DISPLAY FEATURES

This module is a 12.3" HD of 8:3 format amorphous silicon TFT. The pixel format is vertical stripe and sub pixels are arranged as R(red), G(green), B(blue) sequentially. This display is RoHS compliant, and COG (chip on glass) technology and LED backlight are applied on this display

Part Name	TX31D203VM0EAB
Module Dimensions	333.1(W) mm x 150.5(H) mm x 20.6(D) mm
LCD Active Area	292.0(W) mm x 109.5(H) mm
Pixel Pitch	0.1521(W) mm x 0.1521(H) mm
Resolution	1920 x 3(RGB)(W) x 720(H) dots
Color Pixel Arrangement	R, G, B Vertical stripe
LCD Type	IPS, Normally Black, transmissive type
Display Type	Active Matrix
Number of Colors	16.7M Colors (8-bit RGB)
Backlight	Light Emitting Diode (LED)
Weight	600 g
Interface	LVDS; 50 pins
Power Supply Voltage	3.3V for LCD ; 12V for Backlight
Viewing Direction	Super Wide Version (In Plane Switching)

4. ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min.	Max.	Unit	Remarks
Supply Voltage	V _{DD}	-0.3	4.0	V	-
Input Voltage of Logic	V _I	-0.3	V _{DD} +0.3	V	Note 1
Operating Temperature	T _{op}	-40	85	°C	Note 2
Storage Temperature	T _{st}	-40	90	°C	Note 2
Backlight Input Voltage	V _{LED}	6	21	V	-
Backlight Voltage for PWM	V _{PWM}	-0.3	6	V	-
Backlight Voltage for EN	V _{EN}	-0.3	6	V	-

Note 1: The rating is defined for the signal voltages of the interface such as CLK and pixel data pairs.

Note 2: The maximum rating is defined as above based on the chamber temperature, which might be different from ambient temperature after assembling the panel into the application. Moreover, some temperature-related phenomenon as below needed to be noticed:

- Background color, contrast and response time would be different in temperatures other than 25° C.
- Operating under high temperature will shorten LED lifetime.

5. ELECTRICAL CHARACTERISTICS

5.1 OPERATING CONDITIONS

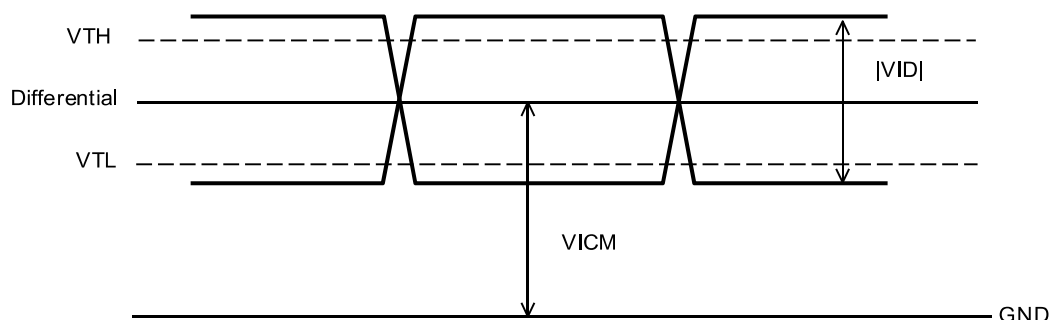
$T_a = 25\text{ }^\circ\text{C}$, $V_{SS} = 0\text{V}$

Item	Symbol	Condition	Standard Value			Unit	Remarks
			Min.	Typ.	Max.		
Power supply voltage	V_{DD}	-	3.0	3.3	3.6	V	-
Power supply current	I_{DD}	Note 1	-	700	1000	mA	Note 1
Input signal voltage (CMOS)	V_{IH1}	-	$0.8V_{DD}$	-	V_{DD}	V	-
	V_{IL1}	-	V_{SS}	-	$0.2V_{DD}$	V	-
Allowable Ripple Voltage	VRP	-	-	-	100	mV (p-p)	-
Differential Input High Threshold	VTH	$V_{ICM}=1.2\text{V}$	-	-	100	mV	Note 2
Differential Input Low Threshold	VTL	$V_{ICM}=1.2\text{V}$	-100	-	-	mV	Note 2
Input Differential Voltage	$ V_{ID} $	-	100	-	600	mV	Note 2
Differential Input Common Mode Voltage	V_{ICM}	-	1.125	1.2	1.375	V	Note 2

Note 1: Measurement picture: Maximum load condition.

Power supply voltage: Typ. voltage.

Note 2:



5.2 BACKLIGHT CHARACTERISTICS

$T_a = 25^\circ\text{C}$

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
LED Input Voltage	V_{LED}	$I_{LED}=1000\text{mA}$	11.5	12	12.5	V	Note 1
LED Forward Current (DIM Control)	I_{LED}	100% duty	-	1000	-	mA	Note 2
		5% duty	-	70	-		
PWM Signal Voltage	-	High	2.5	3.3	5	V	-
		Low	-	-	0.9		
		Range	5	-	100	%	
EN Voltage	V_{EN}	-	2.5	3.3	5.0	V	-
LED Lifetime	-	$I_{LED}=1000\text{mA}$	-	50K	-	hrs	Note 3

Note 1: Fig. 5.1 shows the LED backlight circuit.

Note 2: Dimming function can be obtained by applying PWM signal from the display interface CN2. The recommended PWM signal is 1K ~ 10KHz with 3.3 V amplitude.

Note 3: The estimated lifetime is specified as the time to reduce 50% brightness by applying 1000mA at 25°C .

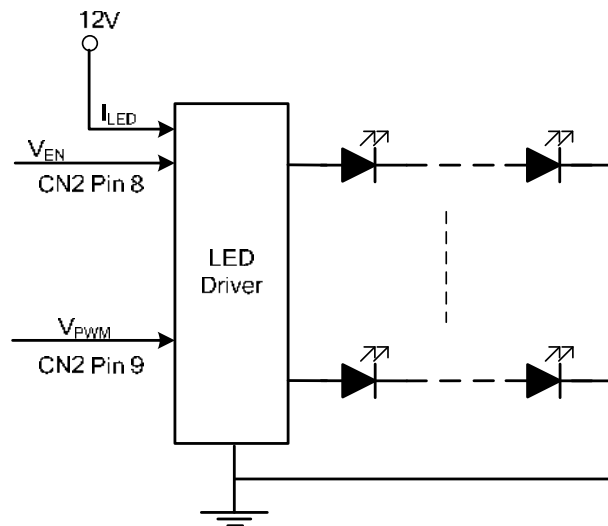


Fig 5.1

6. OPTICAL CHARACTERISTICS

The optical characteristics are measured based on the conditions as below:

- Supplying the signals and voltages defined in the section of electrical characteristics.
- The backlight unit needs to be turned on for 30 minutes.
- The ambient temperature is 25 °C .
- In the dark room less than 100 lx, the equipment has been set for the measurements as shown in Fig 6.1.

$$T_a = 25 \text{ }^\circ\text{C}, f_{Frame} = 60 \text{ Hz}, V_{DD} = 3.3\text{V}$$

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks	
Brightness of White	-	$\phi = 0^\circ, \theta = 0^\circ,$ $I_{LED} = 1000\text{mA}$	800	1000	-	cd/m ²	Note 1	
Brightness Uniformity	-		75	-	-	%	Note 2	
Contrast Ratio	CR		800	1300	-	-	Note 3	
Response Time	-	$\phi = 0^\circ, \theta = 0^\circ$	-	-	25	ms	-	
NTSC Ratio	-	$\phi = 0^\circ, \theta = 0^\circ$	-	70	-	%	-	
Viewing Angle	θ_x	$\phi = 0^\circ, CR \geq 10$	-	85	-	Degree	Note 5	
	$\theta_{x'}$	$\phi = 180^\circ, CR \geq 10$	-	85	-			
	θ_y	$\phi = 90^\circ, CR \geq 10$	-	85	-			
	$\theta_{y'}$	$\phi = 270^\circ, CR \geq 10$	-	85	-			
Color Chromaticity	Red	X	$\phi = 0^\circ, \theta = 0^\circ$	0.59	0.64	0.69	-	Note 6
		Y		0.25	0.30	0.35		
	Green	X		0.28	0.33	0.38		
		Y		0.57	0.62	0.67		
	Blue	X		0.09	0.14	0.19		
		Y		0.02	0.07	0.12		
	White	X		0.26	0.31	0.36		
		Y		0.28	0.33	0.38		

Note 1: The brightness is measured from the panel center point, P5 in Fig. 6.2, for the typical value.

Note 2: The brightness uniformity is calculated by the equation as below:

$$\text{Brightness uniformity} = \frac{\text{Min. Brightness}}{\text{Max. Brightness}} \times 100\%$$

which is based on the brightness values of the 9 points in active area measured by BM-5 as shown in Fig. 6.2.

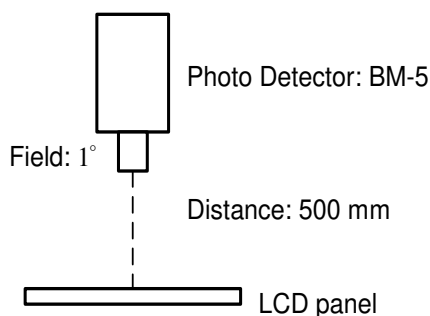


Fig 6.1

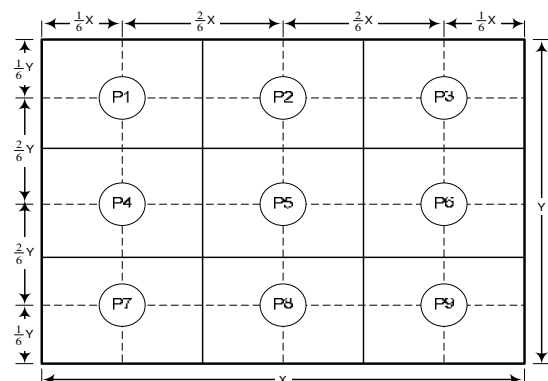


Fig 6.2

Note 3: The Contrast Ratio is measured from the center point of the panel, P5, and defined as the following equation:

$$CR = \frac{\text{Brightness of White}}{\text{Brightness of Black}}$$

Note 4: The definition of response time is shown in Fig. 6.3. The rising time is the period from 10% brightness to 90% brightness when the data is from black to white. Oppositely, Falling time is the period from 90% brightness falling to 10% brightness.

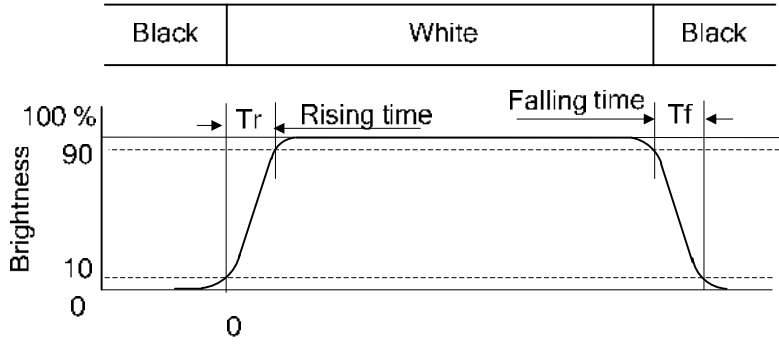


Fig 6.3

Note 5: The definition of viewing angle is shown in Fig. 6.4. Angle ϕ is used to represent viewing directions, for instance, $\phi = 270^\circ$ means 6 o'clock, and $\phi = 0^\circ$ means 3 o'clock. Moreover, angle θ is used to represent viewing angles from axis Z toward plane XY.

The display is super wide viewing angle version; 85° viewing angle can be obtained from each viewing direction.

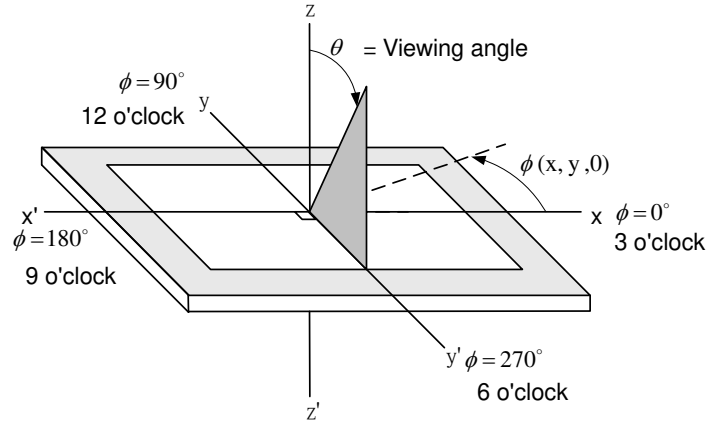
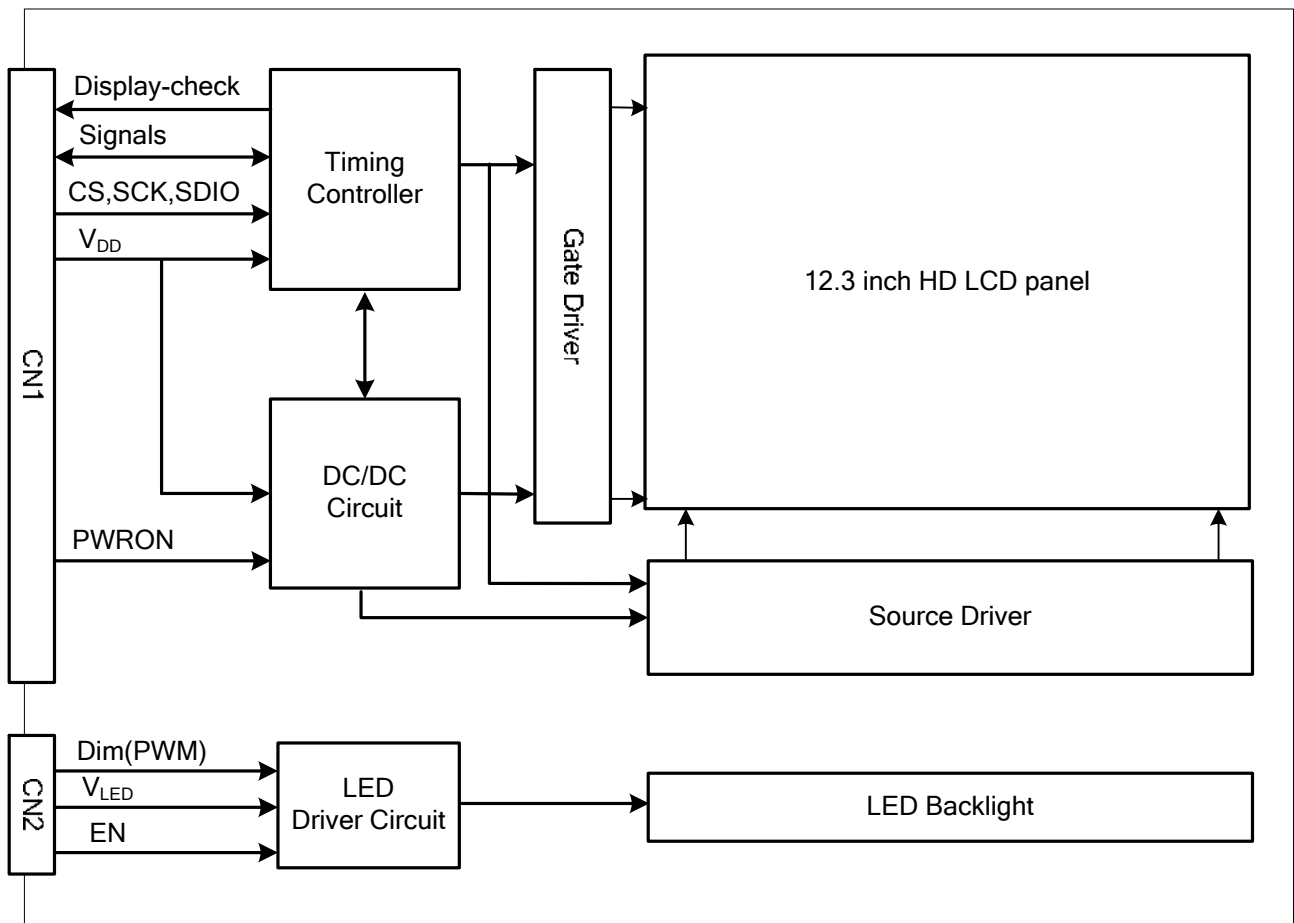


Fig 6.4

Note 6: The color chromaticity is measured from the center point of the panel, P5, as shown in Fig. 6.2.

7. BLOCK DIAGRAM



8. RELIABILITY TESTS

Test Item	Condition	
High Temperature	1) Operating 2) 85 °C	500 hrs
Low Temperature	1) Operating 2) -40 °C	500 hrs
High Temperature	1) Storage 2) 90 °C	500 hrs
Low Temperature	1) Storage 2) -40 °C	500 hrs
Heat Cycle	1) Operating 2) -35 °C ~85 °C 3) 3hrs~1hr~3hrs	500 hrs
Thermal Shock	1) Non-Operating 2) -35 °C ↔ 85 °C 3) 0.5 hr ↔ 0.5 hr	500 hrs
High Temperature & Humidity	1) Operating 2) 40 °C & 85%RH 3) Without condensation	500 hrs (Note 3)
Vibration	1) Non-Operating 2) 10~200 Hz 3) 5G 4) X, Y, and Z directions	1 hr for each direction
Mechanical Shock	1) Non-Operating 2) 10 ms 3) 80G 4) ±X, ±Y and ±Z directions	Once for each direction
ESD	1) Operating 2) Tip:150 pF,330 Ω 3) Air discharge for glass: ±12KV 4) Contact discharge for metal frame: ±15KV	1) Glass: 9 points 2) Metal frame: 8 points (Note4)

Note 1: Display functionalities are inspected under the conditions defined in the specification after the reliability tests.

Note 2: The display is not guaranteed for use in corrosive gas environments.

Note 3: Under the condition of high temperature & humidity, if the temperature is higher than 40 °C, the humidity needs to be reduced as Fig. 8.1 shown.

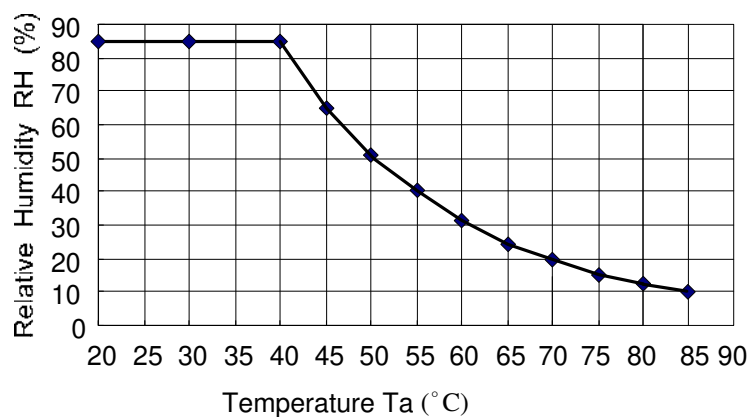


Fig. 8.1

Note 4: All pins of LCD interface (CN1) have been tested by ±100V contact discharge of ESD under non-operating condition.

9. LCD INTERFACE

9.1 INTERFACE PIN CONNECTIONS

The display interface connector is FH41 made by Hirose and pin assignment of LCD interface CN1 is as below.

Pin No.	Symbol	Function	I/O/P	Remarks
1	NC	Not connected	-	Connected to Pin #50 on PWB
2	CS	Serial interface chip select	I	
3	SCK	Serial interface clock	I	
4	SDIO	Serial interface data	I/O	
5	NC	Innter test pin	O	
6	PWRON	Power ON/OFF	I	
7	GND	GND (0V)	P	
8	GND	GND (0V)	P	
9	GND	GND (0V)	P	
10	GND	GND (0V)	P	
11	NC	Not connected	-	
12	V _{DD}	+3.3V	P	
13	V _{DD}	+3.3V	P	
14	V _{DD}	+3.3V	P	
15	V _{DD}	+3.3V	P	
16	NC	Not connected	-	
17	GND	GND (0V)	P	
18	GND	GND (0V)	P	
19	NC	Not connected	-	
20	GND	GND (0V)	P	
21	RO0-	LVDS data (-), Channel 0-odd	I	
22	RO0+	LVDS data (+), Channel 0-odd	I	
23	GND	GND (0V)	P	
24	RO1-	LVDS data (-), Channel 1-odd	I	
25	RO1+	LVDS data (+), Channel 1-odd	I	
26	GND	GND (0V)	P	
27	RO2-	LVDS data (-), Channel 2-odd	I	
28	RO2+	LVDS data (+), Channel 2-odd	I	
29	GND	GND (0V)	P	
30	CLKO-	LVDS clock (-), Odd	I	
31	CLKO+	LVDS clock (+), Odd	I	
32	GND	GND (0V)	P	
33	RO3-	LVDS data (-), Channel 3-odd	I	
34	RO3+	LVDS data (+), Channel 3-odd	I	
35	GND	GND (0V)	P	
36	RE0-	LVDS data (-), Channel 0-Even	I	
37	RE0+	LVDS data (+), Channel 0-Even	I	
38	GND	GND (0V)	P	
39	RE1-	LVDS data (-), Channel 1-Even	I	
40	RE1+	LVDS data (+), Channel 1-Even	I	

Pin No.	Symbol	Function	I/O/P	Remarks
41	GND	GND (0V)	P	
42	RE2-	LVDS data (-), Channel 2-Even	I	
43	RE2+	LVDS data (+), Channel 2-Even	I	
44	GND	GND (0V)	P	
45	CLKE-	LVDS clock (-), Even	I	
46	CLKE+	LVDS clock (+), Even	I	
47	GND	GND (0V)	P	
48	RE3-	LVDS data (-), Channel 3-Even	I	
49	RE3+	LVDS data (+), Channel 3-Even	I	
50	NC	Not connected	-	Connected to Pin #1 on PWB

Note 1: I: input pin, I/O: input / output pin, P: power pin, O: output pin

RO* : 1st , 3rd ...Pixel, RE* : 2nd, 4th,... Pixel

Note 2: It outputs Display_check signal to check the condition of LCD. The TCON monitors the rising edge of the cascade-out of the Gate driver IC. If the TCON is not able to check the rising edge into the Check_window, the Display_check signal is set to Low.

The interface CN2 is SM10B-SRSS-TB(LF)(SN) made by JST and pin assignment is as below:

Connector Name	Pin No.	Symbol	Function
SM10B-SRSS-TB(LF)(SN)	1	V _{LED} (+)	Power Supply for LED
	2	V _{LED} (+)	Power Supply for LED
	3	V _{LED} (+)	Power Supply for LED
	4	NC	No Connected
	5	V _{LED} (-)	GND
	6	V _{LED} (-)	GND
	7	V _{LED} (-)	GND
	8	V _{EN}	Backlight On/Off
	9	NC	No Connected
	10	V _{PWM}	Brightness dimming

Note 1: Normal brightness: 100% PWM duty; Brightness control: 5% to 100% PWM duty.

9.2 FUNCTIONS

Serial interface is performed by three signal lines

CS	Chip select signal (Serial interface chip select)
SCK	Serial interface clock
SDIO	Serial interface data (Input and output)

Command data and parameter data are possible by using the following three pins: CS, SCK, SDIO.

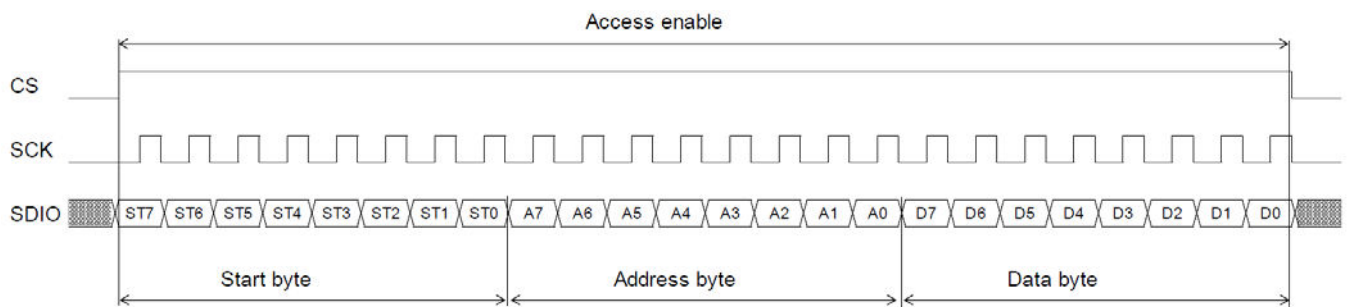
<START BYTE STRUCTURE>

ST7	ST6	ST5	ST4	ST3	ST2	ST1	ST0
Parity	0	R/W	0	0	0	0	0

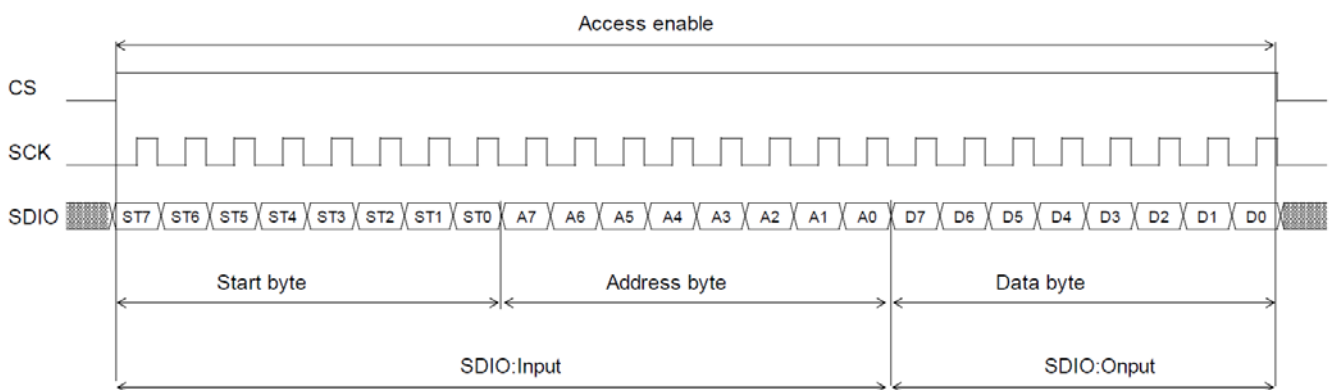
↳

ST5	Access mode
0	Write
1	Read

<Write Access>



<Read Access>



9.3 REGISTER LIST OF SERZAL INTERFACE

Address (HEX)	Initial									Register Name	Description
	BIN								HEX		
	7	6	5	4	3	2	1	0			
05h	0	0	0	0	0	0	0	0	00	-	Fixed value.
06h	0	0	0	0	0	0	0	0	00	-	Fixed value.
07h	0	0	0	1	0	1	1	1	17	-	Fixed value.
08h	0	0	0	0	0	0	1	0	02	-	Fixed value.
09h	0	0	0	1	0	0	1	1	13	-	Fixed value.
0Ah	0	0	0	0	0	0	0	0	00	-	Fixed value.
0Bh	0	0	0	0	0	0	0	0	00	-	Fixed value.
0Ch	0	0	0	0	0	0	0	0	00	-	Fixed value.
0Dh	0	0	0	0	0	0	0	0	00	-	Fixed value.
0Eh	0	0	0	0	0	0	0	0	00	-	Fixed value.
0Fh	0	0	0	0	0	0	0	0	00	-	Fixed value.
10h	1	1	1	1	1	1	1	1	FF	R_YADRS0_M	Gamma correction parameter, Point 0 of R
11h	0	0	0	0	0	0	0	0	00	R_YADRS1_M	Gamma correction parameter, Point 1 of R
12h	0	0	0	0	0	0	0	0	00	R_YADRS2_M	Gamma correction parameter, Point 2 of R
13h	0	0	0	0	0	0	0	0	00	R_YADRS3_M	Gamma correction parameter, Point 3 of R
14h	0	0	0	0	0	0	0	0	00	R_YADRS4_M	Gamma correction parameter, Point 4 of R
15h	0	0	0	0	0	0	0	0	00	R_YADRS5_M	Gamma correction parameter, Point 5 of R
16h	0	0	0	0	0	0	0	0	00	R_YADRS6_M	Gamma correction parameter, Point 6 of R
17h	0	0	0	0	0	0	0	0	00	R_YADRS7_M	Gamma correction parameter, Point 7 of R
18h	0	1	1	1	1	1	1	1	7F	R_YADRS8_M	Gamma correction parameter, Point 8 of R
19h	1	1	1	1	1	1	1	1	FF	G_YADRS0_M	Gamma correction parameter, Point 0 of G
1Ah	0	0	0	0	0	0	0	0	00	G_YADRS1_M	Gamma correction parameter, Point 1 of G
1Bh	0	0	0	0	0	0	0	0	00	G_YADRS2_M	Gamma correction parameter, Point 2 of G
1Ch	0	0	0	0	0	0	0	0	00	G_YADRS3_M	Gamma correction parameter, Point 3 of G
1Dh	0	0	0	0	0	0	0	0	00	G_YADRS4_M	Gamma correction parameter, Point 4 of G
1Eh	0	0	0	0	0	0	0	0	00	G_YADRS5_M	Gamma correction parameter, Point 5 of G
1Fh	0	0	0	0	0	0	0	0	00	G_YADRS6_M	Gamma correction parameter, Point 6 of G
20h	0	0	0	0	0	0	0	0	00	G_YADRS7_M	Gamma correction parameter, Point 7 of G
21h	0	1	1	1	1	1	1	1	7F	G_YADRS8_M	Gamma correction parameter, Point 8 of G
22h	1	1	1	1	1	1	1	1	FF	B_YADRS0_M	Gamma correction parameter, Point 0 of B

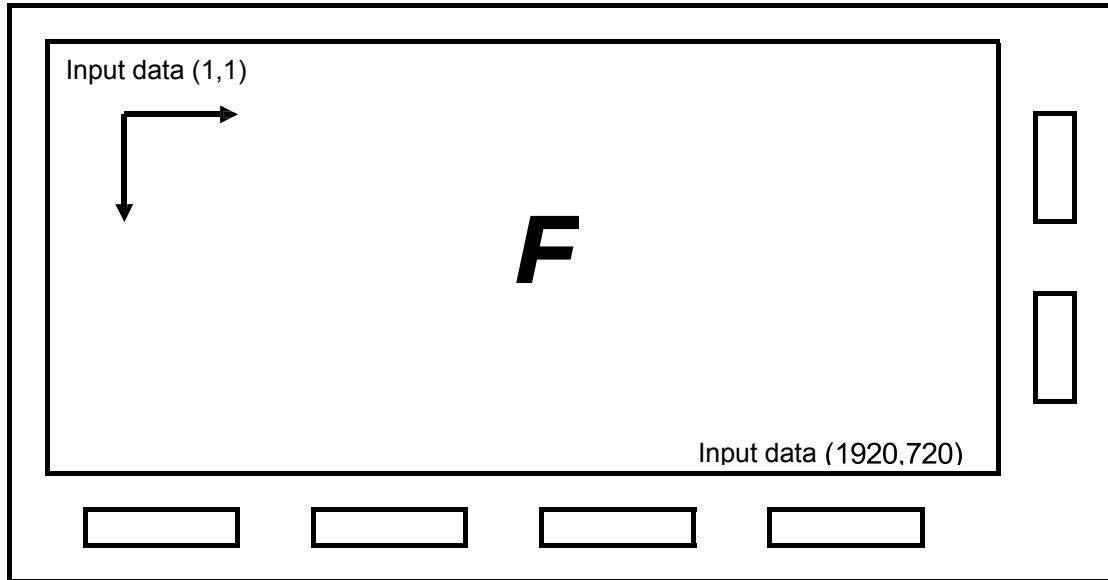
Address (HEX)	Initial								HEX	Register Name	Description
	BIN										
	7	6	5	4	3	2	1	0			
23h	0	0	0	0	0	0	0	0	00	B_YADRS1_M	Gamma correction parameter, Point 1 of B
24h	0	0	0	0	0	0	0	0	00	B_YADRS2_M	Gamma correction parameter, Point 2 of B
25h	0	0	0	0	0	0	0	0	00	B_YADRS3_M	Gamma correction parameter, Point 3 of B
26h	0	0	0	0	0	0	0	0	00	B_YADRS4_M	Gamma correction parameter, Point 4 of B
27h	0	0	0	0	0	0	0	0	00	B_YADRS5_M	Gamma correction parameter, Point 5 of B
28h	0	0	0	0	0	0	0	0	00	B_YADRS6_M	Gamma correction parameter, Point 6 of B
29h	0	0	0	0	0	0	0	0	00	B_YADRS7_M	Gamma correction parameter, Point 7 of B
2Ah	0	1	1	1	1	1	1	1	7F	B_YADRS8_M	Gamma correction parameter, Point 8 of B
2Bh	0	0	1	1	0	1	0	0	34	-	Fixed value.
2Ch	0	0	0	0	0	0	0	0	00	-	Fixed value.
2Dh	0	0	1	0	0	0	0	0	20	-	Fixed value.
2Eh	0	0	1	0	0	0	0	0	20	-	Fixed value.
2Fh	0	0	1	0	0	0	1	1	23	-	Fixed value.
30h	0	0	0	1	1	1	0	1	1D	-	Fixed value.
31h	0	0	0	1	1	1	0	1	1D	-	Fixed value.
32h	0	0	0	1	1	1	0	1	1D	-	Fixed value.
33h	0	0	0	1	1	1	0	0	1C	-	Fixed value.
34h	0	0	0	1	1	1	1	1	1F	-	Fixed value.
35h	0	0	0	1	1	1	0	0	1C	-	Fixed value.
36h	0	0	0	0	1	1	1	0	0E	-	Fixed value.
37h	0	0	0	0	0	1	0	0	04	-	Fixed value.
38h	0	0	1	0	0	0	0	0	20	-	Fixed value.
39h	0	0	0	1	1	0	1	0	1A	-	Fixed value.
3Ah	0	0	0	0	1	1	0	0	0C	-	Fixed value.
3Bh	0	0	0	0	1	1	0	0	0C	-	Fixed value.
3Ch	0	0	0	0	1	0	0	0	08	-	Fixed value.
3Dh	0	0	0	0	1	1	0	0	0C	-	Fixed value.
3Eh	0	0	0	0	1	1	0	1	0D	-	Fixed value.
3Fh	0	0	0	1	0	0	0	1	11	-	Fixed value.
40h	0	0	0	0	1	0	0	0	08	-	Fixed value.
41h	0	0	0	0	0	0	0	0	00	-	Fixed value.
42h	0	1	0	1	1	1	1	1	5F	-	Fixed value.
43h	0	0	0	0	0	0	0	0	00	-	Fixed value.
44h	0	0	0	0	0	0	0	0	00	-	Fixed value.
45h	1	0	1	0	0	0	0	0	A0	-	Fixed value.

Address (HEX)	Initial									Register Name	Description
	BIN								HEX		
	7	6	5	4	3	2	1	0			
46h	1	1	0	1	1	1	1	1	DF	-	Fixed value.
47h	0								00	SREV	Display Setting (0,0)=Normal (1,1)=Vertical and horizontal inversion
		0								GREV	
			0	0	0	0	0	0			-
48h	0	0	0	0	0	0	0	0	00	-	Fixed value.
49h	0	0	0	0	1	0	0	0	08	-	Fixed value.
E0h	0	0	0	0	0	0	0	1	01	DISPON_CMD	Display Enable 00h: Disable(black screen) 01h, Enable
E1h	0	0	0	0	0	0	0	0	00	-	Fixed value
E4h	0	1	0	1	0	1	0	1	55	-	Fixed value.
ECh	0	1	0	1	0	1	0	1	55	-	Fixed value.

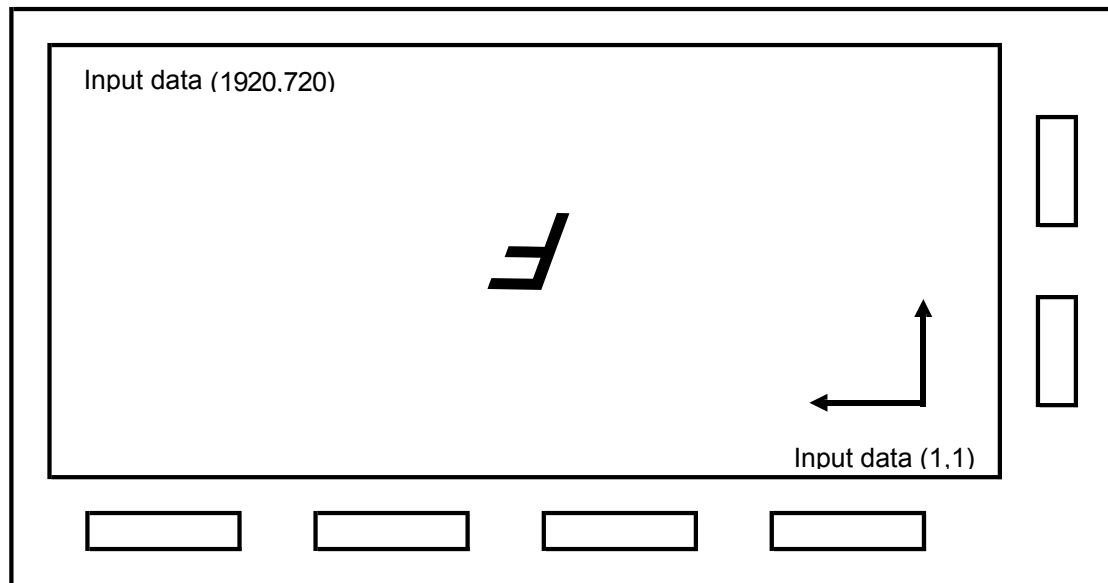
SCANNING DIRECTION

Command	Address	Description	Remarks
SREV	47h[7]	47h[7:6] (0,0)=Normal	
GREV	47h[6]	(1,1)=Vertical and horizontal inversion	

CASE1 (SREV=0, GREV=0)

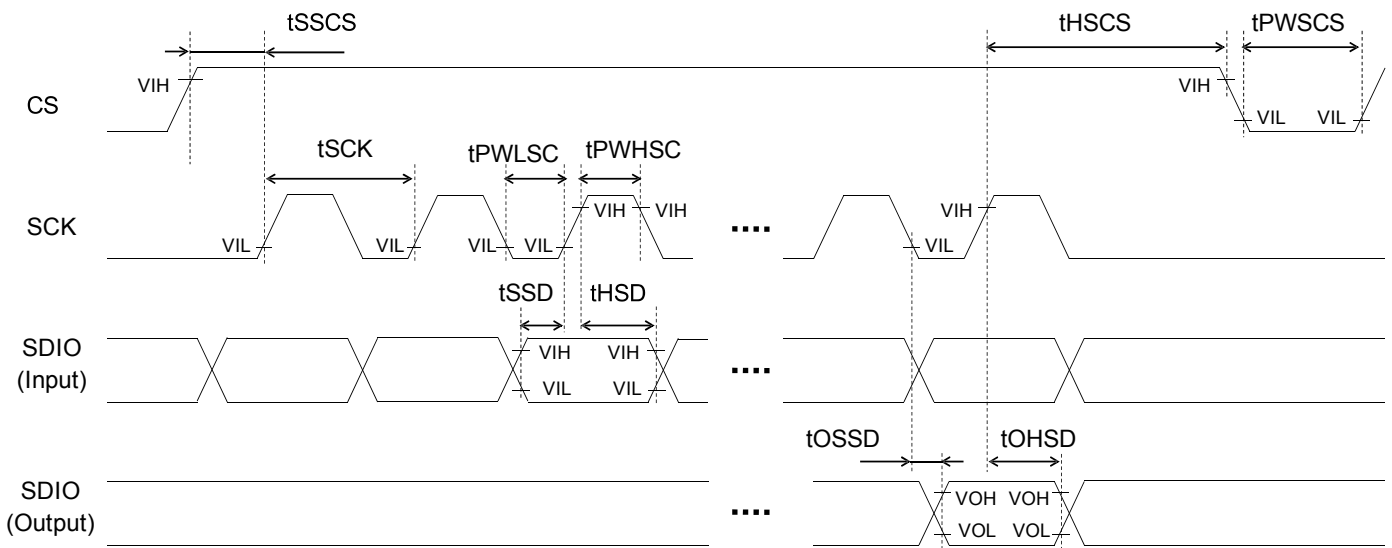


CASE2 (SREV=1, GREV=1)



9.4 AC CHARACTERISTICS OF SERIAL INTERFACE

Symbol	Item	Condition	Min	Typ	Max	Unit
tSCK	Cycle Time of SCK		200	—	—	ns
tPWHSC	High Pulse Width of SCK		80	—	—	ns
tPWLSC	Low Pulse Width of SCK		80	—	—	ns
tSSCS	Setup Time for CS		40	—	—	ns
tHSCS	Hold Time for CS		80	—	—	ns
tPWSCS	Disenable Width of CS		160	—	—	ns
tOSSD	Delay Time for Read Data	Output Load = 20 pF	—	—	30	ns
tOHSD	Hold Time for Read Data		40	—	—	ns



The serial interface uses the three pins: SCK, SDIO and CS.

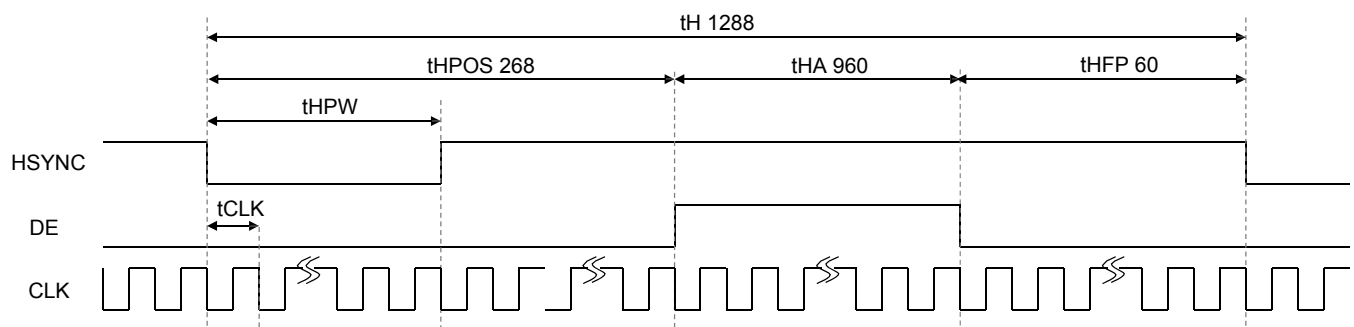
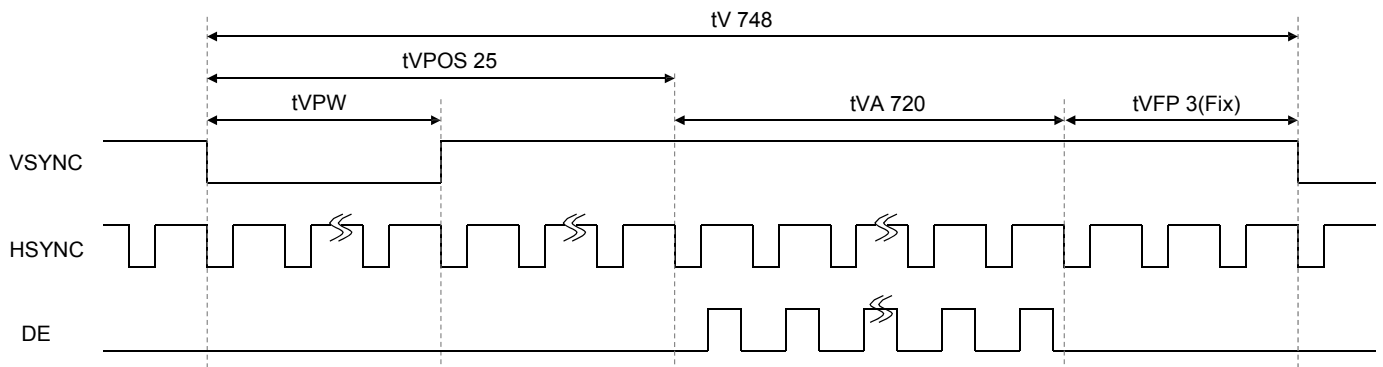
SDIO data is sampled at the rising edge of SCK when CS is high level. Data unit of one access is three bytes. The data unit consists of Start byte and Address byte and Data byte.

The start byte has parity bit and access mode bit. Relationship of access mode setting and the operation are shown in the table below.

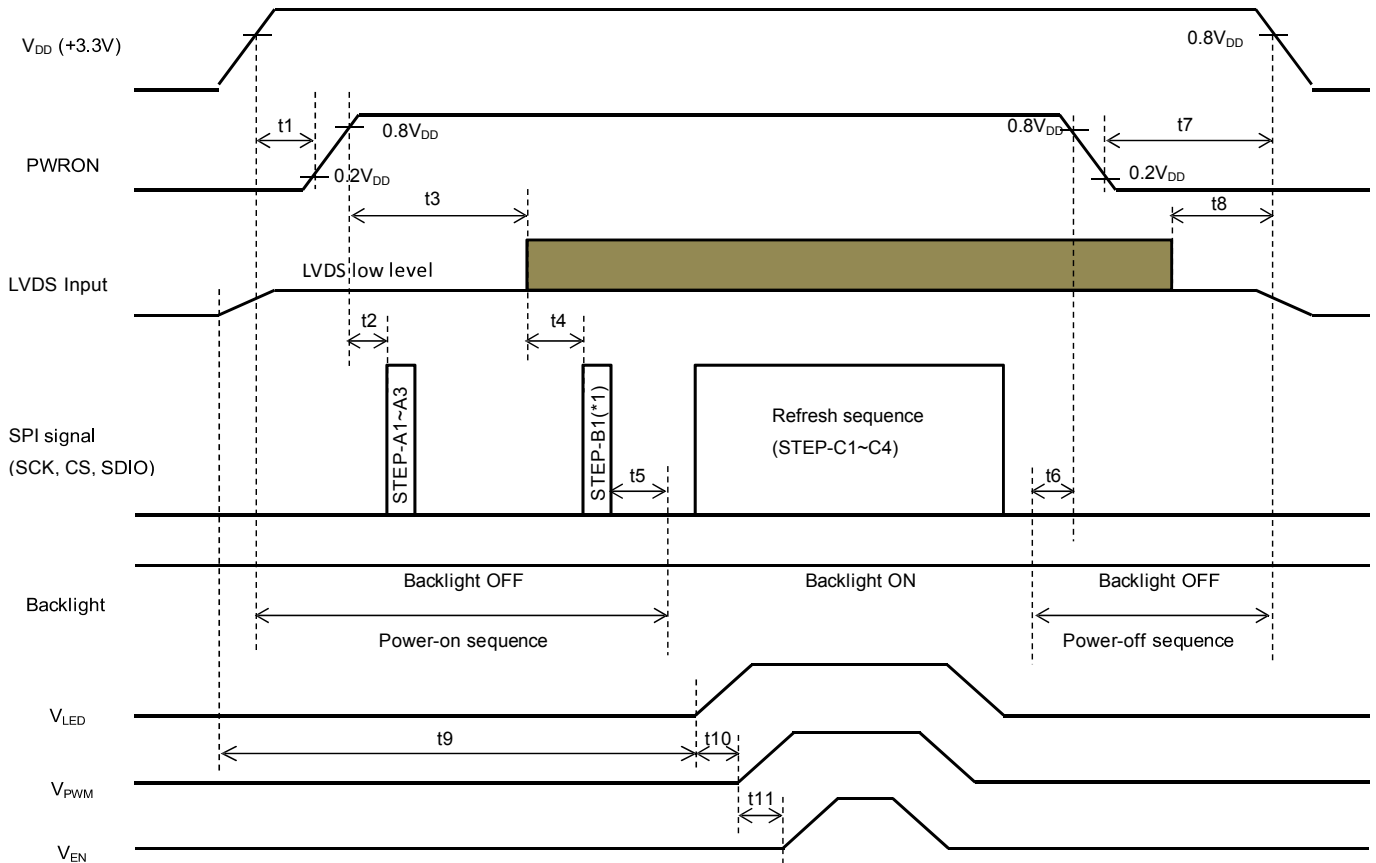
Parity check is odd parity. In Write mode, the parity check is performed on the sum of Start byte and Address byte and Data byte. In Read mode, the parity check is performed on the sum of Start byte and Address byte. Burst access is not support. One access is complete, CS should be set to low level once.

9.5 INTERFACE TIMING CHART

Item	Symbol	Condition	Standard Value			Unit	Remarks
			MIN	TYP	MAX		
CLK frequency	1/ts		55.0	57.81	60.0	MHz	For fv(typ)=60Hz
Vertical Period	tV		748	748	748	Line	
Vertical Display Period	tVA		720	720	720	Line	
Vertical Pulse Width	tVPW		2	5	24	Line	
Vertical Data Position	tVPOS		25	25	25	Line	
Horizontal Period	tH		1288	1288	1288	CLK	
Horizontal Display Period	tHA		960	960	960	CLK	
Horizontal Pulse Width	tHPW		3	16	267	CLK	
Horizontal Data Position	tHPOS		268	268	268	CLK	



9.6 POWER SEQUENCE



Symbol	Item	Min	Typ	Max	Unit	Remarks
t1	Period from Power-on(3.3V) to PWRON↑	0	-	100	ms	
t2	Period from PWRON↑ to SPI-ON1	300	-	-	ms	
t3	Period from Power-on(3.3V) to LVDS input-on	0	-	-	ms	
t4	Period from LVDS input-on to SPI-ON2	2	-	-	Frame	
t5	Period from SPI-ON2 to Backlight-on	2	-	-	Frame	
t6	Period from Backlight-off to PWRON↓	0	-	-	Frame	
t7	Period from PWRON↓ to Power-off(3.3V)	100	-	500	ms	
t8	Period from LVDS input-off to Power-off(3.3V)	0	-	-	ms	
t9	Period from LVDS input-on to V _{LED} -on	500	-	-	ms	
t10	Period from V _{LED} input-on to V _{PWM} on	1	-	-	ms	
t11	Period from V _{PWM} input-on to V _{EN} on	1	-	-	ms	

Note 1:

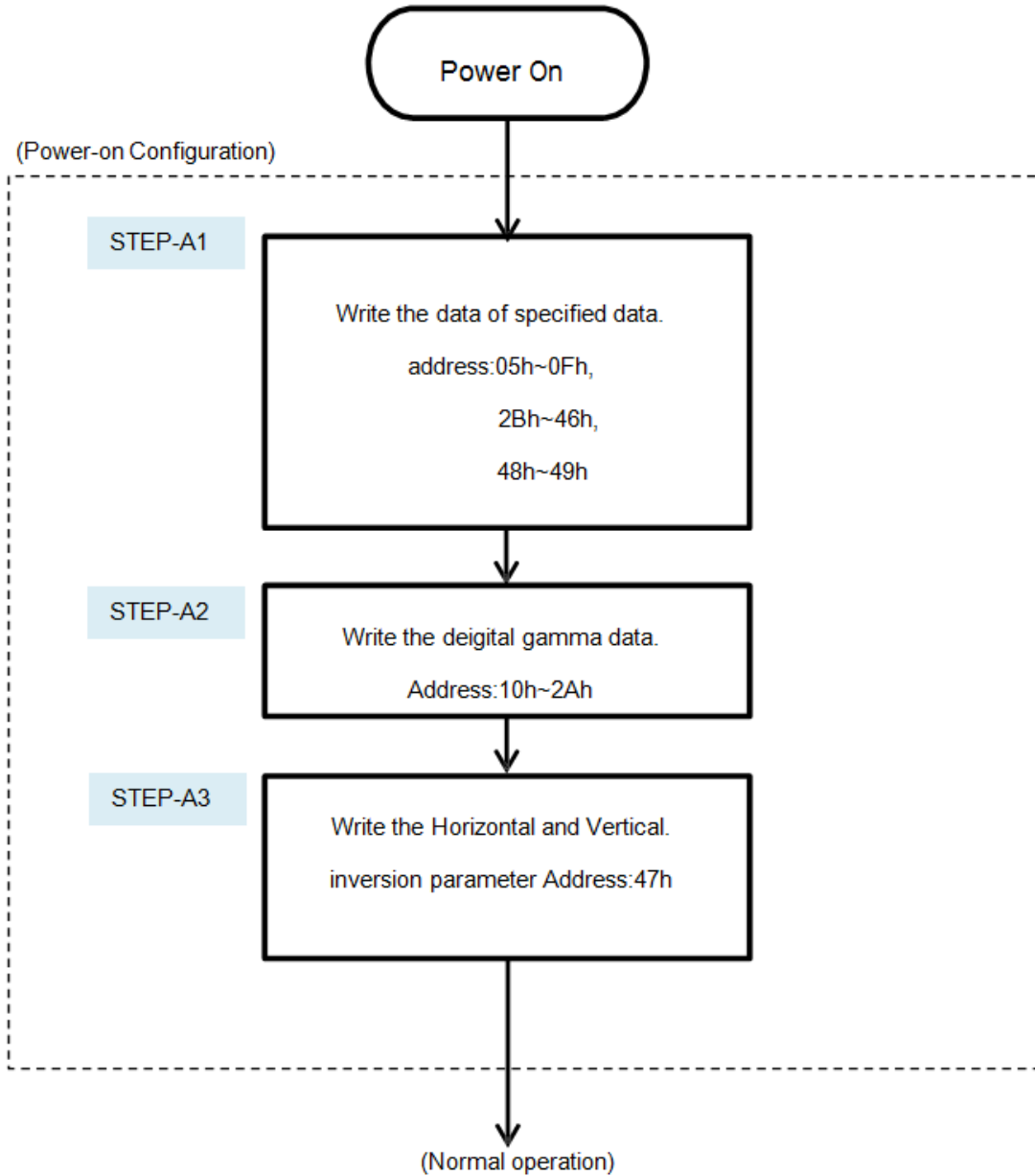
- When power supply is OFF ($V_{DD}=0V$), logic input must be kept at either V_{SS} level or high impedance
- The rising speed of power supply ($V_{DD}=+3.3V$) should be less than $2V/100\mu s$.
- When the PWRON signal is 0V, V_{DD} must be 0V. (However t1 and t7 except)
- LVDS signal level of the invalid period may be within the absolute maximum rating.

Note 2: STEP-B1 send after STEP-A3

Note 3: In order to avoid high Inrush current, V_{LED} rising time need to set more than 0.5ms.

9.6.1 POWER SEQUENCE

After power on, please to configure the panel in the following procedure. Then during normal operation, refresh the register periodically. Initial Register Data is provided. The register information refer to '9.3 REGISTER LIST'.



(Power-on Configuration)0.8V_{DD}

STEP-B1

(Display on)
Write 01h to DISPON_CMD(E0h)

(Refresh sequence)

STEP-C1

Write the specified data.
address:05h~0Fh,
2Bh~46h,
48h~49h

STEP-C2

Write the deigital gamma data.
Address:10h~2Ah

STEP-C3

Write the Horizontal and Vertical.
inversion parameter
Address:47h

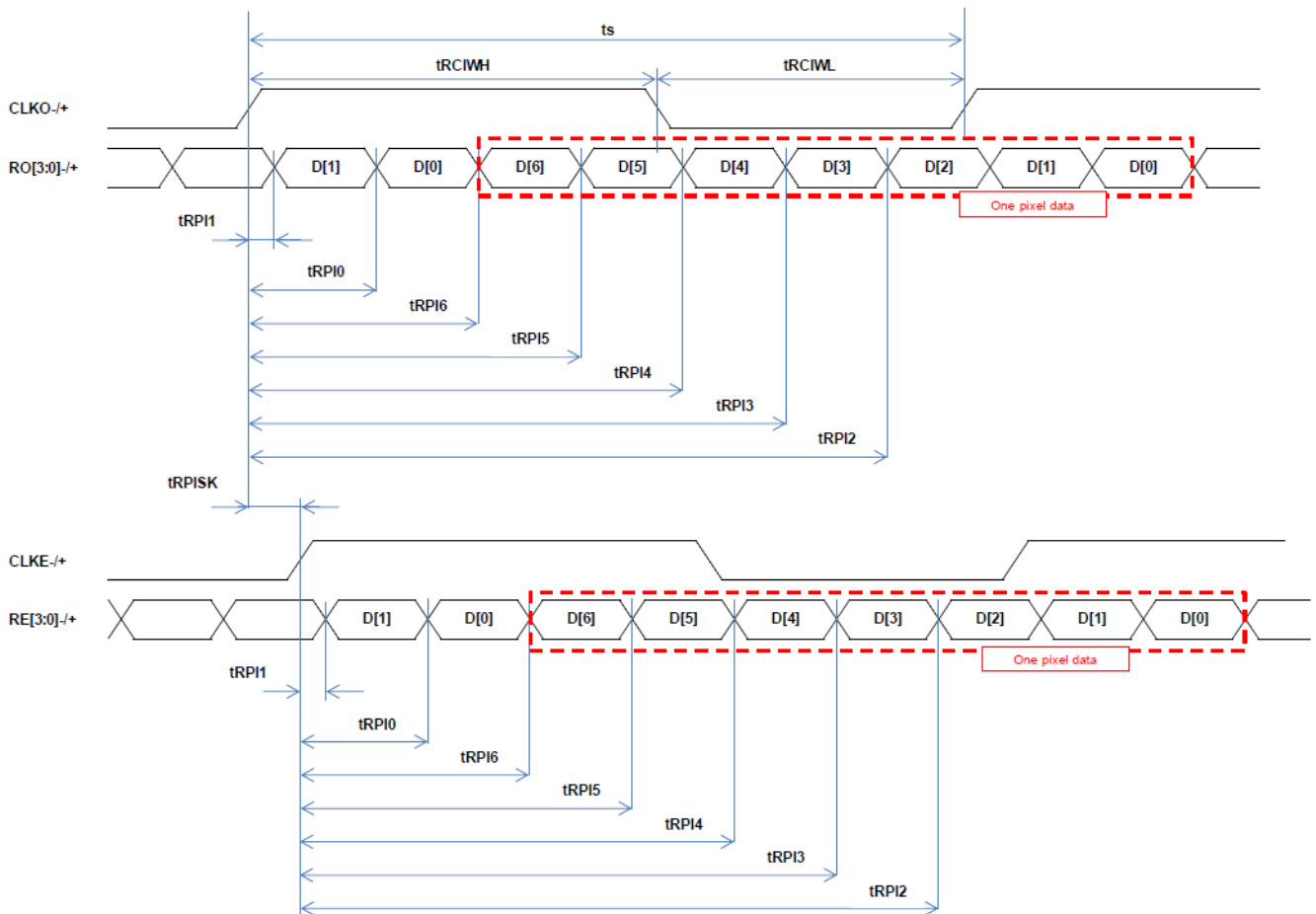
STEP-C4

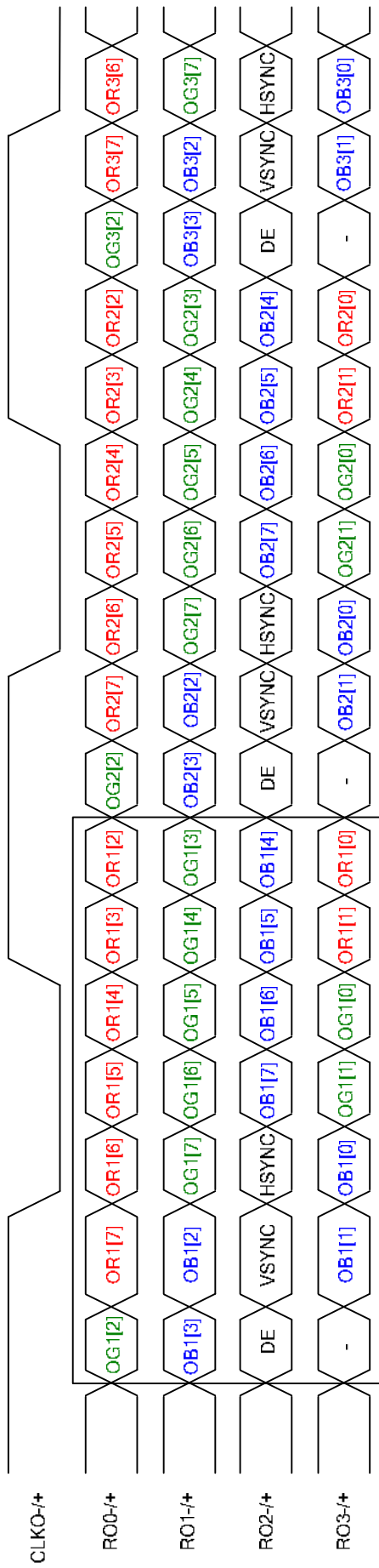
Write the specified data
Address:E0h,E1h,E4h, ECh
(But DISPON_CMD of E0h should be
written a data 01h)

Power Off

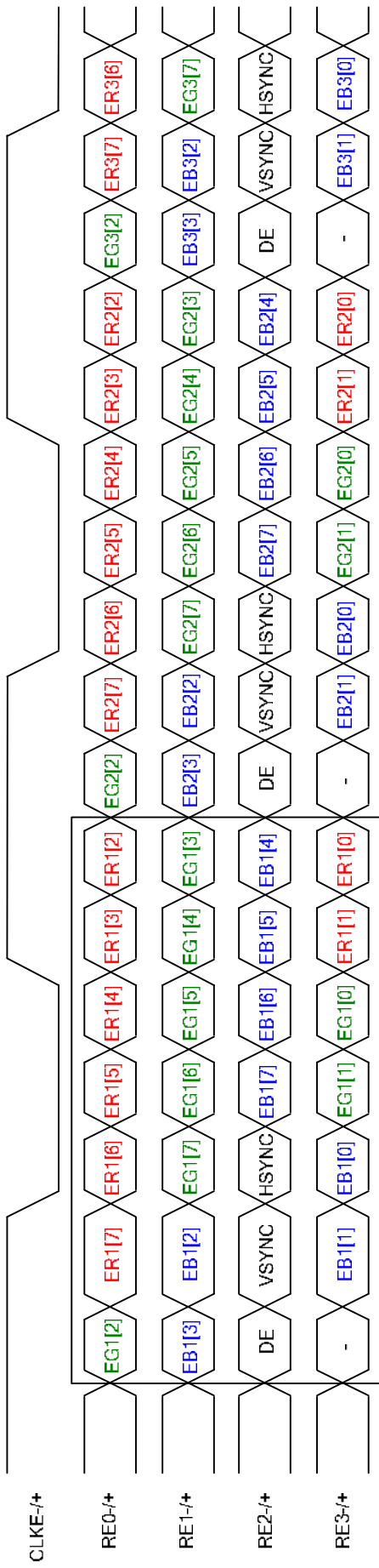
9.7 LVDS RECEIVER TIMING

Item	Symbol	Condition	Standard Value			Unit	Remarks
			MIN.	TYP.	MAX.		
CLK Low Width	tRCIWL		0.37 ts	-	0.55 ts	-	
CLK High Width	tRCIWH		0.45 ts	-	0.63 ts	-	
Skew Margin	tRMG		-	-	400	ps	
Channel Skew	tRCISK		-1/14 ts	-	+1/14 ts	-	
Data Position 0	tRIP0		1/7 ts - tRMG	1/7 ts	1/7 ts + tRMG	-	
Data Position 1	tRIP1		- tRMG	0	+ tRMG	-	
Data Position 2	tRIP2		6/7 ts - tRMG	6/7 ts	6/7 ts + tRMG	-	
Data Position 3	tRIP3		5/7 ts - tRMG	5/7 ts	5/7 ts + tRMG	-	
Data Position 4	tRIP4		4/7 ts - tRMG	4/7 ts	4/7 ts + tRMG	-	
Data Position 5	tRIP5		3/7 ts - tRMG	3/7 ts	3/7 ts + tRMG	-	
Data Position 6	tRIP6		2/7 ts - tRMG	2/7 ts	2/7 ts + tRMG	-	





1st pixel data



2nd pixel data

9.8 DATA INPUT for DISPLAY COLOR

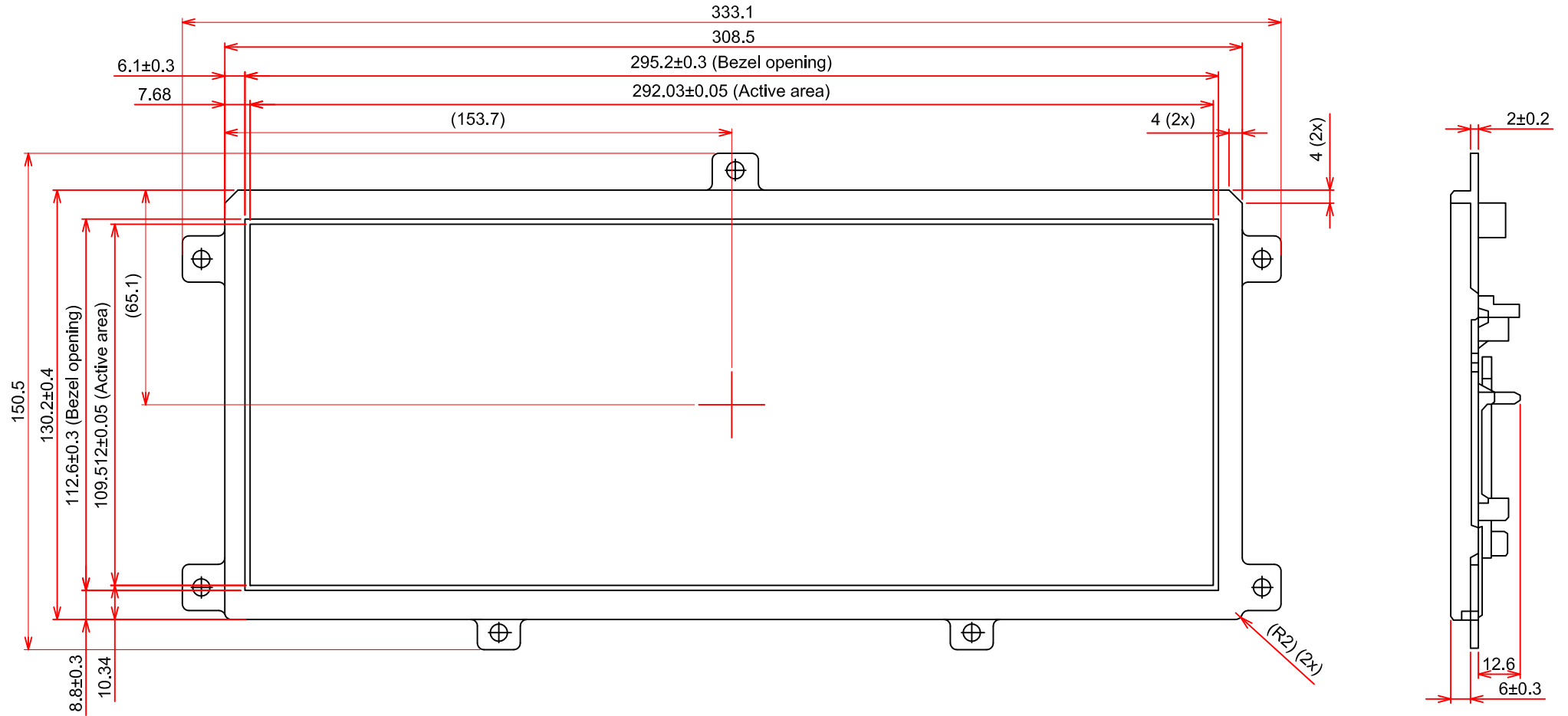
Relationship between input data and display color

Input Data Display Color		R Data								G Data								B Data							
		MSB							LSB	MSB							LSB	MSB							LSB
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Color	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	Red(255)	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	Green(255)	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L
	Blue(255)	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
	Cyan	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
	Magenta	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
	White	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
Red	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	Red(1)	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	Red(2)	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	:																								
	Red(253)	H	H	H	H	H	H	L	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	Red(254)	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	Red(255)	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Green	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	Green(1)	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L
	Green(2)	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L	L	L	L	L	L	L	L
	:																								
	Green(253)	L	L	L	L	L	L	L	L	H	H	H	H	H	H	L	H	L	L	L	L	L	L	L	L
	Green(254)	L	L	L	L	L	L	L	L	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L
	Green(255)	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L
Blue	Black	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
	Blue(1)	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H
	Blue(2)	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L
	:																								
	Blue(253)	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	L	H
	Blue(254)	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	L
	Blue(255)	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H

Note 1: Color (n) --- 'n' indicates gray scale step.

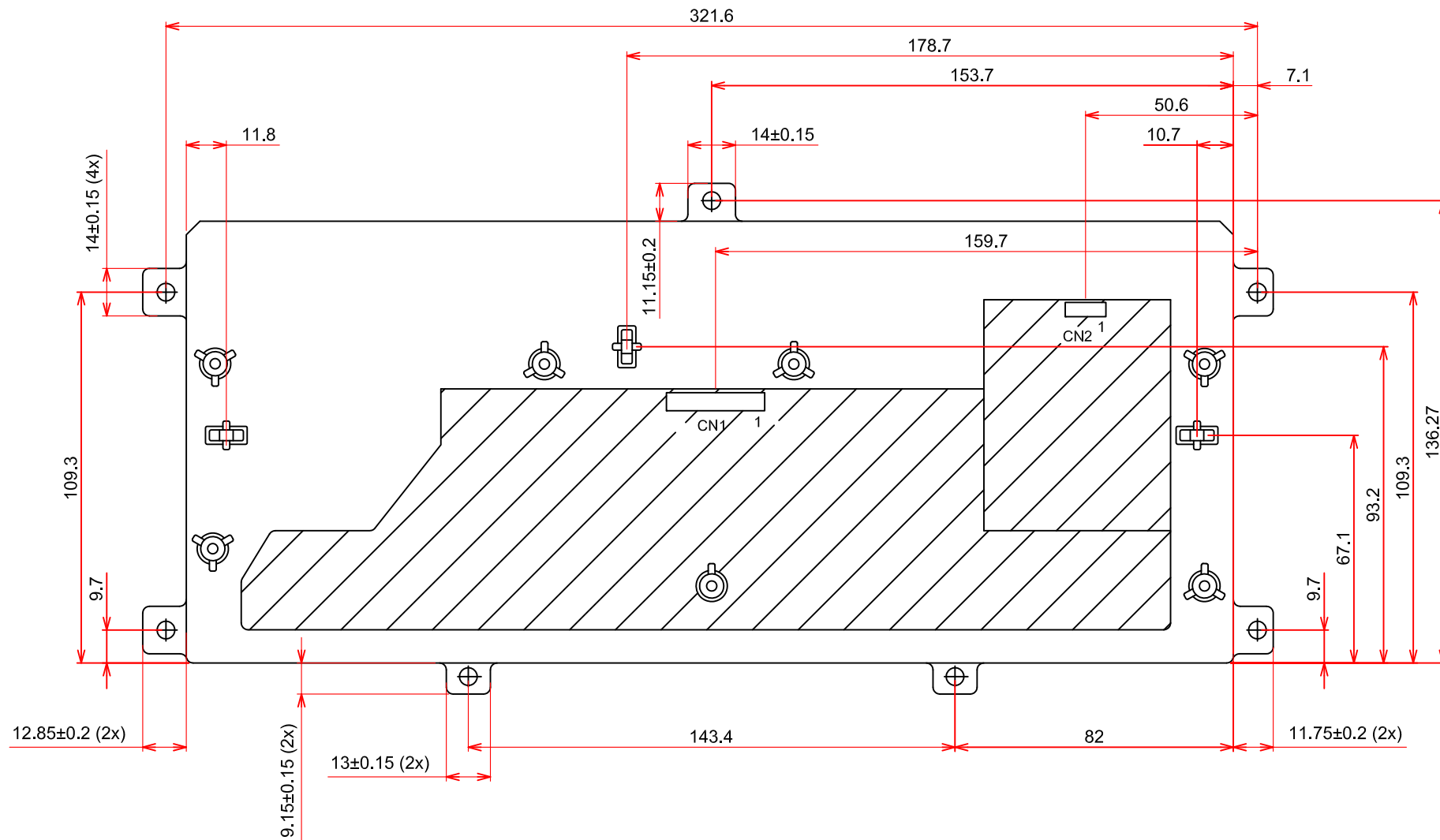
10. OUTLINE DIMENSIONS

10.1 FRONT VIEW



General Tolerance:±0.5mm
 Scale : NTS
 Unit : mm

10.2 REAR VIEW



General Tolerance:±0.5mm
 Scale : NTS
 Unit : mm

11. APPEARANCE STANDARD

The appearance inspection is performed in a room around 500~1000 lx based on the conditions as below:

- The distance between inspector's eyes and display is 30 cm.
- The viewing zone is defined with angle θ shown in Fig. 11.1 The inspection should be performed within 45° when display is shut down. The inspection should be performed within 5° when display is power on.

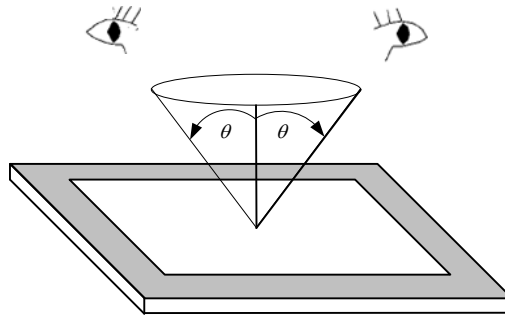


Fig. 11.1

11.1 THE DEFINITION OF LCD ZONE

LCD panel is divided into 3 areas as shown in Fig.11.2 for appearance specification in next section. A zone is the LCD active area (dot area); B zone is the area between A zone and metal frame.

In terms of housing design, B zone is the recommended window area customers' housing should be located in.

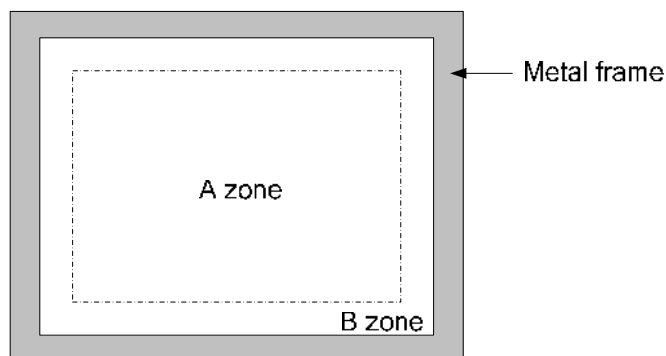


Fig. 11.2

11.2 LCD APPEARANCE SPECIFICATION

The specification as below is defined as the amount of unexpected phenomenon or material in different zones of LCD panel. The definitions of length, width and average diameter using in the table are shown in Fig. 11.3 and Fig. 11.4.

Item	Criteria				Applied zone
	Length (mm)	Width (mm)	Maximum number	Minimum space	
Scratches	Ignored	$W \leq 0.02$	Ignored	-	A, B
	$L \leq 40$	$0.02 < W \leq 0.04$	10	-	
	-	$0.04 < W$	Not allowed	-	
	Serious one is not allowed				
Dent	Serious one is not allowed				A
Wrinkles in polarizer	Serious one is not allowed				A
Bubbles on polarizer	Average diameter (mm)		Maximum number		A
	$D \leq 0.3$		Ignored		
	$0.3 < D \leq 0.5$		12		
	$0.5 < D$		Not allowed		
1) Stains 2) Foreign Materials 3) Dark Spot	Filamentous (Line shape)				A, B
	Length (mm)	Width (mm)	Maximum number		
	$L \leq 2.0$	$W \leq 0.03$	Ignored		
	$L \leq 3.0$	$0.03 < W \leq 0.05$	10		
	$L \leq 2.5$	$0.05 < W \leq 0.1$	1		
	Round (Dot shape)				A, B
	Average diameter (mm)		Maximum number	Minimum Space	
	$D \leq 0.2$		Ignored	-	
	$0.2 < D \leq 0.3$		10	10 mm	
	$0.3 < D \leq 0.4$		5	30 mm	
	$0.4 < D$		Not allowed	-	
	In total		Filamentous + Round=10		
	Those wiped out easily are acceptable				
	Dot-Defect	Bright dot-defect		Type	Maximum number
1 dot				0	
2 adjacent dot				0	
3 adjacent dot or above				Not allowed	
In total		0			
Dark dot-defect		1 dot	5		
		2 adjacent dot	2		
		3 adjacent dot or above	Not allowed		
		In total		5	
In total		5			

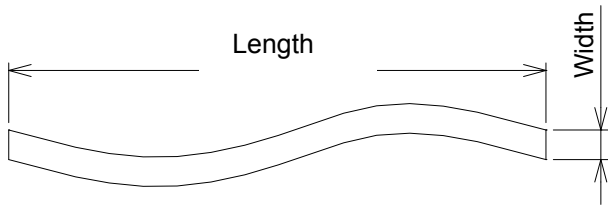


Fig 11.3

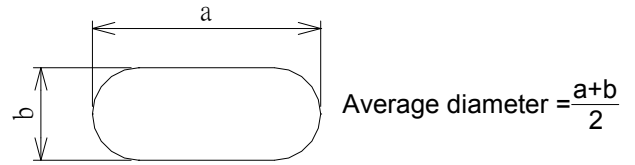
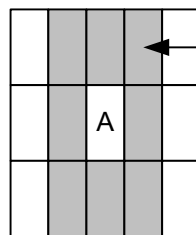


Fig 11.4

Note 1: The definitions of dot defect are as below:

- The defect area of the dot must be bigger than half of a dot.
- For bright dot-defect, showing black pattern, the dot's brightness must be over 30% brighter than others.
- For dark dot-defect, showing white pattern, the dot's brightness must be under 70% darker than others.
- The definition of 1-dot-defect is the defect-dot, which is isolated and no adjacent defect-dot.
- The definition of adjacent dot is shown as Fig. 11.5.
- The Density of dot defect is defined in the area within diameter $\phi = 20\text{mm}$.



The dots colored gray are adjacent to defect-dot A.

Fig 11.5

12. PRECAUTIONS

12.1 PRECAUTIONS of ESD

- 1) Before handling the display, please ensure your body has been connected to ground to avoid any damages by ESD. Also, do not touch display's interface directly when assembling.
- 2) Please remove the protection film very slowly before turning on the display to avoid generating ESD.

12.2 PRECAUTIONS of HANDLING

- 1) In order to keep the appearance of display in good condition, please do not rub any surfaces of the displays by sharp tools harder than 3H, especially touch panel, metal frame and polarizer.
- 2) Please do not pile the displays in order to avoid any scars leaving on the display. In order to avoid any injuries, please pay more attention for the edges of glasses and metal frame, and wear finger cots to protect yourself and the display before working on it.
- 3) Touching the display area or the terminal pins with bare hand is prohibited. This is because it will stain the display area and cause poor insulation between terminal pins, and might affect display's electrical characteristics furthermore.
- 4) Do not use any harmful chemicals such as acetone, toluene, and isopropyl alcohol to clean display's surfaces.
- 5) Please use soft cloth or absorbent cotton with ethanol to clean the display by gently wiping. Moreover, when wiping the display, please wipe it by horizontal or vertical direction instead of circling to prevent leaving scars on the display's surface, especially polarizer.
- 6) Please wipe any unknown liquids immediately such as saliva, water or dew on the display to avoid color fading or any permanently damages.
- 7) Maximum pressure to the surface of the display must be less than 1.96×10^4 Pa. If the area of adding pressure is less than 1 cm^2 , the maximum pressure must be less than 1.96N.

12.3 PRECAUTIONS OF OPERATING

- 1) Please input signals and voltages to the displays according to the values defined in the section of electrical characteristics to obtain the best performance. Any voltages over than absolute maximum rating will cause permanent damages to this display. Also, any timing of the signals out of this specification would cause unexpected performance.
- 2) When the display is operating at significant low temperature, the response time will be slower than it at 25 C° . In high temperature, the color will be slightly dark and blue compared to original pattern. However, these are temperature-related phenomenon of LCD and it will not cause permanent damages to the display when used within the operating temperature.
- 3) The use of screen saver or sleep mode is recommended when static images are likely for long periods of time. This is to avoid the possibility of image sticking.
- 4) Spike noise can cause malfunction of the circuit. The recommended limitation of spike noise is no bigger than $\pm 100 \text{ mV}$.

12.4 PRECAUTIONS of STORAGE

If the displays are going to be stored for years, please be aware the following notices.

- 1) Please store the displays in a dark room to avoid any damages from sunlight and other sources of UV light.
- 2) The recommended long term storage temperature is between 10 C° ~35 C° and 55%~75% humidity to avoid causing bubbles between polarizer and LCD glasses, and polarizer peeling from LCD glasses.
- 3) It would be better to keep the displays in the container, which is shipped from KOE, and do not unpack it.
- 4) Please do not stick any labels on the display surface for a long time, especially on the polarizer.

13. DESIGNATION of LOT MARK

1) The lot mark is showing in Fig.13.1. First 4 digits are used to represent production lot, T represented made in Taiwan, and the last 6 digits are the serial number.

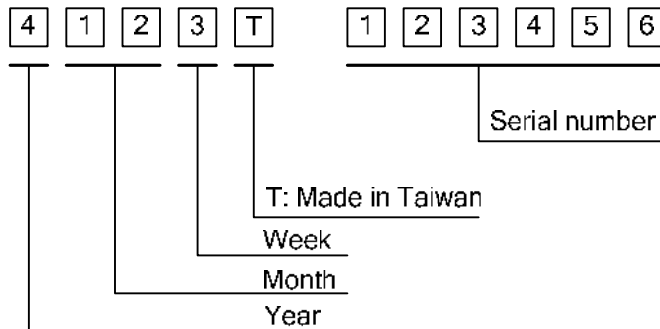


Fig 13.1

2) The tables as below are showing what the first 4 digits of lot mark are shorted for.

Year	Lot Mark
2017	7
2018	8
2019	9
2020	0
2021	1

Month	Lot Mark	Month	Lot Mark
Jan.	01	Jul.	07
Feb.	02	Aug.	08
Mar.	03	Sep.	09
Apr.	04	Oct.	10
May	05	Nov.	11
Jun.	06	Dec.	12

Week	Lot Mark
1~7 days	1
8~14 days	2
15~21 days	3
22~28 days	4
29~31 days	5

3) Except letters I and O, revision number will be shown on lot mark and following letters A to Z.

4) The location of the lot mark is on the back of the display shown in Fig. 13.2.

Label example:

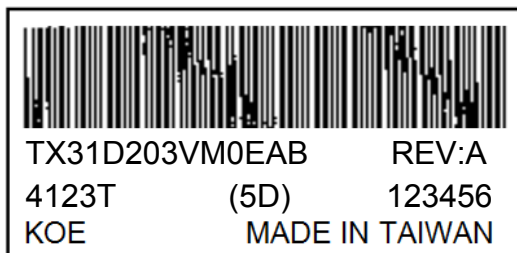


Fig. 13.2