



Specification

20.3cm (8.0") TFT

L5S30978

Rev. 01, September 2009

Note: This specification is subject to change without prior notice

REVISION HISTORY

Product Number	Rev.	Revised item	Date
L5S30978P00	00	Initial issue	Jul .10, 2009
L5S30978P00	01	4.2 Characteristics of LED and LED driving (page:15/43) -'Forward current' and 'life time' items are added. -A graph of 'Ambient Temperature vs. Allowable Forward Current' is deleted. -Note2, Note3 and Note4 are added. 6.2.1 Application scope (page:31/43) - Note is added. (Viewing area = Bezel opening area)	Sep .08, 2009

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1 BASIC SPECIFICATIONS

This document gives the characteristics of the active matrix 8.0 inch TFT LCD.

1.1 STRUCTURE

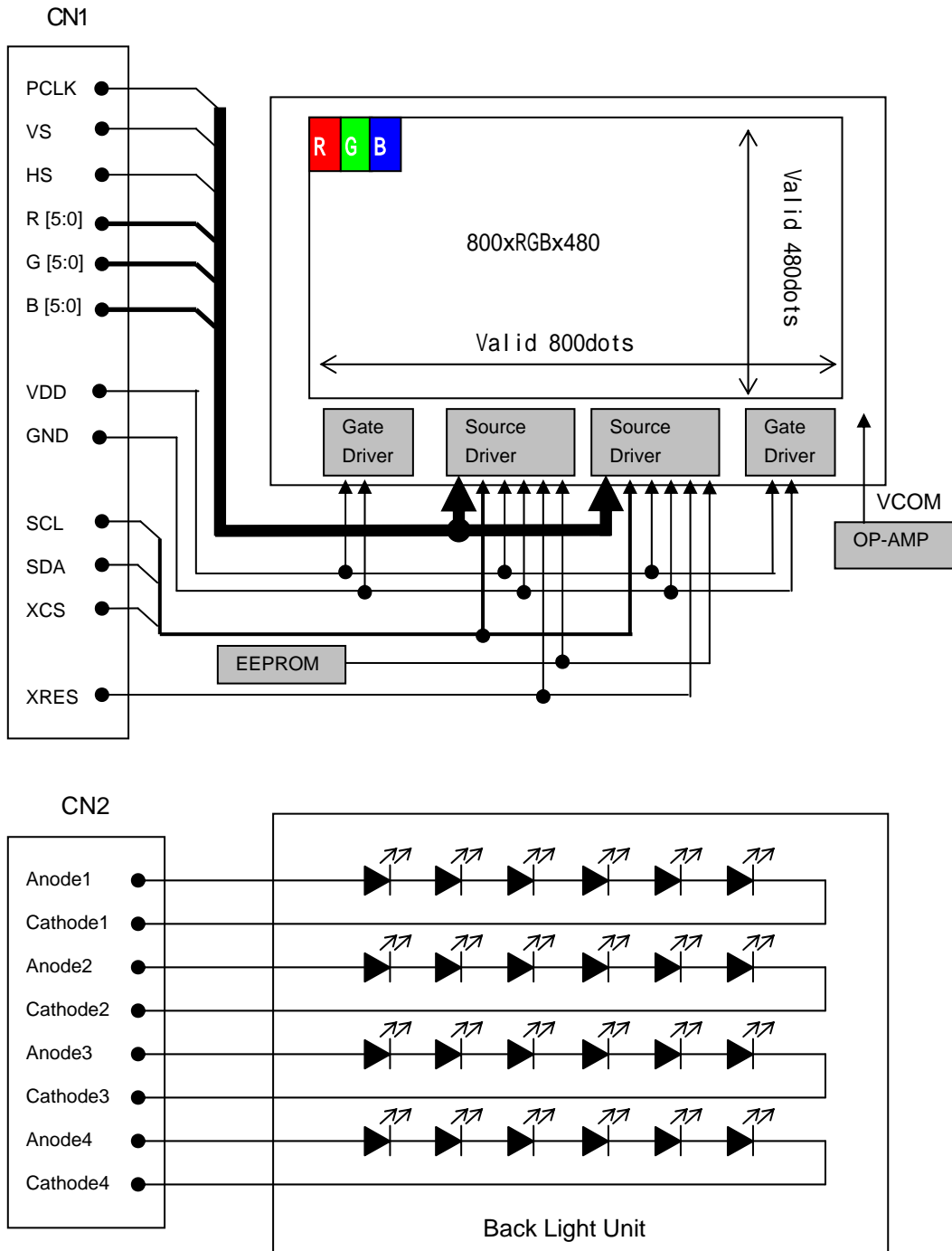
No.	FACTOR	SPECIFICATIONS	UNIT	REMARKS
1	LCD structure	a-TFT LCD	-	
2	Module size (W x H x T)	187.5(W) x 120(H) x 9.9(T)	mm	Note1)
3	Weight	270	g	
4	Active area (W x H)	174.0(W) x 104.4(H)	mm	
5	Screen size	8.0 inch	-	
6	Number of dots	800 x RGB (W) x 480 (H)	-	
7	Dot pitch (Horizontal x Vertical)	0.2175(W) x 0.2175(H)	mm	
8	Dot layout	RGB stripe	-	
9	Liquid crystal mode	Vistarich Technology Normally Black Transmissive type	-	
10	Polarization plate	Hard Coat	-	
11	Operating Temperature	- 30 to +85	deg. C	
12	Storage Temperature	- 40 to +90	deg. C	

Note1) The module size(W) doesn't contain the Fixing boss.

1.2 MECHANICAL DRAWING

Please refer to the outline drawing (P068887-11-00) of this LCD module.

1.3 BLOCK DIAGRAM



1.4 I/O TERMINALS

CN1: Display interface

Pin assignment (50pin) ; Suitable connector : Iriso / 9686 (Au-plating)

Pin No.	Symbol	Function	I/O	Remarks
1	GND	Ground	P	
2	GND	Ground	P	
3	R[0]	Display Data (Red)	I	(LSB)
4	R[1]	Display Data (Red)	I	
5	R[2]	Display Data (Red)	I	
6	R[3]	Display Data (Red)	I	
7	R[4]	Display Data (Red)	I	
8	R[5]	Display Data (Red)	I	(MSB)
9	GND	Ground	P	
10	GND	Ground	P	
11	GND	Ground	P	
12	G[0]	Display Data (Green)	I	(LSB)
13	G[1]	Display Data (Green)	I	
14	G[2]	Display Data (Green)	I	
15	G[3]	Display Data (Green)	I	
16	G[4]	Display Data (Green)	I	
17	G[5]	Display Data (Green)	I	(MSB)
18	GND	Ground	P	
19	GND	Ground	P	
20	GND	Ground	P	
21	B[0]	Display Data (Blue)	I	(LSB)
22	B[1]	Display Data (Blue)	I	
23	B[2]	Display Data (Blue)	I	
24	B[3]	Display Data (Blue)	I	
25	B[4]	Display Data (Blue)	I	
26	B[5]	Display Data (Blue)	I	(MSB)
27	GND	Ground	P	
28	GND	Ground	P	
29	GND	Ground	P	
30	GND	Ground	P	

31	PCLK	Clock for display data	I	Latched at rising edge
32	GND	Ground	P	
33	GND	Ground	P	
34	VS	Vertical synchronous signal	I	“L” active
35	GND	Ground	P	
36	GND	Ground	P	
37	GND	Ground	P	
38	HS	Horizontal synchronous signal	I	“L” active
39	GND	Ground	P	
40	VDD	Power supply	P	
41	VDD	Power supply	P	
42	GND	Ground	P	
43	GND	Ground	P	
44	XRES	Reset	I	“L” active
45	GND	Ground	P	
46	XCS	Chip select for serial data	I	“L” active
47	SCL	Serial clock	I	Latched at rising edge
48	SDA	Serial data	I	
49	SDA	Serial data	I	
50	GND	Ground	P	

CN2 : Backlight Interface

Pin assignment (8pin) ; Suitable connector : Iriso / 9686 (Au-plating)

Pin No.	Symbol	Function	I/O	Description
1	Anode1	LED anode terminal1	P	
2	Cathode 1	LED cathode terminal1	P	
3	Anode 2	LED anode terminal 2	P	
4	Cathode 2	LED cathode terminal2	P	
5	Anode 3	LED anode terminal3	P	
6	Cathode 3	LED cathode terminal3	P	
7	Anode 4	LED anode terminal4	P	
8	Cathode 4	LED cathode terminal4	P	

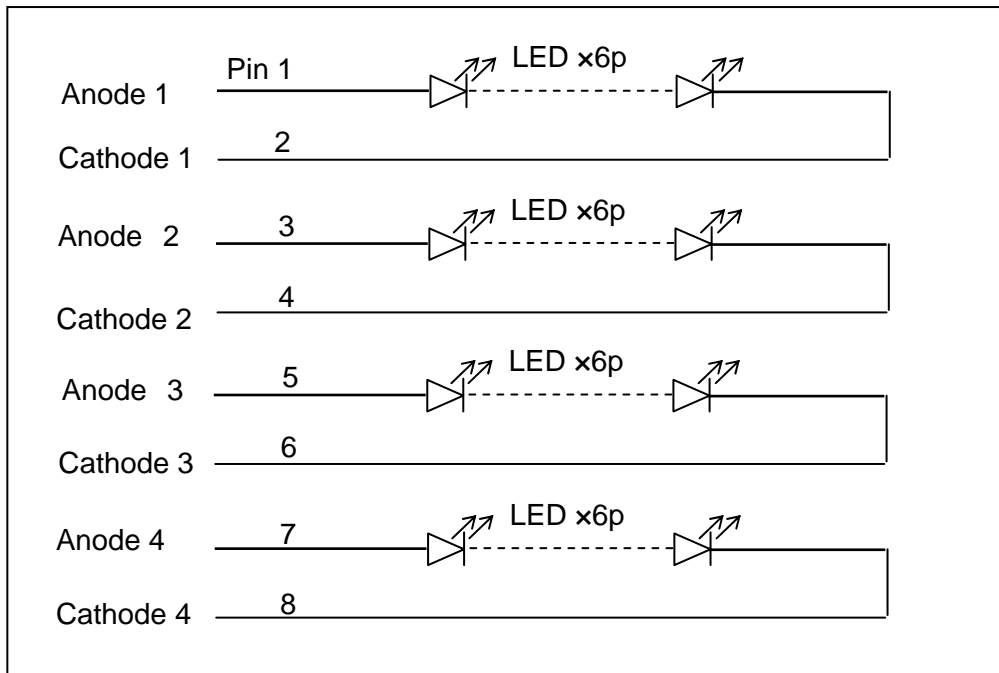
I/O : Input / Output terminal, I : Input terminal, O : Output terminal, P : Power line terminal

1.5 LIGHTING SYSTEM

LED type for lighting

Items	Description
LED Type	NS2W123
Color rank	a93,a94a,b91,b92a,b93,b94a
Luminous intensity rank	Pv5, Pv6, Pv7

LED schematic



2 FUNCTIONS

2.1 OVERVIEW

This LCD module has two types of used for transferring of command and pixel data.

- 1) RGB interface
18bit parallel bus for transferring of pixel data.
- 2) Serial interface
3 wire Serial bus for transferring of commands.

2.2 RGB INTERFACE

2.2.1 General Description for RGB interface

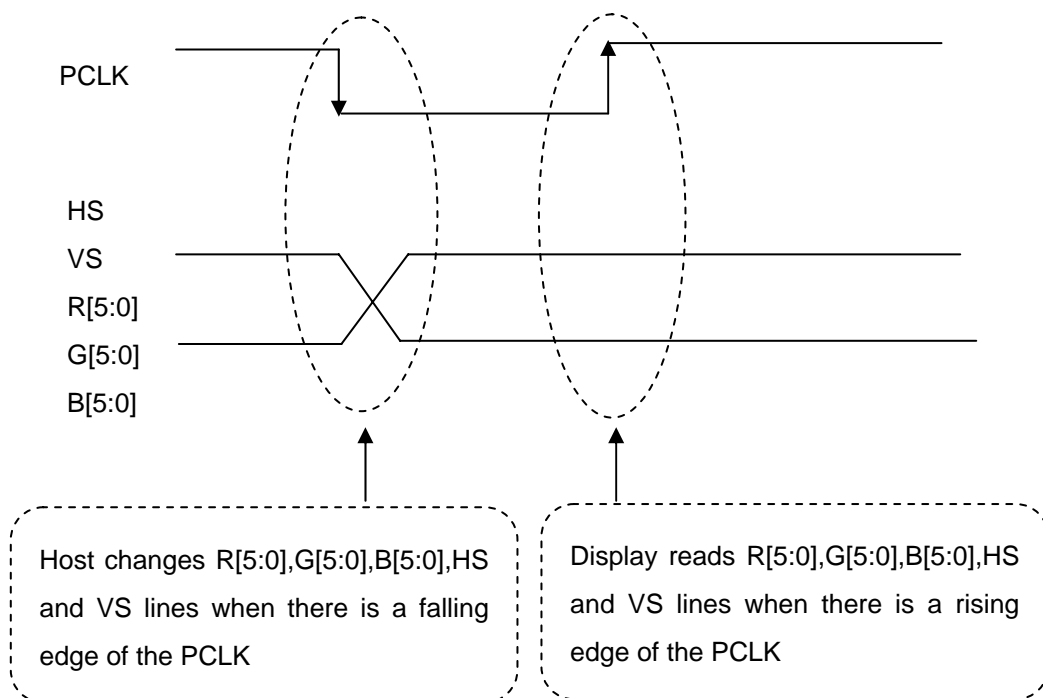
Pixel clock (PCLK) is running all the time without stopping in normal mode and it is used for entering HS, VS and R[5:0],G[5:0],B[5:0] lines states on a rising edge of the PCLK.

Vertical synchronization (VS) informs when a new frame starts. This signal is active low and its state is read to the display module on a rising edge of the PCLK-line.

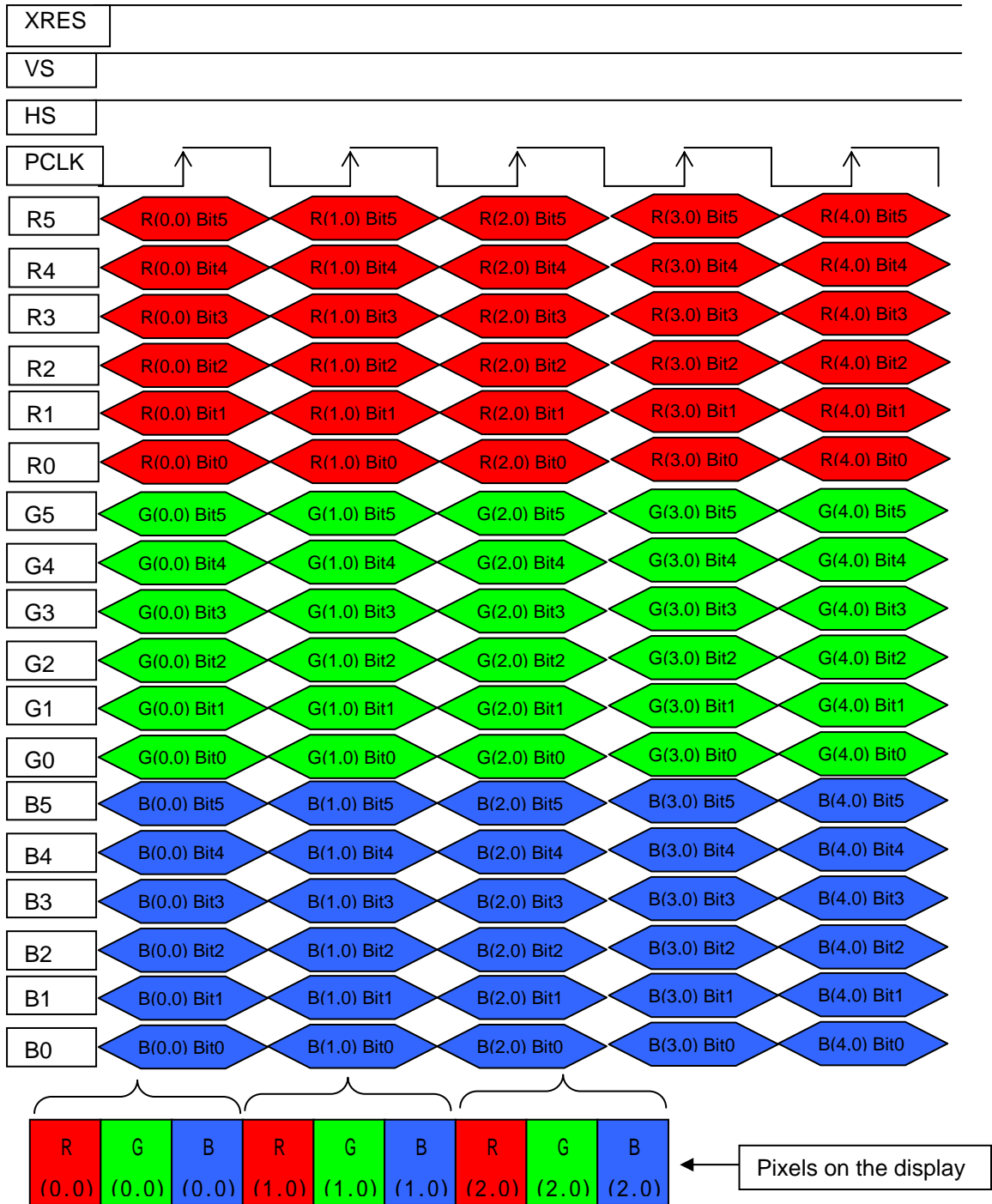
Horizontal synchronization (HS) informs when a new line starts. This signal is active low and its state is read to the display module on a rising edge of the PCLK-line.

R[5:0],G[5:0],B[5:0] consist image information that is transferred on the display. R[5:0],G[5:0],B[5:0] lines can be "0" or "1". These lines are read on a rising edge of the PCLK-line.

The pixel clock cycle is described in the following figure.



2.2.2 18-bit color order of RGB interface



2.3 SERIAL INTERFACE

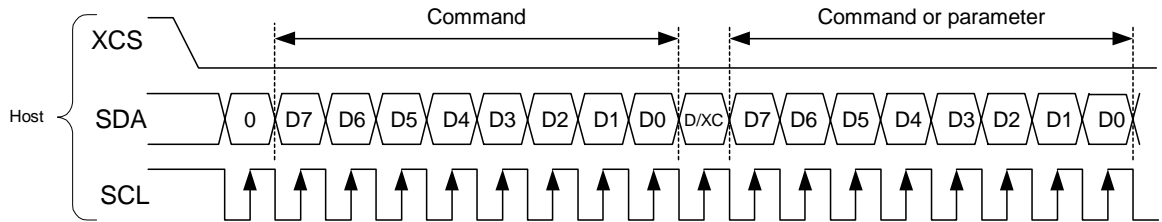
2.3.1 General description

The display module uses 3-wire 9-bit serial interface, which is used as command interface. The chip select, XCS (active low) enables and disables the serial interface. XRES (active low) is external reset signal. SCL is the serial data clock and SDA is serial data.

Serial data is input to SDA in the sequence D/XC, D7 to D0. The display module reads the data at the rising edge of SCL signal. The first bit of serial data, D/XC, is data/command flag. When D/XC = '1', D7 to D0 bits are command parameter. When D/XC = '0', D7 to D0 bits compose a command.

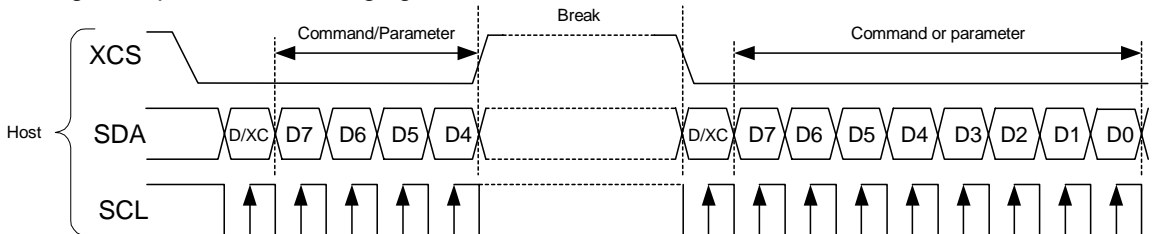
2.3.2 Command write

The host CPU drives the **XCS** pin low and starts by setting the D/XC-bit on **SDA**. The bit is read by the display at the first rising edge of **SCL**. At the next falling edge of **SCL** the MSB data bit (D7) is set on **SDA** by the CPU. At the next falling edge of **SCL** the next bit (D6) is set on **SDA**. This continues until all 8 data bits have been transmitted as shown in the following figure.

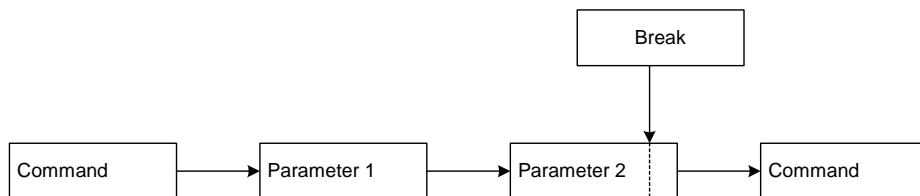


2.3.3 Display module data transfer recovery

If there is a break in data transmission while transferring command, image data or multiple parameters before a whole byte has been completed, the display module must reset the interface in a way that it will be ready to receive the same byte re-transmitted when the chip select line (XCS) is next activated. See the following example in the following figure.

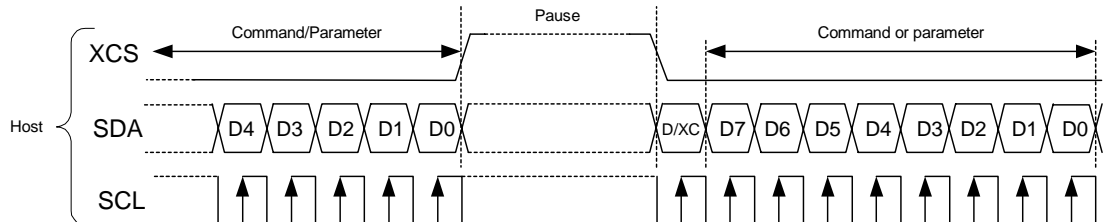


If one or more parameter command is being sent and a break occurs while sending any parameter before the last one and if the host then sends a new command rather than re-transmitting the parameter that was interrupted, then the parameters that were successfully sent are stored and the parameter where the break occurred is rejected. The interface is ready to receive next byte as shown:



2.3.4 Display module data transfer pause

It will be possible when transferring image data, command or multiple parameter data to invoke a pause in the data transmission. If the chip select line is released after a whole byte of image data, command or multiple parameter data has been completed, then the display module will wait and continue command or parameter data transmission from the point where it was paused as shown below figure.



There are 4 cases when this kind of pause is possible:

- 1) Command – Pause – Command
- 2) Command – Pause – Parameter
- 3) Parameter – Pause – Command
- 4) Parameter – Pause – Parameter

2.4 COMMAND SET

No.	Command	Hex	D7	D6	D5	D4	D3	D2	D1	D0	functions
1	NOP	00	0	0	0	0	0	0	0	0	No operation
2	SWRESET	01	0	0	0	0	0	0	0	1	software reset
3	SLPIN	10	0	0	0	1	0	0	0	0	sleep state
4	SLPOUT	11	0	0	0	1	0	0	0	1	sleep state release
5	NORON	13	0	0	0	1	0	0	1	1	test mode release
6	DISOFF	28	0	0	1	0	1	0	0	0	display off
7	DISON	29	0	0	1	0	1	0	0	1	display on
8	MADCTL	36	0	0	1	1	0	1	1	0	Memory access control
	Parameter 1	00	B7	B6	0	0	0	0	0	0	scanning direction of the panel
9	COLMOD	3A	0	0	1	1	1	0	1	0	I/F color format setting
	Parameter 1	60	0	1	1	0	0	0	0	0	262k colors

Note 1: Undefined commands are working as a NOP (00h) command.

Note 2: Commands 10h, 13h, 28h, 29h, and 36h are updated during VS when the display module is in DISPLAY ON MODE to avoid abnormal visual effects. During SLEEP MODE, these commands are updated immediately.

2.5 COMMAND DESCRIPTION

2.5.1 No operation (00h)

00H	NOP (No operation)									
	D/XC	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	0	0	0	0	0	0	0	0	00
Parameter	No parameter									
Description	This command is an empty command. It does not have any effect on the display module.									

2.5.2 Software reset (01h)

01H	SWRESET (Software reset)									
	D/XC	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	0	0	0	0	0	0	0	1	01
Parameter	No parameter									
Description	This command resets LCD module by software.									
Restrictions	It is necessary to wait 5 ms before sending new command following software reset. If SW reset is applied during DISPLAY ON MODE, it is necessary to wait 120ms before sending SLPOUT command.									

2.5.3 Sleep in (10h)

10H	SLPIN (Sleep in)									
	D/XC	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	0	0	0	1	0	0	0	0	10
Parameter	No parameter									
Description	This command sets the sleep state of the LCD module.									
Restrictions	This command has no effect when module is already in SLEEP MODE. It is necessary to wait 5 ms before sending next command. And it is necessary to wait 120 ms after sending SLPOUT command (when in SLEEP MODE) before SLPIN command can be sent.									

2.5.4 Sleep out (11h)

11H	SLPOUT (Sleep out)									
	D/XC	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	0	0	0	1	0	0	0	1	11
Parameter	No parameter									
Description	This command turns off SLEEP MODE. In this mode the DC/DC converter is enabled and panel scanning is started.									
Restrictions	This command has no effect when module is already in DISPLAY ON MODE. It is necessary to wait 5 ms before sending next command. And it is necessary to wait 120 ms after sending SLPIN command (when in DISPLAY ON MODE) before SLPOUT command can be sent.									

2.5.5 Normal mode on (13h)

13H	NORON (Normal mode on)									
	D/XC	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	0	0	0	1	0	0	1	1	13
Parameter	No parameter									
Description	This command returns the display to normal mode. This command turns test mode off.									

2.5.6 Display off (28h)

28H	DISOFF (Display off)									
	D/XC	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	0	0	1	0	1	0	0	0	28
Parameter	No parameter									
Description	This command turns off the display. The output from RGB I/F is disabled and blank page inserted.									

2.5.7 Display on (29h)

29H	DION (Display on)									
	D/XC	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	0	0	1	0	1	0	0	1	29
Parameter	No parameter									
Description	This command turns on the display. It is used to recover from DISOFF command. Output from the RGB I/F to panel is enabled.									

2.5.8 Memory access control (36h)

36H	MADCTL (Memory access control)										
	D/XC	D7	D6	D5	D4	D3	D2	D1	D0	HEX	
Command	0	0	0	1	1	0	1	1	0	36	
1st parameter	1	B7	B6	0	0	0	0	0	0	xx	
Description	This command defines the scanning direction of the panel.										
	BIT	Name			Description						
	B7	Page address order			B7 and B6 control the scanning direction of the panel.						
	B6	Column address order									
	Start Point (0, 0)		B7 = 0 and B6 = 0				B7 = 0 and B6 = 1				Start Point (799, 0)
END Point (799, 479)										END Point (0, 479)	
END Point (799, 0)		B7 = 1 and B6 = 0				B7 = 1 and B6 = 1				END Point (0, 0)	
Start Point (0, 479)										Start Point (799, 479)	

2.5.9 Interface color format (3Ah)

3AH	COLMOD (Interface color format)									
	D/XC	D7	D6	D5	D4	D3	D2	D1	D0	HEX
Command	0	0	0	1	1	1	0	1	0	3A
1st parameter	1	0	1	1	0	0	0	0	0	60
Description	This command defines the format of RGB image data, which is transferred via RGB I/F. This command is used for refresh sequence.									

3 ABSOLUTE MAXIMUM RATINGS

3.1 ABSOLUTE MAXIMUM RATING

LCD Module

Parameter	Symbol	Rating	Unit
Power supply voltage	VDD	-0.3 to +4.2	V
Logic signal input voltage	VI	-0.3 to VDD+0.3	V
Logic signal output voltage	VO	-0.3 to VDD+0.3	V

Note: Ta = 25 deg.C

LED (Backlight unit)

Parameter	Symbol	Rating	Unit
Forward Current	IF	120	mA
Pulse Forward Current	IFP	200	mA
Allowable Reverse Current	IR	85	mA
Power Dissipation	PD	480	mW
Dice Temperature	Tj	130	deg.C

IFP Conditions: Pulse Width =< 10msec. and Duty= < 1/10

Note: Ta = 25 deg.C (from Nichia's one LED specification)

4 ELECTRICAL SPECIFICATION

4.1 DC CHARACTERISTICS

Parameter	Symbol	Condition	Specification			Unit
			Min.	Typ.	Max.	
Power supply voltage	VDD		3.0	3.3	3.6	V
Logic high level input voltage	VIH		0.7VDD	-	VDD	V
Logic low level input voltage	VIL		VSS	-	0.3VDD	V
Logic high level input current	IIH	VIN = VSS to VDD Ta = 25 deg.C	-	-	1	uA
Power supply current	IDD	Note 1	-	140	(200)	mA
Power supply current (SLEEP MODE)	IDD	Note 2	-	7	(10)	mA

Note 1: Typ. VDD=3.3V, Ta = 25 deg.C, Display : All white

Max. VDD=3.0V to 3.6V, Ta = -30 to +85 deg.C, Display : All white

Note2: VDD=3.3V, Ta = 25 deg.C,

Input pins of HS,VS,PCLK,R[5:0],G[5:0],B[5:0],XCS,SCL,SDA are being fixed to "H" or "L".

Note3: VSS= 0 [V]

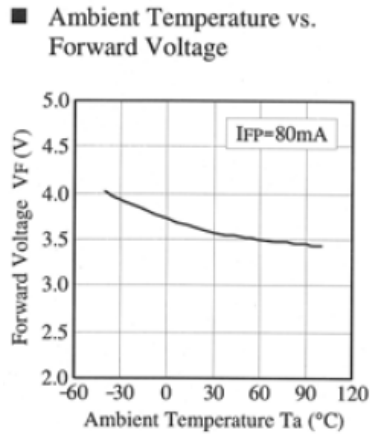
4.2 CHARACTERISTICS OF LED AND LED DRIVING

Item	Value			Unit
	Min.	Typ.	Max.	
Forward current (IF)	-	80		mA
Forward voltage (VF) at IF=80mA		(3.6)	4.0	V
<i>Life time (Note 2)</i>	-	<i>60,000</i>		<i>Hr</i>
Number of LED components	24 pcs. / One LCD Module			

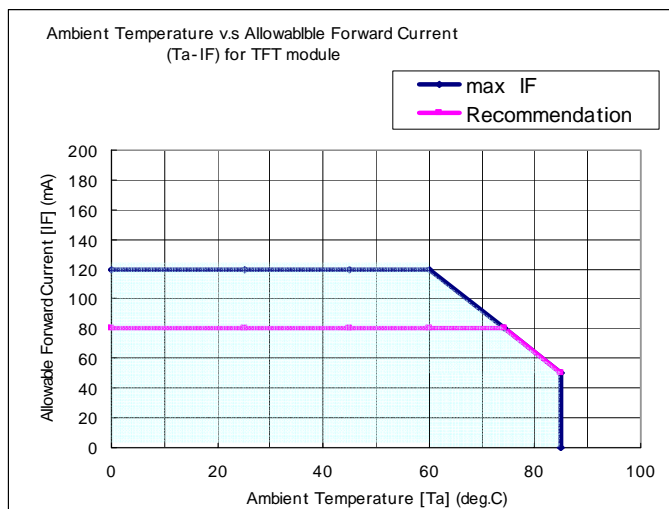
Note 1: Ta = 25 deg.C (from Nichia's one LED specification)

*Note 2: A reference mention (from Nichia's technical information)
This is presumption of life time.
It is not a performance guarantee.*

Note 3: Ambient temperature vs. Forward Voltage (from Nichia's one LED specification)



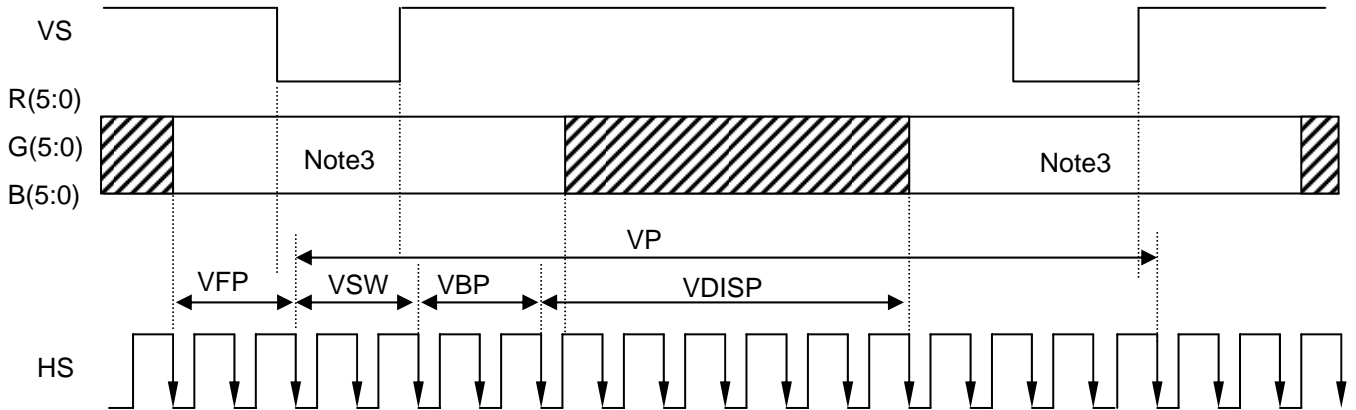
Note 4: [Reference] Ambient Temperature vs. Allowable Forward Current for TFT module
It is a derating curve in a module simple substance.



4.3 AC CHARACTERISTICS

4.3.1 RGB interface

4.3.1.1 Vertical timing of RGB interface



Ta = -30 - +85 deg.C, VDD = 3.0 – 3.6 V, VSS = 0 V

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Vertical cycle	VP		525	525	525	Line
Vertical low pulse width	VSW		2	2	2	Line
Vertical front porch	VFP		13	13	13	Line
Vertical back porch	VBP		30	30	30	Line
Vertical active area	VDISP		480	480	480	Line

Note1: Signal rise and fall times should be equal or less than 3 ns.

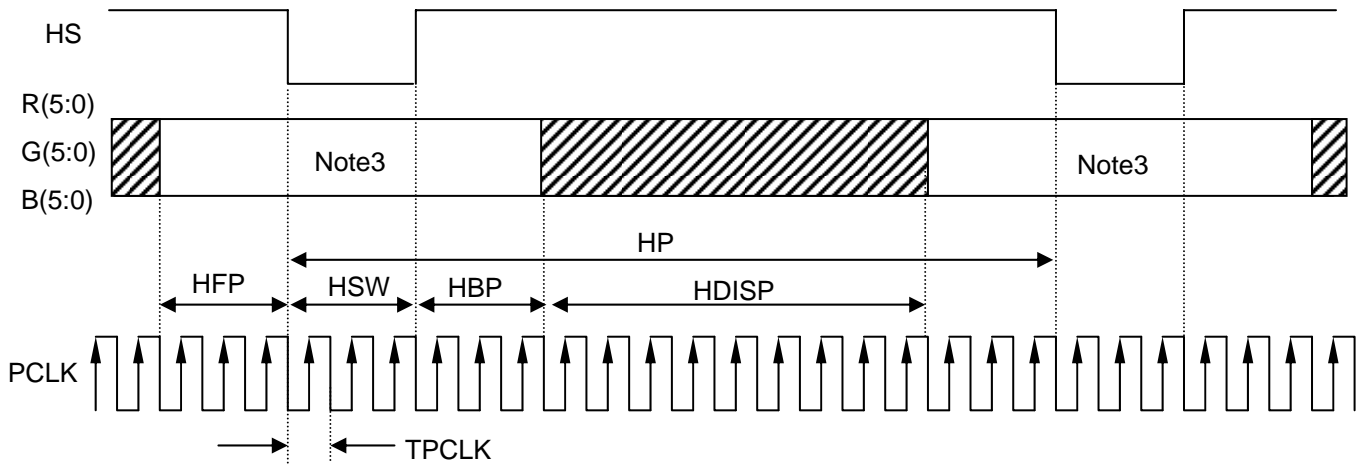
Note2: Logic high and low levels of input signals are specified as $0.3 \times VDD$ for low state and $0.7 \times VDD$ for high state.

Note3: Data lines can be high or low during blanking time.

Note4: VP, VSW, VFP, VBP and VDISP are fixed to one value.

Note5: VP, VSW, VFP, VBP and VDISP are counted by the next falling of HS after transition of VS.

4.3.1.2 Horizontal timing of RGB interface



Ta = -30 - +85 deg.C, VDD = 3.0 – 3.6 V, VSS = 0 V

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Horizontal cycle	HP	Note 3	1048	1048	1048	dot
Horizontal low pulse width	HSW		13	13	13	dot
Horizontal back porch	HBP		203	203	203	dot
Horizontal front porch	HFP		32	32	32	dot
Horizontal active area	HDISP		800	800	800	dot
Pixel clock frequency when RGB is running	TPCLK		28.9	30.3	33.6	ns
	fPCLK		29.7	33.0	34.6	MHz

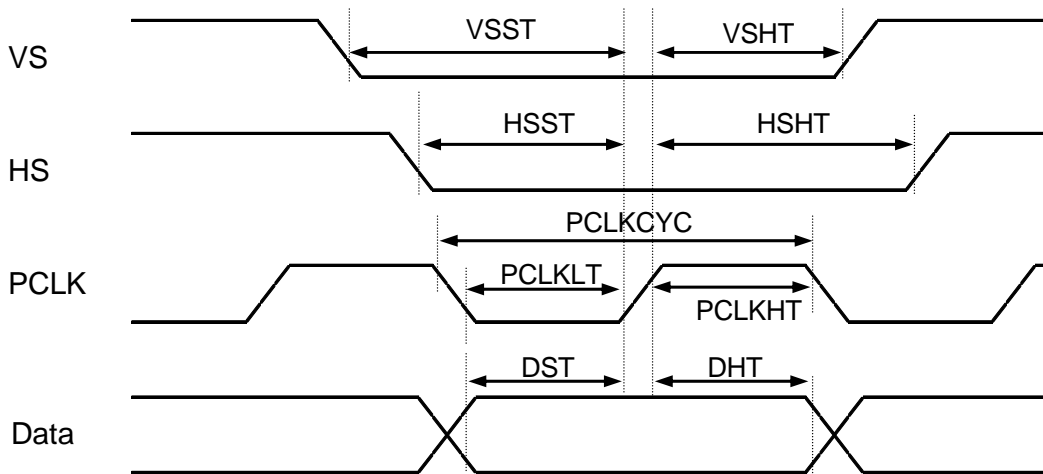
Note1: Signal rise and fall times are equal or less than 3ns.

Note2: Logic high and low levels of input signals are specified as 0.3 x VDD for low state and 0.7 x VDD for high state.

Note3: Data lines can be high or low during blanking time.

Note4: HP, HSW, HFP, HBP and HDISP are fixed to one value.

4.3.1.3 General timing of RGB interface



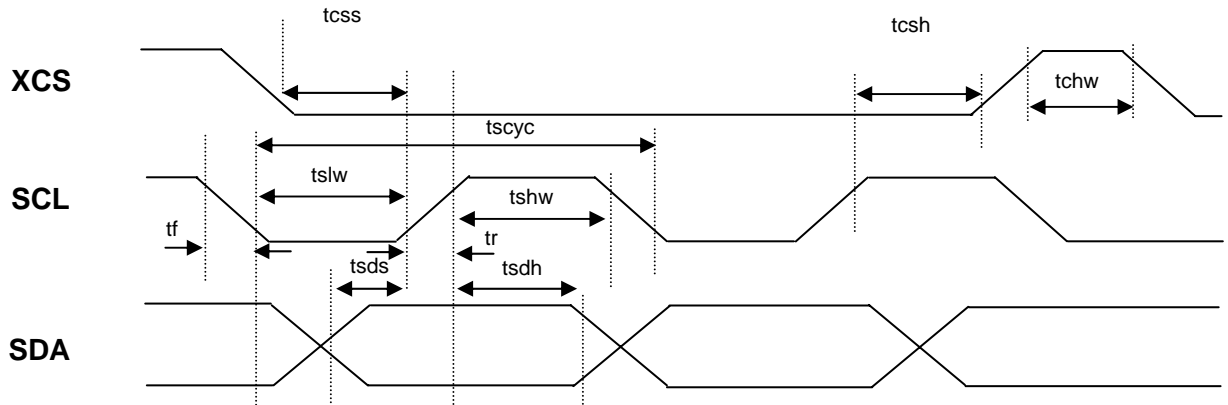
Ta = -30 - +85 deg.C, VDD = 3.0 – 3.6 V, VSS = 0 V

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
VS setup time	VSST		8	-	-	ns
VS hold time	VSHT		8	-	-	ns
HS setup time	HSST		8	-	-	ns
HS hold time	HSHT		8	-	-	ns
Pixel clock cycle when RGB interface is running	PCLKCYC		28.9	30.3	33.6	ns
Pixel clock low time	PCLKLT		12	13	-	ns
Pixel clock high time	PCLKHT		12	13	-	ns
Data setup time	DST		8	-	-	ns
Data hold time	DHT		8	-	-	ns

Note1: Signal rise and fall times should be equal or less than 3ns.

Note2: Logic high and low levels of input signals are specified as 0.3 x VDD for low state and 0.7 x VDD for high state.

4.3.2 Serial interface



Ta = -30 - +85 deg.C, VDD = 3.0 – 3.6 V, VSS = 0 V

Item		Symbol	Condition	Min.	Typ.	Max.	Unit
Write mode	Serial clock cycle	tscyc		160	-	-	ns
	SCL high pulse width	tshw		65	-	-	ns
	SCL low pulse width	tslw		65	-	-	ns
	Data setup time (write)	tsds		40	-	-	ns
	Data hold time	tsdh		40	-	-	ns
XCS high pulse width		tchhw		60	-	-	ns
XCS– SCL time		tcss		60	-	-	ns
		tchsh		60	-	-	ns

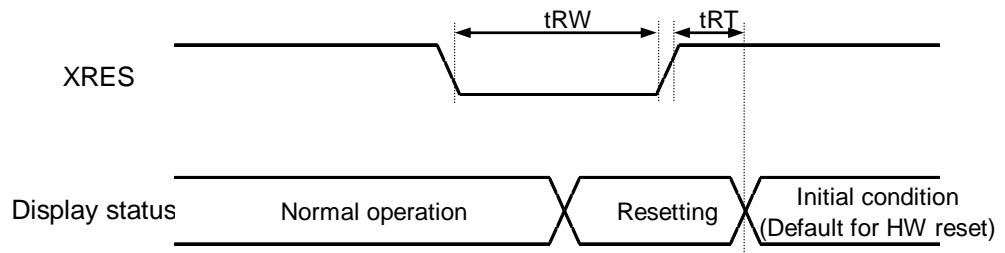
Note 1: The output signal's rise and fall times are to be stipulated maximum 15 ns.

Note 2: The input signals' rise and fall times should be equal or less than 15 ns.

Note 3: Logic high and low levels of input signals are specified as 0.3 x VDD for low state and 0.7 x VDD for high state.

Note 4: Please use the level shifter not voltage divider (drop by resistor) if customer need to change the voltage level. If customer uses the voltage divider, we can not guarantee the serial function.

4.3.3 RESET TIMING



Symbol	Parameter	Min	Max	Unit
t_{RW}	Reset pulse width	10		us
t_{RT}	Reset cancel time		5 (Note 1)	ms
			120 (Note 2)	ms

* It is necessary to wait t_{RT} after releasing XRES before sending commands.

Note 1: When reset applied during SLEEP MODE.

Note 2: When reset applied during DISPLAY ON MODE.

Note3: Signal rise and fall times are equal or less than 15 ns.

Note4: Logic high and low levels of input signals are specified as $0.3 \times V_{DD}$ for low state and $0.7 \times V_{DD}$ for high state.

Note5: During the resetting period, the display will be blanked (Black display) immediately and then return to default condition for hardware reset.

4.4 POWER MODES

4.4.1 DISPLAY ON MODE

In this mode, the display is able to show maximum 262 144 color from RGB interface. PCLK, HS and VS are always activated by the host. Image data from RGB interface is displayed on panel.

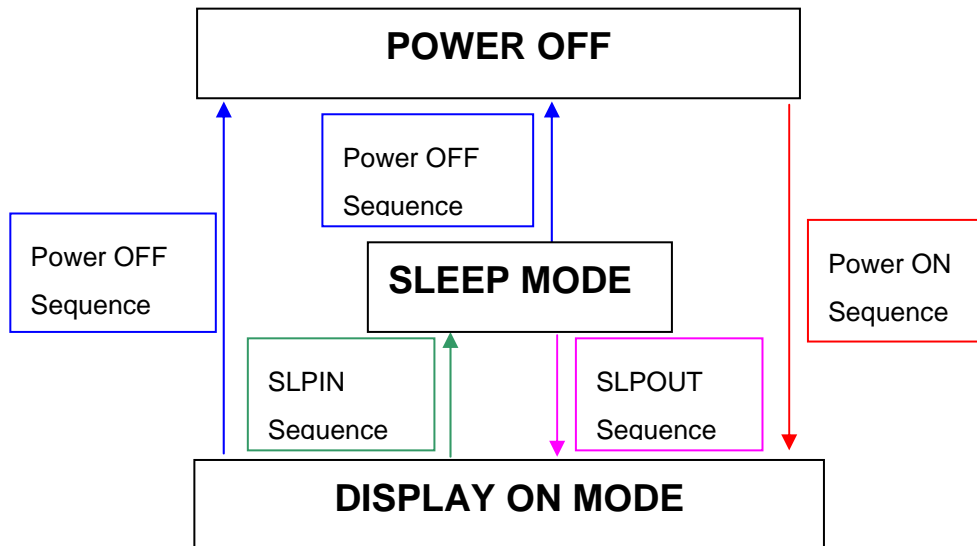
4.4.2 SLEEP MODE

In this mode, the DC/DC converter in the LCD drivers and panel driver circuit are stopped. Display is blank and not any abnormal visual effect on the display.

4.4.3 POWER OFF

In this mode, VDD is able to be removed.

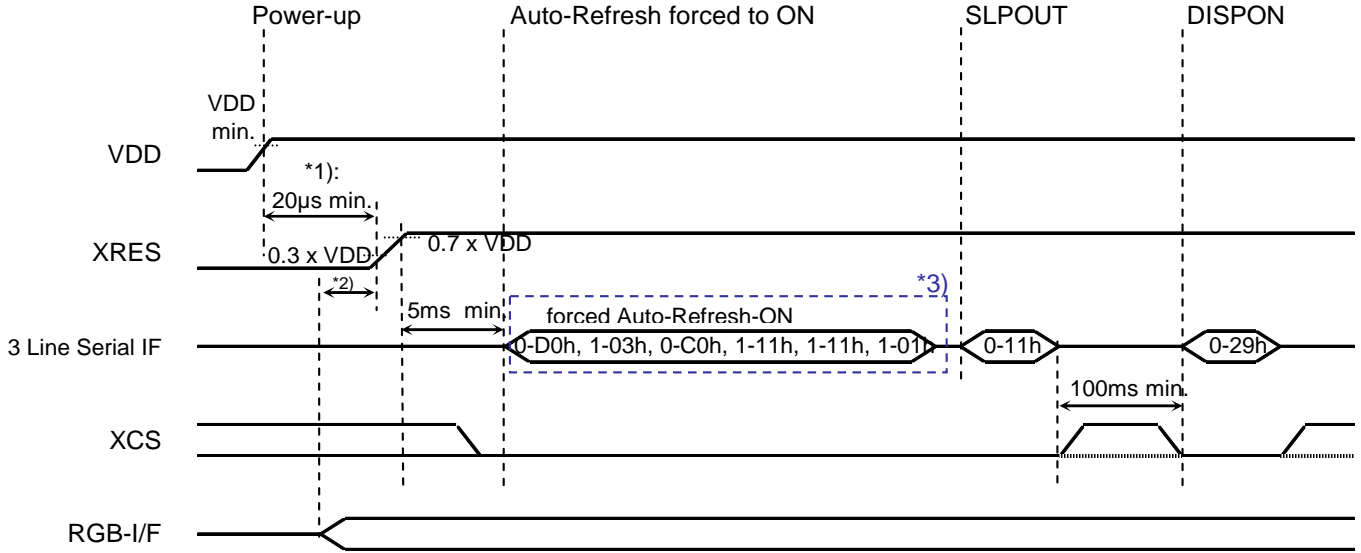
4.4.4 State transition diagram of power modes



4.5 POWER FUNCTIONS

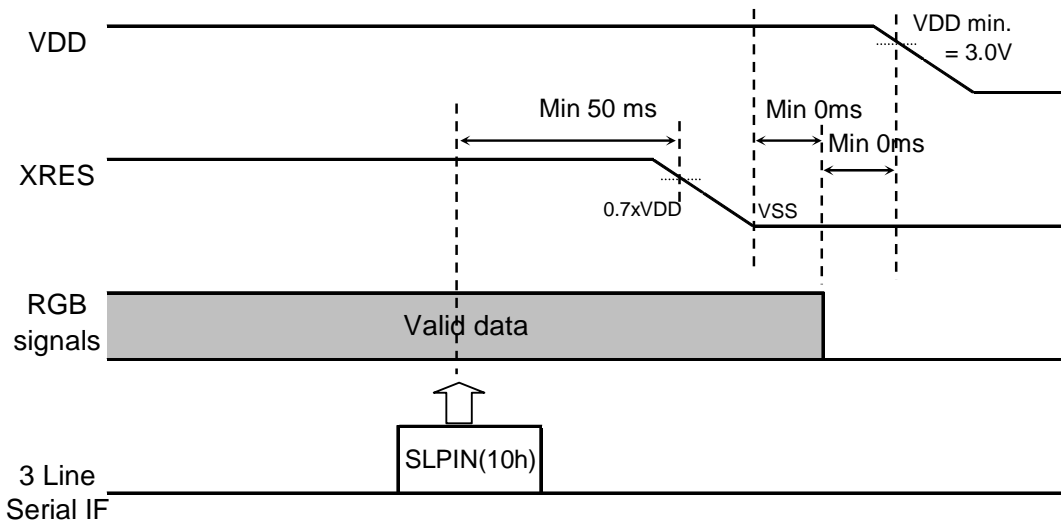
4.5.1 Power ON and OFF sequences

4.5.1.1 Power on sequence

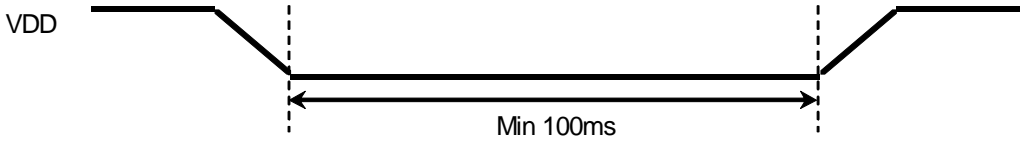


- *1) This relationship must be kept.
- *2) RGB signal should be started before XRES signal is inputted.
- *3) These commands may not be sent.

4.5.1.2 Power off sequence

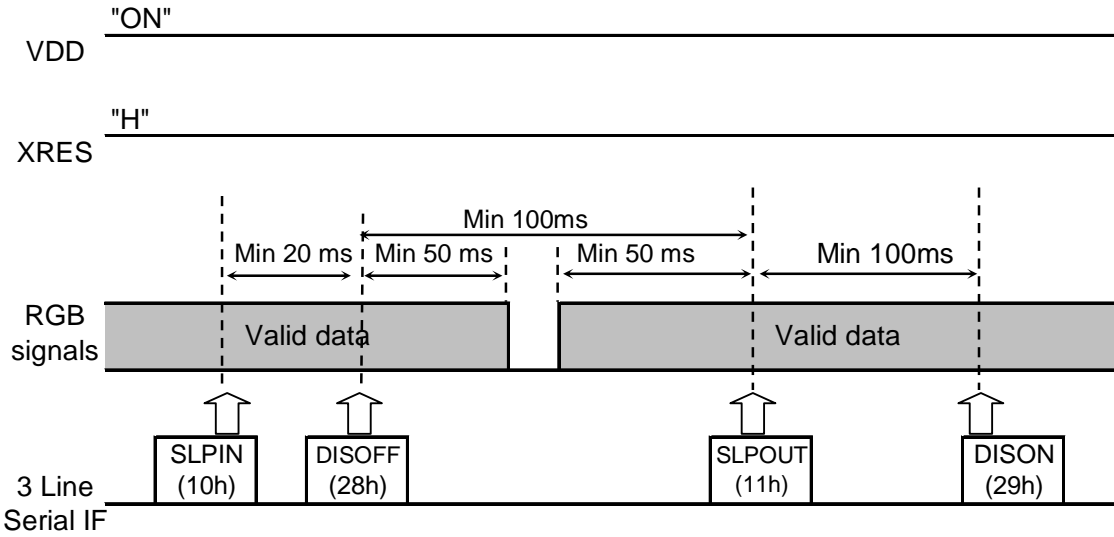


4.5.2 Interval of Power on and Power off



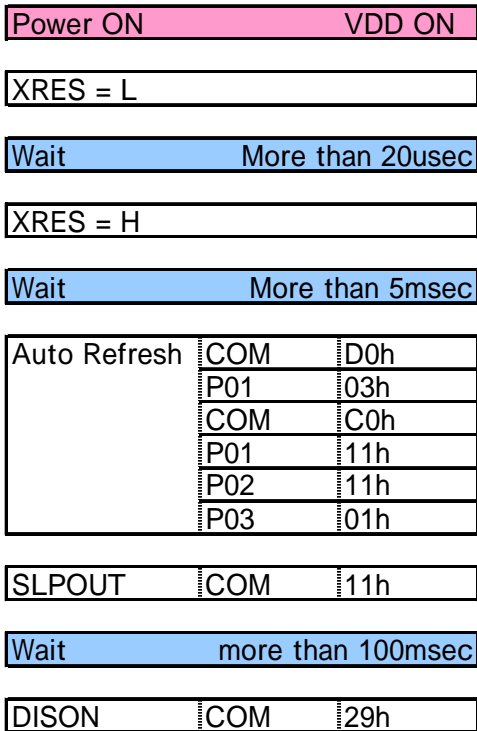
Please refer to Power ON and OFF sequences about other signals timing.

4.5.3 Sleep in and Sleep out sequence



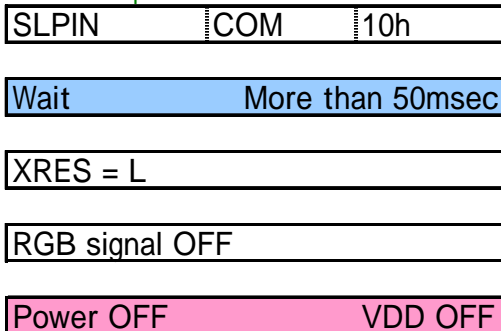
4.6 RECOMMENDED SEQUENCE

4.6.1 Power on sequence



Refer to 4.5.1.1 for details.

4.6.2 Power off sequence



Refer to 4.5.1.12 for details.

4.6.3 Sleep in sequence

DISPLAY ON MODE

SLPIN COM 10h

Wait More than 20msec

DISOFF COM 28h

Wait More than 50msec

RGB signal OFF (if needed)

SLEEP MODE

Refer to 4.5.3 for details.

4.6.4 Sleep out sequence

< SLEEP MODE → DISPLAY ON MODE.>

SLEEP MODE

RGB signal on

Wait More than 50msec

SLPOUT COM 11h

Wait More than 100msec

DISON COM 29h

DISPLAY ON MODE

Refer to 4.5.3 for details.

< DISPLAY ON MODE → DISPLAY ON MODE.>

DISPLAY ON MODE

SLPOUT COM 11h

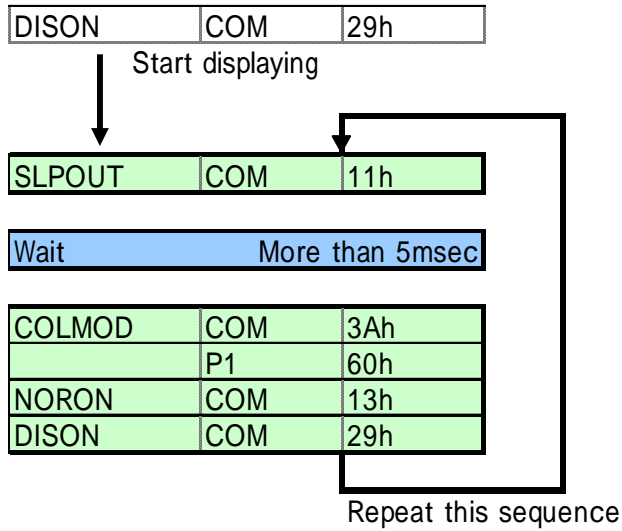
Wait More than 5msec

DISPLAY ON MODE

4.6.5 Refresh sequence

The refresh sequence recovers normal displaying when the display becomes unexpected status because of temporary external factors like ESD, et al.

It is recommended to run this sequence periodically at displayin



5 OPTICAL SPECIFICATION

5.1 OPTICAL CHARACTERISTICS

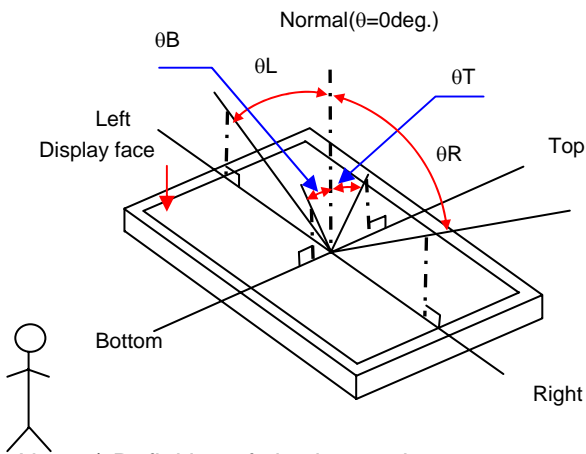
Ta=25deg. C

PARAMETERS	CONDITION	SYMBOL	RATINGS			UNIT	REMARKS
			Min.	Typ.	Max.		
Contrast ratio	$\theta=0$ deg.	CR	400	700	-	-	Note 1, 4, 5
Response time	$\theta=0$ deg.	tr + tf	-	30	40	msec.	Note 1, 3, 5
Brightness	$\theta=0$ deg.	B	450	650	-	cd/m ²	Note 1, 5
NTSC ratio	$\theta=0$ deg.	-	50	56	-	%	Note 1, 5
Viewing angle	CR 100	θ_B	70	80	-	deg	Note 1, 2, 4, 5
		θ_R	70	80	-		
		θ_T	70	80	-		
		θ_L	70	80	-		
Luminance homogeneity	Max brightness	U	75	80	-	%	Note 1, 7
White chromaticity	Max brightness	Wx	Note.8	0.332	Note.8	-	Note 1, 5
	Max brightness	Wy	Note.8	0.348	Note.8	-	Note 1, 5
Red chromaticity	Max brightness	Rx	0.570	0.607	0.644	-	Note 1, 5
	Max brightness	Ry	0.318	0.342	0.365	-	Note 1, 5
Green chromaticity	Max brightness	Gx	0.292	0.326	0.360	-	Note 1, 5
	Max brightness	Gy	0.524	0.568	0.612	-	Note 1, 5
Blue chromaticity	Max brightness	Bx	0.132	0.161	0.190	-	Note 1, 5
	Max brightness	By	0.054	0.093	0.132	-	Note 1, 5

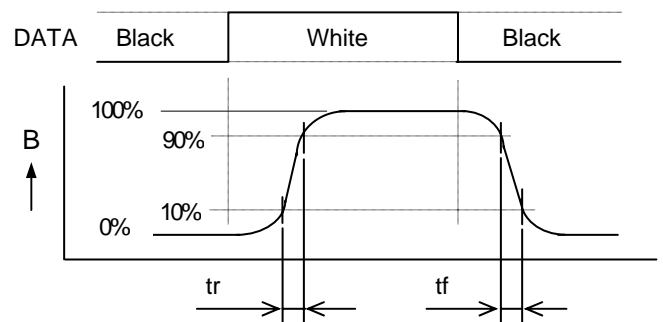
5.2 DEFINITION AND CONDITION OF OPTICAL CHARACTERISTICS

Note1) Measurement condition

- (1) Measurement equipment: DMS 301 / DMS 803
- (2) Ambient temperature Ta: 25 ± 3 deg. C
- (3) LCD: All pixels are WHITE, VDD=3.3V, fclk=33MHz, fV=60Hz
- (4) Measure after 15 minutes of LED warm up.
- (5) IF=320(80x4)mA for LED.



Note 2) Definition of viewing angle



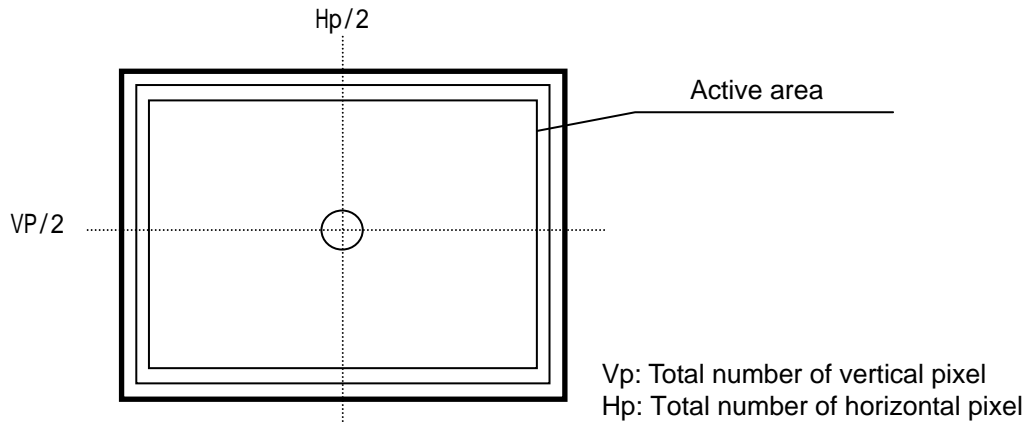
Note 3) Response time

Note 4) Contrast ratio "CR":

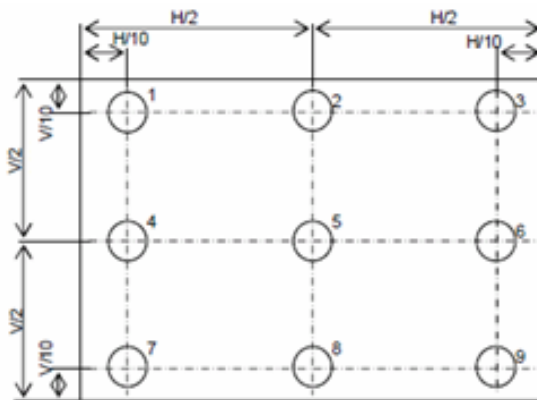
$$CR = \frac{\text{Brightness at White}}{\text{Brightness at Black}}$$

Note 5) These parameters shall be measured at center of active area. (refer to Note 6)

Note 6) Measurement points

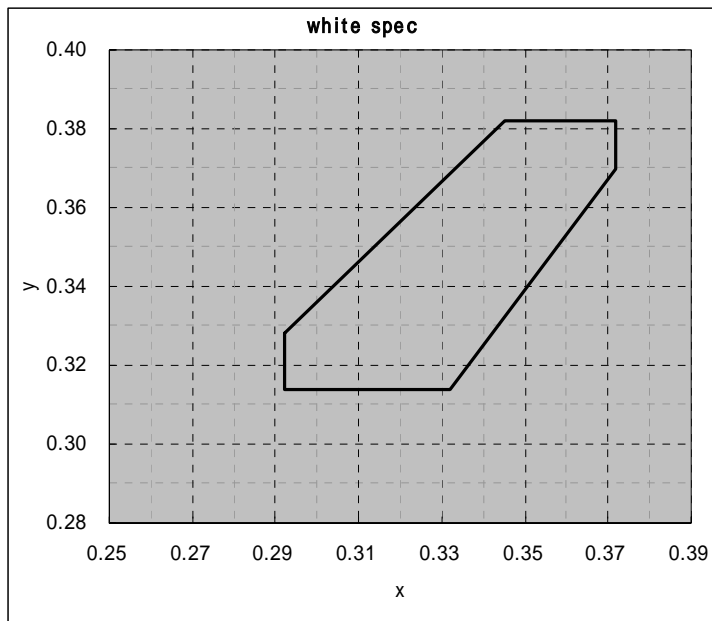


Note 7) Luminance homogeneity



$$\text{Luminance homogeneity} = \frac{B \text{ min.}}{B \text{ max.}} \times 100 \quad [\%]$$

Note 8) White chromaticity



	x	y
a	0.292	0.328
b	0.292	0.314
c	0.332	0.314
d	0.372	0.370
e	0.372	0.382
f	0.345	0.382

6 INSPECTION STANDARD

6.1 QUALITY STANDARD

6.1.1 Standards

Each lot should satisfy the quality standards as shown below.

* Inspection method: Compliant with ANSI/ASQC Z1.4-1993, Normal inspection level II, inspection by single sampling.

* AQL

Defect type	AQL	Definition
Major defects	0.4%	accompanied with functional abnormalities
Minor defects	0.65%	out of the range of "5.2 APPEARANCE STANDARDS", but no functional abnormalities

6.1.2 Lot

Lot means the unit includes all products delivered to your company at one time.

6.1.3 Inspection condition

1) Environmental conditions :

1. Temperature/humidity condition : Normal temperature (25+- 5 degrees)
Normal humidity (60+-20%RH)

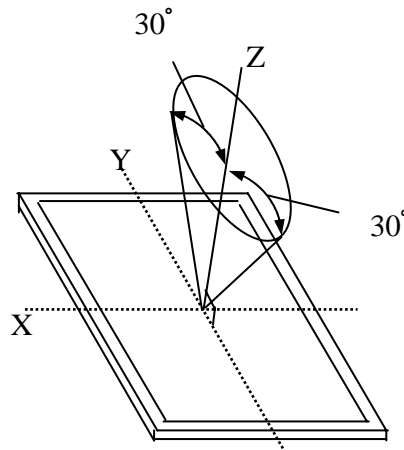
2. Illuminance environment : Not lighted appearance 800 ~ 2000Lx
Lighted appearance : Transmissive type 100 ~ 400Lx
Semi-Transmissive 800 ~ 2000Lx

* Some specified patterns : 50Lx or the less

2) Inspection method : Inspection by naked eye

Inspect the screen by naked eye from a distance of about 30 cm and the angle shall be 30 degrees from the vertical direction to the product.

Viewing angle is 30 degrees from the vertical direction as shown in the picture below.



3) Drive condition : It is done pursuant to product specification.

6.1.4 treatment of other problems

If any troubles should occur concerns our products that have been assembled at your company's manufacturing processes, both companies shall jointly investigate and resolve the causes.

6.2 APPEARANCE STANDARD

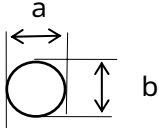
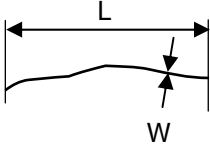
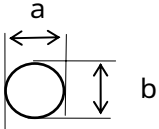
6.2.1 Application scope

The application scope is limited to the viewing area.

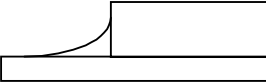
The product should be judged non-defective if all defects are outside of the viewing area and do not interfere with product quality or the assembly process.

Note : Viewing area = Bezel opening area.

6.2.2 Display appearance standard

No.	Items	Judgment criteria	Class															
1	Abnormal display	Must not be abnormal function such as not function or not to get normal pattern for input signal, etc.	Major															
2	Line defect (Open, Short)	No line defect	Major															
3	Dot defect (Dot failure)	<table border="1" style="width:100%; border-collapse: collapse; margin-bottom: 5px;"> <thead> <tr> <th>No.</th> <th>Item</th> <th>Bright dot</th> <th>Dark dot</th> <th>Total</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Defect in screen</td> <td style="text-align: center;">2</td> <td style="text-align: center;">5</td> <td style="text-align: center;">5</td> </tr> <tr> <td>2</td> <td>Combined defect</td> <td colspan="2" style="text-align: center;">2</td> <td style="text-align: center;">2</td> </tr> </tbody> </table> <p>Distance between dots : D D\geq5mm The smallest one unit R,G or B is defined as one dot.</p> <p>Less than 60 % of one dot area is acceptable.</p>	No.	Item	Bright dot	Dark dot	Total	1	Defect in screen	2	5	5	2	Combined defect	2		2	Minor
No.	Item	Bright dot	Dark dot	Total														
1	Defect in screen	2	5	5														
2	Combined defect	2		2														
4	Dot type defect d = (a + b) / 2	<table border="1" style="width:100%; border-collapse: collapse; margin-bottom: 5px;"> <thead> <tr> <th>Size d (mm)</th> <th>Tolerance</th> </tr> </thead> <tbody> <tr> <td>d \leq 0.15</td> <td>ignored</td> </tr> <tr> <td>0.15 < d \leq 0.4</td> <td style="text-align: center;">3</td> </tr> <tr> <td>0.4 < d</td> <td style="text-align: center;">0</td> </tr> </tbody> </table> <p>Distance between defects : D D\geq5mm</p> 	Size d (mm)	Tolerance	d \leq 0.15	ignored	0.15 < d \leq 0.4	3	0.4 < d	0	Minor							
Size d (mm)	Tolerance																	
d \leq 0.15	ignored																	
0.15 < d \leq 0.4	3																	
0.4 < d	0																	
5	Line type defect (Black/ White)	<table border="1" style="width:100%; border-collapse: collapse; margin-bottom: 5px;"> <thead> <tr> <th>Length L (mm)</th> <th>Width W (mm)</th> <th>Tolerance</th> </tr> </thead> <tbody> <tr> <td>ignored</td> <td>W \leq 0.05</td> <td>ignored</td> </tr> <tr> <td>L \leq 10.0</td> <td>0.05 < W \leq 0.1</td> <td style="text-align: center;">3</td> </tr> <tr> <td></td> <td>0.1 < W</td> <td style="text-align: center;">Dot type defect</td> </tr> </tbody> </table> <p>Distance between defects : D D\geq5mm</p> 	Length L (mm)	Width W (mm)	Tolerance	ignored	W \leq 0.05	ignored	L \leq 10.0	0.05 < W \leq 0.1	3		0.1 < W	Dot type defect	Minor			
Length L (mm)	Width W (mm)	Tolerance																
ignored	W \leq 0.05	ignored																
L \leq 10.0	0.05 < W \leq 0.1	3																
	0.1 < W	Dot type defect																
6	Unevenness Display	Should not be remarkable.	Minor															
7	Bubble in Polarizer d = (a + b) / 2	<table border="1" style="width:100%; border-collapse: collapse; margin-bottom: 5px;"> <thead> <tr> <th>Diameter d(mm)</th> <th>Tolerance</th> </tr> </thead> <tbody> <tr> <td>d \leq 0.3</td> <td>ignored</td> </tr> <tr> <td>0.3 < d \leq 0.5</td> <td style="text-align: center;">3</td> </tr> <tr> <td>0.5 < d \leq 1.0</td> <td style="text-align: center;">1</td> </tr> <tr> <td>1.0 < d</td> <td style="text-align: center;">0</td> </tr> </tbody> </table> 	Diameter d(mm)	Tolerance	d \leq 0.3	ignored	0.3 < d \leq 0.5	3	0.5 < d \leq 1.0	1	1.0 < d	0	Minor					
Diameter d(mm)	Tolerance																	
d \leq 0.3	ignored																	
0.3 < d \leq 0.5	3																	
0.5 < d \leq 1.0	1																	
1.0 < d	0																	

6.2.3 General Appearance Specifications

No.	Items	Judgment criteria	Class
1	different specifications	Not permitted.	Major
2	Damaged resist on FPC	Copper patterns on FPC must not be visible.	Minor
3	Circuit pattern	Must not be peeled or separated from FPC.	Major
4	Conductive refuses	No solder refuses or solder balls easily moving. Fixed particle which has no functional affect can be ignored.	Minor
5	Dirt	Should not be prominent. Dirt on backside is permitted.	Minor
6	I/F terminal scratch / dirt	Should not be prominent.	Minor
7	Plating	Must not be peeled, no rust and no discoloration.	Minor
8	Soldering defect	Solder omissions is not permitted at any solder point. Solder bridges is not permitted. Cold soldering is not permitted.	Major Major Minor
9	Parts soldering	There must be fillet. 	Minor
10	Metal frame Scratch / discoloration	Scratch out of viewing area and discoloration shall be ignored.	Minor

6.3 WARRANTY

Epson Imaging Devices Corp. warrants this product for a period of 14 months from the date of delivery.

We replace or compensate for the defective product which is judged as our responsibility within the term of warranty.

7 RELIABILITY

7.1 STANDARD TEST ITEM AND CONDITON / METHOD

Test item	Test condition	Confirm method / Judgment
Dry heat Operating	85 deg.C (surface temperature of polarizer), 240Hr	After 240 hours, product will be left in normal temperature and normal humidity for two hours. It should work without fail mechanically and electrically, and standard in 6.2 has to be met.
Low temperature Operating	-30 deg.C, 240Hr	After 240 hours, product will be left in normal temperature and normal humidity for two hours. It should work without fail mechanically and electrically, and standard in 6.2 has to be met.
Dry heat Storage	85 deg.C, 240Hr	After 240 hours, product will be left in normal temperature and normal humidity for two hours. It should work without fail mechanically and electrically, and standard in 6.2 has to be met.
Low temperature Storage	-40 deg.C, 240Hr	After 240 hours, product will be left in normal temperature and normal humidity for two hours. It should work without fail mechanically and electrically, and standard in 6.2 has to be met.
High temperature High humidity Operating	60 deg.C, 90%RH, 240Hr	After 240 hours, product will be left in normal temperature and normal humidity for two hours. It should work without fail mechanically and electrically, and standard in 6.2 has to be met.
Thermal shock	-40 deg.C(30min.) +85 deg.C(30min.),200 cycles	After 200 cycles, product will be left in normal temperature and normal humidity for two hours. It should work without fail mechanically and electrically, and standard in 6.2 has to be met.

Vibration (Non-operating)	Vibration frequency: 8~33.3Hz , Amplitude 1.3mm Vibration frequency: 33.3~400Hz , Acceleration:3G, Cycle 15min. Direction of XZ: 2Hr, Direction of Y: 4Hr	Product should work without fail mechanically and electrically and standard in 6.2 has to be met.
Impact (Non-operating)	100G, 6ms, half sin wave,±XYZ One time for every direction.	Product should work without fail mechanically and electrically and standard in 6.2 has to be met.
ESD (Non-operating)	Conduct Discharge 100pF, 1500ohm, ±15k Panel center 3 times (intervals of 1s) Non-operating	No abnormality like abnormal display. Current consumption should be less than twice of initial value.
ESD (Non-operating)	Air Discharge 100pF, 1500ohm, ±15k 4 points to metal frame 3 times for each, (intervals of 1s) Non-operating	No abnormality like abnormal display. Current consumption should be less than twice of initial value.

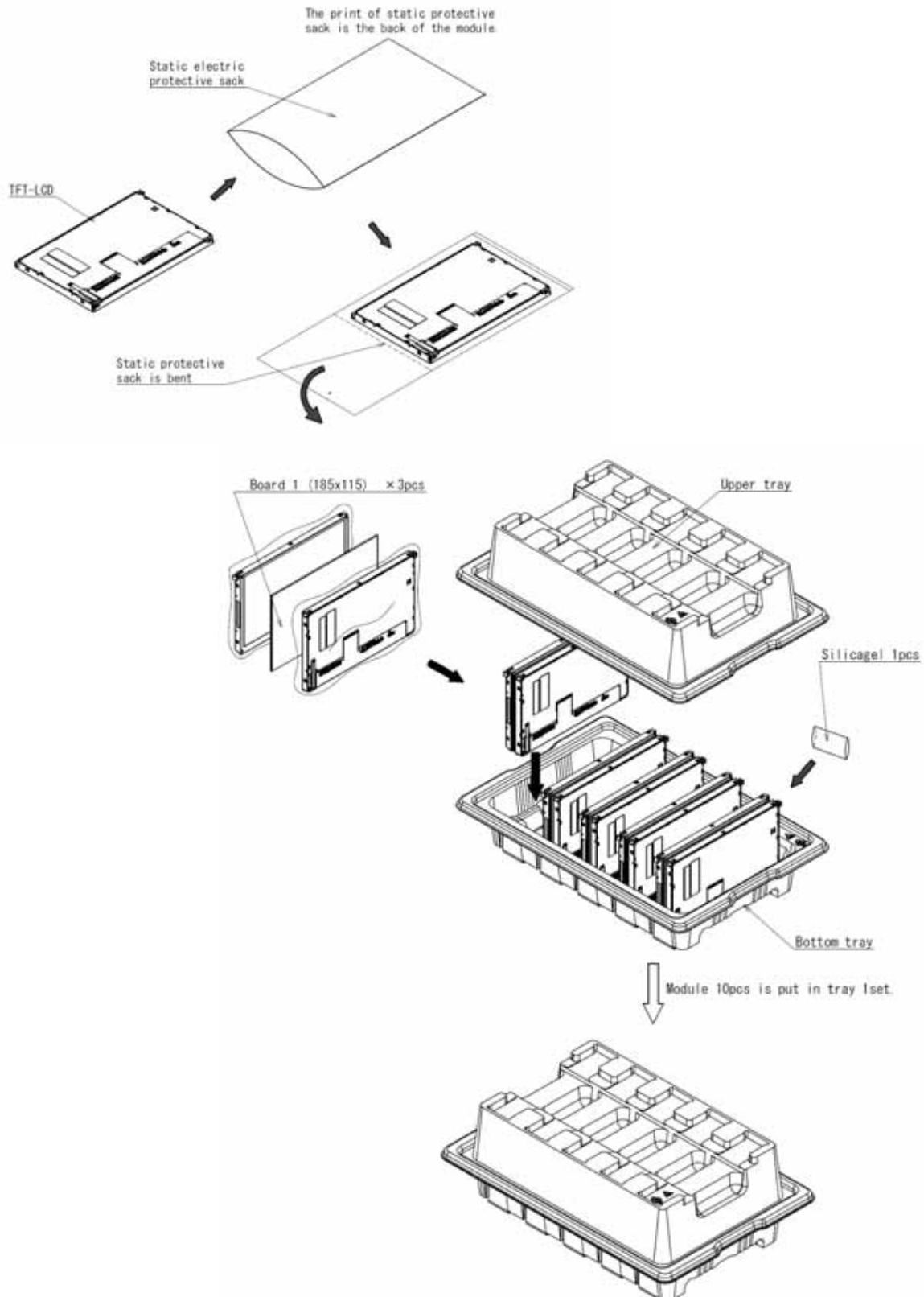
7.2 FAILURE JUDGMENT STANDARD

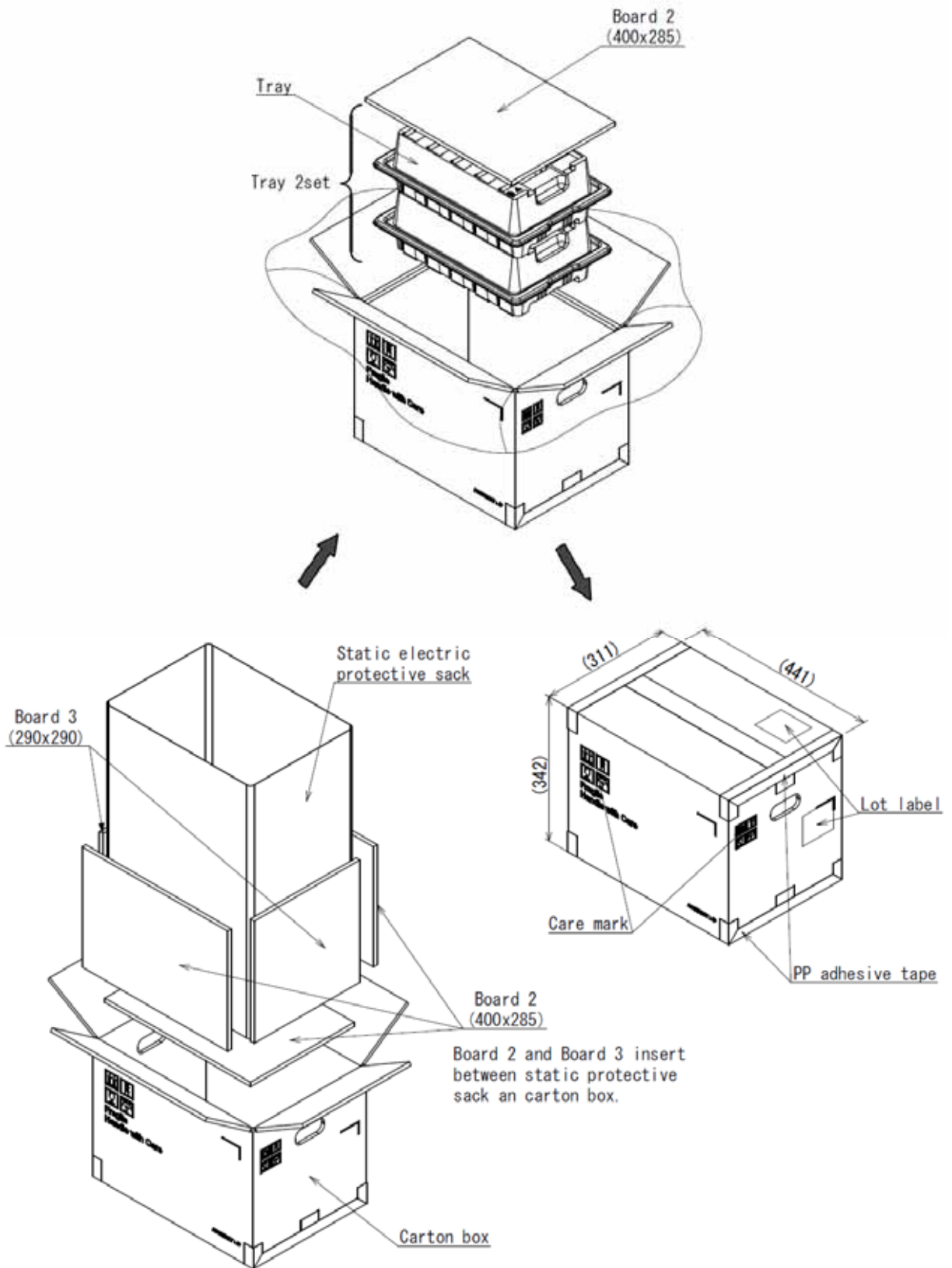
After reliability test, inspection is executed in the normal temperature / humidity environment

- 1) There should be no remarkable deterioration in display quality and appearance.
- 2) Contrast ratio should be over 50% of initial value.
- 3) Brightness should be over 50% of initial value.
- 4) There should be no abnormal function.
- 5) Current consumption should be less than twice of initial value.

8 PACKING

EPSON IMAGING DEVICES CORPORATION make packaging as shown below to protect the products from shock and vibration during transportation.





Lot label

The diagram shows a lot label with the following fields and callouts:

- Product No.:** L5S30978P** (Callout: EPSON's Product number)
- Q'ty:** ** pcs (Callout: Quantity)
- Lot:** ***** (Callout: EPSON's Product Lot number)
- Customer Product No.:** EPSON IMAGING DEVICES CORP.

9 LCD MODULE USAGE AND PRECAUTIONS

9.1 HANDLING

1) Broken glass:

Be careful to broken glass of display surface. When the display surface is damaged, be careful enough not to cut hands by a piece of glass. The surface of a LCD Module is covered by plastic film, and glass is hard to be scattered, but there can be the hurt when touching a broken portion.

2) Broken panel:

Do not touch the liquid which flowed out of a panel. When a panel is damaged, and liquid flow, do not breathe in the liquid or drink it or touch it. When liquid stuck to a hand or clothes, wipe it off in soap or alcohol immediately, then wash in water. When liquid touched to eyes, wash eyes with washing water more than 15 minutes, and undergo a medical treatment of a doctor.

3) Preventing of stain and dust:

Handle a LCD module as much as possible in a room with a few dusts. In addition, when in acceptance inspection or installing process, wear a finger case or the soft gloves which do not make a dust to prevent stain of display surface of a module.

4) Protection film of display surface:

Remove a protection film of display surface in the latest possible assembly process to prevent from dust or scratch on display surface.

5) Wiping off of stain on display surface:

When display surface of a LCD module was stained, please wipe it off lightly with clean cotton or soft cloth.

6) Water drops on display surface:

Do not leave the water drops on the display surface. When water drops are stuck on the surface, wipe it off with cotton or soft cloth immediately. Display surface may change color and get a stain of water. In addition, when water drops flow into the LCD module inside, it may cause a trouble or damage.

7) Disassemble or modify of LCD module:

Do not attempt to disassemble, rework or modify the LCD module by any means. There is the possibility of electric shock, destruction of electronic parts, scratch on a display surface, or dust passing into a LCD module. And if using disassembled, reworked or modified LCD module, electronic parts might emit smoke or outbreak a fire by dust or malfunction of electronic parts. A product guarantee becomes not available for a LCD module which disassembled, reworked or modified by the user.

8) Countermeasures to static electricity:

C-MOS LSI and an electronic part of the LCD module inside can be destroyed by static electricity. In order not to apply static electricity to a LCD module, spread a conductive mat to a floor and a work desk. In addition, worker should wear a wrist strap. Pay attention not to apply static electricity while at work. It is recommended to use anti-static electricity air gun in assembly line for LCD.

9) How to insert the connector:

When inserting a FPC or take it off, make attention so that strong external force is not added to a FPC the LCD module. The inside connection of LCD driver can be damaged by a strong external force. When installing a LCD module to a target, make attention not to put these FPC between the case of target and the

LCD module. A connector of a parent application and an input FPC of target should not be inserted slantways or half-ways. And confirm it by all means. When it is not inserted correctly, a circuit and a part might be damaged.

10) Handling of FPC:

Be careful not to pull or damage a FPC. Damage of a FPC may cause troubles to the LCD module unit.

9.2 DESIGN

1) Absolute maximum ratings:

Follow the absolute maximum ratings specified in this document by all means. The absolute maximum rating is the rating which LCD module must not be violated. When using a LCD module at the condition beyond those, a burning/destruction of electronic parts or a permanent damage of characteristics may be caused. Therefore, make appropriate design not to violate the absolute maximum ratings with consideration of environmental temperature, deviation of input signals, and electronic parts tolerances.

2) Torsion and bending while in the process of installing:

Make attention that no torsion or bending stress is applied on a LCD module in the installing process to a target frame. Even if the stresses are temporarily, they might be the cause of trouble of a LCD module.

3) Preventing of a mechanical shock:

Be careful not to give a strong mechanical shock such as drops or shocks. There can be a cause of trouble such as a scratch of display surface or a malfunction of LCD module. Especially when FPC is bent strongly, FPC will be cut and LCD will be broken.

4) Preventing of a pressure on display surface:

Make attention that no strong external force such as pushing strongly on display surface of a LCD module. Because there can be a scratch on display surface or a cause of trouble of a LCD module.

5) Preventing of a scratch on display surface:

Make attention not to rub or push a display surface of a LCD module by a rigid thing such as tools. In addition, be sure not to put a heavy thing such as a tool on display surface and not to pile up LCD modules each other. A polarizer used for display surface is easy to get a scratch or traces and it might be damaged.

6) Installation holes, torsion, bending:

EPSON IMAGING DEVICES CORPORATION recommends use of all installation holes shown in this document. In addition, a screw to use should be of proper dimensions according to specifications. In addition, Installation portions of a LCD module should be designed not to be applied excess torsion or bending. There might be a display unevenness by application of a stress during installation even if the LCD module has an evenness for display itself.

7) Power supply sequence:

The power supply and the input signals of the users' product unit and the inspection circuit, etc., connecting to LCD module, which satisfy the power supply sequence of the recommended operating condition, must be used.

8) Power supply circuit protection device:

Please examine and apply the power supply circuit protection device if necessary when the LCD module breaks down in accordance with the use condition.

9) Recommendation for use of a protection cover and a UV cut filter:

EPSON IMAGING DEVICES CORPORATION recommends use of a transparent protection cover on a liquid crystal display aperture to prevent scratch and dust of display surface and invasion of water, when using under a too cruel condition in such as outdoors. Furthermore, EPSON IMAGING DEVICES CORPORATION recommends use of a U.V. cut filter (cuts 390nm or less wave length) when it is exposed to direct rays of the sun for a long time. Please consider it so that dew condensation does not occur in the cover.

10) Temperature dependence of display:

The response (optical response) of display varies with temperature. The response becomes slow at low temperature. In addition, brightness and chromaticity vary with temperature, too.

11) Dew condensation:

In an environment of sudden temperature change, there might be a dew condensation on surface or inside of a LCD module. Because it causes a degradation of display or malfunction, be sure to make consideration for design that dew condensation does not occur.

12) Image sticking:

It is recommended to avoid display same image for long term in order to prevent causing image sticking. Also even at displaying moving image, displaying in trimmed image such as pillar-box or letterbox for long term, or repeated frequently, could cause image sticking due to the characteristics of LCD. Displaying in full screen is recommended. Interlace driving will cause image sticking on the display. Please apply non-interlace driving.

In case a image sticking occurred, applying full gray image may work for recovery of sticking image for some, however if severe image sticking occurred by stationary image for more long stretch of time, this recovery measure does not work Please pay attention on these notes at designing

13) Caution about INTERLACE and FRC driving:

Do not input driving signal which apply different voltage in each frame alternately.
These driving may cause abnormal image such as image sticking by DC imbalance.

Please avoid using following driving method basically.

Interlace signal (PAL, NTSC) and FRC (Frame Rate Control)

Because it is leads inappropriate DC apply to LC, and avoidance method is complicated.

The countermeasures written in this section have possibility of some image degradation

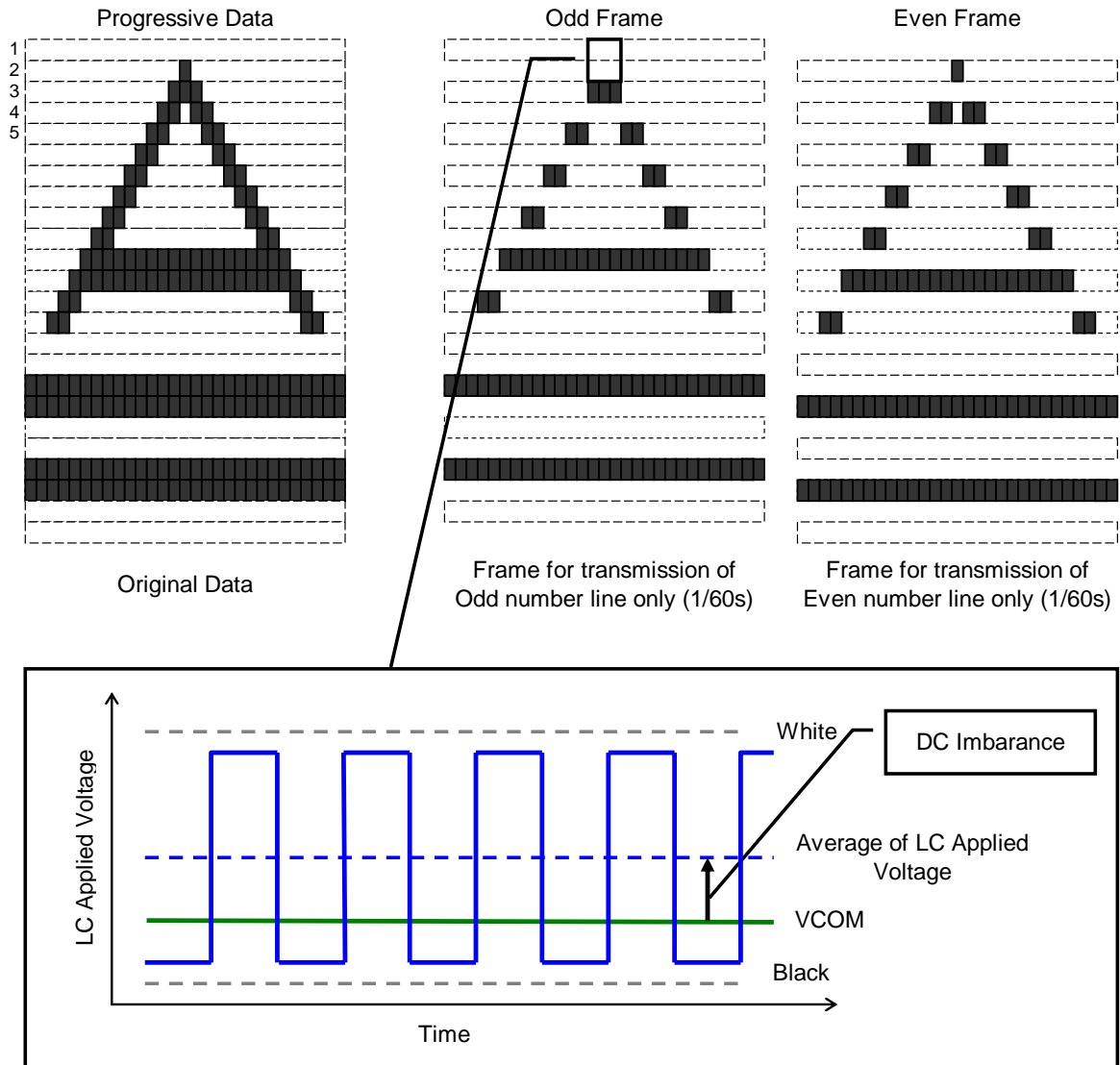
◆ INTERLACE

The following driving cause some abnormal display.

Resize (expand / shrink) of interlace signal source. (50/ 60 FPS)

Complement of interlace signal source

Ex. Display NTSC signal source (480 vertical lines) is shrank to WQVGA (240 vertical lines) LCD.



Countermeasure

Following driving method by frame memory in your system improves DC imbalance.

1. Store an odd frame data to the frame memory.
2. Drive with data in frame memory in steps of 2 frames. It means an even frame data is not used.

◆ FRC

Also the different voltage is applied to LC in each frame caused by the frame rate control.

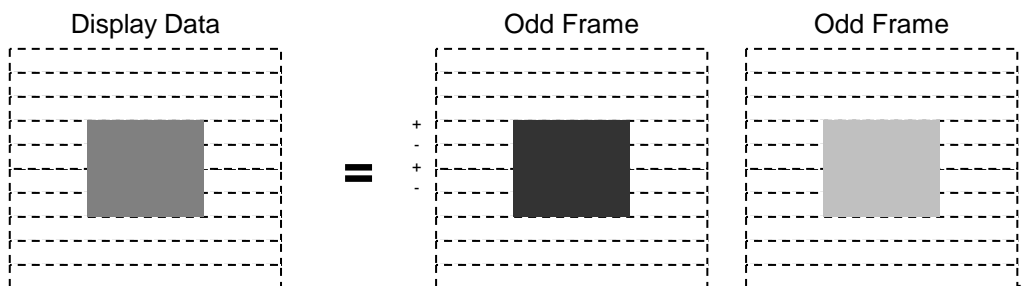


Figure 23 FRC driving

9.3 STORAGE

1) Storage and transport:

Keep a LCD module with a packing form of shipment in a dark room which direct rays of the sun does not irradiate with low temperature, with low humidity, and with no dew condensation. In addition, keep it in an environment with little temperature change because there is the possibility that dew condensation occurs by a sudden temperature change. When dew condensation occurs, it may be a cause of operation abnormality or trouble.

The shipping carton must not be stacked up over 2m in height.

2) Transport:

Because the master carton may be damaged or shape transformed by an excessive load applied, store and transport with piled up in lower than the number which recorded in a master carton label.

Trays are used to package LCD modules for shipment. If LCD modules scratch the tray during shipment, material of the scratched tray may be left onto LCD modules. In such case, clean up LCD modules after removal from trays.

3) Handling:

Because a LCD module is a product having precision electronic parts (FPC etc.) and glass products, it might be damaged by an excessive shock or a dropping, for example, stress by hand. Although a LCD module does protected with master carton, handle it carefully to reduce a shock in transshipping, transporting and loading.

9.4 DISPOSAL

Disposing LCD modules:

When disposing LCD modules, consult a company specialized in industrial waste treatment which is permitted by the government or the local authority.

9.5 OTHER PRECAUTIONS

1) This product is developed and manufactured for the usage of general AV equipments and is not suitable for devices that require high reliability and safety (aircraft/space use equipments, nuclear control apparatus, life maintenance equipments, etc).

2) Use this product correctly according to the operating conditions and precautions that are stated in this specification. Design carefully to prevent accidents, fire hazards, and social damage because of this product.

3) Radiation proof design is not applied to this product.

4) Contents in this specification shall not guarantee any third party's intellectual property right or concession of other rights. EPSON IMAGING DEVICES CORPORATION will not take responsibility for the industrial property issue arising between the user and a third party.

5) This specification includes copyright-related contents. It is strictly prohibited to make partial/full reprints or duplicate copies of this specification without the approval of EPSON IMAGING DEVICES CORPORATION.

6) Damages caused by the using beyond conditions or notices or precautions as mentions in this specifications, are responsible for the users.

7) The thickness of the LCD Module was measured while had suppressed.

