SPECIFICATION
FOR
APPROVAL

( ) **Preliminary Specification**

(●) **Final Specification**

Title	32.0” WXGA TFT LCD

BUYER	General
MODEL	

SUPPLIER	LG.Display Co., Ltd.
*MODEL	LC320DXC
SUFFIX	SMA8 (RoHS Verified)

APPROVED BY		SIGNATURE DATE
	/	
	/	
	/	

Please return 1 copy for your confirmation with your signature and comments.

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LG Display Co., Ltd.

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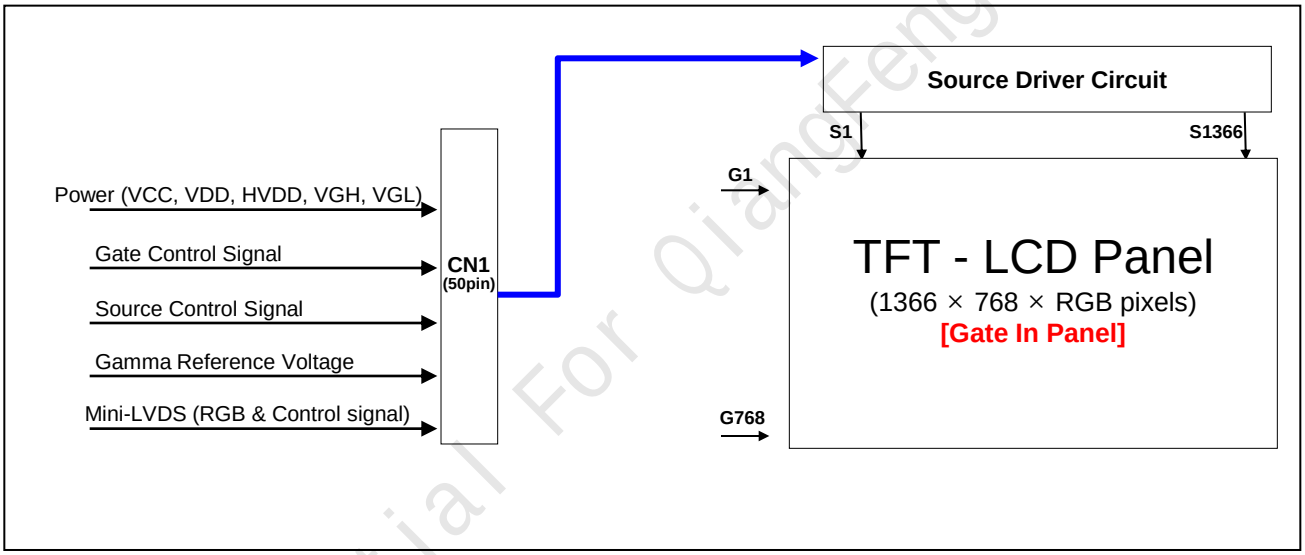
RECORD OF REVISIONS

Revision No.	Revision Date	Page	Description
0.1	Dec. 04, 2019	-	Preliminary Specification(First Draft)
1.0	Dec. 31, 2019		Final Specification

1. General Description

The LC320DDXC is a Color Active Matrix Liquid Crystal Display with an integral the Source PCB and Gate implanted on Panel (GIP). The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally black mode. It has a 31.51 inch diagonally measured active display area with WXGA resolution (768 vertical by 1366 horizontal pixel array). Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the luminance of the sub-pixel color is determined with a 8-bit gray scale signal for each dot. Therefore, it can present a palette of more than 16.7M(6bit + FRC) colors.
It is intended to support LCD TV, PCTV where high brightness, super wide viewing angle, high color gamut, high color depth and fast response time are important.



General Features

Active Screen Size	31.51 inches diagonal
Outline Dimension	715.0(H) x 411.0 (V) x 1.2 mm(D) (Typ.)
Pixel Pitch	170.25㎛ x 510.75㎛ x RGB
Pixel Format	1366 horiz. by 768 vert. Pixels, RGB stripe arrangement
Color Depth	8-bit (D), 16.7 M colors
Drive IC Data Interface	Source D-IC : 6-bit mini-LVDS, gamma reference voltage, and control signals Gate D-IC : Gate In Panel
Transmittance (With POL)	6.14% (Typ.)
Viewing Angle (CR>10)	Viewing angle free (R/L 178 (Min.), U/D 178 (Min.))
Weight	0.86 Kg (Typ.)
Display Mode	Transmissive mode, Normally black
Surface Treatment (Top)	Hard coating(3H), Anti-glare treatment of the front polarizer (Haze 1%(Typ.))

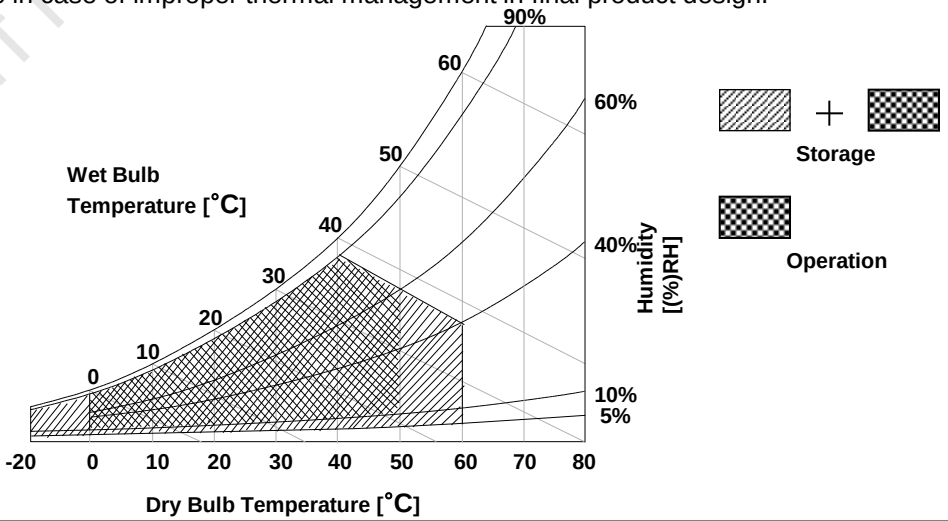
2. Absolute Maximum Ratings

The following items are maximum values which, if exceeded, may cause faulty operation or permanent damage to the LCD module.

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value		Unit	notes
		Min	Max		
Logic Power Voltage	VCC	-0.5	+4.0	VDC	1
Gate High Voltage	VGH	+18.0	+30.0	VDC	
Gate Low Voltage	VGL	-8.0	-4.0	VDC	
Source D-IC Analog Voltage	VDD	-0.3	+18.0	VDC	
Gamma Ref. Voltage (Upper)	VGMH	½VDD-0.5	VDD+0.5	VDC	
Gamma Ref. Voltage (Low)	VGML	-0.3	½ VDD+0.5	VDC	
Panel Front Temperature	TSUR	-	+68	˚C	4
Operating Temperature	TOP	0	+50	˚C	2,3
Storage Temperature**(without packing)**	TST	-20	+60	˚C	
Operating Ambient Humidity	HOP	10	90	%RH	
Storage Humidity	HST	**5**	90	%RH	

Note: 1. Ambient temperature condition (Ta = 25 ± 2 ˚C)
2. Temperature and relative humidity range are shown in the figure below. Wet bulb temperature should be Max 39 ˚C and no condensation of water.
3. Gravity mura can be guaranteed below 40℃ condition.
4. The maximum operating temperature is based on the test condition that the surface temperature of display area is less than or equal to 68 ℃ with LCD module alone in a temperature controlled chamber. Thermal management should be considered in final product design to prevent the surface temperature of display area from being over 68 ℃. The range of operating temperature may degrade in case of improper thermal management in final product design.



3. Electrical Specifications

3-1. Electrical Characteristics

It requires several power inputs. The VCC is the basic power of LCD Driving power sequence, Which is used to logic power voltage of Source D-IC and GIP.

Table 2. ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Condition	MIN	TYP	MAX	Unit	Note
Logic Power Voltage	VCC	-	3.0	3.3	3.6	V_{DC}	
Logic High Level Input Voltage	V_{IH}	-	2.3	-	VCC	V_{DC}	
Logic Low Level Input Voltage	V_{IL}	-	0	-	0.8	V_{DC}	
Source D-IC Analog Voltage	VDD	-	15.2	15.4	15.6	V_{DC}	
Half Source D-IC Analog Voltage	H_VDD	-	7.5	7.7	7.9	V_{DC}	6
Gamma Reference Voltage	V_{GMH}	(GMA1 ~ GMA9)	H_VDD+0.2V	-	VDD-0.2	V_{DC}	
	V_{GML}	(GMA10 ~ GMA18)	0.2	-	H_VDD-0.2V	V_{DC}	
Common Voltage	Vcom	Reverse	5.446	5.946	6.446	V	
mini-LVDS Clock frequency	CLK	3.0V≤VCC ≤3.6V			290	MHz	5
mini-LVDS input Voltage (Center)	V_{IB}	Mini-LVDS Clock and Data	0.7 + (VID/2)		(VCC-1.2) − VID / 2	V	
mini-LVDS input Voltage Distortion (Center)	ΔV_{IB}				0.8	V	
mini-LVDS differential Voltage range	V_{ID}		150		800	mV	
mini-LVDS differential Voltage range Dip	ΔV_{ID}		25		800	mV	
Gate High Voltage	VGH	@ 25℃	26.7	27	27.3	V_{DC}	
		@ 0℃	28.7	29	29.3	V_{DC}	
Gate Low Voltage	VGL	−	-5.2	-5.0	-4.8	V_{DC}	
GIP Bi-Scan Voltage	VGI_P	-	VGL	-	-	V_{DC}	
	VGI_N	-	-	-	VGH	V_{DC}	
GIP Refresh Voltage	VGH even/odd	-	VGL	-	VGH	V	
GIP Start Pulse Voltage	VST	-	VGL	-	VGH	V	
GIP Operating Clock	GCLK	-	VGL	-	VGH	V	
Total Power Current	I_{LCD}	-	-	201	261	mA	1
Total Power Consumption	PL_{CD}	-	-	2.4	3.1	Watt	1

Note: 1. The specified current and power consumption are under the V_{LCD}=12V., 25 ± 2°C, f_V=60Hz condition whereas mosaic pattern(8 x 6) is displayed and f_V is the frame frequency.
2. The above spec is based on the basic model.
3. All of the typical gate voltage should be controlled within 1% voltage level
4. Ripple voltage level is recommended under ±5% of typical voltage
5. In case of mini-LVDS signal spec, refer to Fig.2 for the more detail.
6. HVDD Voltage level is half of VDD and it should be between Gamma 7 and Gamma 8.

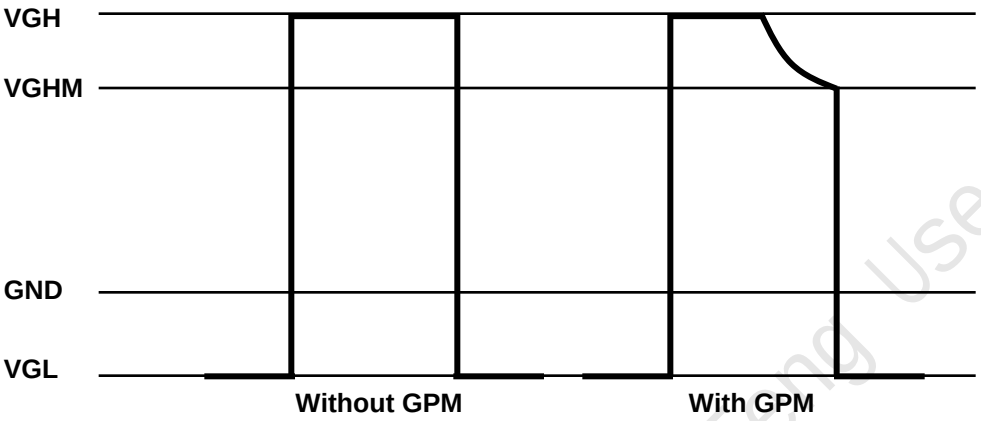


FIG.1 Gate Output Wave form without GPM and with GPM

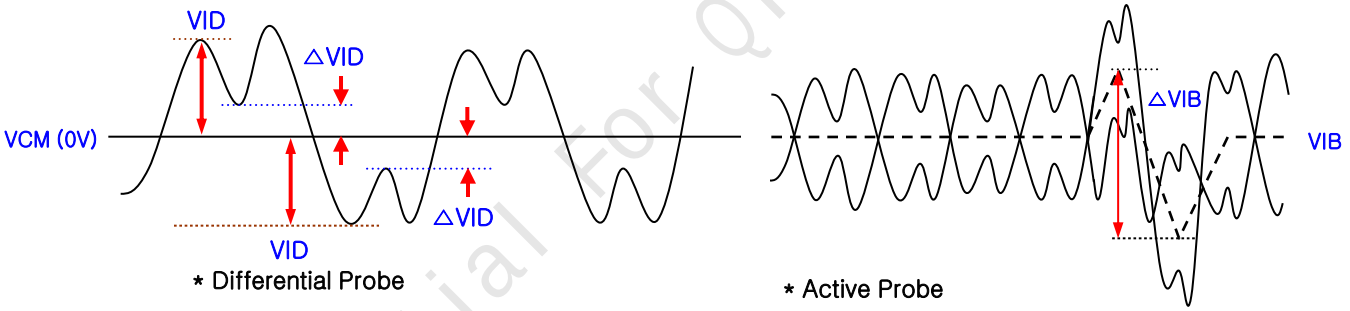


FIG.2 Description of VID, ΔVIB, ΔVID

* Source PCB

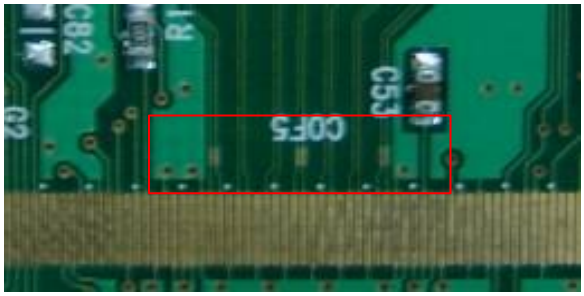


FIG. 3 Measure point

3-2. Interface Connections

This LCD module employs two kinds of interface connection, one 50-pin FFC connector are used for the module electronics.

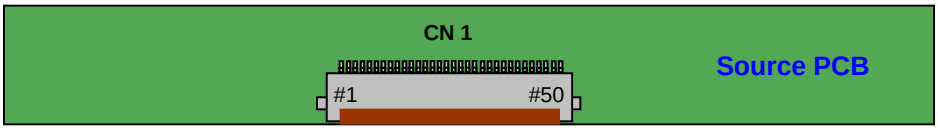
3-2-1. LCD Module

-LCD Connector (CN1): TF06L-50S-0.5SH (Manufactured by HRS) or Compatible

Table 3. MODULE CONNECTOR(CN1) PIN CONFIGURATION

No	Symbol	Description	No	Symbol	Description
1	NC	No Connection	26	VGI_N	GIP Bi-Scan (VGI_N = VGH)
2	SOE	Source Output Enable SIGNAL	27	VGI_P	GIP Bi-Scan (VGI_P = VGL)
3	GND	Ground	28	VGH_ODD	GIP Panel VDD for Odd GATE TFT
4	LCLK -	Mini LVDS Receiver Clock Signal(-)	29	VGH_EVEN	GIP Panel VDD for Even GATE TFT
5	LCLK +	Mini LVDS Receiver Clock Signal(+)	30	VGL	GATE Low Voltage
6	GND	Ground	31	VST	VERTICAL START PULSE
7	LVDS2 -	Mini LVDS Receiver Signal(2-)	32	GIP_Reset	GIP Reset
8	LVDS2 +	Mini LVDS Receiver Signal(2+)	33	GND	Ground
9	GND	Ground	34	VCOM_FB	VCOM Feed-Back Output
10	LVDS1 -	Mini LVDS Receiver Signal(1-)	35	VCOM	VCOM Input
11	LVDS1 +	Mini LVDS Receiver Signal(1+)	36	GND	Ground
12	GND	Ground	37	GMA 12	GAMMA VOLTAGE 12
13	LVDS0 -	Mini LVDS Receiver Signal(0-)	38	GMA 11	GAMMA VOLTAGE 11
14	LVDS0 +	Mini LVDS Receiver Signal(0+)	39	GMA 10	GAMMA VOLTAGE 10
15	GND	Ground	40	GMA 5	GAMMA VOLTAGE 5
16	GND	Ground	41	GMA 4	GAMMA VOLTAGE 4
17	VCC	Logic Power Supply Voltage	42	GMA 3	GAMMA VOLTAGE 3
18	VCC	Logic Power Supply Voltage	43	GND	Ground
19	GND	Ground	44	H_VDD	Half Driver Power Supply Voltage
20	GCLK1	GIP GATE Clock 1	45	H_VDD	Half Driver Power Supply Voltage
21	GCLK2	GIP GATE Clock 2	46	GND	Ground
22	GCLK3	GIP GATE Clock 3	47	VDD	Driver Power Supply Voltage
23	GCLK4	GIP GATE Clock 4	48	VDD	Driver Power Supply Voltage
24	GCLK5	GIP GATE Clock 5	49	GND	Ground
25	GCLK6	GIP GATE Clock 6	50	NC	No Connection

Note : 1. Please refer to application notes for details.
(**GIP** & **Half VDD & Gamma Voltage Setting**)



3-3. Signal Timing Specifications

Table 4. Timing Requirements

Parameter	Symbol	Condition	Min	Typ	Max	Unit	Note
Mini Clock pulse period	T_1		3.2	3.4		ns	1
Mini Clock pulse low period	T_2		1.6	-	-	ns	
Mini Clock pulse high period	T_3		1.6	-	-	ns	
Mini Data setup time	T_6		0.6	-	-	ns	
Mini Data hold time	T_7		0.6	-	-	ns	
Reset low to SOE rising time	T_8		0	-	-	ns	
SOE to Reset input time	T_9		200	-	-	ns	
Receiver off to SOE timing	T_{10}		9	-	-	CLK cycle	
Reset High Period	T_{13}		3			CLK cycle	
SOE signal Pulse Width	T_{16}		200			ns	

Note : 1. Mini-LVDS timing measure conditions
: 189MHz < Clock Frequency < 290MHz , 200mV < VID < 800mV @ 3.0<VCC<3.3
2. Setup time and hold time couldn't be satisfied at the same time

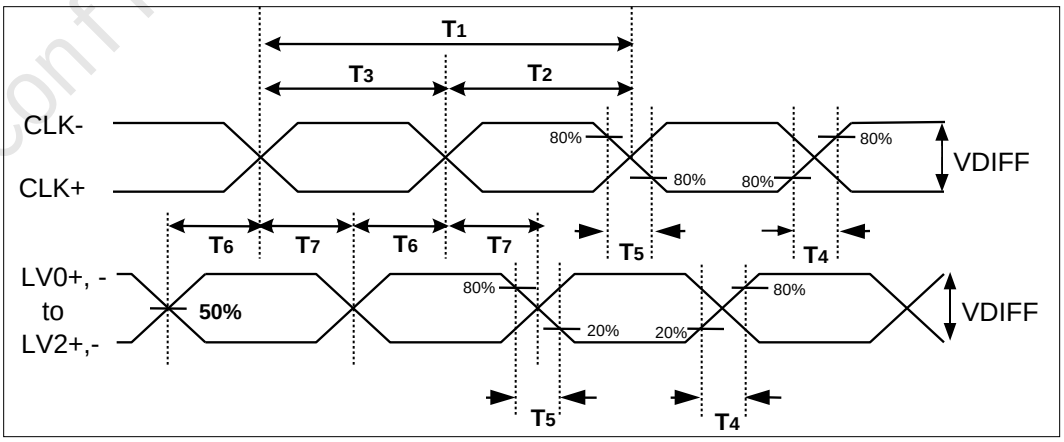


FIG.4 Source D-IC Input Data Latch Timing Waveform

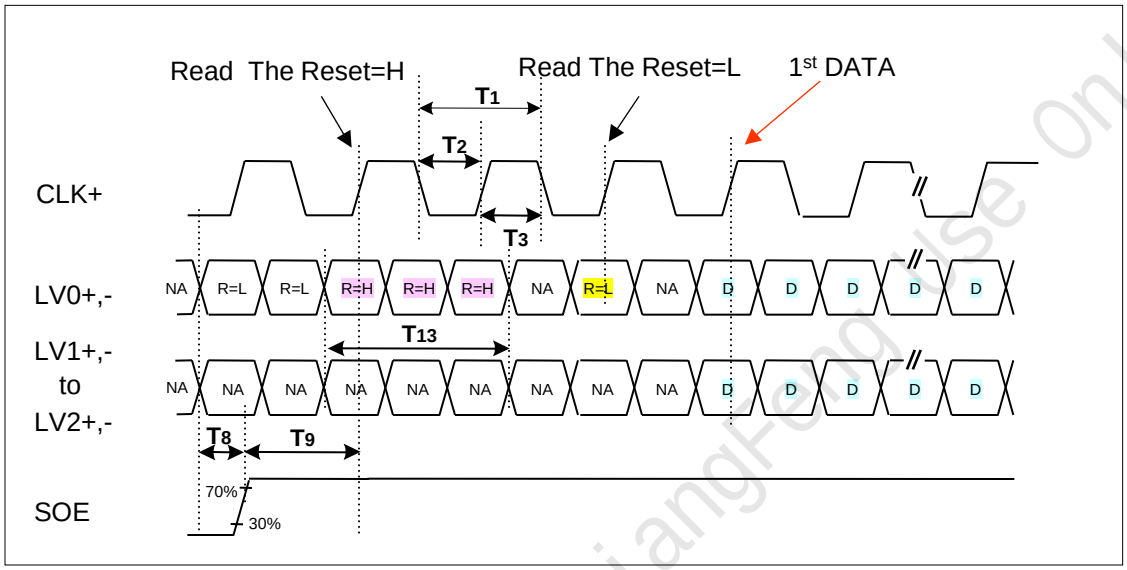


FIG.5-1 Input Data Timing for 1st Source D-IC Chip

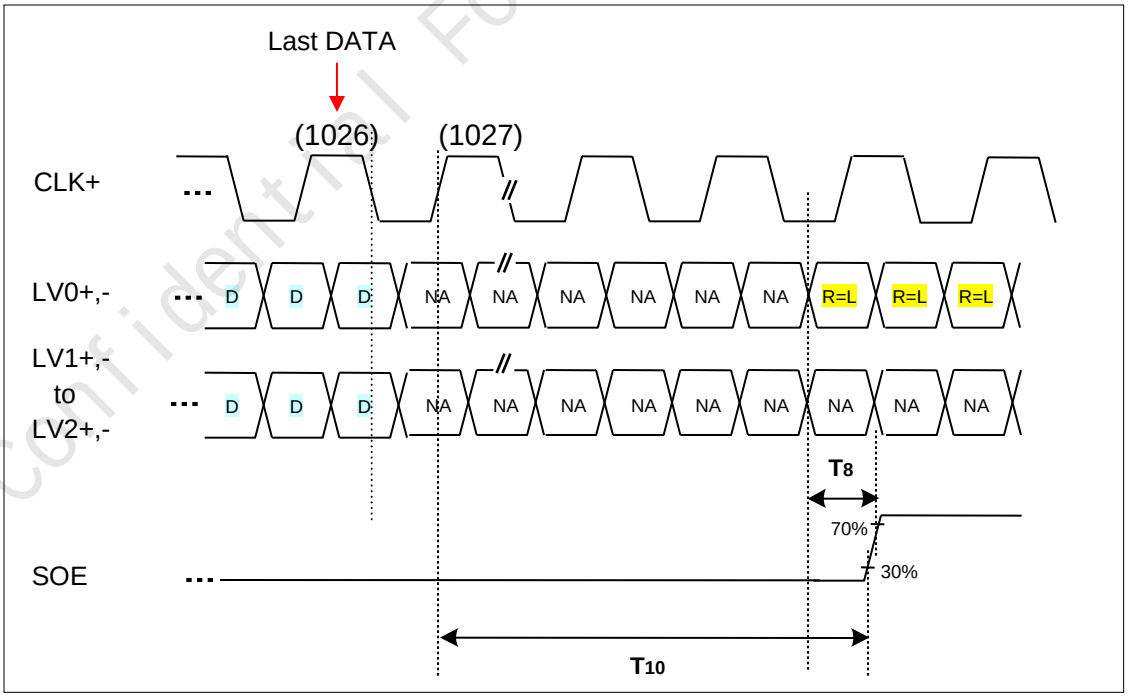


FIG.5-2 Last Data Latch to SOE Timing

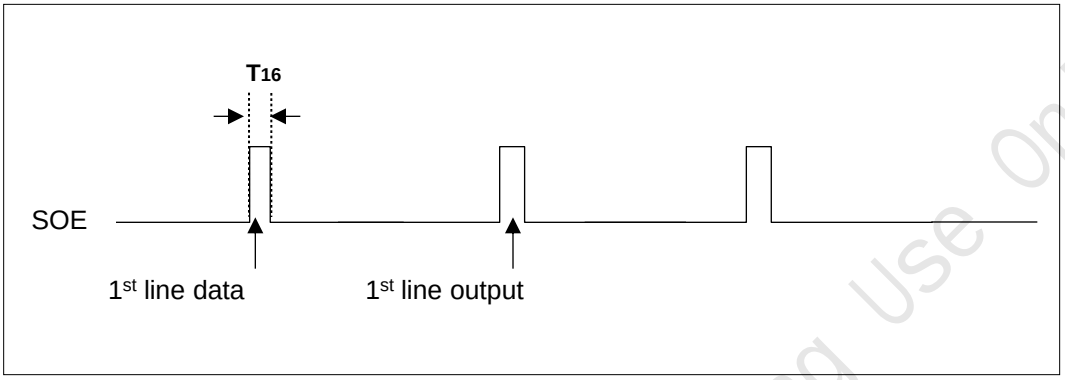
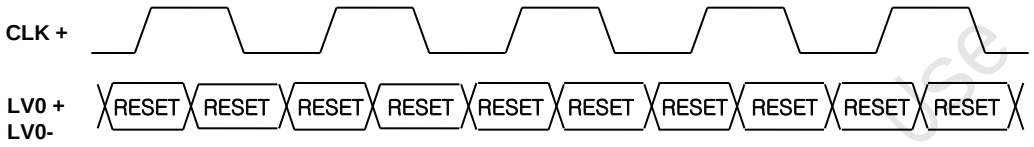


FIG.6 SOE Timing Waveform

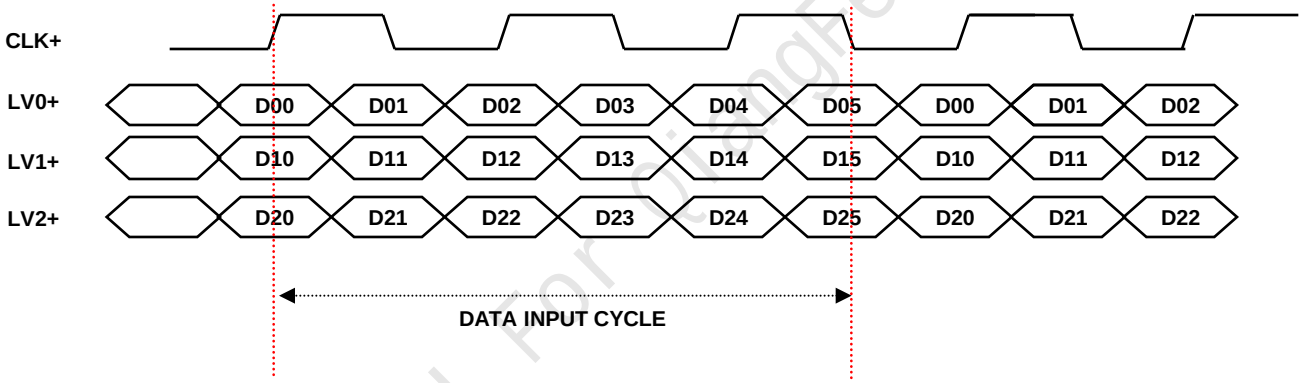
3-4. Data Mapping and Timing

Display data and control signal (RESET) are input to LV0 to LV2.

3-4-1. Control signal input mode



3-4-2. Display data input mode



3-4-3. Control Packet Data

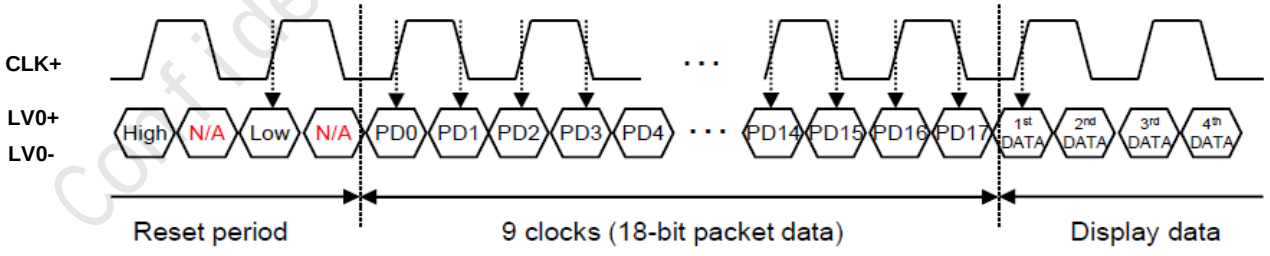


Fig. 5 Mini-LVDS Data

Note : 1. For more detail information about mini-LVDS interface control, please refer to LGD application note.

3-5. Panel Pixel Structure

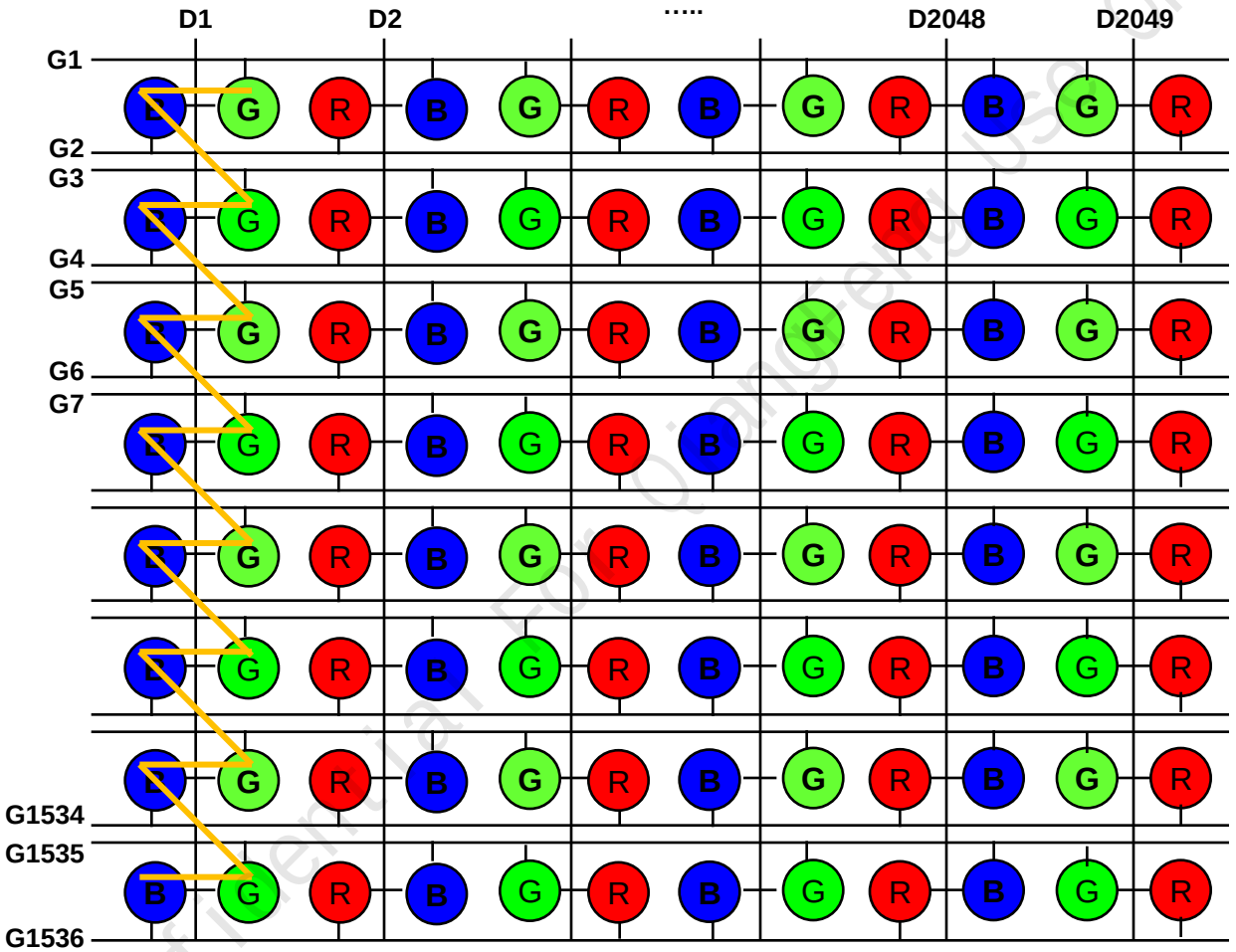


FIG.7 Panel Pixel Structure

3-6. Power Sequence

3-6-1. LCD Driving circuit

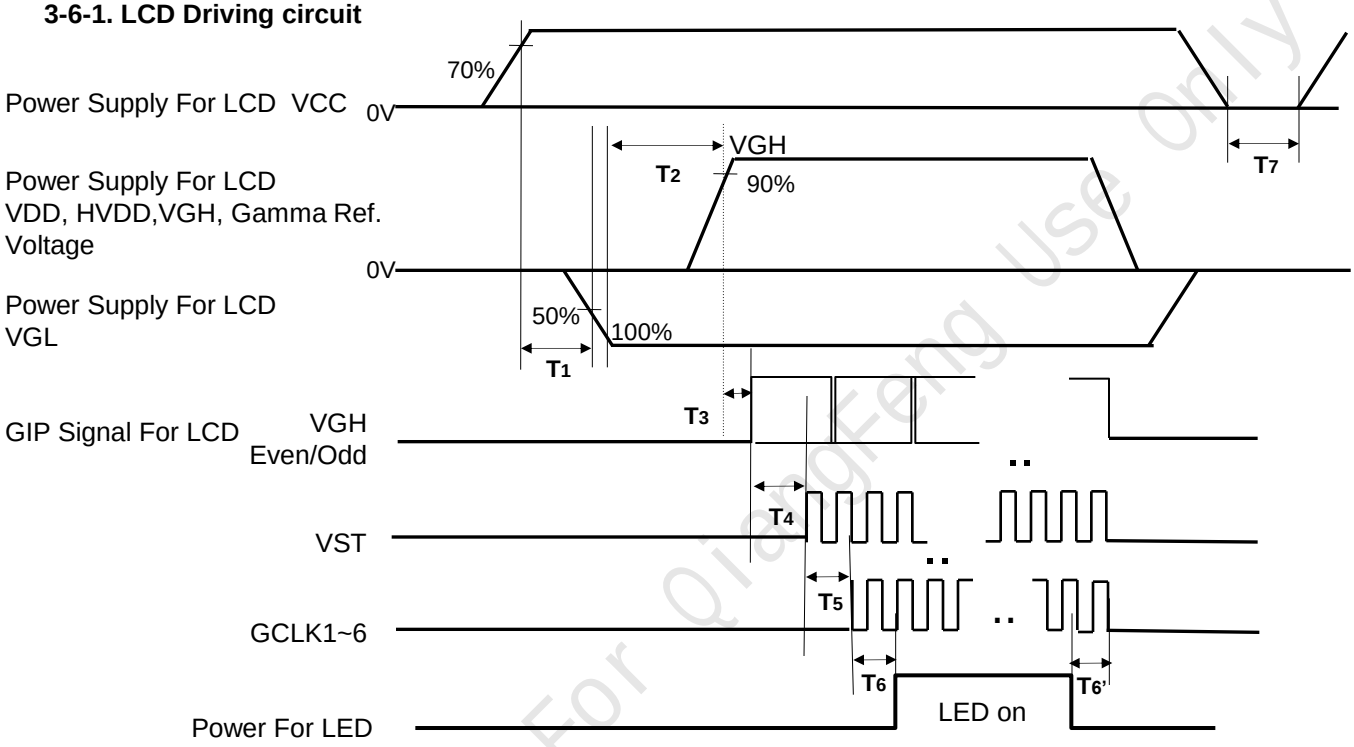


Table 5. POWER SEQUENCE

Ta= 25±2°C, fv=60Hz,

Parameter	Value			Unit	Note
	Min	Typ	Max		
T1	0.5	-	-	ms	
T2	0.5	-	-	ms	
T3	0	-	-	ms	
T4	10	-	-	ms	2
T5	0	-	-	ms	
T6 / T6'	20	-	-	ms	6
T7	2	-	-	s	

Note : 1. Power sequence for Source D-IC must follow the Case1 & 2.
※ Please refer to Appendix Ⅲ for more details.
2. VGH Even & Odd can not be “High at the same time.
3. Power Off Sequence order is reverse of Power On Condition including Source D-IC.
4. GCLK On/Off Sequence
: GCLK3 → GCLK2 →GCLK1 → GCLK6 → GCLK5 → GCLK4.
5. VGH Even/Odd transition time should be within V_blank
6. In case of T6’, If there is no abnormal display, no problem

4. Optical Specification

Optical characteristics are determined after the unit has been 'ON' and stable in a dark environment at 25±2°C. The values are specified at distance 50cm from the LCD surface at a viewing angle of Φ and θ equal to 0 °. FIG.8 shows additional information concerning the measurement equipment and method.

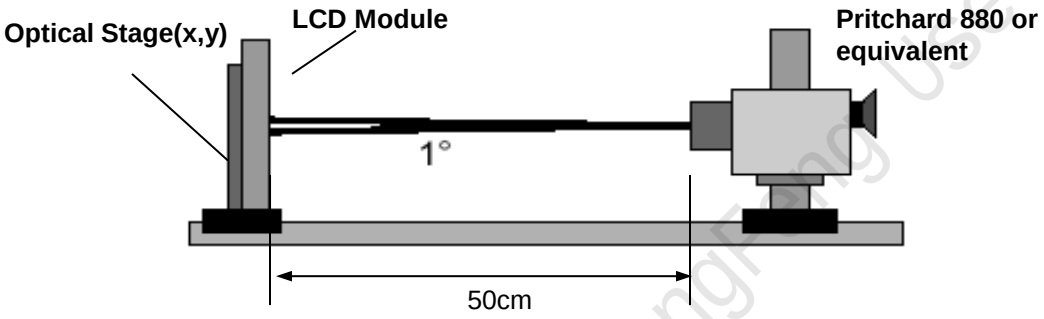


FIG.8 Optical Characteristic Measurement Equipment and Method

Table 6. OPTICAL CHARACTERISTICS

Ta= 25±2°C, VDD,H_VDD,VGH,VGL=typ, fv=60Hz, Dclk = 72.4Mhz, Light Source : D65 Standard

Parameter		Symbol	Value			Unit	notes
			Min	Typ	Max		
Contrast Ratio		CR	800	1100	-		1
Response Time	Rising	Tr	-	7	10	ms	2
	Falling	Tf	-	9	13		
Transmittance		T	5.52	6.14		%	3
Color Coordinates [CIE1931]	RED	Rx	Typ -0.03	0.662	Typ +0.03		
		Ry		0.327			
	GREEN	Gx		0.274			
		Gy		0.585			
	BLUE	Bx		0.136			
		By		0.119			
Viewing Angle (CR>10)							
	x axis, right(ϕ=0°)	θr	89	-	-	degree	4
	x axis, left (ϕ=180°)	θl	89	-	-		
	y axis, up (ϕ=90°)	θu	89	-	-		
	y axis, down (ϕ=270°)	θd	89	-	-		
Gray Scale			-	-	-		5

Note : 1. Contrast Ratio(CR) is defined mathematically as :

$$\text{Contrast Ratio} = \frac{\text{Surface Luminance with all white pixels}}{\text{Surface Luminance with all black pixels}}$$

It is measured at center 1-point.

The value of CR should be extracted using the LGD sheet structure (Diffuser/Prism/Prism)

※. Surface luminance are determined after the unit has been 'ON' and 1 Hour after lighting the backlight in a dark environment at 25±2°C. Surface luminance is the luminance value at center 1-point across the LCD surface 50cm from the surface with all pixels displaying white. For more information see the FIG.8.

2. Response time is the time required for the display to transition from G(0) to G(255) (Rise Time, Tr) and from G(0) to G(255) (Decay Time, Tf). For additional information see the FIG.9.

3. The value of transmittance should be extracted using the standard light source of D65

4. Viewing angle is the angle at which the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD module surface. For more information, see the FIG.10.

5. Gray scale specification
Gamma Value is approximately 2.2. For more information, see the Table 7.

Table 7. GRAY SCALE SPECIFICATION

Gray Level	Luminance [%] (Typ)
L0	0.08
L15	0.27
L31	1.04
L47	2.49
L63	4.68
L79	7.66
L95	11.5
L111	16.1
L127	21.6
L143	28.1
L159	35.4
L175	43.7
L191	53.0
L207	63.2
L223	74.5
L239	86.7
L255	100

Item	Gray Level	Gamma Ref.
Positive Voltage	L0	Gamma7
	L63	Gamma5
	L127	Gamma4
	L191	Gamma3
	L255	Gamma1
Negative Voltage	L255	Gamma14
	L191	Gamma12
	L127	Gamma11
	L63	Gamma10
	L0	Gamma8

Response time is defined as the following figure and shall be measured by switching the input signal for "Black" ~ "White" and "White" ~ "Black".

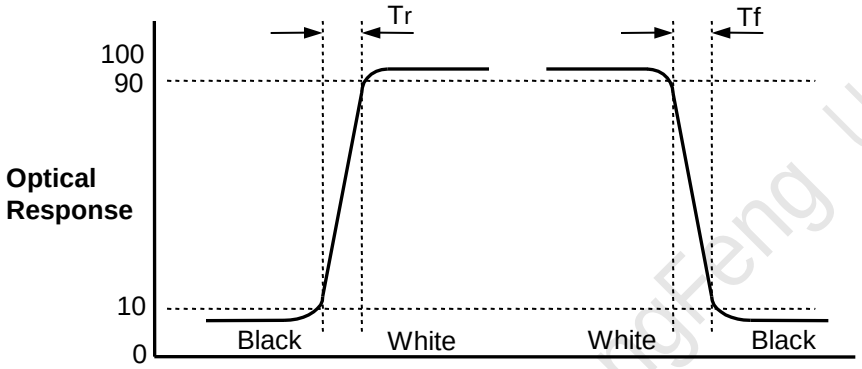


FIG.9 Response Time

Dimension of viewing angle range

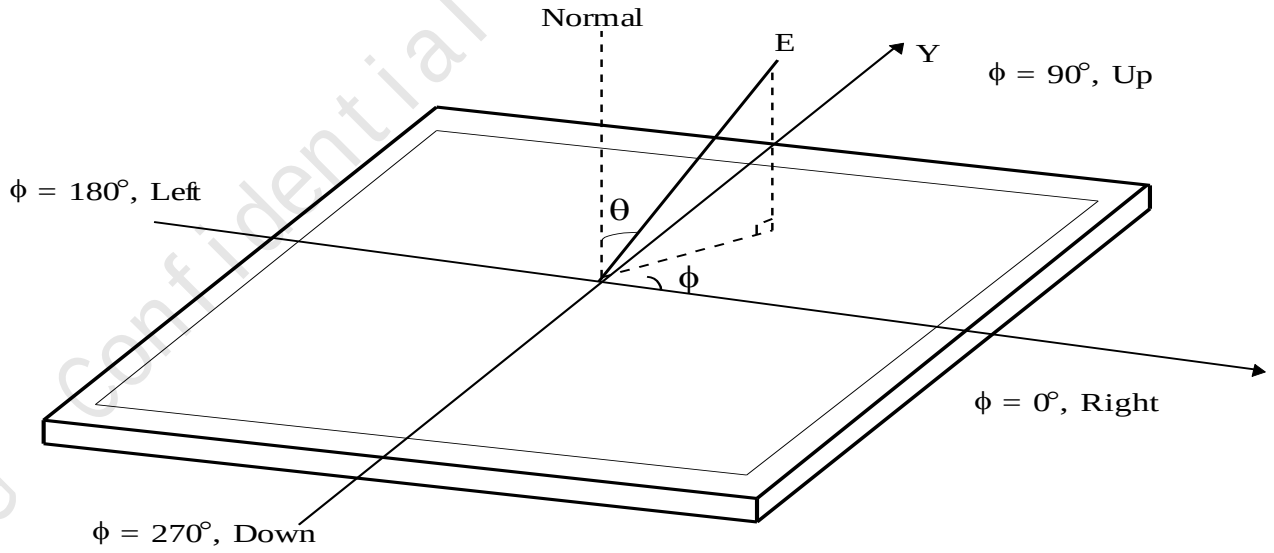


FIG.10 Viewing Angle

5. Mechanical Characteristics

Table 8 provides general mechanical characteristics.

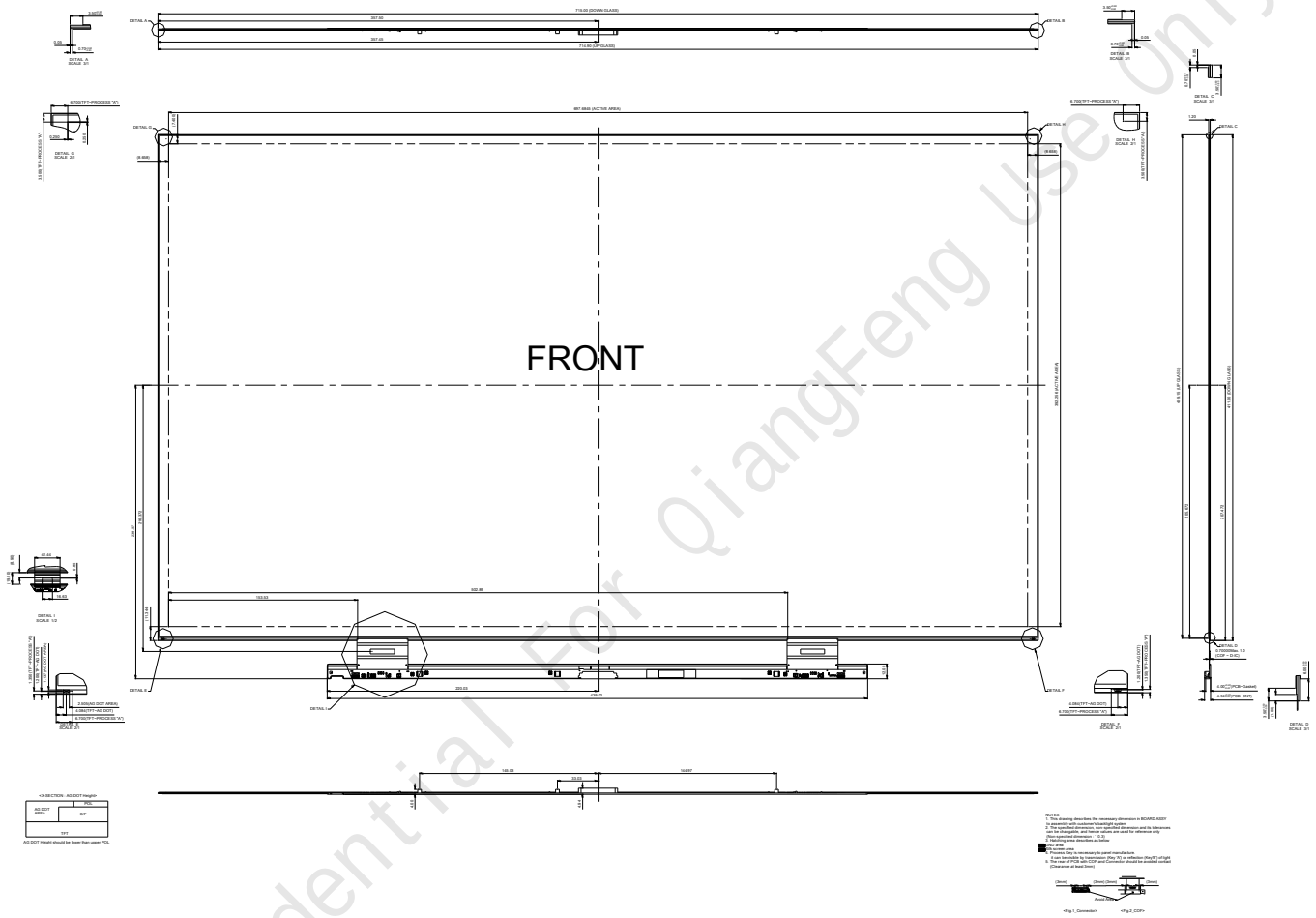
Table 8. MECHANICAL CHARACTERISTICS

Item	Value	
Outline Dimension (Only Glass)	Horizontal	715.0 mm
	Vertical	411.0 mm
	Thickness	1.2 mm
Active Display Area	Horizontal	697.6845 mm
	Vertical	392.256 mm
Weight	0.86 kg(Typ.)	
Surface Treatment	Hard coating(2H), Anti-glare treatment of the front polarizer (Haze 3%(Typ.))	

Note : Please refer to a mechanic drawing in terms of tolerance at the next page.

6. Mechanical Dimension

6-1. Board Assembly Dimension



7. Reliability

Table 9. ENVIRONMENT TEST CONDITION

No.	Test Item	Condition
1	High temperature storage test	Ta= 60˚C 90% 240h
2	Low temperature storage test	Ta= -20˚C 240h
3	High temperature operation test	Ta= 50˚C 50%RH 500h
4	Low temperature operation test	Ta= 0˚C 500h
5	Humidity condition Operation	Ta= 40 ˚C ,90%RH
6	Altitude operating storage / shipment	0 - 16,400 ft 0 - 40,000 ft

Note : Before and after Reliability test, Board ass'y should be operated with normal function.

8. International Standards

8-1. Safety

a) UL 60065, Underwriters Laboratories Inc.
Audio, Video and Similar Electronic Apparatus - Safety Requirements.

b) CAN/CSA C22.2 No.60065:03, Canadian Standards Association.
Audio, Video and Similar Electronic Apparatus - Safety Requirements.

c) IEC 60065, The International Electrotechnical Commission (IEC).
Audio, Video and Similar Electronic Apparatus - Safety Requirements.

8-2. Environment

a) RoHS, Directive **2011/65/EU** of the European Parliament and of the council of **8 June 2011**

9. Packing

9-1. Information of B/Ass'y Label

a) Lot Mark

A	B	C	D	E	F	G	H	I	J	K	L	M	N

A,B,C : SIZE(INCH)
D : YEAR
E : MONTH
F : DATE
G ~ N : SERIAL NO.

notes

1. YEAR

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mark	A	B	C	D	E	F	G	H	J	K

2. MONTH

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mark	1	2	3	4	5	6	7	8	9	A	B	C

3. DATE

DATE	1 ~ 9	10 ~ 31
MARK	1 ~ 9	A ~ X

* Except "I" and "O"

b) Location of Lot Mark

Serial NO. is printed on the label. The label is attached to the front side of the Left Source PCB.
This is subject to change without prior notice.

9-2. Packing Form

a) Package quantity in one Pallet : 272 pcs

b) Pallet Size : 1140 mm(L) X 910 mm(W) X 1110 mm(H)

10. Precautions

Please pay attention to the followings when you use this TFT LCD module.

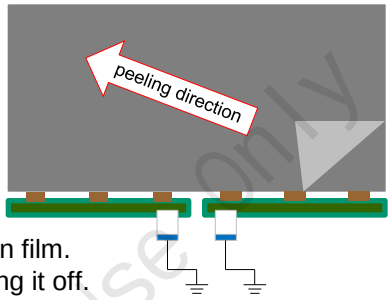
10-1. Handling Precautions

(1) Please attach the surface transparent protective film to the surface in order to protect the polarizer. Transparent protective plate should have sufficient strength in order to the resist external force.
(2) Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.
(3) Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment.
Do not touch the surface of polarizer for bare hand or greasy cloth.(Some cosmetics are detrimental to the polarizer.)
(4) After removing the protective film, when the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzine.
Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.
(5) Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
(6) Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly. Panel ground path should be connected to metal ground.
(7) Please make sure to avoid external forces applied to the Source PCB and D-IC during the process of handling or assembling the TV set. If not, It causes panel damage or malfunction.
(8) Panel and BLU should be protected from the static electricity. If not, it causes IC damage.
(9) Do not pull or fold the source D-IC which connect the source PCB and the panel.
(10) Panel(board ass'y) should be put on the BLU structure precisely to avoid mechanical impact.
(11) FFC Cable should be connected between System board and Source PCB correctly.
(12) Mechanical structure for backlight system should be designed for sustaining board ass'y safely.
(13) Surface temperature of the Component on PCB should be controlled under 100℃ (D-IC : 110℃) with TV Set status.
If not, problems such as IC damage or decrease of lifetime could occur.

10-2. Operating Precautions

(1) Response time depends on the temperature.(In lower temperature, it becomes longer.)
(2) Brightness depends on the temperature. (In lower temperature, it becomes lower.)
And in lower temperature, Stable time(required time that brightness is stable after turned on) becomes longer
(3) Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
(4) When fixed patterns are displayed for a long time, remnant image is likely to occur.
(5) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimized the interference.

10-3. Protection Film



(1) Please keep attaching the protection film before assembly.
(2) Please peel off the protection film slowly.
(3) Please peel off the protection film just like shown in the Fig.11
(4) Ionized air should be blown over during the peeling.
(5) Source PCB should be connected to the ground when peel off the protection film.
(6) The protection film should not be contacted to the source D-IC during peeling it off.

< Fig. 11 >

10-4. Storage Precautions

When storing modules as spares for a long time, the following precautions are necessary.

(1) Temperature : 5 ~ 40 ℃
(2) Humidity : 35 ~ 75 %RH
(3) Period : 6 months
(4) Control of ventilation and temperature is necessary.
(5) Please make sure to protect the product from strong light exposure, water or moisture. Be careful for condensation.
(6) Please keep the modules at a circumstance shown below Fig.12.

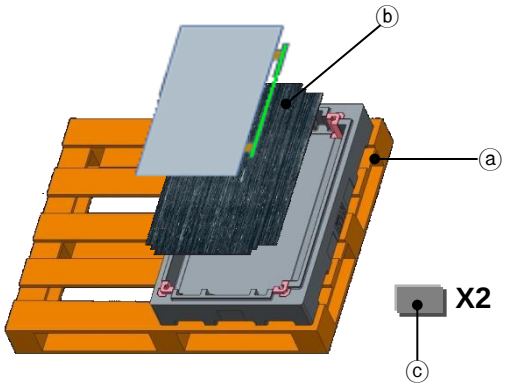
< Fig.12 >

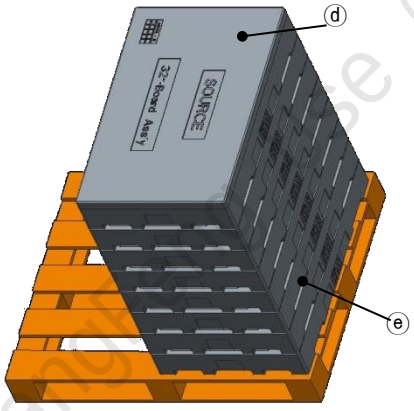
10-5. Packing Precautions

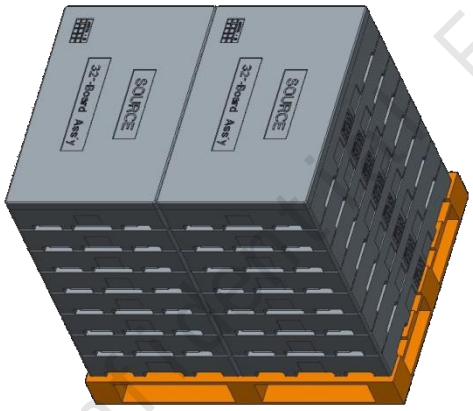
Product assembled into module should be stored in the Al-bag(cover case).

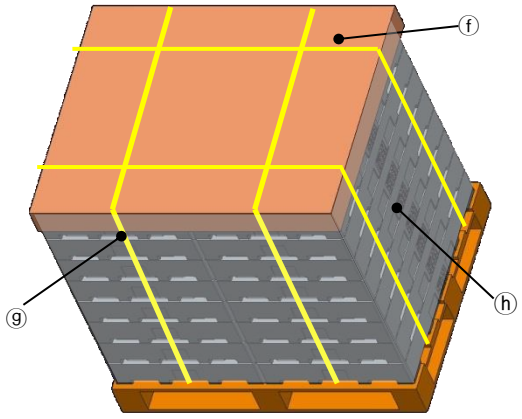
APPENDIX-I-1

■ Pallet Ass'y





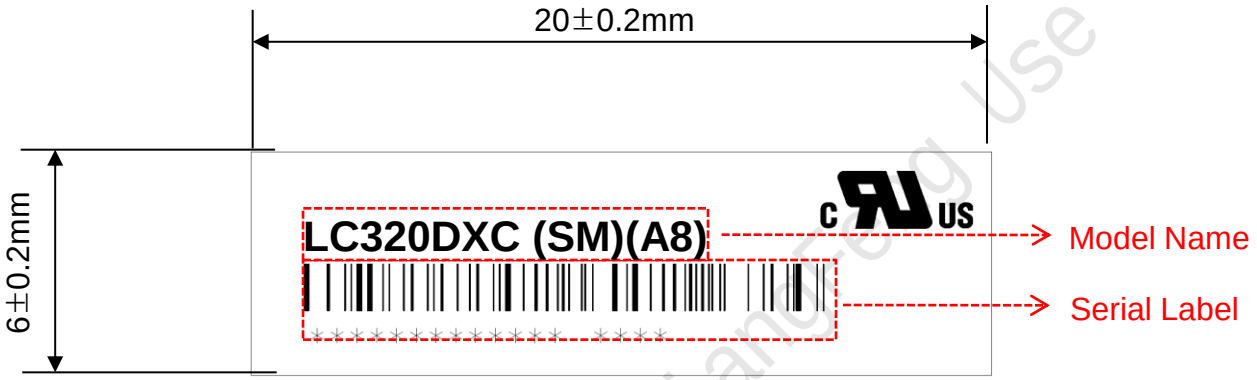




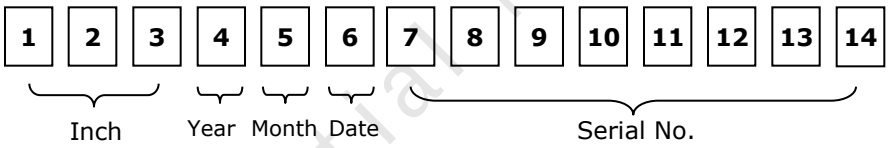
No.	Description	Material
ⓐ	Pallet	Plywood
ⓑ	PE Sheet	LDPE
ⓒ	Desiccant	Power Dry
ⓓ	Top Packing	EPS
ⓔ	Bottom Packing	EPS
ⓕ	Angle Packing	Single Wall
ⓖ	Band	PP
ⓗ	Wrap	L-LDPE

 # APPENDIX- II-1

■ Serial Label

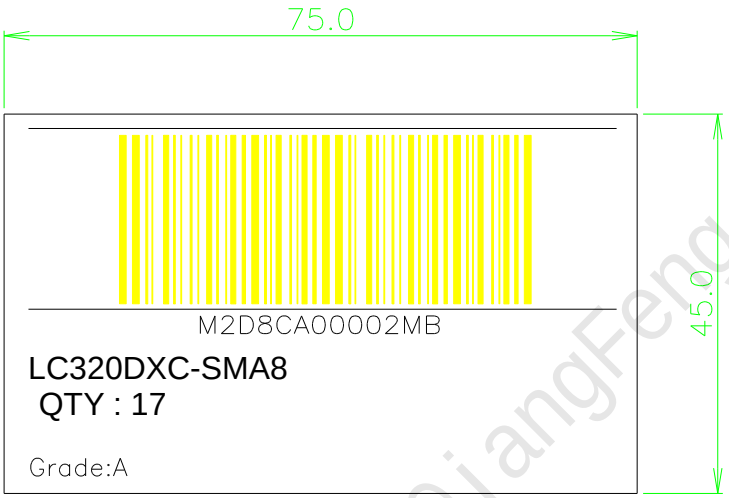


■ Serial No. (See CAS page 21 for more information)

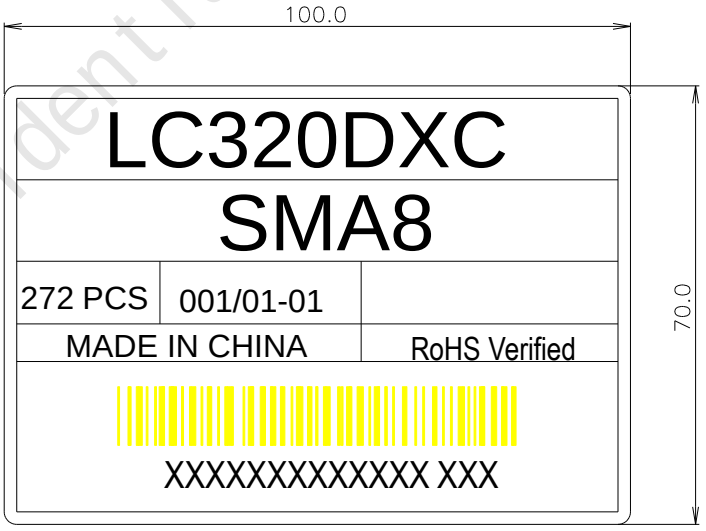


 # APPENDIX- II-2

■ BOX Label



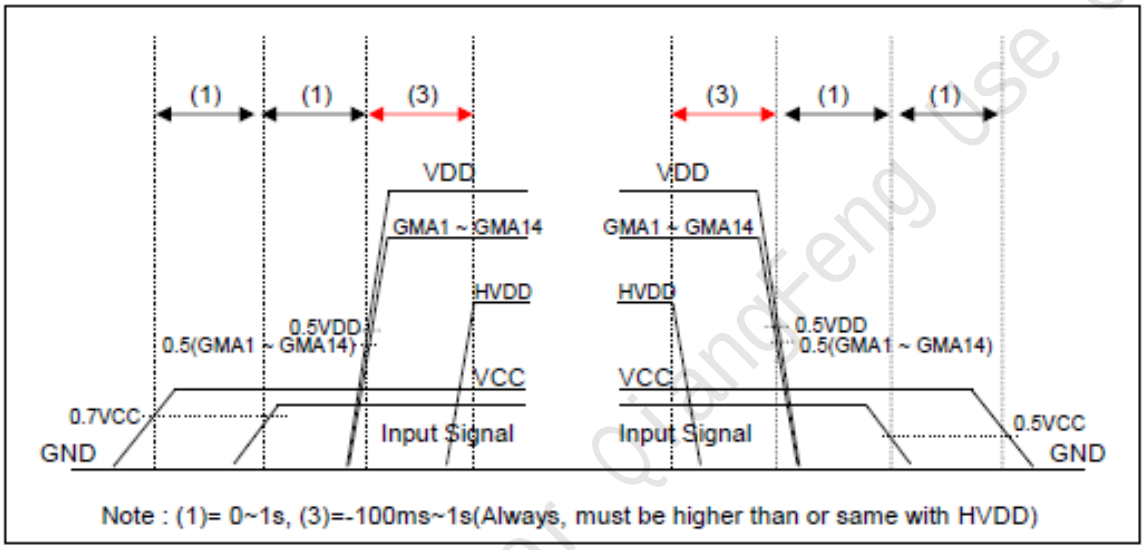
■ Pallet Label



APPENDIX- III

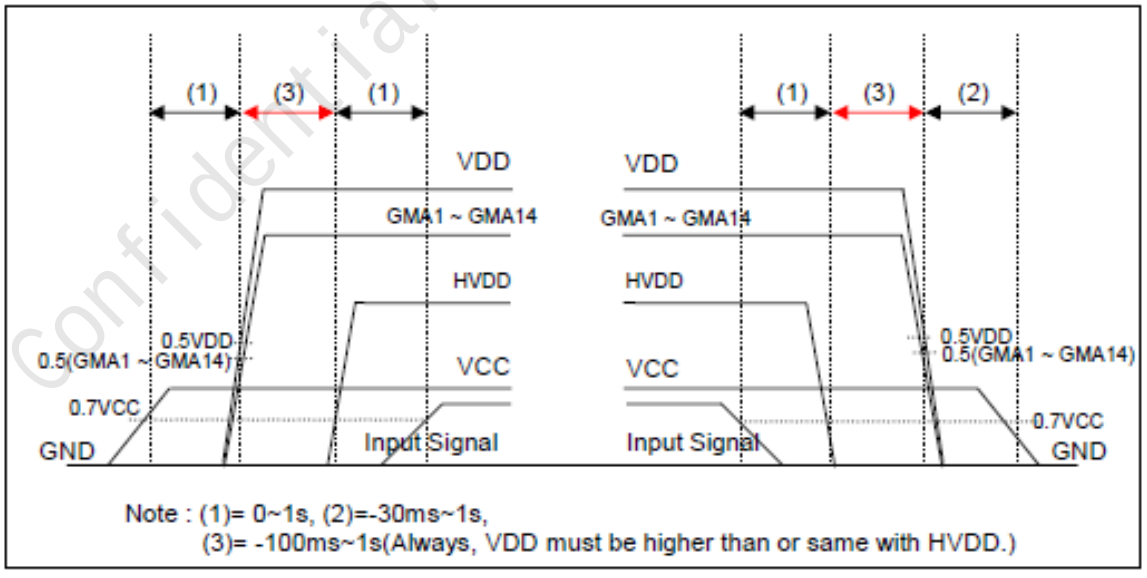
■ Source D-IC Power Sequence

▶ CASE1



Note : (1)= 0~1s, (3)=-100ms~1s(Always, must be higher than or same with HVDD)

▶ CASE2



Note : (1)= 0~1s, (2)=-30ms~1s,
(3)= -100ms~1s(Always, VDD must be higher than or same with HVDD.)

- Input Signal : mini-LVDS