SPECIFICATION
FOR
APPROVAL

( ) Preliminary Specification
(●) Final Specification

Title	12.3"FHD (1,920 X RGB X 720) TFT- LCD

BUYER	Bosch
MODEL	8928554222

SUPPLIER	LG Display Co., Ltd.
MODEL	LA123WF5
SUFFIX	SL01

SIGNATURE	DATE
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Record of Revisions

Revision No.	Revision Date	Page	Description	Note
0.0	Jan.8.2016	-	Preliminary	
0.1	Mar.18.2016	10	Changed USER CONNECTOR PIN CONFIGURATION - Changed Description of No.6 Pin.	
0.2	Jul.19.2016	7	Updated Table 2. - Updated Typ. of I_{VCC}&I_{VDD}&I_{VGH}&I_{VGL}&I_{VCOM}	
		8	Changed Note.1 - Changed Vref. 4, 5, 6, 7, 8, 12, 14, 15 Voltage	
		9	Changed Table3. - Changed LED Current & LED Power - Added LED Voltage Deviation Spec	
		35	Add Appendix III - Added GMA&AVDD&GND Impedance	
		5	Changed General Description - Added Weight Spec	
		23	Changed Table9. - Added Weight Spec	
		24, 25	Changed Front View, Rear View	
		29	Changed LCM Label info.	
0.3	Oct.04.2016	35	Changed Appendix III - Changed GMA&AVDD&GND Impedance(R-String Rev.)	
0.4	Jun.19.2017	1	Changed APPROVED box	
		7	Changed VGL max. voltage and VGH-VGL min. voltage	
		8	Updated the Note 1. Gamma voltage	
		9	Updated the Table 3	
		10	Changed the I/O information of PIN No.6 in Table 4-1	
		11	Changed the I/O information of PIN No.63 in Table 4-1	
		12	Added Note. 7 of Table 7-1	
		24	Updated the drawing	
		25	Updated the drawing	
		26	Added 3) of 8-1	
		27	Changed c) LCM Label info	
1.0	Aug. 18.2017	8	Update Max. Current in Table 2	
		9	Update Reference Gamma Voltage in Note 1	
		15	Update Min. F_{CLK} in AC Characteristic table	
		19	Update Min. spec. in Table 5	

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Record of Revisions

Revision No.	Revision Date	Page	Description	Note
		20	Add the Note 8.	
		25	Update Drawing	
		26	Update Drawing	
		27	Update the Reliability Flow Test	
		29	Update LCM Label information	
1.1	Nov.21.2017	9	Update Gamma reference voltage	
		21	Update Contrast Ratio spec. in Table.8	
		25	Update mechanical drawing	
		26	Update mechanical drawing	
1.2	Mar.16.2018	2	Update the contents table	
		8	Update the Common Voltage Current in Table2	
		9	Changed Note.1 and Value requested by customer	
		10	Add Note 6 LED information	
		21	Changed Table 8 - Added image sticking Value - Added White Color Tolerance at 85℃	
		22	Add Note 6	
		23	Change Note6 → Note7	
		24	Update Table 9	
		25	Added the dimension of viewing area	
		28	Changed 8-2 judgment Criteria	
		30	Change LCM Label info	
1.3	Apr.18.2018	23	Change note. 7	

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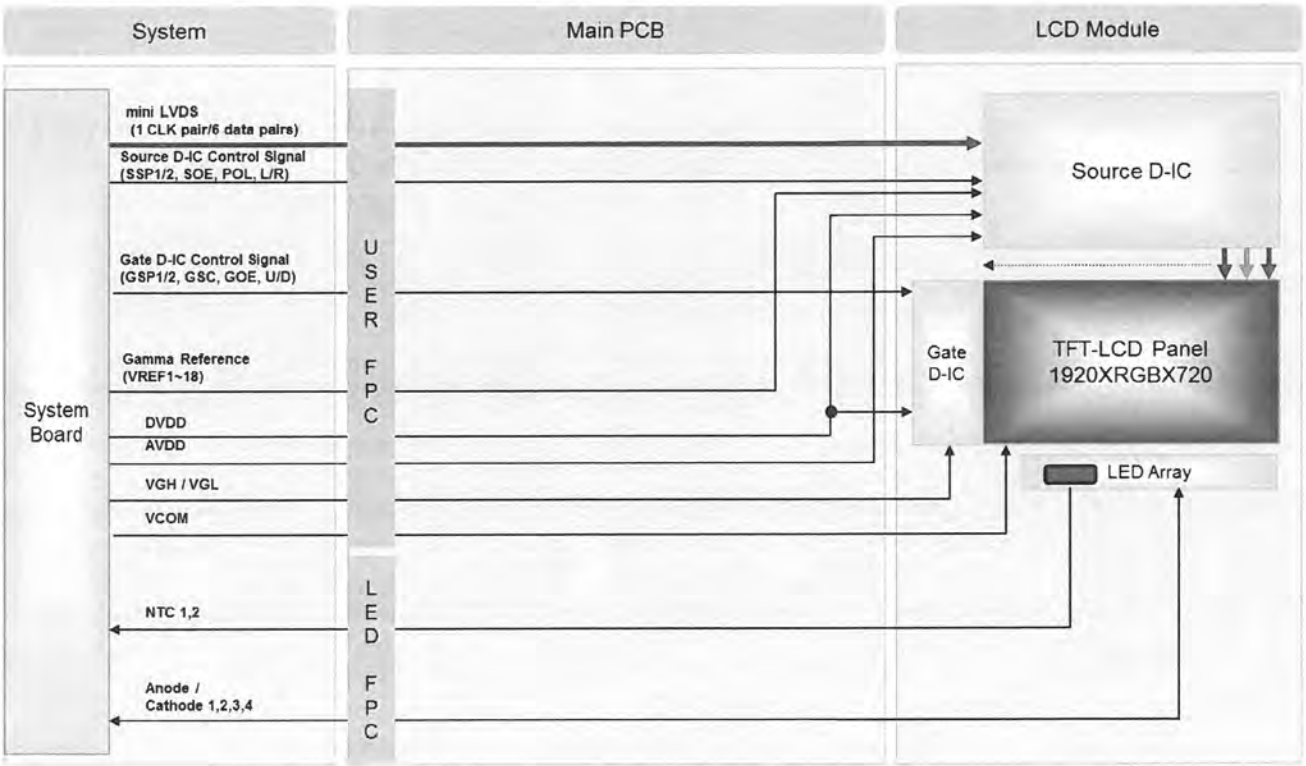
1. Summary

This module utilizes amorphous silicon thin film transistors and a 8:3 aspect ratio. The 12.3" active matrix liquid crystal display allows 16,777,216 colors to be displayed by mini-LVDS interface is available. The applications are Cluster/CID (Center Information Display) and others AV system.

2. Features

- Utilizes a panel with a 8:3 aspect ratio.
- The 12.3" screen produces a high resolution image that is composed of 4,147,200 pixel elements in a stripe arrangement.
- By adopting In Plane Switching (IPS) technology, provide a wide viewing angle.
- By adopting an active matrix drive, a picture with high contrast is realized.
- By using of COG mounting technology, the module became thin, light and compact.
- By adopting a high aperture panel, high transmittance color filter and high transmission polarizing plates, transmittance ratio is realized.
- Gray scale or the brightness of the sub-pixel color is determined with a 8-bit gray scale signal.
- By adopting mini-LVDS interface, the module has a good performance in terms of EMI.



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3. General Description

Active Screen Size	12.3 inches (312.42mm) diagonal
Outline Dimension	308.00mm (H) × 123.92 mm (V) X 8.0 mm (D) (Typ.)
Pixel Pitch	0.1521 mm x 0.1521 mm
Pixel Format	1,920 horiz. by 720 vert. Pixels, RGB stripe arrangement
Color Depth	8bit(D), 16,777,216 colors
Luminance, White	776 cd/m^2 (Min., Center@-40~70℃, Before WP adjustment)
Viewing Angle (CR>15)	Viewing angle free (R/L 170 (Min.), U/D 170 (Min.))
Weight	410 g (Typ.), 420 g (Max.)
Display Mode	Transmissive mode, Normally Black
Surface Treatment	Hard coating (3H)

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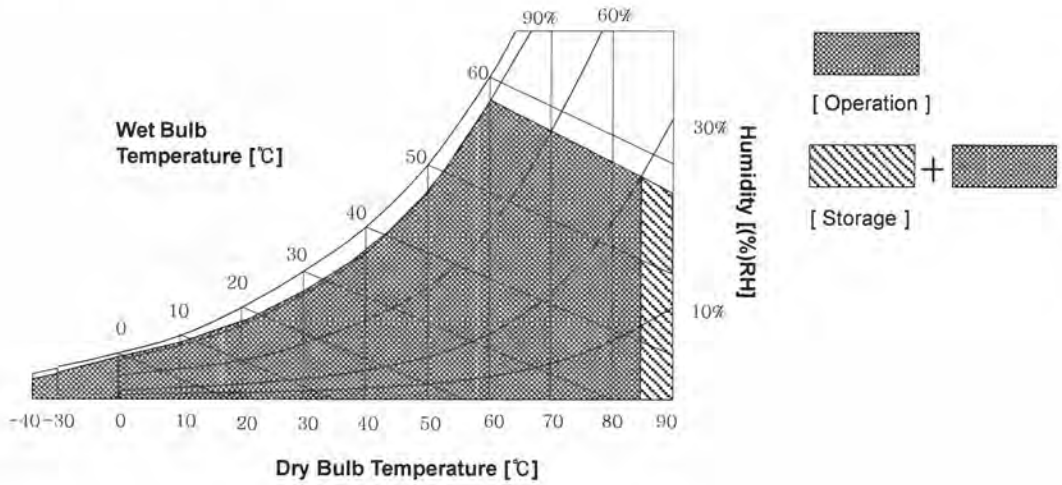
4. Absolute Maximum Ratings

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

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value		Unit	Note
		Min	Max		
Logic Supply Voltage	DVDD	-0.3	3.6	V	
Logic Input Signal	V_{LOGIC}	-0.3	3.6	V	
Gamma Reference Voltage	VREF1~9	0.5AVDD-0.3	AVDD+0.3	V	
	VREF1~9	-0.3	0.5AVDD+0.3		
Analog Supply Voltage	AVDD	-0.3	14.5	V	
Gate Driver Voltage	VGH-VGL	-0.3	38.0	V	
	VGL	-11.0	0.3	V	
Storage Temperature	T_{ST}	-40	90	°C	1
Operating Temperature	T_{OP}	-40	85	°C	1,2,3

Note1. Temperature and relative humidity range are shown in the figure below.
Wet bulb temperature should be Max. 58℃. Condensation of dew must be avoided,
because it may cause electrical current leakage, and deterioration of performance and quality.
2. The operating temperature means that LCD Module guarantees operation of the circuit.
3. This temperature is ambient temperature with regard to the heat which is generated under operation of circuit and backlight on. (reference value)



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5. Electrical Specifications

5-1. Electrical Characteristics

It requires two power inputs. One is employed to power for the LCD circuit. The other is used for the LED backlight.

Table 2. LCD DRIVING CIRCUIT ELECTRICAL CHARACTERISTICS

Parameter			Symbol	Value			Unit	Note
				Min.	Typ.	Max.		
Source Driver	Digital Supply Voltage		DVDD	3	3.3	3.6	V	
	Supply Voltage		AVDD	12.5	13	13.5	V	
	Gamma Reference Voltage		VREF (1~18)	GND+0.2	-	AVDD-0.2	V	1
Gate Driver	TFT	Hi	VGH	16	22	24	V	2
		Low	VGL	-11	-9.5	-9	V	
		Voltage Difference	VGH-VGL	25	-	35	V	
	Logic Supply Voltage		DVDD	3	3.3	3.6	V	
Common Voltage			VCOM	5.0	5.4	6.0	V	3
Digital Supply Voltage Current			I_{VCC}	-	25	35	mA	4
Source Driver Analog Voltage Current			I_{VDD}	-	30	35	mA	
Gate High Voltage Current			I_{VGH}	-	1	3	mA	
Gate Low Voltage Current			I_{VGL}	-	1.5	3	mA	
Common Voltage Current			I_{VCOM}	-	0.01	1	mA	

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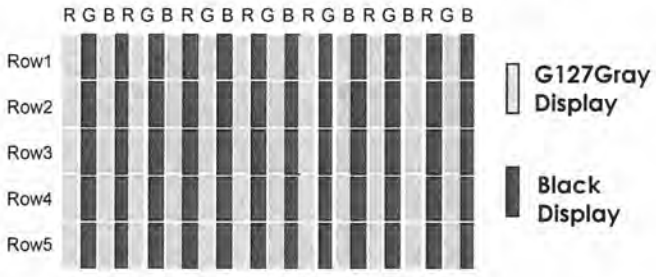
Notes 1. Reference Gamma Correction Voltage . [VREF1 to VREF18]
Each gray gamma should not be too much deviated each other and each gamma tolerance should be 30~40mV.

Symbol	Value			Unit
	Min	Typ	Max	
VREF1	12.350	12.450	12.550	V
VREF2	12.300	12.400	12.500	
VREF3	10.963	11.063	11.163	
VREF4	10.295	10.395	10.495	
VREF5	9.377	9.477	9.577	
VREF6	8.518	8.618	8.718	
VREF7	8.022	8.072	8.122	
VREF8	6.900	6.950	7.000	
VREF9	6.820	6.850	6.880	
VREF10	6.270	6.300	6.330	
VREF11	6.170	6.200	6.230	
VREF12	5.048	5.078	5.108	
VREF13	4.502	4.532	4.562	
VREF14	3.633	3.663	3.693	
VREF15	2.725	2.755	2.785	
VREF16	2.057	2.087	2.117	
VREF17	0.670	0.700	0.730	
VREF18	0.620	0.650	0.680	

[VREF1 > VREF2 > ····· > VREF9 > VREF10 >····· > VREF17 > VREF18]

2. Gate Pulse Modulation Function is recommended for VGH. (Appendix I)
3. VCOM adjustment method.
 1) Recommend
  * Pattern : Column Inversion Flicker pattern
  * VCOM adjustment temperature : 20~40℃
  * Method
   - Adjust the VCOM Voltage to the minimum flicker phenomenon.
   - adjustment must be finished within 30 sec
   - Precaution : 1hr waiting after failed adjustment VCOM. For remove remained panel DC charge



Column Inversion Flicker Pattern

 2) Using Default VCOM
  * Recommend Default VCOM : 5.0V ~ 6.0V
  * If using Default Vcom, During saturation, Flicker can be seen.
4. DVDD=3.3V, AVDD=13.0V, VCOM = 5.4V, VGH = 22.0V, VGL = -9.5V, VREF1=12.45V, VREF18=0.65V, fv = 60Hz, fCLK = 219.92MHz, White(256 Gray) Pattern, with Probe Load.

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Table 3. BACKLIGHT ELECTRICAL CHARACTERISTICS

Parameter		Symbol	Values			Unit	Note
			Min	Typ	Max		
LED Current	-40℃	I_{LED}	-	106	-	mA	1,5
	+25℃		-	78	-		
	+70℃		-	91	-		
LED Voltage	-40℃	V_{LED}	32.2	35.7	36.9	V	1,2
	+25℃		29.7	33.0	34.1		
	+70℃		28.7	31.9	33.0		
LED Power	+25℃	P_{LED}	-	10.3	10.6	W	1,3
LED Chain		-	-	4	-	EA	1
LED Voltage Deviation (Per Chain)		V_{chain}	-	-	1	V	-
Lifetime (@25℃)			10,000	-	-	Hrs	4

Note 1. This values applies to one chain of one LED Array. LCD includes 4 LED Array.
2. The LED Voltage values are defined from Anode to Cathode at Typ. LED Current.
3. LED Power :
   Typ. LED Power = Typ. LED Current x +25℃ Typ. LED Voltage +25℃ x LED Chain number
   Max. LED Power = Typ.. LED Current x +25℃ Max. LED Voltage +25℃ x LED Chain number
4. The life time is determined as the time at which brightness of LED is 80% compare to that of initial value at the typical LED current.
5. DC current dimming is recommended for LED control.
   If PWM dimming is needed, PWM frequency should be optimized for minimal wavy and audible noise.
6. LED P/N: NFSW157HT-HG
   Intensity Rank: P11s14 / P11s15 / P12s14 , Color Rank:Btn24 Btn25 / Btn26

Fig. 5-1) LED PWM Duty ratio

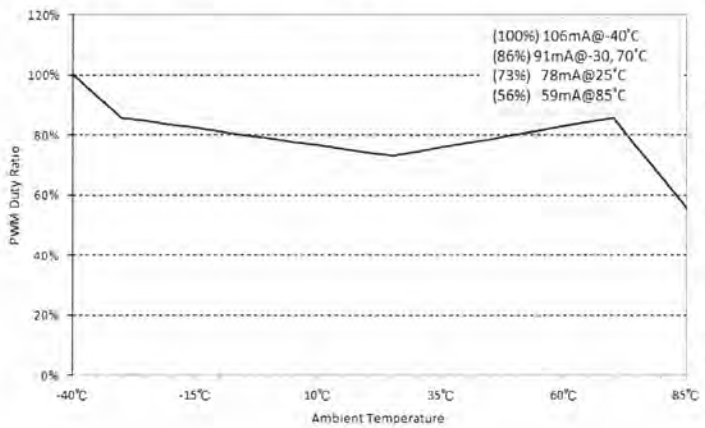
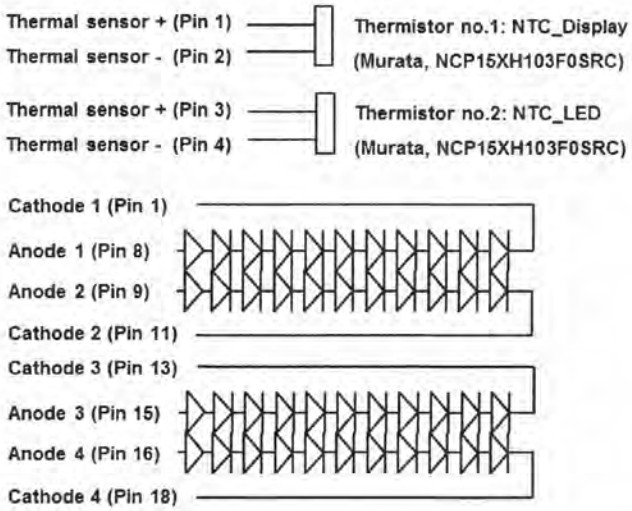


Fig. 5-2) LED Array schematic



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5-2. Interface Connections

5-2-1. User Connector Pin Configuration

The electronics interface connector is a model FH28D-64S-0.5SH manufactured by Hirose or equivalent.

Table 4-1. USER CONNECTOR PIN CONFIGURATION

Pin No	Name	I/O	Description	Note
1	GND	I	Ground	1
2	DVDD	I	LCD Power Supply (+3.3V)	2
3	DVDD	I	LCD Power Supply (+3.3V)	
4	U/D	I	Vertical Scan Direction	3
5	GSP1	I	Start pulse for gate DIC	
6	GSP2	O	Output pulse for gate DIC	
7	GSC	I	Shift clock for gate DIC	
8	GOE	I	Output enable for Gate DIC	
9	GND	I	Ground	1
10	VGL	I	Gate Off voltage	
11	N.C.	-	No connection	4
12	VGH	I	Gate On voltage	5
13	GND	I	Ground	1
14	VCOM	I	Common electrode power supply	6
15	VCOM	I	Common electrode power supply	
16	GND	I	Ground	1
17	AVDD	I	Analog power supply	7
18	AVDD	I	Analog power supply	
19	VREF1	I	Gamma Reference Voltage	
20	VREF2	I	Gamma Reference Voltage	
21	VREF3	I	Gamma Reference Voltage	
22	VREF4	I	Gamma Reference Voltage	
23	VREF5	I	Gamma Reference Voltage	
24	VREF6	I	Gamma Reference Voltage	
25	VREF7	I	Gamma Reference Voltage	
26	VREF8	I	Gamma Reference Voltage	
27	VREF9	I	Gamma Reference Voltage	
28	VREF10	I	Gamma Reference Voltage	
29	VREF11	I	Gamma Reference Voltage	
30	VREF12	I	Gamma Reference Voltage	
31	VREF13	I	Gamma Reference Voltage	
32	VREF14	I	Gamma Reference Voltage	
33	VREF15	I	Gamma Reference Voltage	
34	VREF16	I	Gamma Reference Voltage	
35	VREF17	I	Gamma Reference Voltage	
36	VREF18	I	Gamma Reference Voltage	
37	GND	I	Ground	1

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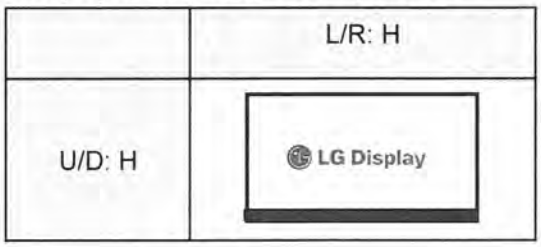
Pin No	Name	I/O	Description	Note
38	LVR__P_O	I	Mini LVDS input data (red, pos)	
39	LVR__N_O	I	Mini LVDS input data (red, neg)	
40	GND	I	Ground	1
41	LVR__P_E	I	Mini LVDS input data (red, pos)	
42	LVR__N_E	I	Mini LVDS input data (red, neg)	
43	GND	I	Ground	1
44	LVG__P_O	I	Mini LVDS input data (green, pos)	
45	LVG__N_O	I	Mini LVDS input data (green, neg)	
46	GND	I	Ground	1
47	LVG__P_E	I	Mini LVDS input data (green, pos)	
48	LVG__N_E	I	Mini LVDS input data (green, neg)	
49	GND	I	Ground	1
50	LVCLKP	I	Mini LVDS input clock (pos)	
51	LVCLKN	I	Mini LVDS input clock (neg)	
52	GND	I	Ground	1
53	LVB__P_O	I	Mini LVDS input data (blue, pos)	
54	LVB__N_O	I	Mini LVDS input data (blue, neg)	
55	GND	I	Ground	1
56	LVB__P_E	I	Mini LVDS input data (blue, pos)	
57	LVB__N_E	I	Mini LVDS input data (blue, neg)	
58	GND	I	Ground	1
59	L/R	I	Horizontal scan direction	3
60	POL	I	Source polarity signal	
61	SOE	I	Source latch pulse	
62	SSP1	I	Start pulse for Source DIC	
63	SSP2	O	Output pulse for Source DIC	
64	GND	I	Ground	1

Note 1. All GND(ground) pins should be connected together.
2. All DVDD pins should be connected together.
3. Display Direction as following pictures.



4. Make sure that NC pins should be floated.
5. Please see the Appendix I for more information about VGH Modulation Method.
6. All VCOM pins should be connected together.
7. All AVDD pins should be connected together.

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5-2-2. Backlight Module

The mating connector part number is FH28D-20S-0.5SH(05) manufactured by Hirose or equivalent.

Table 4-2. BACKLIGHT FPC(FPC2) PIN CONFIGURATION

Pin No	Name	I/O	Description	Note
1	NTC_Display (+)	O	Thermal sensor: for Display	1
2	NTC_Display (-)	O	Thermal sensor: for Display	
3	NTC_LED (+)	O	Thermal sensor: for LED	
4	NTC_LED (-)	O	Thermal sensor: for LED	
5	NC	-	No Connection	
6	Cathode1	O	LED Cathode terminal 1	
7	NC	I	No Connection	
8	Anode 1	I	LED Anode terminal 1	2
9	Anode 2	I	LED Anode terminal 2	2
10	NC	-	No Connection	
11	Cathode 2	O	LED Cathode terminal 2	
12	NC	-	No Connection	
13	Cathode 3	O	LED Cathode terminal 3	
14	NC	-	No Connection	
15	Anode 3	I	LED Anode terminal 3	2
16	Anode 4	I	LED Anode terminal 4	2
17	NC	-	No Connection	
18	Cathode4	O	LED Cathode terminal 4	
19	NC	-	No Connection	
20	NC	-	No Connection	

Note 1. Please see the Appendix II for more information about Thermistor Characteristics.
2. All Anode pins should be connected together.

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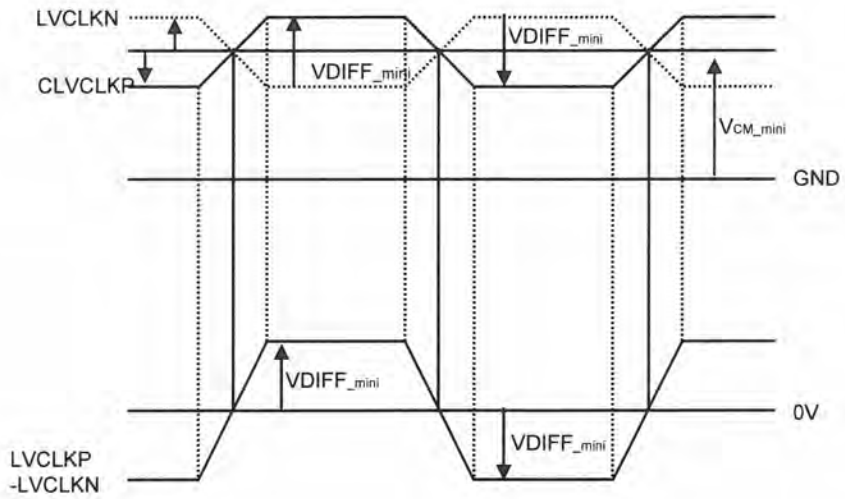
5-3. mini-LVDS Signal Specifications for Source D-IC

5-3-1. DC Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Mini-LVDS Low Level Input Voltage	VIL_mini	-	-200	-150	mV	
Mini-LVDS High Level Input Voltage	VIH_mini	150	200	-	mV	
Mini-LVDS Differential Input Voltage	VDIFF_mini	300	400	600	mV	
Mini-LVDS Common Voltage	VCM_mini	0.8	1.2	VCC-1.6	V	@VDIFF_mini=400mV

Note 1. All LVDS Rx termination resistor (100Ω) is integrated on the PCB.



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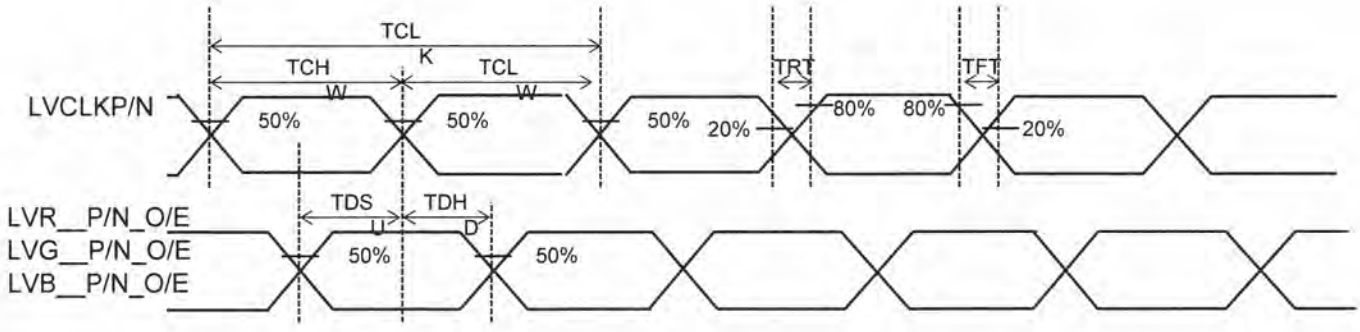
5-3-2. AC Characteristics (1/2)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
CLK Frequency	F_{CLK}	190	219.92	224.04	MHz	
CLK Period	T_{CLK}	4.46	4.55	-	ns	
CLK High Width	T_{CHW}	40%	-	60%	T_{CLK}	
CLK Low Width	T_{CLW}	40%	-	60%	T_{CLK}	
Data setup time	T_{DSU}	1.0	-	-	ns	
Data hold time	T_{DHD}	1.0	-	-	ns	
Falling time	T_{FT}	-	-	0.4	ns	
Rising time	T_{RT}	-	-	0.4	ns	
RESET setup time	T_{RSU}	1.0	-	-	ns	
RESET hold time	T_{RHD}	1.0	-	-	ns	
RESET high period	T_{RST}	3	-	-	T_{CLK}	
SOE to RESET input time	T_{SOERST}	160	-	-	ns	Also more than $21T_{CLK}$
RESET low to SOE rising time	T_{RSOE}	1.0	-	-	ns	
Receiver off to SOE time	T_{DSOE}	10	-	-	T_{CLK}	
SOE high pulse width	T_{SOEW}	24	-	-	T_{CLK}	
POL set-up time	T_{PSU}	20	-	-	ns	
POL hold time	T_{PHD}	15	-	-	ns	



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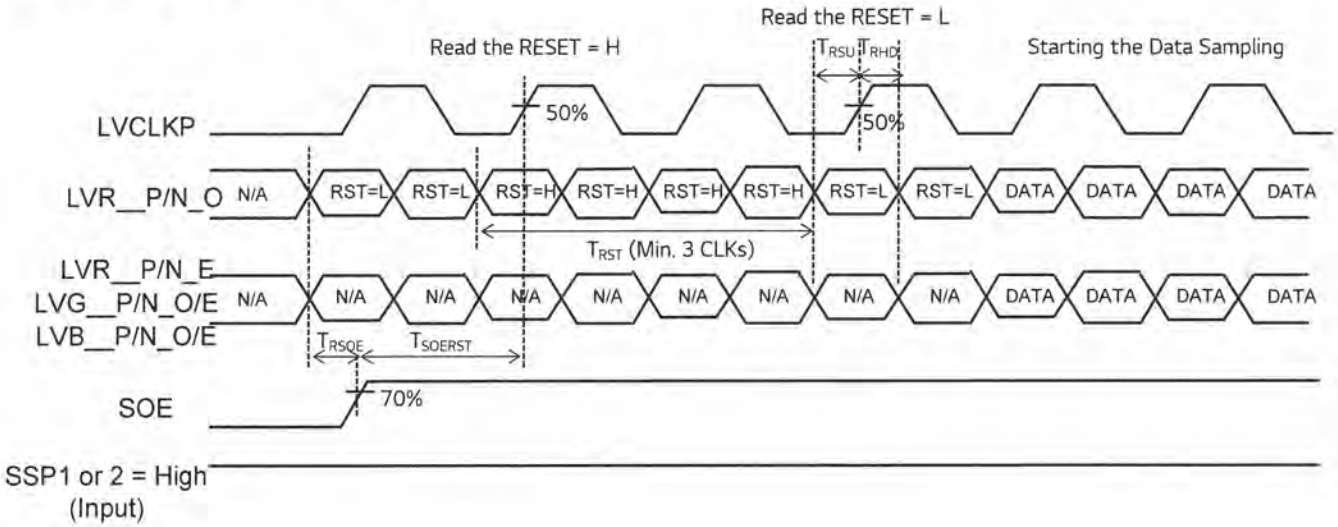
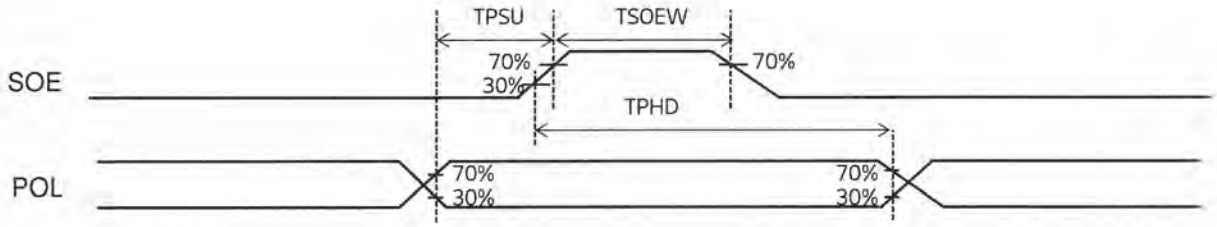
5-3-3. AC Characteristics (2/2)





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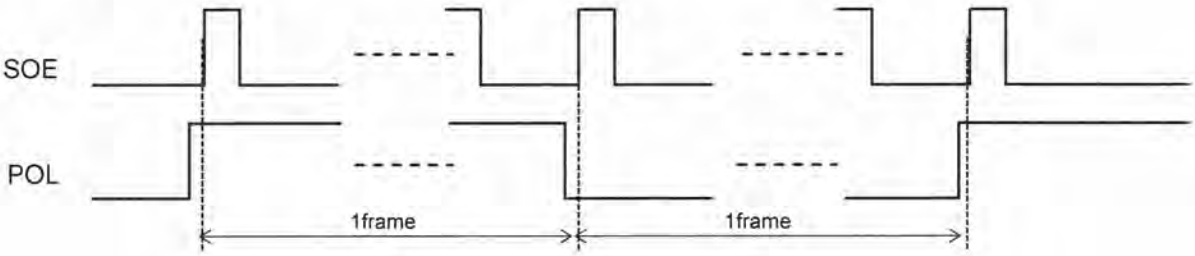

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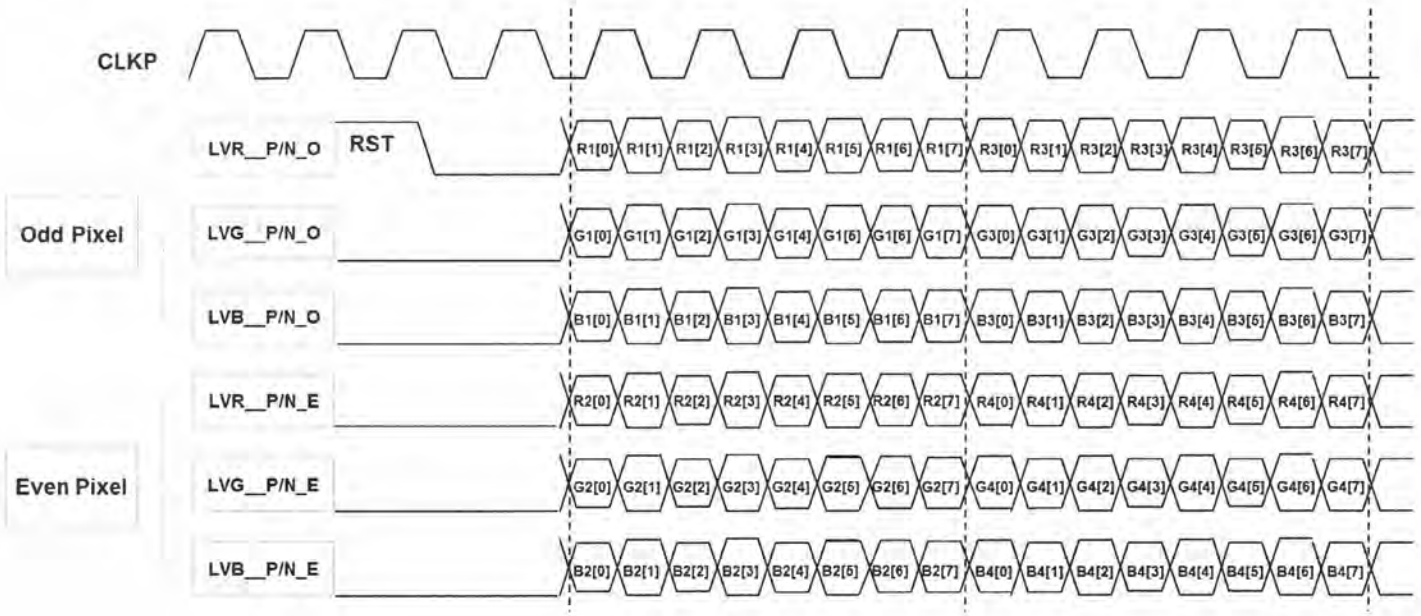
5-3-4. mini-LVDS Data Input Format



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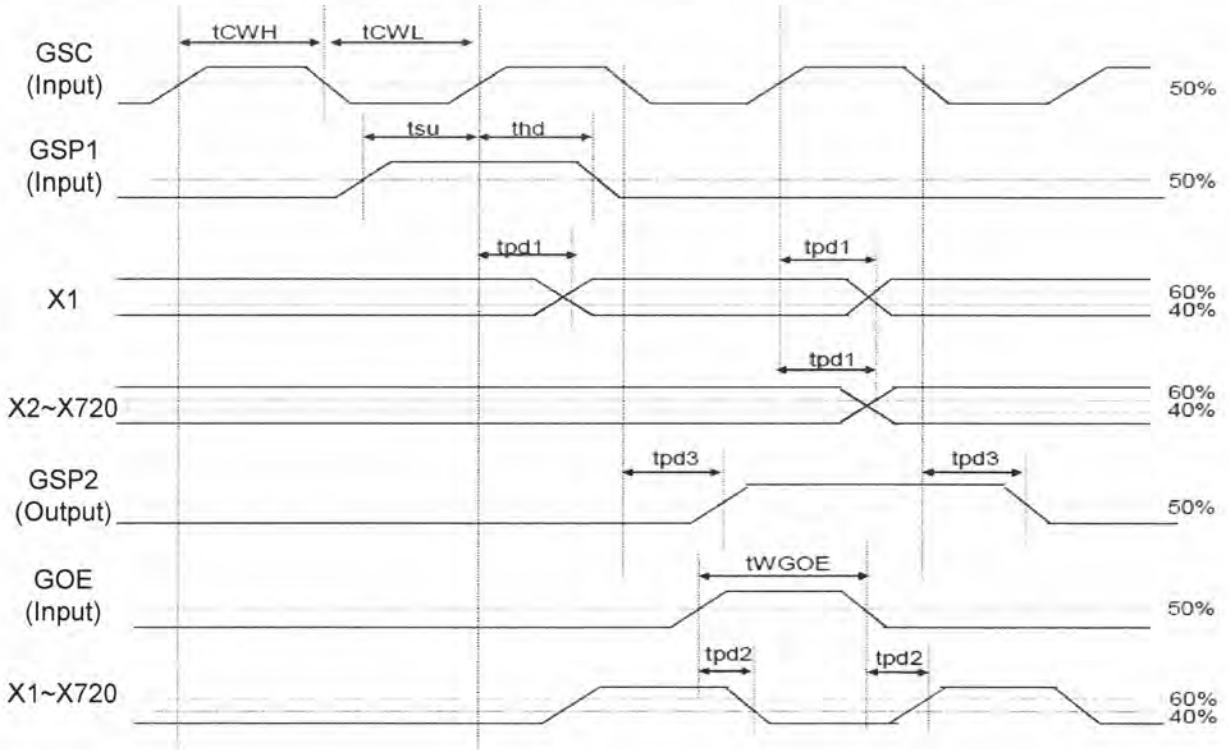
5-4. Gate Control Signal Specifications for Gate D-IC

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
GSC Clock Frequency	tGSC	-	-	200	KHz	
GSC Clock Pulse Width	tCWH	2	-	-	us	
	tCWL	2	-	-	us	
Input signal Rising Time	trin	-	-	100	ns	
Input signal Falling Time	tfin	-	-	100	ns	
GOE Enable Time	tWGOE	1	-	-	us	
Data Setup Time	tsu	500	-	-	ns	
Data Hold Time	thd	500	-	-	ns	
Output Delay to GSC	tpd1	-	500	1000	ns	CL=300pF
Output Delay to GOE	tpd2	-	500	1000	ns	CL=300pF
Data Output Delay Time	tpd3	-	500	1000	ns	CL=30pF

Note: Rising Time and Falling Time is measured between 20% to 80% of the signal.



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5-5. Timing Specifications

Table 5 shows the signal timing required at the input of the mini-LVDS transmitter.
All of the interface signal timing should be satisfied with the following specification for proper operation.

Table 5. SIGNAL TIMING CHARACTERISTICS(f_V=60Hz)

Parameter	Symbol	Min.	Typ.	Max.	Unit
CLK frequency	Fclk	95	109.96	112.02	MHz
Horizontal display area	THD		1920		CLK
HS period time	TH	2180	2460	2496	CLK
HS blanking	THBW + THBP	260	540	576	CLK
Vertical display area	TVD		720		H
VS period time	TV	730	745	748	H
VS blanking	TVBW + TVBP	10	25	28	H

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5-6. Power Sequence

For LCD's normal operation, it is recommended to keep below power supply sequence.

5-6-1. Power On/Off Sequence

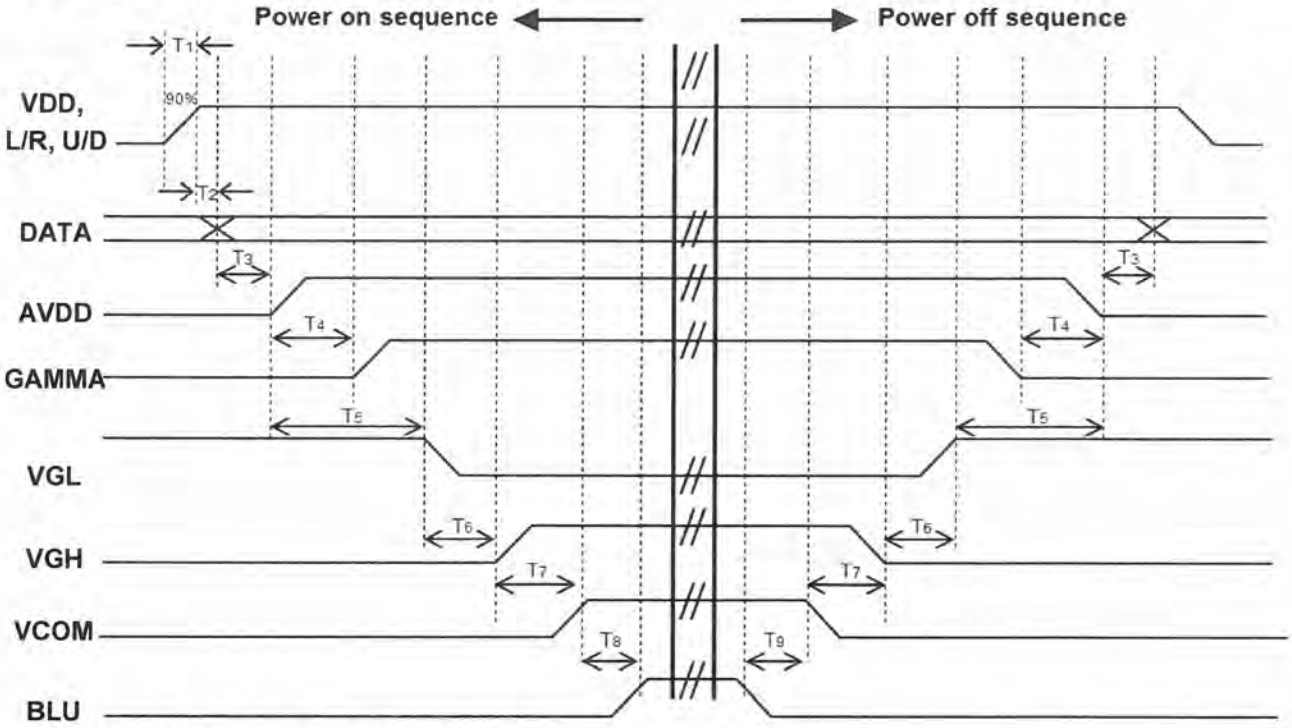

Table 7-1. POWER On/Off SEQUENCE

Parameter	Value			Unit	Note
	Min	Typ	Max		
T1	0.5	-	10	ms	1
T2	20	-	-	ms	
T3	5	-	-	ms	
T4	1	-	-	ms	
T5	5	-	-	ms	
T6	5	-	-	ms	
T7	5	-		ms	
T8	200	500	-	ms	5
T9	10	-	-	ms	

Note 1. Do not change L/R&U/D status to avoid abnormal display during LCD operation.
2. Please avoid floating state of all input signals.
3. When the interface signal is invalid, be sure to pull down the power supply for LCD to 0V.
4. When Power On Sequence or during operation, interface signal is not allowed momentary off or abnormal waveform.
5. Backlight must be turn on after power supply for LCD and interface signal are valid.
   LG display recommend to apply sufficient T8 time for normal operation.
   In case of insufficient T8, might be occurred the phenomenon of display transition at low temperate condition even though normal operation.
6. If it is difficult to perform as our recommendation, customers are asked to confirm the Power sequence with LG Display prior to their use.
7. After Power Off(VDD&all signals are 0V), VDD&all signals maintenance 0V at least 1000ms
8. DATA signal has to be black up to T6, in order not to have electrical stress through VCOM signal before normal operation of Gate starts.

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6. Electro-optical Characteristics

Electro-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 an approximate distance 50cm from the LCD surface at a viewing angle of and equal to 0°. Measured value at the center point of LCD panel after more than 30 minutes while backlight turning on.

It is presented additional information concerning the measurement equipment and method in FIG. 3.

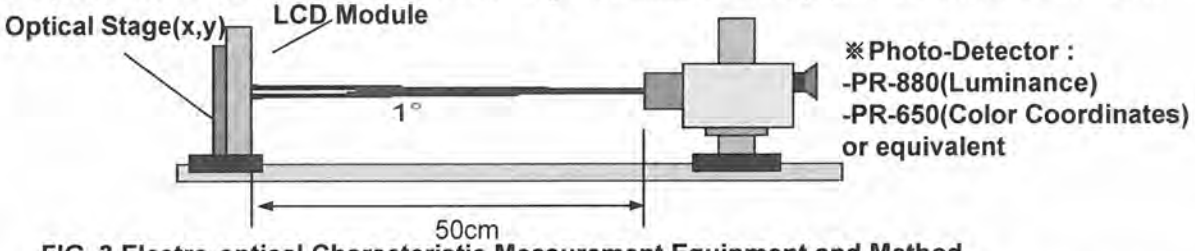

FIG. 3 Electro-optical Characteristic Measurement Equipment and Method

Table 8. ELECTRO-OPTICAL CHARACTERISTICS

Ta=25±2°C, DVDD=3.3V, AVDD=13.0V, VCOM = 5.4V, VGH = 22.0V, VGL = -9.5V, VREF1=12.45V, VREF18=0.65V, fv = 60Hz, fCLK = 219.92MHz, ILED=78mA(no-dimming)

Parameter		Symbol	Value			Unit	Note
			Min	Typ	Max		
Contrast Ratio (@25℃)	Perpendicular	CR (After WPA)	-	-	-		1
	Area A+		800	-	-		
	Area A		500	-	-		
	Area B		100	-	-		
Luminance (@-40~70℃)	Area A+	L_{WH}	776	-	-	cd/m²	2
	Area A		423	-	-		
	Area B		294	-	-		
Uniformity (Area scan)	White	δ_{WHITE}	75	-	-	%	3
	Black	δ_{Black}	50				
Response Time (Tp)	+25℃	TG2G	-	-	19	ms	4, 5
	-20℃		-	-	200		
	-30℃		-	-	500		
	+25℃	MPRT	-	-	25		
	-20℃		-	-	200		
	-30℃		-	-	300		
Color Coordinates [CIE1931]	RED	λ_{dom}	616	623	630	nm	
		Sat.	80	-	-	%	
	GREEN	λ_{dom}	544	549	554	nm	
		Sat.	75	-	-	%	
	BLUE	λ_{dom}	464	469	474	nm	
		Sat.	90	-	-	%	
	WHITE	Wx	0.282	0.307	0.332	-	
		Wy	0.296	0.321	0.346	-	
	White @85℃	Wx / Wy	-0.025	Initial Value @ 25℃	+0.025	-	
Color Gamut		-	-	85	-	%	
Gamma		-	2.0	2.2	2.4	-	7
Image Sticking (@25℃)		-	-	-	2.5 (1sec)	%	6
		-	-	-	1.5 (180sec)		

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Note 1. Contrast Ratio(CR) is defined mathematically as :
Measured area is defined as below. For more information see the FIG. 5, 6.

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

2. Surface luminance are determined after the unit has been 'ON' and More than 30 minutes after lighting the backlight in a dark environment at 25±2°C. Surface luminance is the measured luminance at the active area center of the LCD surface 50cm from the surface with all pixels displaying white. Measured area is defined as below. For more information see the FIG. 5, 6.

3. Based on the Display specification for automotive applications V4.5.1, White uniformity is measured and evaluated according to "Uniformity measurement standard for displays" Version 1.15, 2011-06-14, Copyright: "German automotive OEM working group displays"
LGD Measurement method & equipment will be updated.

4. Response time is obtained by measuring the transition time of photo detector output, when input signals are applied to make center point "Gray(i)" and "Gray(j)".
(7Step at 8bit: Gray0, Gray43, Gray85, Gray128, Gray170, Gray212, Gray255)
For more information, see the FIG. 4

5. Low temperature response time measure method.
: The LCM has remained at low temperature(-20℃ or -30℃) for 30 minutes and then kept turning on for 30 minutes before measured.
This is a part of design warranty. No additional management will be fulfilled for this in Mass Production.

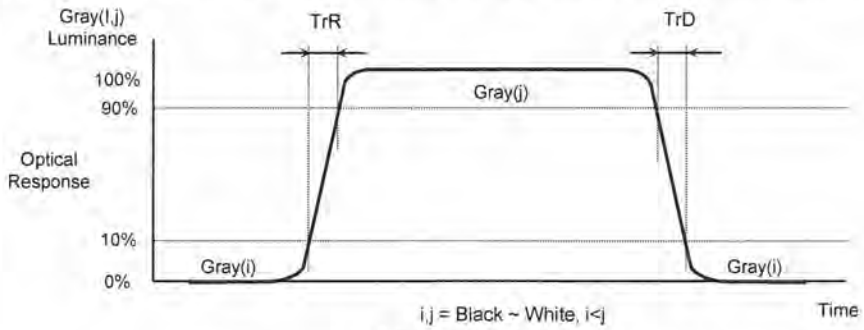

FIG. 4 Response Time

6. Measurement has to be done according to "Image sticking measurement standard for display.
But burn-in pattern & evaluation pattern are below.

Burn-In pattern(1Hrs, @25℃)

Evaluation Pattern(Half Gray)

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7. Gamma is measured and evaluated according to "Bosch Gamma specification V1.0"
   - Measurements 9point: 255, 223, 191, 159, 127, 95, 63, 31, 0Gray

Area A+ : H = +/-10°, V = +8° / -4°

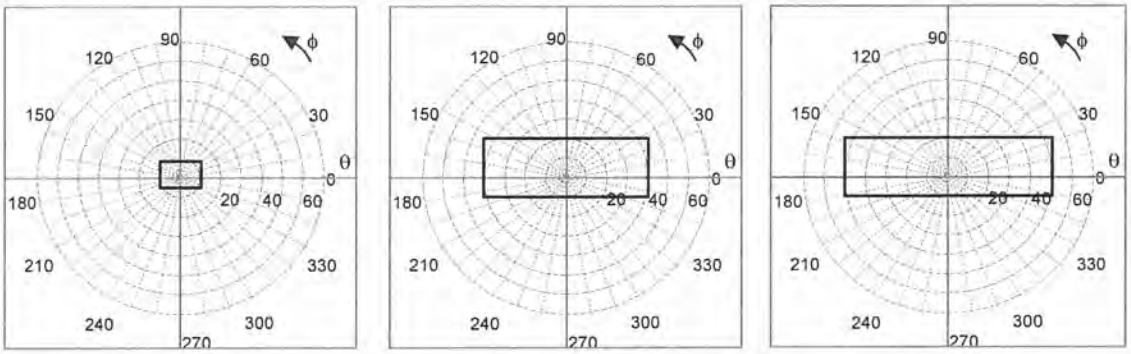
[(Θ, Φ) = (12.7°, 38.6°), (12.7°, 141.4°), (10.7°, 201.6°), (10.7°, 338.4°)]

Area A : H = +/-40°, V = +20° / -10°

[(Θ, Φ) = (42.4°, 23.4°), (42.4°, 156.6°), (40.6°, 191.9°), (40.6°, 348.1°)]

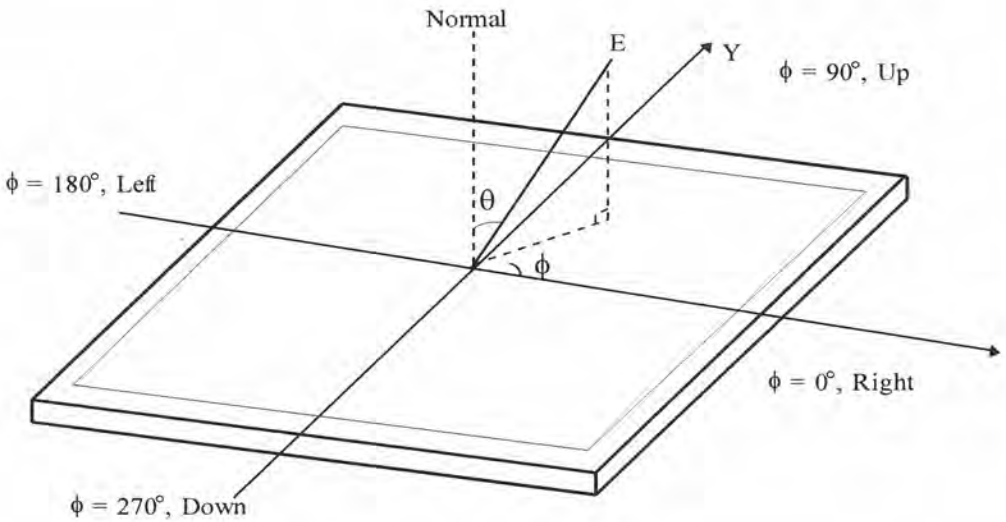
Area B : H = +/-50°, V = +20° / -10°

[(Θ, Φ) = (51.3°, 17.0°), (51.3°, 163.0°), (50.3°, 188.4°), (50.3°, 351.6°)]



[Area A+] [Area A] [Area B]

FIG. 5 Area A+, Area A, Area A' & Area B



[Panel FPC Side]

FIG. 6 LCD viewing direction of defined angle θ, Φ

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7. Mechanical Characteristics

The contents provide general mechanical characteristics for this module. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Table 9. MECHANICAL CHARACTERISTICS

Parameter	Value	
Outline Dimension	Horizontal	308.00 ± 0.5 mm
	Vertical	123.92 ± 0.5 mm
	Depth	8.0 ± 0.3 mm
Inspection Area	Horizontal	295.032mm
	Vertical	112.512mm
Active Display Area	Horizontal	292.032mm
	Vertical	109.512mm
View Area	Horizontal	295.032mm
	Vertical	112.512mm
Weight	410 g(Typ.), 420 g (Max.)	

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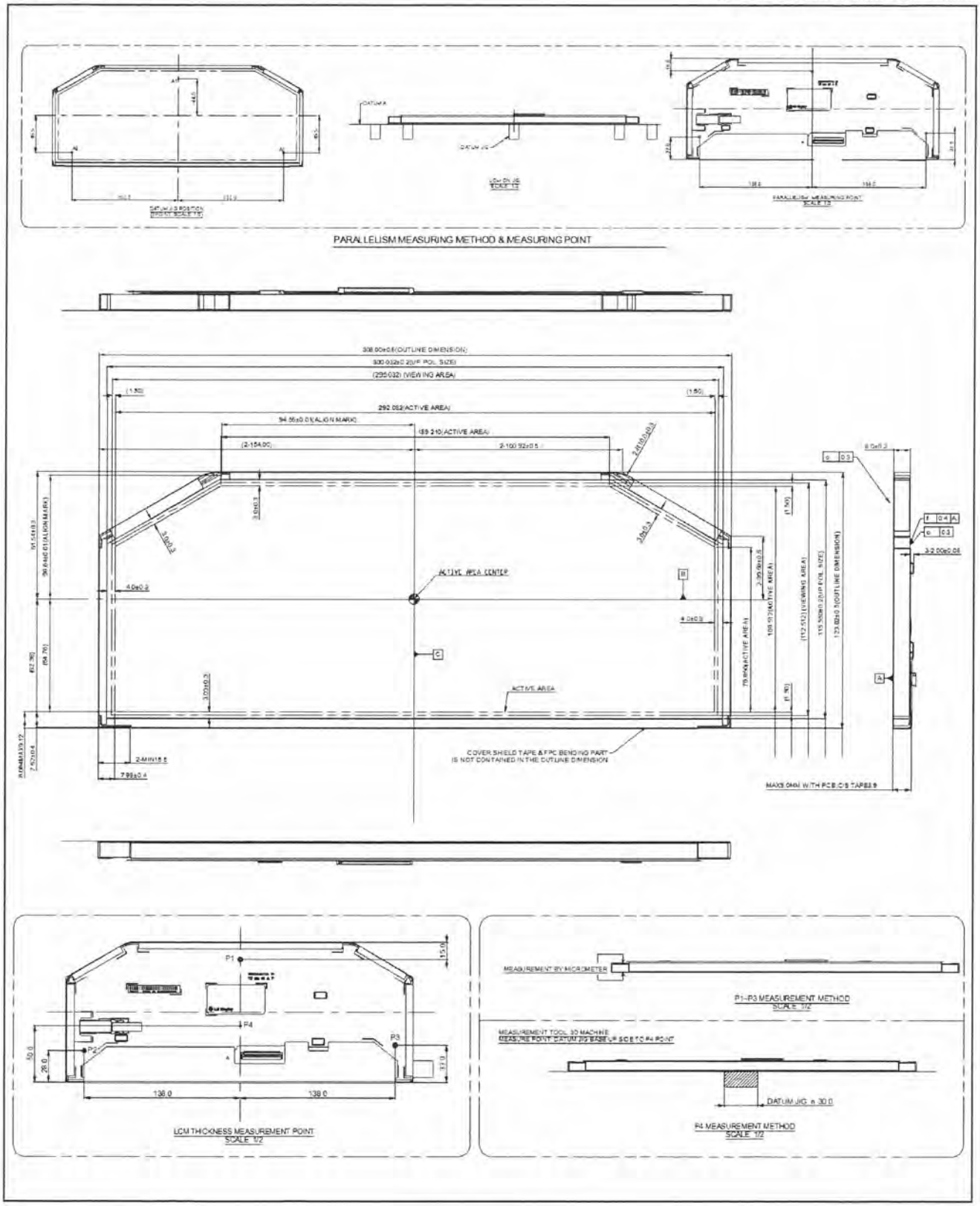
<FRONT VIEW>

Note. Unit:[mm], General tolerance: ± 0.3mm



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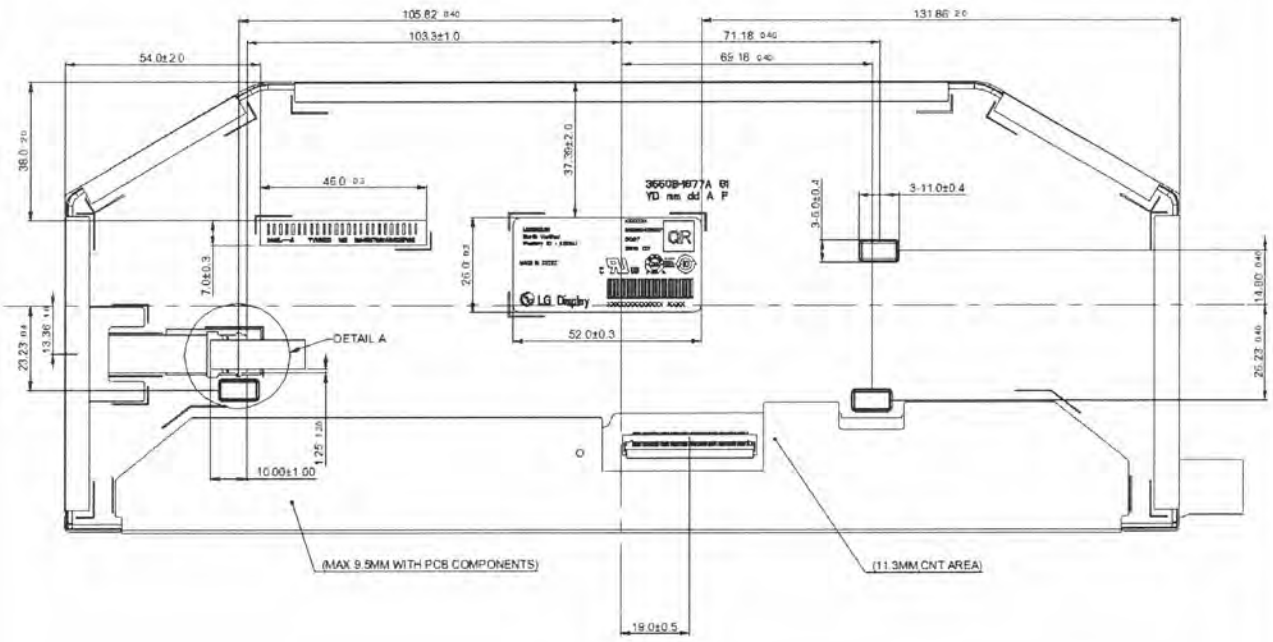
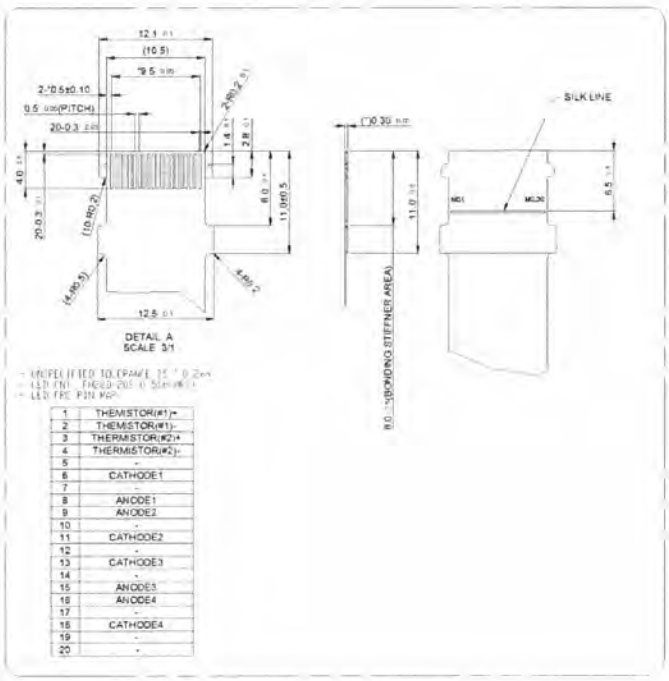
<REAR VIEW>

Note. Unit:[mm], General tolerance: ± 0.3mm





1	THERMISTOR(#1)+
2	THERMISTOR(#1)-
3	THERMISTOR(#2)+
4	THERMISTOR(#2)-
5	-
6	CATHODE1
7	-
8	ANODE1
9	ANODE2
10	-
11	CATHODE2
12	-
13	CATHODE3
14	-
15	ANODE3
16	ANODE4
17	-
18	CATHODE4
19	-
20	-

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8. Reliability

8-1. Flow Test

1) LGD will satisfied with judgment criteria.
   The judgment criteria described below.
2) Galaxy mura is not visible after mixed vibration test for 8 hours per axis (each x, y, z axis) according to the specification OEM 4.5.

FLOW TEST					
Parameter test(small) (Visual inspection & &Function Test & Optical measure @25℃)					
Temperature shock test as pre-aging(-40℃ ~ 85℃ / 15min / 50Cycle)					
Parameter test_Large 1 (Function Test & Optical measure @-40℃&25℃&85℃)					
Test Path 1	**Test Path 2**	**Test Path 3**	**Test Path 4**	**Test Path 5**	**Test Path 6**
EMC/ESD (Panel I : ±15㎸ FPC : ±2㎸)	High/Low temp. storage (-40℃, 85℃ / 각 12hr / 2 Cycle)	Dust Test (5min / 20cycle)	Sunlight exposure -10℃ ~ 80℃ / <65% / 830W/m2 / 25days	Noise under vibration (20~1000Hz / 30dB)	High temp. endurance test (active) Take a Picture at 25%,50%,75% (85℃ / 1500hr)
Thermal efficiency (85℃ , 1Hr)	Temp. step test (25℃ → -40℃ → 85℃ →25℃)	Moist heat cyclical (25℃~55℃ / 95 % / 144Hr)	Harmful gas test (21days)	Temp. cycling Take a picture at 25%,50%,75% (20℃ → -40℃ → 85℃ → 20℃ / 6hr / 250cycle)	Moist heat constant (60℃/93%/504hr)
Endurance Test (On/Off times) 37.8K (25℃) 10.8K (-40℃) 5.4K (85℃)	Vibration test (-40℃, 85℃ / 10~1000Hz / X,Y,Z, 8hrs)	Mech. shock (500m/s2, /6ms)	-	Noise under vibration (20~1000Hz / 30dB)	-
-	-	Drop test	-	-	-
Parameter test_large2(Function Test & Optical measure @-40℃&25℃&85℃)					

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8-2. Judgment Criteria

Parameter Test Small	Flow Path	Luminance (25℃)	CR (25℃)	Response Time (25℃)	Color Coordinate (25℃)	Current Consumption (25℃)	BU (25℃)	WU (25℃)
Room Temp.	Initial	A	A	A	A	A	A	A

Parameter Test Large1	Flow Test	Luminance (-30~70℃)	CR (-30~70℃)	Response Time (-30~25℃)	Color Coordinate (-40~85℃)	Current Consumption (-40~85℃)	BU (-40~85℃)	WU (-40~85℃)
Room Temp.	01	A	A	A	A	A	C	C
Low Temp.	01	A	C	A	B	A	C	C
High Temp.	01	A	C	-	C	A	C	C

Parameter Test Large 2	Flow Test	Luminance (-40~85℃)	CR (-40~85℃)	Response Time (-30~25℃)	Color Coordinate (-40~85℃)	Current Consumption (-40~85℃)	BU (-40~85℃)	WU (-40~85℃)
Room Temp.	Path 1	B	B	A	B	A	C	C
	Path 2	B	B	B	B	A	C	C
	Path 3	B	B	B	B	A	C	C
	Path 4~6	B	C	B	C	A	C	C
Low Temp.	All Path	B	C	B	C	A	C	C
High Temp.	All Path	B	C	-	C	A	C	C

Criteria	Lumi.@ Perpendicular	CR@ Perpendicular	Response time @ (G2G)	Color Coordinate @ (W,R,G,B)	Current consumption	BU	WU
A	Spec. in						
B	less than 50% drop	less than 50% drop	More than 50% increase	Typ. Spec ± 0.04	Less than 50% increase from max. spec	less than 50% drop	less than 50% drop
C	Reference (Measure and share the data to Bosch, no guarantee)						
-	Not Measure						

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9. International Standards

9-1. Safety

a) UL 60950-1, Underwriters Laboratories Inc.
Information Technology Equipment - Safety - Part 1 : General Requirements.
b) CAN/CSA-C22.2 No. 60950-1-07, Canadian Standards Association.
Information Technology Equipment - Safety - Part 1 : General Requirements.
c) EN 60950-1, European Committee for Electrotechnical Standardization (CENELEC).
Information Technology Equipment - Safety - Part 1 : General Requirements.
d) Flammability test for determination of burning behaviour of interior materials in motor vehicles.
- ISO 3795, International Organization for Standardization
Road vehicles, and tractors and machinery for agriculture and forestry - Determination of burning behaviour of interior materials
- DIN 75200, Deutsche Industric Normen
Determination of burning behaviour of interior materials in motor vehicles.
- FMVSS 302, Federal Motor Vehicle Safety Standards
Flammability of Interior Materials

9-2. Environment

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

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10. Packing

10-1. Designation of Lot Mark

a) Lot Mark

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

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

Note

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

b) Location of Lot Mark

Serial No. is printed on the label. The label is attached to the backside of the LCD module.
This is subject to change without prior notice.

c) LCM Label info

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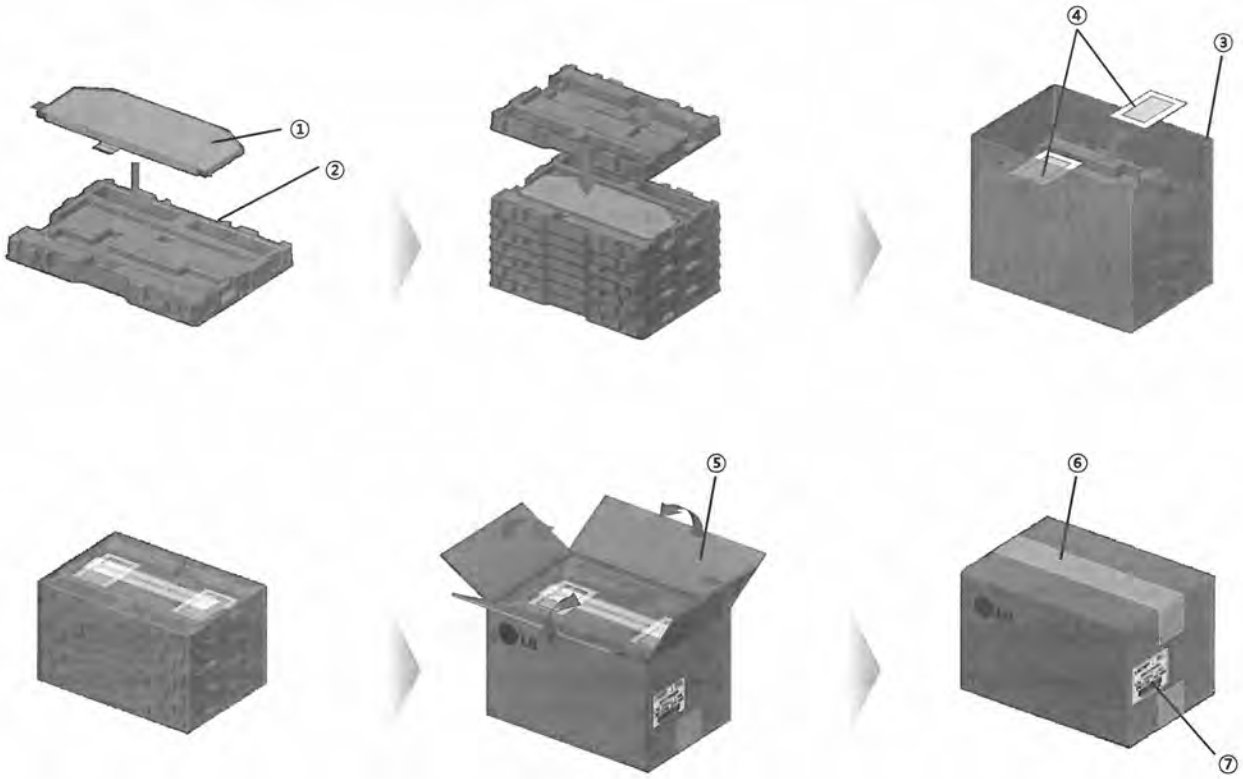
10-2. Packing Form

a) Package quantity in one box : 7 pcs

b) Box Size : 362mm(L) x 254mm(W) x 226mm(H)



NO.	Description	Material
1	Module	7pcs/1 Box
2	Packing, Tray	PET
3	Bag	PE
4	Desiccant	POWER DRY, 60G, UX
5	Box	SW
6	Tape	OPP
7	Box Label	ART Paper

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11. PRECAUTIONS

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

11-1. MOUNTING PRECAUTIONS

(1) You must mount a module using specified mounting holes.(Details refer to the drawings)
(2) You should consider the mounting structure so that uneven force(ex. Twisted stress) is not applied to the module.
And the case on which a module is mounted should have sufficient strength so that external force is not transmitted directly to the module.
(3) Please attach a transparent protective plate to the surface in order to protect the polarizer.
Transparent protective plate should have sufficient strength in order to the resist external force.
(4) You should adopt radiation structure to satisfy the temperature specification.
(5) 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.
(6) 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 deteriorate the polarizer.)
(7) When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzine. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.
(8) Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
(9) Do not open the case because inside circuits do not have sufficient strength.
(10) The metal case of a module should be contacted to electrical ground of your system.

11-2. OPERATING PRECAUTIONS

(1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage : V=±200mV(Over and under shoot voltage)
(2) Response time depends on the temperature.(In lower temperature, it becomes longer.)
(3) Brightness depends on the temperature. (In higher temperature, it becomes lower.)
(4) 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.
(5) When fixed patterns are displayed for a long time, remnant image is likely to occur.
(6) 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 minimize the interference.

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11-3. ELECTROSTATIC DISCHARGE CONTROL

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.

11-4. PRECAUTIONS FOR STRONG LIGHT EXPOSURE

Strong light exposure causes degradation of polarizer and color filter.

11-5. STORAGE

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

(1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.

(2) The polarizer surface should not come in contact with any other object.
It is recommended that they be stored in the container in which they were shipped.

11-6. HANDLING PRECAUTIONS FOR PROTECTION FILM

(1) The protection film is attached to polarizer with a small masking tape or a double side tape.
When the protection film is peeled off, static electricity is generated between the film and polarizer.
This should be peeled off slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition, etc.

(2) When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the bezel after the protection film is peeled off.

(3) Sometimes there are a few foreign material and bubble between protect film and polarizer.
Because inspector peel off protection film for checking in detail.

(4) You can remove the glue and foreign material. When the glue remains on polarizer surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.

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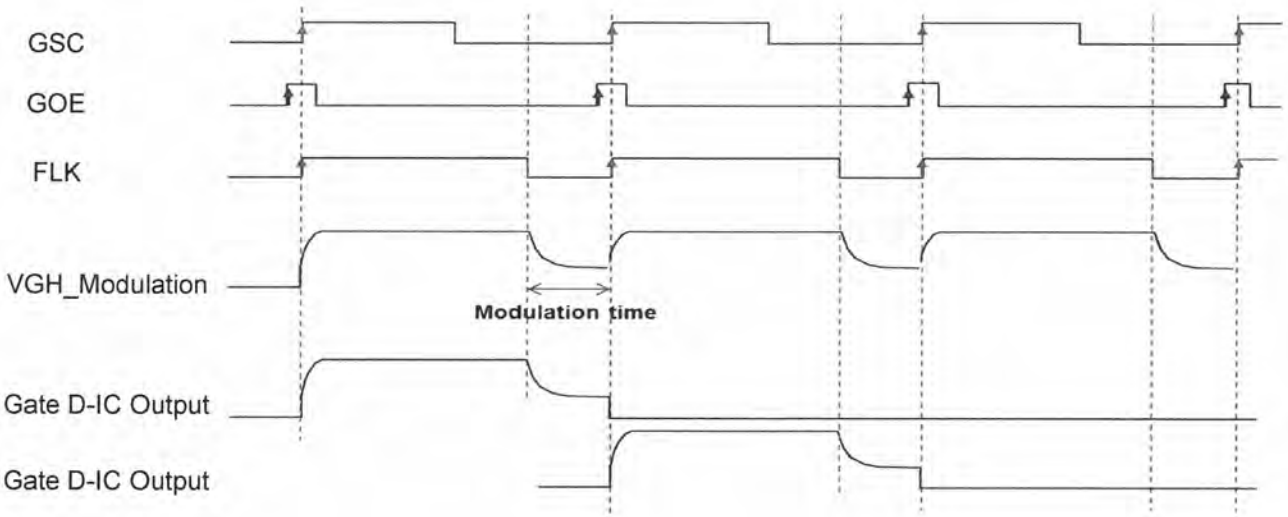
APPENDIX- I

■ VGH Modulation Method

Parameter	Min.	Typ.	Max.	Unit	Notes
VGH_DC	(16)	(22) (Reference)	(24)	V	
VDD_M	(12.6)		(16)	V	
Modulation time	(1.5)	(3)	(6)	us	Frame frequency : 60Hz



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APPENDIX- II

■ Thermistor Characteristics (NCP15XH103F0SRC)

Note 1. The display module shall incorporate a NTC thermistor surface mounted to the display circuit board. The user of LCD module can utilize this thermistor for some special purpose. For example, the user can measure display temperature from the thermistor and then turn off backlight when LCD module temperature exceeds maximum rating.

2. $R_{thermistor}$ in the table is the feature of the thermistor by itself, and R_{THER} is measured value in the LCM. Customers should refer to the value of R_{THER} for LED derating.
3. $R_{thermistor}$ tolerance is ±1% at 25℃.

℃ (Ta)	PWM duty ratio[%]	$R_{thermistor}$ [kΩ] (Thermistor)	R_{THER} [kΩ] (NTC_Display_#1)	R_{THER} [kΩ] (NTC_LED_#2)
-40	100	195.65	123.76	72.40
-35	93	148.17	99.60	91.35
-30	86	113.35	80.65	52.57
-25	85	87.56	63.57	42.44
-20	84	68.24	50.15	34.07
-15	82	53.65	38.29	26.78
-10	81	42.51	31.22	22.17
-5	80	33.89	26.08	18.90
0	79	27.22	21.18	15.64
5	78	22.02	17.32	12.99
10	77	17.93	14.25	10.82
15	75	14.67	11.79	9.06
20	74	12.08	9.76	7.62
25	73	10.00	8.17	6.46
30	75	8.32	6.83	5.43
35	76	6.95	5.69	4.52
40	77	5.83	4.80	3.83
45	79	4.92	4.05	3.23
50	80	4.16	3.44	2.76
55	82	3.54	2.93	2.38
60	83	3.01	2.52	2.06
65	84	2.59	2.16	1.75
70	86	2.23	1.80	1.59
75	76	1.93	1.61	1.45
80	66	1.67	1.45	1.33
85	56	1.45	1.30	1.12

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APPENDIX- III

■ GMA & AVDD & GND Impedance(Ref.) @25℃

[Unit: kΩ]

	GMA1	GMA2	GMA3	GMA4	GMA5	GMA6	GMA7	GMA8	GMA9	GMA10	GMA11	GMA12	GMA13	GMA14	GMA15	GMA16	GMA17	GMA18	AVDD	GND
GMA1		∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
GMA2			3.833	5.668	7.991	10.012	11.700	15.938	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
GMA3				1.897	4.221	6.245	7.932	12.177	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
GMA4					2.376	4.406	6.097	10.344	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
GMA5						2.071	3.763	8.006	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
GMA6							1.723	5.970	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
GMA7								4.287	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
GMA8									∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
GMA9										∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
GMA10											∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
GMA11												4.318	6.011	8.055	10.391	12.236	16.013	∞	∞	∞
GMA12													1.739	3.788	6.125	7.973	11.749	∞	∞	∞
GMA13														2.094	4.440	6.286	10.063	∞	∞	∞
GMA14															2.398	4.254	8.038	∞	∞	∞
GMA15																1.911	5.698	∞	∞	∞
GMA16																	3.857	∞	∞	∞
GMA17																		∞	∞	∞
GMA18																			∞	∞
AVDD																				∞
GND																				

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