SPECIFICATION
FOR
APPROVAL

( ) Preliminary Specification
(●) Final Specification

Title	7.0”WV (800 X RGB X 480) TFT- LCD

BUYER	
MODEL	

SUPPLIER	LG Display Co., Ltd.
MODEL	LA070WV7
SUFFIX	SL02

SIGNATURE	DATE
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Please return 1 copy for your confirmation
With your signature and comments.

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Contents

Record of Revisions

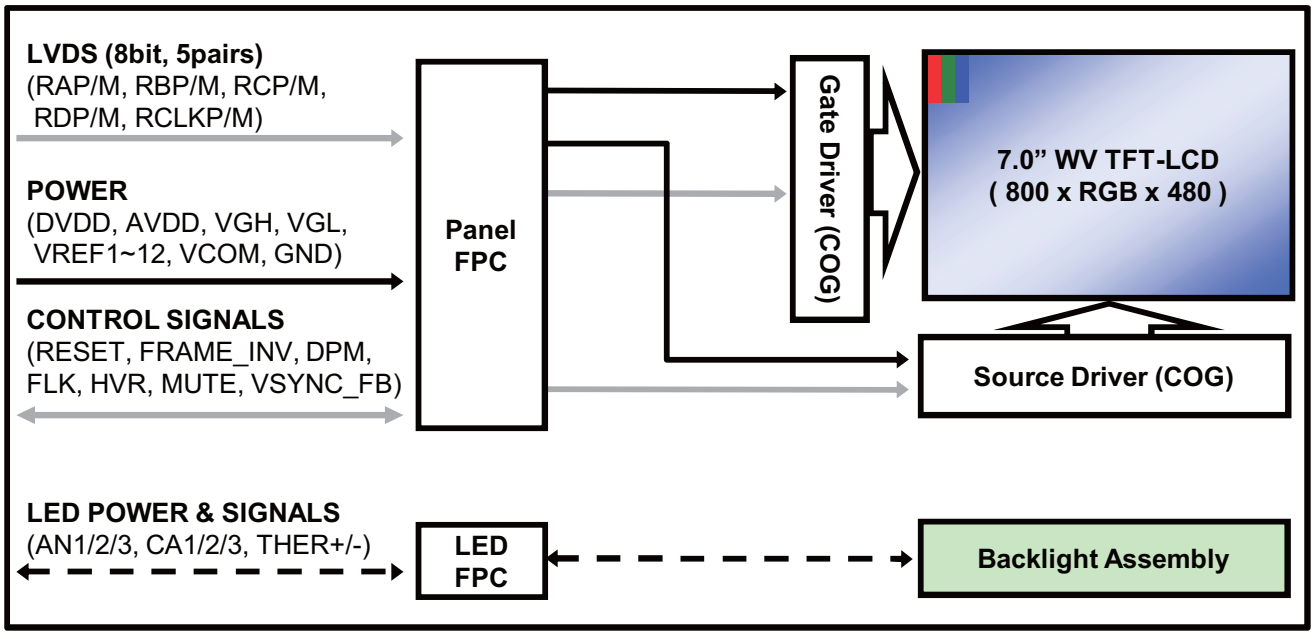
Revision No.	Revision Date	Page	Description	Note
0.0	Jan.24.2014	-	First Draft (Preliminary)	
1.0	Feb.23.2015	5	Update the General Description. : Luminance & Contrast Ratio of Viewing Angle	
		6	Update the Absolute Maximum Ratings : LED Current Max. value	
		7,8,9	Update the Electrical Specifications.	
		8	Add the Note about Gamma Reference Voltage.	
		11	Add the Note 12.	
		13	Correct the diagram of LVDS waveform. Add the Note 1.	
		15	Update the table of Signal Timing Characteristics.	
		17	Update the T9 Max. value of Power On Sequence. : 20ms → 100ms	
		18	Update the T13 Max. value of Power Off Sequence. : 10ms → 50ms	
		19,20,21	Update the Electro-optical Characteristics. : Viewing angle Spec & Color Coordinates.	
		20	Correct the wrong phrase of FIG.2. : 5points → 9points	
		23,24	Update the Drawings. : Add the Screw Hole Inspection Specification.	
		28	Update the Packing Form.	
		31	Update the GPM parameter value of APPENDIX-I.	
		-	Final Specification.	

1. Summary

This module utilizes amorphous silicon thin film transistors and a 15:9 aspect ratio. The 7.0” active matrix liquid crystal display allows 16,777,216 colors to be displayed by LVDS interface is available. The applications are CID(Center Information Display), RSE(Rear Seat Entertainment) and Instrument Cluster for a vehicle.

2. Features

- Utilizes a panel with a 15:9 aspect ratio.
- The 7.0” screen produces a high resolution image that is composed of 384,000 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.



3. General Description

Active Screen Size	7.0 inches(177.7mm) diagonal
Outline Dimension	166.4mm (H) × 106.2mm (V) × 6.8mm (D) (Typ.)
Pixel Pitch	0.1905mm x 0.1905mm (1Dot: 0.0635mm x 0.1905mm)
Pixel Format	800 horiz. by 480 vert. Pixels, RGB stripe arrangement
Color Depth	8bit(D), 16,777,216 colors
Luminance, White	Perpendicular: Typ. 1000cd/m^2, Min. 800cd/m^2 (Center 1point) Viewing angle: Min. 430cd/m^2 (@ U/D=±20º, L/R=±35º)
Contrast Ratio	Perpendicular: Typ. 1100:1, Min. 800:1 (Center 1point) Viewing angle: Typ. 150:1, Min. 90:1 (@ U/D=±20º, L/R=±45º)
Weight	162g (Typ.), 167g (Max.)
Display Mode	Transmissive mode, Normally Black
Surface Treatment	Anti-glare treatment of the front polarizer (Haze 25%)
Backlight Type	LED

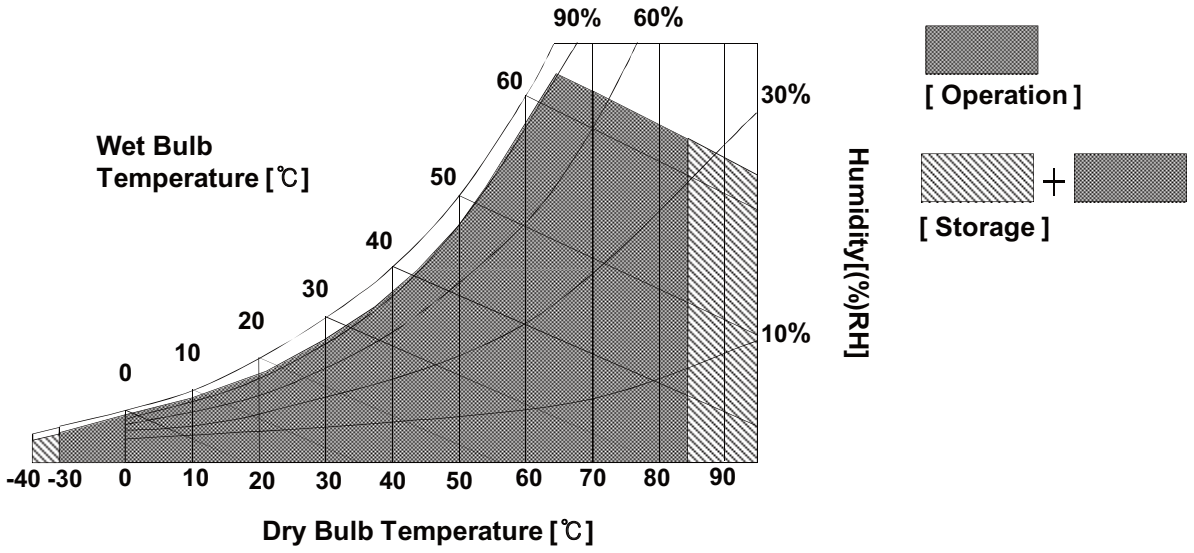
4. Absolute Maximum Ratings

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	
Gamma Reference Voltage	V_{REF} (VREF 1~6)	0.5AVDD-0.5	AVDD+0.5	V	
	V_{REF} (VREF 7~12)	-0.3	0.5AVDD+0.5	V	
Analog Supply Voltage	AVDD	-0.3	14.5	V	
Gate Driver Voltage	VGH	0.0	40.0	V	
	VGL	-12.0	0.0	V	
	VGH-VGL	0.0	40.0	V	
LED Current	I_{LED}	-	90	mA	1
LED Power Consumption	P_{LED}	-	5.36	W	
Storage Temperature	TST	-40	95	°C	2
Operating Temperature	TOP	-30	85	°C	2,3,4

Note 1. Applies to each LED individually.
2. Temperature and relative humidity range are shown in the figure below.
Wet bulb temperature should be Max. 62℃. Condensation of dew must be avoided,
because it may cause electrical current leakage, and deterioration of performance and quality.
3. The operating temperature means that LCD Module guarantees operation of the circuit.
All the contents of Electro-optical specifications are guaranteed under the room temperature condition.
4. This temperature is ambient temperature with regard to the heat which is generated under operation of circuit and backlight on. (reference value)



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		
Logic Supply Voltage			DVDD	3.0	3.3	3.6	V	
Control Signal Voltage			V_H	3.0	-	DVDD	V	1
			V_L	0.0	-	0.3	V	
Source Driver	Analog Supply Voltage		AVDD	12.5	13.0	13.5	V	
	Gamma Reference Voltage		VREF	GND+0.5	-	AVDD-0.5	V	2
Gate Driver	TFT	Turn-on Voltage	VGH	17.0	18.5	20.0	V	
		Turn-off Voltage	VGL	-9.0	-7.5	-7.0	V	
		Voltage Difference	VGH-VGL	24.0	-	29.0	V	
Common Voltage			VCOM	4.5	5.5	6.5	V	3
Ripple Voltage			V_{RP}	-	-	50	mV_{P-P}	4
Logic Supply Current			I_{DVDD}	-	27	50	mA	5
Source Driver Analog Supply Current			I_{AVDD}	-	30	80	mA	
Gate Driver	Turn-on Voltage Current		I_{VGH}	-	0.3	1	mA	
	Turn-off Voltage Current		I_{VGL}	-	0.3	1	mA	
Common Voltage Current			I_{VCOM}	-	0.01	1	mA	

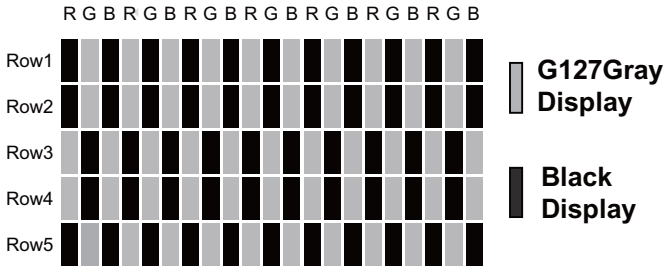
Note 1. RESET, MUTE, HVR, FRAME_INV

2. Reference Gamma Correction Voltage [VREF1 to VREF12]
If Customer use out of range below table, may not be satisfied the Electro-Optical Characteristics.

Symbol	Value			Unit
	Min	Typ	Max	
VREF1	12.00	12.22	12.45	V
VREF2	11.95	12.15	12.35	V
VREF3	9.90	10.10	10.30	V
VREF4	9.05	9.23	9.40	V
VREF5	8.40	8.56	8.70	V
VREF6	6.80	6.93	7.05	V
VREF7	5.45	5.56	5.65	V
VREF8	3.72	3.80	3.88	V
VREF9	2.99	3.06	3.13	V
VREF10	2.34	2.39	2.44	V
VREF11	0.63	0.65	0.67	V
VREF12	0.53	0.55	0.57	V

[VREF1 > VREF2 > ····· > VREF6 > VREF7 >····· > VREF11 > VREF12]

3. VCOM should be optimized at Vertical 2 Dot Inversion Pattern.
(adjustment must be finished within 30 sec)



Vertical 2 Dot Inversion Pattern

4. DVDD, AVDD, VREF, VGH, VGL, VCOM.

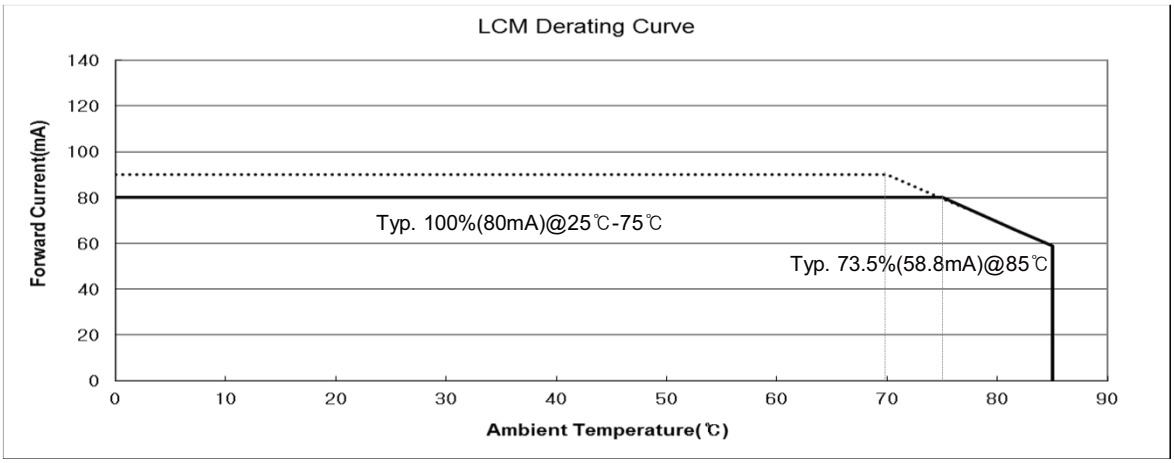
5. DVDD = 3.3V, AVDD = 13.0V, VCOM = 5.5V, VGH = 18.5V, VGL = -7.5V, VREF1 = 12.22V, VREF12 = 0.55V, fv = 60Hz, fCLK = 37.04MHz, White(256 Gray) Pattern, with Probe Load.

Table 3. BACKLIGHT ELECTRICAL CHARACTERISTICS

Parameter		Symbol	Values			Unit	Note
			Min	Typ	Max		
LED Current		I_{LED}	-	80	85	mA	1,2,7
LED Voltage	-30℃	V_{LED}	17.1	18.9	21.0	V	3
	+25℃		15.6	18.0	20.4		
	+85℃		15.0	16.3	18.1		
LED Power		P_{LED}	-	4.32	5.36	W	4
LED Chain			-	3	-	EA	5
Life Time			30,000	-	-	Hrs	6

Note 1. This values applies to one chain (6-LEDs connected in each chain)

2. The allowable forward current of LED vary with environmental temperature.

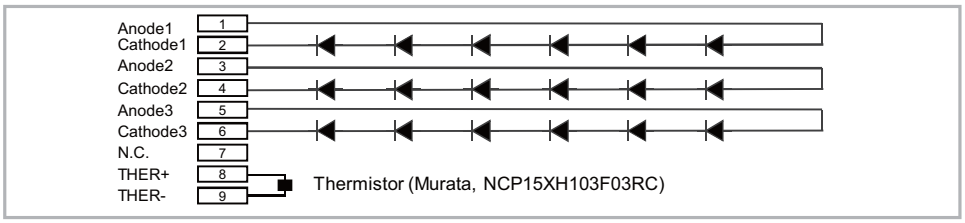


※ Derating Curve with LED Current 90mA is added by Customer's Request

3. The LED Voltage values are defined from Anode to Cathode at Typ. LED Current.

4. LED Power
   - Typ. LED Power = Typ. LED Current x +25℃ Typ. LED Voltage x LED Chain number
   - Max. LED Power = Max. LED Current x -30℃ Max. LED Voltage x LED Chain number

5. LED Chain



6. The life time is determined as the time at which brightness of LED is 50% compare to that of initial value at the typical LED current.

7. DC current dimming is recommended for LED control. If PWM dimming is needed, PWM frequency should be optimized for minimal wavy and audible noise.

5-2. Interface Connections

This LCD employs two interface connections, one FPC is used for the module electronics interface and the other FPC is used for the integral backlight system.

5-2-1. LCD Module

The matching connector model name is 04-6495-650-000-846+ manufactured by Kyocera or equivalent

Table 4-1. PANEL FPC PIN CONFIGURATION

Pin No	Name	I/O	Description	Note
1	VCOM	I	Common Voltage	4
2	VGL	I	TFT Gate Turn-off Voltage	
3	GND	I	Ground	1
4	VGH	I	TFT Gate Turn-on Voltage	7
5	GND	I	Ground	1
6	RDP	I	LVDS Receiver Signal (D+)	
7	RDM	I	LVDS Receiver Signal (D-)	
8	GND	I	Ground	1
9	RCLKP	I	LVDS Receiver Clock Signal (+)	
10	RCLKM	I	LVDS Receiver Clock Signal (-)	
11	GND	I	Ground	1
12	RCP	I	LVDS Receiver Signal (C+)	
13	RCM	I	LVDS Receiver Signal (C-)	
14	GND	I	Ground	1
15	RBP	I	LVDS Receiver Signal (B+)	
16	RBM	I	LVDS Receiver Signal (B-)	
17	GND	I	Ground	1
18	RAP	I	LVDS Receiver Signal (A+)	
19	RAM	I	LVDS Receiver Signal (A-)	
20	GND	I	Ground	1
21	AVDD	I	Analog Supply Voltage of Source Driver	2
22	AVDD	I	Analog Supply Voltage of Source Driver	
23	GND	I	Ground	1
24	DVDD	I	Digital Logic Supply Voltage(+3.3V)	3
25	DVDD	I	Digital Logic Supply Voltage(+3.3V)	
26	GND	I	Ground	1
27	VREF1	I	Gamma Reference Voltage 1	
28	VREF2	I	Gamma Reference Voltage 2	
29	VREF3	I	Gamma Reference Voltage 3	
30	VREF4	I	Gamma Reference Voltage 4	
31	VREF5	I	Gamma Reference Voltage 5	
32	VREF6	I	Gamma Reference Voltage 6	
33	VREF7	I	Gamma Reference Voltage 7	
34	VREF8	I	Gamma Reference Voltage 8	
35	VREF9	I	Gamma Reference Voltage 9	
36	VREF10	I	Gamma Reference Voltage 10	
37	VREF11	I	Gamma Reference Voltage 11	
38	VREF12	I	Gamma Reference Voltage 12	
39	GND	I	Ground	1

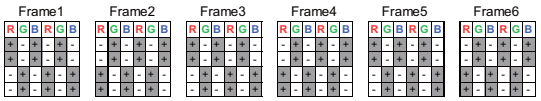
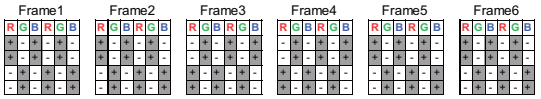
Table 4-1. PANEL FPC PIN CONFIGURATION (Continue)

Pin No	Name	I/O	Description	Note
40	DPM	O	GPM Control Signal	7
41	FLK	O	GPM Control Signal	
42	HVR	I	Horizontal & Vertical Reverse signal	5, 12
43	TEST1	-	No Connection	11
44	TEST2	-	No Connection	
45	MUTE	I	Display Mute Signal	9
46	VSYNC_FB	O	Feedback Signal of VSYNC	10
47	FRAME_INV	I	Frame Inversion Selection Signal	6, 12
48	RESET	I	Reset	8
49	TEST3	-	No Connection	11
50	VCOM	I	Common Voltage	4

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

HVR	Display Image
High (Regular Display)	
Low (Horizontal and Vertical Inverted Display)	

6. Select the Frame of Inversion. Using pull-up resistor to DVDD is recommended.

FRAME_INV	Display Image (ex. Vert. 2 Dot Inversion)
High (1 Frame Inversion Mode)	
Low (2 Frame Inversion Mode)	

7. Please see the Appendix I for more information about VGH Modulation Method.
8. Please see the Appendix II for more information about Reset Timing.
9. MUTE pin should be controlled as 5-6. Power Sequence to avoid Power on-off display flickering.
10. VSYNC_FB pin is the vertical sync output signal of LVDS input signal.
If customer don't use VSTNC_FB signal, Customer should not connect this pin.(Floating)
11. TEST1~3 pins are used for LCD manufacturing. Customer should not connect these pins.(Floating)
12. The 4.7㏀ resistor is recommended for pull-up or pull-down.

5-2-2. Backlight Module

The matching connector model name is TF12-9S-0.5SH manufactured by HIROSE or equivalent.

Table 4-2. LED FPC PIN CONFIGURATION

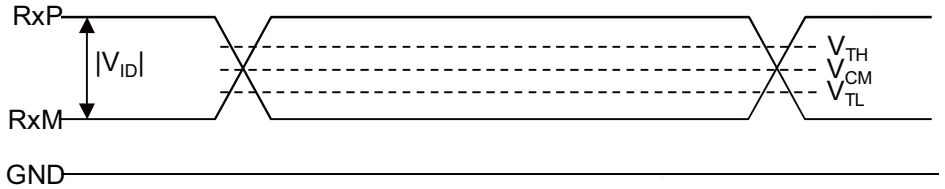
Pin No	Name	Description	Note
1	AN1	LED Anode 1	
2	CA1	LED Cathode 1	
3	AN2	LED Anode 2	
4	CA2	LED Cathode 2	
5	AN3	LED Anode 3	
6	CA3	LED Cathode 3	
7	NC	No Connection	
8	THER1	Temperature Sensor +	1
9	THER2	Temperature Sensor -	

Note 1. Please see the Appendix III for more information about Thermistor Characteristics.

5-3. LVDS Signal Specifications

5-3-1. DC Characteristics

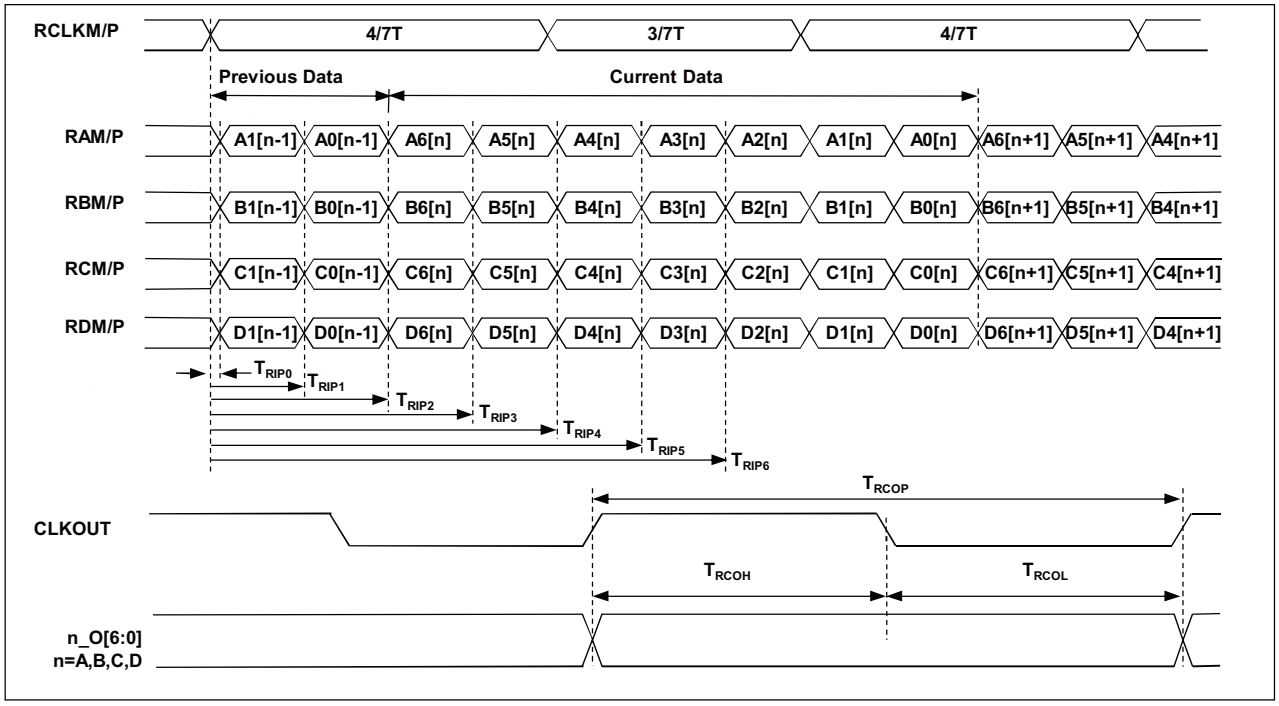
Parameter	Symbol	Min	Typ	Max	Unit	Notes
LVDS Differential Voltage	$\|V_{ID}\|$	200	350	450	mV	1
LVDS Input Common Mode Voltage	V_{CM}	1.0	1.2	1.4	V	
Positive-going Input Threshold Voltage	V_{TH}	-	-	100	mV	
Negative-going Input Threshold Voltage	V_{TL}	-100	-	-	mV	



Note 1. The LVDS termination resistors(56Ω) are mounted at LCD FPC.

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

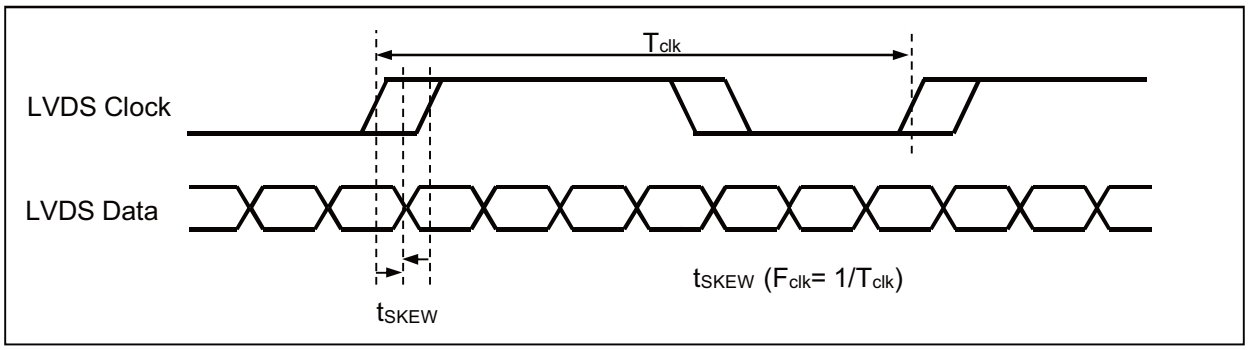
Parameter	Symbol	Min	Typ	Max	Unit
Input Data Position for Bit0	T_{RIP0}	-	0	-	ns
Input Data Position for Bit1	T_{RIP1}	-	T/7	-	ns
Input Data Position for Bit2	T_{RIP2}	-	2T/7	-	ns
Input Data Position for Bit3	T_{RIP3}	-	3T/7	-	ns
Input Data Position for Bit4	T_{RIP4}	-	4T/7	-	ns
Input Data Position for Bit5	T_{RIP5}	-	5T/7	-	ns
Input Data Position for Bit6	T_{RIP6}	-	6T/7	-	ns
CLKOUT Period	T_{RCOP}	-	T	-	ns
CLKOUT High Time	T_{RCOH}	-	T/2	-	ns
CLKOUT Low Time	T_{RCOL}	-	T/2	-	ns



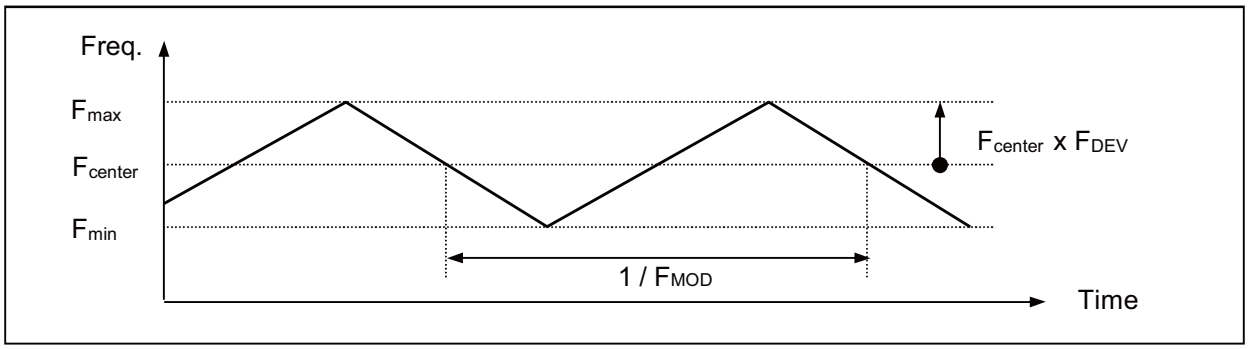
5-3-3. AC Characteristics (2/2)

Parameter	Symbol	Min	Typ	Max	Unit	Notes
LVDS Clock to Data Skew Margin	t_{SKEW}	-200	-	+200	ps	1
Maximum deviation of input clock frequency during SSC	F_{DEW}	-	-	±4	%	2
Maximum modulation frequency of input clock during SSC	F_{MOD}	15	-	90	KHz	

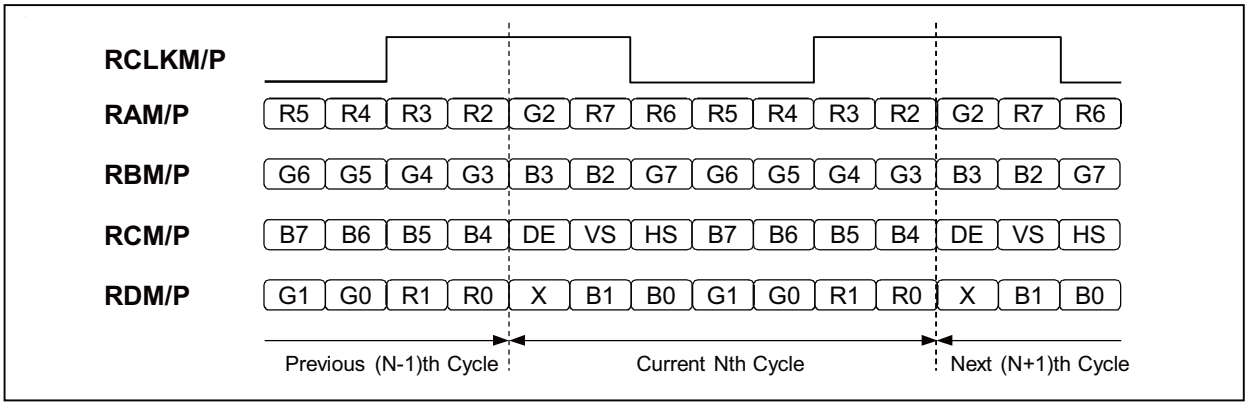
Note:
1. LVDS Clock to Data Skew Margin between channel



2. Spread spectrum



5-3-4. LVDS Bit assignment (LVDS JEIDA Format)



5-4. Signal Timing Specifications

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

Table 5. SIGNAL TIMING CHARACTERISTICS

fv = 60Hz

Parameter		Symbol	Min	Typ	Max	Unit	Note
DCLK	Frequency	f_{CLK}	36.15	37.04	37.69	MHz	1
	Period	t_{CLK}	26.53	26.99	27.66	ns	
HSYNC	Period	t_{HP}	1032	1056	1072	t_{CLK}	
	Width	t_{WH}	10	128	-		
	Horizontal Valid	t_{HV}	800	800	800		
	Horizontal Back Porch	t_{HBP}	10	74	-		
	Horizontal Front Porch	t_{HFP}	10	54	-		
VSYNC	Period	t_{VP}	583	585	587	t_{HP}	
	Width	t_{WV}	2	10	-		
	Vertical Valid	t_{VV}	480	480	480		
	Vertical Back Porch	t_{VBP}	6	55	-		
	Vertical Front Porch	t_{VFP}	2	40	-		

Note 1. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.

5-5. Color Data Reference

The brightness of each primary color(red, green, blue) is based on the 8bit gray scale data input for the color. The higher binary input, the brighter the color. Table 6 provides a reference for color versus data input.

Table 6. COLOR DATA REFERENCE

Color		Input Color Data		
		RED MSB LSB	GREEN MSB LSB	BLUE MSB LSB
		R7 R6 R5 R4 R3 R2 R1 R0	G7 G6 G5 G4 G3 G2 G1 G0	B7 B6 B5 B4 B3 B2 B1 B0
Basic Color	Black	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
	Red (255)	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
	Green (255)	0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0
	Blue (255)	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1
	Cyan	0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1
	Magenta	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1
	Yellow	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0
	White	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1
RED	RED (00)	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
	RED (01)	0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
	…	…	…	…
	RED (254)	1 1 1 1 1 1 1 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
	RED (255)	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
GREEN	GREEN (00)	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
	GREEN (01)	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0
	...	…	…	…
	GREEN (254)	0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 0	0 0 0 0 0 0 0 0
	GREEN (255)	0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0
BLUE	BLUE (00)	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0
	BLUE (01)	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1
	…	…	…	…
	BLUE (254)	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 0
	BLUE (255)	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1

5-6. Power Sequence

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

5-6-1. Power On Sequence

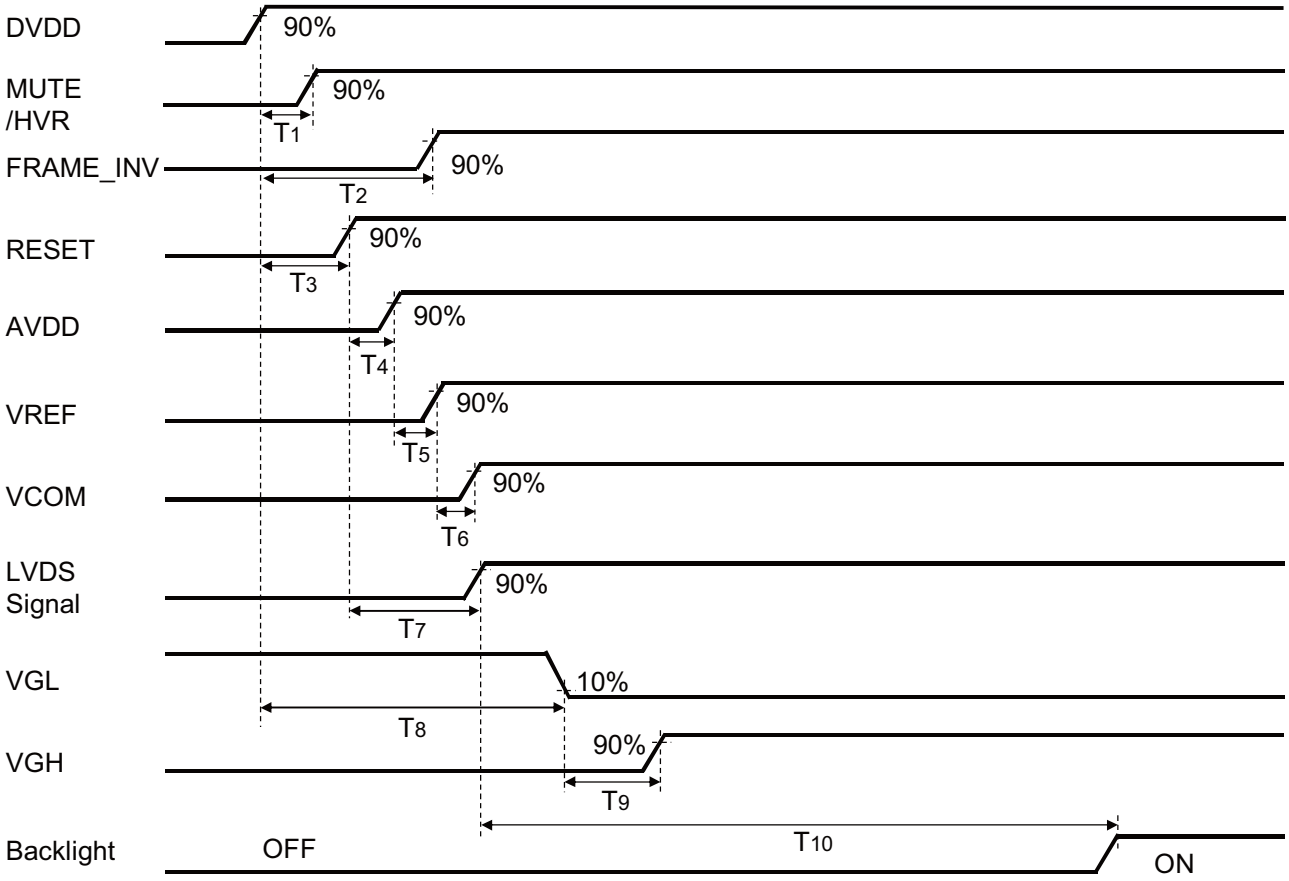


Table 7-1. POWER ON SEQUENCE

Parameter	Value			Unit	Note
	Min	Typ	Max		
T1	0	-	T3	ms	
T2	0	-	-	ms	
T3	5	-	50	ms	
T4	5	-	30	ms	
T5	0	-	10	ms	
T6	0	-	10	ms	
T7	5	-	2000	ms	2,3
T8	20	-	50	ms	
T9	5	-	100	ms	
T10	800	-	-	ms	

Note 1. Please avoid floating state of all input signals.
2. When the interface signal is invalid, be sure to pull down the power supply for LCD to 0V.
3. When Power On Sequence or during operation, interface signal is not allowed momentary off or abnormal waveform.
4. Backlight must be turn on after power supply for LCD and interface signal are valid.
5. If it is difficult to perform as our recommendation, customers are asked to confirm the Power sequence with LG Display prior to their use.

5-6-2. Power Off Sequence

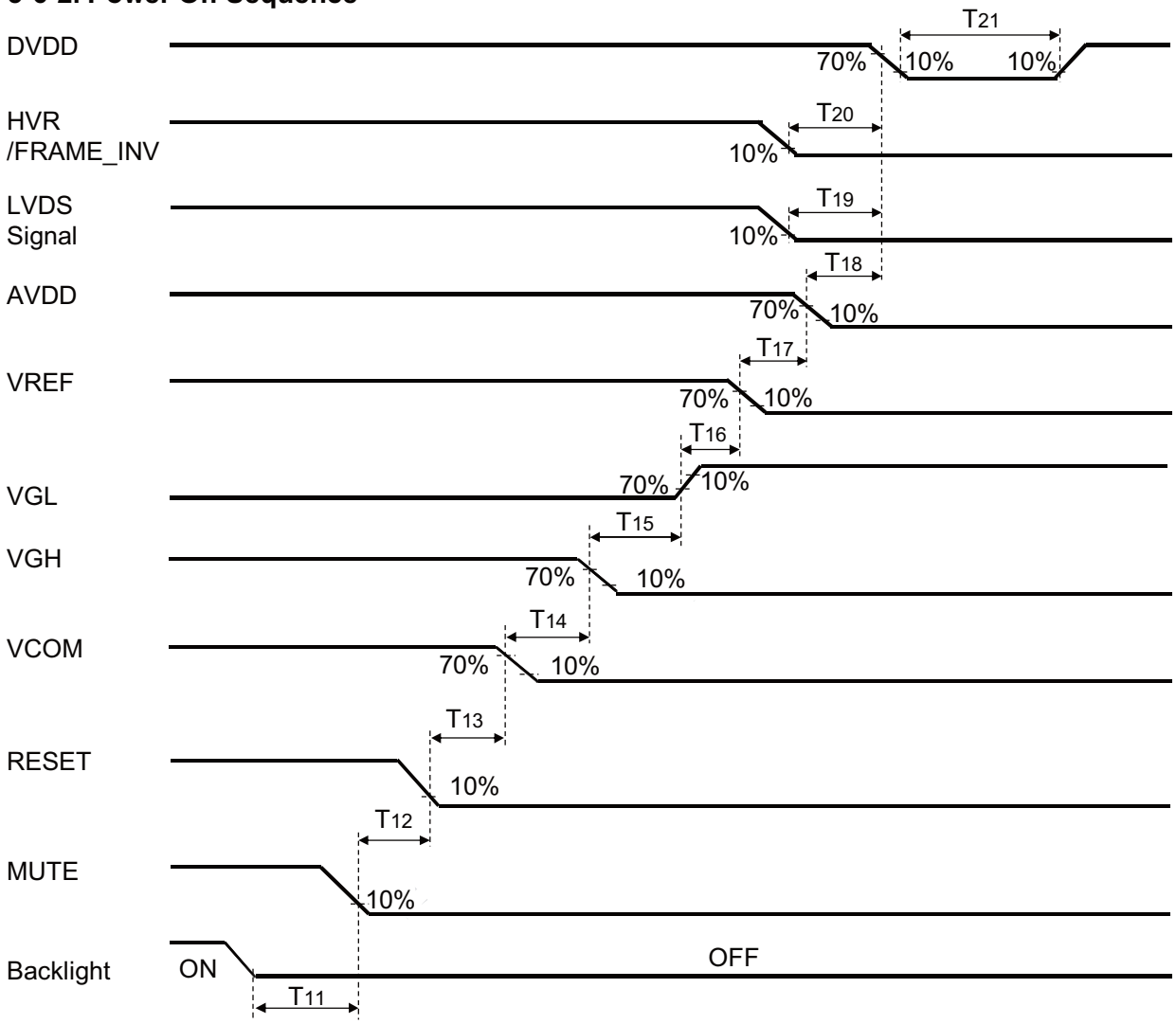


Table 7-2. POWER OFF SEQUENCE

Parameter	Value			Unit	Note
	Min	Typ	Max		
T_{11}	1	-	-	ms	
T_{12}	3	-	10	ms	
T_{13}	0	-	50	ms	
T_{14}	0	-	10	ms	
T_{15}	0	-	10	ms	
T_{16}	0	-	10	ms	
T_{17}	0	-	10	ms	
T_{18}	0	-	10	ms	
T_{19}	0	-	-	ms	
T_{20}	0	-	10	ms	
T_{21}	100	-	-	ms	1, 2

Note 1. Power on Sequence must be observed to restart LCM after all power and signal off.
2. The Falling Time(90%→10%) of DVDD/AVDD/VREF/VCOM/VGH/VGL should be within 100ms.

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 15 minutes while backlight turning on.

It is presented additional information concerning the measurement equipment and method in FIG. 1.

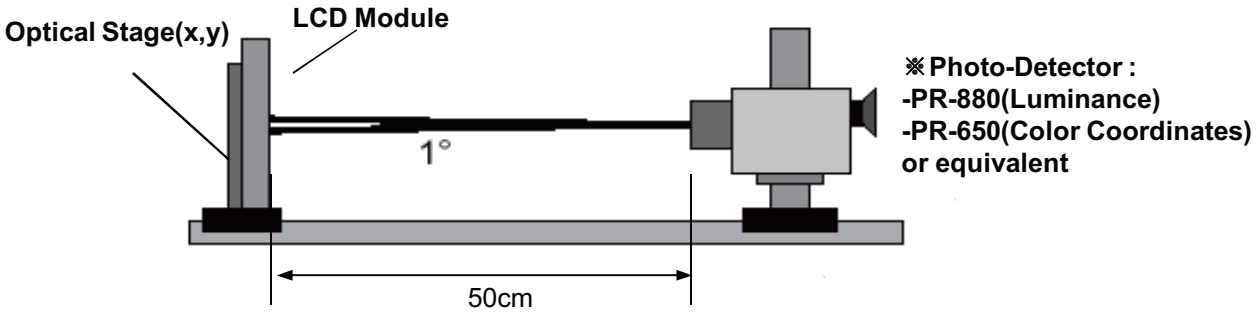


FIG. 1 Electro-optical Characteristic Measurement Equipment and Method

Table 8. ELECTRO-OPTICAL CHARACTERISTICS

Ta=25±2°C, DVDD=3.3V, AVDD=13.0V, fv=60Hz, fclk=37.04MHz, I_{LED}=80mA

Parameter		Symbol	Value			Unit	Note
			Min	Typ	Max		
Contrast Ratio		CR	800	1100	-		1, 2
			90	150	-		1, 3
Surface Luminance, white		L_{WH}	800	1000	-	cd/m²	5, 2
			430	-	-	cd/m²	5, 4
Luminance Variation		δ_{WHITE}	80	-	-	%	6
Response Time	Rise Time	Tr_R	-	-	16	ms	7
	Decay Time	Tr_D	-	-	14	ms	
Color Coordinates [CIE1931]	RED	Rx	Typ -0.03	0.638	Typ +0.03		
		Ry		0.330			
	GREEN	Gx		0.305			
		Gy		0.595			
	BLUE	Bx		0.150			
		By		0.063			
	WHITE	Wx		0.315			
		Wy		0.327			
Color Gamut			-	70	-	%	
Viewing Angle (CR>10)	x axis, right(ϕ=0°)	θr	-	89	-	degree	8
	x axis, left (ϕ=180°)	θl	-	89	-		
	y axis, up (ϕ=90°)	θu	-	89	-		
	y axis, down (ϕ=270°)	θd	-	89	-		

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.

2. Perpendicular: L/R/U/D = 0º

3. Viewing angle(Contrast Ratio) : L/R = ±45º, U/D = ±20º

4. Viewing angle(Luminance) : L/R = ±35º, U/D = ±20º

5. Surface luminance are determined after the unit has been 'ON' and More than 15 Minute 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. 2.

6. The luminance variation(δ_{WHITE}) is determined by measuring LN at each test position 1 through 9. The luminance variation(δ_{WHITE}) is defined as follows ;

$$\text{Luminance Variation } (\delta_{WHITE}) = \frac{\text{Minimum}(L1,L2,\ldots,L8,L9)}{\text{Maximum}(L1,L2,\ldots,L8,L9)} \times 100\ (\%)$$

For more information see the FIG. 2.

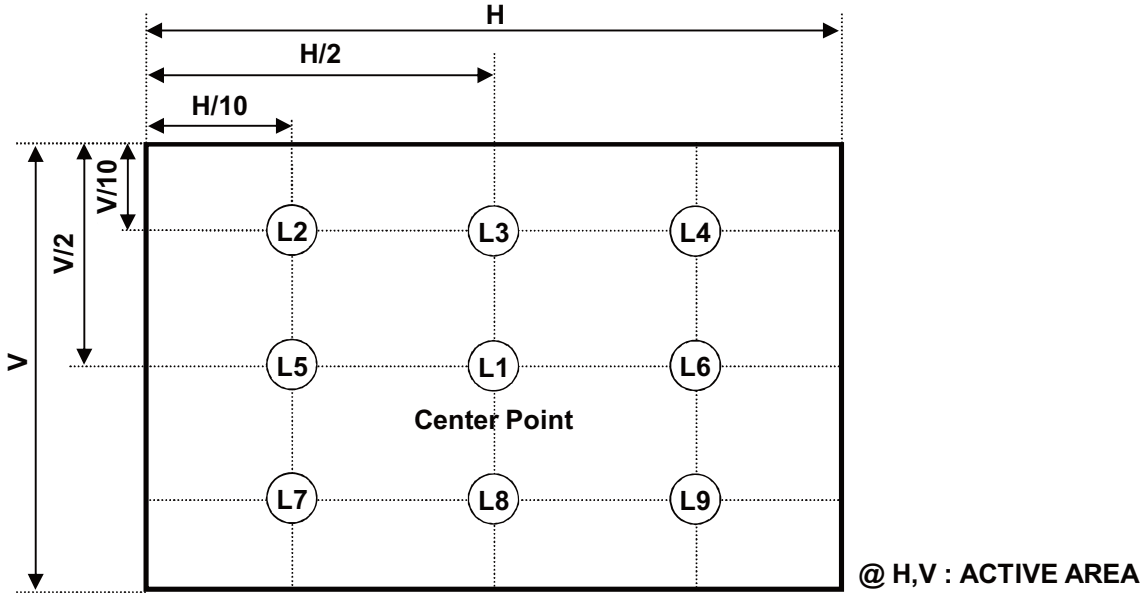


FIG. 2 9 Points for Luminance Measure

Note 7. Response time is obtained by measuring the transition time of photo detector output, when input signals are applied to make center point “black” and “white”. For more information, see the FIG. 3

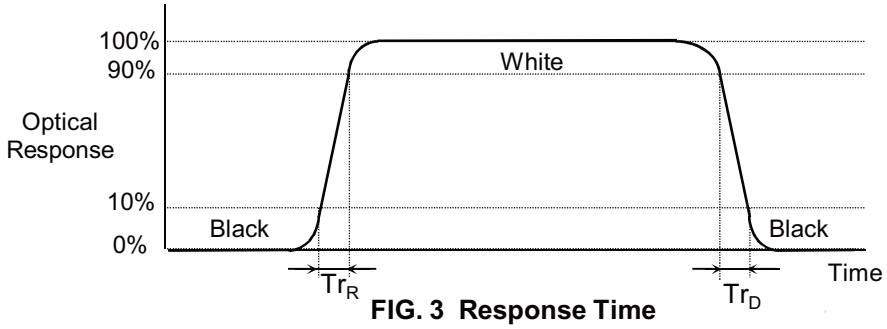


FIG. 3 Response Time

8. 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. 4.

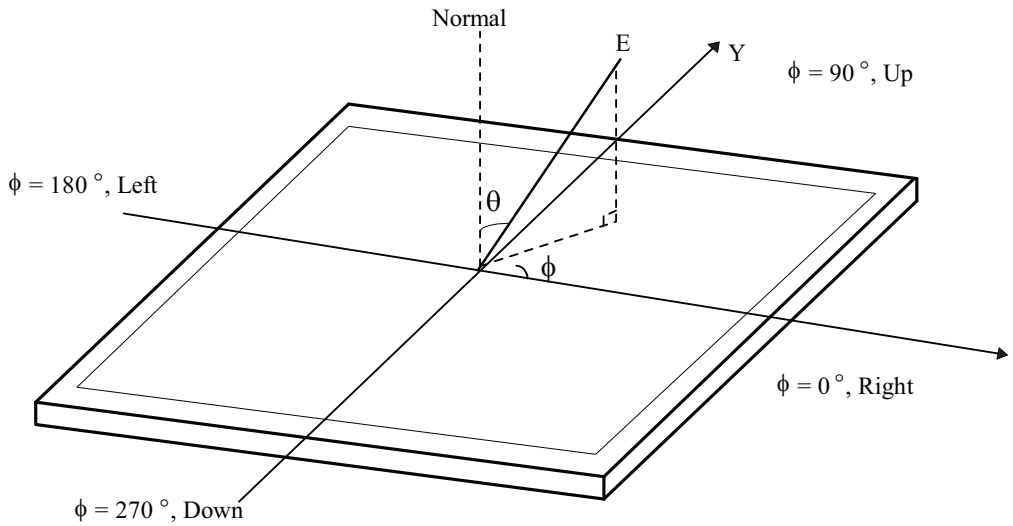


FIG. 4 Viewing Angle

7. Mechanical Characteristics

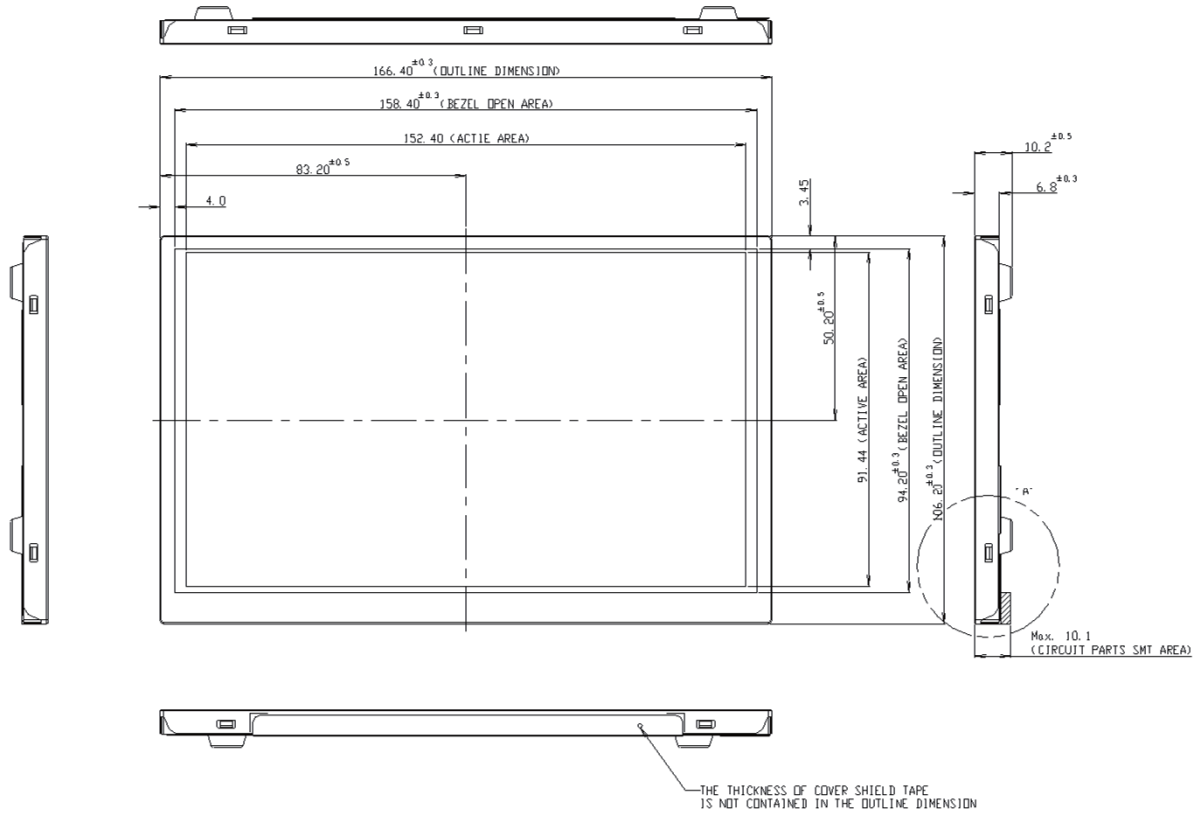
The contents provide general mechanical characteristics for this module. In addition the figures in the next page are detailed mechanical drawing of the LCD.

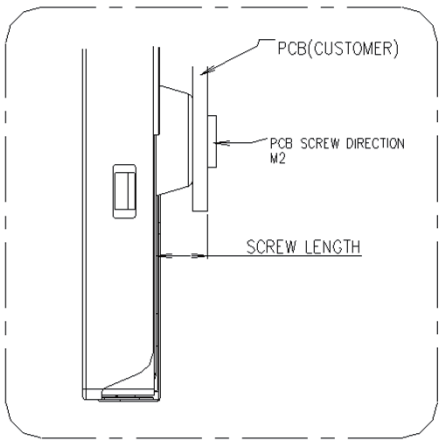
Table 9. MECHANICAL CHARACTERISTICS

Parameter	Value	
Outline Dimension	Horizontal	166.4 ± 0.3 mm
	Vertical	106.2 ± 0.3 mm
	Depth	6.8 ± 0.3 mm
Bezel Area	Horizontal	158.4 ± 0.3 mm
	Vertical	94.2 ± 0.3 mm
Active Display Area	Horizontal	152.40 mm
	Vertical	91.44 mm
Weight	162g (Typ.), 167g (Max.)	

<FRONT VIEW>

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



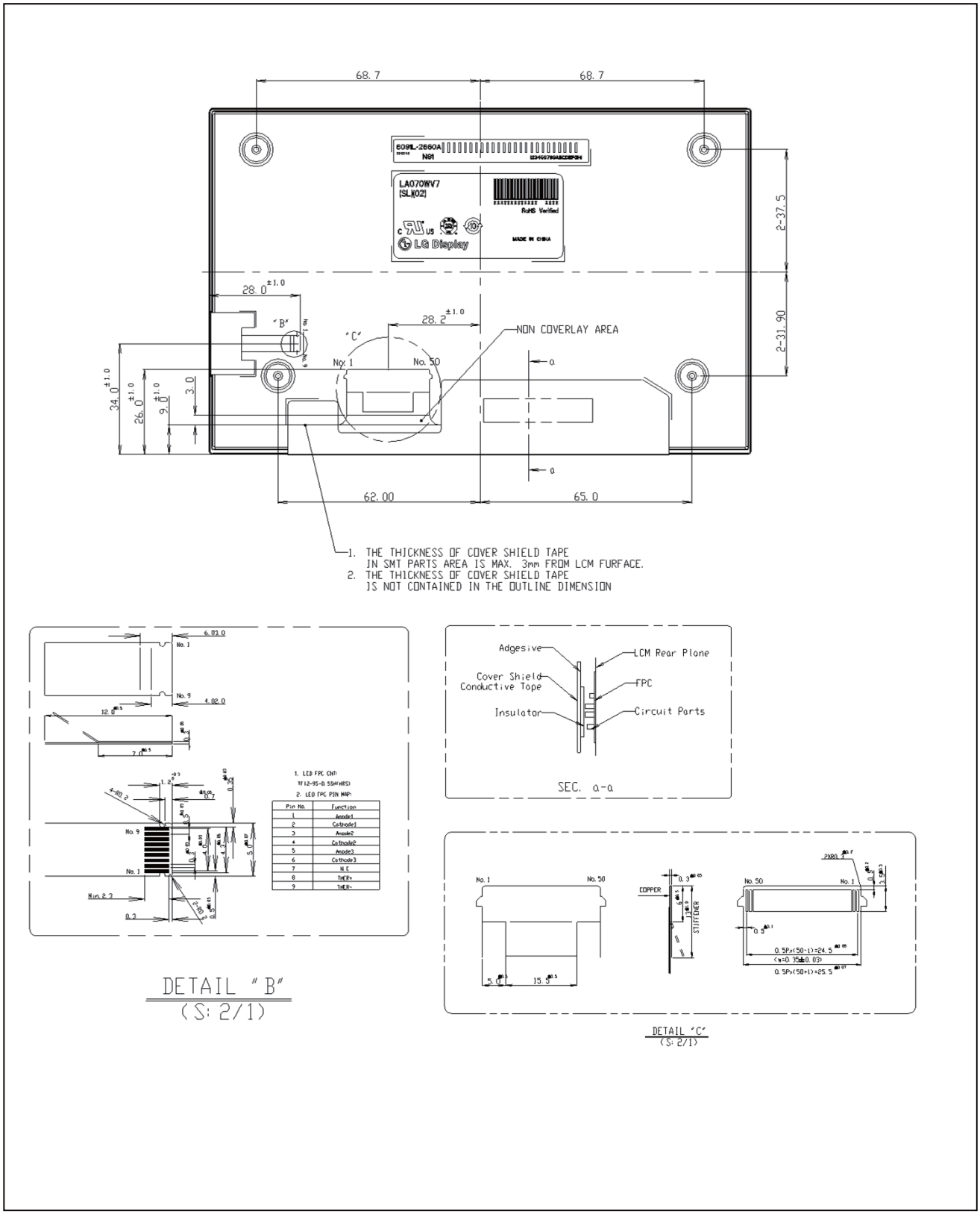


MAX SCREW LENGTH = PCB THICKNESS + 3.4mm
PCB SCREW TORQUE : MAX.2.5kgf*cm
SCREW HOLE INSPECTION SPEC : Ø 1.5GO AND Ø 1.6NO WITH PIN GAUGE

DETAIL "A"
(S:2/1)_4POINTS

<REAR VIEW>

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



8. Reliability

Table 10. ENVIRONMENT TEST CONDITION

No.	Test Item	Test Condition	Note
1	High Temperature Storage Test	Ta = 95℃ 240h	
2	Low Temperature Storage Test	Ta = -40℃ 240h	
3	High Temperature Operation Test	Ta = 85℃ 240h	
4	Low Temperature Operation Test	Ta = -30℃ 240h	
5	High Humidity Operation Test	Ta=65℃ / 90%RH 240h	
6	Humid Heat Cyclic Test	Ta = -10℃~65℃ / 80~96%RH 240h	
7	Thermal Shock Test (non-operating)	- 1cycle : Ta = -40℃(0.5h) ~ 95℃(0.5h) - 240Cycles	
8	Electro Static Discharge Test	- Panel Surface : ±15kV, Air, Power On - Case Top, Cover Bottom : ±10kV, Direct, Power Off (Air : 330pF,2kΩ / Direct : 150pF,2kΩ / 10 times)	
9	Shock Test (non-operating)	- Half sine wave, 50G, 11ms, three times - One in each opposite direction of each perpendicular axis	
10	Vibration Test (non-operating)	- 10Hz to 50Hz, 5.0G, 1mm p-p, logarithm sweep for 1min/cycle, 30 sweeps per axis (only y axis)	
11	Vibration Test Temperature Cycle	- 10Hz to 50Hz, 1min, 1.0G, -20℃~60℃ - 8H×6Cycle	

Note. Result Evaluation Criteria:

1. There should be no particular problems that may affect the display function at room temperature after 2 hours from the reliability tests finish.
2. TFT-LCD panels should take place at room temperature for 24 hours after the reliability tests finish. Then, all of optical and electrical test should be performed.
3. Display performance quality is monitored before, in the middle of, and after the test, and will be verified after turning into room temperature. (No abnormal display found)

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.

9-2. Environment

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

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

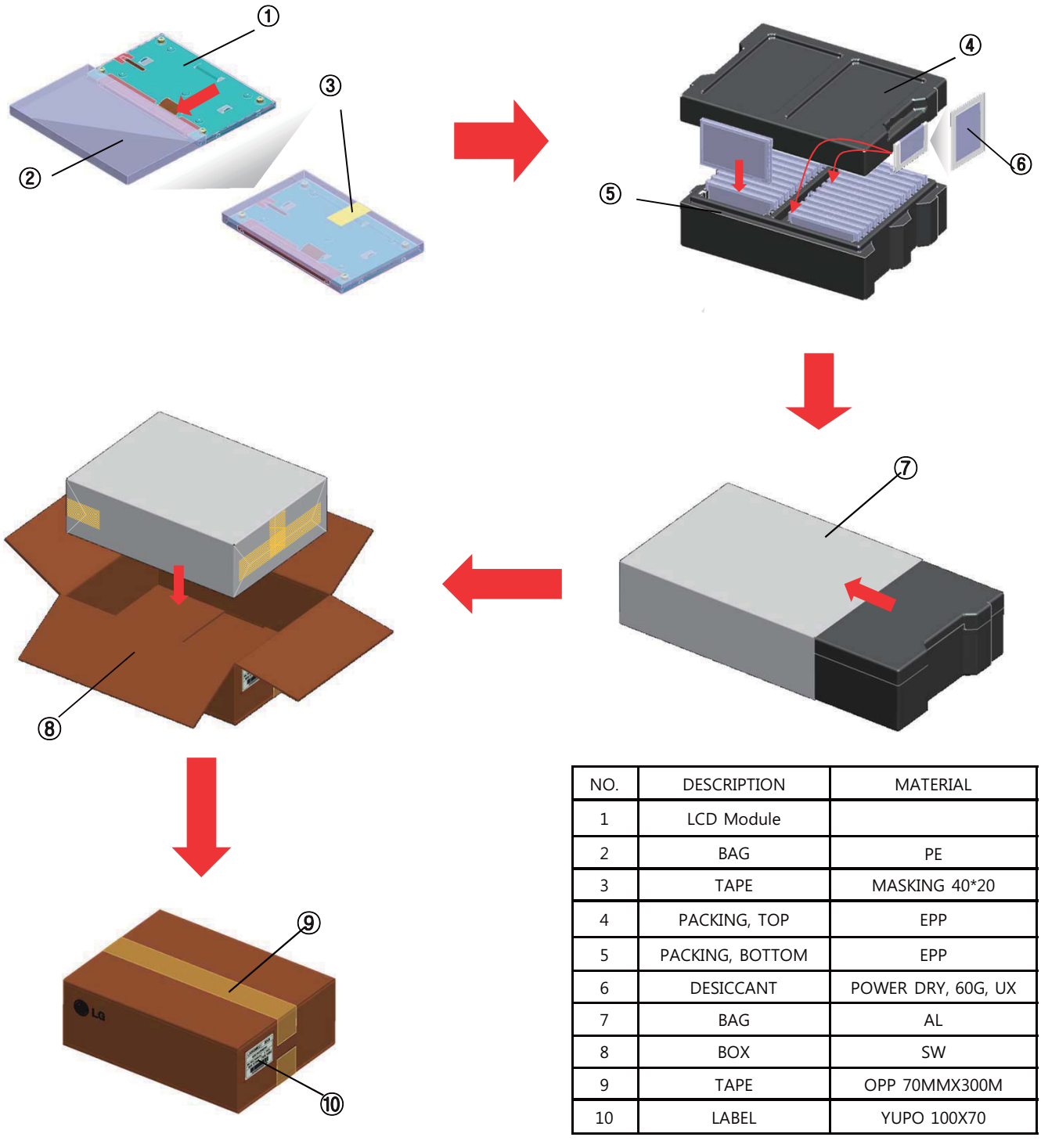
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mark	1	2	3	4	5	6	7	8	9	A	B	C

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.

10-2. Packing Form

a) Package quantity in one box : 26 pcs
b) Box Size : 478 mm × 365 mm × 195 mm



NO.	DESCRIPTION	MATERIAL
1	LCD Module	
2	BAG	PE
3	TAPE	MASKING 40*20
4	PACKING, TOP	EPP
5	PACKING, BOTTOM	EPP
6	DESICCANT	POWER DRY, 60G, UX
7	BAG	AL
8	BOX	SW
9	TAPE	OPP 70MMX300M
10	LABEL	YUPO 100X70

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 structure.(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 are 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.

11-3. ELECTROSTATIC DISCHARGE CONTROL

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that handling 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

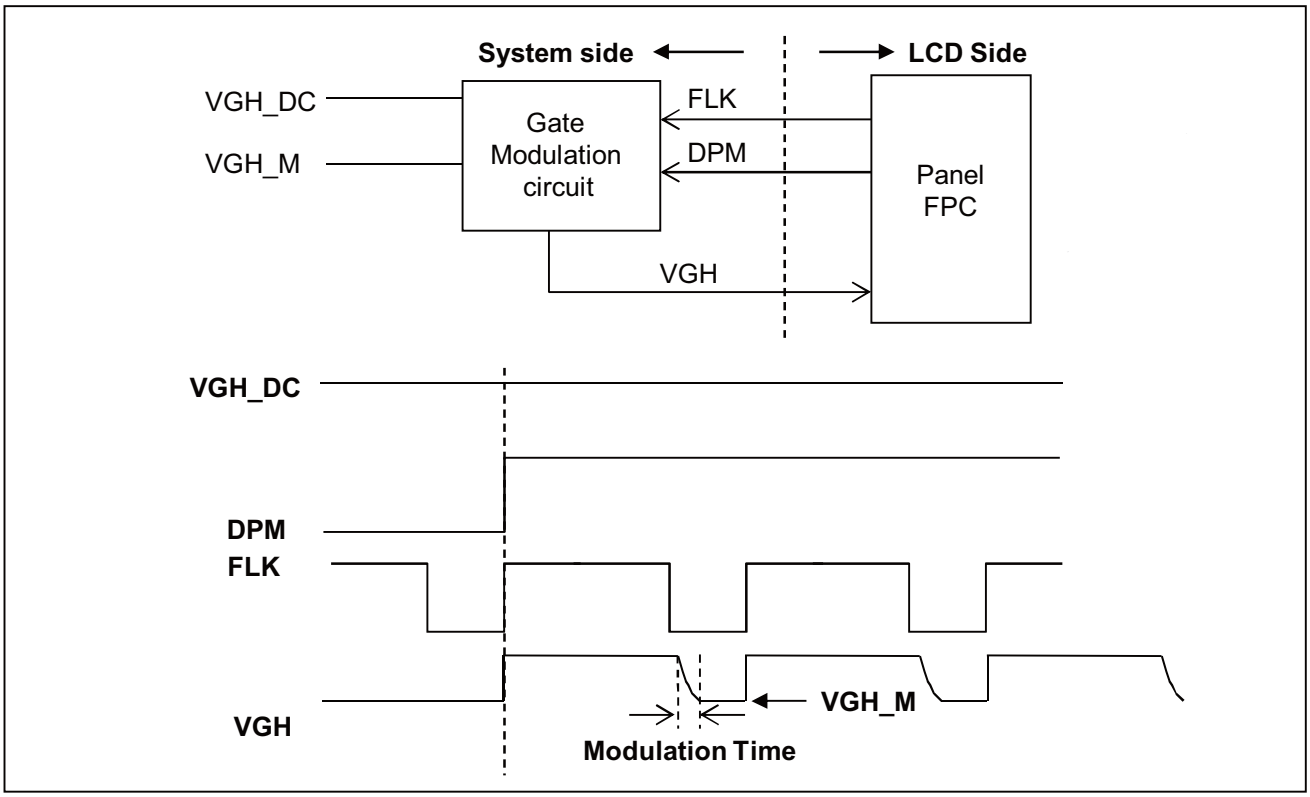
When storing modules as spares for a long time, the following precautions are necessary.
(1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
(2) The polarizer surface should not come in contact with any 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 the bezel 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) You can remove the glue easily. When the glue remains on the bezel surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.

APPENDIX- I

■ VGH Modulation Method

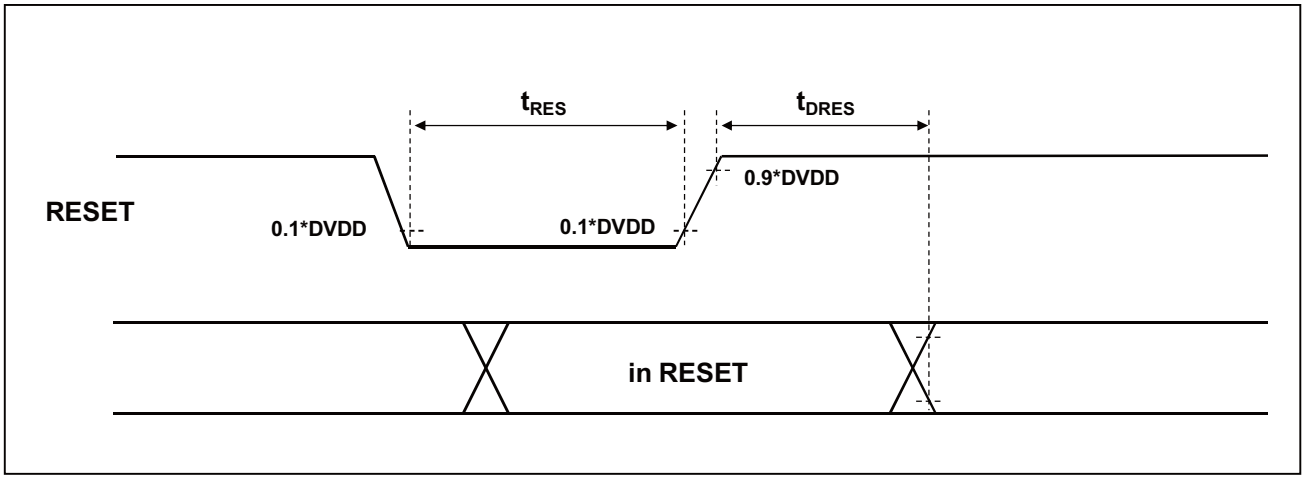


Parameter	Values			Unit	Note
	Min	Typ	Max		
VGH_DC	17.0	18.5	20.0	V	
VGH_M	6.0	6.5	7.0	V	
Modulation time	4	5	6	us	1

Note 1. Slew rate: 1.1 V/us (Typ.)
2. When customers use VGH modulation function, should be asked to confirm the details with LG Display prior to their use.

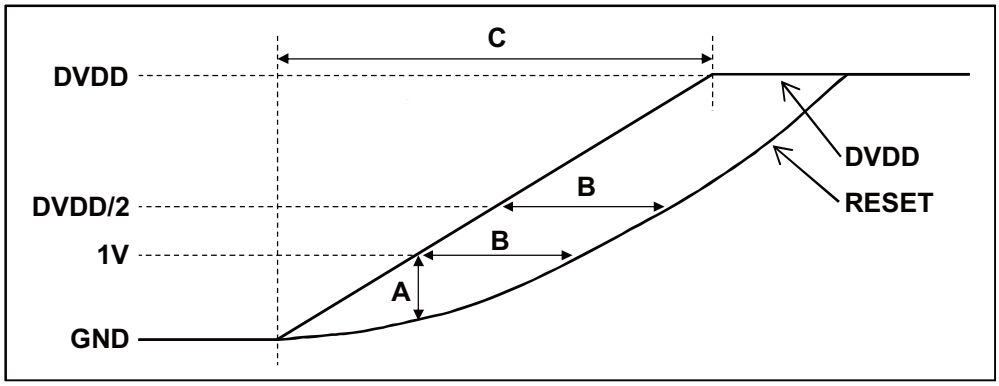
APPENDIX- II

■ Reset Timing



Parameter	Symbol	Value			Unit	Note
		Min	Typ	Max		
RESET Low Pulse Width	t_{RES}	5	10	-	ms	1
RESET Exit Delay Time	t_{DRES}	-	-	1	ms	

Note 1. The RESET IC is recommended for generating RESET signal.
2. If it is difficult to use RESET IC, the timing between DVDD and RESET signal should satisfy below timing.



Parameter	Symbol	Values			Unit	Note
		Min	Typ	Max		
DVDD to Reset Voltage Gap	A	0.5	-	1	V	
DVDD to Reset Delay Time	B	1.5	-	-	ms	
DVDD Rising Time	C	-	-	3	ms	

APPENDIX- III

■ Thermistor Characteristics

Note 1. Thermistor type is NCP15XH103F03RC.
The display module shall incorporate a NTC thermistor surface mounted to the LED array.
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_{TYP} value in the table is the feature of the thermistor by itself.
The measured value in the LCM could be different from R_{TYP}.
3. R_{TYP} tolerance is ±1% at 25℃

Temp. (℃)	$R_{TYP.}$ (kohm)
-30	113.347
-25	87.559
-20	68.237
-15	53.65
-10	42.506
-5	33.892
0	27.219
+5	22.021
+10	17.926
+15	14.674
+20	12.081
+25	10

Temp. (℃)	$R_{TYP.}$ (kohm)
+30	8.315
+35	6.948
+40	5.834
+45	4.917
+50	4.161
+55	3.535
+60	3.014
+65	2.586
+70	2.228
+75	1.925
+80	1.669
+85	1.452