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Record of Revisions

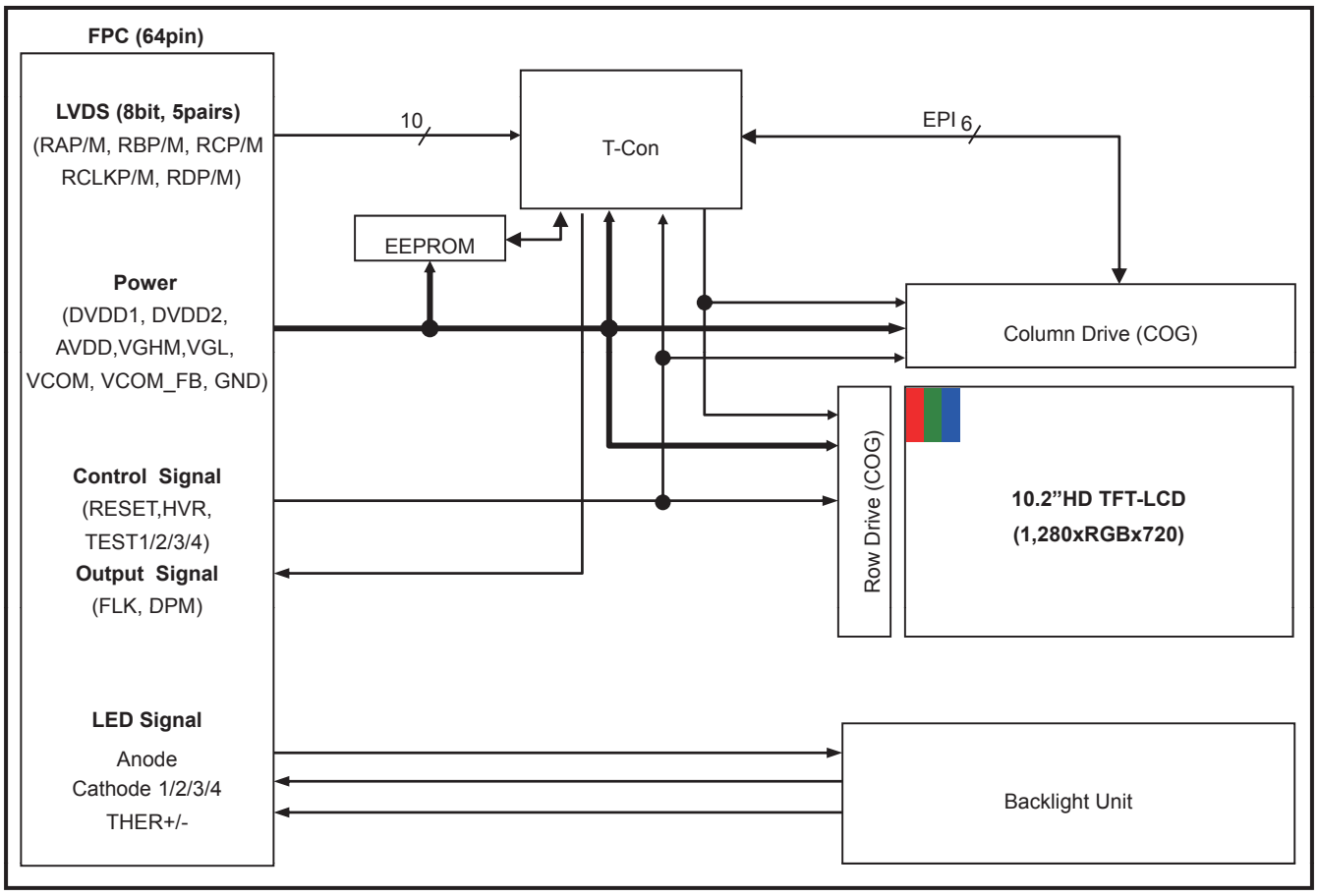
Revision No.	Revision Date	Page	Description	Note
0.0	Jun.24.2015	-	Preliminary	
0.1	Sep.30.2015	7	Modified Table 2 - Modified Logic Supply Current	
		8	Changed Note 2 - Changed Reference Gamma Correction Voltage	
		20	Modified Fig 4	
		24	Changed Drawing (Modify the Screw dome)	
		25	Changed Note 3 - Rattle Noise Spec	
0.2	Apr. 7. 2016	7	Delete Current(Min.) value	
		8	Update Gamma voltage	
		9	Delete Voltage & Current () Marks	
		12	Update AC Characteristics - Delete LVDS Clock out.	
		13	Correct LVDS Bit assignment .	
		14	Update Signal Timing Specifications. - Delete DE/Data & Fig. 1 (Previous CAS 15page)	
		32	Update R_{THER} data and add reference comment.	
1.0	Nov.23.2016	6	Delete Voltage & Current () Marks	
		7	Delete Voltage & Current () Marks Update VCOM Voltage & Current Changed VL of Output Voltage	
		8	Update Gamma voltage (Min.&Typ.&Max.)	
		14	Delete Timing () Marks & High and Low Level Width	
		16	Changed Power Sequence T4(Min) & T6(Max)	
		19	Changed Note.2 Changed Note.3	
		25	Added 9-1 Safety - Added ‘d) Flammability test for determination of burning behavior of interior materials in motor vehicles’	
		30	Delete Voltage () Marks Update VGH Modulation Value - VGH_Low Min & Max - Modulation time Min & Max	
1.1	Mar.30.2017	23	Changed Real View - Changed Cover Shield Tape Shape	
1.2	May.25.2017	14	Change Note of Table 5.(Fig.1 → 1)	

1. Summary

This module utilizes amorphous silicon thin film transistors and a 16:9 aspect ratio. The 10.2" active matrix liquid crystal display allows 16,777,216 colors to be displayed by LVDS interface is available. The applications are CNS(Car Navigation System), RSE(Rear Seat Entertainment) and Instrument Cluster for a vehicle

2. Features

- Utilizes a panel with a 16:9 aspect ratio.
- The 10.2" screen produces a high resolution image that is composed of 921,600 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 LVDS interface, the module has a good performance in terms of EMI.



3. General Description

Active Screen Size	10.2 inches (259.06mm) diagonal
Outline Dimension	238.62 mm (H) × 141.50 mm (V) X 6.30 mm (D) (Typ.)
Pixel Pitch	0.1764 mm x 0.1764 mm
Pixel Format	1,280 horiz. by 720 vert. Pixels, RGB stripe arrangement
Color Depth	8bit(D), 16,777,216 colors
Luminance, White	725 cd/m^2 (Area A+@70℃, Min.)
Viewing Angle (CR>10)	Viewing angle free (R/L 178 (Min.), U/D 178 (Min.))
Weight	303g (Typ.), 313g (Max.)
Display Mode	Transmissive mode, Normally Black
Surface Treatment	Hard coating (3H)

4. Absolute Maximum Ratings

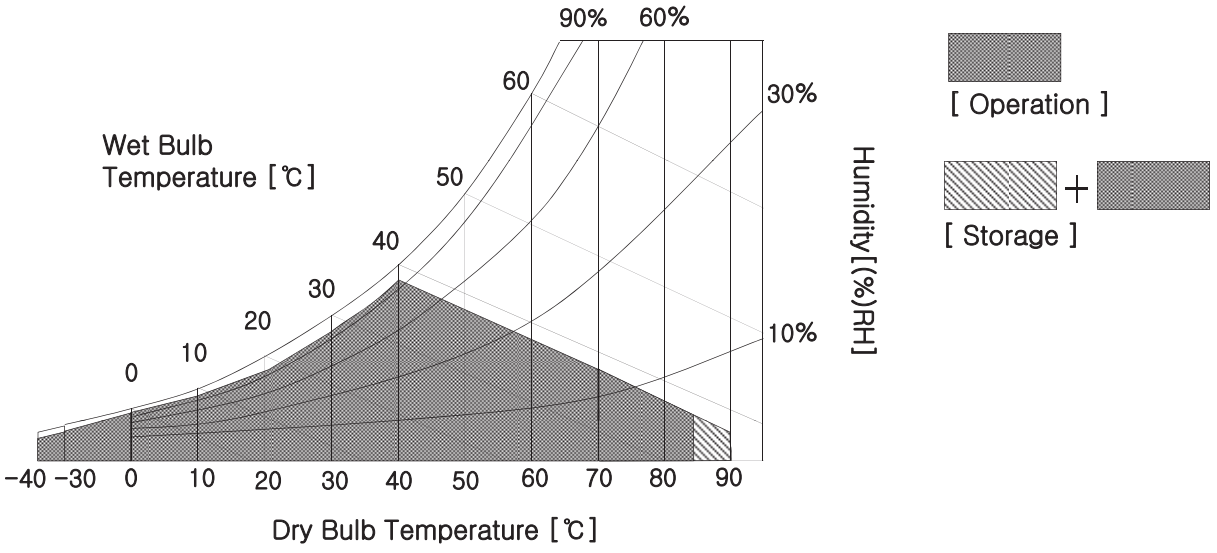
The following items are maximum values which, if exceeded, may cause faulty operation or damage to the LCD module.

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value		Unit	Note
		Min	Max		
Logic Supply Voltage	DVDD1	-0.3	4.0	V	
	DVDD2	-0.3	2.3	V	
Gamma Reference Voltage	VREF1~7	0.5AVDD-0.5	AVDD+0.3	V	
	VREF8~14	-0.3	0.5AVDD+0.5	V	
Analog Supply Voltage	AVDD	-0.3	15.0	V	
Gate Driver Voltage	VGHM-VGL	-0.0	35.0	V	
	VGL	-10.0	0.0	V	
Input Signal Voltage	V_{LVDS}	-0.3	3.0	V	1
	V_{CTRL}	-0.3	3.6	V	
LED Current	I_{LED}	-	85	mA	2
LED Power Consumption	P_{LED}	-	11.6	W	
Storage Temperature	T_{ST}	-40	90	°C	3
Operating Temperature	T_{OP}	-40	85	°C	3,4,5

Note 1. V_{LVDS}: LVDS input signal (RAM/P, RBM/P, RCM/P, RCLKM/P, RDM/P)
V_{CTRL}: HVR, RESET

2. Applies to each LED individually.
3. Temperature and relative humidity range are shown in the figure below.
Wet bulb temperature should be Max. 38℃. Condensation of dew must be avoided,
because it may cause electrical current leakage, and deterioration of performance and quality.
4. The operating temperature means that LCD Module guarantees operation of the circuit.
5. 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

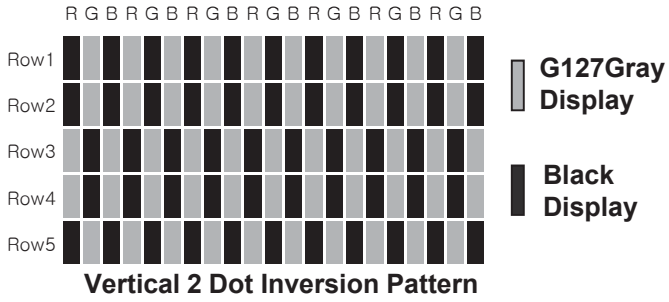
Parameter			Symbol	Value			Unit	Note
				Min	Typ	Max		
Logic Supply Voltage			DVDD1	3.0	3.3	3.6	V	
			DVDD2	1.7	1.8	1.9	V	
Input Control Signal Voltage	RESET		VH	0.9*DVDD1	-	DVDD1	V	
			VL	0.0	-	0.5	V	
	HVR		VH	-	-	Hi-Z	V	1
			VL	0.0	-	0.3	V	
Source Driver	Analog Supply Voltage		AVDD	12.0	12.5	13.0	V	
	Gamma Reference Voltage		VREF	GND+0.2	-	AVDD-0.2	V	2
Gate Driver	TFT	Turn-on Voltage	VGHM	17.0	18.5	20.0	V	3
		Turn-off Voltage	VGL	-9.0	-7.5	-7.0	V	
		Voltage Difference	VGHM-VGL	24.0	-	29.0	V	
Common Voltage			VCOM	4.8	5.3	5.8	V	4
Ripple Voltage			VRP	-	-	50	mVP-P	5
Output Signal Voltage (DPM, FLK)			VH	2.2	-	-	V	
			VL	-	-	0.5	V	
Logic Supply Current			I_{DVDD1}	-	1.8	5.0	mA	6
			I_{DVDD2}	-	60	80	mA	
Source Driver Analog Supply Current			I_{AVDD}	-	80	180	mA	
Gate Driver	Turn-on Voltage Current		I_{VGHM}	-	0.4	2	mA	
	Turn-off Voltage Current		I_{VGL}	-	0.5	2	mA	
Common Voltage Current			I_{VCOM}	-	0.01	1	mA	

Notes 1. HVR pin is pulled-up to high internally.
Please see the Appendix-I for more information about Equivalent Circuits.
2. Reference Gamma Correction Voltage . [VREF1 to VREF14]

Symbol	Value			Unit
	Min	Typ	Max	
VREF1	11.70	11.85	12.00	V
VREF2	10.37	10.52	10.67	
VREF3	9.95	10.10	10.25	
VREF4	9.15	9.30	9.45	
VREF5	8.50	8.60	8.70	
VREF6	7.40	7.50	7.60	
VREF7	6.54	6.64	6.74	
VREF8	5.56	5.66	5.76	
VREF9	4.55	4.62	4.69	
VREF10	3.47	3.52	3.57	
VREF11	2.96	3.01	3.06	
VREF12	2.42	2.47	2.52	
VREF13	1.68	1.71	1.74	
VREF14	0.39	0.40	0.41	

[VREF1 > VREF2 > ····· > VREF7 ≥ 0.5AVDD ≥ VREF8 >····· > VREF13 > VREF14]

3. Gate Pulse Modulation Function is recommended for VGHM. (Appendix I)
4. VCOM should be optimized at Vertical 2 Dot Inversion Pattern.
VCOM is not included in display. Need to be adjusted by customer.
(adjustment must be finished within 30 sec)



Vertical 2 Dot Inversion Pattern

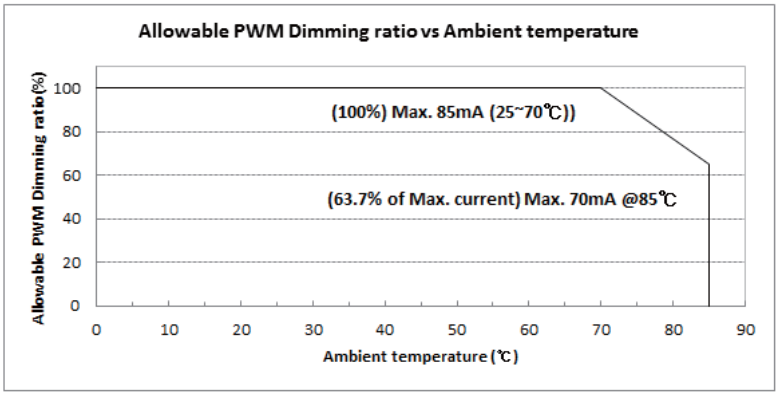
5. DVDD1, DVDD2, VCOM, VREF
6. DVDD1=3.3V, DVDD2=1.8V, AVDD=12.5V, VCOM = 5.3V, VGH = 18.5V, VGL = -7.5V, VREF1=11.85V, VREF14=0.40V, fv = 60Hz, fCLK = 64.0MHz,
White(255 Gray) Pattern, with Probe Load

Table 3. BACKLIGHT ELECTRICAL CHARACTERISTICS

Parameter		Symbol	Values			Unit	Note
			Min	Typ	Max		
LED Current		I_{LED}	-	80	85	mA	1,5
LED Voltage	-40℃	V_{LED}	27.1	30.1	34.1	V	1,2
	+25℃		26.1	29	32.9		
	+75℃		25.2	28	31.7		
LED Power		P_{LED}	-	9.28	11.6	W	1,3
LED Chain		-	-	4	-	EA	1
Lifetime (@25℃)			10,000	-	-	Hrs	4

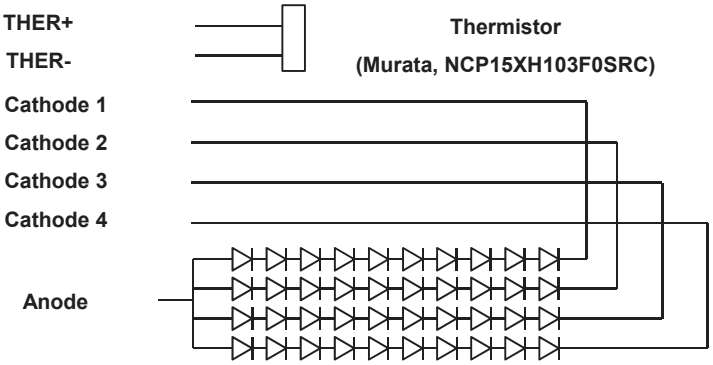
Note 1. This values applies to one chain of one LED Array. LCD includes 4 LED Array.
2. The LED Voltage values are defined from Anode to Cathode at Typ. LED Current.
3. LED Power : Typ. LED Power = Typ. LED Current x +25℃ Typ. LED Voltage x LED Chain number
Max. LED Power = Max. LED Current x -40℃ Max. LED Voltage 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.

Fig. 5-1) LED Derating curve



※ The graph above can be changed due to the engineering change of the LCM.
during the development period. It will be confirmed until the end of the RV Test.

Fig. 5-2) LED Array schematic



5-2. Interface Connections

5-2-1. FPC Pin Configuration

The electronics interface connector is a model 6288 or equivalent.

Table 4. FPC PIN CONFIGURATION

Pin No	Name	I/O	Description	Note
1	THER+	O	Temperature Sensor output (+)	
2	THER-	O	Temperature Sensor output (-)	
3	NC	-	No Connection	
4	Cathode 1	O	LED Cathode 1	
5	Cathode 2	O	LED Cathode 2	
6	Cathode 3	O	LED Cathode 3	
7	Cathode 4	O	LED Cathode 4	
8	NC	-	No Connection	
9	Anode	I	LED Anode of all chains	
10	Anode	I	LED Anode of all chains	
11	NC	-	No Connection	
12	VCOM	I	Common Voltage	1
13	VGL	I	TFT Gate Turn-off Voltage	
14	GND	I	Ground	2
15	VGHM	I	TFT Gate Turn-on Voltage	3
16	GND	I	Ground	2
17	DVDD1	I	LCD Power Supply (+3.3V)	4
18	DVDD1	I	LCD Power Supply (+3.3V)	
19	DPM	O	GPM Control Signal	3
20	FLK	O	GPM Control Signal	
21	RESET	I	TCON Reset Signal	
22	HVR	I	Horizontal & Vertical Reverse signal	5
23	TEST1	-	Test pin for LCD manufacture (NC)	6
24	TEST2	-	Test pin for LCD manufacture (NC)	
25	TEST3	-	Test pin for LCD manufacture (NC)	
26	TEST4	-	Test pin for LCD manufacture (NC)	
27	DVDD2	I	LCD Power Supply (+1.8V)	7
28	DVDD2	I	LCD Power Supply (+1.8V)	
29	GND	I	Ground	2
30	RDP	I	LVDS Receiver Signal (D+)	
31	RDM	I	LVDS Receiver Signal (D-)	
32	GND	I	Ground	2
33	RCLKP	I	LVDS Receiver Clock Signal (+)	
34	RCLKM	I	LVDS Receiver Clock Signal (-)	
35	GND	I	Ground	2
36	RCP	I	LVDS Receiver Signal (C+)	
37	RCM	I	LVDS Receiver Signal (C-)	
38	GND	I	Ground	2
39	RBP	I	LVDS Receiver Signal (B+)	
40	RBM	I	LVDS Receiver Signal (B-)	

Pin No	Name	I/O	Description	Note
41	GND	I	Ground	2
42	RAP	I	LVDS Receiver Signal (A+)	
43	RAM	I	LVDS Receiver Signal (A-)	
44	GND	I	Ground	2
45	AVDD	I	Power for Source Driver IC	8
46	AVDD	I	Power for Source Driver IC	
47	VREF14	I	Voltage for Gamma Correction	
48	VREF13	I	Voltage for Gamma Correction	
49	VREF12	I	Voltage for Gamma Correction	
50	VREF11	I	Voltage for Gamma Correction	
51	VREF10	I	Voltage for Gamma Correction	
52	VREF9	I	Voltage for Gamma Correction	
53	VREF8	I	Voltage for Gamma Correction	
54	VREF7	I	Voltage for Gamma Correction	
55	VREF6	I	Voltage for Gamma Correction	
56	VREF5	I	Voltage for Gamma Correction	
57	VREF4	I	Voltage for Gamma Correction	
58	VREF3	I	Voltage for Gamma Correction	
59	VREF2	I	Voltage for Gamma Correction	
60	VREF1	I	Voltage for Gamma Correction	
61	GND	I	Ground	2
62	VCOM_FB	O	Feedback Common Voltage of Panel	9
63	VCOM	I	Common Voltage	1
64	VCOM	I	Common Voltage	

Note 1. All VCOM pins should be connected together.
2. All GND(ground) pins should be connected together.
3. Please see the Appendix I for more information about VGH Modulation Method.
4. All DVDD1 pins should be connected together.
5. Display Direction as following pictures.
HVR is pulled-up to high internally.
Do not control HVR during LCD operation to avoid abnormal display.

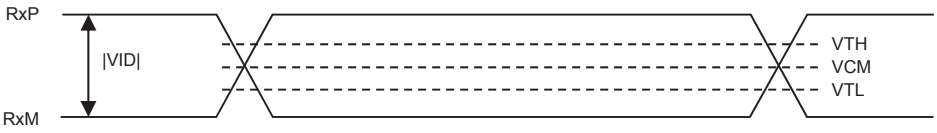
HVR	Display Image
GND (Regular Display)	
Open (Horizontal and Vertical Inverted Display)	

6. TEST pins is used for LCD manufacturing.
7. All DVDD2 pins should be connected together.
8. All AVDD pins should be connected together.
9. VCOM feedback line of Panel for VCOM compensation.
Please see the Appendix II for more information about VCOM compensation Method.
If customer doesn't use this function, this pin should be connected VCOM.
10. Make sure that NC pins should be floated.
11. Please see the Appendix III for more information about Thermistor Characteristics.
12. Please see the Appendix IV for more information about Equivalent Circuits.

5-3. LVDS Signal Specifications

5-3-1. DC Characteristics

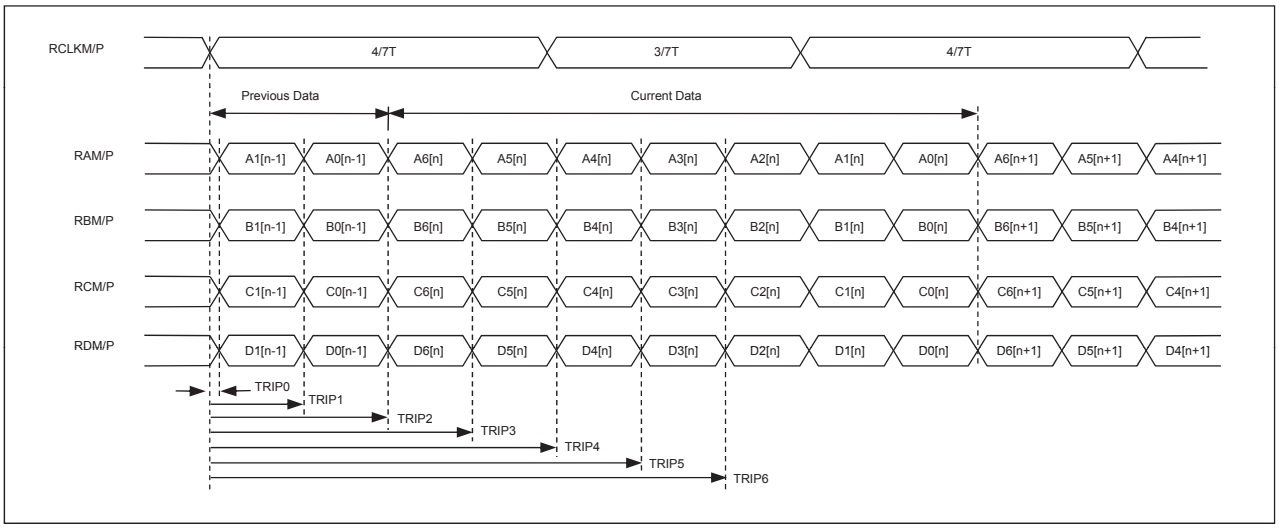
Parameter	Symbol	Min	Typ	Max	Unit	Notes
LVDS Differential Voltage	$\|V_{ID}\|$	250	350	450	mV	1
LVDS Input Common Mode Voltage	V_{CM}	1.0	1.2	1.4	V	
Positive-going Input Threshold Voltage	V_{TH}	-	-	100	mV	
Negative-going Input Threshold Voltage	V_{TL}	-100	-	-	mV	



Note 1. All LVDS Rx termination resistor (100Ω) is integrated on the chip.(T-Con)

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

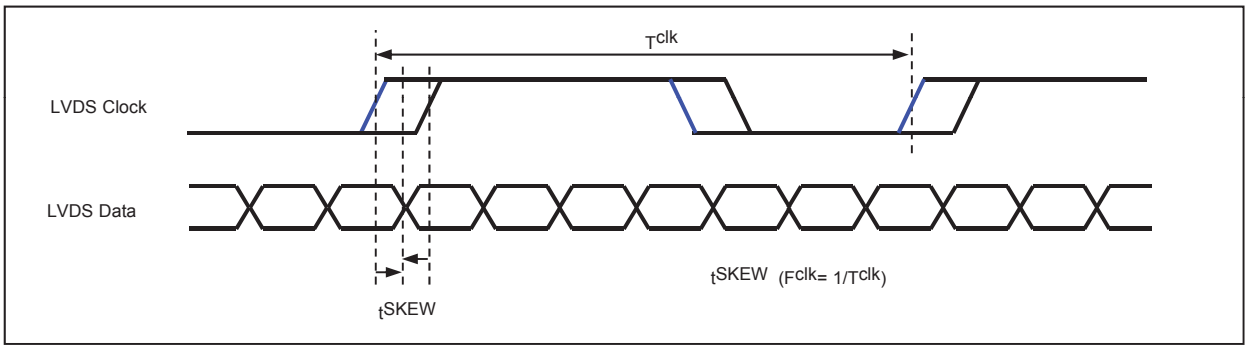


5-3-3. AC Characteristics (2/2)

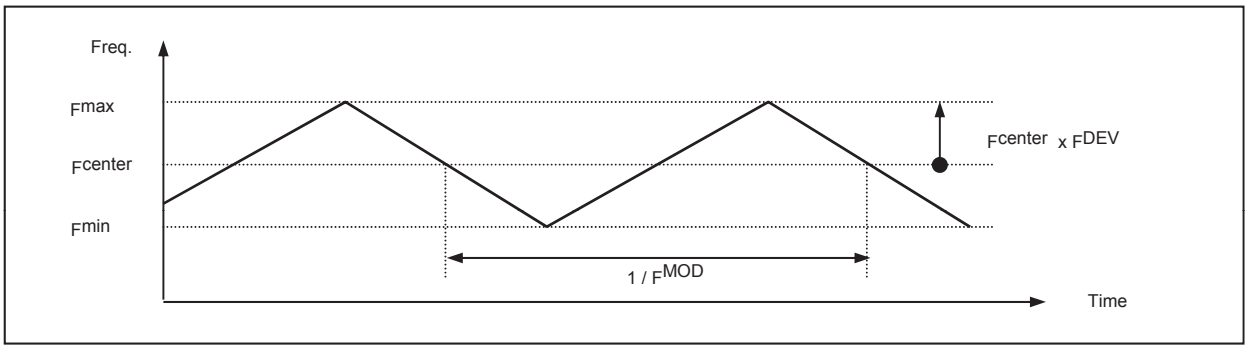
Parameter	Symbol	Min	Typ	Max	Unit	Notes
LVDS Clock to Data Skew Margin	t_{SKEW}	-300	-	+300	ps	1
Maximum deviation of input clock frequency during SSC	F_{DEW}	-	-	±2.5	%	2
Maximum modulation frequency of input clock during SSC	F_{MOD}	-	-	150	KHz	

Note:

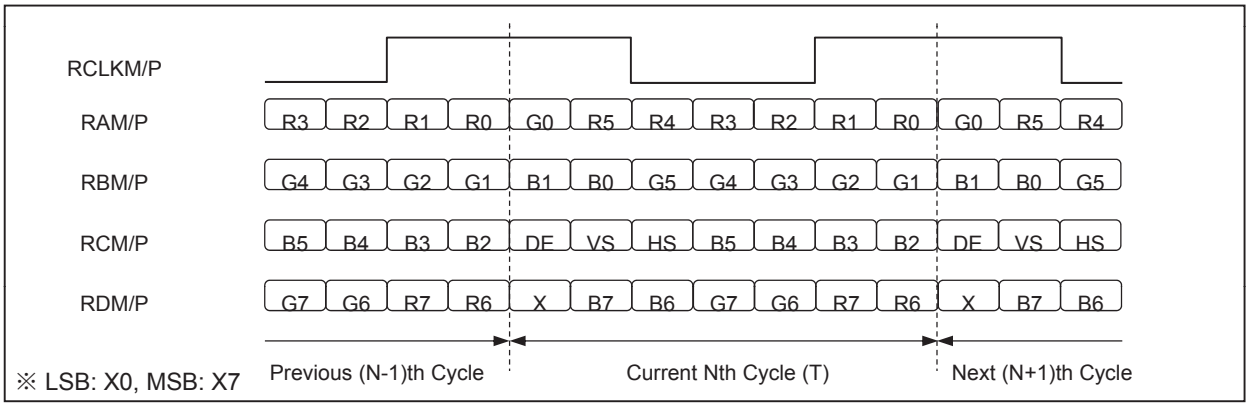
1. LVDS Clock to Data Skew Margin between channel



2. Spread spectrum



5-3-4. LVDS Bit assignment (LVDS VESA 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(f_V=60Hz)

Parameter		Symbol	Min	Typ	Max	Unit	Note
DCLK	Frequency	f_{CLK}	63.00	64.00	75.04	MHz	1
	Period	t_{CLK}	15.87	15.63	13.32	ns	
HSYNC	Period	t_{HP}	1421	1440	1661	t_{CLK}	
	Width	t_{WH}	32	32	32		
	Horizontal Valid	t_{HV}	1280	1280	1280		
	Horizontal Back Porch	t_{HBP}	65	80	220		
	Horizontal Front Porch	t_{HFP}	44	48	129		
VSYNC	Period	t_{VP}	739	741	753	t_{HP}	
	Width	t_{WV}	5	5	5		
	Vertical Valid	t_{VV}	720	720	720		
	Vertical Back Porch	t_{VBP}	12	13	19		
	Vertical Front Porch	t_{VFP}	2	3	9		

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								GREEN								BLUE			
		MSB							LSB	MSB							LSB	MSB			LSB
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Color	Black	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

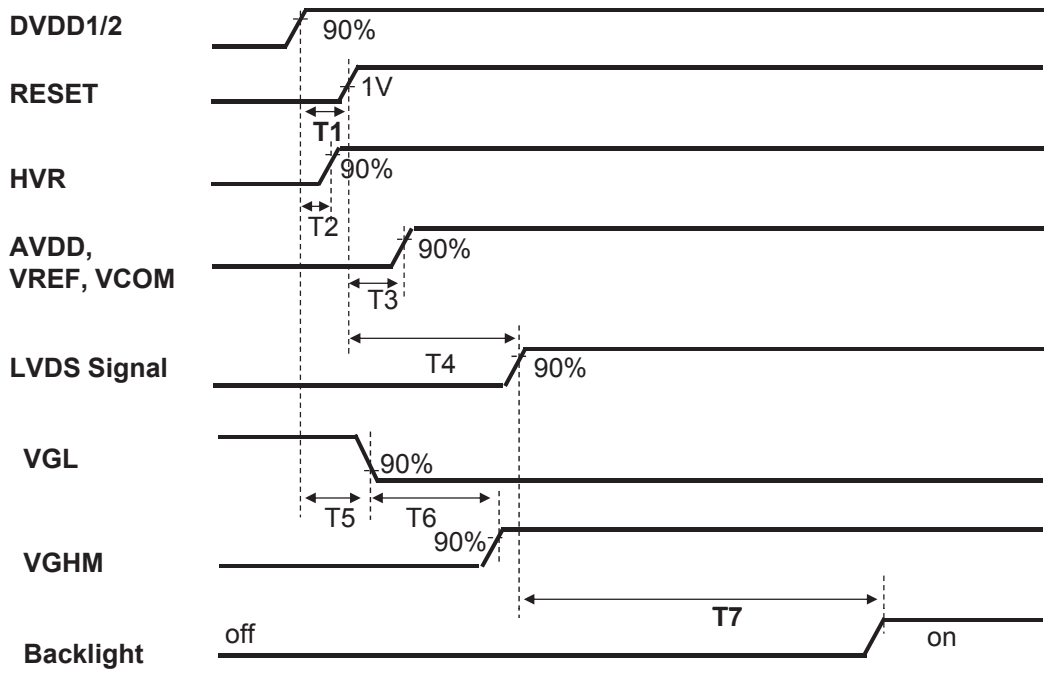


Table 7-1. POWER ON SEQUENCE

Parameter	Value			Unit	Note
	Min	Typ	Max		
T1	2	-	10	ms	
T2	0	-	10	ms	1
T3	0	-	30	ms	
T4	100	-	1000	ms	
T5	10	-	30	ms	
T6	10	-	100	ms	
T7	300	-	-	ms	

Note 1. Do not change HVR 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.
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.

5-6-2. Power Off Sequence

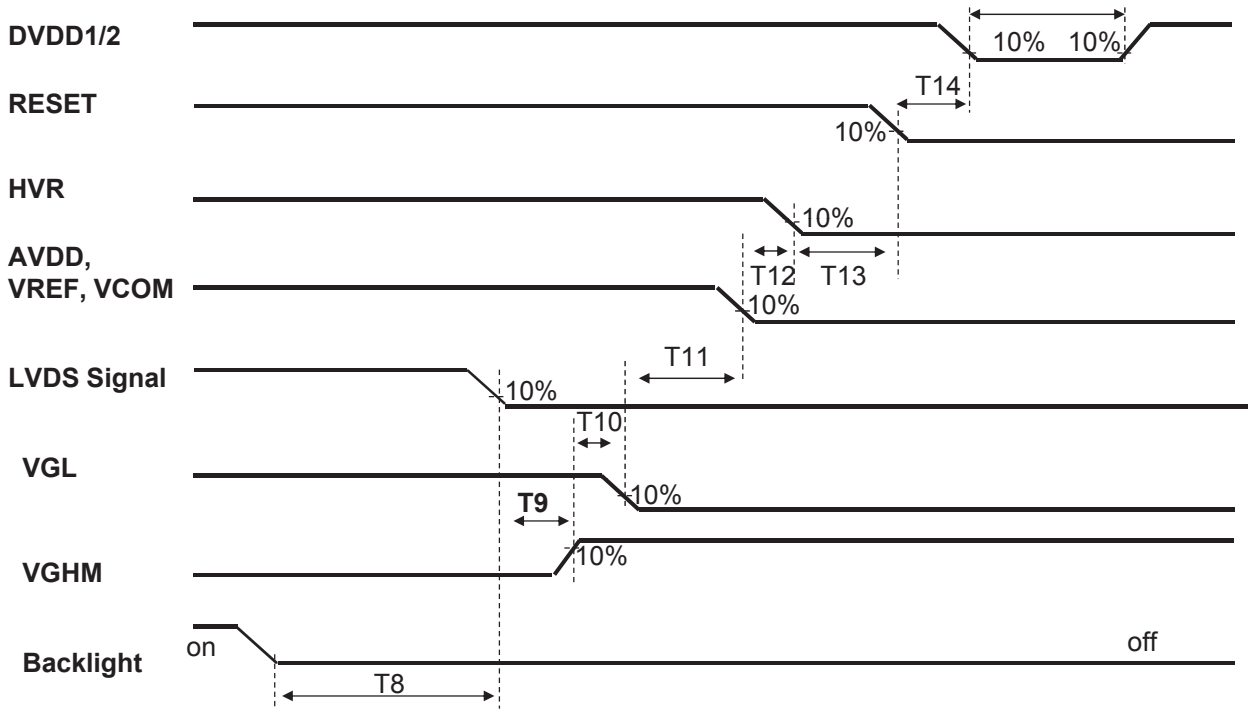


Table 7-2. POWER OFF SEQUENCE

Parameter	Value			Unit	Note
	Min	Typ	Max		
T8	5	-	-	ms	
T9	50	-	100	ms	1
T10	0	-	10	ms	
T11	0	-	10	ms	
T12	0	-	10	ms	
T13	0	-	10	ms	
T14	0	-	10	ms	
T15	500	-	-	ms	

Note 1. T9 must be secured after BLU off.
In case that system inevitably turn on panel after BLU off, LVDS signal should be full black pattern
2. Power on Sequence must be observed to restart LCM after all power and signal off.
3. The Falling Time(90%→10%) of DVDD1/2/AVDD/VREF/VCOM/VGL/VGHM 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 30 minutes while backlight turning on.

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

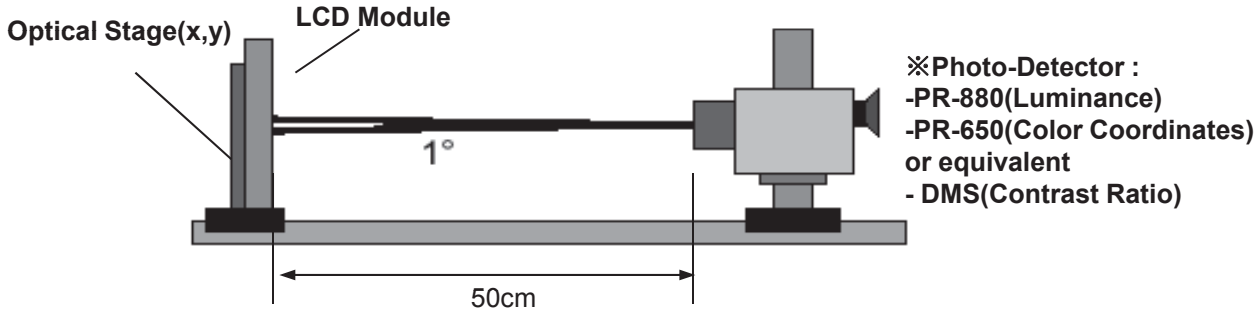


FIG. 3 Electro-optical Characteristic Measurement Equipment and Method

Table 8. ELECTRO-OPTICAL CHARACTERISTICS

Ta=25±2˚C, DVDD1=3.3V, DVDD2=1.8V, AVDD=12.5V, VCOM = 5.3V, VGH = 18.5V, VGL = -7.5V, VREF1=11.85V, VREF14=0.40V, fv = 60Hz, fCLK = 64.0MHz, ILED=80mA(no-dimming)

Parameter		Symbol	Value			Unit	Note
			Min	Typ	Max		
Contrast Ratio	Area A+	CR	800	-	-	-	1
	Area A		500	-	-		
	Area B		100	-	-		
Luminance (@25℃, 70℃)	Area A+	L_{WH}	725	-	-	cd/m^2	2
	Area A		385	-	-		
	Area B		265	-	-		
Uniformity (Area scan)	White	δ_{WHITE}	80	-	-	%	3
	Black	δ_{Black}	50	-	-		
Response Time	+25℃	TG2G	-	-	30	ms	4, 5
	-20℃		-	-	400		
	-30℃		-	-	800		
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	-	
Color Gamut		-	-	85	-	%	
Gamma		-	2.0	2.2	2.4	-	6
Flicker (@V2dot pattern)		-	-	-	20	%	

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 and 70±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"
Customer should be discussed detailed measurement conditions and methods with AGD.

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.

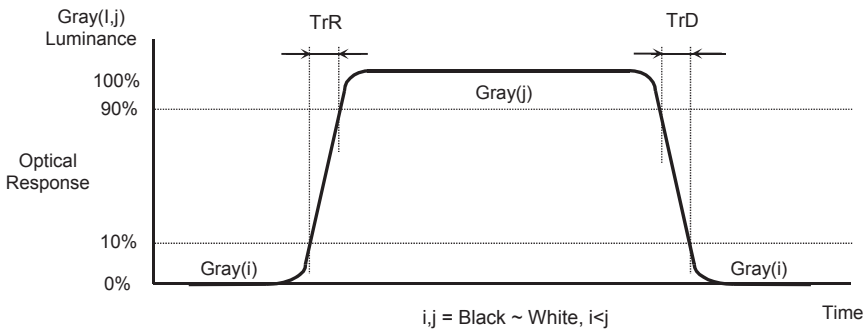


FIG. 4 Response Time

6. Gamma is measured and evaluated according to “Information Display Measurements Standard" Version 1.03, 2012-07-01
   - Measurements 9point: 255, 223, 191, 159, 127, 95, 63, 31, 0Gray

Area A+ : H = +/-10º, V = +8º / -4º

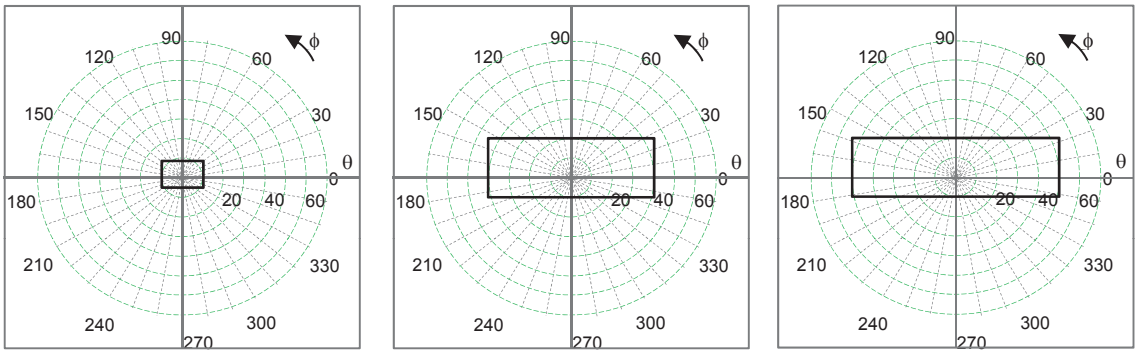
[(Θ, Φ) = (12.7º, 38.6º), (12.7º, 141.4º), (10.7º, 201.6º), (10.7º, 338.4º)]

Area A : H = +/-40º, V = +20º / -10º

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

Area B : H = +/-50º, V = +20º / -10º

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



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

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

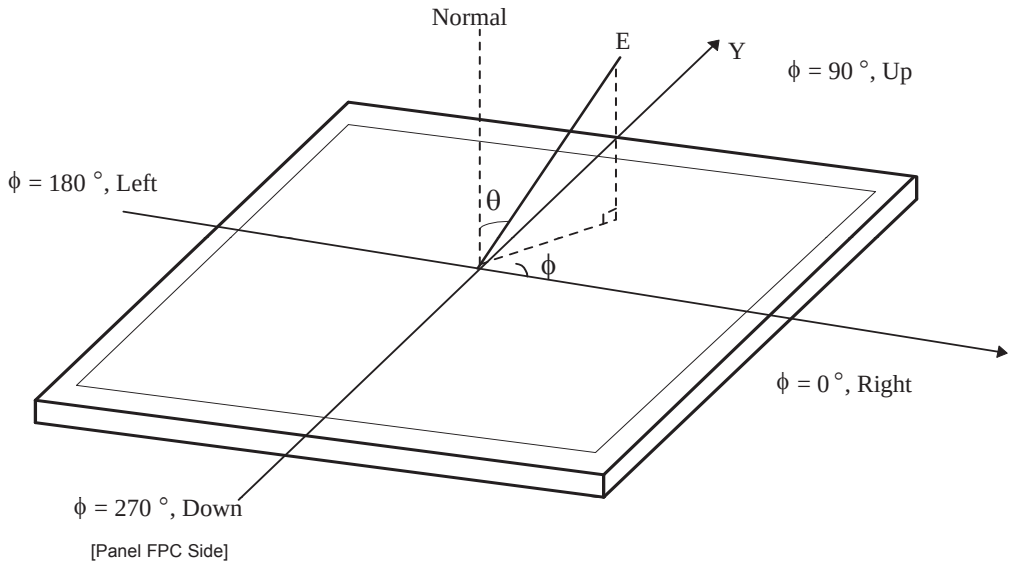


FIG. 6 LCD viewing direction of defined angle θ, Φ

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.

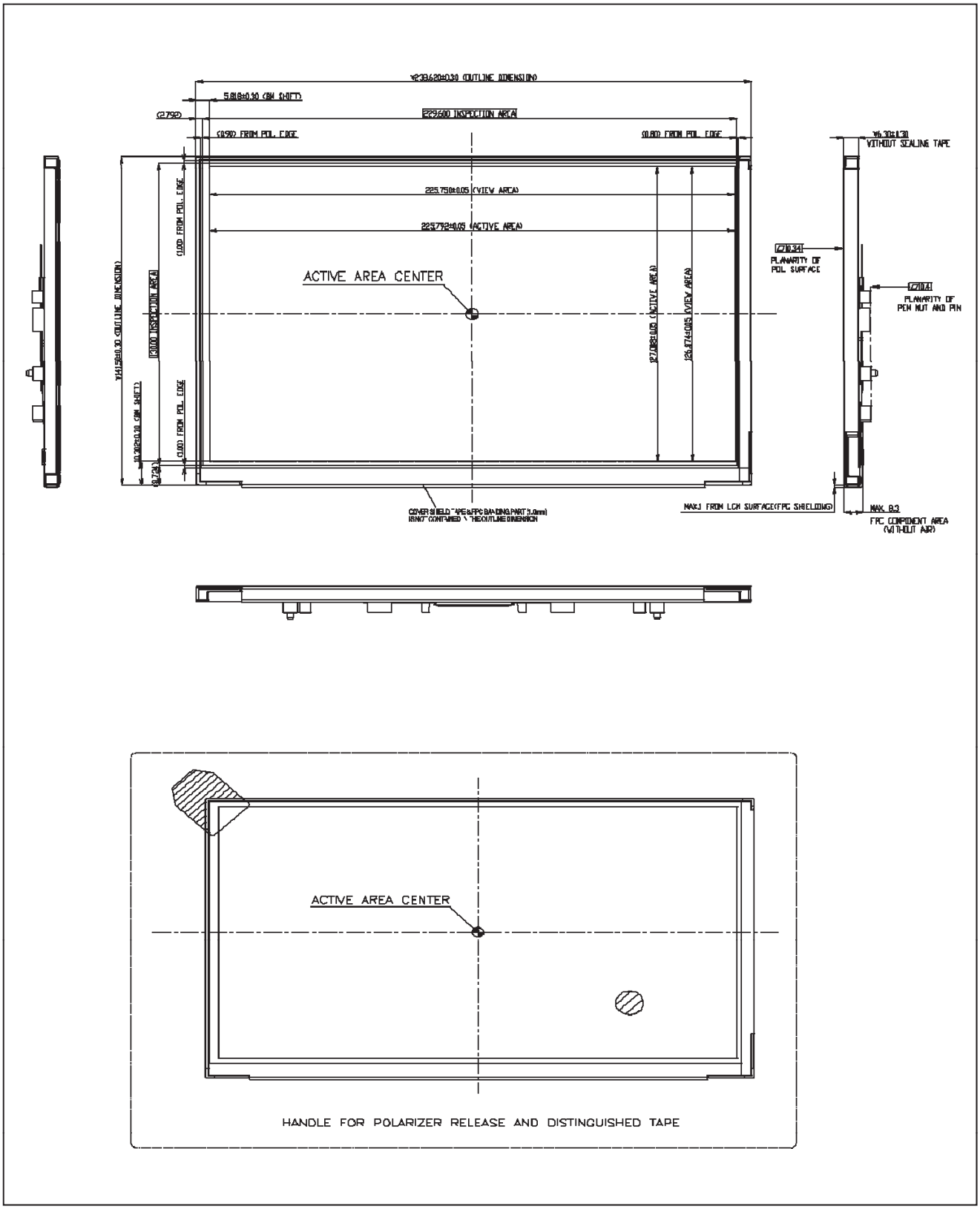
Table 9. MECHANICAL CHARACTERISTICS

Parameter	Value	
Outline Dimension	Horizontal	238.62 ± 0.3 mm
	Vertical	141.50 ± 0.3 mm
	Depth	6.30 ± 0.3 mm
Inspection Area	Horizontal	229.6 mm
	Vertical	130.0 mm
Active Display Area	Horizontal	225.792 mm
	Vertical	127.008 mm
View Area	Horizontal	225.750 mm
	Vertical	126.874 mm
Weight	303g(Typ.), 313g (Max.)	

Note. All defects (scratch, dent, foreign materials, pol. adhesive glue washout, glass chipping) which are not visible in end users' view (= out of the inspection area), are not considered as defect

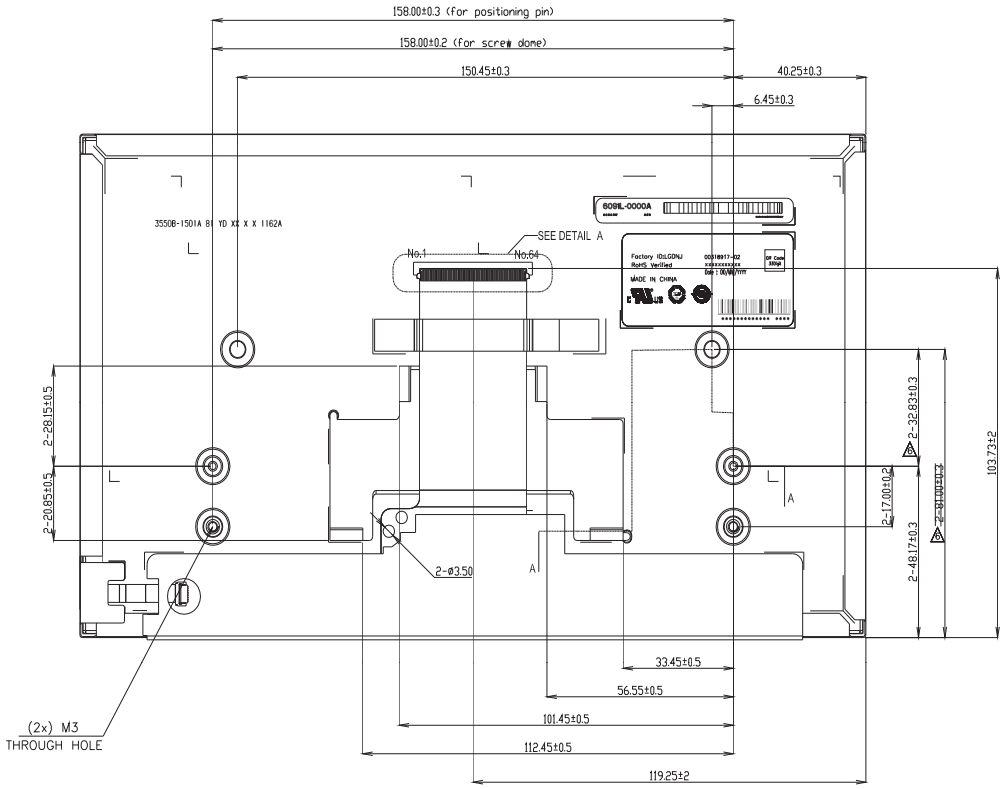
<FRONT VIEW>

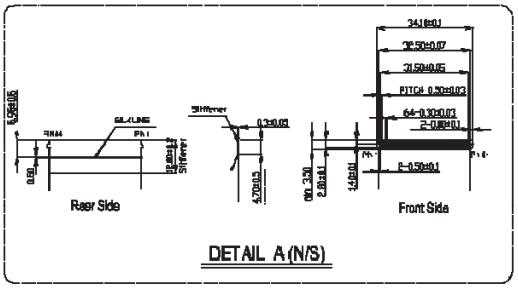
Note. Unit:[mm], General tolerance: ± 0.3mm

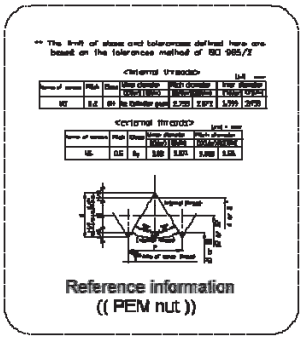


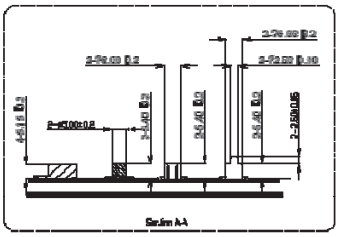
<REAR VIEW>

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









SYSTEM SCREW TORQUE. : MAX 1.5Nm (= MAX 14.76kgf*cm)

※Base on measurement

8. Reliability

Table 10. ENVIRONMENT TEST CONDITION

No	Test Item	Condition	Note
1	High Temperature Storage Test	Ta=90℃, 24h	
2	Low Temperature Storage Test	Ta=-40℃, 24h	
3	High Temperature Operation Test	Ta=85℃, 500h	
4	Low Temperature Operation Test	Ta=-30℃, 48h: Functional Status A Ta=-40℃, 48h: Functional Status B	1
5	High Humidity Operation Test	Ta=40℃/93%, 500h	
6	Humid Heat Cyclic Test	+25°C to +55°C, RH = 90% 6 cycles = 144h; no condensation	
7	Thermal Shock Test (non-operating, without housing)	- 1cycle : Ta=-40℃(0.5h) ~ 85℃(0.5h) - 240Cycles	2
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)	3 directions: X, Y and Z axes; 10 repeats; peak acceleration = 50G; pulse duration = 6ms; 0,5 sine wave	
10	Vibration Test (non-operating)	3 directions: X, Y and Z axes; duration: 6x8h; vibration-profile D (severity 1) peak acceleration = 20G; frequency = 10 to 1000Hz incl. Temperature Cycle Refer to the appendix - V	2
11	Rattle Noise (non-operating)	10 ~ 100Hz ; Sine Sweep, 1g, 0,5oct/min	3

Note 1. Between -40°C and -30°C no correct image has to be on the display
Functional Status A: The DUT shall perform all functions during and after the exposure to the test parameters.
Functional Status B: The DUT shall perform all functions during the exposure to the test parameters. However, one or more functions may lie outside the specified tolerance. After the exposure to the test parameters, the DUT shall automatically revert to functional status A.

2. After this test has done, the specimen should normally without any fatal defect (no picture, line defects, out of synchronization)
Judged whether LCM can operate or not after the Test
3. The rattle noise must not higher than 55dB(A) (audio frequency : 200Hz-15kHz)
In a distance of 30cm including the silent shaker noise
30cm distance means the distance between test sample and microphone Test equipment: silent shaker
4. Result Evaluation Criteria:
TFT-LCD panels should take place at room temperature for 24 hours after the reliability tests finish.
In the standard condition, there should be no particular problems that may affect the display function.

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 behavior 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 behavior of interior materials
- DIN 75200, Deutsche Industric Normen
Determination of burning behavior 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

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

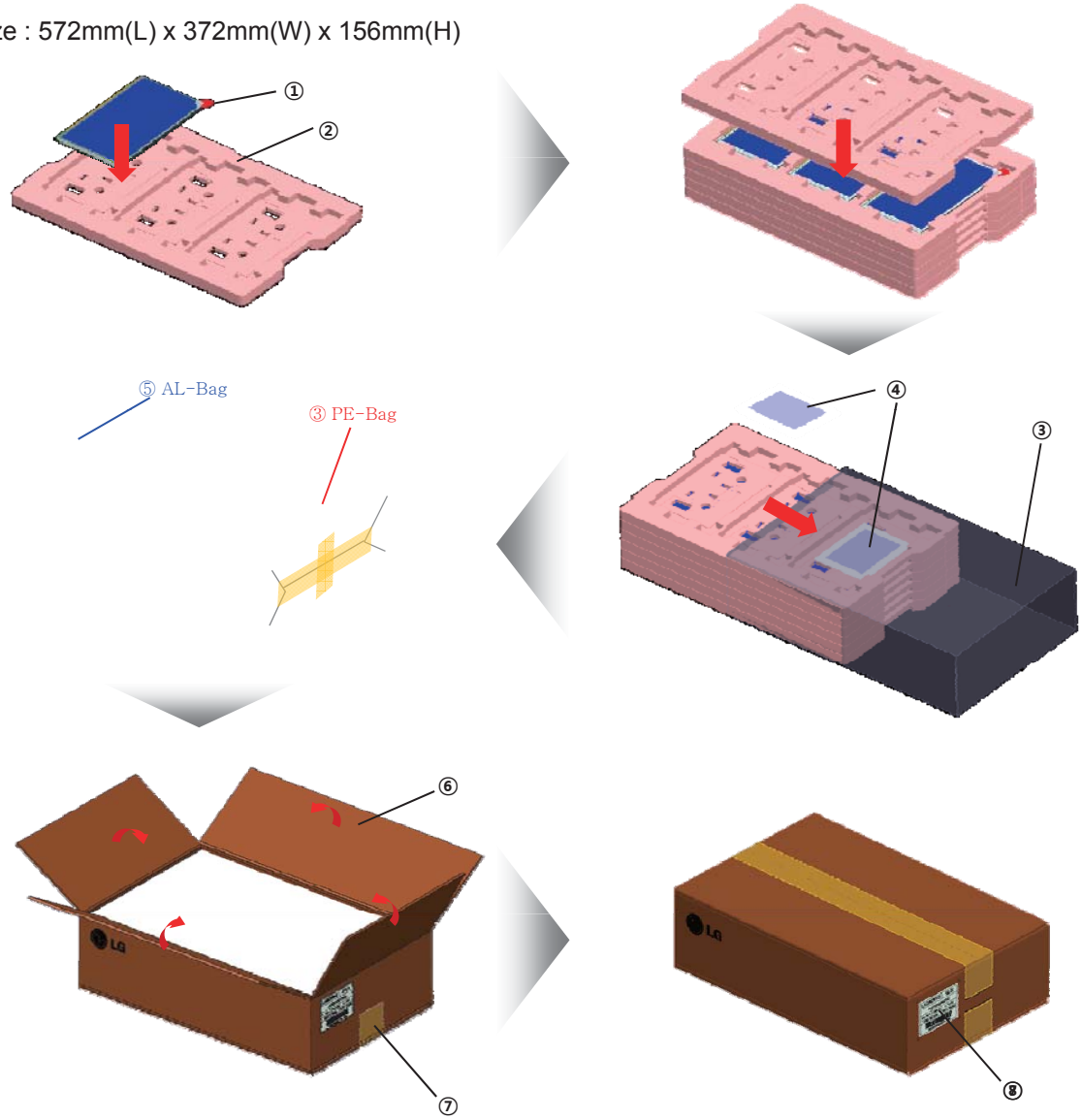
b) Location of Lot Mark

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 : 15 pcs

b) Box Size : 572mm(L) x 372mm(W) x 156mm(H)



NO.	Description	Material
1	Module	15pcs/1 Box
2	Packing, Tray	EPP
3	Bag	PE
4	Desiccant	POWER DRY, 60G, UX
5	Bag	AL
6	Box	SW
7	Tape	OPP
8	Box Label	ART Paper

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.

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

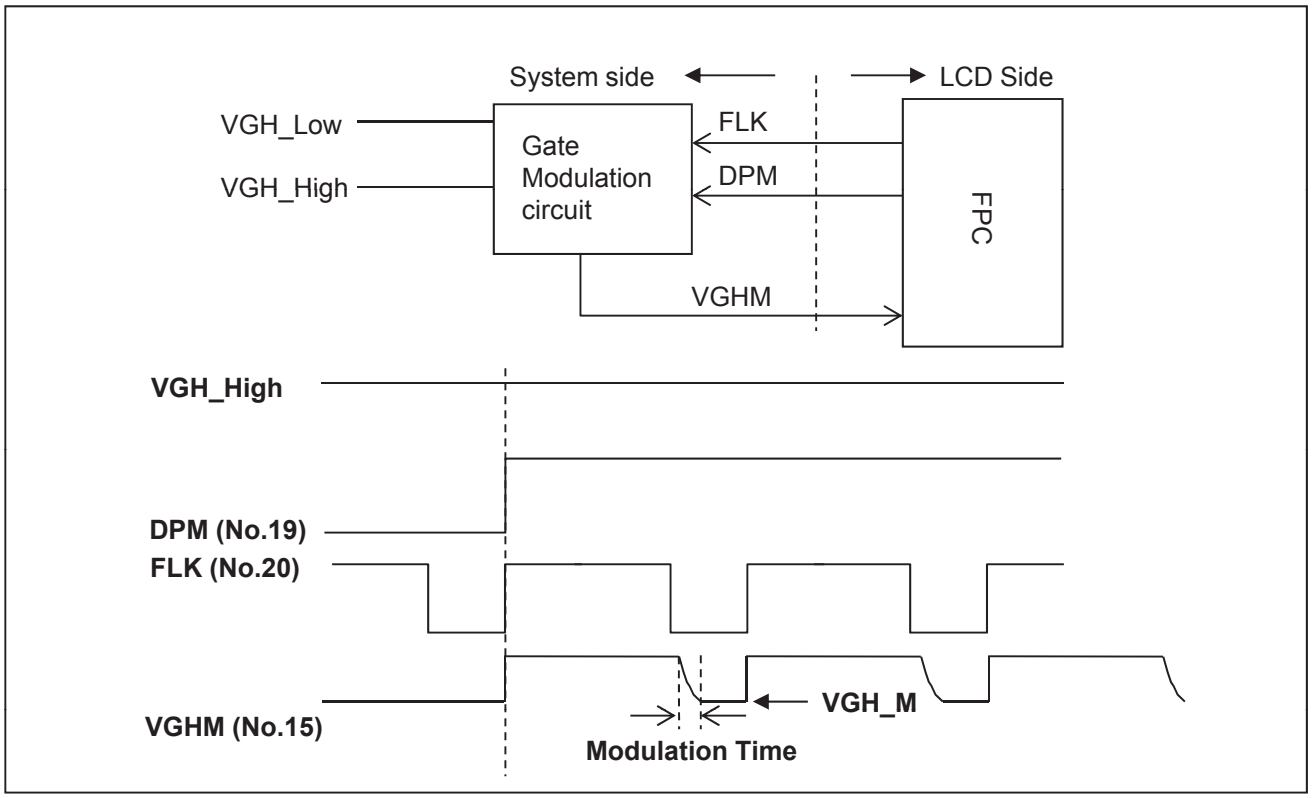
When storing modules as spares for a long time, the following precautions are necessary.
(1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
(2) The polarizer surface should not come in contact with any 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.

APPENDIX- I

■ VGH Modulation Method



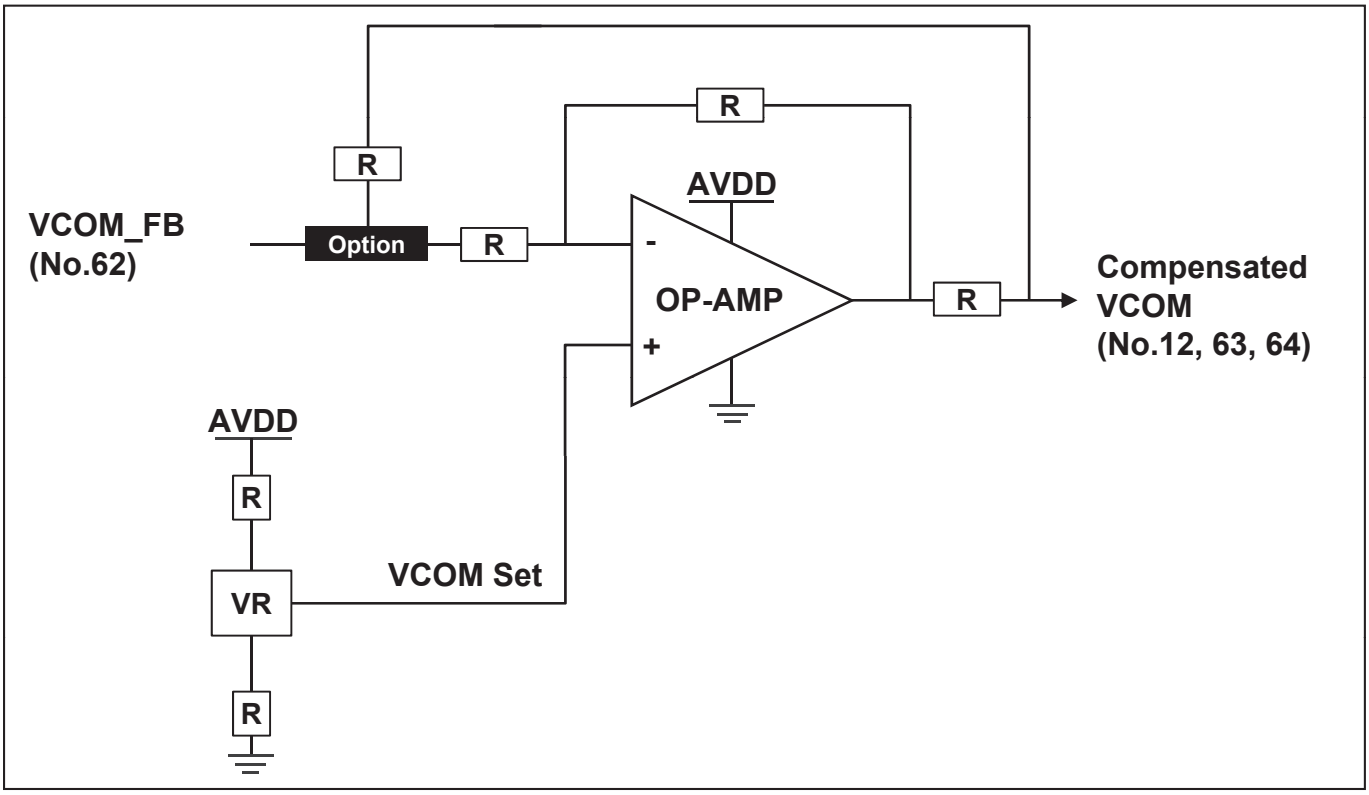
Parameter	Values			Unit	Note
	Min	Typ	Max		
VGH_High	17.0	18.5	20.0	V	
VGH_Low	4.0	6.5	13.5	V	
Modulation time	-	0.8	-	us	1

Note 1. Slew rate: 15 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

■ VCOM Compensation Function

- Purpose: to Minimize the distortion of the VCOM waveform.



APPENDIX- III

■ Thermistor Characteristics

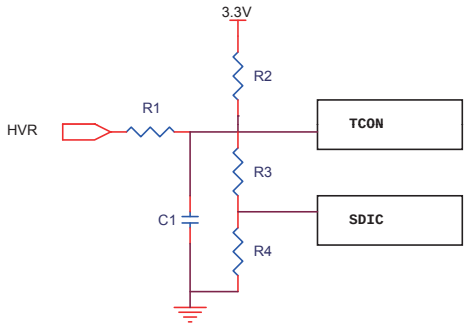
Note 1. The display module shall incorporate a NTC thermistor surface mounted to the display circuit board. The user of LCD module can utilize this thermistor for some special purpose. For example, the user can measure display temperature from the thermistor and then turn off backlight when LCD module 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℃.
4. Please treat R_{THER} data as a reference.

℃ (Ta)	$R_{thermistor}$ [kΩ] (Thermistor)	R_{THER} [kΩ] (LCM)
-40	195.652	40.605
-35	148.171	33.764
-30	113.347	27.843
-25	87.559	24.134
-20	68.237	20.717
-15	53.650	18.620
-10	42.506	15.759
-5	33.892	13.669
0	27.219	11.667
5	22.021	9.775
10	17.926	8.144
15	14.674	6.848
20	12.081	5.770
25	10.000	4.903
30	8.315	4.228
35	6.948	3.719
40	5.834	3.281
45	4.917	2.861
50	4.161	2.481
55	3.535	2.197
60	3.014	1.952
65	2.586	1.739
70	2.228	1.553
75	1.925	1.380
80	1.669	1.233
85	1.452	1.102

APPENDIX- IV

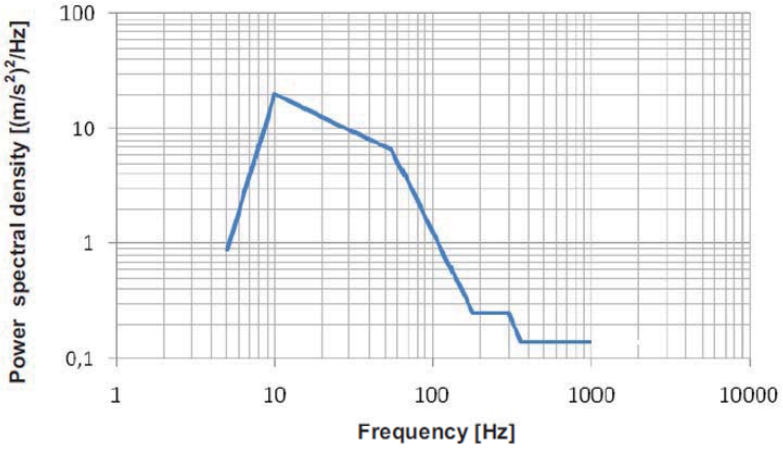
■ Equivalent Circuits

Pin No	Symbol	I/O	Description	Value	Note
22	HVR	I		R1: 470[Ω] R2: 4.7[kΩ] R3: 27[kΩ] R4: 82[kΩ] C1: 47[nF]	
2	THER-	O		RT1: 10[kΩ]	@25℃
1	THER+	O			

APPENDIX- V

■ VIBRATION PROFILE D

Excitation	Broadband random vibration	
Test duration for each dimensional axis	8h	
Acceleration rms value	$30.8\ m/S^2$	
Vibration profile Figure 25	Frequency in Hz	Power spectral density in $(m/s^2)^2$ /Hz
	5	0.884
	10	20
	55	6.5
	180	0.25
	300	0.25
	360	0.14
	1000	0.14



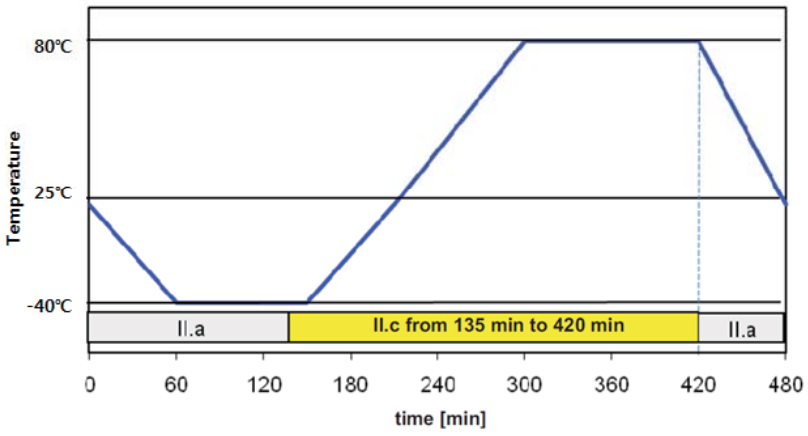


Figure 19: Temperature profile - vibration