LG Display

LD060WX1
Liquid Crystal Display

Product Specification

SPECIFICATION
FOR
APPROVAL

(●) **Preliminary Specification**
( ) **Final Specification**

Title	6.0” WXGA (800 x RGB x 1280) TFT LCD

BUYER	**Amazon**
MODEL	Ariel

SUPPLIER	LG Display Co., Ltd.
MODEL	LD060WX1
Suffix	SMN1

SIGNATURE	DATE
/	
/	
/	

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

SIGNATURE	DATE
C.K. SHIN / G Manager	
REVIEWED BY	
K.J JEON / Manager	
PREPARED BY	
H.J CHO / Engineer	

Products Engineering Dept.
LG Display Co., Ltd

Contents

RECORD OF REVISIONS

Revision No	Revision Date	Page	Description
1.0	Dec. 3. 2013	-	Preliminary specification release
1.1	Jan. 16. 2014	-	MIPI interface specification update
1.2	Mar. 28. 2014	18~19,22,29,30	Initial code, Power Sequence timing, LCM Drawing update
1.3	Jun. 9. 2014	4,28	Update the specifications of the weight and thickness
1.4	Jun. 23. 2014	29,30	LCM Drawing update

1. General Description

The LD060WX1 is a Color Active Matrix Liquid Crystal Display with an integral Light Emitting Diode (LED) backlight system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally Black mode. This TFT-LCD has 6.0 inches diagonally measured active display area with WXGA resolution(800 horizontal by 1280 vertical pixel array). Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16,772,216 colors.

The LD060WX1 has been designed to apply the interface method that enables low power, high speed, low EMI.

The LD060WX1 is intended to support applications where thin thickness, low power are critical factors and graphic displays are important. In combination with the vertical arrangement of the sub-pixels, the LD060WX1 characteristics provide an excellent flat display.

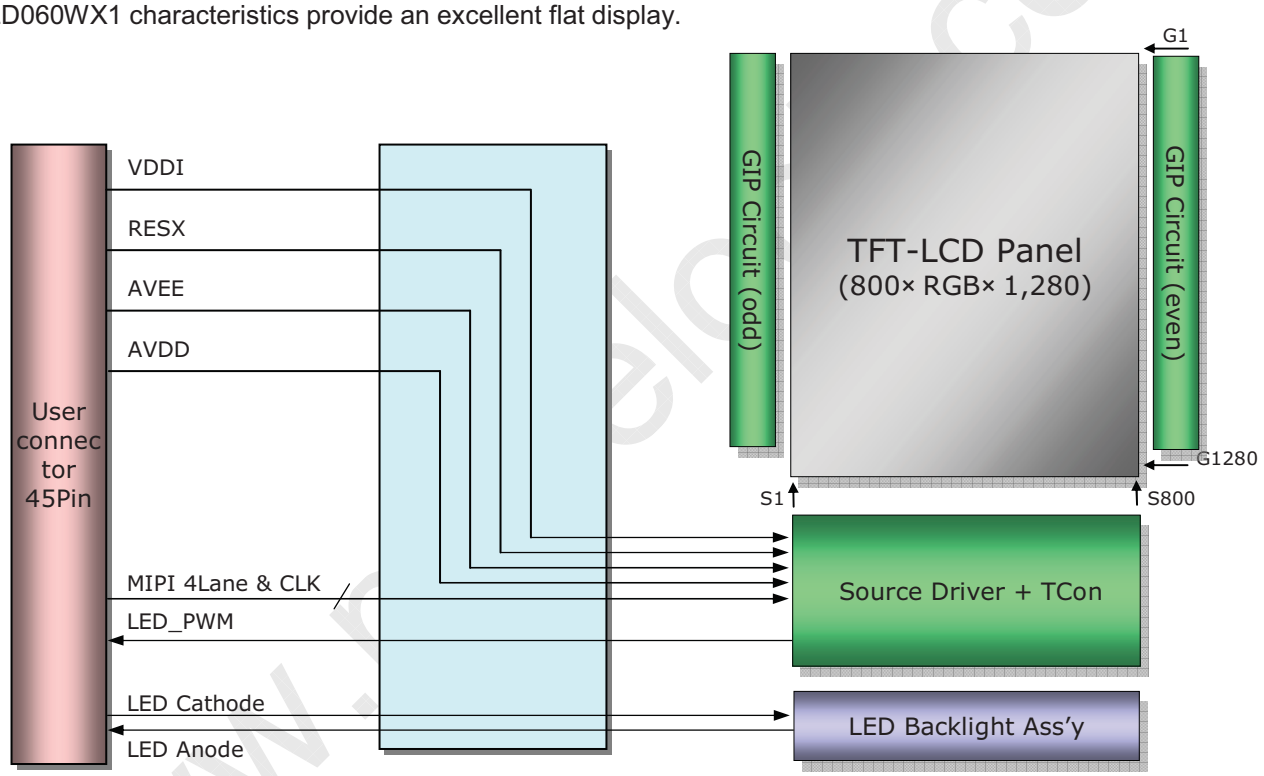


Table1. General Features

Active Screen Size	6.0 inches diagonal
Outline Dimension	86.76mm x 140.07mm x 2.50mm (Typ.)
Dot Pitch	33.65um × 100.95um
Pixel Format	800 horizontal By 1280 vertical Pixels RGB strip arrangement
Color Depth	16,7M colors (8-bit)
Luminance, White	390 cd/m^2 (Min.) 490 cd/m^2 (Typ.)
Weight	73g(Max.)
Display Operating Mode	Transmitting type, Normally black
Surface Treatment	LR

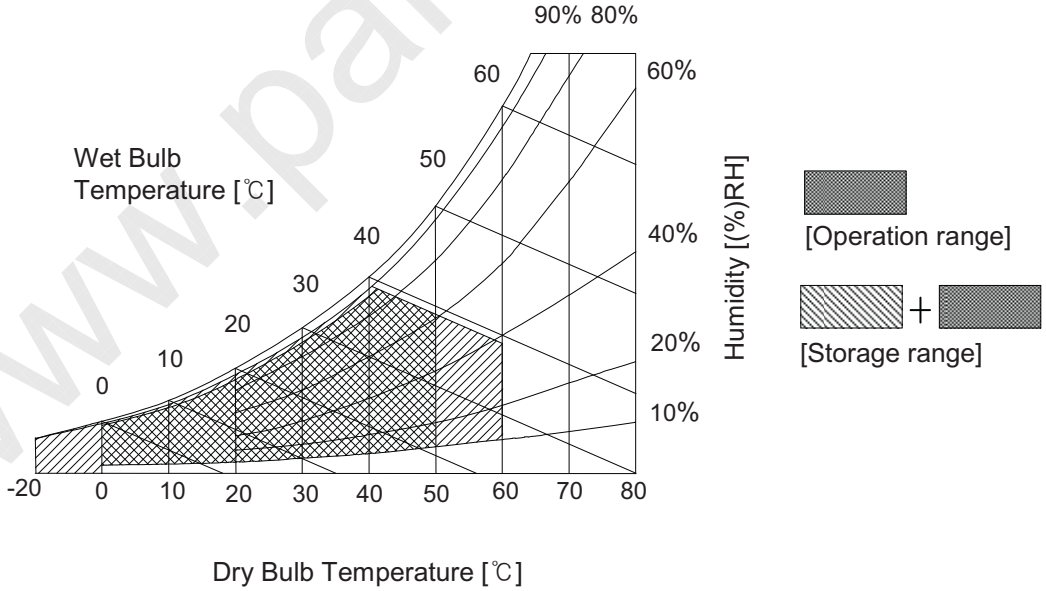
2. Absolute Maximum Ratings

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

Table 2. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Input Voltage	VDDI	-0.3	5.0	Vdc	at 25 ± 5°C
	AVDD	-0.3	6.0	Vdc	
	AVEE	-6.0	-0.3	Vdc	
Operating Temperature	TOP	0	50	°C	[Note 2-1,2,3,4]
Storage Temperature	TST	-20	60	°C	[Note 2-1,2]

[Note 2-1] This rating applies to all parts of the module and should not be exceeded.
[Note 2-2] Maximum wet-bulb temperature is 39.2℃. Condensation of dew must be avoided as electrical current leaks will occur, causing a degradation of performance specifications.
[Note 2-3] The operating temperature only guarantees operation of the circuit and doesn't guarantee all the contents of Electro-optical specification.
[Note 2-4] Ambient temperature when the backlight is lit (reference value).



3. Electrical Specifications

3-1. Electrical Characteristics

The LD060WX1 requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The second input which powers the LED, is typically generated by an LED Driver. The LCD not include LED Driver.

Table 3. ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
LCD :						
Power Supply Logic Voltage	VDDI	1.7	1.8	1.9	V	
Power Supply Panel Voltage	AVDD	4.9	5.2	5.5	V	
	AVEE	-4.9	-5.2	-5.5	V	
Input High-Level Voltage	V_{IH}	0.7xVDDI	-	VDDI	V	
Input Low-Level Voltage	V_{IL}	0	-	0.3xVDDI	V	
Power Supply Input Current	I_{sys}	-	-	500	mA	[Note 1]
Power Consumption	P_{sys}	-	-	0.15	Watt	[Note 1]

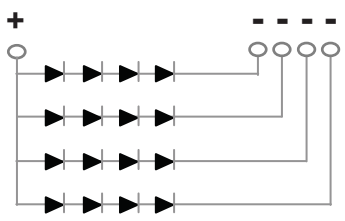
[Note 1] The specified current and power consumption are under the VDDI = 1.8V, AVDD=5.2V, AVEE=-5.2V 25℃, fv = 60Hz condition whereas “Mosaic Pattern” is displayed and fv is the frame frequency.

Table 4. Backlight Unit

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT	REMARK
LED forward Current	I_f	-	20	-	mA	Ta=25℃ (per chain)
LED forward Voltage	V_f	-	2.85	2.9	V	Ta=25℃ (@ Typ. Current, per chain)
Power Consumption	P_{BL}	-	915	930	mW	Ta=25℃ (@ Typ. Current, per chain)

[Note 1] The permissible forward current of LED vary with environmental temperature.

[LED Array Structure]



3-2. Interface (Input Terminal)

This LCD employs one interface connections, a 45 pin connector is needed for the module electronics interface.
(Customer Matching Connector : FH43BW-45S-0.2SHW)

Table 5. Module Connection Pin Configuration(CN1)

No.	Symbol	Description	No.	Symbol	Description
1	VLED	Power supply for LED[Anode]	2	VLED	Power supply for LED[Anode]
3	NC	No Connect	4	FB1	Power supply for LED[Cathode]
5	FB2	Power supply for LED[Cathode]	6	FB3	Power supply for LED[Cathode]
7	FB4	Power supply for LED[Cathode]	8	GND	Ground
9	GND	Ground	10	D2P	MIPI data positive signal
11	GND	Ground	12	D2N	MIPI data negative signal
13	GND	Ground	14	GND	Ground
15	GND	Ground	16	D1P	MIPI data positive signal
17	GND	Ground	18	D1N	MIPI data negative signal
19	GND	Ground	20	GND	Ground
21	GND	Ground	22	CLKP	MIPI CLK positive signal
23	GND	Ground	24	CLKN	MIPI CLK negative signal
25	GND	Ground	26	GND	Ground
27	GND	Ground	28	D0P	MIPI data positive signal
29	GND	Ground	30	D0N	MIPI data negative signal
31	GND	Ground	32	GND	Ground
33	GND	Ground	34	D3P	MIPI data positive signal
35	GND	Ground	36	D3N	MIPI data negative signal
37	MTP_PWR	System must be left open. (MTP Power Input, Only for LCM Side.)	38	GND	Ground
39	AVDD	Power supply for analog(positive)	40	AVEE	Power supply for analog(negative)
41	LED_PWM	Output, LED Dimming control PWM (1.8V)	42	GND	Ground
43	RESX	Reset the device, Active low (1.8V)	44	VDDI	Logic Power Input for system interface
45	VDDI	Logic Power Input for system interface	-	-	-

4. MIPI Interface

4-1. General Description

The LD060WX1 supports the Mobile Industry Process Interface (MIPI) is a differential small amplitude serial interface for high-speed data transfer through the following lines: DATA_P/N 4Pair, CLK_P/N 1Pair
The specifications of MIPI supported by the D-IC meet the MIPI specifications Version 1.01(DSI) with Version 0.90 D-PHY.

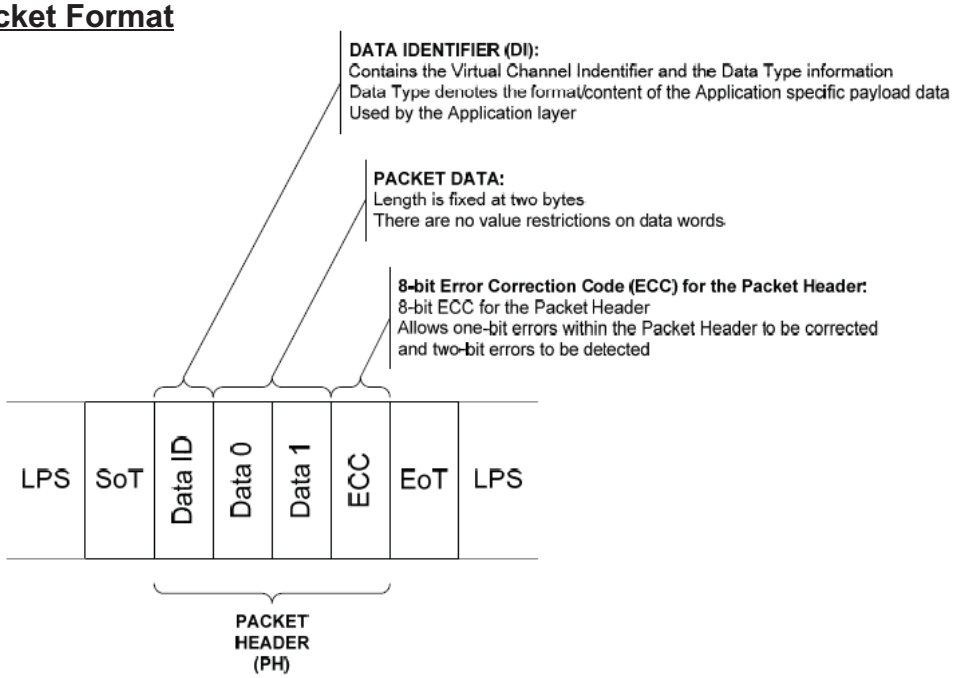
4-2. MIPI DSI Protocol

MIPI DSI Protocol (MIPI DSI version 1.01.00 with D-PHY version 0.90.00) is in accordance with the MIPI specification as published by MIPI ALLIANCE; refer to these specifications for more information on the MIPI Protocol.
The LD060WX1 supports only Video Mode operation because it does not have frame buffer memory. However it has bidirectional DSI interface so that DSI host can read display status registers.

4-2-1. General Packet Structure

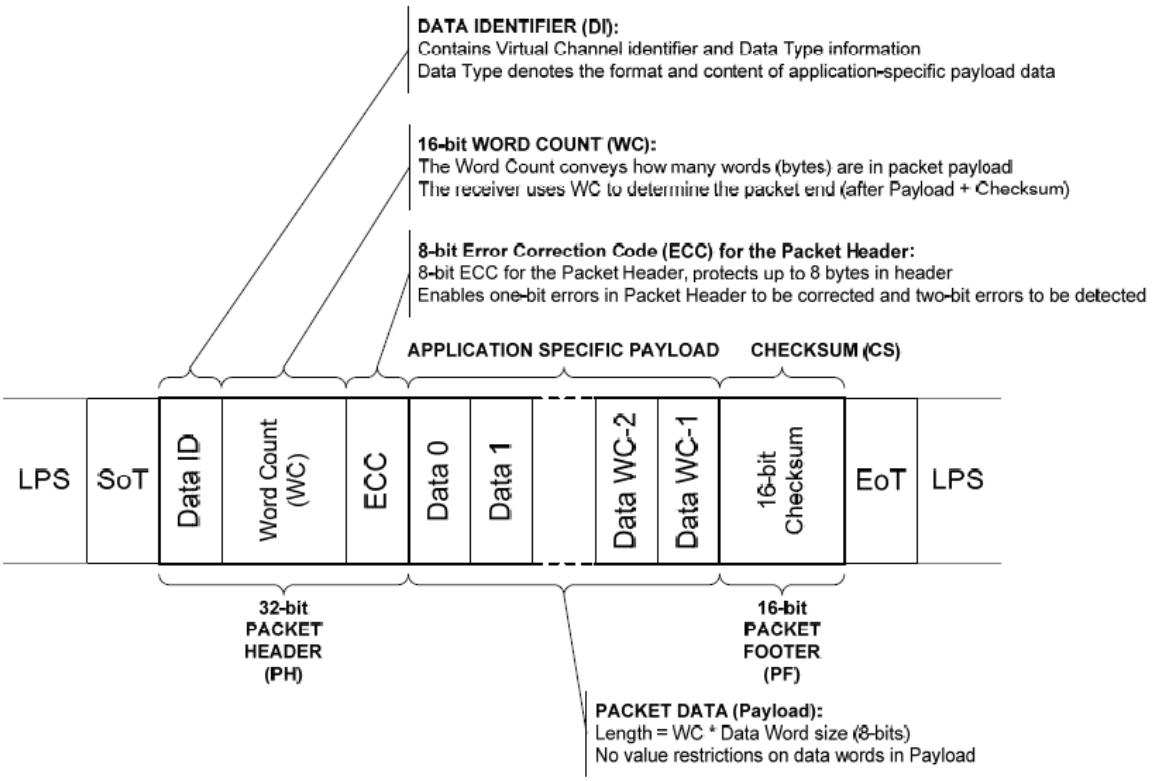
Two packet structure are defined for low-level protocol communication : Long packets and Short packets. For both packets structures, the Data Identifier is always the first byte of the packet.

Short Packet Format



A Short packet shall contain an 8-bit Data ID followed by two command or data bytes and an 8-bit ECC; a Packet Footer shall not be present. Short packet shall be four bytes in length.

Long Packet Format



A long packet shall consist of three elements : a 32-bit Packet Header (PH), an application-specific Data Payload with a variable number of bytes, and a 16-bit Packet Footer (PF).

The Packet Header is further composed of three elements: an 8-bit Data Identifier, a 16-bit Word Count, and 8-bit ECC. The Packet Footer has one element, a 16-bit checksum.

Long packets can be from 6 to 65,541 bytes in length.

4-2-2. Data Identifier Byte

The first byte of any packet is the DI (Data Identifier) byte.

[7:6] : These two bits identify the data as directed to one of four virtual channels.

[5:0] : These six bits specify the Data Type.

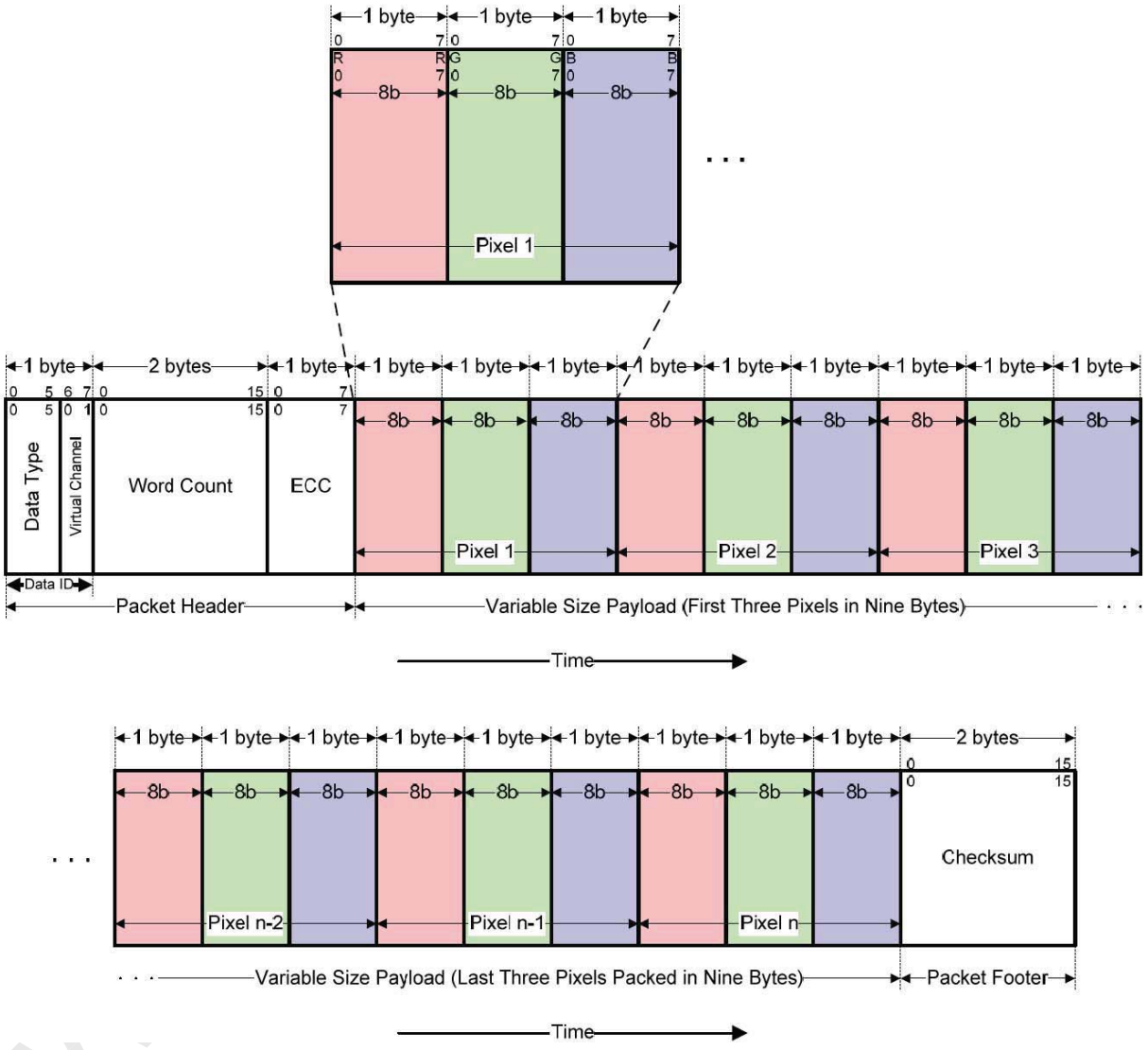
The followings are the description of Data Types.

Table 6. Data identifier Byte Table

Data Type, hex	Data Type, binary	Description	Packet Size
01h	00 0001	Sync Event, V Sync Start	Short
11h	01 0001	Sync Event, V Sync End	Short
21h	10 0001	Sync Event, H Sync Start	Short
31h	11 0001	Sync Event, H Sync End	Short
08h	00 1000	End of Transmission packet (EoTp)	Short
02h	00 0010	Color Mode (CM) Off Command	Short
12h	01 0010	Color Mode (CM) On Command	Short
22h	10 0010	Shut Down Peripheral Command	Short
32h	11 0010	Turn On Peripheral Command	Short
03h	00 0011	Generic Short WRITE, no parameters	Short
13h	01 0011	Generic Short WRITE, 1 parameter	Short
23h	10 0011	Generic Short WRITE, 2 parameters	Short
04h	00 0100	Generic READ, no parameters	Short
14h	01 0100	Generic READ, 1 parameter	Short
24h	10 0100	Generic READ, 2 parameters	Short
05h	00 0101	DCS Short WRITE, no parameters	Short
15h	01 0101	DCS Short WRITE, 1 parameter	Short
06h	00 0110	DCS READ, no parameters	Short
37h	11 0111	Set Maximum Return Packet Size	Short
09h	00 1001	Null Packet, no data	Long
19h	01 1001	Blanking Packet, no data	Long
29h	10 1001	Generic Long Write	Long
39h	11 1001	DCS Long Write/write_LUT Command Packet	Long
0Eh	00 1110	Packed Pixel Stream, 16-bit RGB, 5-6-5 Format	Long
1Eh	01 1110	Packed Pixel Stream, 18-bit RGB, 6-6-6 Format	Long
2Eh	10 1110	Loosely Packed Pixel Stream, 18-bit RGB, 6-6-6 Format	Long
3Eh	11 1110	Packed Pixel Stream, 24-bit RGB, 8-8-8 Format	Long
x0h and xFh, unspecified	xx 0000 xx 1111	DO NOT USE All unspecified codes are reserved	

4-2-3. Pixel Stream and Interface Timing

Packed Pixel Stream structure for 24 bit pixel format (8-8-8) data packet.

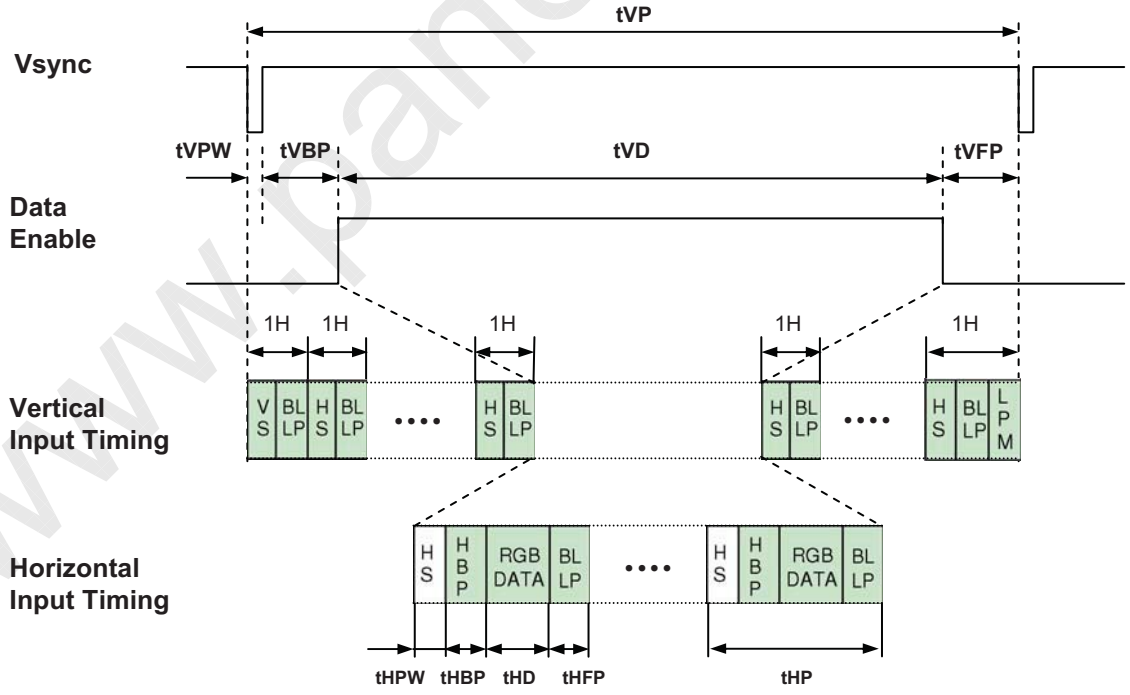


4-2-4. Signal Timing Specifications

This is the signal timing required at the input of the User connector. All of the interface signal timing should be satisfied with the following specifications and specifications of MIPI Tx/Rx for its proper operation.

Table 7. Signal timing Specifications

ITEM	Symbol		Min	Typ	Max	Unit	Note
BRPHY	Bit rate per MIPI Lane		250	470	500	Mbps	
Hsync	Period	t_{HP}	897	913	-	Pixel	
	Display data	t_{HD}	800				
	Width	t_{HPW}	1	-	-		
	Horizontal back porch	t_{HBP}	48	64	-		
	Horizontal front porch	t_{HFP}	48				
Vsync	Period	t_{VP}	1313	1345	-	H	
	Display data	t_{VD}	1280				
	Width	t_{VPW}	1	-	-		
	Vertical back porch	t_{VBP}	16	32			
	Vertical front porch	t_{VFP}	16	32			



< Timing Diagram >

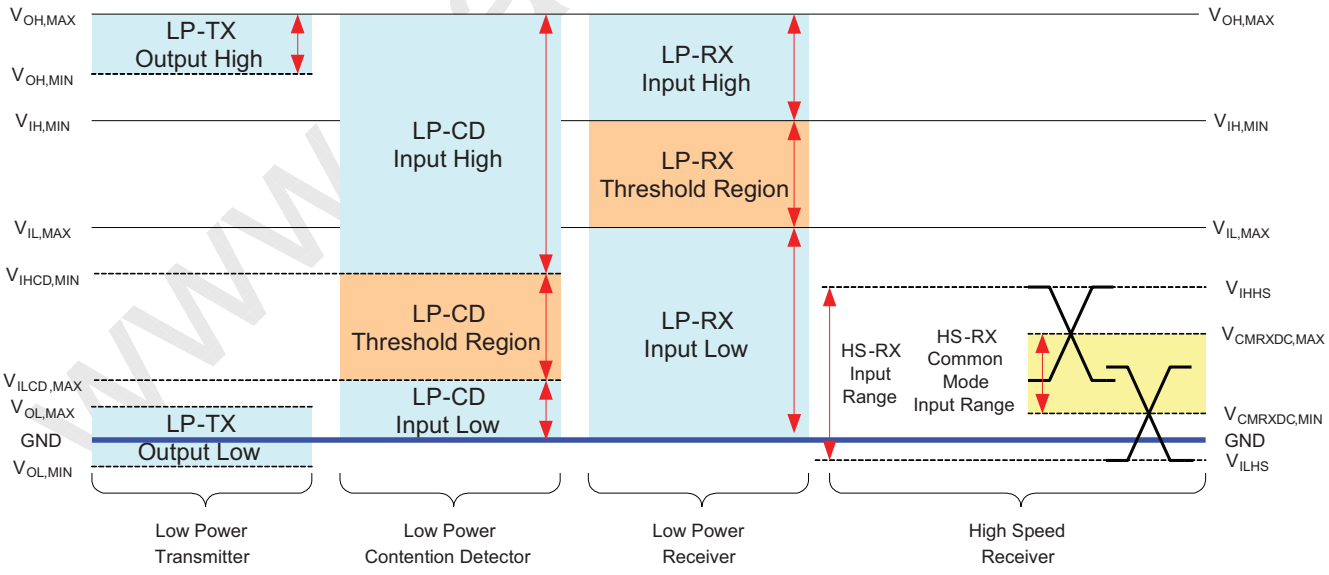
4-3. MIPI Signal Timing Specification

4-3-1. MIPI DC Specification

VDDI= 1.8V, AVDD= 5.2V, AVEE=-5.2V, VSS= 0V, Ta = -20 to +60°C@SDIC

Table 8. MIPI DC Specification

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
MIPI Characteristics for High Speed Receiver						
Single-ended input low voltage	VILHS	-40	-	-	mV	
Single-ended input high voltage	VIHHS	-	-	460	mV	
Common-mode voltage	VCMRXDC	70	-	330	mV	
Differential input impedance	ZID	-	100	-	ohm	
HS transmit differential voltage (VOD=VDP-VDN)	|VOD|	140	-	-	mV	
MIPI Characteristics for Low Power Mode						
Logic 1 contention threshold (LP-CD)	VIHCD_Min	450	-	1350	mV	
Logic 0 contention threshold (LP-CD)	VILCD_Max	-	-	200	mV	
Logic 1 input threshold (LP-RX High)	VIH	880	-	1350	mV	
Logic 0 input threshold (LP-RX Low)	VIL	0	-	550	mV	
Logic 0 input voltage(CLK ULP mode)	VILLPRXULP	0	-	300	mV	
Output high level	VOH	1.1	-	1.3	V	
Output low level	VOL	-50	-	50	mV	



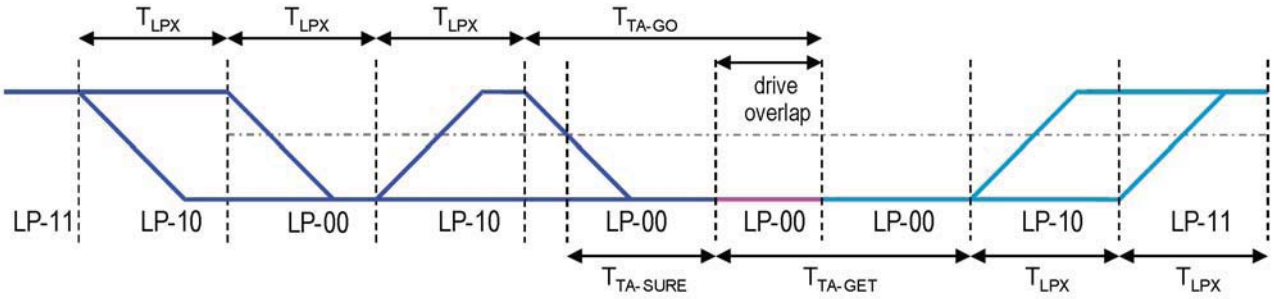
< MIPI DC Diagram >

4-3-2. MIPI signal AC Specification

◆ LP Transmitter AC Specification

Table 9. MIPI LP Transmitter AC Specification

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
Length of any Low-Power state period	T_{LPX}	50	-	75	ns	
Time to drive LP-00 by new TX	T_{TA-GET}	5x T_{LPX}	-	-	ns	
Time to drive LP-00 after Turnaround Request	T_{TA-GO}	4x T_{LPX}	-	-	ns	
Time-out before new TX side start driving	$T_{TA-SURE}$	T_{LPX}	-	2x T_{LPX}	ns	



< LP Transmitter Timing Definitions >

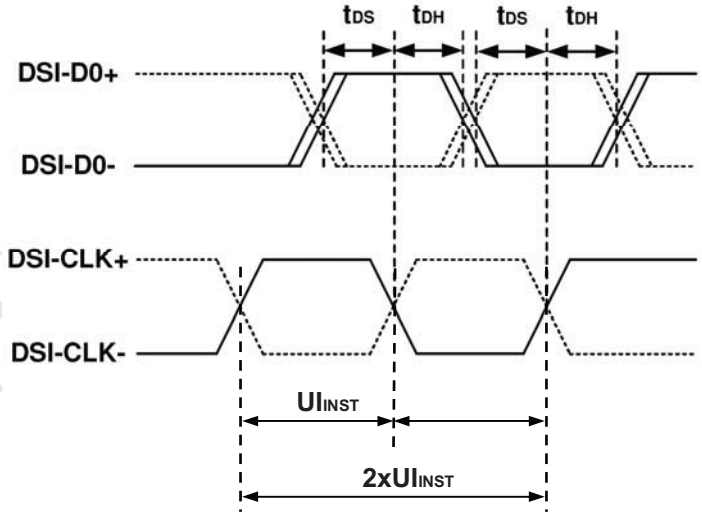
4-3-3. MIPI signal AC Specification

◆ High Speed Transmission specification

Table 10. MIPI High Speed Transmission AC Specification

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
UI instantaneous	UI_{INST}	2	-	4	ns	
Data to Clock Setup Time [measured at receiver]	t_{DS}	0.15xUI	-	-	ns	
Data to Clock Hold Time [measured at receiver]	t_{DH}	0.15xUI	-	-	ns	
20% - 80% rise time and fall time	t_R	150	-	0.3xUI	ps	
	t_F	150	-	0.3xUI	ps	

1. This value corresponds to a minimum 250 Mbps data rate.
2. Maximum total bit rate is 2Gbps for 24-bit data format in 4 lanes application which support to 800RGBx 1280 resolution



< Data to Clock Timing Definitions >

4-3-4. MIPI signal AC Specification

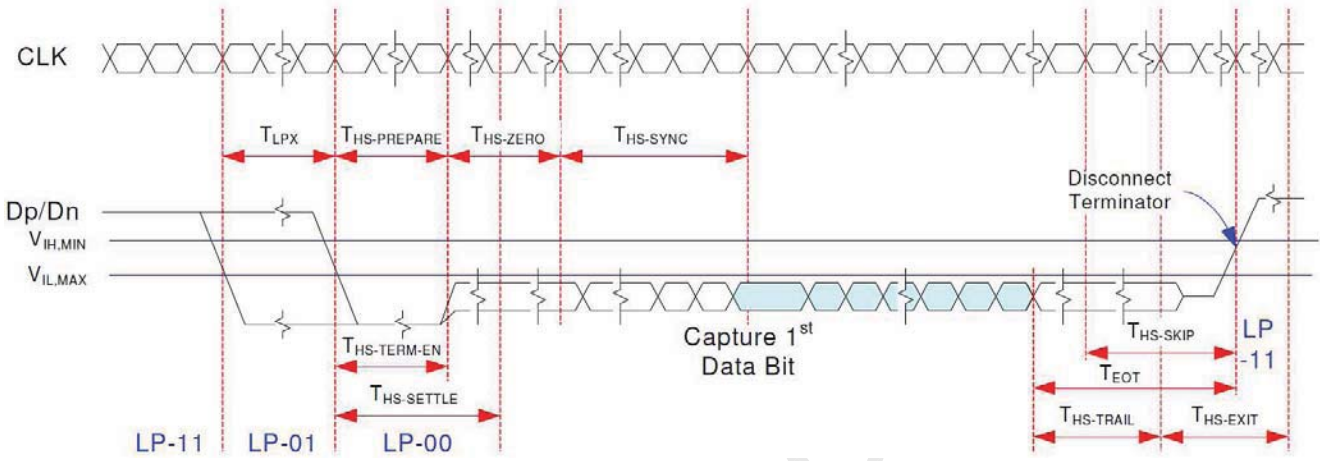
◆ High Speed Data Transmission in Bursts

Table 11. MIPI High Speed Transmission Timing in Bursts

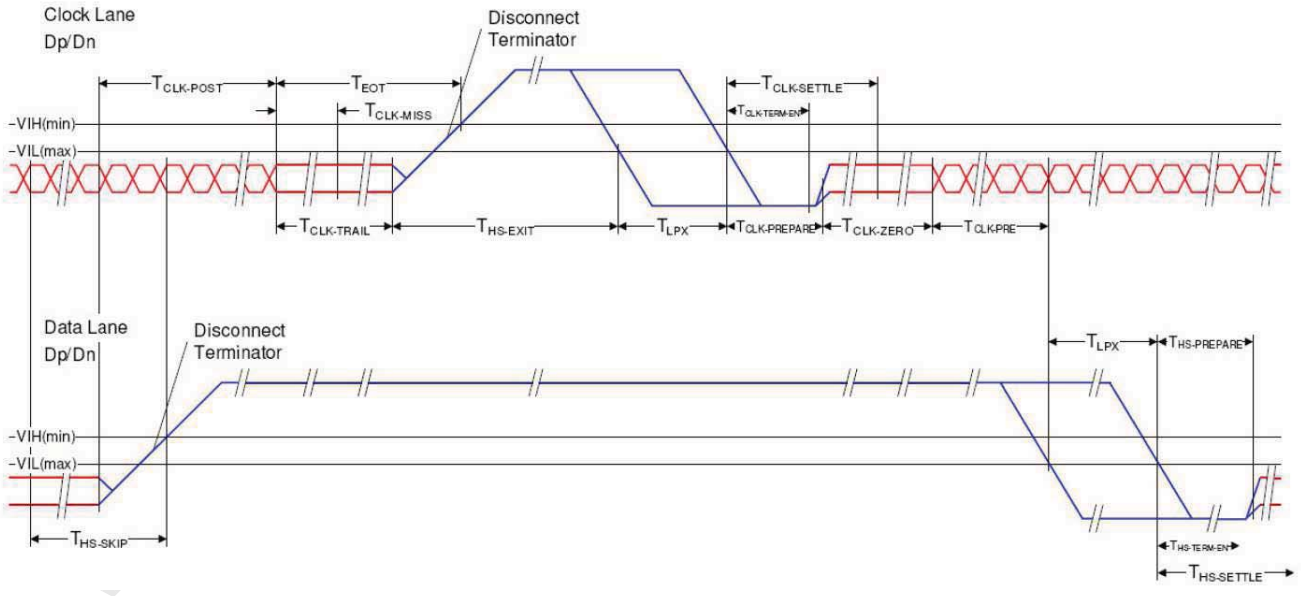
Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
Low Power Mode to High Speed Mode Timing						
Length of any low power state Period	TLPX	50	-	-	ns	
Time to drive LP-00 to prepare for HS transmission	THS-PREPARE	40+4xUI	-	85+6xUI	ns	
Time to enable data receiver line termination measured from when Dn crosses VILMAX	THS-TERM-EN	-	-	35+4xUI	ns	
High Speed Mode to Low Power Mode Timing						
Time-out at display module to ignore transition period of EoT	THS-SKIP	40	-	55+4xUI	ns	
Time to drive LP-11 after HS burst	THS-EXIT	100	-	-	ns	
Time to drive flipped differential state after last payload data bit of a HS transmission burst	THS-TRAIL	60+4xUI	-	-	ns	
High Speed Mode to/from Low Power Mode Timing						
Time that the MPU shall continue sending HS clock after the last associated data lane has transition to LP mode	TCLK-POS	60+52xUI	-	-	ns	
Time to drive HS differential state after last payload clock bit of a HS transmission burst	TCLK-TRAIL	60	-	-	ns	
Time to drive LP-11 after HS burst	THS-EXIT	100	-	-	ns	
Time to drive LP-00 to prepare for HS transmission	TCLK-PREPARE	38	-	95	ns	
Time-out at clock lane display module to enable HS Transmission	TCLK-TERM-EN	-	-	38	ns	
Minimum lead HS-0 drive period before starting clock	TCLK-PREPARE + TCLK-ZERO	300	-	-	ns	
Time that the HS clock shall be driven prior to any associated data lane beginning the transition from LP to HS mode	TCLK-PRE	8xUI	-	-	ns	

4-3-4. MIPI signal AC Specification

◆ High Speed Data Transmission in Bursts



<Data lanes-Low Power Mode to/from High Speed Mode Timing>



<Clock lanes- High Speed Mode to/from Low Power Mode Timing>

4-4. MIPI Command Registers 1/3

```
#2014/3/25
#Ariel_EVT2
#V03
#LGD initial code

HWRESET

delay 10

#CMD3 Enable
mipi.write 0x39 0xFF 0xAA 0x55 0xA5 0x80
mipi.write 0x15 0x6F 0x02
mipi.write 0x39 0xF7 0x47
mipi.write 0x15 0x6F 0x17
mipi.write 0x39 0xF4 0x60


# Page0 Enable
mipi.write 0x39 0xF0 0x55 0xAA 0x52 0x08 0x00

mipi.write 0x39 0xB1 0x28 0x01
mipi.write 0x39 0xB5 0xC8
mipi.write 0x39 0xB6 0x0A
mipi.write 0x39 0xB8 0x01 0x02 0x0C 0x02
mipi.write 0x39 0xBB 0x33 0x33
mipi.write 0x39 0xBC 0x05 0x05
mipi.write 0x39 0xBD 0x02 0x67 0x20 0x20 0x00
// Backlight Dimming control change  ( PWMM active polarity for LEDPWM pin )
// 0xD0 0x01 --> Deleted in initial code ( Default setting )

mipi.write 0x15 0xC8 0x83


# Page1 Enable
mipi.write 0x39 0xF0 0x55 0xAA 0x52 0x08 0x01

mipi.write 0x39 0xB3 0x1E 0x1E       // update for power consumption ( VGH  15V--> 13V )
mipi.write 0x39 0xB4 0x19 0x19
mipi.write 0x39 0xB9 0x34 0x34
mipi.write 0x39 0xBA 0x24 0x24
mipi.write 0x39 0xBC 0x20 0x07      //update for gamma
mipi.write 0x39 0xBD 0x20 0x07      //update for gamma
mipi.write 0x39 0xC3 0x2D 0x2D     // update for power consumption (VRGH 12V)
mipi.write 0x39 0xCA 0x01             // update for power consumption (VGH_REG Off)

// Deleted VCOM setting value in Initial code ( Initial code --> MTP programming for VCOM )


# Page2 Enable
mipi.write 0x39 0xF0 0x55 0xAA 0x52 0x08 0x02

mipi.write 0x15 0xEE 0x01

mipi.write 0x39 0xB0 0x00 0x00 0x00 0x0C 0x00 0x40 0x00 0x5B 0x00 0x6D 0x00 0x99 0x00 0xB8 0x00 0xE3
mipi.write 0x39 0xB1 0x01 0x09 0x01 0x46 0x01 0x75 0x01 0xC1 0x01 0xFE 0x02 0x00 0x02 0x36 0x02 0x6F
mipi.write 0x39 0xB2 0x02 0x92 0x02 0xC8 0x02 0xED 0x03 0x29 0x03 0x4E 0x03 0x8D 0x03 0xA6 0x03 0xC8
mipi.write 0x39 0xB3 0x03 0xEC 0x03 0xF9
//update for Gamma
```

4-4. MIPI Command Registers 2/3

```
# Page3 Enable
mipi.write 0x39 0xF0 0x55 0xAA 0x52 0x08 0x03

mipi.write 0x39 0xB0 0x60 0x00
mipi.write 0x39 0xB1 0x20 0x00

mipi.write 0x39 0xB2 0x15 0x00 0x17 0x00 0xFA  // Update for GIP(STV1 Falling Time 0-->5us)
mipi.write 0x39 0xB3 0x15 0x00 0x17 0x00 0xFA  // Update for GIP(STV2 Falling Time 0-->5us)

mipi.write 0x39 0xBA 0x53 0x10 0x19 0x00 0x00
mipi.write 0x39 0xBB 0x53 0x10 0x19 0x00 0x00
mipi.write 0x39 0xBC 0x53 0x10 0x1A 0x00 0x00
mipi.write 0x39 0xBD 0x53 0x10 0x1A 0x00 0x00

mipi.write 0x39 0xC0 0x00 0x00 0x34 0x00
mipi.write 0x39 0xC1 0x00 0x00 0x34 0x00
mipi.write 0x39 0xC2 0x00 0x00 0x34 0x00
mipi.write 0x39 0xC3 0x00 0x00 0x34 0x00


# Page5 Enable
mipi.write 0x39 0xF0 0x55 0xAA 0x52 0x08 0x05

mipi.write 0x39 0xBD 0x03 0x03 0x00 0x03 0x03

mipi.write 0x15 0xC0 0x07    // Update for GIP(STV01_RISE_START_POS[4:0] = 6-->7 (H-line))
mipi.write 0x15 0xC1 0x06    // Update for GIP(STV01_RISE_START_POS[4:0] = 5-->6 (H-line))
mipi.write 0x15 0xC4 0xA6
mipi.write 0x15 0xC5 0xA6
mipi.write 0x15 0xC6 0xA6
mipi.write 0x15 0xC7 0xA6
mipi.write 0x39 0xC8 0x05 0x20
mipi.write 0x39 0xC9 0x04 0x20
mipi.write 0x39 0xCA 0x01 0x60
mipi.write 0x39 0xCB 0x01 0x60
mipi.write 0x39 0xD1 0x00 0x05 0x03 0x07 0x10
mipi.write 0x39 0xD2 0x10 0x05 0x04 0x03 0x10
mipi.write 0x39 0xD3 0x20 0x00 0x43 0x07 0x10
mipi.write 0x39 0xD4 0x30 0x00 0x43 0x07 0x10
mipi.write 0x39 0xD0 0x00 0x00 0x00 0x00 0x00 0x00 0x00
mipi.write 0x39 0xD5 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
mipi.write 0x39 0xD6 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
mipi.write 0x39 0xD7 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
mipi.write 0x39 0xD8 0x00 0x00 0x00 0x00 0x00
mipi.write 0x39 0xCC 0x00 0x00 0x02
mipi.write 0x39 0xCD 0x00 0x00 0x02
mipi.write 0x39 0xCE 0x00 0x00 0x02
mipi.write 0x39 0xCF 0x00 0x00 0x02
```

4-4. MIPI Command Registers 3/3

```
# Page6 Enable
mipi.write 0x39 0xF0 0x55 0xAA 0x52 0x08 0x06

mipi.write 0x39 0xB0 0x31 0x31
mipi.write 0x39 0xB1 0x31 0x31
mipi.write 0x39 0xB2 0x2D 0x2E
mipi.write 0x39 0xB3 0x2E 0x34
mipi.write 0x39 0xB4 0x29 0x2A
mipi.write 0x39 0xB5 0x16 0x19
mipi.write 0x39 0xB6 0x18 0x17
mipi.write 0x39 0xB7 0x02 0x03
mipi.write 0x39 0xB8 0x08 0x2E
mipi.write 0x39 0xB9 0x34 0x33
mipi.write 0x39 0xBA 0x33 0x34
mipi.write 0x39 0xBB 0x2E 0x08
mipi.write 0x39 0xBC 0x01 0x00
mipi.write 0x39 0xBD 0x11 0x12
mipi.write 0x39 0xBE 0x13 0x10
mipi.write 0x39 0xBF 0x2A 0x29
mipi.write 0x39 0xC0 0x34 0x2E
mipi.write 0x39 0xC1 0x2E 0x2D
mipi.write 0x39 0xC2 0x31 0x31
mipi.write 0x39 0xC3 0x31 0x31


mipi.write 0x39 0xD8 0x00 0x00 0x00 0x00 0x00
mipi.write 0x39 0xD9 0x00 0x00 0x00 0x00 0x00


#CMD3 disable
mipi.write 0x39 0xFF 0xAA 0x55 0xA5 0x00


#CMD2 page0 disable
mipi.write 0x39 0xF0 0x55 0xAA 0x52 0x00 0x00


#Sleep Out
mipi.write 0x05 0x11

#Backlight control
mipi.write 0x15 0x51 0xFF  //  PWM duty = 100%
mipi.write 0x15 0x53 0x2C  //  Enable backlight control
mipi.write 0x15 0x55 0x00  //  CABC Function 00/OFF, 01/UI, 10/Still, 11/Moving

delay 120

#Display On
mipi.write 0x05 0x29
```

4-5. Color Input Data Reference

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

Table 12. COLOR DATA REFERENCE

Colors & Gray Scale	Gray Scale Levels	Data Signal																							
		RED								GREEN								BLUE							
		R0	R1	R2	R3	R4	R5	R6	R7	G0	G1	G2	G3	G4	G5	G6	G7	B0	B1	B2	B3	B4	B5	B6	B7
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
Blue	---	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Green	---	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
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
Red	---	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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
Black	R0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Darker	R1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	R2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Brighter	R253	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	R254	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red	R255	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black	G0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Darker	G1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	G2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Brighter	G253	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	G254	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Green	G255	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Black	B0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Darker	B1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	B2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:
Brighter	B253	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1
	B254	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
Blue	B255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

4-6. Power Sequence

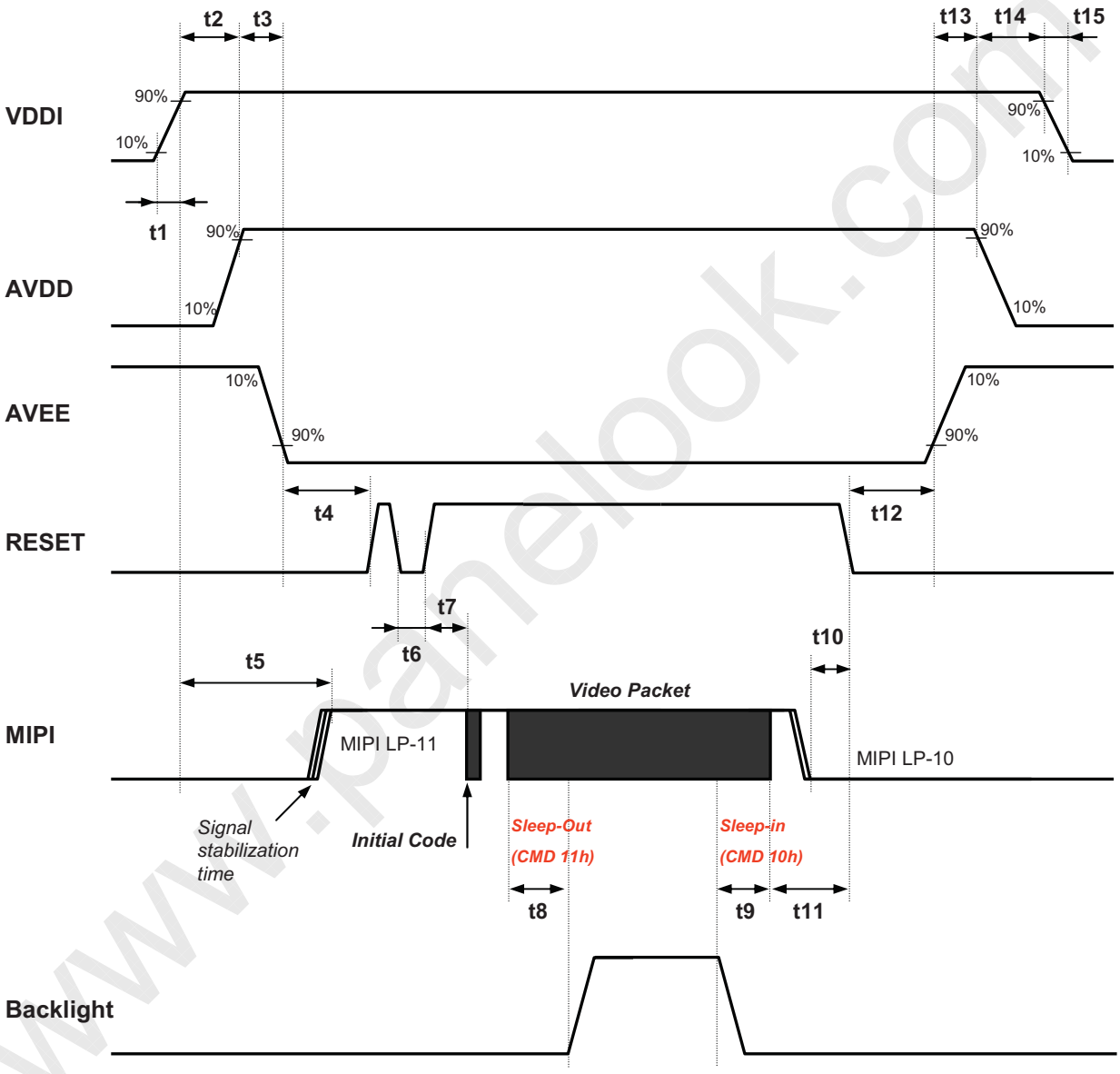
If RESX line is held High or unstable by the host during Power On, then a Hardware Reset must be applied after both VDD and VDDI have been applied – otherwise correct functionality is not guaranteed. There is no timing restriction upon this hardware reset.
If RESX line is held Low (and stable) by the host during Power On, then the RESX must be held low for minimum 10μsec after both VDD and VDDI have been applied.

Table 13. Power Sequence Table

Logic Parameter	Value			Unit
	Min.	Typ.	Max.	
T1	0.5	-	-	ms
T2	0	-	-	ms
T3	0	-	-	ms
T4	40	-	-	ms
T5	0	-	T4	ms
T6	10	-	-	us
T7	20	-	-	ms
T8	135	-	-	ms
T9	0	-	-	ms
T10	0	-	-	ms
T11	100	-	-	ms
T12	0	-	-	ms
T13	0	-	-	ms
T14	0	-	-	ms
T15	150	-	-	us

4-6. Power Sequence

VDDI=1.8V, AVDD=5.2V, AVEE=-5.2V



5. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' and stable for approximately 5 minutes in a dark environment at 25°C. The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of Φ and Θ equal to 0°.
FIG. 1 presents additional information concerning the measurement equipment and method.

FIG. 1 Optical Characteristic Measurement Equipment and Method

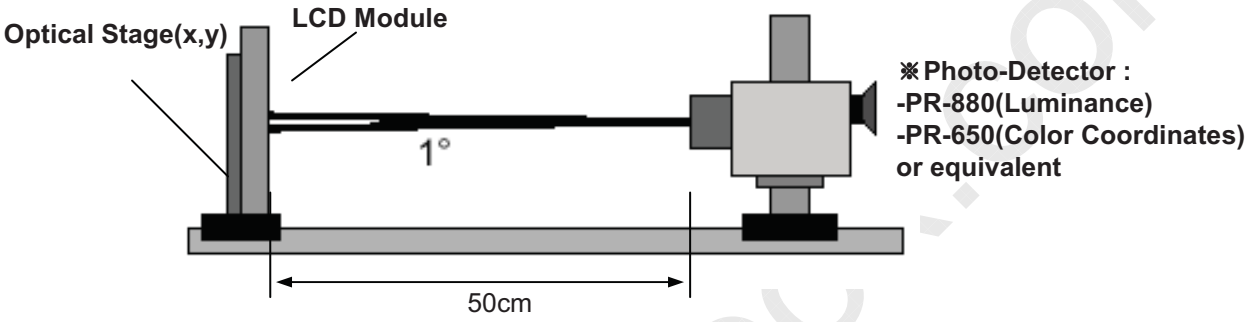


Table 14. OPTICAL CHARACTERISTICS

Ta=25°C, VDDI=1.8V, AVDD=5.2V, AVEE=-5.2V, fv=60Hz, I_{LED} = 20mA

Parameter	Symbol	Values			Units	Notes
		Min	Typ	Max		
Contrast Ratio	CR	700	1000	-		4-1
Surface Luminance, white	L_{WH}	390	490	-	nit	4-2
Luminance Variation	δ_{WHITE}	70	80	-	-	4-3
Response Time						4-4
Rise Time + Decay Time	$Tr_R + Tr_D$	-	-	40	ms	
Color Coordinates						4-2
White	Wx	0.283	0.313	0.343		
	Wy	0.299	0.329	0.359		
Viewing Angle						4-5
x axis, right(Φ=0°)	Θr	-	85	-	degree	3 o'clock
x axis, left (Φ=180°)	Θl	-	85	-	degree	9 o'clock
y axis, up (Φ=90°)	Θu	-	85	-	degree	12 o'clock
y axis, down (Φ=270°)	Θd	-	85	-	degree	6 o'clock
Crosstalk (Vertical, Horizontal)	-	-	-	2.5	%	-

[Note 4-1] Contrast Ratio (CR) is defined mathematically as

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

[Note 4-2] Surface luminance is measured at the center point(L_1) of the LCD with all pixels displaying white at the distance of 50cm by PR-880. Color Coordinates are measured at the center point(L_1) of the LCD with all pixels displaying red, green, blue and white at the distance of 50cm by PR-650. For more information, refer to the FIG 1 and FIG 2.

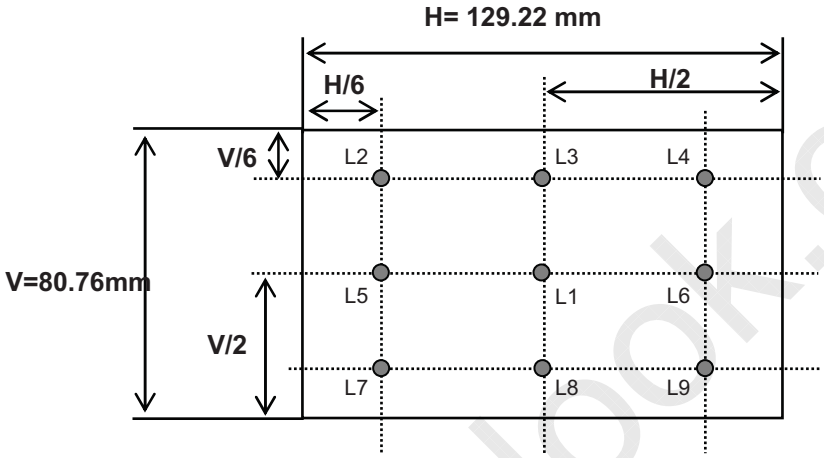
[Note 4-3] Luminance % uniformity is measured for 9 point For more information see FIG 2.
δ_{WHITE} = {Minimum (L1,L2, ….. L9) ÷ Maximum (L1,L2, ….. L9)} * 100

[Note 4-4] Response time is the time required for the display to transition from white to black (Rise Time, Tr_R) and from black to white (Decay Time, Tr_D). For additional information see FIG 3.

[Note 4-5] 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 surface. For more information see FIG 4.

FIG. 2 Luminance

<measuring point for surface luminance & measuring point for luminance variation>



*** H,V: ACTIVE AREA**

FIG. 3 Response Time

The response time is defined as the following figure and shall be measured by switching the input signal for "black" and "white".`

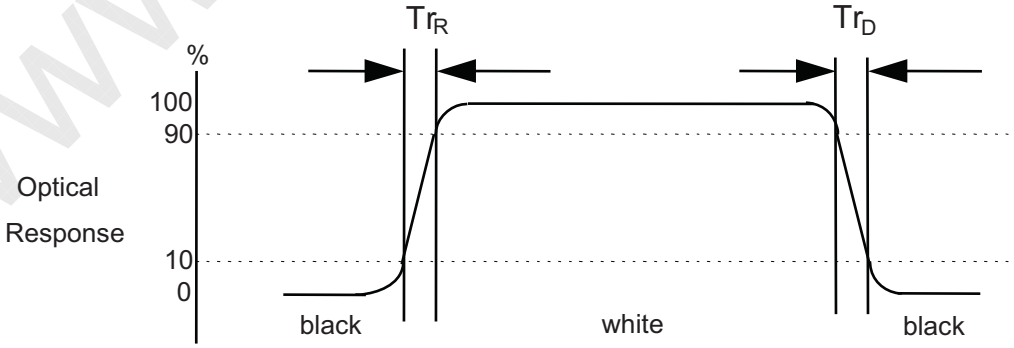


FIG. 4 Viewing angle

<Dimension of viewing angle range>

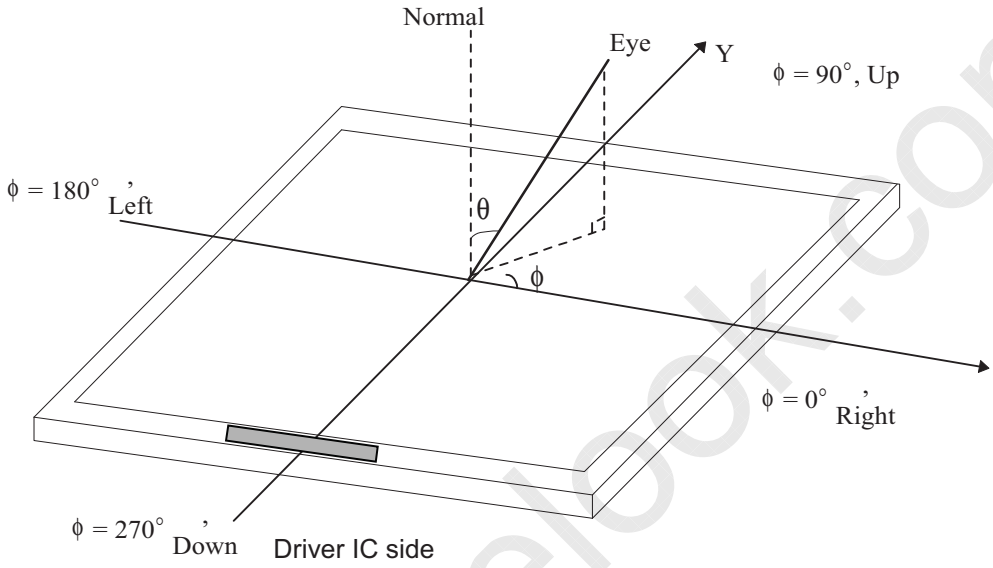
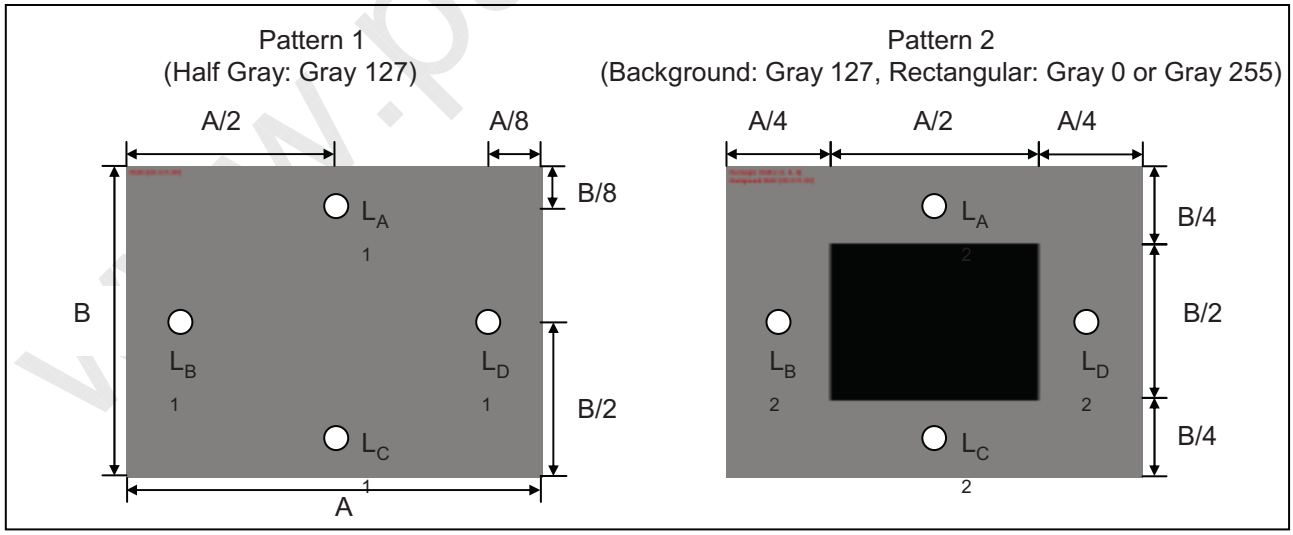


FIG. 5. Crosstalk

$(|L_{A[or\ C]2}-L_{A[or\ C]1}|/L_{A[or\ C]1}) \times 100(\%)$ [Vertical],
$(|L_{B[or\ D]2}-L_{B[or\ D]1}|/L_{B[or\ D]1}) \times 100(\%)$ [Horizontal]



6. Mechanical Characteristics

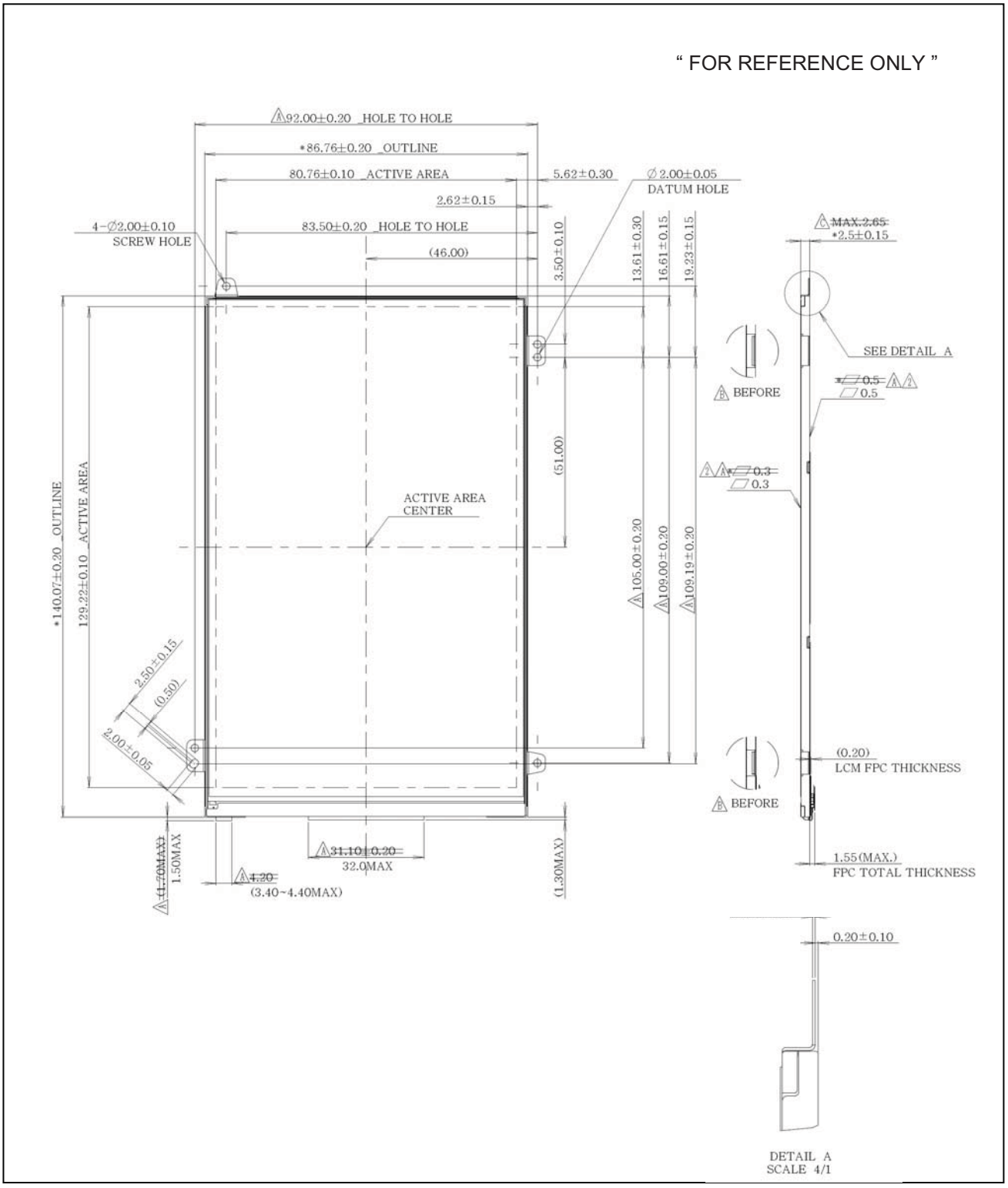
The contents provide general mechanical characteristics for the model LD060WX1. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Table 15. Mechanical Characteristics

Outline Dimension	Horizontal	86.76 mm (Typ.)
	Vertical	140.07 mm (Typ.)
	Thickness	2.50 mm (Typ.), 2.65mm(Max.)
Active Display Area	Horizontal	80.76mm (Typ.)
	Vertical	129.216 mm (Typ.)
Weight	73g (Max.)	
Surface Treatment	LR	

<FRONT VIEW>

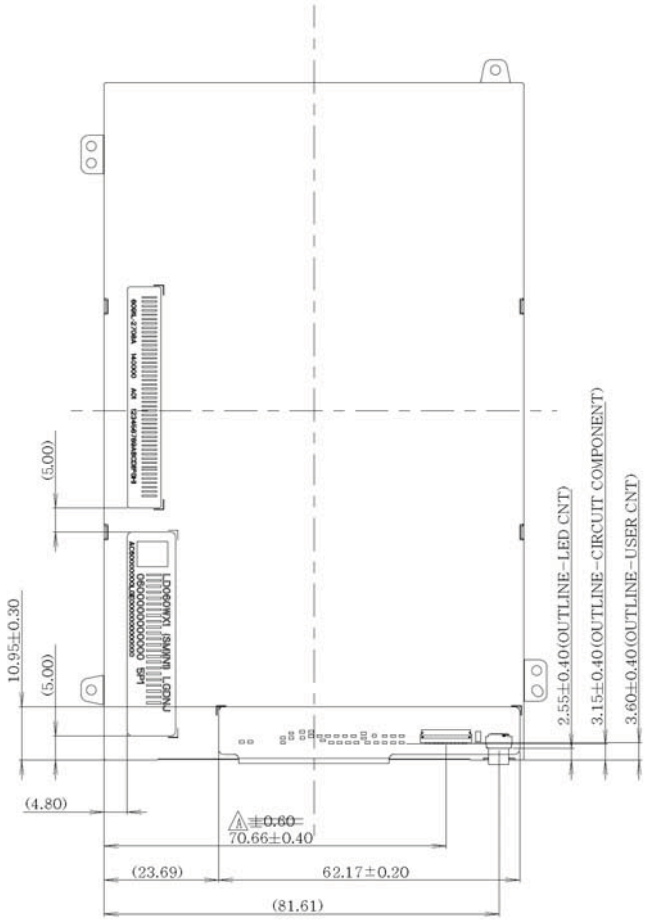
Unit:[mm], General tolerance: ± 0.2mm

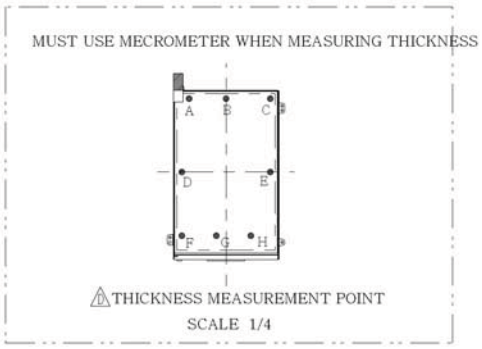


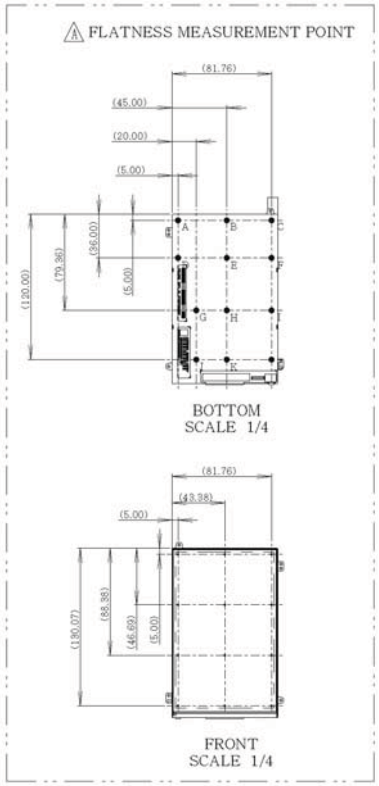
<REAR VIEW>

Unit:[mm], General tolerance: ± 0.2mm

" FOR REFERENCE ONLY "







7. Reliability

Table 16. Reliability item, condition and criteria

No.	Test Items	Test Condition	Criteria	Remark
1	High temperature (Operational)	(Ta=50℃, 500Hr)	No FOS & Functional failure - Pol. light leakage is allowed	[Note 6-1,2,3,4]
2	Low temperature (Operational)	(Ta=0℃, 500Hr)	No FOS & Functional failure - Pol. light leakage is allowed	[Note 6-1,2,3,4]
3	High temperature, High humidity (Operational)	(Ta=50℃, 90%RH, 240Hr)	No FOS & functional failure	[Note 6-1,2,3,4]
		(Ta=60C, 90%RH, 500Hr check after 72, 200, 300, 400 and 500 hrs.)	No functional failure, optical defect is allowed. - Pol. light leakage is allowed	[Note 6-1,2,3,4]
4	High temperature (Non-operational)	(Ta=65℃, 500Hr)	No FOS & Functional failure - Pol. light leakage is allowed	[Note 6-1,2,3,4]
5	Low temperature (Non-operational)	(Ta=-30℃, 500Hr)	No FOS & Functional failure - Pol. light leakage is allowed	[Note 6-1,2,3,4]
6	Dash Board (Non-operational)	(Ta=85℃, 20%RH,48Hr)	No functional failure, optical defect is allowed. - L/C defect is allowed.	[Note 6-1,2,3,4]
7	Thermal Cycling (Non-operational)	(Ta=-30℃~80℃, 100cycle)	No functional failure, optical defect is allowed.	[Note 6-1,2,3,4]
		(Ta=-25℃~60℃, 100cycle)	No FOS & functional failure	[Note 6-1,2,3,4]
8	Hot start test (operational)	(Ramp to 60℃)	No functional failure, optical defect is allowed.	[Note 6-1,4]
9	Cold start test (operational)	(Ramp to 0℃)	No functional failure, optical defect is allowed.	[Note 6-1,4]
10	Altitude (Operational)	(17,000 ft, -15℃ and 30℃, 16hrs dwell2,000ft/min ramp rat)	No FOS & functional failure	[Note 6-1,2,3,4]
11	Altitude (Non-operational)	(20,000 ft, -25℃ and 35℃, 16hrs dwell2,000ft/min ramp rate)	No FOS & functional failure	[Note 6-1,2,3,4]
12	Vibration test	(3.5Grms random vibration, 5~500Hz, 15Min/ axis)	No FOS & functional failure	[Note 6-4]
13	Shock test	(200G, half sine 2ms, 6 sides; 1000G @ 0.5ms)	No FOS & functional failure	[Note 6-4]
14	Ring on Ring	TBD	TBD	[Note 6-4]
15	4PB	TBD	TBD	[Note 6-4]
16	FPC Bending	180° Bending 20cycle at FPC bending area	No FPC Crack, No Functional failure	[Note 6-4]
17	FPC Pulling	Pulling angle : 90°, Speed : 50mm/min,	Min 500gf/㎝ Over OK	[Note 6-4]
18	FPC Twist	Test by Amazon	2,500cycles	[Note 6-4]
19	ESD	discrete electrical components ± 2kV HBM @100pF,1.5kΩ (D-IC, FET, Diode, PMIC)	No functional failure, optical defect is allowed.	[Note 6-4]
20	ESD (Non-operational)	Panel Center Surface - Air : ± 15kV @ 150pF, 330Ω FPC input terminal - Contact : ± 200V @ 200pF, 0Ω	No functional failure, optical defect is allowed.	[Note 6-4]

[Note 6-1] T_a = Ambient Temperature
[Note 6-2] In the Reliability Test, Confirm performance after leaving in room temp.
[Note 6-3] In the standard condition, there shall be no practical problems that may affect the display function 24 hours later after reliability test. After the reliability test, we can guarantee the product only when the corrosion is causing its malfunction. The corrosion causing no functional defect can not be guaranteed.
[Note 6-4] Functional defects are defined as below (Dot defect, Missing lines, No display, Bad display, No backlight, Cracked or broken LCD, Damaged components)

8. International Standards

8-1. 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 Electro technical Standardization (CENELEC).
Information Technology Equipment - Safety - Part 1 : General Requirements.

8-2. Environment

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

9. Packing

9-1. 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 FPC of the LCD module.
This is subject to change without prior notice.

9-2. Packing Form

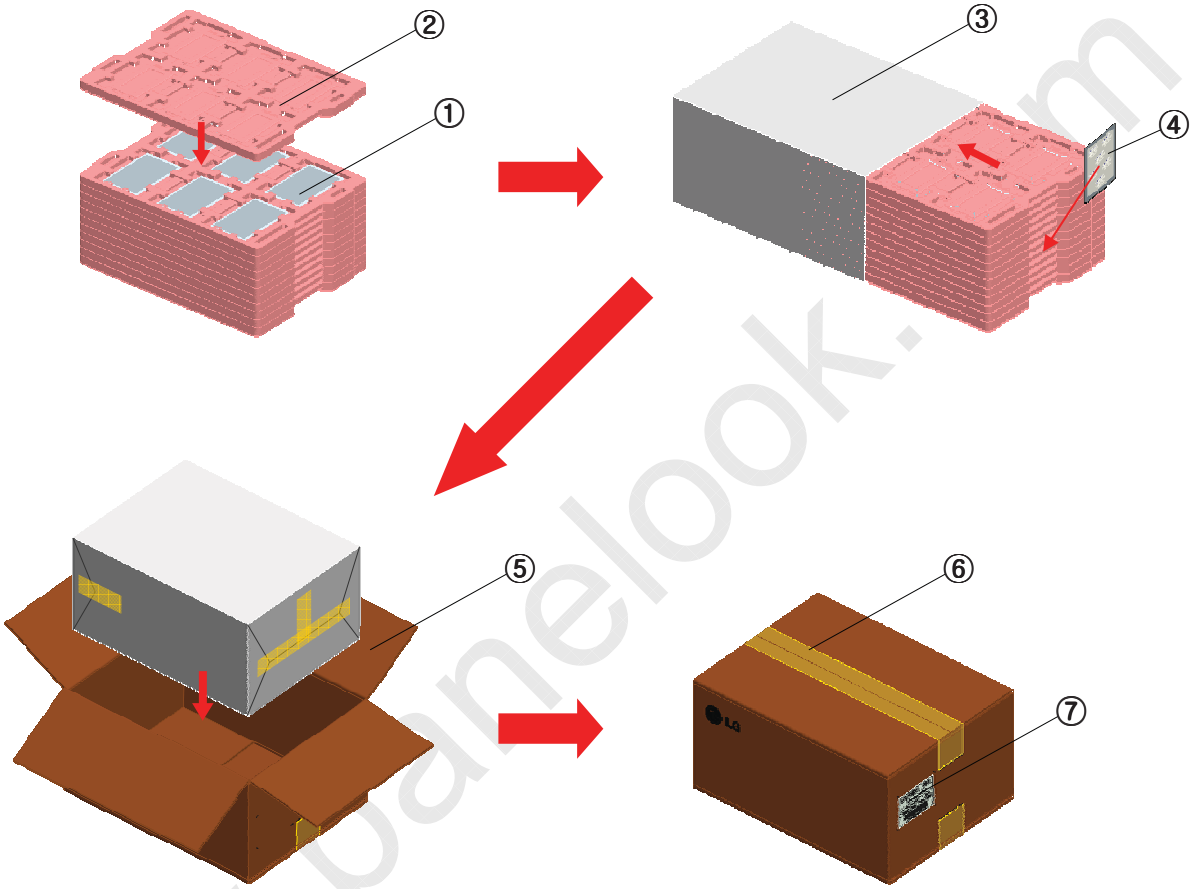
a) Package quantity in one box : 66 pcs

b) Box Size : 478mm(L) x 365mm(W) x 244mm(H)

c) Package quantity in one pallet : 1,584 pcs

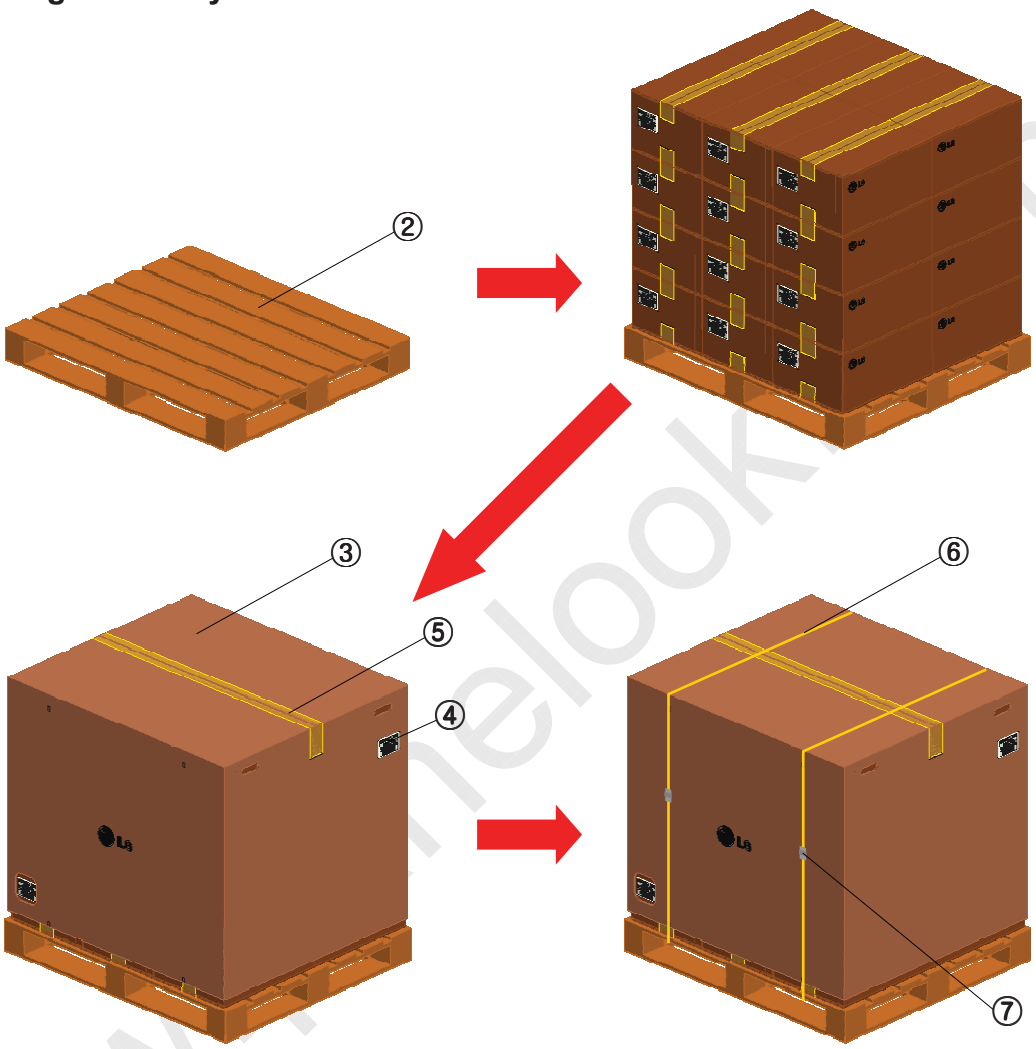
d) Palletized Size : 1,140(L) x 990(W) x 1,105(H)

9-2-1 Packing Assembly



NO.	DESCRIPTION	MATERIAL
1	LCD Module	
2	PACKING, TRAY	EPP
3	BAG	AL, 610*800
4	DESICCANT	POWER DRY, 60G, UX
5	BOX	SW
6	TAPE	OPP 70MMX300M
7	LABEL	YUPO 100X70

9-2-2 Packing Assembly



NO.	DESCRIPTION	MATERIAL
1	Packing AssY	
2	Pallet	Plywood
3	Angle Cover	SW
4	Label	YUPO 100X70
5	TAPE	OPP 70MMX300M
6	Band	PP
7	CLIP	Steel

10. Precautions

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

10-1. Mounting precautions

(1) 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.
(2) Please attach the surface 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.
(3) You should adopt radiation structure to satisfy the temperature specification.
(4) 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.
(5) Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment.
Do not touch the surface of polarizer for bare hand or greasy cloth. (Some cosmetics are detrimental to the polarizer.)
(6) When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzene. 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.
(7) Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
(8) Do not open the case because inside circuits do not have sufficient strength.

10-2. 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 lower temperature, it becomes lower.)
And in lower temperature, response time (required time that brightness is stable after turned on) become longer.
(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 minimized the interference.
(7) This module is not designed to attach TSP (touch screen panels). If TSP is applied, LGD can't guarantee the 'Ripple' related problems.

10-3. 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.

10-4. Precautions for strong light exposure

Strong light exposure causes degradation of polarizer and color filter.

10-5. 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.

10-6. Handling precautions for protection film

(1) 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) The protection film is attached to the polarizer with a small amount of glue. If some stress is applied to rub the protection film against the polarizer during the time you peel off the film, the glue is apt to remain on the polarizer.
Please carefully peel off the protection film without rubbing it against the polarizer.
(3) 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 polarizer after the protection film is peeled off.
(4) You can remove the glue easily. When the glue remains on the 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.