TFT DISPLAY SPECIFICATION

曜凌光電股份有限公司
Raystar Optronics, Inc.
42881台中市大雅區科雅路25號5樓
5F, No. 25, Keya Road, Daya Dist., Taichung City 42881, Taiwan
T：+886-4-2565-0761 | F：+886-4-2565-0760
sales@raystar-optronics.com | www.raystar-optronics.com

RFI350U-AYW-MNN

SPECIFICATION

CUSTOMER:

APPROVED BY	
PCB VERSION	
DATE	

FOR CUSTOMER USE ONLY

SALES BY	APPROVED BY	CHECKED BY	PREPARED BY

Release DATE:

TFT Display Inspection Specification: https://www.raystar-optronics.com/download/products.htm
Precaution in use of TFT module: https://www.raystar-optronics.com/download/declaration.htm

Revision History

VERSION	DATE	REVISED PAGE NO.	Note
0	2022/01/24		First issue

Contents

1.Module Classification Information

R	F	I	35	0U	-	A	Y	W	-	M	N	N
1	2	3	4	5	-	6	7	8	-	9	10	11

Item	Description		
1	R：Raystar Optronics Inc.		
2	Display Type：F→TFT Type, J→ Custom TFT		
3	Solution: A: 128x160 B:320x234 C:320x240 D:480x234 E:480x272 F:800x480 G:640x480 H:1024x600 I:320x480 J:240x320 K:1280x800 L:240x400 M:1024x768 N:128x128 O:480x800 P:640x320 Q:800x600 S:480x128 T:800x320		
4	Display Size：3.5” TFT		
5	Version Code.		
6	Model Type: A：TFT LCD E：TFT+FR+CONTROL BOARD J：TFT+FR+A/D BOARD N：TFT+FR+A/D BOARD+CONTROL BOARD S：TFT+FR+POWER BOARD (DC TO DC) 1：TFT+CONTROL BOARD	6：TFT+FR H：TFT+D/V BOARD I：TFT+FR+D/V BOARD B：TFT+POWER BD	
7	Polarizer Type, Temperature range, View direction	I→Transmissive, W. T, 6:00 ; C→Transmissive, N. T, 6:00 L→Transmissive, W.T,12:00 ; F→Transmissive, N.T,12:00 Y→Transmissive,W.T, IPS TFT ; A→Transmissive, N.T, IPS TFT Z→Transmissive, W.T, O-TFT R→Transmissive, Super W.T, O-TFT N→Transmissive, Super W.T, 6:00; Q→Transmissive, Super W.T, 12:00 V→Transmissive, Super W.T, VA TFT	
8	Backlight	W：LED, White	H：LED, High Light White
		F：CCFL, White	
9	Driver Method	D: Digital A: Analog L：LVDS M:MIPI	
10	Interface	N：without control board A：8Bit B：16Bit S:SPI Interface R: RS232 U:USB I: I2C	
11	TS	N：Without TS S：resistive touch panel C：capacitive touch panel capacitive touch panel (G-F-F) G：capacitive touch panel(G-G)	

2.Summary

TFT 3.5 is a IPS transmissive type color active matrix TFT liquid crystal display that use amorphous silicon TFT as switching devices. This module is a composed of a TFT_LCD module, It is usually designed for industrial application and this module follows RoHs.
.

3.General Specification

- Size: 3.5 inch
- Dot Matrix: 320 x RGBx 480(TFT) dots
- Module dimension: 54.5 (W) x83.0 (H) x 2.46(D) mm
- Active area: 48.96 x 73.44 mm
- Pixel pitch: 0.153 × 0.153 mm
- LCD type: TFT, Normally Black, Transmissive
- View Direction: 80/80/80/80
- Aspect Ratio: Portrait
- TFT Driver IC: ILI9488 or Equivalent
- TFT Interface: 1-Lane MIPI
- Backlight Type: LED,Normally White
- With /Without TP: Without TP
- Surface: Anti-Glare

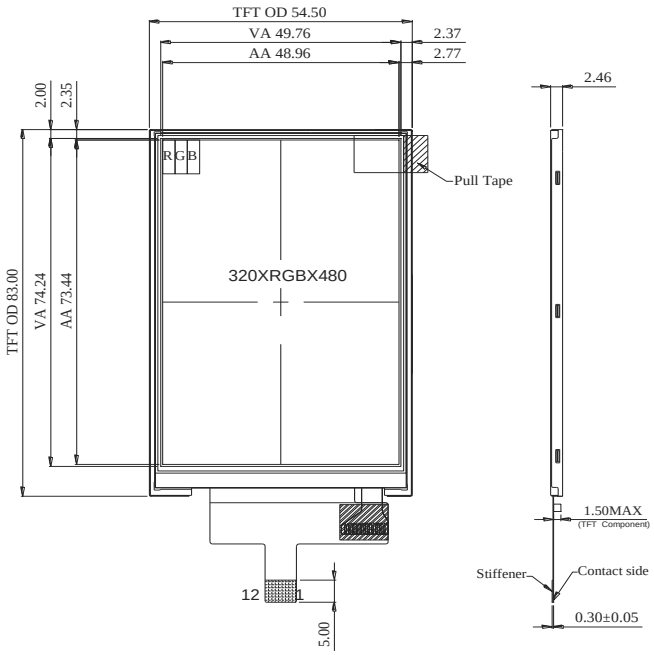
*Color tone slight changed by temperature and driving voltage.

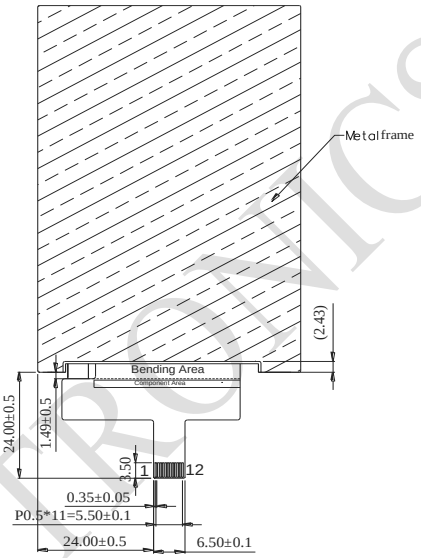
4.Interface

4.1. LCM PIN Definition

NO	Symbol	Function	I/O
1	VCI	A supply voltage to the analog circuit. Connect to an external power supply of 2.5 ~ 3.3V. Connect to a stabilizing capacitor between VCI and GND.	P
2	IOVCC	A supply voltage to the digital circuit. Connect to an external power supply of 1.65 ~ 3.3V.	P
3	RESET	Reset input signal Initialize the chip with a low input. Be sure to execute a power-on reset after supplying power.	I
4	GND	Ground	I
5	MIPI_CLK_P	Positive polarity of low voltage differential clock signal Leave the pin open when not in use.	I
6	MIPI_CLK_N	Negative polarity of low voltage differential clock signal Leave the pin open when not in use	I
7	GND	Ground	I
8	MIPI_DATA_P	Positive polarity of low voltage differential data signal Leave the pin open when not in use.	I
9	MIPI_DATA_N	Negative polarity of low voltage differential data signal Leave the pin open when not in use.	I
10	GND	Ground	I
11	VLED+	Anode of LED backlight.	
12	VLED-	Cathode of LED backlight	

5.Contour Drawing

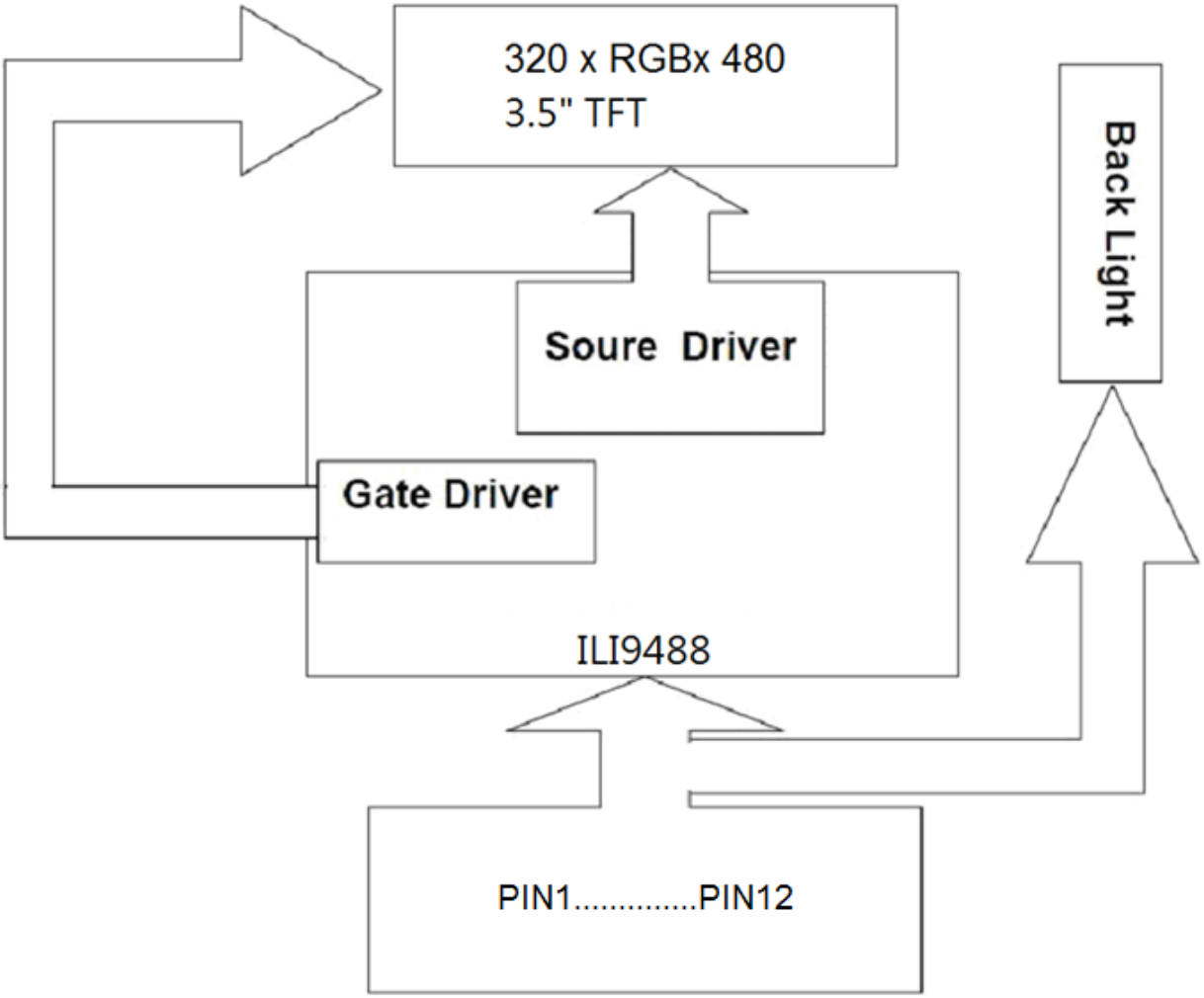




NO.	SYMBOL
1	VCI
2	IOVCC
3	RESET
4	GND
5	MIPI_CLK_P
6	MIPI_CLK_N
7	GND
8	MIPI_DATA_P
9	MIPI_DATA_N
10	GND
11	VLED+
12	VLED-

The non-specified tolerance of dimension is ±0.3 mm .

6.Block Diagram



7.Absolute Maximum Ratings

Item	Symbol	Min	Typ	Max	Unit
Operating Temperature	TOP	-20	—	+70	□
Storage Temperature	TST	-30	—	+80	□

Note: Device is subject to be damaged permanently if stresses beyond those absolute maximum ratings listed above

1. Temp. □60□, 90% RH MAX. Temp.＞60□, Absolute humidity shall be less than 90% RH at 60□

8.Electrical Characteristics

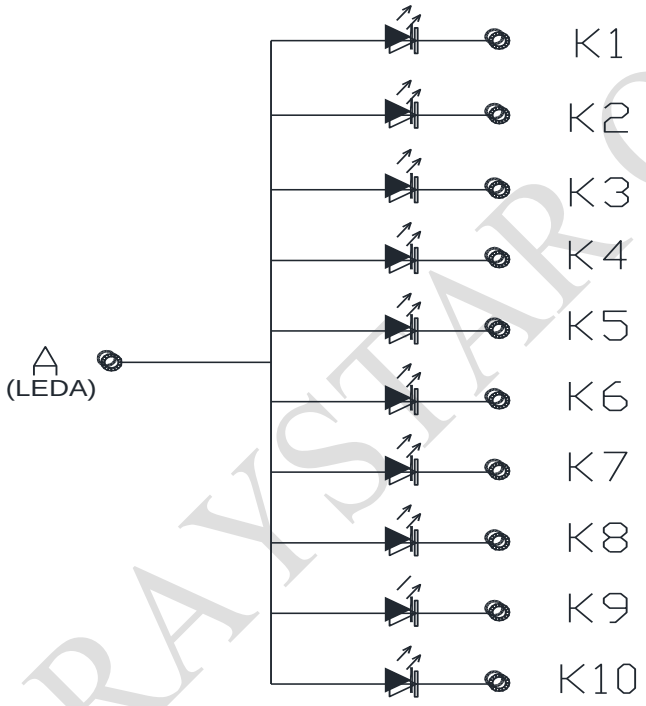
8.1. Operating conditions:

Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage for digital	IOVCC	–	–	1.8/2.8	3.3	V
Supply Voltage for analog	VCI	–	–	2.8	3.3	V
Power Supply for TFT Current	ICC	IOVCC=VCI =VCC=3.3V	–	13.6	–	mA

8.2. LED driving conditions

Parameter	Symbol	Min	Typ	Max	Unit	Remark
LED current	–	–	160	–	mA	–
LED voltage	LEDA	2.7	3.2	3.4	V	Note 1
LED Life Time	–	–	50000	–	Hr	Note 2,3

Note 1 : There are 1 Groups LED
Note 2 : Ta = 25°C



(K1~K10 conector to LEDK)

Note 3 : Brightness to be decreased to 50% of the initial value

9.Interface Timing

9.1. General Description

The MIPI-DSI is enabled or disabled by the external IM [2:0] pin.

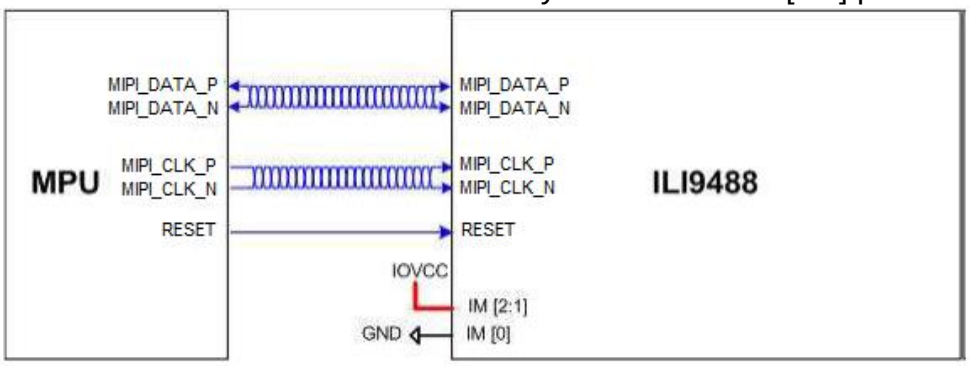


Figure 1: DSI System Interface Diagram

The communication is separated into two different levels between the MCU and the display module:

*Low level communication is done on the interface level.

*High level communication is done on the packet level.

9.2. Interface Level Communication

6.2.1 General

The display module uses data and clock lane differential pairs for DSI. Both differential lane pairs can be driven to Low Power (LP) or High Speed (HS) mode. Low Power mode means that each line of the differential pair is used in the single ended mode, and a differential receiver is disable (the termination resistor of the receiver is disable), and it can be driven into a low power mode. High Speed mode means that differential pairs (the termination resistor of the receiver is enable) are not used in the single ended mode. Different modes and protocols are used in each mode when information is to be transferred from the MCU to the display module and vice versa. The State Codes of the High Speed (HS) and Low Power (LP) lane pair are defined below.

Table 1: High Speed and Low Power Lane Pair State Codes

Lane Pair State Code	Line DC Voltage Levels		High Speed (HS)	Low Power	
	MIPI_DATA_P	MIPI_DATA_N	Burst Mode	Control Mode	Escape Mode
HS-0	Low (HS)	High (HS)	Differential – 0	Note 1	Note1
HS-1	High (HS)	Low (HS)	Differential – 1	Note 1	Note 1
LP-00	Low (LP)	Low (LP)	Not Defined	Bridge	Space
LP-01	Low (LP)	High (LP)	Not Defined	HS – Request	Mark – 0
LP-10	High (LP)	Low (LP)	Not Defined	LP – Request	Mark – 1
LP-11	High (LP)	High (LP)	Not Defined	Stop	Note 2

Notes:

1. Low-Power Receivers (LP-Rx) of the lane pair will check the LP-00 state code, when the Lane Pair is in the High Speed (HS) mode.

2. If Low-Power Receivers (LP-Rx) of the lane pair recognizes LP-11 state code, the lane pair will return to LP-11 of the Control Mode.

6.2.2.MIPI_CLK Lanes

MIPI_CLK_P/N lanes can be driven into three different power modes:
*Low Power Mode (LPM)
*Ultra Low Power Mode (ULPM)
*High Speed Clock Mode (HSCM)

Clock lanes are in the single ended mode (LP = Low Power) when entering or leaving the Low Power Mode (LPM) or Ultra Low Power Mode (ULPM). Clock lanes are in the single ended mode (LP = Low Power) when entering or leaving the High Speed Clock Mode (HSCM). These entering and leaving protocols use clock lanes in the single ended mode to generate an entering or leaving sequence. The principal flow chart of the different clock lanes power modes is illustrated below.

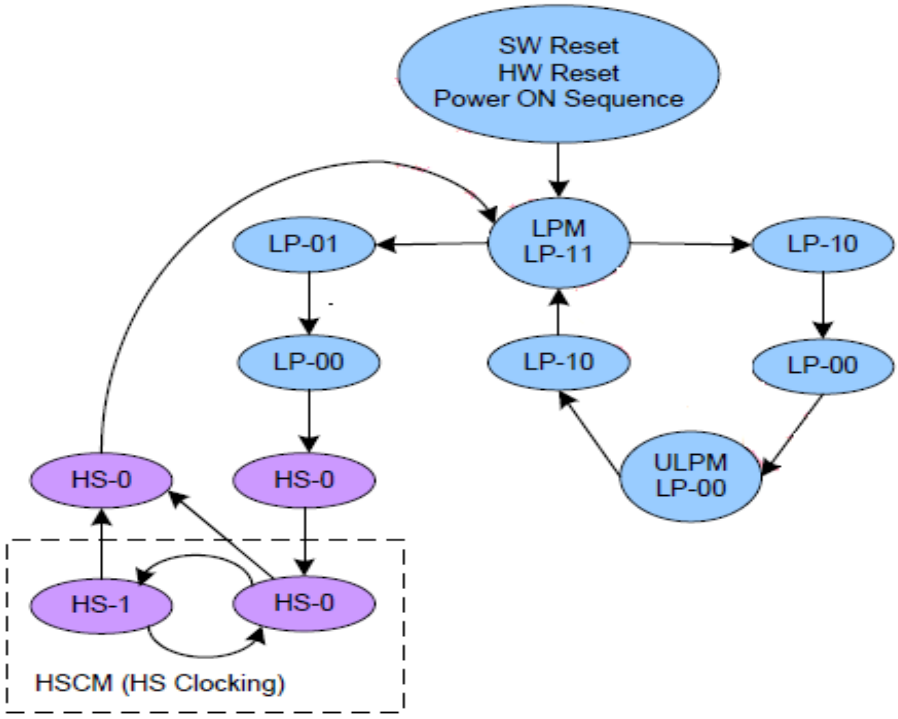


Figure 2: Clock Lanes Power Mode

6.2.2.1. Low Power Mode (LPM)

MIPI_CLK_P/N lanes can be driven to the Low Power Mode (LPM), when MIPI_CLK lanes enter the LP-11
State Code, in three different ways:
(1) After SW Reset, HW Reset or Power On Sequence => LP-11
(2) After MIPI_CLK_P/N lanes leave the Ultra Low Power Mode (ULPM, LP-00 State Code) => LP-10 => LP-11 (LPM).
This sequence is illustrated below.

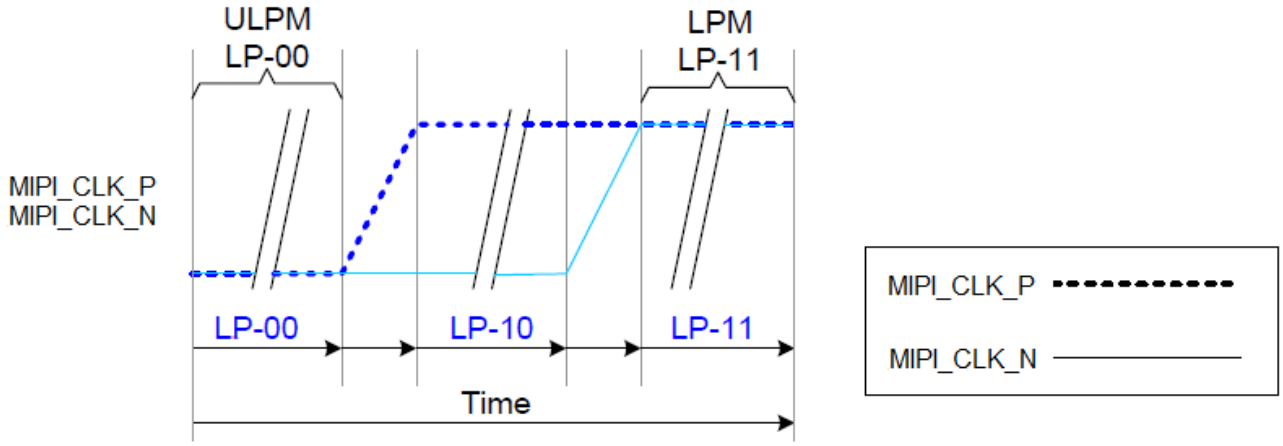


Figure 3: From ULPM to LPM

(3) After MIPI_CLK_P/N lanes leave the High Speed Clock Mode (HSCM, HS-0 or HS-1 State Code) => HS-0 => LP-11 (LPM).
This sequence is illustrated below.

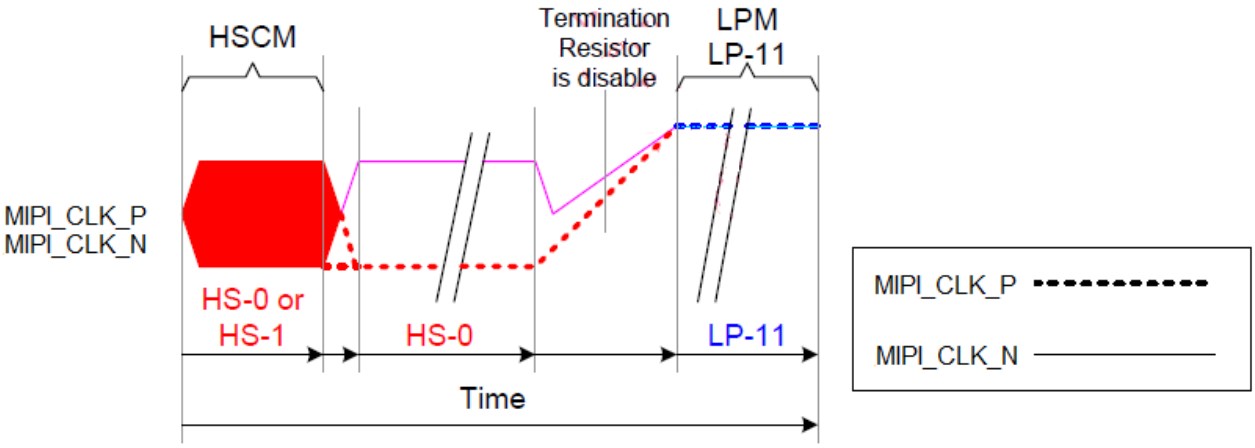


Figure 4: From High Speed Clock Mode (HSCM) to LPM

All changes of the three modes are illustrated in the flow chart below.

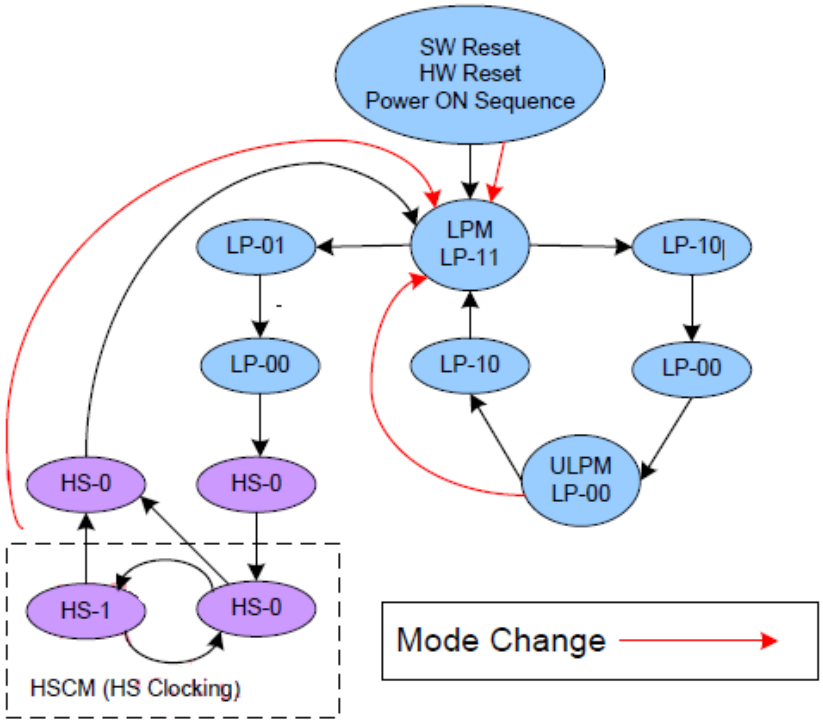


Figure 5: All Changes of the Three Modes to LPM

6.2.2.2 Ultra Low Power Mode (ULPM)

MIPI_CLK_P/N lanes can be driven to the Ultra Low Power Mode (ULPM) when MIPI_CLK lanes enter the LP-00 State Code. The only possibility is from the Low Power Mode (LPM, LP-11 State Code) => LP-10 => LP-00 (ULPM). This sequence is illustrated below.

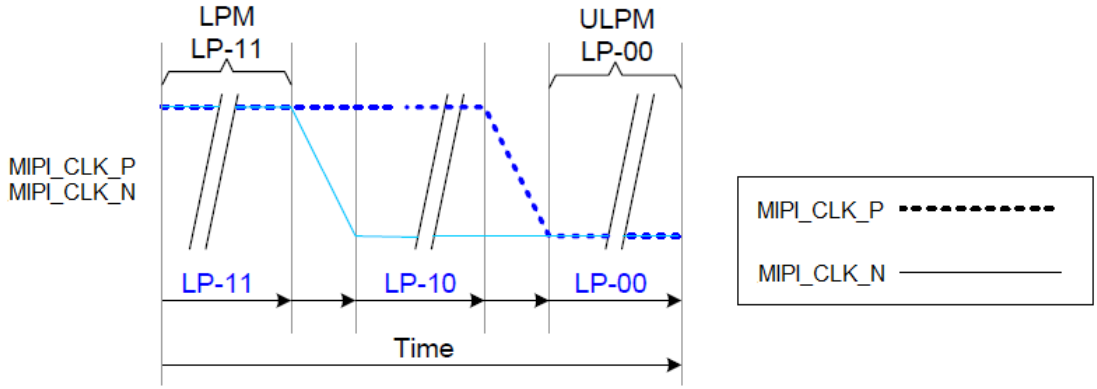


Figure 6: From LPM to HSCM

The mode change is also illustrated below.

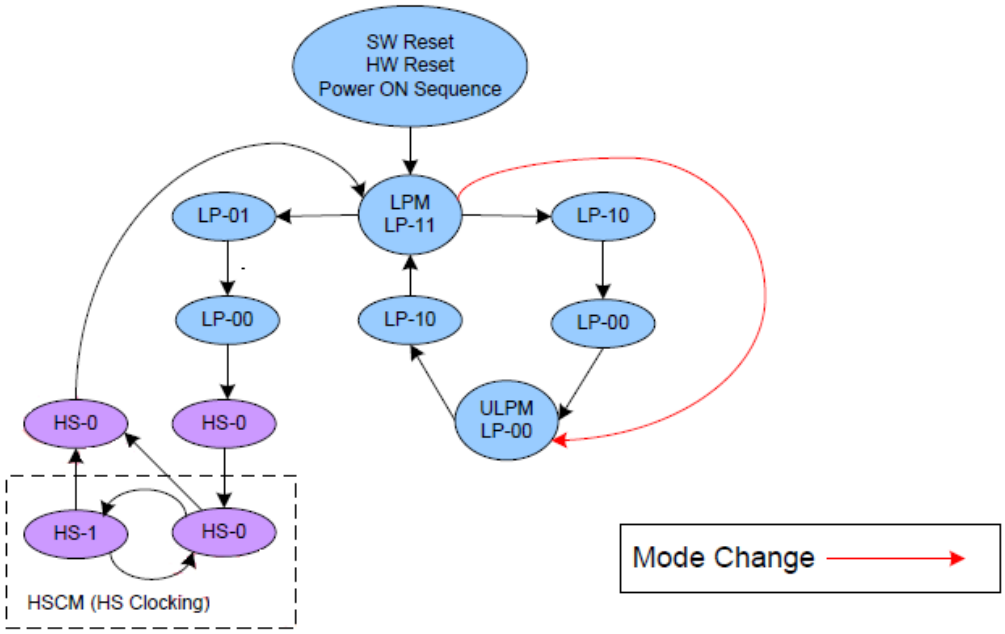


Figure 7: Mode Change from LPM to ULPM

6.2.2.3. High-Speed Clock Mode (HSCM)

MIPI_CLK_P/N lanes can be driven to the High Speed Clock Mode (HSCM), when MIPI_CLK lanes start to work between HS-0 and HS-1 State Codes. The only entering possibility is from the Low Power Mode (LPM, LP-11 State Code) => LP-01 => LP-00 => HS-0 => HS-0/1 (HSCM). This sequence is illustrated below

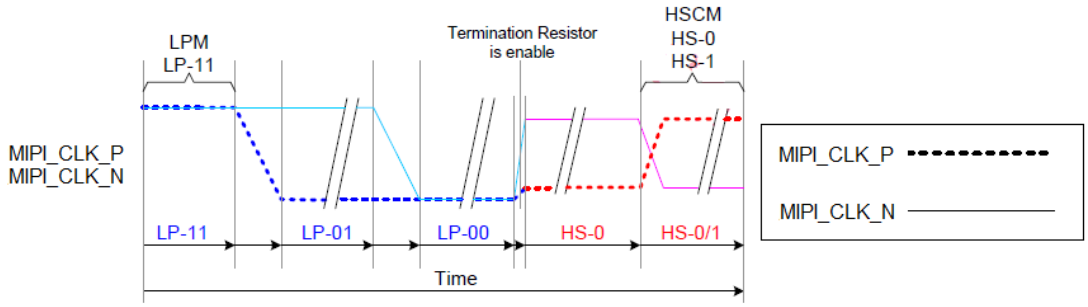


Figure 8: From LPM to HSCM

The high speed clock (MIPI_CLK_P/N) starts before high speed data is sent via MIPI_DATA_P/N lanes. The high speed clock continues clocking after the high speed data sending has been stopped. The burst of the high speed clock consists of:

*Even number of transitions

*Start state is HS-0

*End state is HS-0

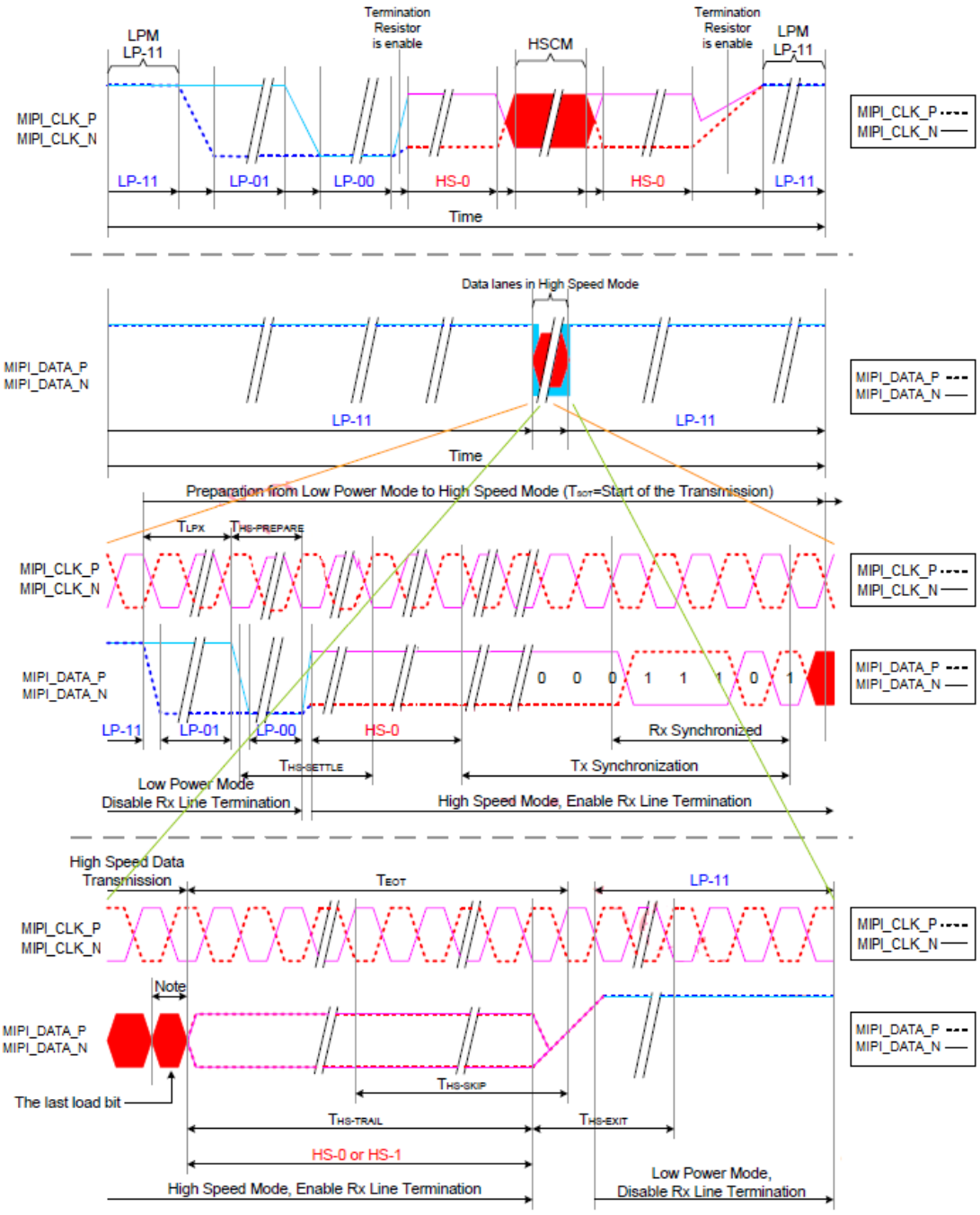


Figure 9: High Speed Clock Burst

Notes:

1. If the last load bit is HS-0, the transmitter changes from HS-0 to HS-1.
2. If the last load bit is HS-1, the transmitter changes from HS-1 to HS-0.

9.3. Reset Timing

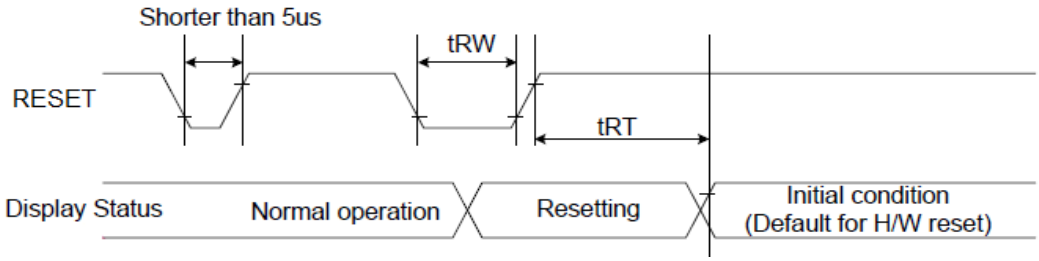


Table 2: Reset Timing

Signal	Symbol	Parameter	Min	Max	Unit
RESET	tRW	Reset pulse duration	10		uS
	tRT	Reset cancel		5 (note 1,5)	mS
				120 (note 1,6,7)	mS

Notes:

1. The reset cancel also includes the required time for loading ID bytes, VCOM setting and other settings from the EEPROM to registers. After a rising edge of RESX, this loading is done within 5 ms after the H/W reset cancel (tRT).
2. According to the Table 40, a spike due to an electrostatic discharge on the RESX line does not cause irregular system reset.

RESET Pulse	Action
Shorter than 5us	Reset Rejected
Longer than 9us	Reset
Between 5us and 9us	Reset starts

3. During the Reset period, the display will be blanked (When Reset starts in the Sleep Out mode, the display will enter the blanking sequence in at least 120 ms. The display remains the blank state in the Sleep In mode.) and then return to the default condition for the Hardware Reset.
4. Spike Rejection can also be applied during a valid reset pulse, as shown below:

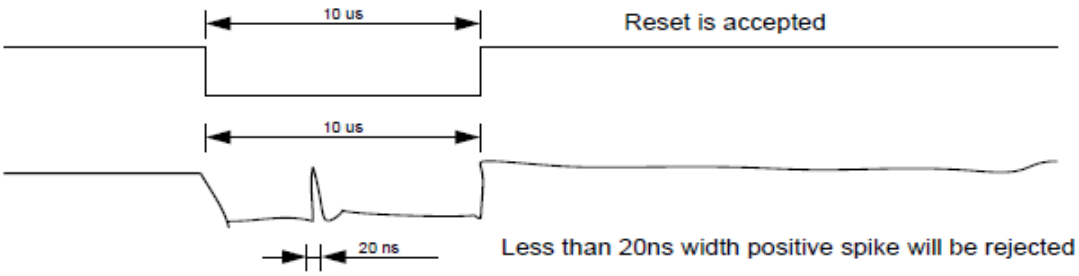


Figure 10: Positive Noise Pulse during Reset Low

5. When Reset is applied during the Sleep In Mode.
6. When Reset is applied during the Sleep Out Mode.
7. It is necessary to wait 5msec after releasing RESX before sending commands. The Sleep Out command also cannot be sent in 120msec.

9.4. Other command, display data format,Please reference the ILI9488 Spec.

10.Optical Characteristics

Item		Symbol	Condition.	Min	Typ.	Max.	Unit	Remark
Response time		Tr Tf	θ=0°、Φ=0°	-	30	-	.ms	Note 3,
Contrast ratio		CR	At optimized viewing angle	-	700	-	-	Note 4,
Color Chromaticity	White	Wx	θ=0°、Φ=0	0.26	0.31	0.36		Note 2,6,7
		Wy		0.28	0.33	0.38		
Viewing angle	Hor.	ΘR	CR≧10	-	80	-	Deg.	Note 1
		ΘL		-	80	-		
	Ver.	ΦT		-	80	-		
		ΦB		-	80	-		
Brightness		-	-	500	600	-	cd/m2	Center of display
Uniformity		(U)	-	75	-	-	%	Note5

Ta=25±2℃ (I_{LED}=160mA)

Note 1: Definition of viewing angle range

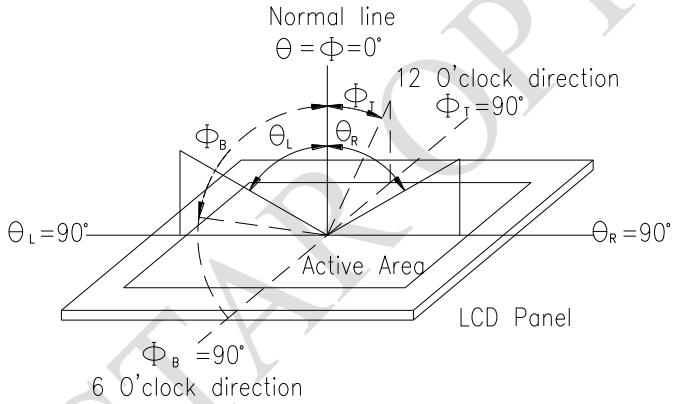


Fig. 10.1. Definition of viewing angle

Note 2: Test equipment setup:

After stabilizing and leaving the panel alone at a driven temperature for 10 minutes, the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. Optical specifications are measured by Topcon BM-7 luminance meter 1.0° field of view at a distance of 50cm and normal direction.

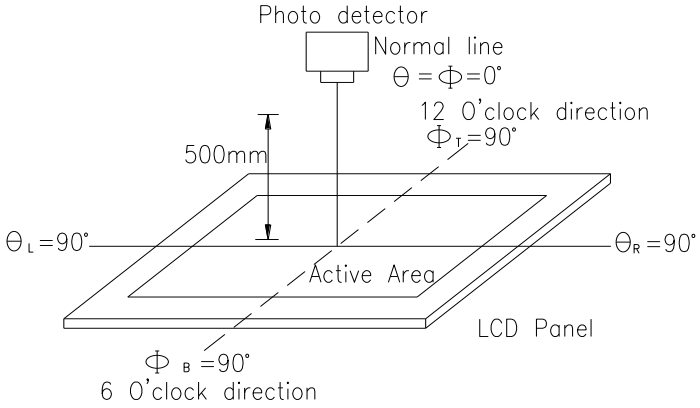
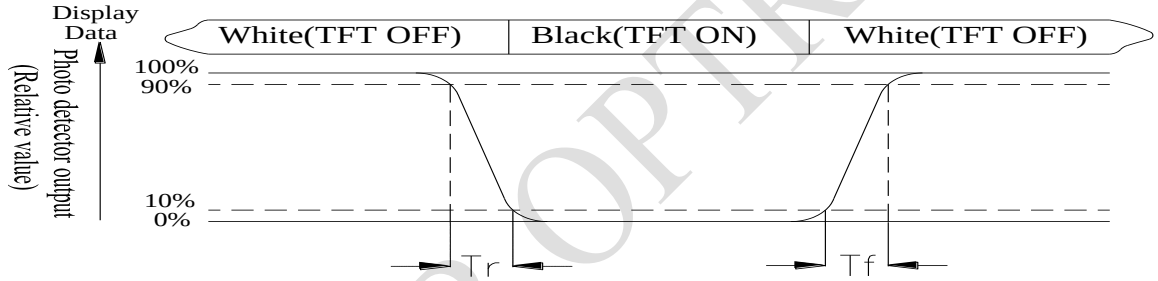


Fig. 10.2. Optical measurement system setup

Note 3: Definition of Response time:
The response time is defined as the LCD optical switching time interval between “White” state and “Black” state. Rise time, Tr, is the time between photo detector output intensity changed from 90%to 10%. And fall time, Tf, is the time between photo detector output intensity changed from 10%to 90%



Note 4: Definition of contrast ratio:
The contrast ratio is defined as the following expression.

$$\text{Contrast ratio (CR)} = \frac{\text{Luminance measured when LCD on the "White" state}}{\text{Luminance measured when LCD on the "Black" state}}$$

Note 5: Definition of Luminance Uniformity
Active area is divided into 9 measuring areas (reference the picture in below). Every measuring point is placed at the center of each measuring area.
Luminance Uniformity (U) = Lmin/Lmax x100%
L = Active area length
W = Active area width

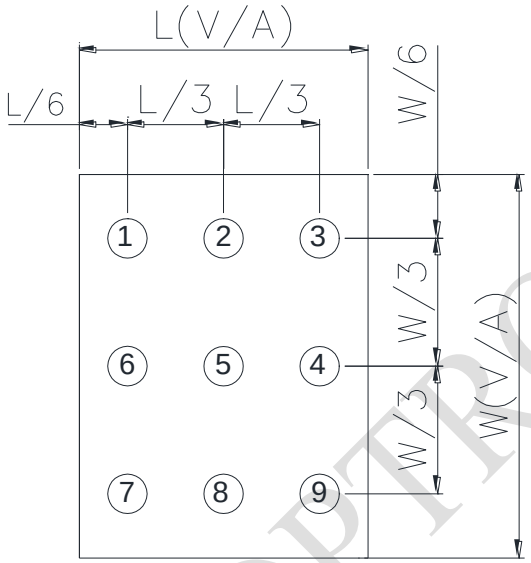


Fig10.3. . Definition of uniformity

Note 6: Definition of color chromaticity (CIE 1931)
Color coordinates measured at the center point of LCD

Note 7: Measured at the center area of the panel when all the input terminals of LCD panel are electrically opened.

11.Reliability

Content of Reliability Test (Wide temperature, -20℃~70℃)

Environmental Test			
Test Item	**Content of Test**	**Test Condition**	**Note**
High Temperature storage	Endurance test applying the high storage temperature for a long time.	80℃ 96hrs	2
Low Temperature storage	Endurance test applying the low storage temperature for a long time.	-30℃ 96hrs	1,2
High Temperature Operation	Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.	70℃ 96hrs	——
Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time.	-20℃ 96hrs	1
High Temperature/ Humidity Operation	The module should be allowed to stand at 40℃,90%RH max	40℃,90%RH 96hrs	1,2
Thermal shock resistance	The sample should be allowed stand the following 10 cycles of operation -20℃ 25℃ 70℃ 30min 5min 30min 1 cycle	-20℃/70℃ 10 cycles	——
Vibration test	Endurance test applying the vibration during transportation and using.	Total fixed amplitude : 1.5mm Vibration Frequency : 10~55Hz One cycle 60 seconds to 3 directions of X,Y,Z for Each 15 minutes	3
Static electricity test	Endurance test applying the electric stress to the terminal.	VS=±600V(contact) ,±800v(air), RS=330Ω CS=150pF 10 times	——

Note1: No dew condensation to be observed.

Note2: The function test shall be conducted after 4 hours storage at the normal Temperature and humidity after remove from the test chamber.

Note3: The packing have to including into the vibration testing.

12.Initial Code For Reference

```
Void ILI9488_Panel_InitialCode(void)
{
    WriteComm(0xE0);
    WriteData(0x0D);
    WriteData(0x13);
    WriteData(0x14);
    WriteData(0x01);
    WriteData(0x0C);
    WriteData(0x03);
    WriteData(0x31);
    WriteData(0x46);
    WriteData(0x45);
    WriteData(0x03);
    WriteData(0x0C);
    WriteData(0x0A);
    WriteData(0x2A);
    WriteData(0x30);
    WriteData(0x0D);

    WriteComm(0xE1);
    WriteData(0x0A);
    WriteData(0x10);
    WriteData(0x16);
    WriteData(0x05);
    WriteData(0x12);
    WriteData(0x08);
    WriteData(0x3D);
    WriteData(0x45);
    WriteData(0x53);
    WriteData(0x07);
    WriteData(0x11);
    WriteData(0x0E);
    WriteData(0x30);
    WriteData(0x33);
    WriteData(0x0A);

    WriteComm(0xC0);
    WriteData(0x0A);    //VERG12=4.187
    WriteData(0x0A);

    WriteComm(0xC1); //VGH=VCIx6, VGL=-VCIx4
    WriteData(0x41);

    WriteComm(0xC5);
    WriteData(0x00);     //VCOM
    WriteData(0x25);
    WriteData(0x80);
```

```
    WriteComm(0x36);
    WriteData(0x08);    // BGR=1 //MY=0,MX=0

    WriteComm(0x3A);
    WriteData(0x77); //(0x66):16bit,(0x77):18bit

    WriteComm(0xF8);
    WriteData(0x05);    //dither on

    WriteComm(0xB1);
    WriteData(0xA0);
    WriteData(0x11);

    WriteComm(0xB4);
    WriteData(0x02);

    WriteComm(0xB6);
    WriteData(0x82);
    WriteData(0x22);
    WriteData(0x3B);

    WriteComm(0xE9);
    WriteData(0x01);

    WriteComm(0xF7);
    WriteData(0xA9);
    WriteData(0x51);
    WriteData(0x2C);
    WriteData(0x82);

    WriteComm(0x21);
    WriteData(0x00);

    WriteComm(0x11);
        delay1(120);

    WriteComm(0x29);
        delay1(20);
}
```

LCM Sample Estimate Feedback Sheet		
Module Number：_____		
1、Panel Specification：		
1. Panel Type：	□ Pass	□ NG ,_____
2. View Direction：	□ Pass	□ NG ,_____
3. Numbers of Dots：	□ Pass	□ NG ,_____
4. View Area：	□ Pass	□ NG ,_____
5. Active Area：	□ Pass	□ NG ,_____
6.Operating Temperature：	□ Pass	□ NG ,_____
7.Storage Temperature：	□ Pass	□ NG ,_____
8.Others：_____		
2、Mechanical Specification：		
1. PCB Size：	□ Pass	□ NG ,_____
2.Frame Size：	□ Pass	□ NG ,_____
3.Materal of Frame：	□ Pass	□ NG ,_____
4.Connector Position：	□ Pass	□ NG ,_____
5.Fix Hole Position：	□ Pass	□ NG ,_____
6.Backlight Position：	□ Pass	□ NG ,_____
7. Thickness of PCB：	□ Pass	□ NG ,_____
8. Height of Frame to PCB：	□ Pass	□ NG ,_____
9.Height of Module：	□ Pass	□ NG ,_____
10.Others：	□ Pass	□ NG ,_____
3、Relative Hole Size：		
1.Pitch of Connector：	□ Pass	□ NG ,_____
2.Hole size of Connector：	□ Pass	□ NG ,_____
3.Mounting Hole size：	□ Pass	□ NG ,_____
4.Mounting Hole Type：	□ Pass	□ NG ,_____
5.Others：	□ Pass	□ NG ,_____
4、Backlight Specification：		
1.B/L Type：	□ Pass	□ NG ,_____
2.B/L Color：	□ Pass	□ NG ,_____
3.B/L Driving Voltage (Reference for LED Type)：□ Pass □ NG ,_____		
4.B/L Driving Current：	□ Pass	□ NG ,_____
5.Brightness of B/L：	□ Pass	□ NG ,_____
6.B/L Solder Method：	□ Pass	□ NG ,_____
7.Others：	□ Pass	□ NG ,_____

>> **Go to page 2** <<

Module Number：_____		
5、Electronic Characteristics of Module：		
1.Input Voltage：	□ Pass	□ NG ,_____
2.Supply Current：	□ Pass	□ NG ,_____
3.Driving Voltage for LCD：	□ Pass	□ NG ,_____
4.Contrast for LCD：	□ Pass	□ NG ,_____
5.B/L Driving Method：	□ Pass	□ NG ,_____
6.Negative Voltage Output：	□ Pass	□ NG ,_____
7.Interface Function：	□ Pass	□ NG ,_____
8.LCD Uniformity：	□ Pass	□ NG ,_____
9.ESD test：	□ Pass	□ NG ,_____
10.Others：	□ Pass	□ NG ,_____

6、Summary：

Sales signature：_____

Customer Signature：_____ **Date**：__/__/__