



RAYSTAR

曜凌光電股份有限公司

住址: 42878 台中市大雅区科雅路 25 號 5F WEB: <http://www.Raystar-Optronics.com>
5F., No.25, Keya Rd., Daya Dist., Taichung E-mail: sales@raystar-optronics.com
City 428, Taiwan Tel:886-4-2565-0761 Fax : 886-4-2565-0760

RFI350U-AYW-DNN

SPECIFICATION

CUSTOMER:

APPROVED BY	
PCB VERSION	
DATE	

FOR CUSTOMER USE ONLY

SALES BY	APPROVED BY	CHECKED BY	PREPARED BY

Release DATE:

Revision History

VERSION	DATE	REVISED PAGE NO.	Note
0	2017/08/29		First issue
A	2018/09/04		Modify AC CHARATERISTICS. Add RGB Interface.

RAYSTAR OPTRONICS

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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.

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3.General Specifications

- 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
- LCD type: TFT, Normally Black, Transmissive
- View Direction: Wide View
- Aspect Ratio: Portrait
- TFT Driver IC: ILI9488 Or Equal
- TFT Interface: MCU 8/16/18-bit, 3-SPI ,RGB interface+3-SPI
- Backlight Type: LED,Normally White
- With /Without TP: Without TP
- Surface: Anti-Glare

*Color tone slight changed by temperature and driving voltage.

4.Interface

LCM PIN Definition

NO	Symbol	Function	I/O
1	LEDK	Cathode of LED backlight	P
2	LEDA	Anode of LED backlight.	P
3	IM0	Note 1	I
4	IM1	Note 1	I
5	IM2	Note 1	I
6	RESET	System reset pin.	I
7	NC(VS)	No Connection (Vrtical Sync signal) Note 2)	I
8	NC(HS)	No Connection (Horizontal Sync signal ; Note 2)	I
9	NC(DCLK)	No Connection (Pixel clock signal; Note 2)	I
10	NC(DE)	No Connection (Data Enable; Note 2)	I
11-16	DB17-12	Data bus (R5~R0; RGB-18bit Pixel; Note 2)	I
17-22	DB11-6	Data bus (G5~G0; RGB-18bit Pixel; Note 2)	I
23-28	DB5-0	Data bus (R5~G0; RGB-18bit Pixel; Note 2)	I
29	NC (SDA)	Connection (serial data input/output pin)	I
30	RD	Read strobe signal. Read out data when RDX is Low.	I
31	WR (SCL)	Write data when WRX is Low.(serial clock input pin)	I
32	D/C	register select	I
33	CS (NCS)	Chip select signal (serial chip select input pin)	I
34	IOVCC	Power supply (TYP:1.8V/2.8V).	P
35	VCI	Power supply(TYP:2.8V).	P
36	GND	Ground	P
37	NC	No connection	
38	NC	No connection	
39	NC	No connection	
40	NC	No connection	

Note 1:

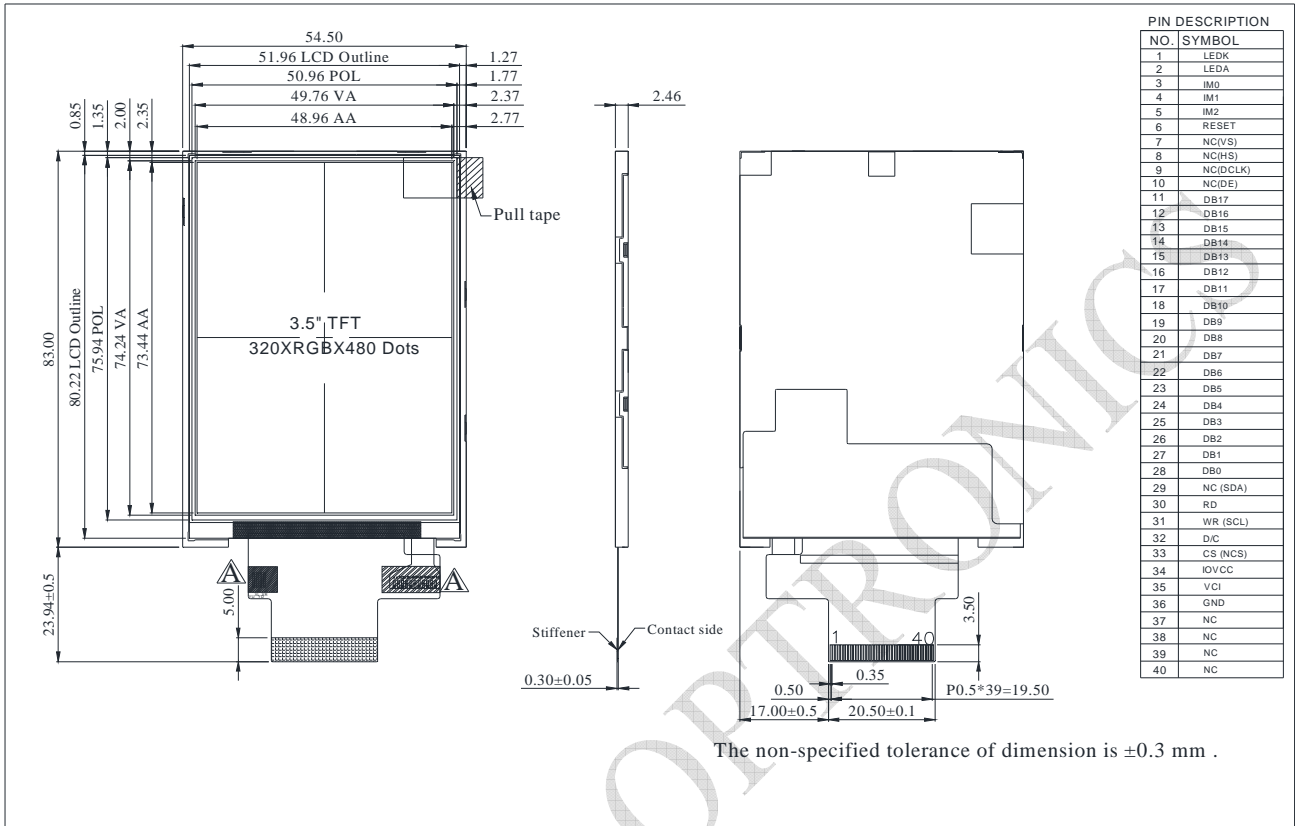
IM2	IM1	IM0	MPU Interface	GRAM
0	0	0	8080 MCU 18-bit bus	D[17:0]
0	1	0	8080 MCU 16-bit bus	D[15:0]
0	1	1	8080 MCU 8-bit bus	D[7:0]
1	0	1	3-Line SPI	SDA,SCL,NCS
1	0	1	RGB interface+3-SPI	D[17:0] (RGB-18bit/Pixel) D[15:0] (RGB-16bit/Pixel)

Note 2:

This module suggests function is for 8080 MCU mode, if this module wants change to use RGB Interface mode, please setting external pin IM [2:0] as 101 (3-SPI Initial code setting RGB-18bit/Pixel or RGB-16bit/Pixel),and reference the **7.5. RGB Interface Selection**

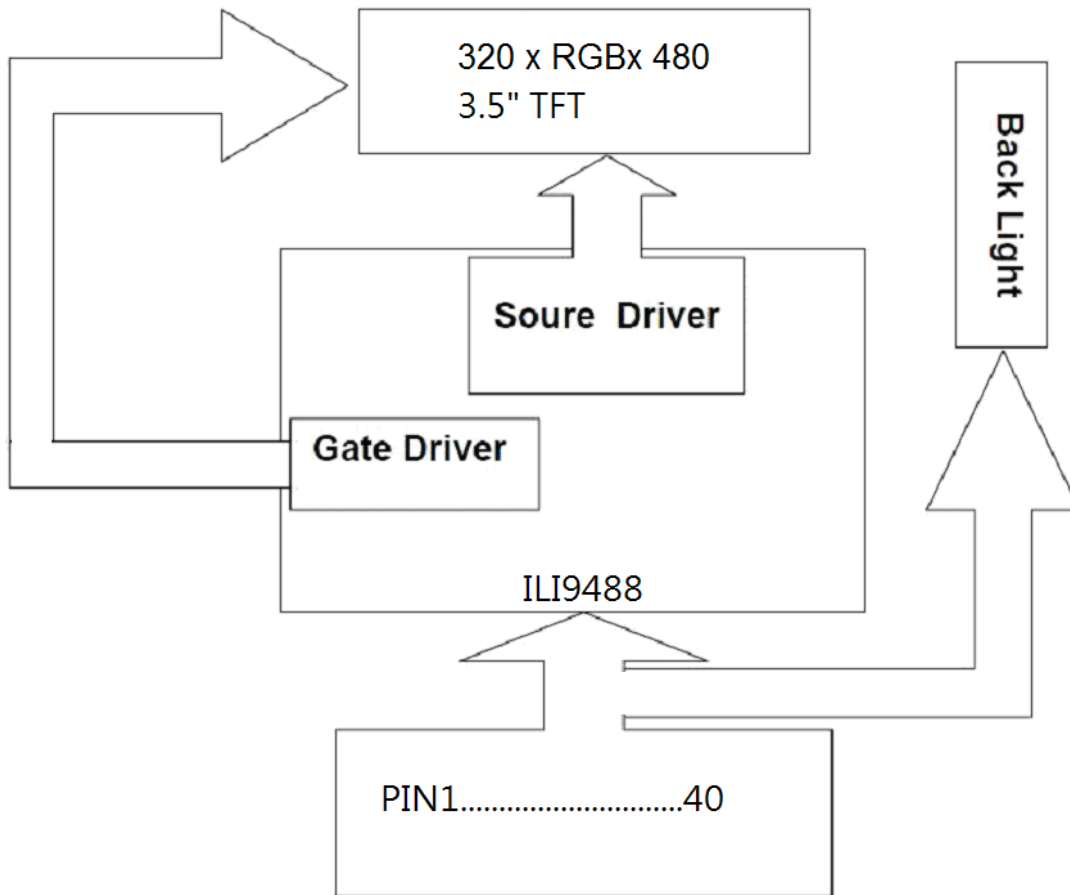
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5. Contour Drawing



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6. Block Diagram



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7. Absolute Maximum Ratings

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

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

- Temp. $\leq 60^{\circ}\text{C}$, 90% RH MAX. Temp. $> 60^{\circ}\text{C}$, Absolute humidity shall be less than 90% RH at 60°C

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8. Electrical Characteristics

8.1. Operating conditions:

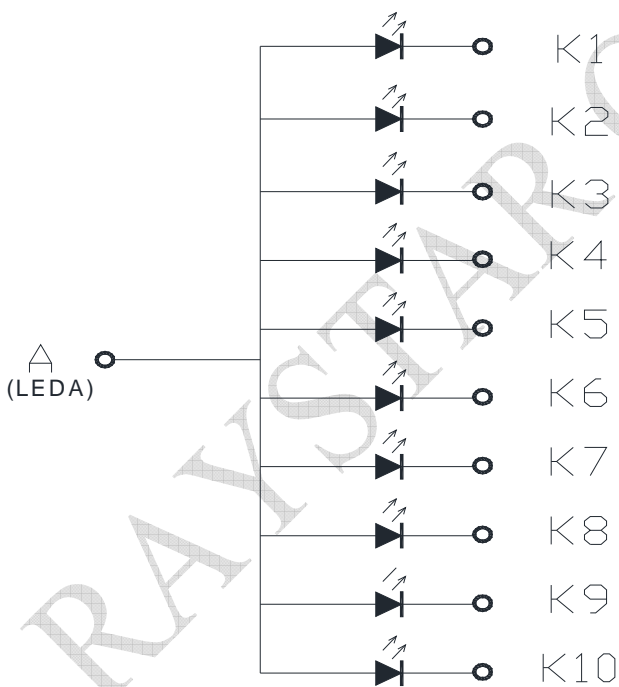
Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage for digital	IOVCC	—	—	1.8/2.8	3.3	V
Supply Voltage for analog	VCI	—	—	2.8	3.3	V
Power Supply for Current	ICC	IOVCC=VCI =VCC=3.3V	—	13.6	—	mA

8.2. LED driving conditions

Parameter	Symbol	Min	Typ	Max	Unit	Remark
LED current	—	—	160	—	mA	—
LED voltage	LEDA	2.6	3.0	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 connector to LEDK)

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

9.DC CHARATERISTICS

Parameter	Symbol	Rating			Unit	Condition
		Min	Typ	Max		
Low level input voltage	V_{IL}	0	-	0.2VCC	V	
High level input voltage	V_{IH}	0.8VCC	-	VCC	V	

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10.AC CHARATERISTICS

10.1. DBI Type C Option 1 (3-Line Serial Interface)

The 3-line/9-bit serial bus interface of the ILI9488 can be used by setting external pin IM [2:0] as 101. Figure 1 describes an interface with 8080 MCU system interface.

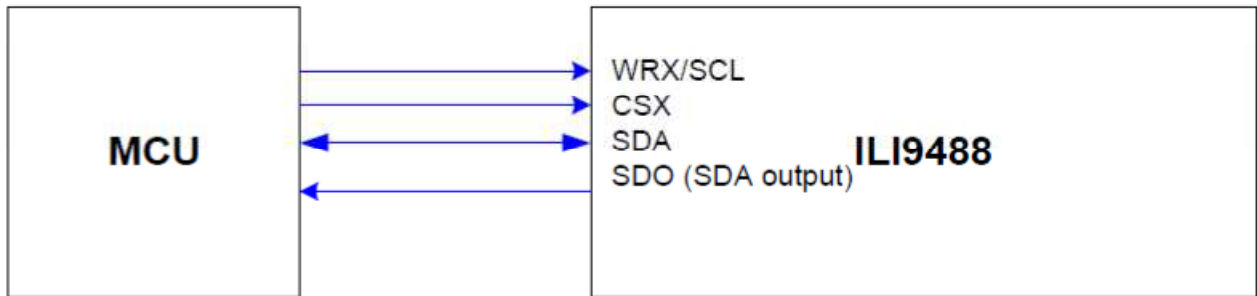


Figure 1: 3-Line Serial Interface

The available display data formats are:

*8 colors, RGB 1, 1, 1 bits input (set Standard Command 3Ah, DBI [2:0] as 001)

*262K-Colors, RGB 6, 6, 6 bits input data (set Standard Command 3Ah, DBI [2:0] as 110)

10.1.1 SPI Data for 3-bit/pixel (RGB 1-1-1 Bits Input), 8-color

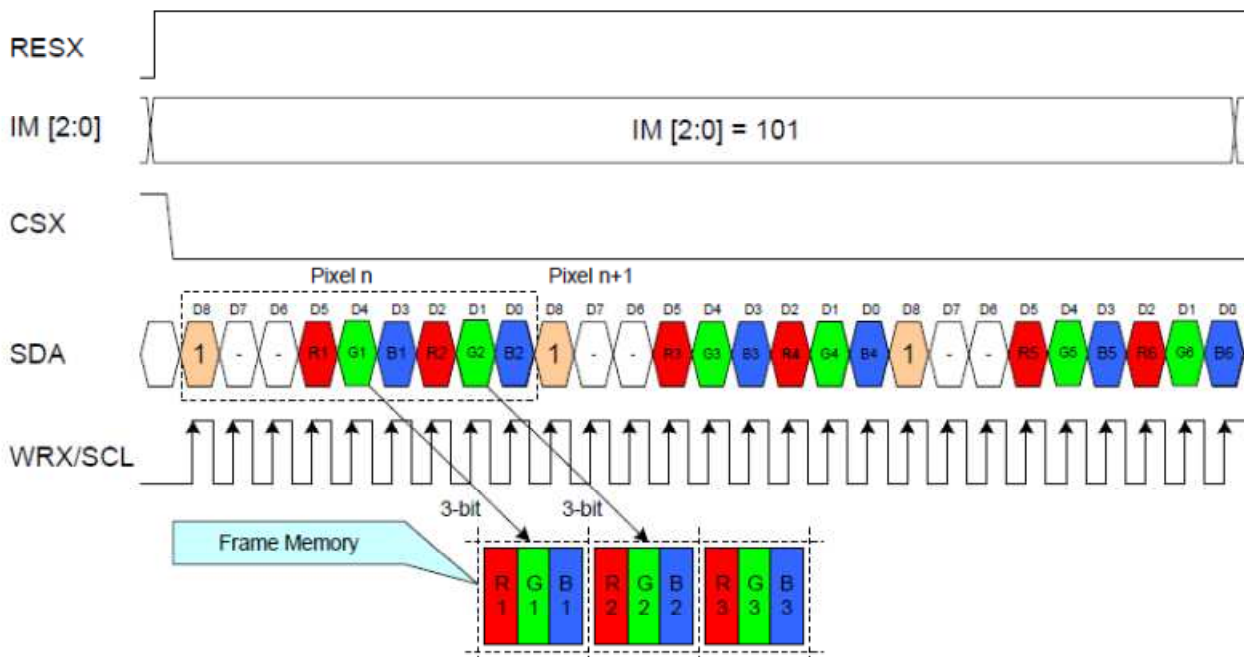


Figure 2: SPI Data for 3 bit/pixel (RGB 1-1-1 Bits Input), 8-color

Notes:

1. One pixel data contains 3-bit color depth information.

10.1.2. SPI Data for 18-bit/pixel (RGB 6-6-6 Bits Input), 262K-color

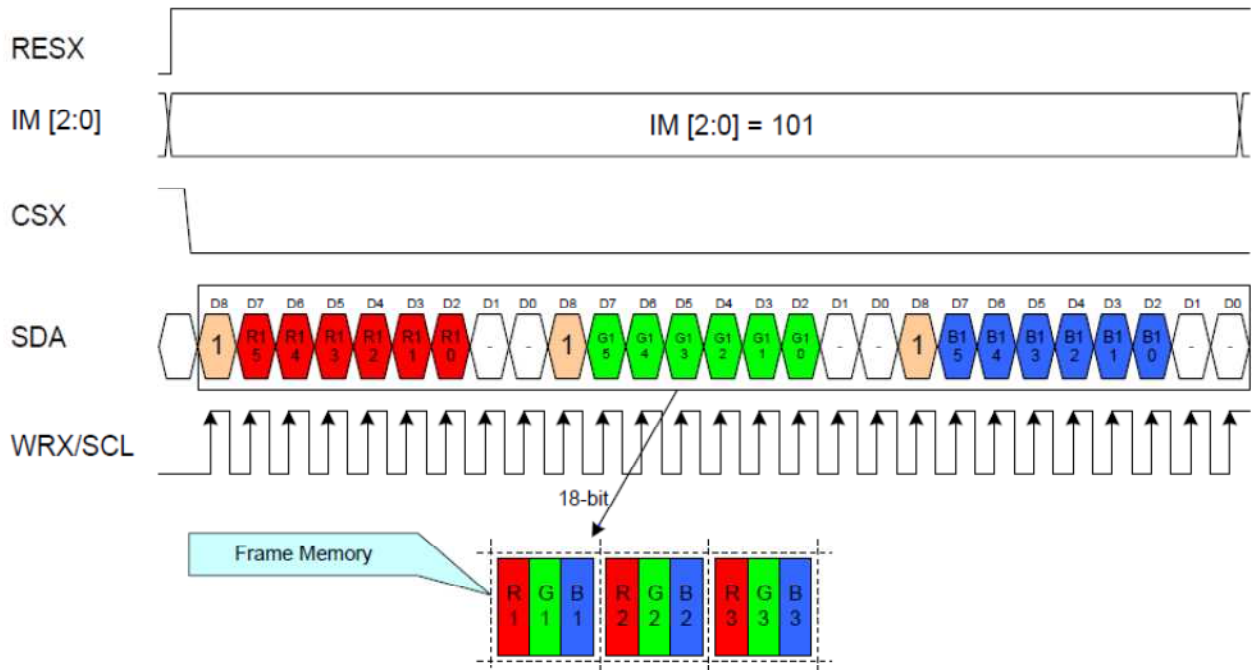


Figure 3: SPI Data for 18-bit/pixel (RGB 6-6-6 Bits Input), 262K-color

Notes:

1. One pixel data contains 18-bit color depth information.
2. The most significant bits are: R x 5, G x 5, and B x 5.
3. The least significant bits are: R x 0, G x 0, and B x 0.

Read data through 3-line SPI mode

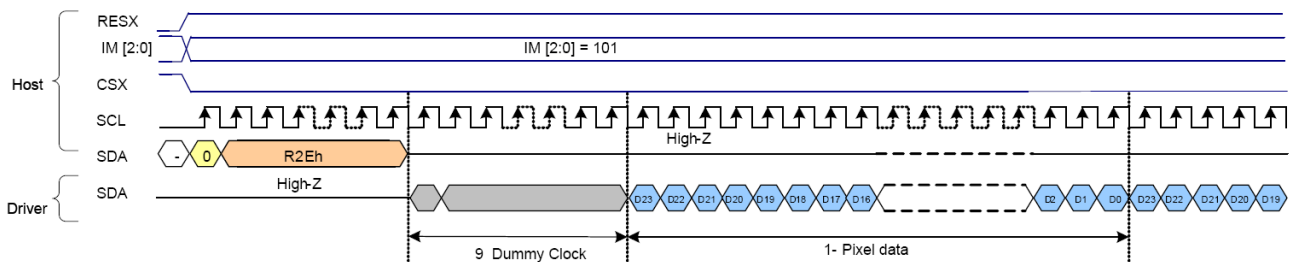


Figure 4: 3-Line SPI Mode Read Data

Note: „-“ = void

10.2. 8-bit Parallel MCU Interface

The DBI TYPE B 8-bit parallel bus interface of the ILI9488 is used by setting the external pin IM [2:0] as 011. Figure 5 shows this system interface.

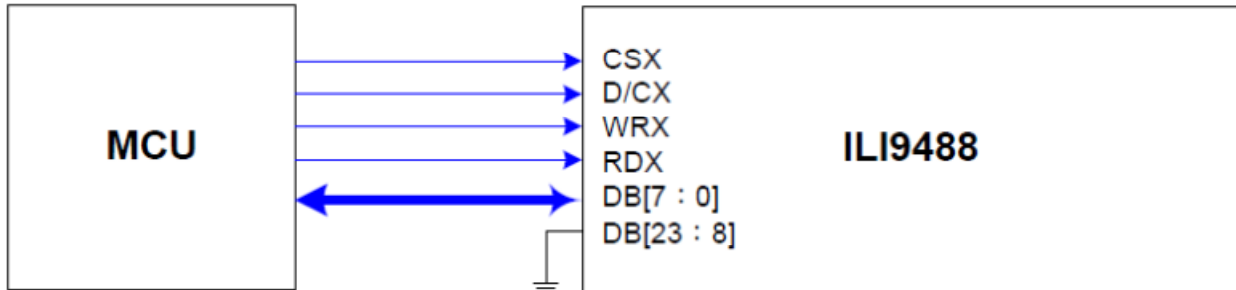


Figure 5: 8-bit Parallel MCU Interface

The available display data formats are:

*65K-Colors, RGB 5, 6, 5 bits input data (set Standard Command 3Ah, DBI [2:0] as 101)

*262K-Colors, RGB 6, 6, 6 bits input data (set Standard Command 3Ah, DBI [2:0] as 110)

10.2.1. 8-bit Data Bus for 16-bit/pixel (RGB 5-6-5 Bits Input), 65K-color

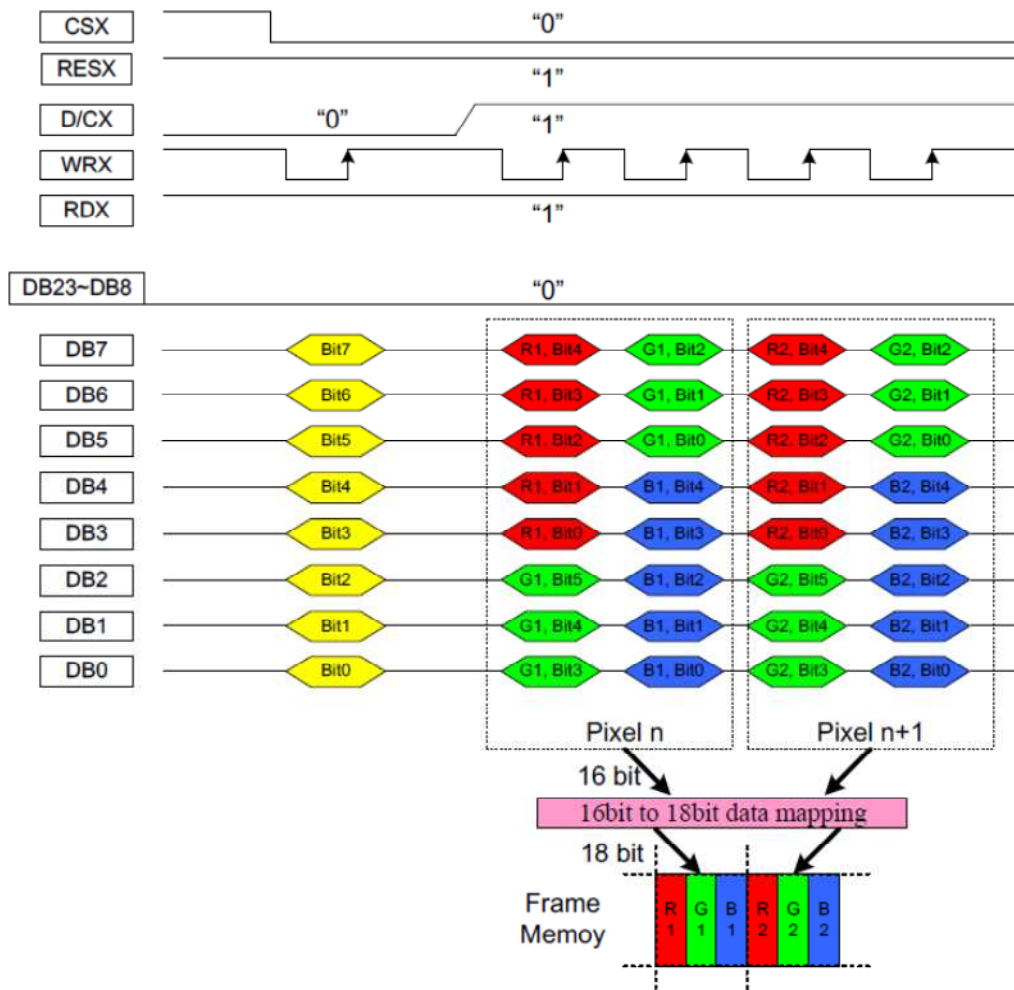


Figure 6: 8-bit Data Bus for 16-bit/pixel (RGB 6-5-6 Bits Input), 65K-color

Notes:

1. The data order is as follows: MSB = DB7, LSB = DB0, and picture data is MSB = Bit 5, LSB = Bit 0 for Green data, and MSB = Bit 4, LSB = Bit 0 for Red and Blue data.
2. 2-times transfer is used to transmit 1 pixel data to the 16-bit color depth information.

10.2.2. 8-bit Data Bus for 18-bit/pixel (RGB 6-6-6 Bits Input), 262K-color

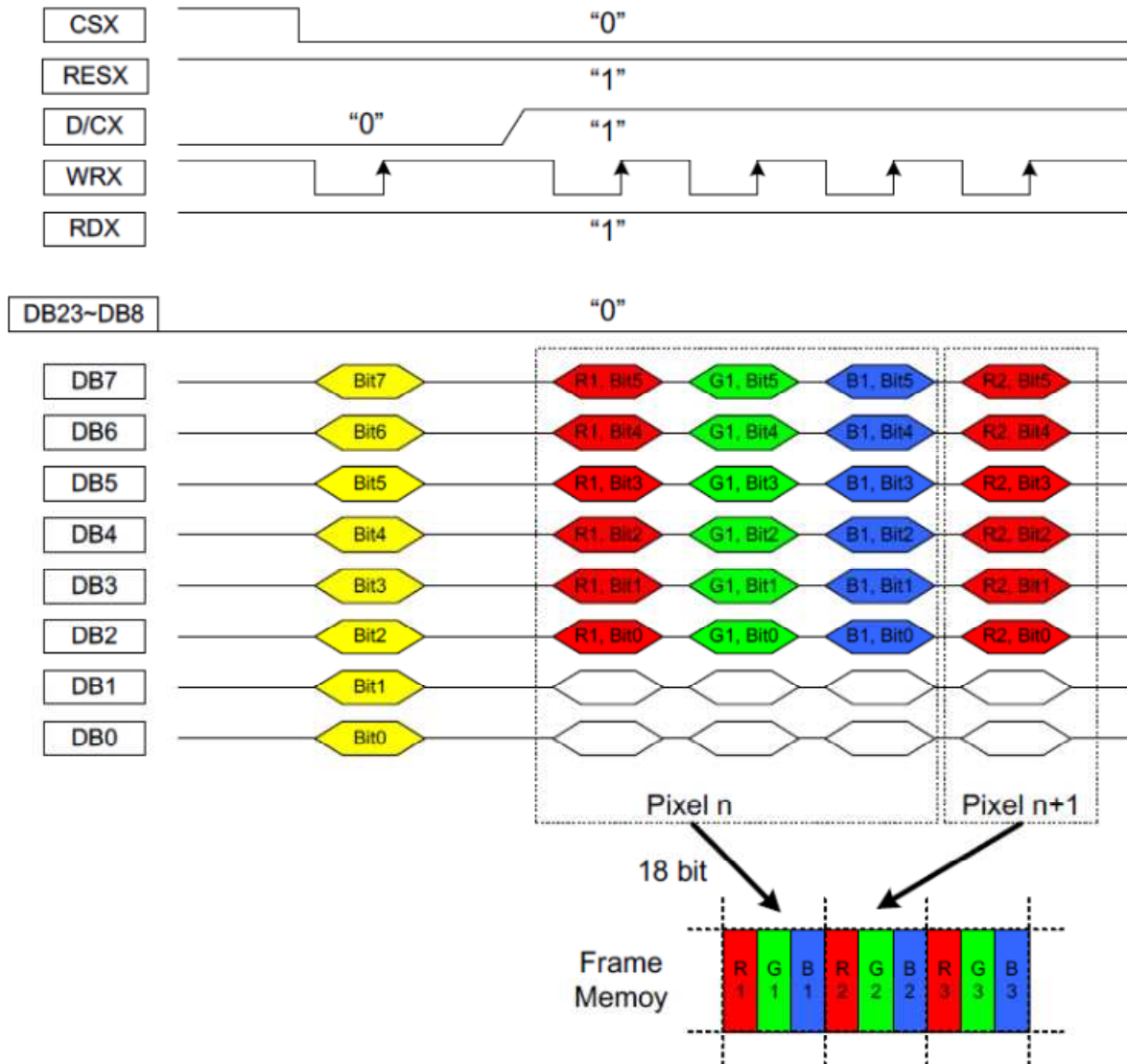


Figure 7: 8-bit Data Bus for 18-bit/pixel (RGB 6-6-6 Bits Input), 262K-color

Notes:

1. The data order is as follows: MSB = DB7, LSB = DB0, and picture data is MSB = Bit 5, LSB = Bit 0 for Green, Red and Blue data.
2. 3-times transfer is used to transmit 1 pixel data to the 18-bit color depth information.

10.3. 16-bit Parallel MCU Interface

The 8080-system 16-bit parallel bus interface of the ILI9488 can be used by setting external pin IM [2:0] as 010.

Figure 8 shows this system interface.

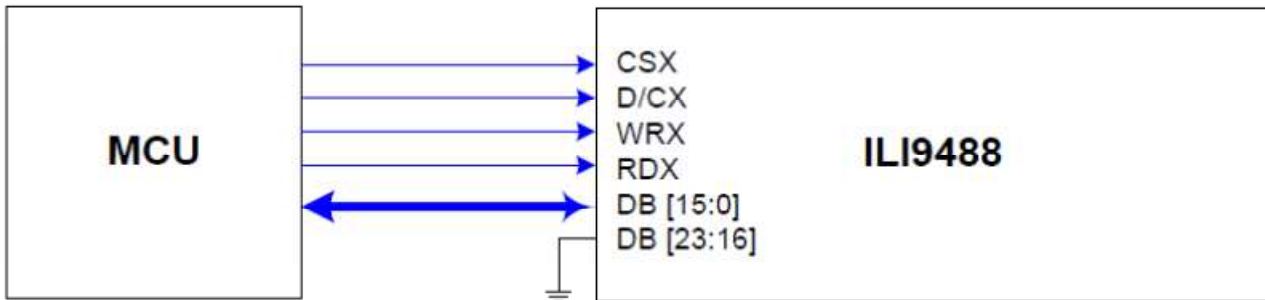


Figure 8: 16-bit Parallel MCU Interface

The available display data formats are:

65K-Colors, RGB 5, 6, 5 bits input data (set Standard Command 3Ah, DBI [2:0] as 101)

262K-Colors, RGB 6, 6, 6 bits input data (set Standard Command 3Ah, DBI [2:0] as 110)

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10.3.1 16-bit Data Bus for 16-bit/pixel (RGB 5-6-5 Bits Input), 65K-color

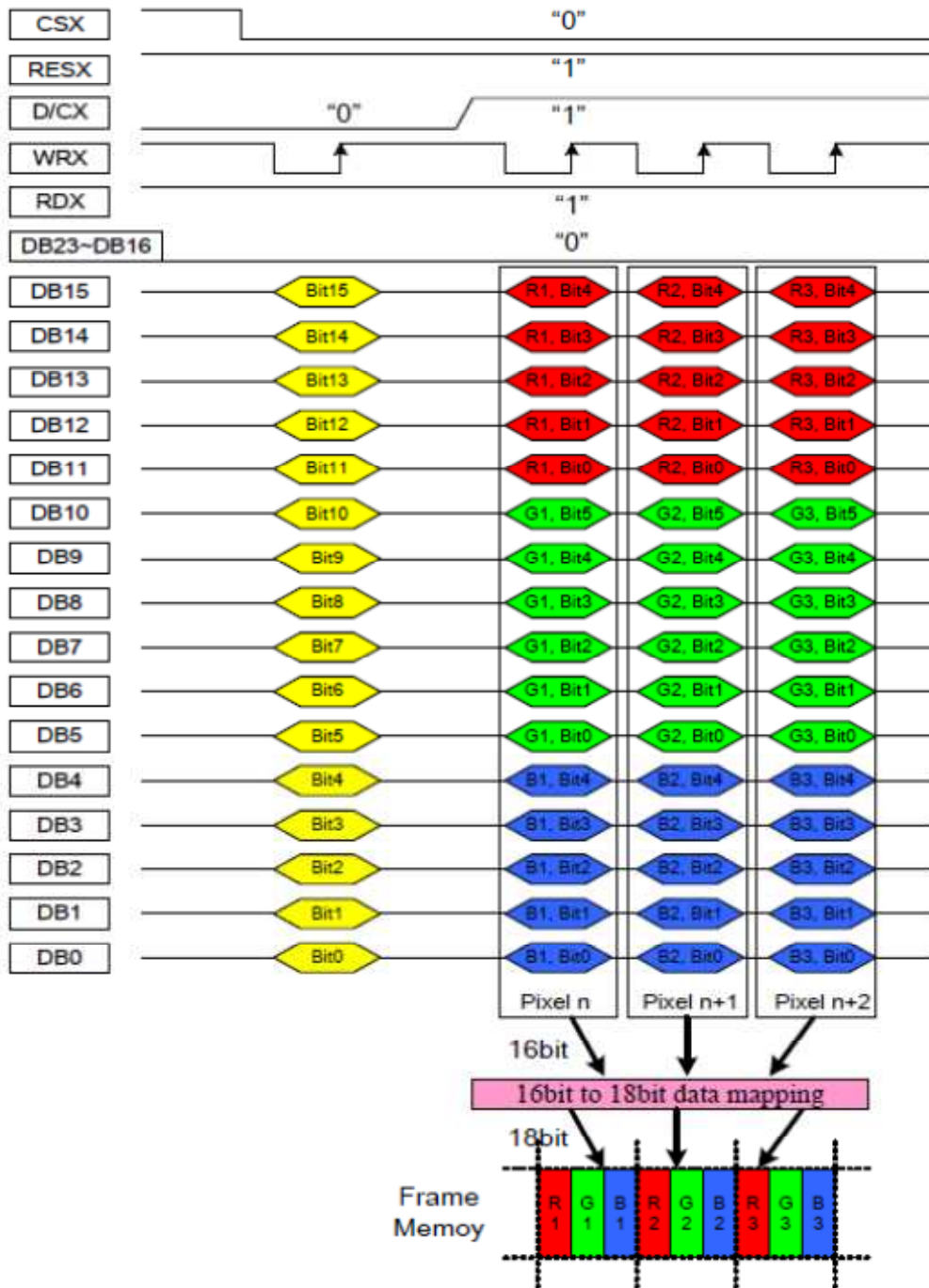


Figure 9: 16-bit Data Bus for 16-bit/pixel (RGB 5-6-5 Bits Input), 65K-color

Notes:

1. The data order is as follows: MSB = DB15, LSB = DB0, and picture data is MSB = Bit 5, LSB = Bit 0 for Green data, and MSB = Bit 4, LSB = Bit0 for Red and Blue data.
2. 1-time transfer is used to transmit 1 pixel data to the 16-bit color depth information.

10.3.2 16-bit Data Bus for 18-bit/pixel (RGB 6-6-6 Bits Input), 262K-color

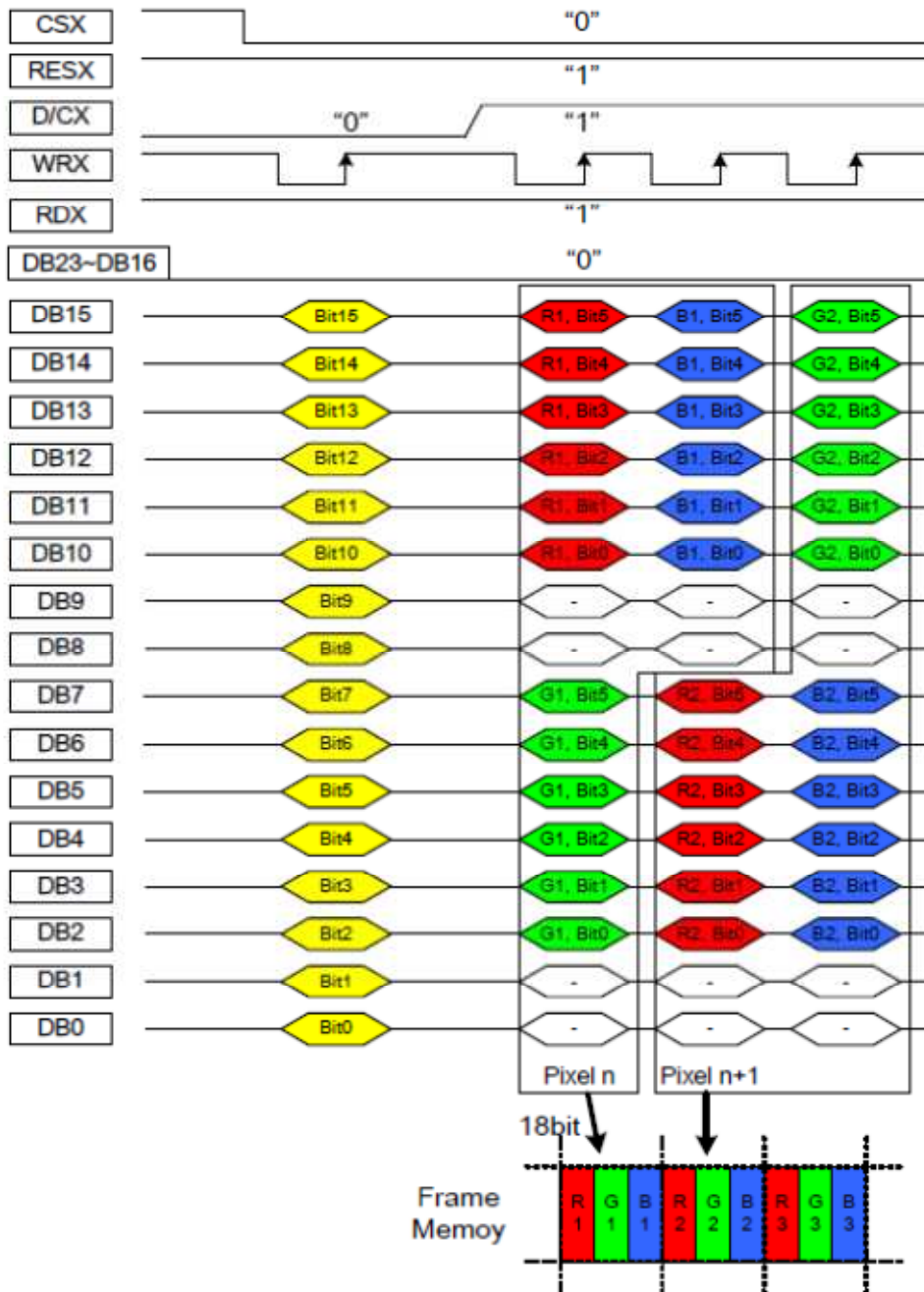


Figure 10: 16-bit Data Bus for 18-bit/pixel (RGB 6-6-6 Bits Input), 262K-color

Notes:

1. The data order is as follows: MSB = DB15, LSB = DB0, and picture data is MSB = Bit 5, LSB = Bit 0 for Green, Red and Blue data.
2. 3-times transfer is used to transmit 2 pixel data to the 18-bit color depth information.

10.4. 18-bit Parallel MCU Interface

The 8080-system 18-bit parallel bus interface of the ILI9488 can be used by setting external pin IM [2:0] as 000.

Figure 11 shows this system interface.

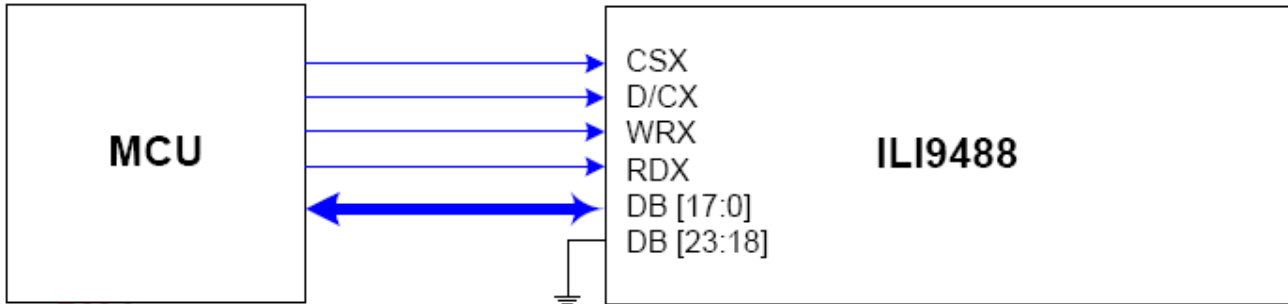


Figure 11: 18-bit Parallel MCU Interface

The available display data formats is:

262K-Colors, RGB 6, 6, 6 bits input data (set Standard Command 3Ah, DBI [2:0] as 110)

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10.4.1 18-bit Data Bus for 18-bit/pixel (RGB 6-6-6 Bits Input), 262K-color

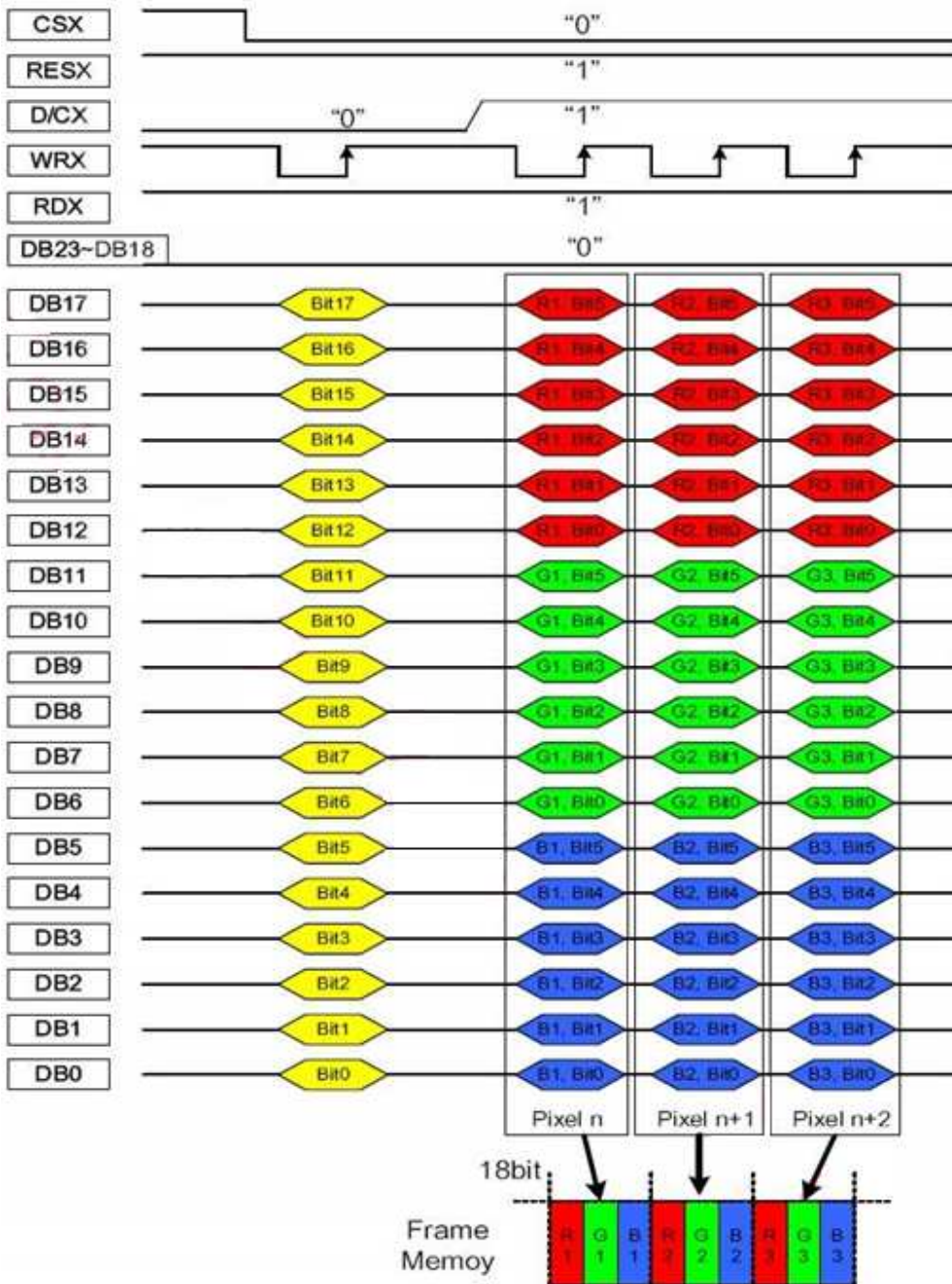


Figure 12: 18-bit Data Bus for 18-bit/pixel (RGB 6-6-6 Bits Input), 262K-color

Notes:

1. The data order is as follows: MSB = DB17, LSB = DB0, and picture data is MSB = Bit 5, LSB = Bit 0 for Green, Red and Blue data.
2. 1-times transfer is used to transmit 1 pixel data to the 18-bit color depth information.

10.5. DPI (RGB Interface)

The DPI can display moving pictures by two ways: rewrite into the GRAM and transmit directly to the shift register. The selection is set by the register BPGRAM (bypass GRAM) and RM bit. The RM bit selects an interface for the access operation of the Frame Memory. For the DPI, RM should be set as 1.

BPGRAM	Display Data Path
1	Direct to shift register
0	Write into Memory
RM	Interface for RAM access
0	System interface
1	RGB interface

The DM bit selects the clock operation mode. It allows switching between display operations in synchronization with the internal oscillation clock. If DM=1, the external DOTCLK cannot be stopped unless it enters the Sleep-In mode.

DM	RGB Interface Operating Clock Selection
0	Internal system clock
1	RGB interface (DOTCLK)

10.5.1 RGB Interface Selection

The DPI can be selected by the RCM bit. When the RCM is set to 0, the DE mode is selected by VSYNC, HSYNC, DOTCLK, ENABLE, and DB[17:0] (or DB[15:0]) pins.

When RCM is set to 1, the SYNC mode is selected by VSYNC, HSYNC, DOTCLK, and DB[17:0] (or DB[15:0]) pins. It supports several pixel formats that can be selected by DPI[2:0] bits in Pixel Format Set (R3Ah) command. The selection of a given interface is done by DPI[2:0], as shown in Table 1 and Figure 13.

Table 1: DPI Interface Selection

RCM	DPI [2:0]			RGB Interface Mode	RGB Mode	Used Pins
0	1	1	0	18-bit RGB interface (262K colors)	DE Mode Valid data is determined by the ENABLE signal.	VSYNC, HSYNC, ENABLE, DOTCLK, DB [17 :0]
0	1	0	1	16-bit RGB interface (65K colors)		VSYNC, HSYNC, ENABLE, DOTCLK, DB [15 :0]
1	1	1	0	18-bit RGB interface (262K colors)	SYNC Mode In the SYNC mode, ENABLE signal is ignored; blanking porch is determined by B5h command.	VSYNC, HSYNC, DOTCLK, DB [17:0]
1	1	0	1	16-bit RGB interface (65K colors)		VSYNC, HSYNC, DOTCLK, DB [15:0]

10.5.2 RGB Interface Timing
DPI Parameters Setting(BYPASS bit = 0)

Parameters	Symbols	Min.	Typ.	Max.	Units
Horizontal Synchronization	H_Low	3	-	H_Low < HBP	DOTCLK
Horizontal Back Porch	HBP	3	-	192	DOTCLK
Horizontal Front Porch	HFP	3	-	255	DOTCLK
Horizontal Address	HACT	-	320	-	DOTCLK
Horizontal Frequency		-	-	33	KHz
Vertical Synchronization	V_Low	1	-	V_Low < VBP	Line
Vertical Back Porch	VBP	2	-	V_Low+VBP+VFP < 32	Line
Vertical Front Porch	VFP	2	-		Line
Vertical Address	VACT	-	480	-	Line
Vertical Frequency		60	-	70	Hz
DOTCLK cycle		100	-	50	ns
DOTCLK Frequency		10	-	20	MHz

DPI Parameters Setting(BYPASS bit = 1)

Parameters	Symbols	Min.	Typ.	Max.	Units
Horizontal Synchronization	H_Low	3	-	H_Low < HBP	DOTCLK
Horizontal Back Porch	HBP	20	-	192	DOTCLK
Horizontal Front Porch	HFP	70	-	255	DOTCLK
Horizontal Address	HACT	-	320	-	DOTCLK
Horizontal Frequency		-	-	33	KHz
Vertical Synchronization	V_Low	1	-	V_Low < VBP	Line
Vertical Back Porch	VBP	2	-	V_Low+VBP+VFP < 32	Line
Vertical Front Porch	VFP	2	-		Line
Vertical Address	VACT	-	480	-	Line
Vertical Frequency		60	-	70	Hz
DOTCLK cycle		83.3	-	50	ns
DOTCLK Frequency		12	-	20	MHz

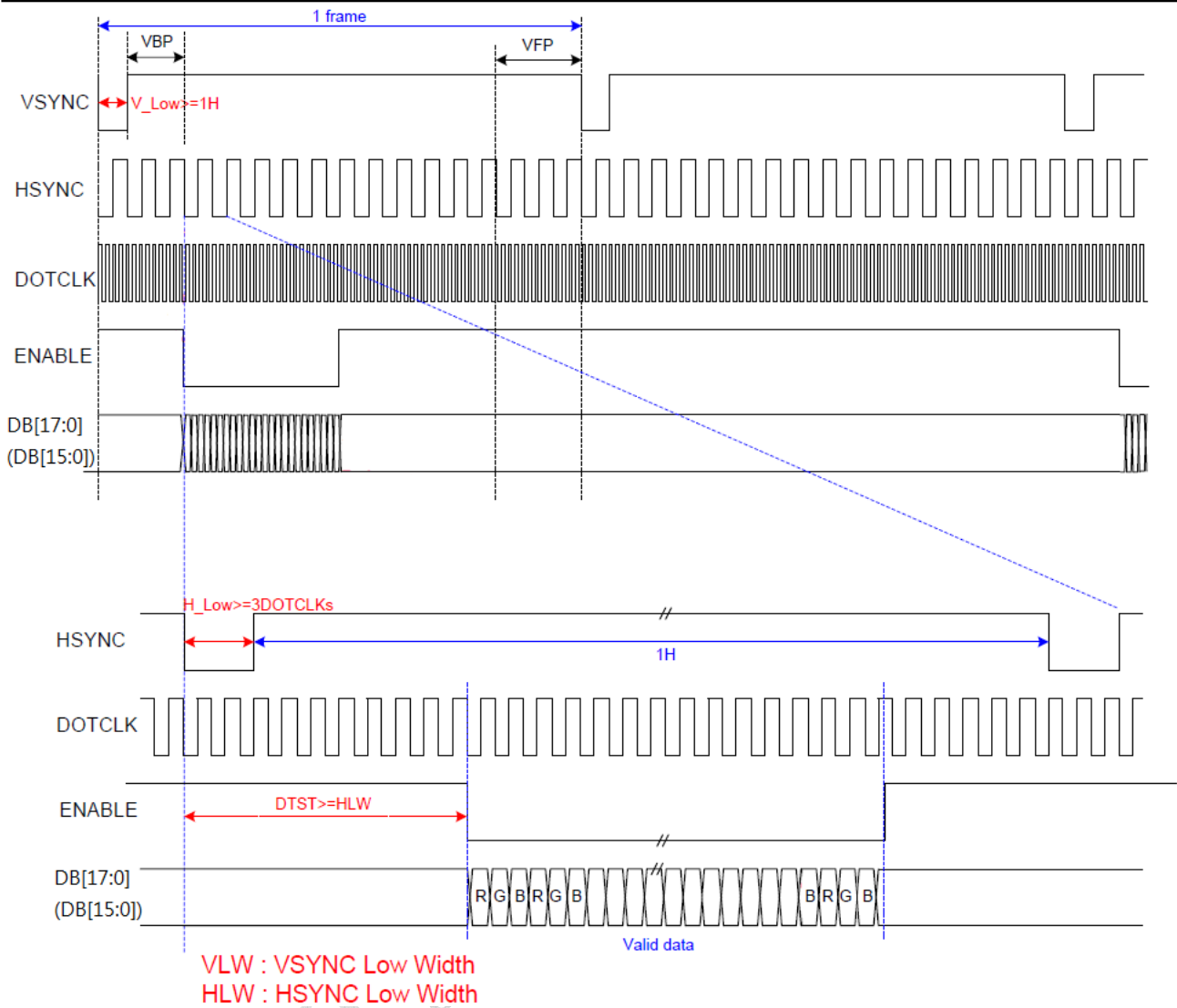


Figure 14: RGB Interface Timing Diagram

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

11. Optical Characteristics

Item	Symbol	Condition.	Min	Typ.	Max.	Unit	Remark	
Response time	T_r	$\theta=0^\circ$ 、 $\Phi=0^\circ$	-	30	-	.ms	Note 3,5	
	T_f							
Contrast ratio	CR	At optimized viewing angle	-	700	-	-	Note 4,5	
Color Chromaticity	White	$\theta=0^\circ$ 、 $\Phi=0^\circ$	0.26	0.31	0.36		Note 2,6,7	
								W_x
Viewing angle	Hor.	$CR \geq 10$	-	80	-	Deg.	Note 1	
								Θ_L
	Ver.							Φ_T
								Φ_B
Brightness	-	-	500	600	-	cd/m2	Center of display	

$T_a=25\pm 2^\circ\text{C}$ (ILED=160mA)

Note 1: Definition of viewing angle range

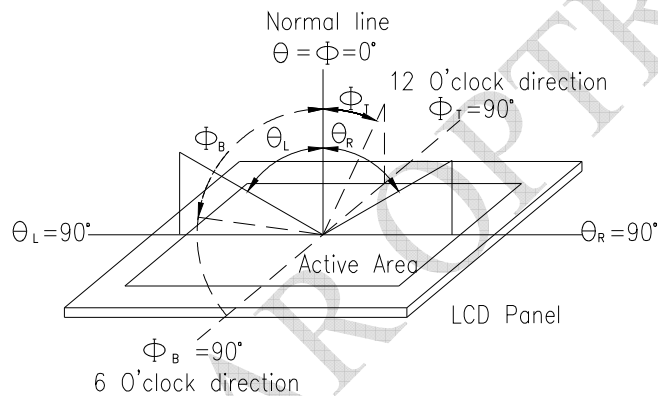


Fig. 11.1. Definition of viewing angle

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.

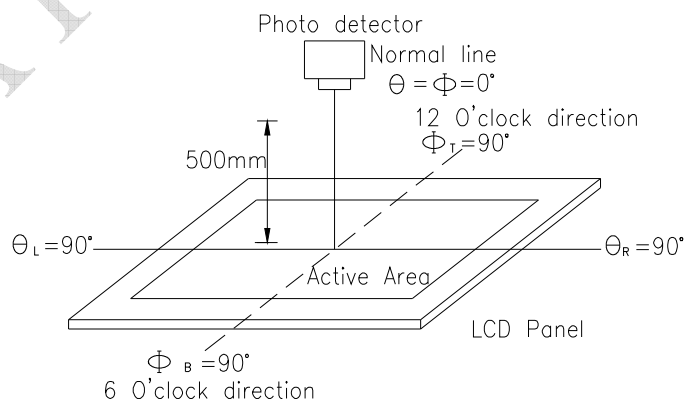
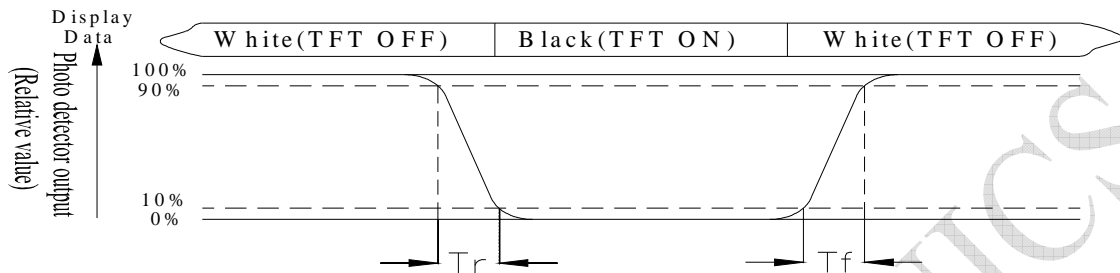


Fig. 11.2. Optical measurement system setup

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, T_r , is the time between photo detector output intensity changed from 90% to 10%. And fall time, T_f , 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: White $V_i = V_{i50} \pm 1.5V$

Black $V_i = V_{i50} \pm 2.0V$

“±” means that the analog input signal swings in phase with VCOM signal.

“±” means that the analog input signal swings out of phase with VCOM signal.

The 100% transmission is defined as the transmission of LCD panel when all the input terminals of module are electrically opened.

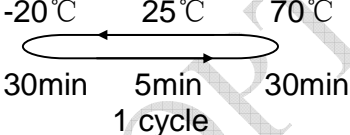
Note 6: Definition of color chromaticity (CIE 1931)

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.

12. Reliability

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

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°C 96hrs	2
Low Temperature storage	Endurance test applying the low storage temperature for a long time.	-30°C 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°C 96hrs	—
Low Temperature Operation	Endurance test applying the electric stress under low temperature for a long time.	-20°C 96hrs	1
High Temperature/ Humidity Operation	The module should be allowed to stand at 40°C, 90%RH max	40°C, 90%RH 96hrs	1,2
Thermal shock resistance	The sample should be allowed stand the following 10 cycles of operation <div style="text-align: center;">  </div>	-20°C/70°C 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.

LCM Sample Estimate Feedback Sheet

Module Number : _____

1 、 Panel Specification :

1. Panel Type :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
2. View Direction :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
3. Numbers of Dots :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
4. View Area :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
5. Active Area :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
6. Operating Temperature :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
7. Storage Temperature :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
8. Others :	_____	

2 、 Mechanical Specification :

1. PCB Size :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
2. Frame Size :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
3. Material of Frame :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
4. Connector Position :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
5. Fix Hole Position :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
6. Backlight Position :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
7. Thickness of PCB :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
8. Height of Frame to PCB :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
9. Height of Module :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
10. Others :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____

3 、 Relative Hole Size :

1. Pitch of Connector :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
2. Hole size of Connector :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
3. Mounting Hole size :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
4. Mounting Hole Type :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
5. Others :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____

4 、 Backlight Specification :

1. B/L Type :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
2. B/L Color :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
3. B/L Driving Voltage (Reference for LED Type) :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
4. B/L Driving Current :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
5. Brightness of B/L :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
6. B/L Solder Method :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
7. Others :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____

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Module Number : _____		
5 · <u>Electronic Characteristics of Module</u> :		
1.Input Voltage :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
2.Supply Current :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
3.Driving Voltage for LCD :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
4.Contrast for LCD :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
5.B/L Driving Method :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
6.Negative Voltage Output :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
7.Interface Function :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
8.LCD Uniformity :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
9.ESD test :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
10.Others :	<input type="checkbox"/> Pass	<input type="checkbox"/> NG , _____
6 · <u>Summary</u> :		
<p style="text-align: right;">Sales signature : _____</p> <p style="text-align: right;">Customer Signature : _____ <u>Date</u> : / /</p>		