晶采光電科技股份有限公司
AMPIRE CO., LTD.

SPECIFICATIONS FOR LCD MODULE

CUSTOMER	
CUSTOMER PART NO.	
AMPIRE PART NO.	**AM-480640BTZQW-00**
APPROVED BY	
DATE	

☑ **Approved For Specifications**
☐ **Approved For Specifications & Sample**

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RECORD OF REVISION

Revision Date	Page	Contents	Editor
2016/05/16	-	New Release	Mark
2016/06/06	4	Modify the ABSOLUTE MAXIMUM RATINGS Temperature	Mark
2016/06/07	11	Add Luminance uniformity	Mark

1. PHYSICAL SPECIFICATIONS

Item	Specifications	Remark
LCD size	3.5 inch(Diagonal)	
Driver IC	HX8363A	
Display resolution	480 (W) × 3(RGB) x 640(H) dots	
Interface	SPI + 18BIT RGB Interface	
Pixel pitch	0.0372 x0.1116 mm	
Active area	53.568 (W) x 71.424 (H) mm	
Module size	75.9 (W) x 95.6 (H) × 7.25 (D) mm	
Display Mode	AIFF/Transmissive/Normally Black	
Color arrangement	RGB vertical stripe	
Viewing Direction	Wide viewing	
Luminance	500	
Weight	TBD	

2. ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min.	Max.	Unit
Supply Voltage	VCC	-0.3	4.6	V
Operating Temperature	T_{OP}	-10	60	°C
Storage Temperature	T_{ST}	-20	70	°C
Storage Humidity	HD	20	90	%RH

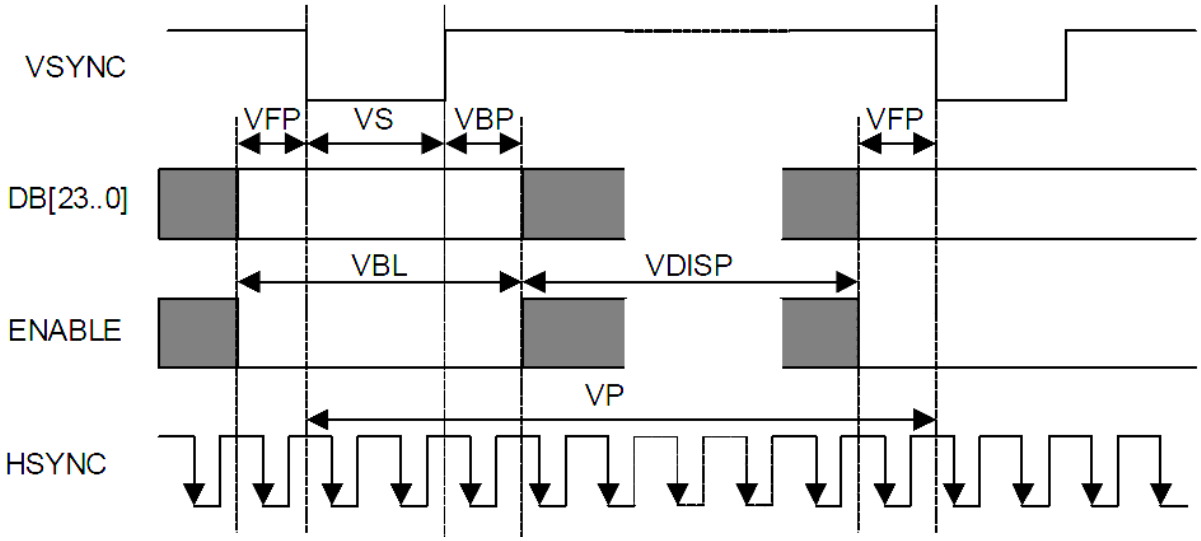
3. DC Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Supply Voltage	VCC	2.3	-	3.3	V	-
Input High Voltage	V_{IH}	0.7VCC	-	VCC	V	Digital input pins
Input Low Voltage	V_{IL}	GND	-	0.3VCC	V	Digital input pins
Output High Voltage	V_{OH}	0.8VCC	-	VCC	V	I_{OH}=-0.1mA
Output Low Voltage	V_{OL}	GND	-	0.2VCC	V	I_{OH}=-0.1mA
I/O Leak Current	ILI	-1	-	1	uA	-

4. Timing Characteristics

4.1 RGB Interface Timing Characteristics

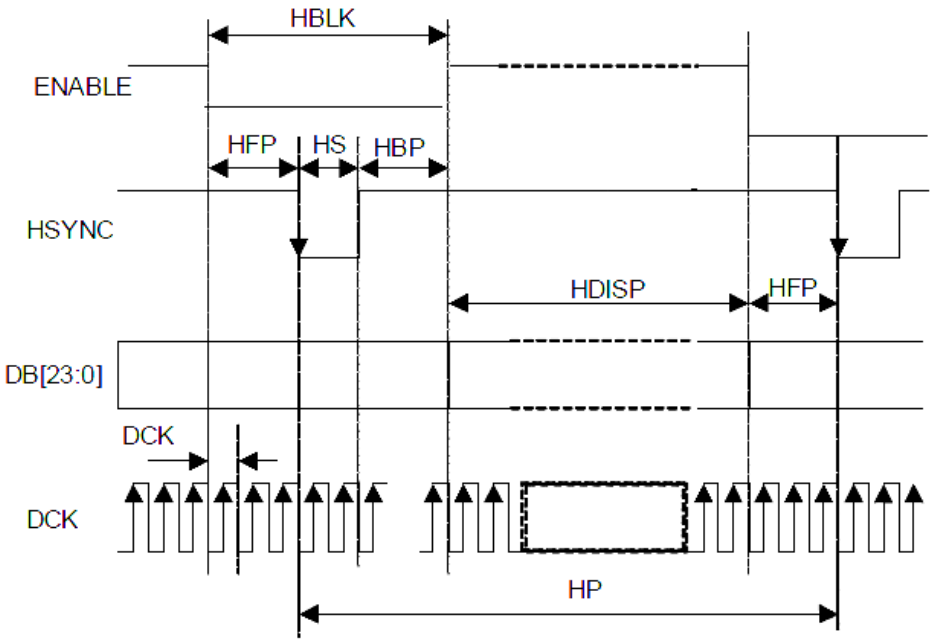
Vertical Timings for RGB I/F



Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Vertical cycle	VP	-	**646**	-	**650**	Line
Vertical low pulse width	VS	-	2	-	4	Line
Vertical front porch	VFP	-	2	-	4	Line
Vertical back porch	VBP	-	2	-	4	Line
Vertical data start point	-	VS+VBP	4	-	8	Line
Vertical blanking period	VBL	VS+VBP+VFP	6	-	10	Line
Vertical active area	-	VDISP	-	**640**	-	Line
Vertical Refresh rate	VRR	-	50	-	70	Hz

Note: (1) Signal rise and fall times are equal to or less than 20 ns.
(2) Input signals are measured by 0.30 x VDD1 for low state and 0.70 x VDD1 for high state.
(3) Data lines can be set to "High" or "Low" during blanking time – Don't care.
(4) VRR must keep from 50Hz to 70Hz when adjust other items

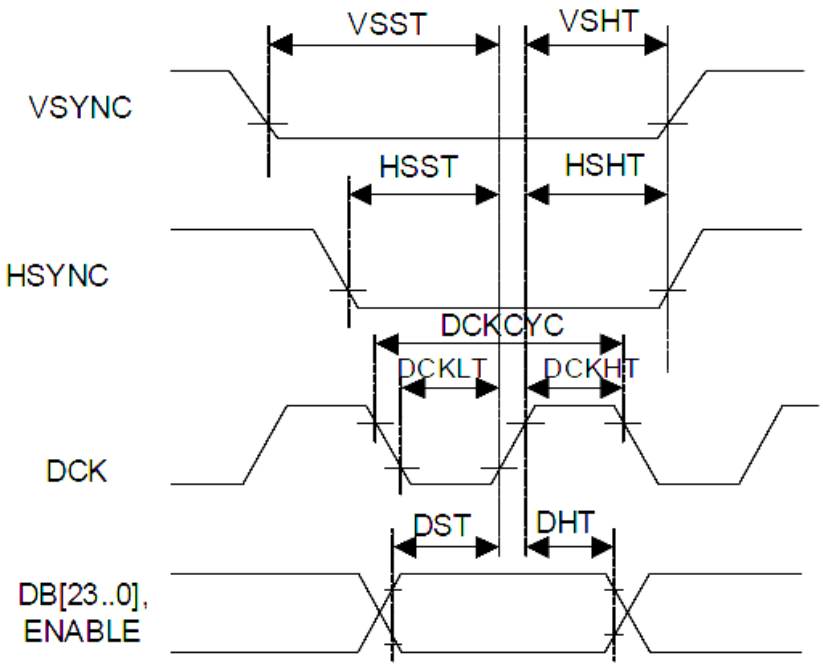
Horizontal Timings for RGB I/F



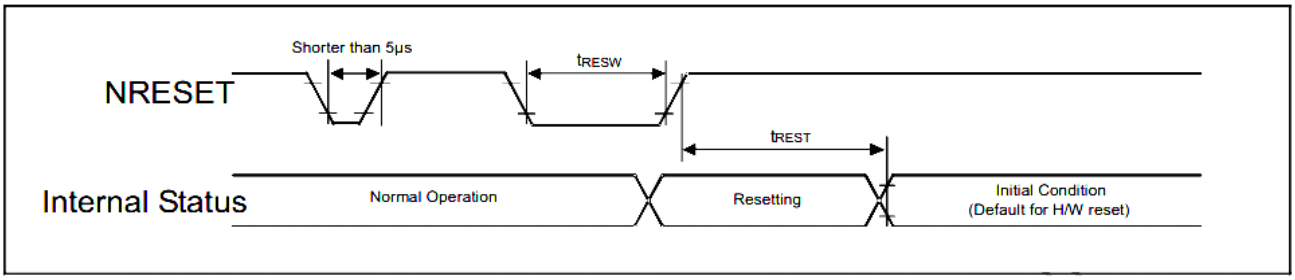
Item	Symbol	Condition	Min.	Typ.	Max.	Unit
HS cycle	HP	Note 3	504	-	568	DCK
HS low pulse width	HS	-	5	-	78	DCK
Horizontal back porch	HBP	-	5	-	78	DCK
Horizontal front porch	HFP	-	5	-	78	DCK
Horizontal data start point	-	HS+HBP	19	-	83	DCK
			700	-	-	ns
Horizontal blanking period	HBLK	HS+HBP+HFP	24	-	88	DCK
Horizontal active area	HDISP	-	-	480	-	DCK
Pixel clock frequency When RGB I/F is running	DCK	VRR = Min. 50 Hz – Max. 70 Hz	21.6	-	34.3	MHz
			29.1	-	46.2	ns

Note: (1) Signal rise and fall times are equal to or less than 20 ns.
(2) Input signals are measured by 0.30 x VDD1 for low state and 0.70 x VDD1 for high state.
(3) HP is multiples of eight DCK.
(4)Data lines can be set to "High" or "Low" during blanking time – Don't care.
(5) DCK must keep from 21.6Hz to 34.3Hz when adjust other items.

General Timings for RGB I/F



4.2 Reset Timing Characteristics

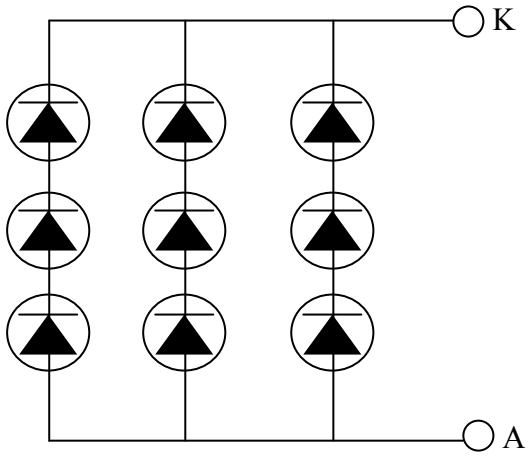


Symbol	Parameter	Related pins	Min.	Typ.	Max.	Note	Unit
t_{RESW}	Reset low pulse width[1]	NRESET	10	-	-	-	µs
t_{REST}	Reset complete time[2]	-	5	-	-	When reset is applied during Sleep In mode	ms
		-	120	-	-	When reset is applied during Sleep Out mode	ms

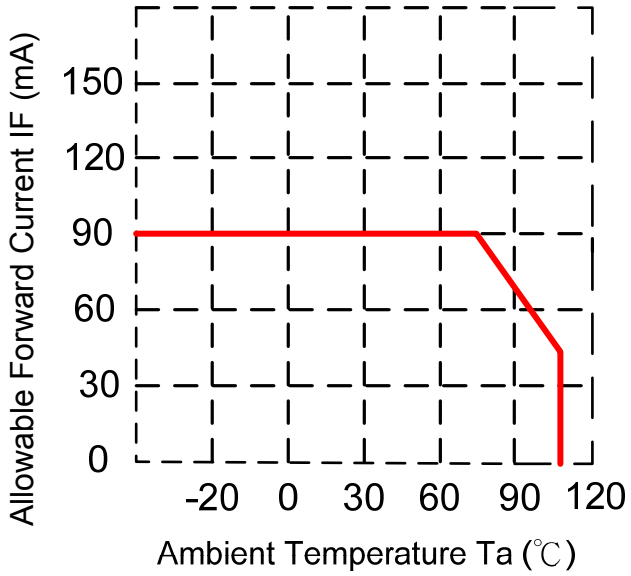
5. Backlight Unit

Item	Symbol	Min.	Typ.	Max.	Unit	Note
LED voltage	VAK	--	9.6	10.4	V	I_{LED} =90mA Ta=25℃
LED current	ILED	--	90	--	mA	Ta=25℃
LED Life Time	-	--	50K	--	Hour	Note (1)
Luminance uniformity	-	--	80	-	%	Note (2)

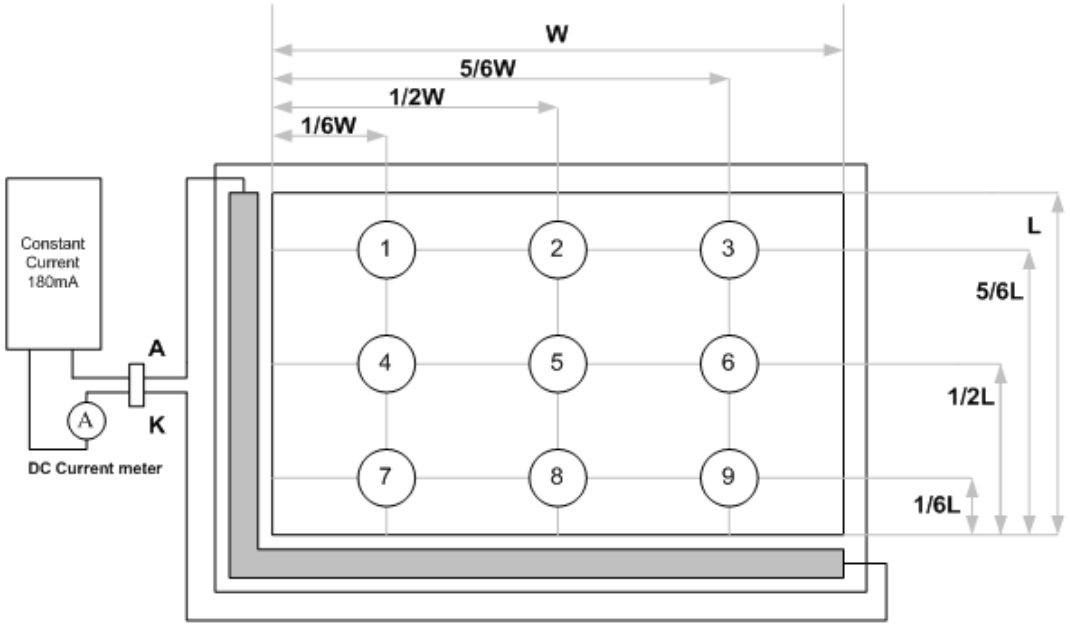
Note (1) Brightness to be decreased to 50% of the initial value.



LED Light Bar Circuit



Note (2): Luminance is measured at point 5 of the display.



Note 6: Definition of Luminance Uniformity

ΔL = [L (min.) of 9 points / L (max.) of 9 points] X 100%

6. Interface

PIN NO.	PIN NAME	DESCRIPTION
1	DE	Display enable signal for RGB interface operation
2	GND	Ground
3	GND	Ground
4	GND	Ground
5	NC	Not connected
6	R0	Data Bus.
7	R1	
8	R2	
9	R3	
10	R4	
11	R5	
12	G0	
13	G1	
14	G2	
15	G3	
16	G4	
17	G5	
18	B0	
19	B1	
20	B2	
21	B3	
22	B4	
23	B5	
24	SCL	Clock input pin in serial mode
25	SDA	Data pin in serial mode
26	/CS	Chip select signal.
27	DOTCLK	Dot clock signal
28	/RESET	Reset pin
29	HSYNC	Line synchronization signal
30	VSYNC	Frame synchronization signal
31	VCC	Power supply
32	VCC	Power supply
33	GND	Ground
34	LEDA	Power supply for backlight anode input terminals.
35	LEDK	Power supply for backlight cathode input terminals.
36	GND	Ground
37	XR	Option for RTP Signal (Default No Connection)
38	YD	
39	XL	
40	YU	

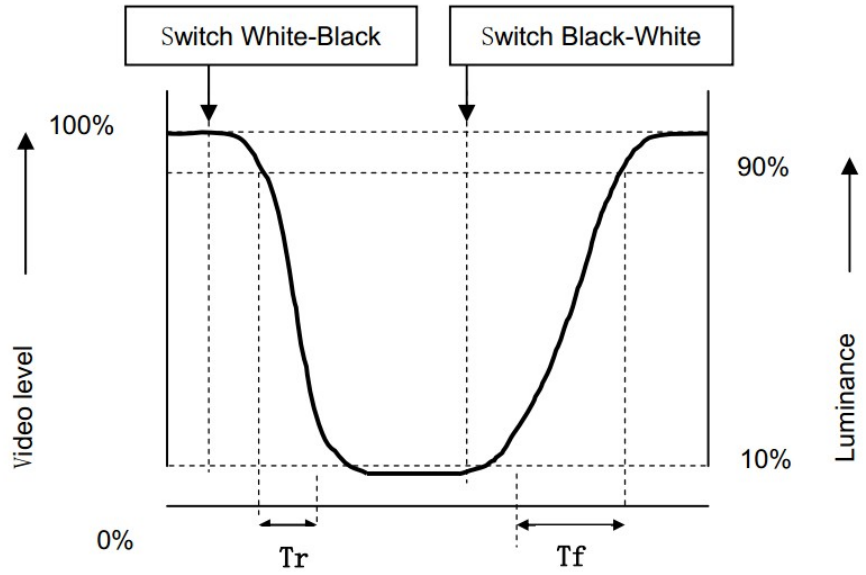
7. Optical Specifications

Item		Symbol	Specifications			Unit	Note
			Min.	Typ.	Max.		
Contrast ratio		Cr (Θ=0°)	-	300	-		Note1
Response time (25℃)		$T_{r+}T_f$	-	30	50	ms	
Viewing angle (Cr≥ 10)*		Θ21	60	80	-	deg	
		Θ22	60	80	-		
		Θ12	60	80	-		
		Θ11	60	80	-		
Chromaticity of LCM	Red	x	-0.05	0.643	+0.05		Chromaticity measuring machine: CFT-01. **Reference Only**
		y		0.333			
	Green	x		0.304			
		y		0.578			
	Blue	x		0.141			
		y		0.137			
	White	x		0.314			
		y		0.346			
Color gamut of CF (NTSC%)		S		58.2		%	
Luminance		L	400	500	-	Cd/m2	
Luminance uniformity		-	-	80	-	%	

7.3 Definitions and measuring methods

[1] Response Time(Tr、Tf)

The rise time 'Tr' is defined as the time for luminance to change from 90% to 10% as a result of a change of the electrical condition. The fall time 'Tf' is defined as the time for luminance to change from 10% to 90% as a result of a change of the electrical condition.

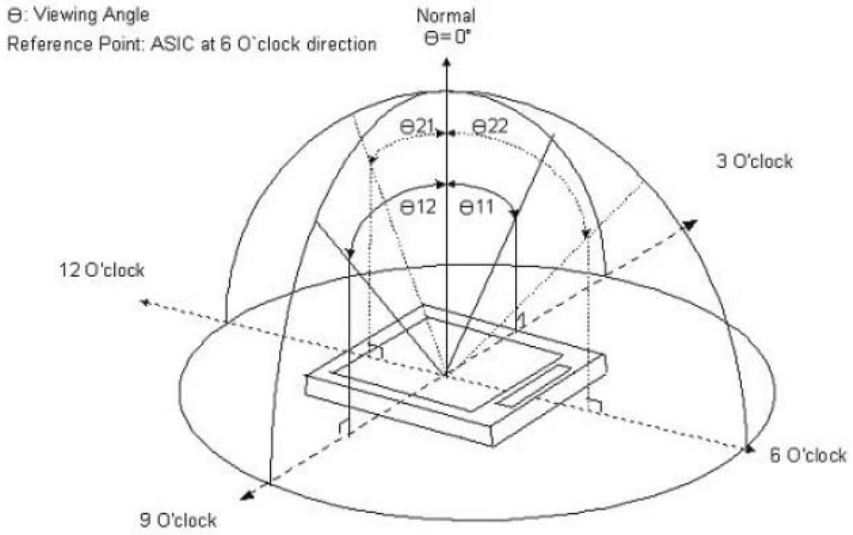


[2] Contrast ratio (Cr)

The contrast ratio (Cr), measured on a module, is the ratio between the luminance (L_w) in a full white area (R=G=B=1) and the luminance (L_d) in a dark area (R=G=B=0):

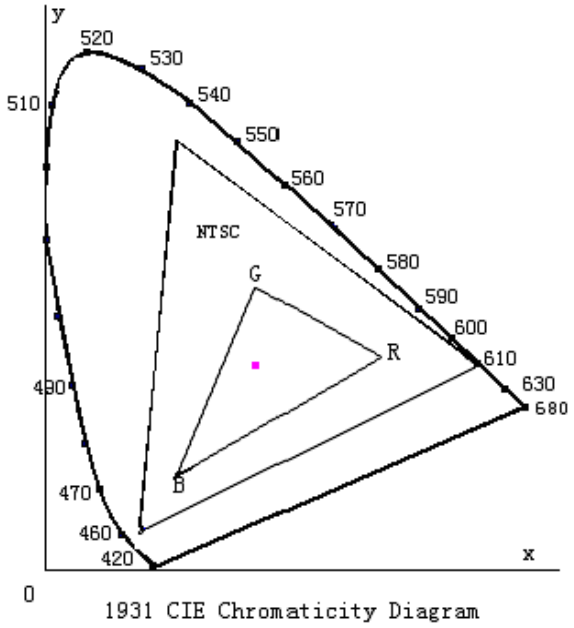
$$Cr = \frac{L\_w}{L\_d}$$

[3] Viewing angle diagram



[4] Definition of color gamut

Measuring machine:CFT-01. NTSC'S Primaries: R(x,y)、G(x,y)、B(x,y).



CIE chromaticity diagram

$$\text{Color gamut: } S = \frac{\text{Area of RGB triangle}}{\text{Area of NTSC triangle}} \times 100\%$$

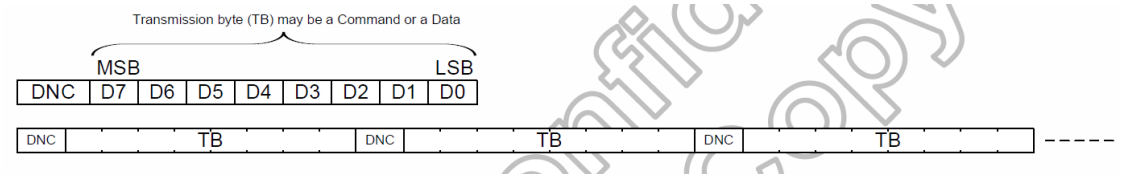
8. Timing Characteristics

8.1 Serial Data Transfer Interface

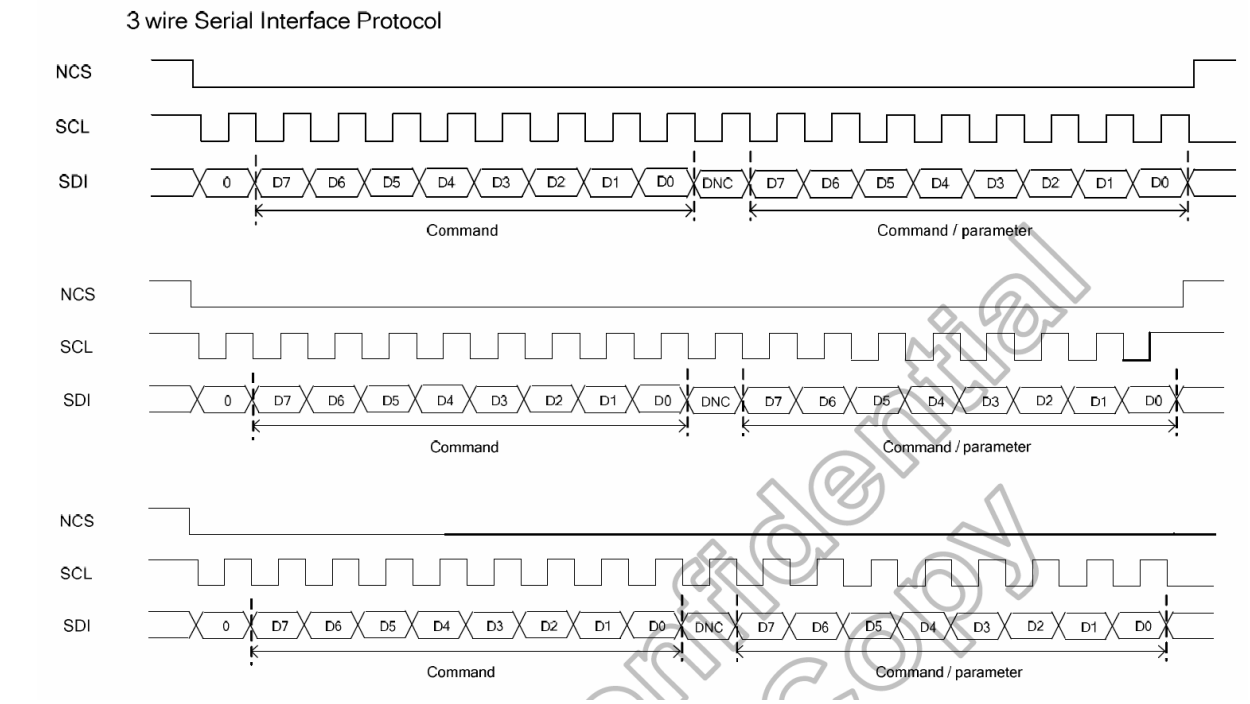
The LCM supports 3 wire serial data transfer interface. The 3 wire serial bus uses chip select line (CS), serial input/output data SDI/SDO and the serial transfer clock line (SCL).

Serial data write mode

The 3-Pin serial data packet contains a control bit DNC and a transmission byte. If DNC is low, the transmission byte is command byte. If DNC is high, the transmission byte is stored to command register. The MSB is transmitted first. The serial interface is initialized when CS is high. In this state, SCL clock pulse or SDI/SDO data have no effect. A falling edge on CS enables the serial interface and indicates the start of data transmission.



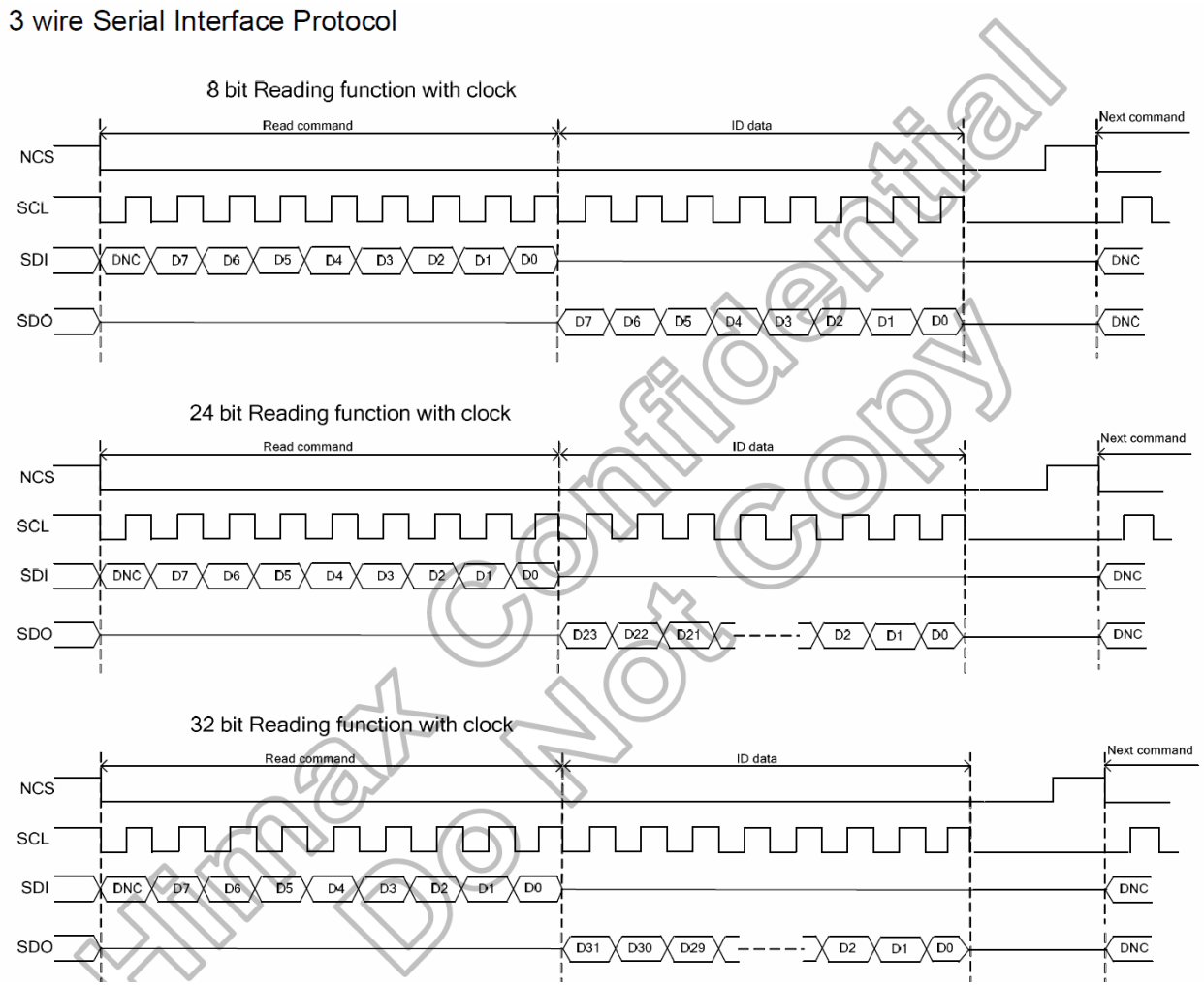
Serial Data stream, write mode



Serial Interface protocol 3 wire serial interface (write mode)

Serial Data Read Mode

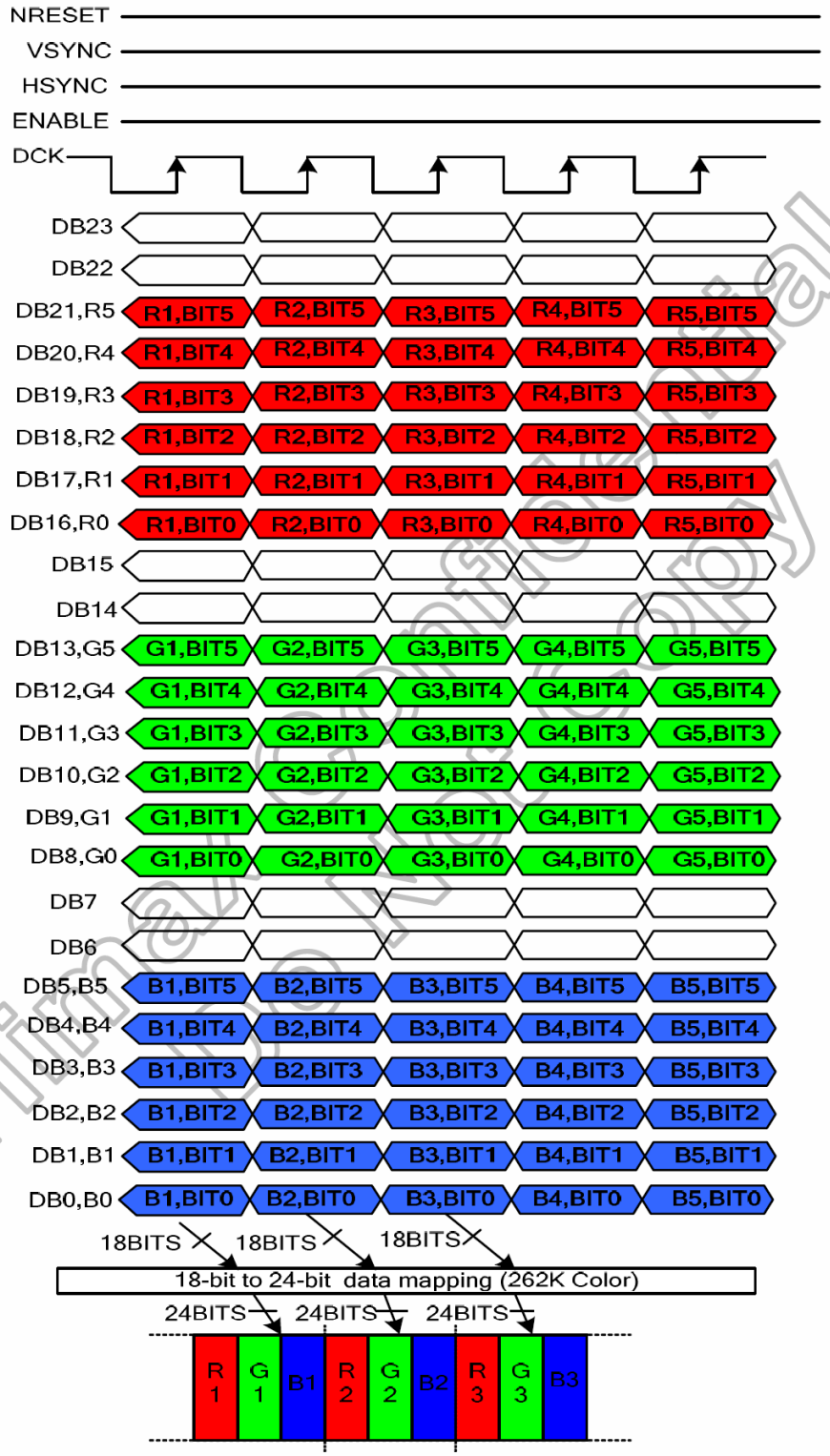
The micro controller firstly has to send a command and then the following byte is transmitted in the opposite direction. The read mode has three types of command data transmitted (8-/24- /32-bit) according command code.



3 wire Serial Interface protocol, read mode

8.2 RGB data format

18 bit/pixel Color Order on the RGB I/F



Note: The Data order is shown as follows, MSB = DB23, LSB = DB0 and Picture Data is MSB = Bit5, LSB = Bit0 for Red, Green and Blue data. DB23, DB22, DB15, DB14, DB7 and DB6 are opened.

8.3 RESET timing

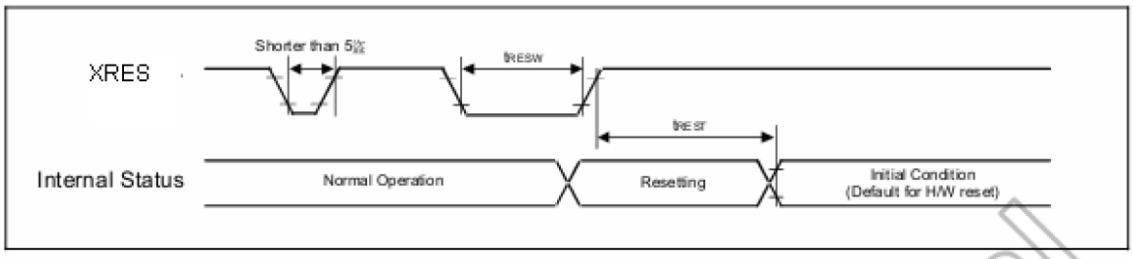


Figure 8.10 Reset Input Timing

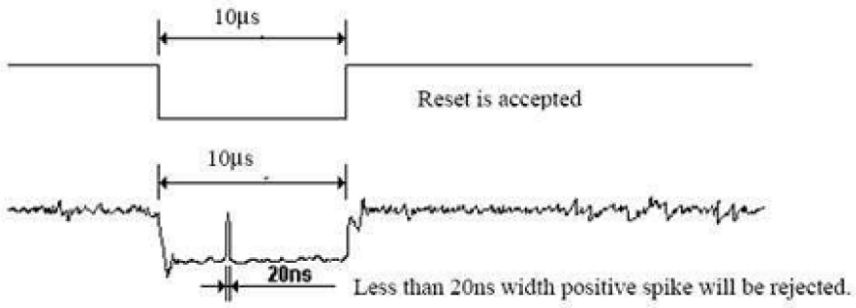
Symbol	Parameter	Related Pins	MIN	TYP	MAX	Note	Unit
tRESW	*1) Reset low pulse width	XRES	10	-	-	-	μs
tREST	*2) Reset complete time	-	-	-	5	When reset is applied during Sleep In mode	ms
		-		-	120	When reset is applied during Sleep Out mode	ms

Table 8.16 Reset Timing

Note: 1. Spike due to an electrostatic discharge on NRESET line does not cause irregular system reset according to the table below.

XRES Pulse	Action
Shorter than 5 μ	Reset Rejected
Longer than 10 μs	Reset
Between 5 μs and 10 μs	Reset Start

2. During the resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep Out –mode. The display remains the blank state in Sleep In –mode) and then returns to Default condition for H/W reset.
3. During Reset Complete Time, ID2 value in OTP will be latched to internal register during this period. This loading is done every time when there is H/W reset complete time (tREST) within 5ms after a rising edge of XRES
4. Spike Rejection also applies during a valid reset pulse as shown below:



5. When Reset is applied during Sleep In Mode.
6. When Reset is applied during Sleep Out Mode.
7. It is necessary to wait 5msec after releasing XRES before sending commands. Also Sleep Out command cannot be sent for 120msec.

8.4 Register List

(Hex)	Operation Code	DNC	D7	D6	D5	D4	D3	D2	D1	D0	Function	Default (HEX)
00	NOP	0	0	0	0	0	0	0	0	0	No operation	
01	SWRESET	0	0	0	0	0	0	0	0	1	Software reset	
06	RDRED	0	0	0	0	0	0	1	1	0	Read Red Color	
		1	R[7:0]									
07	RDGREEN	0	0	0	0	0	0	1	1	1	Read Green Color	
		1	G[7:0]									
08	RDBLUE	0	0	0	0	0	1	0	0	0	Read Blue Color	
		1	B[7:0]									
0A	RDDPM	0	0	0	0	0	1	0	1	0	Read display power mode	
		1	D[7:0]									
0B	RDDMADCTL	0	0	0	0	0	1	0	1	1	Read display MADCTL	
		1	D[7:0]									
0C	RDDCOLMOD	0	0	0	0	0	1	1	0	0	Read display pixel format	
		1	D[7:0]									
0D	RDDIM	0	0	0	0	0	1	1	0	1	Read display image mode	
		1	D[7:0]									
0E	RDDSM	0	0	0	0	0	1	1	1	0	Read Display Signal Mode	
		1	D[7:0]									
0F	RDDSDR	0	0	0	0	0	1	1	1	1	Read display self-diagnostic result	
		1	D[7:0]									
10	SLPIN	0	0	0	0	1	0	0	0	0	Sleep in and charge-pump off	
11	SLPOUT	0	0	0	0	1	0	0	0	1	Sleep out and charge-pump on	
20	INVOFF	0	0	0	1	0	0	0	0	0	Display inversion off	
21	INVON	0	0	0	1	0	0	0	0	1	Display inversion on	
26	GAMSET	0	0	0	1	0	0	1	1	0	Gamma set	
		1	GC[7:0]									
28	DISPOFF	0	0	0	1	0	1	0	0	0	Display off	
29	DISPON	0	0	0	1	0	1	0	0	1	Display on	
51	WRDISBV	0	0	1	0	1	0	0	0	1	Write Display Brightness	
		1	WRDBV[7:0](00)									
52	RDDISBV	0	0	1	0	1	0	0	1	0	Read Display Brightness Value	
		1	RDDBV[7:0]									
53	WRCTRLD	0	0	1	0	1	0	0	1	1	Write CTRL Display	
		1	0	0	BCTRL	0	DD	BL	xx	xx		
54	RDCTRLD	0	0	1	0	1	0	1	0	0	Read Control Value Display	
		1	xx	xx	BCTRL	xx	DD	BL	xx	xx		
55	WRCABC	0	0	1	0	1	0	0	1	0	Write Content Adaptive Brightness Control	
		1	xx	xx	xx	xx	xx	xx	CABC[1:0](00)			
56	RDCABC	0	0	1	0	1	0	1	1	0	Read Content Adaptive Brightness Control	
		1	xx	xx	xx	xx	xx	xx	CABC[1:0]			
5E	WRCABCMB	0	0	1	0	1	1	1	1	0	Write CABC minimum brightness	
		1	CMB 7	CMB 6	CMB 5	CMB 4	CMB 3	CMB 2	CMB 1	CMB 0		
5F	RDCABCMB	0	0	1	0	1	1	0	1	1	Read CABC minimum brightness	
		1	CMB[7:0]									
36	MADCTL	0	0	0	0	1	1	0	1	1	0	Memory access control	
		1	xx	xx	xx	xx	BGR	xx	SS	GS		
3A	COLMOD	0	0	0	0	1	1	1	0	1	0	Interface Pixel Format	
		1	xx	CSEL_RGB[2:0](110)			xx	xx	xx	xx		
A1	Read_DDB_start	0	1	0	1	0	0	0	0	1	Read the DDB from the provided location.	
		1	ID1								The five bytes alaway output	
		1	ID2									
		1	ID3									
		1	ID4									
		1	8'hFF									
A8	Read_DDB_continue	0	1	0	1	0	1	0	0	0	Continue reading the DDB from the last read location.	
		1	DDB data									
		1	:									
		1										
DA	RDID1	0	1	1	0	1	1	0	1	0	Read ID1	
		1	module's manufacturer[7:0]									
DB	RDID2	0	1	1	0	1	1	0	1	1	Read ID2	
		1	1	LCD module/driver version [6:0]								
DC	RDID3	0	1	1	0	1	1	1	0	0	Read ID3	
		1	LCD module/driver ID[7:0]									

9. Reliability Test Items

Test Item	Test Conditions	Note
High Temperature Operation	60±3°C , t=120 hrs	
Low Temperature Operation	-10±3°C , t=120 hrs	
High Temperature Storage	70±3°C , t=120 hrs	1,2
Low Temperature Storage	-20±3°C , t=120 hrs	1,2
Storage at High Temperature and Humidity	60°C, 90% RH , 120 hrs	1,2
Thermal Shock Test	-20°C (30min) ~ 70°C (30min) 50 cycles	1,2
Vibration Test (Packing)	Sweep frequency : 10 ~ 55 ~ 10 Hz/1min Amplitude : 0.75mm Test direction : X.Y.Z/3 axis Duration : 30min/each axis	2

Note 1 : Condensation of water is not permitted on the module.

Note 2 : The module should be inspected after 1 hour storage in normal conditions (15-35°C , 45-65%RH).

10. Handling Precautions

10.1 Mounting method

The LCD panel of SC LCD module consists of two thin glass plates with polarizes which easily be damaged. And since the module in so constructed as to be fixed by utilizing fitting holes in the printed circuit board.

Extreme care should be needed when handling the LCD modules.

10.2 Caution of LCD handling and cleaning

When cleaning the display surface, Use soft cloth with solvent [recommended below] and wipe lightly

- Isopropyl alcohol
- Ethyl alcohol

Do not wipe the display surface with dry or hard materials that will damage the polarizer surface.

Do not use the following solvent:

- Water
- Aromatics

Do not wipe ITO pad area with the dry or hard materials that will damage the ITO patterns

Do not use the following solvent on the pad or prevent it from being contaminated:

- Soldering flux
- Chlorine (Cl) , Salfur (S)

If goods were sent without being sili8con coated on the pad, ITO patterns could be damaged due to the corrosion as time goes on.

If ITO corrosion happen by miss-handling or using some materials such as Chlorine (Cl), Salfur (S) from customer, Responsibility is on customer.

10.3 Caution against static charge

The LCD module use C-MOS LSI drivers, so we recommended that you:

Connect any unused input terminal to Vdd or Vss, do not input any signals before power is turned on, and ground your body, work/assembly areas, assembly equipment to protect against static electricity.

10.4 Packing

- Module employ LCD elements and must be treated as such.
- Avoid intense shock and falls from a height.
- To prevent modules from degradation, do not operate or store them exposed direct to sunshine or high temperature/humidity

10.5 Caution for operation

- It is an indispensable condition to drive LCD's within the specified voltage limit since the higher voltage then the limit cause the shorter LCD life.
- An electrochemical reaction due to direct current causes LCD's undesirable deterioration, so that the use of direct current drive should be avoided.
- Response time will be extremely delayed at lower temperature then the operating temperature range and on the other hand at higher temperature LCD's how dark color in them. However those phenomena do not mean malfunction or out of order with LCD's, which will come back in the specified operation temperature.
- If the display area is pushed hard during operation, some font will be abnormally displayed but it resumes normal condition after turning off once.
- A slight dew depositing on terminals is a cause for electro-chemical reaction resulting in terminal open circuit. Usage under the maximum operating temperature, 50%Rh or less is required.
- Do not keep the LCD at the same display pattern continually. The residual image will happen and it will damage the LCD. Please use screen saver.

10.6 Storage

In the case of storing for a long period of time for instance, for years for the purpose or replacement use, the following ways are recommended.

- Storage in a polyethylene bag with the opening sealed so as not to enter fresh air outside in it . And with no desiccant.
- Placing in a dark place where neither exposure to direct sunlight nor light's keeping the storage temperature range.
- Storing with no touch on polarizer surface by the anything else.
  [It is recommended to store them as they have been contained in the inner container at the time of delivery from us]

10.7 Safety

- It is recommendable to crash damaged or unnecessary LCD's into pieces and wash off liquid crystal by either of solvents such as acetone and ethanol, which should be burned up later.
- When any liquid leaked out of a damaged glass cell comes in contact with your hands, please wash it off well with soap and water
- Do not keep the LCD at the same display pattern continually. The residual image will happen and it will damage the LCD. Please use screen saver.

11. OUTLINE DIMENSION