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-240320J4TZQW-10H
APPROVED BY	
DATE	

☐ Preliminary Specification
☑ Formal Specification

AMPIRE CO., LTD.
4F., No.116, Sec. 1, Xintai 5th Rd., Xizhi Dist., New Taipei City221, Taiwan (R.O.C.)
新北市汐止區新台五路一段 **116** 號 **4** 樓(東方科學園區 **A** 棟)
TEL:886-2-26967269 , FAX:886-2-26967196 or 26967270

Approved by	Checked by	Organized by
Patrick	Lawlite	Tank

*This specification is subject to change without notice.

RECORD OF REVISION

Revision Date	Page	Contents	Editor
2023/02/03	-	New Release	Tank
2023/02/06	4	Modify External Shape Dimensions	Tank
2023/05/09	3,10	Update LCD Driver IC	Tank

1 Features

This single-display module is suitable for cellphone application. The Main-LCD adopts one backlight with High brightness 3-lamps white LED.

(1) Main LCD : 1.1 MVA-TFT 2.2 inch display, transmissive, Normally Black
1.2 240(RGB) X 320 dots Matrix
1.3 Narrow-contact ledge technique.
1.4 Main LCD Driver IC: ST7789T3
1.5 Real 262K colors display:
65K: Red-5bit, Green-6bit, Blue-5bit (8/16-bit interface)
262K: Red-6bit, Green-6bit, Blue-6bit (9/18-bit interface)

(2) Direct data display with display RAM
(3) MPU interface: 8bit/16bit/18bit, 80Serial, parallel interface.
(4) RGB interface:16bit/18bit parallel interface
(5) With light shielding adhesive tape, 3806BWH (SEKISUI CHEMICAL)
(6) New LED Backlight

2 Mechanical specifications

Dimensions and weight

Item		Specifications	Unit
External Shape Dimensions		40.1 (W) x 71.9 (H) x 3.65 (D)	mm
Main LCD	Pixel Pitch	0.1395 (W) x 0.1395(H)	mm
	Active Area	33.48 (W) x 44.64 (H)	mm
	Viewing Area	35.08 (W) x 46.24 (H)	mm

*1. This specification is about External shape on shipment from AMPIRE.

3 Absolute max. ratings and environment

3-1 Absolute max. ratings

Ta=25°C GND=0V

Item	Symbol	Min.	Max.	Unit	Remarks
Power Voltage	VDD – GND	-0.3	+4.0	V	
Power Voltage	LED A – LED K	-0.5	+10.8	V	
Input Voltage	VIN	-0.5	VDDI+0.5	V	

3-2 Environment

Item	Specifications	Remarks
Storage temperature	Max. +80°C Min. -30°C	Note 1: Non-condensing
Operating temperature	Max. +70°C Min. -20°C	Note 1: Non-condensing

Note 1：Ta≦+40°C・・・・Max.85%RH

Ta＞+40°C・・・・The max. humidity should not exceed the humidity with 40°C 85%RH.

4 Electrical specifications

4-1 Electrical characteristics of LCM

(V_{DD}=2.8V, Ta=25 ^{o}C)

Item	Symbol	Conditions	MIN.	TYP.	MAX.	Unit	Note
IC power voltage	V_{DD}		2.4	2.75	3.3	V	
High-level input voltage	V_{IHC}		0.8V_{DD}		V_{DD}	V	Note 1,2,3
Low-level input voltage	V_{ILC}		0		0.2V_{DD}	V	
Consumption current of VDD	I_{DD}	LED OFF	-	T.B.D.	-	mA	
Consumption current of LED	I_f	V_f = 8.7V	-	15	-	mA	Note 5

※ 1. 1/320 duty.

2. Electronic Volumn value: (xxxxh) Decimal

3. Thermal Gradient: -0.05%/^{o}C

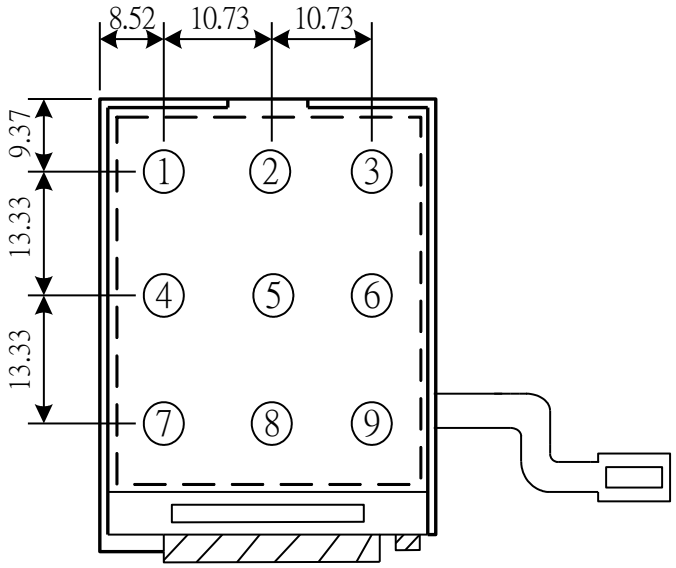
4. Range of Electronic Volumn control: (xxxxH$\pm$3) Decimal

5. Using condition: constant current driving method I_f =15mA (+/-10%)

4-2 LED back light specification

Item	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Forward Voltage	V_f	I_f =15mA	7.8	8.7	9.9	V
Reverse Voltage	V_r		-	-	12	V
Forward Current	I_f	3-chip serial	-	15	-	mA
Power Consumption	P_{BL}	I_f =15mA	-	130	-	mW
Uniformity (with L/G)	-	I_f =15mA	70%*1	-	-	
Luminous Color	White					
Chip Connection	3 chip serial connection					

Bare LED measure position:



*1 Uniformity (LT): $\frac{Min(P1 \sim P9)}{Max(P1 \sim P9)} \times 100$

5 Optical characteristics

Main LCD

5.1 Optical characteristics

(1/320 Duty in case except as specified elsewhere Ta = 25°C)

LED backlight transmissive module:

Item	Symbol	Temp.	Min.	Typ.	Max.	Unit	Conditions
Response Time	Tr+Tf		-	55	85	ms	θ=0°, φ=0° (Note 2)
Contrast Ratio	CR	25°C	300	700	-	-	θ=0°, φ=0° LED:ON, LIGHT:OFF (Note 4)
Visual Angle Range Front and Rear	θ	25°C	(θf) 80 (θb) 80			Degree	φ= 0°, CR≧10 LED:ON LIGHT:OFF (Note 3)
Visual Angle Range Left and Right	θ	25°C	(θl) 80 (θr) 80			Degree	φ=90°, CR≧10 LED:ON LIGHT:OFF (Note 3)
Brightness			300	400		Cd/m2	V_f=8.7V, 15mA Full White pattern

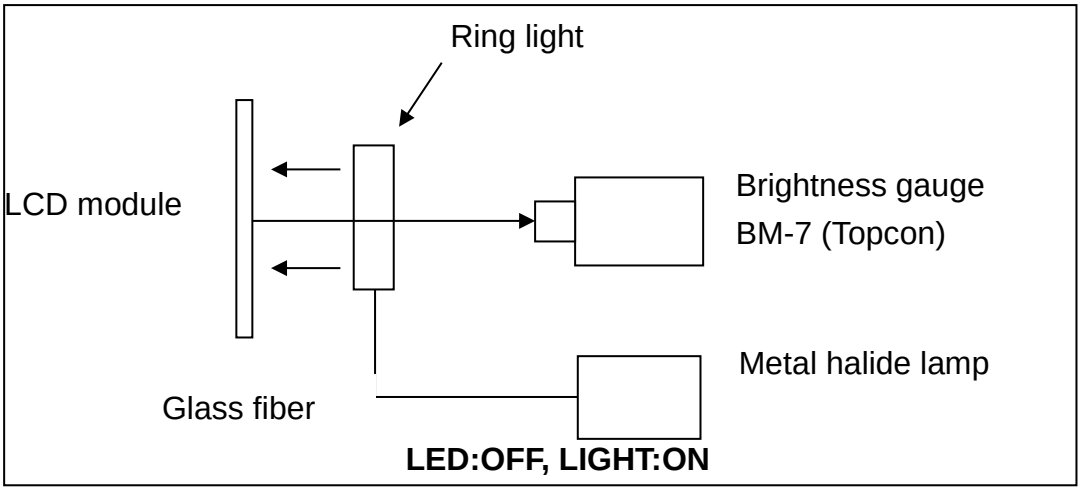
***This value is reference only, follow the limited samples.**

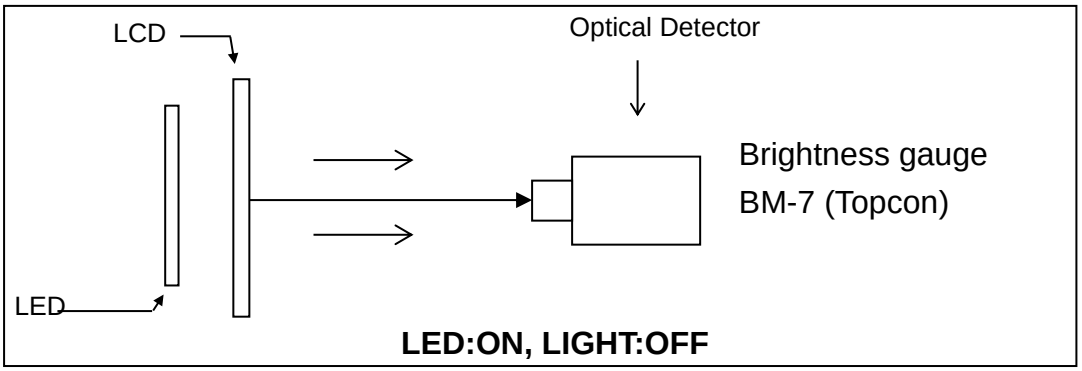
5.2 CIE (x, y) chromaticity (1/320 Duty Ta = 25°C)

Item	Symbol	Tranmissive R G B W Range			Conditions
		Min	Typ.	Max	
Red	XR	Typ. -0.05	0.6429	Typ. +0.05	θ=0°, φ=0°
	YR		0.3400		
Green	XG		0.3393		θ=0°, φ=0°
	YG		0.6209		
Blue	XB		0.1502		θ=0°, φ=0°
	YB		0.0584		
White	XW		0.3280		θ=0°, φ=0°
	YW		0.3546		

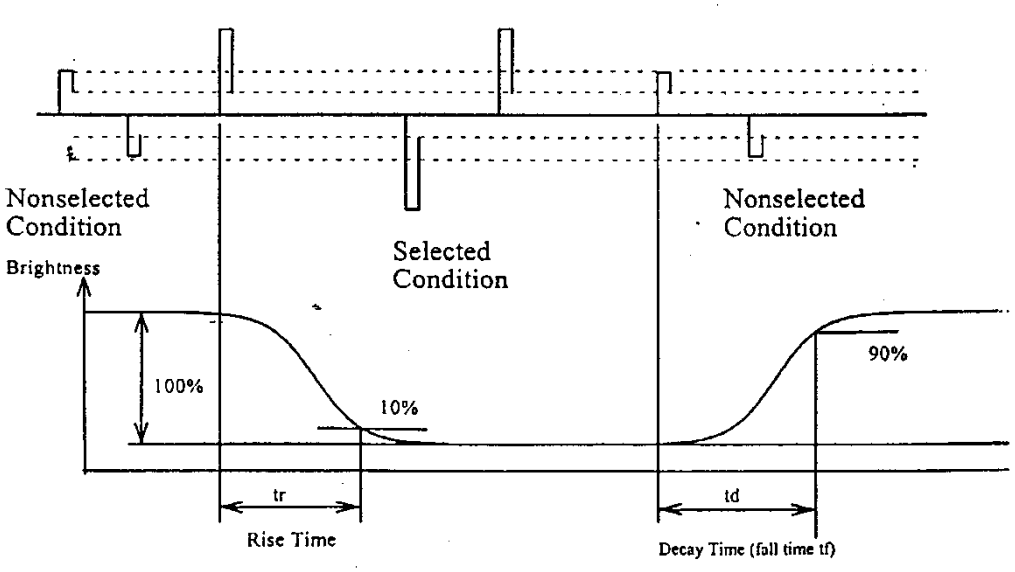
※ **The R G B W ranges are for reference**

NOTE 1: Optical characteristic measurement system

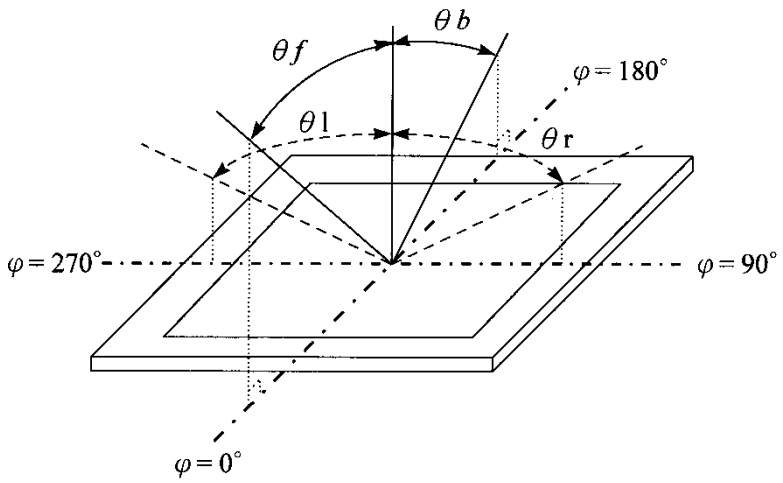




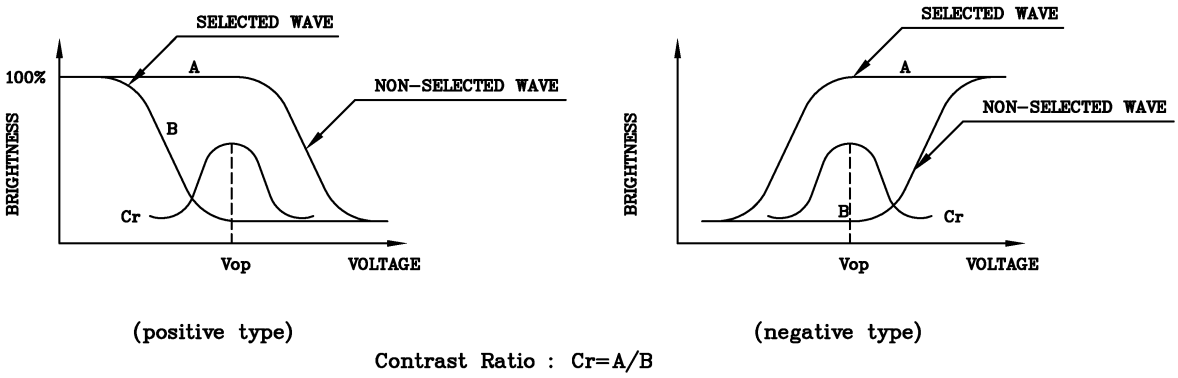
NOTE 2: Response tome definition



NOTE 3: φ、θ definition

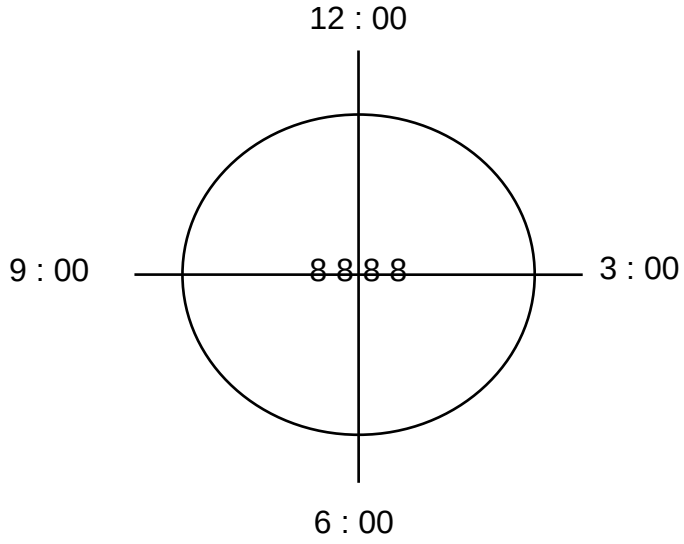


NOTE 4: Contrast definition



Contrast Ratio : Cr=A/B

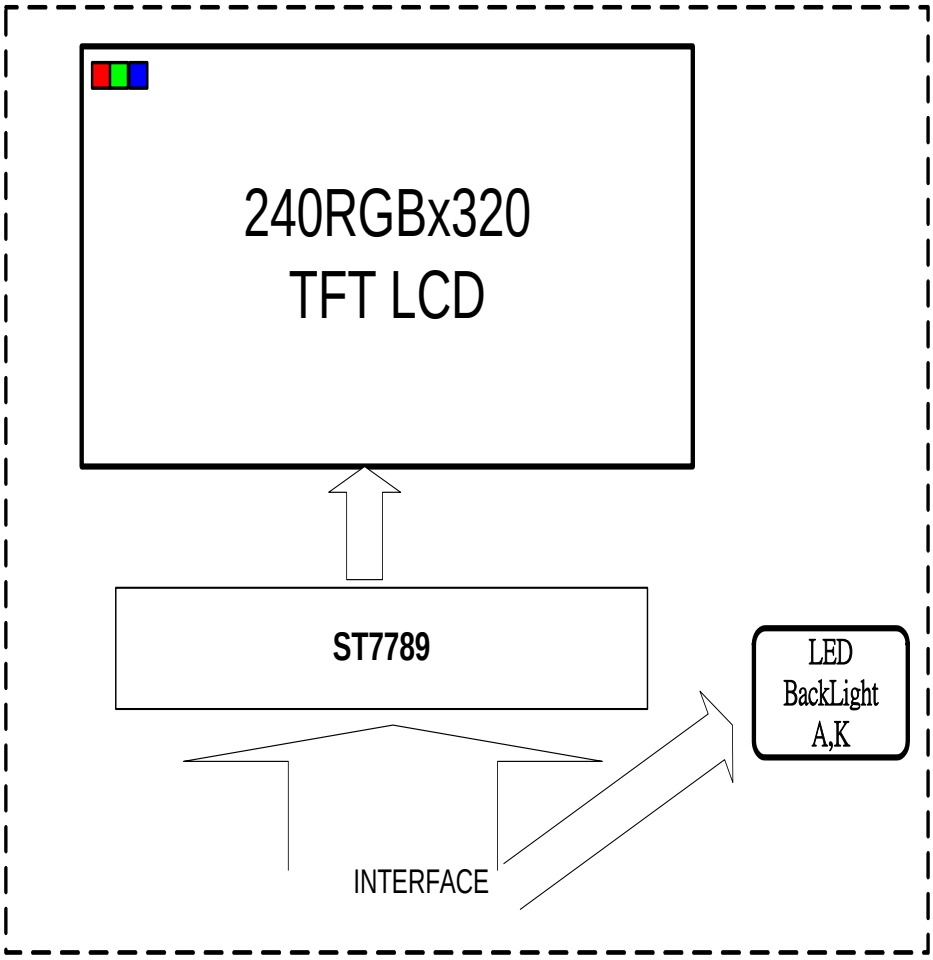
NOTE 5: Visual angle direction priority



6 Block Diagram

Block diagram (Main LCD)

Display format:	MVA- TFT transmissive, Normally black type
Display composition:	240 RGB x 320 dots
LCD Driver :	ST7789T3
Back light:	White LED x 3 (I_f =15mA)



7 Interface specifications

Pin No.	Terminal	Functions
1	GND	Ground
2	GND	Ground
3	CSX	-Chip selection pin Low enable. High disable.
4	DCX	-Display data/command selection pin in parallel interface. -This pin is used to be serial interface clock. DCX='1': display data or parameter. DCX='0': command data. -If not used, please fix this pin at VDDI or DGND.
5	WRX	-Write enable in MCU parallel interface. - Display data/command selection pin in 4-line serial - Second Data lane in 2 data lane serial interface. -If not used, please fix this pin at VDDI or DGND.
6	RDX	-Read enable in 8080 MCU parallel interface. -If not used, please fix this pin at VDDI or DGND.
7	RESX	-This signal will reset the device and it must be applied to properly initialize the chip. -Signal is active low.
8	DB0	-DB[17:0] are used as MCU parallel interface data bus. 8-bit I/F: when IM3:0, DB[7:0] are used; when IM3:1, DB[17:10] are used. 9-bit I/F: when IM3:0, DB[8:0] are used; when IM3:1, DB[17:9] are used. 16-bit I/F: when IM3:0, DB[15:0] are used; when IM3:1, DB[17:10] and DB[8:1] are used. 18-bit I/F: DB[17:0] are used. -DB[17:0] are used as RGB interface data bus. 6-bit RGB I/F: DB[5:0] are used. 16-bit RGB I/F: DB[17:13], DB[11:1] are used. 18-bit RGB I/F: DB[17:0] are used. -If not used, please fix this pin at VDDI or DGND.
9	DB1	
10	DB2	
11	DB3	
12	DB4	
13	DB5	
14	DB6	
15	DB7	
16	DB8	
17	DB9	
18	DB10	
19	DB11	
20	DB12	
21	DB13	
22	DB14	
23	DB15	
24	LED A	Led Anode
25	LED K	Led Cathode
26	DB16	Data Bus
27	DB17	
28	IM3	Interface selecting signal. For the details,please refer to NOTE1.
29	IM2	Interface selecting signal. For the details,please refer to NOTE1.
30	IM1	Interface selecting signal. For the details,please refer to NOTE1.
31	IM0	Interface selecting signal. For the details,please refer to NOTE1.
32	SDA	Serial bus interface data input

33	SDO	SPI interface output pin.
34	VSYNC	Frame synchronizing signal in RGB I/F mode.
35	HSYNC	Horizontal (Line) synchronizing input signal for RGB interface
36	DOTCLK	Dot clock signal in RGB I/F mode.
37	NC(ENABLE)	No Connect
38	NC	No Connect
39	VDD	Power Supply Power Supply for Analog, Digital System and Booster Circuit.
40	VDDI	Power Supply for I/O System.

Note 1:

IM3	IM2	IM1	IM0	MPU Interface Mode	Data pin
0	0	0	0	80-8bit parallel I/F	DB[7:0]
0	0	0	1	80-16bit parallel I/F	DB[15:0]
0	0	1	0	80-9bit parallel I/F	DB[8:0]
0	0	1	1	80-18bit parallel I/F	DB[17:0],
0	1	0	1	3-line 9bit serial I/F	SDA: in/out
				2 data lane serial I/F	SDA: in/out WRX: in
0	1	1	0	4-line 8bit serial I/F	SDA: in/out
1	0	0	0	80-16bit parallel I/F II	DB[17:10], DB[8:1]
1	0	0	1	80-8bit parallel I/F II	DB[17:10]
1	0	1	0	80-18bit parallel I/F II	DB[17:0],
1	0	1	1	80-9bit parallel I/F II	DB[17:9]
1	1	0	1	3-line 9bit serial I/F II	SDA: in/ SDO: out
1	1	1	0	4-line 8bit serial I/F II	SDA:in/ SDO: out

8 Timing Characteristics

8.1 MCU interface

8080 Series MCU Parallel Interface Characteristics: 18/16/9/8-bit Bus

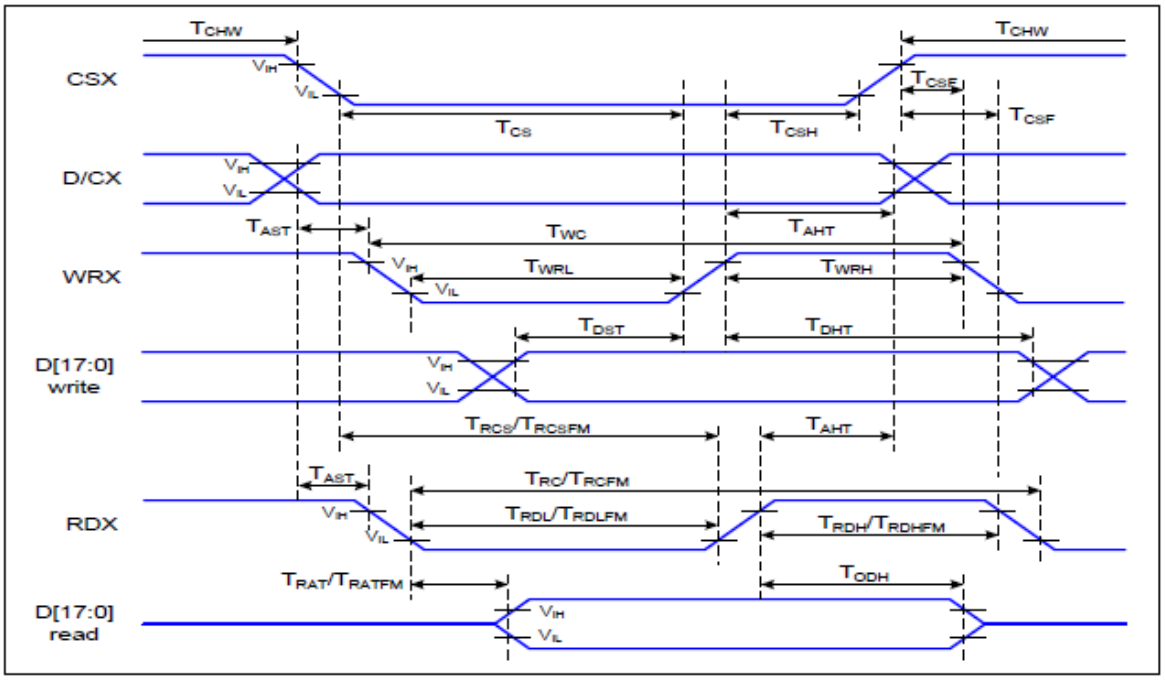


Figure 1 Parallel Interface Timing Characteristics (8080-Series MCU Interface)

VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=25℃

Signal	Symbol	Parameter	Min	Max	Unit	Description
D/CX	T_{AST}	Address setup time	0		ns	-
	T_{AHT}	Address hold time (Write/Read)	10		ns	
CSX	T_{CHW}	Chip select "H" pulse width	0		ns	-
	T_{CS}	Chip select setup time (Write)	15		ns	
	T_{RCS}	Chip select setup time (Read ID)	45		ns	
	T_{RCSFM}	Chip select setup time (Read FM)	355		ns	
	T_{CSF}	Chip select wait time (Write/Read)	10		ns	
	T_{CSH}	Chip select hold time	10		ns	
WRX	T_{WC}	Write cycle	66		ns	
	T_{WRH}	Control pulse "H" duration	15		ns	
	T_{WRL}	Control pulse "L" duration	15		ns	
RDX (ID)	T_{RC}	Read cycle (ID)	160		ns	When read ID data
	T_{RDH}	Control pulse "H" duration (ID)	90		ns	
	T_{RDL}	Control pulse "L" duration (ID)	45		ns	
RDX (FM)	T_{RCFM}	Read cycle (FM)	450		ns	When read from frame memory
	T_{RDHFM}	Control pulse "H" duration (FM)	90		ns	
	T_{RDLFM}	Control pulse "L" duration (FM)	355		ns	
D[17:0]	T_{DST}	Data setup time	10		ns	For CL=30pF

	T_{DHT}	Data hold time	10		ns	
	T_{RAT}	Read access time (ID)		40	ns	
	T_{RATFM}	Read access time (FM)		340	ns	
	T_{ODH}	Output disable time	20	80	ns	

Table 4 8080 Parallel Interface Characteristics

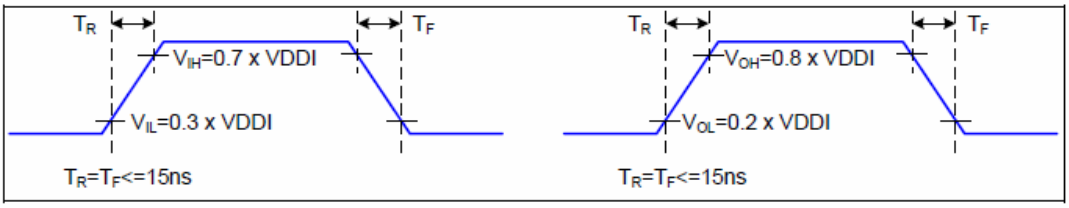


Figure 2 Rising and Falling Timing for I/O Signal

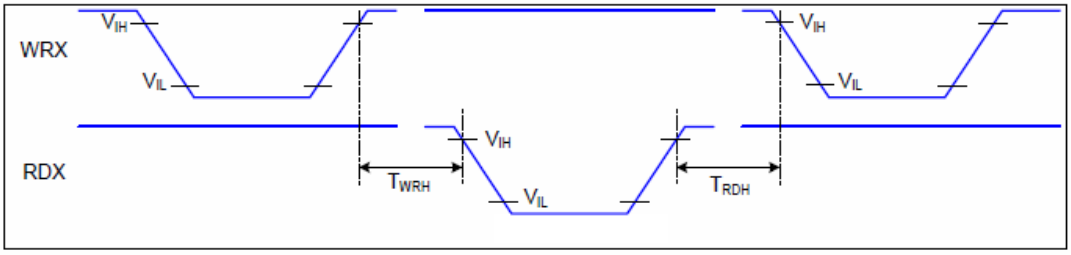


Figure 3 Write-to-Read and Read-to-Write Timing

Note: The rising time and falling time (Tr, Tf) of input signal and fall time are specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.

8.2 RGB interface

8.2.1 RGB interface Selection

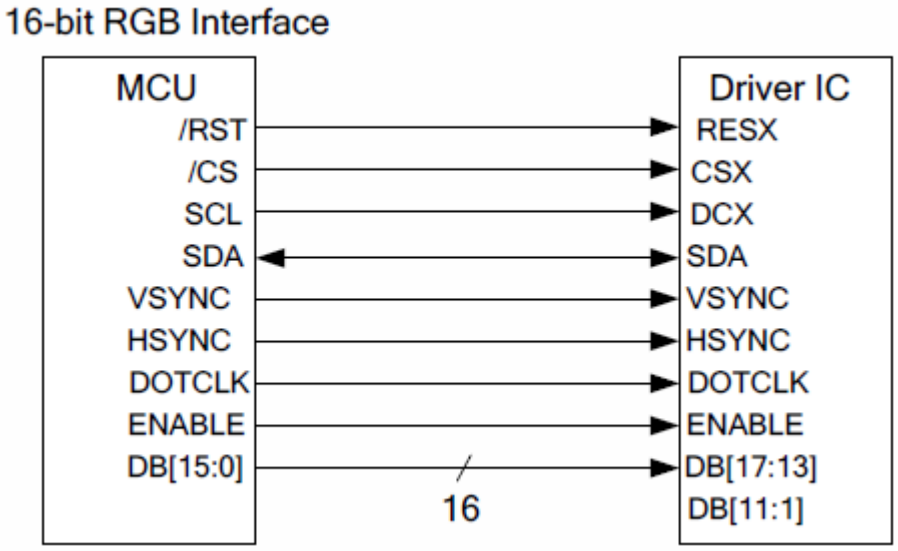
The color format selection of RGB Interface for ST7789 is selected by setting the RIM and command 3Ah, DB [6:4].

RIM	3Ah, DB[6:4]	RGB Interface Mode	Data pins
0	110	18-bit 262K RGB Interface	DB[17:0]
0	101	16-bit 65K RGB Interface	DB[17:13], DB[11:1]
1	110	6-bit 262K RGB Interface	DB[5:0]
1	101	6-bit 65K RGB Interface	DB[5:0]

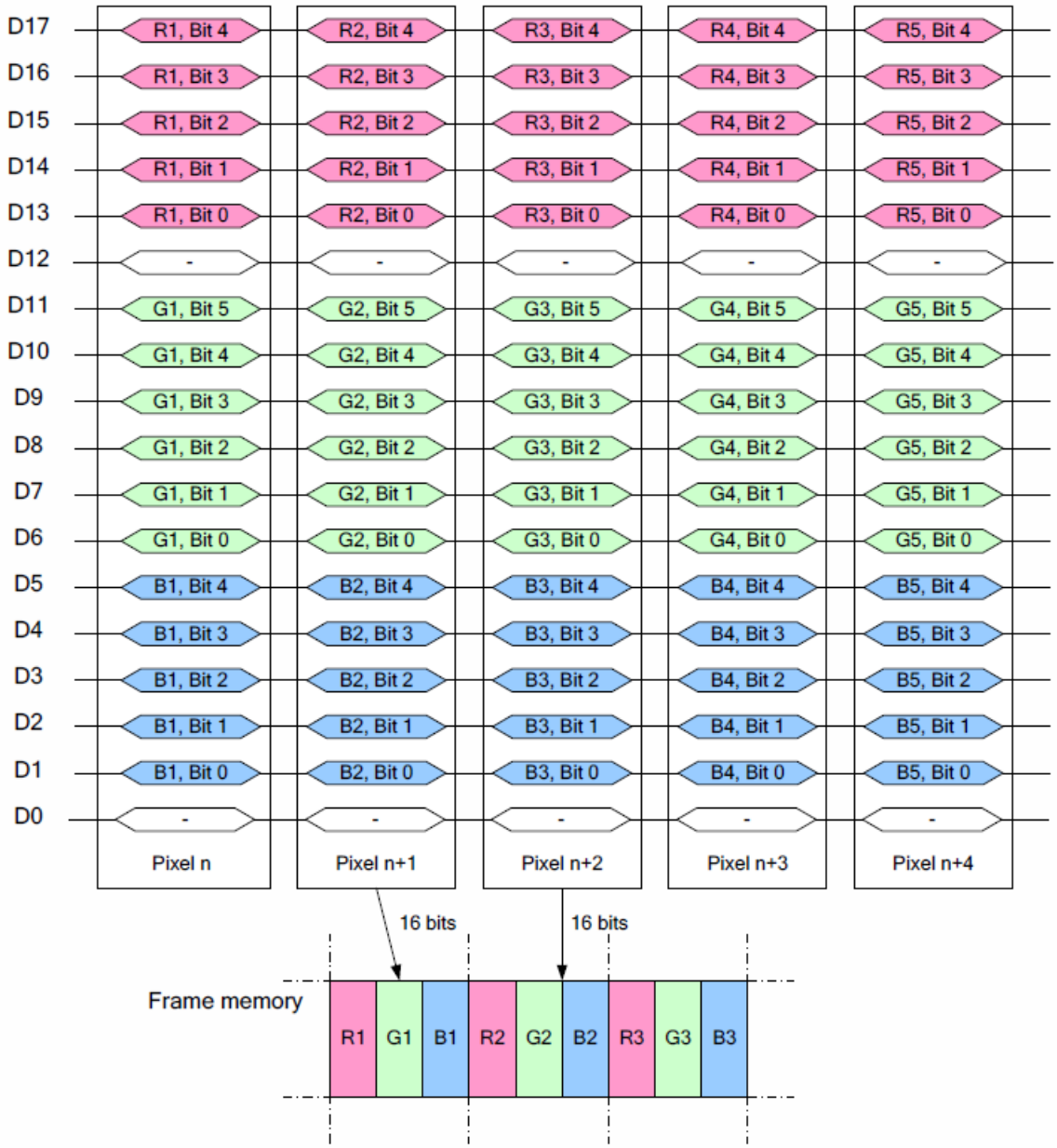
8.2.2 RGB Color Format

ST7789 supports two kinds of RGB interface, DE mode and HV mode, and 6bit/18bit data format. When DE mode is selected and the VSYNC, HSYNC, DOTCLK, DE, D[17:0] pins can be used; when HV mode is selected and the VSYNC, HSYNC, DOTCLK, D[17:0] pins can be used. When using RGB interface, only serial interface can be selected.

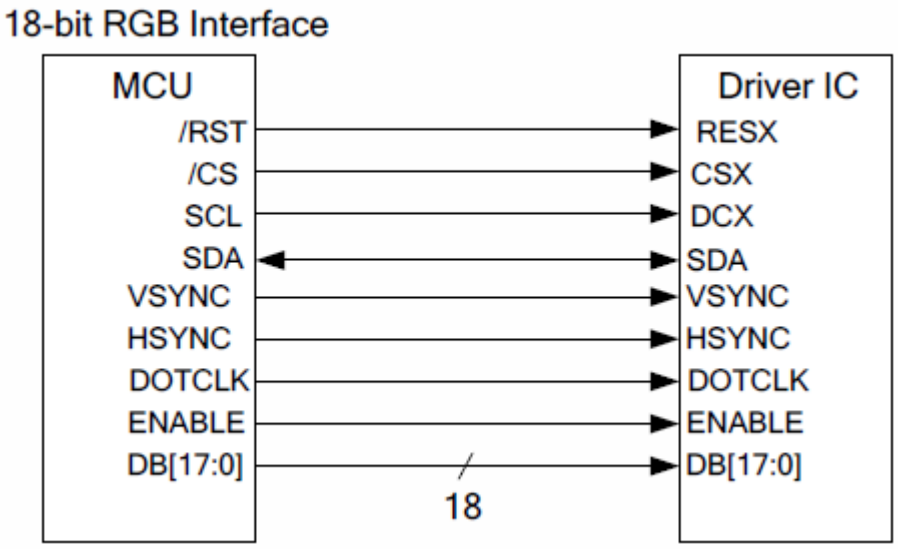
16-bit RGB interface Hardware suggestion, IM[3:0]=0101.



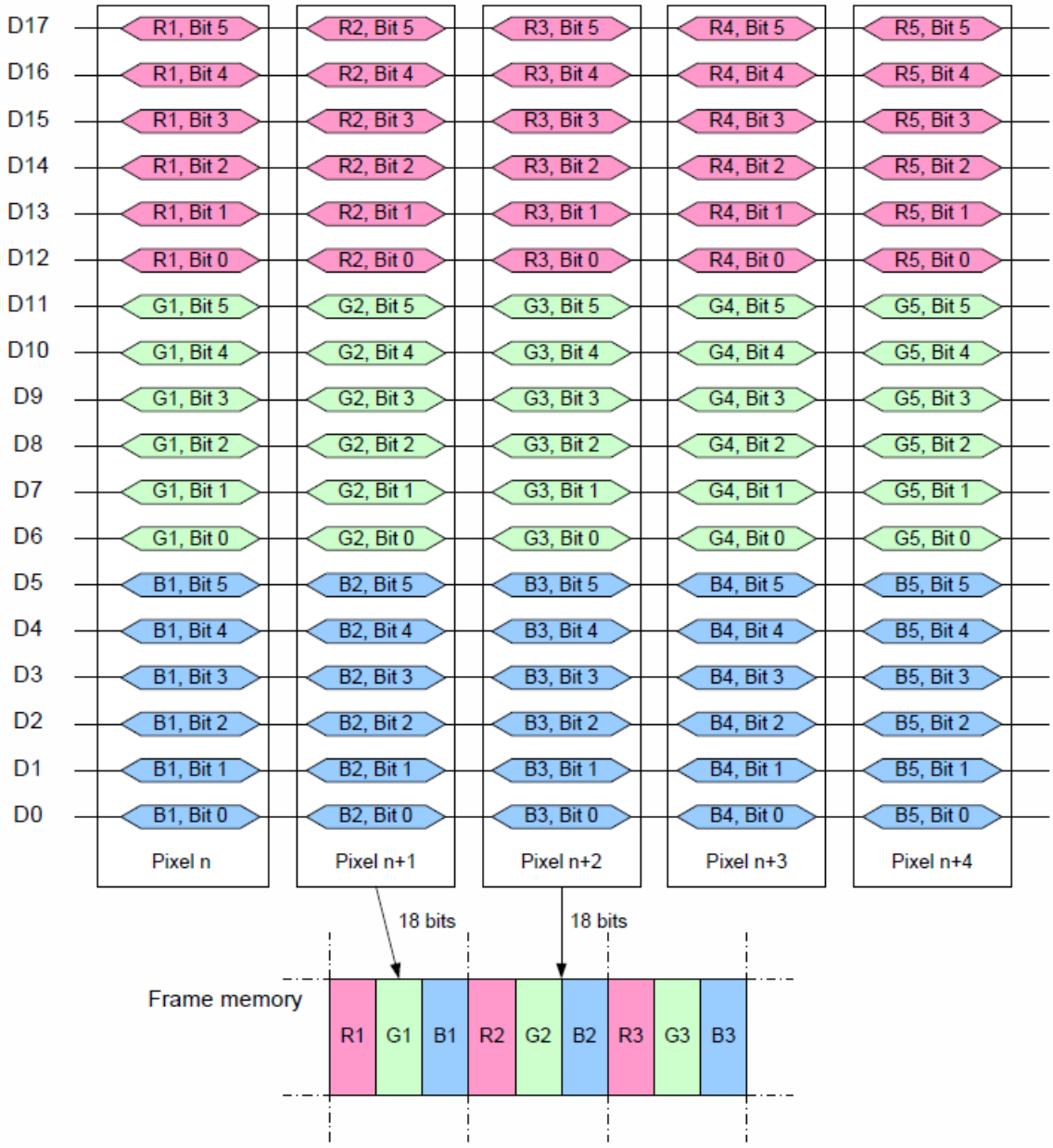
Write data for 16-bit/pixel (RGB 5-6-5-bit input), 65K-Colors



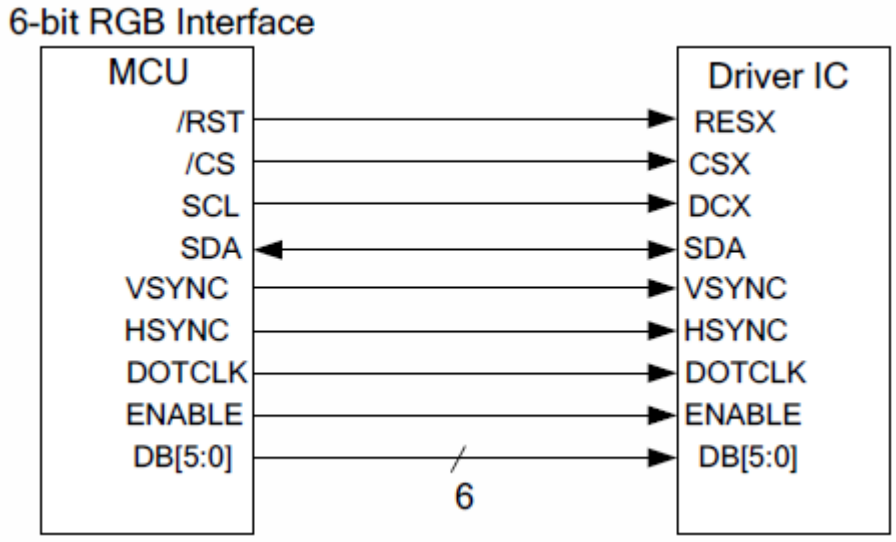
18-bit RGB interface hardware suggestion, IM[3:0]=0101.



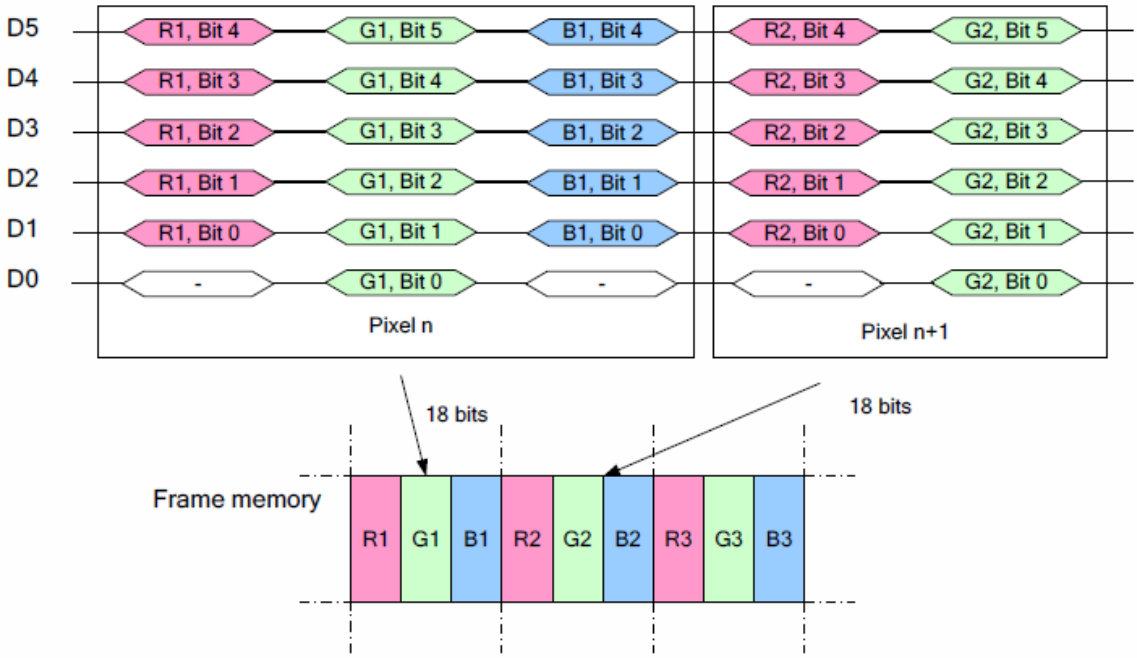
Write data for 18-bit/pixel (RGB 6-6-6-bit input), 262K-Colors



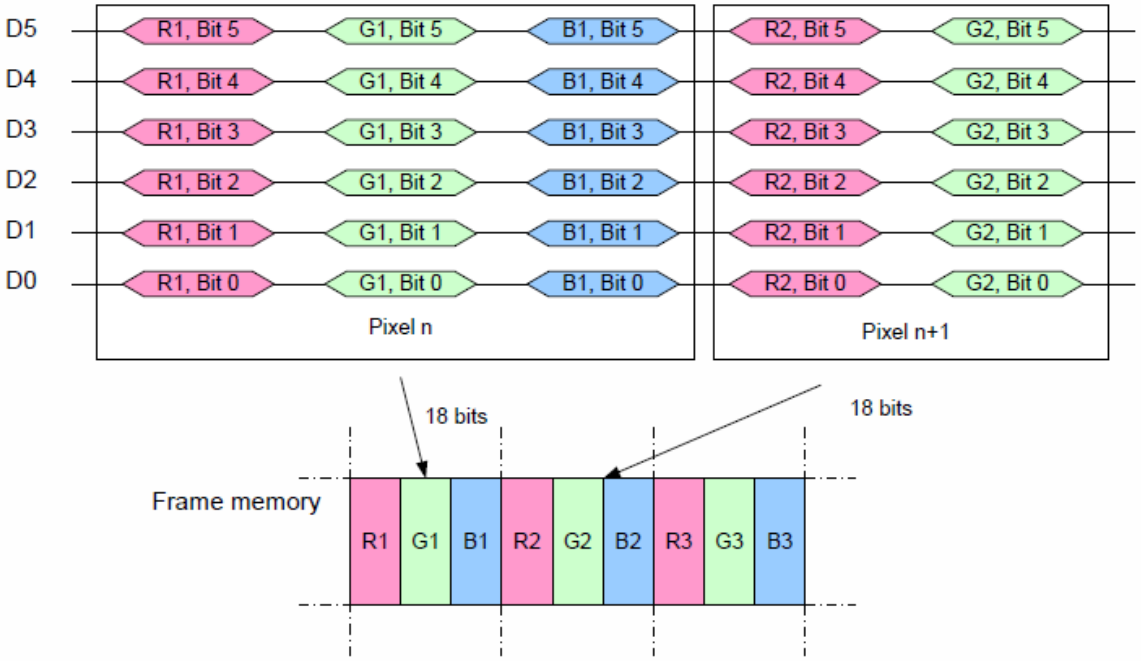
6-bit RGB interface hardware suggestion, IM[3:0]=0101.



Write data for 6-bit/pixel (RGB 5-6-5-bit input), 65K-Colors

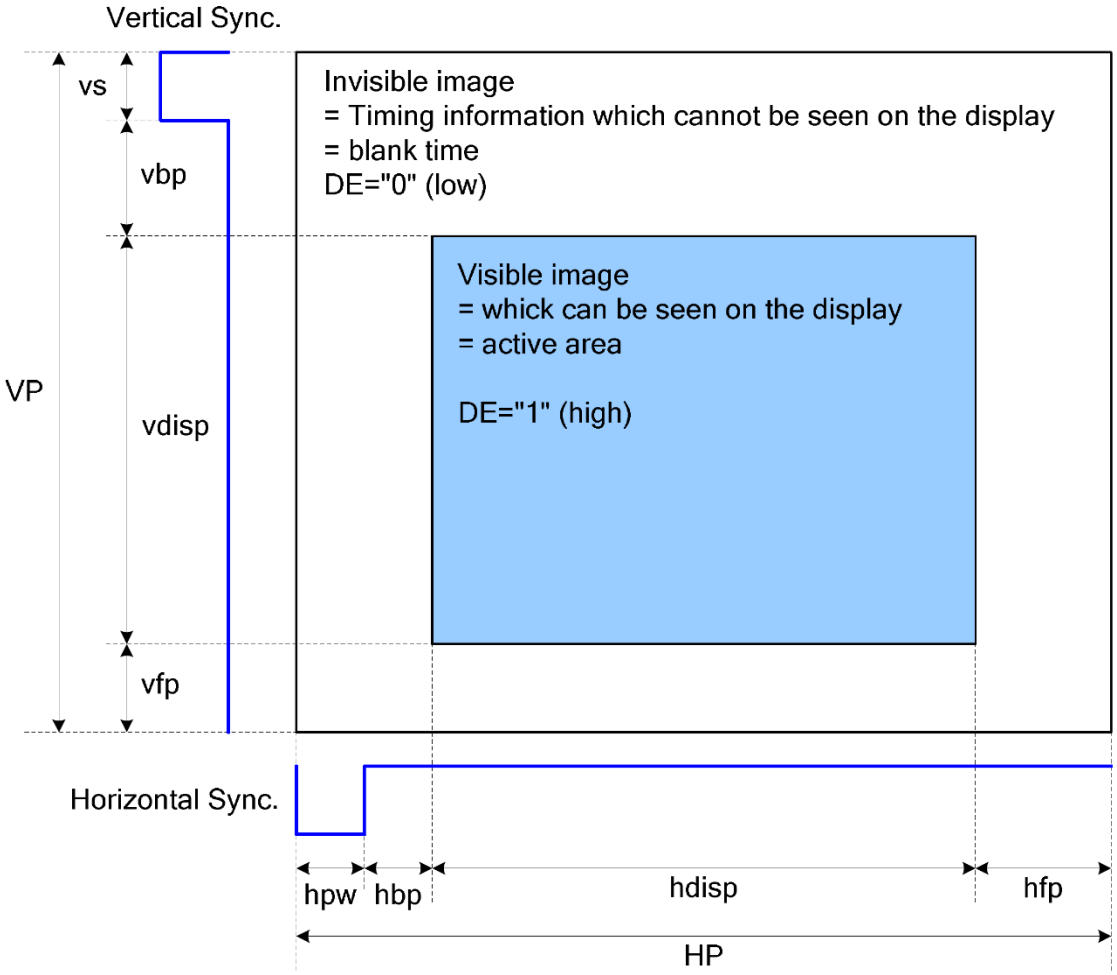


Write data for 6-bit/pixel (RGB 6-6-6-bit input), 262K-Colors



8.2.3 RGB Interface Definition

The display operation via the RGB interface is synchronized with the VSYNC, HSYNC, and DOTCLK signals. The data can be written only within the specified area with low power consumption by using window address function. The back porch and front porch are used to set the RGB interface timing.



Please refer to the following table for the setting limitation of RGB interface signals.

18bit RGB interface:

Parameter	Symbol	Min.	Typ.	Max.	Unit
Horizontal Sync. Width	hpw	2	10	hpw+hbp=31	Clock
Horizontal Sync. Back Porch	hbp	4	10		Clock
Horizontal Sync. Front Porch	hfp	2	38	-	Clock
Vertical Sync. Width	vs	1	4	vs+vbp=127	Line
Vertical Sync. Back Porch	vbp	1	4		Line
Vertical Sync. Front Porch	vfp	1	8	-	Line

Note:
Typical value are related to the setting of dot clock is 7MHz and frame rate is 70Hz..
If the setting of hpw is 10 dot clocks and hbp is 10 dot clocks, the setting of HBP in command B1h is 20 dot clocks
In with ram mode, hpw+hbp+hfp≧22
In without ram mode, hpw+hbp≧20

6bit RGB interface:

Parameter	Symbol	Min.	Typ.	Max.	Unit
Horizontal Sync. Width	hpw	6	30	hpw+hbp=93	Clock
Horizontal Sync. Back Porch	hbp	12	30		Clock
Horizontal Sync. Front Porch	hfp	6	60	-	Clock
Vertical Sync. Width	vs	1	4	vs+vbp=127	Line
Vertical Sync. Back Porch	vbp	1	4		Line
Vertical Sync. Front Porch	vfp	1	8	-	Line

Note:
Typical value are related to the setting of dot clock is 17MHz and frame rate is 60Hz..
In with ram mode, hpw+hbp+hfp≧66
In without ram mode, hpw+hbp≧60

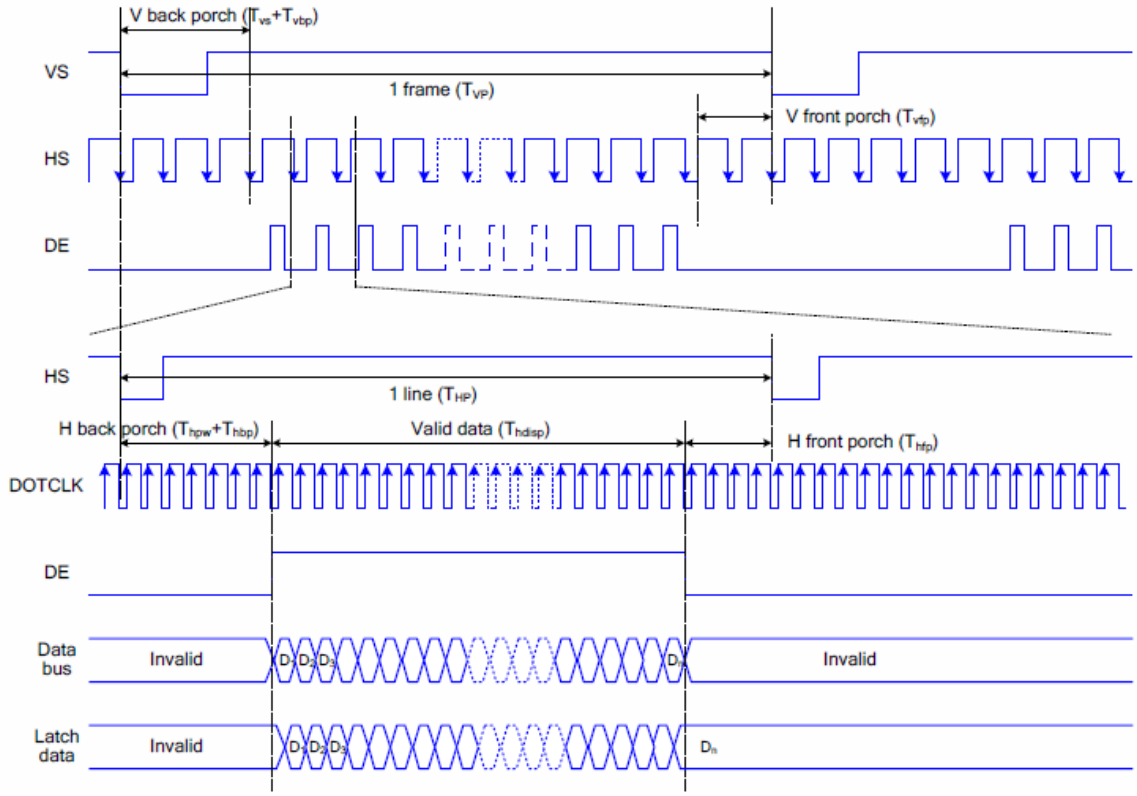
8.2.4 RGB Interface Mode Selection

ST7789 supports two kinds of RGB interface, DE mode and HV mode. Each mode also can select with ram and without ram. The table shown below uses command B1h to select RGB interface mode.

RCM[1:0]	WO	RGB Mode	Data Path
10	0	DE mode	Ram
	1		Shift register (without Ram)
11	0	HV mode	Ram
	1		Shift register (without Ram)

8.2.5 RGB Interface Timing

The timing chart of RGB interface DE mode is shown as follows.



Note: The setting of front porch and back porch in host must match that in IC as this mode.

Figure 25 Timing Chart of Signals in RGB Interface DE Mode

The timing chart of RGB interface HV mode is shown as follows.

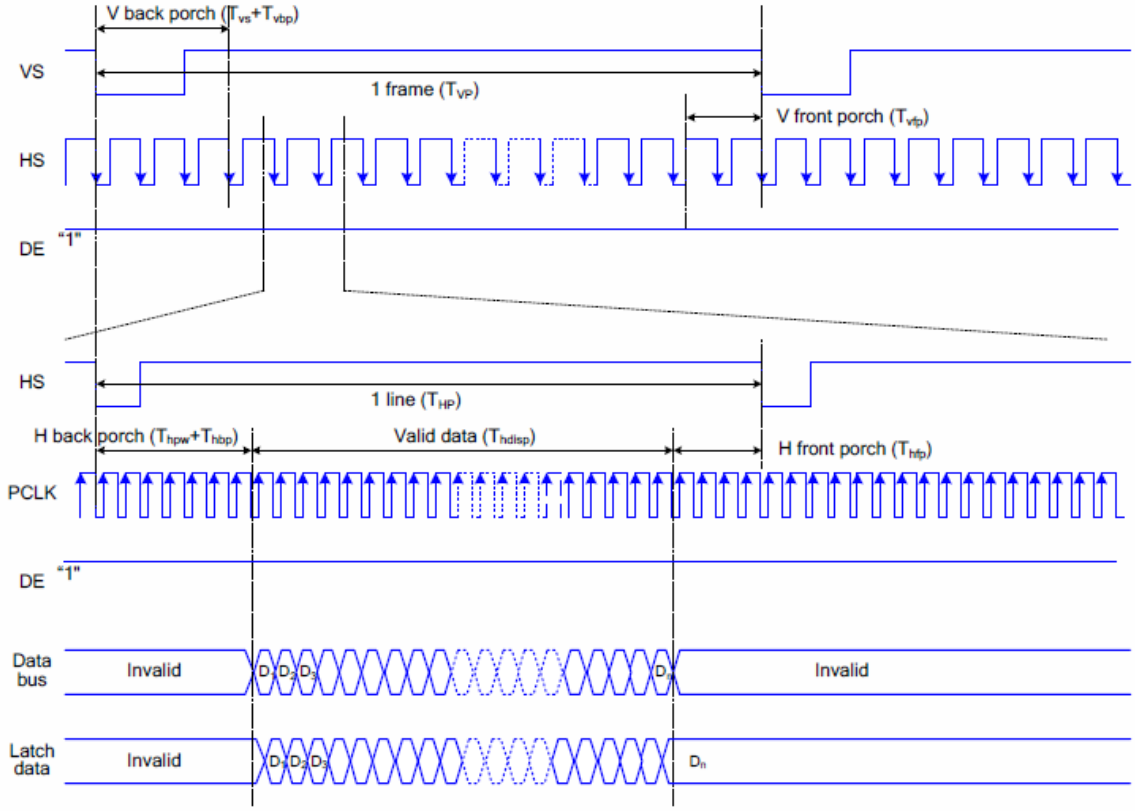


Figure 26 Timing chart of RGB interface HV mod

The following are the functions not available in RGB Input Interface mode.

Function	RGB Interface	I80 System Interface
Partial display	Not available	Available
Scroll function	Not available	Available
Interval scan	Not available	Available
Graphics operation function	Not available	Available

VSYNC, HSYNC, and DOTCLK signals must be supplied during a display operation period.

In RGB interface mode, the panel controlling signals are generated from DOTCLK, not the internal clock generated from the internal oscillator.

In 6-bit RGB interface mode, each of RGB dots are transferred in synchronization with DOTCLK signals. In other words, one pixel data needs to take three DOTCLKs to transfer.

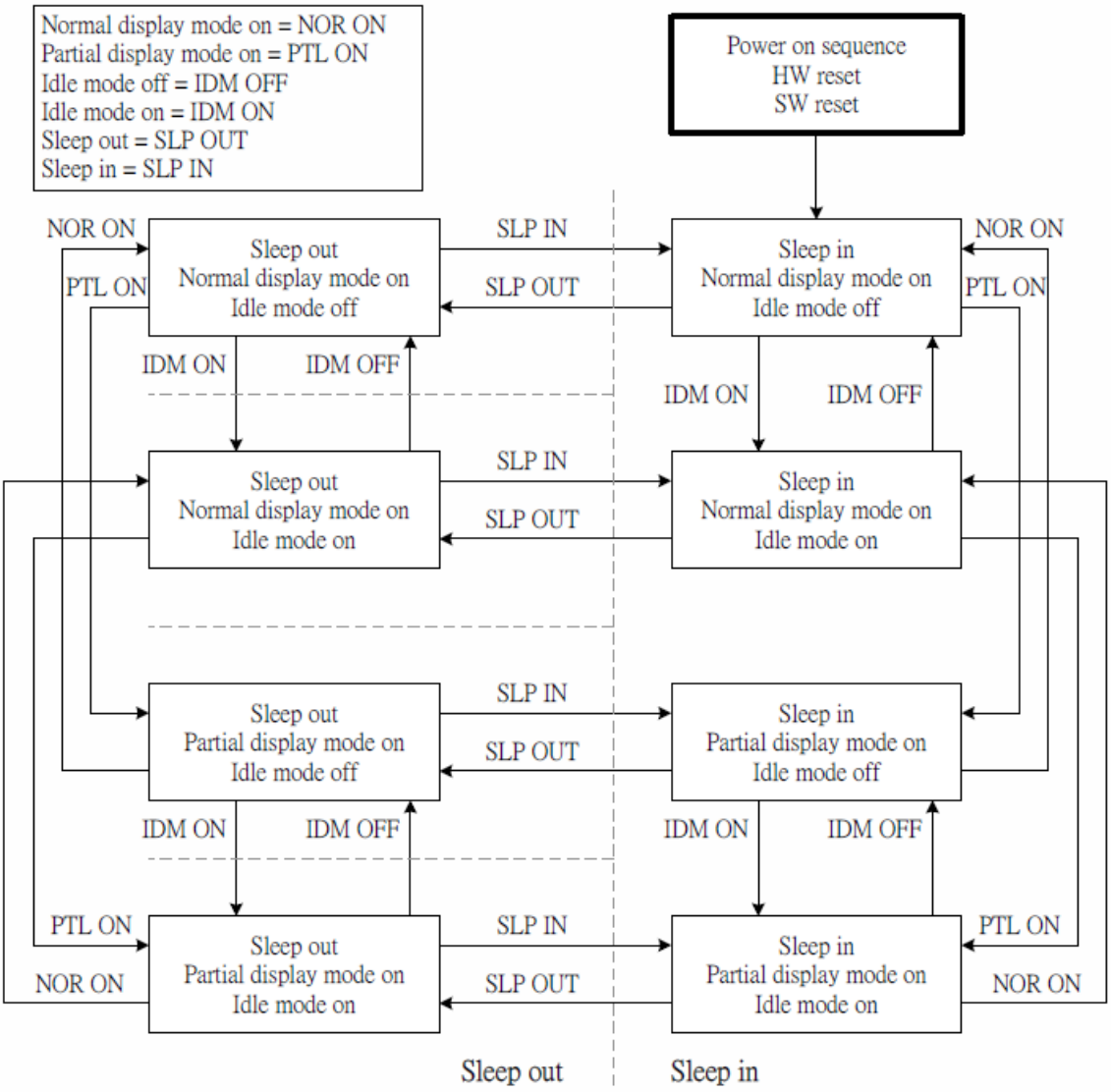
In 6-bit RGB interface mode, the cycles of VSYNC, HSYNC, ENABLE, DOTCLK signals must be set correctly so that the data transfer is completed in units of pixels.

When switching between the internal operation mode and the external display interface operation mode, follow the sequences below in setting instruction.

In RGB interface mode, the front porch period continues until the next VSYNC input is detected after drawing one frame.

In RGB interface mode, a RAM address is set in the address counter every frame on the falling edge of VSYNC.

9 SETUP FLOW OF POWER SUPPLY



10. RELIABILITY

Test Item	Test Conditions	Note
High Temperature Operation	70±3°C , t=240 hrs	
Low Temperature Operation	-20±3°C , t=240 hrs	
High Temperature Storage	80±3°C , t=240 hrs	1,2
Low Temperature Storage	-30±3°C , t=240 hrs	1,2
Storage Humidity Test	60°C , Humidity 90%, 240 hrs	1,2
Thermal Shock Test	-30°C ~ 25°C ~ 80°C 30 min. 5 min. 30 min. (1 cycle) Total 5 cycle	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).

Note 3: The module shouldn't be tested more than one condition, and all the test conditions are independent.

Note 4: All the reliability tests should be done without protective film on the module.

Definitions of life end point :

- Current drain should be smaller than the specific value.
- Function of the module should be maintained.
- Appearance and display quality should not have degraded noticeably.
- Contrast ratio should be greater than 50% of the initial value.

11. USE PRECAUTIONS

11.1 Handling precautions

1) The polarizing plate may break easily so be careful when handling it. Do not touch, press or rub it with a hard-material tool like tweezers.
2) Do not touch the polarizing plate surface with bare hands so as not to make it dirty. If the surface or other related part of the polarizing plate is dirty, soak a soft cotton cloth or chamois leather in benzine and wipe off with it. Do not use chemical liquids such as acetone, toluene and isopropyl alcohol. Failure to do so may bring chemical reaction phenomena and deteriorations.
3) Remove any spit or water immediately. If it is left for hours, the suffered part may deform or decolorize.
4) If the LCD element breaks and any LC stuff leaks, do not suck or lick it. Also if LC stuff is stuck on your skin or clothing, wash thoroughly with soap and water immediately.

11.2 Installing precautions

1) The PCB has many ICs that may be damaged easily by static electricity. To prevent breaking by static electricity from the human body and clothing, earth the human body properly using the high resistance and discharge static electricity during the operation. In this case, however, the resistance value should be approx. 1MΩ and the resistance should be placed near the human body rather than the ground surface. When the indoor space is dry, static electricity may occur easily so be careful. We recommend the indoor space should be kept with humidity of 60% or more. When a soldering iron or other similar tool is used for assembly, be sure to earth it.
2) When installing the module and ICs, do not bend or twist them. Failure to do so may crack LC element and cause circuit failure.
3) To protect LC element, especially polarizing plate, use a transparent protective plate (e.g., acrylic plate, glass etc) for the product case.
4) Do not use an adhesive like a both-side adhesive tape to make LCD surface (polarizing plate) and product case stick together. Failure to do so may cause the polarizing plate to peel off.

11.3 Storage precautions

1) Avoid a high temperature and humidity area. Keep the temperature between 0°C and 35°C and also the humidity under 60%.
2) Choose the dark spaces where the product is not exposed to direct sunlight or fluorescent light.
3) Store the products as they are put in the boxes provided from us or in the same conditions as we recommend.

11.4 Operating precautions

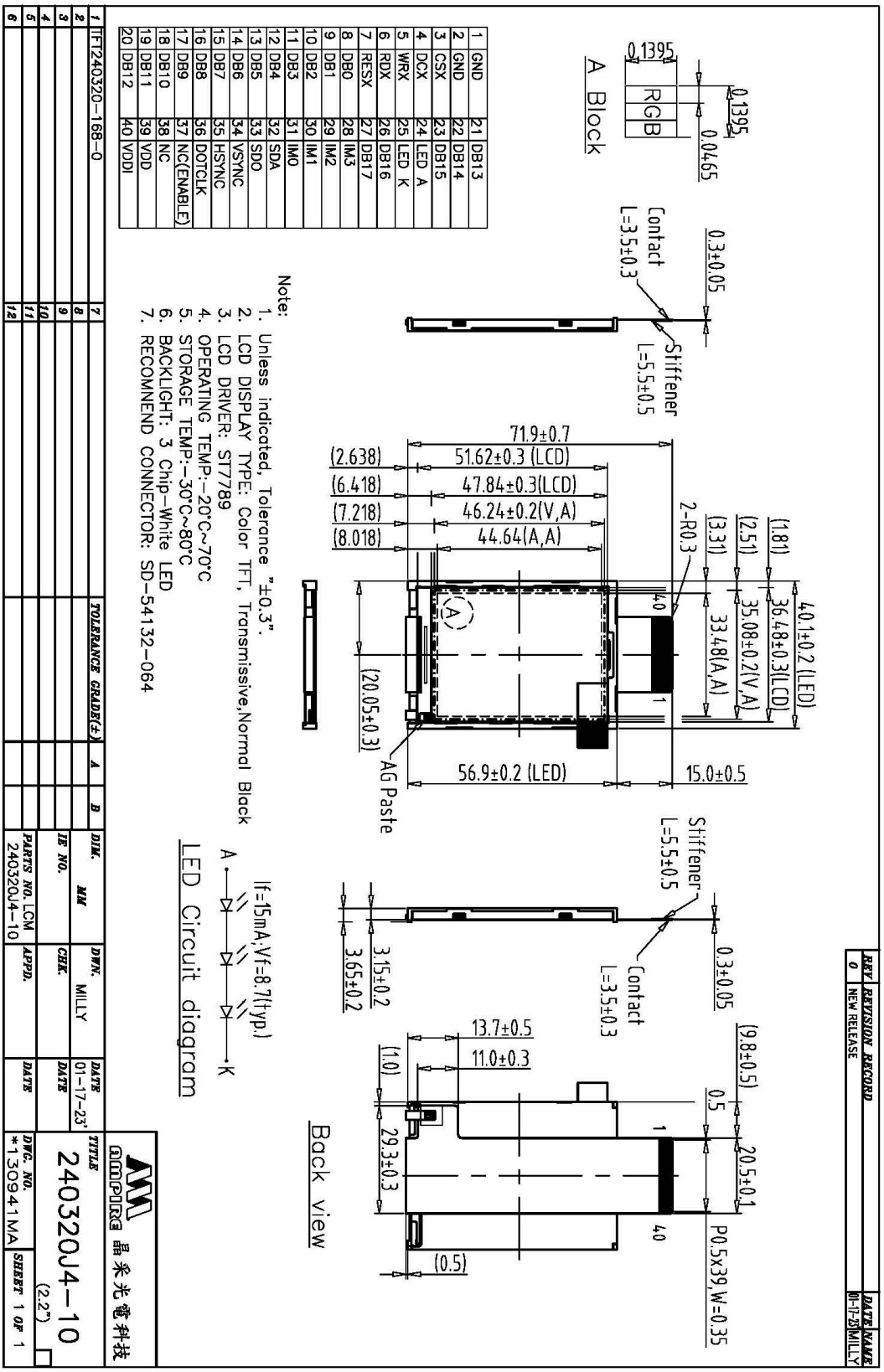
1) Do not boost the applied drive voltage abnormally. Failure to do so may break ICs. When applying power voltage, check the electrical features beforehand and be careful. Always turn off the power to the LC module controller before removing or inserting the LC module input connector. If the input connector is removed or inserted while the power is turned on, the LC module internal circuit may break.
2) The display response may be late if the operating temperature is under the normal standard, and the display may be out of order if it is above the normal standard. But this is not a failure; this will be restored if it is within the normal standard.
3) The LCD contrast varies depending on the visual angle, ambient temperature, power voltage etc. Obtain the optimum contrast by adjusting the LC dive voltage.
4) When carrying out the test, do not take the module out of the low-temperature space suddenly. Failure to do so will cause the module condensing, leading to malfunctions.
5) Make certain that each signal noise level is within the standard (L level: 0.2Vdd or less and H level: 0.8Vdd or more) even if the module has functioned properly. If it is beyond the standard, the module may often malfunction. In addition, always connect the module when making noise level measurements.
6) The CMOS ICs are incorporated in the module and the pull-up and pull-down function is not adopted for the input so avoid putting the input signal open while the power is ON.
7) The characteristic of the semiconductor element changes when it is exposed to light emissions, therefore ICs on the LCD may malfunction if they receive light emissions. To prevent these malfunctions, design and assemble ICs so that they are shielded from light emissions.

8) Crosstalk occurs because of characteristics of the LCD. In general, crosstalk occurs when the regularized display is maintained. Also, crosstalk is affected by the LC drive voltage. Design the contents of the display, considering crosstalk.

11.5 Mechanism precautions

1) Please mount LCD module by using mounting holes arranged in four corners tightly.

11.6 Other

1) Do not disassemble or take the LC module into pieces. The LC modules once disassembled or taken into pieces are not the guarantee articles.
2) 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.
3) AMIPRE will provide one year warrantee for all products and three months warrantee for all repairing products.

12 Mechanical Drawing