

TFT SPECIFICATION

Part Number	USMP-LPS-T024-024032MFW-B1
Size	2.4"
Resolution	240 x 320
Brightness	350 cd/m²
Contrast	1200:1
Viewing Angle	85/85/85/85
Operating Temp.	-20 ~ 70°C

FOR ADDITIONAL INFORMATION
PLEASE CONTACT:
engineering@usmicroproducts.com

Issue Date	Approved by (customer use)	Checked by	Prepared by

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Table of Contents

No.	Item	Page
1	Cover Sheet(Table of Contents)	P1
2	Revision Record	P2
3	General Specifications	P3-P4
4	Outline Drawing and Packaging drawing	P5~P6
5	Absolute Maximum Ratings	P7
6	Electrical Specifications	P8-P17
7	Optical Characteristics	P18-P21
8	Reliability Test Items and Criteria	P22-P23
9	Precautions for Use of LCD Modules	P23-P24

2. Revision Record

Date	Rev.No.	Page	Revision Items	Prepared
2024.1.30	V0		The first release	YZJ

3. General Specifications

USMP-LPS-T024-024032MFW-B1 is a TFT-LCD module. It is composed of a TFT-LCD panel, driver IC, FPC, a back light unit and CTP. The 2.4" display area contains 240x320 pixels and can display up to 262K colors. This product accords with RoHS environmental criterion.

3.1 LCD Parameter

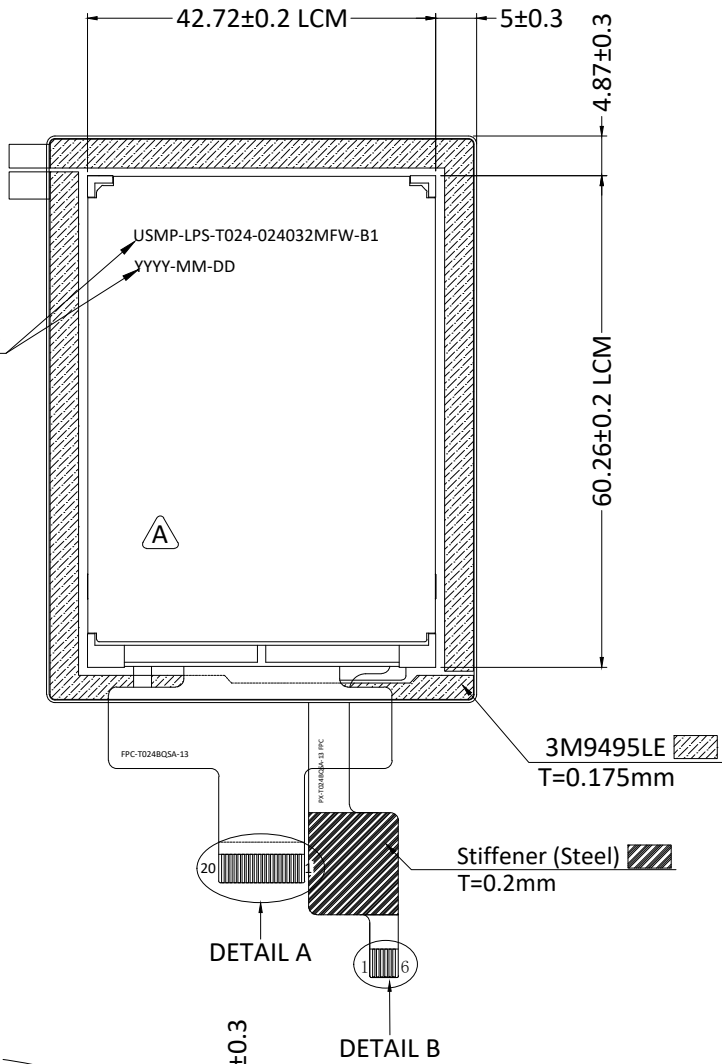
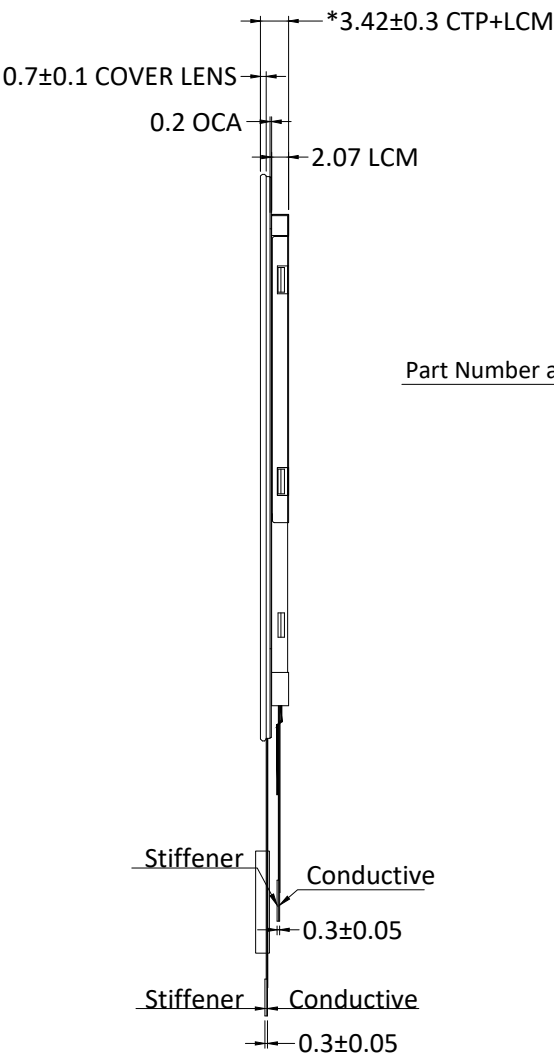
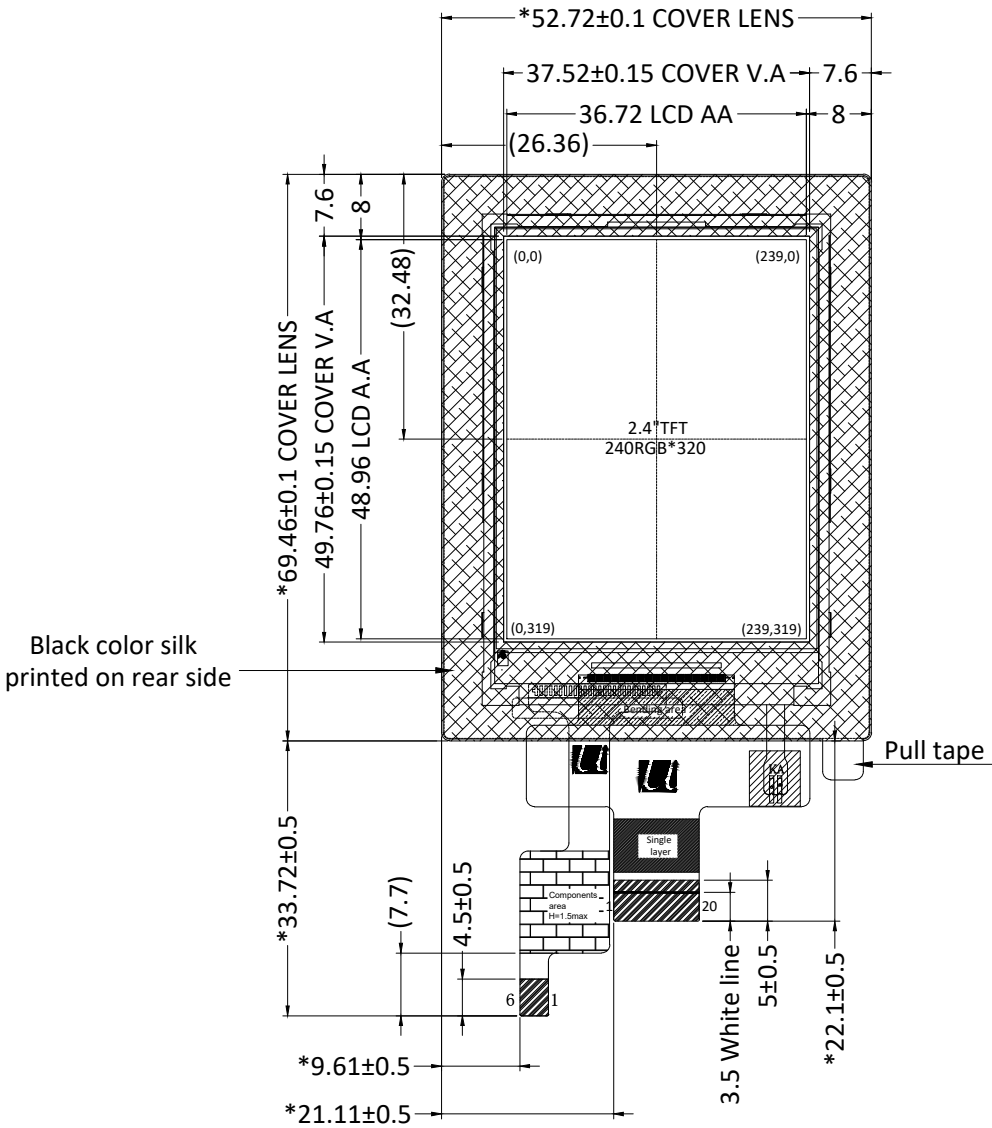
Item	Contents	Unit	Note
LCD Type	TFT	-	
Display color	262K		
Viewing Direction	ALL	O'Clock	
Operating temperature	-20~+70	°C	
Storage temperature	-30~+80	°C	
Module size	Refer to outline drawing	mm	
Active Area(W×H)	48.96X36.72	mm	
Number of Dots	240 (RGB) x320	dots	
Driver IC	ST7789P3	-	
Power Supply Voltage	2.8	V	
Backlight	4P-LEDs (white)	pcs	
Interface	MCU 8bits	-	

3.2 CTP Parameter

Item	Contents	Unit	Note
Outline Size	52.72(H)X69.46(V)X1.15(T)	mm	
Structure	G+FF		
Cover View Area	37.52(H)X49.76(V)		
CTP Resolution	240x320	dots	
Interface Mode	IIC	-	
Touch Mode	2 Human fingers touch	-	
Surface hardness	$\geq 7H$	-	
Transparency	$\geq 85\%$	-	
Accuracy	Entre $\pm 1.5\text{mm}$, Edge $\pm 2.5\text{mm}$	mm	
CTP Controller	ST1633I	-	
Power Supply Voltage	3.3	V	

All MATERIALS MUST COMPLY WITH RoHS DIRECTIVE

FORMAL DRAWING



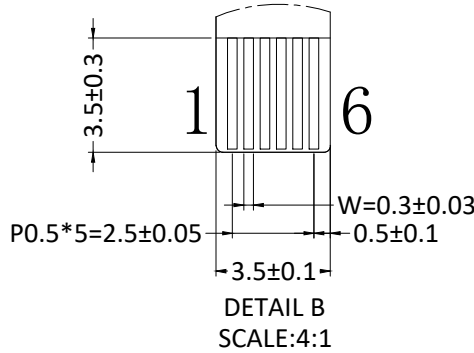
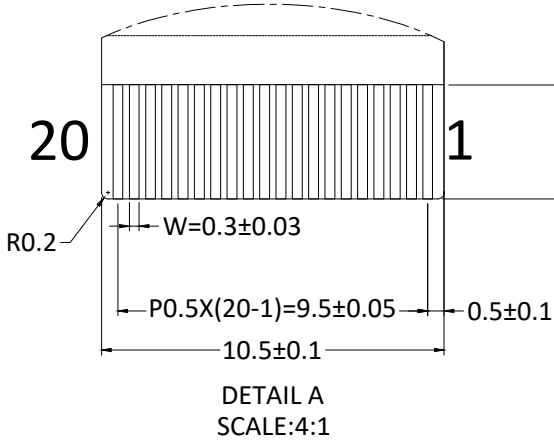
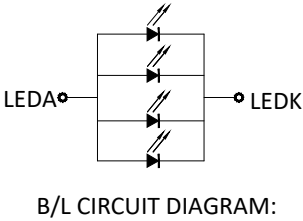
LCM PIN DESCRIPTION:

1	GND
2	VDD
3	VDD
4	GND
5	TE
6	CS
7	DC
8	WR
9	RD
10	D0
11	D1
12	D2
13	D3
14	D4
15	D5
16	D6
17	D7
18	RST
19	LEDA
20	LEDK

CTP PIN DESCRIPTION:

PIN#	Name
1	INT
2	VCC
3	GND
4	RST
5	SCL(1.8V)
6	SDA(1.8V)

- NOTES:
- LCD/TP Driver IC : ST7789P3/ST1633I
 - CTP+LCM Brightness : 300 cd/m2(min.) ; 350 cd/m2(typ.).
 - Chromaticity Coordinate : X : 0.31±0.05 , Y : 0.33±0.05.
 - B/L LED : 1 chip-white LEDS Series*4 , IF = 80mA , VF = 3.3V(typ.).
 - Cover Lens Surface Treatment : Hard-Coating.
 - Dimensions in Brackets"()" are for Reference Only.
 - Dimensions in Brackets " * " are Critical Dimension.
 - Tolerance not Specified: ±0.3mm.



DISPLAY TYPE	2.4 inch-TFT , Normally Black	VERSION	RECORD	DATE		SCALE	1:1	 ENGINEERED DISPLAY SOLUTIONS			
DISPLAY MODE	Transmissive	B0	NEW RELEASE	10-19-23		UNIT	mm				
DISPLAY RESOLUTION	240RGBX320	B1	MODIFY THE BEZEL ON BACKLIGHT	12-20-23	DRAWN BY	CHRIS HO		MODULE NO.			
VIEWING DIRECTION	All Direction				CHECKED BY			USMP-LPS-T024-024032MFW-B1			
OPERATING TEMP.	-20°C ~ +70°C				APPROVED BY			DRAWING NAME			
STORAGE TEMP.	-30°C ~ +80°C							2.4 inch - CTP+LCM Outline			
INTERFACE	LCM: MCU, CTP: I2C				DATE	12-20-23		SHEET	1 of 1	REV.	B1

5. Absolute Maximum Ratings($T_a=25^{\circ}\text{C}$)

5.1 Electrical Absolute Maximum Ratings.($V_{ss}=0\text{V}$, $T_a=25^{\circ}\text{C}$)

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage for TFT	VDD	-0.3	4.6	V	1, 2
Power Supply Voltage for CTP	VCC	-0.5	6	V	1, 2

Notes:

1. If the module is above these absolute maximum ratings. It may become permanently damaged. Using the module within the following electrical characteristic conditions are also exceeded, the module will malfunction and cause poor reliability.
2. $V_{DD} > V_{SS}$ must be maintained.
3. Please be sure users are grounded when handing LCD Module.

5.2 Environmental Absolute Maximum Ratings.

Item	Storage		Operating	
	MIN.	MAX.	MIN.	MAX.
Ambient Temperature	-30°C	80°C	-20°C	70°C
Humidity	-	-	-	-

1. The response time will become lower when operated at low temperature.
2. Background color changes slightly depending on ambient temperature.
The phenomenon is reversible.
3. $T_a \leq 40^{\circ}\text{C}$: 85%RH MAX.
 $T_a > 40^{\circ}\text{C}$: Absolute humidity must be lower than the humidity of 85%RH at 40°C .

6. Electrical Specifications and Instruction Code

6.1 TFT Electrical characteristics($V_{SS}=0V$, $T_a=25^{\circ}C$)

Parameter	Symbol	Condition	Min	Typ	Max	Unit	Note
Power Supply Voltage for TFT	VDD	$T_a=25^{\circ}C$	2.4	2.8	3.3	V	
Power supply current for TFT	IDD	$T_a=25^{\circ}C$	-	10	15	mA	White color display pattern
Logic Input voltage	'H'	V_{IH}	$T_a=25^{\circ}C$	0.7VDD	-	VDD	V
	'L'	V_{IL}	$T_a=25^{\circ}C$	0	-	0.3VDD	V

Note: If one of the above items is exceeded its maximum limitation momentarily, the quality of the product may be degraded. Absolute maximum limitation, therefore, specify the values exceeding which the product may be physically damaged. Be sure to use the product within the recommend range.

6.2 LED backlight specification($V_{SS}=0V$, $T_a=25^{\circ}C$)

Item	Symbol	Condition	Min	Typ	Max	Unit	Note
Supply voltage VLED	V_f	$I_f=80mA$	2.7	3.0	3.3	V	
Uniformity	ΔBp	$I_f=80mA$	80	85	-	%	
LED Life Time	-	$I_f=80mA$	30k	-	-	hr	1

Note 1: Brightness to be decreased to 50% of the initial value at ambient temperature $T_a=25^{\circ}C$

6.3 Interface signals

6.3.1 LCM PIN

Pin No.	Symbol	I/O	Function
1	GND	P	Ground
2	VDD	P	Power Supply Voltage for TFT
3	VDD	P	Power Supply Voltage for TFT
4	GND	P	Ground
5	TE	O	Tearing effect signal is used to synchronize MCU to frame memory
6	CS	I	Chip select input pin
7	DC	I	Serves as the selector of command or data
8	WR	I	Write signal
9	RD	I	Read signal
10~17	D0~D7	I/O	MCU parallel interface data bus
18	RST	I	Global reset signal input pin
19	LED A	P	LED back light(Anode)
20	LED K	P	LED back light(Cathode)

6.3.2 CTP interface

Pin No.	Symbol	I/O	Function
1	INT	I/O	External Interrupt pin
2	VCC	P	Power Supply Voltage for CTP
3	GND	P	Ground
4	RST	I	Reset signal
5	SCL(1.8V)	I/O	Serial interface clock
6	SDA(1.8V)	I/O	Data pin

6.4 Power ON/OFF Sequence

VDDI and VDD connected together.

During power off, if LCD is in the Sleep Out mode, VDD must be powered down minimum 120msec after RESX has been released.

During power off, if LCD is in the Sleep In mode, VDD can be powered down minimum 0msec after RESX has been released.

CSX can be applied at any timing or can be permanently grounded. RESX has priority over CSX.

Note 1: There will be no damage to the display module if the power sequences are not met.

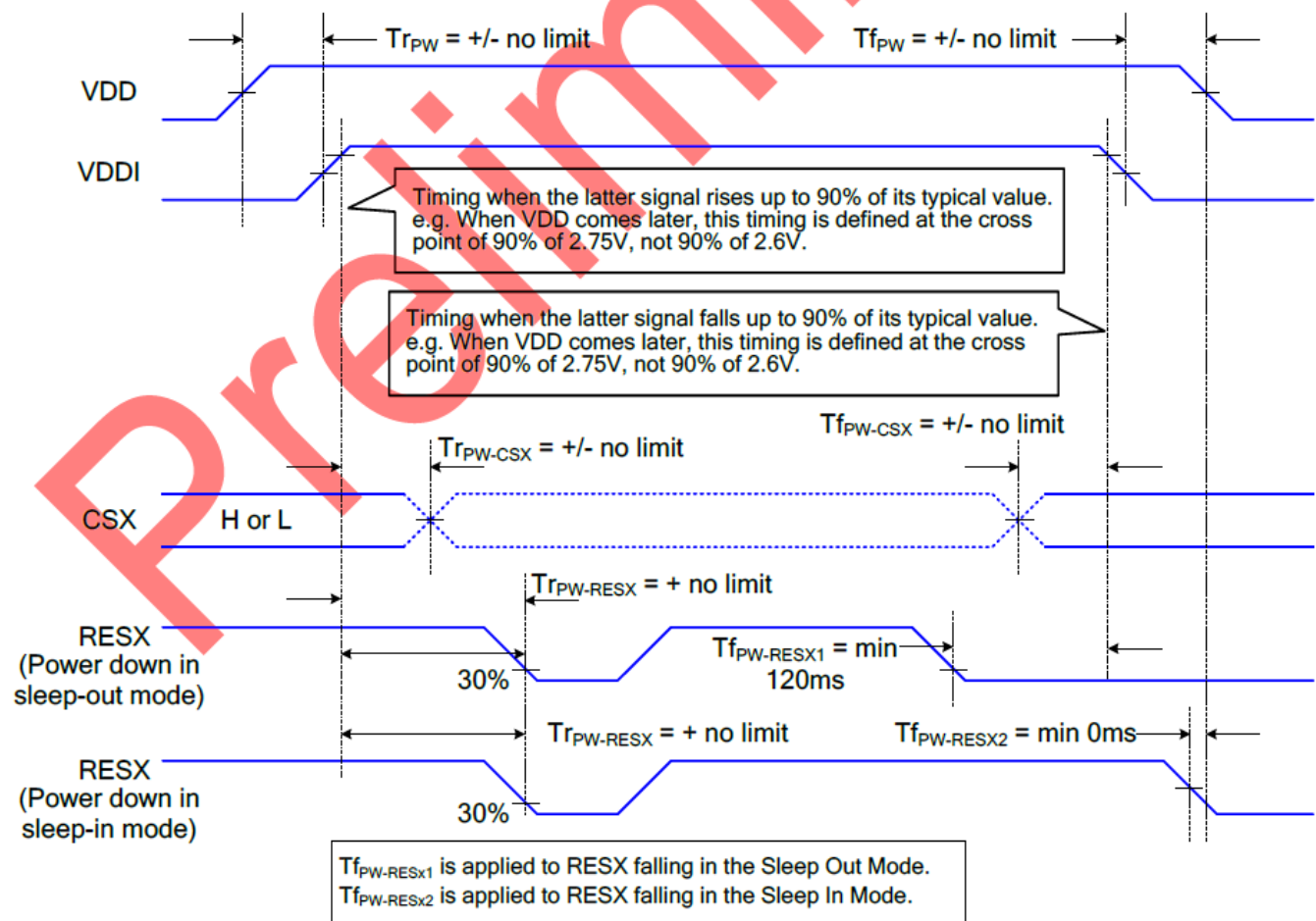
Note 2: There will be no abnormal visible effects on the display panel during the Power On/Off Sequences.

Note 3: There will be no abnormal visible effects on the display between end of Power On Sequence and before receiving Sleep Out

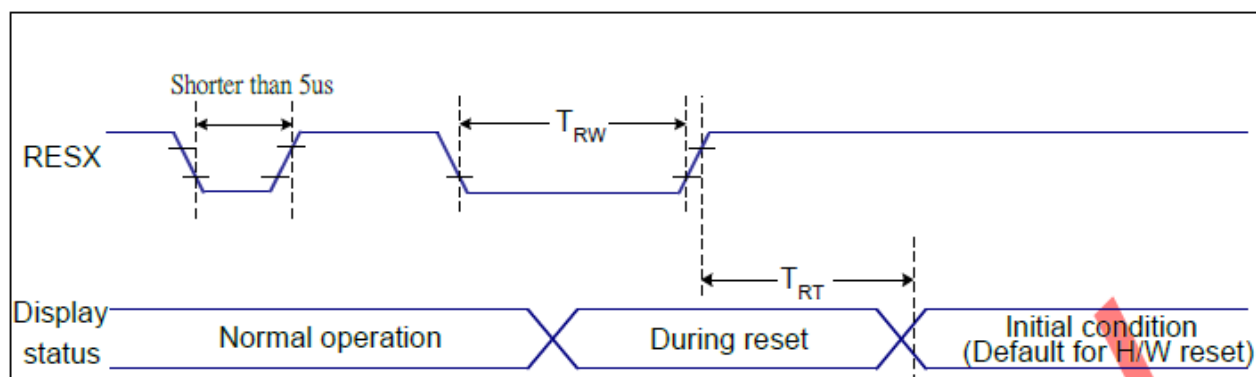
command. Also between receiving Sleep In command and Power Off Sequence.

Note 4: If RESX line is not held stable by host during Power On Sequence as defined in the sequence below, then it will be necessary to

apply a Hardware Reset (RESX) after Host Power On Sequence is complete to ensure correct operation. Otherwise function is not guaranteed.



6.5 Reset Timing



Related Pins	Symbol	Parameter	MIN	MAX	Unit
RESX	TRW	Reset pulse duration	10	-	us
	TRT	Reset cancel	-	5 (Note 1, 5)	ms
			-	120 (Note 1, 6, 7)	ms

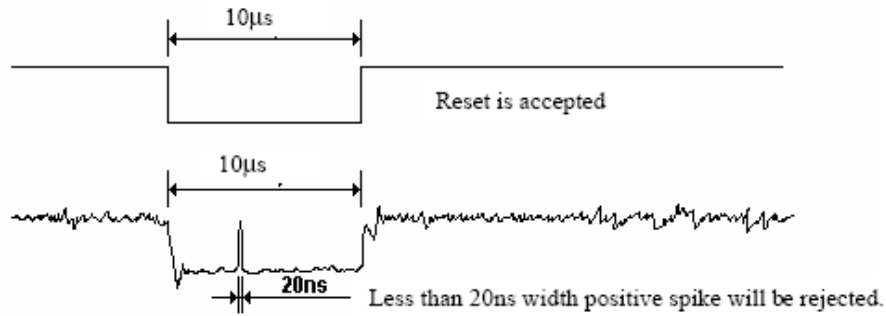
Notes:

1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time (trt) within 5 ms after a rising edge of RESX.
2. Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below:

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

3. 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 return to Default condition for Hardware Reset.

4. Spike Rejection also applies during a valid reset pulse as shown below:



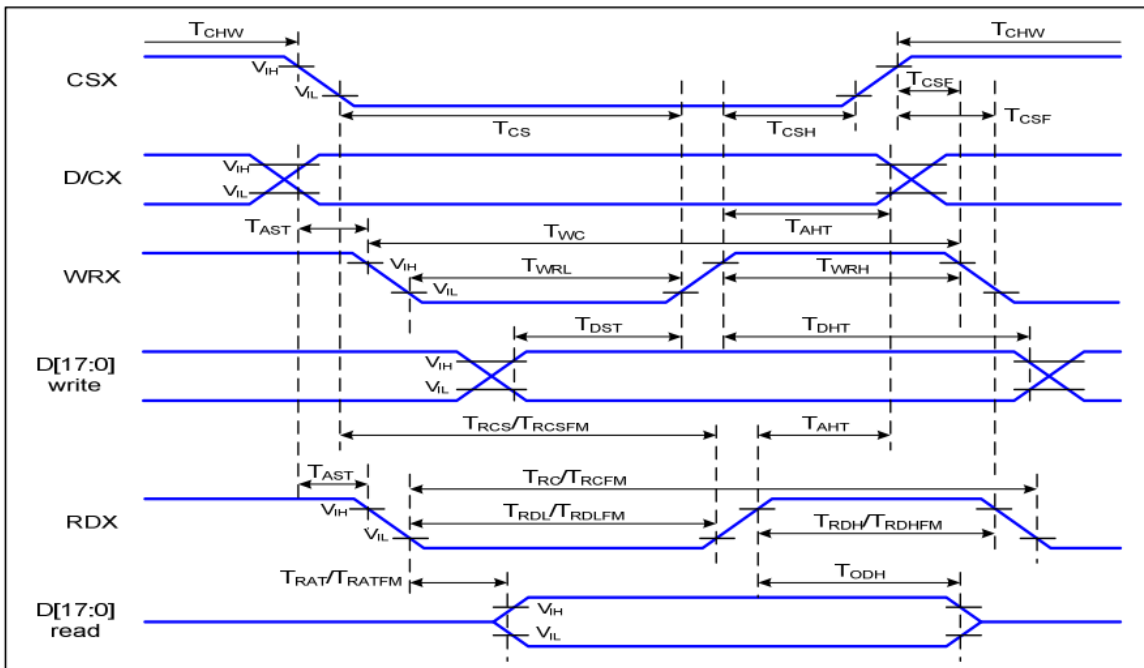
5. When Reset applied during Sleep In Mode.

6. When Reset applied during Sleep Out Mode.

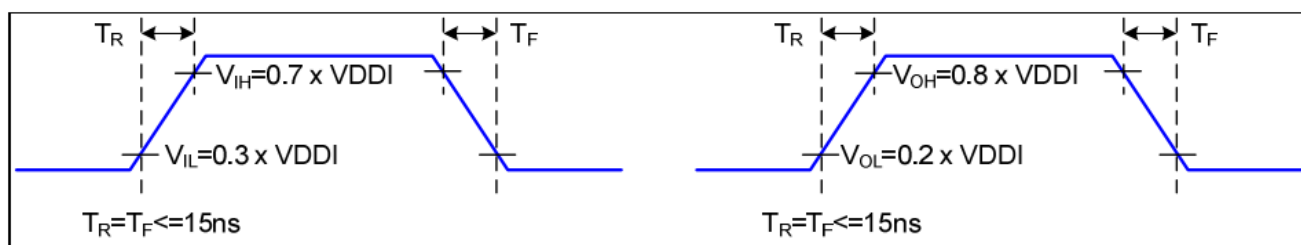
7. It is necessary to wait 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec.

6.6 Timing Characteristics

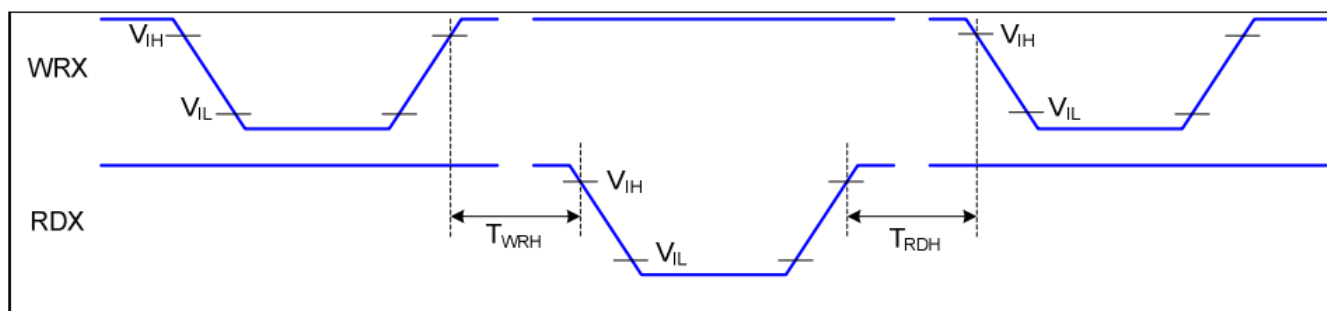
6.6.1 Parallel 8080 Series MCU Parallel Interface Characteristics: 18/16/9/8-bit Bus



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



Rising and Falling Timing for I/O Signal



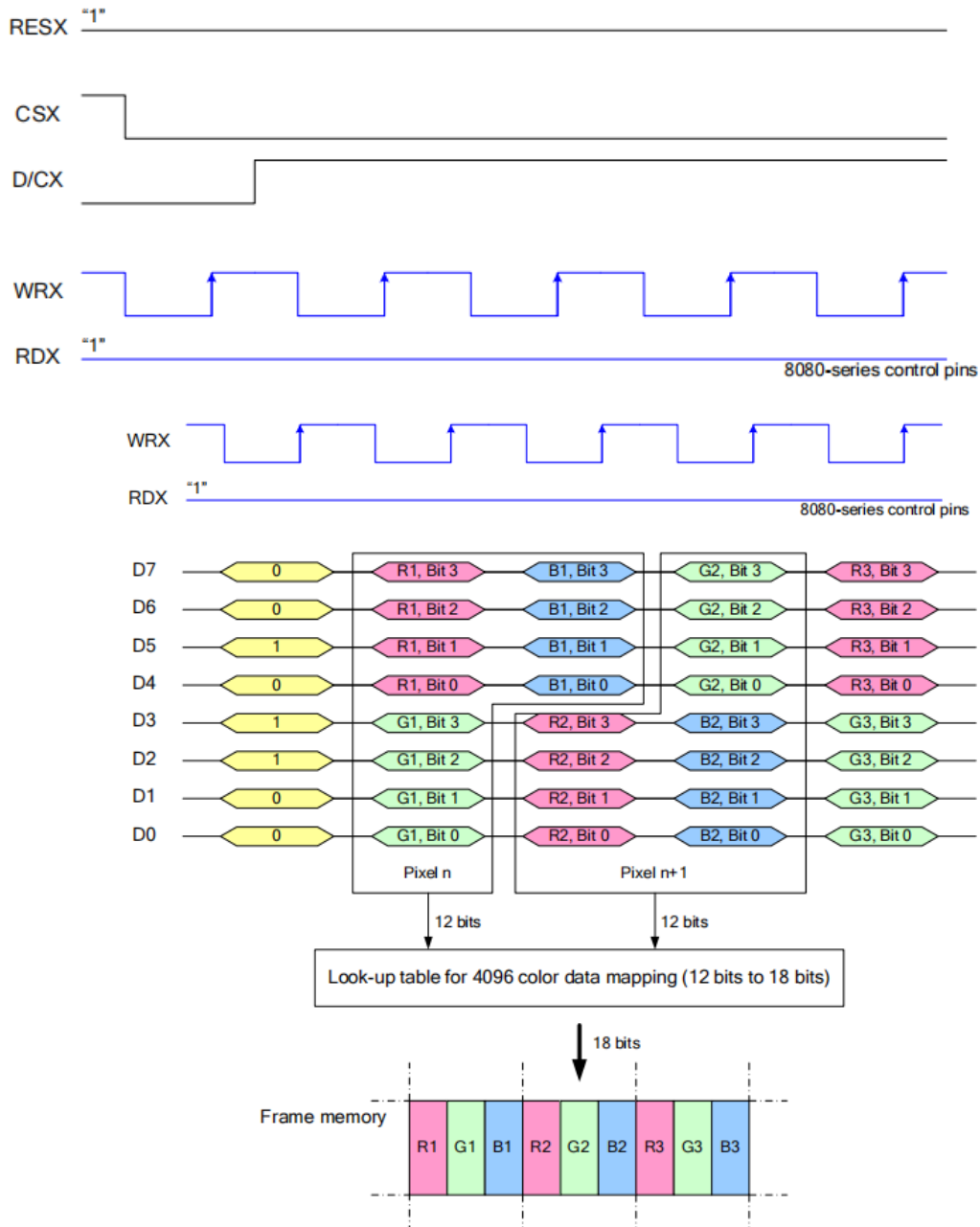
Write-to-Read and Read-to-Write Timing

6.62 Data Color Coding

The 8080- series 8-bit parallel interface of ST7789 can be used by setting IM[3:0]="0000b". Different display data formats are available for three Colors depth supported by listed below.

- 4k colors, RGB 4,4,4-bit input.
- 65k colors, RGB 5,6,5-bit input.
- 262k colors, RGB 6,6,6-bit input.

8-bit data bus for 12-bit/pixel (RGB 4-4-4-bit input), 4K-Colors, 3Ah="03h"



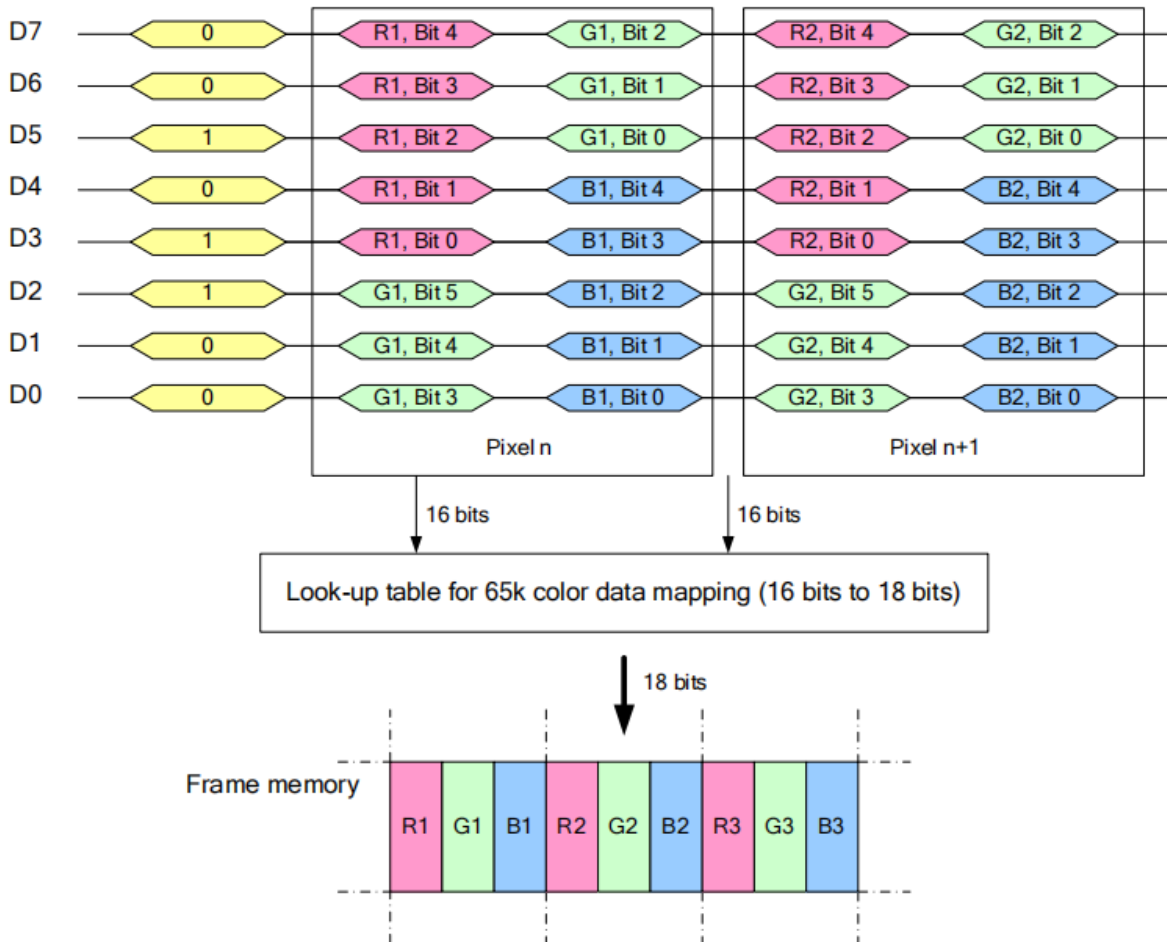
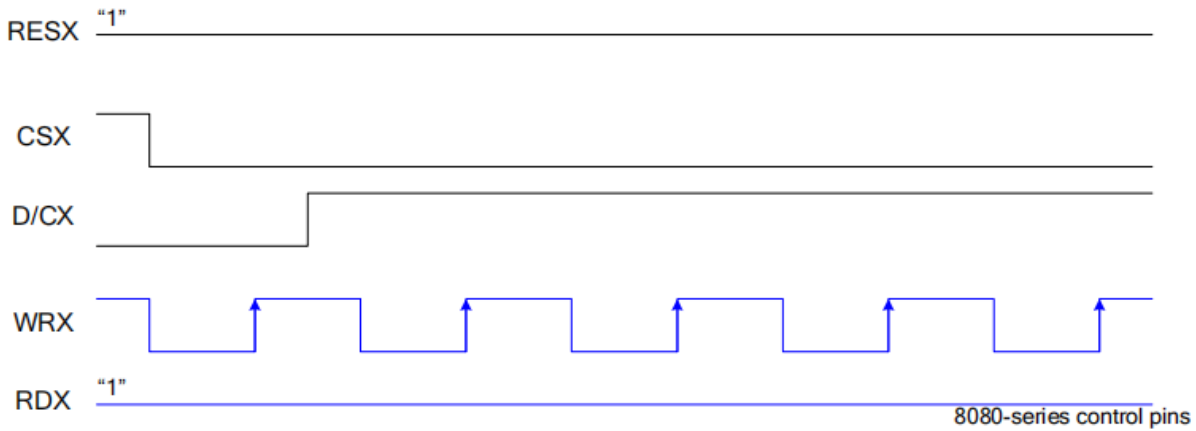
Note 1: The data order is as follows, MSB=D7, LSB=D0 and picture data is MSB=Bit 3, LSB=Bit 0 for Red, Green and Blue data.

Note 2: 3-time transfer is used to transmit 2 pixel data with the 12-bit color depth information.

Note 3: '-' = Don't care – Can be set to '0' or '1'

8-bit data bus for 16-bit/pixel (RGB 5-6-5-bit input), 65K-Colors, 3Ah="05h"

There is 1pixel (3 sub-pixels) per 2-byte



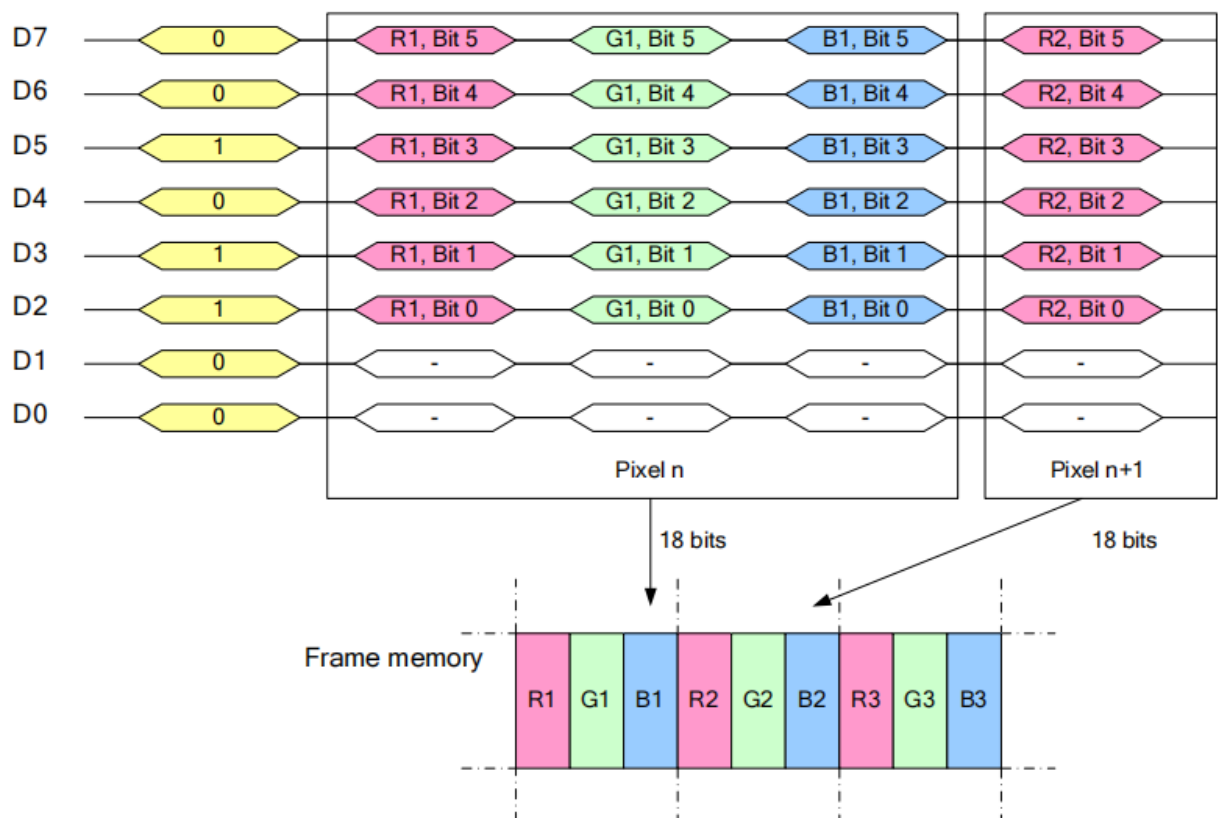
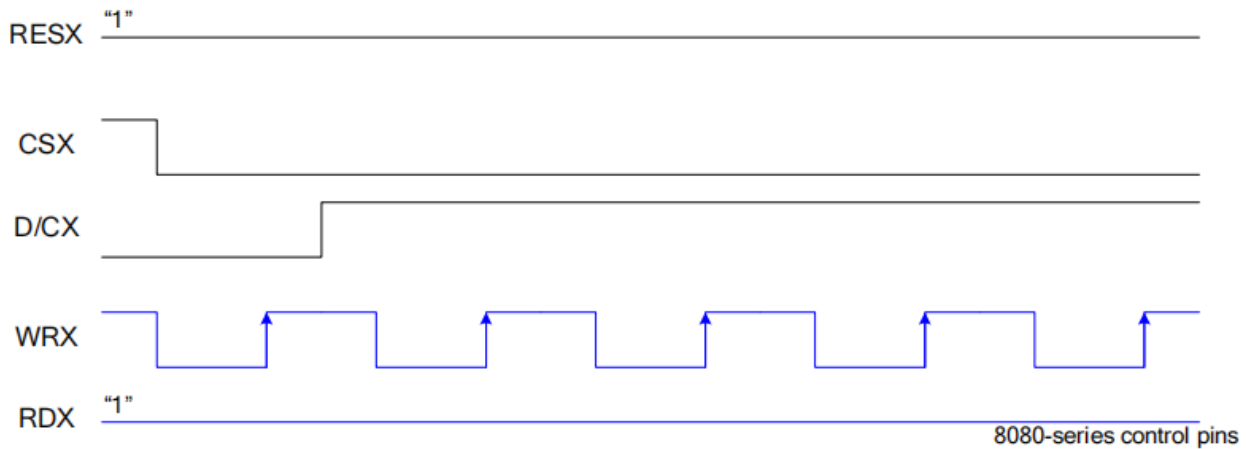
Note 1: The data order is as follows, MSB=D15, LSB=D0 and picture data is MSB=Bit 5, LSB=Bit 0 for Green, and MSB=Bit 4, LSB=Bit 0 for Red and Blue data.

Note 2: 2-times transfer is used to transmit 1 pixel data with the 16-bit color depth information.

Note 3: '-' = Don't care – Can be set to '0' or '1'

8-bit data bus for 18-bit/pixel (RGB-6-6-6-bit input), 262K-Colors, 3Ah="06h"

There is 1pixel (3 sub-pixels) per 3-bytes.



Note 1: The data order is as follows, MSB=D7, LSB=D0 and picture data is MSB=Bit 5, LSB=Bit 0 for Red, Green and Blue data.

Note 2: 3-times transfer is used to transmit 1 pixel data with the 18-bit color depth information.

Note 3: '-' = Don't care – Can be set to '0' or '1'

7. Optical Characteristics

Item	Symbol		Condition	Min.	Typ.	Max.	Unit	Note				
Brightness	Bp		$\theta=0^{\circ}$ $\Phi=0^{\circ}$	300	350	-	cd/m ²	1				
Uniformity	△Bp			80	85	-	%	1,2				
Viewing Angle	3:00		Cr≥10	80	85	-	Deg	3				
	6:00			80	85	-						
	9:00			80	85	-						
	12:00			80	85	-						
Contrast Ratio	Cr		$\theta=0^{\circ}$ $\Phi=0^{\circ}$	900	1200	-	-	4				
Response Time	T _r +T _f			-	35	40	ms	5				
Color of CIE Coordinate	W	x	$\theta=0^{\circ}$ $\Phi=0^{\circ}$	Typ-0 .03	0.310	Typ+0. 03	-	1,6				
		y			0.330		-					
	R	x			0.640		-					
		y			0.350		-					
	G	x			0.336		-					
		y			0.638		-					
	B	x			0.148		-					
		y			0.107		-					
	NTSC Ratio	S			65		70		-	%		

Note: The parameter is slightly changed by temperature, driving voltage and materiel

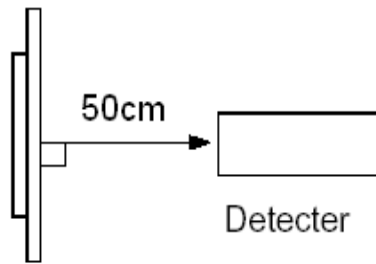
Note 1: The data are measured after LEDs are turned on for 5 minutes. LCM displays full white. The brightness is the average value of 9 measured spots. Measurement equipment BM-7 (Φ5mm)

Measuring condition:

- Measuring surroundings: Dark room.
- Measuring temperature: $T_a=25^\circ\text{C}$.
- Adjust operating voltage to get optimum contrast at the center of the display.

Measured value at the center point of LCD panel after more than 5 minutes while backlight

turning on.

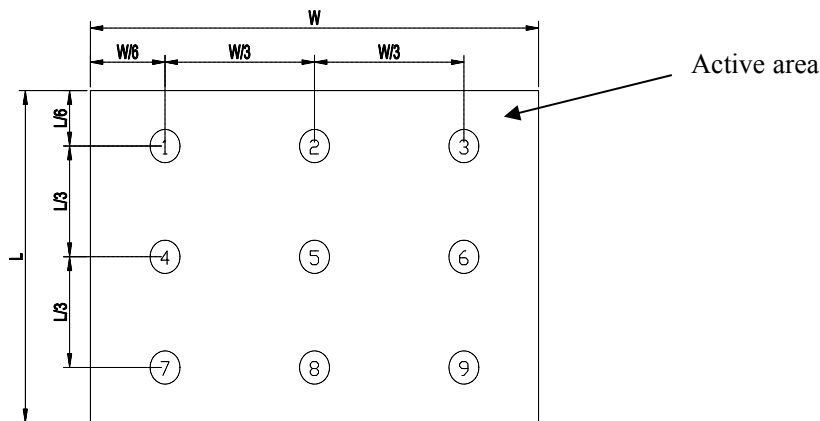


Note 2: The luminance uniformity is calculated by using following formula.

$$\Delta Bp = Bp \text{ (Min.)} / Bp \text{ (Max.)} \times 100 \text{ (\%)}$$

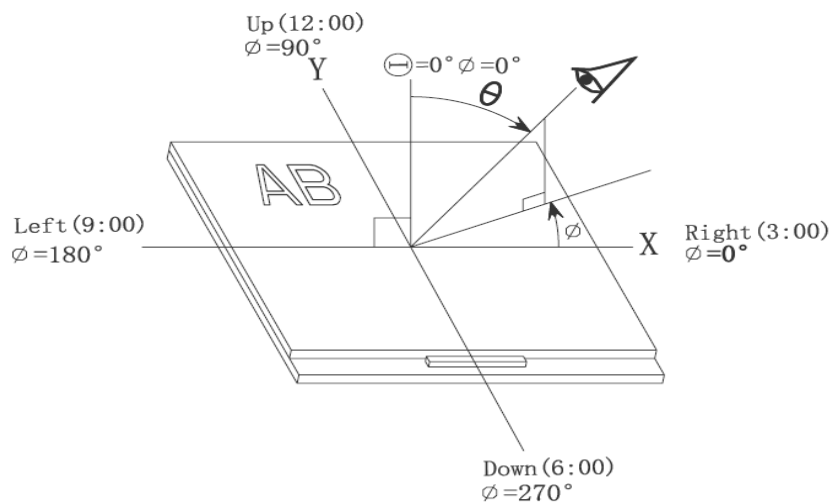
$Bp \text{ (Max.)}$ = Maximum brightness in 9 measured spots

$Bp \text{ (Min.)}$ = Minimum brightness in 9 measured spots.

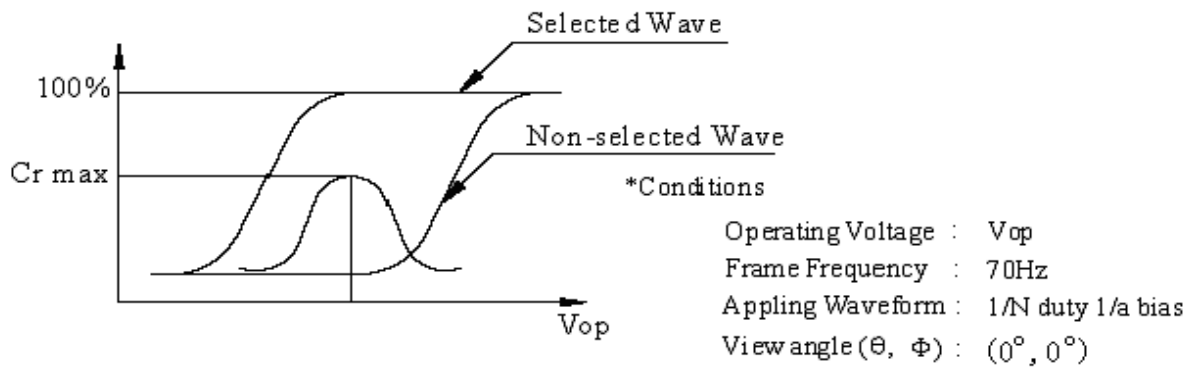


Note 3: The definition of viewing angle:

Refer to the graph below marked by ϑ and ϕ



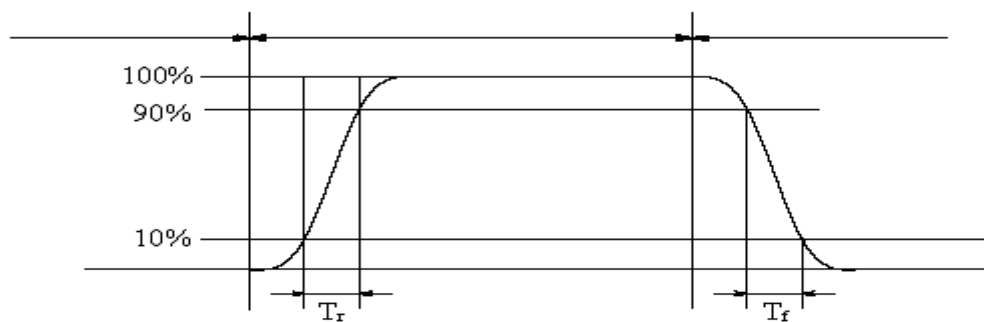
Note 4: Definition of contrast ratio.(Test LCD using DMS501)



$$\text{Contrast ratio}(Cr) = \frac{\text{Brightness of selected dots}}{\text{Brightness of non-selected dots}}$$

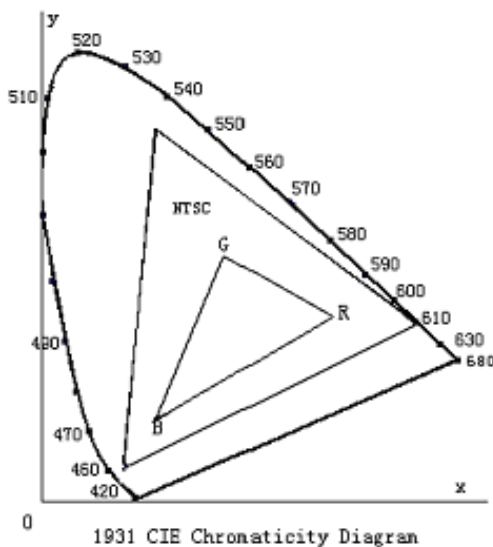
Note 5: Definition of Response time. (Test LCD using DMS501):

The output signals of photo detector are measured when the input signals are changed from "black" to "white"(falling time) and from "white" to "black"(rising time), respectively. The response time is defined as the time interval between the 10% and 90% of amplitudes. Refer to figure as below.



The definition of response time

Note 6: Definition of Color of CIE Coordinate and NTSC Ratio.

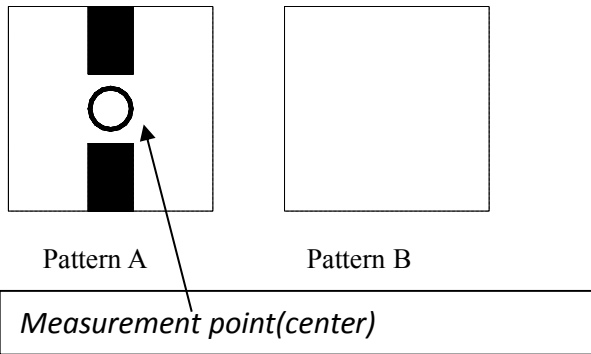


Color gamut:

$$S = \frac{\text{area of RGB triangle}}{\text{area of NTSC triangle}} \times 100\%$$

Note 7: Definition of cross talk.

*Cross talk ratio(%)=|pattern A Brightness-pattern B Brightness|/pattern A Brightness*100*



Electric volume value=3F+/-3Hex

8. Reliability Test Items and Criteria

Test Item	Test condition	Remark
High Temperature Storage	Ta = 80℃ 240hrs	Note1,Note3, 4
Low Temperature Storage	Ta = -30℃ 240hrs	Note1,Note3, 4
High Temperature Operation	Ta = 70℃ 240hrs	Note2,Note3, 4
Low Temperature Operation	Ta = -20℃ 240hrs	Note1,Note3, 4
Operation at High Temperature/Humidity	+50℃, 90%RH 240hrs	Note3, 4
Thermal Shock	-30℃/30 min ~ +80℃/30 min for a total 10 cycles, Start with cold temperature and end with high temperature.	Note3, 4
Package Drop Test	Height:60cm 1 corner, 3 edges, 6 surfaces	
ESD	C=150pF,R=330Ω,5point/panel Air: ±6Kv,10times; Contact: ±4Kv,10times (Environment:15℃~35℃, 30%~60%.86Kpa~106Kpa)	(IEC-61000-4-2)
Package Vibration Test	Frequency range:10~55Hz Stroke:1.5mm Sweep:10Hz~55Hz~10Hz 2 hours for each direction of X. Y. Z. (6 hours for total)	

Note 1: Ta is the ambient temperature of samples.

Note 2: Ts is the temperature of panel's surface.

Note 3: In the standard condition, there shall be no practical problem that may affect the display function. After the reliability test, the product only guarantees operation, but don't guarantee all of the cosmetic specification.

Note 4: Before cosmetic and function test, the product must have enough recovery time,at least 2 hours at room temperature

9. Precautions for Use of LCD Modules

9.1 Handling Precautions

9.1.1 *The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.*

9.1.2 *If the display panel is damaged and the liquid crystal substance inside it leaks out, be sure not to get any in your mouth, if the substance comes into contact with your skin or clothes, promptly wash it off using soap and water.*

9.1.3 *Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.*

9.1.4 *The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.*

9.1.5 *If the display surface is contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If still not completely clear, moisten cloth with one of the following solvents:*

— Isopropyl alcohol — Ethyl alcohol

Solvents other than those mentioned above may damage the polarizer. Especially, do not use the following:

— Water — Ketone — Aromatic solvents

9.1.6 *Do not attempt to disassemble the LCD Module.*

9.1.7 *If the logic circuit power is off, do not apply the input signals.*

9.1.8 *To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.*

a. Be sure to ground the body when handling the LCD Modules.

b. Tools required for assembly, such as soldering irons, must be properly ground.

c. To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.

d. The LCD Module is coated with a film to protect the display surface. Be care when peeling off this protective film since static electricity may be generated.

9.2 Storage precautions

9.2.1 When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps.

9.2.2 The LCD modules should be stored under the storage temperature range. If the LCD modules will be stored for a long time, the recommend condition is:

Temperature : $0^{\circ}\text{C} \sim 40^{\circ}\text{C}$

Relatively humidity: $\leq 80\%$

9.2.3 The LCD modules should be stored in the room without acid, alkali and harmful gas.

9.3 The LCD modules should be no falling and violent shocking during transportation, and also should avoid excessive press, water, damp and sunshine.

END