San Technology, Inc.

SPECIFICATION
FOR
LCD Module

Customer P/N:

Santek P/N: ST0240A2W-RSLW-F

DOC. Revision: RS01

Customer Approval:

	SIGNATURE	DATE
PREPARED BY	Aaron Lu	2018-11-28
CHECKED BY	Andy Song	2018-11-30
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Document Revision History

Version	Revise Date	Description	Changed by
RS01	2018-11-28	First issue	Aaron Lu

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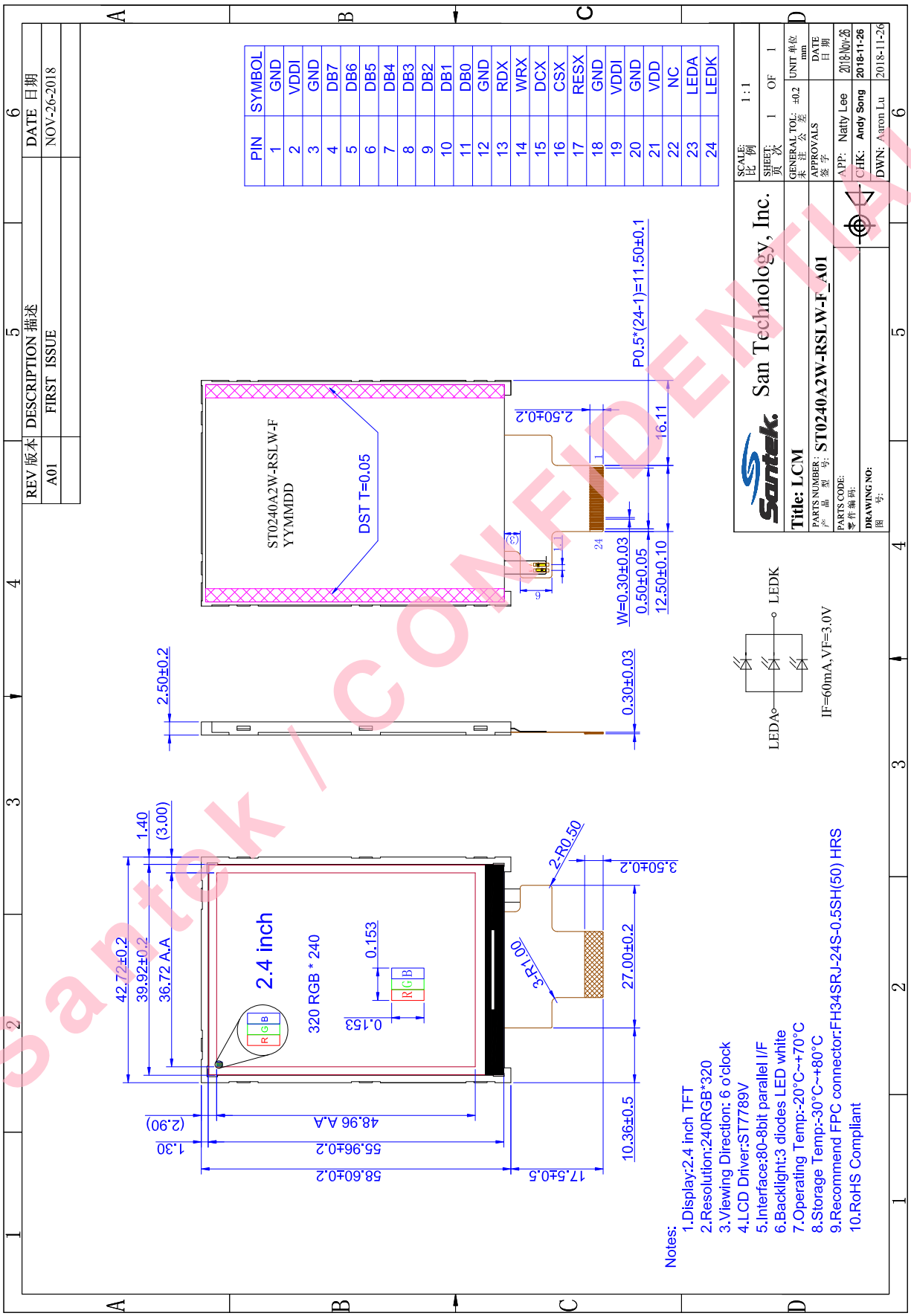
1.General Specification

ITEM	STANDARD VALUES	UNITS
LCD Type	2.4	inch
Resolution	240 x 320	dots
Color Filter Array	RGB Stripe	-
Display Mode	Normally While TN	-
Viewing Direction	6 o'clock	-
Drive IC	ST7789V	-
Interface	80-8bit parallel I/F	-
Module Size	42.72(W) x 58.60（H）x 2.50(T)	mm
Active Area	36.72(W) x 48.96(H)	mm
Pixel Pitch	0.153(W) x 0.153(H)	mm
Luminous Intensity	400	cd/m^2
Operating Temperature	-20 ~ 70	℃
Storage Temperature	-30 ~ 80	℃

2. Mechanical Drawing



3.Pin Description

Pin	Symbol	Description
1	GND	System ground
2	VDDI	I/O Supply Voltage
3	GND	System Ground
4	DB7	Data Bus
5	DB6	Data Bus
6	DB5	Data Bus
7	DB4	Data Bus
8	DB3	Data Bus
9	DB2	Data Bus
10	DB1	Data Bus
11	DB0	Data Bus
12	GND	System Ground
13	RDX	Serves as a read signal and read data at the rising edge If not used, please fix this pin at VDDI or GND
14	WRX	Serves as a write signal and write data at the rising edge If not used, please fix this pin at VDDI or GND
15	DCX	Display data/command selection pin in MCU interface. DCX='1': display data or parameter. DCX='0': command data.
16	CSX	A chip selection signal. When CS is low, the chip can be accessed.
17	RESX	Reset signal. Signal is active low.
18	GND	System Ground
19	VDDI	I/O Supply Voltage
20	GND	System Ground
21	VDD	Supply Voltage
22	NC	No Connect
23	LEDA	Power supply for backlight (anode).
24	LEDK	Power supply for backlight (cathode).

4.Absolute Operation Range

Item	Symbol	Rating	Unit
Supply Voltage	VDD	- 0.3 ~ +4.6	V
Supply Voltage (Logic)	VDDI	- 0.3 ~ +4.6	V
Driver Supply Voltage	VGH-VGL	-0.3 ~ +30.0	V
Logic Input Voltage Range	VIN	-0.3 ~ VDDI + 0.5	V
Logic Output Voltage Range	VO	-0.3 ~ VDDI + 0.5	V
Operating Temperature Range	TOPR	-20 ~ +70	℃
Storage Temperature Range	TSTG	-30 ~ +80	℃

5.DC Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
System Supply Voltage	VDD	2.5	2.8	3.3	V	-
I/O Supply Voltage	VDDI	1.65	1.8	3.3	V	-
Input High Voltage	VIH	0.7IOVCC	-	IOVCC	V	-
Input Low Voltage	VIL	GND	-	0.3IOVCC	V	-
Output High Voltage	VOH	0.8IOVCC	-	IOVCC	V	IOH=-1.0mA
Output Low Voltage	VOL	GND	-	0.2IOVCC	V	IOH=1.0mA
I/O Leak Current	ILI	-	-	1	uA	-

6. Timing Characteristics

6.1 Power ON/OFF Sequence

VDDI and VDD can be applied in any order.

VDD and VDDI can be power down in any order.

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

During power off, if LCD is in the Sleep In mode, VDDI or 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.

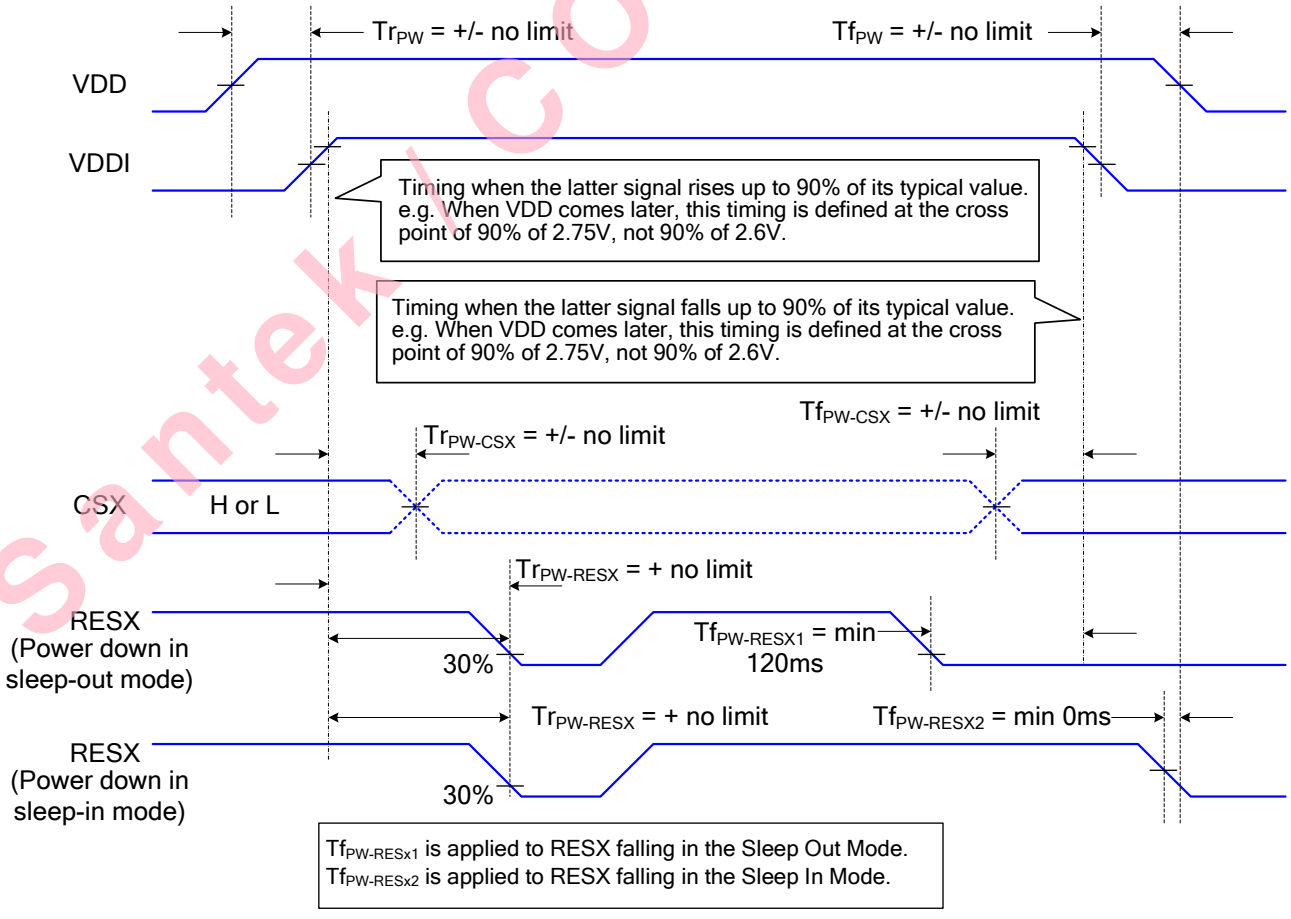
Note 1: There will be no damage to the display module if the power sequences are not met.

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.

The power on/off sequence is illustrated below



6.2 Uncontrolled Power Off

The uncontrolled power-off means a situation which removed a battery without the controlled power off sequence. It will neither damage the module or the host interface.

If uncontrolled power-off happened, the display will go blank and there will not any visible effect on the display (blank display) and remains blank until “Power On Sequence” powers it up.

6.3 Data Color Coding

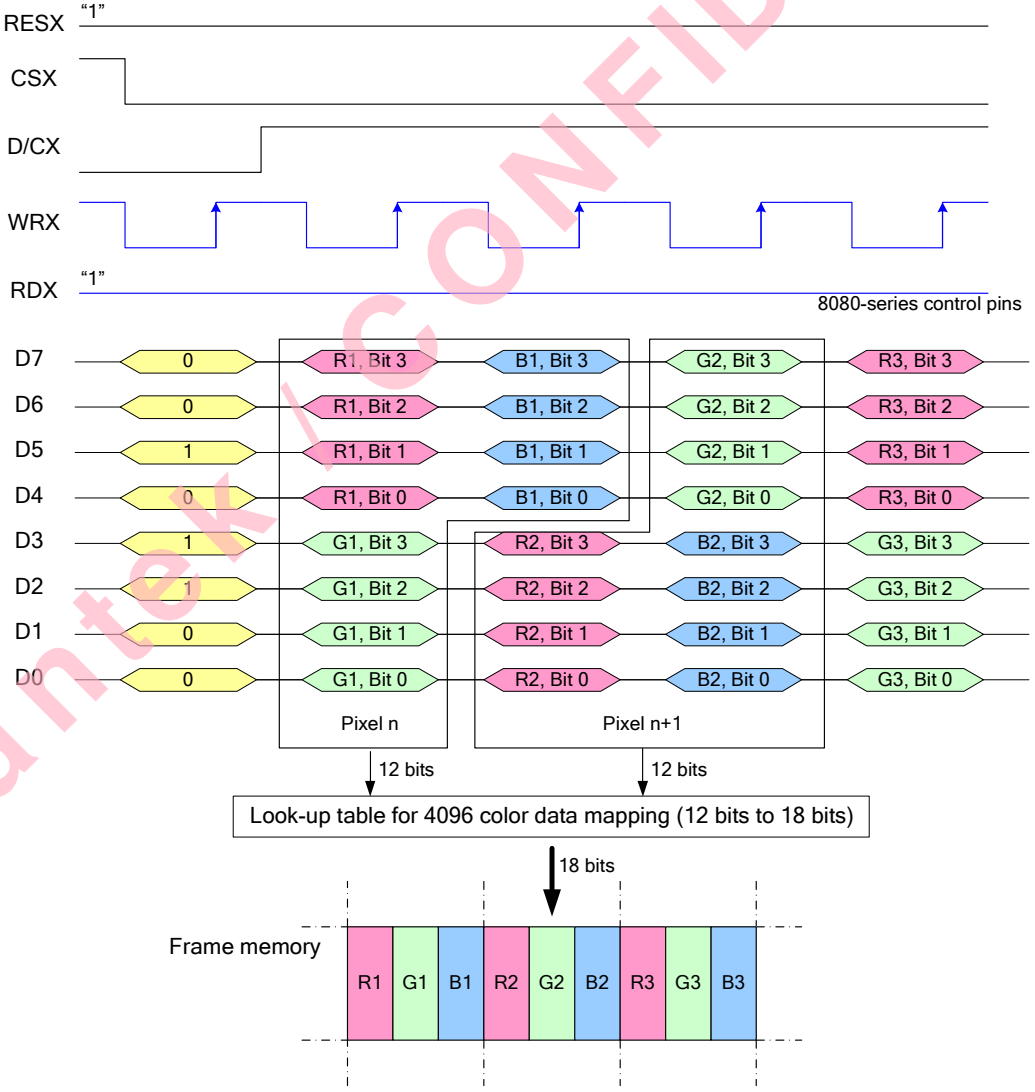
6.3.1 8080-Ⅰ series 8-bit Parallel Interface

FPC has set 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.

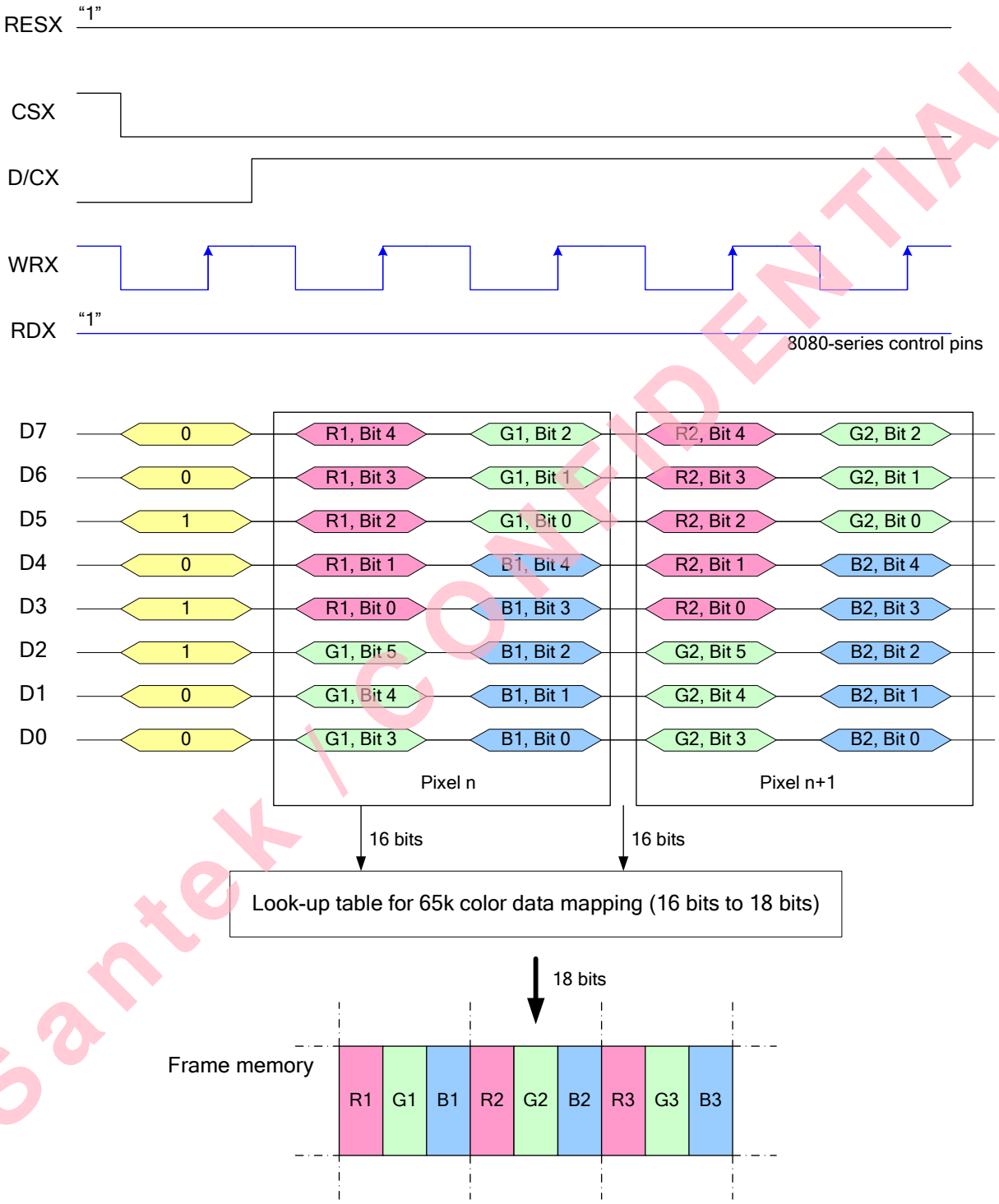
6.3.2 8-bit data bus for 12-bit/pixel (RGB 4-4-4-bit input)



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'

6.3.3 8-bit data bus for 16-bit/pixel (RGB 5-6-5-bit input)

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



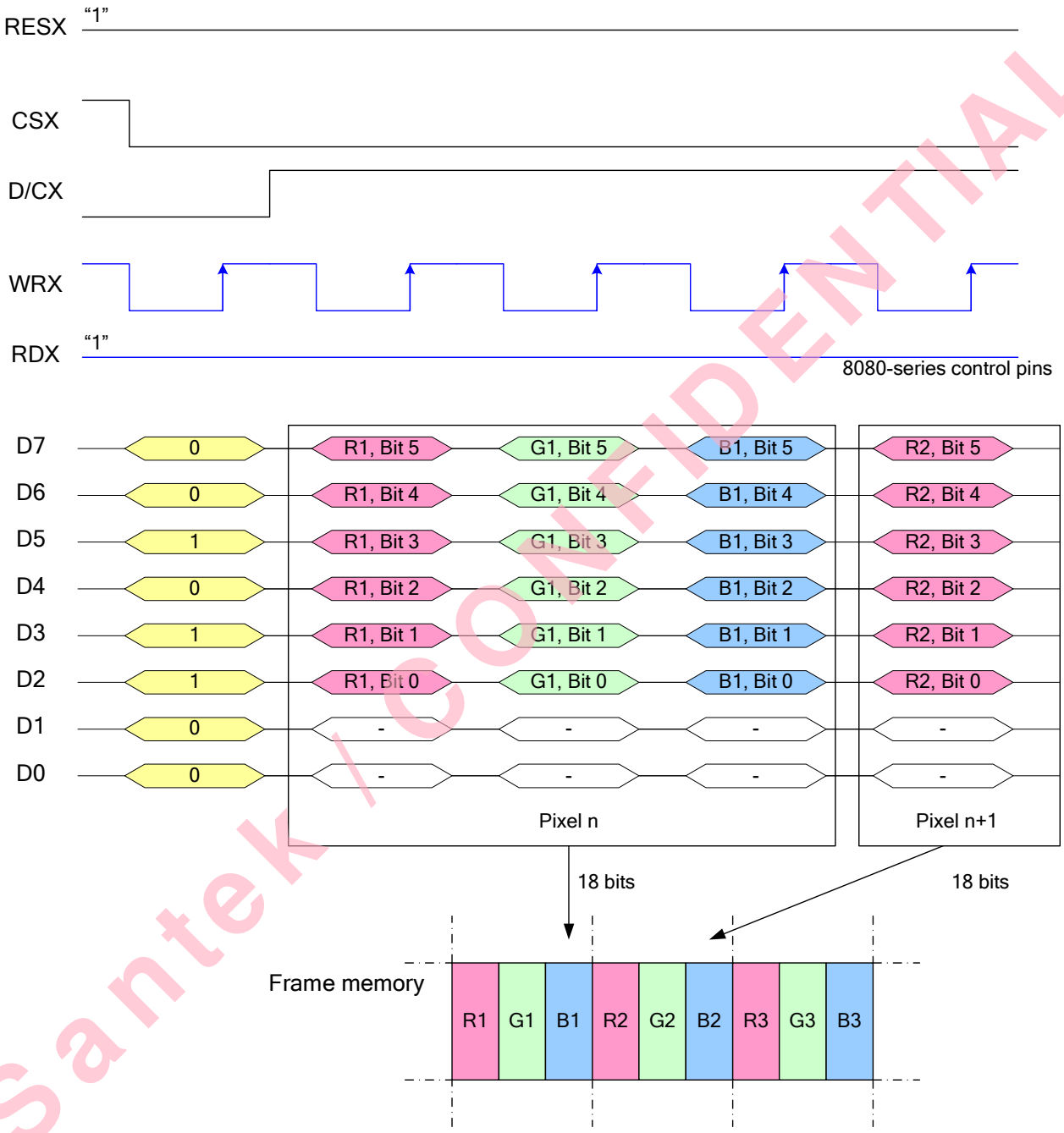
Note 1: The data order is as follows, MSB=D15, LSB=D0 and picture data is MSB=Bit 5, LSB=Bit 0 for Green, and MSB=Bit 4, LSB=Bit 0 for Red and Blue data.

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'

6.3.4 8-bit data bus for 18-bit/pixel (RGB-6-6-6-bit input)

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. AC Characteristics

7.1 8080 Series MCU Parallel Interface Characteristics(8-bit Bus)

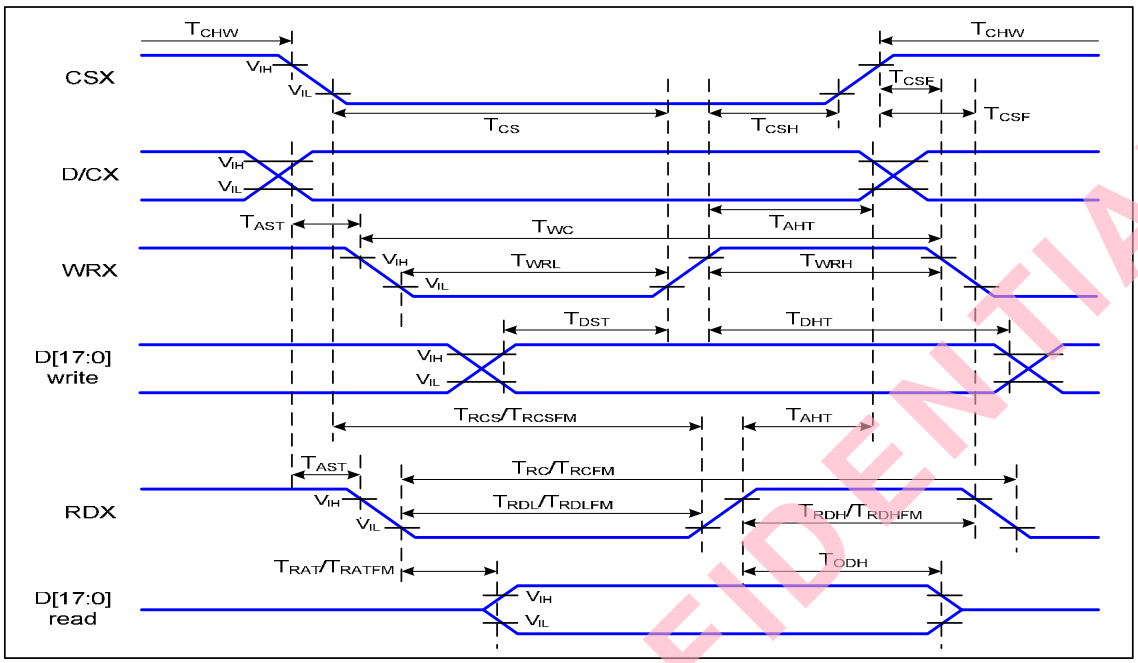


Figure 1 Parallel Interface Timing Characteristics (8080-Series MCU Interface)

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

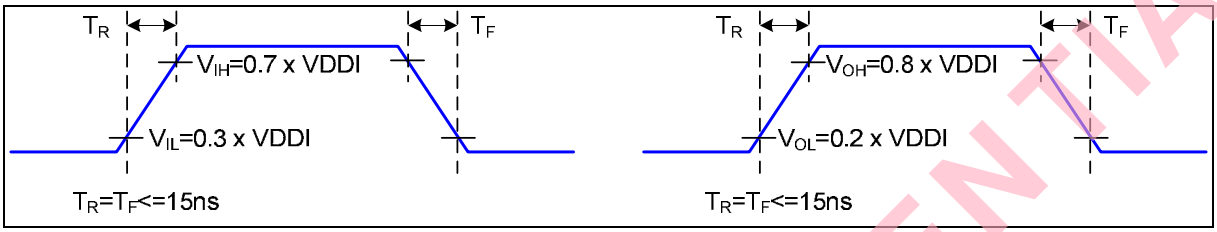


Figure 2 Rising and Falling Timing for I/O Signal

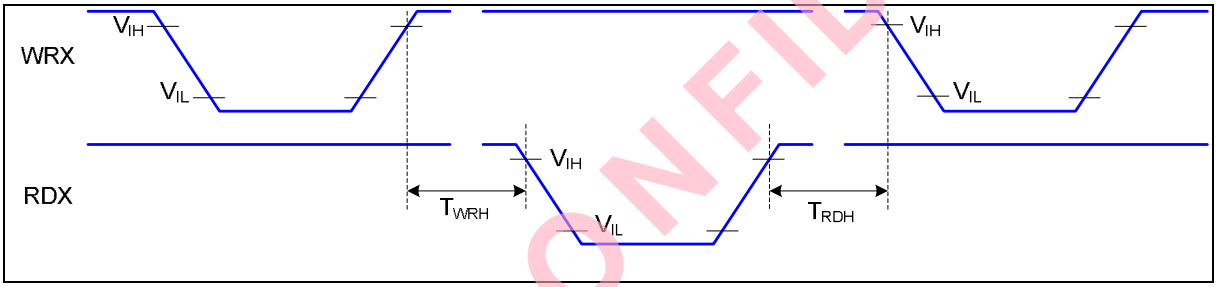
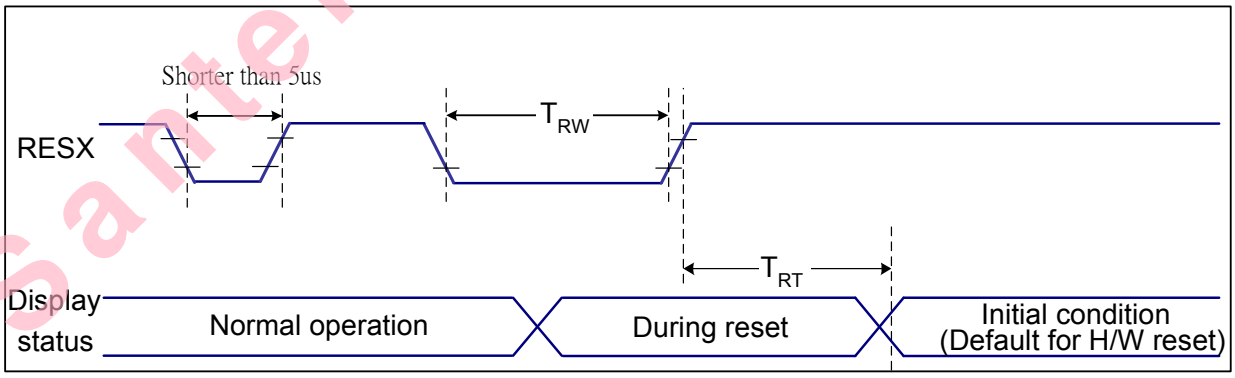


Figure 3 Write-to-Read and Read-to-Write Timing

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.

7.2 Reset Timing



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

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.

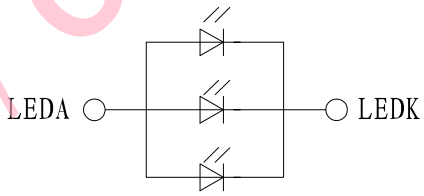
4. Spike Rejection also applies during a valid reset pulse as shown below:

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.

8. Backlight Characteristics



BACKLIGHT LED CIRCUIT 3 PCS LED

Item	Symbol	MIN	TYP	MAX	UNIT	Test Condition
Supply Voltage	Vf	2.8	3.0	3.3	V	If=60mA
Supply Current	If	-	60	-	mA	-
Backlight Color	White					If=60mA

9. Optical Characteristics

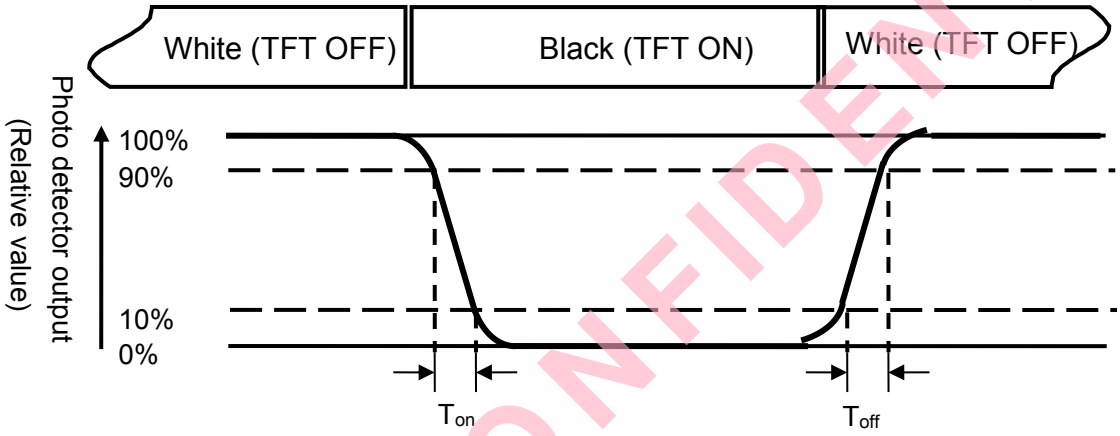
Item		Symbol	Specifications			Unit	Note
			Min.	Typ.	Max.		
Contrast Ratio		Cr(Θ=0°)	300	500	-	-	Note1
Response Time (25℃)		Tr(Θ=0°)	-	8	13	ms	Note2
		Tf(Θ=0°)	-	12	17		
Viewing Angle (Cr≥10)	Θ_R	Φ=0°	40	45	-	deg	Note3
	Θ_T	Φ=90°	15	20	-		
	Θ_L	Φ=180°	40	45	-		
	Θ_B	Φ=270°	40	50	-		
Chromaticity	White	x	0.2713	0.3213	0.3713	-	Note4
		y	0.3083	0.3583	0.4083		
	Red	x	0.5925	0.6425	0.6925		
		y	0.2939	0.3439	0.3939		
	Green	x	0.3152	0.3652	0.4152		
		y	0.5515	0.6015	0.6515		
	Blue	x	0.0960	0.1460	0.1960		
		y	0.0408	0.0908	0.1408		
Luminance		Θ=0°	320	400	-	cd/m^2	Note5
Luminance Uniformity		-	70	85	-	%	Note6
Color Gamut (NTSC%)		CIE 1931	52	55	-	%	-

Note 1: Definition of contrast ratio

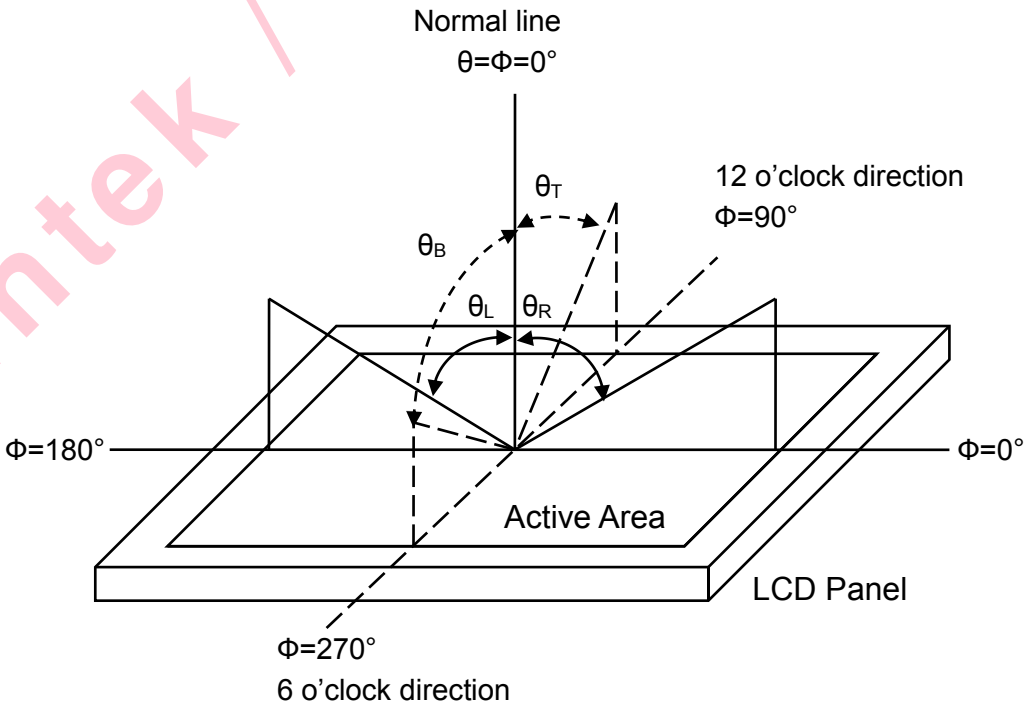
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance measured when LCD on the "White" state}}{\text{Luminance measured when LCD on the "Black" state}}$$

Note 2: 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_{on}) is the time between photo detector output intensity changed from 90% to 10%, and fall time (T_{off}) is the time between photo detector output intensity changed from 10% to 90%.



Note 3: Definition of viewing angle range



Note 4: Definition of color chromaticity (CIE1931)

Color coordinates measured at the center point of LCD when panel is driven at “White”, “Red”, “Green” and “Blue” state respectively.

Note 5: Definition of luminance

Measured at the center area of the panel when LCD panel is driven at “white” state.

Note 6: Definition of luminance uniformity

To test for uniformity, the tested area is divided into 5 spot. The measurement spot is placed at the center of each circle as below.

$$\text{Luminance Uniformity } (U_L) = \frac{L_{min}}{L_{max}}$$

L-------Active area length W----- Active area width

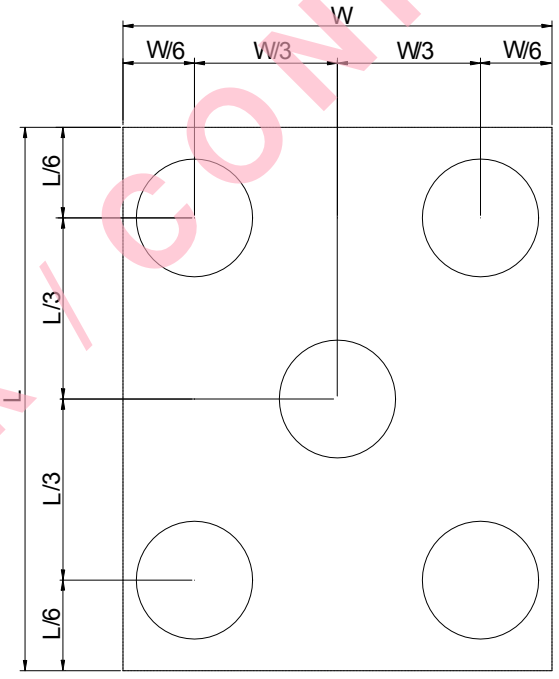


Fig. 5 Definition of luminance uniformity

L_{min} : The measured minimum luminance of all measurement position.

L_{max} : The measured maximum luminance of all measurement position.

10. Reliability Tests

ITEM	CONDITION	CRITERION
Operating Temperature Test	High Temperature: +70 ºC±3℃, 72 hrs	No defects in display and operational functions
	Low Temperature: -20 ºC±3℃, 72 hrs	
Storage Temperature Test	High Temperature: +80 ºC±3℃, 96 hrs	No defects in display and operational functions
	Low Temperature: -30 ºC±3℃, 96 hrs	
Humidity Endurance Test	60 ºC±3℃, 90%±3%RH, 72 hrs	No defects in display and operational functions
Thermal Shock Test	-30 ºC (30mins)～ +80 ºC (30mins) 10 cycles	No defects in display and operational functions
Vibration Resistance Test	Operating Time: thirty minutes exposure for each direction (X,Y,Z) Sweep Frequency:10~55Hz (1 min) Amplitude: 1.5mm	No defects in display and operational functions
Mechanical Shock	100G 6ms,±X, ±Y, ±Z 3 times for each direction	No defects in display and operational functions
Electro Static Discharge	± 2KV, Human Body Mode, 100pF/1500Ω	No defects in display and operational functions

NOTE:

1) The samples must be free from defect before test, must be restored at room condition at least for 2 hours after reliability test before any inspection.

2) After a long period of high temperature , the surrounding edge of the LCM all-black image will appear Mura phenomenon , which is a normal phenomenon.

11. Precautions

11.1 Handling

11.1.1. Polarizer Cleaning, Petroleum ether (or N-hexane) is recommended for cleaning the front/rear polarizers and reflectors, acetone, toluene and ethanol are not allowed to avoid damaging the surface.

11.1.2. Body grounding, must wear Anti-ESD wrist strap while pick up LCDs.

11.1.3. FPC Soldering, less than 300℃/3S, solder must be grounding on grounding bench.

11.1.4. If use electric Screwdriver to do assembly, screwdriver must be grounding.

11.2 Storage

11.2.1. Keep in a sealed polyethylene bag.

11.2.2. Keep in a dark place.

11.2.3. Keep in temperature between 0℃ and 35℃.

NOT allowed at 70℃ for more than 160 Hours, or at -20℃ for more than 48 Hrs.

11.3 Safety

If liquid crystal leak out of a damaged glass cell, DO NOT put it in your mouth or touch eyes, if the liquid crystal touch your skin or clothes, please wash it off immediately using soap and water.

12. Limited Warranty

Unless otherwise agreed between Santek and customer, Santek will replace or repair any of its LCD modules which are found to be functionally defective when inspected in accordance with Santek LCD acceptance standards (copies available upon request) for a period of one year from date of shipments. Cosmetic/visual defects over specs must be returned to Santek within 30 days of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of Santek limited to repair and/or replacement on the terms set forth above. Santek shall not be responsible for any subsequent or consequential events.

12.1 Returning LCM Under Warranty-Teams and Conditions

12.1.1. No warranty can be granted if the precautions stated above have been disregarded. The typical examples of violations are :

- Broken LCD glass.
- Circuit modified in any way, including addition of components.

12.1.2. Module repairs will be invoiced to the customer upon mutual agreement. Modules must be returned with sufficient description of the failures or defects. Any connectors or cable installed by the customer must be removed completely without damaging the PCB's eyelet, conductors and terminals.