珠海三泰克科技有限公司

San Technology (Zhuhai) Co., Ltd.

SPECIFICATION

FOR

LCD Module

Customer P/N:

Santek P/N: ST0280H3W-RSHLW-F

DOC. Revision: RS01

Customer Approval:

	SIGNATURE	DATE
PREPARED BY	Caihua	2024-03-24
CHECKED BY	Aaron Lu Andy Song	2024-03-25
APPROVED BY	Natty Lee	2024.Mar.26

Document Revision History

Version	Revise Date	Description	Changed by
RS01	2024-03-24	First issue	Caihua

Table of Contents

1. General Specification

1.1 Description

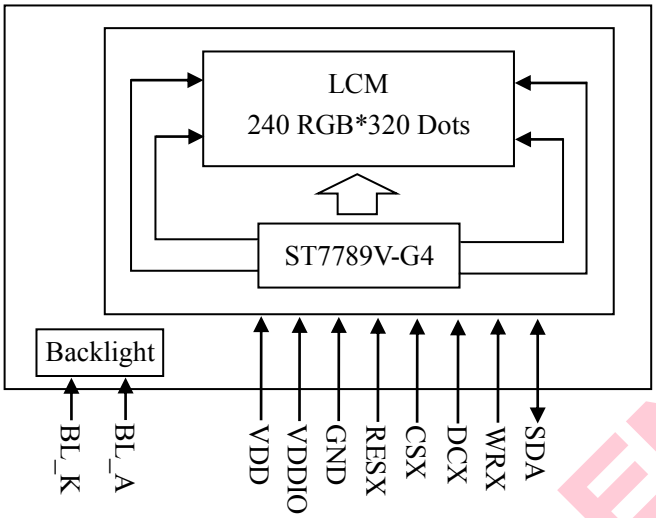
Santek display model ST0280H3W-RSHLW-F is a color active matrix thin film transistor (TFT) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching device. This TFT LCD has a 2.8 (4:3) inch diagonally measured active display area with QVGA (240 horizontal by 320 vertical pixel) resolution.

1.2 General Specification

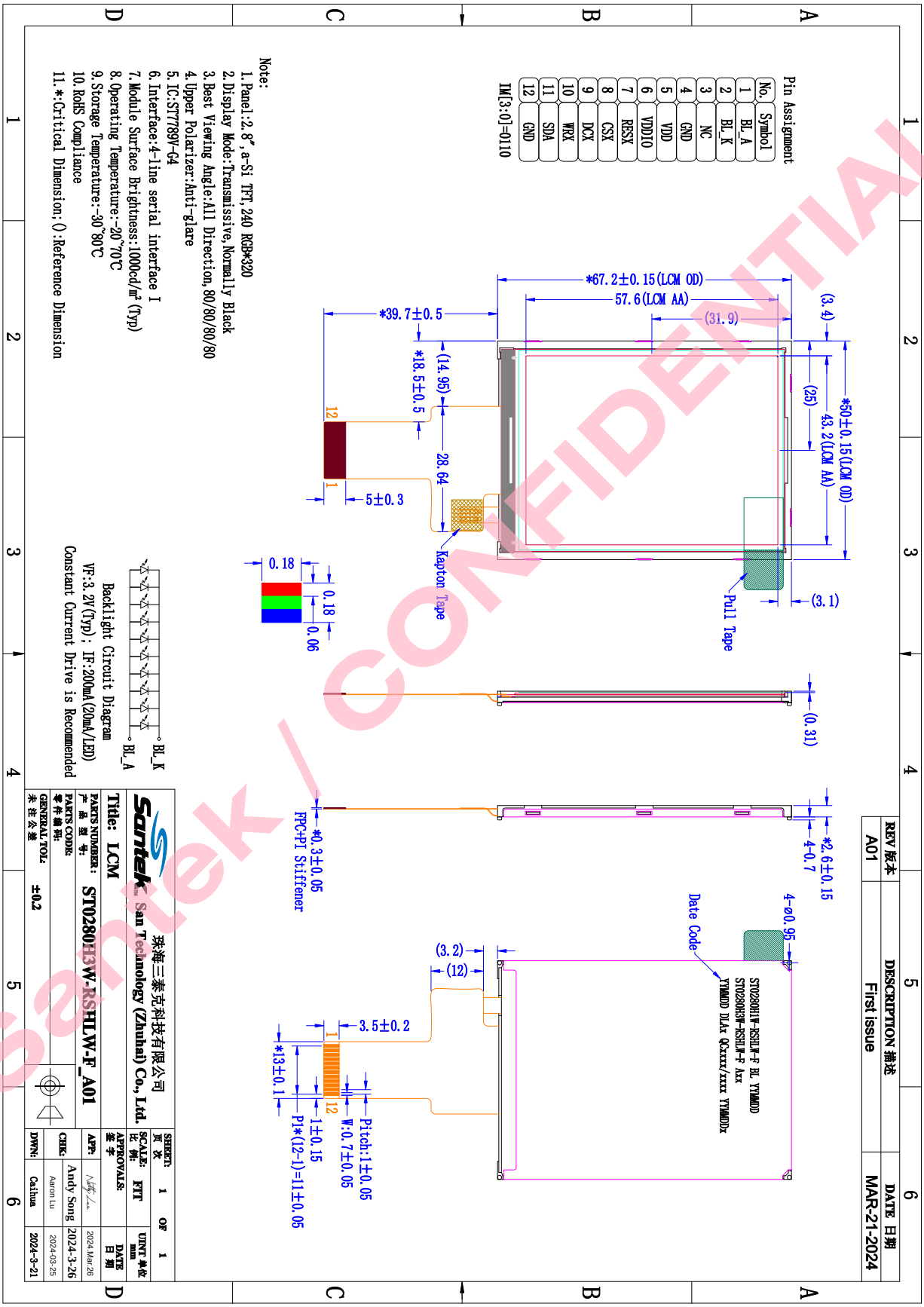
Item	Specification	Unit
LCD Size	2.8	inch
Resolution	240*320	dots
Pixel Arrangement	RGB Vertical Stripe	-
Display Mode	Normally Black, Transmissive	-
Upper Polarizer	Anti-glare	-
Viewing Direction	All Direction	-
Drive IC	ST7789V-G4	-
Interface	4-line serial interface I, IM[3:0]=0110	-
Module Size	50(W) x 67.2(H) x 2.6(D)	mm
Active Area	43.2(W) x 57.6(H)	mm
Pixel Pitch	0.18(W) x 0.18(H)	mm
Operating Temperature	-20~70	℃
Storage Temperature	-30~80	℃

Note: Please refer to the mechanical drawing.

2. Block Diagram



3. Mechanical Drawing



4. Pin Description

Pin	Symbol	Function Descriptions
1	BL_A	Power supply for backlight (Anode).
2	BL_K	Power supply for backlight (Cathode).
3	NC	No Connection.
4	GND	System ground.
5	VDD	Power Supply for Analog, Digital System and Booster Circuit.
6	VDDIO	Power Supply for I/O System.
7	RESX	This signal will reset the device. (Signal is active low)
8	CSX	Chip selection signal.
9	DCX	Clock signal.
10	WRX	Display data/command selection pin in 4-line serial interface.
11	SDA	Serial input/output data.
12	GND	System ground.

Note: Interface: 4-line serial interface I, IM[3:0]=0110.

5. 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
Operating Temperature Range	TOPR	-20 ~ +70	℃
Storage Temperature Range	TSTG	-30 ~ +80	℃

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. DC Characteristics

Parameter	Symbol	Condition	Specification			Unit	Related Pins
			MIN.	TYP.	MAX.		
Power & Operation Voltage							
System Voltage	VDD	Operating voltage	2.4	2.75	3.3	V	
Interface Operation Voltage	VDDI	I/O Supply Voltage	1.65	1.8	3.3	V	
Gate Driver High Voltage	VGH		12.2		14.97	V	Note 4
Gate Driver Low Voltage	VGL		-12.5		-7.16	V	
Gate Driver Supply Voltage		| VGH-VGL |	19.36		27.47	V	Note 5
Input / Output							
Logic-High Input Voltage	VIH		0.7VDDI		VDDI	V	Note 1
Logic-Low Input Voltage	VIL		VSS		0.3VDDI	V	Note 1
Logic-High Output Voltage	VOH	IOH = -1.0mA	0.8VDDI		VDDI	V	Note 1
Logic-Low Output Voltage	VOL	IOL = +1.0mA	VSS		0.2VDDI	V	Note 1
Logic-High Input Current	IIH	VIN = VDDI			1	uA	Note 1
Logic-Low Input Current	IIL	VIN = VSS	-1			uA	Note 1
Input Leakage Current	IIL	IOH = -1.0mA	-0.1		+0.1	uA	Note 1

Parameter	Symbol	Condition	Specification			Unit	Related Pins
			MIN.	TYP.	MAX.		
VCOM Voltage							
VCOM amplitude	VCOM			VSS		V	
Source Driver							
Source Output Range	Vsout		VAN		VAP	V	
Gamma Reference Voltage(Positive)	VAP		4.45		6.4	V	Note 6
Gamma Reference Voltage(Negative)	VAN		-4.6		-2.65	V	
Source Output Settling Time	Tr	Below with 99% precision			20	us	Note 2
Output Offset Voltage	VOFFSET				35	mV	Note 3

Table 2 Basic DC Characteristics

Notes:

1. TA= -30 to 70℃ (to +85℃ no damage).

2. Source channel loading= 2KΩ+12pF/channel, Gate channel loading=5KΩ+40pF/channel.

3. The Max. value is between measured point of source output and gamma setting value.

4. When evaluating the maximum and minimum of VGH, VDD=2.8V.

5. The maximum value of |VGH-VGL| can no over 30V.

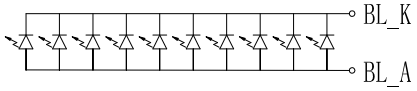
6. Default register setting of Vcom and Vcomoffset is 20h

7. Backlight Specification

Item	Symbol	Min	Typ	Max	Unit
Forward Current	I_F	-	200	-	mA
Forward Voltage	V_F	2.9	3.2	3.4	V
Backlight Power Consumption	W_{BL}	-	0.64	-	W

Note1: If LED is driven by high current, high ambient temperature & humidity condition. The life time of LED will be reduced.

Note2: Constant current drive is recommended.



Backlight Circuit Diagram

8. AC Characteristics

8.1 Serial Interface Characteristics (4-line serial)

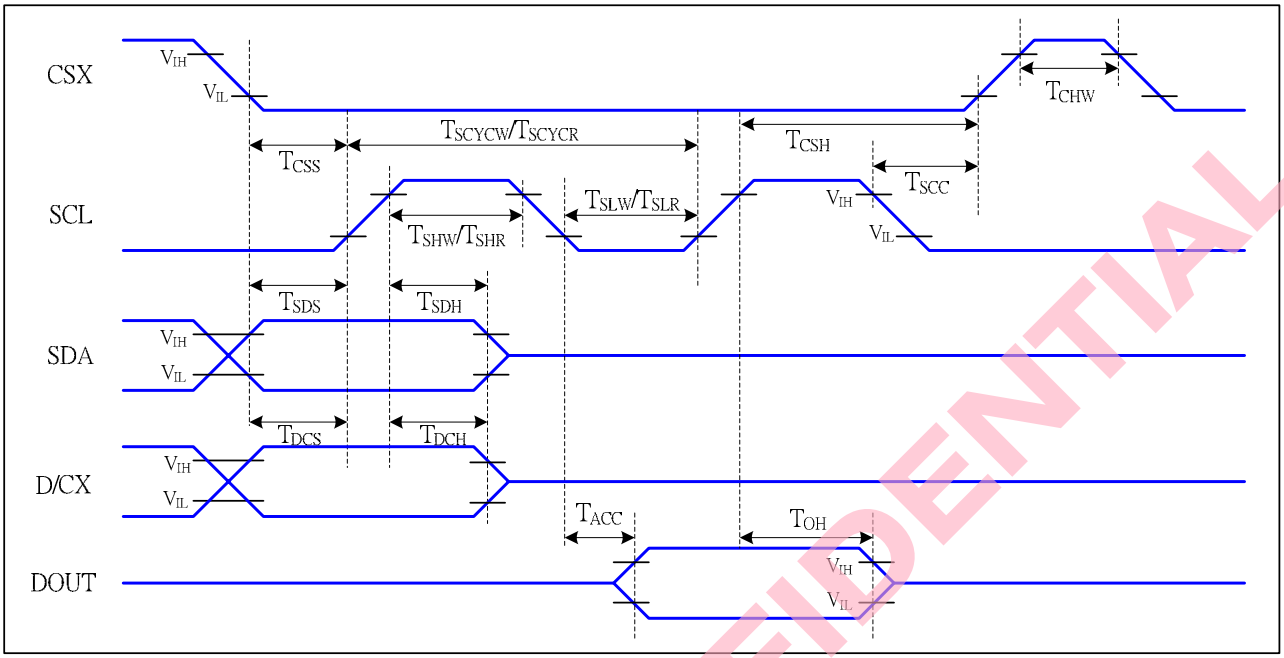


Figure 5 4-line serial Interface Timing Characteristics

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

Signal	Symbol	Parameter	MIN	MAX	Unit	Description
CSX	T_{CSS}	Chip select setup time (write)	15		ns	
	T_{CSH}	Chip select hold time (write)	15		ns	
	T_{CSS}	Chip select setup time (read)	60		ns	
	T_{SCC}	Chip select hold time (read)	65		ns	
	T_{CHW}	Chip select “H” pulse width	40		ns	
SCL	T_{SCYCW}	Serial clock cycle (Write)	66		ns	-write command & data ram
	T_{SHW}	SCL “H” pulse width (Write)	15		ns	
	T_{SLW}	SCL “L” pulse width (Write)	15		ns	
	T_{SCYCR}	Serial clock cycle (Read)	150		ns	-read command & data ram
	T_{SHR}	SCL “H” pulse width (Read)	60		ns	
	T_{SLR}	SCL “L” pulse width (Read)	60		ns	
D/CX	T_{DCS}	D/CX setup time	10		ns	
	T_{DCH}	D/CX hold time	10		ns	
SDA (DIN)	T_{SDS}	Data setup time	10		ns	
	T_{SDH}	Data hold time	10		ns	
DOUT	T_{ACC}	Access time	10	50	ns	For maximum CL=30pF
	T_{OH}	Output disable time	15	50	ns	For minimum CL=8pF

Table 6 4-line serial Interface Characteristics

Note : The rising time and falling time (Tr, Tf) of input signal 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 Reset Timing

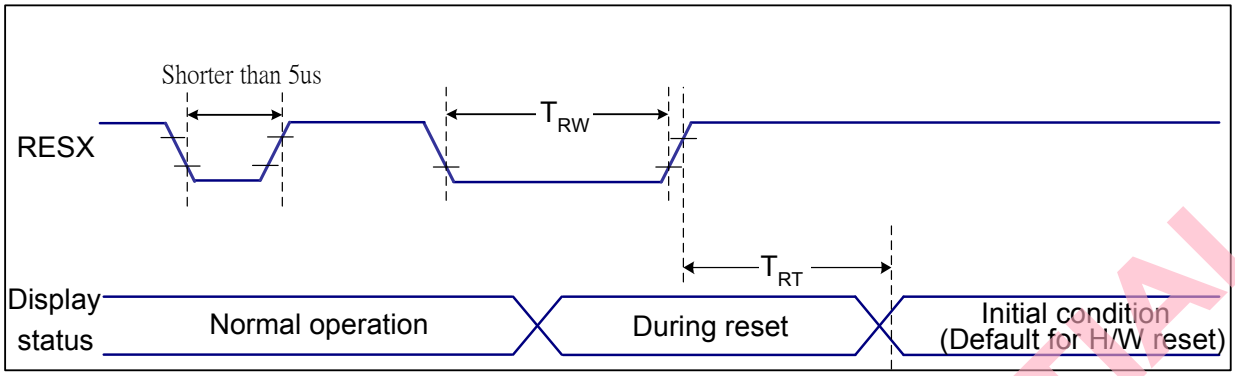


Figure 7 Reset Timing

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

Table 9 Reset Timing

Notes:

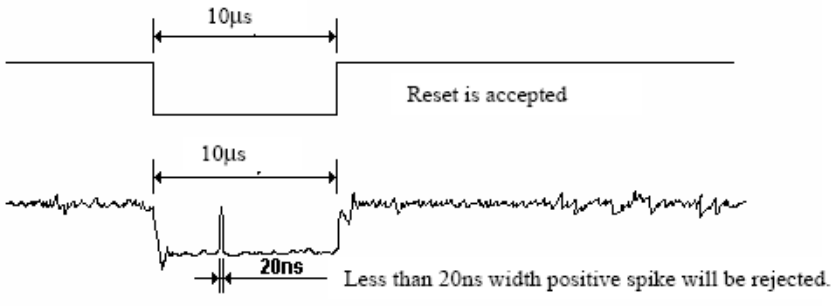
1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time (tRT) within 5 ms after a rising edge of RESX.

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.

9. Serial Interface

IM3	IM2	IM1	IM0	Interface	Read back selection
0	1	0	1	3-line serial interface Ⅰ	Via the read instruction (8-bit, 24-bit and 32-bit read parameter)
0	1	1	0	4-line serial interface Ⅰ	
1	1	0	1	3-line serial interface Ⅱ	
1	1	1	0	4-line serial interface Ⅱ	

Table 13 Selection of serial interface

The serial interface is either 3-lines/9-bits or 4-lines/8-bits bi-directional interface for communication between the micro controller and the LCD driver. The 3-lines serial interface use: CSX (chip enable), SCL (serial clock) and SDA (serial data input/output), and the 4-lines serial interface use: CSX (chip enable), D/CX (data/ command flag), SCL (serial clock) and SDA (serial data input/output). Serial clock (SCL) is used for interface with MCU only, so it can be stopped when no communication is necessary.

9.1 Pin Description

4-line serial interface Ⅰ

Pin Name	Description
CSX	Chip selection signal
WRX	Data is regarded as a command when WRX is low Data is regarded as a parameter or data when WRX is high
DCX	Clock signal
SDA	Serial input/output data

9.2 Command Write Mode

The write mode of the interface means the micro controller writes commands and data to the LCD driver. 3-lines serial data packet contains a control bit D/CX and a transmission byte. In 4-lines serial interface, data packet contains just transmission byte and control bit D/CX is transferred by the D/CX pin. If D/CX is “low”, the transmission byte is interpreted as a command byte. If D/CX is “high”, the transmission byte is stored in the display data RAM (memory write command), or command register as parameter.

Any instruction can be sent in any order to the driver. The MSB is transmitted first. The serial interface is initialized when CSX is high. In this state, SCL clock pulse or SDA data have no effect. A falling edge on CSX enables the serial interface and indicates the start of data transmission.

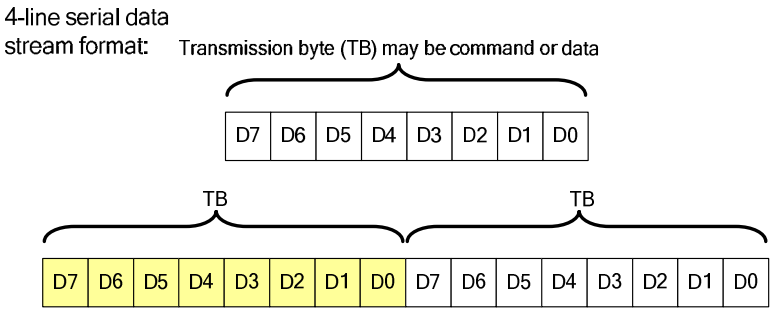


Figure 12 Serial interface data stream format

When CSX is “high”, SCL clock is ignored. During the high period of CSX the serial interface is initialized. At the falling edge of CSX, SCL can be high or low. SDA is sampled at the rising edge of SCL. D/CX indicates whether the byte is command (D/CX=’0’) or parameter/RAM data (D/CX=’1’). D/CX is sampled when first rising edge of SCL (3-line serial interface) or 8th rising edge of SCL (4-line serial interface). If CSX stays low after the last bit of command/data byte, the serial interface expects the D/CX bit (3-line serial interface) or D7 (4-line serial interface) of the next byte at the next rising edge of SCL..

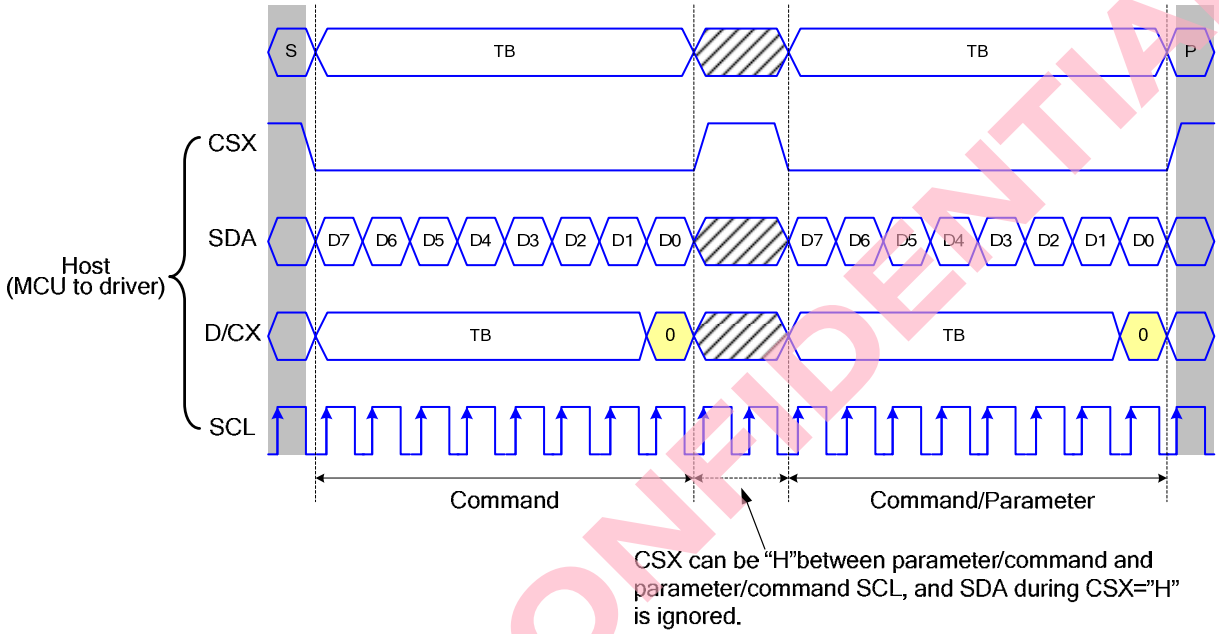


Figure 14 4-line serial interface write protocol (write to register with control bit in transmission)

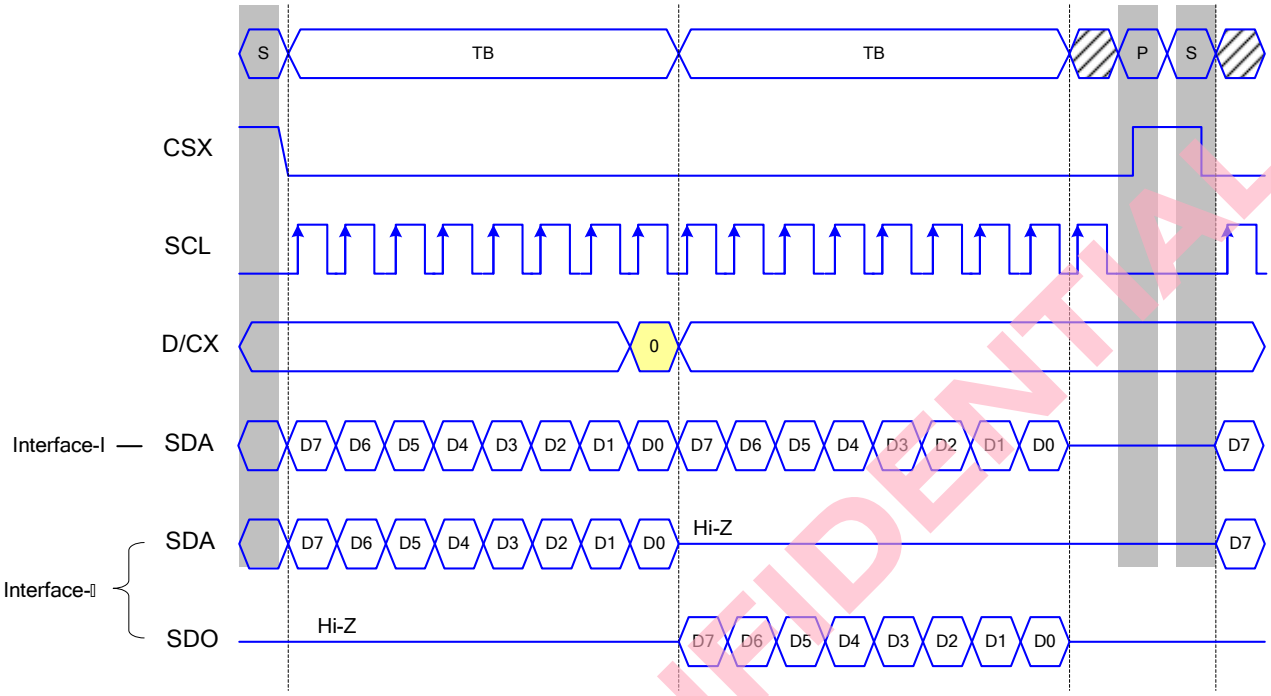
9.3 Read Function

The read mode of the interface means that the micro controller reads register value from the driver. To achieve read function, the micro controller first has to send a command (read ID or register command) and then the following byte is transmitted in the opposite direction. After that CSX is required to go to high before a new command is send (see the below figure). The driver samples the SDA (input data) at rising edge of SCL, but shifts SDA (output data) at the falling edge of SCL. Thus the micro controller is supported to read at the rising edge of SCL.

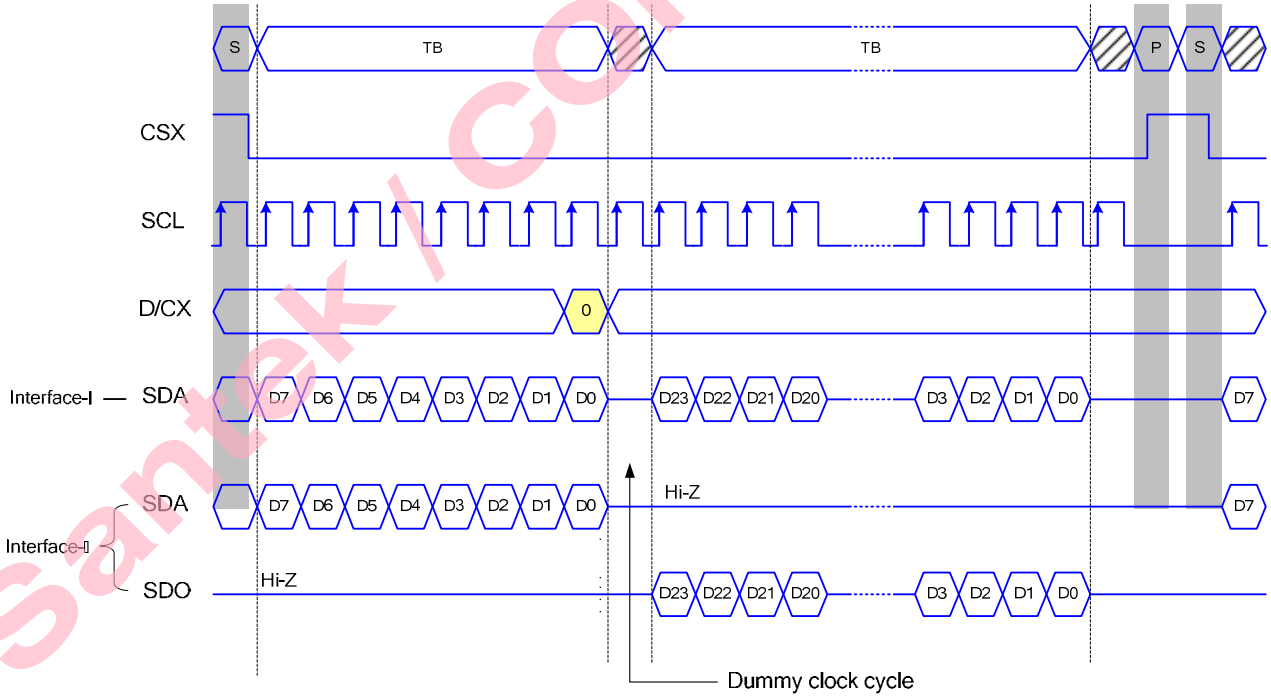
After the read status command has been sent, the SDA line must be set to tri-state no later than at the falling edge of SCL of the last bit.

9.4 4-line Serial Protocol

4-line serial protocol (for RDID1/RDID2/RDID3/0Ah/0Bh/0Ch/0Dh/0Eh/0Fh command: 8-bit read):



4-line serial protocol (for RDDID command: 24-bit read)



4-line Serial Protocol (for RDDST command: 32-bit read)

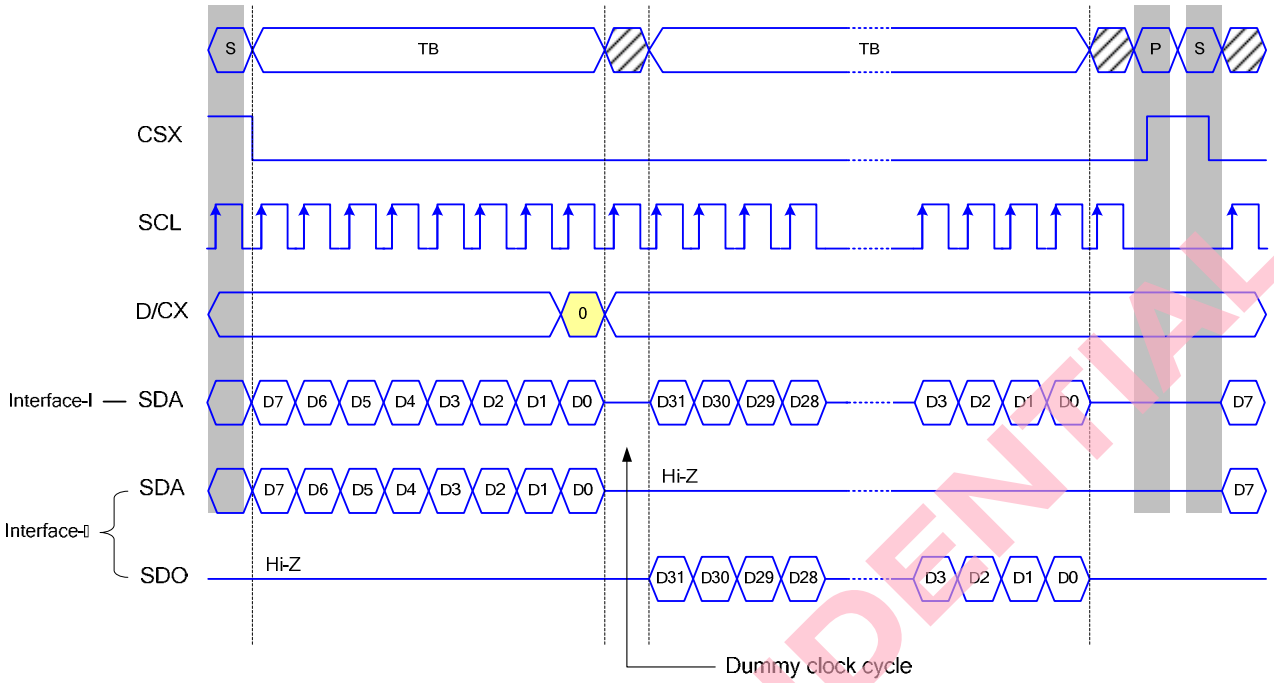


Figure 16 4-line serial interface read protocol

10. Power ON/OFF Sequence

VDDI and VDD can be applied in any order.

In CABC function application, VDDI power on need delay 5ms after VDD has been supplied.

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.

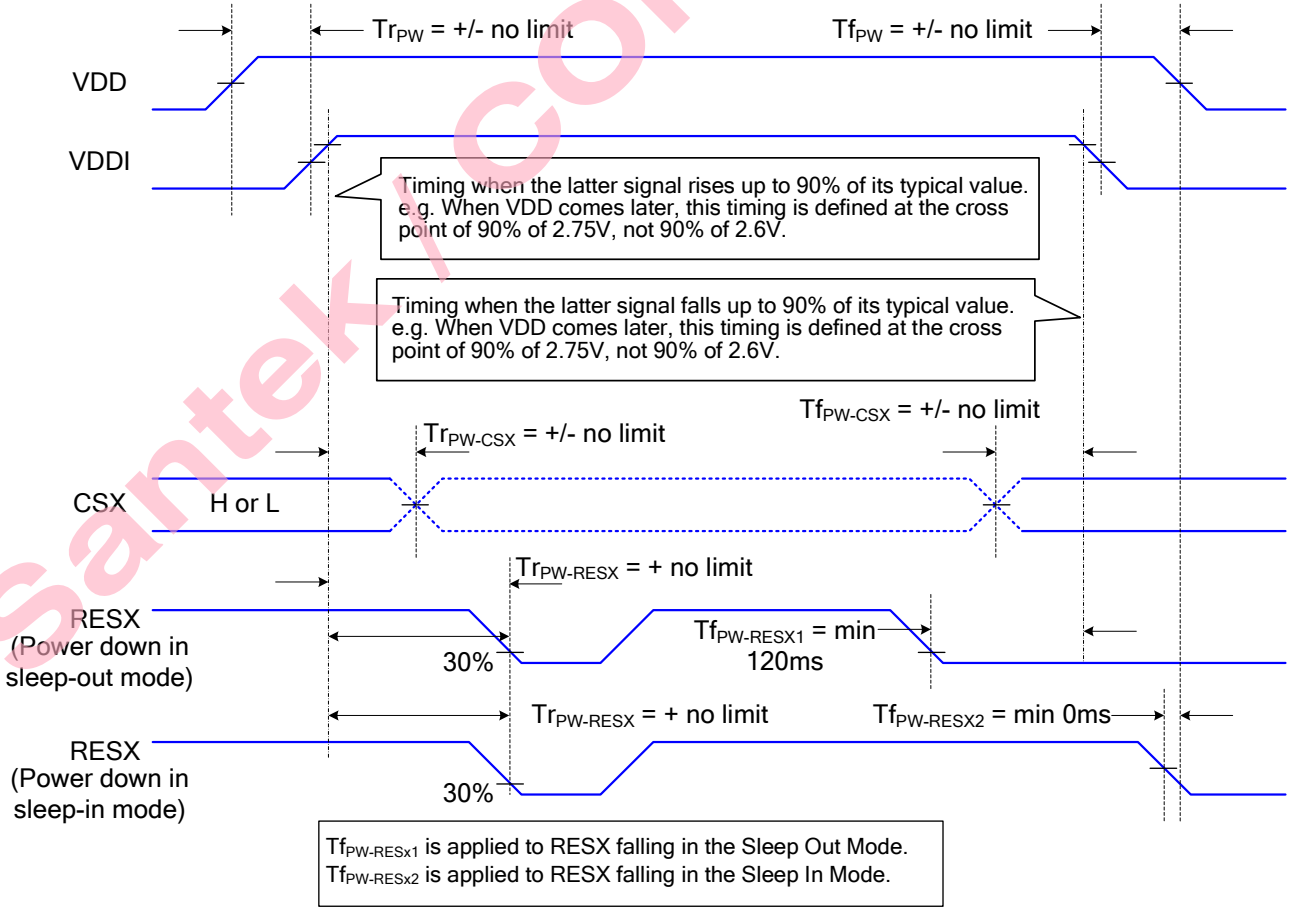
Note 1: There will be no damage to the display module if the power sequences are not met.

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



10. Uncontrolled Power Off

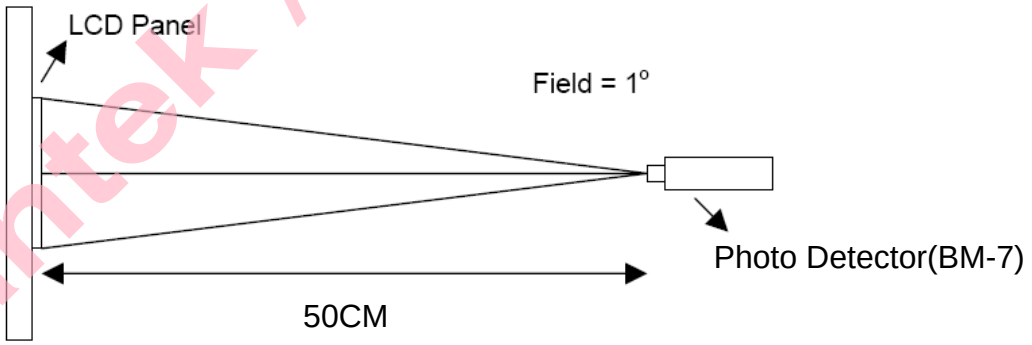
The uncontrolled power-off means a situation which removed a battery without the controlled power off sequence. It will neither damage the module or the host interface.

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.

11. Optical Characteristics

Item		Symbol	Specifications			Unit	Note
			Min.	Typ.	Max.		
Contrast Ratio		Cr(Θ=0°)	300	800	-	-	Note 1,2
Response Time(25℃)		Tr+Tf(Θ=0°)	-	30	40	msec	Note 3
Viewing Angle (Cr≥10)	Θ_R	φ=0°	-	80	-	deg	Note 4
	Θ_T	φ=90°	-	80	-		
	Θ_L	φ=180°	-	80	-		
	Θ_B	φ=270°	-	80	-		
Chromaticity (Θ=0°)	White	x	0.2339	0.2839	0.3339	-	Note 1,5
		y	0.2584	0.3084	0.3584		
	Red	x	0.5854	0.6354	0.6854		
		y	0.2781	0.3281	0.3781		
	Green	x	0.2667	0.3167	0.3667		
		y	0.5675	0.6175	0.6675		
	Blue	x	0.0947	0.1447	0.1947		
		y	0.0039	0.0539	0.1039		
Luminance		Θ=0°	850	1000	-	cd/m²	Note 1,6
Luminance Uniformity		-	70	85	-	%	Note 1,7
Color Gamut(NTSC)		-	-	72	-	%	Reference

Note 1: Definition of contrast ratio

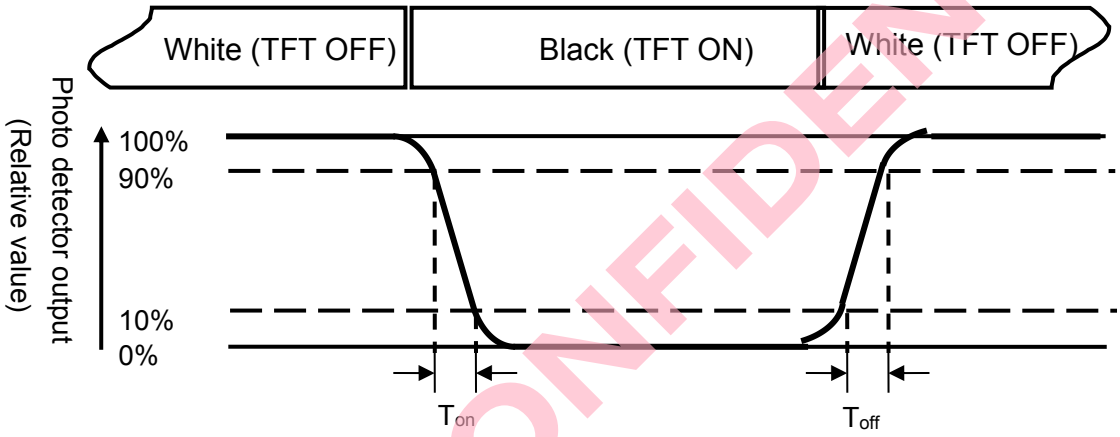


Note 2: Definition of contrast ratio

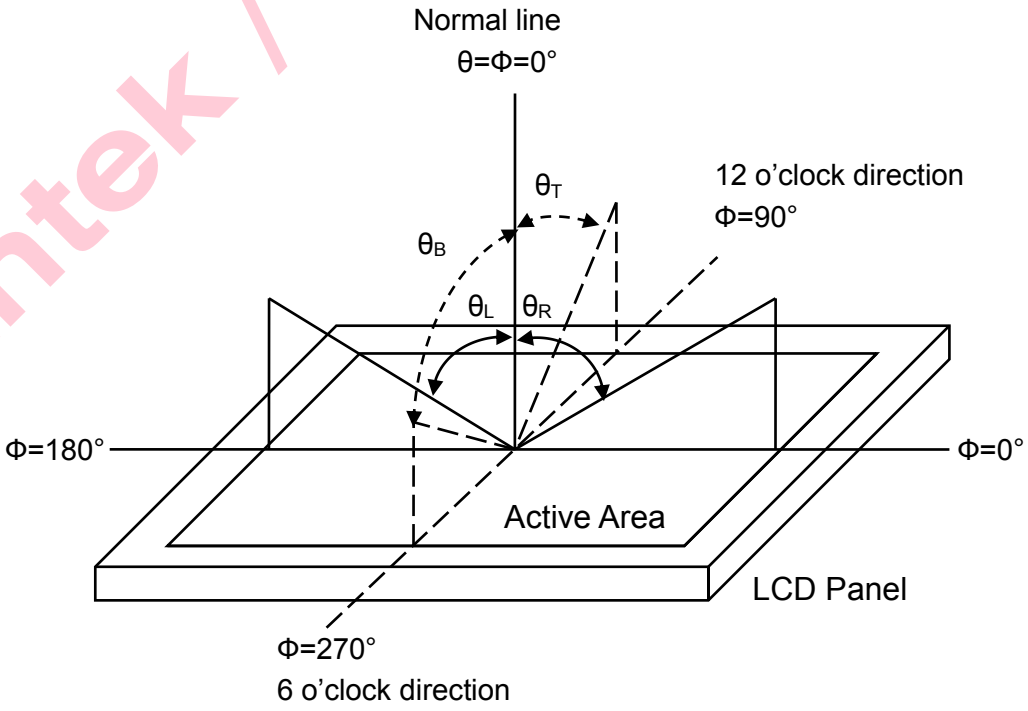
$$\text{Contrast ratio (CR)} = \frac{\text{Luminance measured when LCD on the "White" state}}{\text{Luminance measured when LCD on the "Black" state}}$$

Note 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_{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 4: Definition of viewing angle range



Note 5: 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 6: Definition of luminance

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

Note 7: Definition of luminance uniformity

To test for uniformity, the tested area is divided into 9 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

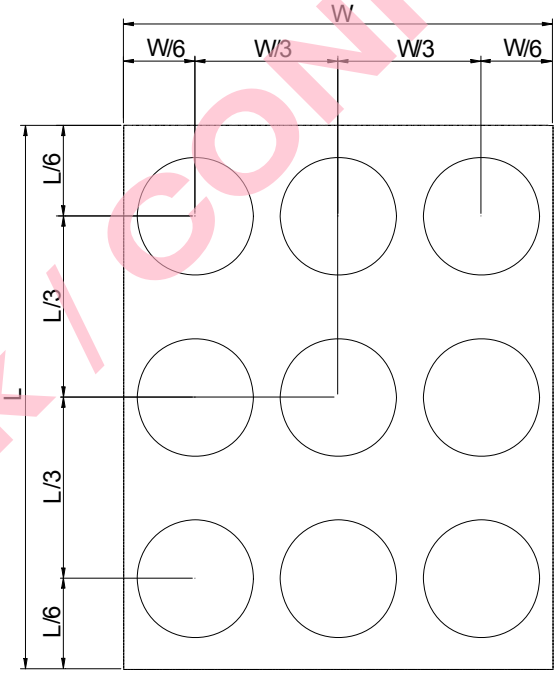


Fig. 5 Definition of luminance uniformity

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

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

12. Reliability Tests

No.	Item	Condition	Criterion
1	High Temperature Storage	80±3℃,120 Hours	No defects in display and operational functions
2	Low Temperature Storage	-30±3℃,120 Hours	
3	High Temperature Operating	70±3℃,120 Hours	
4	Low Temperature Operating	-20±3℃,120 Hours	
5	High Temperature and Humidity Test(Storage)	60±3℃,90±3%RH,120 Hours	
6	Thermal Shock	-30℃(30mins)→80℃(30mins),10Cycle	

Remark:

1. The Test samples should be applied to only one test item.
2. Sample for each test item is 2 pcs.
3. The samples must be free from defect before test, must be restored at room condition at least for 2 hours storage at room temperature after reliability test before any inspection.
4. Failure Judgment Criterion: Basic Specification Electrical Characteristic, Mechanical Characteristic, Optical Characteristic.
5. 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.

13. Package Drawing

TBD

14. Incoming Inspection Specification

TBD

15. Cautions

a. Recommended Storage condition: Temperature: 25ºC+/-5ºC, Humidity: ≤75%RH. Clear and free with dust and flowing particles space.

b. Don't disassemble and reassemble the module by yourself.

c. Acid, alkali, alcohol or touched directly by hand will damage the display.

d. Static electricity will damage the module. Please configure grounding device. And enough anti-statics protection when touching products.

e. The strong vibration, shock, twist or bend will cause material damage, even module broken.

f. It is easy to cause image sticking while displaying the same pattern for very long time.

g. The response time, brightness and performance will vary from different temperature.

h. LCD Devices are made of fragile material such as Glass and may be broken or cracked if dropped it, so please handle them with care. Please be careful not to cut your hand if you break the glass.

i. Do not stack the LCDs to avoid the LCDs damage and contamination.

j. Before using the LCDs, please check the specification.

k. LCDs contain a small amount of Liquid Crystal. Please follow local ordinances or regulations for disposal.

l. LCD shall be stored in same packing material during import, and under the condition of room temperature (20-30 degree C).

m. Please do not leave LCD modules under the direct sunlight or strong infra-red radiation for a long period time to prevent liquid crystal deteriorating.

n. Please turn off the power supply before plugging or unplugging LCD module.

o. Please do not rub, push, or hit LCD surface with hard tool etc. Film on surface is easily scratched, when droplets of water or dirt are on the surface, please gently remove them with soft fabric.

p. Handling of main and LED FPC (Flexible Printed Circuit), please be careful, do not strongly pull or scratch FPC, to avoid failure of the components and bonding part.

16. 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 replacement on the terms set forth above. Santek shall not be responsible for any subsequent or consequential events.

16.1 Returning LCM Under Warranty –Terms and Conditions

a. 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.

b. 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.