DMT024QVNUCMI-3A

PRODUCT SPECIFICATION

Version 0.2
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Customer's Approval	
Signature	***Date***

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Revision History

VERSION	DATE	DESCRIPTION	AUTHOR
0.1	Jun 15, 2022	Preliminary	Victoria Ho
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Legal Notice

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1. General Description

1.1 Introduction

This is a 2.4” size colour active matrix TFT LCD module that uses amorphous silicon TFT as a switching device. The display is normally black mode, transmissive, and featuring high contrast and excellent colour saturation. The resolution of the TFT-LCD is 240 x 320 and can display up to 262K colours. The display module supports 8/9/16/18-bit MCU, 3/4-line SPI + 16/18-bit RGB, 3-/4-line SPI interface and tape bonding touch panel.

1.2 Main Features

Item	Contents
Display Type	TFT LCD
Screen Size	2.4” Diagonal
Display Format	240 x RGB x 320 Dots
No. of Colour	65K/262K
Overall Dimensions	48.72 (W) x 70.26 (H) x 3.9 (D) mm
Active Area	36.72 (W) x 48.96 (H) mm
Mode	Normally Black / Transmissive
Surface Treatment	Glare (6H)
Viewing Direction	All round
Interface	8/9/16/18-bit MCU 3/4-line SPI+16/18-bit RGB
Driver IC	ST7789V
Backlight Type	LED, White, 4 chips
Operating Temperature	-20°C ~ +70°C
Storage Temperature	-30°C ~ +80°C
ROHS	Compliant to RoHS 2.0

1.3 CTP Features

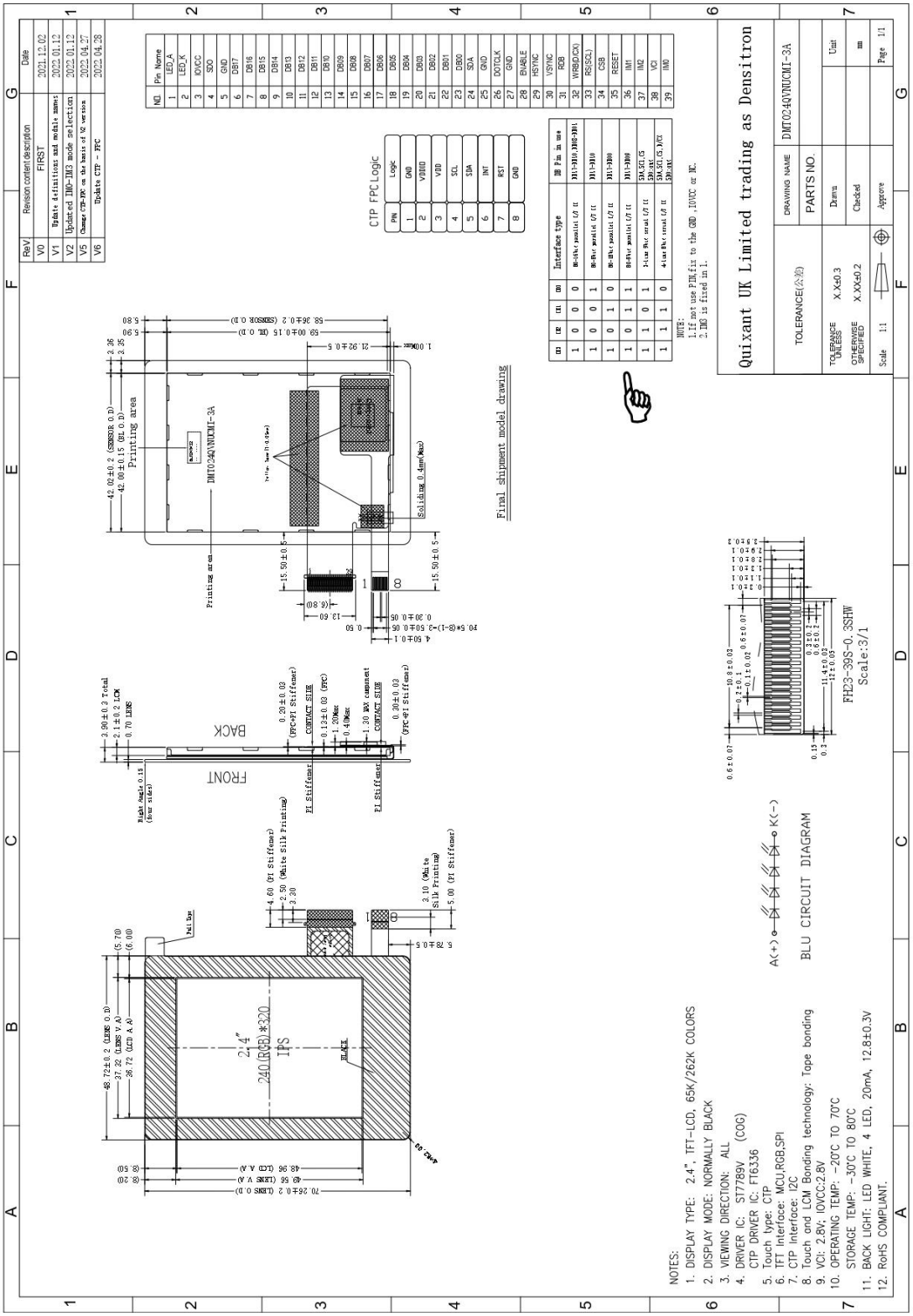
Item	Contents
Touch Panel	CTP
Structure	G+G
Bonding Type	Tape Bonding
Controller IC	FT6336G
Interface	I^2C
Slave Address	0x38(7bit)/8bit:0x70(Write) 0x71(Read)
Touch mode	Single point and Gestures

2. Mechanical Specification

2.1 Mechanical Characteristics

Item	Characteristic	Unit
Display Format	240 x RGB x 320	Dots
Overall Dimensions	48.72 (W) x 70.26 (H) x 3.9 (D)	mm
Active Area	27.72 (W) x 27.72 (H)	mm
Pixel Pitch	0.153 x 0.153	mm
Weight	20	g
IC Controller/Driver	ST7789V	

2.2 Mechanical Drawing



3. Electrical Specification

3.1 Absolute Maximum Ratings

Item	Symbol	Min	Max	Unit	Note
Digital Supply Voltage	VCI	-0.3	4.6	V	-
Interface Operation Voltage	IOVCC	-0.3	4.6	V	-
Operating Temperature	T_{OPR}	-20	+70	°C	-
Storage Temperature	T_{STG}	-30	+80	°C	-

Note 1: When this module is used beyond the above absolute maximum ratings, permanent breakage of the module may occur. For normal operations, it is desirable to use this module under the conditions according to Section 3.2 “Electrical Characteristics”, to avoid malfunctioning.

Note 2: Background colour changes slightly depending on ambient temperature. This phenomenon is reversible.

Note 3: Please refer to item of RELIABILITY.

3.2 Electrical Characteristics

3.2.1 DC Electrical Characteristics

Item	Symbol	Condition	Min	Typ.	Max	Unit	Note
Digital Supply Voltage	VCI	-	2.5	3.3	3.6	V	-
Interface Operation Voltage	IOVCC	-	1.65	1.8	3.3	V	-
Normal mode Current consumption	IDD	-	-	7	14	mA	-
Level Input Voltage	V_{IH}	-	0.7*IOVCC	-	IOVCC	V	-
	V_{IL}	-	GND	-	0.3*IOVCC	V	-
Level Output Voltage	VOH	-	0.8*IOVCC	-	IOVCC	V	-
	VOL	-	GND	-	0.2*IOVCC	V	-

3.3 Interface Pin Assignment

3.3.1 TFT Pin Assignment

No.	Symbol	I/O	Function
1	LED_A	P	Anode pin of backlight
2	LED_K	P	Cathode pin of backlight
3	IOVCC	P	Supply voltage (1.65-3.3V).
4	SDO	O	SPI interface output pin. The data is output on the falling edge of the SCL signal. If it's not used, let this pin open.
5	GND	P	Ground
6-23	DB17-DB0	I/O	18-bit parallel bi-directional data bus for MCU system and RGB interface mode. Fix to GND level when it's not in use
24	SDA	I/O	SPI interface input/output pin. The data is latched on the rising edge of the SCL signal. If it's not used, please fix this pin at IOVCC or DGND level
25	GND	P	Ground.
26	DOTCLK	I	Dot clock signal for RGB interface operation. Fix this pin at IOVCC or GND when it's not in use.
27	GND	P	Ground.
28	ENABLE	I	Data enable signal for RGB interface operation. Fix this pin at IOVCC or GND when it's not in use.
29	HSYNC	I	Line synchronizing signal for RGB interface operation. Fix this pin at IOVCC or GND when it's not in use.
30	VSYNC	I	Frame synchronizing signal for RGB interface operation. Fix this pin at IOVCC or GND when it's not in use.
31	RDB	I	Serves as a read signal and MCU read data at the rising edge. Fix this pin at IOVCC or GND when it's not in use.
32	WRB(D/CX)	I	Write enable in MCU parallel interface. Display data/command selection pin in 4-line serial interface. Second data lane in 2 data lane serial interface. If it's not used, please fix this pin at IOVCC or DGND.

No.	Symbol	I/O	Function
33	RS(SCL)	I	Display data/command selection pin in parallel interface. This pin is used to be serial interface clock. RS='1': display data or parameter. RS='0': command data. If it's not used, please fix this pin at IOVCC or DGND.
34	CSB	I	Chip select input pin ("Low" enable). Fix this pin at IOVCC or GND when it's not in use.
35	RESET	I	This signal will reset the device and must be applied to properly initialize the chip.
36	IM1	I	MPU Parallel interface bus and serial interface select.
37	IM2		
38	VCI	P	Supply voltage (3.3V).
39	IM0	I	MPU Parallel interface bus and serial interface select.

IM3	IM2	IM1	IM0	Interface type	DB Pin in use
1	0	0	0	80-16 bit parallel I/F II	DB17-DB10, DB08-DB01
1	0	0	1	80-8 bit parallel I/F II	DB17-DB10
1	0	1	0	80-18 bit parallel I/F II	DB17-DB00
1	0	1	1	80-9 bit parallel I/F II	DB17-DB09
1	1	0	0	3-line 9-bit serial I/F II	SDA, SCL, CS SDO: out
1	1	1	1	4-line 9-bit serial I/F II	SDA, SCL, CS, D/CX SDO: out

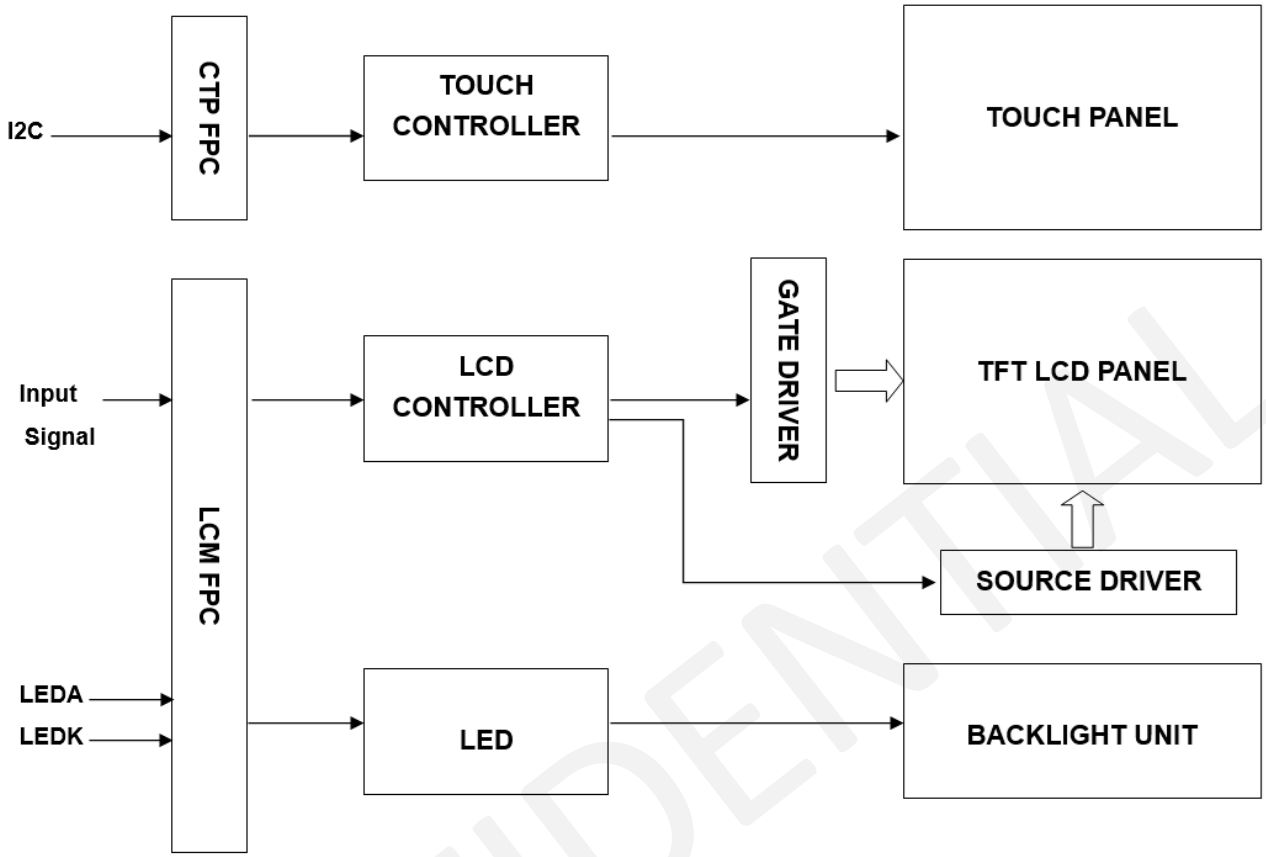
Note1: If not use PIN, fix to the GND, IOVCC or NC

Note2: IM3 is fixed in 1.

3.3.2 CTP PIN Assignment

No.	Symbol	I/O	Function
1	GND	P	Ground.
2	VDDIO	P	I/O power supply voltage. (1.8V)
3	VDD	P	Supply voltage. (3.3V)
4	SCL	I	I^2C clock input.
5	SDA	I/O	I^2C data input and output
6	INT	I	External interrupt to the host.
7	RST	I	External Reset, Low is active.
8	GND	P	Ground.

3.4 Block Diagram



3.5 Timing Characteristics

3.5.1 RGB Interface Characteristics

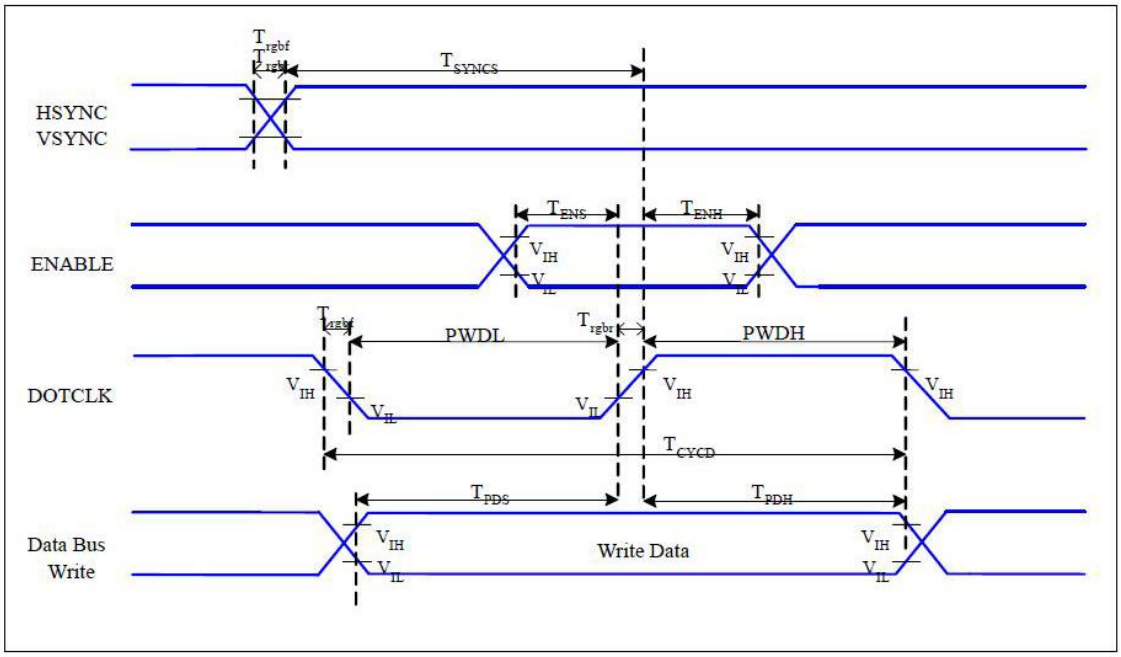
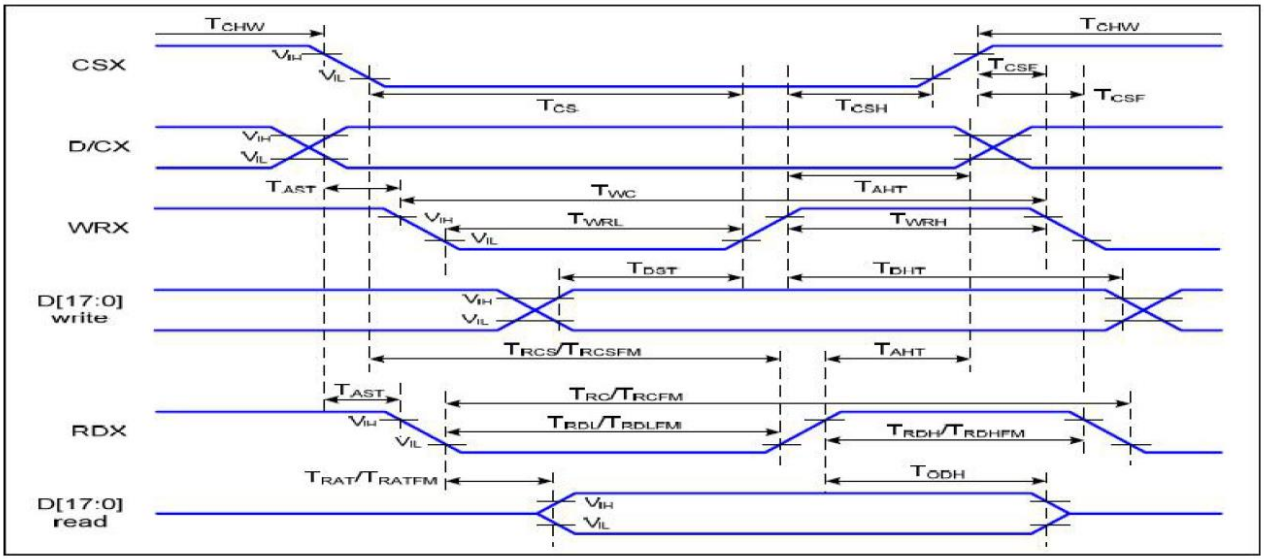


Table: 18/16 Bits RGB Interface Timing Characteristics

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

Signal	Symbol	Item	Min	Max	Unit	Note
HSYNC, VSYNC	T_{SYNCS}	VSYNC, HSYNC Setup Time	30	-	ns	-
Enable	T_{ENS}	Enable Setup Time	25	-	ns	-
	T_{ENH}	Enable Hold Time	25	-	ns	-
DOTCLK	PWDH	DOTCLK High-level Pulse Width	60	-	ns	-
	PWDL	DOTCLK Low-level Pulse Width	60	-	ns	-
	TCYCD	DOTCLK Cycle Time	120	-	ns	-
	Trghr, Trghf	DOTCLK Rise/Fall Time	-	20	ns	-
DB	T_{PDS}	PD Data Setup Time	50	-	ns	-
	T_{PDH}	PD Data Holde Time	50	-	ns	-

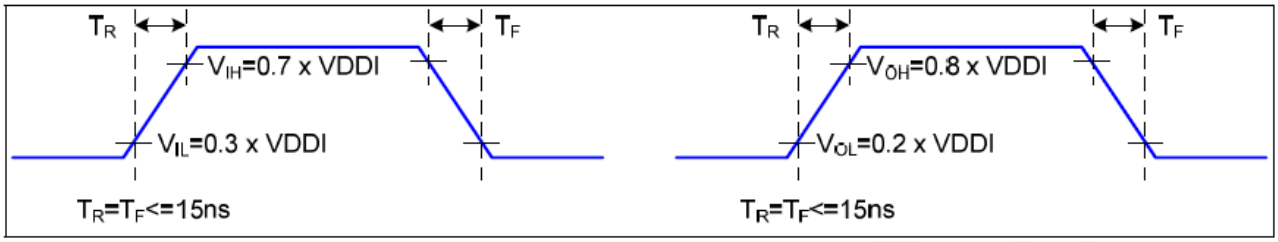
3.5.2 8080 Series MCU Parallel Interface Characteristics: 18/16/9/8-bit Bus



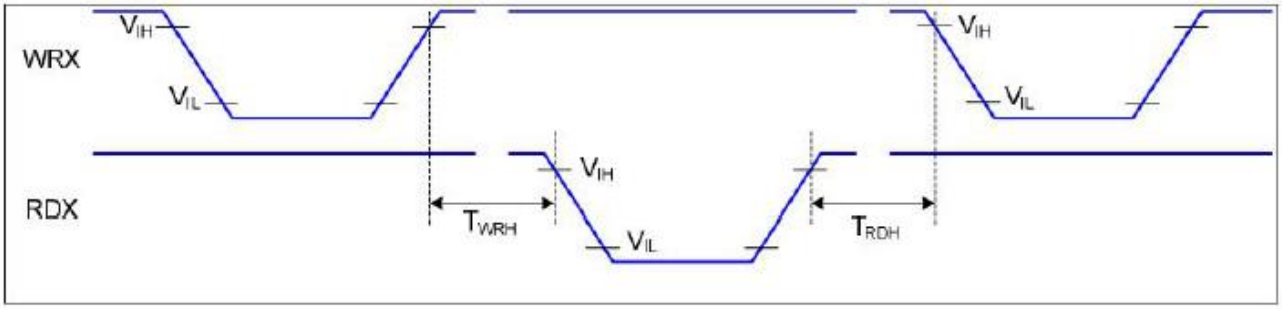
VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=25℃

Signal	Symbol	Item	Min	Max	Unit	Condition
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 fram memory
	T_{RDHFM}	Control pulse “H” duration (FM)	90	-	ns	
	T_{RDLFM}	Control pulse “L” duration (FM)	355	-	ns	

Signal	Symbol	Item	Min	Max	Unit	Condition
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	-	ns	



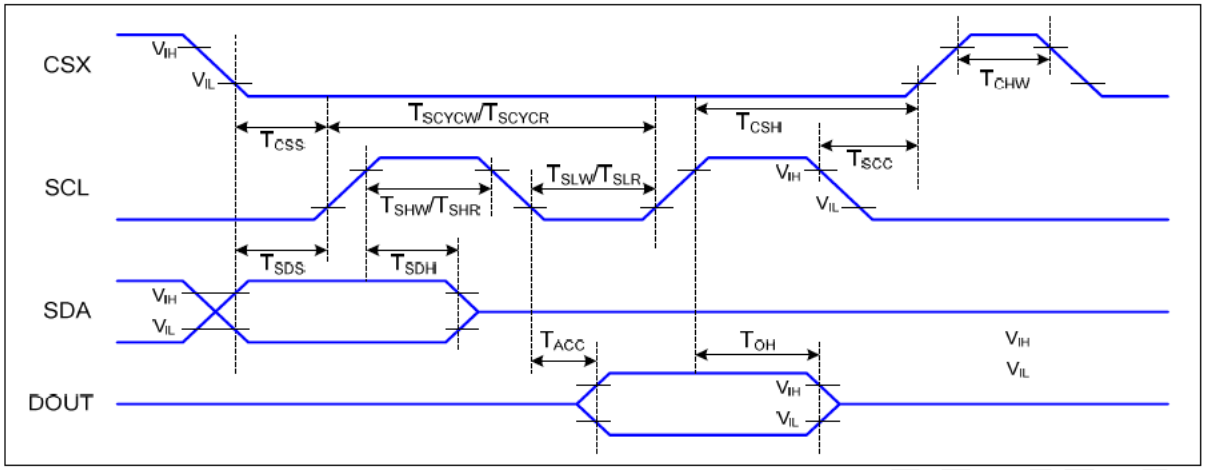
Rising and Falling Timing for I/O Signal



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.

3.5.3 Serial Interface Characteristics (3-Line Serial)

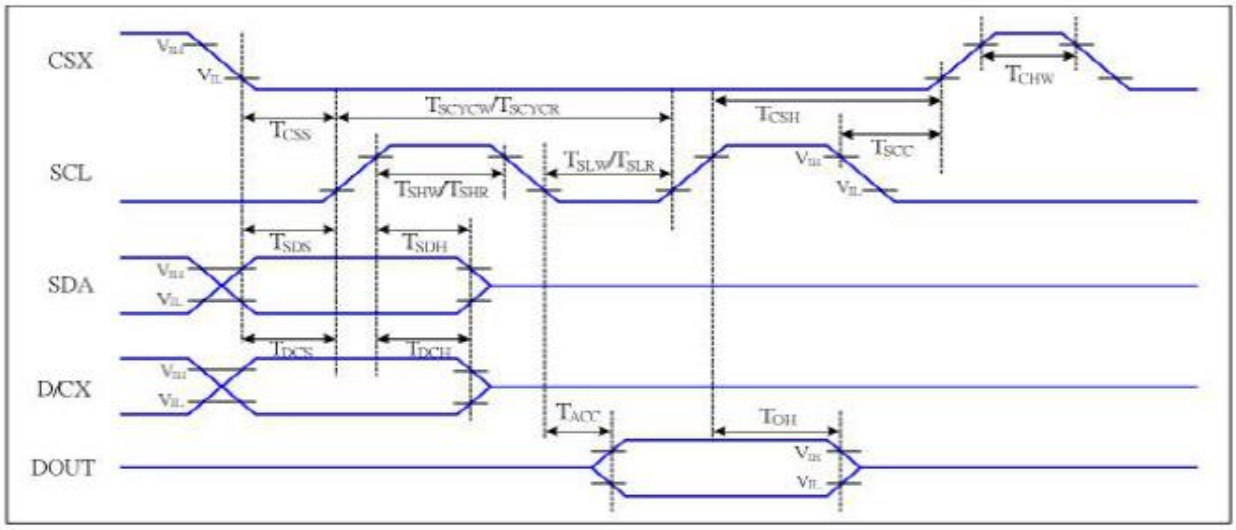


VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=25℃

Signal	Symbol	Item	Min	Max	Unit	Condition
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	-
	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	
	T_{SHR}	SCL “H” pulse width (Read)	60	-	ns	
	T_{SLR}	SCL “L” pulse Width (Read)	60	-	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

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

3.5.4 Serial Interface Characteristics (4-Line Serial)

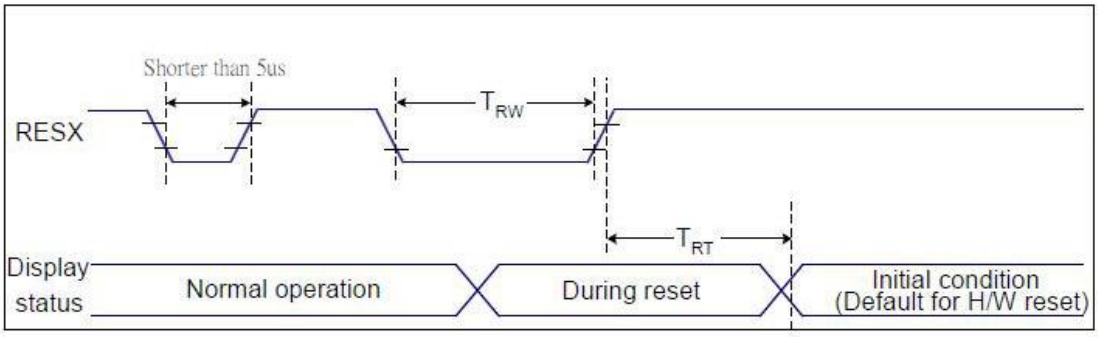


VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=25℃

Signal	Symbol	Item	Min	Max	Unit	Condition
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

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.

3.5.5 Reset Timing



Signal	Symbol	Item	Min	Max	Unit	Note
RESX	TRW	Reset pulse duration	10	-	us	-
	TRT	Reset Cancel	-	5	ms	1, 5
			-	120	ms	1, 6 ,7

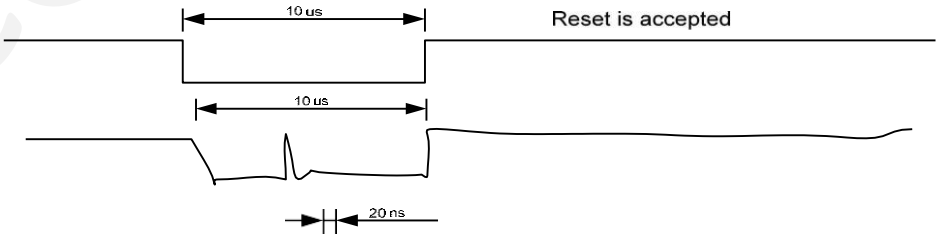
Note 1: The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from OTP to registers. This loading is done every time when there is H/W reset cacncel time (tRT) within 5 ms after a rising edge of RESX.

Note 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

Note 3: During the Resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120ms, 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.

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



Less than 20ns width positive spike will be rejected

Note 5: When Reset applied during Sleep In Mode.

Note 6: When Reset applied during Sleep Out Mode.

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

4. Electrical Specification Touch

4.1 Electrical Characteristics

4.1.1 Absolute Maximum Ratings

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	VDD	-0.3	3.6	V	1
I/O Digital Voltage	VDDIO	1.8	3.6	V	-
Operating Temperature	T_{OP}	-20	+70	℃	-
Storage Temperature	T_{ST}	-30	+80	℃	-

Note 1: If used beyond the absolute maximum ratings, FT6336G may be permanently damaged. It is strongly recommanded that the device be used within the electrical characteristics in normal operations. If exposed to the condition not within the electrical characteristics, it may affect the reliability of the device.

4.1.2 DC Electrical Characteristics

(Ta=25°C)

Item	Symbol	Condition	Min	Typ	Max	Unit	Note
Digital Supply Voltage	VDD	-	2.8	3.3	3.6	V	-
I/O Digital Supply Voltage	VDDIO	-	1.8	3.3	3.6	V	-
Normal Operation Mode Current Consumption	I_{opr}	VDD=2.8V Ta=25°C MCLK=17.5Mhz	-	4	-	mA	-
Monitor Mode Current Consumption	I_{mon}		-	1.5	-	mA	-
Sleep Mode Current Consumption	I_{slp}		-	50	-	μA	-
Level Input Voltage	V_{IH}	-	$0.7V_{DDIO}$	-	V_{DDIO}	V	-
	V_{IL}	-	-0.3	-	$0.3V_{DDIO}$	V	-
Level Output Voltage	V_{OH}	I_{OH}=-0.1mA	$0.7V_{DDIO}$	-	-	V	-
	V_{OL}	I_{OH}=0.1mA	-	-	$0.3V_{DDIO}$	V	-

4.2 AC Electrical Characteristics

AC Characteristics of Oscillators

Item	Symbol	Test Condition	Min	Typ.	Max	Unit	Note
OSC clock 1	fosc1	VDDA= 2.8V； Ta=25°C	34.65	35	35.35	MHz	-

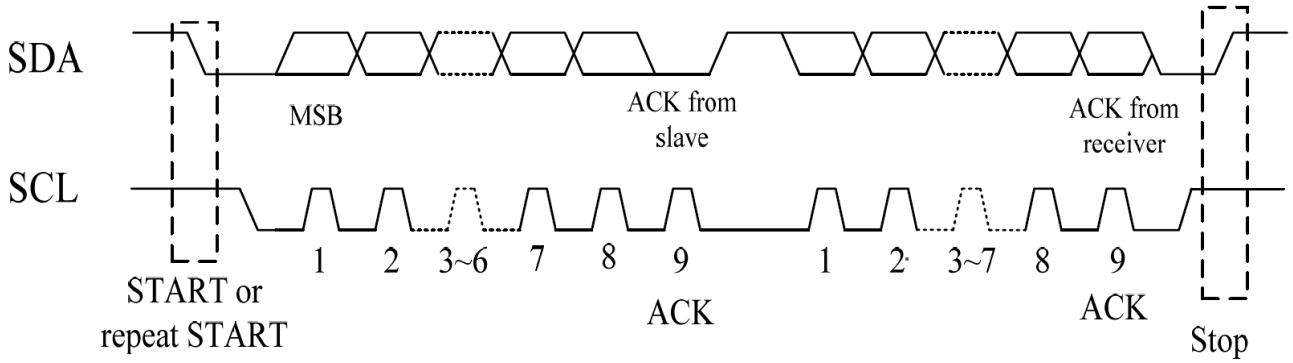
AC Characteristics of sensor

Item	Symbol	Test Condition	Min	Typ.	Max	Unit	Note
Sensor acceptable clock	ftx	VDDA = 2.8V； Ta = 25°C	0	100	300	kHz	-
Sensor output rise time	Ttxr	VDDA = 2.8V； Ta = 25°C	-	100	-	ns	-
Sensor output fall time	Ttxf	VDDA = 2.8V； Ta = 25°C	-	80	-	ns	-
Sensor input voltage	Trxi	VDDA = 2.8V； Ta = 25°C	-	5	-	V	-

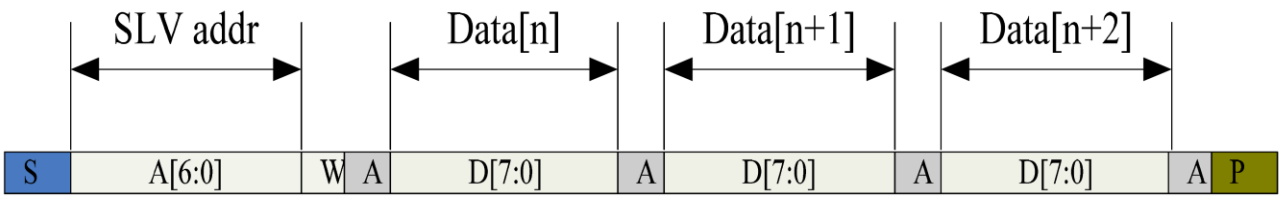
4.2.1 I²C Interface

The I²C is always configured in the Slave mode. The data transfer format is shown as below:

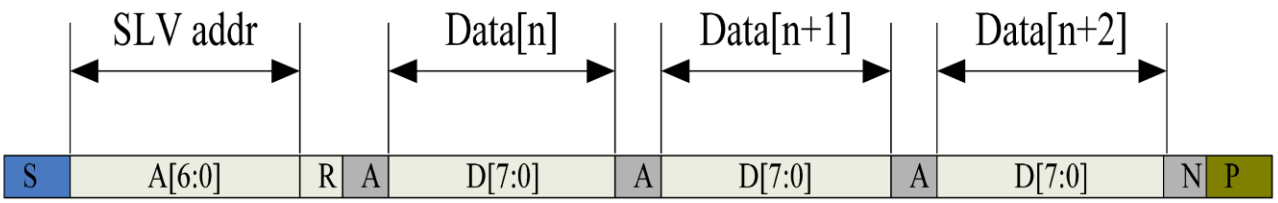
I²C Serial Data Transfer Format



I2C master write, slave read



I2C master read, slave write



Below table lists the meanings of the mnemonics used in above figures.

Mnemonics Description

Mnemonics	Description
S	I^2C Start or I^2C Restart
A [6:0]	Slave address
R/W	READ/WRITE bit, '1' for read, '0'for write
A (N)	ACK (NACK)
P	STOP: the indication of the end of a packet (if this bit is missing, S will indicate the end of the current packet and the beginning of the next packet)

I^2C Timing Characteristics

Parameter	Min	Max	Unit
SCL frequency	10	400	KHz
Bus free time between a STOP and START condition	4.7	-	us
Hold time (repeated) START condition	4.0	-	us
Data setup time	250	-	ns
Setup time for a repeated START condition	4.7	-	us
Setup Time for STOP condition	4.0	-	us

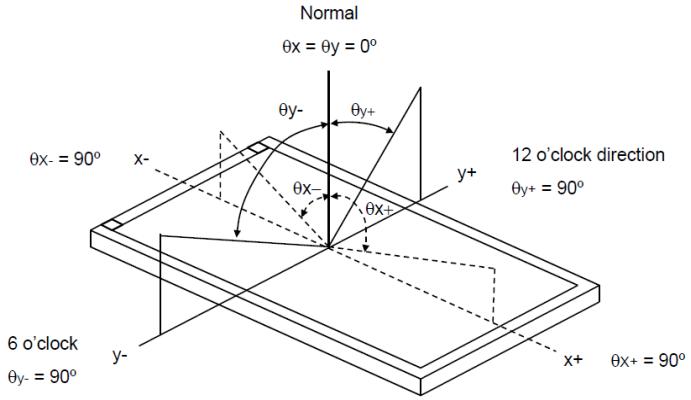
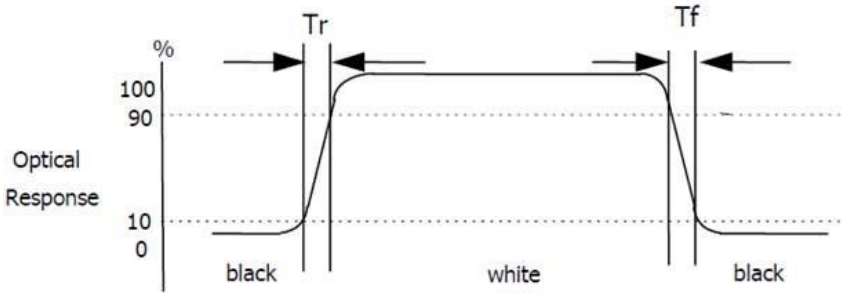
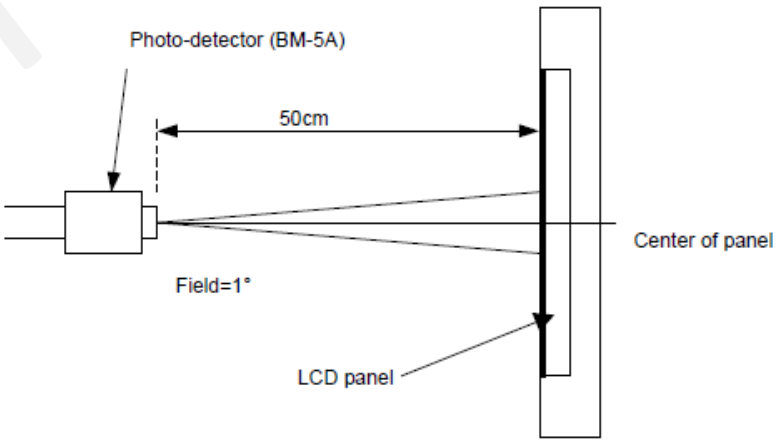
5. Optical Specification

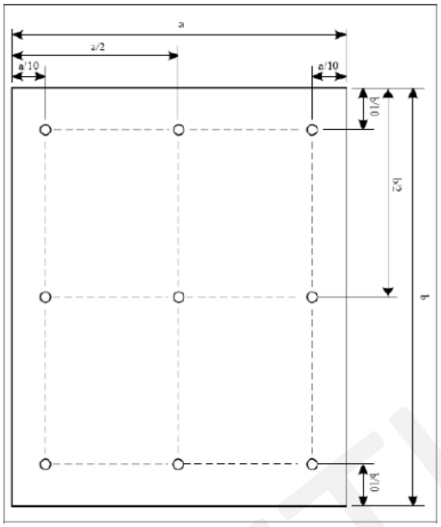
5.1 Optical Characteristics

Characteristics		Symbol	Conditions	Min	Typ.	Max	Unit	Note
Contrast Ratio		CR	$\theta = 0^{\circ}$ Normal viewing angle	640	800	-	-	1, 2
Response time		$T_R + T_F$		-	35	45	msec	1, 3
Color Gamut		S(%)		40	46	-	%	-
Viewing Angle	Left	θ_x-	CR≥10	-	80	-	Degree	1, 4
	Right	θ_x+		-	80	-		
	Up	θ_Y+		-	80	-		
	Down	θ_Y-		-	80	-		
Colour Chromaticity	Red	Rx	$\theta = 0^{\circ}$ Normal viewing angle	0.589	0.629	0.689	-	1, 4 CS-310
		Ry		0.309	0.349	0.389		
	Green	Gx		0.284	0.324	0.364		
		Gy		0.541	0.581	0.621		
	Blue	Bx		0.108	0.148	0.188		
		By		0.027	0.067	0.107		
	White	Wx		0.285	0.325	0.365		
		Wy		0.326	0.366	0.406		
Luminance		LV	I_F = 20mA	450	500	-	cd/m^2	5
Uniformity		Avg	-	80	-	-	%	5

Note: Measuring Condition = in dark room, at ambient temperature 25±2°C, for 15min, warm-up time.

Measuring Equipment: FPM520 of Westar Display technologies, INC., which utilized SR-3 for Chromaticity and BM-5A for other optical characteristics.

Note	Item	Test method
1	Definition of Viewing Angle	
2	Definition of Contrast Ratio (CR)	Measured at the center point of panel $\text{Contrast ratio (CR)} = \frac{\text{Luminance measured when LCD is at "white state"}}{\text{Luminance measured when LCD is at "black state"}}$
3	Definition of Response Time	
4	Definition of Optical Measurement Setup	

Note	Item	Test method
5	Definition of Luminance Uniformity	Luminance Uniformity of these 9 points is defined as below:  $\text{Uniformity} = \frac{\text{minimum luminance in 9 points (1-9)}}{\text{maximum luminance in 9 points (1-9)}}$ $\text{Luminance} = \frac{\text{Total Luminance of 9 points}}{9}$

6. LED Backlight Specification

6.1 LED Backlight Characteristics

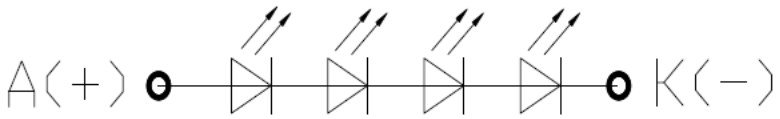
The back-light system is edge-lighting type with 4 chips White LED.

Item	Symbol	Condition	Min	Typ.	Max	Unit	Note
Forward Current	If	-	15	20	-	mA	-
Forward Voltage	Vf	-	-	12.8	-	V	-
LED Lifetime	-	-	50000	-	-	Hours	-

Note 1: LED life time (Hr) can be defined as the time in which it continues to operate under the condition: Ta=25±3℃, typical IL value indicated in the above table until the brightness becomes less than 50%.

Note 2: The "LED lifetime" is defined as the module brightness decreases to 50% original brightness at Ta=25℃ and IL=20mA. The LED lifetime could be decreased if operating IL is larger than 20mA. The constant current driving method is suggested.

6.2 Internal Circuit Diagram



BLU CIRCUIT DIAGRAM

7. Packaging

TBD

8. Quality Assurance Specification

8.1 Conformity

The performance, function and reliability of the shipped products conform to the Product Specification.

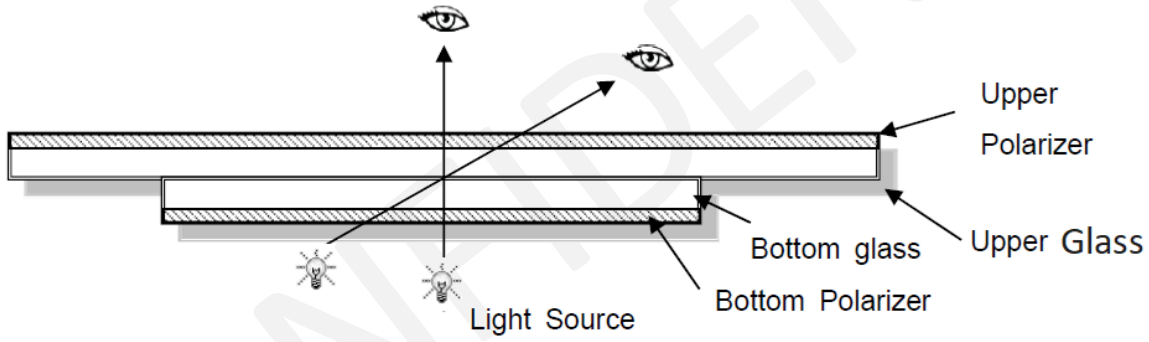
8.2 Environment Required

Customer's test & measurement are required to be conducted under the following conditions:

Temperature:	25 ± 5°C
Humidity:	65% ± 10% RH
Viewing Angle:	Normal Viewing Angle
Illumination:	Single fluorescent lamp (300 to 700Lux)
Viewing distance:	30 - 50 cm

Finger glove (or finger cover) must be worn by the inspector.

Inspection table or jig must be anti-electrostatic.

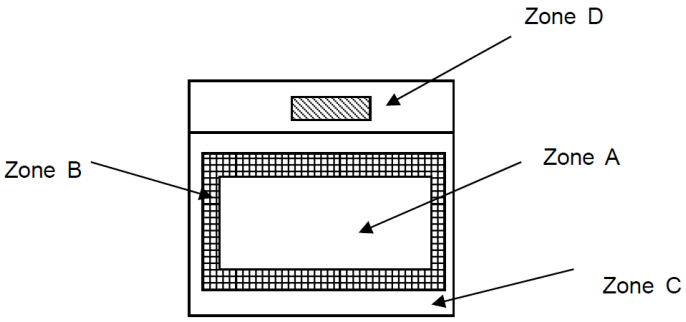


8.3 Delivery Assurance

8.3.1 Delivery Inspection Standards

Class II, Normal Inspection, GB/T 2828-2003

8.3.2 Zone Definition



Zone A: Effective Viewing Area (Character or Digit can be seen)

Zone B: Viewing Area except Zone A

Zone C: Outside (Zone A + Zone B) Area which cannot be seen after assembly by customer.

Zone D: IC Bonding Area

Note: Generally, visual defects in Zone C can be ignored when it doesn't affect product function or appearance after assembly by customer

8.3.3 Criteria & Acceptable Quality Level

Partition	AQL	Definition
Major	0.65	Defects in Pattern Check (Display On)
Minor	1.5	Defects in Cosmetic Check (Display Off)

8.3.4 Criteria & Classification

LCD: Liquid Crystal Display, LCM: Liquid Crystal Module, CTP: Capacitive Touch Panel

No.	Items	Criteria	Classification of defects
1	Functional defects	1) No display, Open or miss line 2) Display abnormally, Short 3) Backlight no lighting, abnormal lighting. 4) TP no function	Major
2	Missing	Missing component.	
3	Outline Dimension	Overall outline dimension beyond the drawing is not allowed.	
4	Color Tone	Color unevenness, refer to limited sample	Minor
5	Spot/ Line Defect	Light dot, Dim spot, Polarizer Bubble, Polarizer accidented spot, etc.	
6	Soldering Appearance	Good soldering, peeling off is not allowed.	
7	LCD/Polarizer/CTP	Black/White spot/line, scratch, crack, etc.	

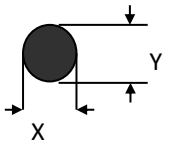
Note1:

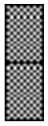
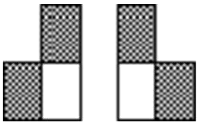
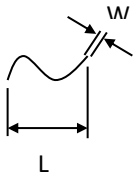
a) Light dot：Dots appear bright and unchanged in size in which LCD panel is displaying under black pattern.

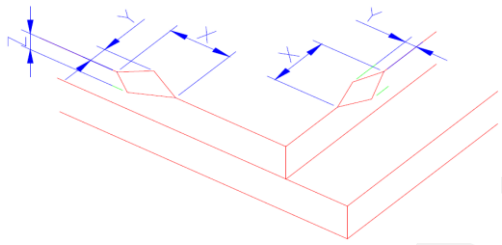
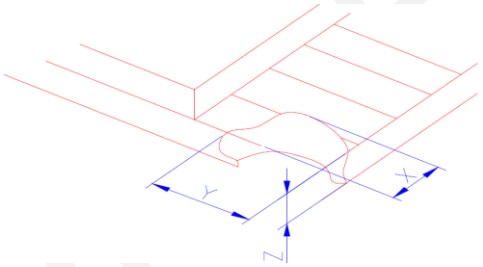
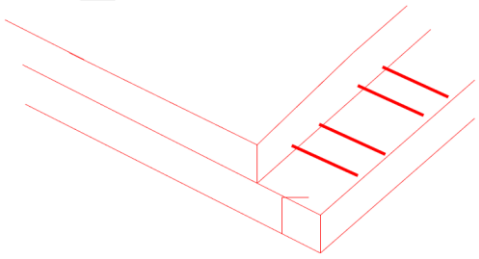
b) Dim dot: Dots appear dark and unchanged in size in which LCD panel is displaying under pure red, green, blue picture.

8.3.5 Criteria & Classification

Units: mm

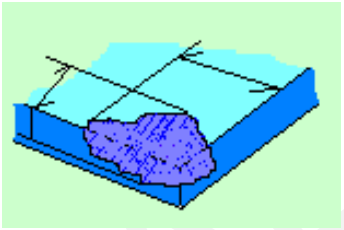
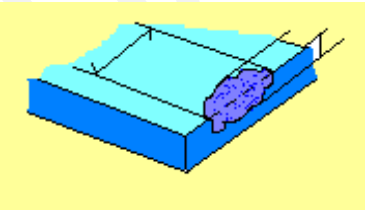
<table>
<tr><th></th><th>Item</th><th colspan="4">Criteria</th></tr>
<tr><td rowspan="25">Minor</td><td rowspan="25">Spot Defect</td><td colspan="4">Round type: as per following drawing, ∅ = (X+Y)/2  </td></tr>
<tr><td colspan="4">1) Light Dot (Black/white spot, Pinhole, Stain)</td></tr>
<tr><td rowspan="2">Size\Zone</td><td colspan="3">Acceptable Quantity</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>∅≤0.15</td><td>Ignore</td><td rowspan="4" colspan="2">Ignore</td></tr>
<tr><td>0.15<∅≤0.25</td><td>3 (distance ≧ 6mm)</td></tr>
<tr><td>0.25<∅≤0.4</td><td>2 (distance ≧ 6mm)</td></tr>
<tr><td>0.4<∅</td><td>0</td></tr>
<tr><td colspan="4">2) Dim Spot (Light leakage, dent, dark spot)</td></tr>
<tr><td rowspan="2">Size\Zone</td><td colspan="3">Acceptable Quantity</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>∅≤0.15</td><td>Ignore</td><td rowspan="4" colspan="2">Ignore</td></tr>
<tr><td>0.15<∅≤0.25</td><td>3 (distance ≧ 6mm)</td></tr>
<tr><td>0.25<∅≤0.4</td><td>2 (distance ≧ 6mm)</td></tr>
<tr><td>0.4<∅</td><td>0</td></tr>
<tr><td colspan="4">3) Polarizer Accidented Spot</td></tr>
<tr><td rowspan="2">Size\Zone</td><td colspan="3">Acceptable Quantity</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>∅≤0.2</td><td colspan="2">Ignore</td><td rowspan="3">Ignore</td></tr>
<tr><td>0.2<∅≤0.5</td><td colspan="2">2 (distance ≧ 6mm)</td></tr>
<tr><td>0.5<∅</td><td colspan="2">0</td></tr>
<tr><td colspan="4">4) Polarizer Bubble</td></tr>
<tr><td rowspan="2">Size (mm) / Zone</td><td colspan="3"></td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>∅≤0.2</td><td colspan="2">Ignore</td><td rowspan="3">Ignore</td></tr>
<tr><td>0.2<∅≤0.4</td><td colspan="2">3(distance ≧ 6mm)</td></tr>
<tr><td>∅>0.4</td><td colspan="2">0</td></tr>
</table>

<table>
<tr><th></th><th>Item</th><th colspan="3">Criteria</th></tr>
<tr><td rowspan="11"></td><td rowspan="11"></td><td colspan="3">5) Pixel bad points</td></tr>
<tr><td>Item</td><td>Zone A</td><td>Acceptable Quantity</td></tr>
<tr><td rowspan="3">Bright Dot</td><td>Random</td><td>N≤2</td></tr>
<tr><td>2 dots adjacent</td><td>N≤0</td></tr>
<tr><td>3 dots adjacent</td><td>N≤0</td></tr>
<tr><td rowspan="3">Dark Dot</td><td>Random</td><td>N≤2</td></tr>
<tr><td>2 dots adjacent</td><td>N≤0</td></tr>
<tr><td>3 dots adjacent</td><td>N≤0</td></tr>
<tr><td>Distance</td><td>1. Minimum Distance Between Bright dots.
2. Minimum Distance Between dark dots
3. Minimum Distance Between dark and bright dot.</td><td>5mm</td></tr>
<tr><td colspan="2">Total bright and dark dot</td><td>N≤4</td></tr>
<tr><td colspan="3">Note:
A) Bright dot：Dots appear bright and unchanged in size in which LCD panel is displaying under black pattern.
B) Dark dot: Dots appear dark and unchanged in size in which LCD panel is displaying under pure red, green, blue picture.
C) 2 dot adjacent = 1 pair = 2 dots Picture:
 
2 dot adjacent
 
2 dot adjacent
 
2 dot adjacent (vertical)
 
2 dot adjacent (slant)</td></tr>
<tr><td rowspan="4">Minor</td><td rowspan="4">Line Defect (LCD/TP/ Polarizer backlight black/white line, scratch,</td><td colspan="3">Line type: as per following drawing
 
W
L</td></tr>
<tr><td rowspan="2">Width (mm)</td><td rowspan="2">Length (mm)</td><td colspan="3">Acceptable quantity</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><th></th><th>Item</th><th colspan="4">Criteria</th></tr>
<tr><td rowspan="4"></td><td rowspan="4">stain)</td><td>W≤0.03</td><td>Ignore</td><td>Ignore</td><td rowspan="3">Ignore</td></tr>
<tr><td>0.03<W≤0.04</td><td>L ≤ 3.0</td><td>N ≤ 2</td></tr>
<tr><td>0.04<W≤0.05</td><td>L ≤ 2.0</td><td>N ≤ 1</td></tr>
<tr><td>0.05<W</td><td colspan="3">Define as spot defect</td></tr>
<tr><td>Minor</td><td>LCD
Crack/Broken</td><td colspan="4">Symbols:
X: Length, Y: Width, Z: Height, L: Length of ITO, T: Height of LCD
1) The edge of LCD broken: X≦3.0mm; Y<Inner border line of the seal; Z≦T
 
2) LCD corner broken: X≦3.0mm; Y≦L; Z≦T
  </td></tr>
<tr><td>Major</td><td>LCD Crack</td><td colspan="4">The LCD with extensive crack is not acceptable.
  </td></tr>
<tr><td>Major</td><td>Electronic Components SMT</td><td colspan="4">Missing parts, solderless connection, cold solder joint, mismatch, or the positive and negative polarity opposite is not allowed.</td></tr>
<tr><td>Minor</td><td>Display Color & Brightness</td><td colspan="4">1) Color: Measuring the colour coordinates in accordance with the datasheet or samples.
2) Brightness: Measuring the brightness of white screen in accordance with the datasheet or samples.</td></tr>
</table>

	Item	Criteria
Minor	LCD Mura/Waving/ Hot spot	Not visible through 5% ND filter in 50% gray or judge by limit sample if necessary.

Class	Item	Criteria				
Minor	CTP Related	1) CTP Cover sensor accidented black/white spot				
		Size (mm)	Acceptable Quantity			
			A	B	C	
		∅≤0.1	Ignore		Ignore	
		0.10<∅≤0.20	3 (distance≧6mm)			
		0.20<∅≤0.25	2 (distance≧6mm)			
		∅＞0.25	0			
		2) CTP Cover Scratch				
		Width (mm)	Ignore (mm)	Acceptable Quantity		
				A	B	C
		∅≤0.03	Ignore	Ignore		
		0.03<∅≤0.04	L≤3.0	N≤2		
		0.04<∅≤0.05	L≤2.0	N≤1		
		0.05<∅	Define as spot defect			
		3) CTP Cover Pinhole/Lack of Ink				
		Size (mm) / Zone	Acceptable Quantity			
			C			
		∅≤0.1	Ignore			
		0.10<∅≤0.25	3 (distance≧6mm)			
		0.25<∅≤0.30	2 (distance≧6mm)			
		∅>0.3	0			
		4) CTP Bonding Bubble/Accidented Spot				
		Size ∅ (mm)	Acceptable Quantity			
			A	B		
		∅≤0.1	Ignore			
		0.10<∅≤0.20	3 (distance≧6mm			
		0.20<∅≤0.25	2 (distance≧6mm)			

<table>
<tr><th>Class</th><th>Item</th><th colspan="2">Criteria</th></tr>
<tr><td></td><td></td><td>∅>0.25</td><td>0</td></tr>
<tr><td></td><td></td><td colspan="2">5) Assembly deflection: beyond the edge of backlight ≤0.2mm</td></tr>
<tr><td></td><td></td><td colspan="2">6) TP cover broken
X：length, Y：width, Z：height</td></tr>
<tr><td></td><td></td><td colspan="2"><table><tr><th>X</th><th>Y</th><th>Z</th></tr><tr><td>X≤0.5mm</td><td>Y≤0.5mm</td><td>Z<cover thickness</td></tr></table>Circuitry broken is not allowed.
  </td></tr>
<tr><td></td><td></td><td colspan="2">7) TP Cover Broken
X：length, Y：width, Z：height</td></tr>
<tr><td></td><td></td><td colspan="2"><table><tr><th>X</th><th>Y</th><th>Z</th></tr><tr><td>X≤0.3mm</td><td>Y≤0.3mm</td><td>Z<cover thickness</td></tr></table>Circuitry broken is not allowed.
  </td></tr>
</table>

Criteria (functional items)

No.	Item	Criteria
1	No display	Not allowed
2	Missing segment	
3	Short circuit	
4	Backlight no lighting	
5	CTP no function	

8.4 Dealing with Customer Complaints

8.4.1 Non-conforming Analysis

Purchaser should supply Densitron with detailed data of non-conforming sample.

8.4.2 Handling of Non-conforming Displays

If any non-conforming displays are found during customer acceptance inspection which Densitron is clearly responsible for, return them to Densitron.

Both Densitron and customer should analyse the reason and discuss the handling of non-conforming displays when the reason is not clear.

Equally, both sides should discuss and come to agreement for issues pertaining to modification of Densitron quality assurance standard.

9. Reliability Specification

9.1 Reliability Tests

Test Item	Test Condition	Evaluation and assessment
High Temperature Operation	70°C / 96 hours	Inspection after 2~4hours storage at room temperature, the sample shall be free from defects: 1. Air bubble in the LCD; 2. Non-display; 3. Missing segments; 4. Glass crack; 5. Current IDD is twice higher than initial value.
Low Temperature Operation	-20°C / 96 hours	
High Temperature Storage	80°C, 96 hrs	
Low Temperature Storage	-30°C, 96 hrs	
High Temperature & High Humidity Operating	+60°C, 90%RH, 96 hrs	
Thermal Shock (Non-operation)	-10°C, 30 min ↔ +60°C,30 min, Change time: 5min 20CYC.	
ESD test	C=150pF, R=330, 5 points/panel Air: ±8KV, 5times; Contact: ±6KV, 5 times; (Environment: 15°C ~35°C, 30%~60%).	
Vibration (Non-operation)	Frequency range:10~55Hz, Stroke:1.5mm Sweep:10Hz~55Hz~10Hz 2 hours for each direction of X.Y.Z. (6 hours for total) (Package condition).	
Box Drop Test	1 Corner 3 Edges 6 faces, 80 cm (MEDIUM BOX)	

Note 1: The test samples should be applied to only one test item.
Note 2: Sample size for each test item is 5~10pcs.
Note 3: For Damp Proof Test, Pure water (Resistance > 10MΩ) should be used.
Note 4: In case of malfunction defect caused by ESD damage, if it would be recovered to normal state after resetting, it would be judge as a good part.
Note 5: Failure Judgment Criterion: Basic Specification, Electrical Characteristic, Mechanical Characteristic, Optical Characteristic.
Note 6: The color fading mura of polarizing filter can be ignored.

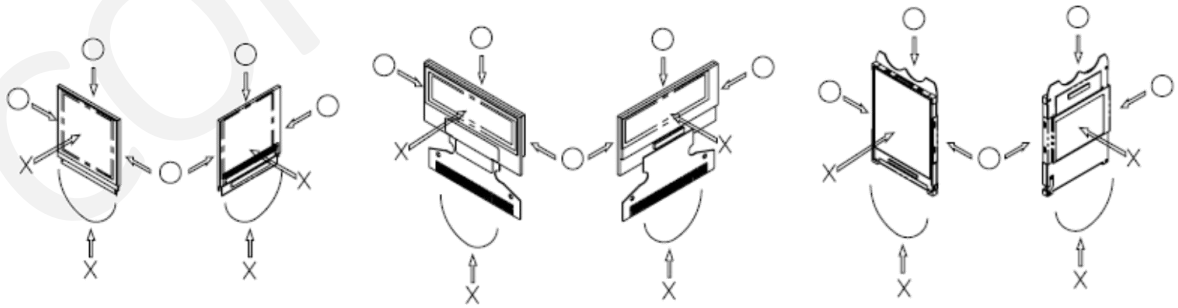
9.1.1 Inspection Check Standard

After the completion of the described reliability test, the samples are to be left at room temperature for 4 hrs prior to conducting the inspection check at 25±5 °C, 65±10% RH.

10. Handling Precautions

10.1 Handling Precautions

1) Since the display panel is being made of glass, do not apply mechanical impacts such as dropping from a high position.
2) If the display panel is broken by some accident and the internal organic substance leaks out, be careful not to inhale nor lick the organic substance.
3) If the liquid crystal touches your skin or clothes, wash it off immediately using soap and plenty of water
4) If pressure is applied to the display surface or its neighbourhood of the display module, the cell structure may be damaged and be careful not to apply pressure to these sections.
5) The polarizer covering the surface of the display module is soft and easily scratched. Please be careful when handling the display module.
6) When the surface of the polarizer of the display module has soil, clean the surface. It takes advantage of by using following adhesion tape.
   a. Scotch Mending Tape No. 810 or an equivalent
   b. Never try to breathe upon the soiled surface nor wipe the surface using cloth containing solvent such as ethyl alcohol, since the surface of the polarizer will become cloudy.
   c. Also, pay attention that the following liquid and solvent may spoil the polarizer:
      - Water
      - Ketone
      - Aromatic Solvents
7) Hold the display module very carefully when placing it into the system housing. Do not apply excessive stress or pressure to display module. And, do not over bend the film with electrode pattern layouts. These stresses will



influence the display performance. Also, secure sufficient rigidity for the outer cases.
8) Do not apply stress to the LSI chips and the surrounding molded sections.
9) Do not disassemble nor modify the display module.
10) Do not apply input signals while the logic power is off.
11) Pay sufficient attention to the working environments when handing display modules to prevent occurrence of element breakage accidents by static electricity.

a. Be sure to make human body grounding when handling display modules.
b. Be sure to ground tools to use or assembly such as soldering irons.
c. To suppress generation of static electricity, avoid carrying out assembly work under dry environments.
d. Protective film is being applied to the surface of the display panel of the display module. Be careful since static electricity may be generated when exfoliating the protective film.

12) Protection film is being applied to the surface of the display panel and removes the protection film before assembling it. If the display module has been stored for a long period of time, residue adhesive material of the protection film may remain on the surface of the display panel after removed of the film. In such case, remove the residue material by the method introduced in the above Section 5).
13) If electric current is applied when the display module is being dewed or when it is placed under high humidity environments, the electrodes may be corroded and be careful to avoid the above.

10.2 Storage Precautions

1) When storing display modules, put them in static electricity preventive bags avoiding exposure to direct sun light nor to lights of fluorescent lamps, etc. and, also, avoiding high temperature and high humidity environments or low temperature (less than 0°C) environments. (We recommend you to store these modules in the packaged state when they were shipped from Densitron) At that time, be careful not to let water drops adhere to the packages or bags nor let dewing occur with them.
2) If electric current is applied when water drops are adhering to the surface of the display module, when the display module is being dewed or when it is placed under high humidity environments, the electrodes may be corroded and be careful about the above.

10.3 Designing Precautions

1) The absolute maximum ratings are the ratings which cannot be exceeded for display module, and if these values are exceeded, panel damage may be happen.
2) To prevent occurrence of malfunctioning by noise, pay attention to satisfy the VIL and VIH specifications and, at the same time, to make the signal line cable as short as possible.
3) We recommend you to install excess current preventive unit (fuses, etc.) to the power circuit (VDD). (Recommend value: 0.5A)
4) Pay sufficient attention to avoid occurrence of mutual noise interference with the neighbouring devices.
5) As for EMI, take necessary measures on the equipment side basically.
6) When fastening the display module, fasten the external plastic housing section.
7) If power supply to the display module is forcibly shut down by such errors as taking out the main battery while the display panel is in operation, we cannot guarantee the quality of this display module.

10.4 Operation Precautions

1) It is indispensable to drive the display within the specified voltage limit since excessive voltage shortens its life.
2) Direct current causes an electrochemical reaction with remarkable deterioration of the display quality. Give careful consideration to prevent direct current during ON/OFF timing and during operation.
3) Response time is extremely delayed at temperatures lower than the operating temperature range while, at high temperatures, displays become dark. However, this phenomenon is reversible and does not mean a malfunction or a display that has been permanently damaged.
4) To protect display modules from performance drops by static electricity rapture, etc., do not touch the following sections whenever possible while handling the display modules.
   a. Pins and electrodes
   b. Pattern layouts such as the FPC
5) When the driver is being exposed (COG), semiconductor elements change their characteristics when light is radiated according to the principle of the solar battery. Consequently, if the driver is exposed to light, malfunctioning may occur.
   a. Design the product and installation method so that the driver may be shielded from light in actual usage.
   b. Design the product and installation method so that the driver may be shielded from light during the inspection processes.
6) Although the display module stores the operation state data by the commands and the indication data, when excessive external noise, etc. enters into the module, the internal status may be changed. It therefore is necessary to take appropriate measures to suppress noise generation or to protect from influences of noise on the system design.
7) We recommend you to construct its software to make periodical refreshment of the operation statuses (re-setting of the commands and re-transference of the display data) to cope with catastrophic noise.

10.5 Other Precautions

1) Request the qualified companies to handle industrial wastes when disposing of the display modules. Or, when burning them, be sure to observe the environmental and hygienic laws and regulations.