DMT028VGNMCMI-1A

PRODUCT SPECIFICATION

Version 1.0
Jan 30, 2023

Customer's Approval	
Signature	*Date*

Prepared by *Victoria Ho*
Approved by *Eric Wan*

Revision History

VERSION	DATE	DESCRIPTION	AUTHOR
1.0	Jan 30, 2023	Initial Release	Victoria Ho

Legal Notice

Table of Contents

1. General Description

1.1 Introduction

This is a 2.83” 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 480 x 640 and can display up to 16.7M colours. The display module supports 2-lane MIPI interface and optical bonding touch panel.

1.2 Main Features

Item	Contents
Display Type	TFT LCD
Screen Size	2.83” Diagonal
Display Format	480 x RGB x 640 Dots
No. of Colour	16.7M
Overall Dimensions	52.9 (W) x 79.3 (H) x 3.29 (D) mm
Active Area	43.2 (W) x 57.6 (H) mm
Mode	Normally Black / Transmissive
Surface Treatment	Glare (7H), IK03
Viewing Direction	All round
Interface	2-lane MIPI
Driver IC	ST7701S
Backlight Type	LED, White, 6 chips
Touch Panel	CTP
Touch Interface	I^2C
Touch Driver IC	FT5446
Bonding Type	Optical Bonding
Operating Temperature	-20°C ~ +70°C
Storage Temperature	-30°C ~ +80°C
ROHS	Compliant to RoHS 2.0

1.3 CTP Features

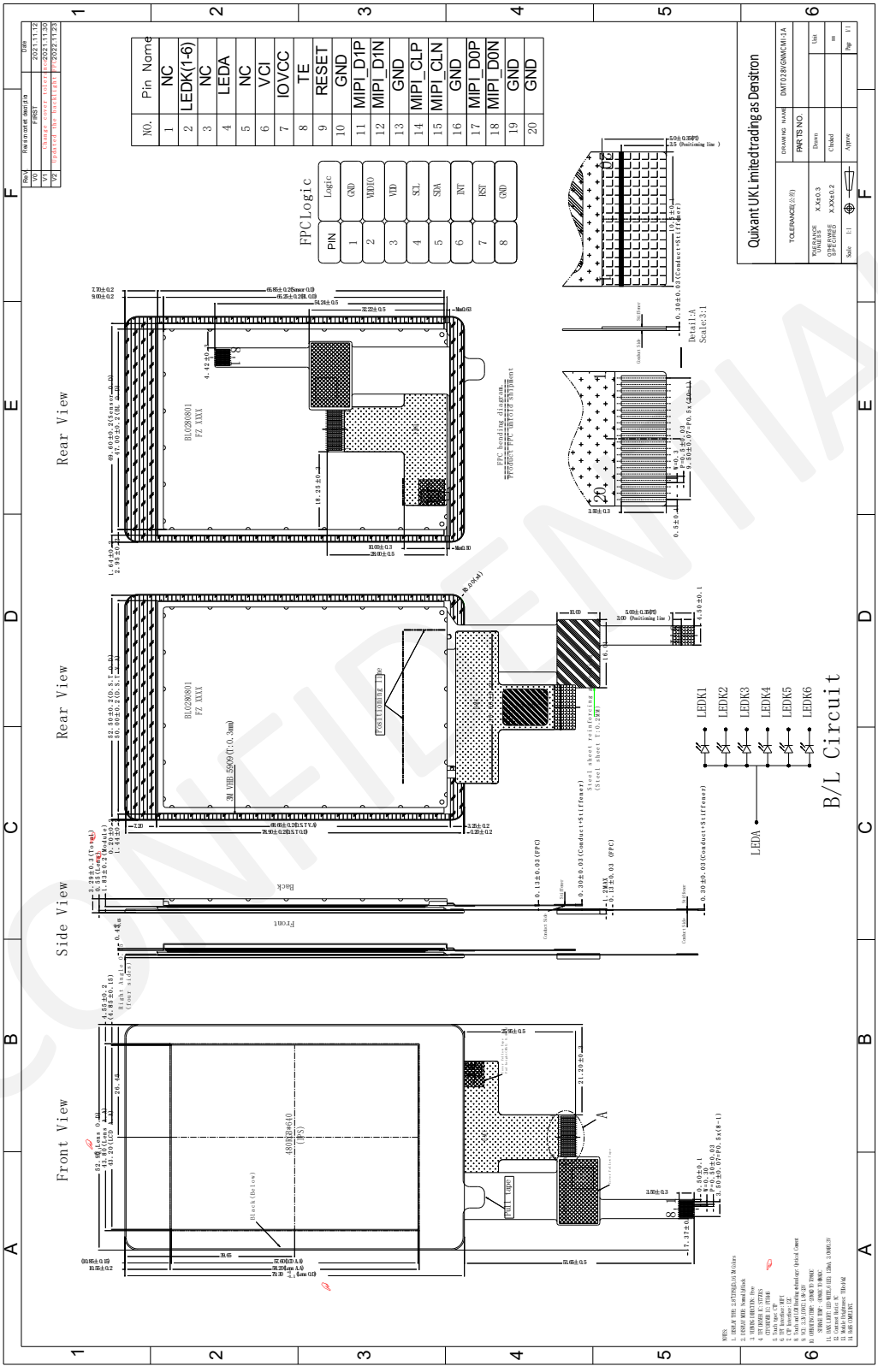
Item	Contents
Touch Panel	CTP
Structure	G+G
Controller IC	FT5446
Interface	I^2C
Slave Address	0x38(7bit)/8bit:0x70(Write) 0x71(Read)
Touch mode	Two points
Logic level	3.3V/1.8V

2. Mechanical Specification

2.1 Mechanical Characteristics

Item	Characteristic	Unit
Display Format	480 x RGB x 640	Dots
Overall Dimensions	52.9 (W) x 79.3 (H) x 3.29 (D)	mm
Active Area	43.2 (W) x 57.6 (H)	mm
Dot Pitch	0.09 x 0.09	mm
Weight	40	g
IC Controller/Driver	ST7701S	

2.2 Mechanical Drawing



3. Electrical Specification

3.1 Absolute Maximum Ratings

Item	Symbol	Min	Max	Unit	Note
Power Supply Voltage	VDD	-0.3	4.6	V	1
I/O Digital Voltage	VDDIO	-0.3	4.6	V	1
Operating Temperature	T_{OP}	-20	+70	°C	-
Storage Temperature	T_{ST}	-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

Ta=25℃

Item	Symbol	Min	Typ.	Max	Unit	Note
Power Supply Voltage	VDD	2.5	3.3	3.6	V	-
I/O Digital Supply Voltage	VDDIO	1.65	1.8	3.3	V	-
Normal Mode Current consumption	ICC	-	27	54	mA	
Differential Input High Threshold Voltage	VIT+	-	0	50	mV	
Differential Input Low Threshold Voltage	VIT-	-50	0	-	mV	MIPI_CLK MIPI_Data
Single-ended Receiver Input Operation Voltage Range	VIR	0.5	-	1.2	V	
Digital Output High Voltage	VOH	0.7*VDDIO	-	-	V	

3.3 Interface Pin Assignment

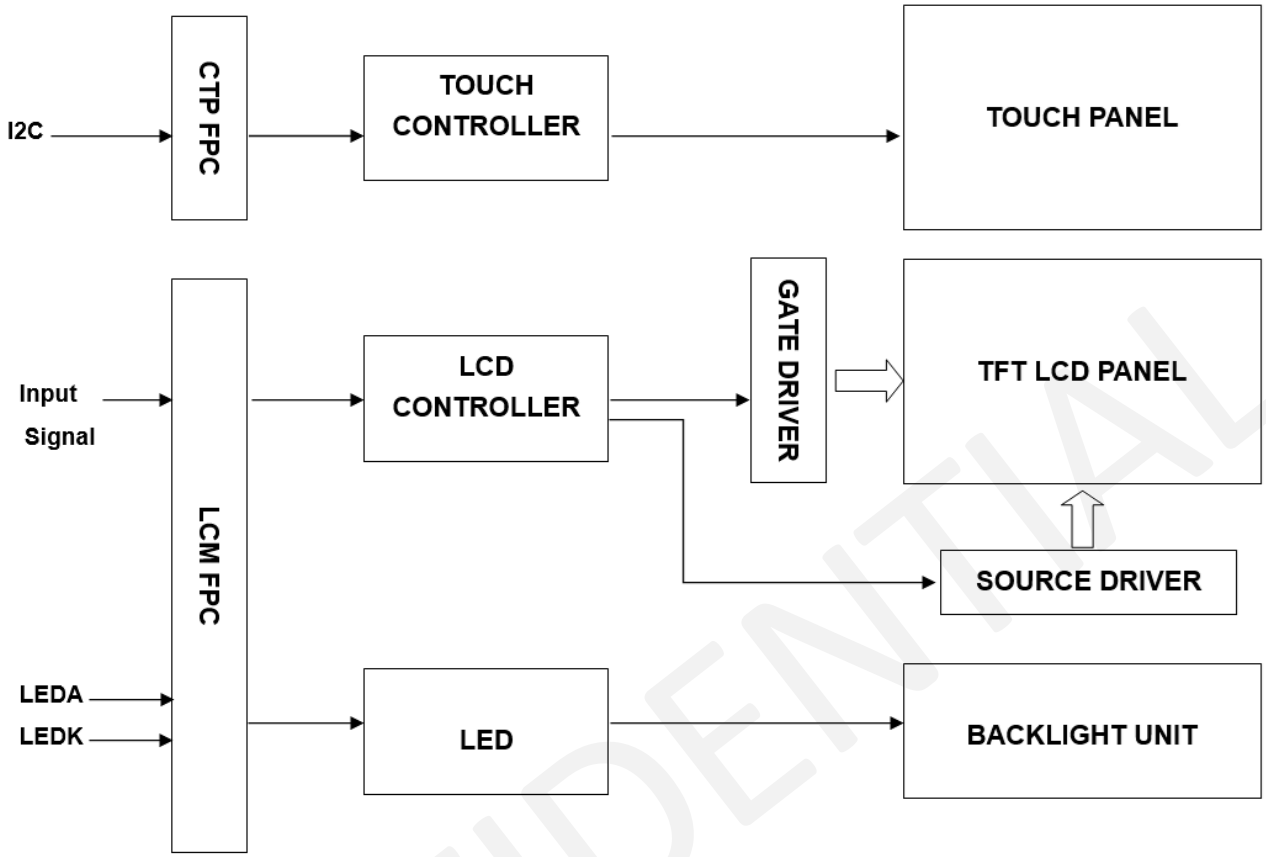
3.3.1 TFT Pin Assignment

No.	Symbol	I/O	Function
1	NC	-	-
2	LEDK	P	Cathode pin of backlight.
3	NC	-	-
4	LEDA	P	Anode pin of backlight.
5	NC	-	-
6	VDD/VCI	P	Supply Voltage (3.3V).
7	IOVCC	P	I/O power supply voltage.
8	TE	O	Tearing effect output. Leave the pin to open when not in use.
9	RESET	I	The external reset input. Initializes the chip with a low input. Be sure to execute a power-on reset after supplying power.
10	GND	P	Ground.
11	MIPI_D1P	I/O	MIPI DSI differential data pair (DSI-Dn+/-).
12	MIPI_D1N	I/O	
13	GND	P	Ground.
14	MIPI_CLP	I	MIPI DSI differential clock pair (DSI-CLK+/-).
15	MIPI_CLN	I	
16	GND	P	Ground.
17	MIPI_D0P	I/O	MIPI DSI differential data pair (DSI-Dn+/-).
18	MIPI_D0N	I/O	
19	GND	P	Ground.
20	GND	P	Ground.

3.3.2 CTP PIN Assignment

No.	Symbol	I/O	Function
1	GND	P	Ground.
2	VDDIO	P	I/O power supply voltage.
3	VDD	P	Supply voltage.
4	SCL	I	I2C clock input.
5	SDA	I/O	I2C 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

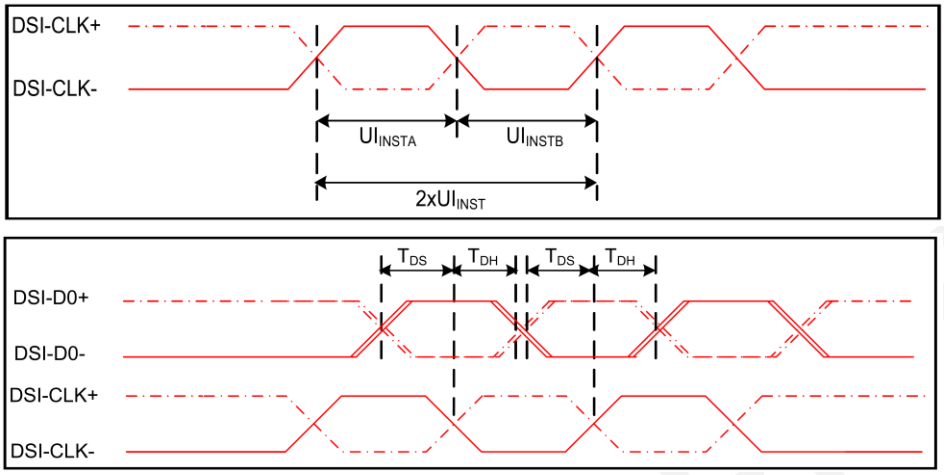


3.5 Timing Characteristics

3.5.1 MIPI Interface Characteristics

3.5.1.1 High Speed Mode

DSI Clock Channel Timing

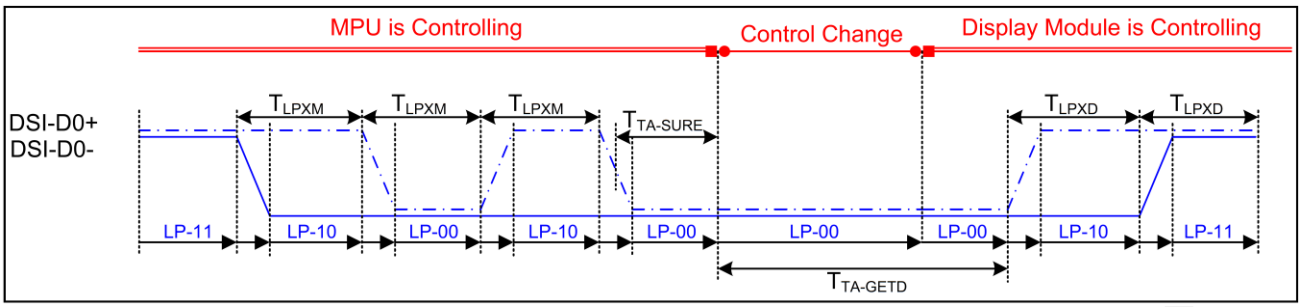


MIPI Interface - High Speed Mode Timing Characteristics

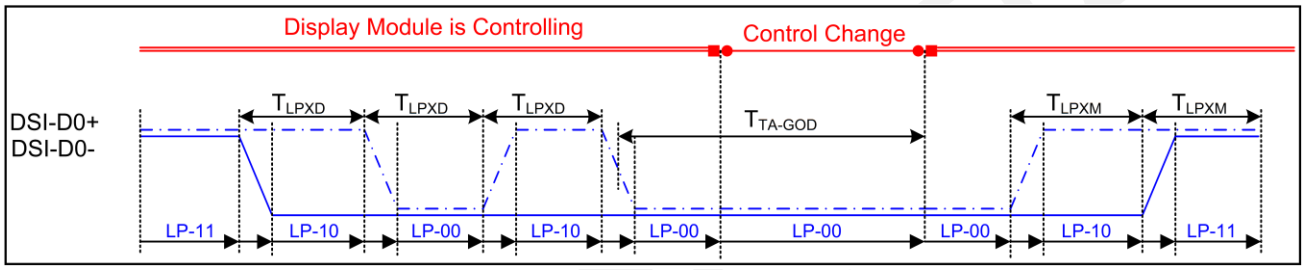
Signal	Symbol	Parameter	Min	Typ.	Max	Unit	Description
DSI-CLK+/-	$2xUI_{INSTA}$	Double UI instantaneous	4	-	25	ns	-
DSI-CLK+/-	UI_{INSTA} UI_{INSTB}	UI instantaneous halves	2	-	12.5	ns	$UI = UI_{INSTA} = UI_{INSTB}$
DSI-Dn+/-	tDS	Data to clock setup time	0.15	-	-	UI	-
DSI-Dn+/-	tDH	Data to clock hold time	0.15	-	-	UI	-

3.5.1.2 Low Power Mode

Bus Turnaround (BTA) from display module to MPU Timing



Bus Turnaround (BTA) from MPU to display module Timing

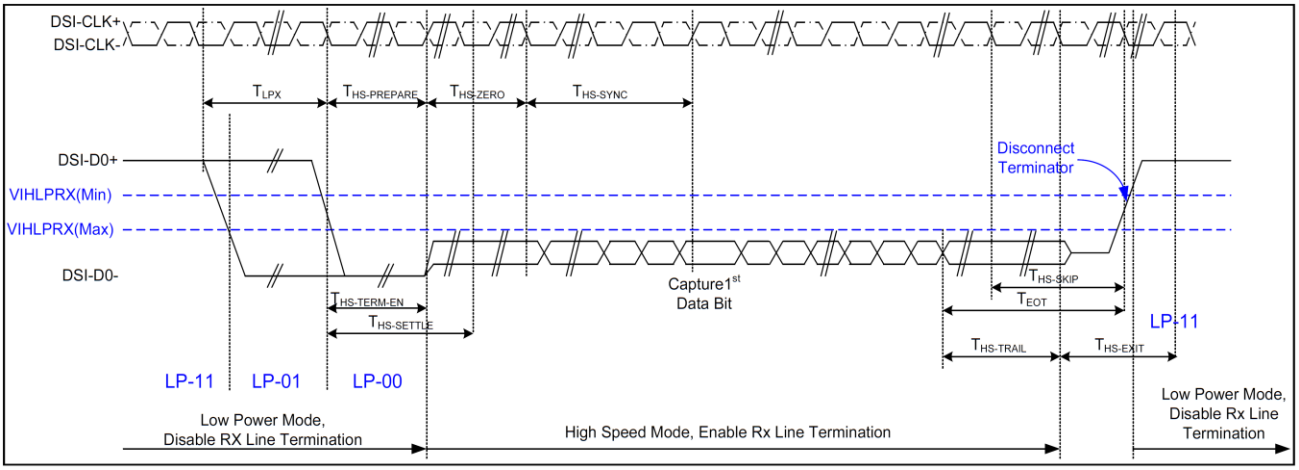


MIPI Interface Low Power Mode Timing Characteristics

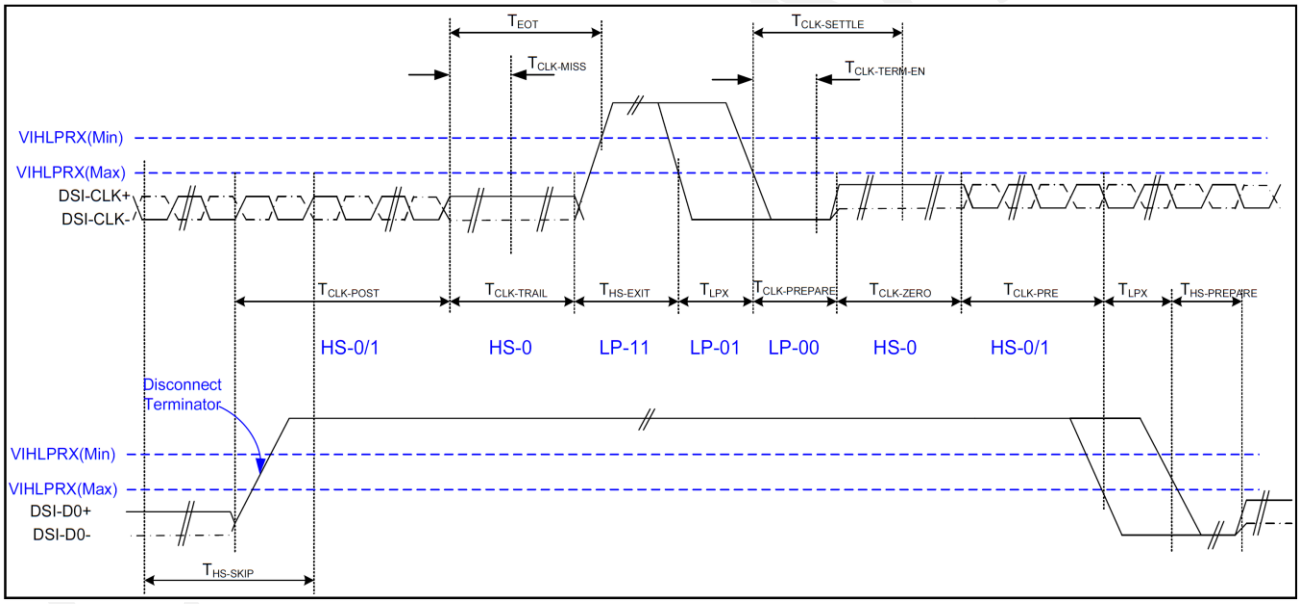
Signal	Symbol	Parameter	Min	Max	Unit	Description
DSI-D0+/-	TLPXM	Length of LP-00, LP-01, LP-10 or LP-11 periods MPU →Display Module	50	75	ns	Input
DSI-D0+/-	TLPXD	Length of LP-00, LP-01, LP-10 or LP-11 periods MPU →Display Module	50	75	ns	Output
DSI-D0+/-	TTA-SURED	Time-out before the MPU start driving	T_{LPXD}	$2xT_{LPXD}$	ns	Output
DSI-D0+/-	TTA-GETD	Time to drive LP-00 by display module	$5xT_{LPXD}$		ns	Input
DSI-D0+/-	TTA-GOD	Time to drive LP-00 after turnaround request-MPU	$4xT_{LPXD}$		ns	Output

3.5.1.3 Bursts Mode

Data lanes-Low Power Mode to/from High-Speed Mode Timing

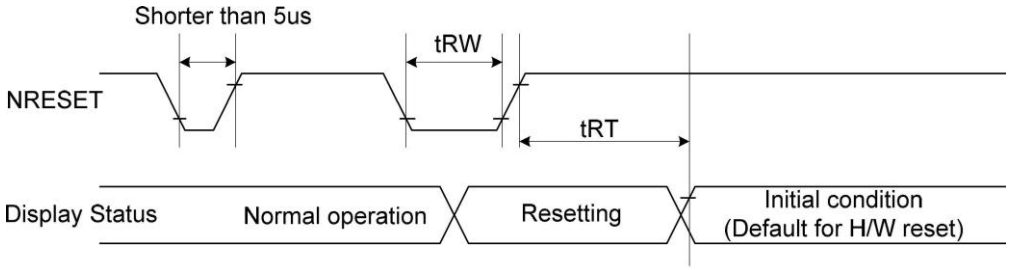


Clock lanes – High-Speed Mode to/from Low Power Mode Timing



Signal	Symbol	Parameter	Min	Max	Unit	Description
Low Power Mode to High-Speed Mode Timing						
DSI-Dn+/-	TLPX	Length of any low power state period	50	-	ns	Input
DSI-Dn+/-	THS-PREPARE	Time to drive LP-00 to prepare for HS transmission	40+4 UI	85+6 UI	ns	Input
DSI-Dn+/-	THS-TERM-EN	Time to enable data receiver line termination measured from when Dn crosses VILMAX	-	35+4 UI	ns	Input
DSI-Dn+/-	THS-PREPARE + THS-ZERO	THS-PREPARE + time to drive HS-0 before the sync sequence	140+ 10UI	-	ns	Input
High Speed Mode to Low Power Mode Timing						
DSI-Dn+/-	THS-SKIP	Time-out at display module to ignore transition period of EoT	40	55+4 UI	ns	Input
DSI-Dn+/-	THS-EXIT	Time to drive LP-11 after HS burst	100	-	ns	Input
DSI-Dn+/-	THS-TRAIL	Time to drive flipped differential state after last payload data bit of a HS transmission burst	60+4 UI	-	ns	Input
High Speed Mode to/from Low Power Mode Timing						
DSI-CLK+/-	TCLK-POS	Time that the MPU shall continue sending HS clock after the last associated data lane has transition to LP mode	60+5 2UI	-	ns	Input
DSI-CLK+/-	TCLK-TRAIL	Time to drive HS differential state after last payload clock bit of a HS transmission burst	60	-	ns	Input
DSI-CLK+/-	THS-EXIT	Time to drive LP-11 after HS burst	100	-	ns	Input
DSI-CLK+/-	TCLK-PREPARE	Time to drive LP-00 to prepare for HS transmission	38	95	ns	Input
DSI-CLK+/-	TCLK-TERM-EN	Time-out at clock lane display module to enable HS transmission	-	38	ns	Input
DSI-CLK+/-	TCLK-PREPARE + TCLK-ZERO	Minimum lead HS-0 drive period before starting clock	300	-	ns	Input
DSI-CLK+/-	TCLK-PRE	Time that the HS clock shall be driven prior to any associated data lane beginning the transition from LP to HS mode	8UI	-	ns	Input
DSI-CLK+/-	TEOT	Time from start of TCLK-TRAIL period to start of LP-11 state	-	105ns+ 12UI	ns	Input

3.5.2 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

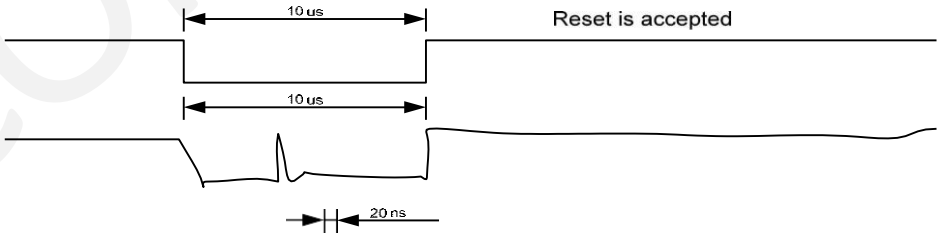
Note 1: The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from OTP to registers. This loading is done every time when there is H/W reset cancel time (tRT) within 5ms after a rising edge of RESX.

Note 2: Spike due to an electrostatic discharge on RESX line does not cause irregular system to 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 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	1
Operating Temperature	T_{OP}	-20	+70	℃	-
Storage Temperature	T_{ST}	-30	+80	℃	-

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 below section 4.2 to avoid malfunctioning.

4.2 DC Electrical Characteristics

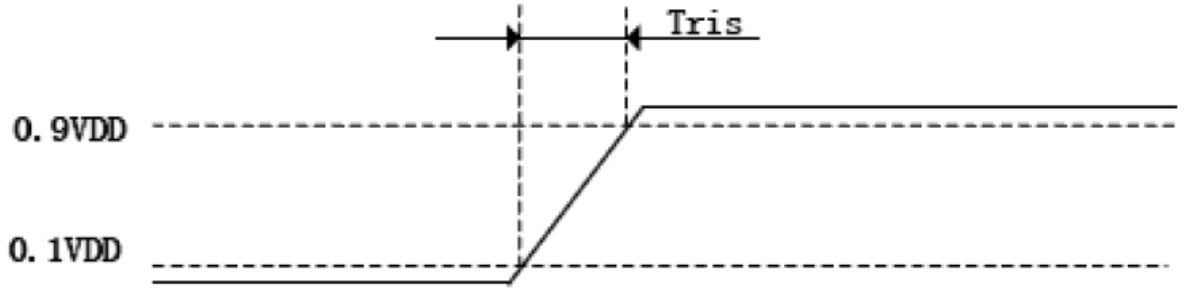
Ta=25℃

Item	Symbol	Min	Typ.	Max	Unit	Note
Power Supply Voltage	VDD	2.7	3.3	3.47	V	-
I/O Digital Supply Voltage	VDDIO	1.8	3.3	3.6	V	-
Normal Mode Operating Current	-	-	9.8	-	mA	VDD=2.8V
Sleep Mode Operating Current	-	-	75	-	uA	VDD=2.8V
Monitor Mode Operating Current	-	-	0.5	-	mA	VDD=2.8V
Digital Input Low Voltage	VIL	-0.3	-	0.3*VDDIO	V	-
Digital Input High Voltage	VIH	0.7*VDDIO	-	VDDIO	V	-
Digital Output Low Voltage	VOL	-	-	0.3*VDDIO	V	-
Digital Output High Voltage	VOH	0.7*VDDIO	-	-	V	-

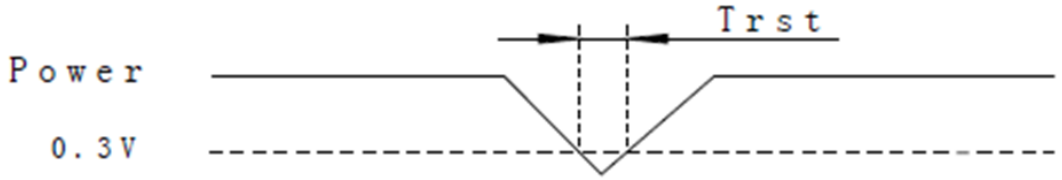
4.3 Power On/Reset/Wake Sequence

Reset should be pulled down to be low before powering on and powering down. I2C shouldn't be used by other devices during Reset time after VDD powering on (Trtp). INT signal will be sent to the host after initializing all parameters and then start to report points to the host. If Power is down, the voltage of supply must be below 0.3V and Tpdt is more than 1ms.

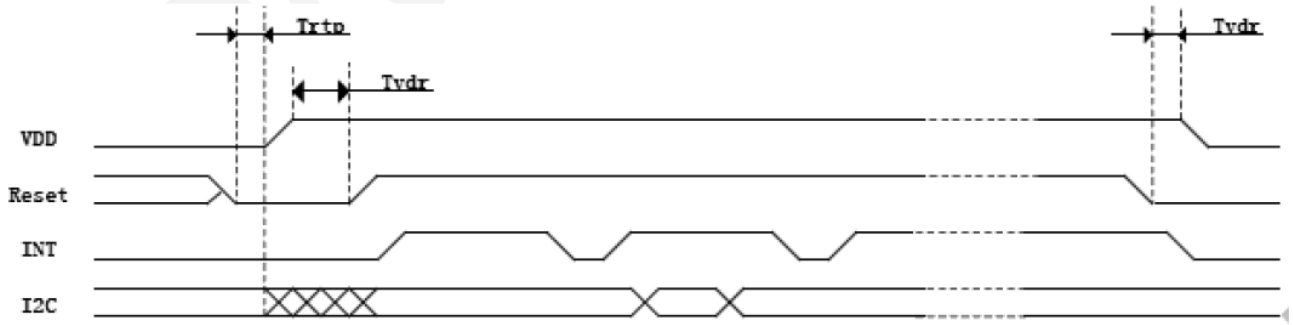
Power On Time



Power Cycle requirement

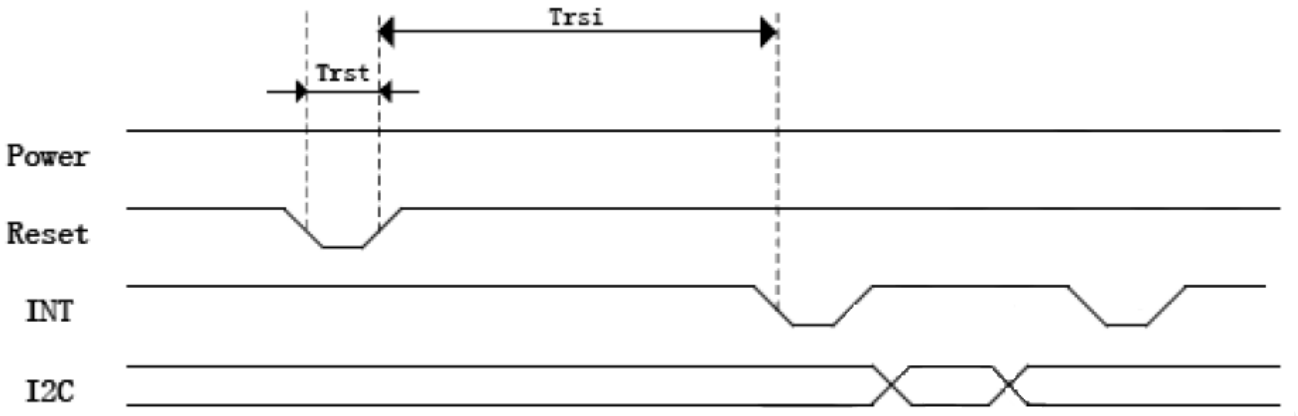


Power on Sequence



Reset time must be enough to guarantee reliable reset, the time of starting to report point after resetting approach to the time of starting to report point after powering on.

Reset Sequence



Power On/Reset Sequence Parameters

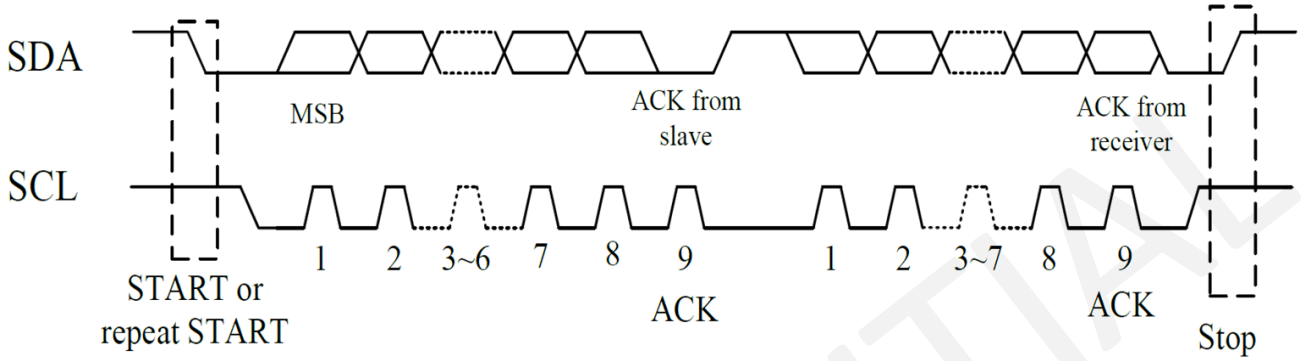
Item	Description	Min	Max	Unit
Tris	Rise time from 0.1VDD to 0.9VDD	-	5	ms
Tpdt	Time of the voltage of supply being below 0.3V	5	-	ms
Trtp	Time of resetting to be low before powering on	100	-	µs
Tvdr	Reset time after VDD powering on	1	-	ms
Trsi	Time of starting to report point after resetting	-	200	ms
Trst	Reset time	1	-	ms

4.4 I²C Timing

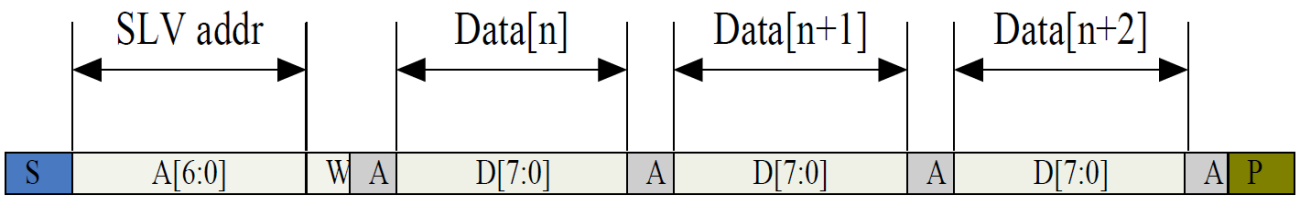
FT5446 supports the I²C interfaces, which can be used by a host processor or other devices.

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

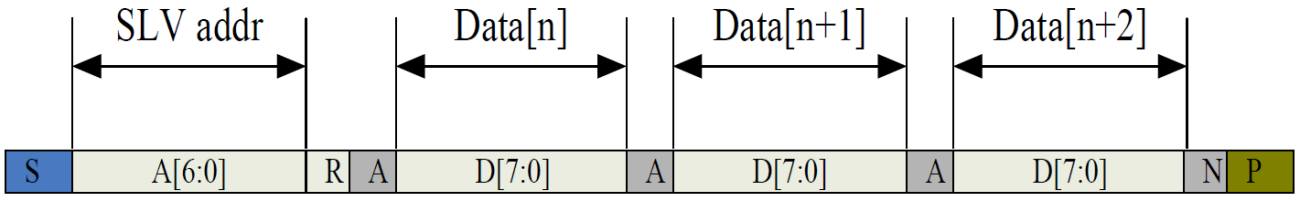
I²C Serial Data Transfer Format



I²C master write, slave read



I²C master read, slave write



Mnemonics Description table has listed the meanings of the mnemonics used in above figures.

Mnemonics	Description
S	I²C Start or I²C Restart
A [6:0]	Slave address
R/W	READ/WRITE bit, '1' for read, '0'for write
A (N)	ACK (NACK) bit
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)

I²C Interface Timing Characteristics is shown as below:

Item	Min	Typ.	Max	Unit
SCL frequency	0	-	400	KHz
Bus free time between a STOP and START condition	1.3	-	-	us
Hold time (repeated) START condition	0.6	-	-	us
Data setup time	100	-	-	ns
Setup time for a repeated START condition	0.6	-	-	us
Setup Time for STOP condition	0.6	-	-	us

5. Optical Specification

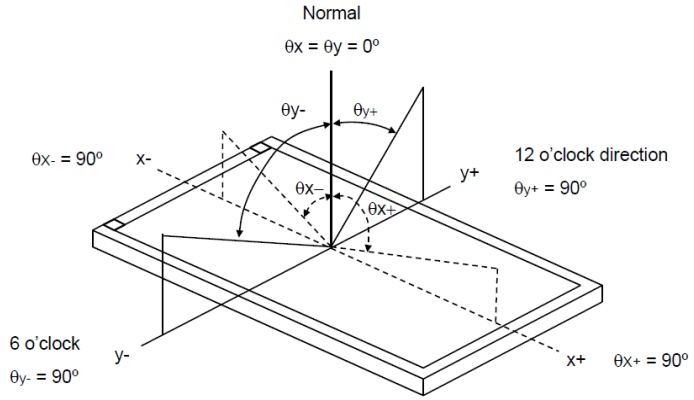
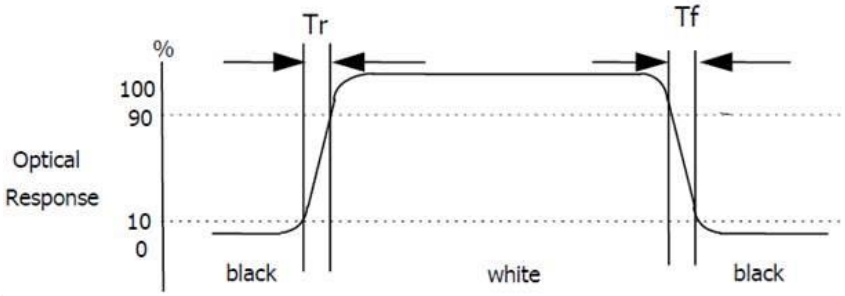
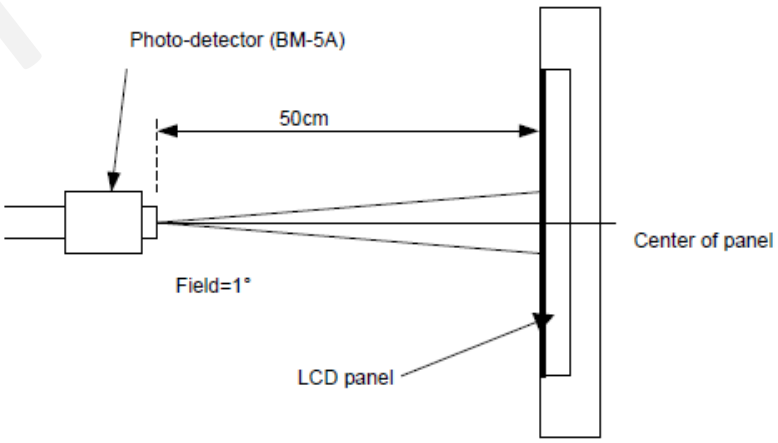
5.1 Optical Characteristics

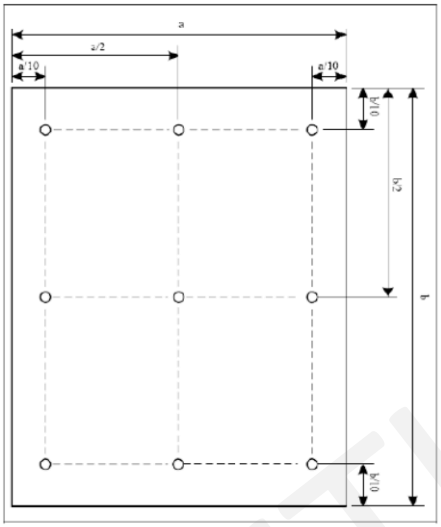
Characteristics		Symbol	Conditions	Min	Typ.	Max	Unit	Note
Contrast Ratio		CR	$\theta = 0^{\circ}$ Normal viewing angle	500	800	-	-	1, 2
Response time		TR + TF		-	30	35	ms	1, 3
Color Gamut		S (%)		60	65	-	%	-
Viewing Angle	Left	θ_x-	CR>10	75	80	-	Degree	1, 4
	Right	θ_x+		75	80	-		
	Up	θ_Y+		75	80	-		
	Down	θ_Y-		75	80	-		
Colour Chromaticity	Red	Rx	$\theta = 0^{\circ}$ Normal viewing angle, CA-310 Test	0.5877	0.6277	0.6677	-	1, 4
		Ry		0.3011	0.3411	0.3811		
	Green	Gx		0.2548	0.2948	0.3348		
		Gy		0.5304	0.5704	0.6104		
	Blue	Bx		0.1111	0.1511	0.1911		
		By		0.0246	0.0646	0.1046		
	White	Wx		0.2440	0.2840	0.3240		
		Wy		0.2715	0.3115	0.3515		
Luminance		LV	I_F = 120mA	450	500	-	cd/m^2	5
Uniformity		Avg	-	80	-	-	%	5

*The data comes from the LCD specification.

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

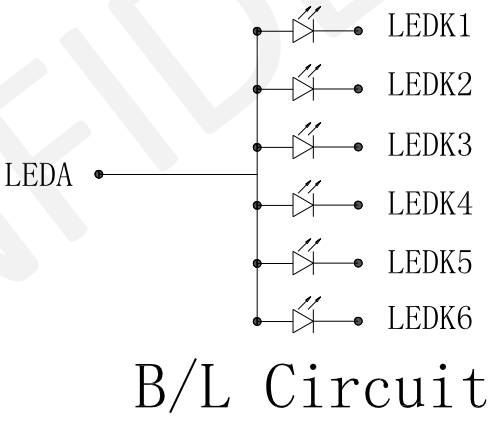
The back-light system is edge-lighting type with 6 LED chips.

Item	Symbol	Condition	Min	Typ.	Max	Unit	Note
Forward Current	I_F	-	90	120	-	mA	-
Forward Voltage	V_F	-	-	3.0	-	V	-
LED Lifetime	Hr	-	50000	-	-	Hour	-

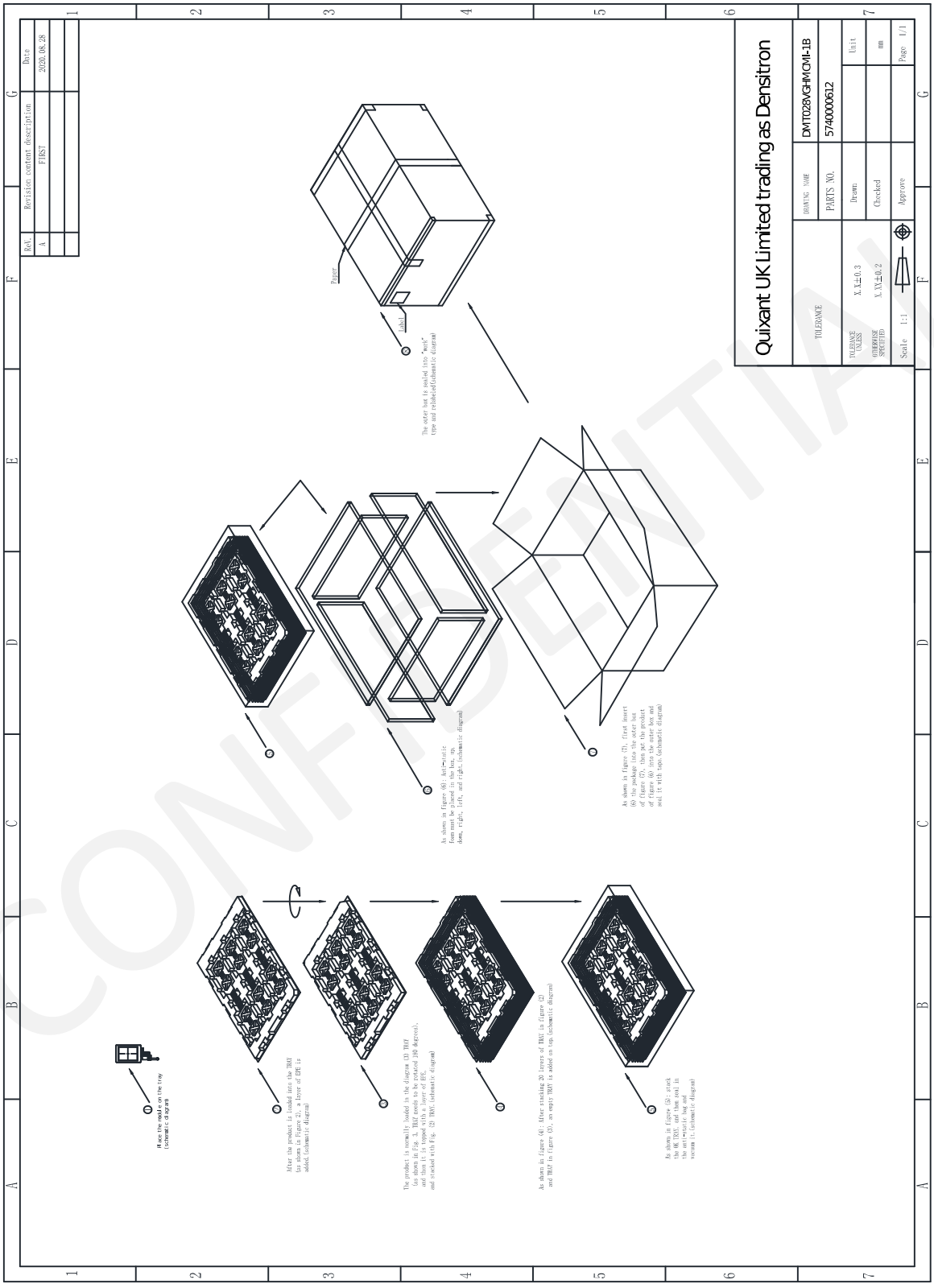
Note 1: LED lifetime (Hr) can be defined as the time in which it continues to operate under the condition: Ta=25±3℃, typical IL(I_F) value indicated in the above table until the brightness becomes less than 50%.

Note 2: The "LED lifetime" is defined as the module brightness decreases to 50% original brightness at Ta=25℃ and IL (I_F) =90mA. The LED lifetime could be decreased if operating IL (I_F) is larger than 120mA. The constant current driving method is suggested.

6.2 Internal Circuit Diagram



7. Packaging



8. Quality Assurance Specification

8.1 Conformity

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

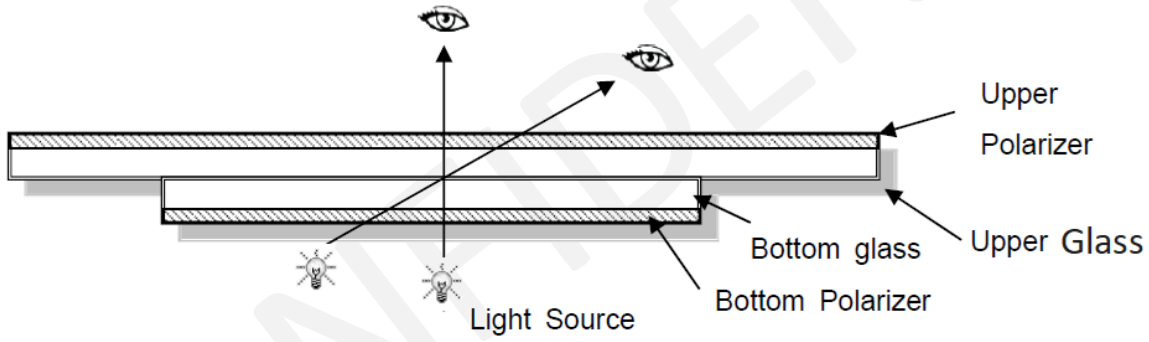
8.2 Environment Required

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.

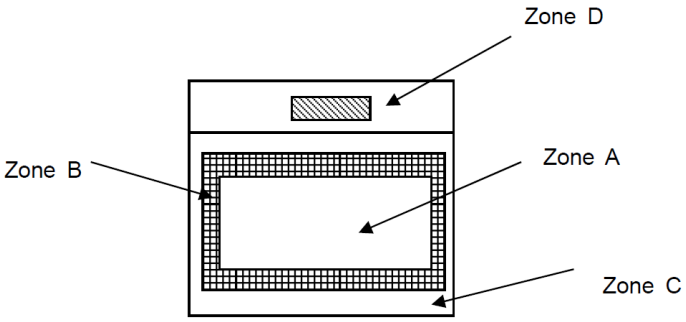


8.3 Delivery Assurance

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 missing line 2) Display abnormally, short circuit 3) Backlight no lighting, abnormal lighting.	Major
2	Missing	Missing components.	
3	Outline Dimension	Overall outline dimension beyond the drawing or deformation is not allowed.	
4	Color Tone	For judging color unevenness, please refer to limited sample.	Minor
5	Spot/ Line Defect	Light dot, dim spot, polarizer air 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.	

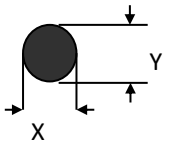
Note:

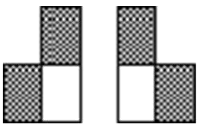
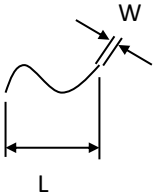
a) Light dot: Dots appearing bright and unchanged in size in which LCD panel is displaying under black pattern.

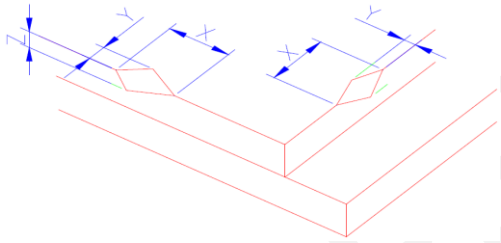
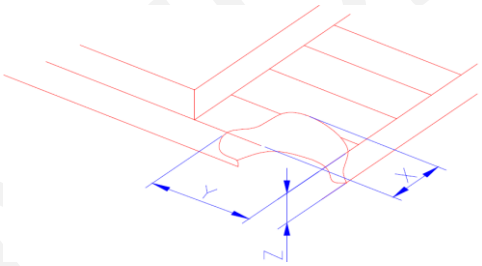
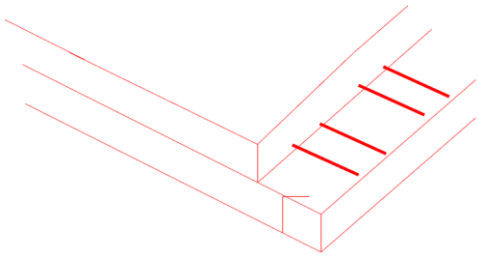
b) Dim dot: Dots appearing dark and unchanged in size in which LCD panel is displaying under pure red, green, or blue picture.

8.3.5 Criteria & Classification

Units: mm

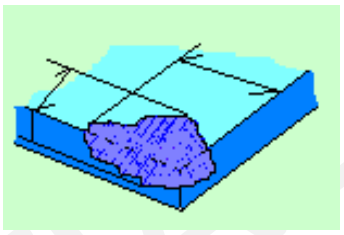
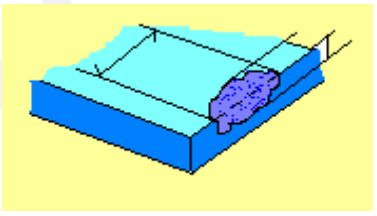
<table>
<tr><th></th><th>Item</th><th colspan="4">Criteria</th></tr>
<tr><td rowspan="25">Minor</td><td rowspan="25">Spot Defect</td><td colspan="4">Round type: as per following drawing, ∅ = (X+Y)/2  </td></tr>
<tr><td colspan="4">1) Light Dot (black/white spot, pinhole, stain, etc.)</td></tr>
<tr><td 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, etc.)</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 dots.</td><td>5mm</td></tr>
<tr><td colspan="2">Total quantity of bright and dark dots</td><td>N≤4</td></tr>
<tr><td colspan="3">Note:
A) Bright dot: Dots appearing bright and unchanged in size in which LCD panel is displaying under black pattern.
B) Dark dot: Dots appearing dark and unchanged in size in which LCD panel is displaying under pure red, green, or 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>Minor</td><td>Line Defect (LCD/ Polarizer backlight black/white</td><td colspan="2">Line type: as per following drawing
  </td></tr>
</table>

<table>
<tr><th></th><th>Item</th><th colspan="5">Criteria</th></tr>
<tr><td rowspan="5"></td><td rowspan="5">line, scratch, stain)</td><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>W≤0.03</td><td>Ignore</td><td colspan="2">Ignore</td><td rowspan="3">Ignore</td></tr>
<tr><td>0.03<W≤0.04</td><td>L ≤ 3.0</td><td colspan="2">N ≤ 2</td></tr>
<tr><td>0.04<W≤0.05</td><td>L ≤ 2.0</td><td colspan="2">N ≤ 1</td></tr>
<tr><td>0.05<W</td><td colspan="5">Define as spot defect</td></tr>
<tr><td>Minor</td><td>LCD Crack/Broken</td><td colspan="6">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="6">The LCD with extensive crack is not acceptable.
  </td></tr>
<tr><td>Major</td><td>Electronic Components SMT</td><td colspan="6">Missing parts, solderless connection, cold solder joint, mismatch, the positive and negative polarity opposite, are not allowed.</td></tr>
<tr><td>Minor</td><td>Display Color & Brightness</td><td colspan="6">1) Color: Measuring the colour coordinates in accordance with the datasheet or samples.</td></tr>
</table>

	Item	Criteria
		2) Brightness: Measuring the brightness of white screen in accordance with the datasheet or samples.
Minor	LCD Mura/Waving/ Hot spot	Not visible through 5% ND filter in 50% gray or judged by limited sample if necessary.

Class	Item	Criteria				
Minor	CTP Related	1) CTP Cover sensor accidented black/white spot				
		Size (mm)	Acceptable Quantity			
			A	B	C	
		∅≤0.10	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			
		∅≤0.10	Ignore			
		0.10<∅≤0.25	3 (distance≧6mm)			
		0.25<∅≤0.3	2 (distance≧6mm)			
		∅>0.3	0			
		4) CTP Bonding Bubble/Accidented Spot				
		Size ∅ (mm)	Acceptable Quantity			
			A	B		
		∅≤0.10	Ignore			
		0.10<∅≤0.20	3 (distance≧6mm)			

<table>
<tr><th>Class</th><th>Item</th><th colspan="2">Criteria</th></tr>
<tr><td></td><td></td><td>0.20<∅≤0.25</td><td>2 (distance≧6mm)</td></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) CTP 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) CTP 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 hrs	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/line; 4. Glass crack; 5. Current IDD is twice higher than initial value.
Low Temperature Operation	-20°C, 96 hrs	
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.
2. Sample size for each test item is 5~10 pieces.
3. For Damp Proof Test, Pure water (Resistance > 10MΩ) should be used.
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.
5. Failure Judgment Criterion: Basic Specification, Electrical Characteristic, Mechanical Characteristic, Optical Characteristic.
6. The color fading mura of polarizing filter can be ignored.

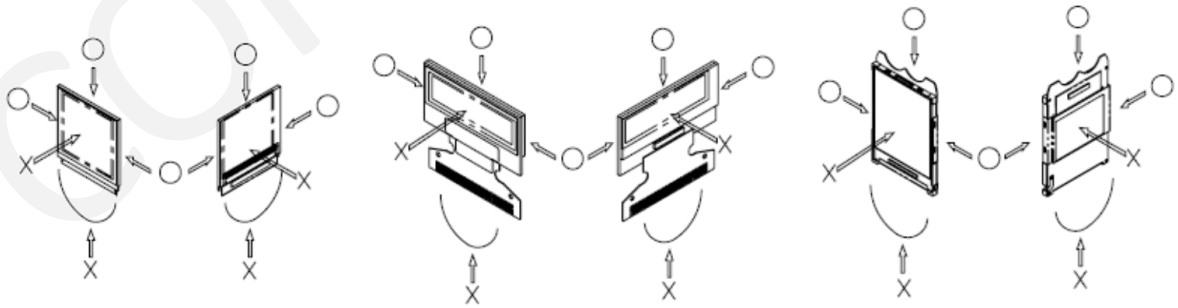
9.1.1 Inspection Check Standard

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±5% 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.