DISPLAY Elektronik GmbH

DATA SHEET

TFT MODULE

DEM 240320T TTH-PW-N

2,4" transfl. TFT

Product Specification   Ver.: 2

02.02.2024

Revision History

Revision	Date	Originator	Detail	Remarks
0	12.01.2024	LL	Initial Release	
1	16.01.2024	LQ	Modfiy Package Drawing(B)	P22
2	02.02.2024	LQ	Add Weight Add Current Consumption Add CIE Value	P4 P5 P6

Table of Contents

1.   General Description

The specification is a transflective type color active matrix liquid crystal display (LCD) which uses amorphous thin film transistor (TFT) as switching devices. This product is composed of a TFT-LCD panel, driver ICs and a backlight unit.

2.   Module Parameter

Features	Details	Unit
Display Size(Diagonal)	2.4"	-
Display Mode	Transflective / Normally White	-
Resolution	240 x 320 DOTS	Pixels
View Direction	FULL VIEW	Best Image
Module Outline	42.72 x 60.26 x 2.30　（Note1）	mm
Active Area	36.72 x 48.96	mm
Pixel Size	0.1530 x 0.1530	mm
Pixel Arrangement	RGB Vertical Stripe	-
Color	262k	-
Interface	4-Wire SPI	-
With or without touch panel	Without	-
Driver IC	ST7789T3 (Sitronix)	-
Operating Temperature	-20 ~ +70	ºC
Storage Temperature	-30 ~ +80	ºC
Weight	11	g

Note 1: Exclusive hooks, posts, FFC/FPC tail etc.

3.   Absolute Maximum Ratings

VSS=0V, Ta=25ºC

Item	Symbol	Min.	Max.	Unit
Supply Voltage	VDD	-0.3	4.6	V
Storage Temperature	T_{STG}	-30	+80	ºC
Operating Temperature	T_{OP}	-20	+70	ºC

Note 1: If Ta below 50ºC, the maximal humidity is 90%RH, if Ta over +50ºC, absolute humidity should be
        less than 60%RH.
Note 2: The response time will be extremely slow when the operating temperature is around -10°C,
        and the back ground will become darker at high temperature operating.

4. DC Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit
Supply Voltage	VDD	2.4	2.8	3.3	V
Logic Low input voltage	V_{IL}	GND	-	0.3*VDD	V
Logic High input voltage	V_{IH}	0.7*VDD	-	VDD	V
Logic Low output voltage	V_{OL}	GND	-	0.2*VDD	V
Logic High output voltage	V_{OH}	0.8*VDD	-	VDD	V
Current Consumption All Black	I_{DD}	-	9	-	mA

5. Backlightlight Characteristic

5.1. Backlight Characteristic

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Forward Voltage	V_F	Ta=25 ºC, I_F=20mA/LED	2.8	3.1	3.4	V
Forward Current	I_F	Ta=25 ºC, V_F=3.1V/LED	-	80	-	mA
Power Dissipation	P_D		-	248	-	mW
Uniformity	Avg		-	80	-	%
LED Lifetime (25℃)	-	-	20000	30,000	-	Hrs
Drive Method		Constant Current				
LED Configuration		4 White LEDs in parallel				

Note1：LED life time defined as follows: The final brightness is at 50% of original brightness.

The environmental conducted under ambient air flow, at Ta=25°C±2 ºC, 60%RH±5%, I_F=20mA/LED.

### 5.2. Backlight Characteristic
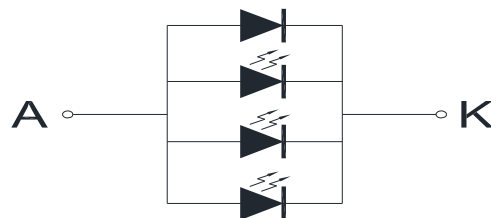
6. Optical Characteristics

6.1. Optical Characteristics

Ta=25ºC,VDD=2.8V

Item		Symbol	Condition	Specification			Unit
				Min.	Typ.	Max.	
Backlight On (Transflective Mode)	Luminance on TFT(I_f=20mA/LED)	Lv	Normally viewing angle θX = φY =0º	130	150	-	cd/m²
	Contrast ratio(See 6.3)	CR		-	15	-	
	Response time (See 6.2)	TR		-	5	7	ms
		TF					
	Chromaticity Transflective (See 6.5) — Red	XR		0.442	0.492	0.542	
		YR		0.237	0.287	0.337	
	Green	XG		0.270	0.320	0.370	
		YG		0.434	0.484	0.534	
	Blue	XB		0.121	0.171	0.221	
		YB		0.081	0.131	0.181	
	White	XW		0.245	0.295	0.345	
		YW		0.267	0.317	0.367	
	Viewing Angle (See 6.4) — Horizontal	θX+	Center CR>2	-	55	-	Deg.
		θX-		-	55	-	
	Vertical	φY+		-	60	-	
		φY-		-	60	-	
	NTSC Ratio(Gamut)			-	13.79	-	%

6.2. Definition of Response Time
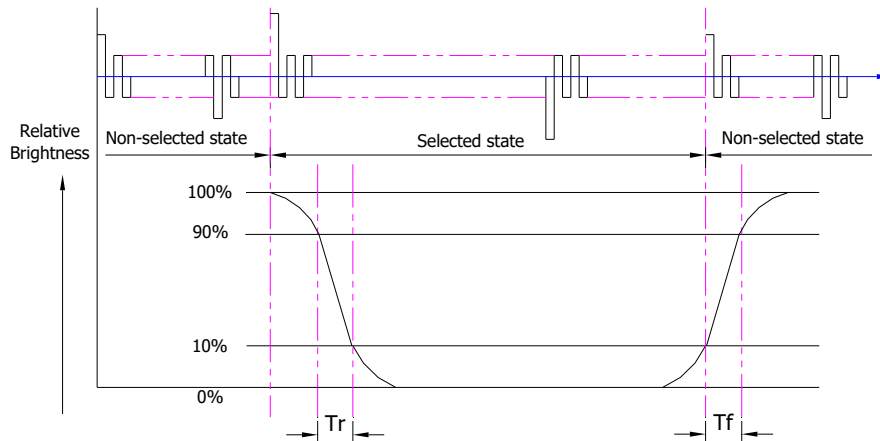
6.2.1. Normally Black Type (Negative)
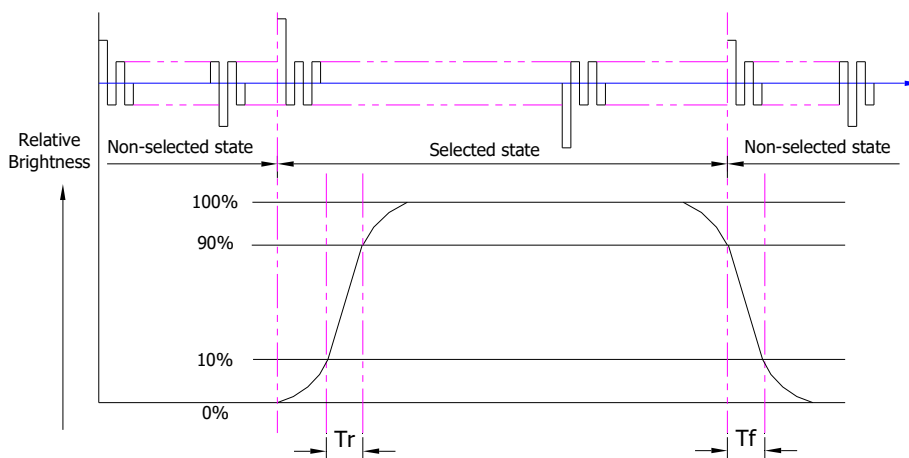
Tr is the time it takes to change form non-selected stage with relative luminance 10% to selected state with relative luminance 90%;

Tf is the time it takes to change from selected state with relative luminance 90% to non-selected state with relative luminance 10%.

Note : Measuring machine: LCD-5100

6.2.2. Normally White Type (Positive)

Tr is the time it takes to change form non-selected stage with relative luminance 90% to selected state with relative luminance 10%;

Tf is the time it takes to change from selected state with relative luminance 10% to non-selected state with relative luminance 90%;

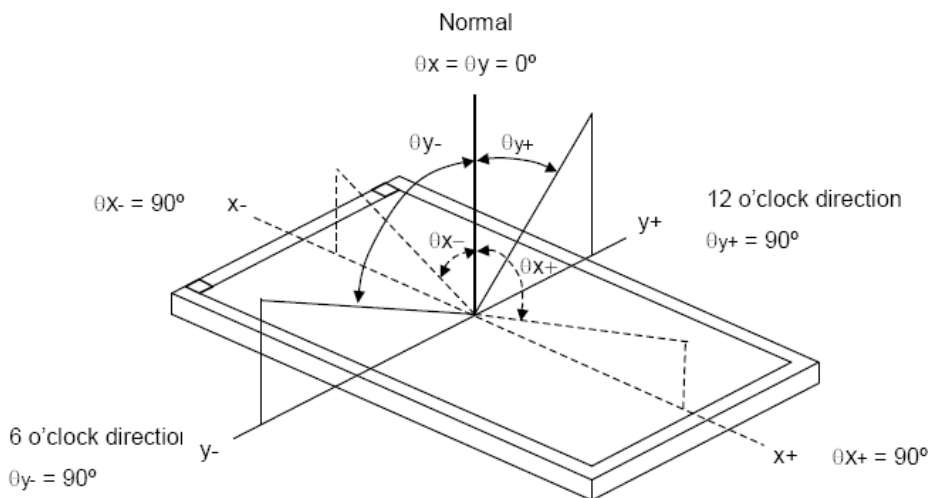Note: Measuring machine: LCD-5100 or EQUI

6.3. Definition of Contrast Ratio

Contrast is measured perpendicular to display surface in reflective and transmissive mode.

The measurement condition is:

Measuring Equipment	Eldim or Equivalent
Measuring Point Diameter	3mm//1mm
Measuring Point Location	Active Area centre point
Test Pattern	A: All Pixels white
	B: All Pixel black
Contrast Setting	Maximum

Definitions: CR (Contrast) = Luminance of White Pixel / Luminance of Black Pixel

6.4. Definition of Viewing Angles

Measuring machine: LCD-5100 or EQUI

6.5. Definition of Color Appearance

R,G,B and W are defined by (x, y) on the IE chromaticity diagram

NTSC=area of RGB triangle/area of NTSC triangleX100%

Measuring picture: Red, Green, Blue and White (Measuring machine: BM-7)
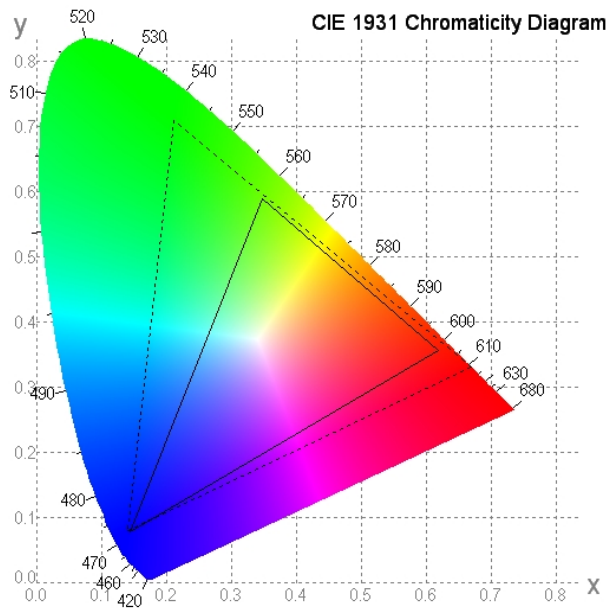
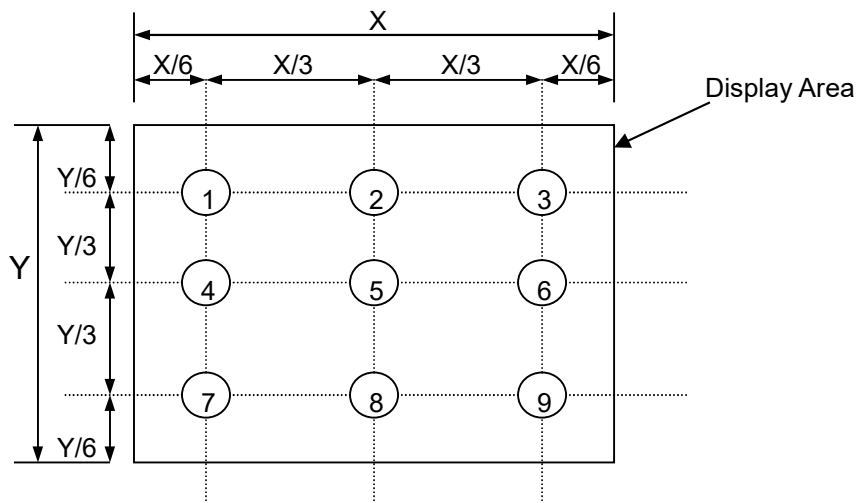### 6.6. Definition of Surface Luminance, Uniformity and Transmittance

Using the reflective mode measurement approach, measure the white screen luminance of the display panel and backlight.

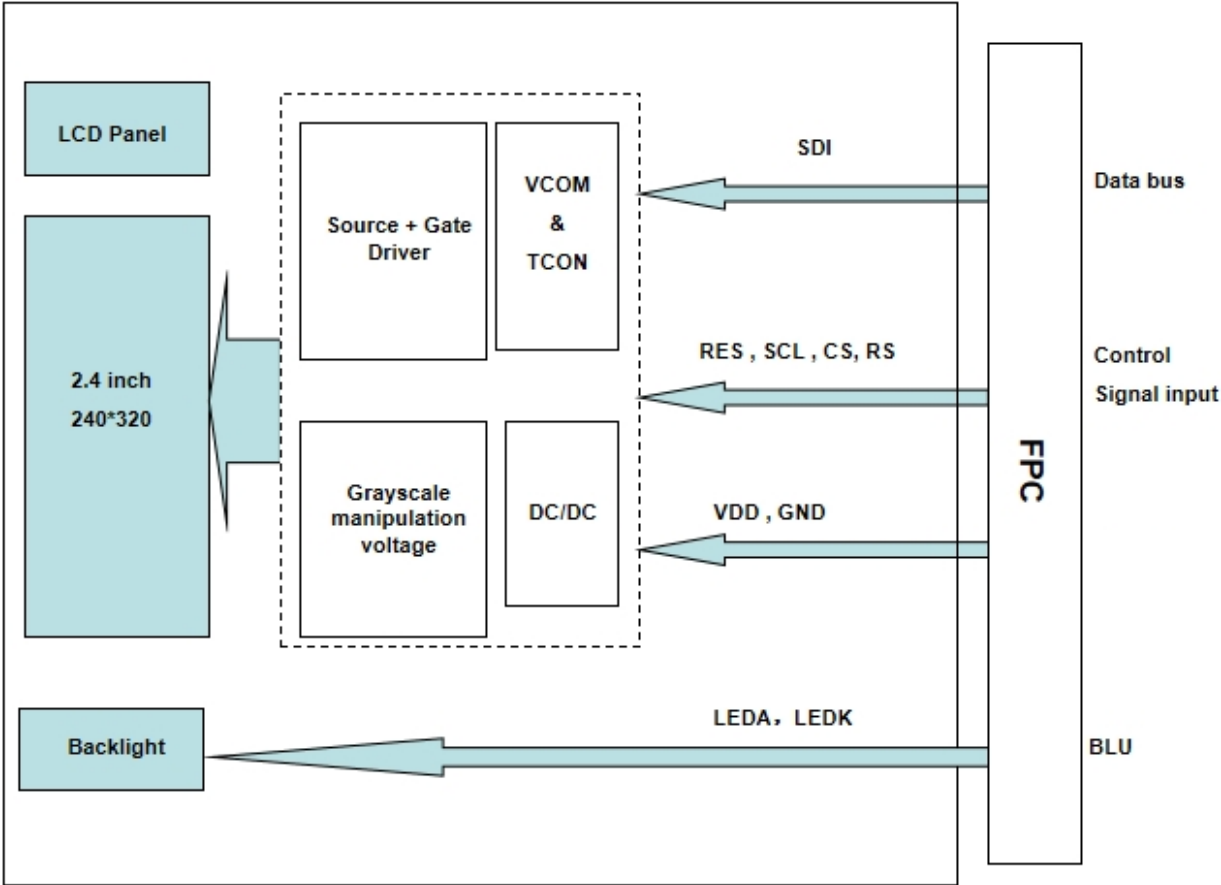6.6.1.   Surface Luminance: L_V = average (L_{P1}:L_{P9})

6.6.2.   Uniformity = Minimal (L_{P1}:L_{P9}) / Maximal (L_{P1}:L_{P9}) * 100%

6.6.3.   Transmittance = L_V on LCD / L_V on backlight * 100%

Note: Measuring machine: BM-7

7.   Block Diagram and Power Supply

8.   Interface Pins Definition

No.	Symbol	Function
1	GND	Ground
2	RS	Data or Command pin
3	CS	Chip selection pin
4	SCL	Serial clock data pin
5	SDI	Serial data input pin
6	RES	Reset input pin
7	VDD	Power supply
8	GND	Ground
9	LEDA	LED Anode
10	LEDK	LED Cathode

9. AC Characteristics

9.1. Serial Interface Characteristics (4-line serial)
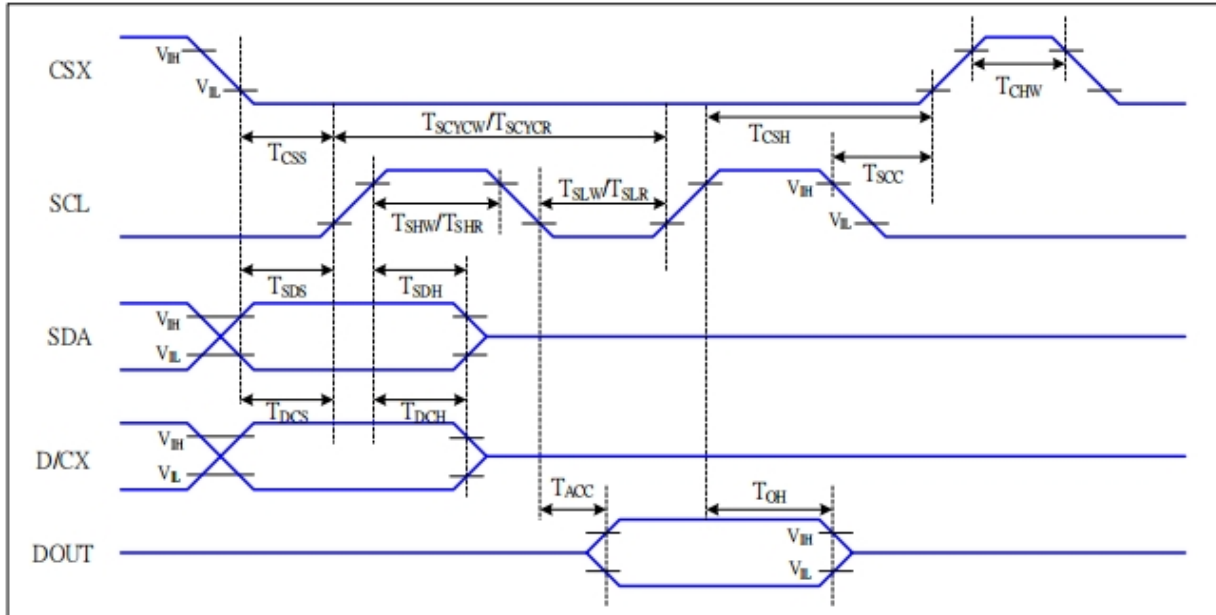
VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=25℃

Signal	Symbol	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)	16		ns	-write command & data ram
	T_{SHW}	SCL "H" pulse width (Write)	7		ns	
	T_{SLW}	SCL "L" pulse width (Write)	7		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	7		ns	
	T_{SDH}	Data hold time	7		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

9.2. Reset Timing
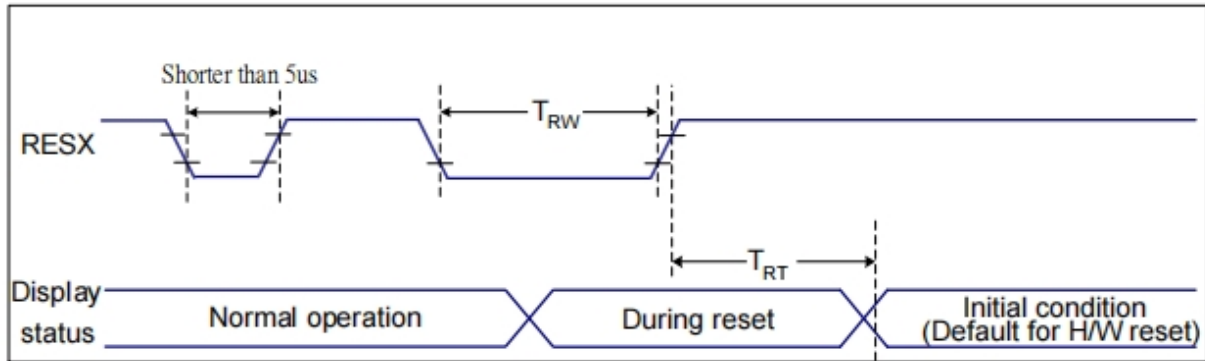
VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=25℃

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

Notes:

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

2. Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below:

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

3. During the Resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep Out –mode. The display remains the blank state in Sleep In –mode.) and then return to Default condition for Hardware Reset.

4. Spike Rejection also applies during a valid reset pulse as shown below:
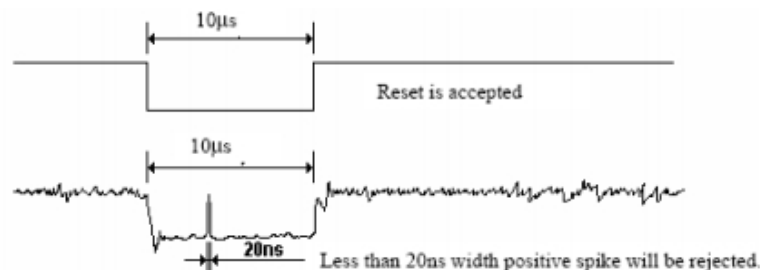
5. When Reset applied during Sleep In Mode.

6. When Reset applied during Sleep Out Mode.

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

10. Quality Assurance

10.1. Purpose

This standard for Quality Assurance assures the quality of LCD module products supplied to customer.

10.2. Standard for Quality Test

10.2.1.   Sampling Plan:

GB2828.1-2012

Single sampling, general inspection level II

10.2.2.   Sampling Criteria:

Visual inspection: AQL 1.5

Electrical functional: AQL 0.65.

10.2.3.   Reliability Test:

Detailed requirement refer to Reliability Test Specification.

10.3. Nonconforming Analysis & Disposition

10.3.1.   Nonconforming analysis:

10.3.1.1. Customer should provide overall information of non-conforming sample for their complaints.

10.3.1.2. After receipt of detailed information from customer, the analysis of nonconforming parts usually should be finished in one week.

10.3.1.3. If cannot finish the analysis on time, customer will be notified with the progress status.

10.3.2.   Disposition of nonconforming:

10.3.2.1. Non-conforming product over PPM level will be replaced.

10.3.2.2. The cause of non-conformance will be analyzed. Corrective action will be discussed and implemented.

10.4. Agreement Items

Shall negotiate with customer if the following situation occurs:

10.4.1.   There is any discrepancy in standard of quality assurance.

10.4.2.   Additional requirement to be added in product specification.

10.4.3.   Any other special problem.

10.5. Standard of the Product Visual Inspection

10.5.1.   Appearance inspection:

10.5.1.1. The inspection must be under illumination about 1000 – 1500 lx, and the distance of view must be at 30cm ± 2cm.

10.5.1.2. The viewing angle should be 45° from the vertical line without reflection light or follows customer's viewing angle specifications.

10.5.1.3. Definition of area: A Zone: Active Area, B Zone: Viewing Area,
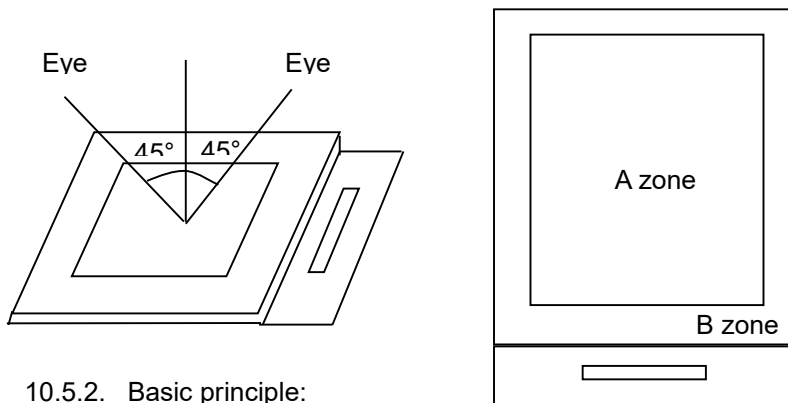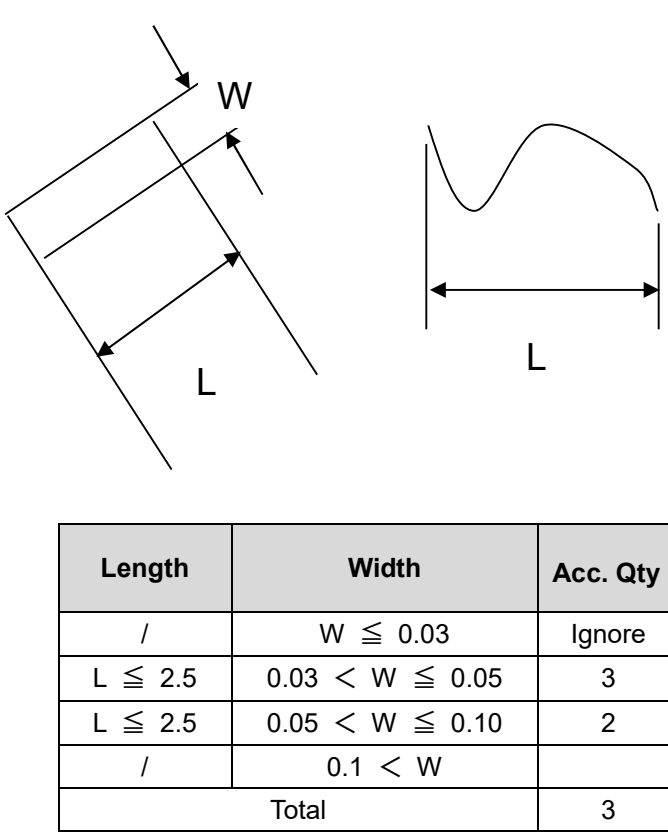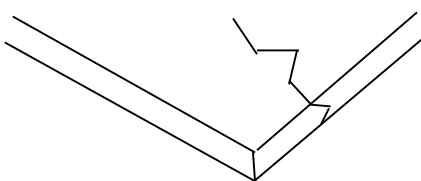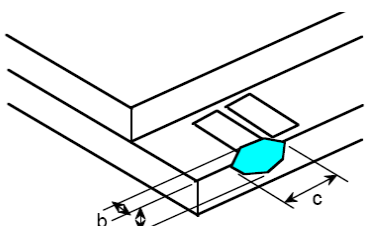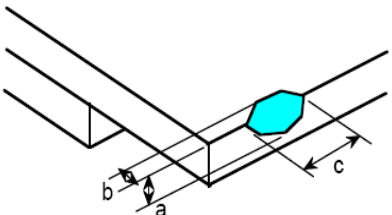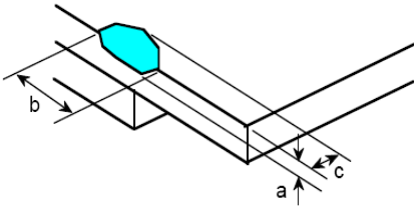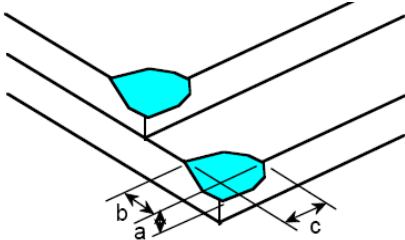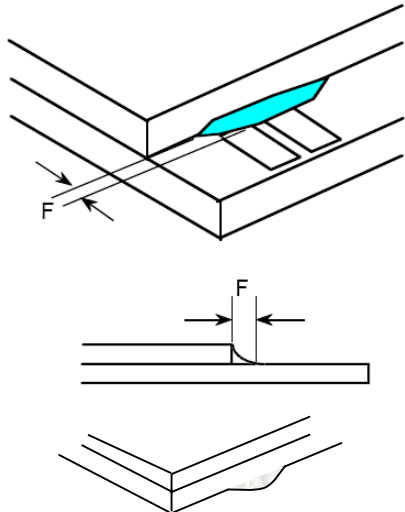

10.5.2.   Basic principle:

10.5.2.1. A set of sample to indicate the limit of acceptable quality level must be discussed by both us and customer when there is any dispute happened.
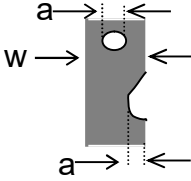
10.5.2.2. New item must be added on time when it is necessary.

10.6. Inspection Specification

No.	Item	Criteria (Unit: mm)		
01	Black / White spot Foreign material (Round type) Pinholes Stain Particles inside cell. (Minor defect)	 $\varphi = (a + b)/2$ Distance between 2 defects should more than 3mm apart.		

	Size \\ Area	Acc. Qty
	$\varphi \leq 0.10$	Ignore
	$0.10 < \varphi \leq 0.15$	2
	$0.15 < \varphi \leq 0.25$	1
	$0.25 < \varphi$	0
	Total	2 no include $\varphi \leq 0.10$

No.	Item		Display Area	Total	
02	Electrical Defect (Minor defect)	Bright dot	0	0	Note1
		Dark dot	$N \leq 2$	$N \leq 2$	
		Total dot	$N \leq 2$	$N \leq 2$	
		Mura	Not visible through 5% ND filters.		Note2

Remark:

1. Bright dot caused by scratch and foreign object accords to item 1.

03	Black and White line Scratch Foreign material (Line type) (Minor defect)	

Length	Width	Acc. Qty
/	W ≦ 0.03	Ignore
L ≦ 2.5	0.03 ＜ W ≦ 0.05	3
L ≦ 2.5	0.05 ＜ W ≦ 0.10	2
/	0.1 ＜ W	
Total		3

Distance between 2 defects should more than 3mm apart. Scratches not viewable through the back of the display are acceptable.

04	Glass Crack (Minor defect)	

Crack is potential to enlarge, any type is not allowed.

05	Glass　Chipping Pad Area: (Minor defect) 	

Length and Width	Acc. Qty
c > 3.0, b< 1.0	1
c< 3.0, b< 1.0	3
a<Glass Thickness	

06	Glass Chipping Rear of Pad Area: (Minor defect)		

Length and Width	Acc. Qty
c > 3.0, b< 1.0	1
c< 3.0, b< 1.0	2
c< 3.0, b< 0.5	4
a<Glass Thickness	

07	Glass Chipping Except Pad Area: (Minor defect)		

Length and Width	Acc. Qty
c > 3.0, b< 1.0	1
c< 3.0, b< 1.0	2
c< 3.0, b< 0.5	4
a<Glass Thickness	

08	Glass Corner Chipping: (Minor defect)		

Length and Width	Acc. Qty
c < 3.0, b< 3.0	Ignore
a<Glass Thickness	

09	Glass Burr: (Minor defect)		

Length	Acc. Qty
F < 1.0	Ignore

Glass burr don't affect assemble and module dimension.

10	FPC Defect: (Minor defect) 	10.1 Dent, pinhole width a<w/3. (w: circuitry width.) 10.2 Open circuit is unacceptable. 10.3 No oxidation, contamination and distortion.

11	Bubble on Polarizer (Minor defect)	Diameter	Acc. Qty
		φ≤0.20	Ignore
		0.20 <φ≤0.30	4
		0.30 <φ≤0.50	1
		0.50 < φ	None

12	Dent on Polarizer (Minor defect)	Diameter	Acc. Qty
		φ≤0.20	Ignore
		0.20 <φ≤0.30	4
		0.30 <φ≤0.50	1
		0.50 < φ	None

13	Bezel	13.1 No rust, distortion on the Bezel. 13.2 No visible fingerprints, stains or other contamination.
14	PCB	14.1 No distortion or contamination on PCB terminals. 14.2 All components on PCB must same as documented on the BOM/component layout. 14.3 Follow IPC-A-600F.
15	Soldering	Follow IPC-A-610C standard
16	Electrical Defect (Major defect)	The below defects must be rejected. 16.1 Missing vertical / horizontal segment, 16.2 Abnormal Display. 16.3 No function or no display. 16.4 Current exceeds product specifications. 16.5 LCD viewing angle defect. 16.6 No backlight. 16.7 Dark backlight. 16.8 Touch Panel no function.

Remark: LCD Panel Broken shall be rejected. Defect out of LCD viewing area is acceptable.

10.7. Classification of Defects

10.7.1.   Visual defects (Except no / wrong label) are treated as minor defect and electrical defect is major.

10.7.2.   Two minor defects are equal to one major in lot sampling inspection.

10.8. Identification/marking criteria

Any unit with illegible / wrong /double or no marking/ label shall be rejected.

10.9. Packaging

10.9.1.   There should be no damage of the outside carton box, each packaging box should have one identical label.

10.9.2.   Modules inside package box should have compliant mark.

10.9.3.   All direct package materials shall offer ESD protection.

Note1: Bright dot is defined as the defective area of the dot is larger than 50% of one sub-pixel area.
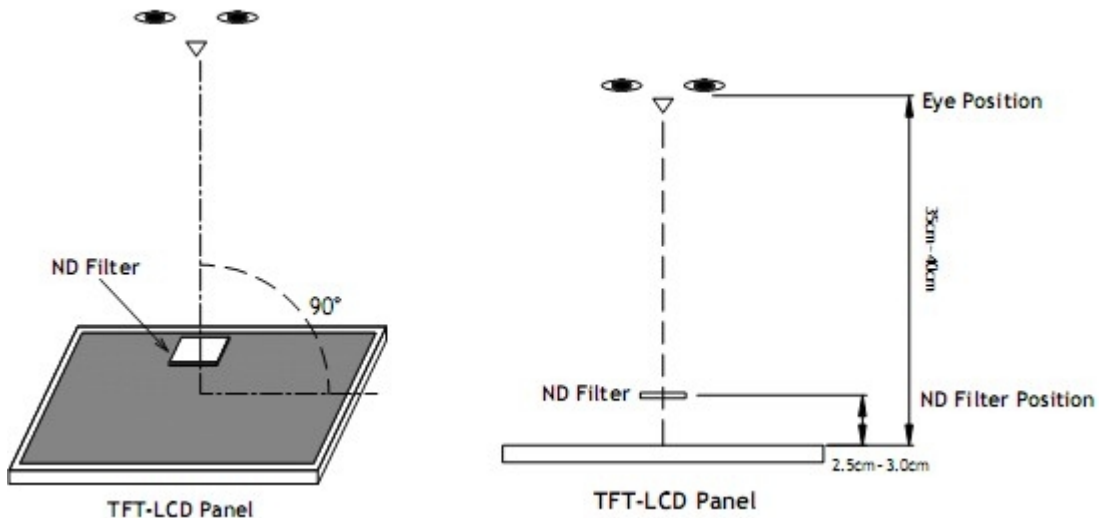
Bright dot: The bright dot size defect at black display pattern. It can be recognized by 2% transparency of filter when the distance between eyes and panel is 350mm±50mm.

Dark dot: Cyan, Magenta or Yellow dot size defect at white display pattern. It can be recognized by 5% transparency of filter when the distance between eyes and panel is 350mm±50mm.

Note2: Mura on display which appears darker / brighter against background brightness on parts of display area.

11. Reliability Specification

No	Item	Condition	Quantity	Criteria
1	High Temperature Operating	70°C, 96Hrs	2	GB/T2423.2 -2008
2	Low Temperature Operating	-20°C, 96Hrs	2	GB/T2423.1 -2008
3	High Humidity Storage	50°C, 90%RH, 96Hrs	2	GB/T2423.3 -2016
4	High Temperature Storage	80°C, 96Hrs	2	GB/T2423.2 -2008
5	Low Temperature Storage	-30°C, 96Hrs	2	GB/T2423.1 -2008
6	Thermal Cycling Test	-20°C, 60min~70°C, 60min, 20 cycles.	2	GB/T2423.22 -2012
7	Packing vibration	Frequency range:10Hz~50Hz Acceleration of gravity:5G X, Y, Z 30 min for each direction.	-	GB/T5170.14 -2009
8	Electrical Static Discharge	Air:±4kV 150pF/330Ω 5 times Contact:±2KV 150pF/330Ω 5 times	2	GB/T17626.2 -2018
9	Drop Test (Packaged)	Height:80 cm,1 corner, 3 edges, 6 surfaces.	-	GB/T2423.8 -1995

Note1.   No defection cosmetic and operational function allowable.

Note2.   Total current Consumption should be below double of initial value.

12. Precautions and Warranty

12.1. Safety

12.1.1.   The liquid crystal in the LCD is poisonous. Do not put it in your mouth. If the liquid crystal touches your skin or clothes, wash it off immediately using soap and water.

12.1.2.   Since the liquid crystal cells are made of glass, do not apply strong impact on them. Handle with care.

12.2. Handling

12.2.1.   Reverse and use within ratings in order to keep performance and prevent damage.

12.2.2.   Do not wipe the polarizer with dry cloth, as it might cause scratch. If the surface of the LCD needs to be cleaned, wipe it swiftly with cotton or other soft cloth soaked with petroleum IPA, do not use other chemicals.

12.3. Storage

12.3.1.   Do not store the LCD module beyond the specified temperature ranges.

12.3.2.   Strong light exposure causes degradation of polarizer and color filter.

12.4. Metal Pin (Apply to Products with Metal Pins)

12.4.1.   Pins of LCD and backlight

12.4.1.1. Solder tip can touch and press on the tip of Pin LEAD during the soldering

12.4.1.2. Recommended Soldering Conditions

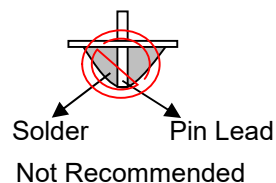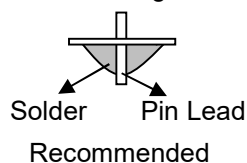Solder Type: Sn96.3~94-Ag3.3~4.3-Cu0.4~1.1

Maximum Solder Temperature: 370℃

Maximum Solder Time: 3s at the maximum temperature

Recommended Soldering Temp: 350±20℃

Typical Soldering Time: ≤3s

12.4.1.3. Solder Wetting

Solder Pin Lead	Solder Pin Lead
Recommended	Not Recommended

12.4.2.   Pins of EL

12.4.2.1. Solder tip can touch and press on the tip of EL leads during soldering.

12.4.2.2. No Solder Paste on the soldering pad on the motherboard is recommended.

12.4.2.3. Recommended Soldering Conditions

Solder type: Nippon Alimit Leadfree SR-34, size 0.5mm
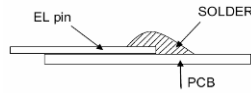
Recommended Solder Temperature: 270～290℃

Typical Soldering Time: ≤2s
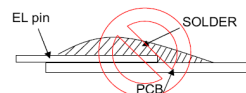
Minimum solder distance from EL lamp (body):2.0mm

12.4.2.4. No horizontal press on the EL leads during soldering.

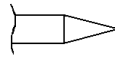12.4.2.5. 180° bend EL leads three times is not allowed.
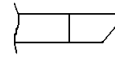
12.4.2.6. Solder Wetting

Recommended   Not Recommended
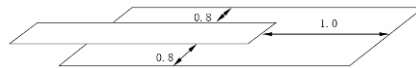
12.4.2.7. The type of the solder iron:

Recommended   Not Recommended

12.4.2.8. Solder Pad

12.5. Operation

12.5.1.   Do not drive LCD with DC voltage

12.5.2.   Response time will increase below lower temperature

12.5.3.   Display may change color with different temperature

12.5.4.   Mechanical disturbance during operation, such as pressing on the display area, may cause the segments to appear "fractured".

12.5.5.   Do not connect or disconnect the LCM to or from the system when power is on.

12.5.6.   Never use the LCM under abnormal condition of high temperature and high humidity.

12.5.7.   Module has high frequency circuits. Sufficient suppression to the electromagnetic interface shall be done by system manufacturers. Grounding and shielding methods may be important to minimize the interference.

12.5.8.   Do not display the fixed pattern for long time（we suggest the time not longer than one hour）because it will develop image sticking due to the TFT structure.
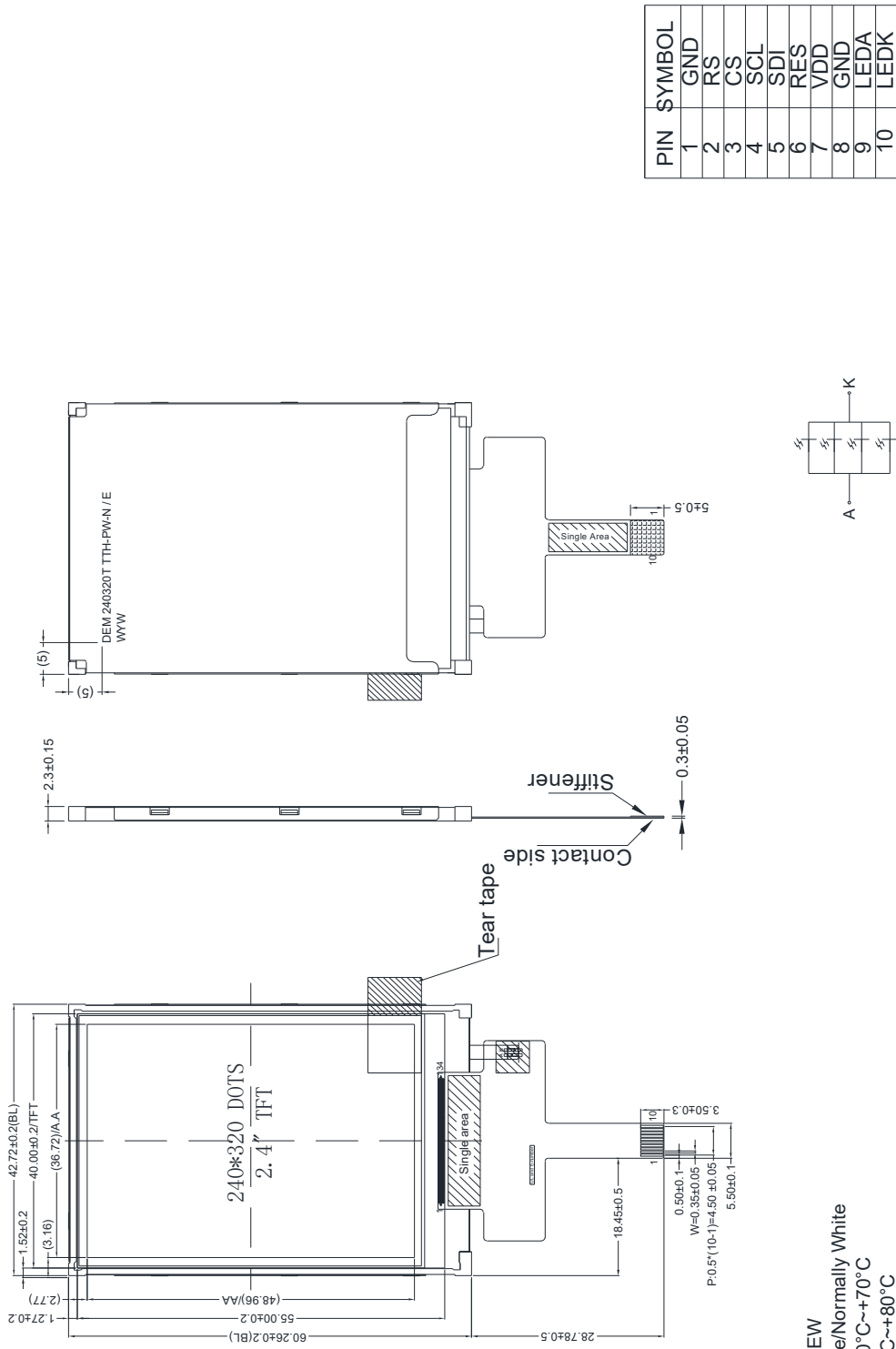
12.6. Static Electricity

12.6.1.   CMOS LSIs are equipped in this unit, so care must be taken to avoid the electro-static charge, by ground human body, etc.

12.6.2.   The normal static prevention measures should be observed for work clothes and benches.

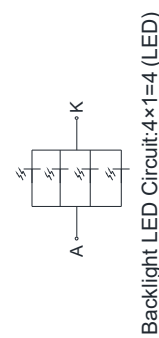12.6.3.   The module should be kept into anti-static bags or other containers resistant to static for storage.

12.7. Limited Warranty

12.7.1.   Our warranty liability is limited to repair and/or replacement. We will not be responsible for any consequential loss.

12.7.2.   If possible, we suggest customer to use up all modules in six months. If the module storage time over twelve months, we suggest that recheck it before the module be used

12.7.3.   . After the product shipped, any product quality issues must be feedback within three months, otherwise, we will not be responsible for the subsequent or consequential events.

13. Outline Drawing

PIN	SYMBOL
1	GND
2	RS
3	CS
4	SCL
5	SDI
6	RES
7	VDD
8	GND
9	LEDA
10	LEDK

Backlight LED Circuit:4×1=4 (LED)

DEM 240320T TTH-PW-N / E
WYW

Single Area

Stiffener

Contact side

Tear tape

240*320 DOTS
2.4" TFT

Single area

NOTES:
1.Display size:2.4"TFT
2.Viewing direction:FULL VIEW
3.Display mode:Transflective/Normally White
4.Operation temperature:-20°C~+70°C
5.Storage temperature:-30°C~+80°C
6.Driver IC:ST7789T3
7.Power supply voltage:2.8V
8.Backlight :White(4 LED)/3.1V(TYP),If=80mA
   Brighness:150(TYP)cd/m^2
9.ROHS must be complied
  * The dimension with mark brackets "()" just for reference