Densitron

TFT DISPLAY MODULE

Product Specification

Customer	Standard	
Product Number	DMT015QVNSNT0-1C	
Customer Part Number		
Customer Approval		**Date:**

Internal Approvals		
Product Mgr	Doc. Control	Electr. Eng
Luo Luo	Filip Kaczorowski	Filip Kaczorowski
Date: 31/07/18	**Date: 31/07/18**	**Date: 31/07/18**

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Revision Record

Rev.	Date	Page	Chapt.	Comment	ECR no.
1.0	02/07/18	All	All	Initial Release	
1.1	31/07/18	8	3.2	Updated current consumption ICC	

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1.0 Main Features

Item	Contents
Screen Size	1.54” Diagonal
Display Format	240 x RGB x 240 Dots
N° of Colour	65K/262K
Active Area	27.72 mm (H) x 27.72 mm (V)
LCD Type	TFT
Mode	IPS Transmissive / Normally Black
Viewing Direction	Full view
Interface	4-Wire SPI
Driver IC	ST7789V or equivalent
Backlight Type	LED
Polarizer Surface	AR film type
Operating Temperature	-20°C ~ +70°C
Storage Temperature	-30°C ~ +80°C
RoHS compliant	Yes

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2.0 Mechanical Specification

2.1 Mechanical Characteristics

Item	Characteristic	Unit
Display Format	240 x RGB x 240 Dots	Dots
Overall Dimensions	31.5 mm (H) x 35.0 mm (V) x 2.1 mm (D)	mm
Active Area	27.72 mm (H) x 27.72 mm (V)	mm
pixel Pitch	0.1155 (H) x 0.1155 (V)	mm
Weight	3	g

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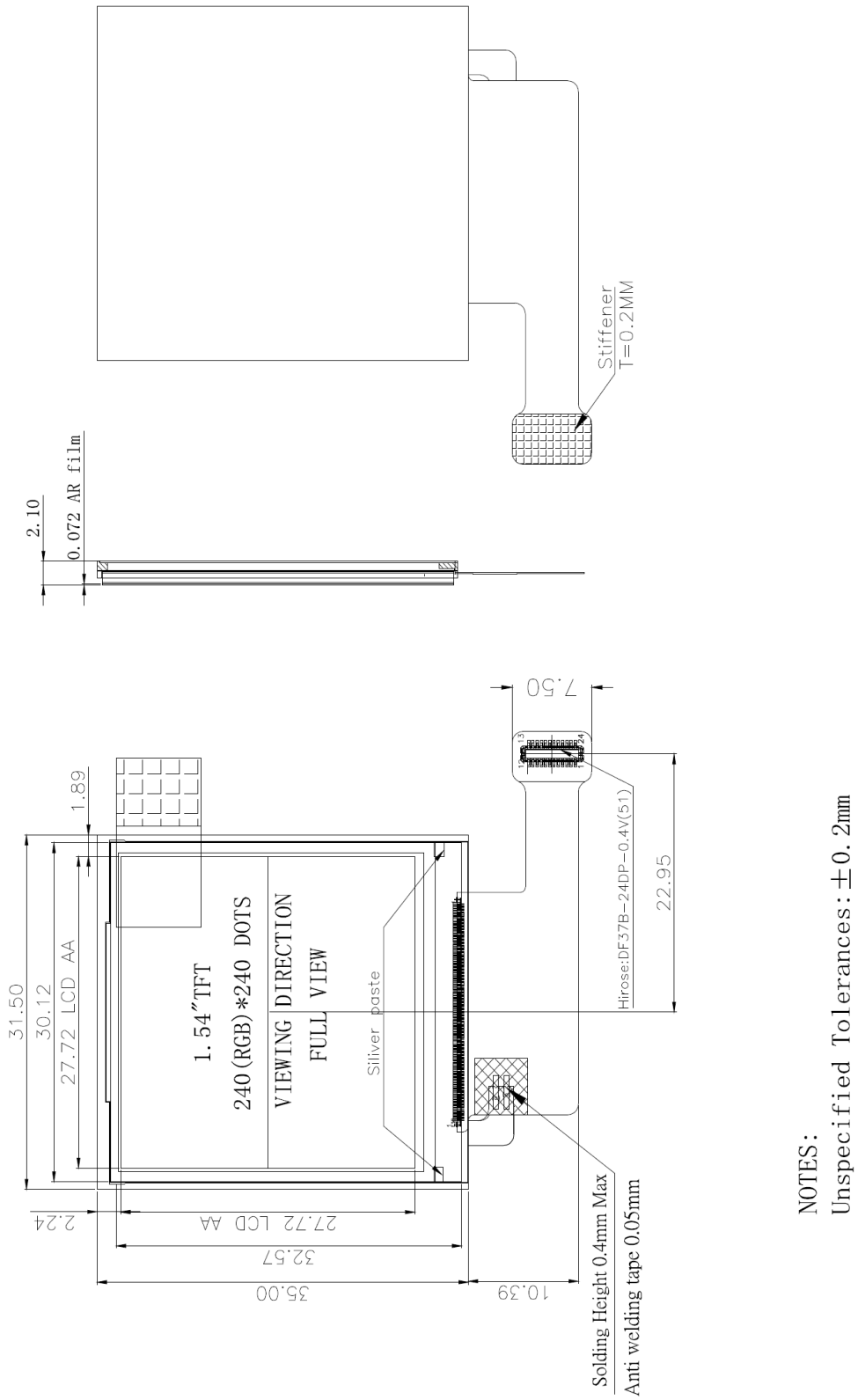
2.2 Mechanical Drawing



NOTES:
Unspecified Tolerances: ±0.2mm

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3.0 Electrical Specification

3.1 Absolute Maximum Ratings

Item	Symbol	Condition	Min	Max	Unit	Note
Power Supply Voltage	VCI		-0.3	4.0	V	-
Power Supply Voltage	IOVCC		-0.3	3.6	V	-
Operating Temperature	TOP		-20	70	°C	1
Storage Temperature	TST		-30	80	°C	1,2,3

Note 1. 75 % RH Max for Ta<60 °C.
Note 2. In case of below 0°C, the response time of liquid crystal (LC) becomes slower and the colour of panel becomes darker than normal one. Level of retardation depends on temperature, because of LC's characteristic.
Note 3. Only operation is guaranteed at operating temperature. Contrast, response time, another display quality are evaluated at +25°C.

3.2 Electrical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit	Note
Supply Voltage for logic	IOVCC	Ta=25˚C	1.65	1.8	3.3	V	
Supply Voltage for analog	VCI	Ta=25˚C	2.6	2.8	3.3	V	
Current Consumption (Logic & TFT)	ICC	VCI&IOVCC= 2.8V	-	6.4	8.8	mA	1

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3.3 Interface Pin Assignment

3.3.1 TFT Pin Assignment

Recommended connector: Hirose DF37NB-24DS-0.4V(51)

No.	Symbol	Function
1	LEDK	Backlight Power supply negative.
2	LEDK	Backlight Power supply negative.
3	GND	Ground.
4	GND	Ground.
5	TE	Tearing effect signal is used to synchronise MCU to frame memory writing. If not used, please leave this pin open.
6	SDA/DATA1	The data is latched on the rising edge of the SCL signal.
7	RS/DATA2	Second data lane in 2 data lane serial interface
8	SCL	Serial interface clock.
9	CSX	Chip select signal input
10	RESX	Reset pin
11	IOVCC	Power supply to interface pins(1.8V/2.8V)
12	IOVCC	Power supply to interface pins(1.8V/2.8V)
13	VCI	Power supply (2.8V)
14	VCI	Power supply (2.8V)
15	GND	Ground.
16	GND	Ground.
17~22	NC	Not connected
23	LEDA	Backlight power supply positive.
24	LEDA	Backlight power supply positive.

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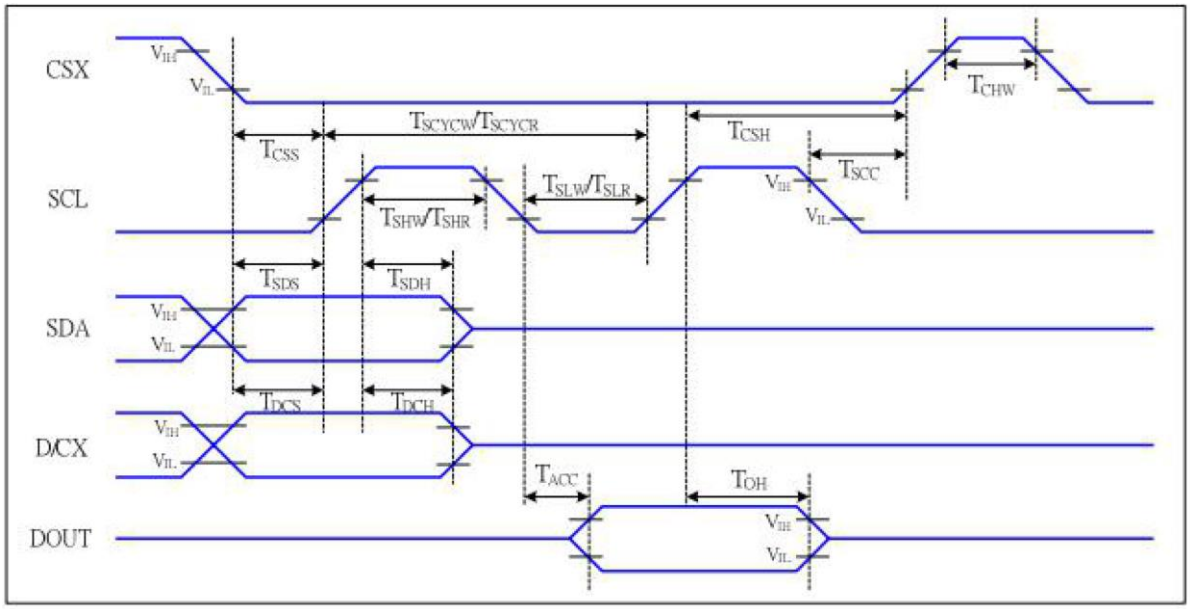
3.4 Timing Characteristics

Please refer to Sitronix IC ST7789V datasheet for more information

3.4.1 SPI Interface Timing Characteristics

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



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3.4.2 Reset Timing Characteristics

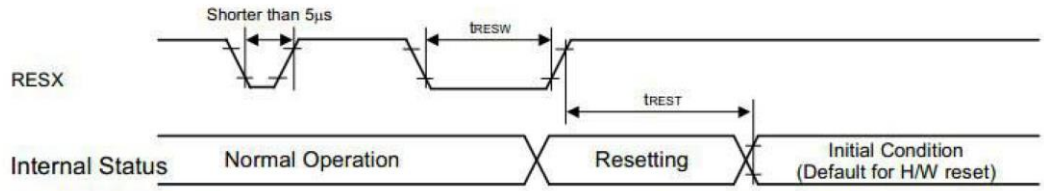

Table 7.3.2.1 Reset input timing — VSS=0V, VDDIO=1.6V to 3.6V, VCI=2.5V to 5.5V,Ta = -30 to 70°C

Symbol	Parameter	Related Pins	MIN	TYP	MAX	Note	Unit
t_{RESW}	*1) Reset low pulse width	RESX	10	-	-	-	µs
t_{REST}	*2) Reset complete time	-	-	-	5	When reset applied during Sleep in mode	ms
		-		-	120	When reset applied during Sleep out mode	ms

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4.0 Optical Specification

4.1 Optical Characteristics

Measuring instruments: LCD-5100, Eldim, Topcon BM-7
Driving condition: VCI = 3.3V, VSS = 0V
Backlight: IF=45mA
Measured temperature: Ta ＝ 25° C

Item		Symbol	Condition	Min	Typ	Max	Unit	Note
Response Time		TR+TF	θ=Φ=0° Normal Viewing Angle	-	25	40	ms	2
Contrast Ratio		CR		400	500	-		3
Viewing Angle	Left	θL	CR ≥ 10	60	80	-	deg	4
	Right	θR		60	80	-	deg	
	Up	ϕU		60	80	-	deg	
	Down	ϕD		60	80	-	deg	
Colour Chromaticity	Red	Rx		0.584	0.634	0.684	-	5
		Ry		0.278	0.328	0.378	-	
	Green	Gx		0.244	0.294	0.344	-	
		Gy		0.527	0.577	0.627	-	
	Blue	Bx		0.087	0.137	0.187	-	
		By		0.084	0.134	0.184	-	
	White	Wx		0.252	0.302	0.352	-	
		Wy		0.285	0.335	0.385	-	
Centre Brightness				450	500	-	cd/m²	6
Brightness Distribution				80	-	-	%	7

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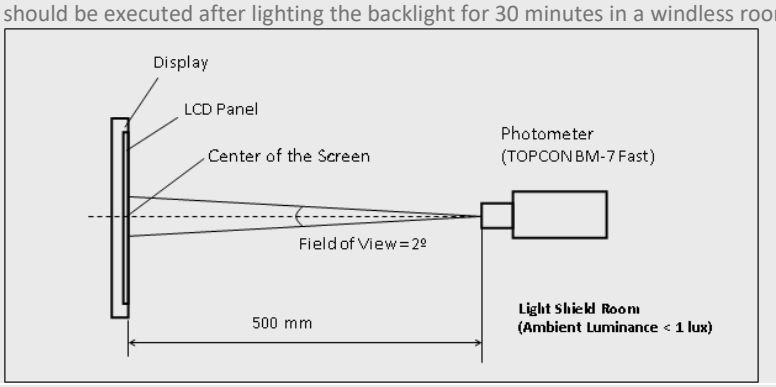
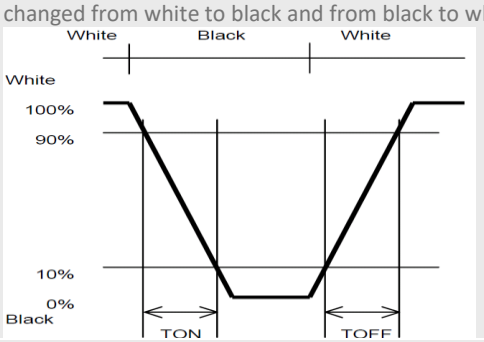
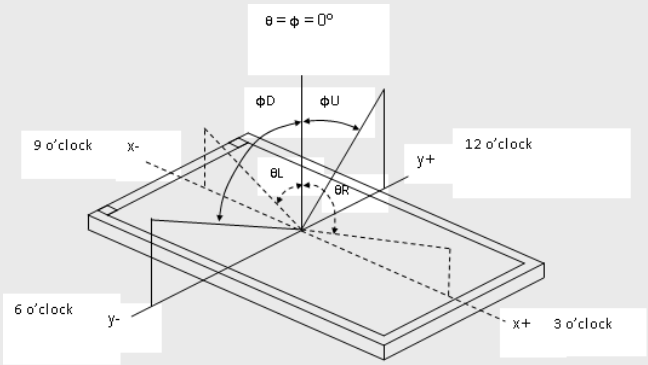
4.1.1 Test Method

Note	Item	Test Method
1	Setup	The display should be stabilised at a given temperature for 30 minutes to avoid abrupt temperature change during measuring. In order to stabilise the luminance, measurements should be executed after lighting the backlight for 30 minutes in a windless room. 
2	Response time	Measure output signal waveform by the luminance meter when raster of window pattern is changed from white to black and from black to white. 
3	Contrast ratio	Measure maximum brightness and minimum brightness at the centre of the screen by displaying raster or window pattern. Then calculate the ratio between these two values. Contrast Ratio (CR) = Brightness of unselected position (white) / Brightness of selected position (black)
4	Viewing angle Horizontal θ Vertical Ø	Move the luminance meter from right to left and up and down and determinate the angles where contrast ratio is 10 
5	Colour chromaticity	Measure chromaticity coordinates x and y of CIE1931 colorimetric system
6	Centre brightness	Measure the brightness at the centre of the screen
7	Brightness distribution	(Brightness distribution) = 100 x B/A % A: max. brightness of the 5 points B: min. brightness of the 5 points

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5.0 Backlight Specification

5.1 LED Driving Conditions

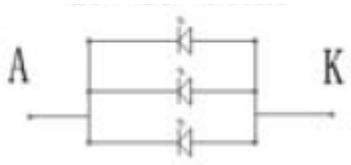
Item	Symbol	Condition	Min	Typ	Max	Unit
Forward Current	IF	Ta=25 °C	-	45	60	mA
Forward Voltage	VF	Ta= 25°C	2.8	2.9	3.0	V
LED life time	Hr	If=15mA	30K	-	-	hour

Note:

- The lifetime of the LED is defined as a period till the brightness of the LED decreases to the half of its initial value.
- This figure is given as a reference purpose only, and not a guarantee.
- This figure is estimated for an LED operating alone.
  The performance of an LED may differ when assembled as a monitor together with a TFT panel due to different environmental temperature.
- Estimated lifetime could vary on a different temperature and usually higher temperature could reduce the life significantly.

5.2 LED Circuit

LED Circuit Drawing



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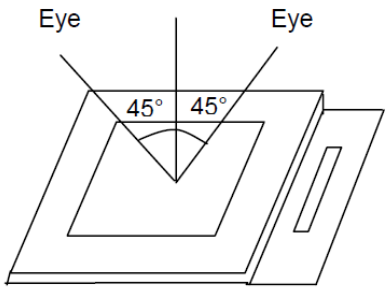
6.0 Quality Assurance Specification

6.1 Delivery Inspection Standards

6.1.1 Inspection Conditions

Inspection distance: 30 cm ± 2 cm
Viewing angle: ±45°



6.1.2 Environmental Conditions

Ambient temperature: 25°C ±5°C
Ambient humidity: 65±10% RH
Ambient illumination: 300~700 lux

6.1.3 Sampling Conditions

1. Lot size: quantity of shipment lot per model
2. Sampling method:

Sampling Plan		GB/T 2828-2003
		Normal inspection, Class II
AQL	Major Defect	0.65%
	Minor Defect	2.5%

No	Items to be inspected	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	Colour tone	Colour unevenness, refer to limit sample	Minor
5	Spot Line defect	Light dot， Dim spot, Polarizer Bubble; Polarizer accidented spot.	
6	Soldering appearance	Good soldering, peeling off is not allowed.	

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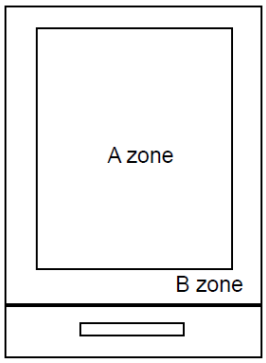
6.1.4 Definition of Area

A zone: active area
B zone: viewing area



6.1.5 Basic Principle

A set of sample to indicate the limit of acceptable quality level shall be discussed should a dispute occur.

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6.1.6 Inspection Criteria

Classify	Item		Note	AQL
Major	Display state	Short or open circuit	1	0.65
		Contrast defect (dim, ghost)		
		LC leakage		
		Flickering		
		No display		
		Wrong viewing direction	2	
		Wrong Back-light	7	
	Non-display	Flat cable or pin reverse	9	
		Wrong or missing component	10	
Minor	Display state	Background color deviation	2	2.5
		Black spot and dust	3	
		Line defect	4	
		Scratch		
		Rainbow	5	
		Pin hole	6	
	Polarizer	Bubble and foreign material	3	
		Scratch	4	
	PCB,FPC	Scratch	4	
	Soldering	Poor connection	8	
	Wire	Poor connection	9	
	LCD	CHIP OUT	11	

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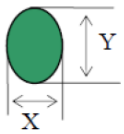
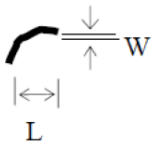
Note on defect classification:

<table>
<tr><th>No.</th><th>Item</th><th>Criterion</th></tr>
<tr><td rowspan="6">1</td><td>Short or open circuit</td><td rowspan="6">Not allow</td></tr>
<tr><td>LC leakage</td></tr>
<tr><td>Flickering</td></tr>
<tr><td>No display</td></tr>
<tr><td>Wrong viewing direction</td></tr>
<tr><td>Wrong Back-light</td></tr>
<tr><td rowspan="2">2</td><td>Contrast defect</td><td rowspan="2">Refer to approval sample</td></tr>
<tr><td>Background color deviation</td></tr>
<tr><td>3</td><td>Point defect,
Black spot, dust (incl. Polarizer) ex.: dirt under polarizer,
Pinhole of reflector ,glass scratch, dirt under glass,scratch on polarizer
ϕ = (X+Y)/2</td><td> 

<table>
<tr><th>Point
Size</th><th>Acceptable Qty.</th></tr>
<tr><td>ϕ≤0.20</td><td>Disregard</td></tr>
<tr><td>0.20<ϕ≤0.25</td><td>3</td></tr>
<tr><td>0.25<ϕ≤0.30</td><td>2</td></tr>
<tr><td>ϕ>0.30</td><td>0</td></tr>
</table>
Unit：mm</td></tr>
<tr><td>4</td><td>Line defect</td><td> 

<table>
<tr><th></th><th>Line</th><th>Acceptable Qty.</th></tr>
<tr><td>L</td><td>W</td><td></td></tr>
<tr><td>---</td><td>0.015≥W</td><td>Disregard</td></tr>
<tr><td>3.0≥L</td><td>0.03≥W</td><td rowspan="2">2</td></tr>
<tr><td>2.0≥L</td><td>0.05≥W</td></tr>
<tr><td>1.0≥L</td><td>0.1＞W</td><td>1</td></tr>
<tr><td>---</td><td>0.05<W</td><td>Applied as point defect</td></tr>
</table>
Unit: mm</td></tr>
<tr><td>5</td><td>Rainbow</td><td>Not more than two color changes across the viewing area</td></tr>
</table>

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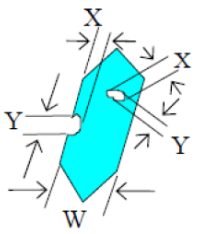
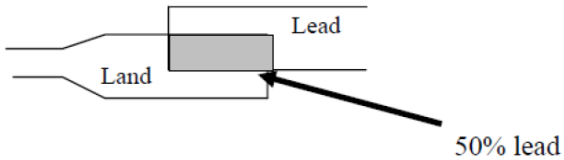
<table>
<tr><th>No.</th><th>Item</th><th>Criterion</th></tr>
<tr><td>6</td><td>Segment
pattern
W = Segment width
ϕ = (X+Y)/2</td><td>(1) Pin hole
ϕ < 0.10mm is acceptable.
 

<table><tr><td>Point Size</td><td>Acceptable Qty</td></tr><tr><td>ϕ≤1/4W</td><td>Disregard</td></tr><tr><td>1/4W< ϕ≤1/2W</td><td>1</td></tr><tr><td>ϕ＞1/2W</td><td>0</td></tr></table>Unit: mm</td></tr>
<tr><td>7</td><td>Back-light</td><td>(1) The color of backlight should correspond its specification.
(2) Not allow flickering</td></tr>
<tr><td>8</td><td>Soldering</td><td>(1) Not allow heavy dirty and solder ball on PCB or FPC.
(The size of dirty refer to point and dust defect)
(2) Over 50% of lead should be soldered on Land.
 
</td></tr>
<tr><td>9</td><td>Wire</td><td>(1) Copper wire should not be rusted
(2) Not allow crack on copper wire connection.
(3) Not allow reversing the position of the flat cable.
(4) Not allow exposed copper wire inside the flat cable.</td></tr>
<tr><td>10</td><td>PCB,FPC</td><td>(1) Not allow screw rust or damage.
(2) Not allow missing or wrong putting of component.</td></tr>
</table>

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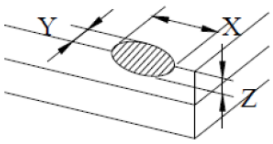
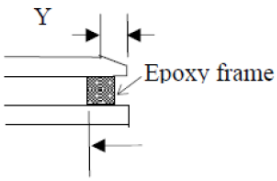
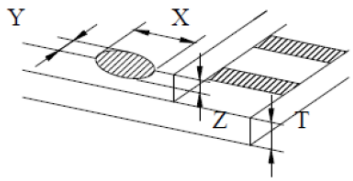
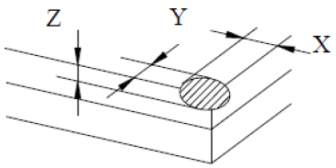
<table>
<tr>
<td>11</td>
<td>LCD</td>
<td>
2.1.1 chip on the surface








Note: A:LCD Length
<table>
<tr><th>X</th><th>Y</th><th>Z</th></tr>
<tr><td>>1/8A</td><td>≤0.3mm</td><td>≤1/2T</td></tr>
<tr><td rowspan="2">≤1/8A</td><td>Not enter into epoxy frame</td><td>≤T</td></tr>
<tr><td>Not enter into the inner edge of epoxy</td><td>≤1/2T</td></tr>
</table>
</td>
</tr>
</table>

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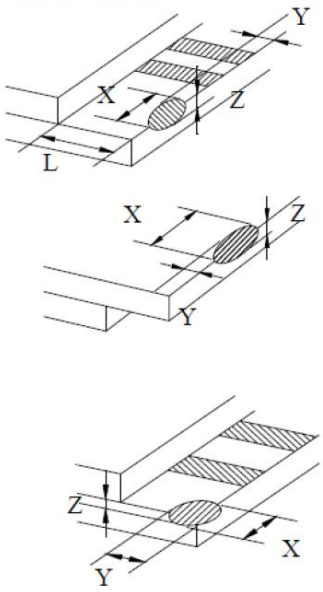
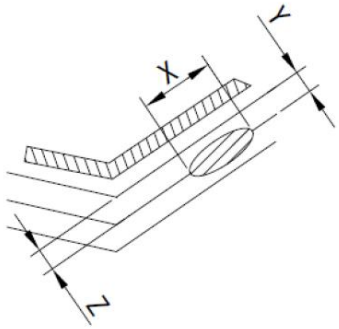
<table>
<tr>
<td rowspan="2">11</td>
<td rowspan="2">LCD</td>
<td>
2.1.2 Chip on the terminal


<table>
<tr><th>X</th><th>Y</th><th>Z</th></tr>
<tr><td>>1/8A</td><td>≤ 0.3mm</td><td>≤ 1/2T</td></tr>
<tr><td>≤ 1/8A</td><td>≤ 1/2L</td><td>≤ T</td></tr>
<tr><td>≤ 1/8A&≤ 1mm</td><td>≤ L</td><td>≤ T</td></tr>
<tr><td>≤ 1/8A&≤ 2mm</td><td>≤ L</td><td>≤ 1/2T</td></tr>
</table>
Note: A:LCD Length.
the distance between crack and contact pad must be greater than the width of 1st contact pad.
</td>
</tr>
<tr>
<td>
2.1.3 Chip out on between side


</td>
</tr>
</table>

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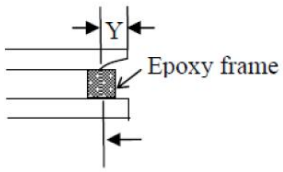
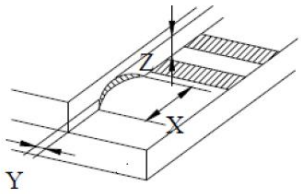
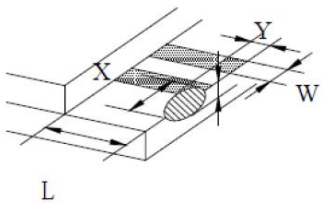
11	**LCD**	  <table><tr><th>X</th><th>Y</th><th>Z</th></tr><tr><td rowspan="2">≤ 1/8A</td><td>Not enter into epoxy frame</td><td>Z≤ 2T</td></tr><tr><td>Not enter into 1/2 epoxy frame</td><td>Z≤ 1/2T</td></tr></table>Note: A : LCD Length **2.1.4 including corner chip and side chip**  Note: A:LCD Length <table><tr><th>X</th><th>Y</th><th>Z</th></tr><tr><td>>1/8A</td><td>≤1/6L</td><td rowspan="3">≤1/2T</td></tr><tr><td>≤1/8A</td><td>≤1/3L</td></tr><tr><td>≤1/4W</td><td>≤2/3L</td></tr></table>

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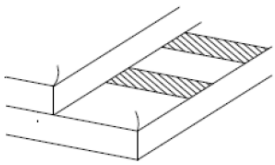
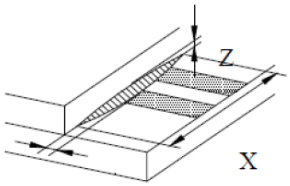
<table>
<tr><td rowspan="2">11</td><td rowspan="2">LCD</td><td>2.2 Chip out
 
1) Chip out is that crackles extend to inner edge.
2) Crackles round epoxy frame will be rejected.
3) Chip out on the terminal will be rejected: Z=T length >1mm or Z<T length >2mm
4) The chip out at ITO will be rejected.</td></tr>
<tr><td>2.3 Poor cutting
 

<table><tr><th>X</th><th>Y</th><th>Z</th></tr><tr><td>>1/8 A</td><td>≤0.3</td><td>≤1/2T</td></tr><tr><td>≤1/8 A</td><td>According to drawing</td><td>1/2T≤Z≤T</td></tr></table>Note : A: LCD Length.</td></tr>
<tr><td>12</td><td>SMT</td><td>According to the <Acceptable of electronic assemblies>
IPC-A-610C class 2 stander. Component missing or function defect are Major defect ,the others are Minor defect.</td></tr>
<tr><td colspan="3">Any one out of the specification will be rejected.</td></tr>
</table>

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6.1.7 Classification of Defects

Visual defects (except no or wrong label) are treated as minor defects, while electrical defects are treated as major defects.
Two minor defects are equal to one major defect in lot sampling inspection.

6.1.8 Identification / marking criteria

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

6.2 Dealing with Customer Complaints

6.2.1 Non-conforming analysis

Purchaser should supply Densitron with detailed data of non-conforming sample.
After accepting it, Densitron should complete the analysis in two weeks from receiving the sample.
If the analysis cannot be completed on time, Densitron must inform the purchaser.

6.2.2 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.

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Densitron

7.0 Reliability Specification

7.1 Reliability Tests

Test Item		Test Condition		Sample Size
Durability Test	High Temperature Operation	Ta= 70˚C	96h	3pcs
	Low Temperature Operation	Ta=-20˚C	96h	3pcs
	Temperature Cycle Operation	-20°C ←→ 70°C ON/OFF, 20 cycles. ON time over 10 seconds, OFF time over 10 seconds		3pcs
	High Temperature Storage	Tp= 80°C	96h	3pcs
	Low Temperature Storage	Tp= -30°C	96h	3pcs
	ESD Test	150pF, 330Ω, ±6KV (Contact)/±8KV (Air), 5 Points/panel, 10 times/point		3pcs
	Thermal Shock Resistance	The sample should be allowed to stand the following 5 cycles of operation: LTS for 30 minutes -> normal temperature for 5 minutes -> HTS for 30 minutes -> normal temperature for 5 minutes, as one cycle, then taking it out and drying it at normal temperature, and allowing it stand for 24 hours		3pcs
	Box Drop Test	1 Corner 3 Edges 6 faces, 66 cm (Medium Box)		1 box

Note: Ta=ambient temperature Tp= Panel temperature

Notes:
1. No dew condensation to be observed.
2. The function test shall be conducted after 4 hours storage at the normal temperature and humidity after removed from the test chamber.
3. No cosmetic or functional defects should be allowed.
4. Total current consumption should be less than twice the initial value.

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8.0 Handling Precautions

Safety

If the LCD panel breaks, be careful not to get the liquid crystal fluid in your mouth or in your eyes.
If the liquid crystal touches your skin or clothes, wash it off immediately using soap and plenty of water.

Mounting and Design

Place a transparent plate (e.g. acrylic, polycarbonate or glass) on the display surface to protect the display from external pressure. Leave a small gap between the transparent plate and the display surface.
When assembling with a zebra connector, clean the surface of the pads with alcohol and keep the surrounding air very clean.
Design the system so that no input signal is given unless the power supply voltage is applied.

Caution during LCD cleaning

Lightly wipe the display surface with a soft cloth soaked with Isopropyl alcohol, Ethyl alcohol or Trichlorotriflorothane.
Do not wipe the display surface with dry or hard materials that will damage the polariser surface.
Do not use aromatic solvents (toluene and xylene), or ketonic solvents (ketone and acetone).

Caution against static charge

As the display uses C-MOS LSI drivers, connect any unused input terminal to VDD or VSS. Do not input any signals before power is turned on. Also, ground your body, work/assembly table and assembly equipment to protect against static electricity.

Packaging

Displays use LCD elements, and must be treated as such. Avoid strong shock and drop from a height. To prevent displays from degradation, do not operate or store them exposed directly to sunshine or high temperature/humidity.

Caution during operation

It is indispensable to drive the display within the specified voltage limit since excessive voltage shortens its life. 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. 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. If the display area is pushed on hard during operation, some graphics will be abnormally displayed but returns to a normal condition after turning off the display once. Even a small amount of condensation on the contact pads (terminals) can cause an electro-chemical reaction which causes missing rows and columns. Give careful attention to avoid condensation.

Storage

Store the display in a dark place where the temperature is 25°C ± 10°C and the humidity below 50%RH. Store the display in a clean environment, free from dust, organic solvents and corrosive gases. Do not crash, shake or jolt the display (including accessories).

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