



Microtips Technology
Innovative Solutions. Your Vision. Our Goal.

TFT Module Specification

MODEL: AWL-320960T46N01

This module uses ROHS material

CUSTOMER
APPROVED BY
DATE:

Approved by	Checked by	Made by
		

Tel: 1 (888) 499-8477

Fax: (407) 273-0771

E-mail: mtusainfo@microtipsusa.com

Web: www.microtipsusa.com



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Revision Record

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1. Scope

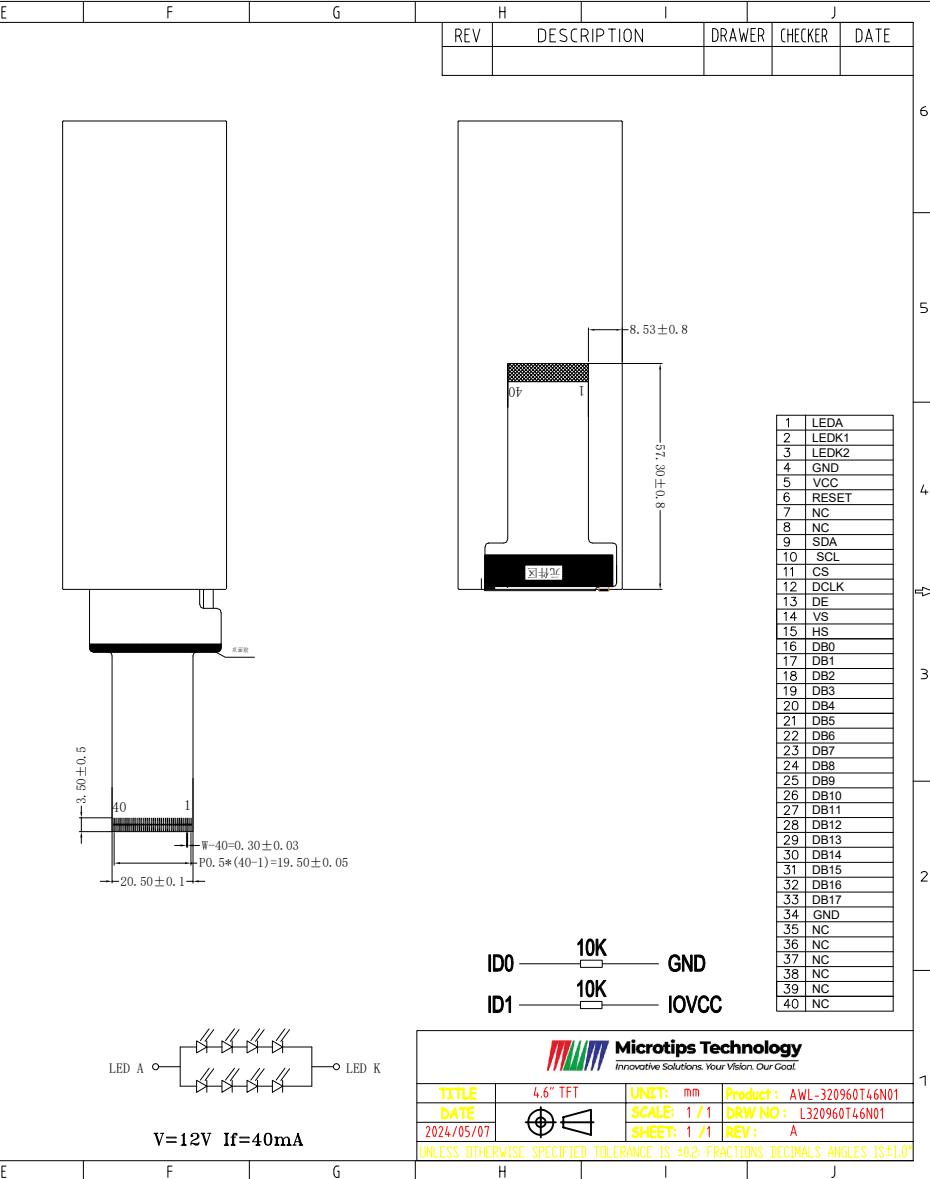
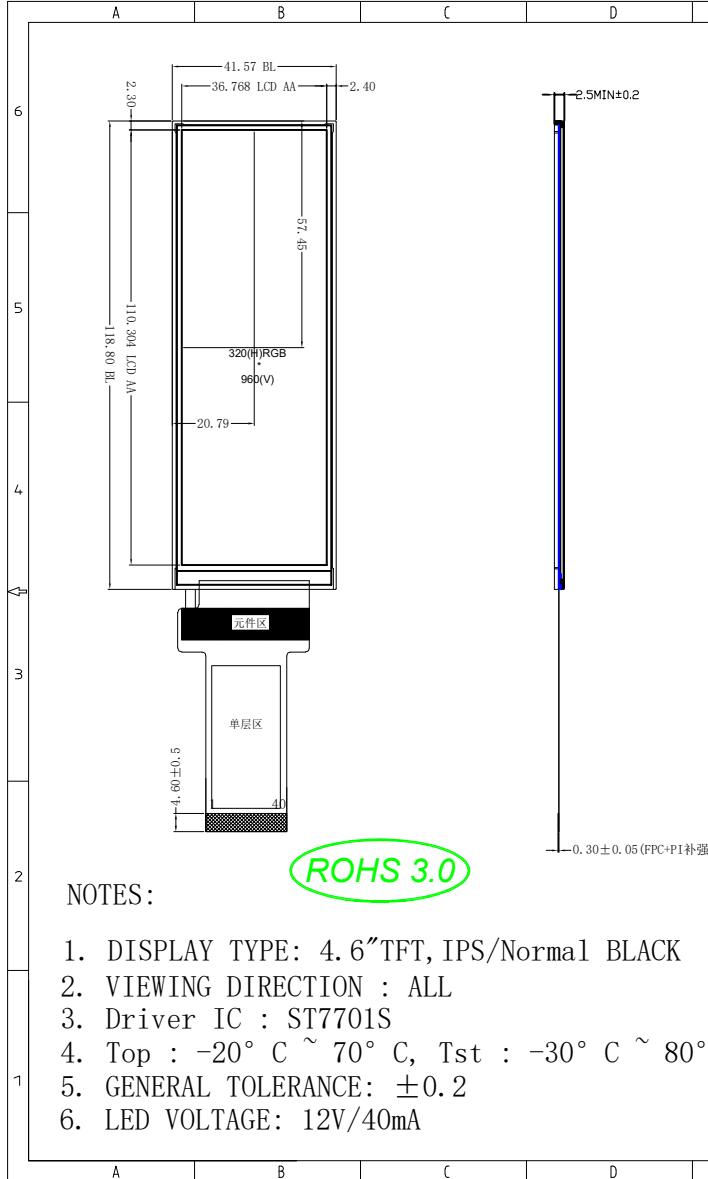
This specification defines general provisions as well as inspection standards for TFT module supplied by Microtips Technology. If the event of unforeseen problem or unspecified items may occur, naturally shall negotiate and agree to solution

1. 2. General Information

Item	Standard Values	Units
LCD type	4.6''TFT	--
Dot arrangement	320 (H)×960(V)	dots
Color filter array	RGB vertical stripe	--
Display mode	IPS / Normally Black	-
Eyes Viewing Direction	ALL	--
Driver IC	ST7701S	--
Module size	41.57(W)×118.80(H)×2.50(T)	mm
Active area	36.768(W)×110.304(H)	mm
Dot pitch	0.1149x0.1149	mm
Interface	SPI+RGB (666) 18bit	--
Operating temperature	-20 ~ +70	°C
Storage temperature	-30 ~ +80	°C
Back Light	8 White LEDS	--
Weight	TBD	g

3. External Dimensions

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4. Interface Description

PIN NO.	PIN NAME	DESCRIPTION
1	LED+	LED backlight (Anode).
2	LEDK-	LED backlight (Cathode).
3	LEDK-	LED backlight (Cathode).
4	GND	Power ground
5	VDD	Digital Power +3.3V
6	RSTB	Reset input pin
7~8	NC	Not Connect
9	SDA	Serial in/out signal pin.
10	SCL	Serial interface clock pin.
11	CS	Chip select input pin.
12	DCLK	Dot clock signal for RGB interface operation
13	DE	Data enable signal for RGB interface operation.
14	VS	Frame synchronizing signal for RGB interface operation.
15	HS	Line synchronizing signal for RGB interface operation.
16~33	DB0~DB17	RGB data input pin.
34	GND	Power ground
35	NC	Not Connect
36	NC	Not Connect
37	NC	Not Connect
38	NC	Not Connect
39	NC	Not Connect
40	NC	Power ground

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5. Absolute Maximum Ratings

Item	Symbol	Min.	Max.	Unit
Power supply voltage	VDD	-0.3	3.6	V
Operating Temperature	TOP	-30	85	°C
Storage Temperature	TST	-30	85	°C
Storage Humidity	HD	20	90	%RH

6. DC Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Power supply voltage	VDD	2.8	3.3	3.6	V	-
Power supply Current	IVDD	-	30	-	mA	-
Input High Voltage	V _{IH}	0.7VDD	-	VDD	V	-
Input Low Voltage	V _{IL}	GND	-	0.3VDD	V	-
Output High Voltage	V _{OH}	0.8VDD	-	VDD	V	-
Output Low Voltage	V _{OL}	GND	-	0.2VDD	V	-
I/O Leak Current	I _{LI}	-0.1	-	1	uA	-

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7. Timing Characteristics

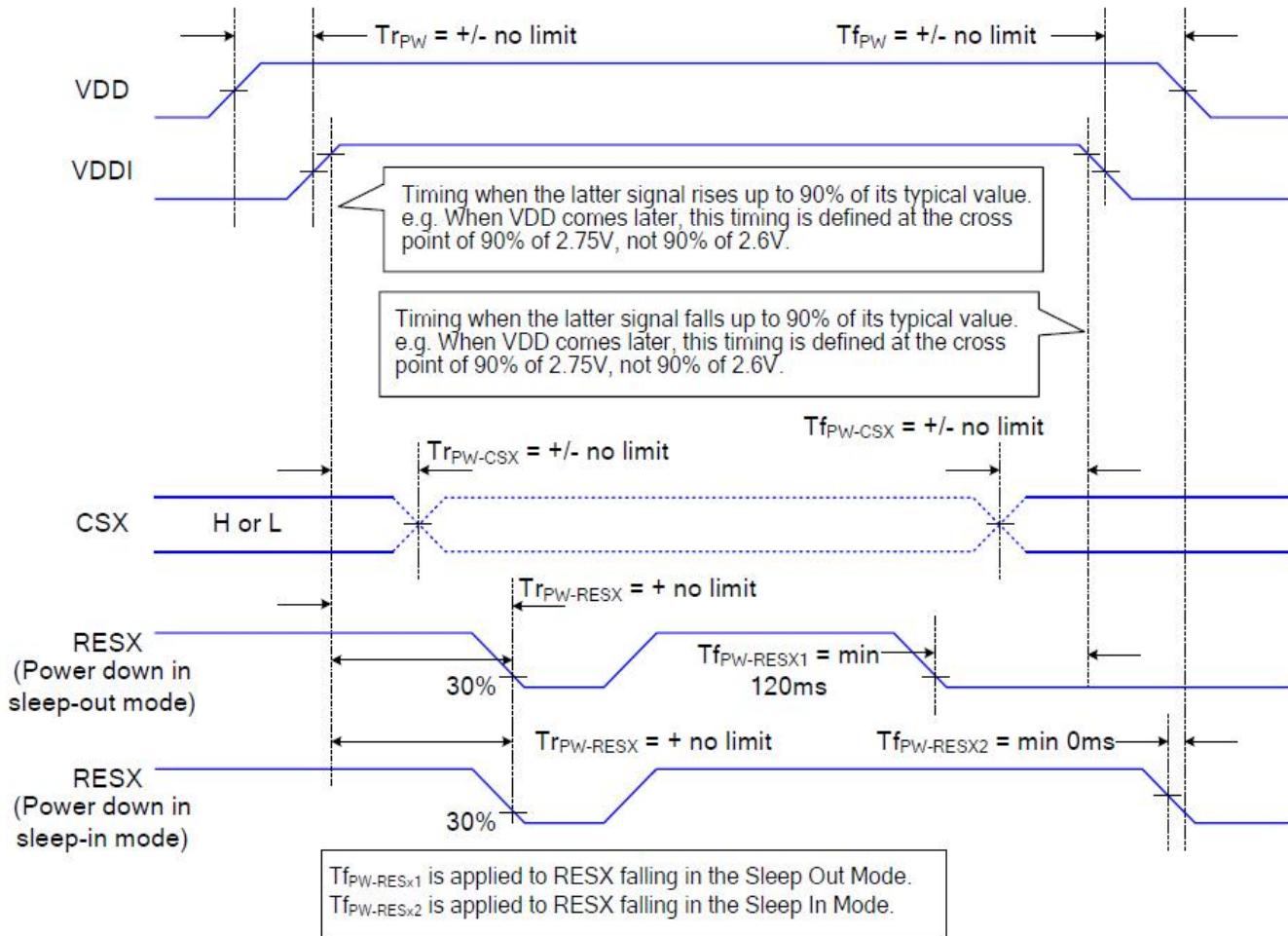
7.1. Power ON/OFF Sequence

VDDI and VDDA can be applied or powered down in any order. During the Power Off sequence, if the LCD is in the Sleep Out mode, VDDA and VDDI must be powered down with minimum 120msec. If the LCD is in the Sleep In mode, VDDA and VDDI can be powered down with minimum 0msec after the RESX is released. CSX can be applied at any timing or can be permanently grounded. RESX has high priority over CSX.

Notes:

1. There will be no damage to the ST7701 if the power sequences are not met.
2. There will be no abnormal visible effects on the display panel during the Power On/Off Sequences.
3. There will be no abnormal visible effects on the display between the end of Power On Sequence and before receiving the Sleep Out command, and also between receiving the Sleep In command and the Power Off Sequence.
4. If the RESX line is not steadily held by the host during the Power On Sequence as defined in Sections 9.1 and 9.2, then it will be necessary to apply the Hardware Reset (RESX) after the completion of the Host Power On Sequence to ensure correct operations. Otherwise, all the functions are not guaranteed.

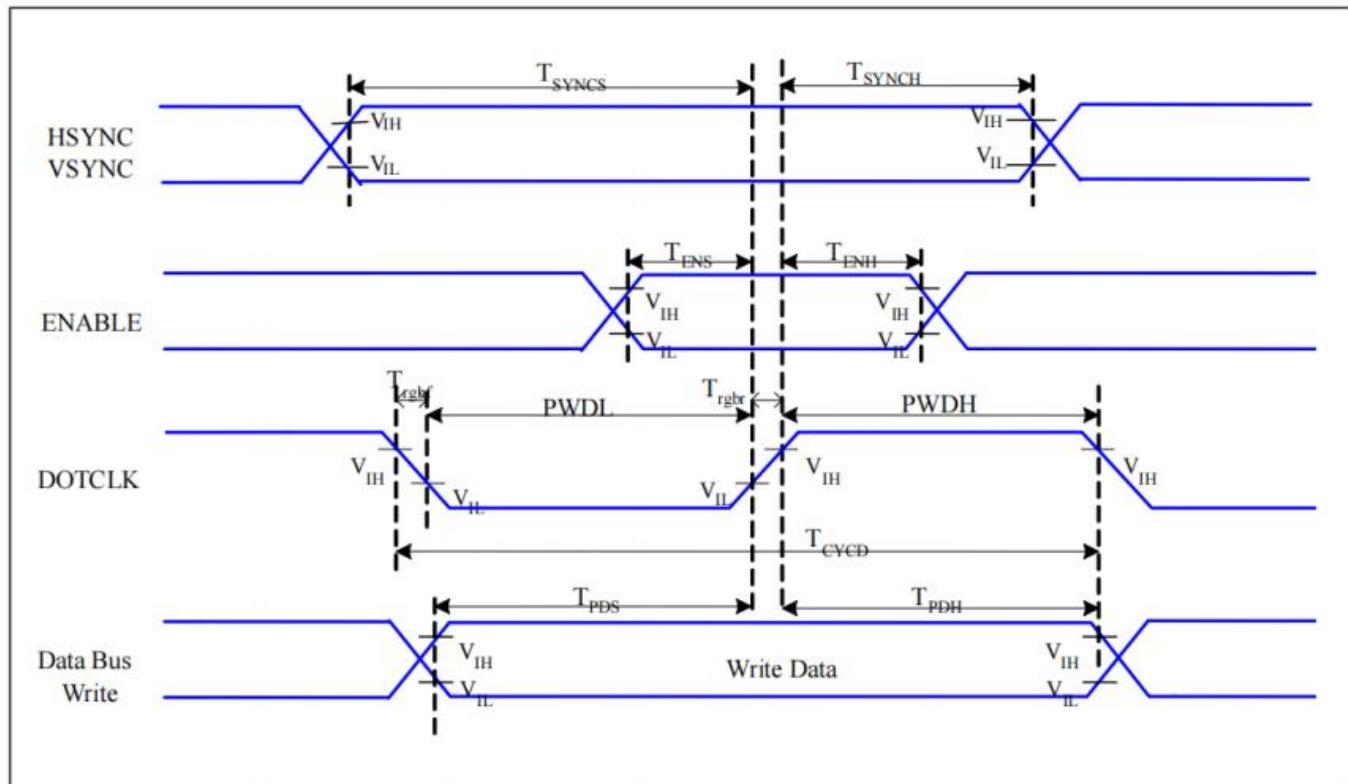
The power on/off sequence is illustrated below



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7.2 AC Characteristics

RGB Interface Characteristics

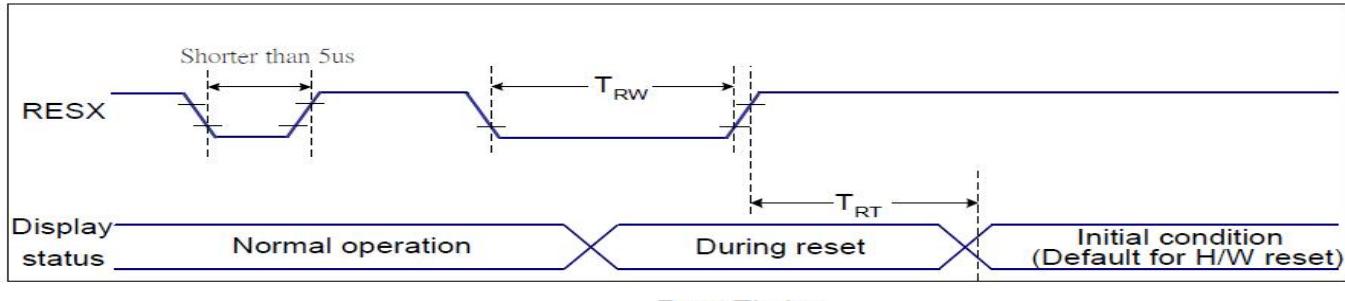


$VDDI=1.8, VDD=2.8, AGND=DGND=0V, Ta=25^{\circ}C$

Signal	Symbol	Parameter	MIN	MAX	Unit	Description
HSYNC, VSYNC	T_{SYNCS}	VSYNC, HSYNC Setup Time	5	-	ns	
ENABLE	T_{ENS}	Enable Setup Time	5	-	ns	
	T_{ENH}	Enable Hold Time	5	-	ns	
DOTCLK	T_{PWDH}	DOTCLK High-level Pulse Width	15	-	ns	
	T_{PWDL}	DOTCLK Low-level Pulse Width	15	-	ns	
	T_{CYCD}	DOTCLK Cycle Time	33	-	ns	
	T_{rgbf}, T_{rghf}	DOTCLK Rise/Fall time	-	15	ns	
DB	T_{PDS}	PD Data Setup Time	5	-	ns	
	T_{PDH}	PD Data Hold Time	5	-	ns	

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7.3 Reset Timing Characteristics



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

Reset Timing

Notes:

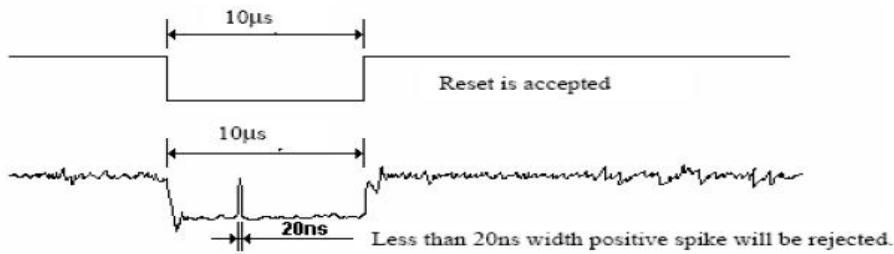
1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time (TRT) within 5 ms after a rising edge of RESX.

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

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

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

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



5. When Reset applied during Sleep In Mode.

6. When Reset applied during Sleep Out Mode.

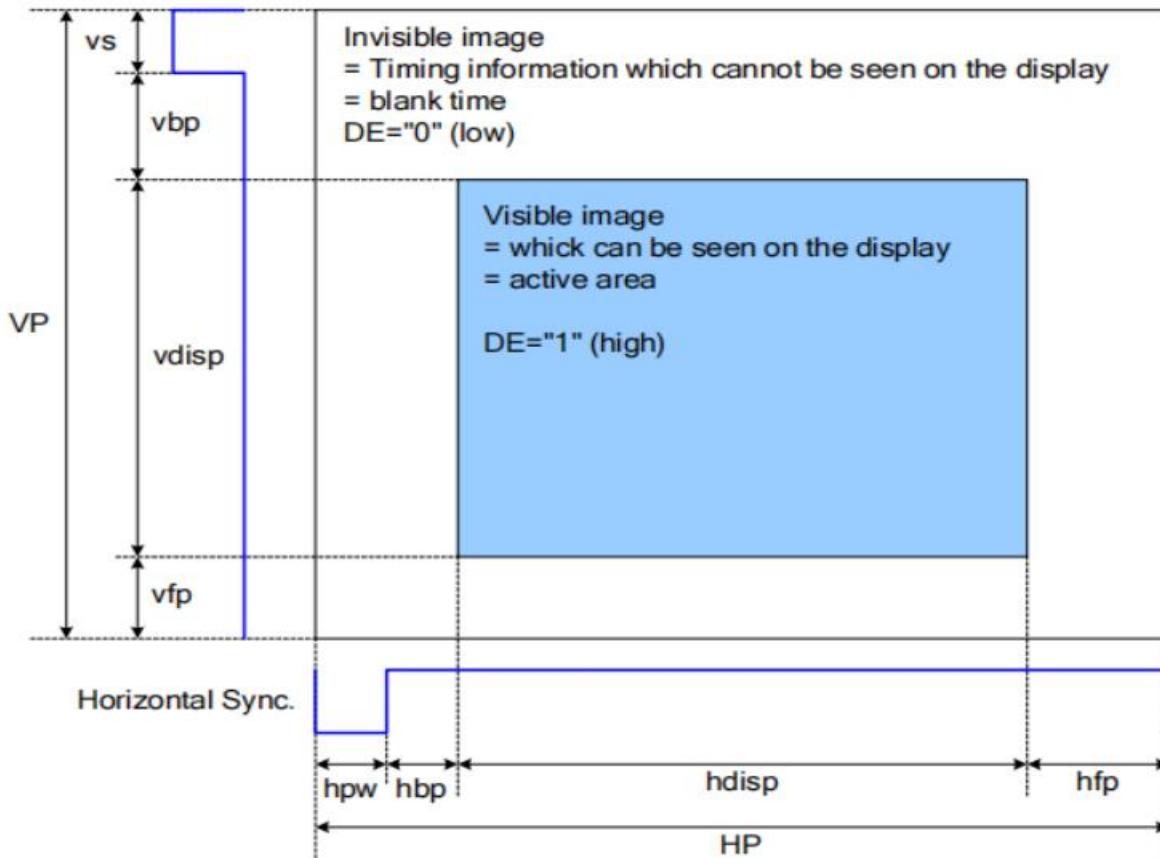
7. It is necessary to wait 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec.

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7.4 RGB Interface Definition

The display operation via the RGB interface is synchronized with the VSYNC, HSYNC, and DOTCLK signals. The data can be written only within the specified area with low power consumption by using window address function. The back porch and front porch are used to set the RGB interface timing.

Vertical Sync.



Please refer to the following table for the setting limitation of RGB interface signals.

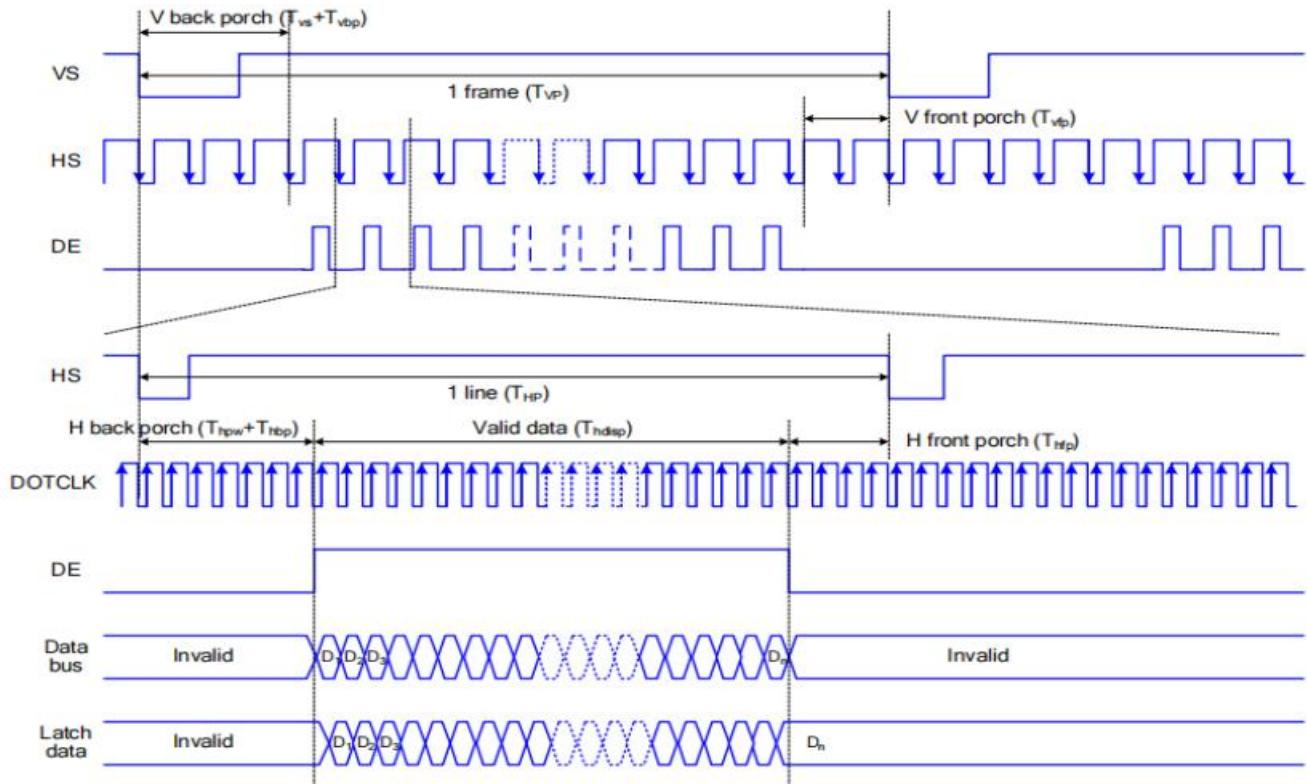
Parameter	Symbol	Min.	Typ.	Max.	Unit
Horizontal Sync. Width	hbw	2	-	255 (Note 2)	Clock
Horizontal Sync. Back Porch	hbp	2	--	255 (Note 2)	Clock
Horizontal Sync. Front Porch	hfp	2	--	-	Clock
Vertical Sync. Width	vs	2	--	254 (Note 2)	Line
Vertical Sync. Back Porch	vbp	2	--	254 (Note 2)	Line
Vertical Sync. Front Porch	vfp	2	--	--	Line

Note:

1. Typical value are related to the setting frame rate is 60Hz..
2. VS+VBP<=254, HPW+HBP<=255

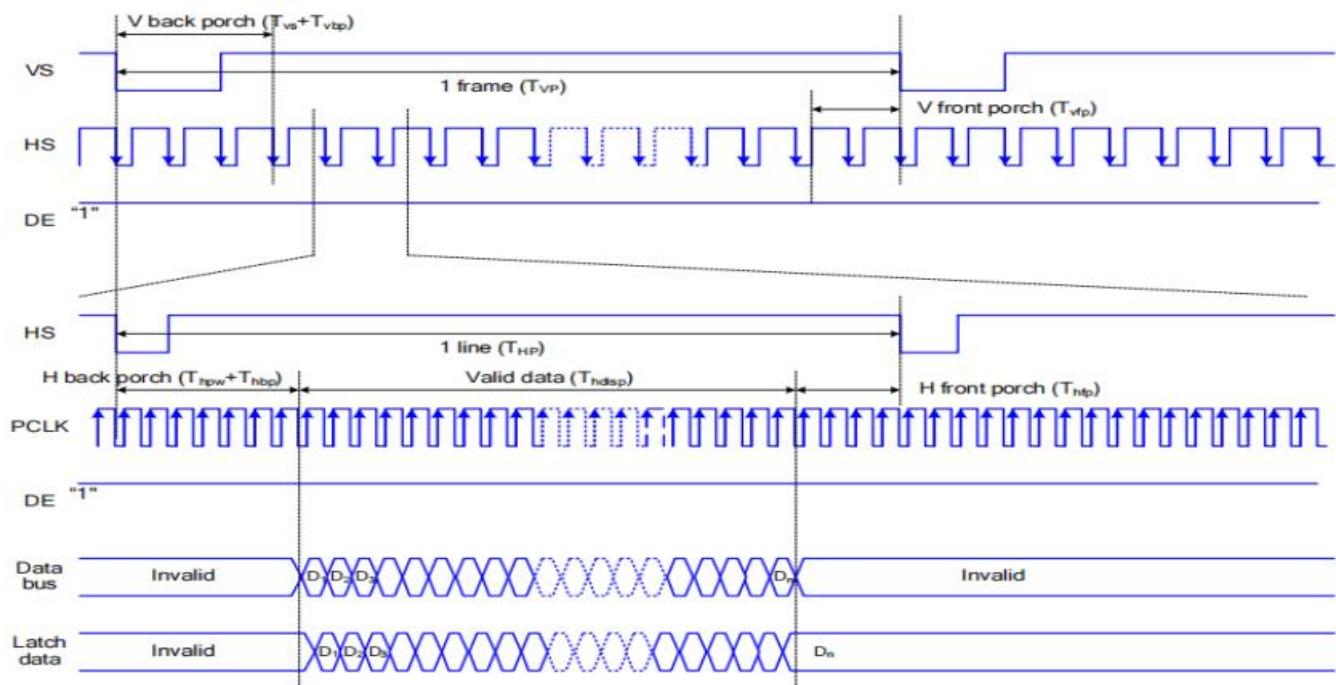
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7.5 RGB Interface Timing



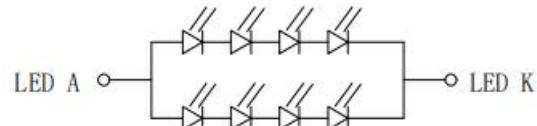
Note: The setting of front porch and back porch in host must match that in IC as this mode.

The timing chart of RGB interface HV mode is shown as follows.



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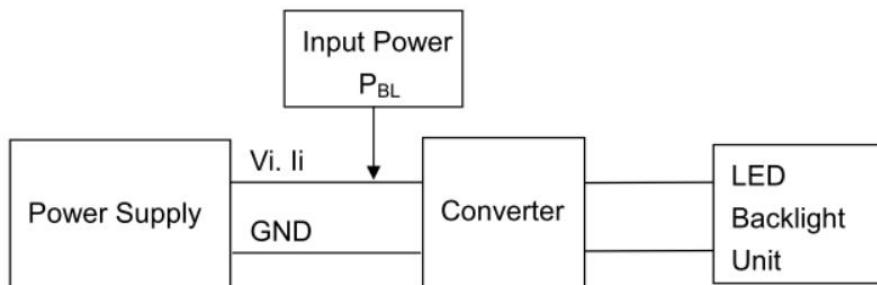
8. Backlight Characteristic



Item	Symbol	MIN	TYP	MAX	UNIT	Remark
Supply Voltage	Vf	10.4	12	14	V	Note 1
Supply Current	If	-	40	-	mA	Note 2
Life Time	-	25000	-	-	Hr	Note 3,4
Backlight Color						White

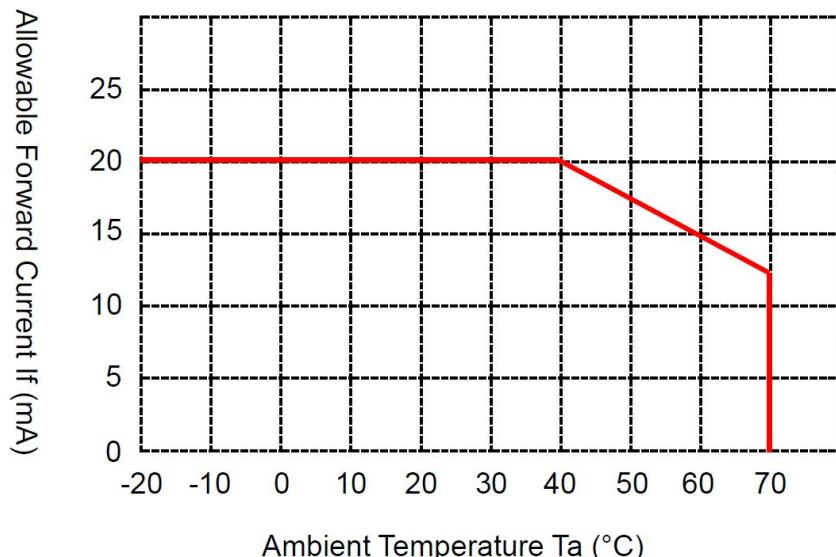
Note 1: The LED Supply Voltage is defined by the number of LED at $T_a=25^{\circ}\text{C}$ and $If = 40\text{mA}$.

Note 2: LED current is measured by utilizing a high frequency current meter as shown below:



Note 3: The "LED life time" is defined as the module brightness decrease to 50% original brightness at $T_a=25^{\circ}\text{C}$ and $If = 40\text{mA}$. The LED lifetime could be decreased if operating If is larger than 40mA .

Note 4: LED light bar circuit:

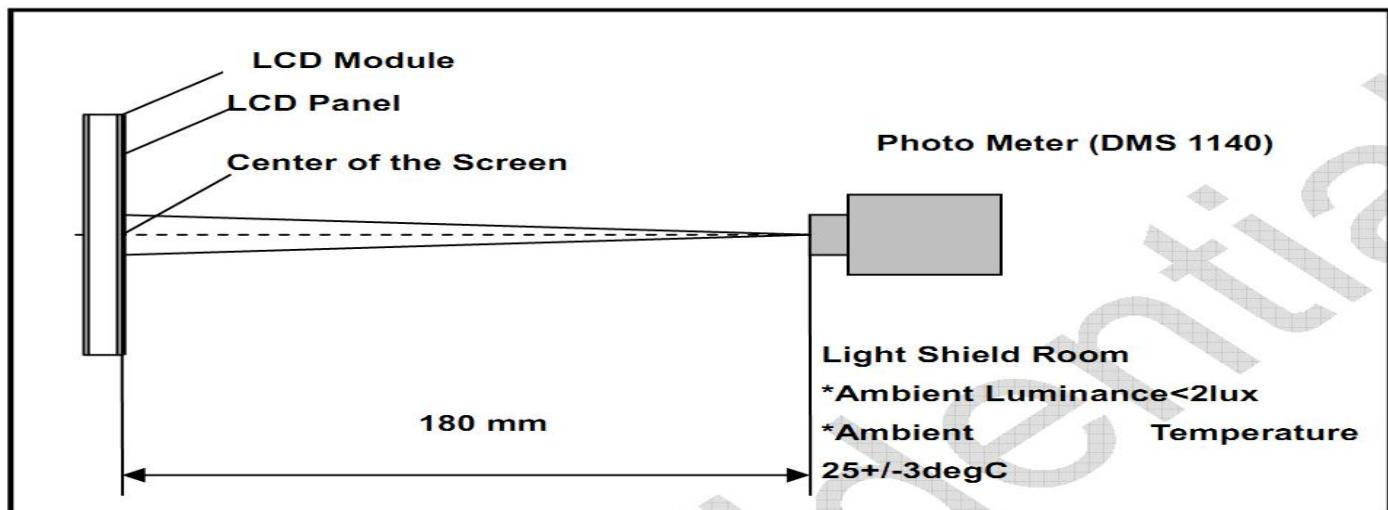


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9. Optical Characteristics

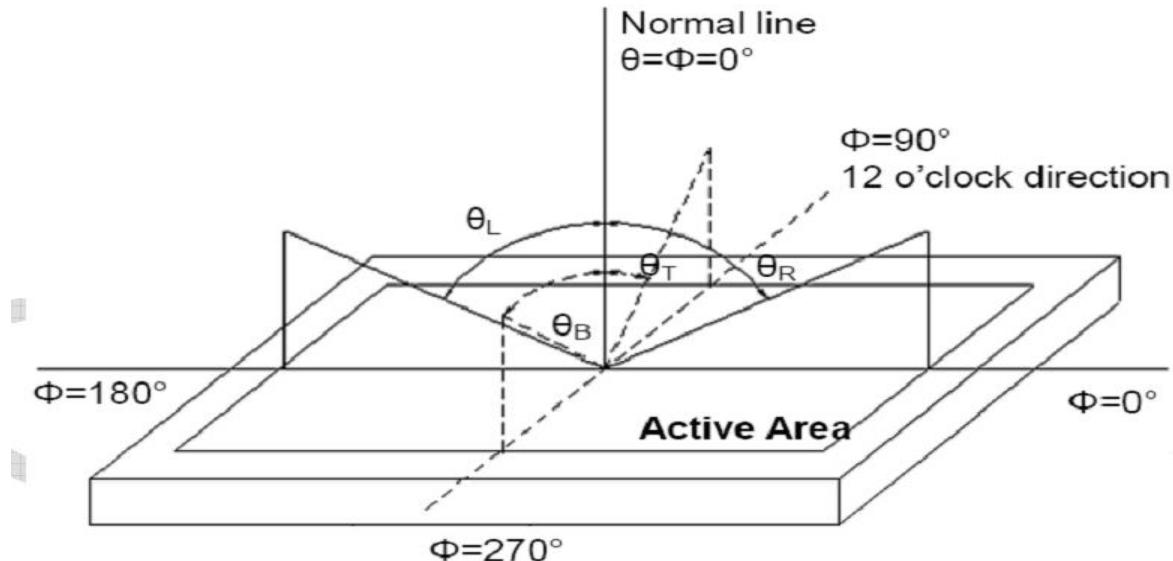
Item	Conditions	Min.	Typ.	Max.	Unit	Note
Viewing Angle (CR>10)	Horizontal	θL	-	80	degree	(1),(2),(6)
		θR	-	80		
	Vertical	θT	-	80		
		θB	-	80		
Luminous Intensity for LCM	-	260	300	-	cd/m ²	If=40mA
Uniformity for LCM	-	80	-	-	%	If=40mA
Contrast Ratio	Center	1000	1200	-	1000	(1),(3),(6)
Response Time	Rising	-	25	35	ms	(1),(4),(6)
	Falling	-	25	35		
CF Color Chromaticity (CIE1931)	White x	0.252	0.302	0.352		(1), (6)
	White y	0.269	0.319	0.369		
	Red x	0.540	0.590	0.640		
	Red y	0.297	0.347	0.397		
	Green x	0.290	0.340	0.390		
	Green y	0.531	0.581	0.631		
	Blue x	0.103	0.153	0.203		
	Blue y	0.054	0.104	0.154		

Note (1) Measurement Setup: The LCD module should be stabilized at given temp. 25°C for 15 minutes to avoid abrupt temperature change during measuring. In order to stabilize the luminance, the measurement should be executed after lighting backlight for 15 minutes in a windless room.



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Note (2) Definition of Viewing Angle



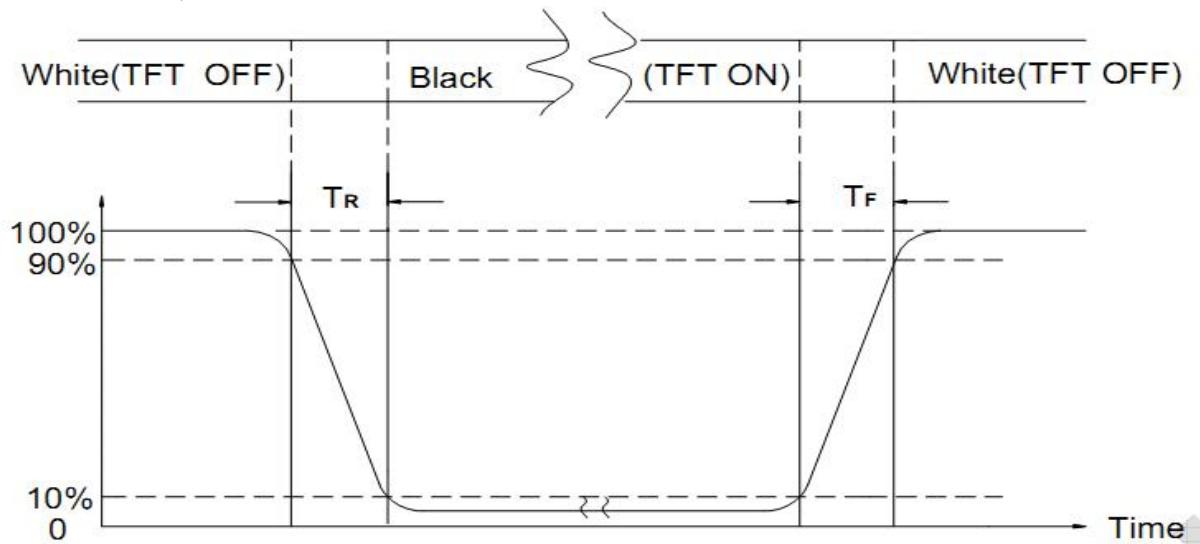
Note (3) Definition of Contrast Ratio (CR)

The contrast ratio can be calculated by the following expression

$$\text{Contrast Ratio (CR)} = L_{255} / L_0$$

L_{255} : Luminance of gray level 255, L_0 : Luminance of gray level 0

Note (4) Definition of response time



Note (5) Definition of Transmittance (Module is without signal input)

$$\text{Transmittance} = \text{Center Luminance of LCD} / \text{Center Luminance of Back Light} \times 100\%$$

Note (6) Definition of color chromaticity (CIE1931)

Color coordinates measured at the center point of LCD

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10. Reliability Test Conditions and Methods

No.	Test Items	Test Condition	Inspection After Test
1	High Temperature Storage	85°C±2°C×96Hours	
2	Low Temperature Storage	-30°C±2°C×96Hours	
3	High Temperature Operating	85°C±2°C×96Hours	
4	Low Temperature Operating	-30°C±2°C×96Hours	
5	Temperature Cycle(Storage)	$ \begin{array}{c} -20^{\circ}\text{C} \xleftarrow{(30\text{min})} 25^{\circ}\text{C} \xleftarrow{(5\text{min})} 60^{\circ}\text{C} \\ \xleftarrow{1\text{cycle}} \qquad \qquad \qquad \text{Total 10cycle} \end{array} $	
6	Damp Proof Test (Storage)	50°C±5°C×90%RH×96Hours	Inspection after 2~4hours storage at room temperature, the samples should be free from defects: 1, Air bubble in the LCD. 2, Seal leak. 3, Non-display. 4, Missing segments. 5, Glass crack. 6, Current IDD is twice higher than initial value. 7, The surface shall be free from damage. 8, The electric characteristic requirements shall be satisfied.
7	Vibration Test	Frequency:10Hz~55Hz~10Hz Amplitude:1.5mm X,Y,Z direction for total 3hours (packing condition test will be tested by a carton)	
8	Drooping Test	Drop to the ground from 1M height one time every side of carton. (packing condition test will be tested by a carton)	
9	ESD Test	Voltage:±6KV,R:330Ω,C:150PF,Air Mode,10times	
10	Image Sticking Test	$25 \pm 2^{\circ}\text{C}$ Operation with test pattern sustained for 2 hrs, then change to gray pattern immediately. After 5 mins, the mura must be disappeared completely  	

REMARK:

- 1, The Test samples should be applied to only one test item.
- 2, Sample side for each test item is 5~10pcs.
- 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, EL evaluation should be accepted from reliability test with humidity and temperature: Some defects such as black spot/blemish can happen by natural chemical reaction with humidity and Fluorescence EL has.
- 6, Failure Judgment Criterion: Basic Specification Electrical Characteristic, Mechanical Characteristic, Optical Characteristic.

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11. Inspection Standard

11.1 Scope

Specifications contain

11.1.1 Display Quality Evaluation

11.1.2 Mechanics Specification

11.2 Sampling Plan

Unless there is other agreement, the sampling plan for incoming inspection shall follow MIL-STD-105E.

11.2.1 Lot size: Quantity per shipment as one lot (different model as different lot).

11.2.2 Sampling type: Normal inspection, single sampling.

11.2.3 Sampling level: Level II.

11.2.4 AQL: Acceptable Quality Level

Major defect: AQL=0.65

Minor defect: AQL=1.5

11.3 Panel Inspection Condition

11.3.1 Environment:

Room Temperature: $25\pm5^{\circ}\text{C}$.

Humidity: $65\pm5\%$ RH.

Illumination: 300 ~ 700 Lux.

11.3.2 Inspection Distance:

35 ± 5 cm

11.3.3 Inspection Angle:

The vision of inspector should be perpendicular to the surface of the Module.

11.3.4 Inspection time:

Perceptibility Test Time: 20 seconds max.

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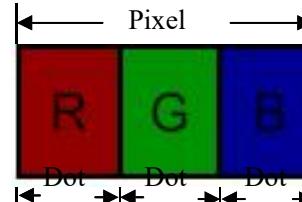
11.4 Inspection Plan

Class	Item	Judgment	Class
Packing & Indicate	1. Outside and inside package.	"MODEL NO.", "LOT NO." and "QUANTITY" should indicate on the package.	Minor
	2. Model mixed and quantity.	Other model mixed Quantity short or over	Major
	3. Product indication.	"MODEL NO." should indicate on the product.	Major
Assembly	4. Dimension, LCD glass scratch and scribe defect.	According to specification or drawing.	Major
Appearance	5. Viewing area.	Polarizer edge or LCD's sealing line is visible in the viewing area.....Rejected.	Minor
	6. Blemish, black spot, white spot in the LCD and LCD glass cracks.	According to standard of visual inspection.(inside viewing area)	Minor
	7. Blemish, black spot, white spot and scratch on the polarizer.	According to standard of visual inspection.(inside viewing area)	Minor
	8. Bubble in polarizer.	According to standard of visual inspection.(inside viewing area)	Minor
	9. LCD's rainbow color.	Strong deviation color (or newton ring) of LCD.....Rejected. Or according to limited sample.(if needed, and inside viewing area)	Minor
Electrical	10. Electrical and optical characteristics.(contrast chromaticity....etc)	According to specification or drawing.(inside viewing area)	Major
	11. Missing line.	Missing dot line character	Major
	12. Short circuit. Wrong pattern display.	No display, wrong pattern display, current consumption. Out of specification	Major
	13. Dot defect.(for color and TFT)	According to standard of visual Inspection.	Minor

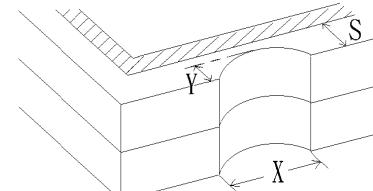
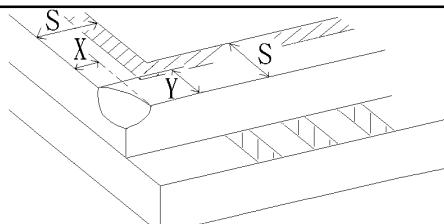
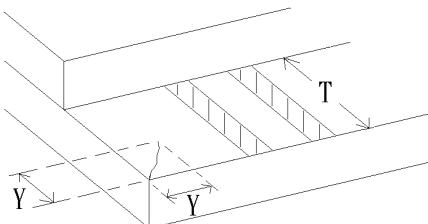
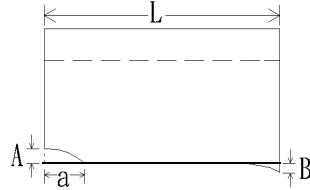
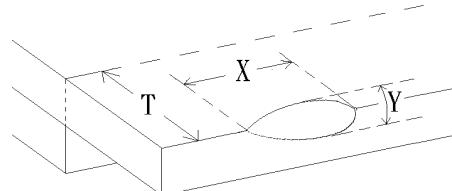
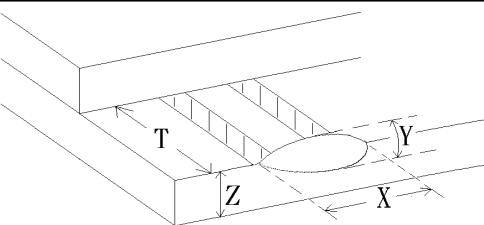
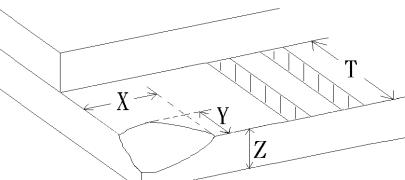


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11.5 Standard Of Visual Inspection

No.	Class	Item	Judgment																					
11.5.1	Minor	Black and white spot. Foreign materiel. Dust. Blemish. Scratch.	(A) Round type: Unit: mm <table border="1"> <tr><td>Diameter (mm.)</td><td>Acceptable Q'ty</td></tr> <tr><td>$\Phi \leq 0.2$</td><td>Disregard</td></tr> <tr><td>$0.2 < \Phi \leq 0.25$</td><td>3(Distance>5mm)</td></tr> <tr><td>$0.25 < \Phi$</td><td>0</td></tr> </table> Note: $\Phi = (\text{length}+\text{width})/2$ (B) Linear type: Unit: mm <table border="1"> <tr><td>Length</td><td>Width (mm.)</td><td>Acceptable Q'ty</td></tr> <tr><td>--</td><td>$W \leq 0.03$</td><td>Disregard</td></tr> <tr><td>$L \leq 5.0$</td><td>$0.03 < W \leq 0.07$</td><td>2(Distance>5mm)</td></tr> <tr><td>--</td><td>$0.07 < W$</td><td>FOLLOW ROUND TYPE</td></tr> </table>		Diameter (mm.)	Acceptable Q'ty	$\Phi \leq 0.2$	Disregard	$0.2 < \Phi \leq 0.25$	3(Distance>5mm)	$0.25 < \Phi$	0	Length	Width (mm.)	Acceptable Q'ty	--	$W \leq 0.03$	Disregard	$L \leq 5.0$	$0.03 < W \leq 0.07$	2(Distance>5mm)	--	$0.07 < W$	FOLLOW ROUND TYPE
Diameter (mm.)	Acceptable Q'ty																							
$\Phi \leq 0.2$	Disregard																							
$0.2 < \Phi \leq 0.25$	3(Distance>5mm)																							
$0.25 < \Phi$	0																							
Length	Width (mm.)	Acceptable Q'ty																						
--	$W \leq 0.03$	Disregard																						
$L \leq 5.0$	$0.03 < W \leq 0.07$	2(Distance>5mm)																						
--	$0.07 < W$	FOLLOW ROUND TYPE																						
11.5.2	Minor	Dent on polarizer.	Unit: mm. <table border="1"> <tr><td>Diameter</td><td>Acceptable Q'ty</td></tr> <tr><td>$\Phi \leq 0.2$</td><td>Disregard</td></tr> <tr><td>$0.2 < \Phi \leq 0.5$</td><td>2(Distance>5mm)</td></tr> <tr><td>$0.5 < \Phi$</td><td>0</td></tr> </table>		Diameter	Acceptable Q'ty	$\Phi \leq 0.2$	Disregard	$0.2 < \Phi \leq 0.5$	2(Distance>5mm)	$0.5 < \Phi$	0												
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11.5.3	Minor	Bubble in polarizer.	Unit: mm. <table border="1"> <tr><td>Diameter</td><td>Acceptable Q'ty</td></tr> <tr><td>$\Phi \leq 0.2$</td><td>Disregard</td></tr> <tr><td>$0.2 < \Phi \leq 0.5$</td><td>2(Distance>5mm)</td></tr> <tr><td>$0.5 < \Phi$</td><td>0</td></tr> </table>		Diameter	Acceptable Q'ty	$\Phi \leq 0.2$	Disregard	$0.2 < \Phi \leq 0.5$	2(Distance>5mm)	$0.5 < \Phi$	0												
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11.5.4	Minor	Dot defect	<table border="1"> <tr><td>Items</td><td>Acceptable Q'ty</td></tr> <tr><td>Bright dot</td><td>$N \leq 2$(Distance>5mm)</td></tr> <tr><td>Dark dot</td><td>$N \leq 2$(Distance>5mm)</td></tr> <tr><td>Total dot</td><td>$N \leq 4$</td></tr> </table> Pixel define :  Note1: The definition of dot: The size of a defective dot over 1/2 of whole dot is regarded as one defective dot. Note 2: Bright dot: Dots appear bright and unchanged in size in which LCD panel is displaying under black pattern. Note 3: The bright dot defect must be visible through 2% ND filter Note 4: Dark dot: Dots appear dark and unchanged in size in which LCD panel is displaying under pure red, green, blue pattern.		Items	Acceptable Q'ty	Bright dot	$N \leq 2$ (Distance>5mm)	Dark dot	$N \leq 2$ (Distance>5mm)	Total dot	$N \leq 4$												
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Dark dot	$N \leq 2$ (Distance>5mm)																							
Total dot	$N \leq 4$																							
11.5.5	Minor	Mura	ND 5% (In 50% gray screen)																					

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No.	Class	Item	Judgment		
11.5.6	Minor	LCD glass chipping.		Y>S	Reject
11.5.7	Minor	LCD glass chipping.		X or Y>S	Reject
11.5.8	Major	LCD glass crack.		Y>(1/2)T	Reject
11.5.9	Major	LCD glass scribe defect.		1. a>L/3, A>1.5mm 2. B : According to dimension	Reject
11.5.10	Minor	LCD glass chipping. (on the terminal area)		$\Phi = (x+y)/2>2.5mm$	Reject
11.5.11	Minor	LCD glass chipping. (on the terminal surface)		Y>(1/3)T	Reject
11.5.12	Minor	LCD glass chipping.		Y>T	Reject

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12. Handling Precautions

12.1 Mounting Method

The LCD panel of MTUSATFT module consists of two thin glass plates with polarizers which easily be damaged. And since the module is so constructed as to be fixed by utilizing fitting holes in the printed circuit board.

Extreme care should be needed when handling the LCD modules.

12.2 Caution of LCD Handling And Cleaning

When cleaning the display surface, Use soft cloth with solvent

[Recommended below] and wipe lightly

- Isopropyl alcohol
- Ethyl alcohol

Do not wipe the display surface with dry or hard materials that will damage the polarizer surface.

Do not use the following solvent:

- Water
- Aromatics

Do not wipe ITO pad area with the dry or hard materials that will damage the ITO patterns

Do not use the following solvent on the pad or prevent it from being contaminated:

- Soldering flux
- Chlorine (Cl) , Sulfur (S)

If goods were sent without being silicon coated on the pad, ITO patterns could be damaged due to the corrosion as time goes on.

If ITO corrosion happen by miss-handling or using some materials such as Chlorine (Cl), Sulfur (S) from customer, Responsibility is on customer.

12.3 Caution Against Static Charge

The LCD module use C-MOS LSI drivers, so we recommended that you:

Connect any unused input terminal to power or ground, do not input any signals before power is turned on, and ground your body, work/assembly areas, and assembly equipment to protect against static electricity.

12.4 Packing

- Module employs LCD elements and must be treated as such.
- Avoid intense shock and falls from a height.
- To prevent modules from degradation, do not operate or store them exposed direct to sunshine or high temperature/humidity

12.5 Caution for operation

It is an indispensable condition to drive LCD's within the specified voltage limit since the higher

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- voltage then the limit cause the shorter LCD life.
- An electrochemical reaction due to direct current causes LCD's undesirable deterioration, so that the use of direct current drive should be avoided.
- Response time will be extremely delayed at lower temperature then the operating temperature range and on the other hand at higher temperature LCD's have dark color in them. However those phenomena do not mean malfunction or out of order with LCD's, which will come back in the specified operation temperature.
- If the display area is pushed hard during operation, some font will be abnormally displayed but it resumes normal condition after turning off once.
- Slight dew depositing on terminals is a cause for electro-chemical reaction resulting in terminal open circuit. Usage under the maximum operating temperature, 50%RH or less is required.

12.6 Storing

In the case of storing for a long period of time for instance, for years for the purpose or replacement use, the following ways are recommended.

- Storage in a polyethylene bag with the opening sealed so as not to enter fresh air outside in it. And with no desiccant.
- Placing in a dark place where neither exposure to direct sunlight nor light's keeping the storage temperature range.
- Storing with no touch on polarizer surface by the anything else.

[It is recommended to store them as they have been contained in the inner container at the time of delivery from us

12.7 Safety

- It is recommendable to crush damaged or unnecessary LCD's into pieces and wash off liquid crystal by either of solvents such as acetone and ethanol, which should be burned up later.
- When any liquid leaked out of a damaged glass cell comes in contact with your hands, please wash it off well with soap and water

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13. Precaution for Use

13.1

A limit sample should be provided by the both parties on an occasion when the both parties agreed its necessity. Judgment by a limit sample shall take effect after the limit sample has been established and confirmed by the both parties.

13.2

On the following occasions, the handing of problem should be decided through discussion and agreement between responsible of the both parties.

- When a question is arisen in this specification
- When a new problem is arisen which is not specified in this specifications
- When an inspection specifications change or operating condition change in customer is reported to Microtips TFT , and some problem is arisen in this specification due to the change
- When a new problem is arisen at the customer's operating set for sample evaluation in the customer site.

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