



Typical Design



# Industrial Solutions Flatpanel Technology

## DESIGN FOR TFT COLOR LCD MODULE

Design No.	dah113_150
Revision	Rev. 3.1
Type	15" 1024 x 768
Specification	
Version	Internal Revision 1.0
Date	02.10.2008
Preliminary <input checked="" type="checkbox"/>	
Final <input type="checkbox"/>	

This typical design can be used to manufacture dedicated products at i-sft according to the mentioned specification without additional NRE cost.  
 Please send us a RFQ for this design and stating the number of displays to be build. We will send a formal quote including a final specification. With your formal order please also send a written approval of the final specification.  
 No further activities will start before formal order is processed and written approval of final specification is in!



Typical Design

# Liquid Crystal Display Design

I-SFT dah113\_150



Revision	Date	Description
1.0	23.08.05	First Draft
2.0	15.12.07	BLU revision
3.0	09.04.08	Interface LVDS; glare polarizer
3.1	02.10.08	new e <sup>3</sup> driver revision



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## 1 DESCRIPTION

**i-sft dah113\_150** is a custom specific development based module and is not available on the open market.

**i-sft dah113\_150** is a TFT(thin film transistor) active matrix color liquid crystal display (LCD) comprising of amorphous silicon TFT attached to each signal electrode, a driving circuit.

**i-sft dah113\_150** is an **i-sft** GmbH in-house design consisting of:

- a. **i-sft** specific third party manufactured LCD-Glass-Matrix (NOT available in retail).
- b. **i-sft** customized backlight emitting a display surface brightness typ. 1600 nits.
- c. **i-sft** custom made integrated e<sup>3</sup> driver to control the backlight.

This model is composed of a TFT LCD panel, a driver circuit and a backlight system.

The 15" display has a resolution of 1024 x 768 pixels and can display up to 256k colours. 12 o'clock direction is the optimum viewing angle.

## 2 FEATURES

- High brightness 1600 cd/m<sup>2</sup>
- Extended temperature range
- Integrated e<sup>3</sup> driver for driving backlight
- High contrast ratio, high aperture structure
- XGA (1024 x 768 pixels) resolution
- Low power consumption
- e<sup>3</sup> long life system
- 1ch LVDS interface

## 3 APPLICATIONS

Monitors for industrial use only



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## 4 STRUCTURE AND FUNCTIONS

A TFT colour LCD module comprises a TFT LCD panel and LSIs for driving the liquid crystal. The TFT LCD panel is composed of a TFT array glass substrate superimposed on a colour filter glass substrate with liquid crystal filled in the narrow gap between two substrates.

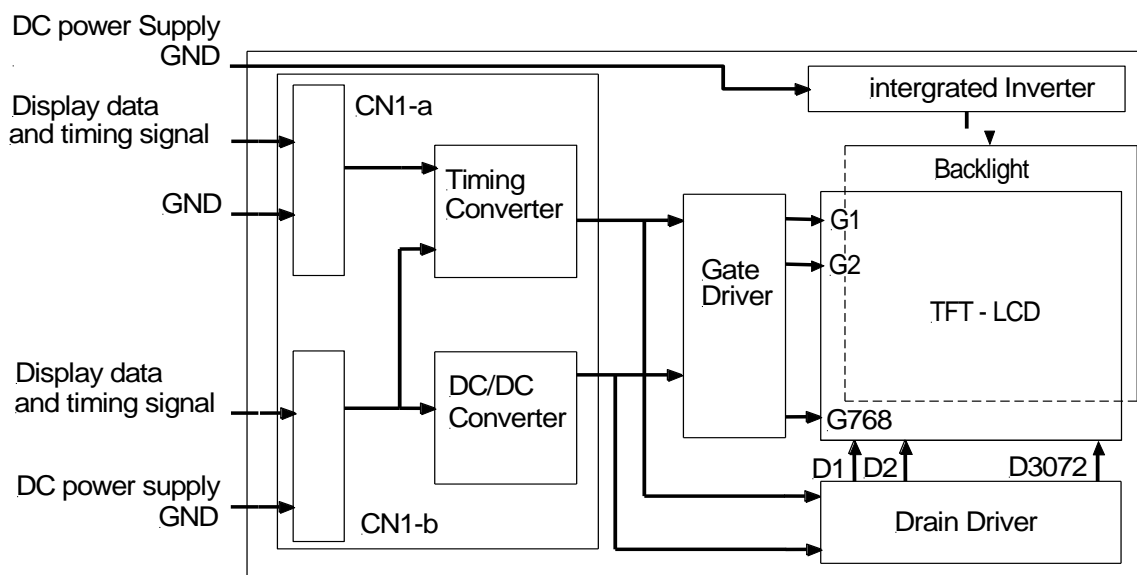
RGB (Red, Green, Blue) data signals are sent through a signal processor to the LCD panel drivers after modulation into suitable forms for active matrix addressing.

Each of the liquid crystal cells acts as an electro-optical switch that controls the incident light transmission. The liquid crystal cell is driven by a signal applied to the TFT switch.

## 5 OUTLINE OF CHARACTERISTICS

ITEM	SPECIFICATION	UNIT	NOTE
Active display area	304.1 (H) x 228.1 (V) (15 inch diagonal)	mm	
Driver element	a – Si TFT active matrix		
Display colours	256k		
Number of pixels	1024 x 768	pixel	
Luminance (typ.)	1600	cd/m <sup>2</sup>	
Dimming ratio	1 : 1000		
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.297 (H) x 0.297 (W)	mm	
Display mode	Normally White		
Surface treatment	glare, hard - coating (3H)		

## 6 BLOCK DIAGRAM





## 7 SPECIFICATIONS

### 7-1 GENERAL SPECIFICATIONS

ITEM		TYP.	UNIT
Module size	Horizontal (H)	353.7	mm
	Vertical (V)	264.8	mm
	Depth (D)	26.4	mm
Weight		2230	g

### 7-2 ABSOLUTE MAXIMUM RATINGS

ITEM	SYMBOL	MIN.	MAX.	UNIT	NOTE
Storage temperature	$T_{STG}$	-25	70	°C	(1)
Operating temperature (Surface of glass)	$T_{OPR}$	-10	60	°C	(1)
Shock (operating)	$S_{nop}$	-	35	g	(2)*
Vibration (operating)	$V_{nop}$	-	3	g	(3)*

\*target specification

#### Note

(1) measured at center of display area (front side); no condensation

(2) 6 ms.

(3) 5 – 2000 Hz



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### 7-3 ELECTRICAL ABSOLUTE RATINGS

#### TFT LCD MODULE

V<sub>ss</sub>=0V

ITEM	SYMBOL	MIN.	MAX.	UNIT	NOTE
Power supply voltage	VDD	0	4	V	
Input signal voltage for logic	V <sub>I</sub>	-0.2	VDD+0.2	V	(1)
Electrostatic durability	VESDO	± 100		V	(2), (3)
	VESD1	± 8		KV	(2), (4)

#### Notes

- (1) The specification shall be applied to pixel data signal and clock signal
- (2) Discharge circuit to be connected: 200 pF – 0 Ω, Environmental: 25°C – 70% RH
- (3) The specification shall be applied to I/F connector pins are subjected
- (4) The specification shall be applied to the surface of both a metal bezel and a LCD panel.



**7-4 ELECTRICAL CHARACTERISTIC**

TFT LCD MODULE

Ta=25±2°C

ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT	NOTE
Power supply voltage	VDD	3.0	3.3	3.6	V	
Power supply current	IDD	-	400	650	mA	(2) ; (3)
VSYNC Frequency	fV	-	60	-	Hz	(4) ; (5)
HSYNC Frequency	fH	-	48.3	-	kHz	(4)
DCLK Frequency	fCLK	60	65	68	MHz	(4)
Differential Input Voltage for LVDS Receiver Threshold	ViL	- 100	-	-	mV	(1)
	ViH	-	-	+ 100		

Note

(1) VCM=+1.25V

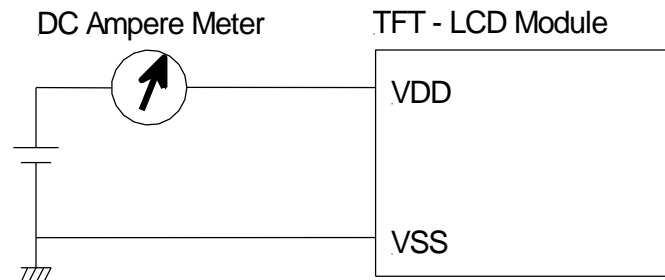
VCM is common mode voltage of LVDS transmitter/receiver.

The input terminal of LVDS transmitter is terminated with 100Ω.

(2) fV=60 Hz, fCLK=65 MHz, VDD=3.3 V, DC current.

Typical value is measured when displaying vertical 64 gray scale.

Maximum is measured when displaying vertical-stripe (black-gray 7)



(3) As this module contains 0.8A fuse, prepare current source that is enough for cutting current fuse when a trouble happens. (larger than 2.0A)

(4) For LVDS Transmitter Input

(5) Vertical frequency is encouraged to be used by 60Hz. The flicker level changes by the gap of the vertical frequency.



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# Liquid Crystal Display Design

I-SFT dah113\_150



e<sup>3</sup> driver

Ta=25±2°C

ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT	NOTE
Power supply voltage	V <sub>inv</sub>	23.5	24	25.5	V	
Power consumption	P <sub>inv</sub>	-	40	-	W	



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### 7-5 INTERFACE PIN CONNENCTION

TFT LCD MODULE (Interface Signal & Power)

Connector: LVDS DF13-30DP-1.25V, Matching Socket: LVDS DF13-30DS-1.25C

Pin No.	Symbol	Description	Note
1	VDD	Power supply (3.3V)	(2)
2			
3	VSS	Ground (0V)	(1)
4			
5	IN0-	Pixel Data	
6	IN0+	Pixel Data	
7	VSS	GND (0V)	(1)
8	IN1-	Pixel Data	
9	IN1+	Pixel Data	
10	VSS	GND (0V)	(1)
11	IN2-	Pixel Data	
12	IN2+	Pixel Data	
13	VSS	GND (0V)	(1)
14	CLK IN-	clock	
15	CLK IN+	clock	
16	VSS	GND (0V)	(1)
17			
18			
19			
20			

Note

- (1) All VSS pins should be connected to GND(0V). Metal bezel is connected internally to VSS.
- (2) All VDD pins should be connected to +3.3V



**7-6 DISPLAY COLOUR vs. INPUT DATA SIGNAL**

Input		Red Data								Green Data								Blue Data															
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0								
Color		MSB				LSB				MSB				LSB				MSB				LSB											
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Magenda	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Red	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (1)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (2)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	Red (254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	Green (254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	Blue (2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
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	Blue (254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Blue (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0

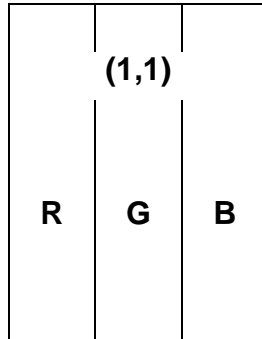
Notes 1) Definition of gray scale:

Color(n) .... Number in parenthesis indicates gray scale level. Larger n corresponds to brighter level.

2) Data: 1: 0:  
High, Low

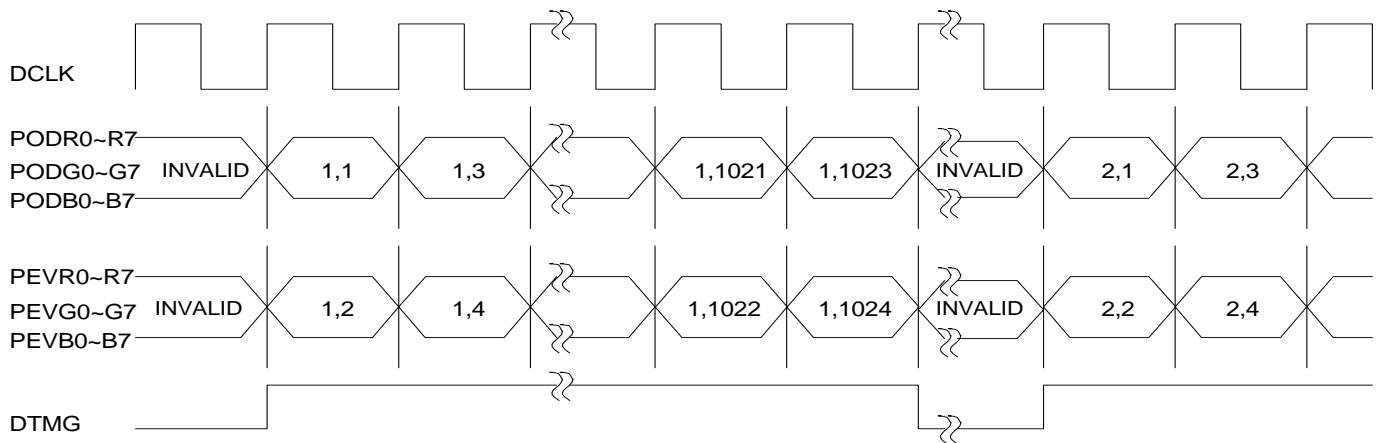
## 7-7 INPUT SIGNAL TIMING

### (1) RELATIONSHIP BETWEEN INPUT DATA AND SCREEN IMAGE

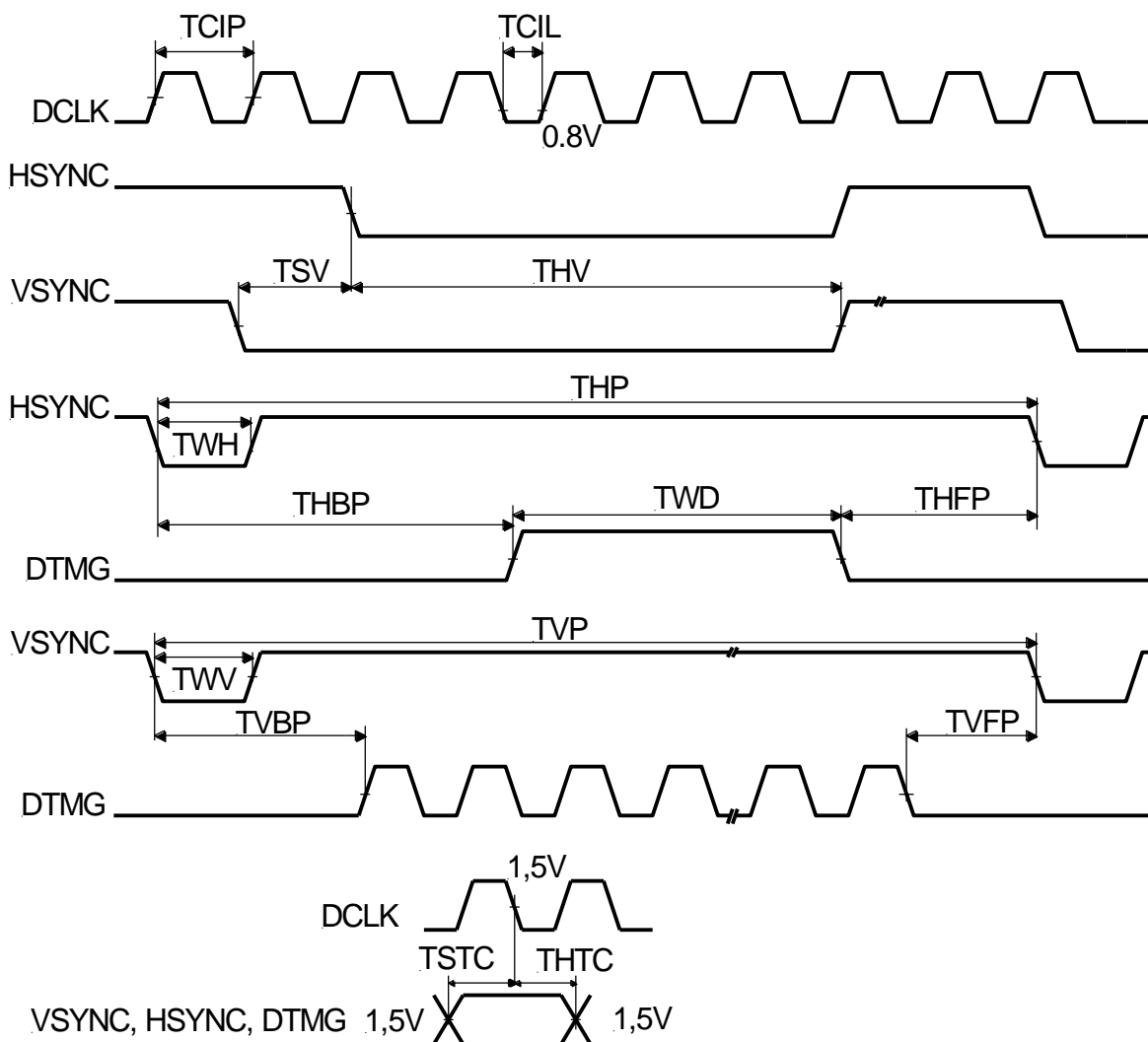


Pixel: PEVR0~R7 : R data  
 PODR0~R7 : R data  
 PEVG0~G7 : G data  
 PODG0~G7 : G data  
 PEVB0~B7 : B data  
 POVB0~B7 : B data

1,1	1,2	1,3		1,1024
2,1	2,2	2,3		2,1024
3,1	3,2	3,3		3,1024
768,1	768,2	768,3		768,1024



**(2) TIMING DIAGRAMS OF INTERFACE SIGNAL**



PEVRO ~ R7, PEVG ~ G7, PEVB0 ~ B7, PEVR0 ~ R7, PODG0 ~ G7, PODB0 ~ B7

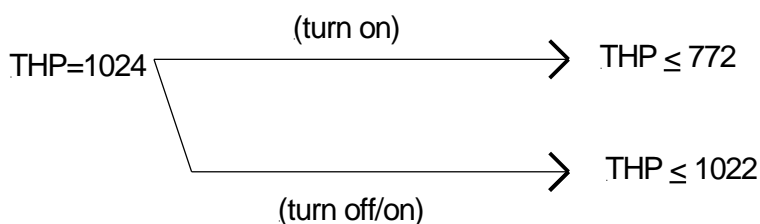
Notes

- (1) Reference level for each timing signal is 1.5V unless it is stated on the chart, high level voltage (VIH) and low level voltage (VIL) are defined as follows:  

$$V_{IH} \geq 2.0 \text{ V} \quad V_{IL} \leq 0.8 \text{ V}$$
- (2) HSYNC, VSYNC timing is specified in negative polarity.
- (3) HSYNC pulse is need while data is invalid (blanking period)

## 7-8 TIMING PARAMETERS

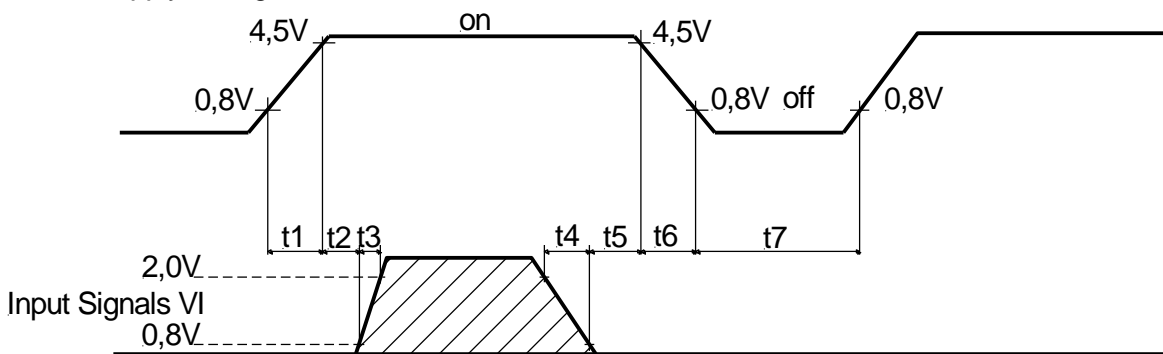
- (1)  $THBP + THFP \leq 260 TCIP$
- (2)  $TVBP + TVFP \leq 232 THP$
- (3)  $fV = 1/TVP \leq 75 \text{ HZ}$
- (4)  $fH = 1/THP \leq 60.24 \text{ kHz}$
- (5) When  $THP = 1024$  comes, display does not work.  
In this case, the following procedure is recommended.



- (6) 16 of 28 is used data transfer a new FCA system.

## 7-9 SUPPLY VOLTAGE SEQUENCE

Power Supply Voltage VDD



$$t1 \leq 40 \text{ ms}$$

$$0 \text{ ms} < t2 \leq 50 \text{ ms}$$

$$0 \text{ ms} < t3 \leq 3 \text{ ms}$$

$$ms < t4 \leq 3 \text{ ms}$$

$$0 \text{ ms} < t5 \leq 50 \text{ ms}$$

$$0 \text{ ms} < t6 \leq 1 \text{ s}$$

$$t7 \geq 0.2 \text{ s}$$

Power ON OFF

Notes



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- (1) Set  $0V \leq VI(t) \leq VDD(t)$   
Here,  $VI(t)$ ,  $VDD(t)$  indicate the transitive state of  $VI$ ,  $VDD$  when power supply is turned ON or OFF.
- (2) Do not keep interface signal high-impedance when power ON.



## 7-10 OPTICAL CHARACTERISTICS

Measuring equipment:

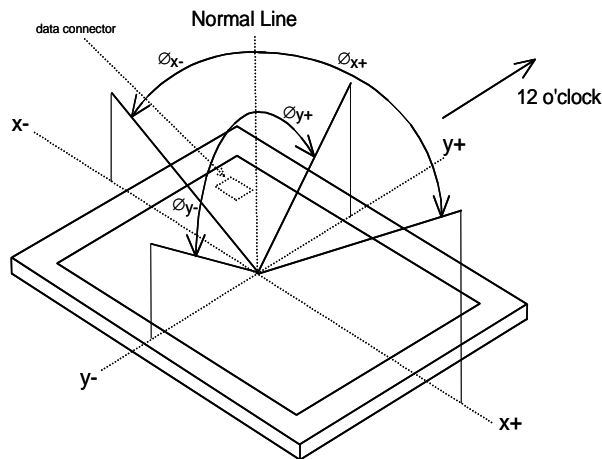
Luminance: TOPCON BM-7  
Viewing Angle, Contrast: ELDIM EZContrast 160D  
Colour Gamut: ELDIM MURA

TA = 25°C ± 2°C, VDD = 5 V, fv = 60 Hz, fV = 60 Hz

Parameter	Symbol	Condition	Min	Typ	Max	Unit	Remark	
Viewing Angle	Horizontal	$\varnothing_{x+}$	CR>10, $\varnothing_{y} = \pm 0^\circ$	-	70	-	deg.	(1), (4)
		$\varnothing_{x-}$	CR>10, $\varnothing_{y} = \pm 0^\circ$	-	70	-	deg.	
	Vertical	$\varnothing_{y+}$	CR>10, $\varnothing_{x} = \pm 0^\circ$	-	60	-	deg.	
		$\varnothing_{y-}$	CR>10, $\varnothing_{x} = \pm 0^\circ$	-	70	-	deg.	
Contrast ratio	CR	$\varnothing_{y} = -10^\circ$ , $\varnothing_{x} = \pm 0^\circ$	-	800:1	-	-	(1), (2), (4)	
Response time	$T_R$	rising	-	30	-	ms	(1), (3)	
	$T_F$	falling	-	-	-	-		
Luminance (center of screen)	Lw	at center v(abs)	-	1700	-	cd/m <sup>2</sup>	(1), (4)	
		at center v( $\lambda$ )	-	1600	-	-		
Dimming range	DR		-	1000:1	-	-	(4)	
Colour gamut	C	PAL	-	76	-	%		
	C	CCIR601	-	55	-	%		

Note

(1) Definition of viewing angle



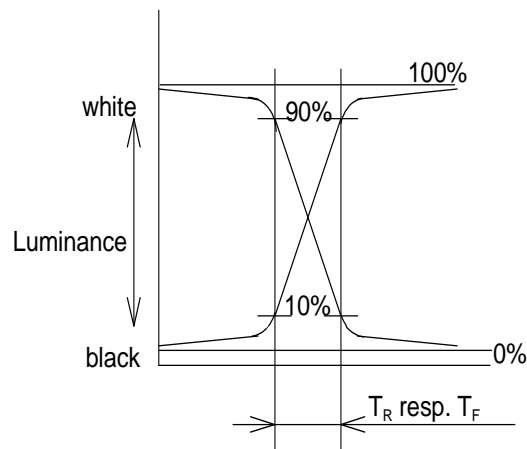
- (2) The contrast ratio is calculated by using the following formula:

$$\text{Contrast ratio} = \frac{\text{Brightness (Luminance) with all pixels in "White"}}{\text{Brightness (Luminance) with all pixels in "Black"}}$$

The brightness is measured in a darkroom.

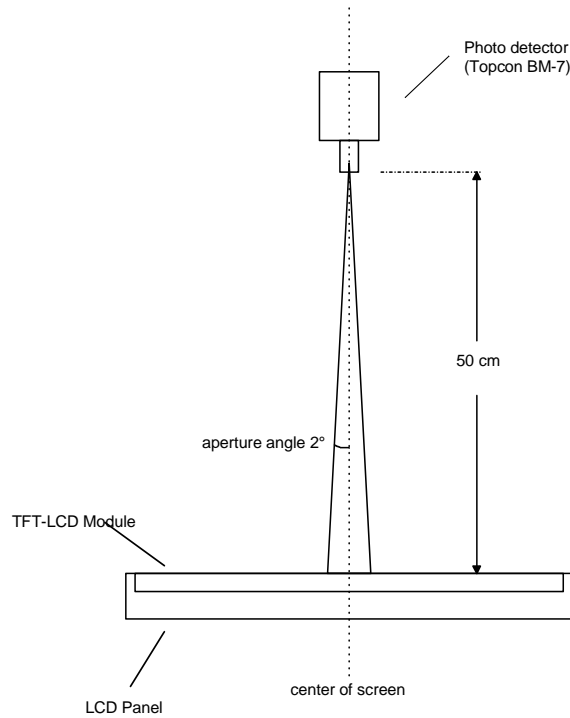
- (3) Definition of the response time:

Photodetector output signal is measured when the brightness changes from "white" to "black" or "black" to "white", respectively. The response time is the time between 10% and 90% of the photodetector output.



(4) Brightness measurements setup

The measurements should be executed in a dark room 30 min. after lightning the backlight. Matrix: off state. The brightness is measured at the centre of the screen. Environment condition:  $T = 25 \pm 2 \text{ }^\circ\text{C}$ . It has to be assured that a sufficient heat flow / air circulation is given





## 7-11 e<sup>3</sup> DRIVER SPECIFICATION

### PIN CONNECTION

Connector: JST S8B-PH-SM3-TBc

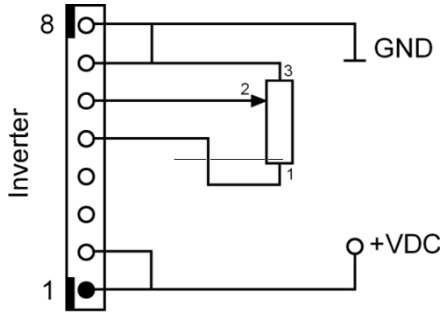
Corresponding connector: housing JST PHR-8, contacts JST SPH-002T-P0.5S

Pin #	Description	value
1	Supply voltage for e <sup>3</sup> driver (1)	typ. 24 VDC
2	Supply voltage for e <sup>3</sup> driver (1)	typ. 24 VDC
3	Factory use only <b>(Do not connect an external signal!)</b>	
4	Remote on / off Digital dimming	GND -> off not connected -> on
5	Reference current output for dimming with variable resistor (2)	typ. 2.5 mA
6	Analog dimming input (2)	0 – 2.5 VDC
7	Ground (1)	GND
8	Ground (1)	GND

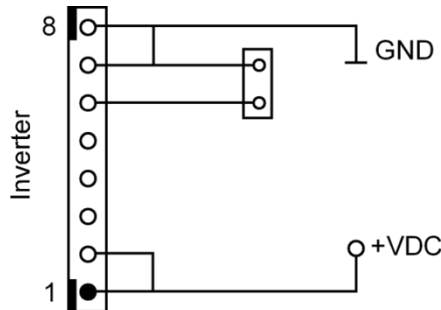
#### Note

- (1) For connecting use both pin 1 and 2 parallel and pin 7 and 8 parallel
- (2) For the dimming a 1K $\Omega$  variable resistor is required. The wires to use from the loose end of the connector are 5, 6 and 7.

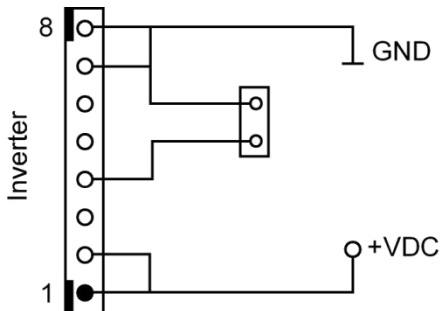
1) Dimming with variable resistor (pin 7: 0 V)



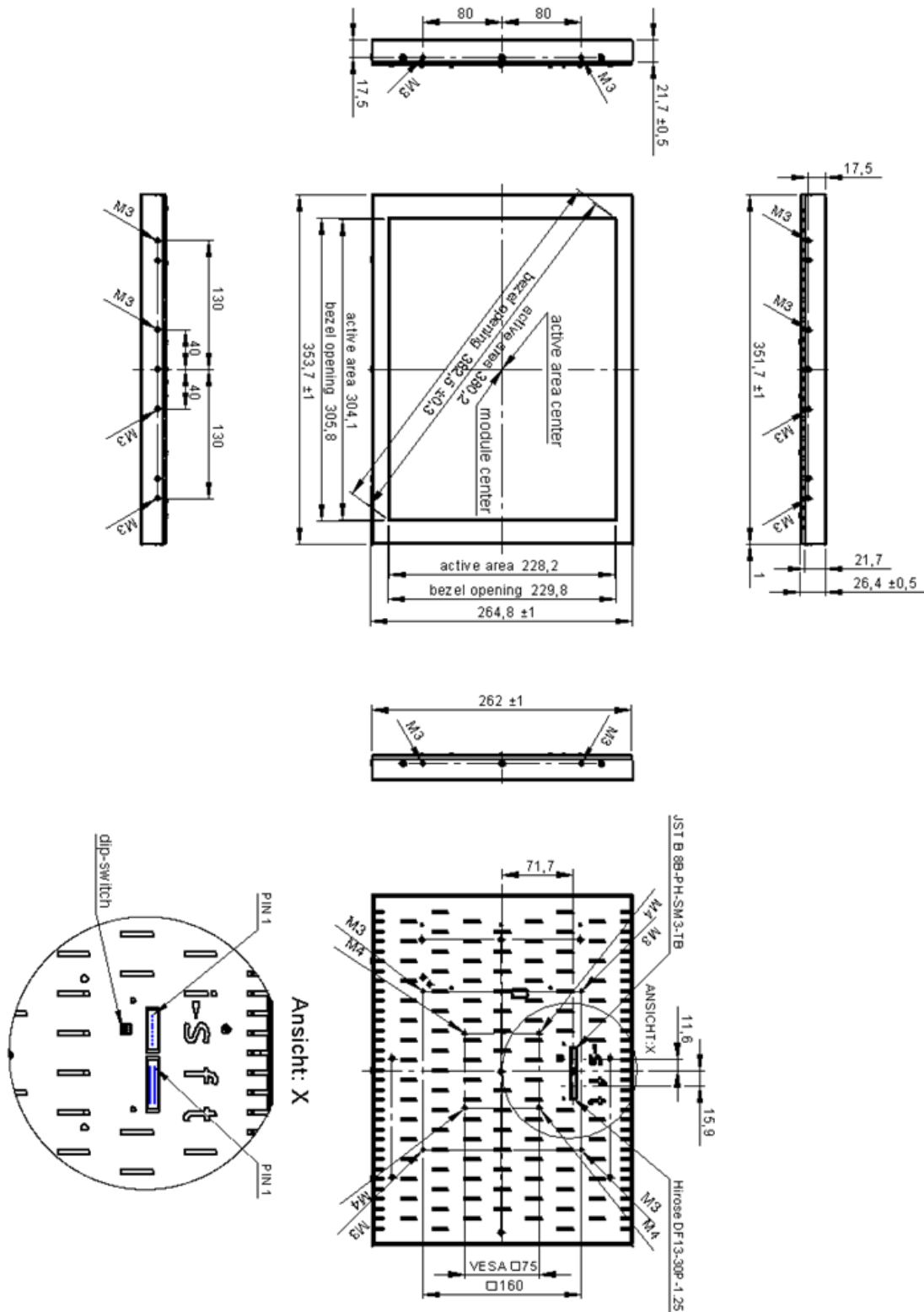
2) Dimming with variable analog DC voltage. Variable voltage 0 to 2.5 VDC (pin 7: 0 V)



3) Digital dimming with PWM control 0 to 100% PWM, PWM 200 – 1000 Hz; TTL-Level (pin 7: 0 V)



**7-12 OUTLINE DIMENSION**



tolerances in DIN ISO 2768 T1 class m

**7-13 DEFECT SPECIFICATIONS**

a) Inspection conditions

Distance : the distance between the inspector's eye and the LCD panel is 20cm.

Illumination : the distance between a 20-W fluorescent lamp and the LCD panel is 25-30 cm.

Temperature : Room temperature is 25C°±5C°.

Viewing angle:

Display specifications :  $-20^\circ \leq \theta_x \leq +20^\circ$ ,  $0^\circ \leq \theta_y \leq +20^\circ$

Appearance specifications:  $-45^\circ \leq \theta_x \leq +45^\circ$ ,  $-45^\circ \leq \theta_y \leq +45^\circ$

Measuring light conditions: Lamp: Cold Cathode Fluorescent Lamp

Chromaticity coordinates (x = 0.320, y = 0.325) typ.

Luminance of backlight surface for inspection: 1200 cd/m<sup>2</sup>

b) Display specifications

Item	Specifications			
Line defect	Not allowed			
Luminous dots *1	Color	Brightness	Distance between same color dots	Quantity
	Red, Green	F + H	-	R + G ≤ 6
		F	-	R ≤ 6, G ≤ 3
	Blue	F + H	-	≤ 6
		F	-	≤ 6
	Red, Green, Blue	F	≤ 6.5 mm *4	R, G, B ≤ 0
Linked two or *3 more dots			R, G, B ≤ 0	
Dark dots *2	Color	Distance between dark dots		Quantity
	Black	-		R + G + B ≤ 16 R, G, B ≤ 7
		Linked two dots *3	≤ 1 pair	
		Linked three or more dots *3	≤ 0	
		≤ 6.5 mm *4	≤ 0	

\*1 F: Full luminous dots (Bright point independent of viewing angle)

H: Half luminous dots (Bright point dependent on viewing angle)

Luminous dots are measured while the screen is black.

\*2 Dark dots are measured while the screen is illuminated with Red, Green, or Blue.

\*3 Linkage means linked two or more dots.

■ ( : Luminous or Dark dot)

To be counted



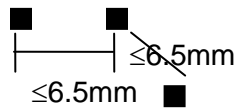
To be uncouned



\*4 ≤ 6.5 mm is considered with:

■ ( : Luminous or Dark dot)

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	To be counted	To be uncounted
Luminous dots	Same color	Different color
Dark dots	Same screen	Different screen

\*5 The dot-amounts of linkage and  $<6.5$  mm are counted when the dots are only full luminous.

c) Appearance specifications

Item	Specifications		Quantity
	Measurement criteria		
Other objects Stains Dust (dot shape)	Average diameter( $\varnothing$ ) mm		Allowed value
	$\varnothing \leq 0.2$		all allowed
	$0.2 < \varnothing < 0.3$		$\leq 10$ points
	$0.3 < \varnothing \leq 0.5$		$\leq 3$ points
	$0.5 < \varnothing$		0 point
Other objects Stains Dust (line shape)	Width(W) mm	Length(L) mm	all allowed
	$W \leq 0.05$	-	
	$0.05 \leq W \leq 0.1$	$L < 0.7$	$\leq 4$ points
		$0.7 \leq L \leq 1.0$	0 point
	$0.1 < W$	-	
Polarizer Bubbles	Average diameter( $\varnothing$ ) mm		
Wrinkles Dent	$\varnothing \leq 0.5$		$< 2$ points
Panel dent	$\varnothing \leq 0.5$		$< 2$ points
Polarizer scratch	Remarkable scratches		0 point
Form	Specified labels and parts are put		

The relevant data for the values above a only valid under conditions described at 7-7 "a".





## 8 GENERAL PRECAUTIONS

### 8-1 MOUNTING

- (a) The module must be attached firmly to the system using every mounting hole. Be careful not to twist and bend the modules during mounting and operation.
- (b) To avoid the local build-up of heat, there must be a sufficient heat flow / air circulation on the rear side of the display. We recommend a minimum gap of 6 to 15 mm between the rear side of the display module and the application - depending on display size and orientation of mounting. As higher the display as wider the gap.
- (c) The length of fixation screws for the housing must not exceed 4 mm on the top, the bottom and on the sides. Length of fixation screws on the backplate must not exceed 4 mm
- (d) Refrain from strong mechanical shock and / or any force to the module, this may cause improper operation or damage to the module and e<sup>3</sup> backlight.

### 8-2 HANDLING

- (a) Note that polarizers are very fragile and could be easily damaged. Do not press or scratch the surface harder than a HB pencil lead.
- (b) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, staining and discoloration may occur.
- (c) If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.
- (d) The desirable cleaners are water, IPA (Isopropyl Alcohol) or Hexane. Do not use Ketone type materials (ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might produce a permanent damage to the polarizer due to chemical reaction.
- (e) If the liquid crystal material leaks from the panel (i.e. when broken ), it should be kept away from the eyes or mouth. In case of contact with hands, legs or clothes, it must be washed away thoroughly with soap.
- (f) Protect the module from static electricity, it may cause damage to the C-MOS Gate Array IC`s.
- (g) Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.
- (h) Do not disassemble the module.
- (i) Pins of I/F connector must not be touched directly with bare hands.



### **8-3 STORAGE**

- (a) The module shall be stored in a dark place. It is prohibited to apply sunlight or fluorescent light during the store.

### **8-4 OPERATION**

- (a) Do not connect, or disconnect the module in the “Power On” mode.
- (b) Power supply should always be turned on/off by following item 7.9 “ SUPPLY VOLTAGE SEQUENZE “. (see specification of your model)
- (c) Module has high frequency circuits. Sufficient suppression of electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimize the interference.

### **8-5 OTHERS**

- (a) Ultra-violet ray filter is necessary for outdoor operation.
- (b) Avoid condensation. It may result in improper operation or permanent damage.
- (c) Do not exceed the absolute maximum rating values (e.g. the supply voltage variation, input voltage variation, variation in part contents and environmental temperature and so on). Otherwise the module may be damaged.
- (d) If the module displays the same pattern continuously for a long period of time, image “sticking” can be seen on the screen. For proper operations avoid such conditions.
- (e) This module has its circuitry PCB’s on the rear side. Please handle carefully in order to avoid any kind of stress.

## 9 COSMETIC SPECIFICATIONS

### 9-1 VISUAL INSPECTION

#### 1) INSPECTED AREA

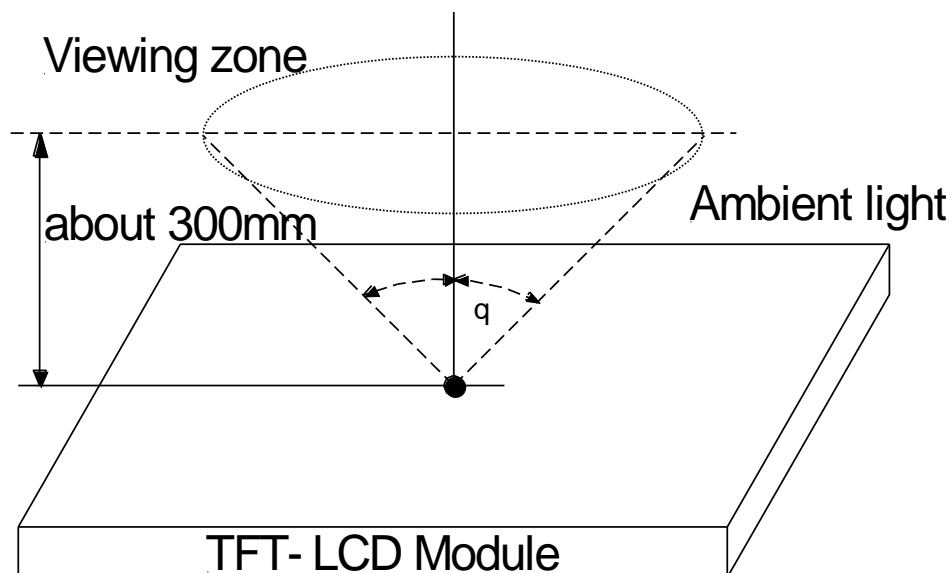
- i) The distance between inspector's eyes and the module is around 300 mm.  
Viewing angle for inspection is as follows:  
 $q \leq 45^\circ$  when non-operating inspection.  
 $q \leq 5^\circ$  when operating inspection.
- ii) Inspection should be executed only from front side, and only for A-zone. The visual defects of B & C-zone are ignored (refer to 9.2 DEFINITION OF ZONE)

#### 2) ENVIRONMENTAL

- i) Ambient temperature: 25°C
- ii) Illumination for inspection should be around 2000 (lx) in module operation and around 1000 (lx) in non-operation.
- iii) Backlight is powered on during inspection for module operation.

#### 3) OPERATING INSPECTION

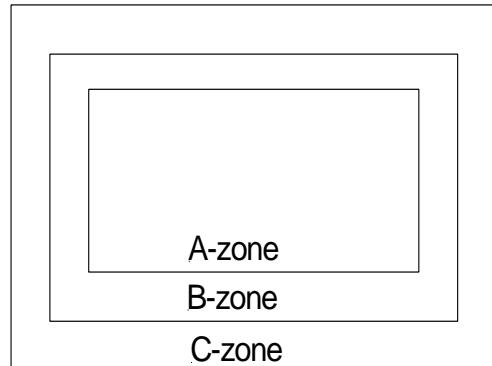
Number of display colours in the inspection is 8 only (Gray scale 0 and 255 for each Red, Green, Blue and White).



## 9-2 DEFINITION OF ZONE

The zones are defined as follows.

- A-zone: Display area (pixel area)
- B-zone: Area between A-zone and C-zone
- C-zone: Metallic bezel area (include I/F connector)



The visual defects are specified at A-zone and the specification is not applicable to B & C-zone. (Defects in B & C-zone are disregarded.)



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# Liquid Crystal Display Design

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## 9-3 COSMETIC SPECIFICATION

The following defect types are inspected at stable module operation. Defects appearing during powered on & off are disregarded.

	No.	ITEM		Maximum Acceptable Number		Note		
				A-zone	Unit			
Operating Inspection	1	Dot Defect	Sparkle Mode	1 dot	7	pcs	(1),(2),(4)	
				2 dot	3	Unit	(1),(2),(5)	
				3 dot	0			
				4 dot	0			
				Density	0	pcs/Ø20mm	(1),(2),(6)	
			Total	7	pcs	(1),(2)		
			Black Mode	1 dot	7	pcs	(1),(3),(4)	
				2 dot	3	Unit	(1),(3),(5)	
				3 dot	0			
				4 dot	0			
	Density	3		pcs/Ø30mm	(1),(3),(6)			
	Total	7	pcs	(1),(3)				
	Total	7	pcs	(1)				
	2	Line Defect			Serious one is Not allowed		-	-
	3	Uneven brightness					-	-
	4	Stain Inclusion	Line shape W: width(mm) L: length(mm)	W ≤ 0.02	L: ignore	Ignore	pcs	(7)
				W ≤ 0.04	L ≤ 2.0	10		
					L > 2.0	0		
				W ≤ 0.08	L ≤ 1.0	10		
					L > 1.0	0		
W > 0.08				-	see Dot shape			
5	Stain Inclusion	Dot shape D: average dia.(mm)	D ≤ 0.24		Ignore	pcs	(7)	
			D ≤ 0.4		5			
			D > 0.4		0			
6	Scratch on polarizer	Line shape W: width(mm) L: length(mm)	W ≤ 0.01	L: ignore	Ignore	pcs	(8)	
			W ≤ 0.02	L ≤ 40	10			
				L > 40	0			
			W ≤ 0.04	L ≤ 20	10			
				L > 20	0			
7	Scratch on polarizer	Dot shape D: average dia.(mm)	D ≤ 0.2		Ignore	pcs	(8)	
			D ≤ 0.4		10			
			D > 0.4		0			
8	Bubbles, Peeling in Polarizer	D: average dia.(mm)	D ≤ 0.3		Ignore	pcs	(8)	
			D ≤ 0.5		10			
			D ≤ 1.0		5			
			D > 1.0		0			
9	Wrinkles on Polarizer			Serious one is not allowed		-	-	



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## Liquid Crystal Display Design

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### Note

- (1) Defect whose area per each dot is over 50% is regarded as Dot Defect.
- (2) Defect whose brightness at all black screen is more than 30% is regarded as Bright Dot Defect.
- (3) Defect whose brightness at all white screen is less than 70% is regarded as Dark Dot Defect.
- (4) Defect dots which are not adjacent are regarded as Single Dot Defect each.
- (5) Two or more Adjacent Defect dots are regarded as n (number)-Adjacent Dot Defect.
- (6) Defect density is defined by the number of defects existing in a 20 mm Ø.
- (7) Defect which can be easily wiped off is disregarded.
- (8) The specification is applicable only to A-zone. Defects in B-zone are disregarded.
- (9) In case of gray scale pattern, obvious defects are to be rejected.