



Typical Design



# Industrial Solutions Flatpanel Technology

## DESIGN FOR TFT COLOR LCD MODULE

Design No.	dah203_65
Revision	Rev. 1.0
Type	6.5" 640 x 480
Specification	
Version	Internal Revision 0.2
Date	25.11.2008
Preliminary <input checked="" type="checkbox"/>	
Final <input type="checkbox"/>	

<p style="text-align: center; color: red;"> <b>This typical design can be used to manufacture dedicated products at i-sft according to the mentioned specification without additional NRE cost.</b>  <b>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.</b>  <b>No further activities will start before formal order is processed and written approval of final specification is in!</b> </p>	
Approved	



Typical Design

# Liquid Crystal Display Design

I-SFT dah203\_65



Revision	Date	Description
1.0	25.11.2008	First Draft



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## 1 DESCRIPTION

**I-SFT dah203\_65** is a custom specific development based module and is not available on the open market.

**I-SFT dah203\_65** 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 dah203\_65** 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. 1000 nits.
- c. **i-sft** custom made integrated e<sup>3</sup> driver to control the backlight.

The 6.5 inch diagonal display area contains 640×480 pixels and can display 256k colors.

## 2 FEATURES

Backlight for 1000 nit display surface

Thin and light weight

High contrast ratio, wide viewing angle, wide color gamut

Wide viewing angle with retardation film (antiglare treatment)

Wide temperature range

Accepting high shock and vibration levels

Fixable connector

Integrated e<sup>3</sup> driver for driving backlight

## 3 APPLICATIONS

Industrial application



## 4 STRUCTURE AND FUNCTIONS

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

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

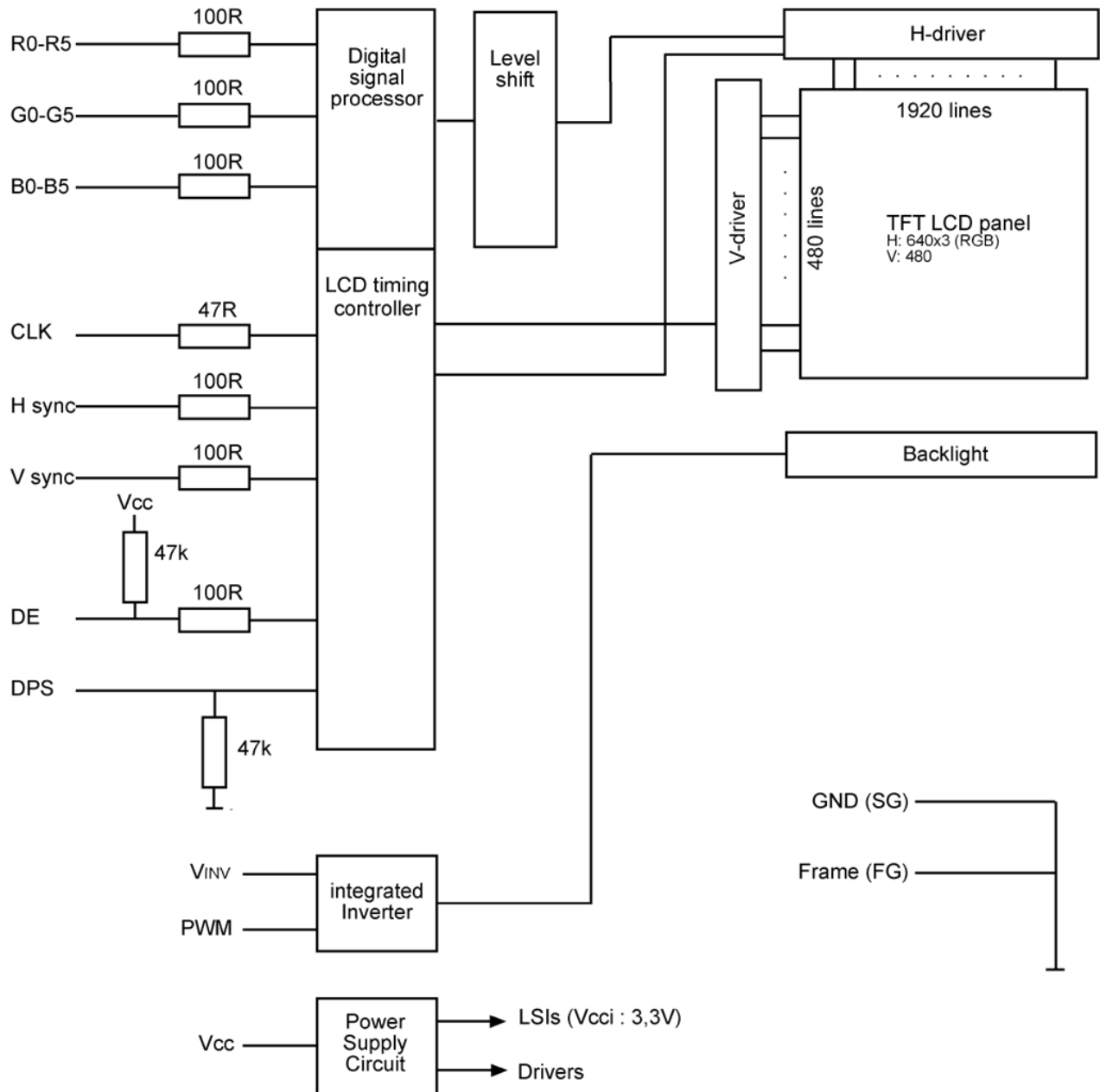
Each of the liquid crystal cells acts as an electro-optical switch that controls the incident light transmission by a signal applied to a signal electrode through the TFT switch.



## 5 OUTLINE OF CHARACTERISTICS

ITEM	SPECIFICATION	UNIT	NOTE
Active display area	132.5 (H) x 99.4 (V) (6.5 inch diagonal)	mm	
Driver element	a – Si TFT active matrix		
Display colours	256k		
Number of pixels	640 x 480	pixel	
Luminance (typ.)	1000	cd/m <sup>2</sup>	
Dimming ratio	1 : 900		
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.207 (H) x 0.207 (W)	mm	
Display mode	Normally White		
Surface treatment	Haze 25, Anti-glare & hard-coating (3H)		

## 6 BLOCKDIAGRAMM





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## 7 SPECIFICATIONS

### 7-1 GENERAL SPECIFICATIONS

ITEM		TYP.	UNIT
Module size	Horizontal (H)	191	mm
	Vertical (V)	123	mm
	Depth (D)	16.5	mm
Weight		475	g

### 7-2 ABSOLUTE MAXIMUM RATINGS

ITEM	SYMBOL	MIN.	MAX.	UNIT	NOTE
Storage temperature	$T_{nop}$	-45	75	°C	(1)
Operating temperature	$T_{op}$	-25	60	°C	(1)
Shock (operating)	$S_{op}$	-	tbd	g	(2)
Vibration (operating)	$V_{op}$	-	tbd	g	(3)

Note

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

(2)

(3)



### 7-3 ELECTRICAL CHARACTERISTICS

#### (1) Logic, LCD driving

Ta = 25°C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	V <sub>cc</sub>	4.75 (3.0)	5 (3.3)	5.25 (3.6)	V	-
Supply current	I <sub>cc</sub>	-	200 (320)	450 (600)	mA	V <sub>cc</sub> =5.0V (V <sub>cc</sub> =3,3V)
Logic input "L" voltage	V <sub>IL</sub>	0	-	V <sub>cci</sub> x 0.3	V	CMOS level note
Logic input "H" voltage	V <sub>IH</sub>	V <sub>cci</sub> x 0.7	-	V <sub>cc</sub>		

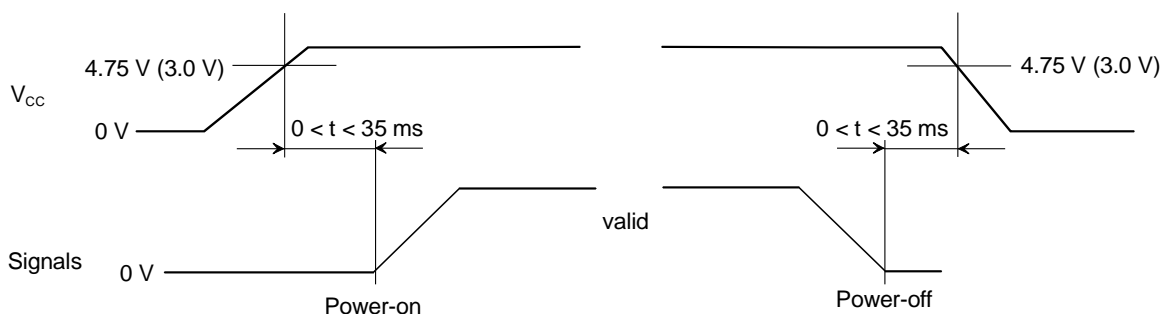
Note: V<sub>CC</sub> = 3.3V : is given by DC/DC converter in the LCD module

#### (2) Backlight, e<sup>3</sup> driver driving

Ta = 25°C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	V <sub>inv</sub>	-	12	-	V	
Power consumption	P <sub>inv</sub>	-	7.5	-	W	V <sub>inv</sub> = 12V

### 7-4 SUPPLY VOLTAGE SEQUENCE



note 1: The supply voltage for input signals should be the same as V<sub>CC</sub>.

note 2: Turn on the backlight within the LCD operation period. When the backlight turns on before LCD operation or the LCD operation turns off before the backlight turns off, the display becomes momentarily white.

note 3: When the power is off, please keep whole signals (Hsync, Vsync, CLK, DE, MODE and DATA) low level or high impedance.

## 7-5 INTERFACE PIN CONNECTION

(( 1) Interface signals, power supply

Module side connector

CN40 : DF13-40DS-1.25C (HIROSE)

Mating connector

DF13-40DS (KAB-DF13-40DS-0500FK; ES&S)

Pin NO.	Symbol	Function	Pin NO.	Symbol	Function
1	CLK	Dot clock	21	B2	Blue data
2	GND	Ground	22	B1	Blue data
3	Vsync	Vertical sync	23	B4	Blue data
4	Hsync	Horizontal sync	24	B3	Blue data
5	R0	Red data (LSB)	25	GND	Ground
6	GND	Ground	26	B5	Blue data (MSB)
7	R2	Red data	27	Vcc	Power supply panel
8	R1	Red data	28	DE	Data enable
9	R4	Red data	29	N.C.	Non-connection (Open)
10	R3	Red data	30	Vcc	Power supply panel
11	GND	Ground	31	GND	Ground
12	R5	Red data (MSB)	32	DPS	Scan Direction select
13	G1	Green data	33	GND	Ground
14	G0	Green data (LSB)	34		N.C.
15	G3	Green data	35	PWM	
16	G2	Green data	36	VINV	Power supply 12VDC
17	G5	Green data (MSB)	37	GND	Ground
18	G4	Green data	38	VINV	Power supply 12VDC
19	B0	Blue data (LSB)	39	GND	Ground
20	GND	Ground	40	VINV	Power supply 12VDC

LSB: Least Significant Bit

MSB: Most Significant Bit



**7-6 DISPLAY COLORS vs. INPUT DATA SIGNALS**

Display colors		Data signal(0: Low level, 1: High level)																	
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0
Basic colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	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
Red grayscale	Black	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	0	0	0	0	0	0	0	0	0
	dark	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑																		
	↓																		
	bright	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	
Green grayscale	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	1	0	0	0	0	0	0
	dark	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	↑																		
	↓																		
	bright	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0
	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	
Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	
Blue grayscale	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	0	0	0	1
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	↑																		
	↓																		
	bright	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1
	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	
Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	

note: colors are developed in combination with 6 bit signals (64 steps in grayscale) of each primary red, green, and blue color.

This process can result in up to 262,144 (64×64×64) colors.



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# Liquid Crystal Display Design

I-SFT dah203\_65



## 7-7 INPUT SIGNAL TIMING

### (1) INPUT SIGNAL SPECIFICATION

	Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Remarks	
CLK	Frequency	1/Tc	21.0	25.175	29.0	MHz	39.722 ns(TYP.)	
	Duty	Tch/Tc	0.4	0.5	0.6	-	-	
	Rise, Fall	Tcrf	-	-	10	ns	-	
Hsync	Period	Th	30.0	31.778	33.6	μs	31.468 kHz(TYP.)	
			-	800	-	CLK		
	Display period	Thd	-	25.422	-	μs		
			-	640	-	CLK		
	Front-porch	Thf	-	0.636	-	μs		
			0	16	-	CLK		
	Pulse width	Thp*)	-	3.813	-	μs		
			10	96	-	CLK		
	Back-porch	Thb *)	-	1.907	-	μs		
			5	48	-	CLK		
	*) Thp+Thb			64	144	-	CLK	
	CLK-Hsync timing	Thch	12	-	-	ns		
	Hsync-CLK timing	Thcs	8	-	-	ns		
	Hsync-Vsync timing	Tvh	15	-	-	ns		
Vsync-Hsync timing	Tvs	15	-	-	ns			
Rise, Fall	Thrf	-	-	10	ns			
Vsync	Period	Tv	16.1	16.683	17.2	ms	59.94 Hz(TYP.)	
			-	525	-	H		
	Display period	Tvd	-	15.253	-	ms		
			-	480	-	H		
	Front-porch	Tvf	-	0.381	-	ms		
			1	12	-	H		
	Pulse width	Tvp *)	-	0.063	-	ms		
			2	2	-	H		
Back-porch	Tvb *)	-	0.985	-	ms			
		4	31	-	H			
*) Tvp+Tvb			6	33	-	H		
Rise, Fall	Tvrf	-	-	10	ns			
DATA R0-R5	CLK-DATA timing	Tds	8	-	-	ns		
G0-G5	DATA-CLK timing	Tdh	12	-	-	ns		
B0-B5	Rise, Fall	Tdrf	-	-	10	ns		
	DE-CLK timing	Tes	8	-	-	ns		

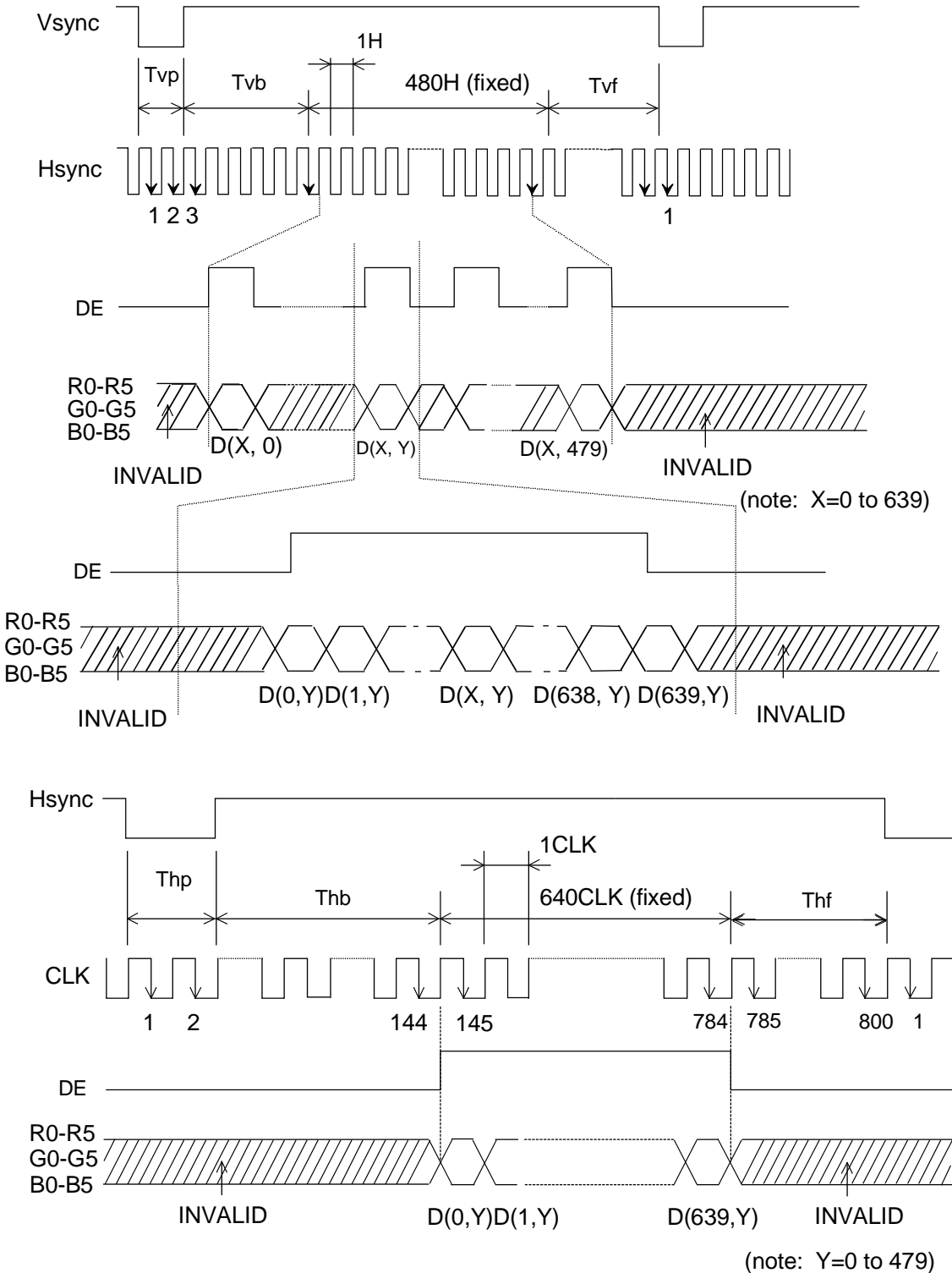


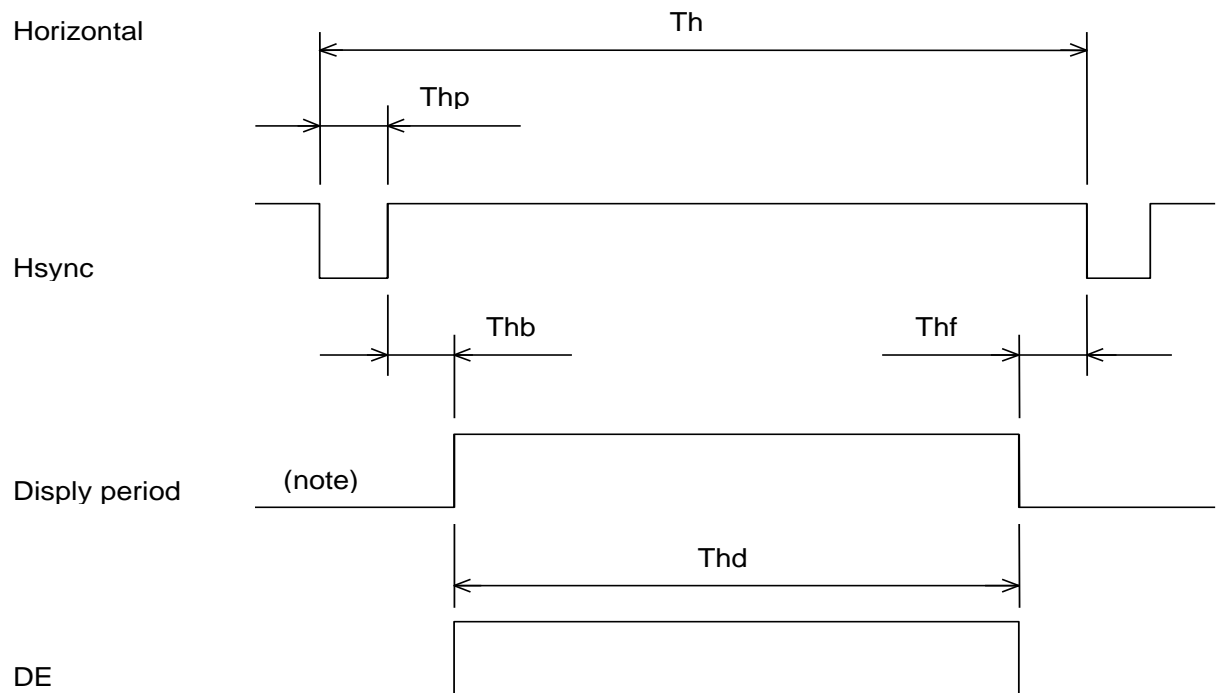
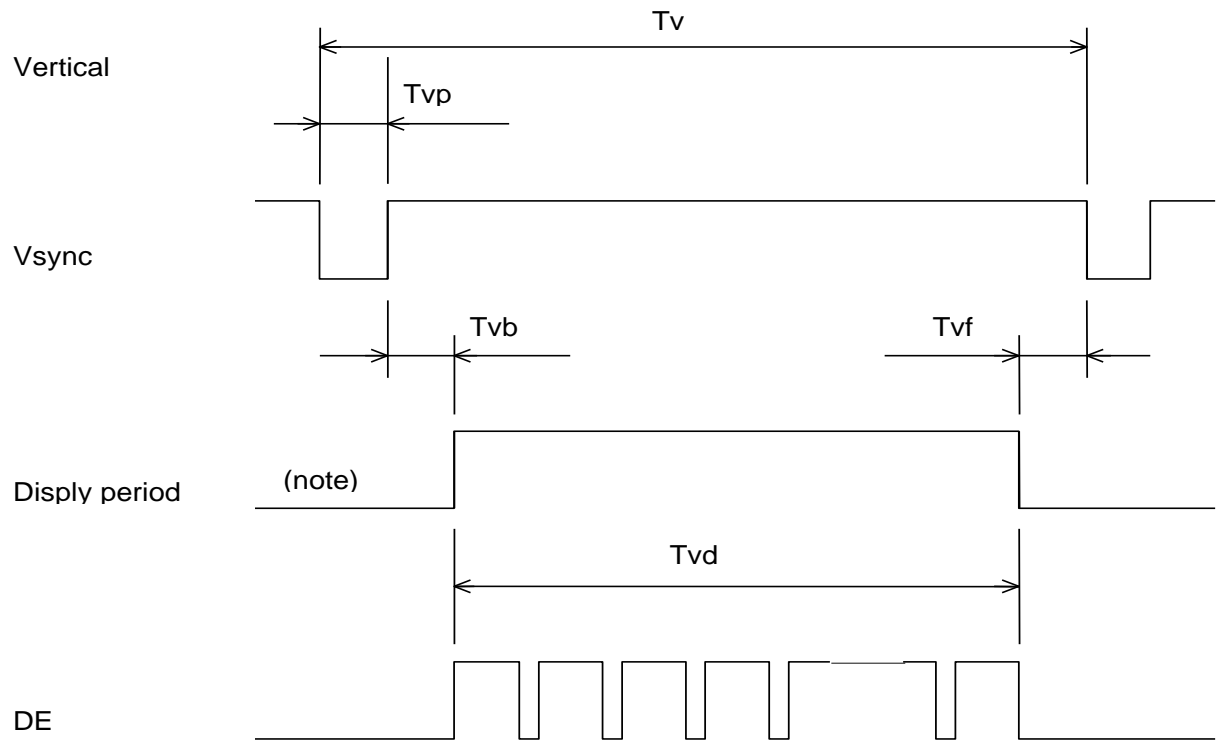
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DE	CLK-DE timing	Teh	12	-	-	ns
	Rise, Fall	Terf	-	-	10	ns

note: All parameters should be kept within the specified range.

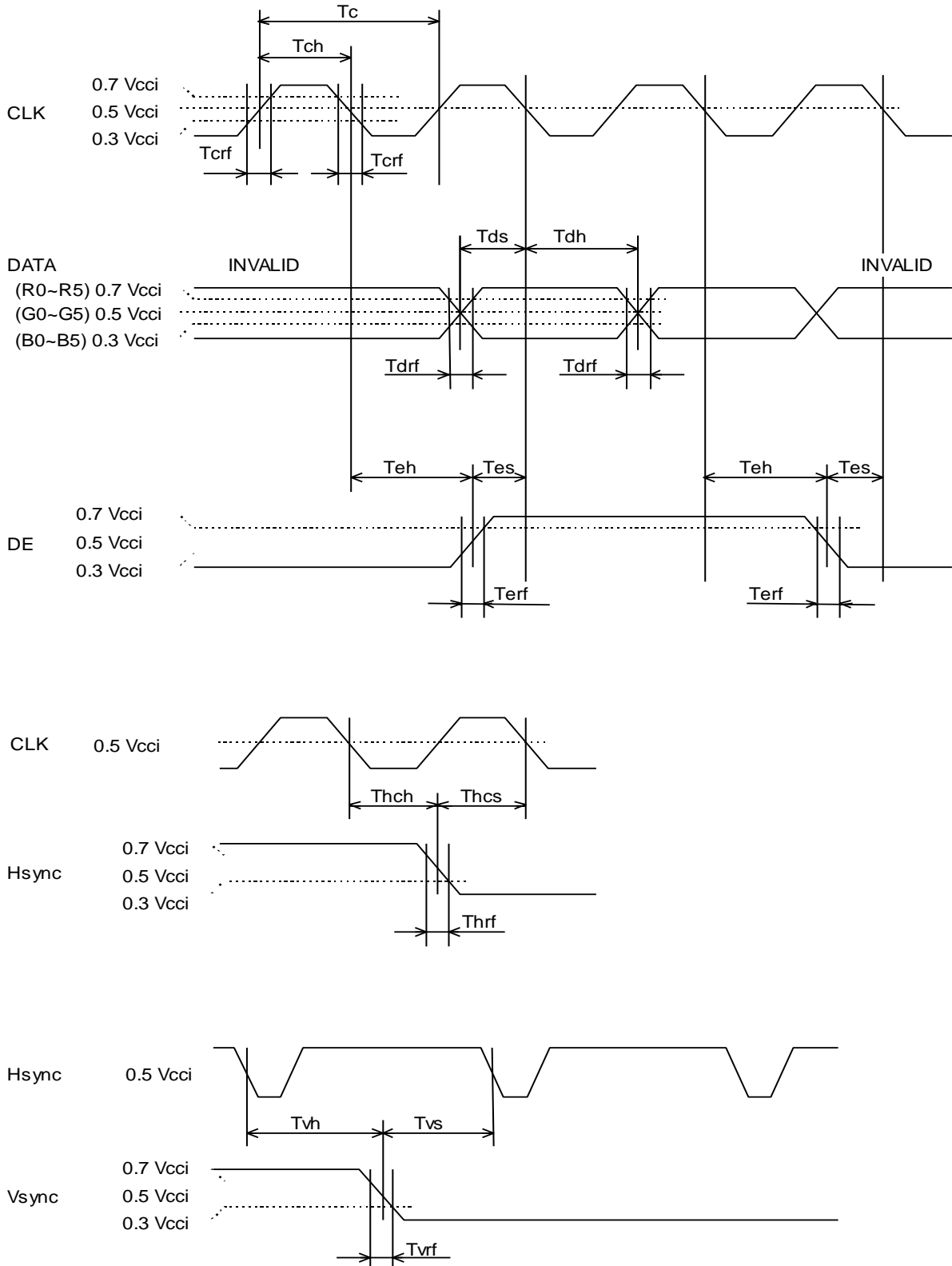
(2) DEFINITION OF INPUT SIGNAL TIMING





note: these signals do not exist

(3) INPUT SIGNAL TIMING CHART



**7-8 DISPLAY POSITION at HRV: L and VRV: L**

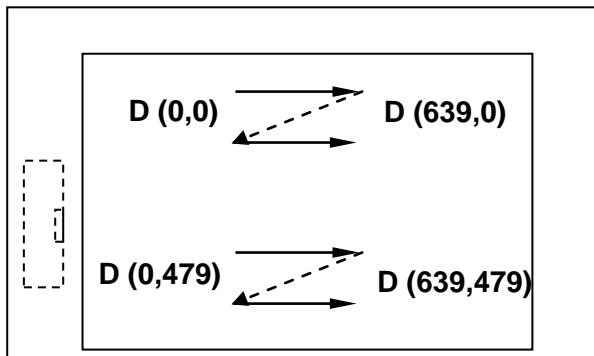
Normal scan: DPS = "L" (factory set)

D(0,0)	D(1,0)		D(X,0)		D(638,0)	D(639,0)
D(0,1)	D(1,1)		D(X,1)		D(638,1)	D(639,1)
D(0,Y)	D(1,Y)		D(X,Y)		D(638,Y)	D(639,Y)
D(0,478)	D(1,478)		D(X,478)		D(638,478)	D(639,478)
D(0,479)	D(1,479)		D(X,479)		D(638,479)	D(639,479)

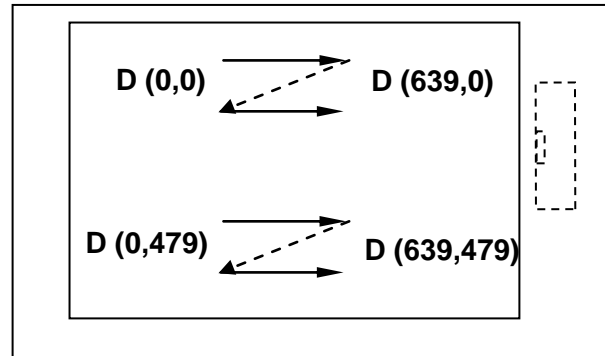
Note Below drawings show relations between the scan direction and the viewing direction.

Front

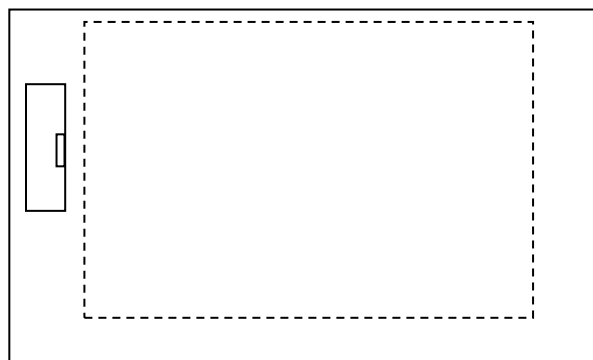
Normal scan (factory set)



Reverse scan (DPS = "H", external signal)



Back



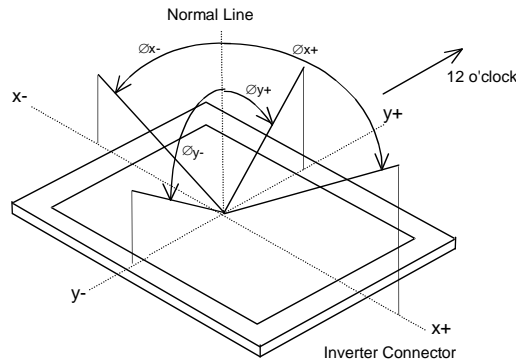


**7-9 OPTICAL CHARACTERISTICS**

Ta = 25°C ± 5°C

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Remark	
Viewing angle range	Horizontal	∅x+	CR>10, ∅y = ±0°	-	60	-	deg.	note 1
		∅x-	CR>10, ∅y = ±0°	-	60	-	deg.	note 1
	Vertical	∅y+	CR>10, ∅x = ±0°	-	40	-	deg.	note 1
		∅y-	CR>10, ∅x = ±0°	-	80	-	deg.	note 1
Contrast ratio	CR	∅y=0°, ∅x=±0°	-	800	-	-	note 2	
Response time	tpd	white to black	-	13	-	ms	note 3	
		black to white	-	36	-			
Luminance (center of screen)	Lw	at center		1000		cd/m <sup>2</sup>	note 4	
Dimming range	DR			1000:1				

Note 1: Definitions of viewing angle are as follows. (Matrix facing up, connector on the right side)



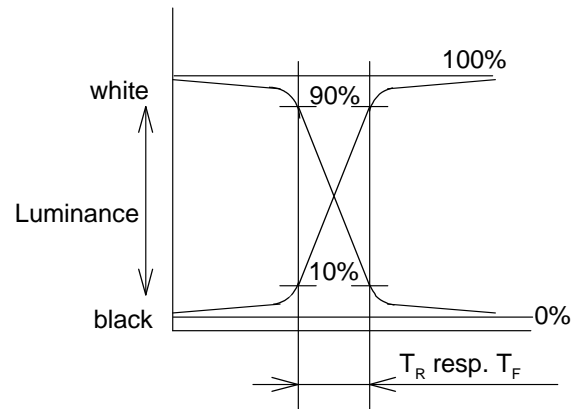
Note 2: The contrast ratio is calculated by using the following formula:

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

The brightness is measured in a darkroom.

Note 3: Definition of response time is as follows.

Photo detector output signal is measured when the brightness changes "white" to "black". Response time is the time between 10% and 90% of the photo detector output amplitude.

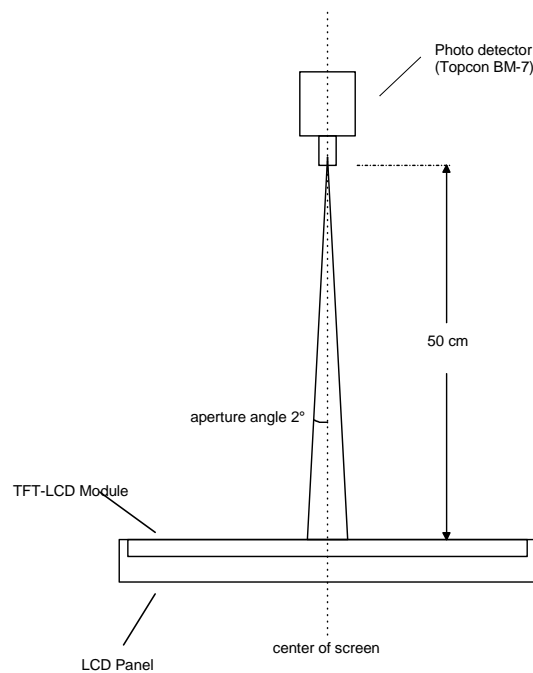


Note 4: Brightness measurements setup.

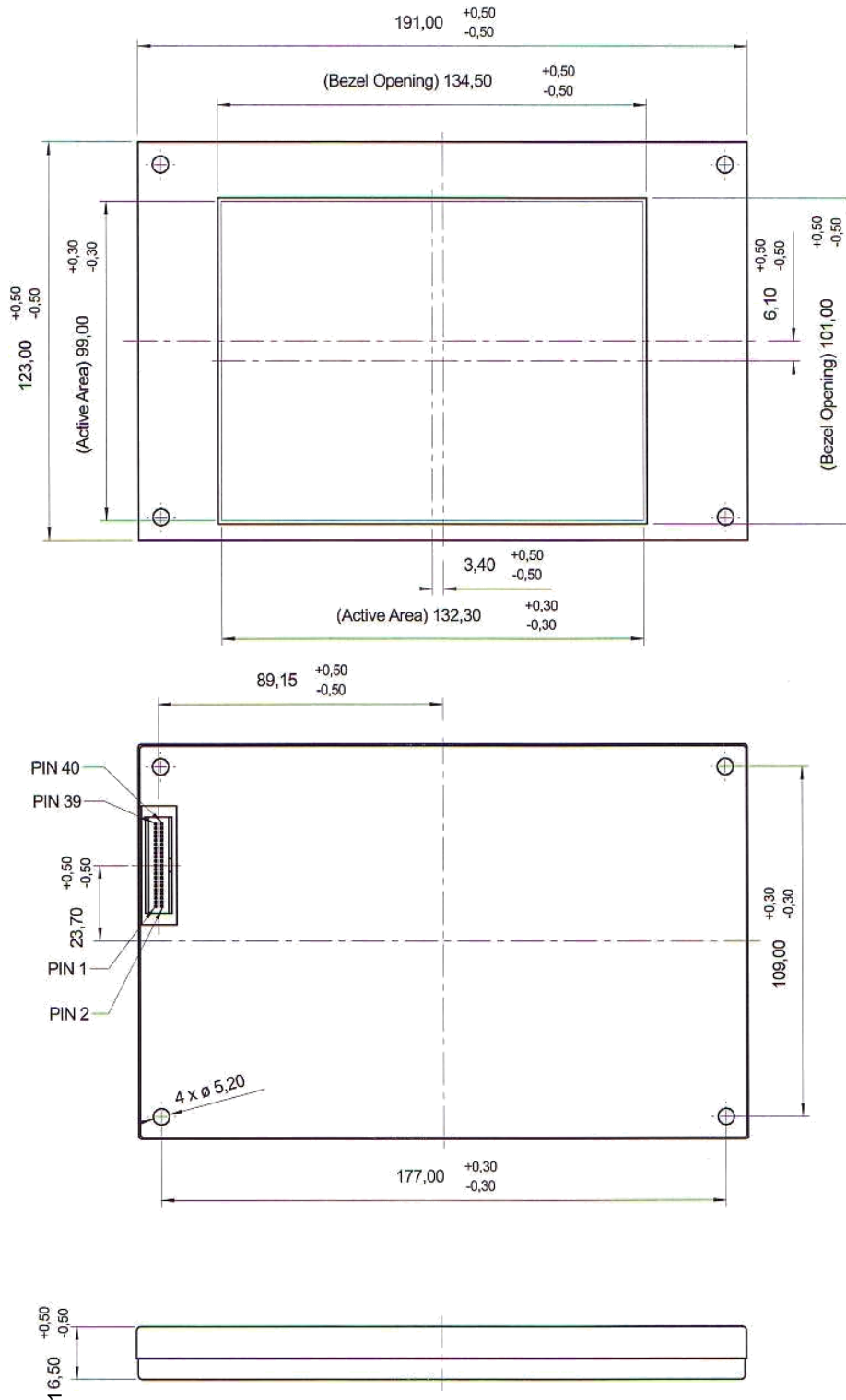
Measurement should be executed in a dark room 30 minutes after lighting the backlight. Matrix: on state.

The brightness is measured at the centre of the screen surface.

Environmental conditions:      Temperature should be  $25 \pm 2$  °C. Ensure there is sufficient heat flow / air circulation is given



**7-10 OUTLINE DIMENSIONS**



tolerances in DIN ISO 2768 T1 class m

**7-11 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)

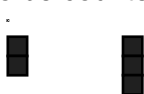
Luminous dots are measured while the screen is black.

\*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



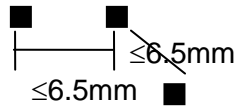
To be uncounted



\*4 ≤ 6.5 mm is considered with:

■ ( : Luminous or Dark dot)

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	To be counted	To be uncouncted
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)	Linked other objects		
	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 should 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) 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 polarizer's 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.



Typical Design



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### 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 7.3 “ 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.