



Typical Design



# Industrial Solutions Flatpanel Technology

## DESIGN FOR TFT COLOUR LCD MODULE

Design No.	dah168_104
Revision	Rev. 1.0
Type	10,4" 640 x 480
Specification	
Version	Internal Revision 0.1
Date	10/06/2013
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!

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Typical Design

# Liquid Crystal Display Design

I-SFT dah168\_104



Revision	Date	Description
1.0	16.01.2012	First Draft



<b>1</b>	<b>DESCRIPTION.....</b>	<b>4</b>
<b>2</b>	<b>FEATURES.....</b>	<b>4</b>
<b>3</b>	<b>APPLICATIONS .....</b>	<b>4</b>
<b>4</b>	<b>STRUCTURE AND FUNCTIONS.....</b>	<b>5</b>
<b>5</b>	<b>OUTLINE OF CHARACTERISTICS.....</b>	<b>6</b>
<b>6</b>	<b>BLOCK DIAGRAM .....</b>	<b>7</b>
<b>7</b>	<b>SPECIFICATIONS .....</b>	<b>8</b>
	7-1 GENERAL DIMENSIONS.....	8
	7-2 ABSOLUTE MAXIMUM RATINGS.....	8
	7-3 ELECTRICAL CHARACTERISTICS .....	9
	7-4 SUPPLY VOLTAGE SEQUENCE.....	10
	7-5 INTERFACE PIN CONNECTION.....	11
	7-6 SCANNING DIRECTION.....	12
	7-7 DISPLAY COLOURS vs. INPUT DATA SIGNALS .....	13
	7-8 INPUT SIGNAL TIMING .....	14
	7-9 DISPLAY POSITION .....	16
	7-10 DEFECT SPECIFICATIONS.....	16
	7-11 OPTICAL CHARACTERISTICS.....	19
	7-12 e <sup>3</sup> DRIVER SPECIFICATIONS .....	22
	7-13 MECHANICAL DIMENSIONS.....	24
<b>8</b>	<b>GENERAL PRECAUTIONS.....</b>	<b>26</b>
	8-1 MOUNTING.....	26
	8-2 HANDLING.....	26
	8-3 STORAGE.....	27
	8-4 OPERATION .....	27
	8-5 OTHERS .....	27



Typical Design



## 1 DESCRIPTION

**I-SFT dah168\_104** is a custom specific development based module and is not available on the open market.

**I-SFT dah168\_104** is a TFT (thin film transistor) active matrix color liquid crystal display (LCD) comprising of an amorphous silicon TFT attached to each signal electrode with circuit drivers.

**I-SFT dah168\_104** is an **i-sft** GmbH in-house product 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. 500 nits.
- c. **i-sft** custom made integrated e<sup>3</sup> driver to control the backlight.

The 10.4 inch diagonal display area contains 640×480 pixels and can display 256k colors.

## 2 FEATURES

500 nits display surface

Thin and light weight

High contrast ratio, wide viewing angle, high colour gamut

Wide temperature range

Accepting high shock and vibration levels

Data enable function

Standard connector

Minimized image sticking (ghost pictures)

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

Colour spectrum adjusted to sunlight

## 3 APPLICATIONS

Industrial application



## 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.



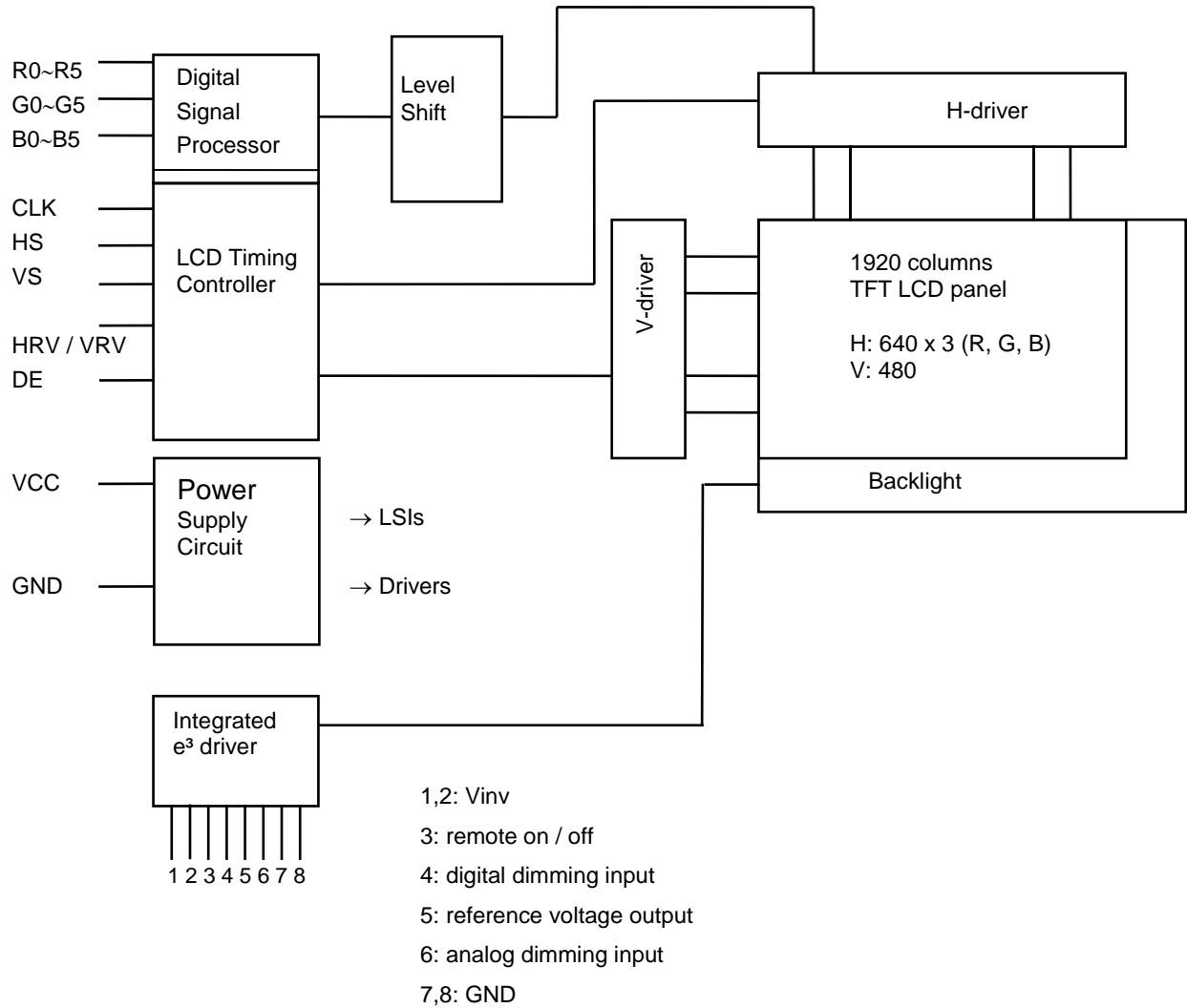
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## 5 OUTLINE OF CHARACTERISTICS

ITEM	SPECIFICATION	UNIT	NOTE
Active display area	211.2(H) x 158.4(V) (10.4 inch diagonal)	mm	
Driver element	a – Si TFT active matrix		
Display colours	262,144		
Number of pixels	640 x R.G.B. x 480	pixel	
Luminance (typ.)	500	cd/m <sup>2</sup>	
Dimming ratio	500 : 1		
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.33 (H) x 0.33 (W)	mm	
Display mode	Normally Black		
Surface treatment	mate, hard - coating (3H)		

## 6 BLOCK DIAGRAM





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## 7 SPECIFICATIONS

### 7-1 GENERAL DIMENSIONS

ITEM		TYP.	UNIT
Module size	Horizontal (H)	269.5	mm
	Vertical (V)	189.4	mm
	Depth (D)	25.25	mm
Weight		1400	g

### 7-2 ABSOLUTE MAXIMUM RATINGS

ITEM	SYMBOL	MIN.	MAX.	UNIT	NOTE
Storage temperature	$T_{STG}$	-35	85	°C	(1)
Operating temperature (Surface of glass)	$T_{OPR}$	-25	78	°C	(1)
Shock (operating)	$S_{nop}$	-	50	g	(2) tbd
Vibration (operating)	$V_{nop}$	-	3	g	(3) tbd

Note

- (1) measured at center of display area (front side); no condensation
- (2) 11 ms
- (3) 5 – 2000 Hz



### 7-3 ELECTRICAL CHARACTERISTICS

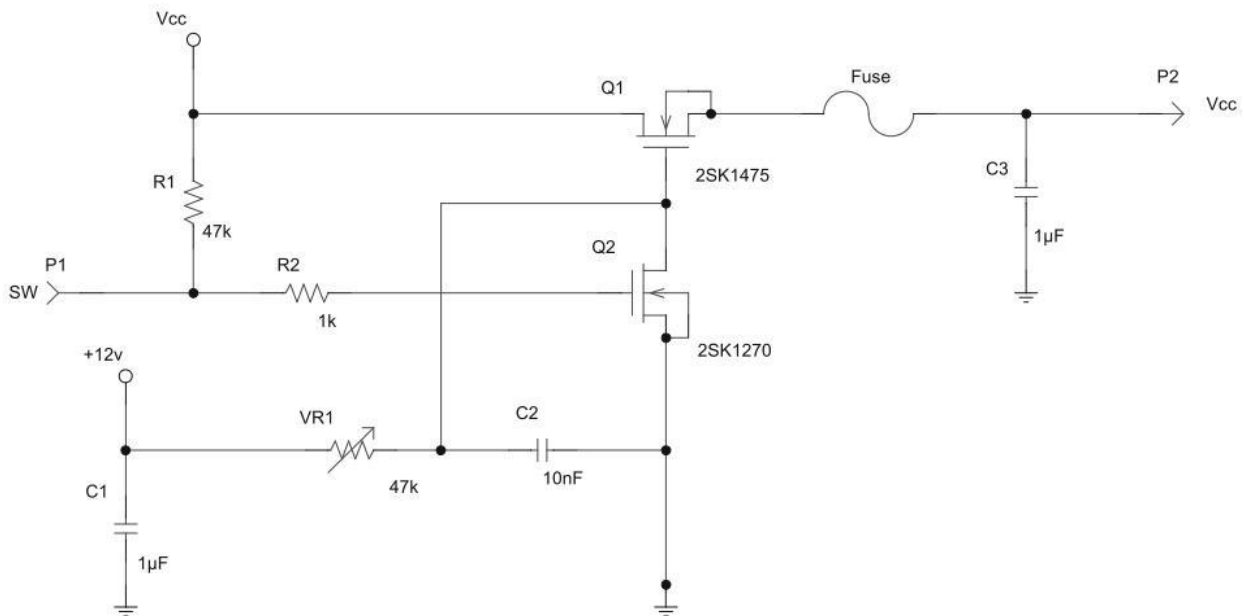
(1) Logic, LCD driving

Ta = 25 ± 2 °C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Supply voltage	V <sub>CC</sub>	4.75 (3.0)	5.0 (3.3)	5.25 (3.6)	V	V <sub>CC</sub> =5.0V (V <sub>CC</sub> =3.3V)
Logic input "L" voltage	V <sub>IL</sub>	0	-	V <sub>CC</sub> x 0.3	V	CMOS level
Logic input "H" voltage	V <sub>IH</sub>	V <sub>CC</sub> x 0.7	-	5.25		
Supply current	White	-	495	-	mA	V <sub>CC</sub> = 3.3 V
	Black	-	450	-		
	Vertical Stripe	-	563	-		
Ripple Voltage	V <sub>RP</sub>	-	-	100	mV	-
Rush Current	I <sub>RUSH</sub>	-	-	(1)	A	-

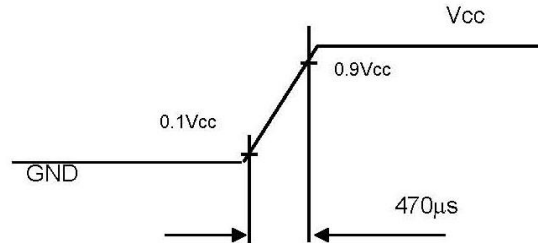
Note (1) As recommended under the normal specification ranges listed.

Note (2) Measurement Conditions: V<sub>CC</sub> = 3.3V

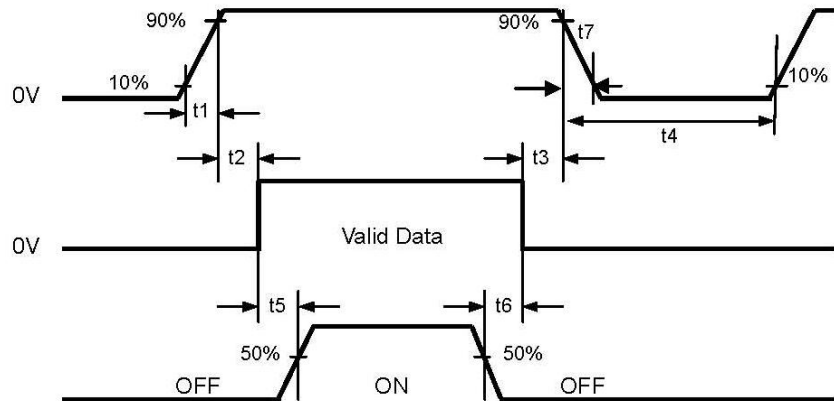


## 7-4 SUPPLY VOLTAGE SEQUENCE

VCC rising time



- Power supply
- Interface signal
- Backlight on  
(Recommended)



note 1: The supply voltage for input signals should be the same as  $V_{CC}$ .

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 and DATA) at a low level or high impedance.

note 4: Please avoid floating state of interface signal at invalid period.

note 5: When the interface signal is invalid, be sure to pull down the power supply of LCD  $V_{CC}$  to 0 V.

## 7-5 INTERFACE PIN CONNECTION

### (1) Interface signals, power supply

Module side connector

CN1 : PS-34PE-D4LT1-SM1 (JAE)

Mating connector

PS-34SM-D4P1-1C

Pin No.	Symbol	Function
1	GND	Ground
2	CLK	Dot clock
3	Hsync	Horizontal sync
4	Vsync	Vertical sync
5	GND	Ground
6	R0	Red data (LSB)
7	R1	Red data
8	R2	Red data
9	R3	Red data
10	R4	Red data
11	R5	Red data (MSB)
12	GND	Ground
13	G0	Green data (LSB)
14	G1	Green data
15	G2	Green data
16	G3	Green data
17	G4	Green data

Pin No.	Symbol	Function
18	G5	Green data (MSB)
19	GND	Ground
20	B0	Blue data (LSB)
21	B1	Blue data
22	B2	Blue data
23	B3	Blue data
24	B4	Blue data
25	B5	Blue data (MSB)
26	GND	Ground
27	DE	Data enable
28	Vcc	Power supply
29	Vcc	Power supply
30	N.C.	keep floating
31	HRV / VRV	Scan direction
32	N.C.	keep floating
33	N.C.	keep floating
34	N.C.	keep floating

**note:**

- 1) HRV / VRV: L or OPEN = scanning is normal  
H = scanning is reverse
- 2) LSB: Least Significant Bit  
MSB: Most Significant Bit

**7-6 SCANNING DIRECTION**

see from TFT side

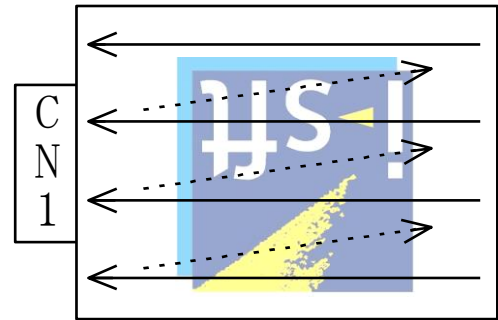
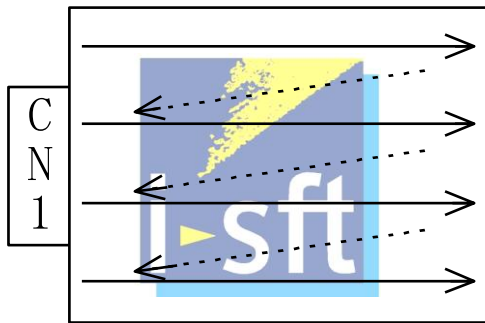


Figure1: Normal scan (HRV / VRV: Low or Open)

Figure 2: Reverse scan (HRV / VRV: High)

**7-7 DISPLAY COLOURS vs. INPUT DATA SIGNALS**

Display colours		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 colours	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
	dark	0	0	0	0	0	1	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
	Red	1	1	1	1	1	1	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
	dark	0	0	0	0	0	0	0	0	0	1	0	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
	Green	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
	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
	Blue	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 1: colours are developed in combination with 6 bit signals (64 steps in grayscale) of each primary red, green and blue colour.  
 This process can result in up to 262,144 (64x64x64) colours.



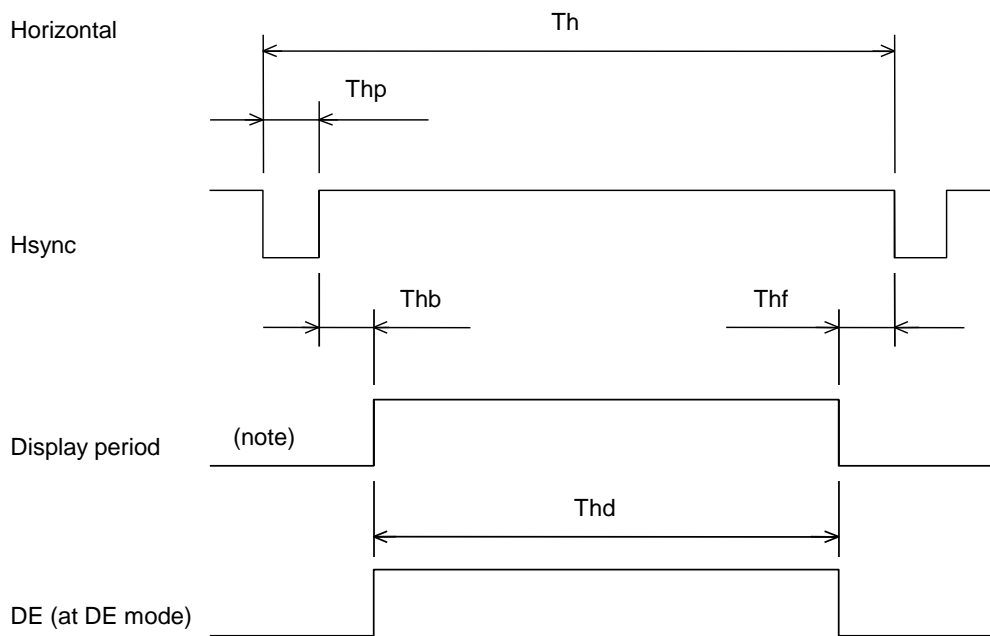
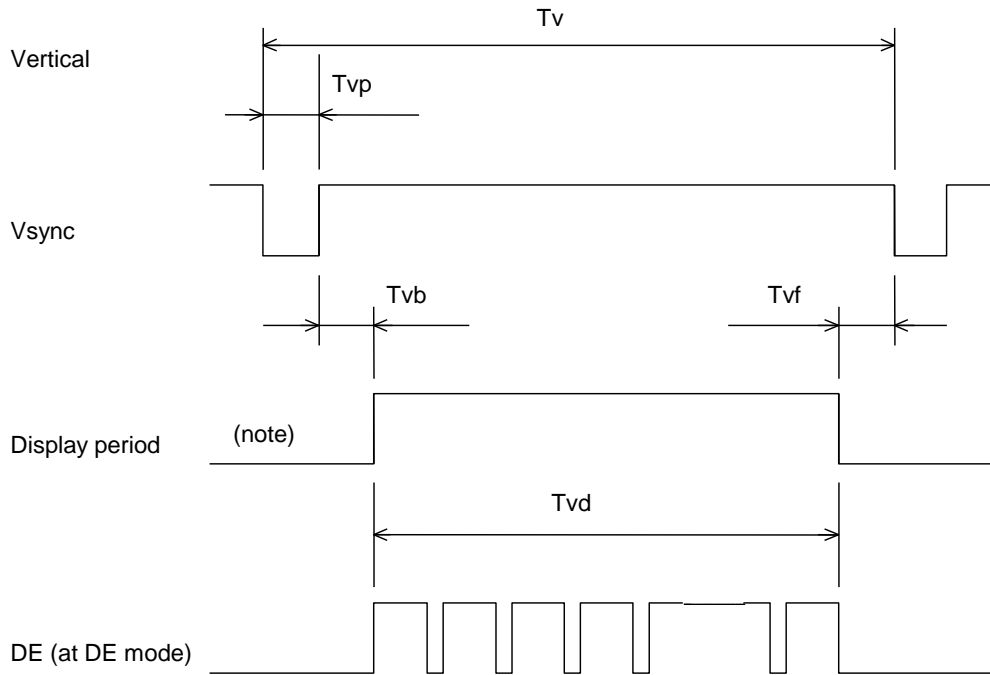
## 7-8 INPUT SIGNAL TIMING

### (1) INPUT SIGNAL SPECIFICATIONS

Parameter		Symbol	MIN.	TYP.	MAX.	Unit	Remarks
CLK	Frequency	1/Tc	21.0	25.175	29.0	MHz	39.722ns (TYP.)
	Duty	Tch/Tc	0.4	0.5	0.6		
Hsync	Period	Th	30.0	31.778	33.6	µs	31.469kHz (TYP.)
			720	800	1279	CLK	Th=Thd+Thb
	Display period	Thd	640			CLK	
	Blank	Thb	80	160	Th-Thd	ns	Thb=Th-Thd
Vsync	Period	Tv	16.1	16.683	17.2	ms	60Hz (TYP.)
			482	525	959	H	Tv=Tvd+Tvb
	Display Period	Tvd	480			H	
	Blank	Tvb	2	45	Tv-Tvb	ns	Tvb=Tv-Tvb
<b>DATA</b>							
<b>R0 – R5</b>	CLK-DATA timing	Tds	8	-	-	ns	
<b>G0 – G5</b>							
<b>B0 – B5</b>	DATA-CLK timing	Tdh	12	-	-	ns	

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

(2) DEFINITION OF INPUT SIGNAL TIMING



note: these signals do not exist

**7-9 DISPLAY POSITION**

at HRV / VRV: LOW

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)

**7-10 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 25 °C ± 5 °C.

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: e<sup>3</sup> plasma lamp

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

Luminance of backlight surface for inspection: 12000 cd/m<sup>2</sup>.



**b. Display specifications**

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

\*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

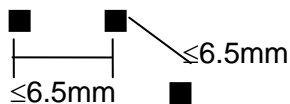


To be uncouped



\*4  $\leq 6.5 \text{ mm}$  is considered with:

(■ : Luminous or Dark dot)



	To be counted	To be uncouped
Luminous dots	Same colour	Different colour
Dark dots	Same screen	Different screen

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

**c. Appearance specifications**

Item	Specifications		
	Measurement criteria	Quantity	
Other objects Stains Dust (dot shape)	Average diameter ( $\varnothing$ )mm		
	$\varnothing \leq 0.2$	all allowed	
	$0.2 < \varnothing < 0.3$	$\leq 10$ points	
	$0.3 < \varnothing \leq 0.5$	$\leq 3$ points	
	$0.5 < \varnothing$ Linked other objects	0 point	
Other objects Stains Dust (line shape)	Width(W) mm	Length(L) mm	
	$W \leq 0.05$	-	
	$0.05 \leq W \leq 0.1$	$L < 0.7$	all allowed
		$0.7 \leq L \leq 1.0$	$\leq 4$ points
	$0.1 < W$	-	0 point
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 are only valid under conditions described at 7-9 "a".

## 7-11 OPTICAL CHARACTERISTICS

Measuring equipment:

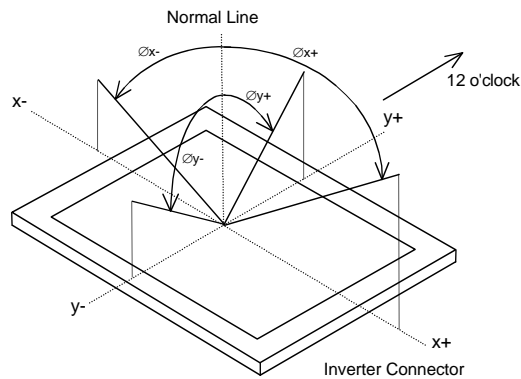
Luminance: TOPCON BM-7

Viewing Angle, Contrast: ELDIM EZContrast 160D

TA = 25°C ± 2°C, VCC = 5 V

Parameter	Symbol	Condition	Min	Typ	Max	Unit	Remark	
Viewing Angle	Horizontal	$\phi_{x+}$	CR>10, $\phi_y = \pm 0^\circ$	80	88	-	deg.	note 1
		$\phi_{x-}$	CR>10, $\phi_y = \pm 0^\circ$	80	88	-	deg.	
	Vertical	$\phi_{y+}$	CR>10, $\phi_x = \pm 0^\circ$	80	88	-	deg.	
		$\phi_{y-}$	CR>10, $\phi_x = \pm 0^\circ$	80	88	-	deg.	
Contrast ratio	CR	$\phi_y = \pm 0^\circ, \phi_x = \pm 0^\circ$	-	1000:1	-	-	note 2	
Response time	$T_R$	rising	-	14	19	ms	note 3	
	$T_F$	falling	-	9	14			
Luminance (center of screen)	Lw	at center Vabs at center V(λ)	-	500 500	-	cd/m <sup>2</sup>	note 4 note 5	
Dimming range	DR			500:1		-		
Colour gamut	T%	PAL	-	70	-	%	note 6	

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



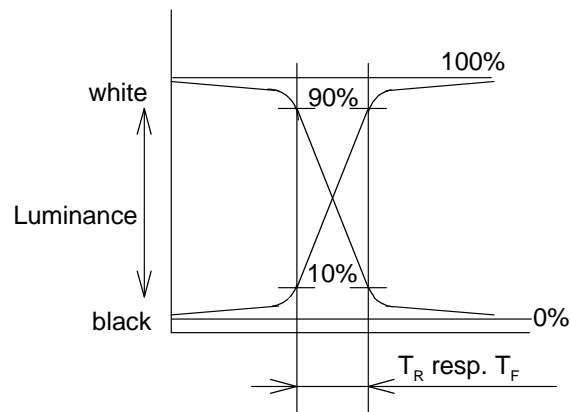
note 2: The contrast ratio is calculated by using the following formula:

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

the brightness is measured in darkroom.

note 3: Definition of response time is as follows.

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



Reference data

$T_a = 0^\circ\text{C}$  white to black tpd = 14 ms typ.  
black to white tpd = 9 ms typ.

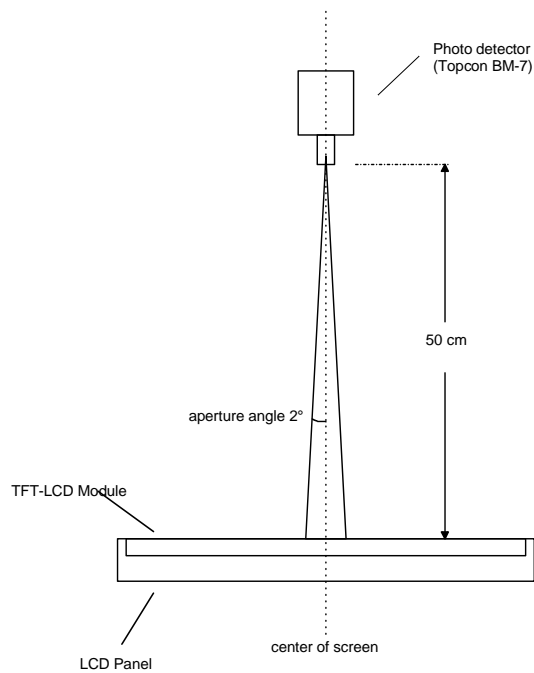
note 4: Brightness measurements setup.

measurement should be executed in a dark room 30 min.

after lightning the backlight. Matrix: off state.

The brightness is measured in the center of the screen.

Environment condition:  $T = 25 \pm 2^\circ\text{C}$ , it has to be assured that a sufficient heat flow / air circulation is given





Typical Design

# Liquid Crystal Display Design

## I-SFT dah168\_104



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note 5: Brightness measurements setup.

measurement should be executed in a daylight room 30 min.

after lightning the backlight. Matrix: off state.

The brightness is measured in the center of the screen.

Environment condition:  $T = 25 \pm 2$  °C, it has to be assured that a sufficient heat flow / air circulation is given

note 6: For the measurement of colour gamut and chromaticity, transmittance, use e3 technology with a colour temperature of 9000 K.



## 7-12 e<sup>3</sup> DRIVER SPECIFICATIONS

### a. PIN CONNECTION

Connector (Series): 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	typ. 12 VDC *1
2	Supply voltage for e <sup>3</sup> driver	typ. 12 VDC *1
3	Factory use only <b>(Do not connect an external signal!)</b>	
4	Digital dimming input	PWM, TTL – Level
5	Reference voltage output For dimming with variable resistor	5 V 4K7
6	Analog dimming input	0-5 VDC *2
7	Ground	GND *1
8	Ground	GND *1

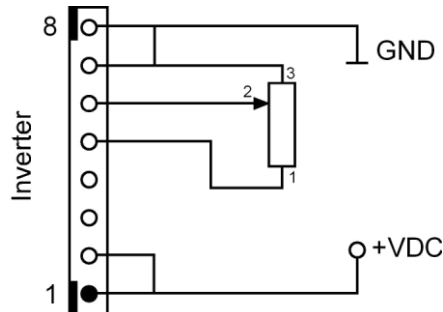
Attention: depending on source and temperature, when switching on, the e<sup>3</sup> driver current can be much higher (see separate application note)

\*1 for connection use both pin 1 and 2 parallel and pin 7 and 8 parallel

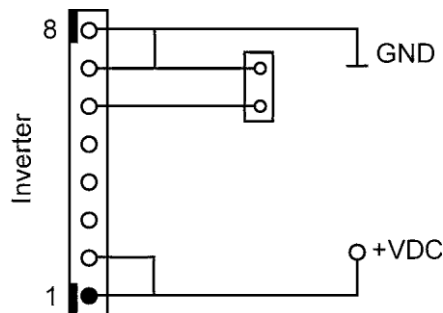
\*2 If no dimming is required, you have to short pin 6 and pin 5 for maximum brightness, 0 VDC= dark, 5 VDC= bright

**b. e<sup>3</sup> DRIVER CONNECTIONS**

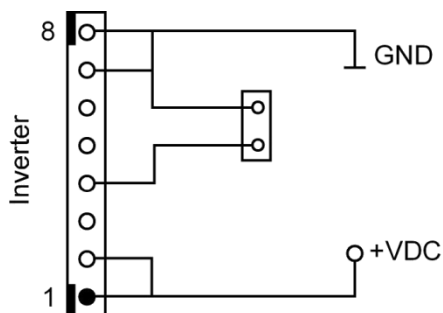
1. Dimming with variable Resistor (pin 7: 0 V)



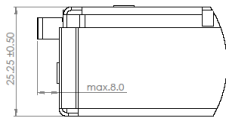
2. Dimming with variable analog DC voltage. Variable voltage 0 to 5 VDC (pin 7: 0 V)



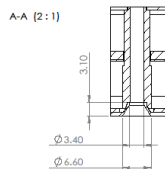
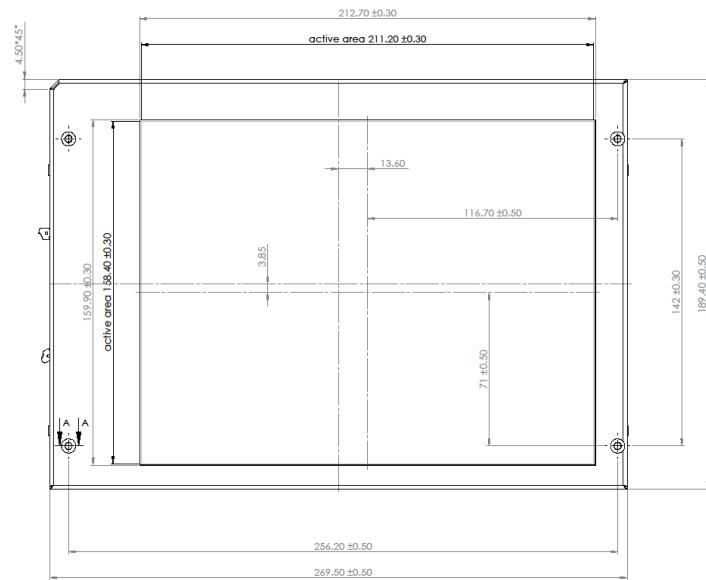
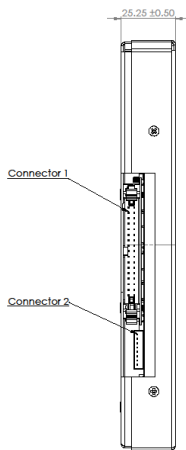
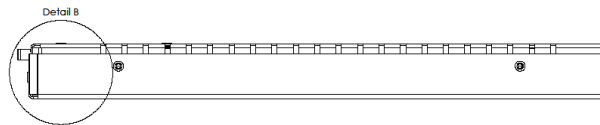
3. Digital Dimming with PWM control 0 to 100% PWM, PWM 200-1000 Hz; TTL-Level (pin 7: 0 V), recommended frequency 200Hz,



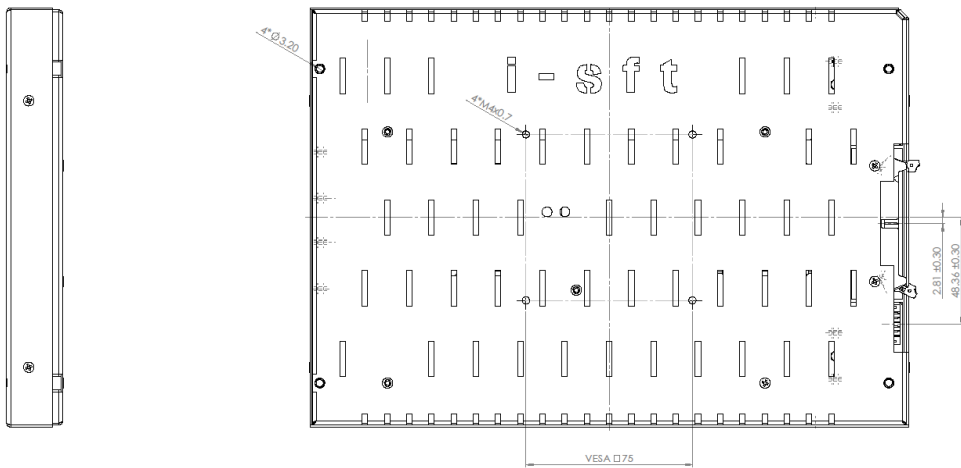
**7-13 MECHANICAL DIMENSIONS**



Detail B (2 : 1)







tolerances according to DIN ISO 2768 T1 class m



## 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 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



### **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 7.4 “ 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.