

Industrial Solutions Flatpanel Technology

DESIGN FOR TFT COLOUR LCD MODULE

Design No.	doh013_105
Revision	i-sft ↔ Rev. 0.2
Specification	
Version	Internal Revision 1.1
Date	28.03.2007
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. 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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1 DESCRIPTION

i-sft doh013_105 is a colour active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) design that uses amorphous silicon TFT as switching devices. This model is composed of a TFT LCD panel, a driver circuit and a backlight system.

i-sft doh013_105 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 surface brightness of up to 12000 nits.
- c. **i-sft** custom made integrated inverter to drive the backlight.

The 10.5 inch diagonal display area contains 640×480 pixels and can display 256k colours simultaneously.

2 FEATURES

- 500 nits display surface
- Thin and light weight
- High contrast ratio, wide viewing angle, high colour gamut
- Variable γ control
- Wide temperature range
- Accepting high shock and vibration levels
- Data enable function
- Fixable connector
- Minimized image sticking (ghost pictures)
- Integrated inverter 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.

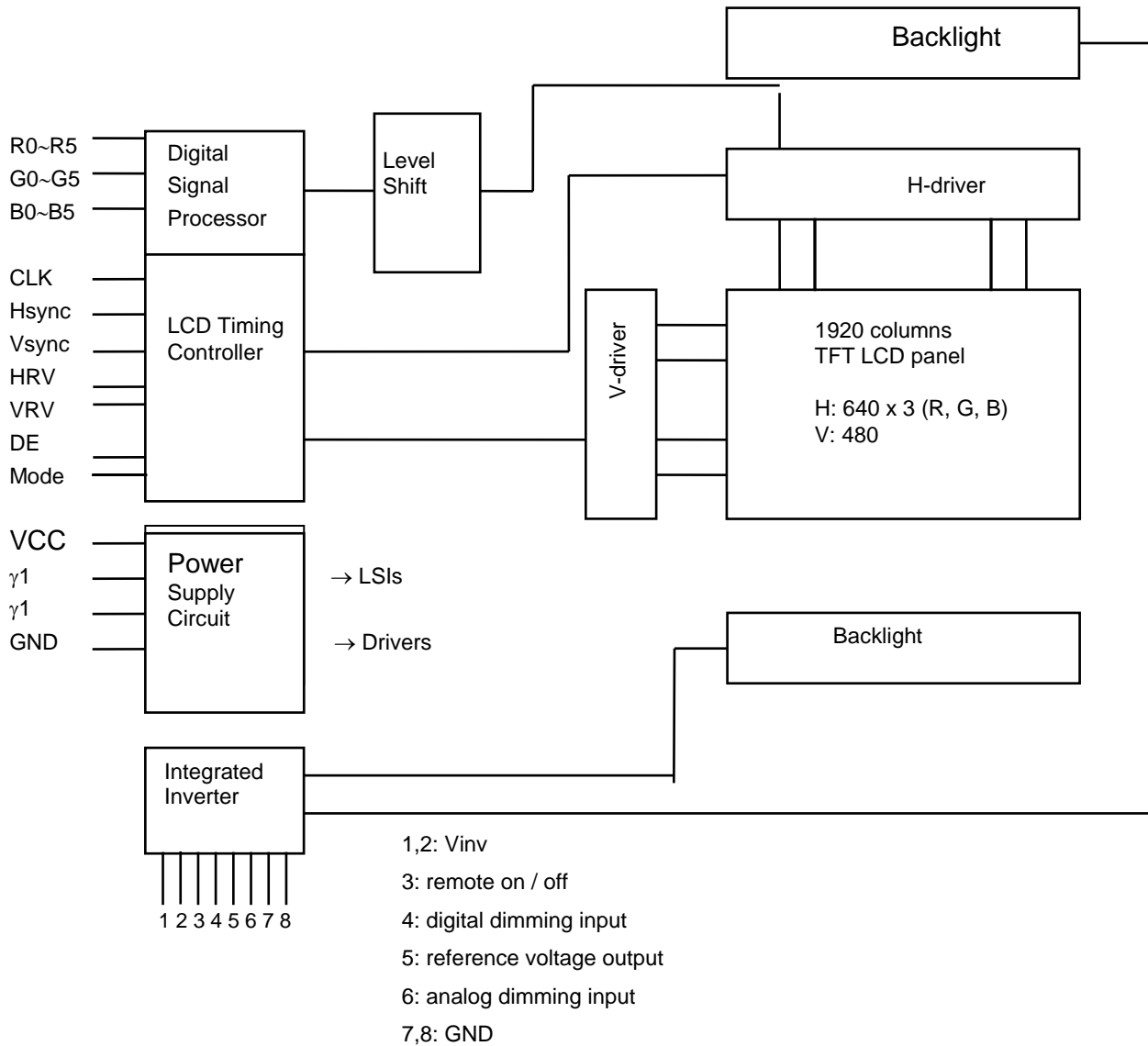
RGB (Red, Green, Blue) data signals are sent through a signal processor to the LCD panel drivers after modulation into suitable forms for active matrix addressing.

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.

5 OUTLINE OF CHARACTERISTICS

ITEM	SPECIFICATION	UNIT	NOTE
Active display area	211.7 (H) x 158.9 (V) (10.5 inch diagonal)	mm	
Driver element	a – Si TFT active matrix		
Display colours	262,144		
Number of pixels	640 x 480	pixel	
Luminance (typ.)	500	cd/m ²	
Dimming ratio	1 : 250		
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.33 (H) x 0.33 (W)	mm	
Display mode	Normally White		
Surface treatment	Anti - glare, hard - coating (3H)		

6 BLOCK DIAGRAM



7 SPECIFICATIONS

7-1 GENERAL SPECIFICATIONS

ITEM		TYP.	UNIT
Module size	Horizontal (H)	271.0	mm
	Vertical (V)	192.0	mm
	Depth (D)	27.0	mm
Weight		1220	g

7-2 ABSOLUTE MAXIMUM RATINGS

ITEM	SYMBOL	MIN.	MAX.	UNIT	NOTE
Storage temperature	T_{STG}	-35	85	°C	
Operating temperature (Surface of glass)	T_{OPR}	-25	85	°C	
Shock (operating)	S_{nop}	-	100	g	(1)
Vibration (operating)	V_{nop}	-	3	g	(2)

Note

(1) 11 ms.

(2) 5 – 150 Hz

7-3 ELECTRICAL CHARACTERISTICS

(1) Logic, LCD driving

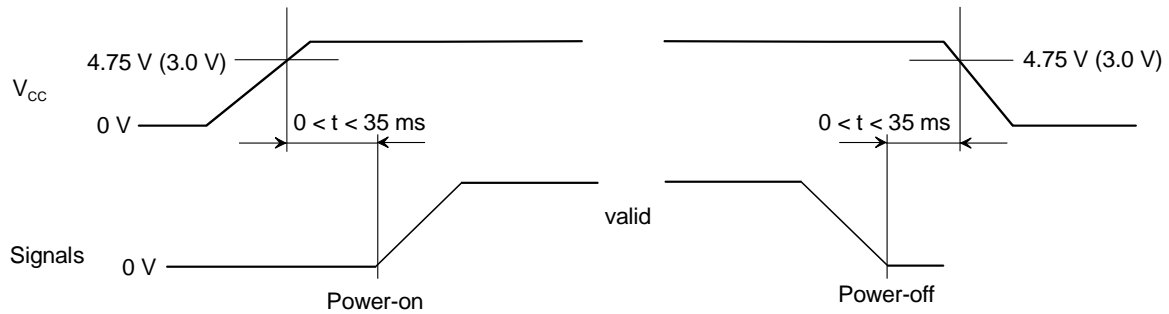
Ta = 25°C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	V _{CC}	4.75 (3.0)	5.0 (3.3)	5.25 (3.6)	V	V _{CC} = 5.0 V (V _{CC} = 3.3 V)
Logic input "L" voltage	V _{IL}	0	-	V _{CC} x 0.3	V	CMOS level
Logic input "H" voltage	V _{IH}	V _{CC} x 0.7	-	5.25	V	
Supply current	I _{CC}	-	400 ‡ 1	500	mA	V _{CC} = 5.0 V
		-	(500)	600		(V _{CC} = 3.3 V)
Input current (Low) ‡ 2 VI = 0V	I _{OL1}	-	10 ⁻⁵ (10 ⁻⁵)	10.0 (8.0)	µA	V _{CC} = 5.0 V
	I _{OL2}	-	-0.15 (-0.2)	-0.3 (-0.4)	µA	(V _{CC} = 3.3 V)
Input current (High) ‡ 2 VI = V _{CC}	I _{OH1}	-	10 ⁻⁵ (10 ⁻⁵)	10.0 (8.0)	µA	V _{CC} = 5.0 V
	I _{OH2}	-	100 (70)	200 (150)	µA	(V _{CC} = 3.3 V)

‡ 1: Checker flag pattern (in EIAJ ED-2522)

‡ 2: I_{OL1}, I_{OH1} CLK, Hsync, Vsync, R0-R5, G0-G5, B0-B5, DE, MODE
I_{OL2}, I_{OH2} HRV, VRV

7-4 SUPPLY VOLTAGE SEQUENCE



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, MODE and DATA) low level or high impedance.

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	MODE	note 1
31	HRV	note 2
32	VRV	note 3
33	γ 1	note 4
34	γ 2	note 5

note:

- | | | |
|-----------|---|---|
| 1) MODE: | L or OPEN = DE mode
H = fixed timing mode | LSB: Least Significant Bit
MSB: Most Significant Bit |
| 2) HRV *: | L or OPEN = scanning is normal
H = scanning is reverse
47 K Ω at pull down (old 1 K Ω) | Input current
Vin = 0 V-0,15 μ Vcc 5.0 V
-0,2 μ Vcc 3.3 V |
| 3) VRV *: | L or OPEN = scanning is normal
H = scanning is reverse
47 K Ω at pull down (old 1 K Ω) | Vin = Vcc100 μ Vcc 5.0 V
70 μ Vcc 3.3 V |

*see from TFT side

HRV : L

HRV : H

HRV : L

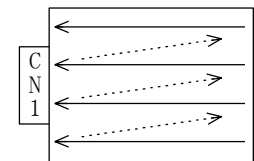
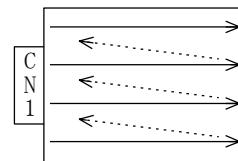
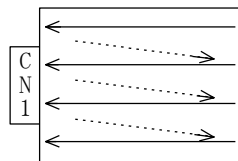
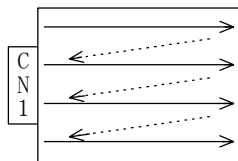
HRV : H

VRV : L

VRV : L

VRV : H

VRV : H

4) γ_1, γ_2 : Adjustment of γ correction.

The pins 33 " γ_1 " and 34 " γ_2 " should be left open for best optical performance! (otherwise the optical performance will be programmed for special use).



Variable resistor for special use ONLY!
Mating VR: 2.2 k Ω \pm 5%

5) GND is connected to frame of the LCD module.

7-6 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	0	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	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
	Green	0	0	0	0	0	0	1	1	1	1	1	0	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: 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.

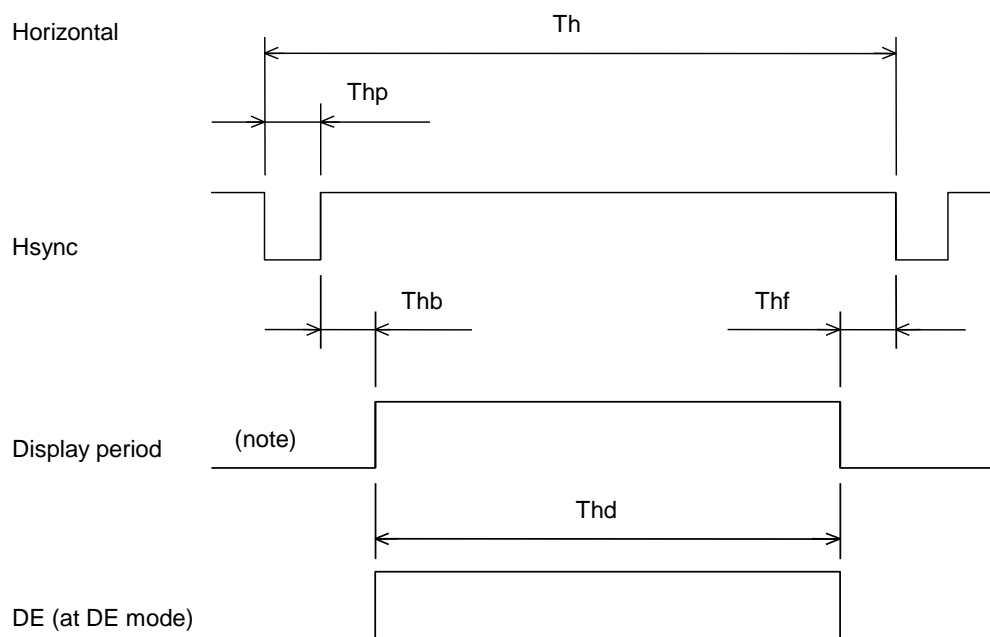
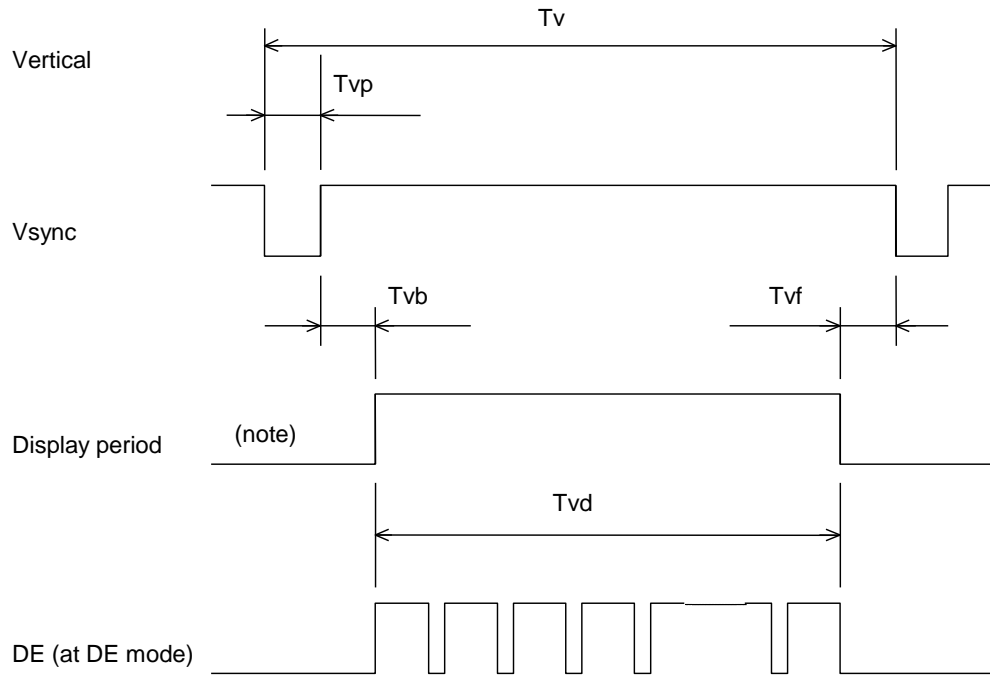
7-7 INPUT SIGNAL TIMING

(1) INPUT SIGNAL SPECIFICATIONS

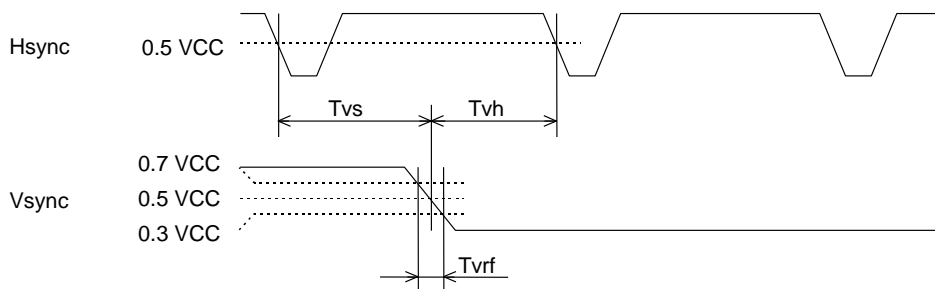
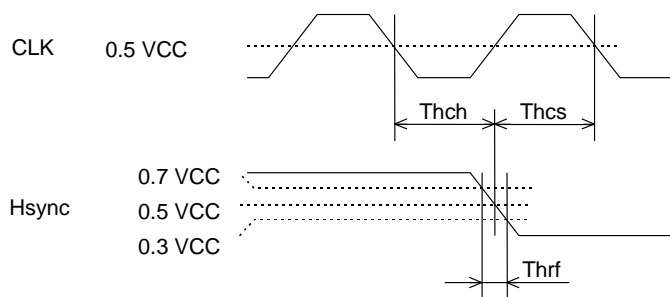
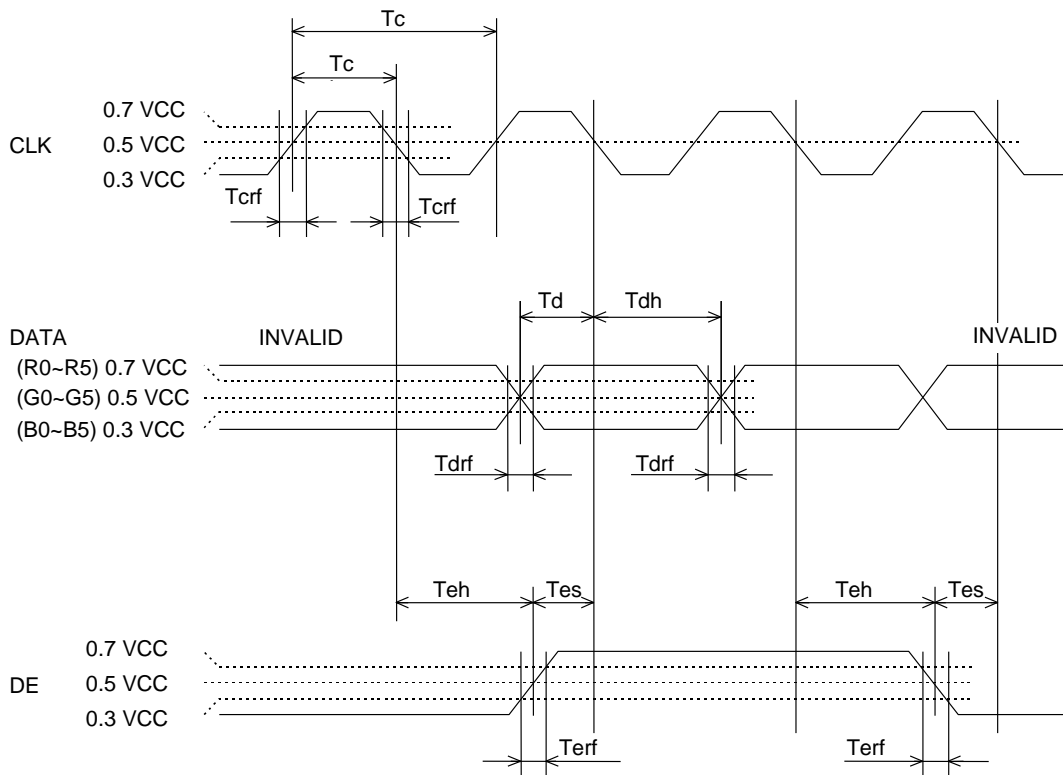
Parameter		Symbol	MIN.	TYP.	MAX.	Unit	Remarks
CLK	Frequency	1/Tc	21.0	25.175	29.0	MHz	39.722ns (TYP.)
	Duty	Tch/Tc	0.4	0.5	0.6		
	Rise, Fall	Tcrf	-	-	10	ns	
Hsync	Period	Th	30.0	31.778	33.6	μs	31.469kHz (TYP.)
			-	800	-	CLK	
	Display period	Thd	640			CLK	
	Front-porch	Thf	-	16	-	CLK	fixed timing mode
			4	16	-	CLK	DE mode
	Pulse width	Thp *)	10	96	140	CLK	fixed timing mode
			10	96	-	CLK	DE mode
	Back-porch	Thb *)	4	48	134	CLK	fixed timing mode
			4	48	-	CLK	DE mode
	*) Thp-Thb		144			CLK	fixed timing mode
	*) Thp-Thb		14	144	-	CLK	DE mode
	CLK-Hsync timing	Thch	12	-	-	ns	
	Hsync-CLK timing	Thcs	8	-	-	ns	
Hsync-Vsync timing	Tvh	1	-	-	CLK	1CLK=39,722ns (TYP.)	
Vsync-Hsync timing	Tvs	30	-	-	ns		
Rise, Fall	Thrf	-	-	10	ns		
Vsync	Period	Tv	16.1	16.683	17.2	ms	59.94Hz (TYP.)
			-	525	-	H	
	Display Period	Tvd	480			H	
	Front-porch	Tvf	-	12	-	H	fixed timing mode
			1	12	-	H	DE mode
	Pulse width	Tvp *)	1	2	29	H	fixed timing mode
			1	2	-	H	DE mode
	Back-porch	Tvb *)	4	31	32	H	fixed timing mode
4			31	-	H	DE mode	
*) Tvp+Tvb		33			H	fixed timing mode	
*) Tvp+Tvb		5	33	-	H	DE mode	
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	DE-CLK timing	Tes	8	-	-	ns	DE mode
	CLK-DE timing	The	12	-	-	ns	
	Rise, Fall	Terf	-	-	10	ns	

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

(2) DEFINITION OF INPUT SIGNAL TIMING

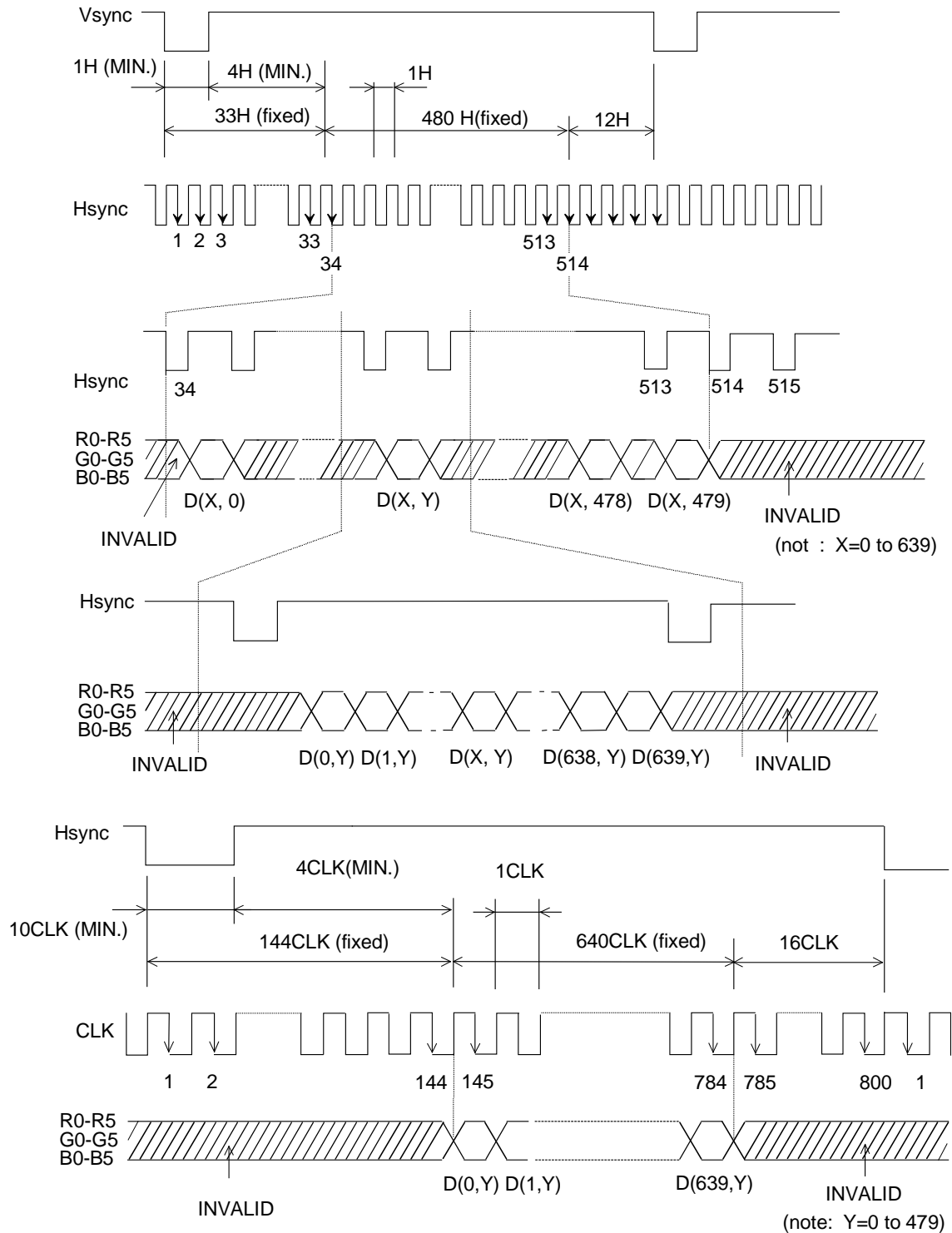


note: these signals do not exist

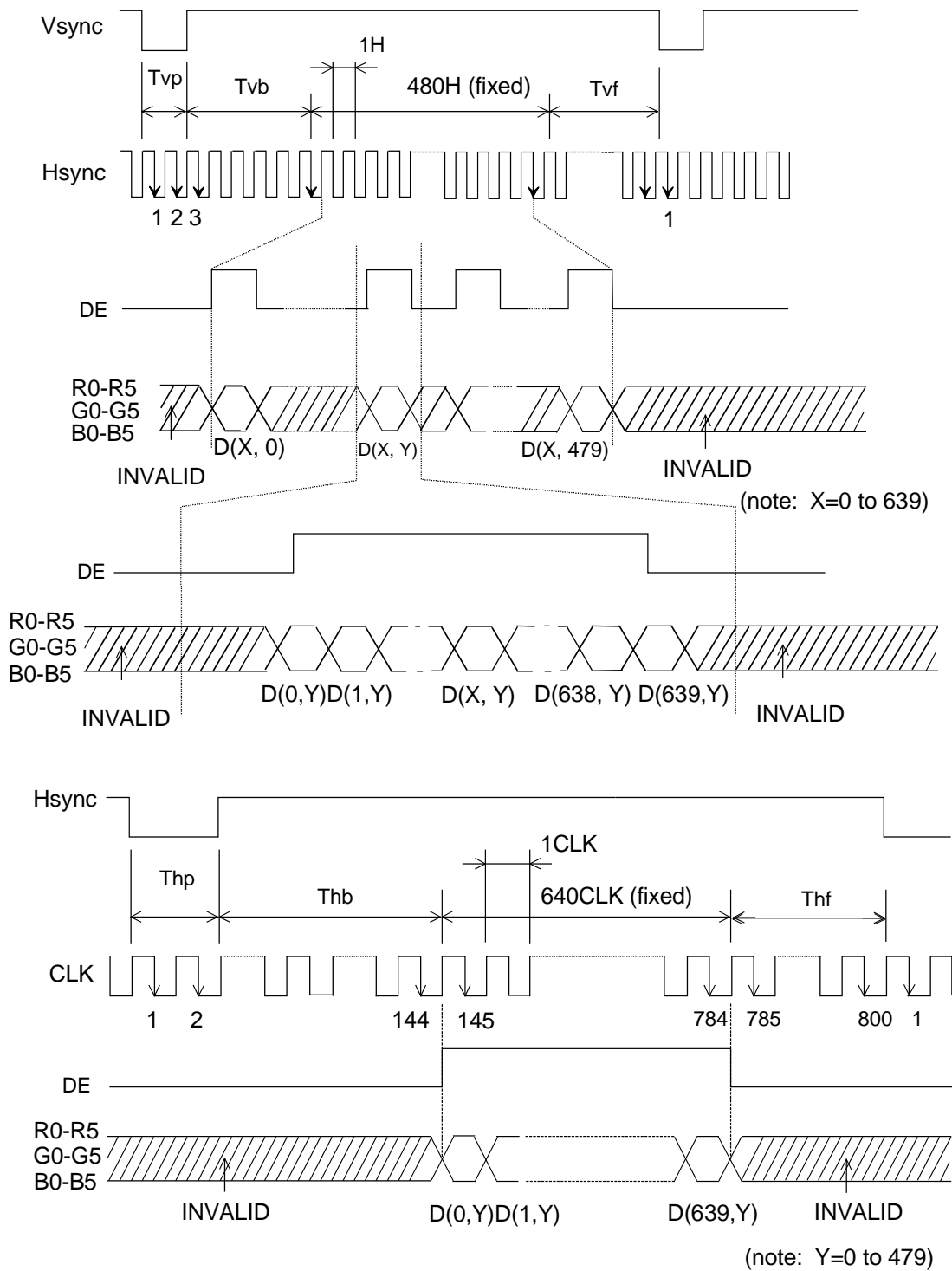


(3) INPUT SIGNAL TIMING CHART

a. fixed timing mode



b. DE mode



7-8 DISPLAY POSITION

at HRV: L and VRV: L

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)

7-9 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: Cold Cathode Fluorescent Lamp

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

Luminance of backlight surface for inspection: 12000 cd/m².

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 ≤ 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 more dots *3			R, G, B ≤ 0	
Dark dots *2	Colour	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	

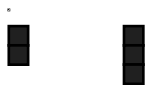
*1 F: Full luminous dots (Bright point independent of viewing angle)
 H: Half luminous dots (Bright point dependent on viewing angle)
 Luminous dots are measured while the screen is black.

*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)



	To be counted	To be uncounted
Luminous dots	Same colour	Different colour
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
	$0.2 < \varnothing < 0.3$		≤ 10 points
	$0.3 < \varnothing \leq 0.5$		≤ 3 points
	$0.5 < \varnothing$ Linked other objects		0 point
Other objects Stains Dust (line shape)	Width(W) mm	Length(L) mm	all allowed
	$W \leq 0.05$	-	
	$0.05 \leq W \leq 0.1$	$L < 0.7$	≤ 4 points
		$0.7 \leq L \leq 1.0$	≤ 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".

7-10 OPTICAL CHARACTERISTICS

Measuring equipment:

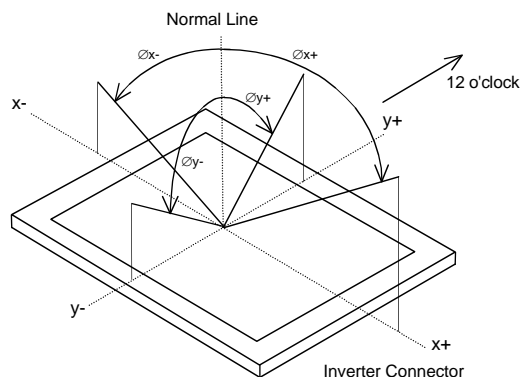
Luminance: TOPCON BM-7

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	$\varnothing x+$	CR>5, $\varnothing y = \pm 0^\circ$	-	80	-	deg.	note 1
		$\varnothing x-$	CR>5, $\varnothing y = \pm 0^\circ$	-	80	-	deg.	
	Vertical	$\varnothing y+$	CR>5, $\varnothing x = \pm 0^\circ$	-	80	-	deg.	
		$\varnothing y-$	CR>5, $\varnothing x = \pm 0^\circ$	-	45	-	deg.	
Contrast ratio		CR	$\varnothing y = -5^\circ, \varnothing x = \pm 0^\circ$	-	250:1	-	-	note 2
Response time		T_R T_F	rising falling	-	15 35	-	ms	note 3
Luminance (center of screen)		Lw	at center Vabs at center V(λ)	-	600 500	-	cd/m ²	note 4 note 5
Dimming range		DR			250:1		-	
Colour gamut		C	NTSC	-	50	-	%	note 6
Chromaticity	red x	at center	-	0.594				note 6
	red y		-	0.372				
	green x	at center	-	0.343			note 6	
	green y		-	0.560				
	blue x	at center	-	0.171			note 6	
	blue y		-	0.191				
	white x	at center	-	0.361			note 6	
	white y		-	0.368				

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



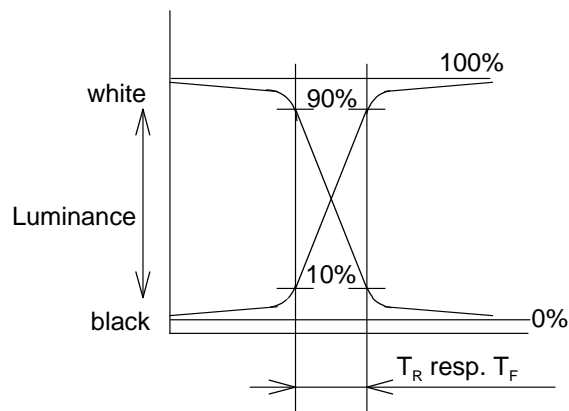
note 2: The contrast ratio is calculated by using the following formula:

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

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 = 15 ms typ.

black to white tpd = 35 ms typ.

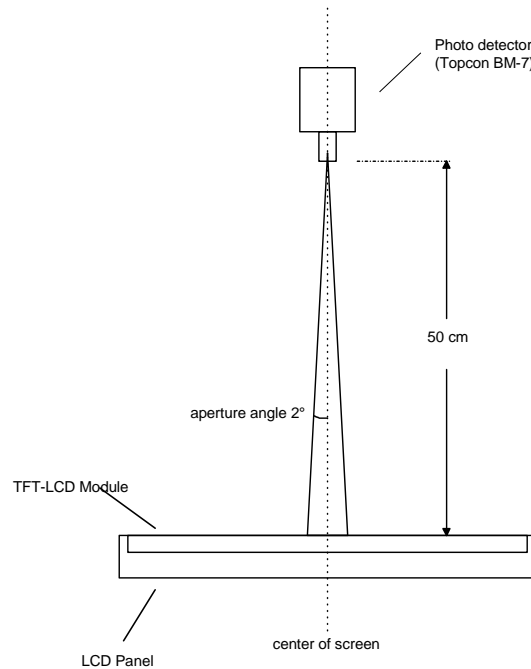
note 4: Brightness measurements setup.

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



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 a lamp with a colour temperature of 6000 K.

7-11 INVERTER 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 inverter	typ. 12 VDC / 1.6 A *1
2	Supply voltage for inverter	typ. 12 VDC / 1.6 A *1
3	Backlight on / off	n.c. -> on *2 GND -> off
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 *3
7	Ground	GND *1
8	Ground	GND *1

Attention: depending on source and temperature, when switching on, the inverter current can be much higher (see separate application note)

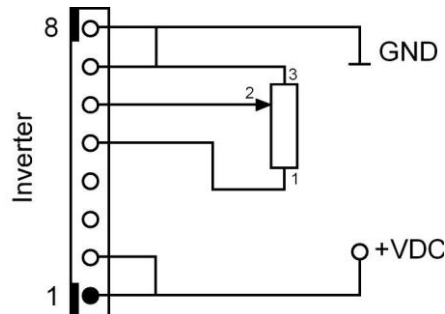
*1 for connection use both pin 1 and 2 parallel and pin 7 and 8 parallel

*2 n.c.: no connection (leave pin open)

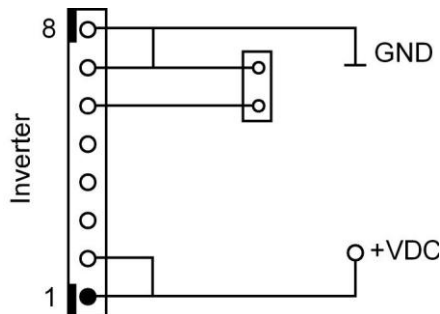
*3 If no dimming is required, you have to short pin 6 and pin 5 for maximum brightness, 0 VDC= dark, 5 VDC= bright

b. INVERTER CONNECTIONS

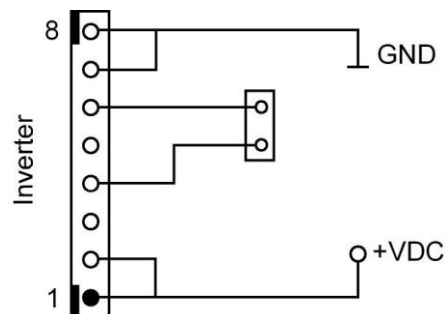
1. Dimming with variable Resistor (pin 7: 0 V)



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,



7-12 RELIABILITY TESTS

No.	Test Item	Number	Test Condition	Judgement
1.	High Temperature (operation)	10p	1. $85 \pm 2 \text{ }^\circ\text{C}$ 2. 120 hours 2. Display data is black. *4	*1
2.	High Temperature / Humidity (operation)	10p	1. $60 \pm 2 \text{ }^\circ\text{C}$, 90% relative humidity 2. 24 hours 3. Display data is black. *4	*1
3.	Thermal shock (operation)	10p	1. $-35 \pm 3 \text{ }^\circ\text{C}$, ... 30 minutes $85 \pm 3 \text{ }^\circ\text{C}$, ... 30 minutes 2. 100 cycles 3. Temperature change within 5 minutes	*1
4.	Heat Cycle (operation)	10p	1. $-25 \pm 3 \text{ }^\circ\text{C}$, ... 2 hours $85 \pm 3 \text{ }^\circ\text{C}$, ... 2 hours 2. 35 cycles 3. Temperature change within 2 hours 4. Display data is black. *4	*1
5.	Vibration (operation)	5p	1. 5 Hz...21 mmp-p 5-150 Hz..3G 1 minute/cycle, X,Y,Z 6 direction sine wave, log sweep, $25 \pm 5 \text{ }^\circ\text{C}$ 2. 20 times each direction Display data is black. *4	*1
6.	Mechanical Shock (operation)	5p	1. 100 G, 11 ms X, Y, Z direction half sine wave, $25 \pm 5 \text{ }^\circ\text{C}$ 2. 5 times each direction 3. Display data is black. *4	*1 *2
7.	ESD (non-operation)	5p	150 PF, 150 Ω , +10 kV 9 places on a panel *3 10 times each place at 1sec. intervals	*1
8.	Drop Test (non-operation)	1 box	Drop packaged modules to concrete floor from 70 cm high, 3 times each face.	*1

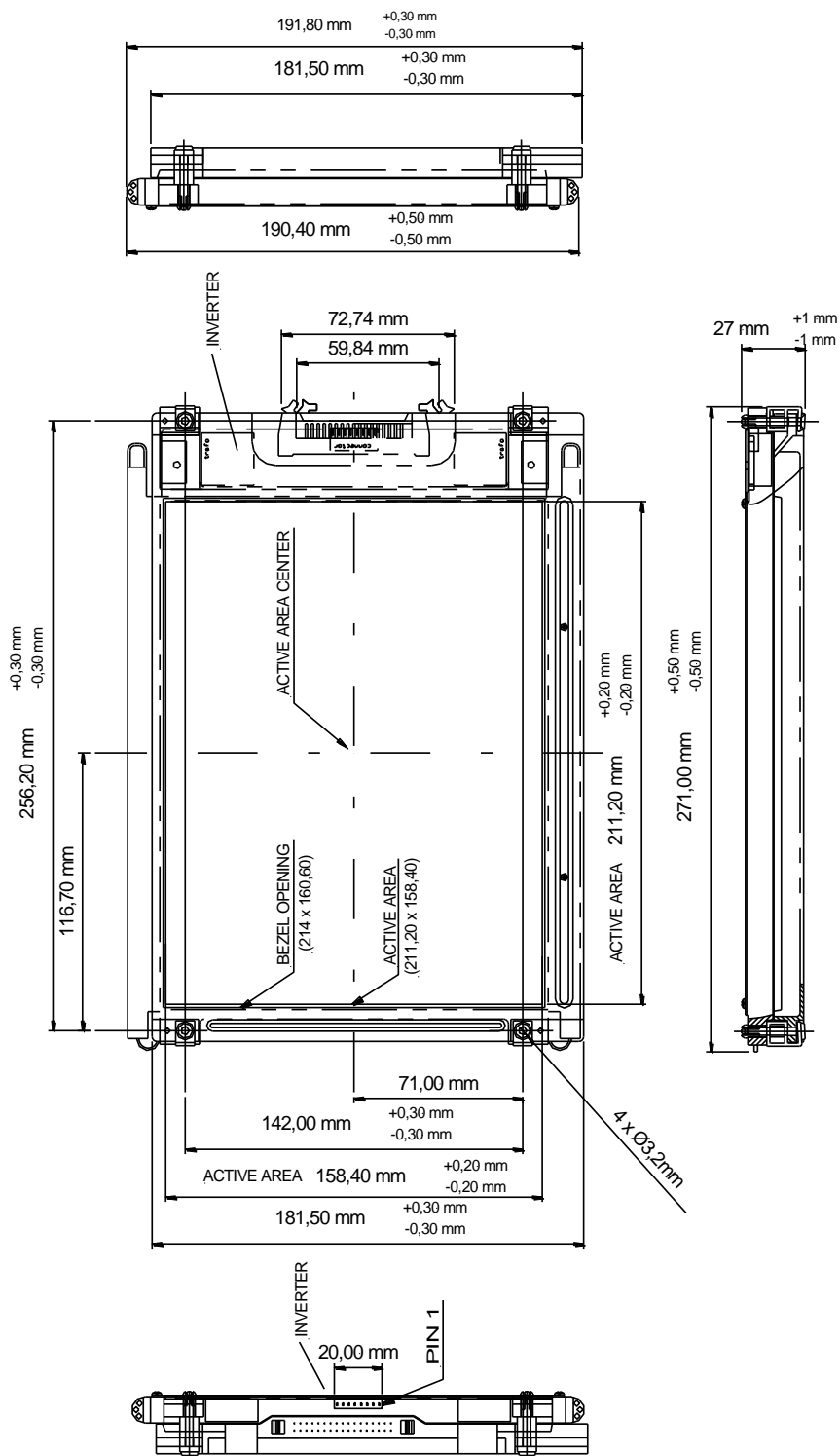
*1: Display function

*2: Physical damage

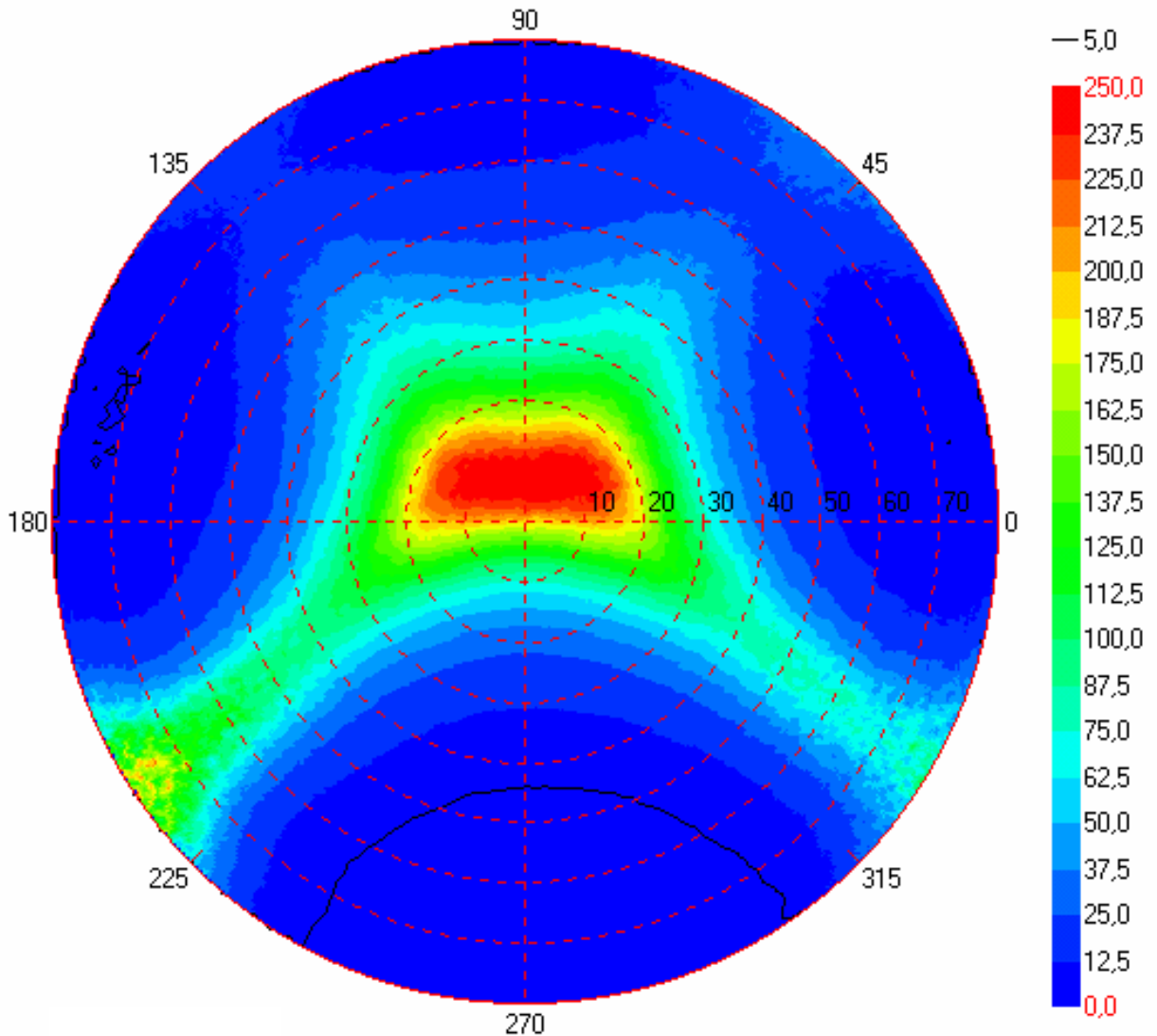
*3: Discharge points are
shown in the figure

*4: all pixel are "ON"

7-13 OUTLINE DIMENSIONS



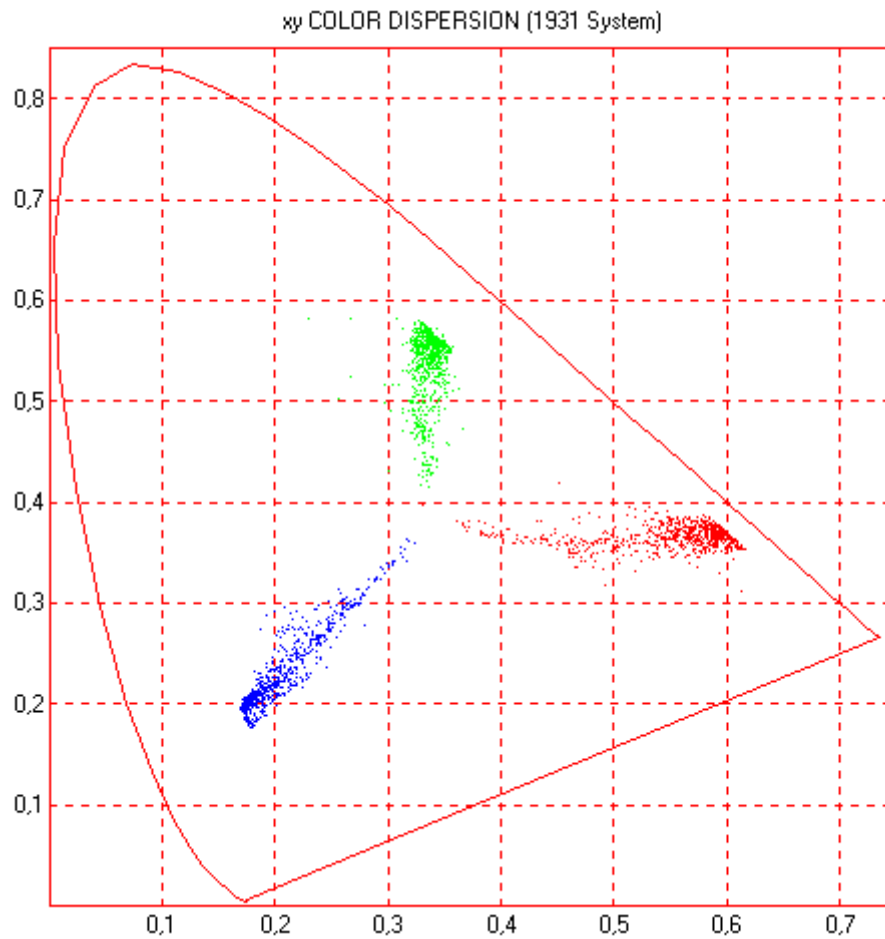
7-14 MEASUREMENTS



Typical measurement for i-sft Rel 2 (Display orientation: connector points to the left)

This omni-directional plot shows contrast ratio vs. viewing angle in range of left/right 80° / 80° and top/down 80° / 80°.

The different colours represent the contrast from 0 contrast (dark blue) to 250:1 contrast (bright red)



This plot shows the distribution of colour coordinates for red, green and blue over the complete viewing angle of left / right $80^\circ / 80^\circ$ and top / down $80^\circ / 80^\circ$.