



Display Future Ltd

www.displayfuture.com

LCD MODULE SPECIFICATION

Model: DF-TFC0345FW-M1

This module uses ROHS materials

For customer acceptance

Customer		date
Approved		
Comments		

The standard product specification may change without prior notice in order to improve performance or quality. Please contact Display Future Ltd for updated specification and product status before design for the standard product or release of the order.

Revision	1.0
Engineering	
Date	2018/01/4
Our Reference	

REVISION RECORD

REV NO.	REV DATE	CONTENTS	REVISED PAGE NO.
1.0	2017-12-01	First Release	

CONTENTS

- GENERAL INFORMATION
- EXTERNAL DIMENSIONS
- ABSOLUTE MAXIMUM RATINGS
- ELECTRICAL CHARACTERISTICS
- BACKLIGHT CHARACTERISTICS
- ELECTRO-OPTICAL CHARACTERISTICS
- INTERFACE DESCRIPTION
- APPLICATION NOTES
- RELIABILITY TEST
- INSPECTION CRITERION
- PRECAUTIONS FOR USING LCD MODULES
- USING LCD MODULES
- PRIOR CONSULT MATTER

■ GENERAL INFORMATION

Item	Contents	Unit
LCD type	TFT/Transmissive/Normally white	/
Size	3.5	Inch
Viewing direction	12:00(without image inversion and least brightness change)	O' Clock
Gray scale inversion direction	6:00 (contrast peak located at)	O' Clock
LCM (W × H × D)	76.90×63.90×5.0	mm ³
Active area (W×H)	70.08×52.56	mm ²
Pixel pitch (W×H)	0.219×0.219	mm ²
Number of dots	320 (RGB) × 240	/
Driver IC	NV3035C	/
Backlight type	6 LEDs	/
Interface type	RGB/CCIR656/601	/
Color depth	16.7M	/
Pixel configuration	R.G.B vertical stripe	/
Top polarizer surface treatment	Glare	/
Input voltage	3.3	V
With/Without TSP	With CTP	/
TP surface treatment	-	g
Weight	TBD	g

Note 1 :RoHS compliant;

Note 2 :LCM weight tolerance: ± 5% .

EXTERNAL DIMENSIONS

DETAIL A
(SCALE 50:1)

DETAIL B
(SCALE 2:1)

DETAIL C
(SCALE 2:1)

FRONT

BACK

BACKLIGHT CIRCUIT DIAGRAM

PN ASSIGNMENT FOR CTP

1	VSS
2	VCC
3	SCL
4	NC
5	SDA
6	NC
7	/INT
8	NC
9	/MI
10	VSS

PN ASSIGNMENT FOR LCM

1	LED_A	29	SD17
2	LED_A	30	D18
3	LED_A	31	SD19
4	LED_A	32	D20
5	NC	33	SD21
6	NC	34	D22
7	NC	35	D23
8	NC	36	SD24
9	NC	37	SD25
10	NC	38	SD26(SD27)
11	NC	39	NC
12	D28	40	NC
13	SD29	41	SD30
14	SD31	42	SD32
15	SD33	43	SD34(SD35)
16	SD36	44	NC
17	SD37	45	NC
18	SD38	46	NC
19	SD39	47	NC
20	SD40	48	NC
21	SD41	49	SD42(SD43)
22	SD44	50	SD45(SD46)
23	SD47	51	NC
24	SD48	52	SD49(SD50)
25	SD51	53	D50
26	SD52	54	D51
27	SD53	55	D52
28	SD54	56	D53

NOTES FOR LCM:

- DISPLAY TYPE: TFT TRANSMISSIVE
- OPERATING VOLTAGE: VDD=3.3V
- VIEWING DIRECTION: 12 O'CLOCK.
- IC DRIVER: NV2035C
- OPERATING TEMP.: -20C ~ 70C.
- STORAGE TEMP.: -30C ~ 80C.
- BACKLIGHT: 6-CHIP WHITE LED (I=30mA/V=19.2V).
- SURFACE LUMINANCE: 4200D/N(7/TP?)
- TOP POLARIZER SURFACE TREATMENT: GLARE.
- GENERAL TOLERANCE: ±0.2mm.
- ROHS COMPLIANT:

NOTES FOR CTP:

- 3.5" PROTECTIVE CAPACITIVE TOUCH PANEL.
- OPERATING VOLTAGE: VCC=10V/VC=3.3V.
- COVER GLASS + SENSOR GLASS + FPCK.
- RESOLUTION: 320 X 240 DOTS.
- CONTROLLER: FT5446D03; IIC INTERFACE.
- MULTI-FIGER: UP TO 5.
- HARDNESS OF COVER SURFACE: 7H.
- TRANSMITTANCE: >=85%.
- FIRMWARE FILE: M0350CFP-C3 V02 FIRMWARE 20170322.

REVISION HISTORY

DT	REVISION DESCRIPTION	REVISION DATE	VERSION
01 <td>FIRST ISSUE <td></td> <td>01</td> </td>	FIRST ISSUE <td></td> <td>01</td>		01

MODULE P/N: 2017.12.01

CHECKED BY: _____

APPROVED BY: _____

UNIT: mm

DESCRIPTION: TFT & CTP MODULE

Display Future Ltd.

■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Min	Max	Unit
Power supply voltage	VDD	-0.3	5.0	V
Logic input signal voltage	VIN	-0.3	VDD+0.3	V
Backlight forward current	I _{LED}	-	25	mA
Operating temperature	Top	-20	70	°C
Storage temperature	Tst	-30	80	°C

Note 1: VIN:R7-R2,G7-G2,B7-B2,RESET,SPENA,SPCK,SPDA,HSYNC,VSYNC,CLK,DEN.

■ ELECTRICAL CHARACTERISTICS

DC CHARACTERISTICS

Parameter	Symbol	Min	Typ	Max	Unit
Power supply voltage	VDD	3.0	3.3	3.6	V
Input voltage'H'level	VIH	0.8xVDD	-	VDD	V
Input voltage'L'level	VIL	0	-	0.2xVDD	V

■ BACKLIGHT CHARACTERISTICS

Item	Symbol	Min.	Typ.	Max.	Unit	Condition
Forward voltage	Vf	-	19.2	21.6	V	Ta=25±2°C, 60%RH±5%
Forward current	If	-	20	25	mA	
Power consumption	W _{BL}	-	384	-	mW	
Operating life time	-	20,000	-	-	Hrs	

Note :

Operating life time means brightness goes down to 50% initial brightness;

The life time of LED will be reduced if LED is driven by high current,high ambient temperature and humidity conditions.

■ELECTRO-OPTICAL CHARACTERISTICS

Item	Symbol	Condition	Min	Typ	Max	Unit	Remark	Note
Response time	Tr+Tf	θ=0° ∅=0° Ta=25°C	-	25	30	ms	FIG 1.	4
Contrast ratio	Cr		400	500	-	---	FIG 2.	1
Luminance uniformity	δ WHITE		75	80	-	%	FIG 2.	3
Surface Luminance	Lv		350	420	-	cd/m ²	FIG 2.	2
Viewing angle range	θ	∅ = 90°	50	60	-	deg	FIG 3.	6
		∅ = 270°	60	70	-	deg	FIG 3.	
		∅ = 0°	60	70	-	deg	FIG 3.	
		∅ = 180°	60	70	-	deg	FIG 3.	
CIE (x, y) chromaticity	Red	x	0.541	0.591	0.641	FIG 2.	5	
		y	0.260	0.310	0.360			
	Green	x	0.292	0.342	0.402			
		y	0.511	0.561	0.611			
	Blue	x	0.095	0.145	0.195			
		y	0.037	0.087	0.137			
	White	x	0.260	0.310	0.360			
		y	0.283	0.333	0.383			

Note 1. Contrast Ratio(CR) is defined mathematically as For more information see FIG 2.:

$$\text{Contrast Ratio} = \frac{\text{Average Surface Luminance with all white pixels (P}_1, P_2, P_3, P_4, P_5)}{\text{Average Surface Luminance with all black pixels (P}_1, P_2, P_3, P_4, P_5)}$$

Note 2. Surface luminance is the LCD surface from the surface with all pixels displaying white. For more information see FIG 2.

$$L_v = \text{Average Surface Luminance with all white pixels (P}_1, P_2, P_3, P_4, P_5)$$

Note 3. The uniformity in surface luminance, δ WHITE is determined by measuring luminance at each test position 1 through 5, and then dividing the maximum luminance of 5 points luminance by minimum luminance of 5 points luminance. For more information see FIG 2.

$$\delta \text{ WHITE} = \frac{\text{Minimum Surface Luminance with all white pixels (P}_1, P_2, P_3, P_4, P_5)}{\text{Maximum Surface Luminance with all white pixels (P}_1, P_2, P_3, P_4, P_5)}$$

Note 4. Response time is the time required for the display to transition from White to black(Rise Time, Tr) and from black to white(Decay Time, Tf). For additional information see FIG 1. The test equipment is Autronic-Melchers's ConoScope. Series

Note 5. CIE (x, y) chromaticity, The x,y value is determined by measuring luminance at each test position 1 through 5, and then make average value

Note 6. Viewing angle is the angle at which the contrast ratio is greater than 2. For TFT module the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface. For more information see FIG 3.

Note 7. For Viewing angle and response time testing, the testing data is base on Autronic-Melchers's ConoScope. Series Instruments. For contrast ratio, Surface Luminance, Luminance uniformity, CIE The test data is base on TOPCON's BM-5 photo detector.

Note 8. For TFT module, Gray scale reverse occurs in the direction of panel viewing angle.

FIG.1. The definition of Response Time

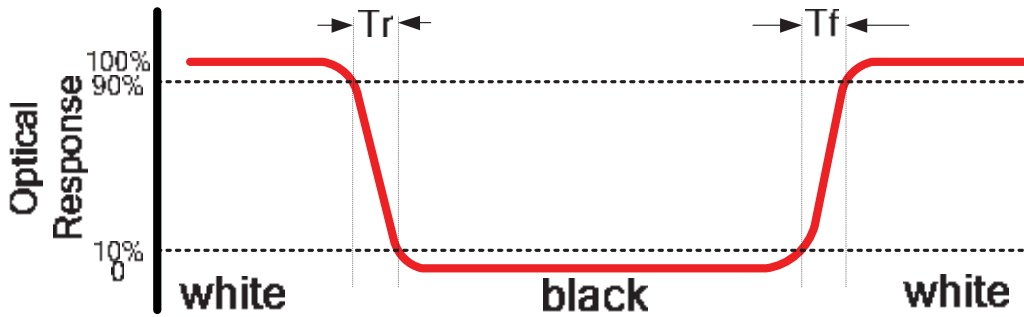


FIG.2. Measuring method for Contrast ratio, surface luminance, Luminance uniformity, CIE (x, y) chromaticity

A : 5 mm
 B : 5 mm
 H, V : Active Area
 Light spot size $\varnothing=5\text{mm}$, 500mm distance from the LCD surface to detector lens
 measurement instrument is TOPCON's luminance meter BM-5

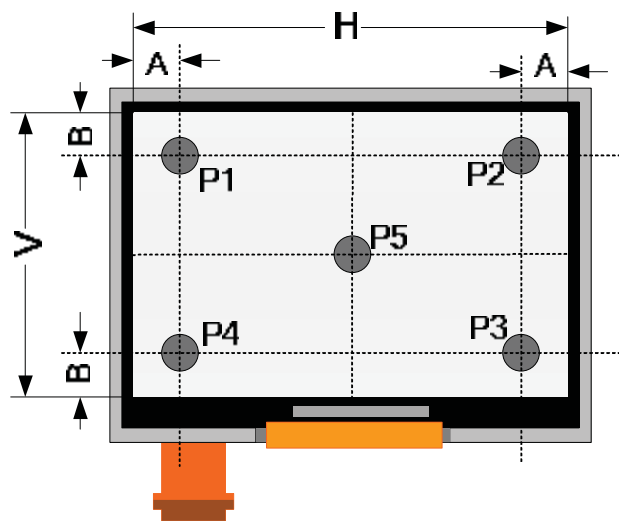
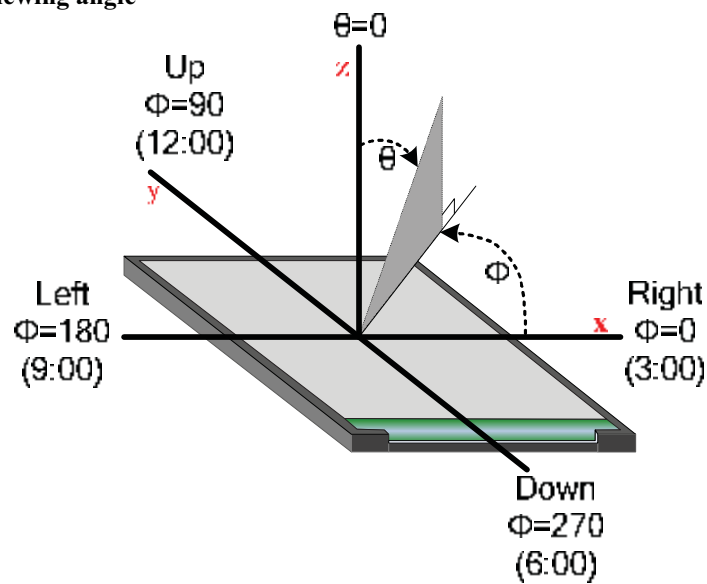


FIG.3. The definition of viewing angle



■ INTERFACE DESCRIPTION

Pin No.	Symbol	Description
1	LEDK	Cathode of LED backlight
2	LEDK	Cathode of LED backlight
3	LEDA	Anode of LED backlight
4	LEDA	Anode of LED backlight
5	NC	No connect
6	RESET	Reset pin
7	NC	No connect
8	NC	No connect
9	NC	No connect
10	NC	No connect
11	NC	No connect
12	D00	Data bus
13	D01	Data bus
14	D02	Data bus
15	D03	Data bus
16	D04	Data bus
17	D05	Data bus
18	D06	Data bus
19	D07	Data bus
20	D08	Data bus
21	D09	Data bus
22	D10	Data bus
23	D11	Data bus
24	D12	Data bus
25	D13	Data bus
26	D14	Data bus
27	D15	Data bus
28	D16	Data bus
29	D17	Data bus
30	D18	Data bus
31	D19	Data bus
32	D20	Data bus
33	D21	Data bus
34	D22	Data bus
35	D23	Data bus
36	HSYNC	Horizontal sync signal
37	VSYNC	Vertical sync signal
38	CLK (Dotclock)	Pixel clock

39	NC	NO connect
40	NC	NO connect
41	VDD	Power supply
42	VDD	Power supply
43	SPENA(ncs)	Serial transmissive enable
44	NC	No connect
45	NC	No connect
46	NC	No connect
47	NC	No connect
48	NC	No connect
49	SPCK (SCL)	Serial clock
50	SPDA (SDA)	Serial data input
51	NC	No connect
52	DEN	Data enable
53	GND	Ground
54	GND	Ground

Note :

Mode	D(23:16)	D(15:8)	D(7:0)	HSYNC	VSYNC	DEN
CCIR 656	D(23:16)	GND	GND	NC	NC	NC
CCIR 601	D(23:16)	GND	GND	HSYNC	VSYNC	NC
8 Bit RGB	D(23:16)	GND	GND	HSYNC	VSYNC	NC for HV mode
						DEN for DEN mode
24 Bit RGB	R(7:0)	G(7:0)	B(7:0)	HSYNC	VSYNC	NC for HV mode
						DEN for DEN mode

■ APPLICATION NOTES

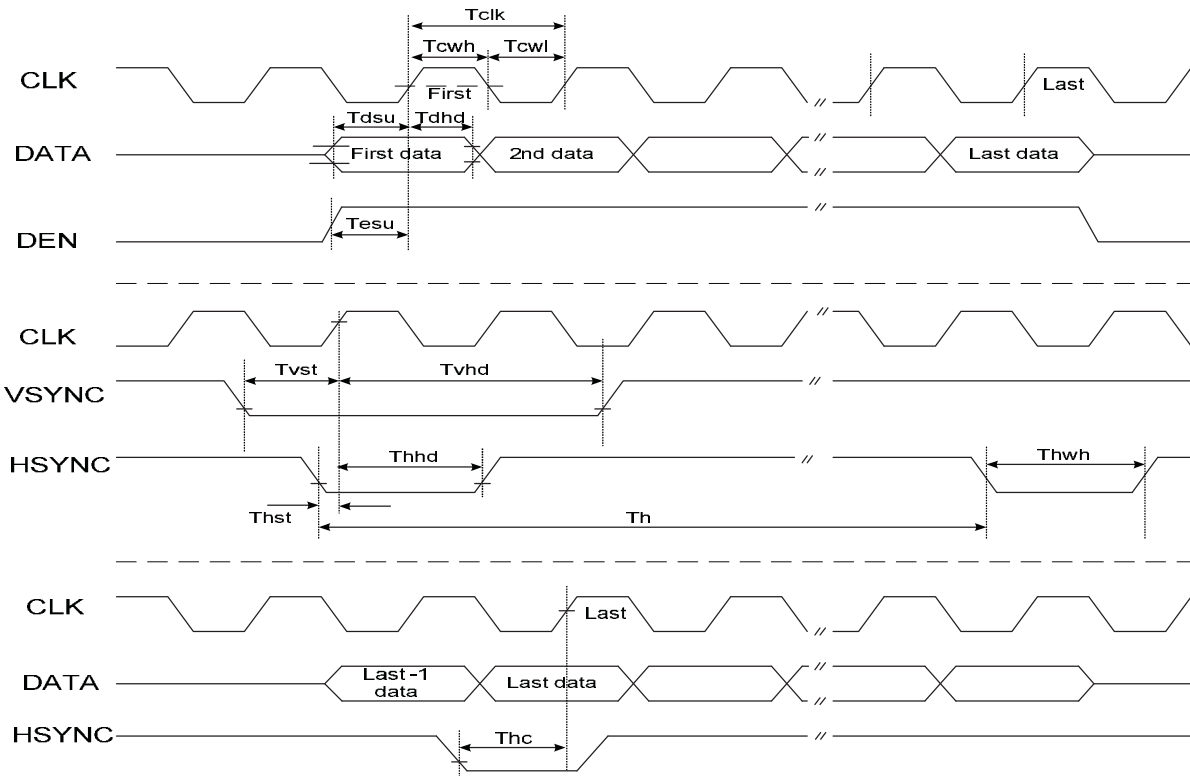
1 Timing Chart

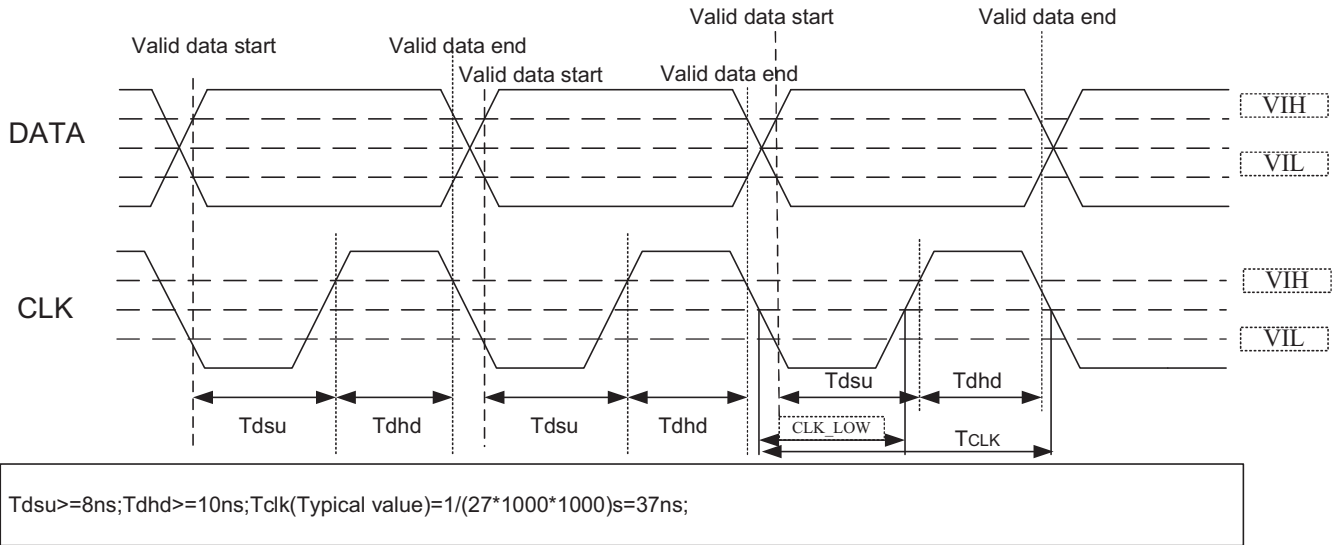
1.1 Timing Parameter

(VCC=3.3V GND=0V,Ta=25°C)

Parameter	Symbol	Min	Typ	Max	Unit	Condition
CLK Clock Time	T_{clk}	1/Max(Fclk)	--	1/Min(Fclk)	ns	
CLK Pulse Duty	T_{chw}	40	50	60	%	T_{clk}
HSYNC to CLK	T_{hc}	--	--	1	CLK	--
HSYNC Width	T_{hwh}	1	--	--	CLK	--
VSYNC Width	T_{vwh}	1	--	--	ns	--
HSYNC Period Time	T_h	60	63.56	67	ns	--
VSYNC Set-up Time	T_{vst}	12	--	--	ns	--
VSYNC Hold Time	T_{vhd}	12	--	--	ns	--
HSYNC Setup Time	T_{hst}	12	--	--	ns	--
HSYNC Hold Time	T_{hhd}	12	--	--	ns	--
Data Set-up Time	T_{dsu}	12	--	--	ns	D00~D23 to CLK
Data Hold Time	T_{dhd}	12	--	--	ns	D00~D23 to CLK
DEN Set up Time	T_{esu}	12	--	--	ns	DEN to CLK

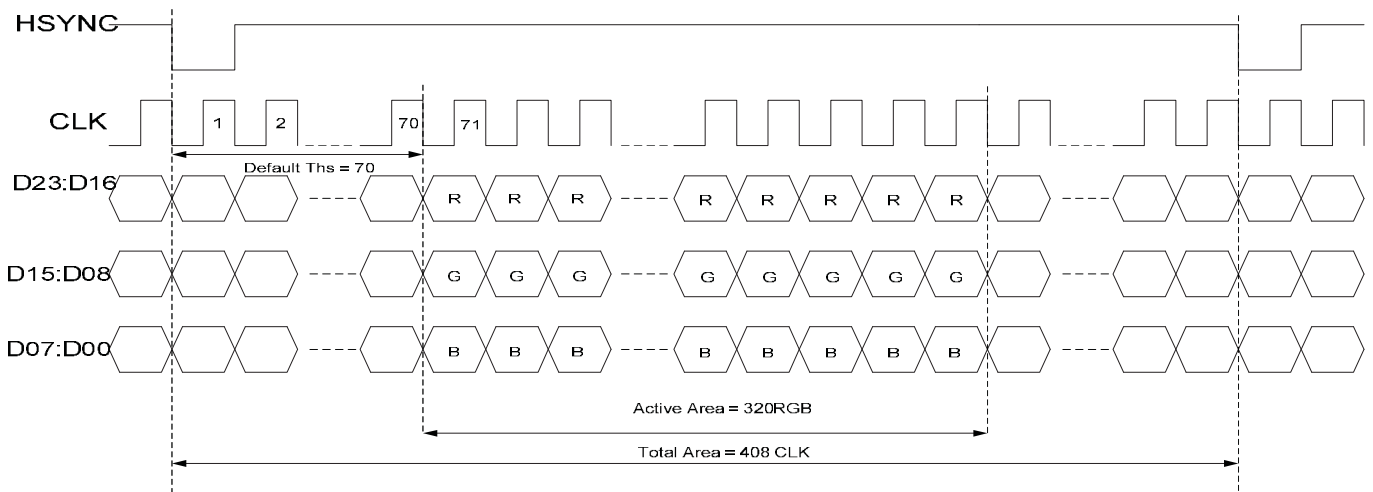
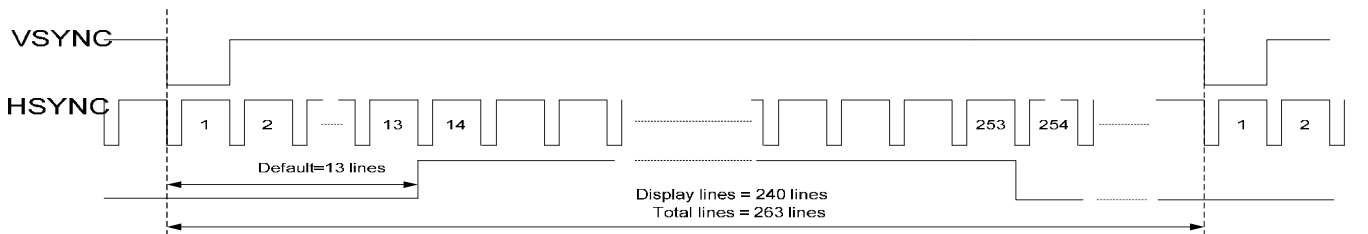
Note: Each CLK Frequency of 24 Bit RGB Mode,8 Bit RGB Mode,CCIR601 and CCIR656 are different.





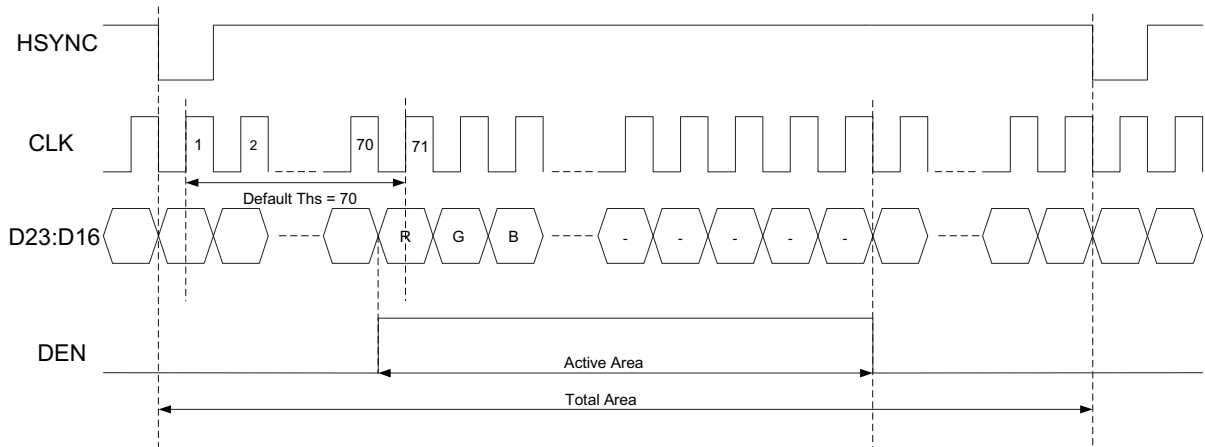
1.2 24 Bit RGB Mode for 320RGB x 240

Parameter	Symbol	Min	Typ	Max	Unit	Condition
CLK Frequency	F_{clk}	6.1	6.4	8.0	MHz	VCC=3.0V~3.6V
CLK Cycle Time	T_{clk}	125	156	164	ns	
CLK Pulse Duty	T_{cwh}	40	50	60	%	
Time that HSYNC to 1 st data input(NTSC)	T_{hs}	40	70	255	CLK	DDLY =70, Offset = 0 (fixed)



1.3 8 Bit RGB Mode for 320RGB x 240

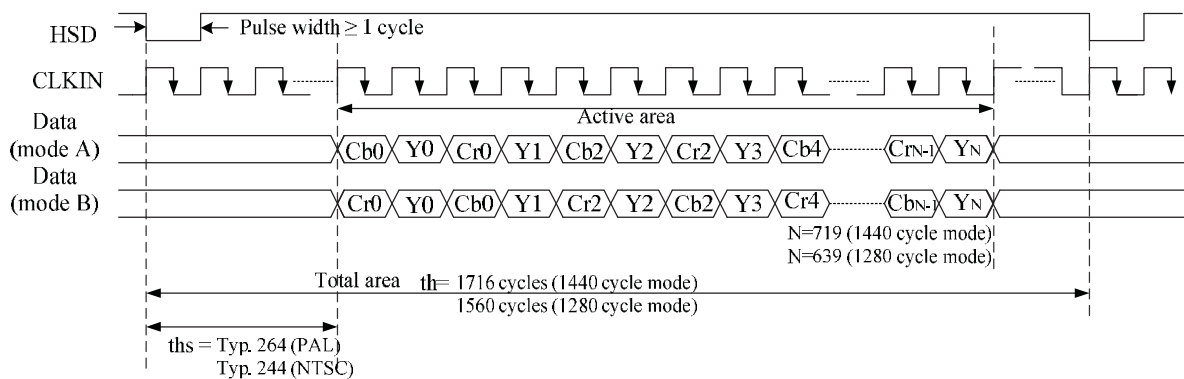
Parameter	Symbol	Min	Typ	Max	Unit	Condition
CLK Frequency	F _{clk}	--	27	30	MHz	VCC=3.0~3.6V
CLK Cycle Time	T _{clk}	--	37	--	ns	
Time that HSYNC to 1'st data input(NTSC)	T _{hs}	35	70	255	CLK	DDLY = 70, Offset = 0 (fixed)



1.4 CCIR601

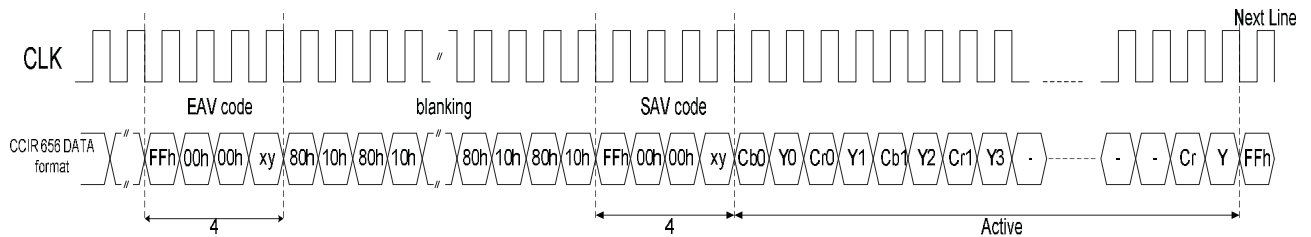
Parameter	Symbol	Min	Typ	Max	Unit	Condition
CLK Frequency	F _{clk}	--	24.54/ 27	30	MHz	VCC=3.0V~3.6V
CLK Cycle Time	T _{clk}	--	40/37	--	ns	
Time From HSYNC to 1 st data input(PAL)	T _{hs}	128	264	--	CLK	DDLY = 136, Offset = 128 (fixed)
Time From HSYNC to 1 st data input(NTSC)	T _{hs}	128	244	--	CLK	DDLY = 116, Offset = 128 (fixed)

CLKIN frequency:
 24.54MHz for 1280-cycle mode
 27MHz for 1440-cycle mode



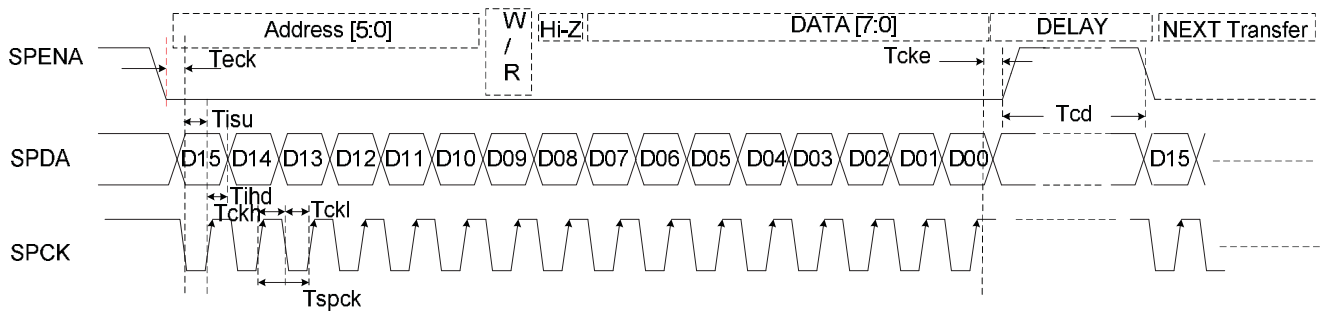
1.5 CCIR656

Parameter	Symbol	Min	Typ	Max	Unit	Condition
CLK Frequency	Fclk	--	27	30	MHz	VCC=3.0V~3.6V
CLK Cycle Time	Tclk	--	37	--	ns	
Time that EVA to 1'st data input(PAL)	Ths	128	288	--	CLK	DDLY = 152, Offset = 128 (fixed)
Time that EVA to 1'st data input(NTSC)	Ths	128	276	--	CLK	DDLY = 140, Offset = 128 (fixed)



1.6 3-Wire Serial Communication AC Timing

Parameter	Symbol	Min	Typ	Max	Unit	Remark
Serial Clock	T _{SPCK}	320	--	--	ns	
SPCK Pulse Duty	T _{scdut}	40	50	60	%	
Serial Data Setup Time	T _{isu}	120	--	--	ns	
Serial Data Hold Time	T _{ihd}	120	--	--	ns	
Serial Clock High/Low	T _{ssw}	120	--	--	ns	
Chip Select Distinguish	T _{cd}	1	--	--	us	



Note: DDLY Description (Ths= DDLY+ Offset)

R04: Source Timing Delay Control Register

Bit	Name	Initial	Description
Bit [7:0]	DDLY[7:0]	46h	Select the HSD signal to 1'st input data delay timing Under CCIR601 mode, Ths = DDLY[7:0] + 128, (Unit = CLKIN) Under CCIR656 mode, Ths = DDLY[7:0] + 136, (Unit = CLKIN) Under RGB 8/24 bit mode, Ths = DDLY[7:0] , (Unit = CLKIN) The register value will be update to the different mode,such as 24RGB,8RGB,CCIR mode. Read the section of "24RGB, 8RGB, CCIR mode" for the detail.

1.7 3-Wire Control Registers List

3-Wire Registers		Register Description		
D[15:10]	Name	Init	R/W	Function Description
000000b	R00	03h	R/W	System control register
000001b	R01	00h	R/W	Timing controller function register
000010b	R02	03h	R/W	Operation control register
000011b	R03	CCh	R/W	Input data Format control register
000100b	R04	46h	R/W	Source timing delay control register
000101b	R05	0Dh	R/W	Gate timing delay control register
000111b	R07	00h	R/W	Internal function control register
001000b	R08	08h	R/W	RGB contrast control register
001001b	R09	40h	R/W	RGB brightness control register
001011b	R0B	88h	R/W	R/B sub-contrast control register
001100b	R0C	20h	R/W	R sub-brightness control register
001101b	R0D	20h	R/W	B sub-brightness control register
001110b	R0E	2Bh	R/W	VCOMDC level control register
001111b	R0F	A6h	R/W	VCOMAC level control register
010000b	R10	04h	R/W	VGAM2 level control register
010001b	R11	24h	R/W	VGAM3/4 level control register
010010b	R12	24h	R/W	VGAM5/6 level control register
011101b	R1D	00h	R/W	OTP operation control register
011110b	R1E	00h	R/W	OTP operation control register
011111b	R1F	00h	R/W	OTP operation control register

Note :

R03: c4h:CCIR656 Mode

c2h:CCIR601 Mode

c8h:8 bit RGB Mode(HV Mode)

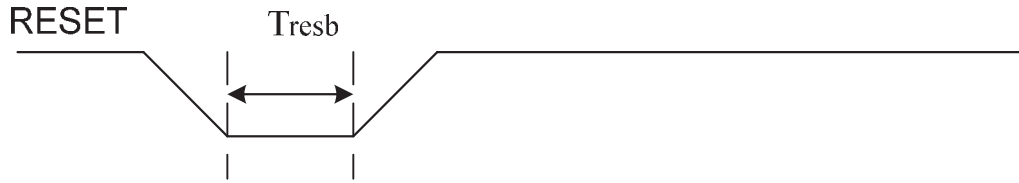
c9h:8 bit RGB Mode(DEN Mode)

cch(default):24 bit RGB Mode (HV mode)

cdh:24 bit RGB Mode (DEN mode)

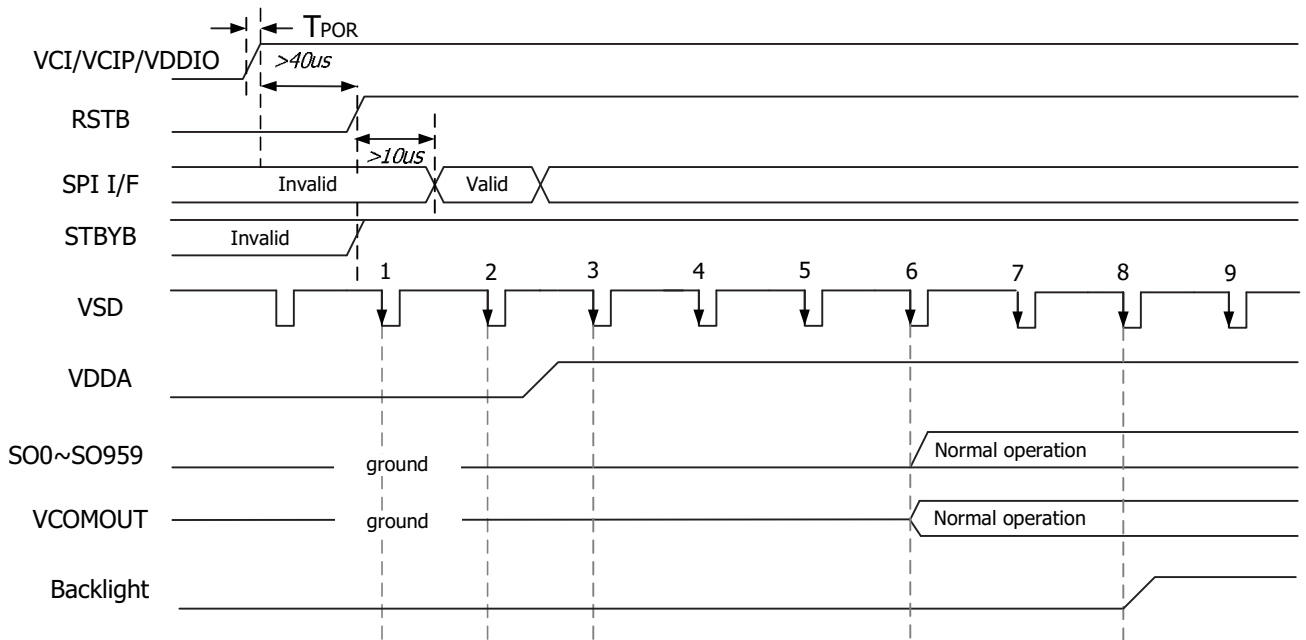
R0F: A4h(default):VGH=15V,VGL=-10V. 24h(recommend): VGH=15V,VGL=-7V.

1.8 Reset Timing

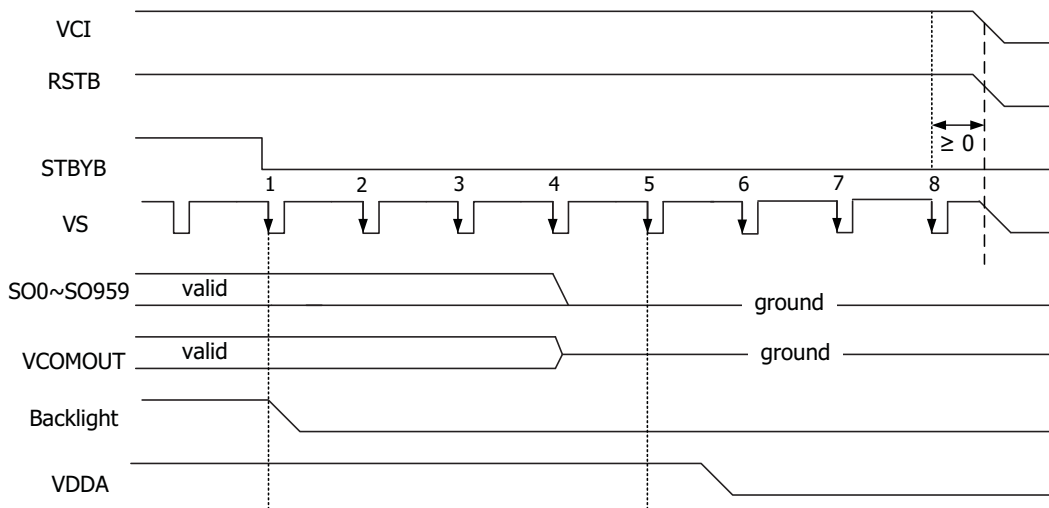


Parameter	Min	Typ	Max	Unit	Conditions
T _{resb}	40	-----	----	us	VCC = 3.3V

1.9 Power On Sequence



1.10 Power off Sequence



■ CTP SPECIFICATIONS

1. GENERAL SPECIFICATIONS

Item	Specification	Unit
Type	Projective capacitive type touch panel	
Structure	Cover glass+Sensor glass+FPCA	
Input mode	Human's finger	
Finger	Up to 5	
Resolution	320 x 240	dots
Cover viewing area	70.68(W) x 53.16(H)	mm
Sensor Active Area	71.68(W) x 54.16(H)	mm
Hardness	7H	Pencil hardness
Driver IC	FT5446DQS	/

2. ABSOLUTE MAXIMUM RATINGS

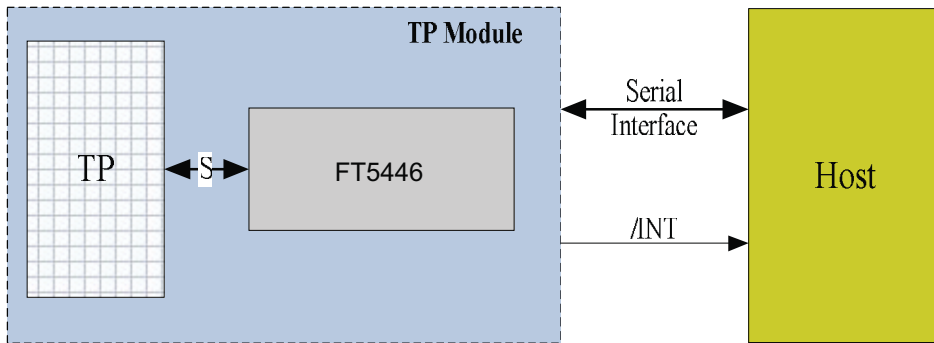
Symbol	Description	Min	Typ	Max	Unit	Notes
VCC	Supply voltage	2.8	3.3	3.6	V	
ICC	Supply current	-	TBD	-	mA	
VIH	Input high-level voltage	0.7VCC	-	VCC	V	
VIL	Input low-level voltage	-0.3	-	0.3VCC	V	
VOH	Output high-level voltage	0.7VCC	-	-	V	
VOL	Output low-level voltage	-	-	0.3VCC	V	

3. PIN CONNECTIONS

No.	Name	I/O	Description
1	VSS	P	Ground
2	VCC	P	Power supply
3	SCL	I/O	I2C clock signal
4	NC	-	No connection
5	SDA	I/O	I2C data signal
6	NC	-	No connection
7	/RST	I	Reset.active low
8	NC	-	No connection
9	/INT	I/O	Interrupt signal to host from CTP
10	VSS	P	Ground

Note: SCL/SDA for I2C in terface internal pull up on pin 3&5(100KΩ)

4. BLOCK DIAGRAM



5. CTP TIMING

The I2C is always configured in the Slave mode. The data transfer format is shown in [Figure 1-1](#).

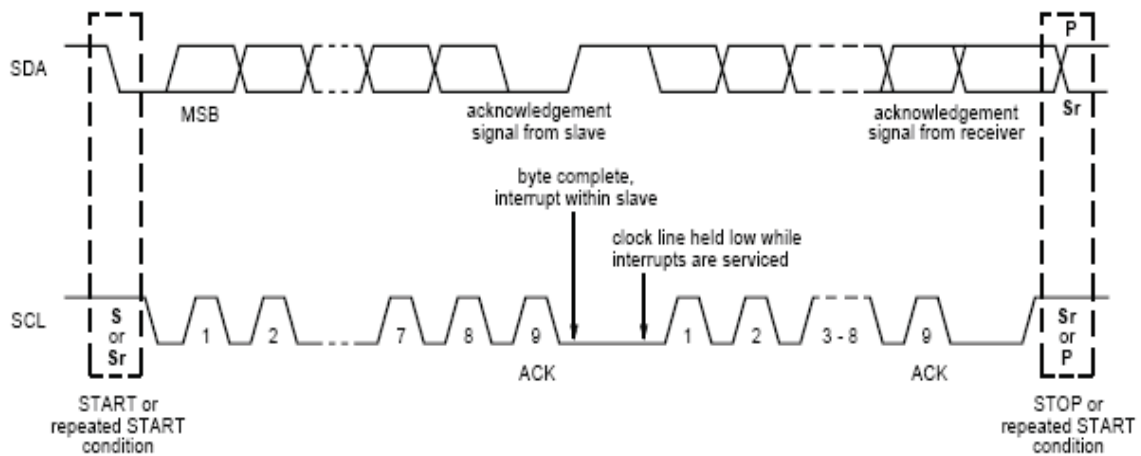


Figure 1-1 I2C Serial Data Transfer Format

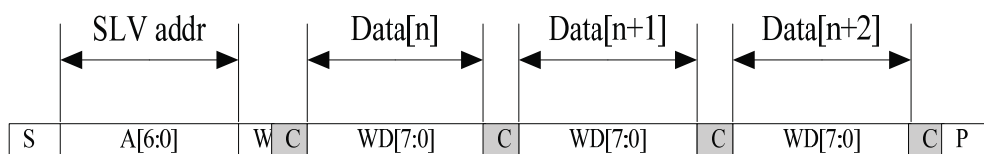


Figure 1-2 I2C master write, slave read

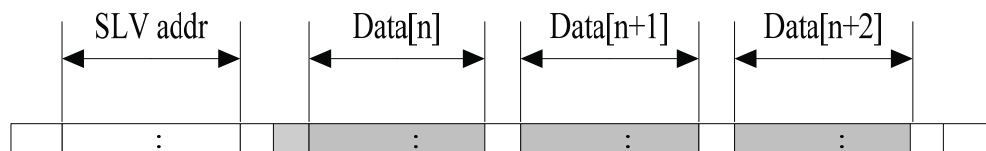


Figure 1-3 I2C master read, slave write

Table 1-1 lists the meanings of the mnemonics used in the above figures.

Table 1-1 Mnemonics Description

Mnemonics	Description
S	I2C Start or I2C Restart
A[6:0]	Slave address A[6:4]: 3'b011 A[3:0]: data bits are identical to those of I2CCON[7:4] register.
W	1'b0: Write
R	1'b1: Read
C	ACK
P	STOP: the indication of the end of a packet (if this bit is missing, S will indicate the end of the current packet and the beginning of the next packet)

I2C Interface Timing Characteristics is shown in Table 1-2.

Table 1-2 I2C Timing Characteristics

Parameter	Unit	Min	Max
SCL frequency	KHz	0	400
Bus free time between a STOP and START condition	us	4.7	\
Hold time (repeated) START condition	us	4.0	\
Data setup time	ns	250	\
Setup time for a repeated START condition	us	4.7	\
Setup Time for STOP condition	us	4.0	\

Note: More information pls refer to IC spec.

■ RELIABILITY TEST

No.	Test Item	Test Condition	Remarks
1	High Temperature Storage Test	80°C±2°C/240Hrs.	Note2
2	Low Temperature Storage Test	-30°C±2°C/240Hrs.	Note1,2
3	High Temperature Operation Test	70°C±2°C/120Hrs.	
4	Low Temperature Operation Test	-20°C±2°C/120Hrs.	Note1
5	High Temperature and High Humidity Operation Test	60±5°C, 90%RH 240Hrs.	Note1,2
6	Thermal Shock Test (Non-operating)	-30±2°C(30Min.)~25±2°C(5Min.)~80±2°C(30Min.) 10Cycles	
7	Vibration Test (Non-operating)	Frequency:10~55Hz Amplitude: 1.5mm Sweep Time: 11Mins Test Period: 6 Cycles For Each Direction Of X, Y, Z (Packing Condition)	
8	Shock Test (Non-operating)	100G, 6Ms Direction: ±X, ±Y, ±Z Cycle: 3 Times	
9	Electro Static Discharge Test (Non-operating)	Voltage: ±4KV, R:330Ω, C:150pF, Air Discharge, 10 Times. (Packing Condition)	

Note 1: Without water condensation

Note 2: The function test shall be conducted after 2 hours storage at the room temperature and humidity after removed from the test chamber.

INSPECTION CRITERION

OUTGOING QUALITY STANDARD	PAGE 1 OF 5
TITLE:FUNCTIONAL TEST & INSPECTION CRITERIA	

This specification is made to be used as the standard acceptance/rejection criteria for TFT module.

1 Sample plan

- 1.1 Lot size: Quantity per shipment lot per model
- 1.2 Sampling type: Normal inspection,Single sampling
- 1.3 Inspection level: II
- 1.4 Sampling table: MIL-STD-105D
- 1.5 Acceptable quality level (AQL)

Major defect: AQL=0.65
 Minor defect: AQL=1.50

2. Inspection condition

2.1 Ambient conditions:

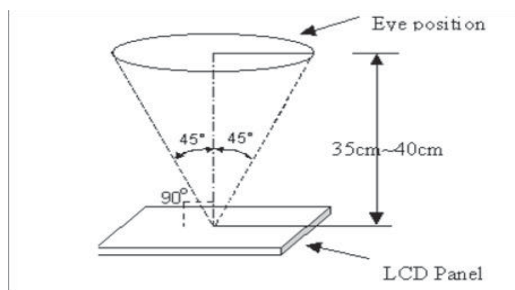
- a. Temperature: Room temperature $25 \pm 5^\circ\text{C}$
- b. Humidity: $(60 \pm 10)\% \text{RH}$
- c. Illumination: Single fluorescent lamp non-directive (300 to 700 Lux)

2.2 Viewing distance:

The distance between the LCD and the inspector's eyes shall be at least $35 \pm 5\text{cm}$.

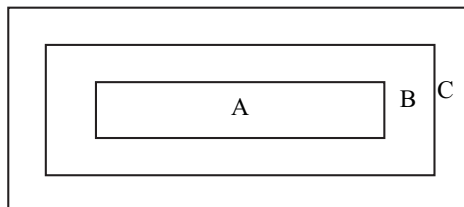
2.3 Viewing Angle

U/D: $45^\circ / 45^\circ$, L/R: $45^\circ / 45^\circ$



3. Definition of Inspection Item.

3.1 Definition of inspection zone in LCD.



Zone A: character/Digit area

Zone B: viewing area except Zone A (ZoneA+ZoneB=minimum Viewing area)

Zone C: Outside viewing area (invisible area after assembly in customer's product)

Fig.1 Inspection zones in an LCD.

OUTGOING QUALITY STANDARD	PAGE 2 OF 5
---------------------------	-------------

TITLE:FUNCTIONAL TEST & INSPECTION CRITERIA

Note: As a general rule, visual defects in Zone C are permissible, when it is no trouble for quality and assembly of customer’s product.

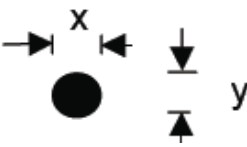
4. Inspection standards

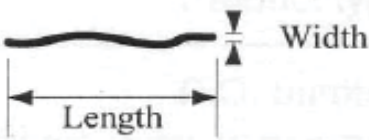
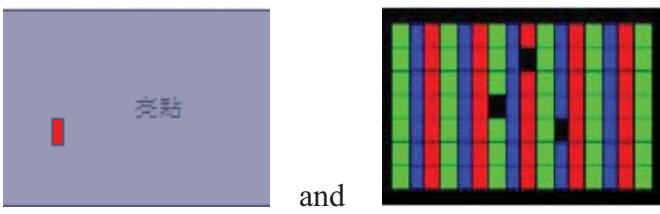
Defects are classified as major defects and minor defects according to the degree of defectiveness defined herein.

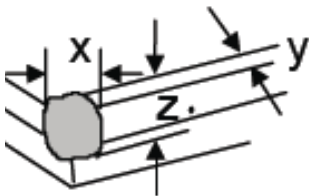
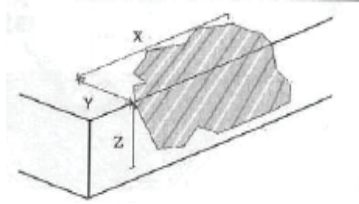
4.1 Major defect

Item No	Items to be inspected	Inspection Standard
4.1.1	All functional defects	1) No display 2) Display abnormally 3) Short circuit 4) Line defect 5) Excess power consumption
4.1.2	Missing	Missing function component
4.1.3	Crack	Glass crack

4.2 Minor defect

Item No	Items to be inspected	Inspection standard	
4.2.1	Spot Defect Including Black spot White spot Pinhole Foreign particle Polarizer dirt	For dark/white spot is defined $\varphi = (x+y) / 2$ 	
		Size φ (mm)	Acceptable Quantity
		$\varphi \leq 0.15$ 2mm(min) apart	Ignore
		$0.15 < \varphi \leq 0.25$ 5mm(min) apart	3
		$0.25 < \varphi$	Not allowed

OUTGOING QUALITY STANDARD		PAGE 3 OF 5	
TITLE:FUNCTIONAL TEST & INSPECTION CRITERIA			
4.2.2	Line Defect Including Black line White line Scratch	Define: 	
		Width(mm) Length(mm)	Acceptable Quantity
		$W \leq 0.05$ and $L \leq 10$	Ignore
		$0.05 < W \leq 0.08$ and $L \leq 10$ 3mm(min) apart	3
		$0.08 < W \leq 0.10$ and $L \leq 5$ 3mm(min) apart	1
4.2.3	Polarizer Dent/Bubble	Size φ (mm)	Acceptable Quantity
		$\varphi \leq 0.25$	Ignore
		Non visible area	Ignore
		$0.25 < \varphi \leq 0.40$ 5mm(min) apart	2
		$0.40 < \varphi$	Not allowed
4.2.4	Electrical Dot Defect	Bright and Black dot define: 	
		Inspection pattern: Full white, Full black, Red, green and blue screens	
		Item	Acceptable Quantity
		Black dot defect	2
		Bright dot defect	0
Total Dot		2	

OUTGOING QUALITY STANDARD		PAGE 4 OF 5	
TITLE:FUNCTIONAL TEST & INSPECTION CRITERIA			
4.2.5	Touch panel chips		
		1. Corner chips:	
		Size(mm)	Acceptable Quantity
		$X \leq 3\text{mm}$ $Y \leq 3\text{mm}$ $Z \leq T$	Ignore T: Glass thickness X: Length Y: Width Z: thickness
			
		2. Side chips:	
Size(mm)	Acceptable Quantity		
$X \leq 5\text{mm}$ $Y \leq 3\text{mm}$ $Z \leq T$	Ignore T: Glass thickness X: Length Y: Width Z: thickness		

<p style="text-align: center;">OUTGOING QUALITY STANDARD</p>	<p style="text-align: center;">PAGE 5 OF 5</p>
<p>TITLE:FUNCTIONAL TEST & INSPECTION CRITERIA</p>	
<p>Note:</p> <ol style="list-style-type: none"> 1. Dot defect is defined as the defective area of the dot area is larger than 50% of the dot area. 2. The distance between black dot defects or black and bright dot defects should be more than 5mm apart. The distance between two bright dot defects should be more than 15mm apart 3. Polarizer bubble is defined as the bubble appears on active display area. The defect of polarizer bubble shall be ignored if the polarizer bubble appears on the outside of active display area. 4. Mura is checker by 6% ND filter. 5. Foreign particle on the surface of the LCM should be ignore. 	

■ PRECAUTIONS FOR USING LCD MODULES

Handing Precautions

(1) The display panel is made of glass and polarizer. As glass is fragile. It tends to become or chipped during handling especially on the edges. Please avoid dropping or jarring. Do not subject it to a mechanical shock by dropping it or impact.

(2) If the display panel is damaged and the liquid crystal substance leaks out, be sure not to get any in your mouth. If the substance contacts your skin or clothes, wash it off using soap and water.

(3) Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary. Do not touch the display with bare hands. This will stain the display area and degraded insulation between terminals (some cosmetics are determined to the polarizer).

(4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully. Do not touch, push or rub the exposed polarizers with anything harder than an HB pencil lead (glass, tweezers, etc.). Do not put or attach anything on the display area to avoid leaving marks on. Condensation on the surface and contact with terminals due to cold will damage, stain or dirty the polarizer. After products are tested at low temperature they must be warmed up in a container before coming is contacting with room temperature air.

(5) If the display surface becomes contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, moisten cloth with one of the following solvents

- Isopropyl alcohol
- Ethyl alcohol

Do not scrub hard to avoid damaging the display surface.

(6) Solvents other than those above-mentioned may damage the polarizer. Especially, do not use the following.

- Water
- Ketone
- Aromatic solvents

Wipe off saliva or water drops immediately, contact with water over a long period of time may cause deformation or color fading. Avoid contacting oil and fats.

(7) Exercise care to minimize corrosion of the electrode. Corrosion of the electrodes is accelerated by water droplets, moisture condensation or a current flow in a high-humidity environment.

(8) Install the LCD Module by using the mounting holes. When mounting the LCD module make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the I/O cable or the backlight cable.

(9) Do not attempt to disassemble or process the LCD module.

(10) NC terminal should be open. Do not connect anything.

(11) If the logic circuit power is off, do not apply the input signals.

(12) Electro-Static Discharge Control, Since this module uses a CMOS LSI, the same careful attention should be paid to electrostatic discharge as for an ordinary CMOS IC. To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

- Before remove LCM from its packing case or incorporating it into a set, be sure the module and your body have the same electric potential. Be sure to ground the body when handling the LCD modules.

- Tools required for assembling, such as soldering irons, must be properly grounded. make certain the AC power source for the soldering iron does not leak. When using an electric screwdriver to attach LCM, the screwdriver should be of ground potentiality to minimize as much as possible any transmission of electromagnetic waves produced sparks coming from the commutator of the motor.

- To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions. To reduce the generation of static electricity be careful that the air in the work is not too dried. A relative humidity of 50%-60% is recommended. As far as possible make the electric potential of your work clothes and that of the work bench the ground potential

- The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated

(13) Since LCM has been assembled and adjusted with a high degree of precision, avoid applying excessive shocks to the module or making any alterations or modifications to it.

- Do not alter, modify or change the shape of the tab on the metal frame.
- Do not make extra holes on the printed circuit board, modify its shape or change the positions of components to be attached.
- Do not damage or modify the pattern writing on the printed circuit board.
- Absolutely do not modify the zebra rubber strip (conductive rubber) or heat seal connector.
- Except for soldering the interface, do not make any alterations or modifications with a soldering iron.
- Do not drop, bend or twist LCM.

Handling precaution for LCM

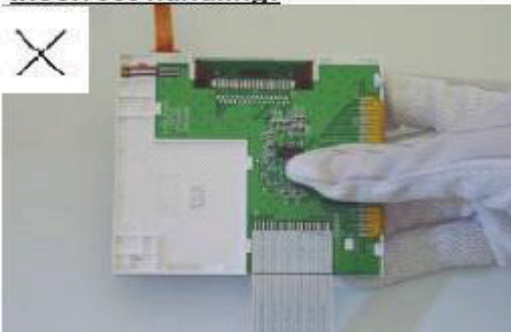
LCM is easy to be damaged.
Please note below and be careful for handling!

Correct handling:

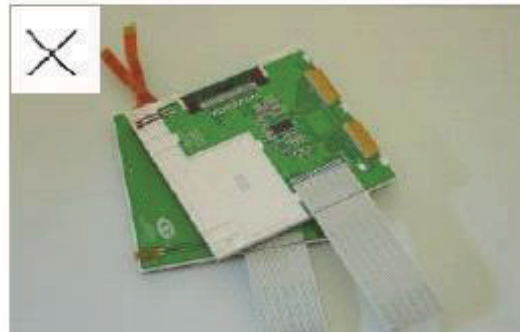


As above picture, please handle with anti-static gloves around LCM edges.

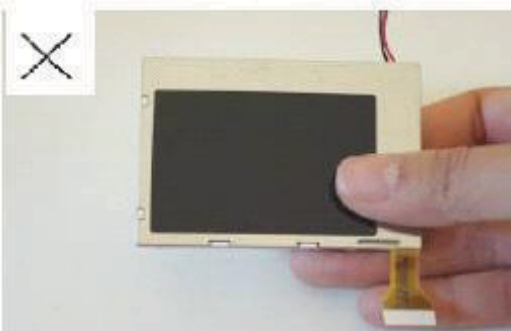
Incorrect handling:



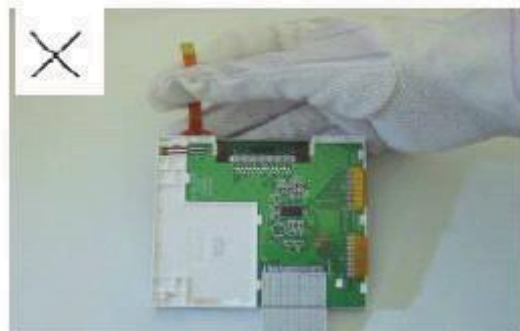
Please don't touch IC directly.



Please don't stack LCM.



Please don't hold the surface of panel.

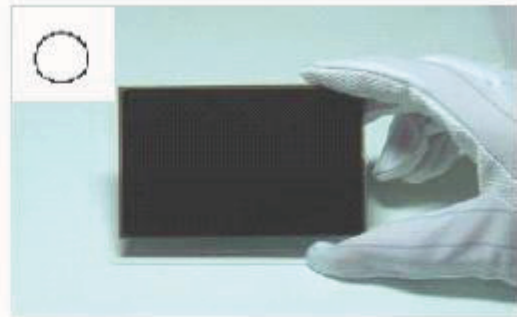


Please don't stretch interface of output, such as FPC cable.

Handling precaution for LCD

LCD is easy to be damaged.
Please note below and be careful for handling!

Correct handling:

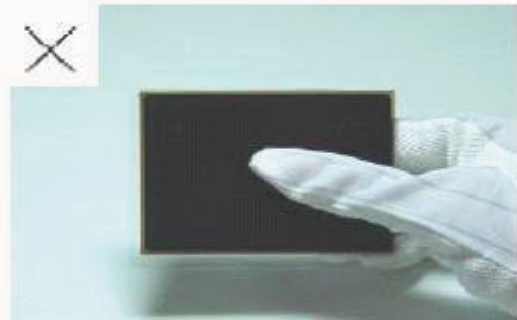


As above photo, please handle with anti-static gloves around LCD edges.

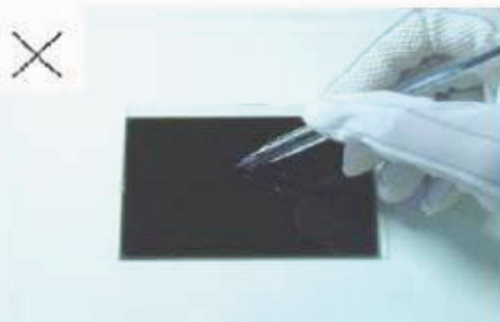
Incorrect handling:



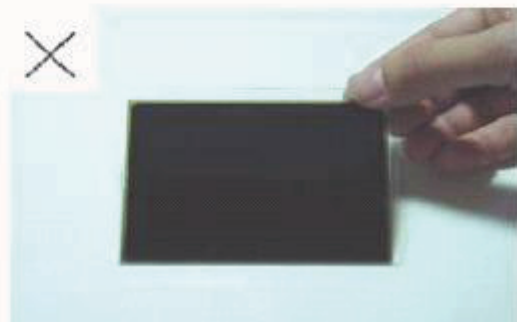
Please don't stack the LCDS.



Please don't hold the surface of LCD.



Please don't operate with sharp stick such as pens.



Please don't touch ITO glass without anti-static gloves.

Storage Precautions

When storing the LCD modules, the following precaution is necessary.

- (1) Store them in a sealed polyethylene bag. If properly sealed, there is no need for the dessicant.
- (2) Store them in a dark place. Do not expose to sunlight or fluorescent light, keep the temperature between 0°C and 35°C, and keep the relative humidity between 40%RH and 60%RH.
- (3) The polarizer surface should not come in contact with any other objects. (We advise you to store them in the anti-static electricity container in which they were shipped.

Others

Liquid crystals solidify under low temperature (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subject to a low temperature.

If the LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.

To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity etc., exercise care to avoid holding the following sections when handling the modules.

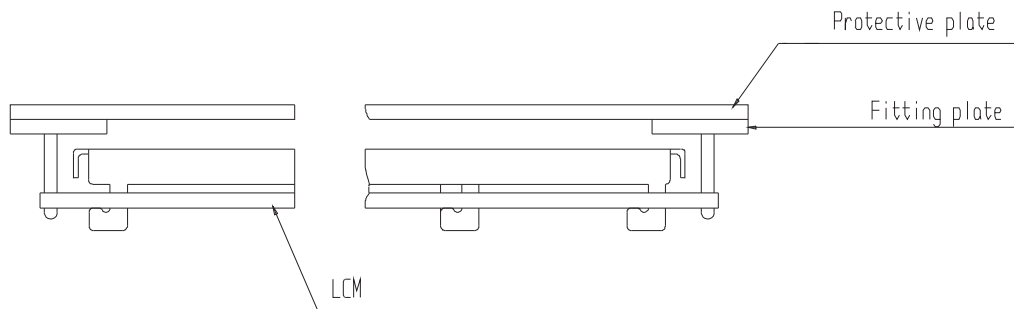
- Exposed area of the printed circuit board.
- Terminal electrode sections.

USING LCD MODULES

Installing LCD Modules

The hole in the printed circuit board is used to fix LCM as shown in the picture below. Attend to the following items when installing the LCM.

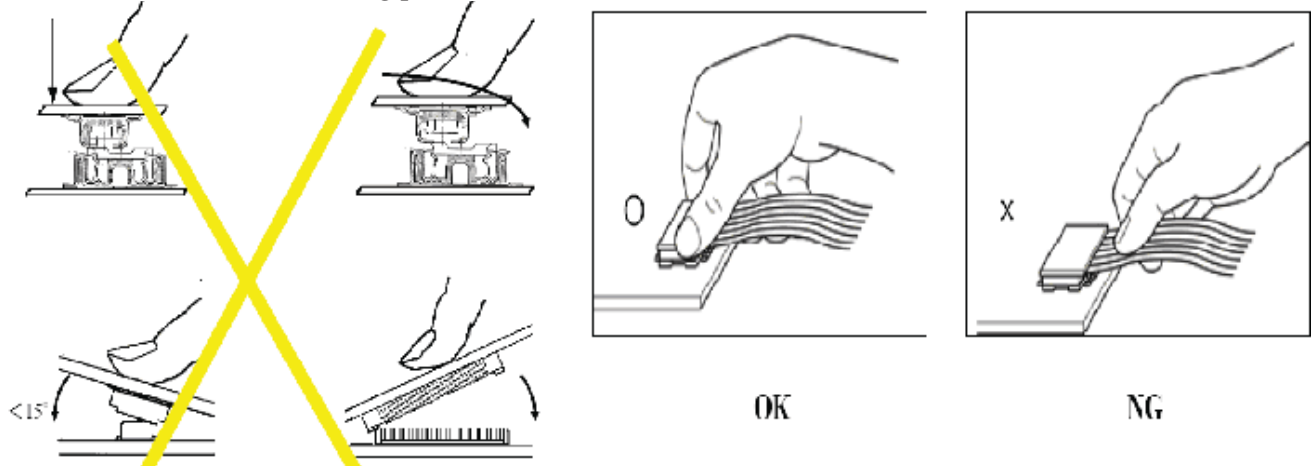
- (1) Cover the surface with a transparent protective plate to protect the polarizer and LC cell.



- (2) When assembling the LCM into other equipment, the spacer to the bit between the LCM and the fitting plate should have enough height to avoid causing stress to the module surface, refer to the individual specifications for measurements. The measurement tolerance should be ± 0.1 mm.

Precaution for assemble the module with BTB connector:

Please note the position of the male and female connector position, don't assemble or assemble like the method which the following picture shows



Precaution for soldering to the LCM

	Hand soldering	Machine drag soldering	Machine press soldering
No ROHS product	290°C ~350°C. Time : 3-5S.	330°C ~350°C. Speed : 4-8 mm/s.	300°C ~330°C. Time : 3-6S. Press: 0.8~1.2Mpa
ROHS product	340°C ~370°C. Time : 3-5S.	350°C ~370°C. Time : 4-8 mm/s.	330°C ~360°C. Time : 3-6S. Press: 0.8~1.2Mpa

(1) If soldering flux is used, be sure to remove any remaining flux after finishing to soldering operation. (This does not apply in the case of a non-halogen type of flux.) It is recommended that you protect the LCD surface with a cover during soldering to prevent any damage due to flux spatters.

(2) When soldering the electroluminescent panel and PC board, the panel and board should not be detached more than three times. This maximum number is determined by the temperature and time conditions mentioned above, though there may be some variance depending on the temperature of the soldering iron.

(3) When remove the electroluminescent panel from the PC board, be sure the solder has completely melted, the soldered pad on the PC board could be damaged.

Precautions for Operation

(1) Viewing angle varies with the change of liquid crystal driving voltage (VLCD). Adjust VLCD to show the best contrast.

(2) It is an indispensable condition to drive LCD's within the specified voltage limit since the higher voltage then the limit cause the shorter LCD life. An electrochemical reaction due to direct current causes LCD's undesirable deterioration, so that the use of direct current drive should be avoided.

(3) Response time will be extremely delayed at lower temperature than the operating temperature range and on the other hand at higher temperature LCD's show dark color in them. However those phenomena do not mean malfunction or out of order with LCD's, Which will come back in the specified operating temperature.

(4) If the display area is pushed hard during operation, the display will become abnormal. However, it will return to normal if it is turned off and then back on.

(5) A slight dew depositing on terminals is a cause for electro-chemical reaction resulting in terminal open circuit. Usage under the maximum operating temperature,50%RH or less is required.

(6) Input each signal after the positive/negative voltage becomes stable.

(7) Please keep the temperature within specified range for use and storage. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature and high humidity.

Safety

(1) It is recommended to crush damaged or unnecessary LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned.

(2) If any liquid leaks out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

Safety

- (1) It is recommended to crush damaged or unnecessary LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned.
- (2) If any liquid leaks out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

Limited Warranty

Unless agreed otherwise between Display Future Ltd and customer, Display Future will replace or repair any of its LCD modules which are found to be functionally defective when inspected in accordance with LCD acceptance standards (copies available upon request) for a period of one year from date of production. Cosmetic/visual defects must be returned within 90 days of the shipment. Confirmation of such date shall be based on data code on the product. The warranty liability of Display Future limited to repair and/or replacement on the terms set forth above. Display Future will not be responsible for any subsequent or consequential events.

Return LCM under warranty

No warranty can be granted if the precautions stated above have been disregarded. The typical examples of violations are :

- Broken LCD glass.
- PCB eyelet is damaged or modified.
- PCB conductors damaged.
- Circuit modified in any way, including addition of components.
- PCB tampered with by grinding, engraving or painting varnish.
- Soldering to or modifying the bezel in any manner.

Module repairs will be invoiced to the customer upon mutual agreement. Modules must be returned with sufficient description of the failures or defects. Any connectors or cable installed by the customer must be removed completely without damaging the PCB eyelet, conductors and terminals.

■ PRIOR CONSULT MATTER

- 1.①For Display Future standard products, we keep the right to change material and processes for improving the product, without notice to our customers.
②For OEM products, if any change is needed, which may affect the product property, we will consult with our customer in advance.
2. If you have special requirement about reliability condition, please let us know before you start the test on our samples.