

PRODUCT SPECIFICATION

TFT LCD MODULE

MODEL : KWH0154DF03-C02 Version: 1.0

【 】 Preliminary Specification

【 ◆ 】 Finally Specification

CUSTOMER'S APPROVAL	
SIGNATURE:	DATE:

- It signifies that you fully understand and accept all the contents of this specification if you sign and send back the first page of this specifications.

Designed by	R&D Checked by	Quality Department by	Approved by
LEO			

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- This specification is subject to change without notice. Please contact FORMIKE or it's representative before designing your product based on this specification.

Revision record

[illegible]

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1. General Description

1.1 Description

KWH0154DF03-C02 is a Transmissive type color active matrix liquid crystal display (LCD), which uses amorphous thin film transistor (TFT) as switching devices. This product is composed of a TFT LCD panel, driver IC, FPC, CTP and backlight unit . The following table described the features of FORMIKE KWH0154DF03-C02.

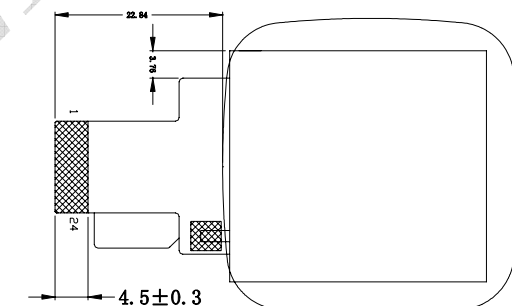
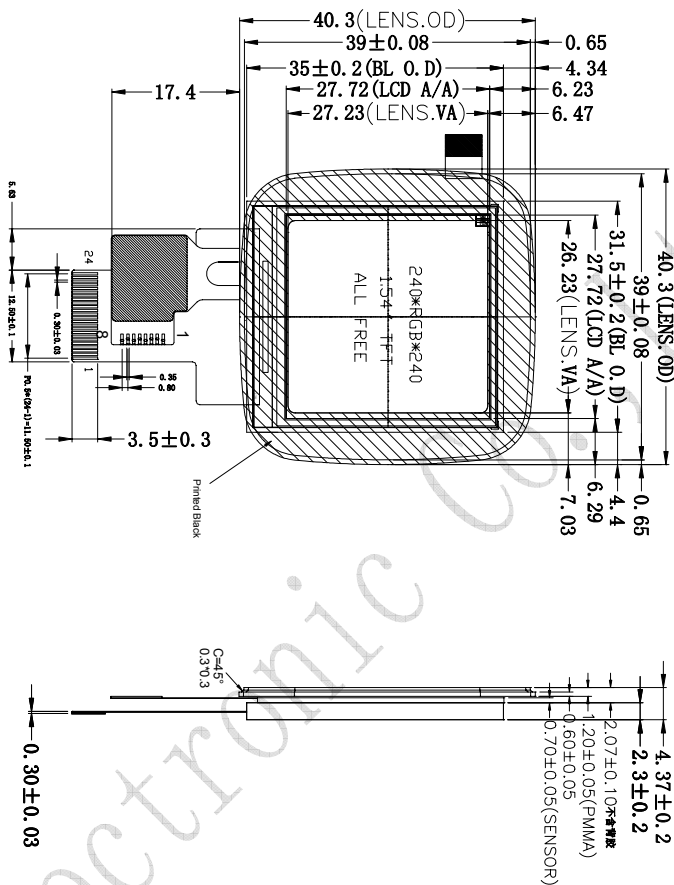
1.2 Application

Mobile phone, Multimedia products
and other electronic Products
Etc.

1.3 Features:

Features	Description	UNITS
LCD type	1.54" TFT	--
Dot arrangement	240 (RGB) × 240	dots
Driver IC	ST7789H2	--
Color Depth	262K	
Interface	4W SPI	--
View Direction	ALL	--
Module size	40.30(W) × 40.30 (H) × 4.37(T)	mm
Active area	27.72(W) × 27.72(H)	mm
Dot pitch	0.1155 (W) × 0.1155 (H)	mm
Back Light	3 White LED In parallel	--
With/Without TSP	With TSP	
Weight(g)	TBD	

2. External Dimensions



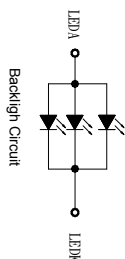
VERSION	DESCRIPTION	DATE
A	First issue	2019-02-22

No.	SYMBOL
1	LEDK
2	LEDK
3	GND
4	GND
5	FMARK
6	SDA
7	RS
8	WR
9	CS
10	RESET
11	IDVCC
12	IDVCC
13	VCC
14	VCC
15	GND
16	GND
17	NC
18	NC
19	NC
20	NC
21	NC
22	NC
23	LEDA
24	LEDA

PIN	SYMBOL
1	GND
2	SCL
3	SDA
4	RST
5	INT
6	VCC
7	GND
8	GND

Note:

- 1). Viewing angle: FREE
- 2). Display mode: IPS/Transmissive/Normal Black
- 3). Operating temp.: -20°C ~ $+60^{\circ}\text{C}$
Storage temp.: -30°C ~ $+70^{\circ}\text{C}$
- 4). LCD IC: ST17789H2
- 5). CTP IC: FT15306
- 6). Surface Hardness: 3H
- 7). Backlight: 3 chip White LED
- 8). Dimensions with mark "*" are important
- 9). All component are compatible with RoHS.



CUSTOMER APPROVE				 FORME ELECTRONIC CO.,LTD. 深圳市科方宏电子有限公司 www.kwofsp.com.cn			
	MODULE NO.		KMH154DF03-002		VERSION: A		
	MATERIAL NO.						
	ISSUED	CHECKED	APPROVED				
	LEO	ZENG	LIU				
		DATE: Feb-22-2019					

3. Interface Description

LCD: (suggest to use connector Hirose FH12-24S-0.5SH or equivalent)

PIN NO.	PIN NAME	DESCRIPTION
1-2	LEDK	Power supply for LED backlight Cathode input
3-4	GND	Ground.
5	FMARK	Tearing effect signal is used to synchronize MCU to frame memory
6	SDA	Data input PIN for SPI interface.
7	RS	Clock input PIN for SPI interface
8	WR	Data/command selection PIN for SPI interface
9	CS	Chip selection PIN for SPI interface.
10	RESET	This signal will reset the device and must be applied to properly initialize the chip. Signal is active low.
11-12	IOVCC	Power supply voltage for I/O logical(+1.8V~+3.3V).
13-14	VCC	Power supply for system(+2.8V~+3.3V).
15-16	GND	Ground.
17-22	NC	No connection
23-24	LEDA	Power supply for LED backlight Anode input

CTP:

PIN NO.	PIN NAME	DESCRIPTION
1	GND	Ground.
2	SCL	Clock signal for IIC interface
3	SDA	Data bus for IIC interface
4	RST	Reset pin for CTP
5	INT	Interrupt pin for CTP
6	VCC	Power supply (+2.8V~+3.3V).
7	GND	Ground.
8	GND	Ground.

4. Absolute Maximum Ratings

4.1 LCM

Parameter	Symbol	Min	Max	Unit
Supply voltage for system	VCC	-0.3	5.0	V
Supply voltage for logic	IOVCC	-0.3	5.0	V
Operating temperature	T _{OP}	-20	+70	°C
Storage temperature	T _{ST}	-30	+80	°C

4.2 CTP

Parameter	Symbol	Min	Max	Unit
Supply voltage for system	VCC	-0.3	3.6	V
Supply voltage for logic	-	-0.3	3.6	V

5. Electrical Characteristics

5.1 LCM Electrical Characteristics

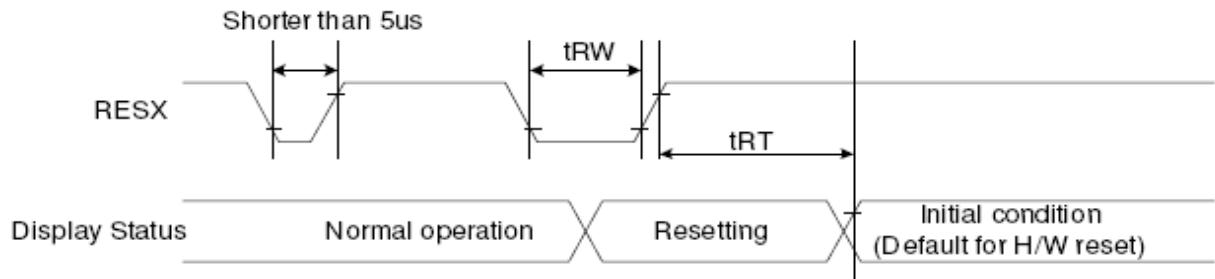
Item	Symbol	Min	Typ	Max	Unit	Applicable terminal
Supply voltage for system	VCC	2.8	-	3.3	V	VCC
Supply voltage for logic	IOVCC	1.8	-	3.3	V	VCC
Input voltage	V _{IL}	0	-	0.3*IOVCC	V	
	V _{IH}	0.7*IOVCC	-	IOVCC	V	

5.2 CTP Electrical Characteristics

Item	Symbol	MIN	TYP	MAX	UNIT	Test Condition	Note
Supply Voltage	VCC	2.8	3.3	3.6	V		-
Input high-level voltage	VIH	0.7*VCC	-	VCC	V		
Input low -level voltage	VIL	-0.3		0.3*VCC	V		
Output high -level voltage	VOH	0.7*VCC	-	-	V		
Output low -level voltage	VOL	-	-	0.3*VCC	V		

6. Timing Characteristics.

6.1 Reset Timing Characteristics.



Signal	Symbol	Parameter	Min	Max	Unit
RESX	tRW	Reset pulse duration	10		uS
	tRT	Reset cancel		5 (note 1,5)	mS
				120 (note 1,6,7)	mS

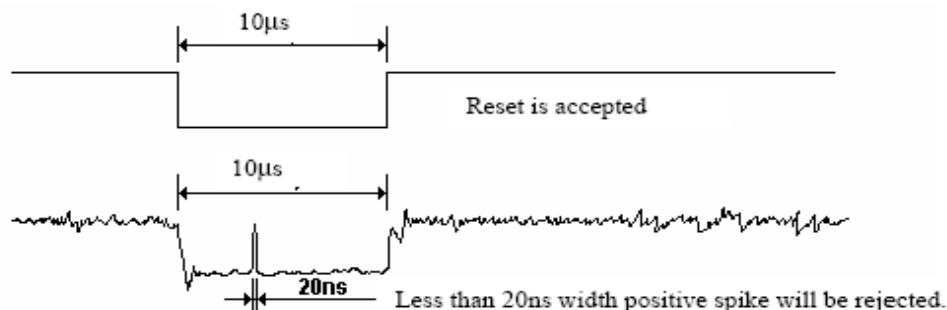
Note 1: The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NV memory to registers. This loading is done every time when there is HW reset cancel time (tRT) within 5 ms after a rising edge of RESX.

Note 2: Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below: -

RESX Pulse	Action
Shorter than 5us	Reset Rejected
Longer than 10us	Reset
Between 5us and 10us	Reset starts

Note 3: During the Resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep Out –mode. The display remains the blank state in Sleep In -mode.) And then return to Default condition for Hardware Reset.

Note 4: Spike Rejection also applies during a valid reset pulse as shown below:

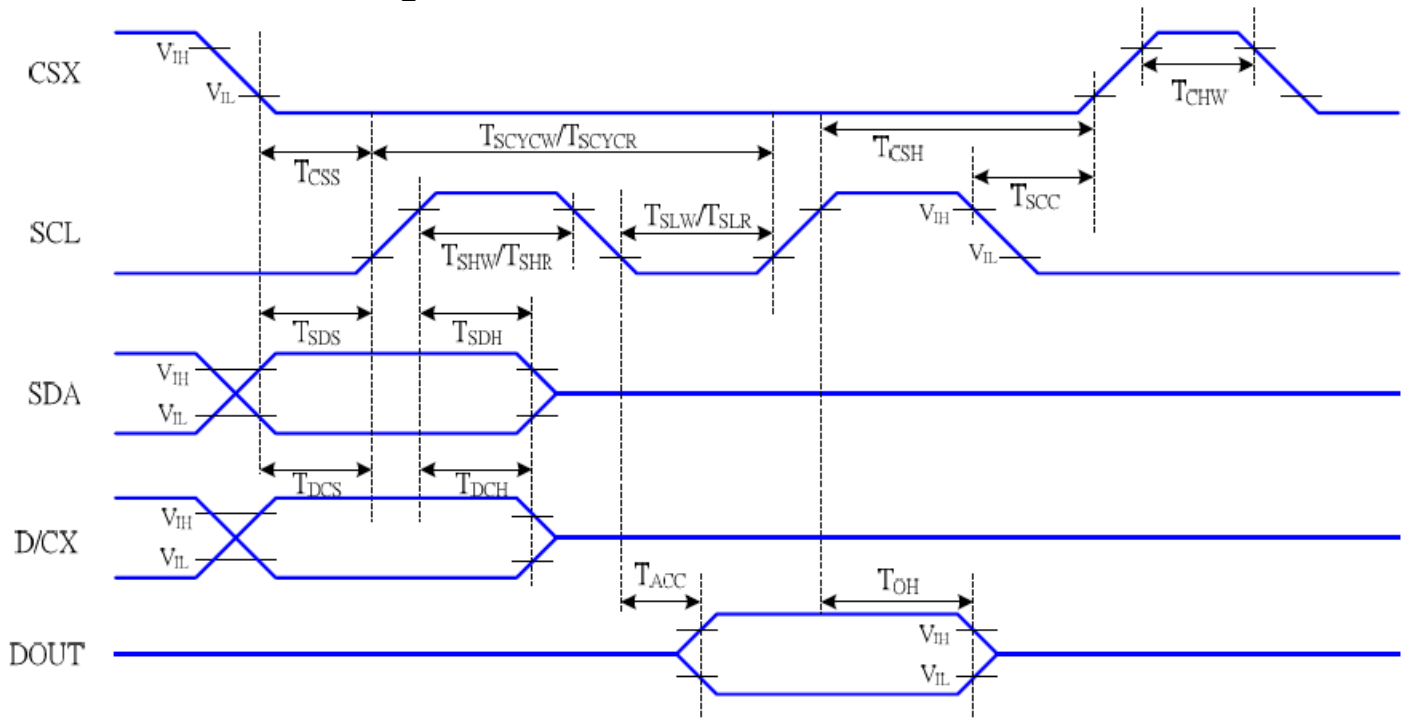


Note 5: When Reset applied during Sleep In Mode.

Note 6: When Reset applied during Sleep Out Mode.

Note 7: It is necessary to wait 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec.

6.2. SPI Interface Timing Characteristics for LCM.



VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=-30 to 70 °C

Signal	Symbol	Parameter	MIN	MAX	Unit	Description
CSX	T_{CSS}	Chip select setup time (write)	15		ns	
	T_{CSH}	Chip select hold time (write)	15		ns	
	T_{CSS}	Chip select setup time (read)	60		ns	
	T_{SCC}	Chip select hold time (read)	65		ns	
	T_{CHW}	Chip select "H" pulse width	40		ns	
SCL	T_{SCYCW}	Serial clock cycle (Write)	16		ns	-write command & data ram
	T_{SHW}	SCL "H" pulse width (Write)	7		ns	
	T_{SLW}	SCL "L" pulse width (Write)	7		ns	
	T_{SCYCR}	Serial clock cycle (Read)	150		ns	-read command & data ram
	T_{SHR}	SCL "H" pulse width (Read)	60		ns	
	T_{SLR}	SCL "L" pulse width (Read)	60		ns	
D/CX	T_{DCS}	D/CX setup time	10		ns	
	T_{DCH}	D/CX hold time	10		ns	
SDA (DIN)	T_{SDS}	Data setup time	7		ns	
	T_{SDH}	Data hold time	7		ns	
DOUT	T_{ACC}	Access time	10	50	ns	For maximum CL=30pF
	T_{OH}	Output disable time	15	50	ns	For minimum CL=8pF

6.3. IIC Interface Timing Characteristics for CTP.

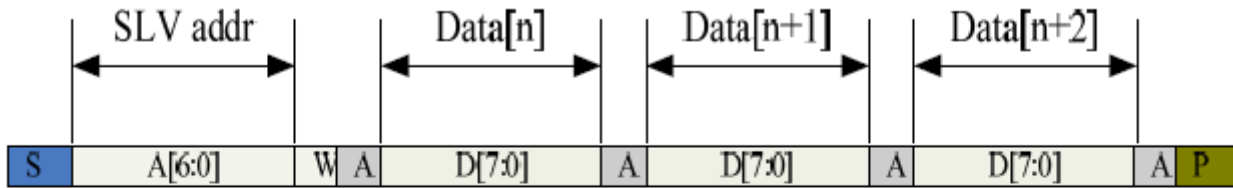
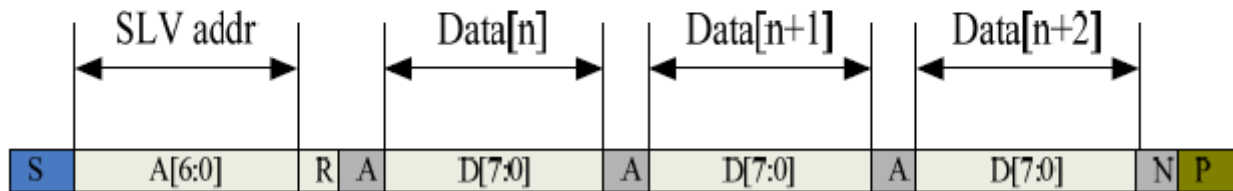


Figure 2-5 I2C master write, slave read

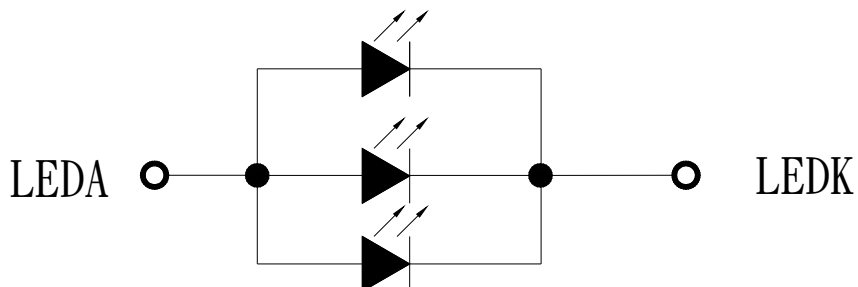


I2C master read, slave write

Mnemonics	Description
S	I2C Start or I2C Restart
A[6:0]	Slave address A[6:0]: address bits are identical to those of I2CADDR [7:1] register.
R/ W	'1' for read, '0' for write
A(N)	ACK(NACK)
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)

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	\

7. Backlight Characteristics.



Item	Symbol	MIN	TYP	MAX	UNIT	Test Condition	Note
Supply Voltage	Vf	3.0	3.2	3.4	V	If=60 mA	-
Supply Current	If	-	60	-	mA	-	-
Reverse Voltage	Vr	-	-	5	V	10uA	
Power dissipation	Pd	-	192	-	mW	-	
Luminous Intensity for LCM		350	400	-	Cd/m2	If=60 mA	
Uniformity for LCM	-	80	-	-	%	If=60 mA	
Life Time	-	20000	50000	-	Hr	If=60 mA	-
Color	x	0.27	0.29	0.31	-	If=60 mA	-
	y	0.27	0.29	0.31	-	If=60 mA	-

8.Optical Characteristics

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Transmittance (with Polarizer)		T(%)	—	4.25	5	—	%	
Transmittance (without Polarizer)		T(%)	—	14.03	16.5	—	%	
Contrast Ratio		CR	$\Theta=0$ Normal viewing angle		800	—	—	(1)(2)
Response Time		$T_R + T_F$		—	30	40	msec	(1)(3)
Color Gamut		S(%)			50	—	%	
Color Chromaticity (CIE1931)	White	W_x		0.283	0.303	0.323		(1)(4) CF glass
		W_y		0.305	0.325	0.345		
	Red	R_x		0.600	0.620	0.640		
		R_y		0.312	0.332	0.352		
	Green	G_x		0.264	0.284	0.304		
		G_y		0.514	0.534	0.554		
	Blue	B_x		0.126	0.146	0.166		
		B_y		0.109	0.129	0.149		
Viewing Angle	Hor.	Θ_L	CR>10	—	80	—		Viewing Angle base on using Normal Polarizer , Reference Only
		Θ_R		—	80	—		
	Ver.	Θ_U		—	80	—		
		Θ_D		—	80	—		
Optima View Direction		ALL						(5)

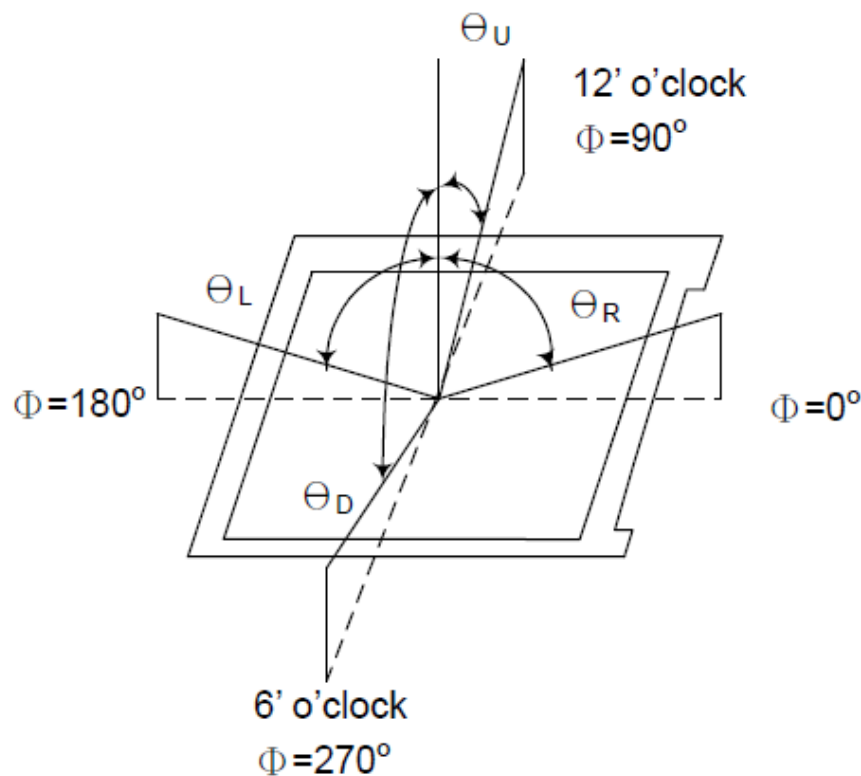
Measuring Condition

- Measuring surrounding : dark room
- Ambient temperature : $25 \pm 2^\circ\text{C}$
- 15min. warm-up time.

Measuring Equipment

FPM520 of Westar Display technologies, INC., which utilized SR-3 for Chromaticity and BM-5A for other optical characteristics.

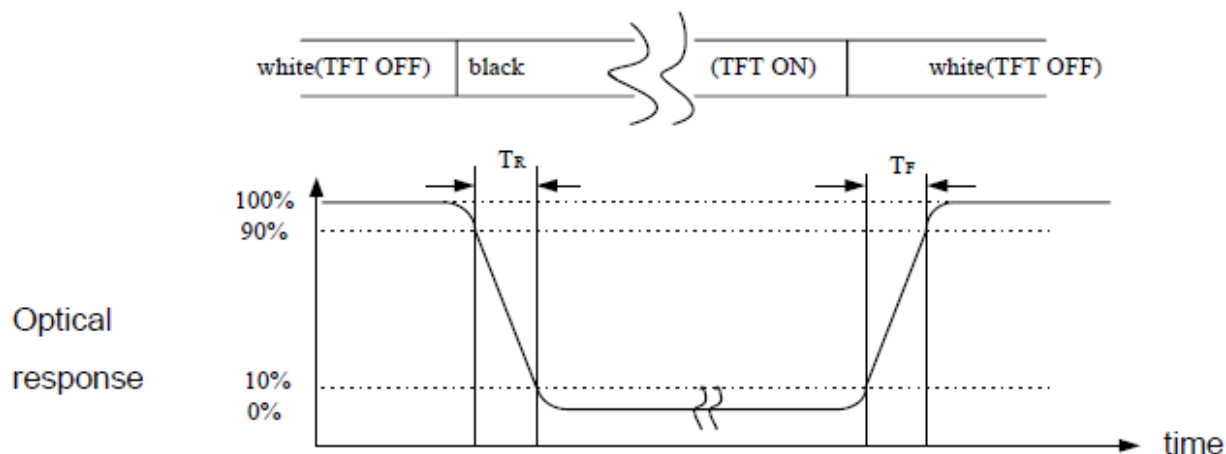
Note (1) Definition of Viewing Angle:



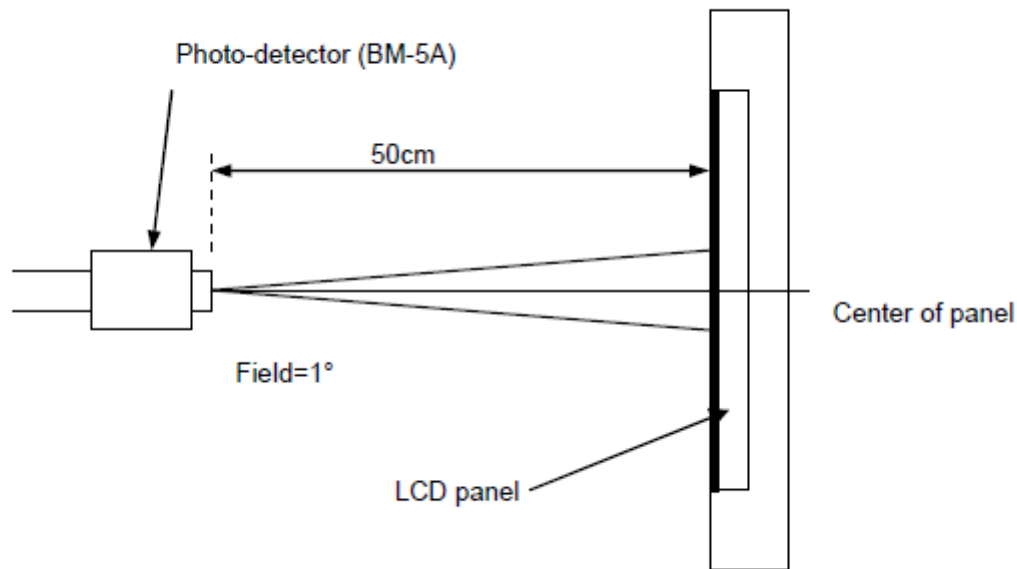
Note (2) Definition of Contrast Ratio (CR) :
measured at the center point of panel

$$CR = \frac{\text{Luminance with all pixels white}}{\text{Luminance with all pixels black}}$$

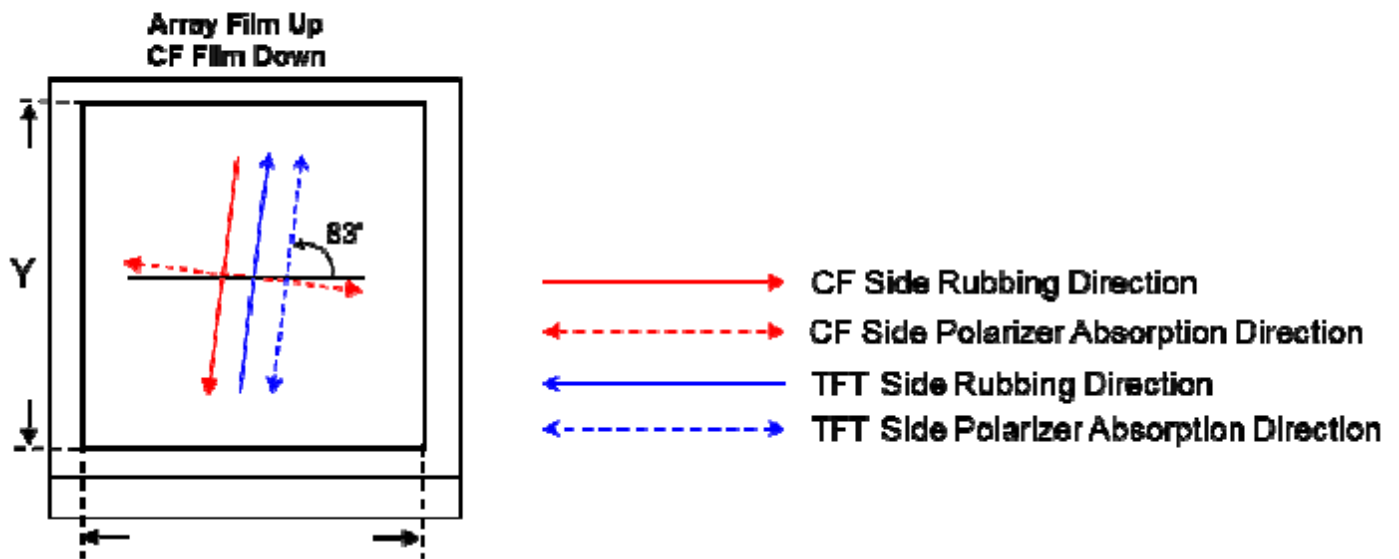
Note (3) Definition of Response Time : Sum of T_R and T_F



Note (4) Definition of optical measurement setup



Note (5) Rubbing Direction & Polarizer Absorption Direction



9. RELIABILITY

No.	Test Item	Test Condition	Remark
1	High Temperature Storage	+80℃± 2℃, 96 hrs	Note
2	Low Temperature Storage	-30℃± 2℃, 96 hrs	Note
3	High Temperature Operation	+70℃± 2℃, 96 hrs	Note
4	Low Temperature Operation	+20℃± 2℃, 96 hrs	Note
5	High Temperature & High Humidity Storage Test	+50℃± 5℃, 90%R.H, 96 hours	Note
6	Temperature Cycle (non operation)	-30℃ ← +25℃ → +80℃ (30mins ← 5mins → 30mins) 10 Cycles	Note
7	Electronic Static Discharge	Air Discharge: 2KV to with 5 times	Discharge for each polarity Mode of Operation: Single Discharge, successive discharge at least 1 sec
		Ambiance: 15℃~35℃, 30%~60%R.H Resistance(Rd): 330Ω ±10% Capacitance(Cs + Cd): 150pF±10%	
8	Vibration (Packaged)	Frequency range: 10Hz ~ 55 Hz Amplitude: 1.5mm Direction of X.Y. Z for 3 Hrs in total	
9	Drop Test (Packaged)	Height: 80cm, Time: 1 1 corner, 3 edged, 6 surfaces	

Note : Recovery Time should be 2~4 hours at room temperature (20±8℃) and humidity (below 60% R.H). No abnormalities in functions and appearance

10.INSPECTION CRITERION

10.1 Scope

Display Quality Evaluation
Mechanics Specification

10.2 Sampling Plan

MIL-STD-105E

Unless there is other agreement, the sampling plan for incoming inspection shall follow MIL-STD-105E

Lot size: Quantity per shipment as one lot (different model as different lot).

Sampling type: Normal inspection, single sampling

Sampling level: Level II.

10.3 Acceptable Quality Level

Item	Major	Minor
Appearance	1.0%	1.5%
Electrical	0.65	1.0%

10.3.1 Classification of defects:

10.3.1.1 Major defect

Any defect may result in functional failure, or reduce the usability of product for its purpose. For Example: Electrical failure, deformation and etc.

10.3.1.2 Minor defect

The criteria on major or minor judgment will be according with the classification of defects.

10.4 Panel Inspection Condition

10.4.1 Environment:

10.4.2 Room Temperature: $25 \pm 5^{\circ}$ C.

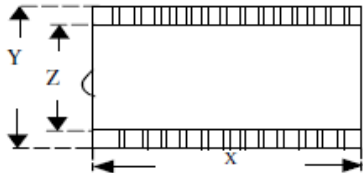
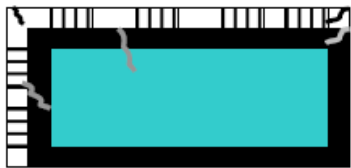
10.4.3 Humidity: $50 \pm 20\%$ RH.

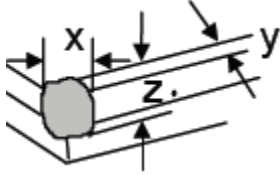
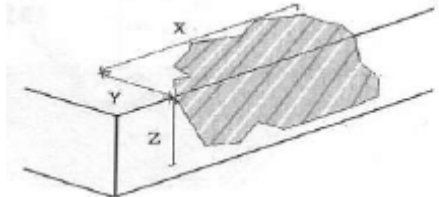
Illumination: 300 ~ 700 Lux.

10.4.4 Inspection Distance: 35 ± 5 cm

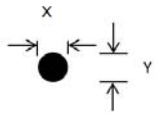
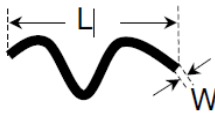
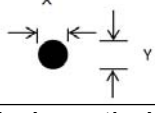
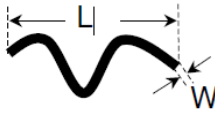
10.5 TFT Inspection Criteria

10.5.1 Visual inspection criterion in cosmetic / appearance

Glass defect			
No	Item	Criteria	Remark
1	Dimension (Minor)	By engineering diagram	
2	Crack (Major)	Extensive crack	

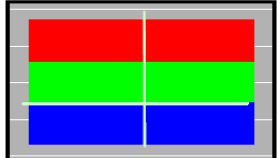
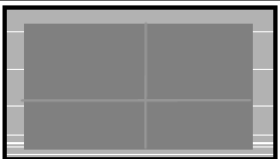
3	Corner (Minor)	$X \leq 3 \text{ mm}$ $Y \leq 3 \text{ mm}$ $Z \leq T$ Ignore	 T: Glass thickness Z: Thickness X: Length Y: Width
4	Side (Minor)	$X \leq 5 \text{ mm}$ $Y \leq 3 \text{ mm}$ $Z \leq T$ Ignore	 T: Glass thickness Z: Thickness X: Length Y: Width

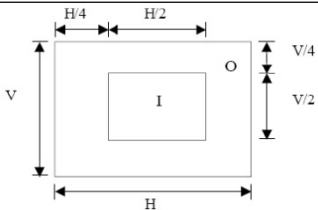
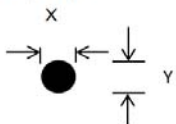
TFT defect in appearance

No	Item	Criteria	Remark
1	Foreign Spot (Minor) Including: Black spot, White spot Pin hole Foreign particle	$D \leq 0.15 \text{ mm}$, Ignore $0.15 \text{ mm} < D \leq 0.3 \text{ mm}$, $N \leq 3$ $0.3 \text{ mm} < D$, $N = 0$ Distance $\geq 5 \text{ mm}$ Ignore if out of Area AA	$D = (X+Y)/2$, X: Length, Y: Width $D = (X+Y) / 2$ 
2	Foreign Line(Minor) Including: Black line White line Bright line	$W \leq 0.03 \text{ mm}$, Ignore $0.03 \text{ mm} < W \leq 0.05 \text{ mm}$, $L \leq 4 \text{ mm}$, $N \leq 3$ $0.05 \text{ mm} < W \leq 0.08 \text{ mm}$, $L \leq 4 \text{ mm}$, $N \leq 1$ $W > 0.08 \text{ mm}$, $N = 0$ Ignore if out of Area AA	L: Length, W: Width 
3	Polarizer Dent/Air Bubble (Minor)	$D \leq 0.2 \text{ mm}$, Ignore $0.2 \text{ mm} < D \leq 0.3 \text{ mm}$, $N \leq 3$ $0.3 \text{ mm} < D \leq 0.5 \text{ mm}$, $N \leq 1$ $D > 0.50 \text{ mm}$, $N = 0$ Distance $\geq 5 \text{ mm}$	$D = (X+Y)/2$, X: Length, Y: Width $D = (X+Y) / 2$ 
4	Polarizer Scratches (Minor)	$W \leq 0.03 \text{ mm}$, Ignore $0.03 \text{ mm} < W \leq 0.05 \text{ mm}$, $L \leq 4 \text{ mm}$, $N \leq 3$ $0.05 \text{ mm} < W \leq 0.08 \text{ mm}$, $L \leq 4 \text{ mm}$, $N \leq 1$ $W > 0.08 \text{ mm}$, $N = 0$ Ignore if out of Area AA	L: Length, W: Width 

Other defects			
No	Item	Criteria	Remark
1	FPC (Minor)	Any crack or breakage which effect the function are not allowed Disregard if the dirty removed	
2	Backlight (Minor)	Power up is allowed. Breaking off is not allowed. The scratch which may causes a problem in practical use is not allowed	
3	Bezel (Minor)	Erasable dirt is ignore	

10.5.2 Visual inspection criterion in electrical display

Glass defect			
No	Item	Criteria	Remark
1	No display (Major) Abnormally Short circuit	Not allowed	
2	Missing line (Major)	Not allowed	
3	Darker or lighter line (Major)	Not allowed	
4	Weak line (Minor)	By limit sample	

Display Inspection						
No	Item	Criteria				Remark
1	Bright / Dark dot	Items	Area I	Area O	Total	 1. 1 sub-pixel: 1R or 1G or 1B 2. Point defect area $\geq 1/2$ sub pixel
		Bright	1	1	1	
		Dark	1	3	3	
		Bright & Dark	2	3	4	
		2 adjacent dots	0	0	0	
		Minimum Distance $\geq 5\text{mm}$				
2	Tiny bright dot	Visible through 6% ND filter $D \leq 0.15\text{mm}$, Ignore $0.15\text{mm} < D \leq 0.3\text{mm}$, $N \leq 3$ $0.3\text{mm} < D \leq 0.35\text{mm}$, $N \leq 1$ $D > 0.35\text{mm}$, $N = 0$ Distance $\geq 5\text{mm}$ Ignore if out of Area AA				$D = (X+Y)/2$, X: Length, Y: Width 
4	Mura/Waving/ Hot spot	Not visible through 6% ND filter in 50% gray or judge by limit sample if necessary				

* Note:

- Defect which is on the Black Matrix (outside of active area) are not considered as a defect.
- If any specific defect is not included in the above defect table, this defect should be judged by Formike.
- W: Width, L: Length D: Average Diameter N: Count.

11. PRECAUTION RELATING & PRODUCT HANDLING

Display is assembled and adjusted with a high degree of precision. Do not attempt to make any alteration or modification.

11.1 SAFETY

11.1.1 If the LCD panel breaks, be careful not to get the liquid crystal to touch your skin.

11.1.2 If the liquid crystal touches your skin or clothes, please wash it off immediately by using soap and water.

11.2 HANDLING

11.2.1 Avoid any strong mechanical shock which can break the glass.

11.2.2 Avoid static electricity which can damage the CMOS LSI - When working with the module, be sure to ground your body and any electrical equipment you may be using. The followings should be noted:

11.2.2.1 CMOS-LSI is used for the module circuit; therefore operators should be grounded whenever he/she comes into contact with the module.

11.2.2.2 Do not touch any of the conductive parts such as the LSI pads; the copper leads on the PCB and the interface terminals with any parts of the human body.

11.2.2.3 Do not touch the connection terminals of the display with bare hand; it will cause disconnection or defective insulation of terminals.

11.2.2.4 The modules should be kept in anti-static bags or other containers resistant to static for storage.

11.2.2.5 Only properly grounded soldering irons should be used.

11.2.2.6 If an electric screwdriver is used, it should be grounded and shielded to prevent sparks.

11.2.2.7 The normal static prevention measures should be observed for work clothes and working benches.

11.2.3.8 Since dry air is inductive to static, a relative humidity of 50-60% is recommended

11.2.3 Do not remove the panel or frame from the module.

11.2.4 The polarizing plate of the display is very fragile. Please handle it very carefully, do not touch, push or rub the exposed polarizing with anything harder than an HB pencil lead (glass, tweezers, etc.)

11.2.5 Do not wipe the polarizing plate with a dry cloth, as it may easily scratch the surface of plate.

11.2.6 Do not touch the display area with bare hands, this will stain the display area.

11.2.7 Do not use ketonics solvent & aromatic solvent. Use with a soft cloth soaked with a cleaning naphtha solvent.

11.2.8 To control temperature and time of soldering is $300 \pm 10^{\circ}\text{C}$ and 3-4 sec.

To avoid liquid (include organic solvent) stained on LCD Module.

11.3 STORAGE

11.3.1 Store the panel or module in a dark place where the temperature is $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and the humidity is below 60% RH.

11.3.2 Avoid exposure to direct sunlight or to the light of fluorescent lamps.

11.3.3 Do not place the module near organic solvents or corrosive gases.

Do not crush, shake, or jolt the module.

11.4 LIMITED WARRANTY

11.4.1 FORMIKE modules are not consumer products, but may be incorporated by FORMIKE's customers into consumer products or components thereof, FORMIKE does not warrant that its modules and components are fit for any such particular purpose.

11.4.2 The liability of FORMIKE is limited to repair or replacement on the terms set forth below. FORMIKE will not be responsible for any subsequent or consequential events or injury or damage to any personnel or user including third party personnel and/or user. Unless otherwise agreed in writing between FORMIKE and the customer, FORMIKE will only replace or repair any of its Modules which is found defective electrically or visually when inspected in accordance with FORMIKE INSPECTION CRITERIA

11.4.3 No warranty can be granted if any of the precautions state in handling liquid crystal display has been disregarded. Broken glass, scratches on polarizer mechanical damages as well as defects that are caused accelerated environment tests are excluded from warranty.

11.4.4 In returning the modules, they must be properly packaged; there should be detailed description of the failures or defect.

12. OTHERS

12.1 If there is any not specified quality standard in this specification as well as RMA , please refer to < INSPECTION CRITERIA>. Contact FORMIKE to get the complete <INSPECTION CRITERIA> by the contact window or feedback@wandisplay.com.

12.2 Special agreement of <INSPECTION CRITERIA> is recognized only in writhing between FORMIKE and the customer also indicated it before ordering.