

MODEL NO. : TM028LDH01ISSUED DATE: 2010-01-27VERSION : Ver 1.2☒ Preliminary Specification☐ Final Product Specification

Customer : _____

Approved by	Notes

SHANGHAI TIANMA Confirmed :

Prepared by	Checked by	Approved by

This technical specification is subjected to change without notice.



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Record of Revision

Rev	Issue Date	Description	Editor
1.0	2009-06-09	Preliminary release.	Qiuping Yang
1.1	2009-08-04	Update mechanical drawing on page 21.	Qiuping Yang
1.2	2010-01-27	Update driving backlight on page 8; Update reliability test on page 21.	Qiuping Yang



1 General Specifications

Feature		Spec
Display Spec	Size	2.8 inch
	Resolution	240(RGB) x400
	Interface	CPU 16 bit
	Color Depth	65K
	Technology Type	a-Si
	Pixel Pitch (mm)	0.153 x 0.153
	Pixel Configuration	R.G.B. Vertical Stripe
	Display Mode	TM with Normally White
	Surface Treatment	Clear type (3H)
	Viewing Direction	6 o'clock
	Gray Scale Inversion Direction	12 o'clock
Mechanical Characteristics	LCM (W x H x D) (mm)	42.42x72.80x2.60
	Active Area(mm)	36.72×61.20
	With /Without TSP	Without TSP
	Weight (g)	TBD
	LED Numbers	4 LEDs
Electronic	Driver IC	HX8352-A

Note 1: Viewing direction for best image quality is different from TFT definition, there is a 180 degree shift.

Note 2: Requirements on Environmental Protection: RoHS.

Note 3: LCM weight tolerance: +/- 5%.



2 Input/Output Terminals

2.1 TFT LCD Panel

No	Symbol	I/O	Description	Remark
1	LCM_ID	O	ID pin.	
2	X(L)	—	No connection	
3	Y(U)	—	No connection	
4	X(R)	—	No connection	
5	Y(D)	—	No connection	
6	GND	P	Ground	
7	IOVCC	P	Digital I/O PAD power supply	
8	VCC/VCI	P	Digital/Analog power supply	
9	FMARK	O	Tearing effect output. If not used, please open this	
10	CS	I	Chip select signal, low: chip can be accessed;	
11	RS	I	Command or parameter select signal; Low:	
12	WR	I	Write signal;	
13	RD	I	Read signal;	
14	DB0	I	Data input	
15	DB1	I	Data input	
16	DB2	I	Data input	
17	DB3	I	Data input	
18	DB4	I	Data input	
19	DB5	I	Data input	
20	DB6	I	Data input	
21	DB7	I	Data input	
22	DB8	I	Data input	
23	DB9	I	Data input	
24	DB10	I	Data input	
25	DB11	I	Data input	
26	DB12	I	Data input	
27	DB13	I	Data input	
28	DB14	I	Data input	
29	DB15	I	Data input	
30	RESET	I	Reset signal; Must be reset after power is supplied;	
31	GND	P	Ground;	
32	A	P	Back light cathode LEDA	
33	K1	P	Back light cathode LEDK1	
34	K2	P	Back light cathode LEDK2	
35	K3	P	Back light cathode LEDK3	
36	K4	P	Back light cathode LEDK4	
37	NC	—	No connection	

Note: I/O definition: I----Input; O---Output; P----Power/Ground.

Remark:

Interface	DB pin	Correspondence IC DB pin
16bit interface	DB [15~0]	D[15~0]



3 Absolute Maximum Ratings

3.1 Driving TFT LCD Panel

GND=0V, Ta=25°C

Item	Symbol	Min	Max	Unit	Remark
Analog Supply Voltage	VCC	-0.3	4.6	V	
Digital Supply Voltage	IOVCC	-0.3	4.6	V	
Input Signal Voltage	CS,RS,WR,RD RESET,DB[0:15]	-0.3	VCC +0.3	V	
Back Light Forward Current	I _{LED}	--	25.0	mA	For each LED
Operating Temperature	T _{OPR}	-20	70	°C	
Storage Temperature	T _{STG}	-30	80	°C	



4 Electrical Characteristics

4.1 Driving TFT LCD Panel

GND=0V, Ta=25°C

Item		Symbol	Min	Typ	Max	Unit	Remark
Analog Supply Voltage		VDD	2.5	2.8	3.3	V	
Digital Supply Voltage		IOVCC	1.65	2.8	3.3	V	
Input Signal Voltage	Low Level	V _{IL}	0	--	0.2xIOVCC	V	CS,RS,WR,RD RESET,DB[0:15]
	High Level	V _{IH}	0.8xIOVCC	--	IOVCC	V	
Output Signal Voltage	Low Level	V _{OL}	0	--	0.2xIOVCC	V	LCM_ID, FMARK
	High Level	V _{OH}	0.8xIOVCC	--	IOVCC	V	
(Panel+ LSI) Power Consumption		Black Mode	--	TBD	--	mW	Frame Rate:60Hz
		8 Color Mode	--	TBD	--	μW	
		Sleeping Mode	--	TBD	--	μW	

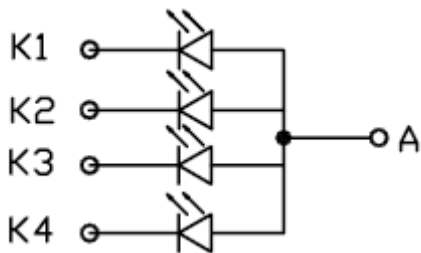


4.2 Driving Backlight

Ta=25°C

Item	Symbol	Min	Typ	Max	Unit	Remark
Forward Current	I_F	--	15	--	mA	For each LED
Forward Voltage	V_F	--	3.2	--	V	
Power Consumption	W_{BL}	--	192	--	mW	
Operating Life Time	--	10000	(20000)	--	Hrs	

Note 1: The figure below shows the connection of backlight LED.



Note 2: One LED: $I_F = 15\text{mA}$, $V_F = 3.2\text{V}$.

Note 3:

I_F is defined for one channel LED.

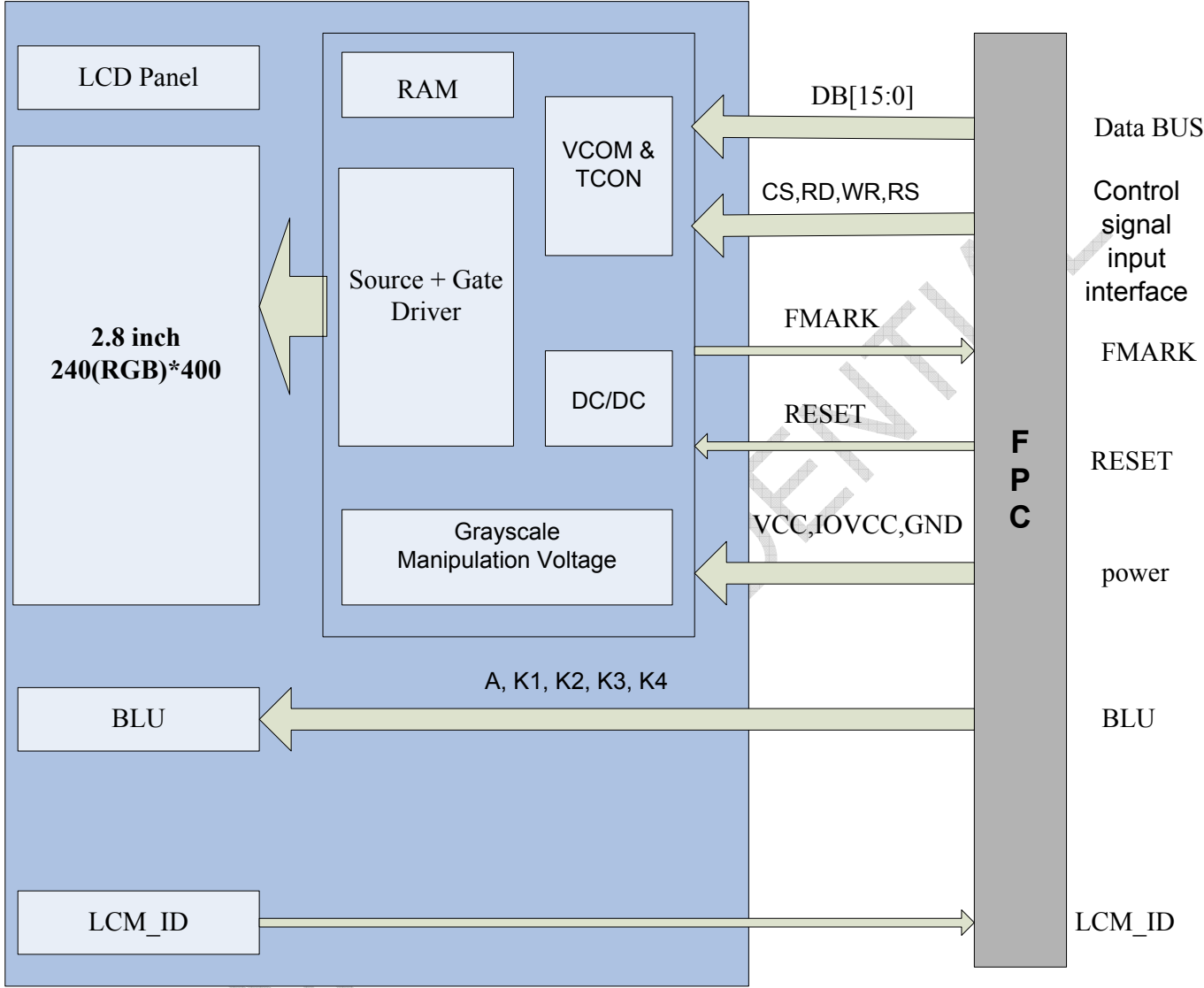
Optical performance should be evaluated at Ta=25°C only.

If LED is driven by high current, high ambient temperature & humidity condition. The life time of LED will be reduced.

Operating life means brightness goes down to 50% initial brightness. Typical operating life time is estimated data.



4.3 Block Diagram





5 Timing Chart

5.1 Interface Characteristics

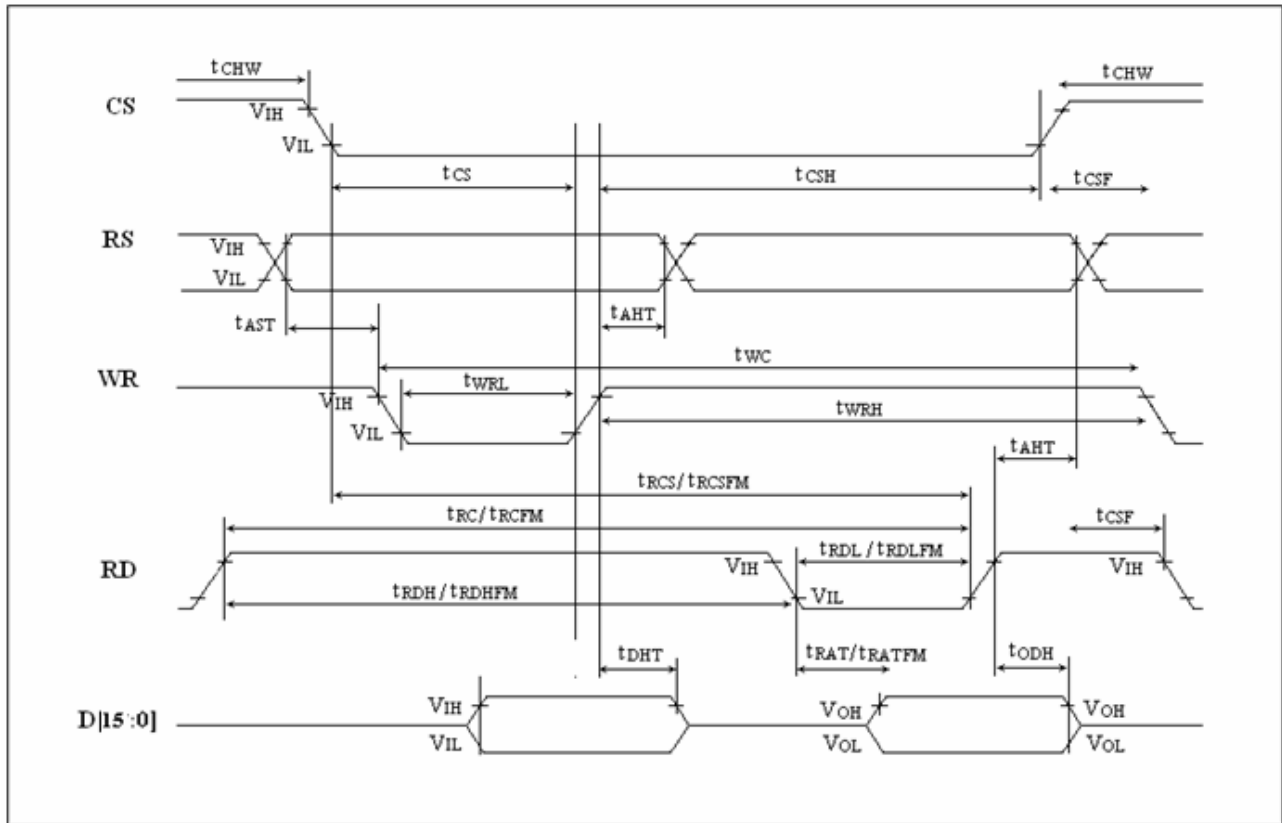


Figure 5.1 CPU Interface Characteristics



5.2 Interface Timing Parameters

Signal	Symbol	Parameter	Spec			Description
			Min	Max	Unit	
RS	t_{AST}	Address setup time	10	-	ns	-
	t_{AHT}	Address hold time(Write/Read)	10	-	ns	-
CS	t_{CHW}	Chip select "H" pulse width	0	-	ns	-
	t_{CS}	Chip select setup time (Write)	35	-	ns	-
	t_{RCS}	Chip select setup time (Read ID)	100	-	ns	-
	t_{RCSFM}	Chip select setup time (Read FM)	100	-	ns	-
	t_{CSF}	Chip select wait time(Write/Read)	10	-	ns	-
	t_{CSH}	Chip select hold time	10	-	ns	-
WR	t_{WC}	Write cycle	100	-	ns	-
	t_{WRH}	Control pulse "H" duration	20	-	ns	-
	t_{WRL}	Control pulse "L" duration	20	-	ns	-
RD	t_{RC}	Read cycle (ID)	150	-	ns	When read ID data
	t_{RDH}	Control pulse "H" duration (ID)	40	-	ns	When read ID data
	t_{RDL}	Control pulse "L" duration (ID)	50	-	ns	When read ID data
RD	t_{RCFM}	Read cycle (FM)	250	-	ns	When read from frame memory
	t_{RDHFM}	Control pulse "H" duration (FM)	50	-	ns	When read from frame memory
	t_{RDLFM}	Control pulse "L" duration (FM)	150	-	ns	When read from frame memory
D[15:0]	t_{DST}	Data setup time	20	-	ns	For maximum $C_L=30pF$
	t_{DHT}	Data hold time	20	-	ns	For minimum $C_L=8pF$
	t_{RAT}	Read access time (ID)	-	70	ns	For minimum $C_L=8pF$
	t_{RATFM}	Read access time (FM)	-	100	ns	For minimum $C_L=8pF$
	t_{ODH}	Output disable time	20	80	ns	For minimum $C_L=8pF$



5.3 Interface Register write/read timing

5.3.1 System Bus Interface Register Write Timing

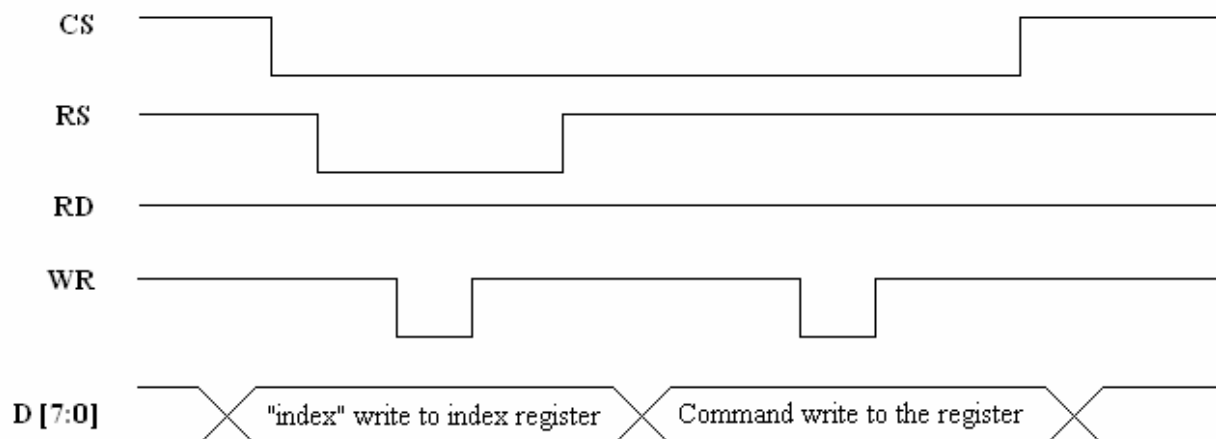


Figure 5.3.1 System Bus Interface Write Register Timing

5.3.2 System Bus Interface Register Read Timing

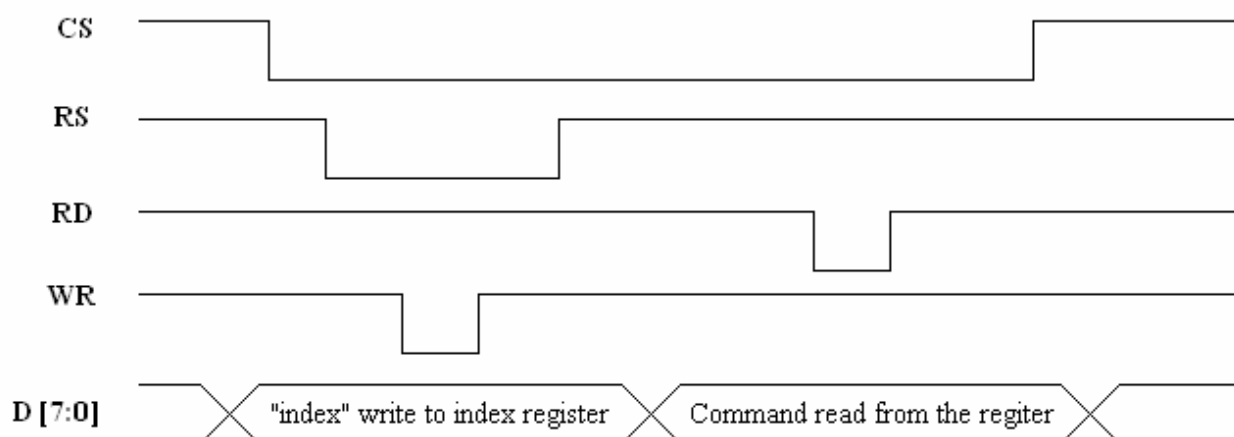


Figure 5.3.2 System Bus Interface Read Register Timing



5.4 GRAM Write/Read Data Format

5.4.1 16-bit Read/Write GRAM Data Format(65K)

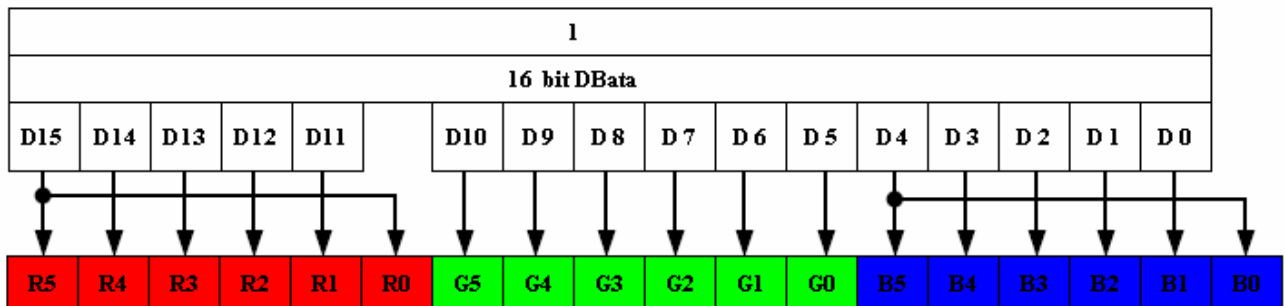


Figure 5.4.1 16-bit Data Bus GRAM Write/Read Data Format (16bit, 65k)

5.5 Data Bus GRAM Write/Read Timing

5.5.1 16-bit Data Bus GRAM Write Timing(65k)

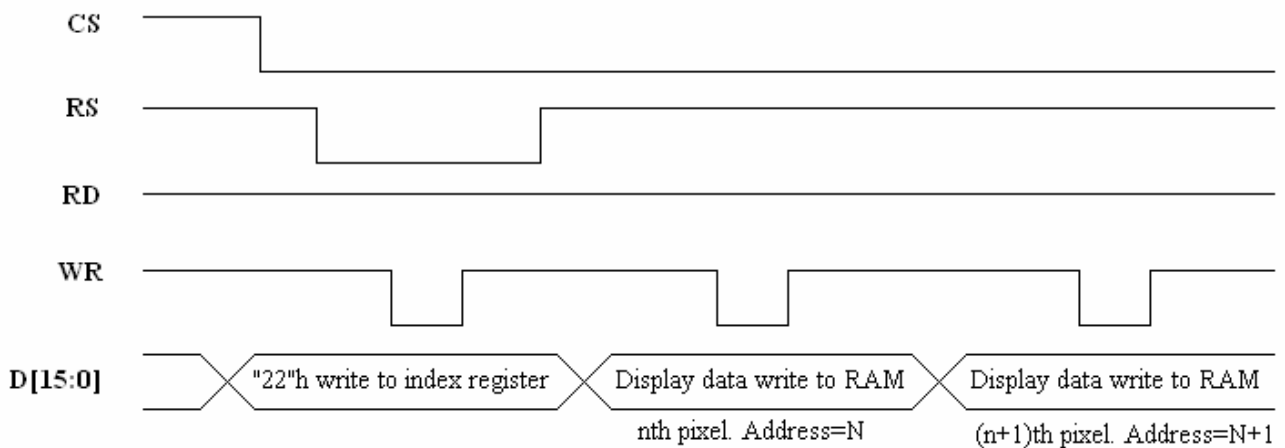


Figure 5.5.1 16-bit Data Bus GRAM Write Timing(16bit,65k)

5.5.2 16-bit Data Bus GRAM Read Timing(65k)

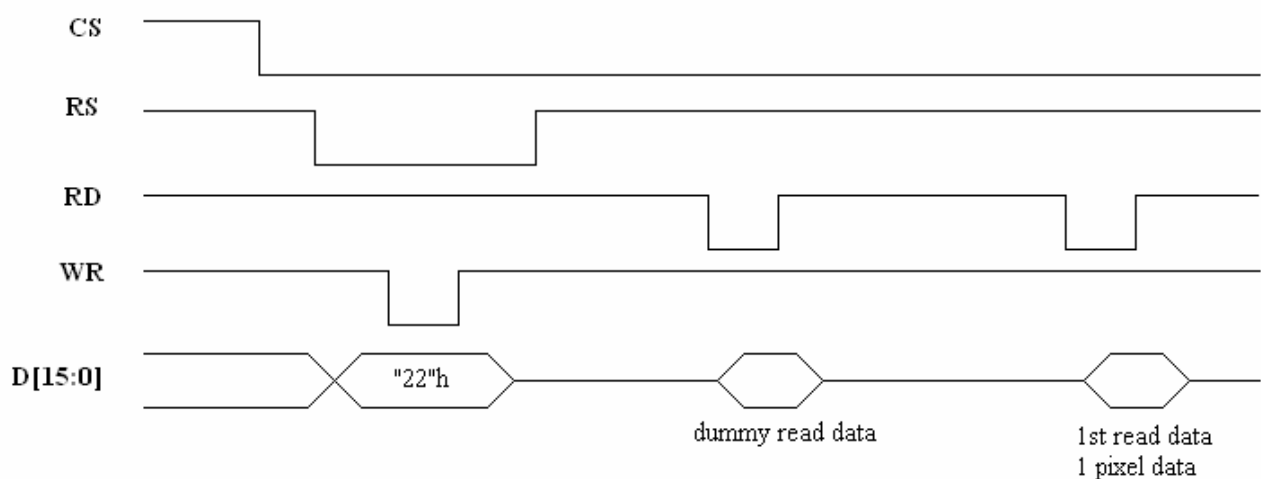


Figure 5.5.2 16-bit Data Bus GRAM Read Timing(16bit,65k)



5.6 Reset Timing Characteristics

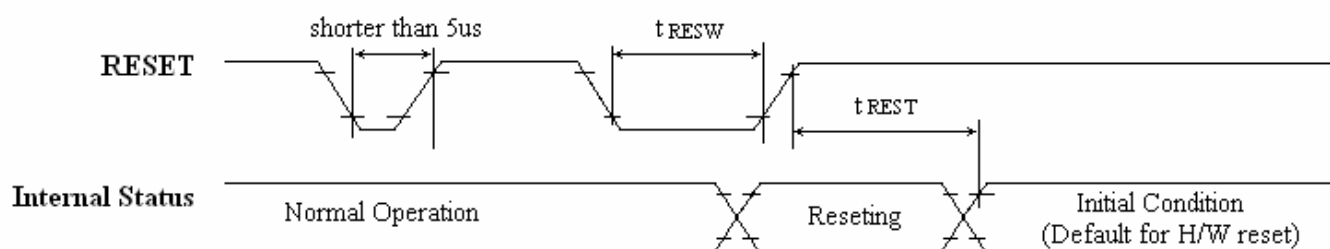


Figure 5.6.1 Reset Input Timing

IOVCC=1.65~3.3V, VCC=2.3~3.3V

Symbol	Parameter	Related Pins	Spec			Note	Unit
			Min	Typ	Max		
t_{RESW}	Reset low pulse width	RESET	10	-	-	-	us
t_{REST}	Reset complete time	-	-	-	5	When reset applied during "Sleep In mode"	ms
		-	-	-	120	When reset applied during "Sleep Out mode"	ms

Table 5.6 Reset Timing Parameters

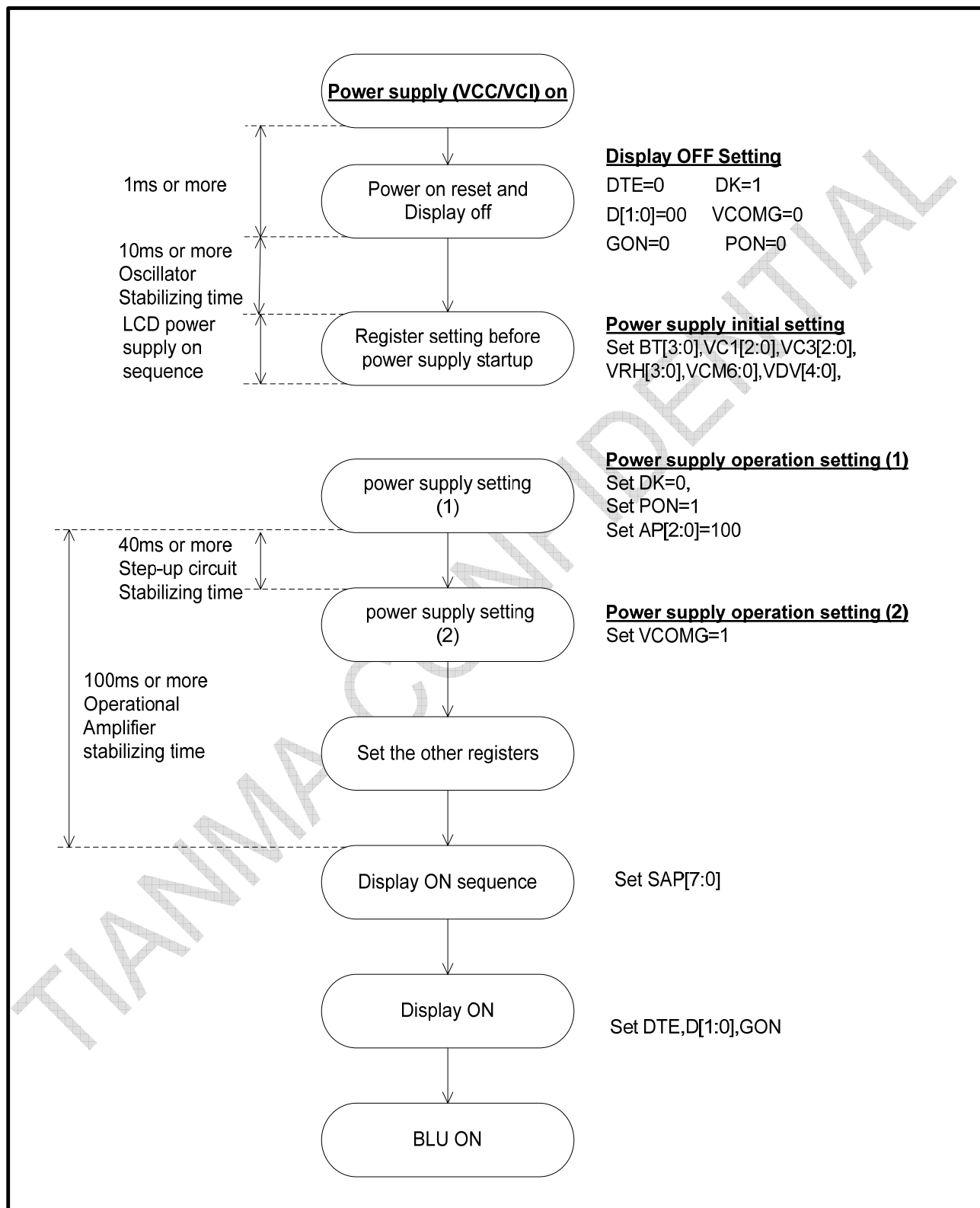
Remark:

RESET Pulse	Action
Shorter than 5μs	Shorter than 5μs
Longer than 10μs	Reset
Between 5μs and 10μs	Reset Start



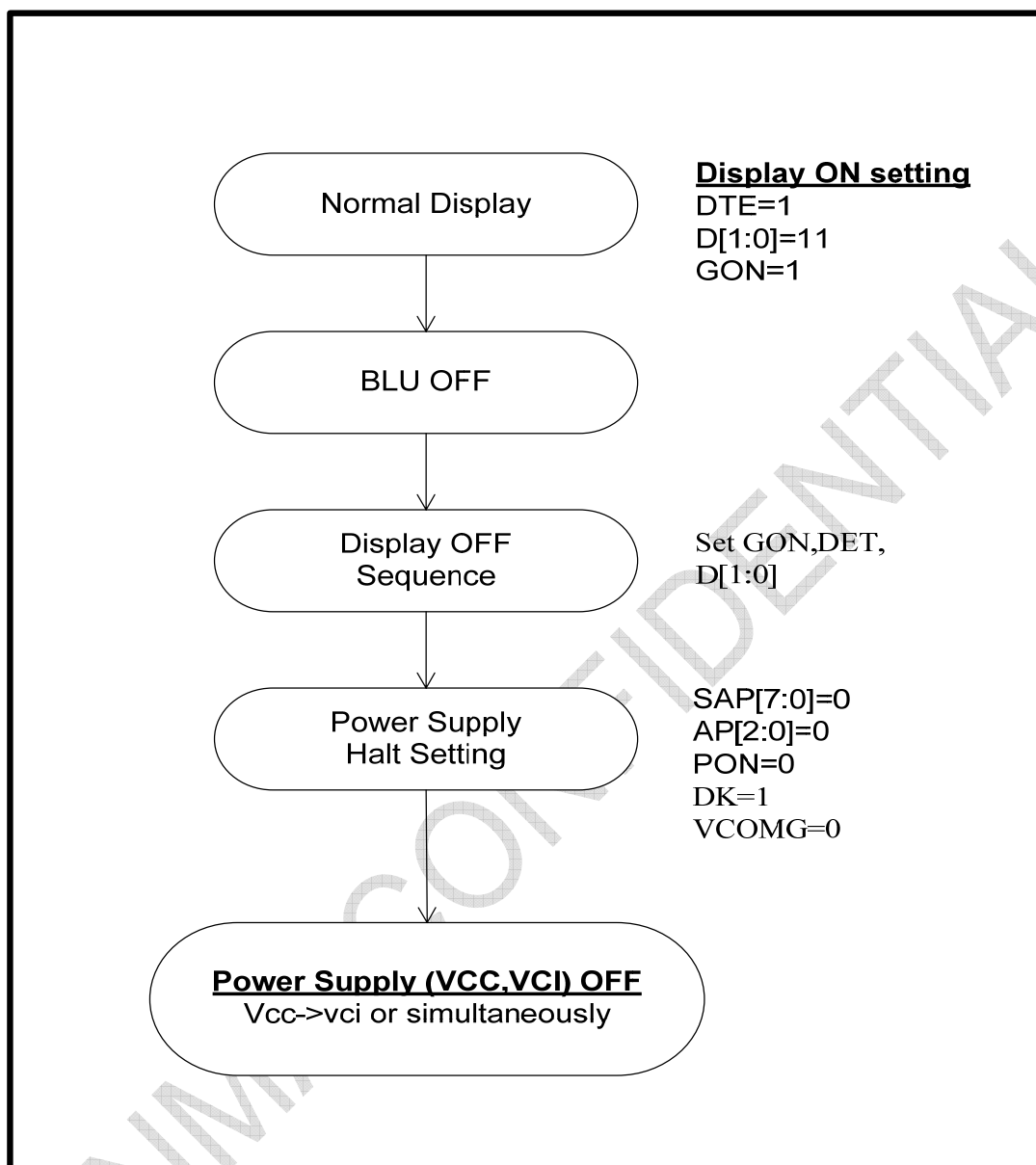
5.7 Power ON/OFF Sequence

5.7.1 Power ON Sequence





5.7.2 Power OFF Sequence





6 Optical Characteristics Optical Specification

Ta=25°C

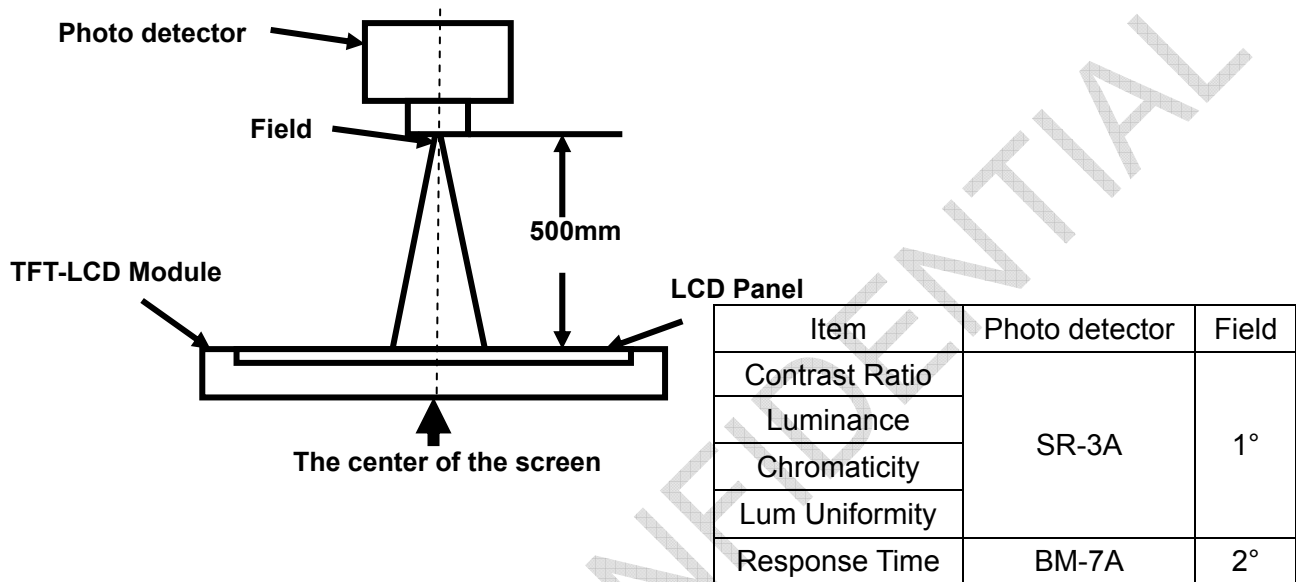
Item		Symbol	Condition	Min	Typ	Max	Unit	Remark
View Angle		θT	CR≥10	60	70	--	Degree	Note 2
		θB		40	50	--		
		θL		60	70	--		
		θR		60	70	--		
Contrast Ratio		CR	θ=0°	300	450	--		Note1 Note3
Response Time		T _{ON}	25℃	--	25	40	ms	Note1
		T _{OFF}						Note4
Chromaticity	White	x	Backlight is on	0.236	0.286	0.336		Note1 Note5
		y		0.265	0.315	0.365		
	Red	x		0.549	0.599	0.649		
		y		0.301	0.351	0.401		
	Green	x		0.284	0.334	0.384		
		y		0.516	0.566	0.616		
	Blue	x		0.086	0.136	0.186		
		y		0.052	0.102	0.152		
Uniformity (%)		U		--	80	--		Note1 Note6
NTSC (%)				--	52.4	--		Note5
Luminance(Without TSP)		L		170	220	--		Note1 Note7

Test Conditions:

1. $V_F=3.2V$, $I_F=15mA$ (LED current), the ambient temperature is 25°C.
2. The test systems refer to Note1 and Note2.

**Note 1: Definition of optical measurement system.**

The optical characteristics should be measured in dark room. After 5 minutes operation, the optical properties are measured at the center point of the LCD screen. All input terminals LCD panel must be ground when measuring the center area of the panel.

**Note 2: Definition of viewing angle range and measurement system.**

viewing angle is measured at the center point of the LCD by CONOSCOPE(ergo-80).

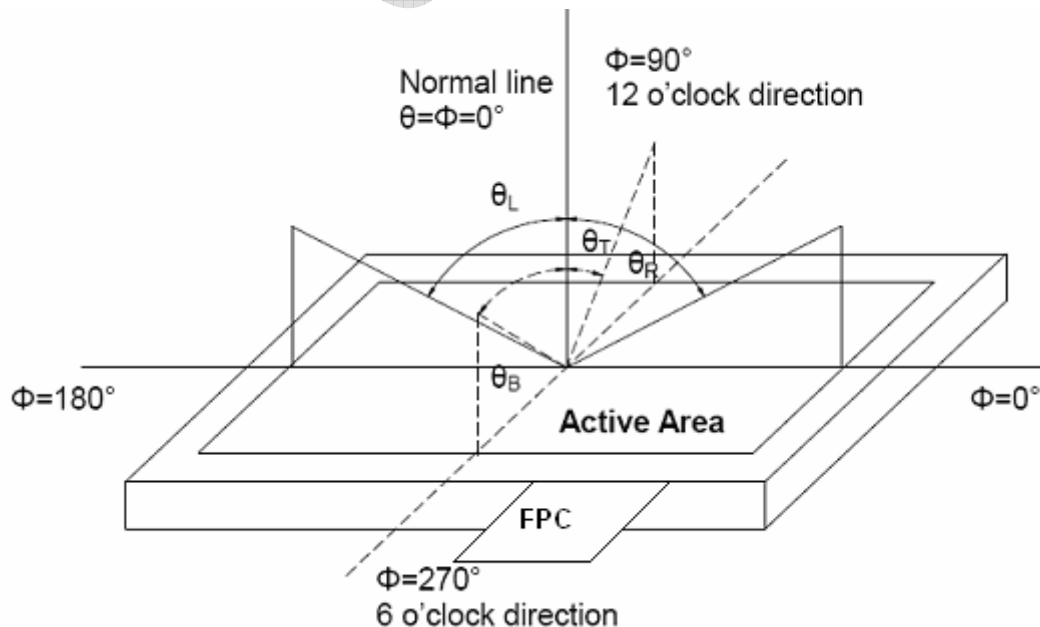


Fig. 1 Definition of viewing angle

**Note 3: Definition of contrast ratio**

$$\text{Contrast ratio (CR)} = \frac{\text{Luminance measured when LCD is on the "White" state}}{\text{Luminance measured when LCD is on the "Black" state}}$$

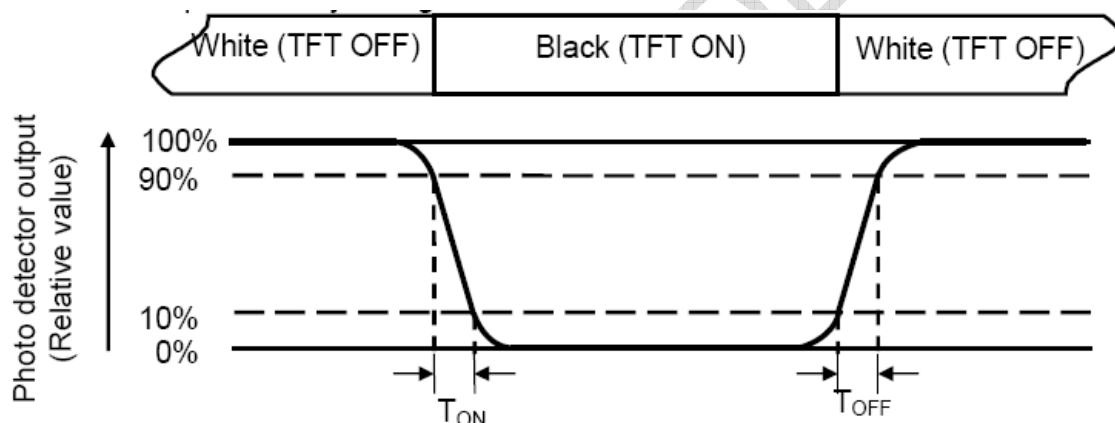
"White state": The state is that the LCD should be driven by V_{white} .

"Black state": The state is that the LCD should be driven by V_{black} .

V_{white} : To be determined V_{black} : To be determined.

Note 4: Definition of response time

The response time is defined as the LCD optical switching time interval between "White" state and "Black" state. Rise time (T_{ON}) is the time between photo detector output intensity changed from 90% to 10%. And fall time (T_{OFF}) is the time between photo detector output intensity changed from 10% to 90%.

**Note 5: Definition of color chromaticity (CIE1931)**

Color coordinates measured at center point of LCD.

**Note 6: Definition of luminance uniformity**

Active area is divided into 9 measuring areas (Refer Fig. 2). Every measuring point is placed at the center of each measuring area.

$$\text{Luminance Uniformity}(U) = L_{\min} / L_{\max}$$

L-----Active area length W----- Active area width

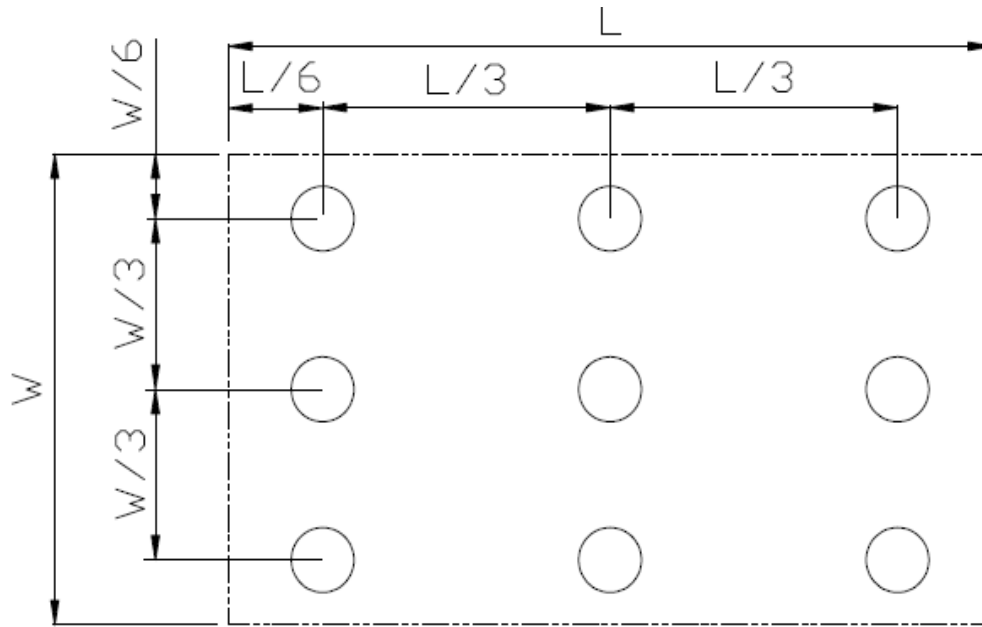


Fig. 2 Definition of uniformity

L_{\max} : The measured maximum luminance of all measurement position.

L_{\min} : The measured minimum luminance of all measurement position.

Note 7: Definition of luminance:

Measure the luminance of white state at center point.



7 Environmental / Reliability Test

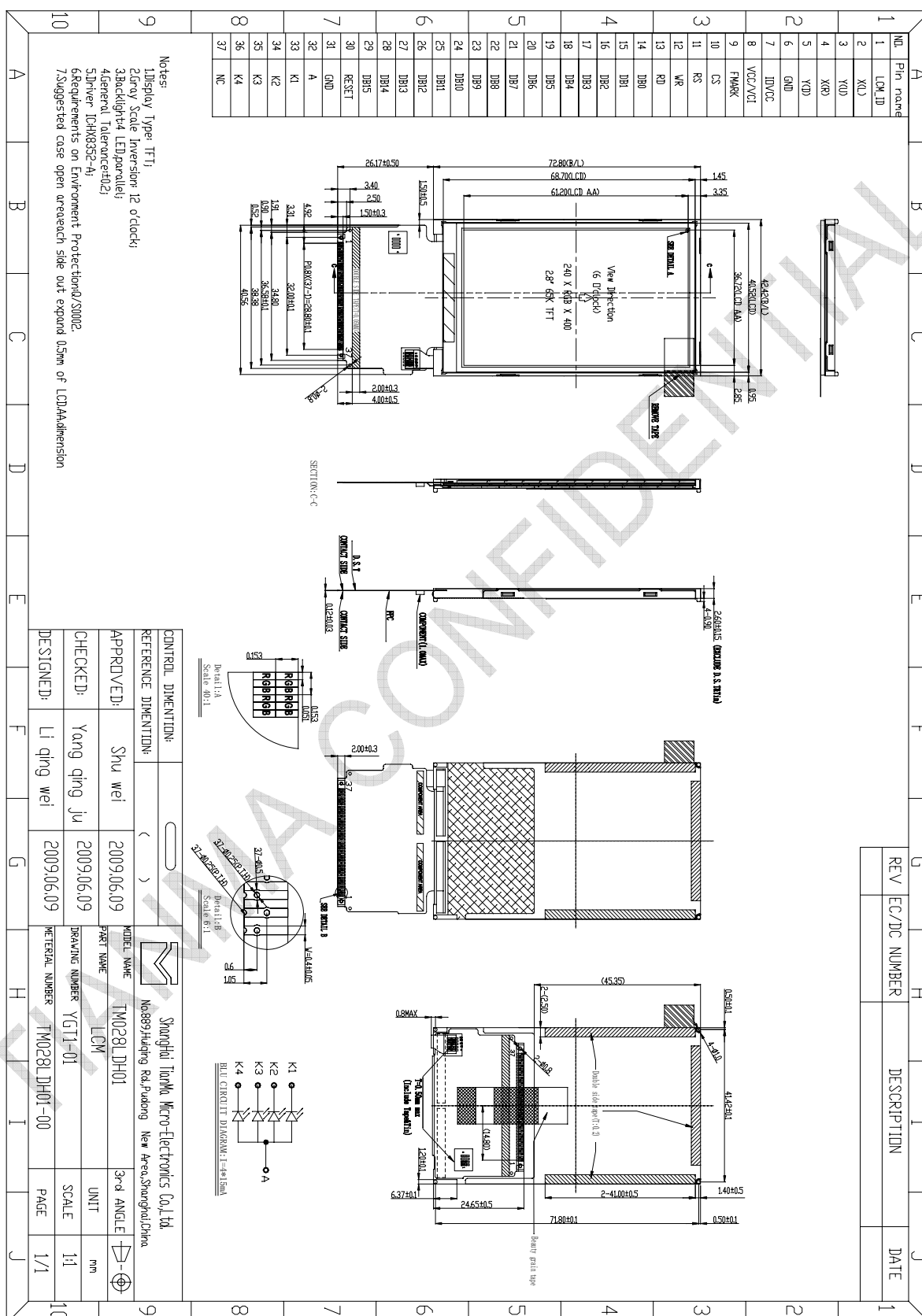
No	Test Item	Condition	Remark
1	High Temperature Operation	Ts=+70℃, 120hrs	Note1 IEC60068-2-1,GB2423.2
2	Low Temperature Operation	Ta=-20℃, 120hrs	IEC60068-2-1 GB2423.1
3	High Temperature Storage	Ta=+80℃, 120hrs	IEC60068-2-1 GB2423.2
4	Low Temperature Storage	Ta=-30℃, 120hrs	IEC60068-2-1 GB2423.1
5	High Temperature & High Humidity Storage	Ta=+60℃, 90% RH 120 hours	Note2 IEC60068-2-78 GB/T2423.3
6	Thermal Shock (Non-operation)	-30℃ 30 min~+80℃ 30 min, Change time:5min, 20 Cycles	Start with cold temperature, End with high temperature, IEC60068-2-14,GB2423.22
7	Electro Static Discharge (Operation)	C=150pF, R=330Ω, 5points/panel Air:±8KV, 5times; Contact:±4KV, 5 times; (Environment: 15℃~35℃, 30%~60%, 86Kpa~106Kpa).	IEC61000-4-2 GB/T17626.2
8	Vibration (Non-operation)	Frequency range:10~55Hz, Stroke:1.5mm Sweep:10Hz~55Hz~10Hz 2 hours for each direction of X.Y.Z. (6 hours for total)(Package condition)	IEC60068-2-6 GB/T2423.10
9	Shock (Non-operation)	60G 6ms, ±X,±Y,±Z 3times, for each direction	IEC60068-2-27 GB/T2423.5
10	Package Drop Test	Height:80 cm,1 corner, 3 edges, 6 surfaces	IEC60068-2-32 GB/T2423.8

Note1: Ts is the temperature of panel's surface.

Note2: Ta is the ambient temperature of sample.



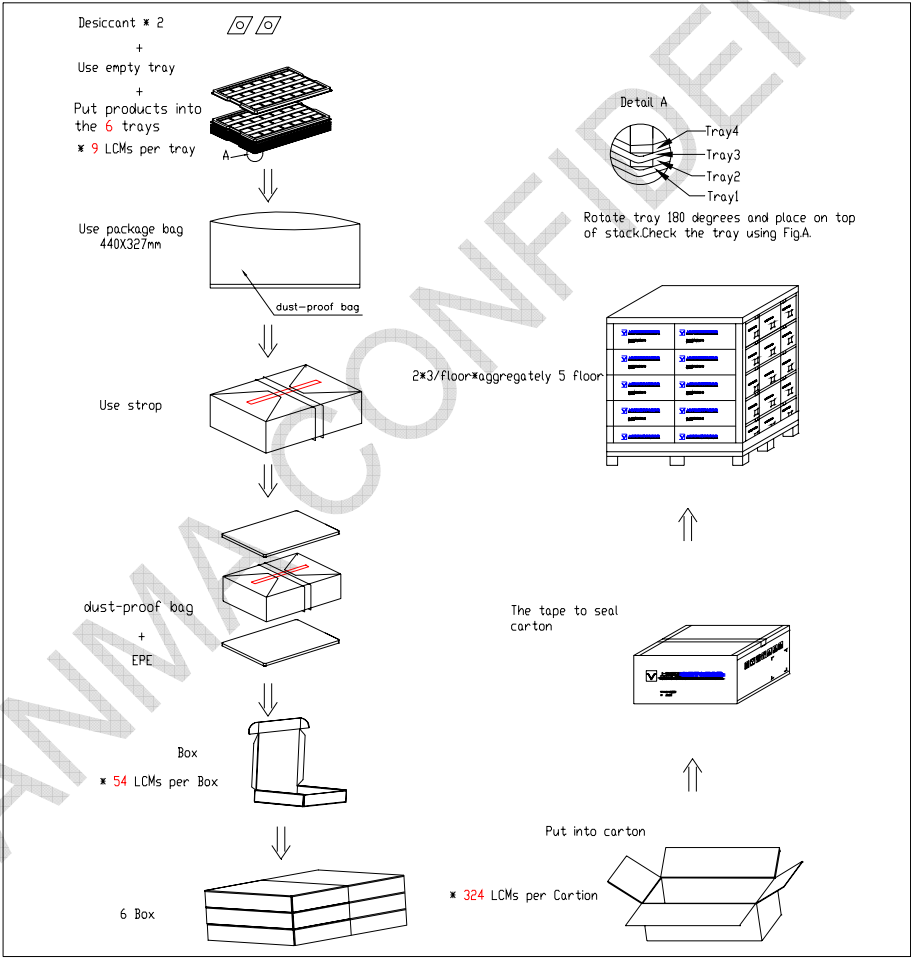
8 Mechanical Drawing





9 Packing Drawing

No	Item	Model (Material)	Dimensions(mm)	Unit Weight(Kg)	Quantity	Remark
1	LCM module	TM028LDH01	TBD	TBD		
2	Tray	PET(Transmit)	TBD	TBD		Anti-static
3	EPE	EPE	TBD	TBD		
4	Desiccant	Desiccant	TBD	TBD		
5	Anti-static bag	PE	TBD	TBD		
6	BOX	Corrugated paper	TBD	TBD		
7	Carton	Corrugated paper	TBD	TBD		
8	Total Weight(Kg)	TBD				





10 Precautions for Use of LCD Modules

10.1 Handling Precautions:

- 10.1.1 The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.
- 10.1.2 If the display panel is damaged and the liquid crystal substance inside it leaks out, be sure not to get any in your mouth, if the substance comes into contact with your skin or clothes, promptly wash it off using soap and water.
- 10.1.3 Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.
- 10.1.4 The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.
- 10.1.5 If the display surface is contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If still not completely clear, moisten cloth with one of the following solvents:

- Isopropyl alcohol
- Ethyl alcohol

Solvents other than those mentioned above may damage the polarizer. Especially, do not use the following:

- Water
- Ketone
- Aromatic solvents

- 10.1.6 Do not attempt to disassemble the LCD Module.
- 10.1.7 If the logic circuit power is off, do not apply the input signals.
- 10.1.8 To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.
 - 10.1.8.1 Be sure to ground the body when handling the LCD Modules.
 - 10.1.8.2 Tools required for assembly, such as soldering irons, must be properly ground.
 - 10.1.8.3 To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.
 - 10.1.8.4 The LCD Module is coated with a film to protect the display surface. Be care when peeling off this protective film since static electricity may be generated.

10.2 Storage precautions:

- 10.2.1 When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps.
- 10.2.2 The LCD modules should be stored under the storage temperature range. If the LCD modules will be stored for a long time, the recommend condition is:
- 10.2.3 Temperature: 0°C~40°C Relatively humidity: ≤80%
- 10.2.4 The LCD modules should be stored in the room without acid, alkali and harmful gas.

10.3 Transportation Precautions:

The LCD modules should be no falling and violent shocking during transportation, and also should avoid excessive press, water, damp and sunshine.