MODEL NO. :   TM028LDH05

ISSUED DATE: 2010-04-26

VERSION   :   Ver 1.0

■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.

Table of Contents

Record of Revision

Rev	Issue Date	Description	Editor
1.0	2010-04-26	Preliminary release.	Qiuping Yang

1 General Specifications

Feature		Spec
Display Spec	Size	2.8 inch
	Resolution	240(RGB) x 400
	Interface	CPU 16/8 bit
	Color Depth	262K/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)	42.00×72.80×1.85
	Active Area(mm)	36.72×61.20
	With /Without TSP	Without TSP
	Weight (g)	TBD
	LED Numbers	4 LEDs
Electronic	Driver IC	HX8352B

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	NC	-	No connection	
2	NC(X+)	-	No connection	
3	NC(Y+)	-	No connection	
4	NC(X-)	-	No connection	
5	NC(Y-)	-	No connection	
6	GND	P	Ground	
7	IOVCC	P	Digital power supply	
8	VCC/VCI	P	Analog power supply	
9	FMARK	O	Tearing effect output, if not used ,let it open	
10	CS	I	Chip select signal, low: chip can be accessed;	
11	RS	I	Command or parameter select signal; Low: command; High: parameter;	
12	WR	I	A write strobe signal and enables an operation to write data when the signal is low.	
13	RD	I	A read strobe signal and enables an	
14	DB0	I	Data input/output	
15	DB1	I	Data input/output	
16	DB2	I	Data input/output	
17	DB3	I	Data input/output	
18	DB4	I	Data input/output	
19	DB5	I	Data input/output	
20	DB6	I	Data input/output	
21	DB7	I	Data input/output	
22	DB8	I	Data input/output	
23	DB9	I	Data input/output	
24	DB10	I	Data input/output	
25	DB11	I	Data input/output	
26	DB12	I	Data input/output	
27	DB13	I	Data input/output	
28	DB14	I	Data input/output	
29	DB15	I	Data input/output	
30	RESET	I	Reset signal; Must be reset after power is supplied;	
31	GND	P	Ground	
32	A	I	LED Anode	
33	K1	I	LED Cathode	
34	K2	I	LED Cathode	
35	K3	I	LED Cathode	
36	K4	I	LED Cathode	
37	IM0	I	CPU I/F select pin. IM0=0,16bit; DB[15:0] IM0=1,8bit; DB[15:8]	

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

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	
Logic Supply Voltage	IOVCC	-0.3	4.6	V	
Input Signal Voltage	CS,WR,RD,RS,RESET IM0,DB[15:0]	-0.3	VCC+0.3	V	
Back Light Forward Current	I_{LED}	--	25.0	mA	For each LED
Operating Temperature	T_{OPR}	-20	70	℃	
Storage Temperature	T_{STG}	-30	80	℃	

4   Electrical Characteristics

4.1   Driving TFT LCD Panel

GND=0V, Ta=25℃

Item		Symbol	Min	Typ	Max	Unit	Remark
Analog Supply Voltage		VCC	2.5	2.8	3.3	V	
Logic Supply Voltage		IOVCC	1.65	2.8	3.3	V	
Input Signal Voltage	Low Level	V_{IL}	0	--	0.2xIOVCC	V	CS,WR,RD,RS,RESET IM0,DB[15:0]
	High Level	V_{IH}	0.8xIOVCC	--	IOVCC	V	
Output Signal Voltage	Low Level	V_{OL}	0	--	0.2xIOVCC	V	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℃

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.
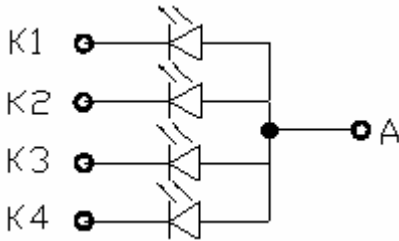
Note 2: One LED: I_F =15mA, V_F =3.2V.

Note 3:

I_F is defined for one channel LED.

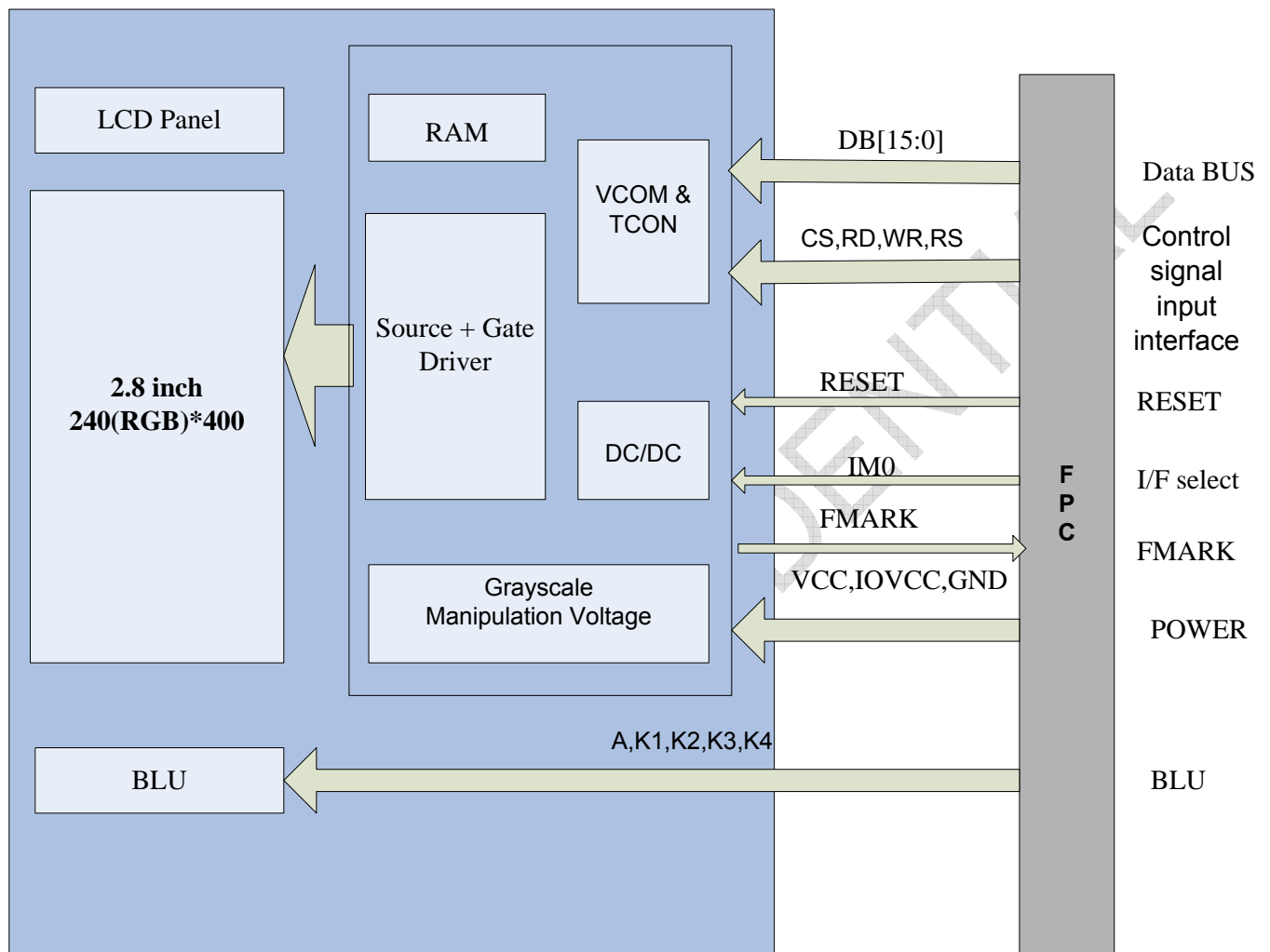Optical performance should be evaluated at Ta=25℃ only.

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
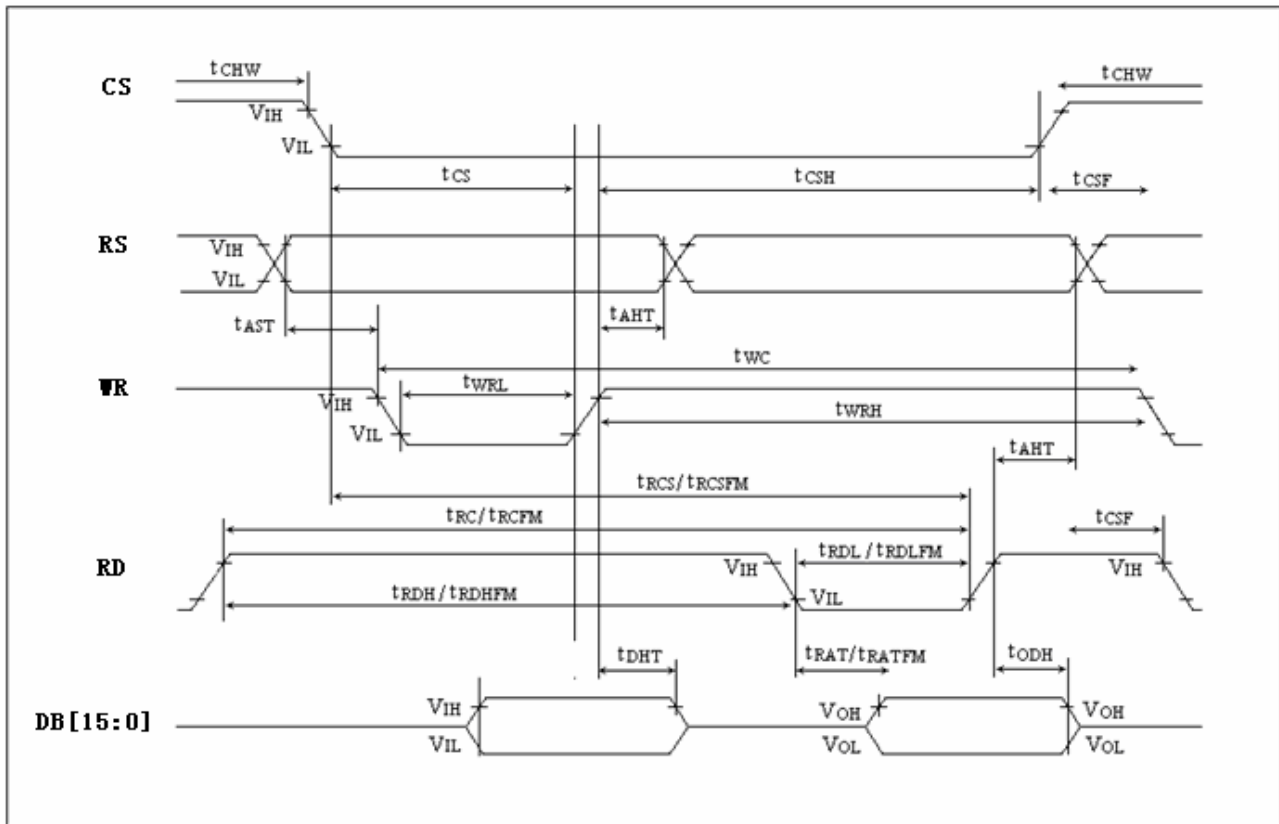
5 Timing Chart

5.1 Interface Characteristics

Figure 5.1 CPU Interface Characteristics

5.2 Interface Timing Parameters   Normal Write Mode

Signal	Symbol	Parameter	Spec. Min.	Spec. Max.	Unit	Description
RS	t_{AST}	Address setup time	10	-	ns	-
	t_{AHT}	Address hold time(Write/Read)	10			
CS	t_{CHW}	Chip select "H" pulse width	0			-
	t_{CS}	Chip select setup time (Write)	35			
	t_{RCSFM}	Chip select setup time	355	-	ns	
	t_{CSF}	Chip select wait time(Write/Read)	10			
	t_{CSH}	Chip select hold time	10			
WR	t_{WC}	Write cycle	100			IOVCC=1.65V
		Write cycle	77			IOVCC=2.8V
	t_{WRH}	Control pulse "H" duration	15	-	ns	
	t_{WRL}	Control pulse "L" duration	15			
RD(FM)	t_{RCFM}	Read cycle (FM)	450			When read from GRAM
	t_{RDHFM}	Control pulse "H" duration (FM)	90	-	ns	
	t_{RDLFM}	Control pulse "L" duration (FM)	355			
DB[15:0]	t_{DST}	Data setup time	15	-		For maximum C_L=30pF
	t_{DHT}	Data hold time	10	-		
	t_{RATFM}	Read access time	-	340(4)	ns	For minimum C_L=8pF
	t_{ODH}	Output disable time	20(4)	80(4)		

Table 5.1 CPU Interface Timing Parameters

5.3 Interface Register write/read timing

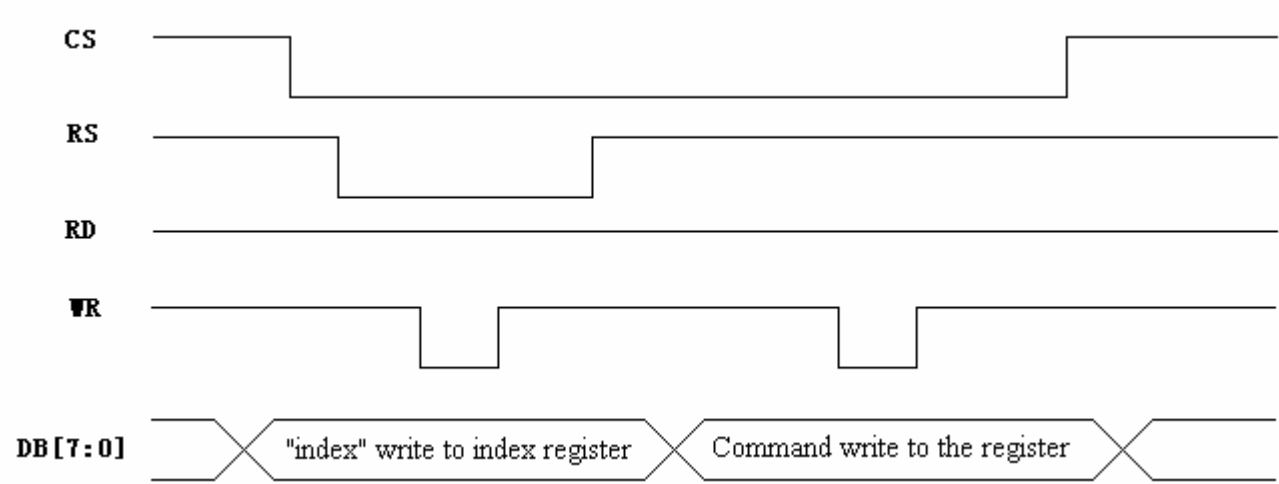### 5.3.1 System Bus Interface Register Write Timing

Figure 5.3.1 System Bus Interface Write Register Timing

5.3.2 System Bus Interface Register Read Timing
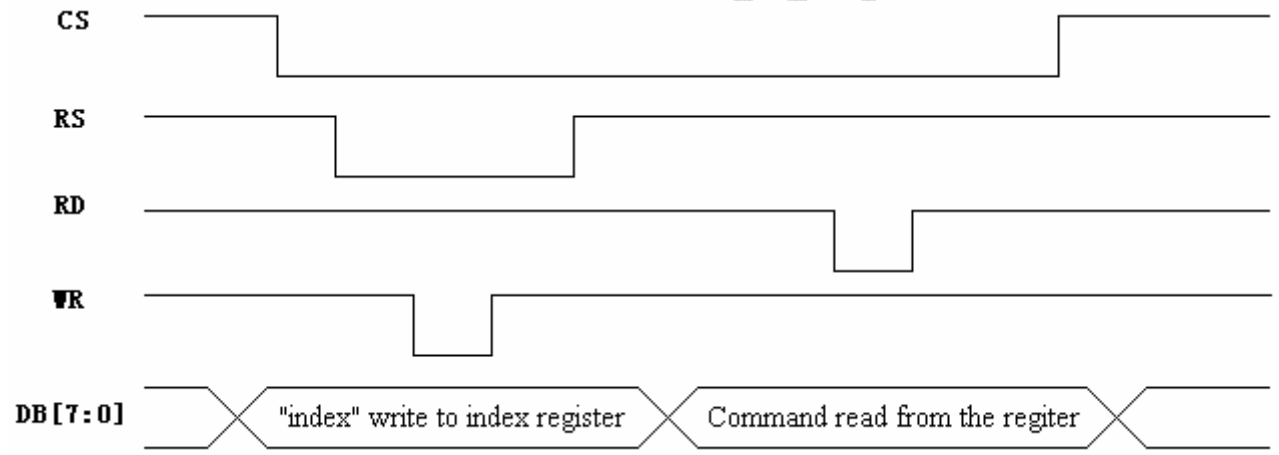
Figure 5.3.2 System Bus Interface Read Register Timing

5.4   GRAM write/read timing

5.4.1 16-bit Read/Write GRAM Data format(262K)
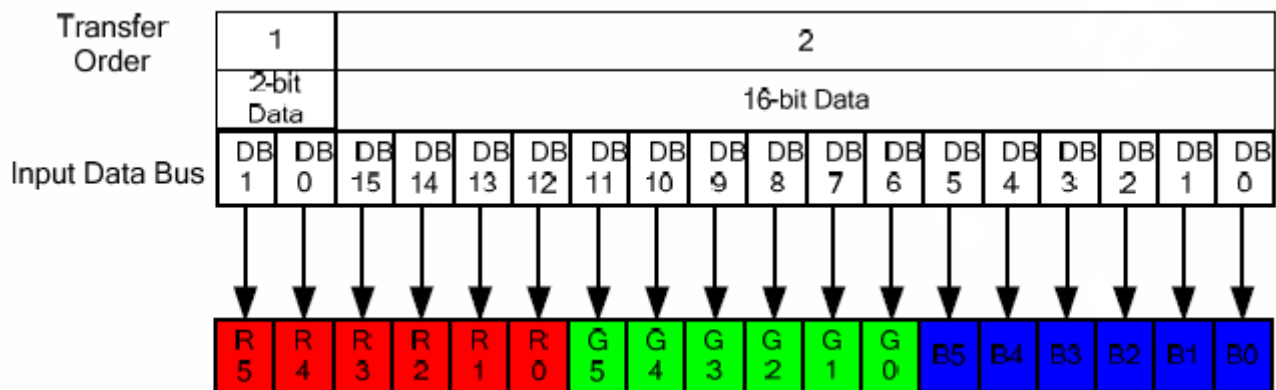
Figure 5.4.1 16-bit Data Bus GRAM Write/Read Data Format (16bit，262k,IM0=0)

5.4.2 16-bit Read/Write GRAM Data Format(65K)
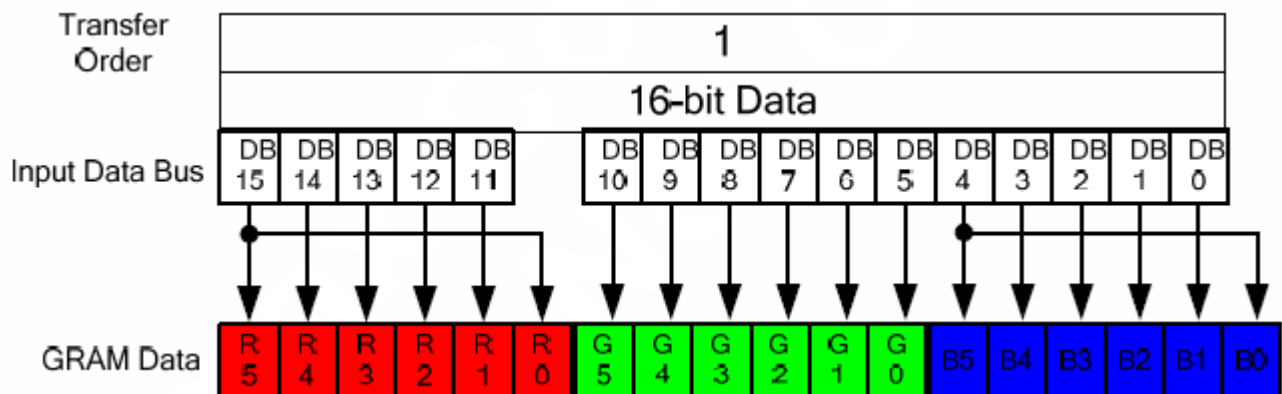
5.4.3 8-bit Read/Write GRAM Data format(262K)

Figure 5.4.3 8-bit Data Bus GRAM Write/Read Data Format (8bit，262k,IM0=1)

5.4.4 8-bit Read/Write GRAM Data Format(65K)
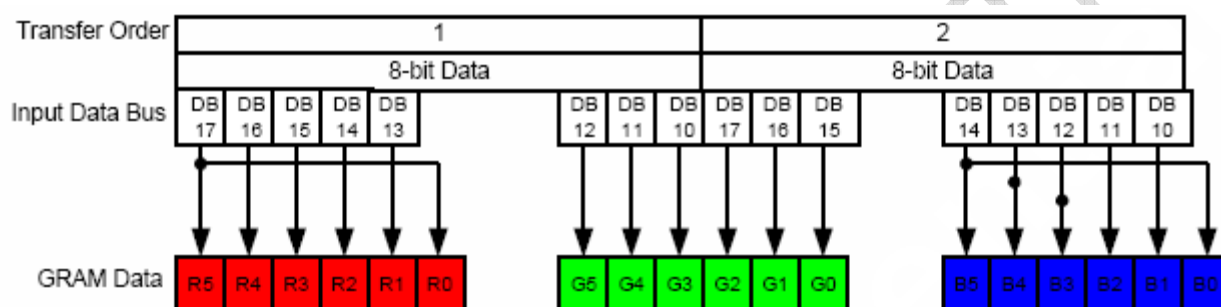
Figure 5.4.4 8-bit Data Bus GRAM Write/Read Data Format (8bit，65k,IM0=1)

5.5   Data Bus GRAM Write/Read Timing
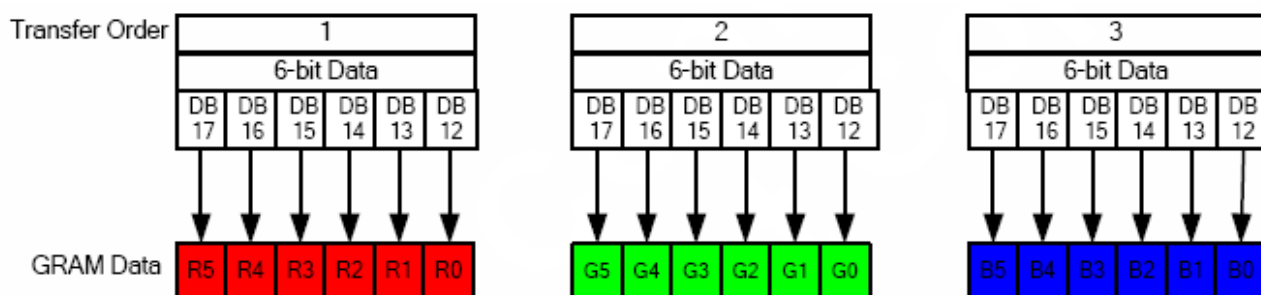
5.5.1 Data Bus GRAM Write Timing
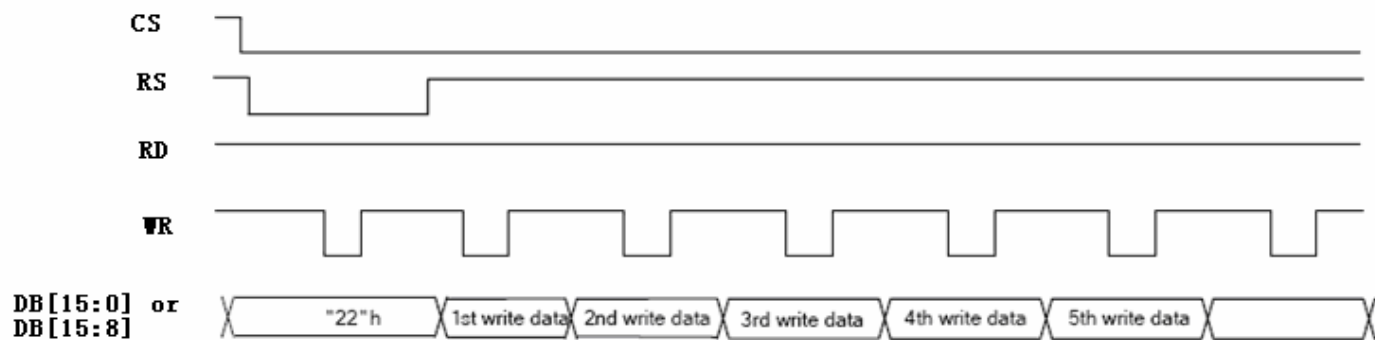
Figure 5.5.1 Data Bus GRAM Write Timing

5.5.2 Data Bus GRAM Read Timing
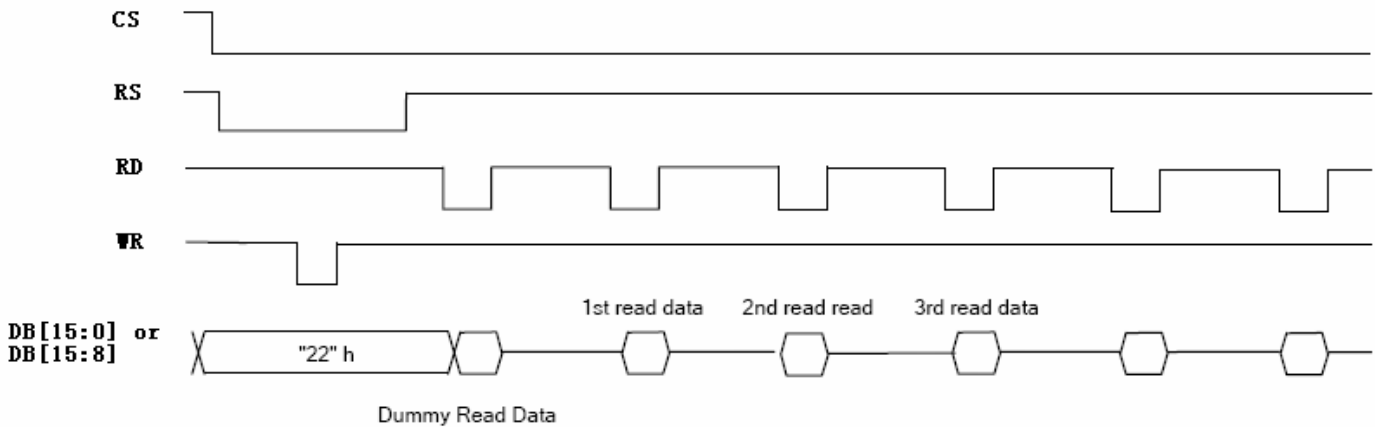
Figure 5.5.2 Data Bus GRAM Read Timing

5.6 Reset Timing Characteristics

IOVCC=1.65~3.3V, VDD=2.3~3.3V
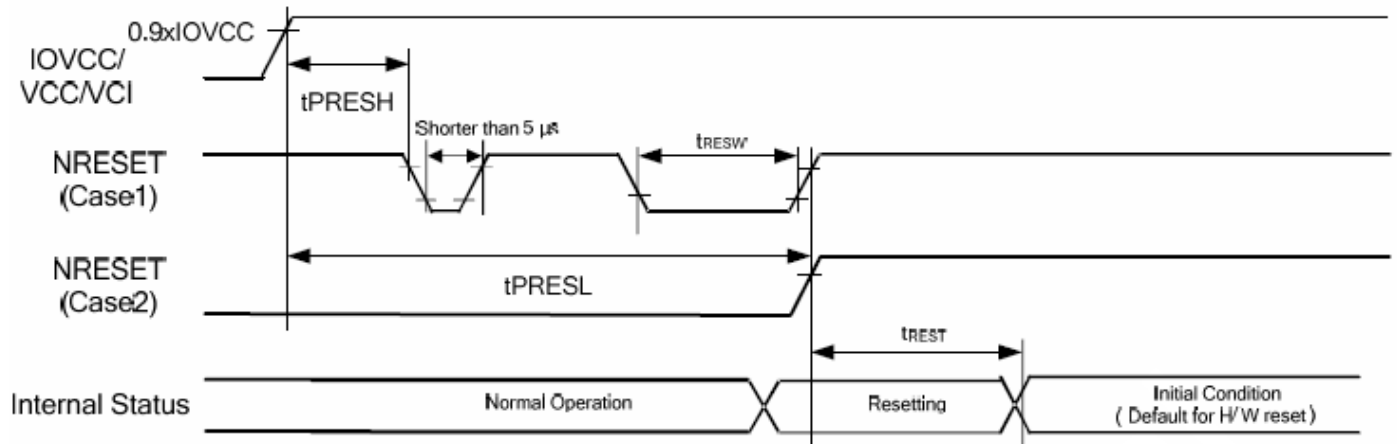
Figure 5.6.1 Reset Input Timing

Symbol	Parameter	Related Pins	Spec.			Note	Unit
			Min.	Typ.	Max.		
tRESW	Reset low pulse width	RESET	10	-	-	-	us
tREST	Reset complete time	-	-	-	10	When reset applied during STB mode	ms
		-		-	120	When reset applied during STB mode	ms
tPRESH	Reset goes high level after Power on time	NRESET & IOVCC	1	-	-	Reset goes high level after Power on	ms
tPRESL	Reset goes low level in Power on time	NRESET & IOVCC	5	-	-	Reset goes low level in Power on	ms

Table 5.6 Reset Timing Parameters

Note:

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

5.7   Power ON/OFF Sequence

5.7.1 Power ON Sequence

```
         ┌─────────────────────────────────┐
         │  Power supply (IOVCC/VCC/VCI) on │
         │           RESET=L                │
         └─────────────────────────────────┘
                          │
   1ms or more            │
                          ▼
                  ┌───────────────┐
                  │    reset=H    │
                  └───────────────┘
   5ms or more            │
   Oscillator             │
   Stabilizing time       ▼
              ┌──────────────────────┐       Power supply initial setting
              │ Register setting before│      Set BT[3:0],VRH[5:0],VMF[7:0],
              │ power supply startup   │          VML[7:0],VMH[7:0]
              └──────────────────────┘
                          │
                          ▼
              ┌──────────────────────┐       Power supply operation setting
              │                      │        OSC_EN=1
              │  power supply setting │        Wait >5ms
              │                      │        STB=0
              └──────────────────────┘        AP=100
                          │                    Wait >3ms
   5ms or more            │                    DK=0
                          │                    Wait >3ms
                          │                    PON=1
                          │                    Wait >3ms
                          ▼                    VCOMG=1
              ┌──────────────────────┐
              │     Display ON       │        Set GON,DTE,D[1:0],
              └──────────────────────┘
                          │
                          ▼
              ┌──────────────────────┐
              │      BLU ON          │
              └──────────────────────┘
```

5.7.2 Power OFF Sequence

```
┌──────────────────────────────────────────────────────────────────┐
│                                                                    │
│        ╭─────────────────────╮      Display ON setting            │
│        │   Normal Display     │      DTE=1                         │
│        ╰─────────────────────╯      D[1:0]=11                      │
│                  │                   GON=1                          │
│                  ▼                                                  │
│        ╭─────────────────────╮                                     │
│        │      BLU OFF         │                                     │
│        ╰─────────────────────╯                                     │
│                  │                                                  │
│                  ▼                                                  │
│        ╭─────────────────────╮      Set GON,DTE,                   │
│        │   Display OFF        │      D[1:0]                         │
│        │   Sequence           │                                    │
│        ╰─────────────────────╯                                     │
│                  │                   VCOMG=0                        │
│                  ▼                   Wait >1ms                      │
│        ╭─────────────────────╮      PON=0                          │
│        │   Power Supply       │      DK=1                          │
│        │   Halt Setting       │      AP[2:0]=0                     │
│        ╰─────────────────────╯      STB=1                          │
│                  │                                                  │
│                  ▼                                                  │
│        ╭─────────────────────────╮                                 │
│        │ Power Supply (IOVCC,VCC,VCI) │                            │
│        │          OFF             │                                 │
│        ╰─────────────────────────╯                                 │
│                                                                    │
└──────────────────────────────────────────────────────────────────┘
```

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6 Optical Characteristics Optical Specification

Ta=25℃

Item		Symbol	Condition	Min	Typ	Max	Unit	Remark
View Angle		θT	CR≥10	45	50	--	Degree	Note 2
		θB		15	20	--		
		θL		40	45	--		
		θR		40	45	--		
Contrast Ratio		CR	θ=0°	400	450	--		Note1 Note3
Response Time		T_{ON}	25℃		20	30	ms	Note1 Note4
		T_{OFF}						
Chromaticity	White	x	Backlight is on	0.250	0.300	0.350		Note1 Note5
		y		0.270	0.320	0.370		
	Red	x		0.550	0.600	0.650		
		y		0.300	0.350	0.400		
	Green	x		0.290	0.340	0.390		
		y		0.550	0.600	0.650		
	Blue	x		0.100	0.150	0.200		
		y		0.030	0.080	0.130		
Uniformity		U		--	80	--	%	Note1 Note6
NTSC				--	52	--	%	Note5
Luminance		L		180	200	--	nits	Note1 Note7

Test Conditions:

1. V_F =3.2V ,I_F =15mA(LED current), the ambient temperature is 25℃.

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.

Item	Photo detector	Field
Contrast Ratio		
Luminance	SR-3A	1°
Chromaticity		
Lum Uniformity		
Response Time	BM-7A	2°
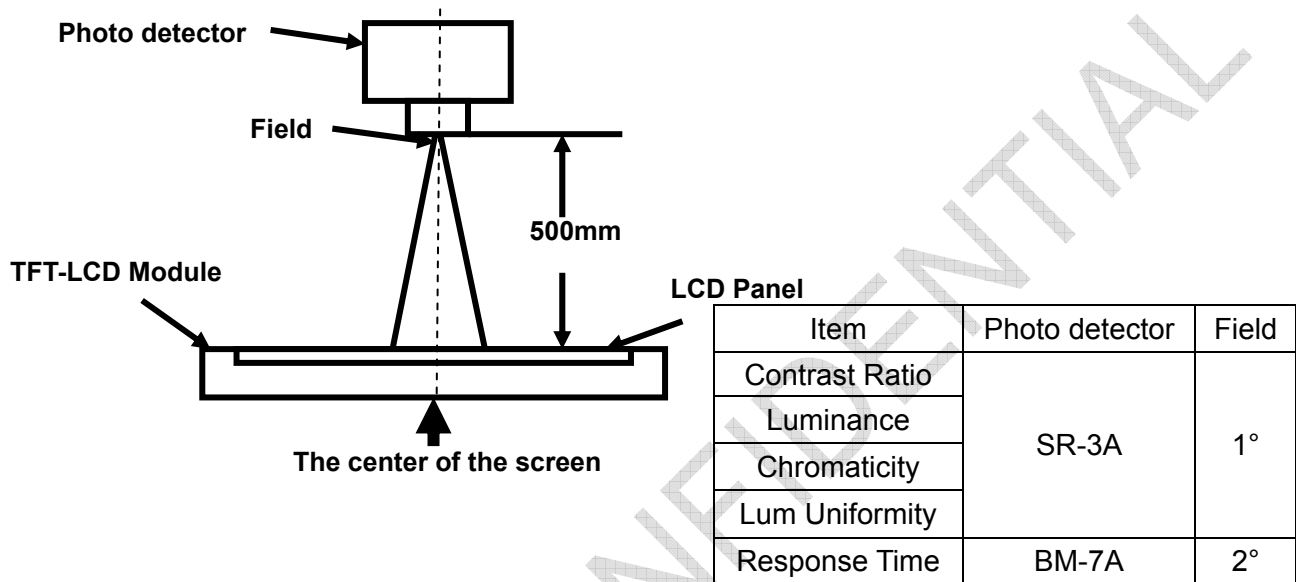
Note 2: Definition of viewing angle range and measurement system.

viewing angle is measured at the center point of the LCD by CONOSCOPE(ergo-80)。
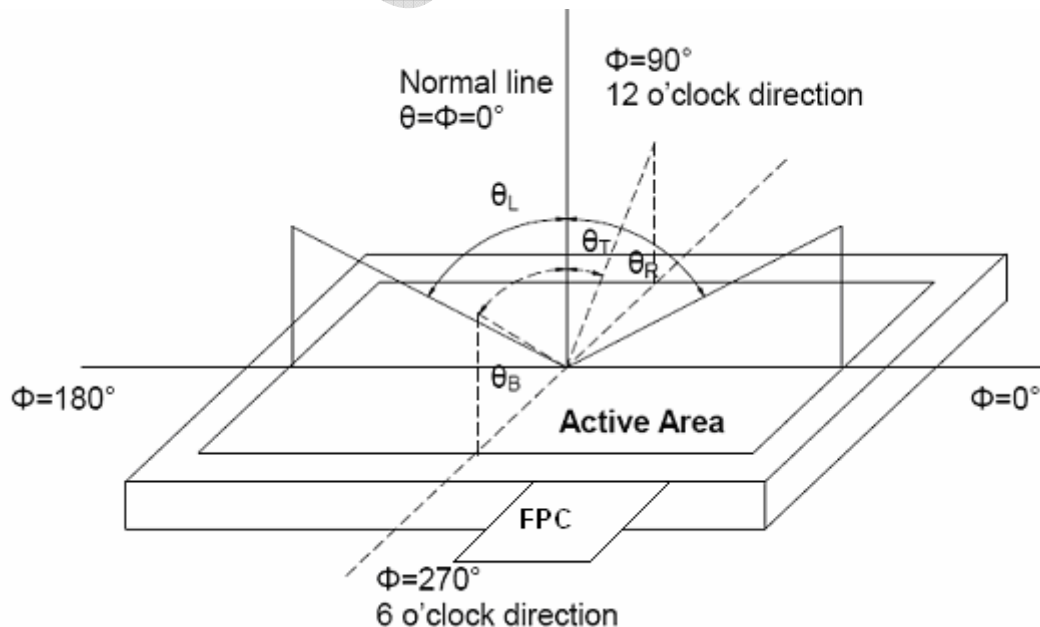
Fig. 1 Definition of viewing angle

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 driven by Vwhite.

"Black state": The state is that the LCD should driven by Vblack.

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%.
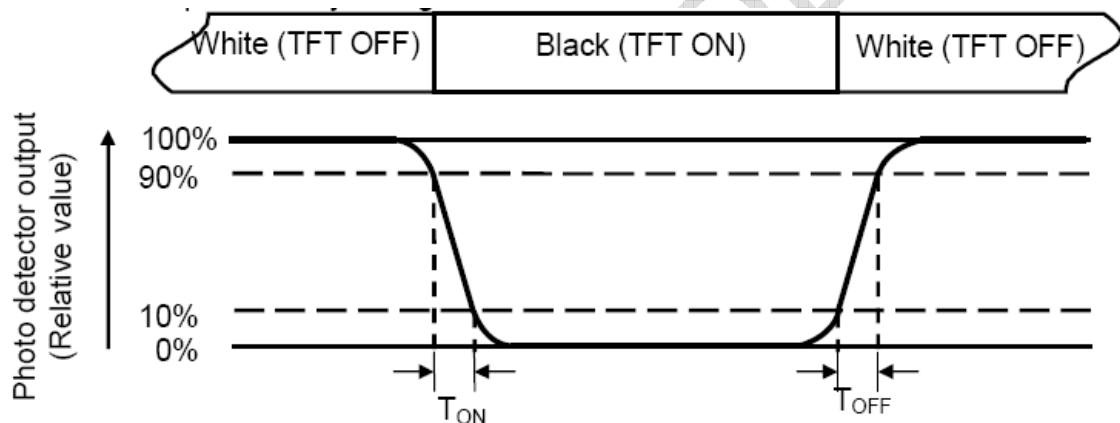
Note 5: Definition of color chromaticity (CIE1931)

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.

Luminance Uniformity(U) = Lmin/ Lmax
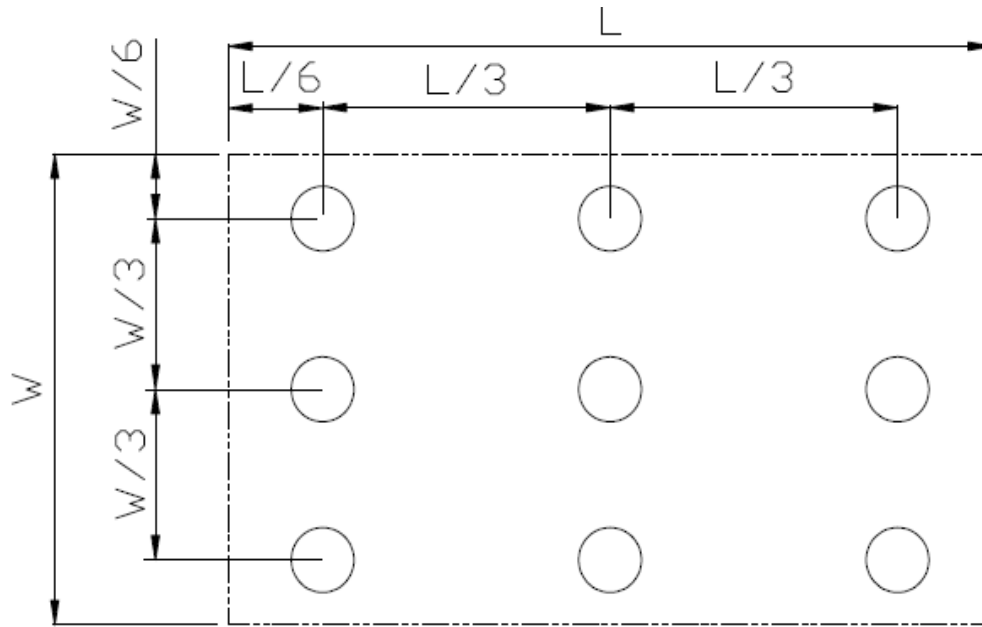
L-------Active area length W----- Active area width

Fig. 2 Definition of uniformity

Lmax: The measured maximum luminance of all measurement position.

Lmin: 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℃, 240hrs	Note1 IEC60068-2-1,GB2423.2
2	Low Temperature Operation	Ta=-20℃, 240hrs	IEC60068-2-1 GB2423.1
3	High Temperature Storage	Ta=+80℃, 240hrs	IEC60068-2-1 GB2423.2
4	Low Temperature Storage	Ta=-30℃, 240hrs	IEC60068-2-1 GB2423.1
5	High Temperature & High Humidity Storage	Ta=+60℃, 90% RH 240 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
11	Package Vibration Test	Random Vibration: 0.015GxG/Hz for 5-200Hz, -6dB/Octave from 200-500Hz 2 hours for each direction of X,Y,Z (6 hours for total)	IEC60068-2-34 GB/T2423.11

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

Note2: Ta is the ambient temperature of sample.

8 Mechanical Drawing
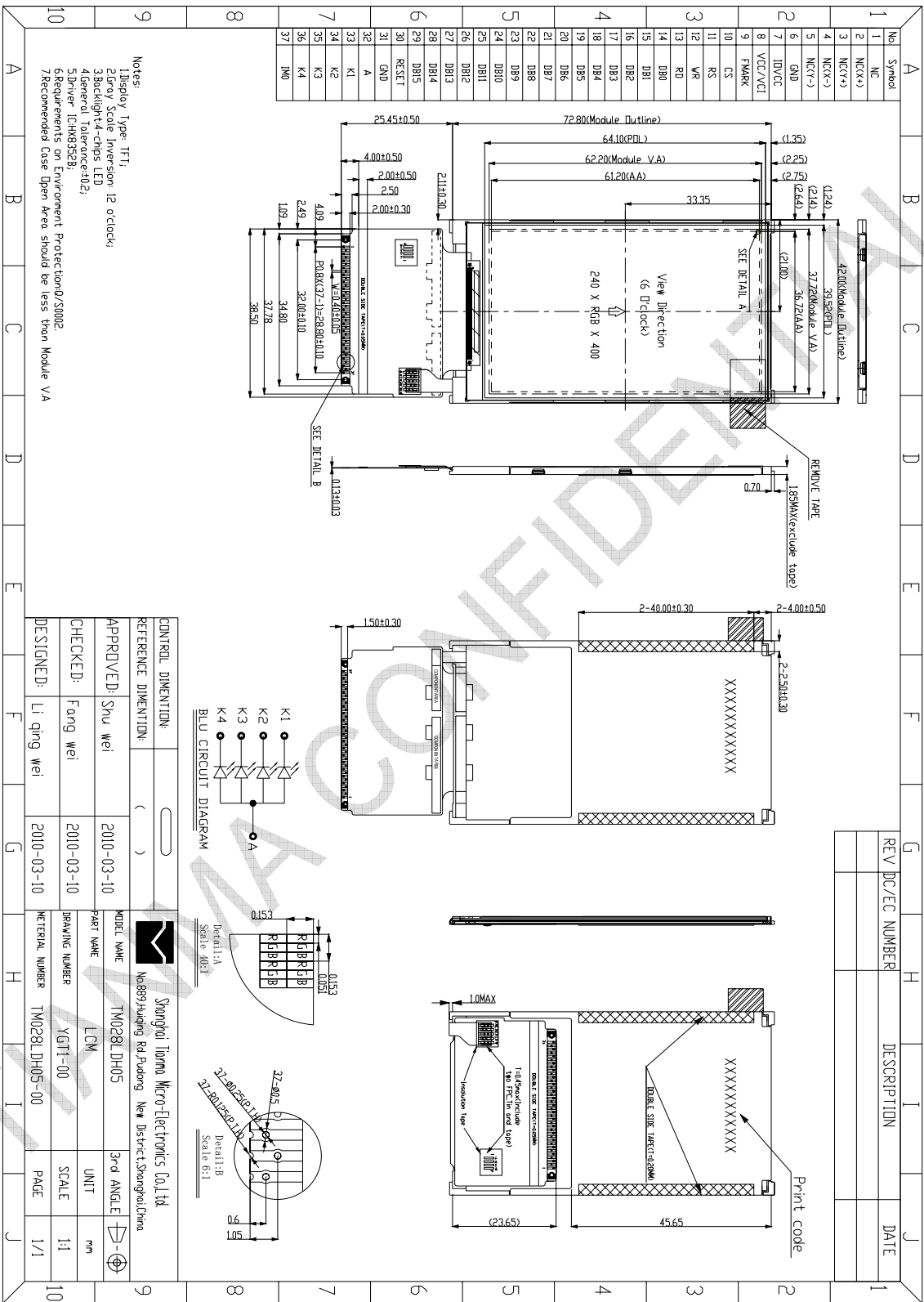
9 Packing Drawing

No	Item	Model (Material)	Dimensions(mm)	Unit Weight(Kg)	Quantity	Remark
1	LCM module	TM028LDH05	42.00×72.80×1.85	TBD	TBD	
2	Tray	PET(Transmit)	TBD	TBD	TBD	
3	EPE	EPE	TBD	TBD	TBD	
4	Desiccant	Desiccant	TBD	TBD	TBD	
5	Anti-static bag	PE	TBD	TBD	TBD	
6	BOX	Corrugated paper	TBD	TBD	TBD	
7	Carton	Corrugated paper	TBD	TBD	TBD	
8	Total Weight(Kg)	TBD				
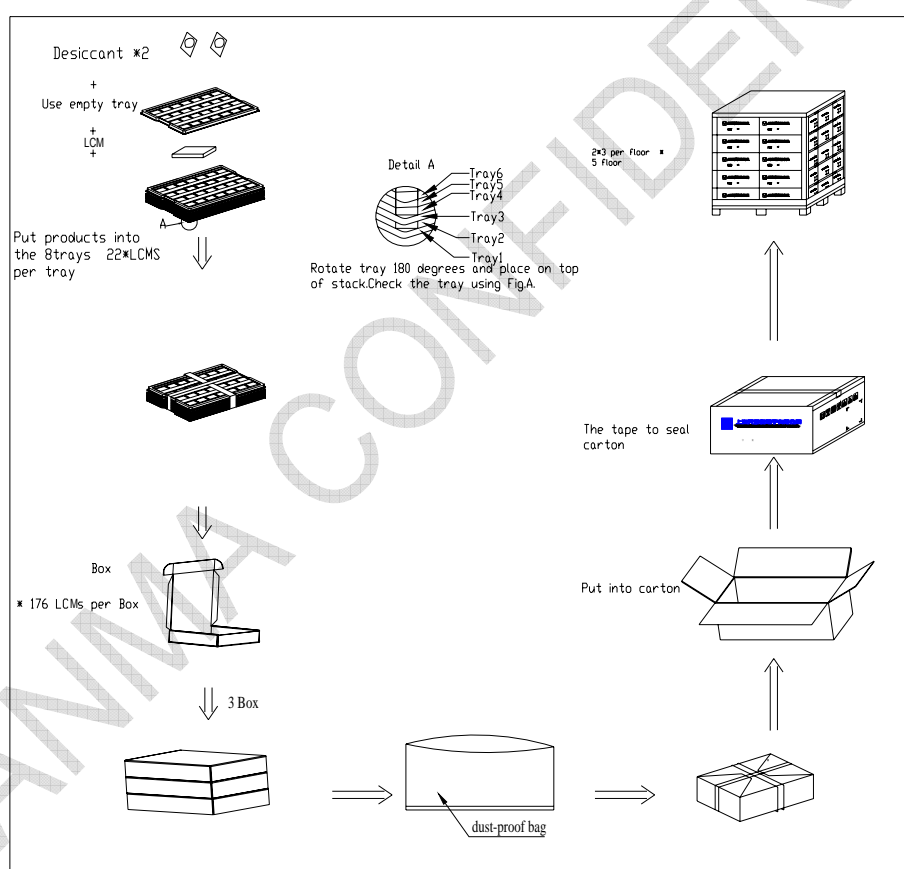
10 Precautions for Use of LCD Modules

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℃~40℃ 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.