■**Preliminary Specifications**
□**Final Specifications**

Module	2.4 Inch Color TFT-LCD
Model Name	H240QN02 V3

Customer	**Date**	**Approved by**	**Date**
		Grace Hung	2014/3/19
Checked & Approved by		**Prepared by**	
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Note: This Specification is subject to change without notice.		Audio-Video Business Unit / AU Optronics corporation	

Contents

Record of Revision

Version Date	Page	Old description	New Description
V 0.1	All	First Edition	

1. Operating Precautions

1) Since front polarizer is easily damaged, please be cautious not to scratch it.
2) Be sure to turn off power supply when inserting or disconnecting from input connector.
3) Wipe off water drop immediately. Long contact with water may cause discoloration or spots.
4) When the panel surface is soiled, wipe it with absorbent cotton or soft cloth.
5) Since the panel is made of glass, it may be broken or cracked if dropped or bumped on hard surface.
6) To avoid ESD (Electro Static Discharde) damage, be sure to ground yourself before handling TFT-LCD Module.
7) Do not open nor modify the module assembly.
8) Do not press the reflector sheet at the back of the module to any direction.
9) In case if a module has to be put back into the packing container slot after it was taken out from the container, do not press the center of the LED Reflector edge. Instead, press at the far ends of the LED Reflector edge softly. Otherwise the TFT Module may be damaged.
10) At the insertion or removal of the Signal Interface Connector, be sure not to rotate nor tilt the Interface Connector of the TFT Module.
11) After installation of the TFT Module into an enclosure (Notebook PC Bezel, for example), do not twist nor bend the TFT Module even momentary. At designing the enclosure, it should be taken into consideration that no bending/twisting forces are applied to the TFT Module from outside. Otherwise the TFT Module may be damaged.
12) Small amount of materials having no flammability grade is used in the LCD module. The LCD module should be supplied by power complied with requirements of Limited Power Source (IEC60950 or UL1950), or be applied exemption.
13) Severe temperature condition may result in different luminance, response time.
14) Continuous operating TFT-LCD Module under high temperature environment may accelerate LED light bar exhaustion and reduce luminance dramatically.
15) The data on this specification sheet is applicable when LCD module is placed in landscape position.
16) Continuous displaying fixed pattern may induce image sticking. It is recommended to use screen saver or shuffle content periodically if fixed pattern is displayed on the screen.

2. General Description

This specification applies to the 2.4 inch color TFT LCD module H240QN02 V3.

H240QN02 V3 is built in timing controller and CPU interface. The screen format is intended to support the QVGA 240X320 screen and 262K colors. H240QN02 V3 is a RoHS product.

2.1 Display Characteristics

The following items are characteristics summary on the table under 25 ℃ condition:

Items	Unit	Specifications
Screen Diagonal	[inch]	2.4
Active Area	[mm]	36.72(W) x 48.96(H)
Pixels H x V		240 X 320
Pixel Pitch	[mm]	0.153(W) x 0.153(H)
Pixel Arrangement		RGB stripe
Display Mode		TN, Normally White
Nominal Input Voltage VDD	[Volt]	2.8
LCD Typical Power Consumption	[mWatt]	14.85 (All pixels black)
Back Light Power Consumption	[Watt]	0.186
Weight	[Grams]	10g
Physical Size	[mm]	41.72(H) x 58.46(V) x 1.9(D)
Electrical Interface		8080 CPU 8-bits
Surface Treatment		AG, 3H
Support Color		262K
Temperature Range Operating Storage (Non-Operating)	[°C] [°C]	-15 ~70 -40 ~ 85
RoHS Compliance		Yes
Viewing Direction		10 o'clock (drawing follow page 23)
Gray Scale Inversion Direction		10 o'clock (drawing follow page 23)

2.2 Optical Characteristics

The optical characteristics are measured under stable conditions at 25℃ (Room Temperature):

Item	Unit	Conditions	Min.	Typ.	Max.	Note
White Luminance	[cd/m2]	I_F= 18mA (center point)	330	390		
Uniformity	%	9 Points	70	75		
Contrast Ratio			450	600		
Response Time	[msec]	Rising + Falling		20	30	
Viewing Angle	[degree] [degree]	Horizontal (Right) CR ≧ 10 (Left)	70 70	80 80		
	[degree] [degree]	Vertical (Upper) CR ≧ 10 (Lower)	70 70	80 80		
Color / Chromaticity Coordinates (CIE 1931)		Red x	0.511	0.561	0.611	
		Red y	0.267	0.317	0.367	
		Green x	0.292	0.342	0.392	
		Green y	0.492	0.542	0.592	
		Blue x	0.097	0.147	0.197	
		Blue y	0.045	0.095	0.145	
		White x	0.255	0.305	0.355	
		White y	0.268	0.318	0.368	
Color Gamut	%		40	45		

Note 1: Measurement method

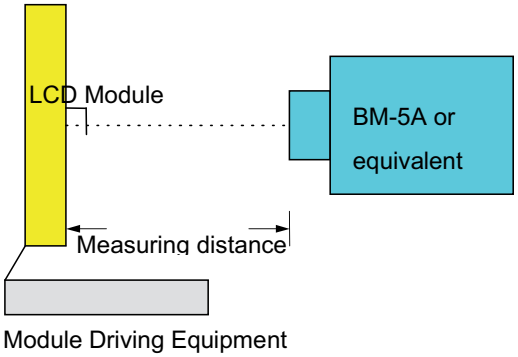
Equipment: Pattern Generator, Power Supply, Digital Voltmeter, Luminance meter (BM-5A or equivalent)

Scanning Direction : Normal Scan

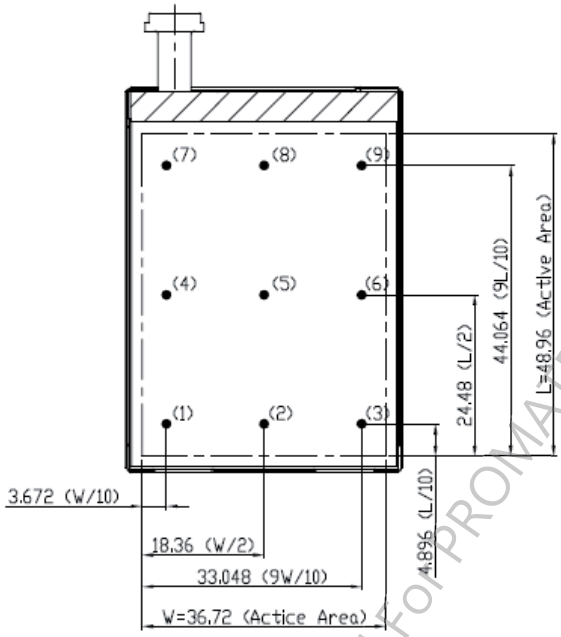
Aperture 1° with 50cm viewing distance

Test Point Center,

Environment *< 1 lux*



Note 2: Definition of 9 points position (Display active area: 36.72(H) x 48.96(V)) mm



Note 3:

The luminance uniformity of 9 points is defined by dividing the maximum luminance value by the minimum luminance value at full white condition.

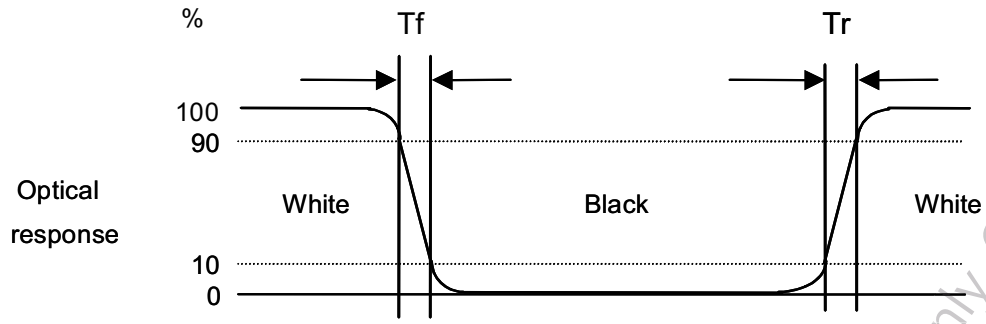
$$\text{Uniformity (\%)} = \frac{\text{Minimum Brightness of nine points}}{\text{Maximum Brightness of nine points}}$$

Note 4： Definition of contrast ratio (CR):

$$\text{Contrast ratio (CR)} = \frac{\text{Brightness on the “White” state}}{\text{Brightness on the “Black” state}}$$

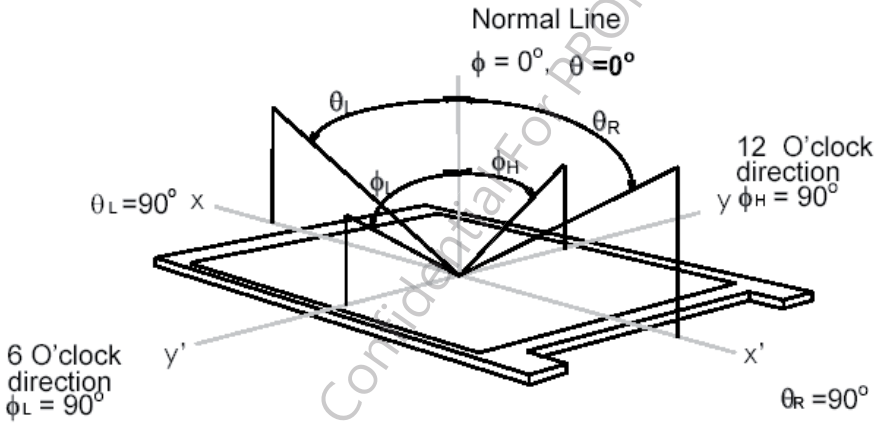
Note 5: Definition of response time:

The output signals of photo detector are measured when the input signals are changed from “White” to “Black” (falling time) and from “Black” to “White” (rising time), respectively. The response time interval is between 10% and 90% of amplitudes. Please refer to the figure as below.



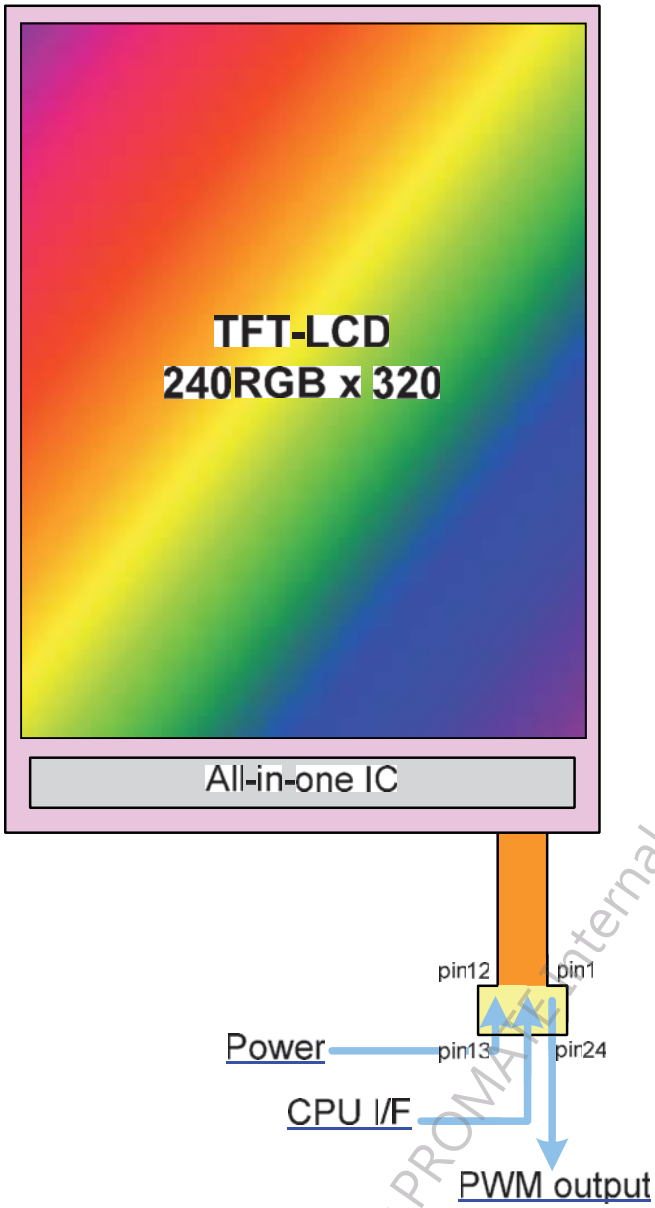
Note 6: Definition of viewing angle

Viewing angle is the measurement of contrast ratio ≧10, at the screen center, over a 180° horizontal and 180° vertical range (off-normal viewing angles). The 180° viewing angle range is broken down as below: 90° (θ) horizontal left and right, and 90° (Φ) vertical high (up) and low (down). The measurement direction is typically perpendicular to the display surface with the screen rotated to its center to develop the desired measurement viewing angle.



3. Functional Block Diagram

The following diagram shows the functional block of the 2.4 inch color TFT/LCD module:



4. Absolute Maximum Ratings

4.1 Absolute Ratings of TFT LCD Module

Item	Symbol	Min	Max	Unit	Remark
Analog Supply Voltage	VDD	-0.3	+4.6	[Volt]	
I/O Supply Voltage	VDDI	-0.3	+4.6	[Volt]	

Note : Device is subject to be damaged permanently if stresses beyond those absolute maximum ratings listed above.

5. Electrical Characteristics

5.1 TFT LCD Module

5.1.1 Power Specification

Symbol	Parameter	Min	Typ	Max	Units	Remark
VDD	Analog Power Supply	2.6	2.8	2.9	[Volt]	
I_{VDD}	VDD Current		5.30	6.36	[mA]	All pixels black
VDDI	I/O Power Supply	1.68	1.8	1.95	[Volt]	
I_{VDDI}	VDDI Current		0.005	0.006	[mA]	All pixels black
P	Power Consumption		14.85	17.82	[mWatt]	All pixels black

5.1.2 Signal Electrical Characteristics

Input signals shall be low or Hi-Z state when VDD is off.

Parameter		Symbol	Min.	Typ.	Max.	Unit	Remark
Logic Input Voltage	High	VIH	0.7VDDI	-	VDDI	Volt	
	Low	VIL	VSS	-	0.3VDDI	Volt	

5.2 Backlight Unit

5.2.1 Parameter guideline for LED

Following characteristics are measured under a stable condition using an inverter at 25℃ (Room Temperature):The backlight (LED module, Note 1) is suggested to drive by constant current 140mA.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
LED light bar Voltage	V_L	8.4	9.6	10.65	V	
Current of Each LED	I_{LED}		18	20	mA	
Power Consumption	P_{BL}		0.1728	0.213	W	
LED Life Time	L_L	15,000			Hr	Note 1, 2, 3

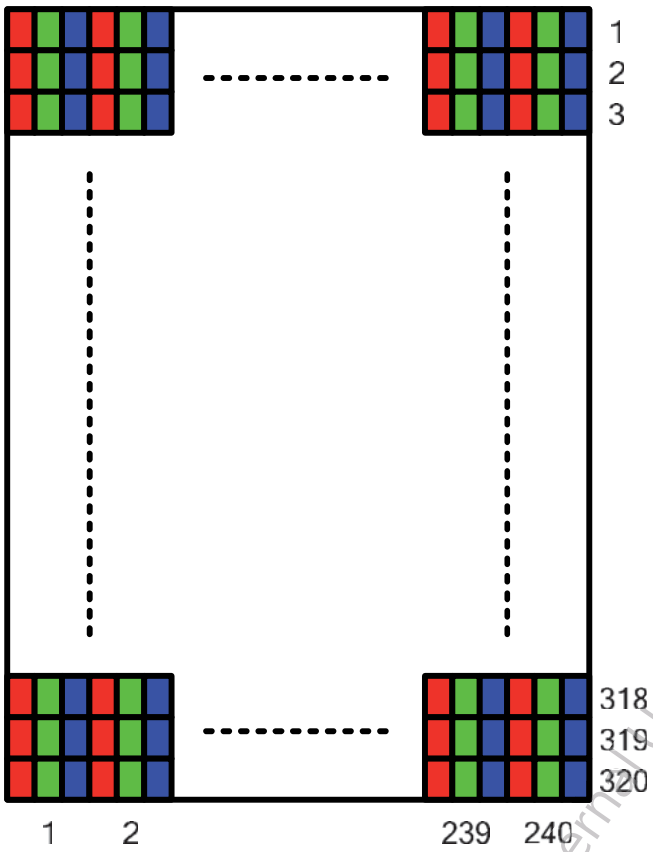
Note 1: LED backlight is LED light bar type (3 pcs of LED).

Note 2: Definition of “LED Lifetime”: brightness is decreased to 50% of the initial value. LED Lifetime is restricted under normal condition. (Ambient temperature at 25℃ and LED light bar current as 18mA)

Note 3: If user drives the LED light bar above 20mA, the LED lifetime will be decreased.

6. Signal Characteristic

6.1 Pixel Format Image



6.2 Signal Description

Recommended connector : WP6-S024VA2

Pin No.	Symbol	I/O	Description
1	RDX	I	A read strobe signal can be input via this pin and initializes a read operation when the signal is low. Must connect to GND or VDDI level when not used.
2	TE	O	Tearing effect output pin to synchronies MCU to frame writing, activated by SW command. When this pin is not activated(TE function OFF), this pin is GND level.
3	WRX	I	A write strobe signal can be input via this pin and initializes a write operation when the signal is low. Must connect to GND or VDDI level when not used.
4	D/CX	I	Display Data / Command selection pin. Low : Command High : Display Data Must connect to GND or VDDI level when not used.
5	GND	P	Ground
6	VDDI	P	Power supply input
7	VDD	P	Power supply input
8	RESX	I	Reset pin. This is an active low signal.
9	GND	P	Ground
10	D7	I/O	MCU parallel interface data bus
11	D6	I/O	MCU parallel interface data bus
12	D5	I/O	MCU parallel interface data bus
13	GND	P	Ground
14	D4	I/O	MCU parallel interface data bus
15	D3	I/O	MCU parallel interface data bus
16	D2	I/O	MCU parallel interface data bus
17	D1	I/O	MCU parallel interface data bus
18	D0	I/O	MCU parallel interface data bus
19	GND	P	Ground
20	BC	O	PWM output
21	VLED+	P	LED backlight anode
22	VLED-	P	LED backlight cathode
23	CSX	I	Chip select signal Low : the driver is accessible High : the driver is not accessible
24	GND	P	Ground

6.3 8080 CPU 8-bits Interface

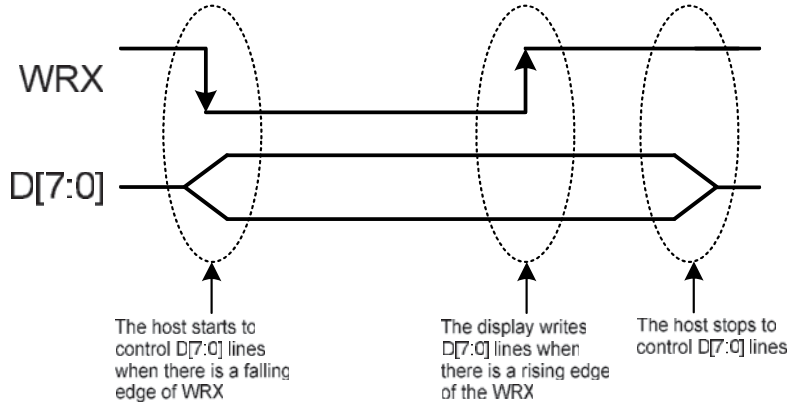
The MCU uses a 11-wire 8-data parallel interface. The chip-select CSX(active low) enables and disables the parallel interface. RESX (active low) is an external reset signal. WRX is the parallel data write, RDX is the parallel data read and D[7:0] is parallel data.

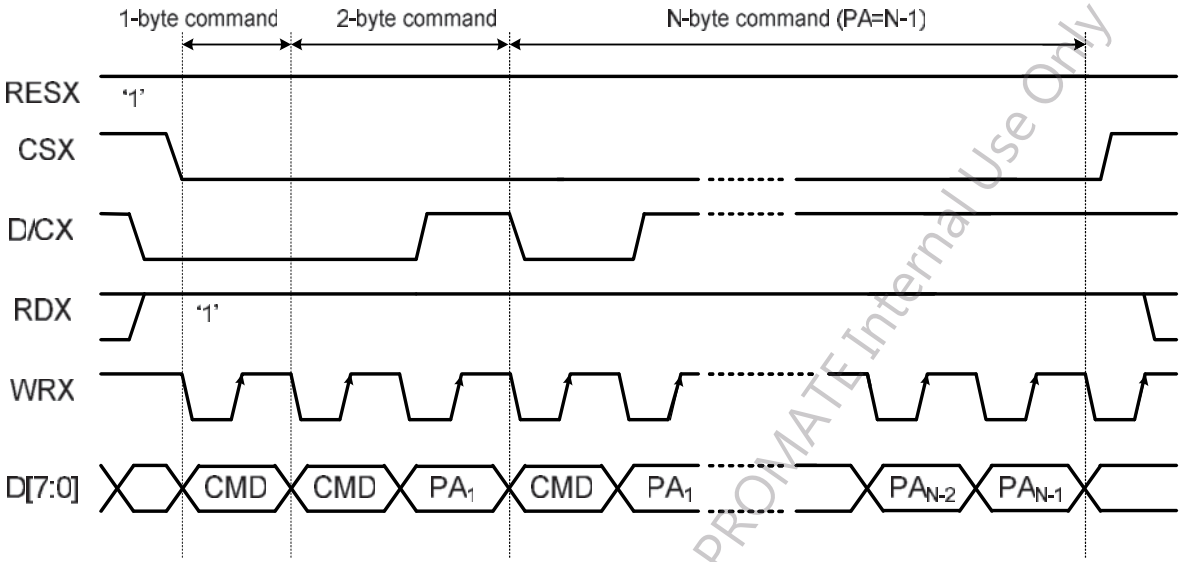
The graphics controller chip reads the data at the rising edge of WRX signal. The D/CX is the data/command flag. When D/CX='1', D[7:0] bits are display RAM data or command parameters. When D/CX='0', D[7:0] bits are commands.

D/CX	RDX	WRX	Function
0	1	↑	Write 8-bits command
1	1	↑	Write 8-bits display data or 8-bits parameter
1	↑	1	Read 8-bits command
1	↑	1	Read 8-bits parameter or status

6.3.1 Write cycle sequence

The write cycle means that the host writes information (command or/ and data) to the display via the interface. Each write cycle (WRX high-low-high sequence) consists of 3 control (D/CX, RDX, WRX) and data signals (D[7:0]). D/CX bit is a control signal, which tells if the data is a command or a data. The data signals are the command if the control signal is low and vice versa it is data.

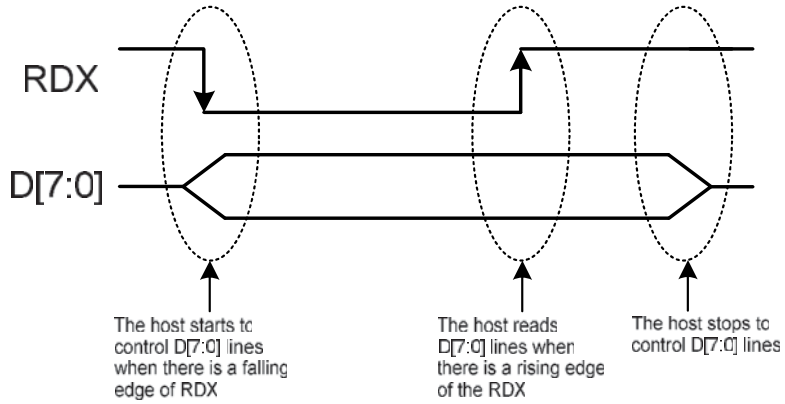


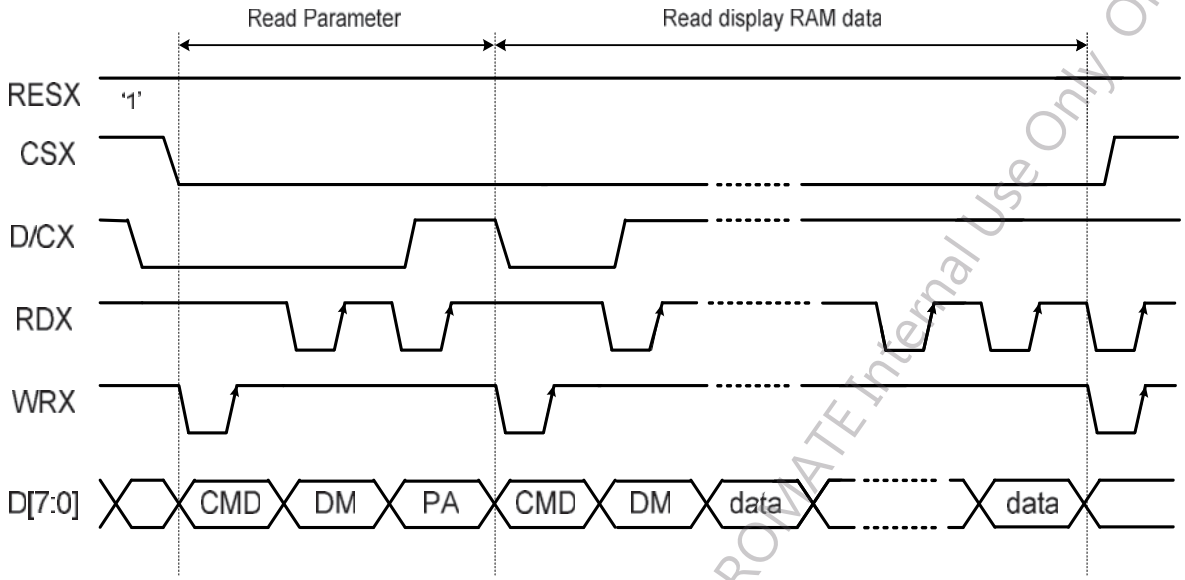


CMD : Write command code
PA : Parameter or RAM data

6.3.2 Read cycle sequence

The read cycle (RDX high-low-high sequence) means that the host reads information from display via interface. The display sends data (D[7:0]) to the host when there is a falling edge of RDX and the host reads data when there is a rising edge of RDX.



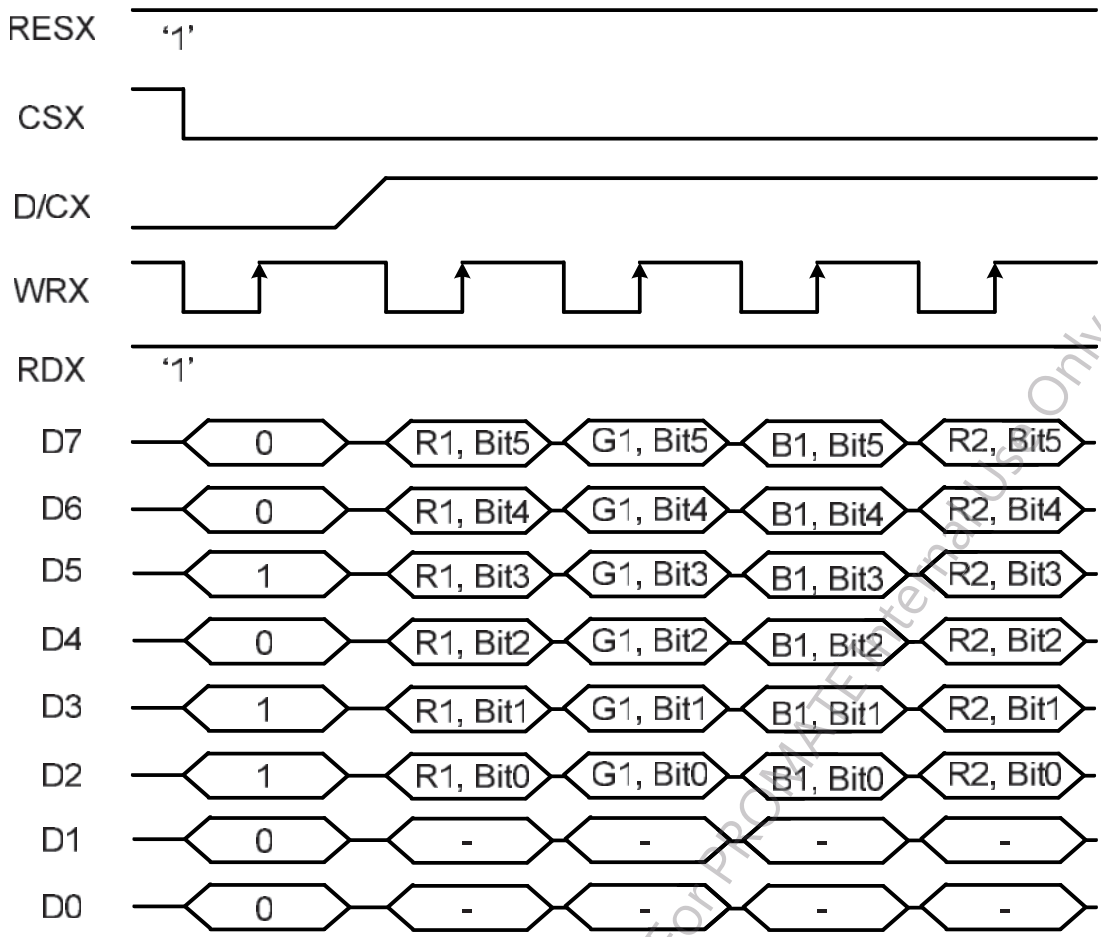


CMD : Write command code
PA : Parameter or RAM data
DM : Dummy

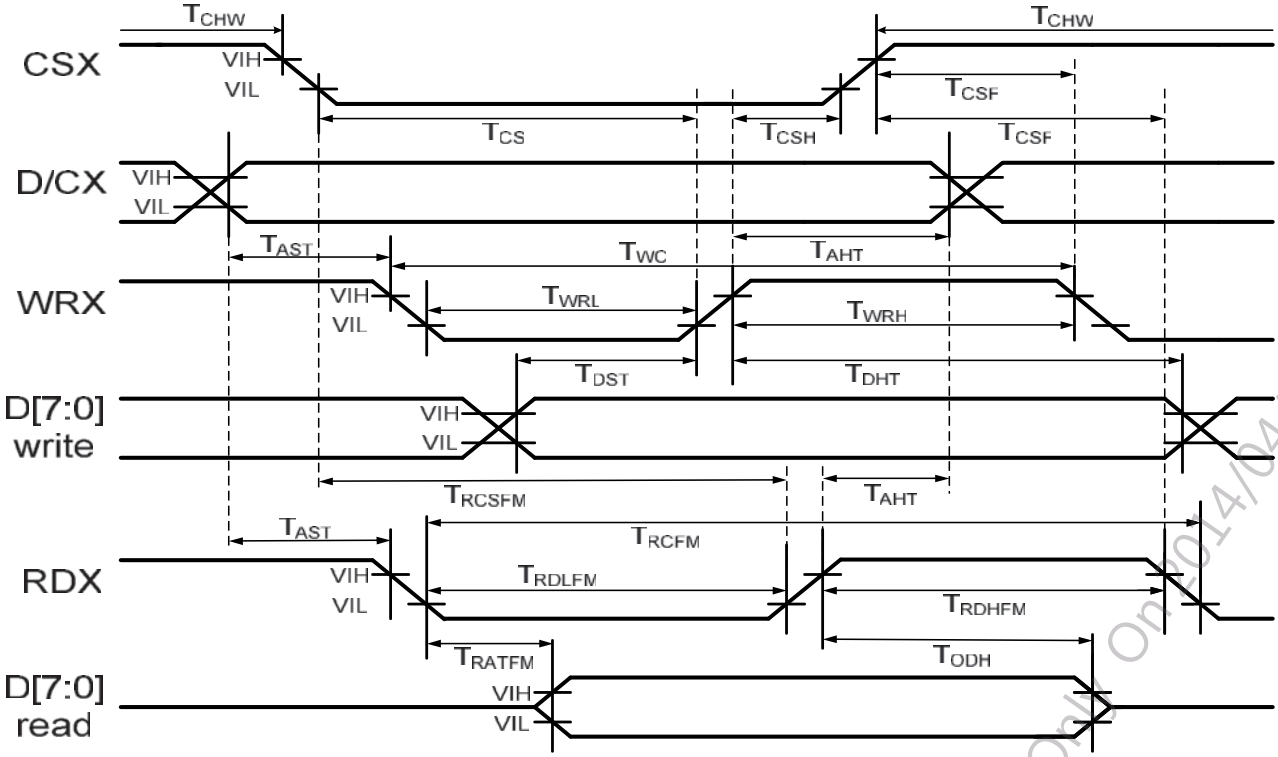
6.3.3 MCU data color coding for RAM data write

8-bits parallel interface set table

Command	D7	D6	D5	D4	D3	D2	D1	D0
2CH	0	0	1	0	1	1	0	0
Color	**D7**	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**
262K-Color (1pixel / 3bytes)	R5	R4	R3	R2	R1	R0	x	x
	G5	G4	G3	G2	G1	G0	x	x
	B5	B4	B3	B2	B1	B0	x	x

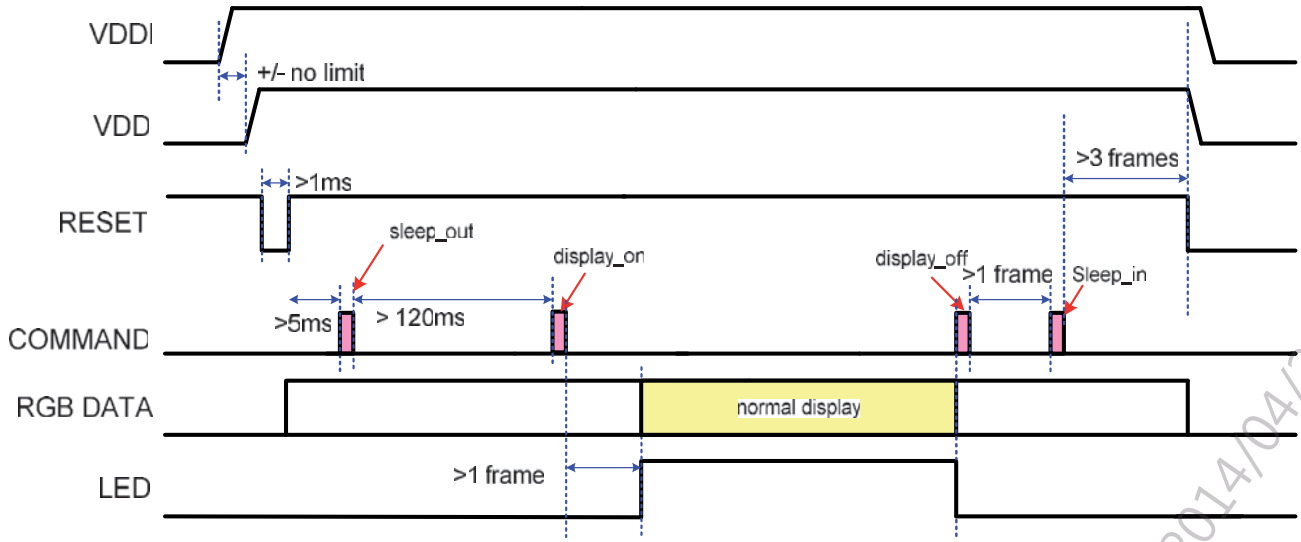


6.3.4 AC timing characteristics



Signal	Symbol	Parameter	MIN	MAX	Unit
D/CX	T_{AST}	Address setup time	0		ns
	T_{AHT}	Address hold time (W / R)	10		ns
CSX	T_{CHW}	Chip select “H” pulse width	0		ns
	T_{CS}	Chip select setup time (write)	15		ns
	T_{RCSFM}	Chip select setup time (read)	355		ns
	T_{CSF}	Chip select wait time (W / R)	10		ns
	T_{CSH}	Chip select hold time	10		ns
WRX	T_{WC}	Write cycle	66		ns
	T_{WRH}	Control pulse “H” duration	15		ns
	T_{WRL}	Control pulse “L” duration	15		ns
RDX	T_{RCFM}	Read cycle	450		ns
	T_{RDHFM}	Control pulse “H” duration	90		ns
	T_{RDLFM}	Control pulse “L” duration	355		ns
D[7:0]	T_{DST}	Data setup time	10		ns
	T_{DHT}	Data hold time	10		ns
	T_{RATFM}	Read access time		340	ns
	T_{ODH}	Output disable time	20	80	ns

6.4 Power ON/OFF Sequence



6.5 Command Setting

Command list

Instruction	D/CX	WRX	RDX	D7	D6	D5	D4	D3	D2	D1	D0	HEX	Function
NOP	0	↑	1	0	0	0	0	0	0	0	0	00h	No Operation
SLPIN	0	↑	1	0	0	0	1	0	0	0	0	10h	Sleep in & booster off
SLPOUT	0	↑	1	0	0	0	1	0	0	0	1	11h	Sleep out & booster on
DISPOFF	0	↑	1	0	0	1	0	1	0	0	0	28h	Display off
DISPON	0	↑	1	0	0	1	0	1	0	0	1	29h	Display on
RAMWR	0	↑	1	0	0	1	0	1	1	0	0	2Ch	Memory write
	1	↑	1	D7	D6	D5	D4	D3	D2	D1	D0		Write data
MADCTR	0	↑	1	0	0	1	1	0	1	1	0	36h	Memory data access control
	1	↑	1	MY	MX	0	0	0	0	0	0		Reverse scan (default 0x00)

7. Reliability Test Criteria

Items	Required Condition	Note
Temperature Humidity Bias	60℃/90%, 240 hours, Power On	Note 1
High Temperature Operation	70℃,240 hours	Note 1
Low Temperature Operation	-15℃,240 hours	Note 1
Hot Storage	85℃,240 hours	Note 1
Cold Storage	-40℃,240 hours	Note 1
Thermal Cycle	-40℃(30mins)<- -> + 85 ℃(30 mins) Total 50 Cycles	Note 1
Shock Test (Non-Operating)	100G,6ms, 3 times for each direction	
Vibration Test (Non-Operating)	Frequency Range : 10 ~ 55 Hz Stroke : 1.5mm Sweep : 10 Hz ~ 55 Hz ~ 10 Hz 2 hours for each direction of X, Y, Z(6 hours of total)	
Vibration Test (Packaging Box)	Random vibration 0.015G2/Hz from 5~200Hz –6dB/Octave from 200~500Hz Axis : 6 (x, y, z) Times : 30 Min for each direction (Total 3 Hours)	
Drop Test (Packaging Box)	Drop height : 75cm, Drop sequence : 1 Corner, 3 Edges, 6 Faces	
ESD	Contact = ± 4 kV, class B (R=330,C=150pF) Air = ± 8 kV, class B (R=330,C=150pF) 5 points, 10times/point	Note 2

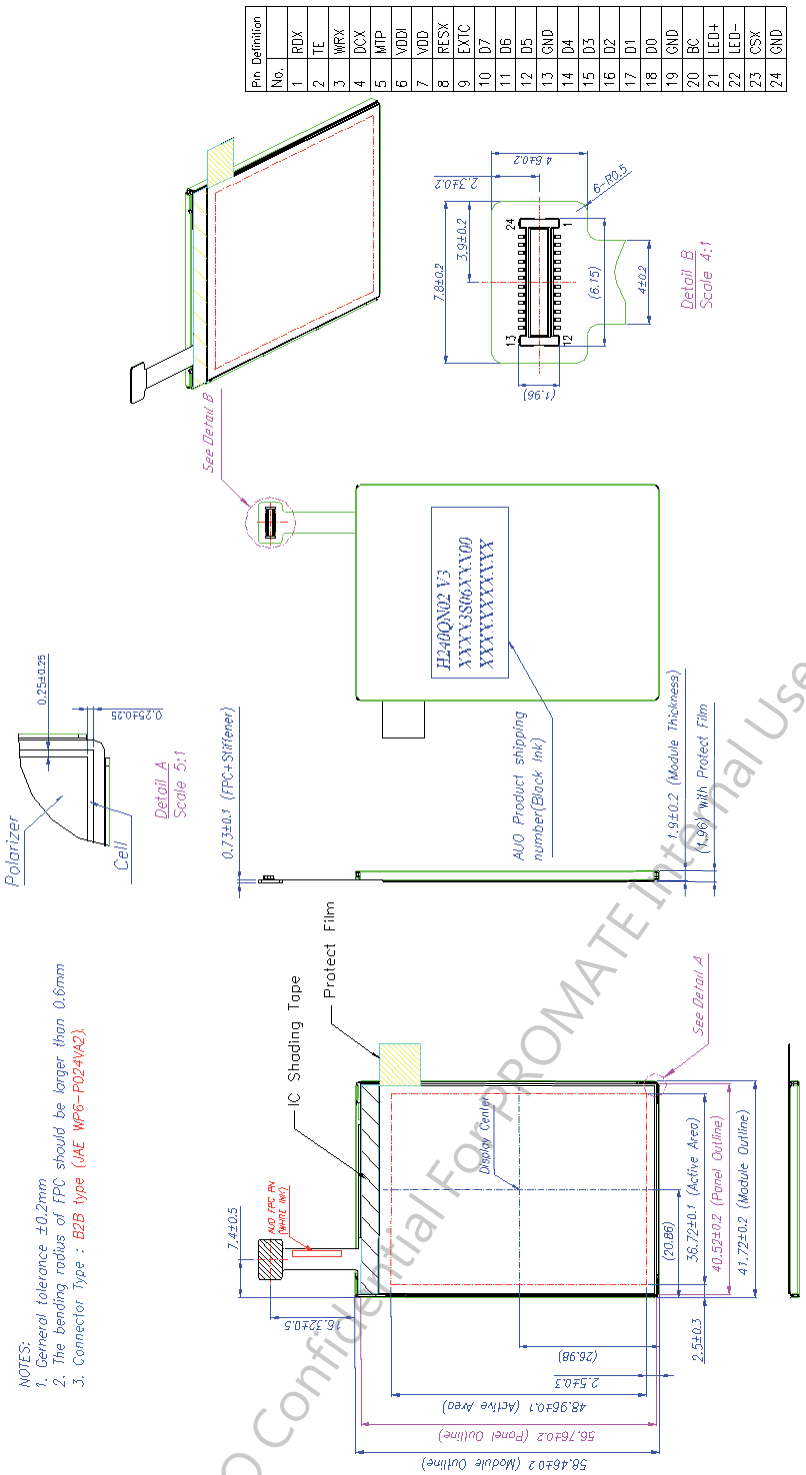
Note 1: All of cosmetic specification is judged before the reliability stress. After AUO reliability test, the function defect is not allowed. Cosmetic defects, optical performance decay and deficiencies are excluded from the inspection.

Note 2: ESD criteria is as below :

Class A	Normal operation. No degradation. No failures.
Class B	Some performance degradation allowed. No data lost. Self-recoverable. No hardware failures.
Class C	Temporary performance degradation. Recovery by operator is acceptable. No hardware failures.
Class D	Hardware failures.

8. Mechanical Characteristics

8.1 LCM Outline Dimension



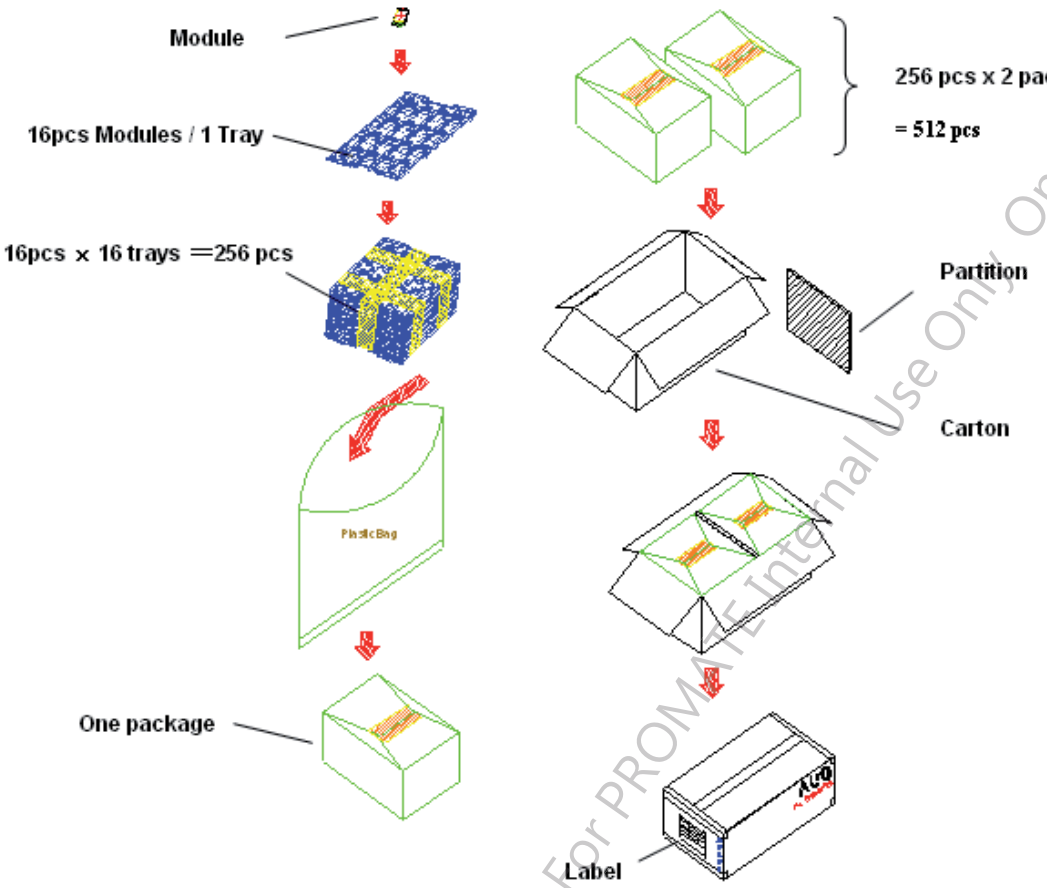
9. Label and Packaging

9.1 Shipping Label (on the rear side of TFT-LCD display)

Print shipping label, printing rule as below

第一行：	XX	X	S06	X	XX	XX
	周别	料号倒数第三位	厂别	等级	流水号	料号后两位
第二行：产品批号						

9.2 Carton Package



Max capacity：512pcs TFT-LCD module per carton

Max weight: 11.5 kg per carton

Outside dimension of carton: 575mm(L)* 382mm(W)*222mm(H)

Pallet size： 1200 mm * 800 mm * 135mm

10 Safety

10.1 Sharp Edge Requirements

There will be no sharp edges or corners on the display assembly that could cause injury.

10.2 Materials

10.2.1 Toxicity

There will be no carcinogenic materials used anywhere in the display module. If toxic materials are used, they will be reviewed and approved by the responsible AUO toxicologist.

10.2.2 Flammability

All components including electrical components that do not meet the flammability grade UL94-V1 in the module will complete the flammability rating exception approval process.

The pRxINted circuit board will be made from material rated 94-V1 or better. The actual UL flammability rating will be pRxINted on the pRxINted circuit board.

10.3 Capacitors

If any polarized capacitors are used in the display assembly, provisions will be made to keep them from being inserted backwards.

10.4 National Test Lab Requirement

The display module will satisfy all requirements for compliance to:

UL 1950, First Edition	U.S.A. Information Technology Equipment