Crystal Clear Technology

Product Specification

T280A09X00

(REVISION 2)

Customers are requested to read through and understand this product specification. If no feedback is received from customer by 30 days, it is deemed that customer has fully need, understand and agreed on the specification set forth in this document.

Acknowledged by,   Date: _____

_____

(CUSTOMER'S SIGNATURE)

REMARK: AFTER THE ACKNOWLEDGEMENT HAS BEEN SIGNED, PLEASE RETURN TO CCT.

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2. Record of Revision

Rev	Date	Item	Page	Comment	Prepared	Checked
PRE	15.09.17			Preliminary	SCChong	Azhar
1.0	05.09.18			Initial Release	SCChong	W.Hong
2.0	04.09.19	3	4	Update the CTP information	SCChong	W.Hong
		5	15	Add AC/DC Characteristics (CTP)		
		6	17	Update Optical Characteristics		
		7	20	Update Reliability Test Condition		
		8	21	Update Inspection Criteria		
		10	28	Update Mechanical drawing		

3. General Specification

T280A09X00 is 2.8" color TFT-LCD (Thin Film Transistor Liquid Crystal Display) module composed of LCD panel, driver ICs control circuit, and LED backlight. This display area contains 240(RGB) x 320 pixels and can display up to 262K colors. This product compliant with RoHS environmental requirement.

	Item	Specifications	Unit	Note
	Size (Diagonal)	2.8"	inch	
	Outline dimensions	50.0(W) x 69.2(H) x 3.05(T)	mm	(1)
TFT	Display type	262k color TFT, Normally Black	-	(2)
	Viewing direction	All	O'clock	
	TFT Active area	43.19(W) x 57.6(H)	mm	
	TFT Resolution	240(RGB) x 320	-	
	Pixel size	0.18(W) x 0.18(H)	mm	
	Pixel arrangement	RGB vertical strip	-	
	TFT Driving IC	ST7789V or Equivalent	-	
	TFT Interface mode	MCU Parallel 8-bit / 3-SPI / 4-SPI	-	
	Luminance	350 (Typ)	cd/m2	(3)
CTP	CTP Active area	43.20(W) x 57.60(H)	mm	
	CTP Resolution	240 x 320	-	
	CTP Origin	Top-left (FPC down)	-	
	CTP Controller	ST1633i	-	
	CTP Interface mode	I2C	-	
	Touch mode	5 fingers multi touch	-	
	Cover lens material	Glass	-	
	Transparency	85	%	
	Operating temperature	-20 ~ +70	°C	(4)
	Storage temperature	-30 ~ +80	°C	(4)

Note:
(1) FPC or Wire or Foam Tape are not included.
(2) Color tone is slightly changed by temperature and driving voltage.
(3) Brightness on LCD surface. Module with CTP or RTP, brightness will be about 20% (max) lower on the touch panel surface.
(4) This product specification shows range of value either in the minimum, typical or maximum category. Operating under extreme condition, bordering on the minimum or maximum range, does not mean that the product can survive perpetually under these extremities. In fact, it only means that the product can operate under such condition with no information of lifetime, other than those already indicated in the specification. User is advised to test it on their own if the specification's reliability data did not indicate it.

STANDARD TFT MODULE ORDER INFORMATION (TABLE)

T ☐ ☐☐☐ ☐ ☐☐ ☐ ☐☐ ☐ ☐

MODEL NUMBER
DISPLAY SIZE (DIAGONAL) in inch

VIEWING ANGLE
T : Top view (12 O'clock)
B : Bottom view (6 O'clock)
W : Wide viewing angle (O-Film)
A : All Direction

MODULE VERSION
SERIES NUMBER FOR THIS STANDARD SPECIFICATION

TOUCH PANEL OPTION
N : Without Touch Panel
C : Capacitive Touch Panel
R : Resistive Touch Panel

SEMI - CUSTOMISE (MINOR CHANGES FROM STANDARD MODEL)
00 - STANDARD SPECIFICATION MODEL
REFER TO FACTORY FOR OTHER VERSIONS. TERMS AND CONDITIONS APPLY

COVER LENS OPTION
C : Cover Lens

OTHER OPTION (if any)
H : with HDMI board

4. AC/DC Characteristics (TFT)

4.1 Absolute Maximum Ratings (VSS = 0V, Ta = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Note
Power Supply Voltage	VDD	-0.3	-	+4.6	V	
Backlight Forward Current	If	-	-	180	mA	
Storage Humidity	HST	10	-	90	%RH	(1)
Storage Temperature	TST	-30	-	+80	°C	
Operating Humidity	HOP	10	-	90	%RH	(1)
Operating Temperature	TOP	-20	-	+70	°C	

Note:
(1) At 25±5°C. Absolute humidity shall be less than 90%RH at +60°C.
(2) Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of this device at these or any other conditions above those indicated in the operational sections of this specification is not implied and exposure to absolute maximum rating conditions for extended periods may affect device reliability.

4.2 Electrical Characteristics (VSS = 0V, VDD = 3.3V, Ta = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Note
Power Supply Voltage	VDD	2.6	-	3.3	V	
Interface Operation Voltage	VDDIO	1.65	-	3.3	V	
Operation Current	IDD	-	8.0	9.4	mA	
Low Level Input Voltage	VIL	0	-	0.3VDDIO	V	
High Level Input Voltage	VIH	0.7VDDIO	-	VDDIO	V	
Low Level Output Voltage	VOL	0	-	0.2 VDDIO	V	
High Level Output Voltage	VOH	0.8VDDIO	-	VDDIO	V	

Note:
(1) The recommended operating conditions refer to a range in which operation of this product is guaranteed. Accordingly, please make sure that the module is used within this range. And these current values are measured under the condition that all devices are stopped, each component is stable and logic signal is input.

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4.3 LED Backlight Specification (Ta = 25°C)

Item	Symbol	Condition	Min	Typ	Max	Unit
LED Supply Voltage	V_f	I_f = 120mA	-	3.0	3.3	V
LED Supply Current	I_f		-	120	-	mA
Luminous Intensity	L_V	White	300	350	-	cd/m^2
Half Life Expectancy	L_L	I_f = 20mA/LED	30000	-	-	hrs
LED Configuration	6 White LED, 6 in Parallel					

Note:
(1) The LED Supply Voltage is defined by the number of LED at Ta = 25ºC and I_f = 120mA.
(2) The "Half Life Expectancy" is defined as the module brightness decrease to 50% original brightness at Ta = 25ºC and I_f = 20mA/LED. The LED lifetime could be decreased if the operating I_f is larger than I_f = 20mA/LED.
(3) Brightness measurement done at LCD surface.

### 4.4 AC Timing Characteristics (VSS = 0V, VDD = 3.3V, Ta = 25°C)

4.4.1   8080 Series MCU Parallel Interface Characteristics: 8-bit Bus
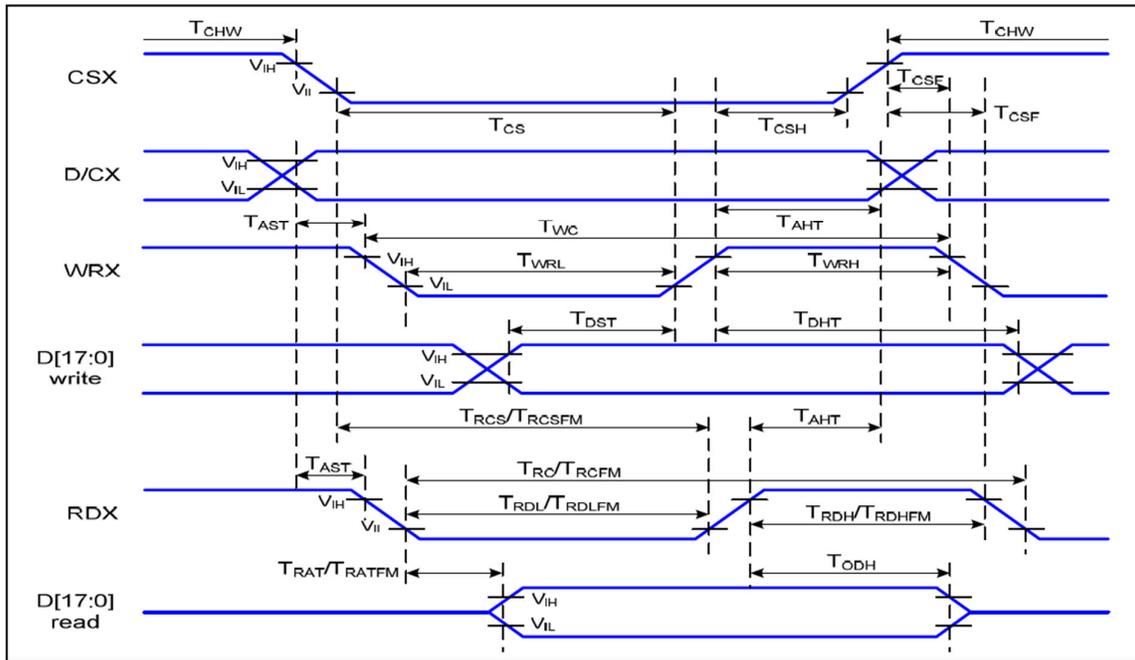
Signal	Symbol	Parameter	Min	Max	Unit	Description
D/CX	T_{AST}	Address setup time	0		ns	-
	T_{AHT}	Address hold time (Write/Read)	10		ns	
CSX	T_{CHW}	Chip select "H" pulse width	0		ns	-
	T_{CS}	Chip select setup time (Write)	15		ns	
	T_{RCS}	Chip select setup time (Read ID)	45		ns	
	T_{RCSFM}	Chip select setup time (Read FM)	355		ns	
	T_{CSF}	Chip select wait time (Write/Read)	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 (ID)	T_{RC}	Read cycle (ID)	160		ns	When read ID data
	T_{RDH}	Control pulse "H" duration (ID)	90		ns	
	T_{RDL}	Control pulse "L" duration (ID)	45		ns	
RDX (FM)	T_{RCFM}	Read cycle (FM)	450		ns	When read from frame memory
	T_{RDHFM}	Control pulse "H" duration (FM)	90		ns	
	T_{RDLFM}	Control pulse "L" duration (FM)	355		ns	
D[17:0]	T_{DST}	Data setup time	10		ns	For CL=30pF

|						
T_{DHT}	Data hold time	10		ns	
T_{RAT}	Read access time (ID)		40	ns	
T_{RATFM}	Read access time (FM)		340	ns	
T_{ODH}	Output disable time	20	80	ns	
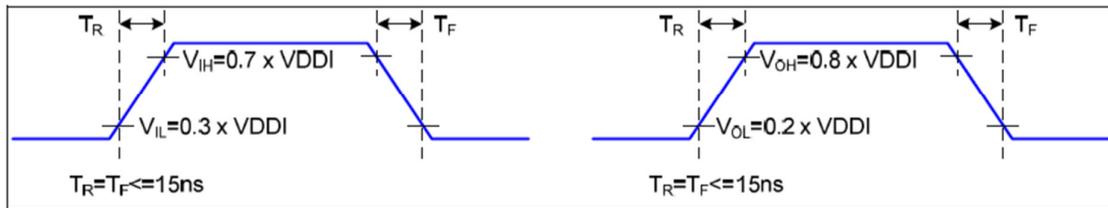
Rising and Falling Timing for I/O Signal
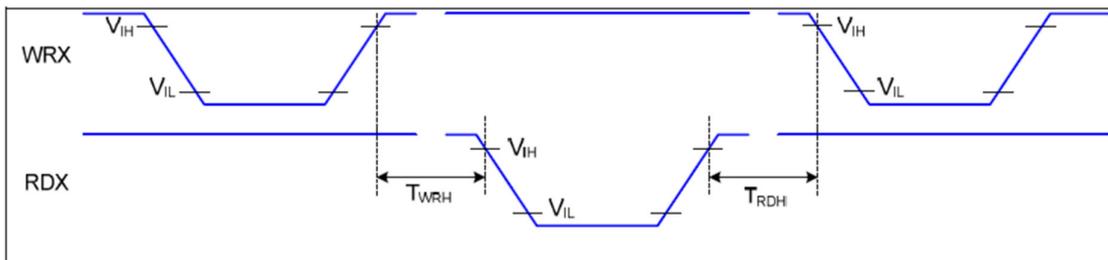
Write-to-Read and Read-to-Write Timing

Note: The rising time and falling time (Tr, Tf) of input signal and fall time are specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.

### 4.4.2 Serial Interface Characteristics (3-line serial)

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)	66		ns	
	T_{SHW}	SCL "H" pulse width (Write)	15		ns	
	T_{SLW}	SCL "L" pulse width (Write)	15		ns	
	T_{SCYCR}	Serial clock cycle (Read)	150		ns	
	T_{SHR}	SCL "H" pulse width (Read)	60		ns	
	T_{SLR}	SCL "L" pulse width (Read)	60		ns	
SDA (DIN)	T_{SDS}	Data setup time	10		ns	
	T_{SDH}	Data hold time	10		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

**Table 5 3-line serial Interface Characteristics**

Note : The rising time and falling time (Tr, Tf) of input signal are specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.

4.4.3 Serial Interface Characteristics (4-line serial)

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)	66		ns	-write command & data ram
	T_{SHW}	SCL "H" pulse width (Write)	15		ns	
	T_{SLW}	SCL "L" pulse width (Write)	15		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	10		ns	
	T_{SDH}	Data hold time	10		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

4.4.4 Reset Timing
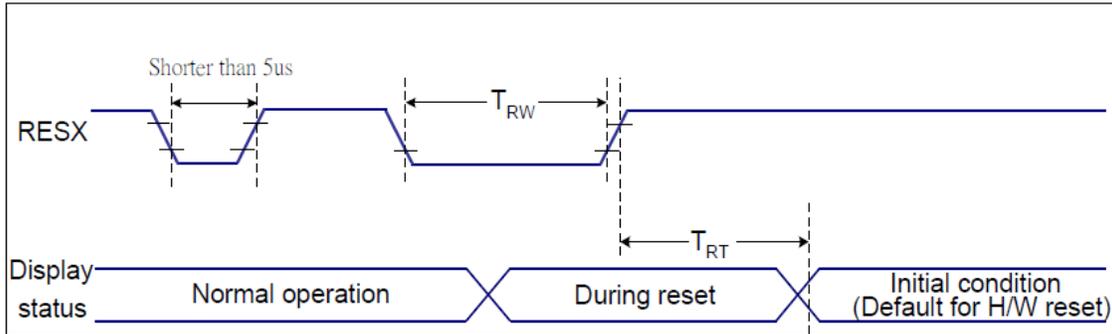
Related Pins	Symbol	Parameter	MIN	MAX	Unit
RESX	TRW	Reset pulse duration	10	-	us
	TRT	Reset cancel	-	5 (Note 1, 5)	ms
				120 (Note 1, 6, 7)	ms

Note:

(1) The reset cancel includes also required time for loading ID bytes, VCOM setting and other setting from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time (tRT) whithin 5ms after arising edge of RESX.

(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 9us	Reset
Between 5us and 9us	Reset starts

(3) During the Resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120ms, 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.

(4) Spike Rejection also applies during a valid reset pulses as shown below:
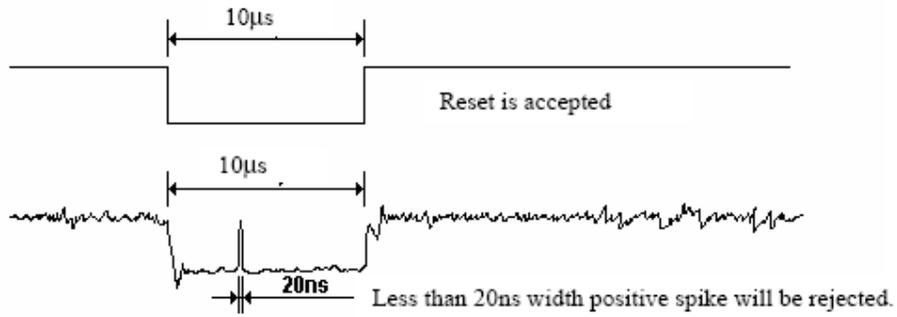
(5) When Reset applied during Sleep In Mode.
(6) When Reset applied during Sleep Out Mode.
(7) It is necessary to wait 5ms after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120ms.

4.5 Pin Assignment Table

Pin No.	Symbol	I/O	Description					Note
1	NC	-	No Connection					
2	LEDK	P	LED back light(Cathode)					
3	LEDA	P	LED back light(Anode)					
4	IM0	I		IM2	IM1	IM0	MCU Interface Mode	
5	IM1	I		0	0	0	8080 8-bit parallel	
				1	0	1	3-line 9-bit	
6	IM2	I		1	1	0	4-line 8-bit	
7	VDD	P	Power Supply					
8	VDDIO	P	Interface Operating Voltage					
9	TE	O	Tearing effect signal is used to synchronize MCU to frame memory					(1)
10	SDA	I/O	SPI interface input/output pin If not used, please fix this pins at VDDIO or GND					(2)
11	CS	I	Chip select pin					(3)
12	RESET	I	Reset pin					(4)
13	RS/SCL	I	Display data/command selection pin in parallel interface Used to be serial interface clock					(5)
14	WR	I	Write enable in MCU parallel interface If not used, please fix this pins at VDDIO or GND					(6)
15	RD	I	Read enable in parallel interface If not used, please fix this pins at VDDIO or GND					(7)
16 - 23	D7 – D0	I/O	DB[7:0] are used as MCU parallel interface data bus If not used, please fix this pins at VDDIO or GND					
24	GND	P	Ground					

Note:
(1) TE: If not used, please let this pin open.
(2) SDA: The data is latched on the rising edge of the SCL signal. If not used, fix at VDDI or GND.
(3) CS: "H"- Disable, "L"- Enable.
(4) RESET: Active low.
(5) RS/SCLK : "H"- Display data or parameter, "L"- Command data – 8-bit Parallel
            Used to be serial interface clock.
(6) WR :DB[7:0] latched at the falling edge – 8-bit Parallel
        Display data/command – 4-line serial interface
(7) RD : DB[7:0] latched at the falling edge

5. AC/DC Characteristics (CTP)

5.1 Absolute Maximum Ratings (VSS = 0V, Ta = 25°C)

Item	Symbol	Min	Typ	Max	Unit	Note
Power Supply Voltage	VCC	-0.3	-	+6.0	V	
Storage Humidity	HST	10	-	90	%RH	(1)
Storage Temperature	TST	-30	-	+80	°C	
Operating Humidity	HOP	10	-	90	%RH	(1)
Operating Temperature	TOP	-20	-	+70	°C	

Note:
(1) At 25±5°C. Absolute humidity shall be less than 90%RH at +60°C.
(2) Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of this device at these or any other conditions above those indicated in the operational sections of this specification is not implied and exposure to absolute maximum rating conditions for extended periods may affect device reliability.

5.2 Electrical Characteristics (VSS = 0V, VCC = 3.3V, Ta = 25°C)

| Item	Symbol	Min	Typ	Max	Unit	Note
Power Supply Voltage	VCC	2.8	-	3.3	V	
Operation Current	ICC	-	16.1	24	mA	
Low Level Input Voltage	VIL	-	-	0.15 VCC	V	
High Level Input Voltage	VIH	0.85 VCC	-	-	V	
Output Driving Current	IDRV	6	-	-	mA	VOH=0.8Vcc
Output Sinking Current	ISINK	10	-	-	mA	VOL=0.2Vcc
Low Voltage Reset	VLVR	-	-	2.3	V	

Note:
(1) The recommended operating conditions refer to a range in which operation of this product is guaranteed. Accordingly, please make sure that the module is used within this range. And these current values are measured under the condition that all devices are stopped, each component is stable and logic signal is input.

5.3 I2C Interface

Touch panel is used as I2C slave device, I2C slave address is 0x55, refer ST1633i datasheet for details.
There are three communication pins connected between host and CTP module which are including external interrupt IRQ, I2C pins SCL and SDA. The IRQ is active low while the touch state is calculated by CTP module and the touch information can be translated via I2C communication interface.

5.4 I2C Timing Characteristics (VSS = 0V, VDD = 3.3V, Ta = 25°C)
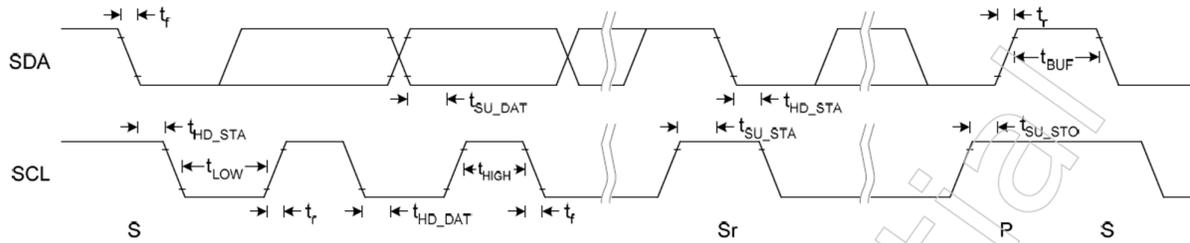
Symbol	Parameter	Rating			Unit
		Min.	Typ.	Max.	
f_{SCL}	SCL clock frequency	0	-	400	kHz
t_{LOW}	Low period of the SCL clock	1.3	-	-	us
t_{HIGH}	High period of the SCL clock	0.6	-	-	us
t_f	Signal falling time	-	-	300	ns
t_r	Signal rising time	-	-	300	ns
t_{SU_STA}	Set up time for a repeated START condition	0.6	-	-	us
t_{HD_STA}	Hold time (repeated) START condition. After this period, the first clock pulse is generated	0.6	-	-	us
t_{SU_DAT}	Data set up time	100	-	-	ns
t_{HD_DAT}	Data hold time	0	-	0.9	us
t_{SU_STO}	Set up time for STOP condition	0.6	-	-	us
t_{BUF}	Bus free time between a STOP and START condition	1.3	-	-	us
C_b	Capacitive load for each bus line	-	-	400	pF

5.5 Pin Assignment Table

Pin No.	Symbol	I/O	Description	Note
1	RST	I	Reset	(1)
2	VCC	P	Power Supply	
3	GND	P	Ground	
4	IRQ	O	Interrupt	(2)
5	SDA	I/O	I2C Serial Data	
6	SCL	I	I2C Serial Clock	
7 - 10	NC	-	No Connection	

Note:
(1) RST (CTP) : Active low
(2) IRQ (CTP) : Active low

6. Optical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit	Note
Brightness	Bp	θ=0° Φ=0°	300	350	-	cd/m^2	(2)
Uniformity	⊿Bp		70	80	-	%	(2)(3)
Viewing Angle	3:00	Cr≥10	70	80	-	degree	(4)
	6:00		70	80	-		
	9:00		70	80	-		
	12:00		70	80	-		
Contrast Ratio	Cr	θ=0° Φ=0° T=25°C	500	800	-	-	(5)
Response Time	Tr + Tf		-	30	35	ms	(6)
NTSC Ratio	S		65	70	-	%	(7)
CTP Transmittance	T		85	90	-	%	(8)

Note:
(1) The parameter is slightly changed by temperature, driving voltage and materiel.
(2) The data are measured after LEDs are turned on for 5 minutes. LCM displays full white. The brightness is the average value of 5 measured spots. Measurement equipment BM-7A.
Measuring condition:
-    Measuring surroundings: Dark room.
-    Measuring temperature: Ta=25°C.
-    Adjust operating voltage to get optimum contrast at the center of the display.
Measured value at the center point of LCD panel after more than 5 minutes while backlight turning on.
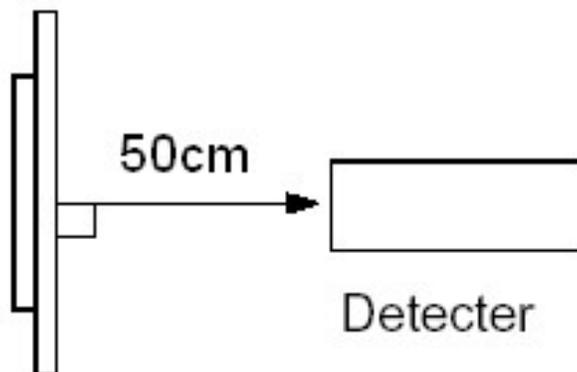
(3) The luminance uniformity is calculated by using following formula:
$\Delta Bp = Bp\ (Min.)\ /\ Bp\ (Max.) \times 100\ (\%)$
Bp (Max.) = Maximum brightness in 5 measured spots.
Bp (Min.) = Minimum brightness in 5 measured spots.
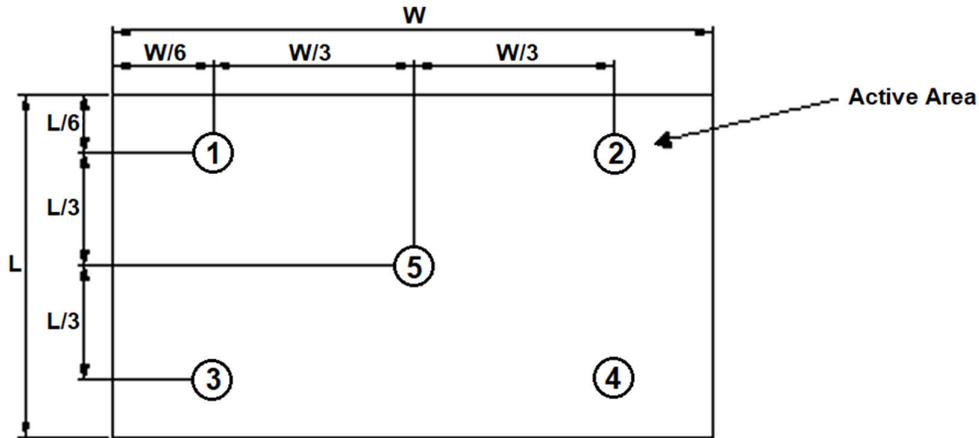
(4) The definition of viewing angle:
Refer to the graph below marked by θ and Φ
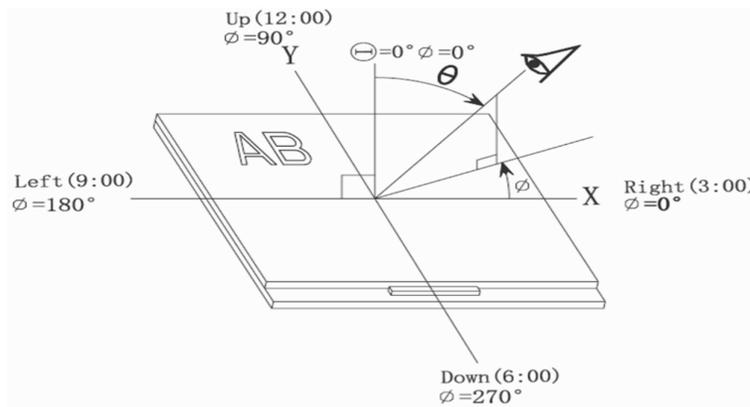
(5) Definition of contrast ratio.

*Conditions

Operating Voltage : Vop
Frame Frequency : 70Hz
Appling Waveform : 1/N duty 1/a bias
View angle (θ, Φ) : (0°, 0°)
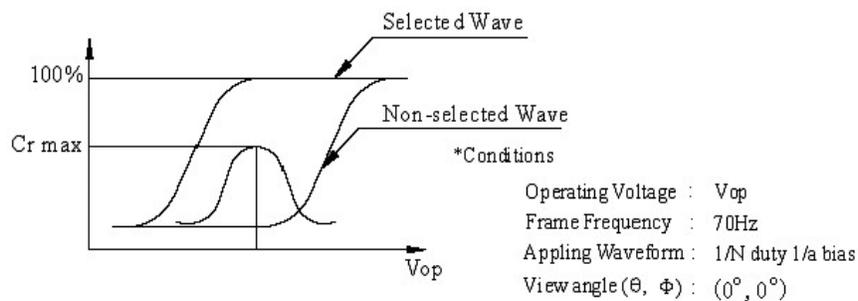
$$\text{Contrast ratio}\ (Cr) = \frac{\text{Brightness of selected dots}}{\text{Brightness of non−selected dots}}$$

(6) Definition of Response time.
The output signals of photo detector are measured when the input signals are changed from "black" to "white" (falling time) and from "white" to "black" (rising time), respectively. The response time is defined as the time interval between the 10% and 90% of amplitudes. Refer to figure as below.
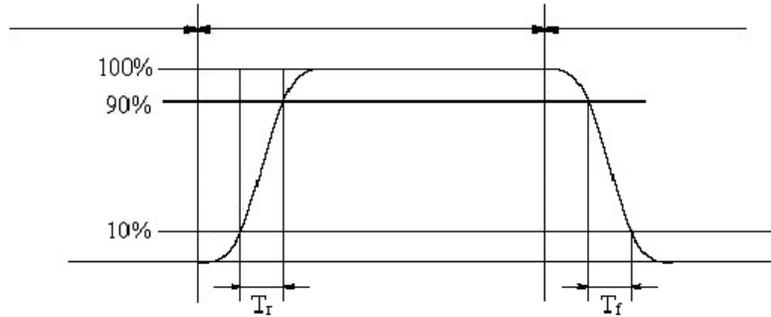
The Definition of response time

(7) Definition of Color of CIE Coordinate and NTSC Ratio.
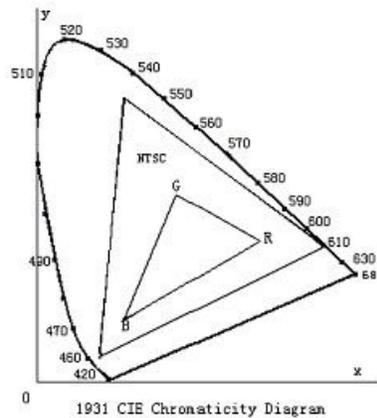
1931 CIE Chromaticity Diagram

(8) Definition of the transmittance measurements shall be made at viewing angle of θ = 0° and at the center of the touch panel by using BM-7A. Transmittance shall be calculated by the difference of the luminance between a standard light source with touch panel and a standard light source without touch panel.

$$\text{Transmittance} = \frac{\text{Luminance on touch panel surface}}{\text{Luminance of standard light source}}$$

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7. Reliability Test Condition

Item		Test Condition	Note
Operating	High Temperature	+70°C, 240hrs	(3)
	Low Temperature	-20°C, 240hrs	(3)
	High Temperature and High Humidity	+60°C, 90%RH, 240hrs	(3)(4)
	Cycle	RT (0m) → -20°C (30m) → RT (5m) → +70°C (30m) → RT (5m) 50 cycles	(1)(2)(3)
Storage	High Temperature	+80°C, 240hrs	(3)
	Low Temperature	-30°C, 240hrs	(3)

Note:
(1) RT means Room Temperature.
(2) m means minute.
(3) Before cosmetic and functional test, the product must have enough recovery time, at least 2 hours at room temperature.
(4) No condensation.

8. Inspection Criteria

- Inspection distance: 25~30cm.
- From lamp source to product: 250 ± 100cm.
- Angle of inspection: Ambient brightness 1k-1.5k lux inspection from front view, perpendicular to the surface of product.
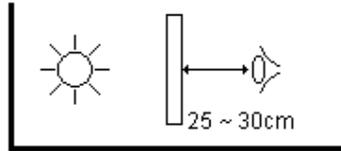
No	Defect	Definition of defect	Inspection Criteria
1	a) Definition of dot	The size of defective dot over ½ of whole is regards as one defective dot. Smaller than ½ Larger than ½ R G B R G B 'No dot defect' '1 dot defect' (ignore) (counted)	A – Viewing Area B – Outside viewing area
	b) Bright Dot	Dot appear bright and unchanged in size when LCD panel is displaying black pattern.	<table><tr><td>Defect</td><td>A</td><td>B</td></tr><tr><td>Bright Dot</td><td>1</td><td rowspan=3>NC</td></tr><tr><td>Dark Dot</td><td>2</td></tr><tr><td>Total</td><td>3</td></tr></table>NC – Not Count
	c) Dark Dot	Dot appear dark and unchanged in size when LCD panel is displaying pure color (RED, GREEN or BLUE) pattern.	
	d) 2 dot adjacent	1 pair = 2 dots Type 1 Type 2 or Type 3	<table><tr><td>Defect</td><td>Acc. Count</td></tr><tr><td>2 Bright dot Adjacent</td><td>0</td></tr><tr><td>2 Dark dot Adjacent</td><td>1</td></tr></table>
2	a) Black Spot b) White Spot c) Bright Spot d) Pin Hole e) Foreign Particle	- Black / Dark / Bright Spot is points on display which appear dark/bright and usually result from contamination. - These defect do not vary in size intensity (contrast) when contras is varied.	<table><tr><td>Defect Category</td><td>A</td><td>B</td></tr><tr><td>D < 0.10</td><td>NC</td><td rowspan=4>NC</td></tr><tr><td>0.10 ≤ D ≤ 0.15</td><td>2</td></tr><tr><td>0.15 ≤ D ≤ 0.20</td><td>1</td></tr><tr><td>D > 0.2</td><td>0</td></tr></table>

		$D = (a+b)/2 \text{(mm)}$	

| | a) Black Line
b) White Line
c) Particle between POL and Glass
d) Scratch on Glass | L: length (mm)
W: width (mm) | Defect Category / A / B table below |

Defect Category	A	B
W < 0.03	NC	NC
0.03 ≤ W ≤ 0.05, L ≤2.0	2	
W > 0.05	0	

	a) POL Bubble b) POL Dented		

Defect Category	A	B
D < 0.20	NC	NC
0.20 ≤ D ≤ 0.30	3	
0.30 ≤ D ≤ 0.50	2	
D > 0.5	0	

3	Mura (50% Grey)		Judged by Limit sample

4	Corner Chip		Accept if (only allowed 1):- a) X ≤ 1.0mm b) Y ≤ 1.0mm c) Z ≤ 1/2T
	Edge Chip	- Touch sensor corner and edge chip that do not cause any damage to tracer and not visible to end-user after housing assembly. - Lens edge and corner chip that is not visible to end-user after housing assembly.	Accept if (only allowed 1):- a) X ≤ 1.0mm b) Y ≤ 1.0mm c) Z ≤ 1/2T Reject – if the sensor surface edge/corner chip damage circuit and visible from front view
	Glass Crack		Reject – if any crack

5	Printing Ink Light Leakage		Accept if:- Light leakage at marginal area width ≤ 0.15mm
6	Surface Smudginess	- For those that can be cleaned, ≤20% of inspected quantity in one lot under > class 10K area; ≤10% of inspected quantity in one lot ≤ class 10K area. - For those that cannot be cleaned it is classified as foreign round shape defect.	
7	FPC Defects on Contact Pad		Accept if dent, pinhole:- a) a ≤ w/3 Reject – if open circuit / cracking / oxidation / contamination
	FPC Broken		Reject if FPC broken / extruded
	FPC Warped		Accept if FPC warped
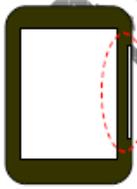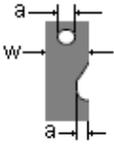
9. Precaution

1. Handing Precautions
   a. The display panel is made of glass and polarizer. As glass is fragile. It tends to chip during handling especially on the edges. Please avoid dropping or jarring. Do not subject it to a mechanical shock of impact or by dropping it.
   b. 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 is in contact with your skin or clothes, wash it off using soap and water.
   c. 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 degrade the insulation between terminals. Scratch and dents may occur on polarizer too.
   d. 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 a HB pencil lead (glass, tweezers, etc.). Do not put or attach anything on the display area to avoid leaving marks on it. 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 in to contact with room temperature air.
   e. 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.
   f. 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 colour fading. Avoid contact with oil and fats.
   g. 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.
   h. 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.
   i. Do not attempt to disassemble or process the LCD module.
   j. NC terminal should be open. Do not connect anything.
   k. If the logic circuit power is off, do not apply the input signals.
   l. 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 removing 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 assembly, 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 screw driver 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 assembly and other work under dry conditions. To reduce the generation of static electricity be careful that the air in the work environment is not too dry. 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.

m. 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 the LCM.

2. Storage Precautions
   When storing the LCD modules, the following precaution are necessary.
   a. Store the LCD at a temperature from 10°C to 30°C and a relative humidity of 65% RH or less.
   b. Please store display in a dry place and shelter from direct sunlight.

3. Others
   a. 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.
   b. 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.
   c. 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.

4. Using LCD Modules
   a. 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.
   b. Cover the surface with a transparent protective plate to protect the polarizer and LC cell.

Protective Plate

Fitting Plate

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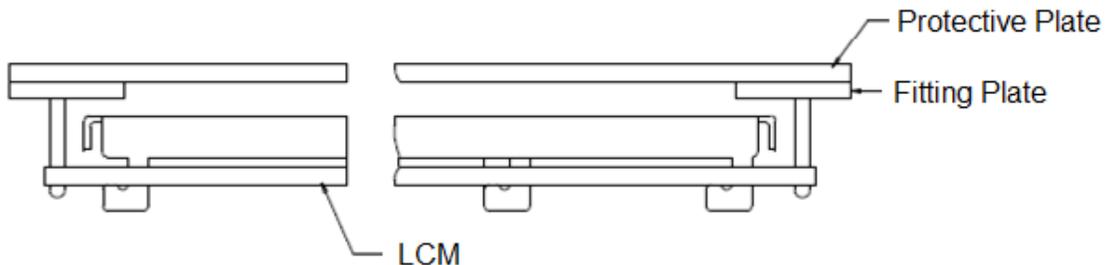
c. When assembling the LCM into other equipment, the spacer to the bit between the LCM and the fitting plate should have enough height to avoid causing stress to the module surface, refer to the individual specifications for measurements. The measurement tolerance should be 0.1mm.

d. 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.
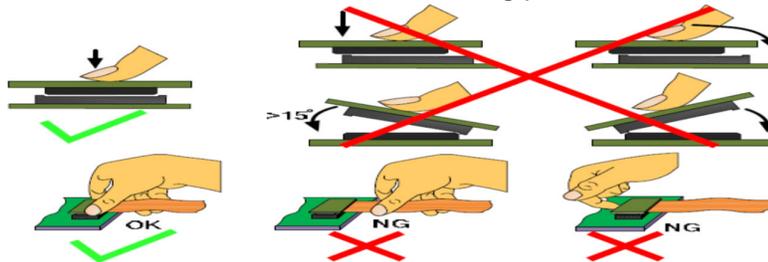
5. Precaution for soldering the LCM

	Manual 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

a. If soldering flux is used, be sure to remove any remaining flux after finishing the 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.

b. 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.

c. When removing the electroluminescent panel from the PC board, be sure the solder has completely melted, the soldered pad on the PC board could be damaged.

6. Precautions for Operation

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

b. It is recommended to drive LCD's within the specified voltage limit since over limit will cause shorter LCD life. An electrochemical reaction due to direct current causes LCD deterioration. Avoid the use of direct current drive.

c. Response time will be extremely delayed at lower temperature compared to room operating temperature range and on the other hand, at higher temperature LCD shows dark colour in them. However those phenomena do not mean malfunction. The LCD will return to normal performance when ambient temperature revert to room condition.

d. 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 on.

e. A slight dew depositing on terminals is a cause for electro-chemical reaction resulting in terminal open circuit.

f. Input logic voltage before apply analogue high voltage such as LCD driving voltage when power on. Remove analogue high voltage before logic voltage when power off the module. Input each signal after the positive/negative voltage becomes stable.

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

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

8. Limited Warranty
Unless otherwise agreed between Crystal Clear Technology and customer, Crystal Clear Technology will replace or repair any of its LCD and LCM which is found to be defective electrically and visually when inspected in accordance with Crystal Clear Technology acceptance standards, for a period of one year from date of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of Crystal Clear Technology is limited to repair and/or replacement on the terms set forth above. Crystal Clear Technology will not responsible for any subsequent or consequential events.

9. 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's 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 customer upon mutual agreement. Modules must be returned with sufficient description of failure or defects. Any connectors or cable installed by customer must be removed completely without damaging the PCB eyelet's, conductors and terminals.

10.　　Mechanical Specification

CRYSTAL CLEAR TECHNOLOGY SDN. BHD

⚠️ ADD CTP PIN OUT
CHANGE BL CIRCUIT
AZHAR 09-07-2018
⚠️ REVISE BL SHAPE
AZHAR 04-09-2019

General Tolerance (unless specified)

Dim	Tol
X.X	±0.3
X.XX	±0.10
ANGULAR	±0.25°

CTP PIN OUT

No	SYMBOL
1	RST
2	VCC
3	GND
4	IRQ
5	SDA
6	SCL
7	NC
8	NC
9	NC
10	NC

No: PIN NAME

No	PIN NAME
1	NC
2	LEDK
3	LEDA
4	IM0
5	IM1
6	IM2
7	VDD 2.8V
8	VDDIO 1.8V
9	TE
10	SDA
11	/CS
12	/RESET
13	RS/SCL
14	WR
15	RD
16	D7
17	D6
18	D5
19	D4
20	D3
21	D2
22	D1
23	D0
24	GND

IM2	IM1	IM0	
0	0	0	80-8bit parallel
1	0	1	3-line 9bit
1	1	0	4-line 8bit

STIFFENER — CONTACT SIDE
CONTACT SIDE — STIFFENER

LED-A — LEDK

BACKLIGHT CIRCUIT DIAGRAM

DISPLAY MODE	NORMALLY BLACK, TRANSMISSIVE
VIEWING ANGLE	ALL DIRECTION
DISPLAY COLOR	262K
NUMBER OF PIXEL	240 (H) RGB X 320(V)
PIXEL PITCH	0.180(H) X 0.180 (V)
BACKLIGHT	6 WHITE LED
BRIGHTNESS (typ)	350 cd/m2 (LCD SURFACE)

CRYSTAL CLEAR TECHNOLOGY SDN BHD

PART NAME
2.8" TFT MODULE

( ) : REPEATED OR REFERENCE DIMENSION ONLY   SPECIAL CHARACTERISTIC : Ⓟ= SPC IS REQUIRED , Ⓢ= MSA IS REQUIRED , Ⓒ= NO SPC/MSA REQUIRED

REFERENCE (FOR PD USE ONLY)

APPROVED	CHECKED	DRAWN		DRAWING NUMBER	SHEET	REV.
		AZHAR 28-09-2017	UNIT : MM NTS	T280A09C00	1/1	3