DMT050HDNHCMU-1A
PRODUCT SPECIFICATION

Version 0.1
Dec 12, 2019

TBD

Customer's Approval	
Signature	*Date*

Prepared by *Chi Huang*
Approved by *Ryan Lin & Evan Huang*

Revision History

VERSION	DATE	DESCRIPTION	AUTHOR
0.1	Dec 12, 2019	Preliminary	Chi Huang

Legal Notice

Table of Contents

1. General Description

1.1 Introduction

This is a 5” size colour active matrix TFT LCD module that uses amorphous silicon TFT as a switching device. The display is normally black mode, transmissive, and featuring high contrast and excellent colour saturation. The resolution of the TFT-LCD is 720x 1280 and can display up to 65K / 262K / 16.7M colours. The display module supports HDMI interface and optical bonding touch panel.

1.2 Main Features

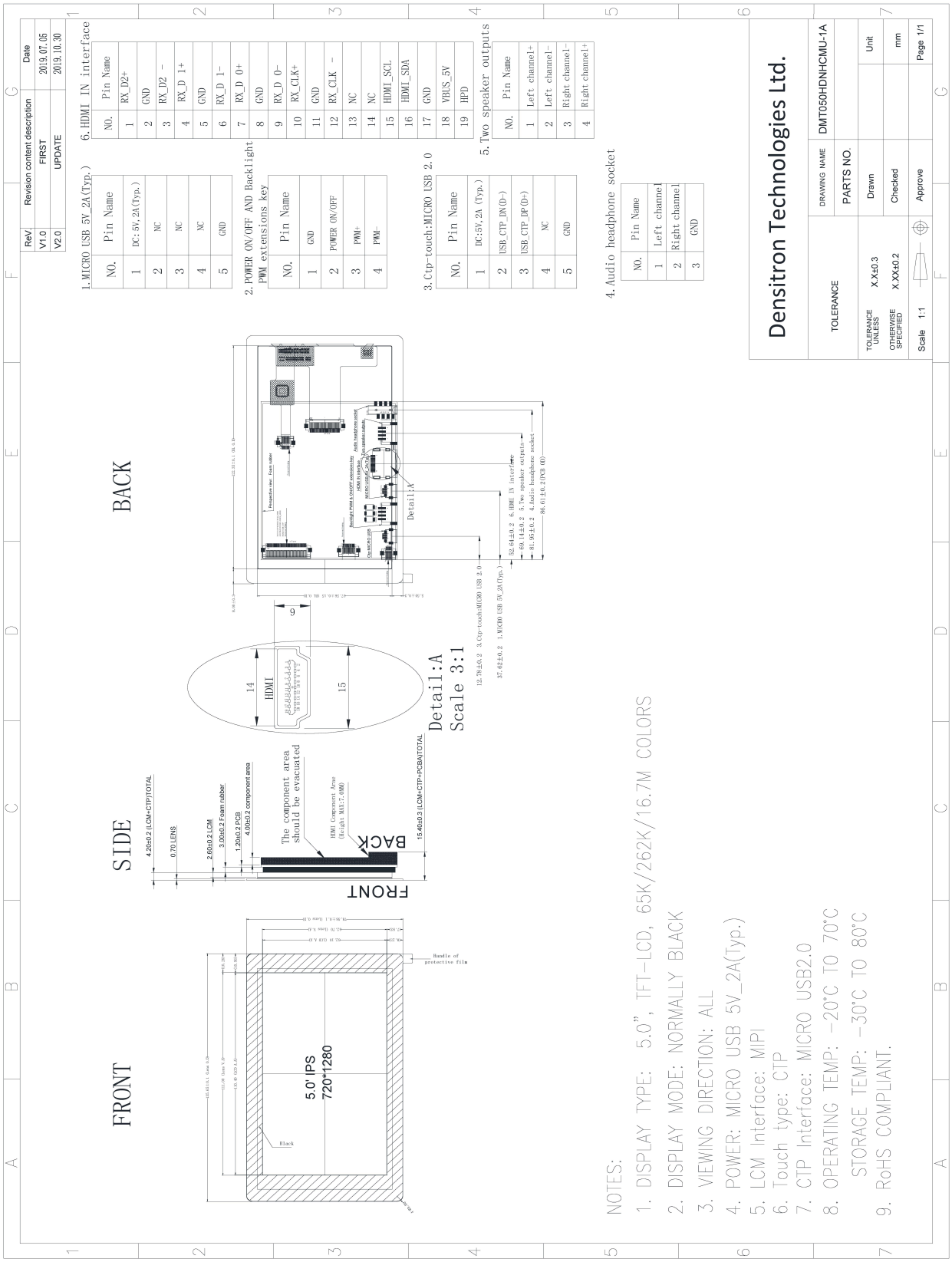
Item	Contents
Display Type	TFT LCD
Screen Size	5” Diagonal
Display Format	720 x RGB x 1280 Dots
No. of Colour	65K / 262K / 16.7M
Overall Dimensions	78.56 (W) x 135.65 (H) x 4.2 (D) mm
Active Area	62.10 (W) x 110.40 (H) mm
Mode	Normally Black / Transmissive
Surface Treatment	-
Viewing Direction	All round
Interface	HDMI
Driver IC	ILI9881C
Backlight Type	LED, White, 12 chips
Touch Panel	PCT
Touch Interface	Micro USB
Bonding Type	Optical bonding
Operating Temperature	-20°C ~ +70°C
Storage Temperature	-30°C ~ +80°C
ROHS	Compliant to RoHS 2.0

2. Mechanical Specification

2.1 Mechanical Characteristics

Item	Characteristic	Unit
Display Format	720 x RGB x 1280	Dots
Overall Dimensions	78.56 (W) x 135.65 (H) x 4.2 (D)	mm
Active Area	62.10 (W) x 110.40 (H)	mm
Dot Pitch	0.08625 (W) x 0.08625 (H)	mm
Weight	98	g
IC Controller/Driver	ILI9881C	

2.2 Mechanical Drawing



3. Electrical Specification

3.1 Absolute Maximum Ratings

Item	Symbol	Min	Max	Unit	Note
Power Supply Voltage (Analog)	VDD-GND	-0.3	6.0	V	-
	VDDp.GND	-0.3	6.0	V	-
Input Signal Voltage (LED)	$V_{(LED)}$	-0.3	6.0	V	LED_EN
Input Signal Voltage (PWR)	$V_{(PWR)}$	-0.3	5.5	V	DCDC EN
Operating Temperature	T_{OP}	-20	+70	°C	2, 3
Storage Temperature	T_{ST}	-30	+80	°C	2, 3

Note 1: When this module is used beyond the above absolute maximum ratings, permanent breakage of the module may occur. For normal operations, it is desirable to use this module under the conditions according to Section 3.2 “Electrical Characteristics”, to avoid malfunctioning.

Note 2: Background colour changes slightly depending on ambient temperature. This phenomenon is reversible.

Note 3: Please refer to item of RELIABILITY.

3.2 Electrical Characteristics

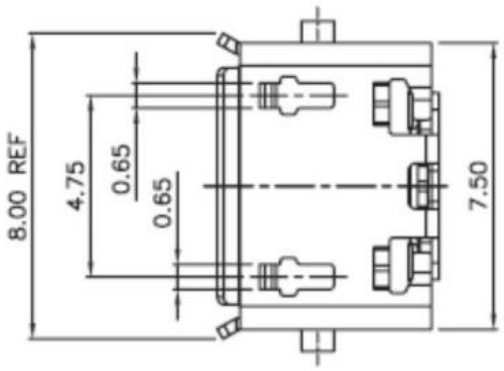
Item	Symbol	Condition	Min	Typ	Max	Unit	Note
Digital Supply Voltage	VCC	-	2.5	3.3	6.0	V	-
Digital interface supple Voltage	IOVCC	-	1.65	1.8	3.3	V	-
Normal mode Current consumption	IDD	-	--	40	--	mA	-
Level Input Voltage	V_{IH}	-	0.7*IOVDD	-	IOVDD	V	-
	V_{IL}	-	-0.3	-	0.3*IOVDD	V	-
Level output voltage	V_{OH}	-	0.8*IOVCC	-	IOVCC	V	-

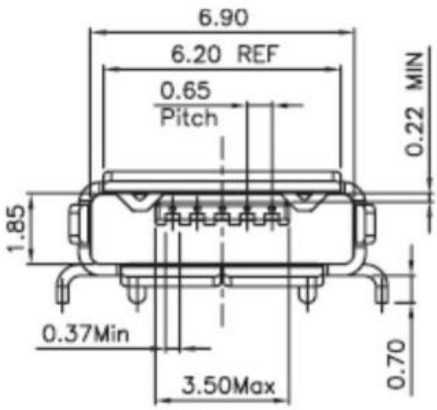
3.3 Interface Pin Assignment

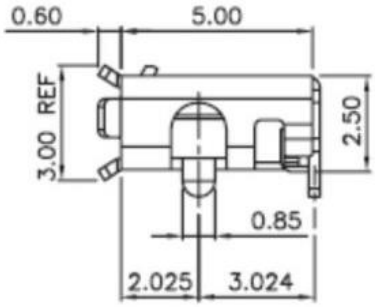
3.3.1 MICRO USB 5V_2A(Typ.) PIN Definition & Signal Connector

No.	Symbol	I/O	Function
1	DC:5V,2A(Typ.)	P	Supply voltage(5.0V,2A Typ.).
2	NC	-	No Connection.
3	NC	-	No Connection.
4	NC	-	No Connection.
5	GND	P	Ground.

Note: Mirco-USB Connector Dimension:

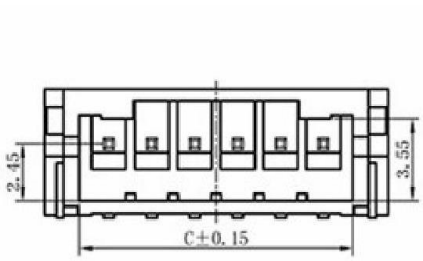


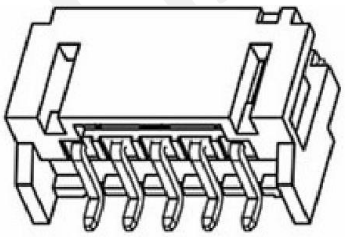


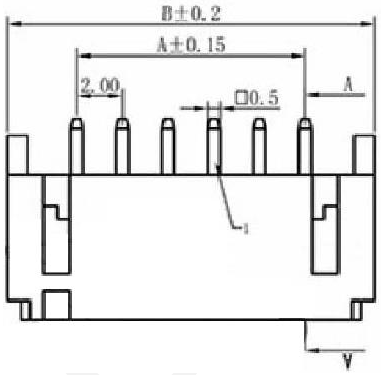


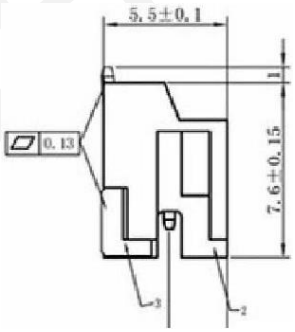
3.3.2 POWER ON/OFF AND Backlight PWM extensions key PIN Definition & Signal Connector

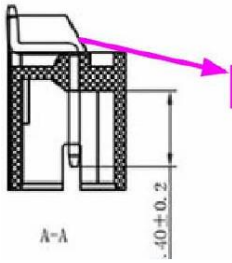
No.	Symbol	I/O	Function
1	GND	-	Ground
2	POWER ON/OFF	-	ON/OFF KEY
3	PWM+	-	The backlight brightness of each button is increased by one level until the maximum brightness reaches (9 level).
4	PWM-	-	The backlight brightness of each button is reduced by one level until the lowest brightness reaches (level 9).









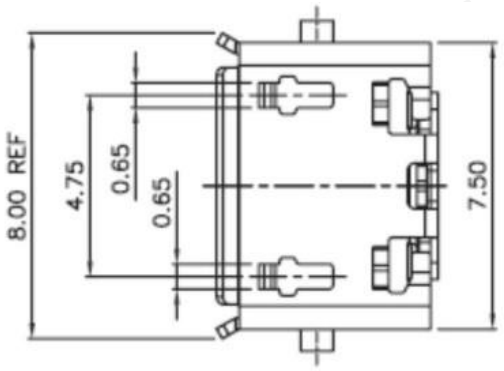


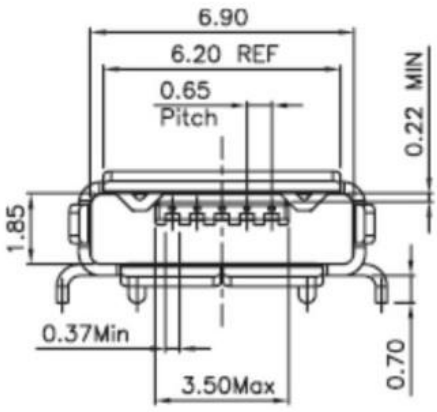
孔位 poles	A	B	C
2	2.00	8.00	4.75
3	4.00	10.00	6.75
4	6.00	12.00	8.75
5	8.00	14.00	10.75
6	10.00	16.00	12.75
7	12.00	18.00	14.75
8	14.00	20.00	16.75
9	16.00	22.00	18.75

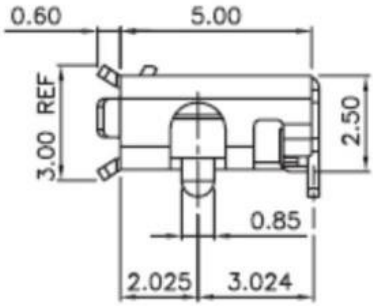
3.3.3 CTP: MICRO USB PIN Definition & Signal Connector

No.	Symbol	I/O	Function
1	DC:5V,2A(Typ.)	P	Supply voltage (5.0V,2A Typ.).
2	USB_CTP_DN(D-)	I/O	USB data negative analog input.
3	USB_CTP_DP(D+)	I/O	USB data positive analog input.
4	NC	I	No Connection.
5	GND	P	Ground.

Note: Mirco-USB Connector Dimension:

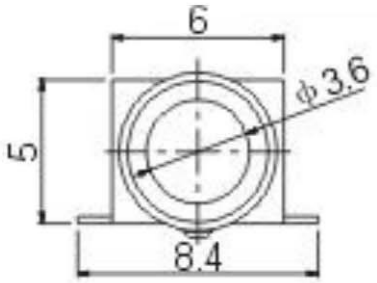


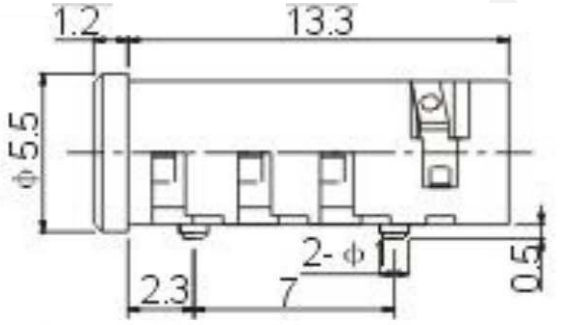




3.3.4 Audio headphone socket PIN Define & Input Signal Connector

NO.	SYMBOL	I/O	DISCRIPTION
1	Left channel	-	Audio output left channel
2	Right channel	-	Audio output right channel
3	GND	-	Ground
4	GND	-	Ground

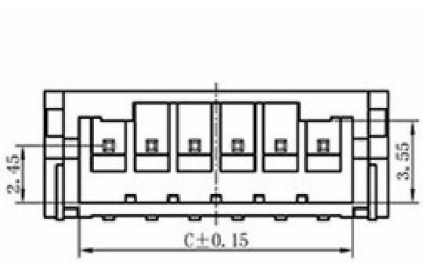


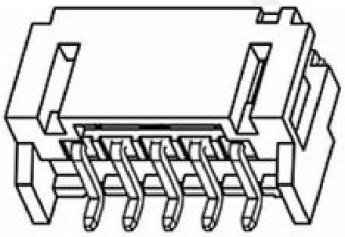


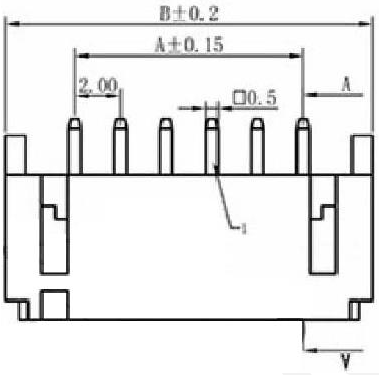
P.C.B Layout(copper-sided view)

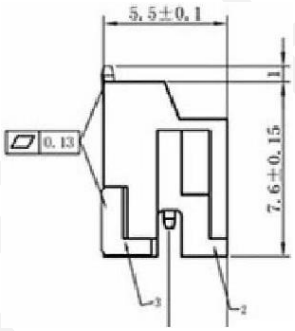
3.3.5 Two speaker outputs PIN Define & Input Signal Connector

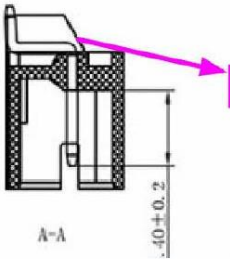
NO.	SYMBOL	I/O	DISCRIPTION
1	Left channel+	-	Audio output left channel
2	Left channel-	-	
3	Right channel-	-	Audio output right channel
4	Right channel+	-	









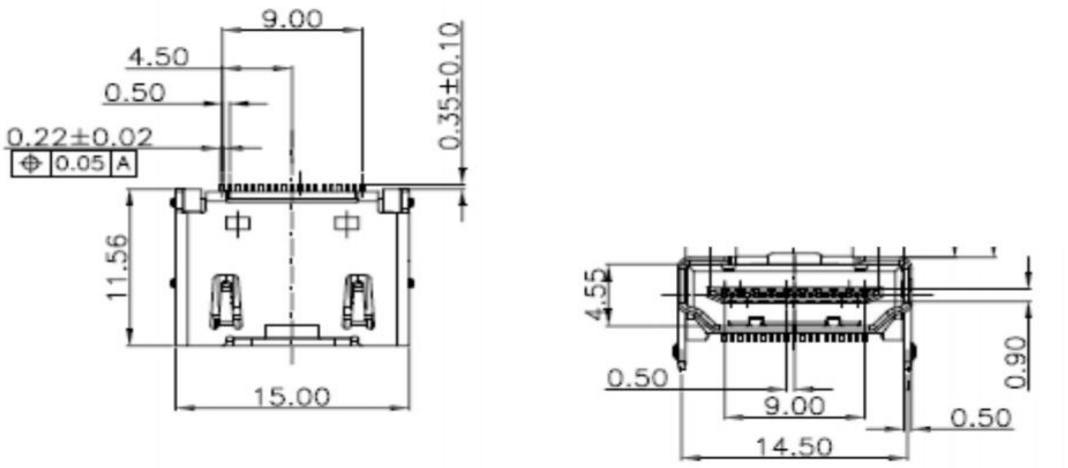


孔位 poles	A	B	C
2	2.00	8.00	4.75
3	4.00	10.00	6.75
4	6.00	12.00	8.75
5	8.00	14.00	10.75
6	10.00	16.00	12.75
7	12.00	18.00	14.75
8	14.00	20.00	16.75
9	16.00	22.00	18.75

3.3.6 HDMI PIN Definition & Signal Connector

NO.	SYMBOL	I/O	DISCRIPTION
1	RX_D2+	I	HDMI Receiver channel 2 positive analog input.
2	GND	P	Ground.
3	RX_D2-	I	HDMI Receiver channel 2 negative analog input.
4	RX_D1+	I	HDMI Receiver channel 1 positive analog input.
5	GND	P	Ground.
6	RX_D1-	I	HDMI Receiver channel 1 negative analog input.
7	RX_D0+	I	HDMI Receiver channel 0 positive analog input.
8	GND	P	Ground.
9	RX_D0-	I	HDMI Receiver channel 0 negative analog input.
10	RX_CLK+	I	HDMI Receiver clock positive analog input.
11	GND	P	Ground.
12	RX_CLK-	I	HDMI Receiver clock negative analog input.
13	NC	-	No connect
14	NC	-	No connect
15	HDMI_SCL	I/O	HDMI Receiver DDC data channel.
16	HDMI_SDA	I	HDMI Receiver DDC clock channel.
17	GND	P	Ground.
18	HDMI_5V	P	HDMI Supply voltage (5.0V).
19	HPD	O	HDMI Receiver hot plug detect output

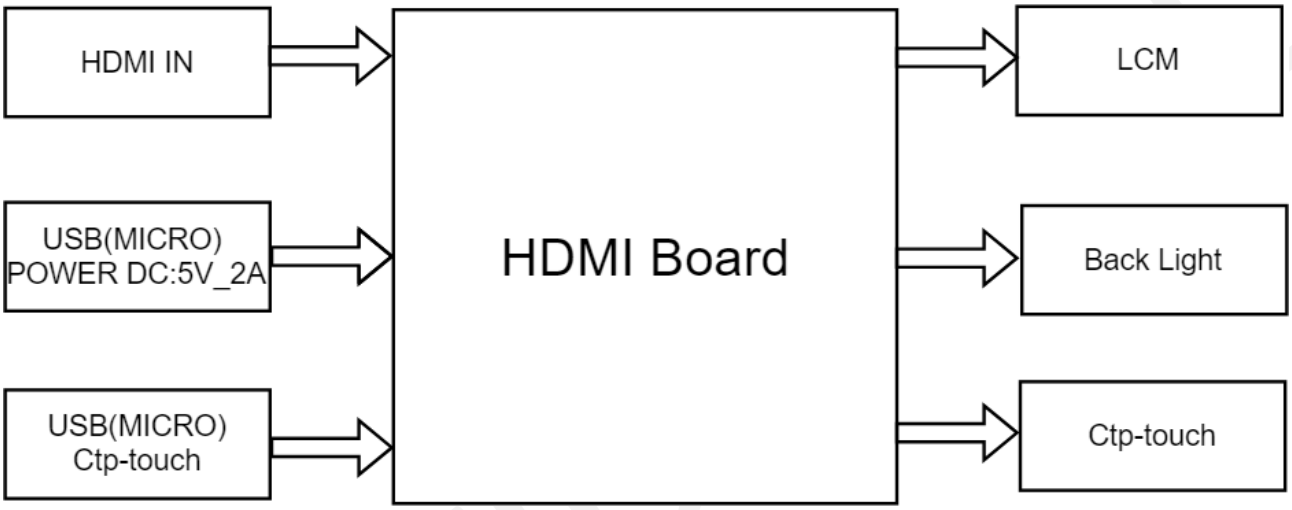
Note: HDMI Connector Dimension



3.4 Operating Instructions:

- This product supports the following operating systems: Windows 7/8/10, Raspberry Pi, Ubuntu, Andriod.
- Connect the HDMI cable to Windows 7/8/10 or Raspberry Pi or Ubuntu or Andriod.
- Connect the CTP to micro USB.
- Connect the micro USB DC POWER.

3.5 Block Diagram

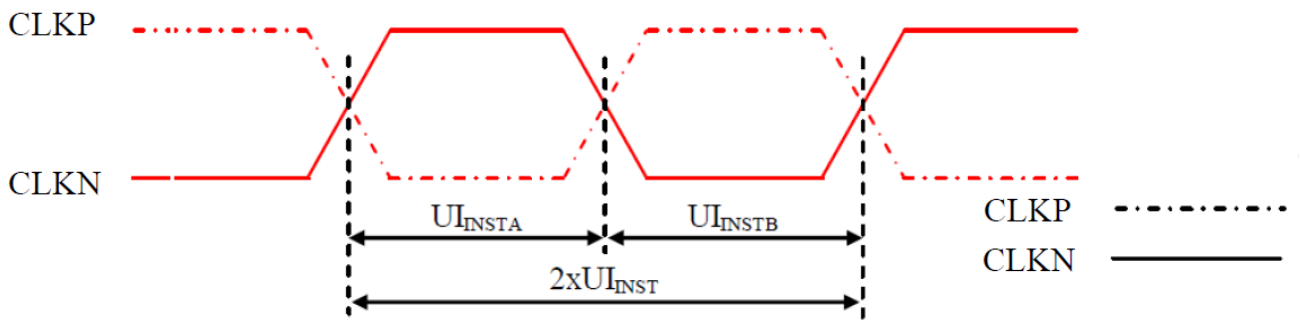


3.6 Timing Characteristics

Please refer to ILITEK IC ILI9881C datasheet for more information.

3.6.1 High Speed Mode – Clock Channel Timing

DSI Clock Channel Timing



DSI Clock Channel Timing Table

Parameter	Symbol	Signal	Min	Max	Unit
Double UI instantaneous	2 x UI_{INST}	CLKP/N	4	25	ns
UI instantaneous Half	UI_{INSTA}, UI_{INSTB} (Note 1)	CLKP/N	2 (Note 2)	12.5	ns

Note 1: UI = UIINSTA = UIINSTB

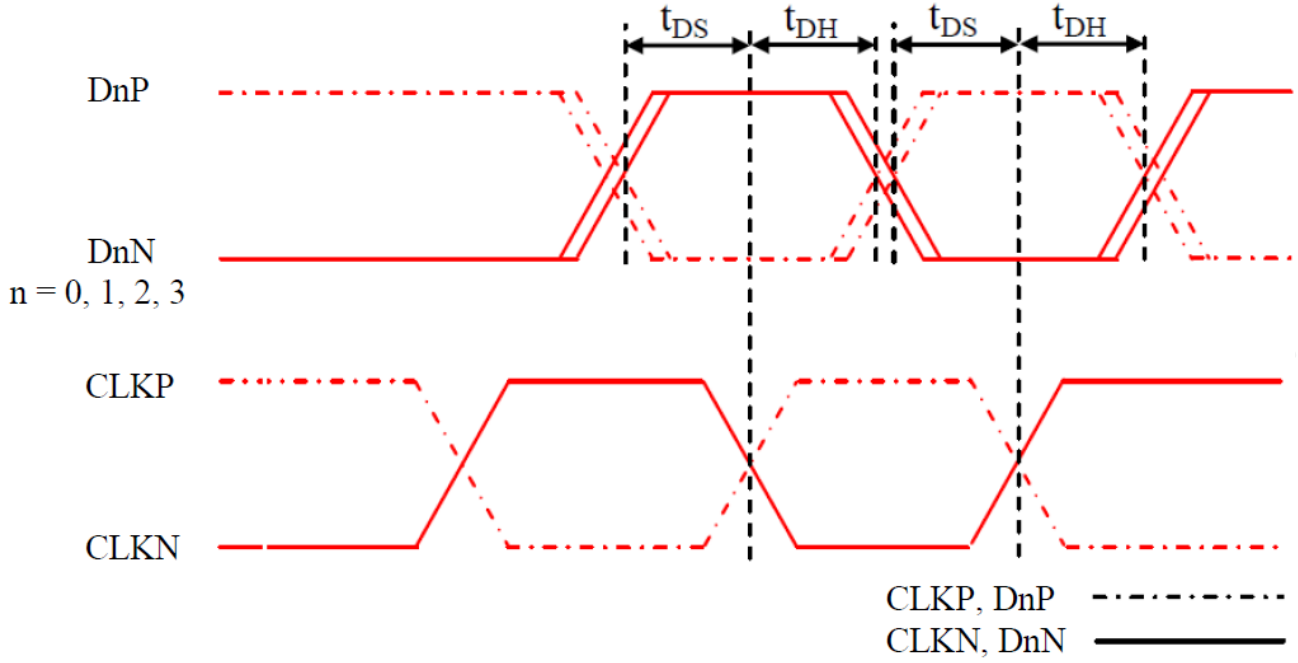
Note 2: Define the minimum value of 24 UI per Pixel, see as below as table.

Limited Clock Channel Speed Table

Data type	Two Lanes speed	Three Lanes speed	Four Lanes speed
Data Type = 00 1110 (0Eh), RGB 565, 16 UI per Pixel	566 Mbps	433 Mbps	366 Mbps
Data Type = 01 1110 (1Eh), RGB 666, 18 UI per Pixel	637 Mbps	487 Mbps	412 Mbps
Data Type = 10 1110 (2Eh), RGB 666 Loosely, 24 UI per Pixel	850 Mbps	650 Mbps	550 Mbps
Data Type = 11 1110 (3Eh), RGB 888, 24 UI per Pixel	850 Mbps	650 Mbps	550 Mbps

3.6.2 High Speed Mode – Data Clock Channel Timing

DSI Data to Clock Channel Timings

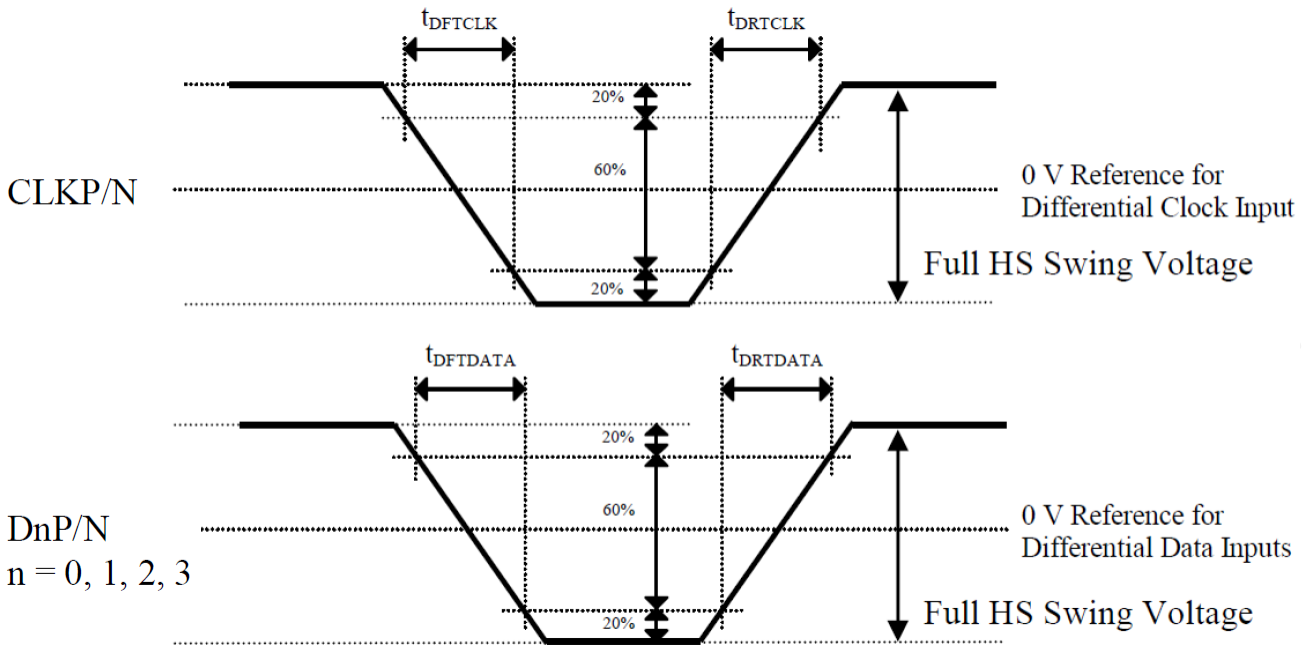


DSI Data to Clock Channel Timings Table

Parameter	Signal	Symbol	Min	Max
Data to Clock Setup time	DnP/N, n=0 and 1	t_{DS}	0.15 x UI	-
Clock to Data Hold Time		t_{DH}	0.15 x UI	-

3.6.3 High Speed Mode – Rising and Fall Timings

Rising and Falling Timings on Clock and Data Channels



Rise and Fall Timings on Clock and Data Channels Table

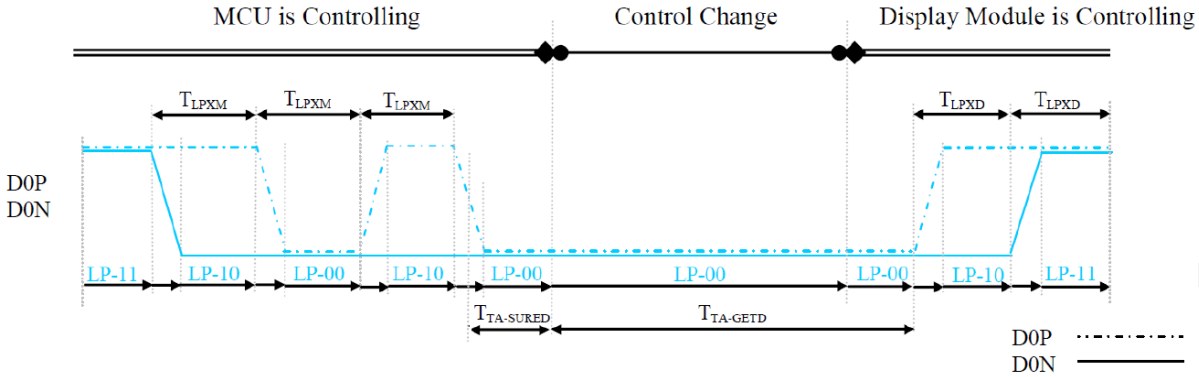
Parameter	Symbol	Condition	Min	Typ	Max
Differential Rise Time for Clock	t_{DRTCLK}	CLKP/N	150 ps	-	0.3UI (Note)
Differential Rise Time for Data	$t_{DRTDATA}$	DnP/N n=0 and 1	150 ps	-	0.3UI (Note)
Differential Fall Time for Clock	t_{DFTCLK}	CLKP/N	150 ps	-	0.3UI (Note)
Differential Fall Time for Data	$t_{DFTDATA}$	DnP/N n=0 and 1	150 ps	-	0.3UI (Note)

Note: The display module has to meet timing requirements, which are defined for the transmitter (MCU) on MIPI D-Phy standard.

3.6.4 Low Speed Mode – Bus Turn Around

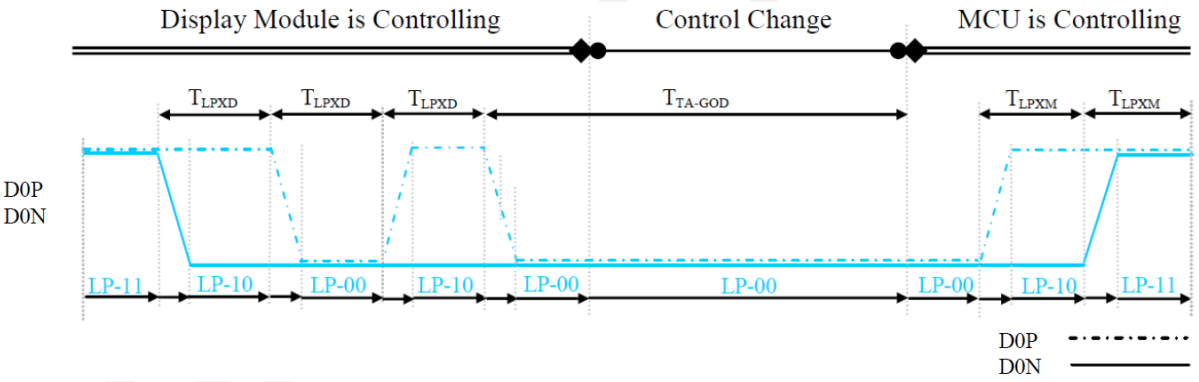
Lower Power Mode and its State Periods on the Bus Turnaround (BTA) from the MCU to the Display Module (ILI9881C) are illustrated for reference purposes below.

BTA from the MCU to the Display Module



Lower Power Mode and its State Periods on the Bus Turnaround (BTA) from the Display Module (ILI9881C) to the MCU are illustrated for reference purposes below.

BTA from the Display Module to the MCU



Low Power State Period Timings – A Table

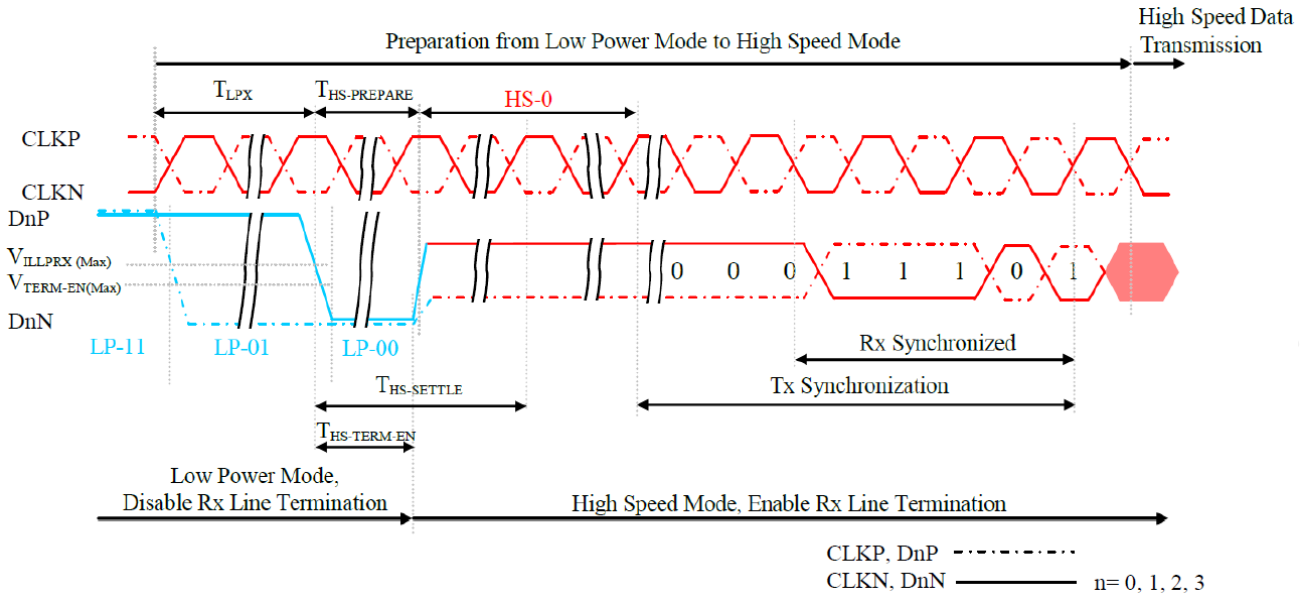
Description	Signal	Symbol	Min	Max	Unit
Length of LP-00, LP-01, LP-10 or LP-11 periods MCU ➔ Display Module (ILI9881C)	D0P/N	T_{LPXM}	50	75	ns
Length of LP-00, LP-01, LP-10 or LP-11 periods Display Module (ILI9881C) ➔ MCU	D0P/N	T_{LPXD}	50	75	ns
Time-out before the Display Module (ILI9881C) starts driving	D0P/N	$T_{TA-SURED}$	T_{LPXD}	2 x T_{LPXD}	ns

Low Power State Period Timings – B Table

Description	Signal	Symbol	Time	Unit
Time to drive LP-00 by Display Module (ILI9881C)	D0P/N	$T_{TA-GETD}$	5 x T_{LPXD}	ns
Time to drive LP-00 after turnaround request - MCU	D0P/N	T_{TA-GOD}	4 x T_{LPXD}	ns

3.6.5 Data Lanes from Low Power Mode to High Speed Mode

Data Lanes - Low Power Mode to High Speed Mode Timings

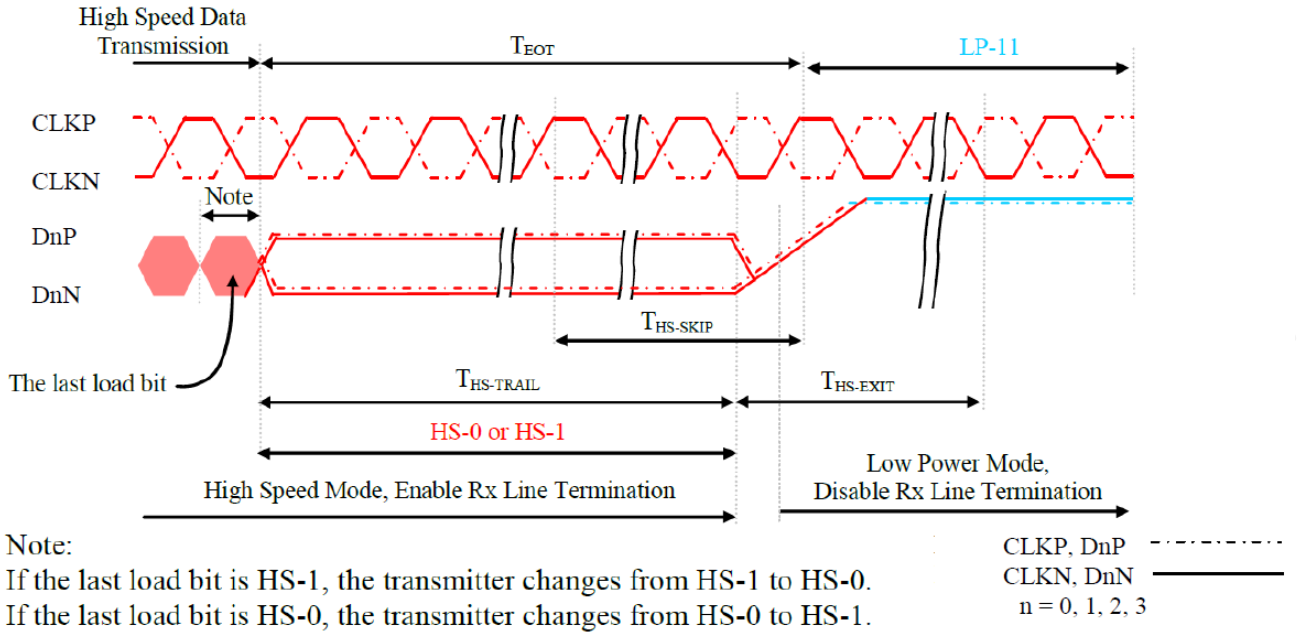


Data Lanes - Low Power Mode to High Speed Mode Timings Table

Description	Signal	Symbol	Min	Max	Unit
Length of any Low Power State Period	DnP/N, n = 0 and 1	T_{LPX}	50	-	ns
Time to drive LP-00 to prepare for HS Transmission	DnP/N, n = 0 and 1	$T_{HS-PREPARE}$	40 + 4 x UI	85 + 6 x UI	ns
Time to enable Data Lane Receiver line termination measured from when Dn crosses VILMAX	DnP/N, n = 0 and 1	$T_{HS-TERM-EN}$	-	35 + 4 x UI	ns

3.6.6 Data Lanes from High Power Mode to High Speed Mode

Data Lanes - High Speed Mode to Low Power Mode Timings



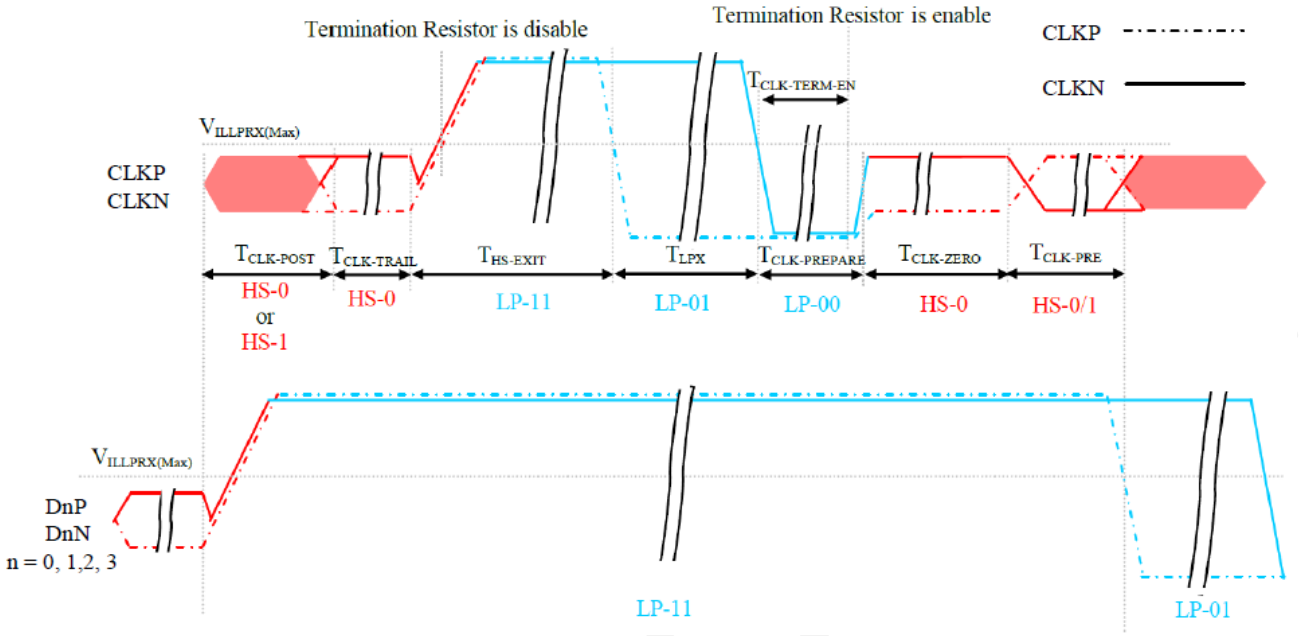
Note:
If the last load bit is HS-1, the transmitter changes from HS-1 to HS-0.
If the last load bit is HS-0, the transmitter changes from HS-0 to HS-1.

Data Lanes - High Speed Mode to Low Power Mode Timings Table

Description	Signal	Symbol	Min	Max	Unit
Time-Out at Display Module (ILI9881C) to ignore transition period of EoT	DnP/N, n = 0 and 1	$T_{HS-SKIP}$	40	55 + 4 x UI	ns
Time to driver LP-11 after HS burst	DnP/N, n = 0 and 1	$T_{HS-EXIT}$	100	-	ns

3.6.7 DSI Clock Burst – High Speed Mode to/from Low Power Mode

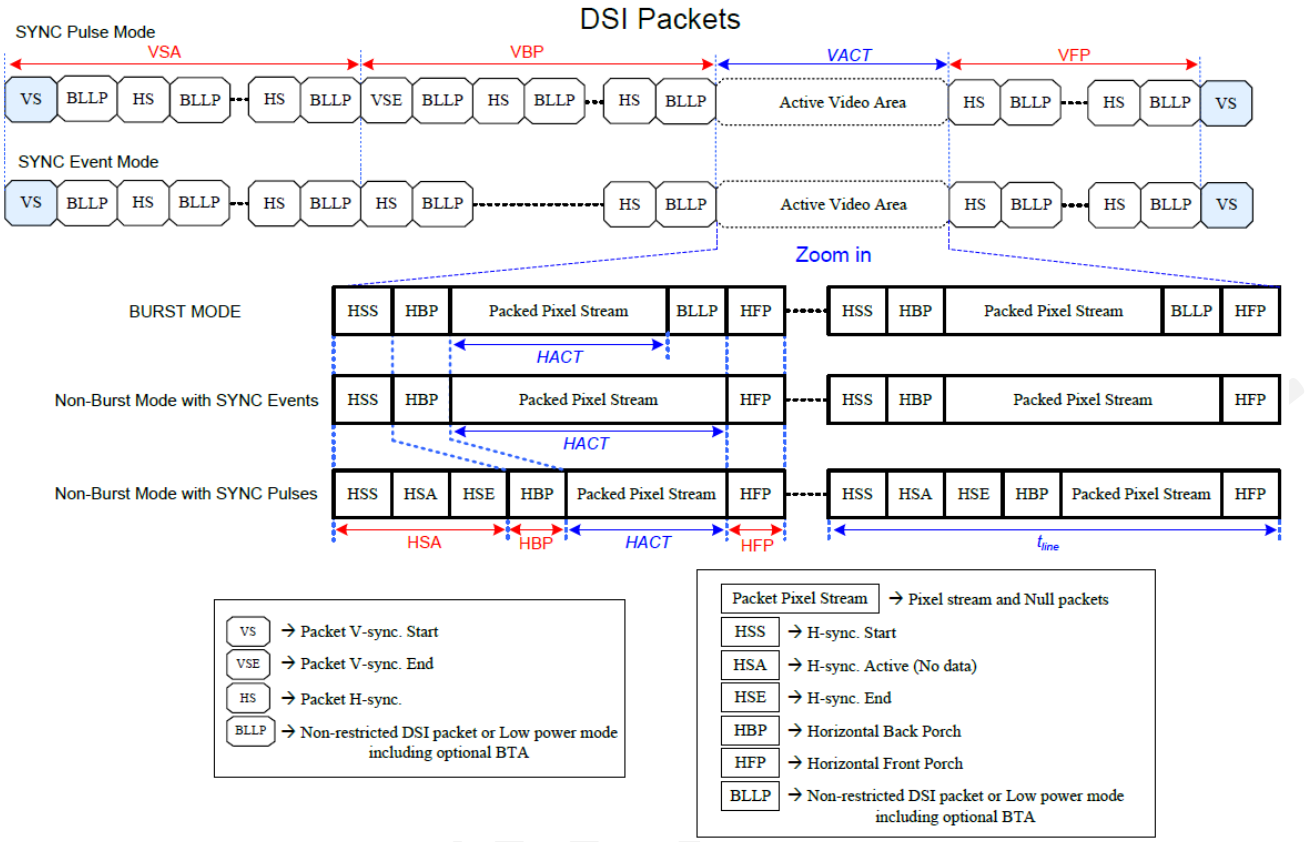
Clock Lanes - High Speed Mode to/from Low Power Mode Timings



Clock Lanes - High Speed Mode to/from Low Power Mode Timings Table

Description	Signal	Symbol	Min	Max	Unit
Time that the MCU shall continue sending HS clock after the last associated Data Lanes has transitioned to LP mode	CLKP/N	$T_{CLK-POST}$	60 + 52 x UI	-	ns
Time to drive HS differential state after last payload clock bit of a HS transmission burst	CLKP/N	$T_{CLK-TRAIL}$	60	-	ns
Time to drive LP-11 after HS burst	CLKP/N	$T_{HS-EXIT}$	100	-	ns
Time to drive LP-00 to prepare for HS transmission	CLKP/N	$T_{CLK-PREPARE}$	38	95	ns
Time-out at Clock Lane to enable HS termination	CLKP/N	$T_{CLK-TERM-EN}$	-	38	ns
Minimum lead HS-0 drive period before starting Clock	CLKP/N	$T_{CLK-PREPARE} + T_{CLK-ZERO}$	300	-	ns
Time that the HS clock shall be driven prior to any associated Data Lane beginning the transition from LP to HS mode	CLKP/N	$T_{CLK-PRE}$	8 x UI	-	ns

3.6.8 Timing for DSI video mode



Parameters	Symbols	Min.	Typ.	Max.	Units
Vertical sync. active	VSA	TBD	TBD	-	Line
Vertical Back Porch	VBP	TBD	TBD	-	Line
Vertical Front Porch	VFP	TBD	TBD	-	Line
Active lines per frame	VACT	-	1280	-	Line
Horizontal sync. active	HSA	TBD	TBD	-	Pixel
Horizontal Back Porch	HBP	TBD	TBD	-	Pixel
Horizontal Front Porch	HFP	TBD	TBD	-	Pixel
Active pixels per line	HACT	-	800	-	Pixel
Line time	t_{line}	TBD		-	bps/lane
Bit rate	BR_{bps}	200		Note 5	Line

1 UI=1/Bit rate

HAS(pixel)= (tHSA*lane number) / (UI* pixel format)

HBP(pixel)= (tHBP*lane number) / (UI* pixel format)

HFP(pixel)= (tHFP*lane number) / (UI* pixel format)

$$\text{Frame Rate} = \frac{BR_{bps} \times Lane_{num}}{(VACT+VSA+VBP+VFP) \times (HACT+HSA+HBP+HFP) \times \text{Pixel Format}}$$

Example: BR_{bps} = 457Mbps/lane, 1UI=2.1883ns, Frame rate=60Hz, VACT=1280, VSA=2, VBP=30, VFP=20, HACT=720, HSA=33, HBP=100, HFP=100, $Lane_{num}$=4(lane), Pixel Format=24(bit).

Note 1: $Lane_{num}$: Date lane of MIPI-DSI.

Note 2: Pixel Format: Please reference to “4.1DSI System Interface”.

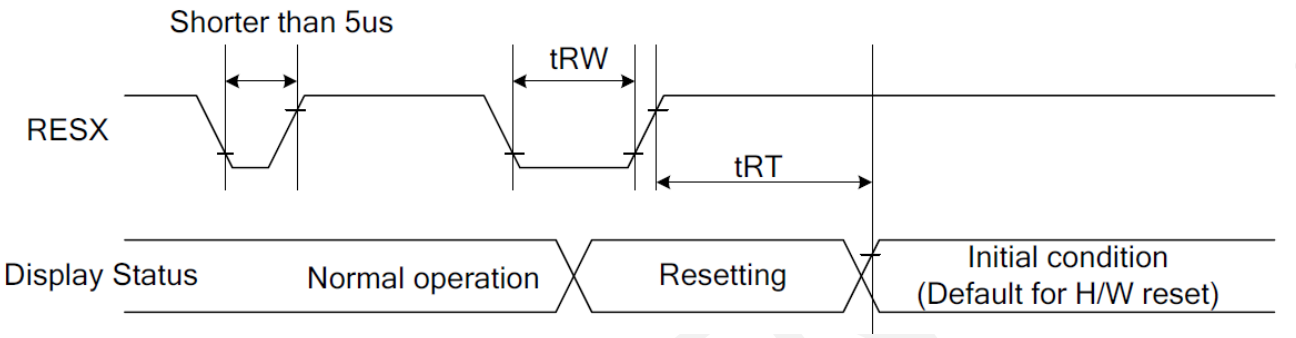
Note 3: The formula exists slightly error because of the host-transmission way.

Note 4: The best frame rate setting: 2 data lanes：50~60 Hz / 3 data lanes：50~70 Hz / 4 data lanes：50~70 Hz.

Note 5: Please reference to table of “Limited Clock Channel Speed” in 3.6.1

3.6.9 Reset input timing

Reset Timing



Reset Timing Table

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

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

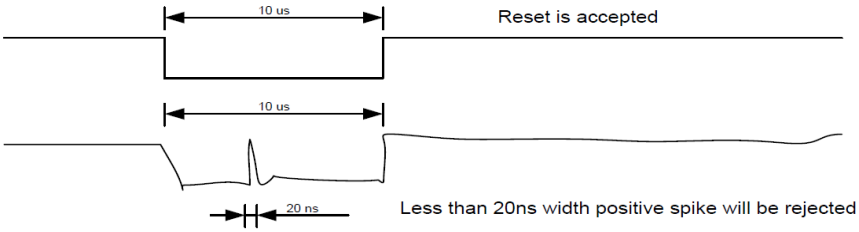
Note 2: Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to as below as table.

Reset Descript Table

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

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

Note 4: Spike Rejection can also be applied during a valid reset pulse, as shown below:



Note 5: When Reset applied during Sleep In Mode.

Note 6: When Reset applied during Sleep Out Mode.

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

4. Electrical Specification Touch

4.1 Electrical Characteristics

4.1.1 Absolute Maximum Ratings

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	VCC	2.66	3.47	V	-
Operating temperature	T_{OP}	-20	+70	℃	-
Storage temperature	T_{ST}	-30	+80	℃	-

4.1.2 DC Electrical Characteristics (Ta=25°C)

(Ambient temperature:25℃, AVDD=2.8V, VDDIO=1.8V or VDDIO=AVDD)

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Normal Mode Operating Current	-	-	8	14.5	mA	-
Green Mode Operating Current	-	-	3.3	-	mA	-
Sleep Mode Operating Current	-	70	-	120	uA	-
Doze Mode Operating Current	-	-	0.78	-	mA	-
Digital Input Low Voltage	VIL	-0.3	-	0.25*VDD	V	-
Digital Input High Voltage	VIH	0.75*VDD	-	VDD+0.3	V	-
Digital Output Low Voltage	VOL	-	-	0.15*VDD	V	-
Digital Output High Voltage	VOH	0.85*VDD	-	-	V	-

4.1.3 AC Electrical Characteristics (Ta=25°C)

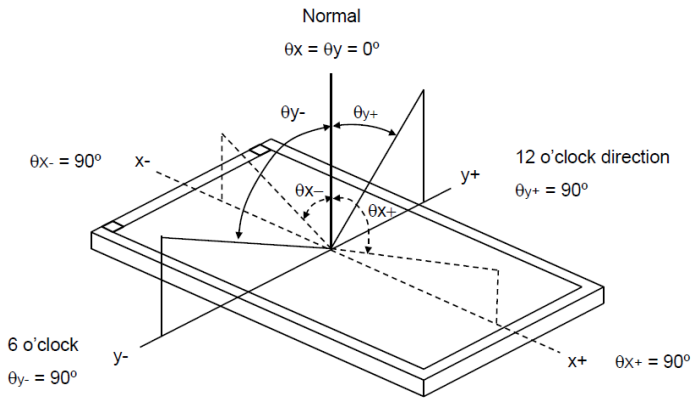
(Ambient temperature:25℃, AVDD=2.8V, VDDIO=1.8V)

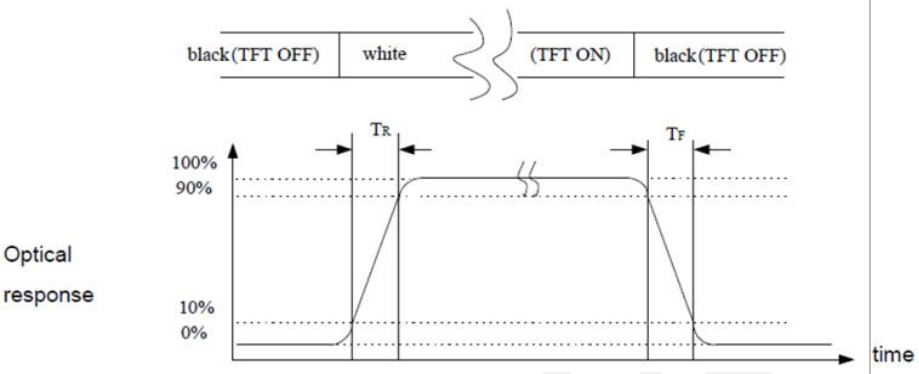
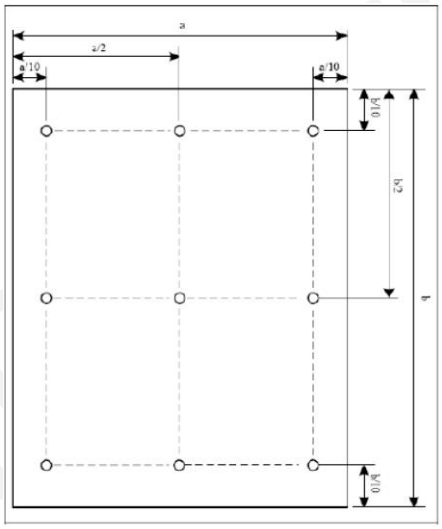
Item	Symbol	Min.	Typ.	Max.	Unit	Note
OSC Oscillation Frequency	-	59	60	61	MHz	-
I/O Output Rise Time, Low to High	-	-	14	-	ns	-
I/O Output Fall Time, High to Low	-	-	14	-	ns	-

5. Optical Specification

5.1 Optical Characteristics

Characteristics		Symbol	Conditions	Min	Typ	Max	Unit	Note
Contrast Ratio		CR	θ = 0° Normal viewing angle	640	800	-	-	2
Response time		TR + TF		-	30	40	ms	3
Viewing Angle	Left	θ_{x-}	CR>10	-	80	-	deg	1
	Right	θ_{x+}		-	80	-		
	Up	θ_{Y+}		-	80	-		
	Down	θ_{Y-}		-	80	-		
Colour Chromaticity	Red	Rx	θ = 0° Normal viewing angle	0.5639	0.6039	0.6439	-	CF glass
		Ry		0.3143	0.3543	0.3943		
	Green	Gx		0.324	0.364	0.404		
		Gy		0.5494	0.5894	0.6294		
	Blue	Bx		0.1107	0.1507	0.1907		
		By		0.0639	0.1039	0.1439		
	White	Wx		0.293	0.333	0.373		
		Wy		0.330	0.370	0.410		
Luminance		Lv	I_F = 40mA	380	420	-	cd/m^2	4
Uniformity		Avg	-	80	-	-	%	4

Note	Item	Test method
1	Definition of Viewing Angle (θx, θy)	

Note	Item	Test method
2	Definition of Contrast Ratio (CR)	Contrast ratio (CR) = $\frac{\text{Luminance measured when LCD is at "white state"}}{\text{Luminance measured when LCD is at "black state"}}$
3	Definition of Response Time (T_R, T_F)	
4	Definition of Luminance Uniformity	 $\text{Uniformity} = \frac{\text{minimum luminance in 9 points (1-9)}}{\text{maximum luminance in 9 points (1-9)}}$ $\text{Luminance} = \frac{\text{Total Luminance of 9 points}}{9}$

6. LED Backlight Specification

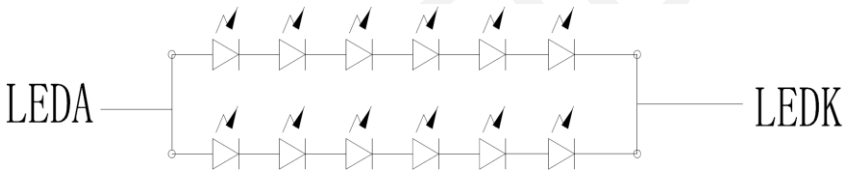
6.1 LED Backlight Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit	Note
Forward Current	I_F	-	30	40	-	mA	-
Forward Voltage	V_F	-	-	19.2	-	V	-
LED Life Time	Hr	-	-	50000	-	Hour	1, 2

Note 1: LED life time (Hr) can be defined as the time in which it continues to operate under the condition: Ta=25±3℃, typical IL (I_F) value indicated in the above table until the brightness becomes less than 50%.

Note 2: The "LED life time" is defined as the module brightness decreases to 50% original brightness at Ta=25℃ and IL=40mA. The LED lifetime could be decreased if operating IL is larger than 40mA. The constant current driving method is suggested.

6.2 INTERNAL CIRCUIT DIAGRAM



CIRCUIT DIAGRAM

7. Packaging

TBD

8. Quality Assurance Specification

8.1 Conformity

The performance, function and reliability of the shipped products conform to the Product Specification.

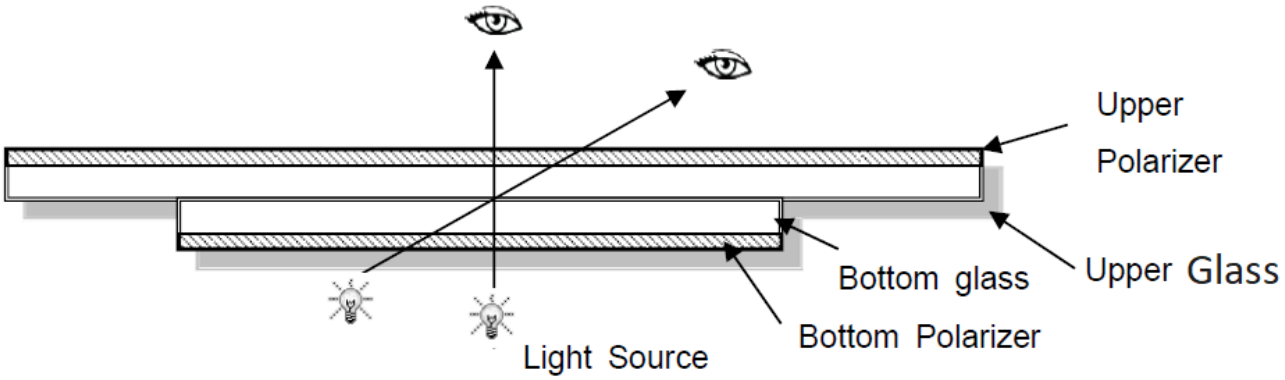
8.2 Environment Required

Customer's test & measurement are required to be conducted under the following conditions:

Temperature:	25 ± 5°C
Humidity:	65% ± 10% RH
Viewing Angle:	Normal Viewing Angle
Illumination:	Single fluorescent lamp (300 to 700 Lux)
Viewing distance:	30 - 50cm

Finger glove (or finger cover) must be worn by the inspector.

Inspection table or jig must be anti-electrostatic.

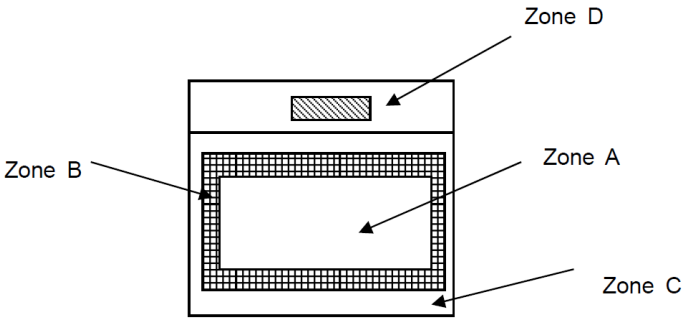


8.3 Delivery Assurance

8.3.1 Delivery Inspection Standards

Class II, Normal Inspection, MIL-STD-105E

8.3.2 Zone Definition



Zone A: Effective Viewing Area (Character or Digit can be seen)

Zone B: Viewing Area except Zone A

Zone C: Outside (Zone A + Zone B) Area which cannot be seen after assembly by customer.

Zone D: IC Bonding Area

Note: Generally, visual defects in Zone C can be ignored when it doesn't affect product function or appearance after assembly by customer

8.3.3 Criteria & Acceptable Quality Level

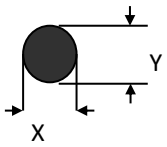
Partition	AQL	Definition
Major	0.65	Defects in Pattern Check (Display On)
Minor	1.5	Defects in Cosmetic Check (Display Off)

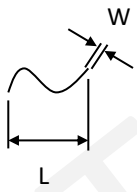
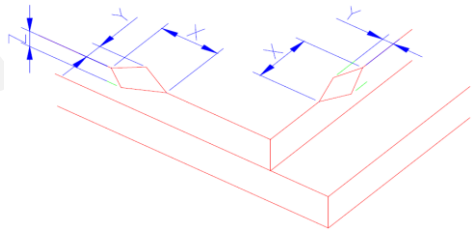
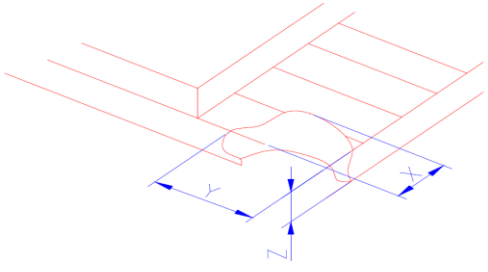
LCD: Liquid Crystal Display, TP: Touch Panel, LCM: Liquid Crystal Module

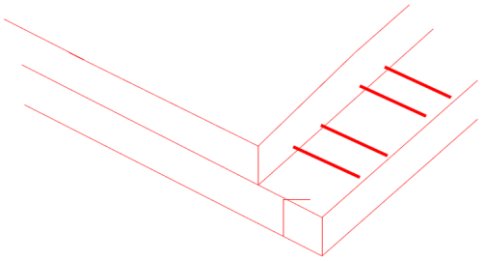
No.	Items	Criteria	Classification of defects
1	Functional defects	1) No display, open or miss line 2) Display abnormally 3) Backlight no lighting, abnormal lighting. 4) TP no function	Major
2	Missing	Missing component	
3	Outline dimension	Overall outline dimension beyond the drawing is not allowed	
4	Color tone	Color unevenness, refer to limited sample	Minor
5	Spot Line defect	Light dot, Dim spot, Polarizer Bubble; Polarizer accidented spot.	
6	Soldering Appearance	Good soldering, Peeling off is not allowed.	
7	LCD/Polarizer/TP	Black/White spot/line, scratch, crack, etc.	

8.3.4 Criteria & Classification

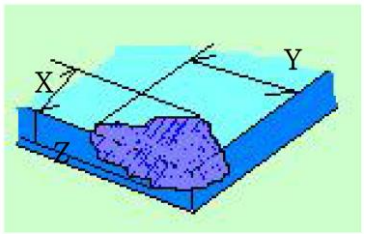
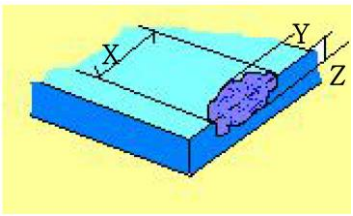
Units: mm

<table>
<tr><th>Class</th><th>Item</th><th colspan="4">Criteria</th></tr>
<tr><td rowspan="20">Minor</td><td rowspan="20">Spot Defect</td><td colspan="4">Round type: as per following drawing, ∅ = (X+Y)/2  </td></tr>
<tr><td colspan="4">1) Light Dot (LCD/TP/Polarizer black/white spot, light dot, pinhole, dent, stain)</td></tr>
<tr><td rowspan="2">Size\Zone</td><td colspan="3">Acceptable Quantity</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>∅≤0.10</td><td colspan="2">Ignore</td><td rowspan="4">Ignore</td></tr>
<tr><td>0.10<∅≤0.25</td><td colspan="2">4 (distance ≧ 10mm)</td></tr>
<tr><td>0.25<∅≤0.35</td><td colspan="2">3</td></tr>
<tr><td>0.4<∅</td><td colspan="2">0</td></tr>
<tr><td colspan="4">2) Dim Spot (LCD/TP/Polarizer dim dot, light leakage, dark spot)</td></tr>
<tr><td rowspan="2">Size\Zone</td><td colspan="3">Acceptable Quantity</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>∅≤0.10</td><td colspan="2">Ignore</td><td rowspan="4">Ignore</td></tr>
<tr><td>0.10<∅≤0.25</td><td colspan="2">4 (distance ≧ 10mm)</td></tr>
<tr><td>0.25<∅≤0.35</td><td colspan="2">3</td></tr>
<tr><td>0.4<∅</td><td colspan="2">0</td></tr>
<tr><td colspan="4">3) Polarizer Accidented Spot</td></tr>
<tr><td rowspan="2">Size\Zone</td><td colspan="3">Acceptable Quantity</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>∅≤0.2</td><td colspan="2">Ignore</td><td rowspan="3">Ignore</td></tr>
<tr><td>0.3<∅≤0.5</td><td colspan="2">3 (distance ≧ 10mm)</td></tr>
<tr><td>0.5<∅</td><td colspan="2">TBD</td></tr>
<tr><td colspan="4">4) Pixel Bad Points (light dot, dim dot, colour dot)</td></tr>
<tr><td rowspan="2">Size\Zone</td><td colspan="3">Acceptable Quantity</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>∅≤0.15</td><td>Ignore</td><td colspan="2" rowspan="3">Ignore</td></tr>
<tr><td>0.2<∅≤0.3</td><td>2 (distance ≧ 10mm)</td></tr>
<tr><td>0.4<∅</td><td>TBD</td></tr>
</table>

<table>
<tr><th>Class</th><th>Item</th><th colspan="6">Criteria</th></tr>
<tr><td rowspan="6"></td><td rowspan="6"></td><td colspan="6">5) Polarizer Bubble</td></tr>
<tr><td rowspan="2">Size\Zone</td><td colspan="5">Acceptable Quantity</td></tr>
<tr><td colspan="2">A</td><td>B</td><td colspan="2">C</td></tr>
<tr><td>∅≤0.20</td><td colspan="3">Ignore</td><td colspan="2" rowspan="4">Ignore</td></tr>
<tr><td>0.3<∅≤0.4</td><td colspan="3">4 (distance ≧ 10mm)</td></tr>
<tr><td>0.4<∅≤0.5</td><td colspan="3">3</td></tr>
<tr><td>0.5<∅</td><td colspan="3">TBD</td></tr>
<tr><td rowspan="6">Minor</td><td rowspan="6">Line Defect
(LCD/TP/
Polarizer
backlight
black/white line,
scratch, stain)</td><td colspan="6">Line type: as per following drawing  </td></tr>
<tr><td rowspan="2">Width</td><td rowspan="2">Length</td><td colspan="3">Acceptable quantity</td></tr>
<tr><td>A</td><td>B</td><td>C</td></tr>
<tr><td>W≤0.05</td><td>Ignore</td><td colspan="2">Ignore</td><td rowspan="3">Ignore</td></tr>
<tr><td>0.05<W≤0.06</td><td>L ≤ 4.0</td><td colspan="2">N ≤ 3</td></tr>
<tr><td>0.07<W≤0.08</td><td>L ≤ 3.0</td><td colspan="2">N ≤ 2</td></tr>
<tr><td>0.08<W</td><td colspan="5">Define as spot defect</td></tr>
<tr><td>Minor</td><td>LCD
Crack/Broken</td><td colspan="6">Symbols:
X: Length, Y: Width, Z: Height, L: Length of ITO, T: Height of LCD
1) The edge of LCD broken: X≦3.0mm; Y<Inner border line of the seal; Z≦T
 
2) LCD corner broken: X≦3.0mm; Y≦L; Z≦T
  </td></tr>
</table>

Class	Item	Criteria
Major	LCD Crack	The LCD with extensive crack is not acceptable. 
Major	Electronic Components SMT	Not allow missing parts, solderless connection, cold solder joint, mismatch, The positive and negative polarity opposite
Minor	Display colour & Brightness	1) Colour: Measuring the colour coordinates in accordance with the datasheet or samples. 2) Brightness: Measuring the brightness of white screen in accordance with the datasheet or samples.

Class	Item	Criteria				
Minor	CTP Related	1) CTP Cover Sensor Accidented Black/White Spot				
		Size\Zone	Acceptable Qty			
			A	B	C	
		∅≤0.1	Ignore		Ignore	
		0.15<∅≤0.25	4（distance≧10mm）			
		0.25<∅≤0.35	3			
		0.4<∅	TBD			
		2) CTP Cover Scratch				
		Width	Length	Acceptable Qty		
				A	B	C
		Φ≤0.05	Ignore	Ignore		
		0.05<W≤0.06	L≤4.0	N≤3		
		0.07<W≤0.08	L≤3.0	N≤2		
		0.08<W	Define as spot defect			
		3) CTP Cover Pinhole / Lack of ink				
		Size\Zone	Acceptable Qty			
			C			

<table>
<tr><th>Class</th><th>Item</th><th colspan="3">Criteria</th></tr>
<tr><td rowspan="13"></td><td rowspan="13"></td><td>∅≤0.2</td><td colspan="2">Ignore</td></tr>
<tr><td>0.2<∅≤0.3</td><td colspan="2">4 (distance ≧ 10mm)</td></tr>
<tr><td>0.3<∅≤0.4</td><td colspan="2">3</td></tr>
<tr><td>0.4<∅</td><td colspan="2">0</td></tr>
<tr><td colspan="3">4) CTP Bonding Bubble / Accidented Spot</td></tr>
<tr><td rowspan="2">Size\Zone</td><td colspan="2">Acceptable Qty</td></tr>
<tr><td>A</td><td>B</td></tr>
<tr><td>∅≤0.1</td><td colspan="2">Ignore</td></tr>
<tr><td>0.15<∅≤0.2</td><td colspan="2">3 (distance≧10mm）</td></tr>
<tr><td>0.2<∅≤0.25</td><td colspan="2">2</td></tr>
<tr><td>0.25<∅</td><td colspan="2">0</td></tr>
<tr><td colspan="3">Assembly Deflection: beyond the edge of backlight ≤0.2mm</td></tr>
<tr><td rowspan="2">Minor</td><td rowspan="2">CTP Related</td><td colspan="3">TP cover broken X: length, Y: width, Z: height
X≤0.5mm; Y≤0.5mm; Z<Cover thickness
*Circuitry broken is not allowed.
  </td></tr>
<tr><td colspan="3">TP cover broken X: length, Y: width, Z: height
X≤0.3mm; Y≤0.3mm; Z<LCD thickness
*Circuitry broken is not allowed.
  </td></tr>
</table>

Criteria (functional items)

No.	Item	Criteria
1	No display	Not allowed
2	Missing segment	
3	Short	
4	Backlight no lighting	
5	TP no function	

8.4 Dealing with Customer Complaints

8.4.1 Non-conforming Analysis

Purchaser should supply Densitron with detailed data of non-conforming sample.

After accepting it, Densitron should complete the analysis in two weeks from receiving the sample.
If the analysis cannot be completed on time, Densitron must inform the purchaser.

8.4.2 Handling of Non-conforming Displays

If any non-conforming displays are found during customer acceptance inspection which Densitron is clearly responsible for, return them to Densitron.
Both Densitron and customer should analyse the reason and discuss the handling of non-conforming displays when the reason is not clear.
Equally, both sides should discuss and come to agreement for issues pertaining to modification of Densitron quality assurance standard.

9. Reliability Specification

9.1 Reliability Tests

Test Item	Test Condition	Sample Size	Test Result	Note
Low Temperature Operation	-20°C, 96 hrs	3ea	Pass	-
High Temperature Storage	80°C, 96 hrs	3ea	Pass	-
Low Temperature Storage	-30°C, 96 hrs	3ea	Pass	-
Thermal Humidity Operating Life test	70℃, 90％RH, 96HR	3ea	Pass	-
Temperature Cycle ON/OFF test	-20℃ ↔ 70℃, ON/OFF, 20CYC	3ea	Pass	1
Thermal Shock Resistance	The sample should be allowed to stand the following 5 cycles of operation: TSTL for 30 minutes -> normal temperature for 5 minutes -> TSTH for 30 minutes -> normal temperature for 5 minutes, as one cycle, then taking it out and drying it at normal temperature, and allowing it stand for 24 hours	3ea	Pass	-
ESD test	150pF, 330Ω , ±6KV(Contact)/± 8KV(Air), 5 points/panel, 10 times/point	3ea	Pass	-
Box Drop Test	1 Corner 3 Edges 6 faces, 66 cm (MEDIUM BOX)	1box	Pass	-

Note 1: ON Time over 10 seconds, OFF Time under 10 seconds

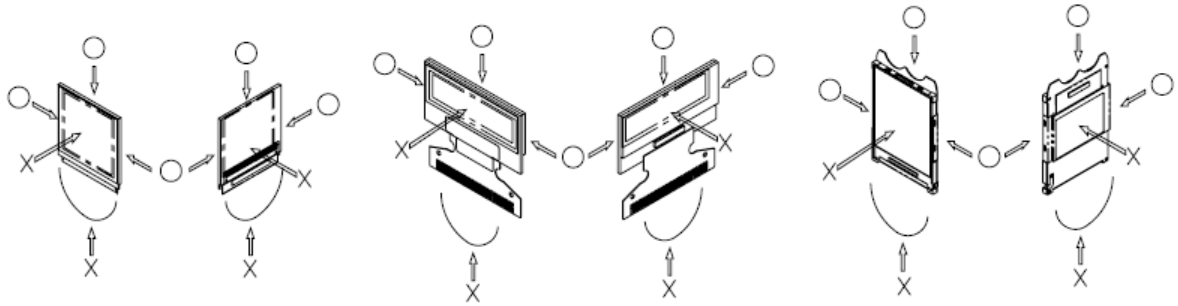
9.1.1 Inspection Check Standard

After the completion of the described reliability test, the samples are to be left at room temperature for 4 hrs prior to conducting the inspection check at 23±5 °C, 55±15% RH.

10. Handling Precautions

10.1 Handling Precautions

1) Since the display panel is being made of glass, do not apply mechanical impacts such us dropping from a high position.
2) If the display panel is broken by some accident and the internal organic substance leaks out, be careful not to inhale nor lick the organic substance.
3) If the liquid crystal touches your skin or clothes, wash it off immediately using soap and plenty of water
4) If pressure is applied to the display surface or its neighbourhood of the display module, the cell structure may be damaged and be careful not to apply pressure to these sections.
5) The polarizer covering the surface of the display module is soft and easily scratched. Please be careful when handling the display module.
6) When the surface of the polarizer of the display module has soil, clean the surface. It takes advantage of by using following adhesion tape.
   a. Scotch Mending Tape No. 810 or an equivalent
   b. Never try to breathe upon the soiled surface nor wipe the surface using cloth containing solvent such as ethyl alcohol, since the surface of the polarizer will become cloudy.
   c. Also, pay attention that the following liquid and solvent may spoil the polarizer:
      - Water
      - Ketone
      - Aromatic Solvents
7) Hold the display module very carefully when placing it into the system housing. Do not apply excessive stress or pressure to display module. And, do not over bend the film with electrode pattern layouts. These stresses will



influence the display performance. Also, secure sufficient rigidity for the outer cases.
8) Do not apply stress to the LSI chips and the surrounding molded sections.
9) Do not disassemble nor modify the display module.
10) Do not apply input signals while the logic power is off.
11) Pay sufficient attention to the working environments when handing display modules to prevent occurrence of element breakage accidents by static electricity.

a. Be sure to make human body grounding when handling display modules.
b. Be sure to ground tools to use or assembly such as soldering irons.
c. To suppress generation of static electricity, avoid carrying out assembly work under dry environments.
d. Protective film is being applied to the surface of the display panel of the display module. Be careful since static electricity may be generated when exfoliating the protective film.

12) Protection film is being applied to the surface of the display panel and removes the protection film before assembling it. If the display module has been stored for a long period of time, residue adhesive material of the protection film may remain on the surface of the display panel after removed of the film. In such case, remove the residue material by the method introduced in the above Section 5).
13) If electric current is applied when the display module is being dewed or when it is placed under high humidity environments, the electrodes may be corroded and be careful to avoid the above.

10.2 Storage Precautions

1) When storing display modules, put them in static electricity preventive bags avoiding exposure to direct sun light nor to lights of fluorescent lamps, etc. and, also, avoiding high temperature and high humidity environments or low temperature (less than 0°C) environments. (We recommend you to store these modules in the packaged state when they were shipped from Densitron) At that time, be careful not to let water drops adhere to the packages or bags nor let dewing occur with them.
2) If electric current is applied when water drops are adhering to the surface of the display module, when the display module is being dewed or when it is placed under high humidity environments, the electrodes may be corroded and be careful about the above.

10.3 Designing Precautions

1) The absolute maximum ratings are the ratings which cannot be exceeded for display module, and if these values are exceeded, panel damage may be happen.
2) To prevent occurrence of malfunctioning by noise, pay attention to satisfy the VIL and VIH specifications and, at the same time, to make the signal line cable as short as possible.
3) We recommend you to install excess current preventive unit (fuses, etc.) to the power circuit (VDD). (Recommend value: 0.5A)
4) Pay sufficient attention to avoid occurrence of mutual noise interference with the neighbouring devices.
5) As for EMI, take necessary measures on the equipment side basically.
6) When fastening the display module, fasten the external plastic housing section.
7) If power supply to the display module is forcibly shut down by such errors as taking out the main battery while the display panel is in operation, we cannot guarantee the quality of this display module.

10.4 Operation Precautions

1) It is indispensable to drive the display within the specified voltage limit since excessive voltage shortens its life.
2) Direct current causes an electrochemical reaction with remarkable deterioration of the display quality. Give careful consideration to prevent direct current during ON/OFF timing and during operation.
3) Response time is extremely delayed at temperatures lower than the operating temperature range while, at high temperatures, displays become dark. However, this phenomenon is reversible and does not mean a malfunction or a display that has been permanently damaged.
4) To protect display modules from performance drops by static electricity rapture, etc., do not touch the following sections whenever possible while handling the display modules.
   a. Pins and electrodes
   b. Pattern layouts such as the FPC
5) When the driver is being exposed (COG), semiconductor elements change their characteristics when light is radiated according to the principle of the solar battery. Consequently, if the driver is exposed to light, malfunctioning may occur.
   a. Design the product and installation method so that the driver may be shielded from light in actual usage.
   b. Design the product and installation method so that the driver may be shielded from light during the inspection processes.
6) Although the display module stores the operation state data by the commands and the indication data, when excessive external noise, etc. enters into the module, the internal status may be changed. It therefore is necessary to take appropriate measures to suppress noise generation or to protect from influences of noise on the system design.
7) We recommend you to construct its software to make periodical refreshment of the operation statuses (re-setting of the commands and re-transference of the display data) to cope with catastrophic noise.

10.5 Other Precautions

1) Request the qualified companies to handle industrial wastes when disposing of the display modules. Or, when burning them, be sure to observe the environmental and hygienic laws and regulations.