



**RAYSTAR**

# 曜凌光電股份有限公司

住址: 42878 台中市大雅区科雅路 25 號 5F WEB: <http://www.Raystar-Optronics.com>  
5F., No.25, Keya Rd., Daya Dist., Taichung E-mail: [sales@raystar-optronics.com](mailto:sales@raystar-optronics.com)  
City 428, Taiwan Tel:886-4-2565-0761 Fax : 886-4-2565-0760

## RF3500D-AYH-MNN

---

### SPECIFICATION

CUSTOMER:

|             |  |
|-------------|--|
| APPROVED BY |  |
| PCB VERSION |  |
| DATE        |  |

FOR CUSTOMER USE ONLY

| SALES BY | APPROVED BY | CHECKED BY | PREPARED BY |
|----------|-------------|------------|-------------|
|          |             |            |             |

Release DATE:

## Revision History

| VERSION | DATE                     | REVISED PAGE NO. | Note                                          |
|---------|--------------------------|------------------|-----------------------------------------------|
| 0<br>A  | 2019/03/07<br>2020/04/01 |                  | First issue<br>TFT Interface:<br>4-Lanes MIPI |

# Contents

1.Module Classification Information

2.Summary

3.General Specification

4.Interface

5.Contour Drawing

6.Absolute Maximum Ratings

7.Electrical Characteristics

8.DC Characteristics

9.AC Characteristics

10. Waveform

11.Optical Characteristics

12.Reliability

13.Other

# 1.Module Classification Information

|          |          |          |           |           |          |          |          |          |          |          |          |          |
|----------|----------|----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|----------|
| <b>R</b> | <b>F</b> | <b>3</b> | <b>50</b> | <b>0D</b> | <b>-</b> | <b>A</b> | <b>Y</b> | <b>H</b> | <b>-</b> | <b>M</b> | <b>N</b> | <b>N</b> |
| 1        | 2        | 3        | 4         | 5         | -        | 6        | 7        | 8        | -        | 9        | 10       | 11       |

| Item | Description                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                      |                           |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|---------------------------|
| 1    | R : Raystar Optronics Inc.                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                      |                           |
| 2    | Display Type : F→TFT Type, J→ Custom TFT                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                      |                           |
| 3    | Solution: A: 128x160    B:320x234    C:320x240    D:480x234    E:480x272<br>F:800x480    G:640x480    H:1024x600    I:320x480    J:240x320<br>K:1280x800    L:240x400    M:1024x768    N:128x128    O:480x800<br>P:640x320    Q:800x600    S:480x128    T:800x320    Y: 1920 x 720<br>8: 480 x 1920    7: 1280 x 480    6: 1280 x 320    5:1366 x 768    4:1920 x 1200<br>3: 720 x 1280    2: 1024 x 324 |                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                      |                           |
| 4    | Display Size : 5.0” TFT                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                      |                           |
| 5    | Version Code.                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                      |                           |
| 6    | Model Type:<br>A : TFT LCD<br>E : TFT+FR+CONTROL BOARD<br>J : TFT+FR+A/D BOARD<br>N : TFT+FR+A/D BOARD+CONTROL BOARD<br>S : TFT+FR+POWER BOARD (DC TO DC)                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                            | 6 : TFT+FR<br>H : TFT+D/V BOARD<br>I : TFT+FR+D/V BOARD<br>B : TFT+POWER BD<br>1 : TFT+CONTROL BOARD |                           |
| 7    | Polarizer Type,<br>Temperature range,<br>View direction                                                                                                                                                                                                                                                                                                                                                  | I→Transmissive, W. T, 6:00 ;    C→Transmissive, N. T, 6:00<br>L→Transmissive, W.T,12:00 ;    F→Transmissive, N.T,12:00<br>Y→Transmissive,W.T, IPS TFT ; W→Transmissive, Super W.T, IPS TFT<br>A→Transmissive, N.T, IPS TFT;    Z→Transmissive, W.T, O-TFT<br>R→Transmissive, Super W.T, O-TFT<br>N→Transmissive, Super W.T, 6:00;<br>Q→Transmissive, Super W.T, 12:00<br>V→Transmissive, Super W.T, VA TFT |                                                                                                      |                           |
| 8    | Backlight                                                                                                                                                                                                                                                                                                                                                                                                | W : LED, White                                                                                                                                                                                                                                                                                                                                                                                             | F : CCFL, White                                                                                      | H : LED, High Light White |
| 9    | Driver Method                                                                                                                                                                                                                                                                                                                                                                                            | D: Digital    A: Analog    L : LVDS    M:MIPI                                                                                                                                                                                                                                                                                                                                                              |                                                                                                      |                           |
| 10   | Interface                                                                                                                                                                                                                                                                                                                                                                                                | N : without control board    A : 8Bit    B: 16Bit    H: HDMI<br>S:SPI Interface    R: RS232    U:USB    I: I2C                                                                                                                                                                                                                                                                                             |                                                                                                      |                           |
| 11   | TS                                                                                                                                                                                                                                                                                                                                                                                                       | N : Without TS    S : resistive touch panel<br>C : capacitive touch panel capacitive touch panel (G-F-F)<br>G : capacitive touch panel(G-G)                                                                                                                                                                                                                                                                |                                                                                                      |                           |

## 2.Summary

TFT 5.0" is a color active matrix thin film transistor (TFT) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching device. This TFT LCD has a 4.99 (16:9) inch diagonally measured active display area with HD (720 horizontal by 1280 vertical pixel) resolution. This module is composed of a TFT\_LCD module and follows RoHs.

RAYSTAR OPTRONICS

---

### 3.General Specifications

- Size: 5.0 inch
- Dot Matrix: 720× 3(RGB) ×1280 dots
- Module dimension: 68.4 (W) × 122.7 (H) ×4.15 mm
- Active area: 62.1 (W) × 110.4 (H) mm
- Dot pitch: 0.08625(W) ×0.08625(H) mm
- LCD type: TFT, Normally Black, Transmissive
- Viewing angle: 80/80/80/80
- TFT Drive IC: ILI9881C or Equivalent
- TFT Interface: 4-Lanes MIPI
- Aspect Ratio: 16:9
- Backlight Type: LED ,Normally White
- With /Without TP: Without TP
- Surface: Glare

\*Color tone slight changed by temperature and driving voltage.

## 4.Interface

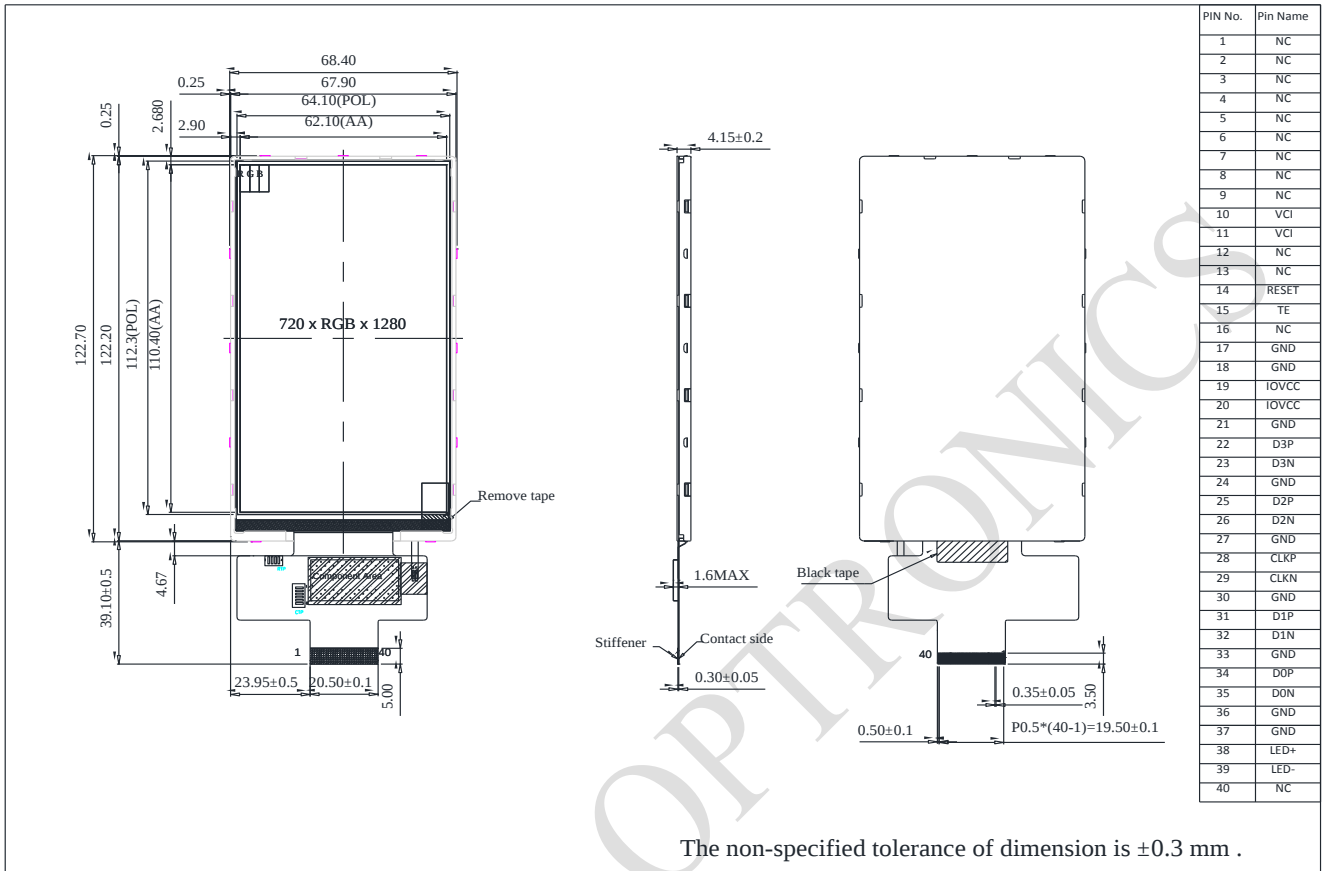
### 4.1. LCM PIN Definition

| Pin   | Symbol | Function                                                                                                                                                            | Remark |
|-------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| 1-9   | NC     | No connection                                                                                                                                                       |        |
| 10-11 | VCI    | Power supply for analog circuits. Connect to an external power supply of 2.5V to 3.6V                                                                               |        |
| 12-13 | NC     | No connection                                                                                                                                                       |        |
| 14    | RESET  | The external reset input<br>Initializes the chip with a low input. Be sure to execute a power-on reset after supplying power.<br>Fix to VDDI level when not in use. |        |
| 15    | TE     | Tearing effect output pin.<br>Leave the pin open when not in use.                                                                                                   |        |
| 16    | NC     | No connection                                                                                                                                                       |        |
| 17-18 | GND    | Power ground                                                                                                                                                        |        |
| 19-20 | IOVCC  | Power supply for analog circuits. Connect to an external power supply of 1.65V to 3.6V                                                                              |        |
| 21    | GND    | Power ground                                                                                                                                                        |        |
| 22    | D3P    | MIPI DSI differential data pair. (Data lane 3)                                                                                                                      |        |
| 23    | D3N    |                                                                                                                                                                     |        |
| 24    | GND    | Power ground                                                                                                                                                        |        |
| 25    | D2P    | MIPI DSI differential data pair. (Data lane 2)                                                                                                                      |        |
| 26    | D2N    |                                                                                                                                                                     |        |
| 27    | GND    | Power ground                                                                                                                                                        |        |
| 28    | CLKP   | MIPI DSI differential clock pair                                                                                                                                    |        |
| 29    | CLKN   |                                                                                                                                                                     |        |
| 30    | GND    | Power ground                                                                                                                                                        |        |
| 31    | D1P    | MIPI DSI differential data pair. (Data lane 1)                                                                                                                      |        |
| 32    | D1N    |                                                                                                                                                                     |        |
| 33    | GND    | Power ground                                                                                                                                                        |        |
| 34    | D0P    | MIPI DSI differential data pair. (Data lane 0)                                                                                                                      |        |
| 35    | D0N    |                                                                                                                                                                     |        |
| 36-37 | GND    | Power ground                                                                                                                                                        |        |
| 38    | LED+   | Power for LED backlight anode                                                                                                                                       |        |
| 39    | LED-   | Power for LED backlight cathode                                                                                                                                     |        |

|    |    |               |  |
|----|----|---------------|--|
| 40 | NC | No connection |  |
|----|----|---------------|--|

RAYSTAR OPTRONICS

## 5. Contour Drawing



## 6. Absolute Maximum Ratings

| Item                  | Symbol | Min | Typ | Max | Unit |
|-----------------------|--------|-----|-----|-----|------|
| Operating Temperature | TOP    | -20 | —   | +70 | °C   |
| Storage Temperature   | TST    | -30 | —   | +80 | °C   |

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

1. Temp.  $\leq 60^{\circ}\text{C}$ , 90% RH MAX. Temp.  $> 60^{\circ}\text{C}$ , Absolute humidity shall be less than 90% RH at  $60^{\circ}\text{C}$

## 7. Electrical Characteristics

### 7.1. Typical Operation Conditions

| Item                            | Symbol | Values |      |      | Unit | Remark   |
|---------------------------------|--------|--------|------|------|------|----------|
|                                 |        | Min.   | Typ. | Max. |      |          |
| Power supply for analog circuit | VCI    | 2.5    | 3.3  | 3.6  | V    |          |
| Power supply for logic circuit  | IOVCC  | 1.65   | 1.8  | 3.6  | V    |          |
| Current for Driver              | IDD    | -      | 44   | -    | mA   | VDD=3.3V |

### 7.2. Backlight Driving Conditions

| Parameter     | Symbol            | Min.   | Typ. | Max. | Unit | Remark     |
|---------------|-------------------|--------|------|------|------|------------|
| LED current   | I <sub>LED</sub>  | -      | 150  | -    | mA   |            |
| LED voltage   | V <sub>LED+</sub> | 18.2   | 21   | 23.8 | V    | Note 1     |
| LED Life Time |                   | 50,000 | -    | -    | Hr   | Note 2,3,4 |

Note 1 : There are 1 Groups LED



### B/L CIRCUIT DIAGRAM

Note 2 : T<sub>a</sub> = 25 °C

Note 3 : Brightness to be decreased to 50% of the initial value

Note 4 : The single LED lamp case

## 8.DC CHARATERISTICS

### 8.1. Basic Characteristics for Panel Driving

| Parameter                            | Symbol   | Rating            |     |                   | Unit | Condition         | Note  |
|--------------------------------------|----------|-------------------|-----|-------------------|------|-------------------|-------|
|                                      |          | Min               | Typ | Max               |      |                   |       |
| Logic Low level input voltage        | $V_{IL}$ | -0.3              | -   | $0.3 \cdot IOVCC$ | V    |                   | Note1 |
| Logic High level input voltage       | $V_{IH}$ | $0.7 \cdot IOVCC$ | -   | $IOVCC$           | V    |                   | Note1 |
| Logic Low level output voltage (TE)  | $V_{OL}$ | 0                 |     | $0.2 \cdot IOVCC$ | V    | $I_{OL} = +1.0mA$ | Note1 |
| Logic High level output voltage (TE) | $V_{OH}$ | $0.8 \cdot IOVCC$ |     | $IOVCC$           | V    | $I_{OH} = -1.0mA$ | Note1 |

NOTE1:

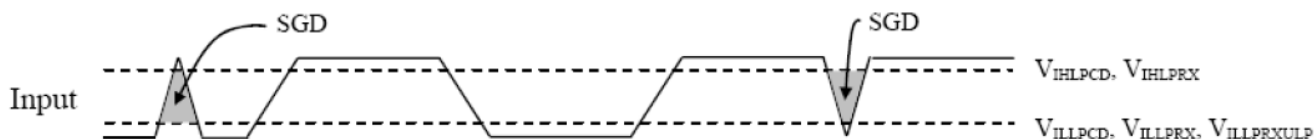
$T_a = -20$  to  $70^\circ C$ ,  $V_{CI} = 2.5V$  to  $3.6V$ ,  $IOVCC = 1.65V$  to  $3.6V$

### 8.2. DSI DC Characteristics

#### LP Mode

| Parameter              | Symbol          | Condition                   | Specification |      |      | Unit    |
|------------------------|-----------------|-----------------------------|---------------|------|------|---------|
|                        |                 |                             | Min.          | Typ. | Max. |         |
| Logic 1 input voltage  | $V_{IHLPCD}$    | LP-CD                       | 450           | -    | 1350 | mV      |
| Logic 0 input voltage  | $V_{ILLPCD}$    | LP-CD                       | 0.0           | -    | 200  | mV      |
| Logic 1 input voltage  | $V_{IHLPRX}$    | LP-RX (CLK, D0, D1, D2, D3) | 880           | -    | 1350 | mV      |
| Logic 0 input voltage  | $V_{ILLPRX}$    | LP-RX (CLK, D0, D1, D2, D3) | 0.0           | -    | 550  | mV      |
| Logic 0 input voltage  | $V_{ILLPRXULP}$ | LP-RX (CLK ULP mode)        | 0.0           | -    | 300  | mV      |
| Logic 1 output voltage | $V_{OHLPTX}$    | LP-TX (D0)                  | 1.1           | -    | 1.3  | V       |
| Logic 0 output voltage | $V_{OLLPTX}$    | LP-TX (D0)                  | -50           | -    | 50   | mV      |
| Logic 1 input current  | $I_{IH}$        | LP-CD, LP-RX                | -             | -    | 10   | $\mu A$ |
| Logic 0 input current  | $I_{IL}$        | LP-CD, LP-RX                | -10           | -    | -    | $\mu A$ |

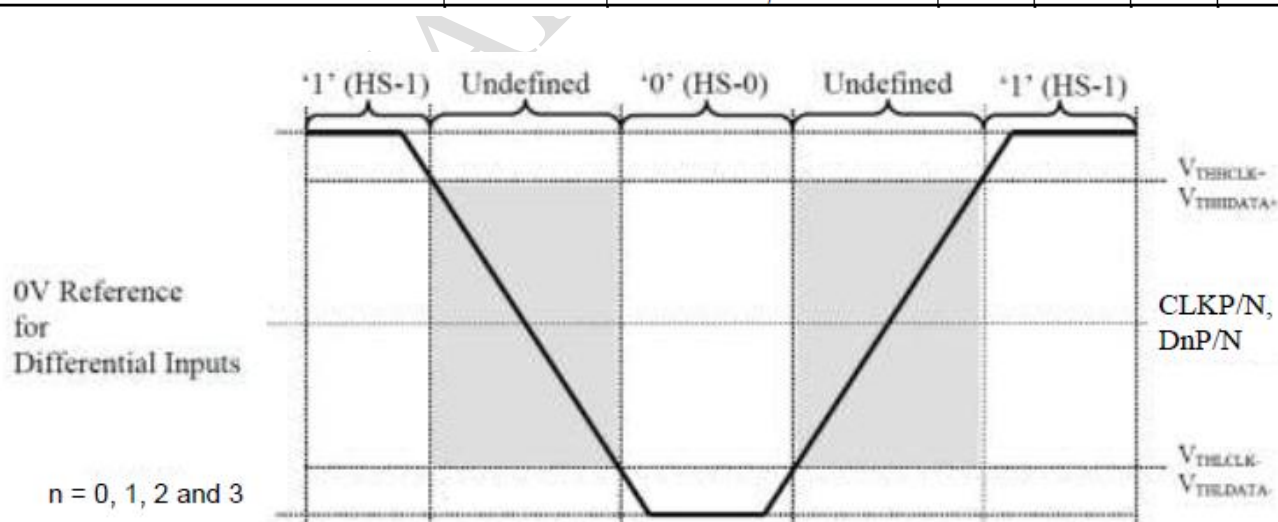
#### Spike/Glitch Rejection

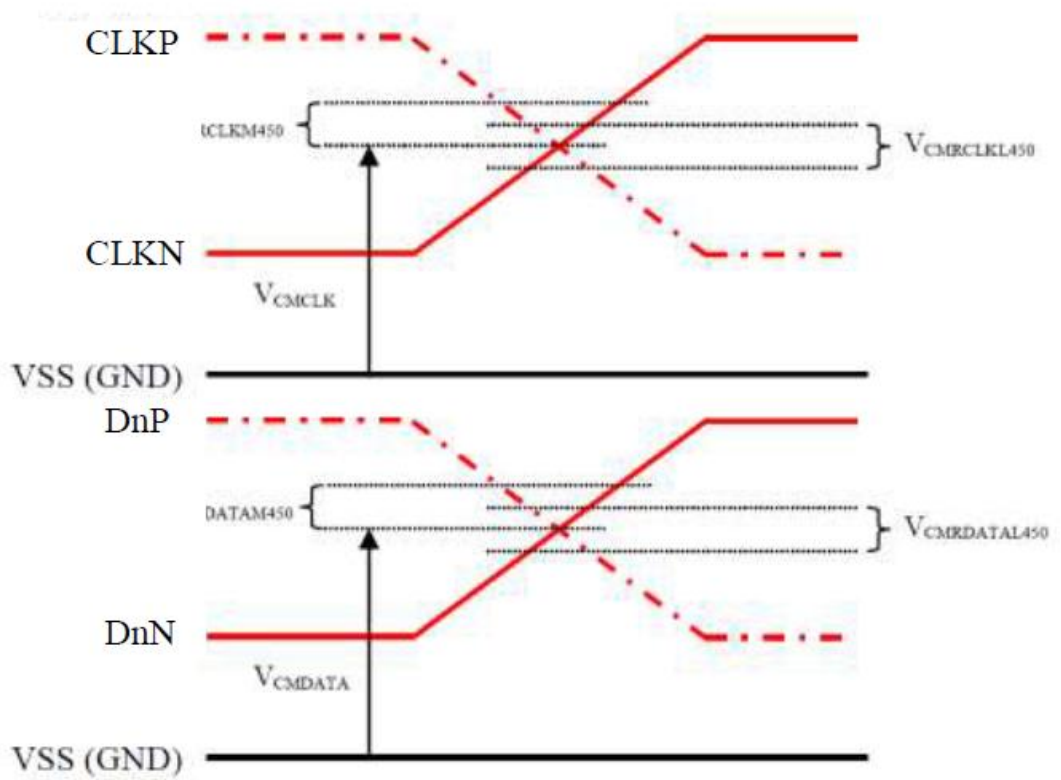


| Spike/Glitch Rejection – DSI |        |                               |     |     |      |
|------------------------------|--------|-------------------------------|-----|-----|------|
| Signal                       | Symbol | Parameter                     | Min | Max | Unit |
| CLKP/N, DnP/N                | SGD    | Input pulse rejection for DSI | -   | 300 | Vps  |

## High Speed Mode

| Parameter                                                      | Symbol            | Condition                       | Specification |     |     | Unit     |
|----------------------------------------------------------------|-------------------|---------------------------------|---------------|-----|-----|----------|
| Input Common Mode Voltage for Clock                            | $V_{CMCLK}$       | CLKP/N<br>Note 2, Note 3        | 70            | -   | 330 | mV       |
| Input Common Mode Voltage for Data                             | $V_{CMDATA}$      | DnP/N<br>Note 2, Note 3, Note 5 | 70            | -   | 330 | mV       |
| Common Mode Ripple for Clock Equal or Less than 450MHz         | $V_{CMRCLK450}$   | CLKP/N<br>Note 4                | -50           | -   | 50  | mV       |
| Common Mode Ripple for Data Equal or Less than 450MHz          | $V_{CMRDATAL450}$ | DnP/N<br>Note 4, Note 5         | -50           | -   | 50  | mV       |
| Common Mode Ripple for Clock More than 450MHz (peak sine wave) | $V_{CMRCLKM450}$  | CLKP/N                          | -             | -   | 100 | mV       |
| Common Mode Ripple for Data More than 450MHz (peak sine wave)  | $V_{CMRDATAM450}$ | DnP/N<br>Note 5                 | -             | -   | 100 | mV       |
| Differential Input Low Level Threshold Voltage for Clock       | $V_{THLCLK-}$     | CLKP/N                          | -70           | -   | -   | mV       |
| Differential Input Low Level Threshold Voltage for Data        | $V_{THLDATA-}$    | DnP/N<br>Note 5                 | -70           | -   | -   | mV       |
| Differential Input High Level Threshold Voltage for Clock      | $V_{THHCLK+}$     | CLKP/N                          | -             | -   | 70  | mV       |
| Differential Input High Level Threshold Voltage for Data       | $V_{THHDATA+}$    | DnP/N<br>Note 5                 | -             | -   | 70  | mV       |
| Single-ended Input Low Voltage                                 | $V_{ILHS}$        | CLKP/N, DnP/N<br>Note 3, Note 5 | -40           | -   | -   | mV       |
| Single-ended Input High Voltage                                | $V_{IHHS}$        | CLKP/N, DnP/N<br>Note 3, Note 5 | -             | -   | 460 | mV       |
| Differential Termination Resistor                              | $R_{TERM}$        | CLKP/N, DnP/N<br>Note 5         | 80            | 100 | 125 | $\Omega$ |
| Single-ended Threshold Voltage for Termination Enable          | $V_{TERM-EN}$     | CLKP/N, DnP/N<br>Note 5         | -             | -   | 450 | mV       |
| Termination Capacitor                                          | $C_{TERM}$        | CLKP/N, DnP/N<br>Note 5, Note 6 | -             | -   | 60  | pF       |



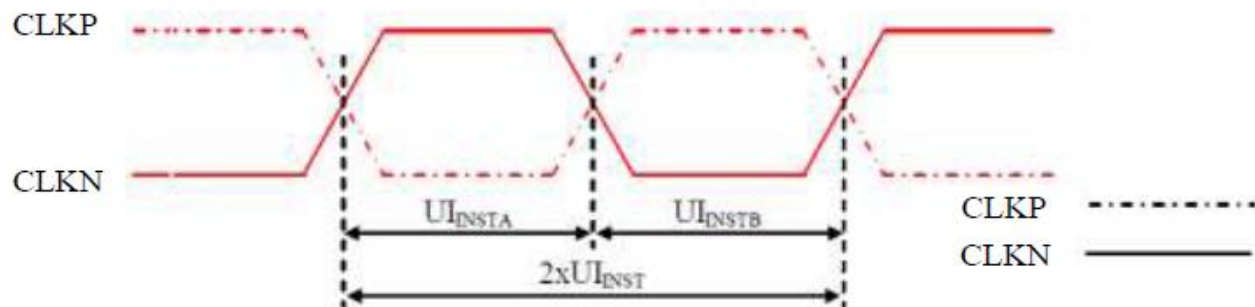


Note:  $n = 0, 1, 2$  and  $3$

## 9.AC Characteristics

### 9.1. DSI Interface Timing Characteristics

#### 9.1.1 High Speed Mode – Clock Channel Timing



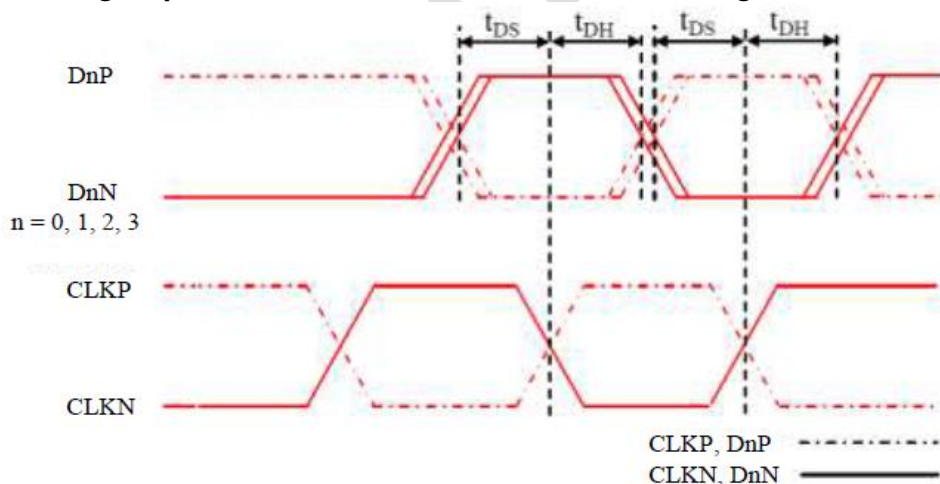
| Signal | Symbol                               | Parameter               | Min    | Max  | Unit |
|--------|--------------------------------------|-------------------------|--------|------|------|
| CLKP/N | $2xUI_{INST}$                        | Double UI instantaneous | Note 2 | 25   | ns   |
| CLKP/N | $UI_{INSTA}, UI_{INSTB}$<br>(Note 1) | UI instantaneous Half   | Note 2 | 12.5 | ns   |

Notes:

1.  $UI = UI_{INSTA} = UI_{INSTB}$

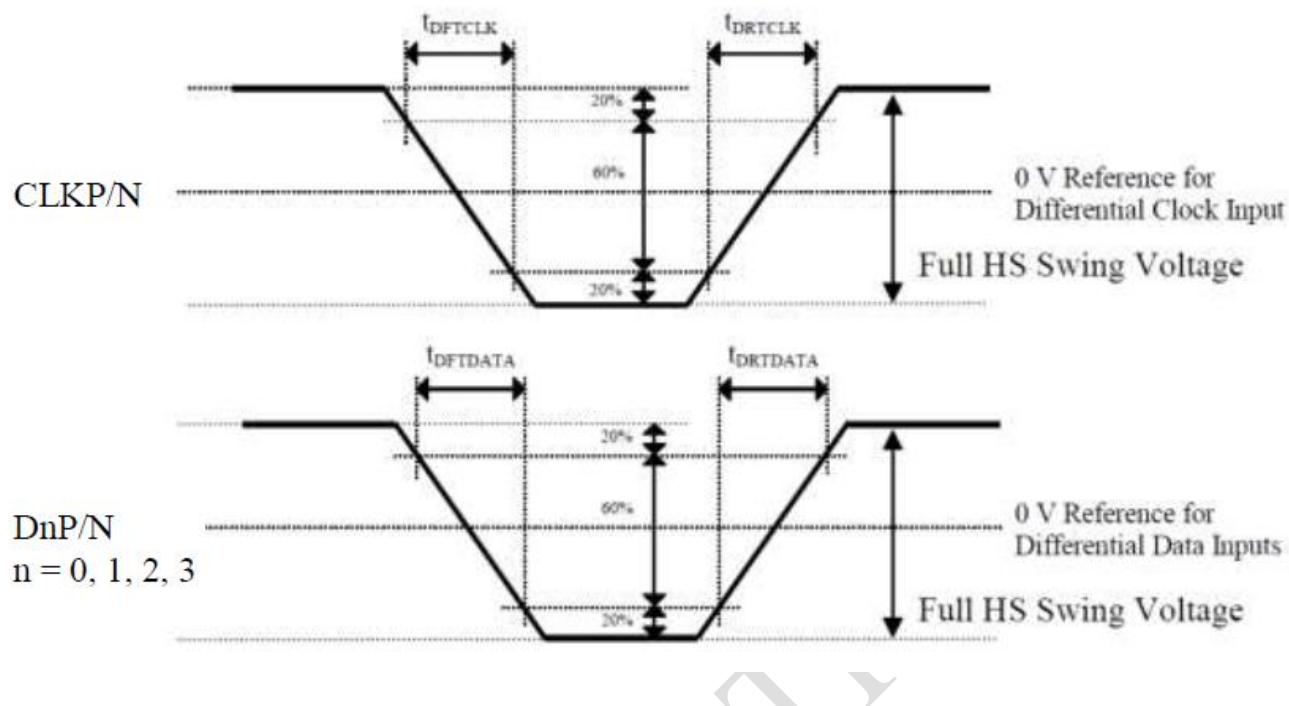
| Data type                                                   | Two Lanes speed | Three Lanes speed | Four Lanes speed |
|-------------------------------------------------------------|-----------------|-------------------|------------------|
| Data Type = 00 1110 (0Eh), RGB 565, 16 UI per Pixel         | 566 Mbps        | 466 Mbps          | 366 Mbps         |
| Data Type = 01 1110 (1Eh), RGB 666, 18 UI per Pixel         | 637 Mbps        | 525 Mbps          | 412 Mbps         |
| Data Type = 10 1110 (2Eh), RGB 666 Loosely, 24 UI per Pixel | 850 Mbps        | 700 Mbps          | 550 Mbps         |
| Data Type = 11 1110 (3Eh), RGB 888, 24 UI per Pixel         | 850 Mbps        | 700 Mbps          | 550 Mbps         |

#### 9.1.2 High Speed Mode – Data Clock Channel Timing



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

### 9.1.3 High Speed Mode – Rising and Falling Timings

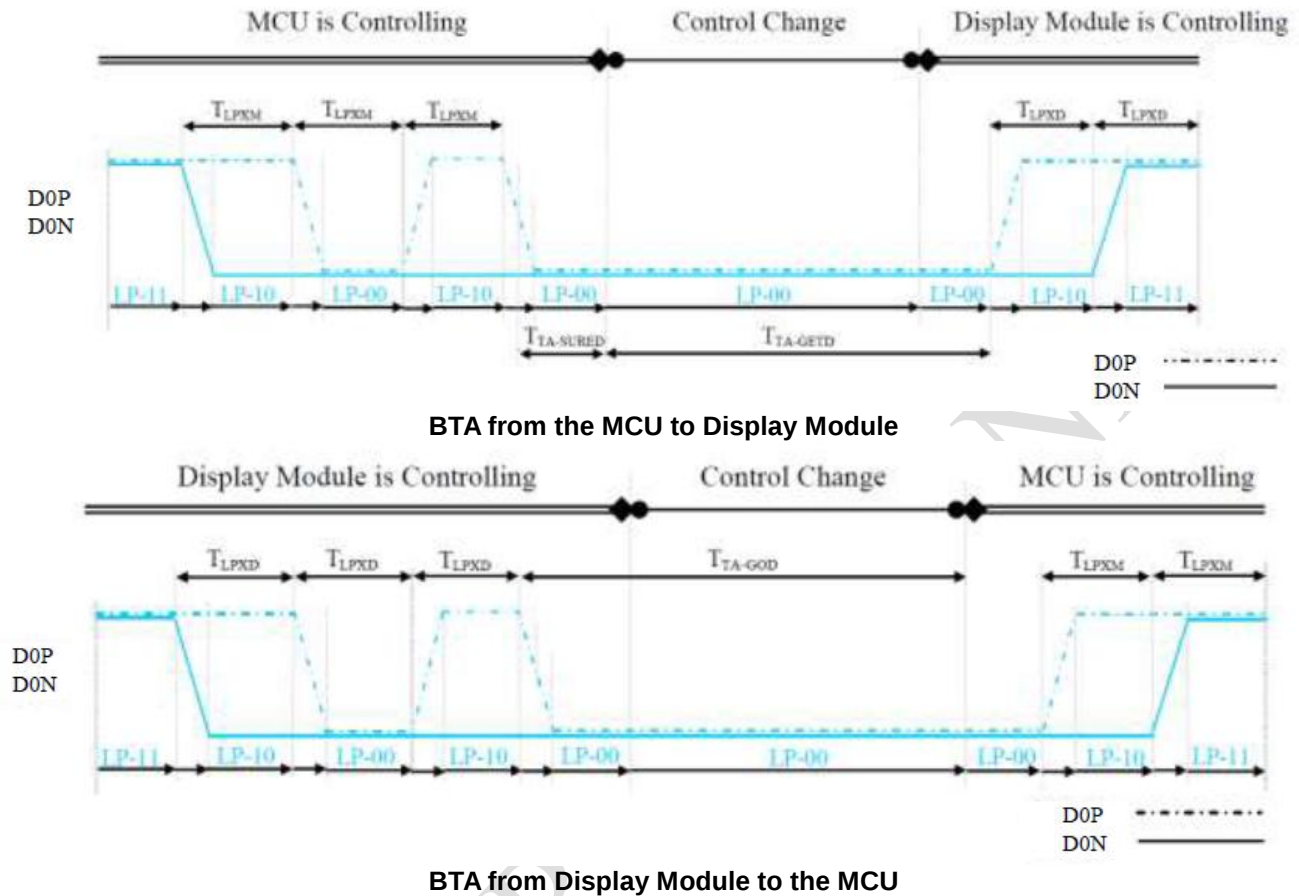


**Table 41: Rise and Fall Timings on Clock and Data Channels**

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

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

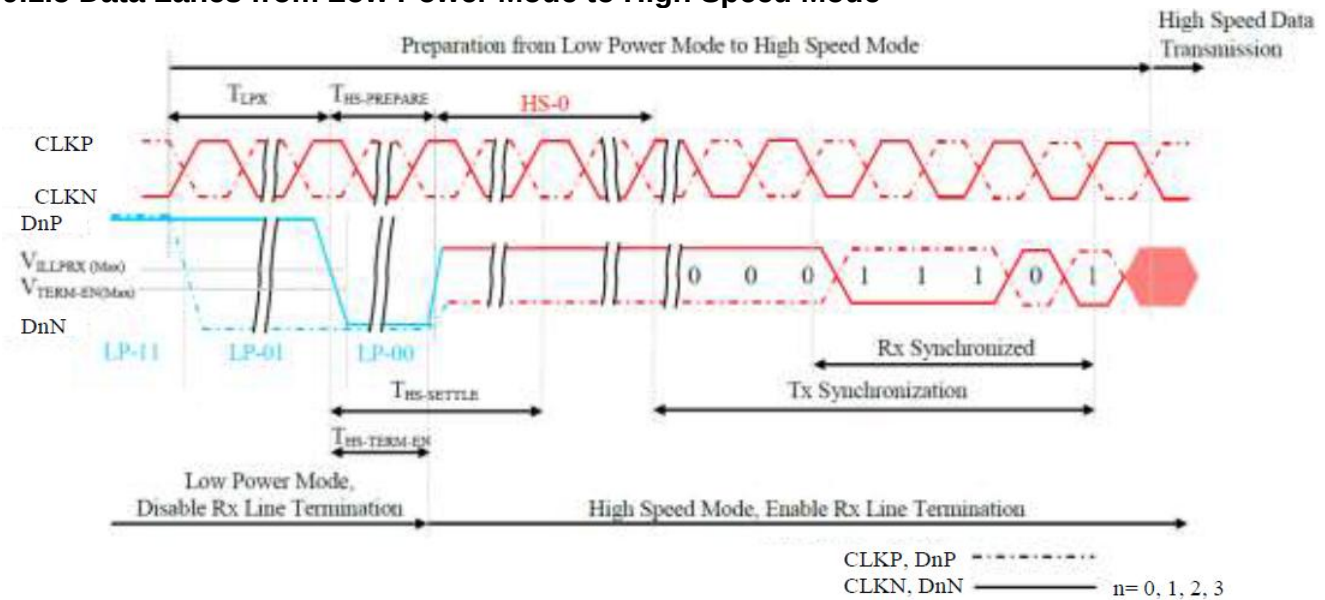
### 9.1.4 Low Power Mode – Bus Turn Around



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

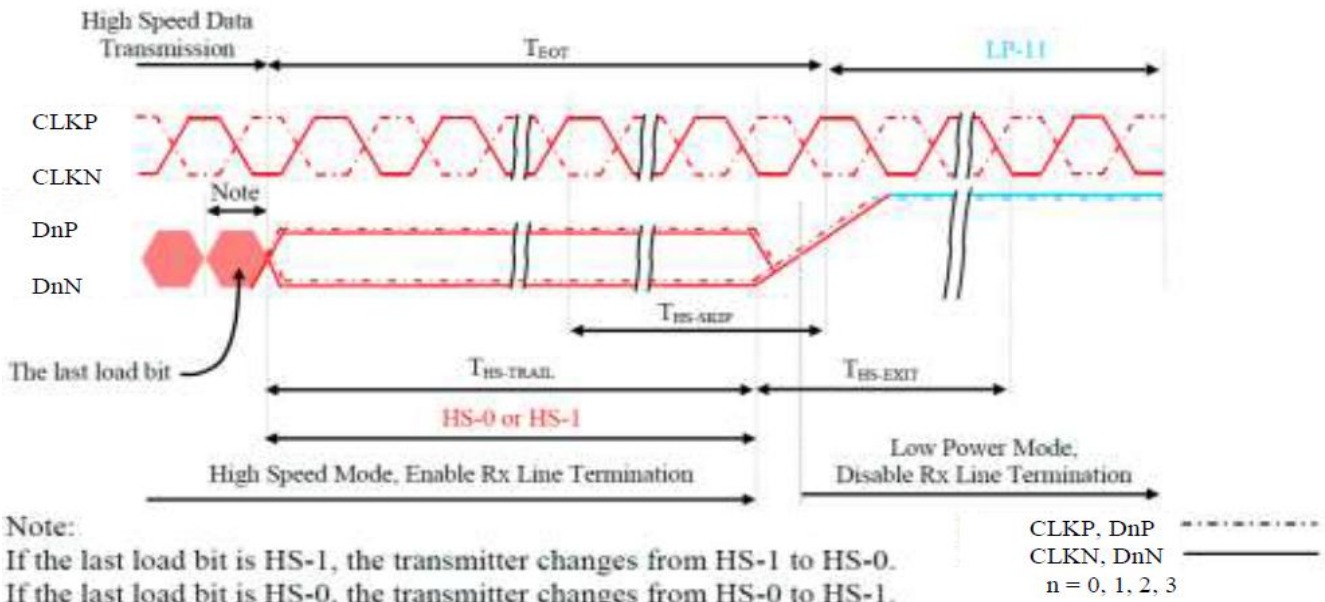
| Signal | Symbol        | Description                                        | Time                | Unit |
|--------|---------------|----------------------------------------------------|---------------------|------|
| D0P/N  | $T_{TA-GETD}$ | Time to drive LP-00 by Display Module (ILI9881C)   | $5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

### 9.1.5 Data Lanes from Low Power Mode to High Speed Mode



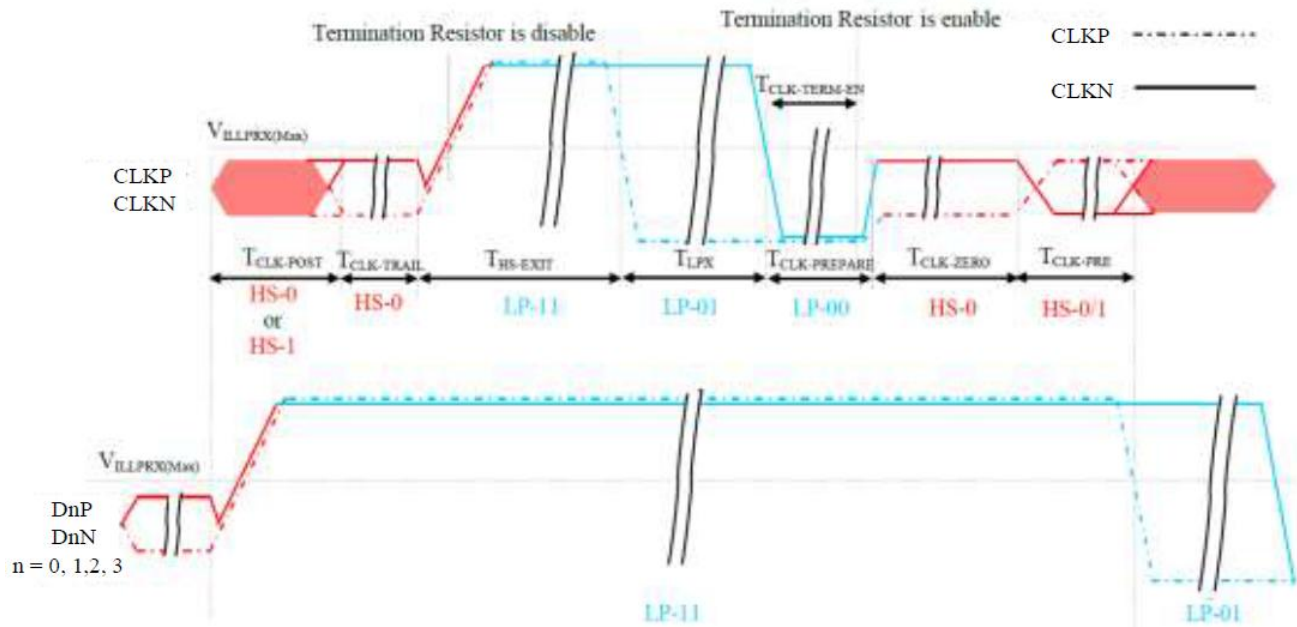
| Signal                 | Symbol           | Description                                                                                  | Min       | Max       | Unit |
|------------------------|------------------|----------------------------------------------------------------------------------------------|-----------|-----------|------|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

### 9.1.6 Data Lanes from High Speed Mode to Low Power Mode



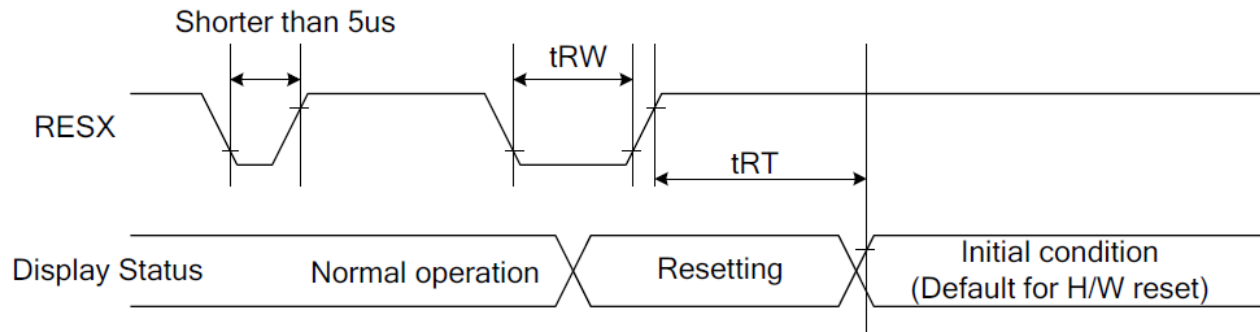
| Signal                 | Symbol        | Description                                                              | Min | Max       | Unit |
|------------------------|---------------|--------------------------------------------------------------------------|-----|-----------|------|
| DnP/N, $n = 0$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

### 9.1.7 Clock Lanes High Speed Mode to/from Low Power Mode Timing



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

## 9.2. Reset Timing



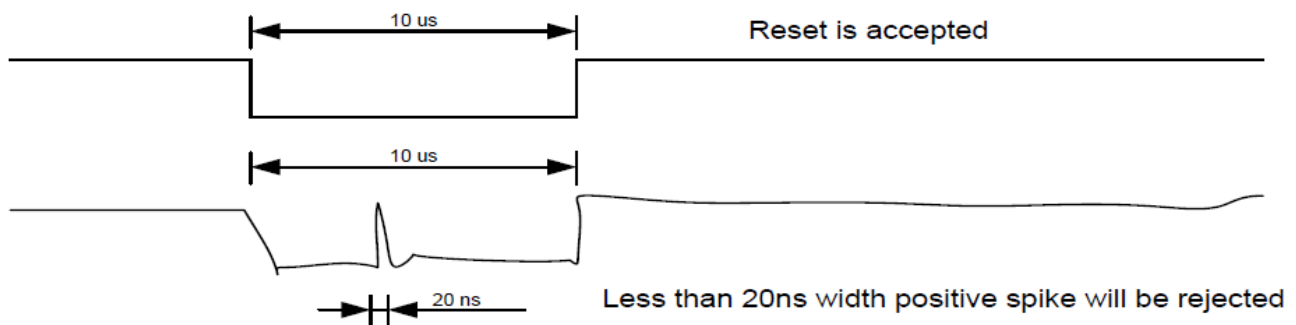
| Signal | Symbol   | Parameter            | Min | Max                | Unit |
|--------|----------|----------------------|-----|--------------------|------|
| RESX   | $t_{RW}$ | Reset pulse duration | 10  |                    | us   |
|        | $t_{RT}$ | Reset cancel         |     | 5 (Note 1, 5)      | ms   |
|        |          |                      |     | 120 (Note 1, 6, 7) |      |

### Notes:

1. The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time ( $t_{RT}$ ) within 5 ms after a rising 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 10us     | Reset          |
| Between 5us and 10us | Reset starts   |

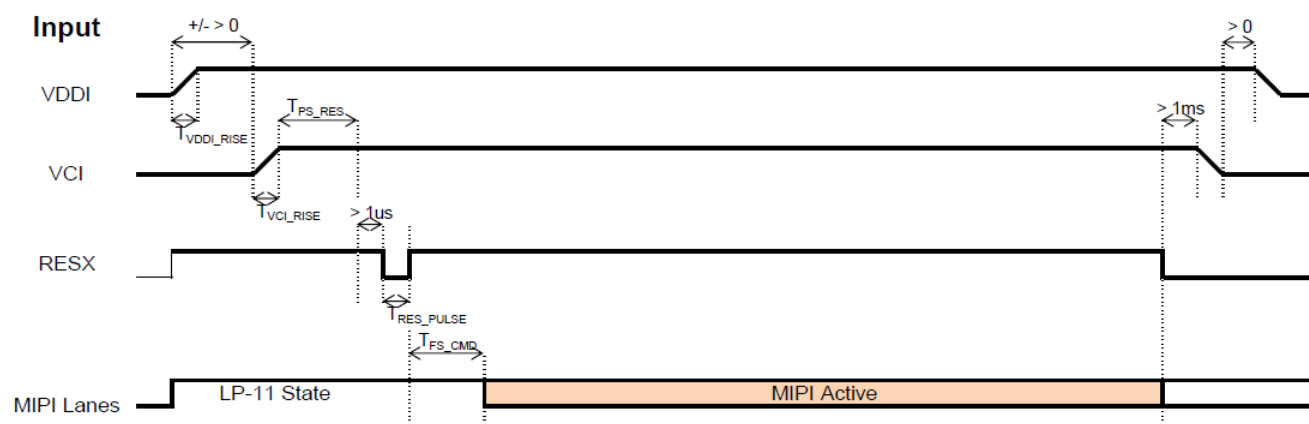
3. During the Resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep Out –mode. The display remains the blank state in Sleep In –mode.) and then return to Default condition for Hardware Reset.
4. Spike Rejection also applies during a valid reset pulse as shown below:



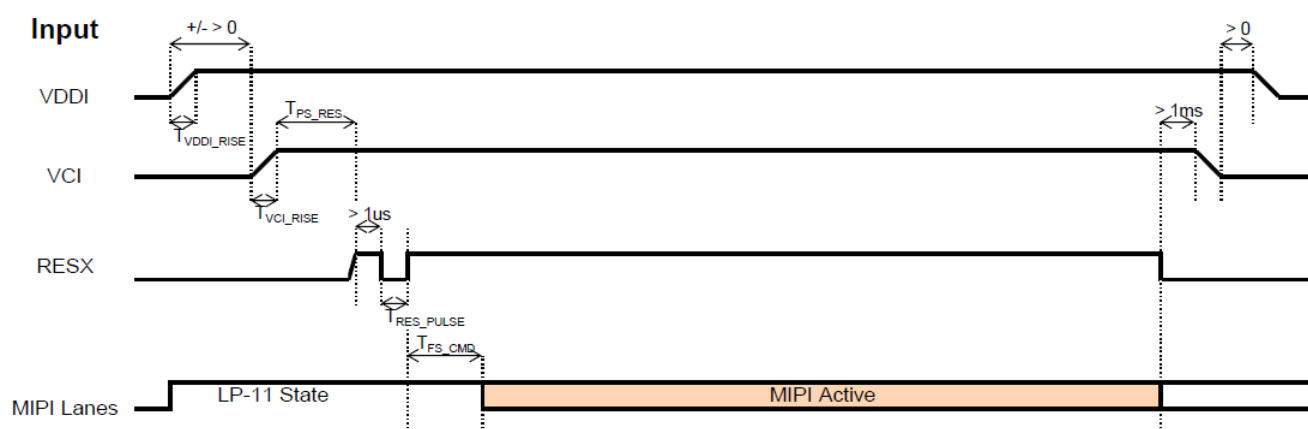
5. When Reset applied during Sleep In Mode.
6. When Reset applied during Sleep Out Mode.
7. It is necessary to wait 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec.

## 10.Power ON/OFF Sequence

Case A:



Case B:



| Symbol           | Characteristics           | Min. | Typ. | Max. | Units |
|------------------|---------------------------|------|------|------|-------|
| $T_{VDDI\_RISE}$ | VDDI Rise time            | 10   | -    | -    | us    |
| $T_{VCI\_RISE}$  | Case A: VCI Rise time     | 130  | -    | -    | us    |
|                  | Case B: VCI Rise time     | 40   |      |      |       |
| $T_{PS\_RES}$    | VDDI/VCI on to Reset high | 5    | -    | -    | ms    |
| $T_{RES\_PULSE}$ | Reset low pulse time      | 10   | -    | -    | us    |
| $T_{FS\_CMD}$    | Reset to first command    | 10   | -    | -    | ms    |

## 11. Optical Characteristics

| Item               | Symbol | Condition.                        | Min  | Typ. | Max. | Unit  | Remark            |
|--------------------|--------|-----------------------------------|------|------|------|-------|-------------------|
| Response time      | Tr     | $\theta=0^\circ$ 、 $\phi=0^\circ$ | -    | 10   | 15   | .ms   | Note 3            |
|                    | Tf     |                                   | -    | 20   | 25   | .ms   |                   |
| Contrast ratio     | CR     | At optimized viewing angle        | 640  | 800  | -    | -     | Note 4            |
| Color Chromaticity | White  | $\theta=0^\circ$ 、 $\phi=0^\circ$ | 0.26 | 0.31 | 0.36 |       | Note 2,6,7        |
|                    | Wy     |                                   | 0.28 | 0.33 | 0.38 |       |                   |
| Viewing angle      | Hor.   | $\theta_R$                        | -    | 80   | -    | Deg.  | Note 1            |
|                    |        | $\theta_L$                        | -    | 80   | -    |       |                   |
|                    | Ver.   | $\phi_T$                          | -    | 80   | -    |       |                   |
|                    |        | $\phi_B$                          | -    | 80   | -    |       |                   |
| Brightness         | -      | -                                 | 1000 | 1100 | -    | cd/m2 | Center of display |
| Uniformity         | (U)    | -                                 | 75   | -    | -    | %     | Note 5            |

Ta=25±2℃

Note 1: Definition of viewing angle range

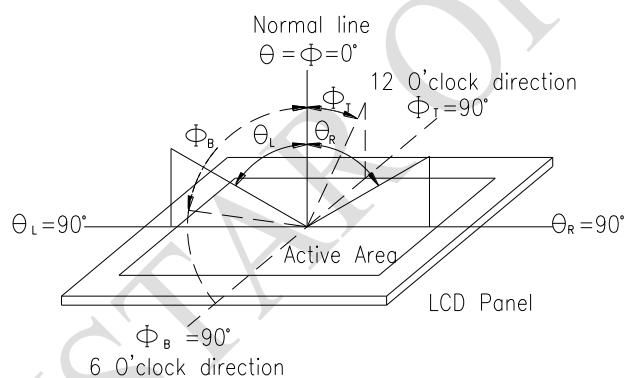
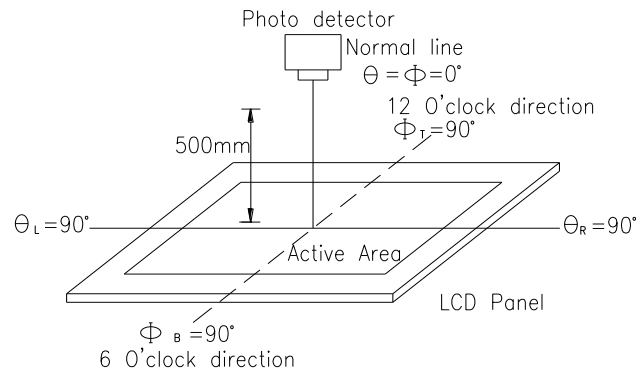


Fig. 11.1. Definition of viewing angle

Note 2: Test equipment setup:

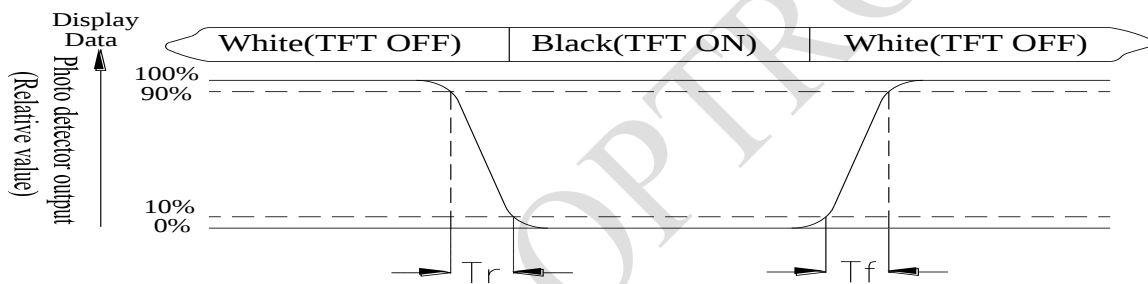
After stabilizing and leaving the panel alone at a driven temperature for 10 minutes, the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. Optical specifications are measured by Topcon BM-7or BM-5 luminance meter 1.0° field of view at a distance of 50cm and normal direction.



**Fig. 11.2. Optical measurement system setup**

**Note 3: Definition of Response time:**

The response time is defined as the LCD optical switching time interval between “White” state and “Black” state. Rise time,  $T_r$ , is the time between photo detector output intensity changed from 90% to 10%. And fall time,  $T_f$ , is the time between photo detector output intensity changed from 10% to 90%



**Note 4: Definition of contrast ratio:**

The contrast ratio is defined as the following expression.

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

**Note 5: Definition of Luminance Uniformity**

Active area is divided into 9 measuring areas (reference the picture in below). Every measuring point is placed at the center of each measuring area.

Luminance Uniformity (U) =  $L_{\min}/L_{\max} \times 100\%$

L = Active area length

W = Active area width

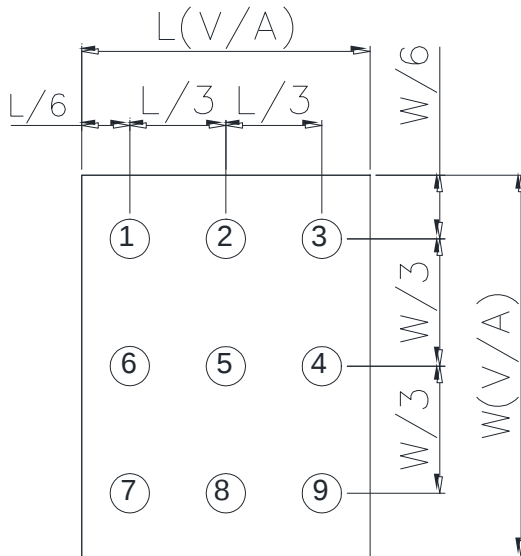


Fig 11.3. Definition of uniformity

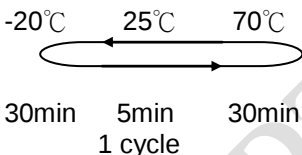
**Note 6: Definition of color chromaticity (CIE 1931)**

Color coordinates measured at the center point of LCD

Note 7: Measured at the center area of the panel when all the input terminals of LCD panel are electrically opened.

## 12. Reliability

Content of Reliability Test (Wide temperature, -20°C~70°C)

| Environmental Test                   |                                                                                                                                                                  |                                                                                                                                                      |      |
|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Test Item                            | Content of Test                                                                                                                                                  | Test Condition                                                                                                                                       | Note |
| High Temperature storage             | Endurance test applying the high storage temperature for a long time.                                                                                            | 80°C<br>200hrs                                                                                                                                       | 2    |
| Low Temperature storage              | Endurance test applying the low storage temperature for a long time.                                                                                             | -30°C<br>200hrs                                                                                                                                      | 1,2  |
| High Temperature Operation           | Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.                                           | 70°C<br>200hrs                                                                                                                                       | —    |
| Low Temperature Operation            | Endurance test applying the electric stress under low temperature for a long time.                                                                               | -20°C<br>200hrs                                                                                                                                      | 1    |
| High Temperature/ Humidity Operation | The module should be allowed to stand at 60°C,90%RH max                                                                                                          | 60°C,90%RH<br>96hrs                                                                                                                                  | 1,2  |
| Thermal shock resistance             | <p>The sample should be allowed stand the following 10 cycles of operation</p>  | -20°C/70°C<br>10 cycles                                                                                                                              | —    |
| Vibration test                       | Endurance test applying the vibration during transportation and using.                                                                                           | Total fixed amplitude : 3<br>1.5mm<br>Vibration Frequency :<br>10~55Hz<br>One cycle 60<br>seconds to 3<br>directions of X,Y,Z for<br>Each 15 minutes | 3    |
| Static electricity test              | Endurance test applying the electric stress to the terminal.                                                                                                     | VS=±600V(contact)<br>,±800v(air),<br>RS=330Ω<br>CS=150pF<br>10 times                                                                                 | —    |

Note1: No dew condensation to be observed.

Note2: The function test shall be conducted after 4 hours storage at the normal Temperature and humidity after remove from the test chamber.

Note3: The packing have to including into the vibration testing.

| LCM Sample Estimate Feedback Sheet                                                                                  |                               |                                     |
|---------------------------------------------------------------------------------------------------------------------|-------------------------------|-------------------------------------|
| Module Number : _____                                                                                               |                               |                                     |
| <b>1 、 Panel Specification :</b>                                                                                    |                               |                                     |
| 1. Panel Type :                                                                                                     | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 2. View Direction :                                                                                                 | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 3. Numbers of Dots :                                                                                                | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 4. View Area :                                                                                                      | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 5. Active Area :                                                                                                    | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 6. Operating Temperature :                                                                                          | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 7. Storage Temperature :                                                                                            | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 8. Others : _____                                                                                                   |                               |                                     |
| <b>2 、 Mechanical Specification :</b>                                                                               |                               |                                     |
| 1. PCB Size :                                                                                                       | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 2. Frame Size :                                                                                                     | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 3. Material of Frame :                                                                                              | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 4. Connector Position :                                                                                             | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 5. Fix Hole Position :                                                                                              | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 6. Backlight Position :                                                                                             | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 7. Thickness of PCB :                                                                                               | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 8. Height of Frame to PCB :                                                                                         | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 9. Height of Module :                                                                                               | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 10. Others :                                                                                                        | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| <b>3 、 Relative Hole Size :</b>                                                                                     |                               |                                     |
| 1. Pitch of Connector :                                                                                             | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 2. Hole size of Connector :                                                                                         | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 3. Mounting Hole size :                                                                                             | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 4. Mounting Hole Type :                                                                                             | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 5. Others :                                                                                                         | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| <b>4 、 Backlight Specification :</b>                                                                                |                               |                                     |
| 1. B/L Type :                                                                                                       | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 2. B/L Color :                                                                                                      | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 3. B/L Driving Voltage (Reference for LED Type) : <input type="checkbox"/> Pass <input type="checkbox"/> NG , _____ |                               |                                     |
| 4. B/L Driving Current :                                                                                            | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 5. Brightness of B/L :                                                                                              | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 6. B/L Solder Method :                                                                                              | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 7. Others :                                                                                                         | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |

&gt;&gt; Go to page 2 &lt;&lt;

**Module Number :** \_\_\_\_\_

**5 、 Electronic Characteristics of Module :**

|                             |                               |                                     |
|-----------------------------|-------------------------------|-------------------------------------|
| 1.Input Voltage :           | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 2.Supply Current :          | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 3.Driving Voltage for LCD : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 4.Contrast for LCD :        | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 5.B/L Driving Method :      | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 6.Negative Voltage Output : | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 7.Interface Function :      | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 8.LCD Uniformity :          | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 9.ESD test :                | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |
| 10.Others :                 | <input type="checkbox"/> Pass | <input type="checkbox"/> NG , _____ |

**6 、 Summary :**
**Sales signature :** \_\_\_\_\_

**Customer Signature :** \_\_\_\_\_

**Date :**    /    /