

Royal Display Co.,Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

A

2020,07,17

1 / 24

SPECIFICATION

Model:RYTPQ28NN08-02

Acceptance

| Approved by | Checked by | | Made by |
|-------------|------------|--|---------|
| | | | |

Royal Display Co.,Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

A

2020,07,17

3 / 24

1.General Description and Features

RYTPQ28NN08-02 is a TM (Transmissive) type color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching device. This model is composed of a TFT-LCD module, a driver circuit and a back-light unit . The resolution of a 2.8" contains 240RGBx320 dots and can display up to 26 2K colors. The following table described the features of RYTPQ28NN08-02.

LCD Module

| Item | Specification | Unit |
|--------------------------------|------------------------------|---------|
| Screen Size | 2.8inches | Diagona |
| Display Resolution | 240RGB(H)x320(V) | Dot |
| Active Area | 43.2(H) x57.6 (V) | mm |
| Outline Dimension | 50.2(W) x 69.3 (H) x 4.0 (D) | mm |
| Display Mode | Normally white/Transmissive | -- |
| Pixel Arrangement | RGB-Vertical Stripe | -- |
| Display Color | 262K | -- |
| Gray scale inversion Direction | 12 o'clock | |
| Viewing Direction | 6 o'clock | -- |
| Drive IC | ILI9341V | -- |

Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

A

2020,07,17

4 / 24

2. Mechanical Information

| Item | | Min. | Typ. | Max. | Unit | Note |
|-------------|----------------|------|------|------|------|------|
| Module Size | Horizontal (H) | -- | 50.2 | -- | mm | -- |
| | Vertical (V) | -- | 69.3 | -- | mm | (1) |
| | Thickness (T) | -- | 4.0 | -- | mm | (2) |
| Weight | | -- | N/A | -- | g | -- |

Note (1) Not include FPC.

Refer to the Outline Dimension for further information.

(2) Back-light unit are included.

3. Electrical Specifications

3.1 Absolute Max. Ratings

3.1.1 Absolute Ratings of Environment

If the operating condition exceeds the following absolute maximum ratings, the TFT LCD module may be damaged permanently.

(Ta=25±2°C, V_{SS}=GND=0)

| Item | Symbol | Min. | Max. | Unit | Note |
|-----------------------|------------------|------|------|------|---------|
| Operating temperature | T _{OPR} | -20 | 70 | °C | (1) |
| Storage temperature | T _{STG} | -30 | 80 | °C | (1,2,3) |

Note (1) 95 % RH Max. (40 °C ≥ Ta). Maximum wet-bulb temperature at 39 °C or less.
(Ta > 40 °C) No condensation.

Note (2) In case of below 0°, the response time of liquid crystal (LC) becomes slower and the color of panel becomes darker than normal one. Level of retardation depends on temperature, because of LC's character

Note (3) Only operation is guaranteed at operating temperature. Contrast, response time, another display quality are evaluated at +25°C.

Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

A

2020,07,17

5 / 24

3.2 Electrical Absolute Rating

3.2.1 TFT-LCD Module

(Voltage Referenced to VSS)

| Item | Symbol | Min. | Typ. | Max. | Unit | Remark |
|-------------------------|---------|------------------|------|------------------|------|--------|
| Power supply | VDD | 2.6 | 3.0 | 3.3 | V | |
| Input Voltage for logic | H Level | $0.8 \times VDD$ | - | VDD | V | |
| | L Level | 0 | - | $0.2 \times VDD$ | V | |
| Power Supply current | IDD | - | - | 50 | mA | Note 1 |

4 Electrical Characteristics

4.1 Backlight Unit

The back-light system is an edge-lighting type with 4 white LEDs (Light Emitting Diode).

($T_a = 25 \pm 2^\circ\text{C}$)

| Item | Symbol | Value | | | Unit | Condition |
|-------------------|----------|-------|------|------|------|-----------|
| | | Min. | Typ. | Max. | | |
| LED Voltage | V_F | 2.8 | 3.0 | 3.3 | V | |
| LED Current | I_F | - | 60 | -- | mA | |
| Power Consumption | P_{BL} | - | 180 | - | mW | |

Note (1) Where $I_F = 60\text{mA}$, $V_F = 2.8\text{-}3.3\text{V}$, $P_{BL} = V_F \times I_F$

Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

A

2020,07,17

6 / 24

5 Input Terminal Pin Assignment

| PIN.NO | SYMBOL | I/O/P | FUNCTION | REMARK | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------|--------|-------|---|---------------------------------------|---------------------------------------|---------------------|------------------|--------------------|---------------|--------------------|------------------|------|---|---|---|---|------------------------------|--------|--------|---|---|---|---|-------------------------------|--------|---------|---|---|---|---|------------------------------|--------|--------|---|---|---|---|-------------------------------|--------|---------|---|---|---|---|--------------------------------------|-------------|--|---|---|---|---|--------------------------------------|-------------|--|---|---|---|---|--------------------------------|--------|------------------|---|---|---|---|-------------------------------|----------|----------|---|---|---|---|--------------------------------|--------|---------|---|---|---|---|-------------------------------|----------|---------|---|---|---|---|---------------------------------------|---------------------|--|---|---|---|---|---------------------------------------|---------------------|--|--|
| 1 | LED K | P | POWER FOR BACKLIGHT (GROUND) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | LED A1 | P | POWER FOR BACKLIGHT(ANODE) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | LED A2 | P | POWER FOR BACKLIGHT(ANODE) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | LED A3 | P | POWER FOR BACKLIGHT(ANODE) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | LED A4 | P | POWER FOR BACKLIGHT(ANODE) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | IM0 | I | <p>- Select the MCU interface mode</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">IM3</th> <th rowspan="2">IM2</th> <th rowspan="2">IM1</th> <th rowspan="2">IM0</th> <th rowspan="2">MCU-Interface Mode</th> <th colspan="2">DB Pin in use</th> </tr> <tr> <th>Register/Content</th> <th>GRAM</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>80 MCU 8-bit bus interface I</td> <td>D[7:0]</td> <td>D[7:0]</td> </tr> <tr> <td>0</td> <td>0</td> <td>0</td> <td>1</td> <td>80 MCU 16-bit bus interface I</td> <td>D[7:0]</td> <td>D[15:0]</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>0</td> <td>80 MCU 9-bit bus interface I</td> <td>D[7:0]</td> <td>D[8:0]</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>80 MCU 18-bit bus interface I</td> <td>D[7:0]</td> <td>D[17:0]</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> <td>1</td> <td>3-wire 9-bit data serial interface I</td> <td colspan="2" style="text-align: center;">SDA: In/OUT</td> </tr> <tr> <td>0</td> <td>1</td> <td>1</td> <td>0</td> <td>4-wire 8-bit data serial interface I</td> <td colspan="2" style="text-align: center;">SDA: In/OUT</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>0</td> <td>80 MCU 16-bit bus interface II</td> <td>D[8:1]</td> <td>D[17:10], D[8:1]</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>1</td> <td>80 MCU 8-bit bus interface II</td> <td>D[17:10]</td> <td>D[17:10]</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> <td>0</td> <td>80 MCU 18-bit bus interface II</td> <td>D[8:1]</td> <td>D[17:0]</td> </tr> <tr> <td>1</td> <td>0</td> <td>1</td> <td>1</td> <td>80 MCU 9-bit bus interface II</td> <td>D[17:10]</td> <td>D[17:9]</td> </tr> <tr> <td>1</td> <td>1</td> <td>0</td> <td>1</td> <td>3-wire 9-bit data serial interface II</td> <td colspan="2" style="text-align: center;">SDI: In SDO: Out</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> <td>0</td> <td>4-wire 8-bit data serial interface II</td> <td colspan="2" style="text-align: center;">SDI: In SDO: Out</td> </tr> </tbody> </table> <p>MPU Parallel interface bus and serial interface select If use RGB Interface must select serial interface. * : Fix this pin at VDDI or VSS.</p> | IM3 | IM2 | IM1 | IM0 | MCU-Interface Mode | DB Pin in use | | Register/Content | GRAM | 0 | 0 | 0 | 0 | 80 MCU 8-bit bus interface I | D[7:0] | D[7:0] | 0 | 0 | 0 | 1 | 80 MCU 16-bit bus interface I | D[7:0] | D[15:0] | 0 | 0 | 1 | 0 | 80 MCU 9-bit bus interface I | D[7:0] | D[8:0] | 0 | 0 | 1 | 1 | 80 MCU 18-bit bus interface I | D[7:0] | D[17:0] | 0 | 1 | 0 | 1 | 3-wire 9-bit data serial interface I | SDA: In/OUT | | 0 | 1 | 1 | 0 | 4-wire 8-bit data serial interface I | SDA: In/OUT | | 1 | 0 | 0 | 0 | 80 MCU 16-bit bus interface II | D[8:1] | D[17:10], D[8:1] | 1 | 0 | 0 | 1 | 80 MCU 8-bit bus interface II | D[17:10] | D[17:10] | 1 | 0 | 1 | 0 | 80 MCU 18-bit bus interface II | D[8:1] | D[17:0] | 1 | 0 | 1 | 1 | 80 MCU 9-bit bus interface II | D[17:10] | D[17:9] | 1 | 1 | 0 | 1 | 3-wire 9-bit data serial interface II | SDI: In SDO: Out | | 1 | 1 | 1 | 0 | 4-wire 8-bit data serial interface II | SDI: In SDO: Out | | |
| IM3 | IM2 | | IM1 | | | | | | IM0 | MCU-Interface Mode | DB Pin in use | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | Register/Content | GRAM | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | | 0 | 0 | 80 MCU 8-bit bus interface I | D[7:0] | D[7:0] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | | 0 | 1 | 80 MCU 16-bit bus interface I | D[7:0] | D[15:0] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | | 1 | 0 | 80 MCU 9-bit bus interface I | D[7:0] | D[8:0] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 0 | | 1 | 1 | 80 MCU 18-bit bus interface I | D[7:0] | D[17:0] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 1 | | 0 | 1 | 3-wire 9-bit data serial interface I | SDA: In/OUT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | 1 | | 1 | 0 | 4-wire 8-bit data serial interface I | SDA: In/OUT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | | 0 | 0 | 80 MCU 16-bit bus interface II | D[8:1] | D[17:10], D[8:1] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | | 0 | 1 | 80 MCU 8-bit bus interface II | D[17:10] | D[17:10] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | | 1 | 0 | 80 MCU 18-bit bus interface II | D[8:1] | D[17:0] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 0 | | 1 | 1 | 80 MCU 9-bit bus interface II | D[17:10] | D[17:9] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 1 | | 0 | 1 | 3-wire 9-bit data serial interface II | SDI: In SDO: Out | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | 1 | 1 | 0 | 4-wire 8-bit data serial interface II | SDI: In SDO: Out | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | IM1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | IM2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | IM3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | RST | I | This signal will reset the device and must be applied to properly initialize the chip. Signal is active low. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | VSYN | I | Frame synchronizing signal for RGB interface operation. <i>Fix to VDDI or VSS level when not in use.</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | HSYN | I | Line synchronizing signal for RGB interface operation. <i>Fix to VDDI or VSS level when not in use.</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

A

2020,07,17

7 / 24

| | | | | |
|-------|----------|-----|---|--|
| 13 | DCLK | I | Dot clock signal for RGB interface operation. <i>Fix to VDDI or VSS level when not in use.</i> | |
| 14 | DE | I | Data enable signal for RGB interface operation. <i>Fix to VDDI or VSS level when not in use.</i> | |
| 15-32 | DB17-DB0 | I/O | 18-bit parallel bi-directional data bus for MCU system and RGB interface mode <i>Fix to VSS level when not in use</i> | |
| 33 | SDO | O | Serial output signal. The data is outputted on the falling edge of the SCL signal. If not used, open this pin | |
| 34 | SDI | I/O | When IM[3] : Low, Serial in/out signal. When IM[3] : High, Serial input signal. The data is applied on the rising edge of the SCL signal. <i>If not used, fix this pin at VDDI or VSS.</i> | |
| 35 | RD | I | 8080- I /8080- II system (RDX): Serves as a read signal and MCU read data at the rising edge. <i>Fix to VDDI level when not in use.</i> | |
| 36 | D/C (WR) | I | - 8080- I /8080- II system (WRX): Serves as a write signal and writes data at the rising edge. - 4-line system (D/CX): Serves as command or parameter select. <i>Fix to VDDI level when not in use.</i> | |
| 37 | SCL(D/C) | I | This pin is used to select "Data or Command" in the parallel interface or 4-wire 8-bit serial data interface. When DCX = '1', data is selected. When DCX = '0', command is selected. This pin is used serial interface clock in 3-wire 9-bit / 4-wire 8-bit serial data interface. <i>If not used, this pin should be connected to VDDI or VSS.</i> | |
| 38 | CS | I | Chip select input pin ("Low" enable). This pin can be permanently fixed "Low" in MPU interface mode only. * note1,2 | |
| 39 | TE | O | Tearing effect output pin to synchronize MPU to frame writing, activated by S/W command. When this pin is not activated, this pin is low. If not used, open this pin. | |
| 40 | VDDI | P | Low voltage power supply for interface logic circuits (1.65 ~ 3.3 V) | |
| 41 | VDDI | P | Low voltage power supply for interface logic circuits (1.65 ~ 3.3 V) | |
| 42 | VCI | I | <i>High voltage power supply for analog circuit blocks (2.5 ~ 3.3 V)</i> | |
| 43 | GND | P | GROUND | |

Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

A

2020,07,17

8 / 24

| | | | | |
|----|-----|---|--------------------------|--|
| 44 | X+ | | RIGHT ELECTRODE FOR RTP | |
| 45 | Y+ | | TOP ELECTRODE FOR RTP | |
| 46 | X- | | LEFT ELECTRODE FOR RTP | |
| 47 | Y- | | BOTTOM ELECTRODE FOR RTP | |
| 48 | GND | P | GROUND | |
| 49 | GND | P | GROUND | |
| 50 | GND | P | GROUND | |

Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

A

2020,07,17

9 / 24

6 Optical Characteristics

The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods. Measuring equipment: BM-7A

| Item | Symbol | Condition | Min | Type | Max | Unit | Note | |
|-------------------------------|----------------|----------------------------|---------------------------|-------|-------|-------------------|--------|-------|
| Brightness | B | | -- | 300 | -- | cd/m ² | | |
| Response time | T _r | θ=0° | - | 3 | 6 | ms | . | |
| | T _f | | -- | 7 | 14 | ms | | |
| Contrast ratio | CR | At optimized viewing angle | 400 | 500 | -- | -- | | |
| Luminance Uniformity | ΔL | | 70 | 80 | | % | | |
| Color Chromaticity (CIE 1931) | White | W _x | θ=0° Normal Viewing Angle | 0.250 | 0.290 | 0.330 | -- | BM-7A |
| | | W _y | | 0.268 | 0.318 | 0.368 | | |
| Viewing Angle (6H) | Hor. | θ _R | CR≥10 | 60 | 70 | -- | Degree | |
| | | θ _L | | 60 | 70 | -- | | |
| | Ver. | θ _U | | 65 | 75 | -- | | |
| | | θ _D | | 50 | 60 | -- | | |

a. Test equipment setup

After stabilizing and leaving the panel alone shall be warmed up for the stable operation of LCM, the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. Optical specifications are measured by Topcon BM-7(fast) with a viewing angle of 2° at a distance of 50cm and normal direction.

b. Definition of response time: Tr and Tf

The response time is defined as the following figure and shall be measured by switching the input signal for "black" and "white".

Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

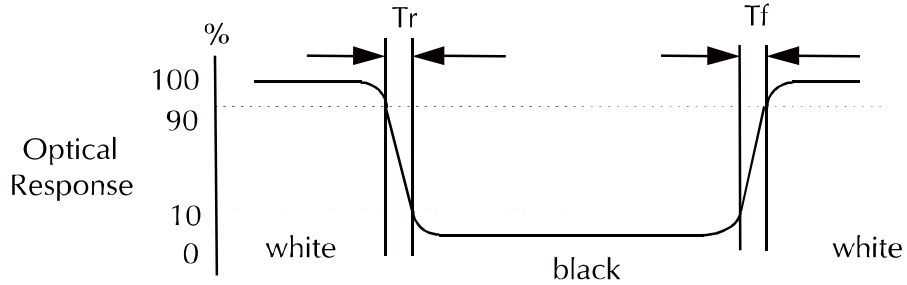
Issued Date.

Page.

A

2020,07,17

10 / 24



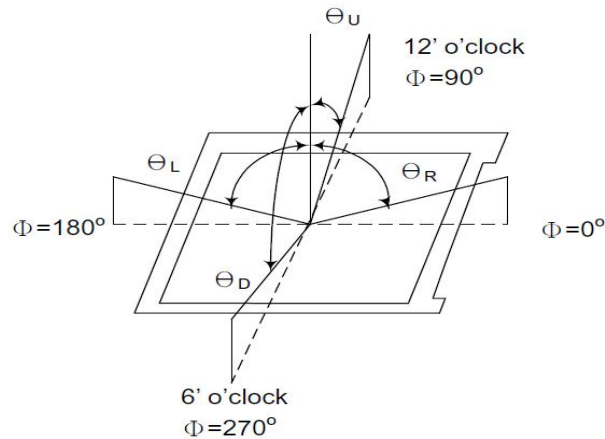
c. Definition of contrast ratio:

Brightness measured when LCD is at "white state"

Contrast Ratio (CR) =

Brightness measured when LCD is at "black state"

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




e. Definition of Luminance of White: Luminance of white at the center points

| | |
|---------------------------------|----------|
| Light Source of Back-Light Unit | LED Type |
|---------------------------------|----------|

f. Definition of White Uniformity

Min. luminance of white among 9-points

Royal Display Co., Limited

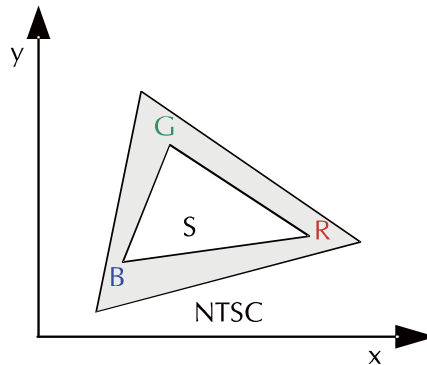
| | | | | |
|---|-----------------------|----------|--------------|---------|
|  | Model: RYTPQ28NN08-02 | Rev. No. | Issued Date. | Page. |
| | | A | 2020,07,17 | 11 / 24 |

$$\text{White Uniformity} = \frac{\text{Max. luminance of white among 9-points}}{\text{Max. luminance of white among 9-points}} \times 100\%$$

g. The definition of Color Gamut -Color Chromaticity CIE 1931

Color coordinate of white & red, green, blue at center point.

Color Gamut : NTSC(%) = (RGB Triangle Area / NTSC Triangle Area) x 100



Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

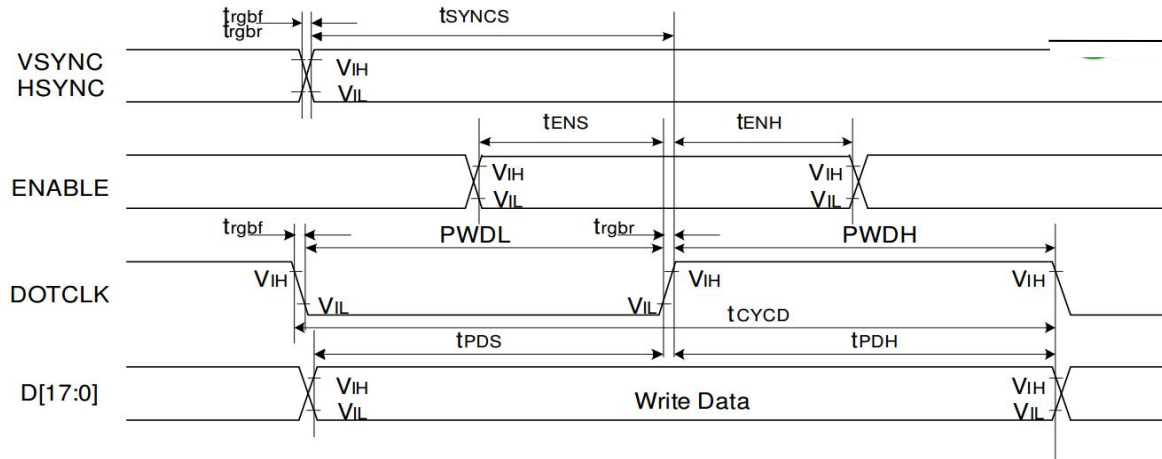
A

2020,07,17

12 / 24

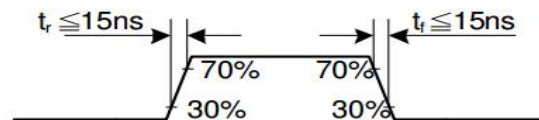
7 Interface Timing

18.3.5 Parallel 18/16/6-bit RGB Interface Timing Characteristics



| Signal | Symbol | Parameter | min | max | Unit | Description |
|---------------|--------------|-------------------------------------|-----|-----|------|----------------------------------|
| VSYNC / HSYNC | tSYNCS | VSYNC/HSYNC setup time | 15 | - | ns | 18/16-bit bus RGB interface mode |
| | tSYNCH | VSYNC/HSYNC hold time | 15 | - | ns | |
| DE | tENS | DE setup time | 15 | - | ns | |
| | tENH | DE hold time | 15 | - | ns | |
| D[17:0] | tPOS | Data setup time | 15 | - | ns | |
| | tPDH | Data hold time | 15 | - | ns | |
| DOTCLK | PWDH | DOTCLK high-level period | 15 | - | ns | |
| | PWDL | DOTCLK low-level period | 15 | - | ns | |
| | tCYCD | DOTCLK cycle time | 100 | - | ns | |
| | trgbr, trgbf | DOTCLK, HSYNC, VSYNC rise/fall time | - | 15 | ns | |
| VSYNC / HSYNC | tSYNCS | VSYNC/HSYNC setup time | 15 | - | ns | 6-bit bus RGB interface mode |
| | tSYNCH | VSYNC/HSYNC hold time | 15 | - | ns | |
| DE | tENS | DE setup time | 15 | - | ns | |
| | tENH | DE hold time | 15 | - | ns | |
| D[17:0] | tPOS | Data setup time | 15 | - | ns | |
| | tPDH | Data hold time | 15 | - | ns | |
| DOTCLK | PWDH | DOTCLK high-level pulse period | 15 | - | ns | |
| | PWDL | DOTCLK low-level pulse period | 15 | - | ns | |
| | tCYCD | DOTCLK cycle time | 100 | - | ns | |
| | trgbr, trgbf | DOTCLK, HSYNC, VSYNC rise/fall time | - | 15 | ns | |

Note: Ta = -30 to 70 °C, VDDI=1.65V to 3.3V, VCI=2.5V to 3.3V, AGND=VSS=0V



Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

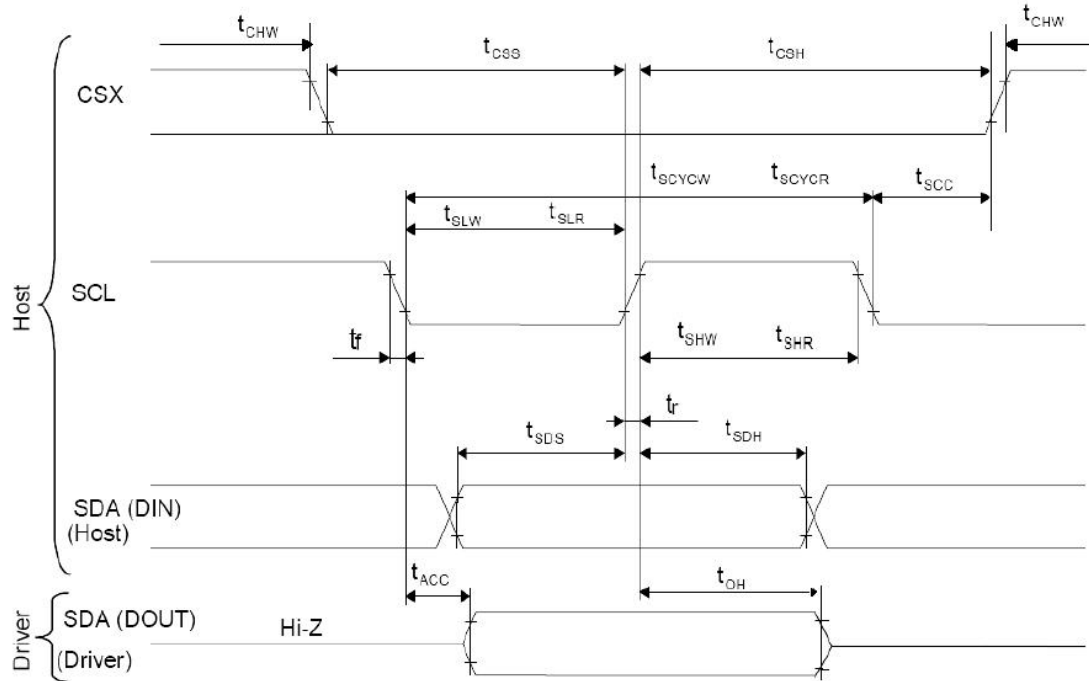
Page.

A

2020,07,17

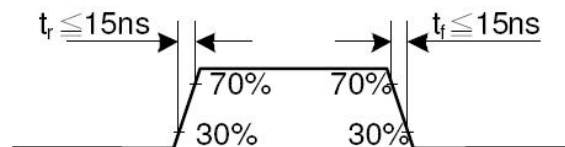
13 / 24

18.3.3 Display Serial Interface Timing Characteristics (3-line SPI system)



| Signal | Symbol | Parameter | min | max | Unit | Description |
|--------------------|--------|-----------------------------|-----|-----|------|-------------|
| SCL | tscycw | Serial Clock Cycle (Write) | 100 | - | ns | |
| | tshw | SCL "H" Pulse Width (Write) | 40 | - | ns | |
| | tslw | SCL "L" Pulse Width (Write) | 40 | - | ns | |
| | tscycr | Serial Clock Cycle (Read) | 150 | - | ns | |
| | tshr | SCL "H" Pulse Width (Read) | 60 | - | ns | |
| | tslr | SCL "L" Pulse Width (Read) | 60 | - | ns | |
| SDA / SDI (Input) | tsds | Data setup time (Write) | 30 | - | ns | |
| | tsdh | Data hold time (Write) | 30 | - | ns | |
| SDA / SDO (Output) | tacc | Access time (Read) | 10 | - | ns | |
| | toh | Output disable time (Read) | 10 | 50 | ns | |
| CSX | tsc | SCL-CSX | 20 | - | ns | |
| | tchw | CSX "H" Pulse Width | 40 | - | ns | |
| | tcss | CSX-SCL Time | 60 | - | ns | |
| | tcs | | 65 | - | ns | |

Note: $T_a = 25\text{ }^\circ\text{C}$, $V_{DDI} = 1.65\text{V to } 3.3\text{V}$, $V_{CI} = 2.5\text{V to } 3.3\text{V}$, $AGND = VSS = 0\text{V}$



Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

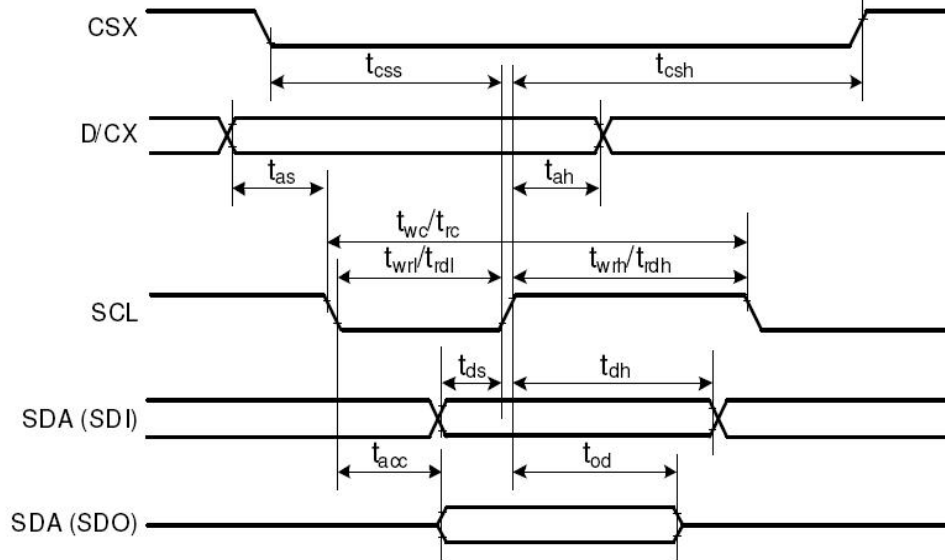
Page.

A

2020,07,17

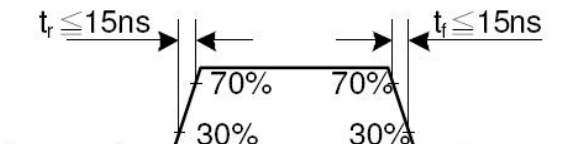
14 / 24

18.3.4 Display Serial Interface Timing Characteristics (4-line SPI system)



| Signal | Symbol | Parameter | min | max | Unit | Description |
|-----------------------|--------|-------------------------------|-----|-----|------|---------------------|
| CSX | tcss | Chip select time (Write) | 40 | - | ns | |
| | tcsh | Chip select hold time (Read) | 40 | - | ns | |
| SCL | twc | Serial clock cycle (Write) | 100 | - | ns | |
| | trc | Serial clock cycle (Read) | 150 | - | ns | |
| | twrh | SCL "H" pulse width (Write) | 40 | - | ns | |
| | trdl | SCL "L" pulse width (Read) | 60 | - | ns | |
| | trdh | SCL "H" pulse width (Read) | 60 | - | ns | |
| | trdl | SCL "L" pulse width (Read) | 60 | - | ns | |
| D/CX | tas | D/CX setup time | 10 | - | | |
| | tah | D/CX hold time (Write / Read) | 10 | - | | |
| SDA / SDI (Input) | tds | Data setup time (Write) | 30 | - | ns | |
| | tdh | Data hold time (Write) | 30 | - | ns | |
| SDA / SDO (Output) | tacc | Access time (Read) | 10 | - | ns | For maximum CL=30pF |
| | tod | Output disable time (Read) | 10 | 50 | ns | For minimum CL=8pF |

Note: $T_a = 25\text{ }^\circ\text{C}$, $V_{DDI}=1.65\text{V to }3.3\text{V}$, $V_{CI}=2.5\text{V to }3.3\text{V}$, $AGND=VSS=0\text{V}$



Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

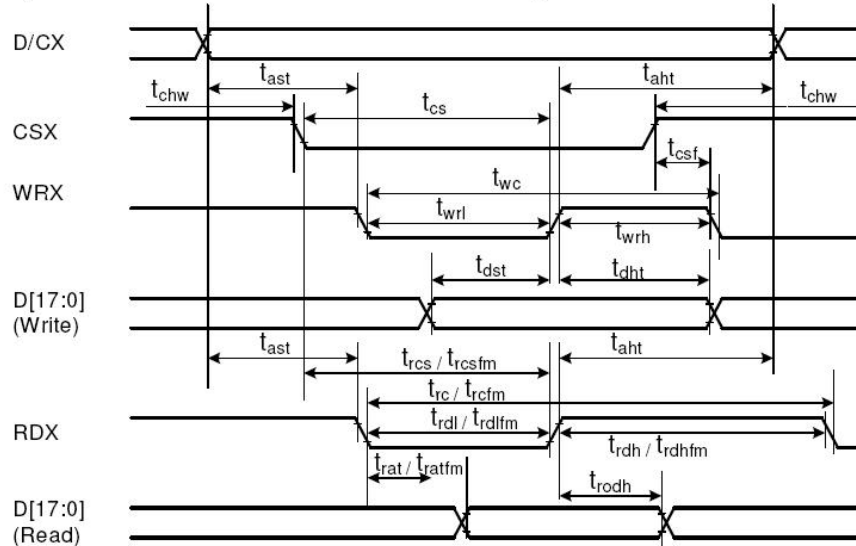
Page.

A

2020,07,17

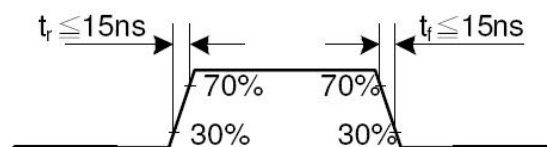
15 / 24

18.3.2 Display Parallel 18/16/9/8-bit Interface Timing Characteristics(8080- II system)



| Signal | Symbol | Parameter | min | max | Unit | Description |
|--|--------|------------------------------------|-----|-----|------|---|
| DCX | tast | Address setup time | 0 | - | ns | |
| | taht | Address hold time (Write/Read) | 0 | - | ns | |
| CSX | tchw | CSX "H" pulse width | 0 | - | ns | |
| | tcs | Chip Select setup time (Write) | 15 | - | ns | |
| | trcs | Chip Select setup time (Read ID) | 45 | - | ns | |
| | trcsfm | Chip Select setup time (Read FM) | 355 | - | ns | |
| | tcsf | Chip Select Wait time (Write/Read) | 10 | - | ns | |
| WRX | twc | Write cycle | 66 | - | ns | |
| | twrh | Write Control pulse H duration | 15 | - | ns | |
| | twrl | Write Control pulse L duration | 15 | - | ns | |
| RDX (FM) | trcfm | Read Cycle (FM) | 450 | - | ns | |
| | trdhfm | Read Control H duration (FM) | 90 | - | ns | |
| | trdlfm | Read Control L duration (FM) | 355 | - | ns | |
| RDX (ID) | trc | Read cycle (ID) | 160 | - | ns | |
| | trdh | Read Control pulse H duration | 90 | - | ns | |
| | trdl | Read Control pulse L duration | 45 | - | ns | |
| D[17:0], D[17:10]&D[8:1], D[17:10], D[17:9] | tdst | Write data setup time | 10 | - | ns | For maximum CL=30pF For minimum CL=8pF |
| | tdht | Write data hold time | 10 | - | ns | |
| | trat | Read access time | - | 40 | ns | |
| | tratfm | Read access time | - | 340 | ns | |
| | trod | Read output disable time | 20 | 80 | ns | |

Note: $T_a = -30$ to 70 °C, $V_{DDI}=1.65V$ to $3.3V$, $V_{CI}=2.5V$ to $3.3V$, $V_{SS}=0V$.



Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

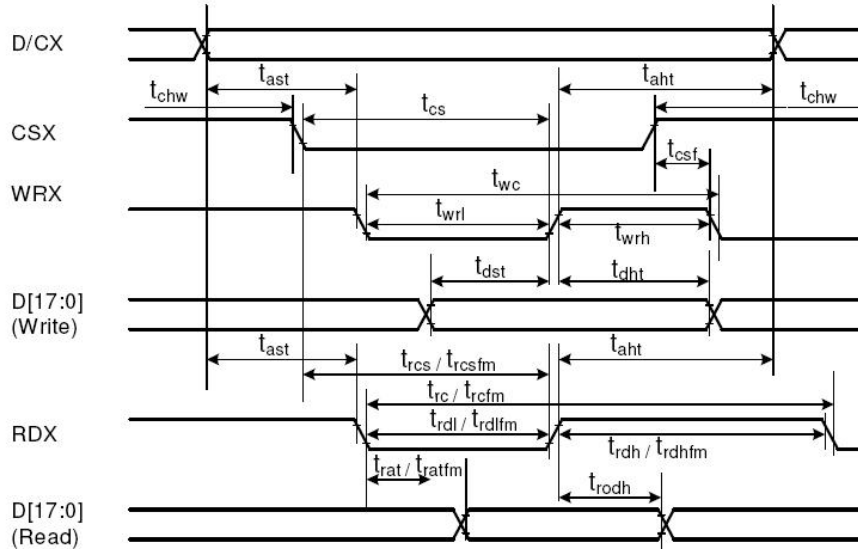
A

2020,07,17

16 / 24

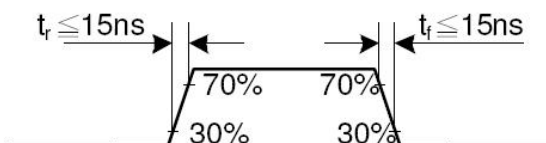
18.3 AC Characteristics

18.3.1 Display Parallel 18/16/9/8-bit Interface Timing Characteristics (8080- I system)




| Signal | Symbol | Parameter | min | max | Unit | Description |
|---|--------|------------------------------------|-----|-----|------|---|
| DCX | tast | Address setup time | 0 | - | ns | |
| | taht | Address hold time (Write/Read) | 0 | - | ns | |
| CSX | tchw | CSX "H" pulse width | 0 | - | ns | |
| | tcs | Chip Select setup time (Write) | 15 | - | ns | |
| | trcs | Chip Select setup time (Read ID) | 45 | - | ns | |
| | trcsfm | Chip Select setup time (Read FM) | 355 | - | ns | |
| | tcsf | Chip Select Wait time (Write/Read) | 10 | - | ns | |
| WRX | twc | Write cycle | 66 | - | ns | |
| | twrh | Write Control pulse H duration | 15 | - | ns | |
| | twrl | Write Control pulse L duration | 15 | - | ns | |
| RDX (FM) | trcfm | Read Cycle (FM) | 450 | - | ns | |
| | trdhfm | Read Control H duration (FM) | 90 | - | ns | |
| | trdlfm | Read Control L duration (FM) | 355 | - | ns | |
| RDX (ID) | trc | Read cycle (ID) | 160 | - | ns | |
| | trdh | Read Control pulse H duration | 90 | - | ns | |
| | trdl | Read Control pulse L duration | 45 | - | ns | |
| D[17:0], D[15:0], D[8:0], D[7:0] | tdst | Write data setup time | 10 | - | ns | For maximum CL=30pF For minimum CL=8pF |
| | tdht | Write data hold time | 10 | - | ns | |
| | trat | Read access time | - | 40 | ns | |
| | tratfm | Read access time | - | 340 | ns | |
| | trod | Read output disable time | 20 | 80 | ns | |

Note: $T_a = -30$ to 70 °C, $V_{DDI} = 1.65V$ to $3.3V$, $V_{CI} = 2.5V$ to $3.3V$, $V_{SS} = 0V$



Royal Display Co., Limited

| | | | | |
|---|-----------------------|----------|--------------|---------|
|  | Model: RYTPQ28NN08-02 | Rev. No. | Issued Date. | Page. |
| | | A | 2020,07,17 | 17 / 24 |

8 Reliability Condition for LCD

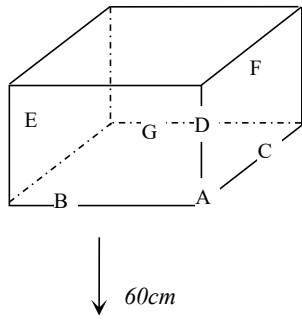
No change on display and in operation under the following test condition.

Condition: Unless otherwise specified, tests will be conducted under the following condition.

Temperature: 20±5°C Humidity: 65±5%RH

Tests will be not conducted under functioning state.

| No. | Parameter | Condition | Notes |
|-----|---|---|-------|
| 1 | High Temperature Operating | 70°C±2°C, 240hrs (Operation state) | -- |
| 2 | Low Temperature Operating | -20°C±2°C, 240hrs (Operation state) | -- |
| 3 | High Temperature Storage | 80°C±2°C, 240hrs | -- |
| 4 | Low Temperature Storage | -30°C±2°C, 240hrs | -- |
| 5 | High Temperature and High Humidity Operation Test | 60°C±2°C, 90%, 240hrs | -- |
| 6 | Vibration Test | Total fixed amplitude: 1.5mm Vibration Frequency: 10~55Hz One cycle 60 seconds to 3 direction of X, Y, Z each 15 minutes. | -- |

| | | | |
|----|-----------|--|----|
| 7. | Drop Test | <p>To be measured after dropping from 60cm high on the concrete surface in packing state.</p> <div style="text-align: center;">  </div> <p style="text-align: right; margin-right: 20px;"> <i>Dropping method corner dropping</i> <i>A corner: once</i> <i>Edge dropping</i> <i>B, C, D edge: once</i> <i>Face dropping</i> <i>E, F, G face: once</i> </p> | -- |
|----|-----------|--|----|

- Notes:
1. No dew condensation to be observed.
 2. The function test shall be conducted after 4 hours storage at the normal temperature and humidity after removed from the test chamber.
 3. Vibration test will be conducted to the product itself without putting I in a container.

Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

A

2020,07,17

18 / 24

9 Dimensional outlines

CUSTOMER'S APPROVED:

REV.

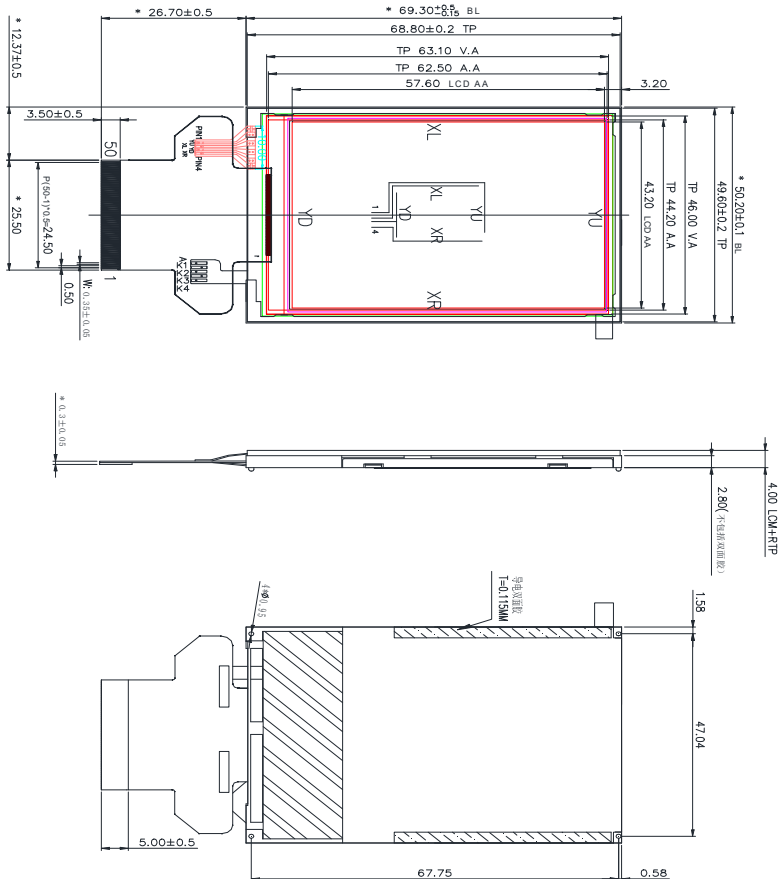
DESCRIPTION OF MODIFY

DATE

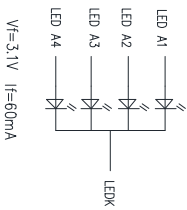
A

First Issue

2020-07-17



| | |
|--------------------------|---------------|
| Display Type | TFI |
| 262K COLORS TRANSMISSIVE | |
| VIEWING ANGLE | 6:00 CLOCK |
| LCD DRIVE IC | ILI9341V |
| OPERATING VOLTAGE | VDD=3.3V |
| BRIGHTNESS | 300nit(typ) |
| OPERATION TEMPERATURE | -20C° TO 70C° |
| STORAGE TEMPERATURE | -30C° TO 80C° |



| PIN | SYMBOL |
|-----|--------|
| 1 | LED A1 |
| 2 | LED A2 |
| 3 | LED A2 |
| 4 | LED A3 |
| 5 | LED A4 |
| 6 | LED A4 |
| 7 | MI |
| 8 | MI2 |
| 9 | MI3 |
| 10 | RES |
| 11 | VSYN |
| 12 | RESN |
| 13 | DOCK |
| 14 | RES |
| 15 | RES |
| 16 | RES |
| 17 | RES |
| 18 | RES |
| 19 | RES |
| 20 | RES |
| 21 | RES |
| 22 | RES |
| 23 | RES |
| 24 | RES |
| 25 | RES |
| 26 | RES |
| 27 | RES |
| 28 | RES |
| 29 | RES |
| 30 | RES |
| 31 | RES |
| 32 | RES |
| 33 | RES |
| 34 | RES |
| 35 | RES |
| 36 | RES |
| 37 | RES |
| 38 | RES |
| 39 | RES |
| 40 | RES |
| 41 | RES |
| 42 | RES |
| 43 | RES |
| 44 | RES |
| 45 | RES |
| 46 | RES |
| 47 | RES |
| 48 | RES |
| 49 | RES |
| 50 | RES |

CHECKED BY: 深圳市罗亚微电子科技有限公司
 Royal Display Co., Limited

DESIGNED BY: Lemton

VERSION: 1.0

NO. 1 OF 1

APPROVED BY: Siom

UNIT: MM

DATE: YYY-MM-DD

Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

A

2020,07,17

19 / 24

10 Incoming Inspection Standards

10.1 VISUAL & FUNCTION INSPECTION STANDARD

10.1.1 Inspection conditions

Inspection performed under the following conditions is recommended.

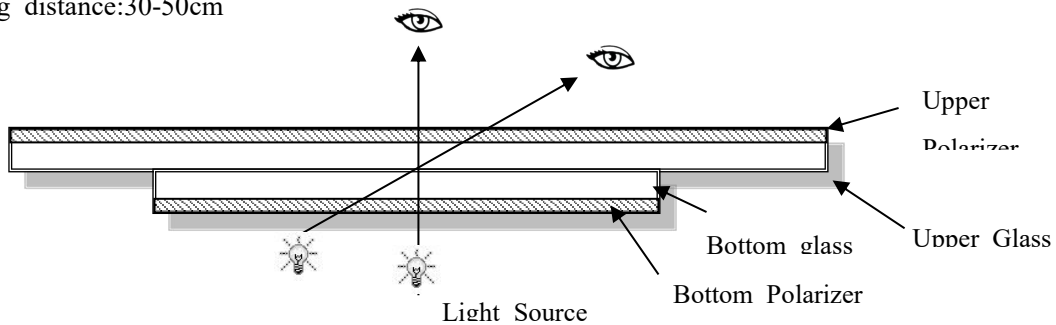
Temperature : $25 \pm 5^{\circ}\text{C}$

Humidity : $65\% \pm 10\% \text{RH}$

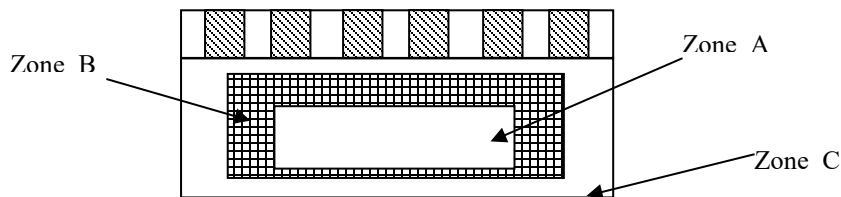
Viewing Angle : Normal viewing Angle.

Illumination: Single fluorescent lamp (300 to 700Lux)

Viewing distance: 30-50cm



10.1.2 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) which can not be seen after assembly by customer .)

Note:

As a general rule ,visual defects in Zone C can be ignored when it doesn't effect product function

or appearance after assembly by customer.

Royal Display Co., Limited

| | | | | |
|---|-----------------------|----------|--------------|---------|
|  | Model: RYTPQ28NN08-02 | Rev. No. | Issued Date. | Page. |
| | | A | 2020,07,17 | 20 / 24 |

10.1.3 Sampling Plan

According to GB/T 2828-2003 ; , normal inspection, Class II

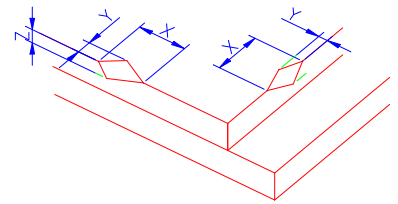
AQL:

| | |
|--------------|--------------|
| Major defect | Minor defect |
| 0.65 | 1.5 |

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

| No | Items to be inspected | Criteria | Classification of defects |
|----|-----------------------|---|---------------------------|
| 1 | Functional defects | 1) No display, Open or miss line 2) Display abnormally, Short 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 | Soldering appearance | Good soldering , Peeling off is not allowed. | |
| 6 | LCD/Polarizer/TP | Black/White spot/line, scratch, crack, etc. | |

10.1.4 Criteria (Visual)

| Number | Items | Criteria(mm) | | | |
|-------------------------|----------------------------|--|---|---|---|
| 1.0 LCD Crack/Broken | (1) The edge of LCD broken |  | | | |
| NOTE: | | <table border="1" style="margin: auto; border-collapse: collapse;"> <tr> <td style="width: 30%; text-align: center;">X</td> <td style="width: 30%; text-align: center;">Y</td> <td style="width: 30%; text-align: center;">Z</td> </tr> </table> | X | Y | Z |
| X | Y | Z | | | |

Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

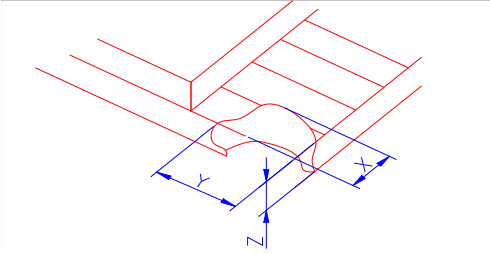
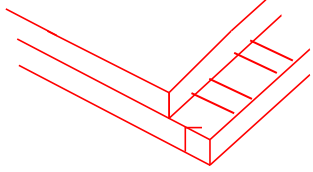
Issued Date.

Page.

A

2020,07,17

21 / 24

| X: Length Y: Width Z: Height L: Length of ITO, T: Height of LCD | | $\leq 3.0\text{mm}$ | $< \text{Inner border line of the seal}$ | $\leq T$ | | | | | |
|---|---|--|--|----------|---|---|---|---------------------|----------|
| | (2) LCD corner broken |  | | | | | | | |
| | | <table border="1"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td>$\leq 3.0\text{mm}$</td> <td>$\leq L$</td> <td>$\leq T$</td> </tr> </tbody> </table> | | | X | Y | Z | $\leq 3.0\text{mm}$ | $\leq L$ |
| X | Y | Z | | | | | | | |
| $\leq 3.0\text{mm}$ | $\leq L$ | $\leq T$ | | | | | | | |
| (3) LCD crack |  <p style="text-align: center;">Crack Not allowed</p> | | | | | | | | |

Royal Display Co.,Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

A

2020,07,17

22 / 24

| Number | Items | Criteria (mm) |
|--------|-------|---------------|
|--------|-------|---------------|

Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

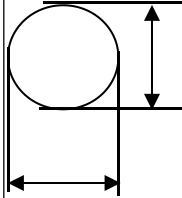
A

2020,07,17

23 / 24

2.0

Spot defect



Y

X

$$\Phi = (X+Y)/2$$

① light dot (LCD/TP/Polarizer black/white spot , light dot, pinhole, dent, stain)

| Zone Size (mm) | Acceptable Qty | | |
|-------------------------|----------------------------------|---|---|
| | A | B | C |
| $\Phi \leq 0.10$ | Ignore | | |
| $0.10 < \Phi \leq 0.15$ | 3(distance $\geq 10\text{mm}$) | | |
| $0.15 < \Phi \leq 0.2$ | 1 | | |
| $0.2 < \Phi$ | 0 | | |

② Dim spot (LCD/TP/Polarizer dim dot, light leakage, dark spot)

| Zone Size (mm) | Acceptable Qty | | |
|-----------------------|----------------------------------|---|---|
| | A | B | C |
| $\Phi \leq 0.1$ | Ignore | | |
| $0.1 < \Phi \leq 0.2$ | 2(distance $\geq 10\text{mm}$) | | |
| $0.2 < \Phi \leq 0.3$ | 1 | | |
| $\Phi > 0.3$ | 0 | | |

③ Polarizer accidented spot

| Zone Size (mm) | Acceptable Qty | | |
|-----------------------|----------------------------------|---|---|
| | A | B | C |
| $\Phi \leq 0.2$ | Ignore | | |
| $0.2 < \Phi \leq 0.5$ | 2(distance $\geq 10\text{mm}$) | | |
| $\Phi > 0.5$ | 0 | | |

Royal Display Co., Limited



Model: RYTPQ28NN08-02

Rev. No.

Issued Date.

Page.

A

2020,07,17

24 / 24

| | Line defect (LCD/TP /Polarizer black/white line, scratch, stain) | <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2" style="width: 25%;">Width(mm)</th> <th rowspan="2" style="width: 25%;">Length(mm)</th> <th colspan="3" style="width: 50%;">Acceptable Qty</th> </tr> <tr> <th style="width: 16.6%;">A</th> <th style="width: 16.6%;">B</th> <th style="width: 16.6%;">C</th> </tr> </thead> <tbody> <tr> <td>$\Phi \leq 0.03$</td> <td>Ignore</td> <td colspan="3">Ignore</td> </tr> <tr> <td>$0.03 < W \leq 0.05$</td> <td>$L \leq 3.0$</td> <td colspan="3">$N \leq 2$</td> </tr> <tr> <td>$0.05 < W \leq 0.08$</td> <td>$L \leq 2.0$</td> <td colspan="3">$N \leq 2$</td> </tr> <tr> <td>$0.08 < W$</td> <td colspan="4" style="text-align: center;">Define as spot defect</td> </tr> </tbody> </table> | Width(mm) | Length(mm) | Acceptable Qty | | | A | B | C | $\Phi \leq 0.03$ | Ignore | Ignore | | | $0.03 < W \leq 0.05$ | $L \leq 3.0$ | $N \leq 2$ | | | $0.05 < W \leq 0.08$ | $L \leq 2.0$ | $N \leq 2$ | | | $0.08 < W$ | Define as spot defect | | | |
|----------------------|--|---|-------------------|----------------|----------------|--|---|---|---|--------------|------------------|--------|--------|--------------------|----------------------------------|----------------------|--------------|--------------------|---|--|----------------------|--------------|------------|--|--|------------|-----------------------|--|--|--|
| Width(mm) | Length(mm) | Acceptable Qty | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | A | B | C | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $\Phi \leq 0.03$ | Ignore | Ignore | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $0.03 < W \leq 0.05$ | $L \leq 3.0$ | $N \leq 2$ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $0.05 < W \leq 0.08$ | $L \leq 2.0$ | $N \leq 2$ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $0.08 < W$ | Define as spot defect | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3.0 | Polarizer bubble | <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2" style="width: 25%;">Zone Size (mm)</th> <th colspan="3" style="width: 75%;">Acceptable Qty</th> </tr> <tr> <th style="width: 25%;">A</th> <th style="width: 25%;">B</th> <th style="width: 25%;">C</th> </tr> </thead> <tbody> <tr> <td>$\Phi < 0.2$</td> <td colspan="3" style="text-align: center;">Ignore</td> </tr> <tr> <td>$0.2 < \Phi < 0.4$</td> <td colspan="3" style="text-align: center;">2 (distance $\geq 10\text{mm}$)</td> </tr> <tr> <td>$0.4 < \Phi < 0.6$</td> <td colspan="3" style="text-align: center;">1</td> </tr> <tr> <td>$0.6 < \Phi$</td> <td colspan="3" style="text-align: center;">0</td> </tr> </tbody> </table> | Zone Size (mm) | Acceptable Qty | | | A | B | C | $\Phi < 0.2$ | Ignore | | | $0.2 < \Phi < 0.4$ | 2 (distance $\geq 10\text{mm}$) | | | $0.4 < \Phi < 0.6$ | 1 | | | $0.6 < \Phi$ | 0 | | | | | | | |
| Zone Size (mm) | Acceptable Qty | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | A | B | C | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $\Phi < 0.2$ | Ignore | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $0.2 < \Phi < 0.4$ | 2 (distance $\geq 10\text{mm}$) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $0.4 < \Phi < 0.6$ | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $0.6 < \Phi$ | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.0 | SMT | According to IPC-A-610C class II standard . Function defect and missing part are major defect ,the others are minor defect. | | | | | | | | | | | | | | | | | | | | | | | | | | | | |