TFT COLOR LCD MODULE

NL10276BC20-04

26.3cm (10.4 Type)
XGA

DATA SHEET

(5th edition)

All information is subject to change without notice.
Please confirm the delivery specification before starting to design your system.
INTRODUCTION

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Anti-radioactive design is not implemented in this product.
CONTENTS

INTRODUCTION ................................................................................................................... 2

1. OUTLINE ........................................................................................................................ 5
   1.1 STRUCTURE AND PRINCIPLE .................................................................................. 5
   1.2 APPLICATIONS ......................................................................................................... 5
   1.3 FEATURES ................................................................................................................. 5

2. GENERAL SPECIFICATIONS ............................................................................................ 6

3. BLOCK DIAGRAM ........................................................................................................... 7

4. DETAILED SPECIFICATIONS .......................................................................................... 8
   4.1 MECHANICAL SPECIFICATIONS ............................................................................. 8
   4.2 ABSOLUTE MAXIMUM RATINGS .......................................................................... 8
   4.3 ELECTRICAL CHARACTERISTICS ......................................................................... 9
       4.3.1 Driving for LCD panel signal processing board ...................................................... 9
       4.3.2 Working for backlight lamp ................................................................................. 9
       4.3.3 Power supply voltage ripple .............................................................................. 10
       4.3.4 Fuses ............................................................................................................... 10
   4.4 POWER SUPPLY VOLTAGE SEQUENCE .................................................................. 11
       4.4.1 Sequence for LCD panel signal processing board ................................................... 11
       4.4.2 Sequence for backlight inverter (Option) .............................................................. 11
   4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS ........................................ 12
       4.5.1 LCD panel signal processing board ..................................................................... 12
       4.5.2 Backlight lamp ................................................................................................... 13
       4.5.3 Positions of a plug and a socket ......................................................................... 13
       4.5.4 Connection between receiver and transmitter for LVDS ....................................... 14
   4.6 DISPLAY COLORS AND INPUT DATA SIGNALS ....................................................... 15
   4.7 DISPLAY POSITIONS .................................................................................................. 16
   4.8 SCANNING DIRECTIONS ........................................................................................... 16
   4.9 INPUT SIGNAL TIMINGS FOR LCD PANEL SIGNAL PROCESSING BOARD ............... 17
       4.9.1 Outline of input signal timings ............................................................................ 17
       4.9.2 Detailed input signal timing chart for DE mode .................................................... 17
       4.9.3 Timing characteristics ....................................................................................... 18
   4.10 OPTICS .................................................................................................................... 19
       4.10.1 Optical characteristics ..................................................................................... 19
       4.10.2 Definition of contrast ratio .............................................................................. 20
       4.10.3 Definition of luminance uniformity ................................................................. 20
       4.10.4 Definition of response times ............................................................................. 20
       4.10.5 Definition of viewing angles ............................................................................. 20
## CONTENTS

5. RELIABILITY TESTS .................................................................................................................. 21

6. PRECAUTIONS ..................................................................................................................... 22
   6.1 MEANING OF CAUTION SIGNS ....................................................................................... 22
   6.2 CAUTIONS ....................................................................................................................... 22
   6.3 ATTENTIONS .................................................................................................................... 22
      6.3.1 Handling of the product .......................................................................................... 22
      6.3.2 Environment .......................................................................................................... 22
      6.3.3 Characteristics ........................................................................................................ 23
      6.3.4 Other ...................................................................................................................... 23

7. OUTLINE DRAWINGS .......................................................................................................... 24
   7.1 FRONT VIEW .................................................................................................................... 24
   7.2 REAR VIEW ..................................................................................................................... 25
1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

NL10276BC20-04 module is composed of the amorphous silicon thin film transistor liquid crystal display (a-Si TFT LCD) panel structure with driver LSIs for driving the TFT (Thin Film Transistor) array and a backlight unit.

The a-Si TFT LCD panel structure is injected liquid crystal material into a narrow gap between the TFT array glass substrate and a color-filter glass substrate.

Color (Red, Green, Blue) data signals from a host system (e.g. PC, signal generator, etc.) are modulated into best form for active matrix system by a signal processing board, and sent to the driver LSIs which drive the individual TFT arrays.

The TFT array as an electro-optical switch regulates the amount of transmitted light from the backlight assembly, when it is controlled by data signals. Color images are created by regulating the amount of transmitted light through the TFT array of red, green and blue dots.

1.2 APPLICATIONS

- Display terminal for control system
- Industrial PC

1.3 FEATURES

- High luminance
- Wide viewing angle
- Extensive temperature
- 6-bit digital RGB signals
- Single link LVDS interface
- Reversible-scan direction
- Edge light type
- Replaceable lamp for backlight unit (Inverter less)
- Acquisition product for UL1950 3rd edition/CSA C22.2 No.950-95 (File number: E170632)
2. GENERAL SPECIFICATIONS

**Display area**  
210.4 (W) × 157.8 (H) mm (typ.)

**Diagonal size of display**  
26.3 cm (10.4 inches)

**Drive system**  
a-Si TFT active matrix

**Display color**  
262,144 colors

**Pixel**  
1,024 (H) × 768 (V) pixels

**Pixel arrangement**  
RGB (Red dot, Green dot, Blue dot) vertical stripe

**Dot pitch**  
0.0685 (W) × 0.2055 (H) mm

**Pixel pitch**  
0.2055 (W) × 0.2055 (H) mm

**Module size**  
243.0 (W) × 185.1 (H) × 11.0 (D) mm (typ.)

**Weight**  
530 g (typ.)

**Contrast ratio**  
300:1 (typ.)

**Viewing angle**  
At the contrast ratio 10:1
- Horizontal: Left side 60° (typ.), Right side 60° (typ.)
- Vertical: Up side 45° (typ.), Down side 60° (typ.)

**Designed viewing direction**  
At DPSR: normal scan
- Viewing direction without image reversal: up side (12 o'clock)
- Viewing direction with contrast peak: down side 5° to 10° (6 o'clock)
- Viewing angle with optimum grayscale (γ=2.2): normal axis

**Polarizer surface**  
Non matt treatment

**Polarizer pencil-hardness**  
3H (min.) [by JIS K5400]

**Color gamut**  
At LCD panel center  
40 % (typ.) [against NTSC color space]

**Response time**  
Ton (White 90% → Black 10%)
15 ms (typ.)

**Luminance**  
At 5.0mA rms / lamp  
300 cd/m² (typ.)

**Signal system**  
Single link LVDS (Receiver: THC63LVDF64A, THine Electronics Inc.)  
[6-bit digital signals for data of RGB colors,  
Dot clock (CLK), Data enable (DE)]

**Power supply voltage**  
LCD panel signal processing board: 3.3V

**Backlight**  
Edge light type: 2 cold cathode fluorescent lamps

- Replaceable parts
  - Lamps for backlight unit: Type No. 104LHS35

- Recommended inverter (Option)
  - Inverter: Type No. 104PW191

**Power consumption**  
At maximum luminance and checkered flag pattern  
6.2W (typ.)
3. BLOCK DIAGRAM

Note1: GND (Signal ground) and GNDB (Backlight inverter ground) should be connected together in customer equipment.

Note2: Neither FG (Frame ground) nor the metallic frame of lamp holder is connected to VBLC (Lamp low voltage terminal).
Note3: Connections between GND, FG (Frame ground) and VBLC in the LCD module

<table>
<thead>
<tr>
<th>Connections</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>GND - FG</td>
<td>Not connected</td>
</tr>
<tr>
<td>GND - VBLC</td>
<td>Not connected</td>
</tr>
<tr>
<td>FG - VBLC</td>
<td>Not connected</td>
</tr>
</tbody>
</table>

4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module size</td>
<td>243.0 ± 0.5 (W) × 185.1 ± 0.5 (H) × 11.0 ± 0.5 (D)</td>
<td>mm</td>
</tr>
<tr>
<td>Display area</td>
<td>210.4 ± 0.5 (W) × 157.8 ± 0.5 (H)</td>
<td>mm</td>
</tr>
<tr>
<td>Weight</td>
<td>530 (typ.), 550 (max.)</td>
<td>g</td>
</tr>
</tbody>
</table>

Note1: See "11. OUTLINE DRAWINGS".

4.2 ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply voltage</td>
<td>LCD panel signal board</td>
<td>VCC</td>
<td>-0.3 to +4.0</td>
<td>V</td>
</tr>
<tr>
<td>Lamp voltage Note1</td>
<td>VBLH</td>
<td>1,500 Vrms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input voltage for signals</td>
<td>Display signals Note2</td>
<td>VD</td>
<td>-0.3 to VCC+0.3</td>
<td>V</td>
</tr>
<tr>
<td>Function signals Note3</td>
<td>VF</td>
<td>-0.3 to VCC+0.3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>Tst</td>
<td>-20 to +70 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>Front surface</td>
<td>TopF</td>
<td>0 to +60 °C</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td>Rear surface</td>
<td>TopR</td>
<td>0 to +60 °C</td>
<td>°C</td>
</tr>
<tr>
<td>Relative humidity Note4</td>
<td>RH</td>
<td>≤ 95 %</td>
<td>°C</td>
<td>Ta ≤ 40°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤ 85 %</td>
<td>°C</td>
<td>40 &lt; Ta ≤ 50°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤ 70 %</td>
<td>°C</td>
<td>50 &lt; Ta ≤ 55°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤ 60 %</td>
<td>°C</td>
<td>55 &lt; Ta ≤ 60°C</td>
</tr>
<tr>
<td>Absolute humidity Note4</td>
<td>AH</td>
<td>≤ 78 g/m³</td>
<td>°C</td>
<td>Ta &gt; 60°C</td>
</tr>
</tbody>
</table>

Note1: "VBLH" is the voltage value between low voltage terminal (Cold) and high voltage terminal (Hot).
Note2: Display signals are D0+/-, D1+/-, D2+/- and CK+/-.
Note3: Function signal is DPSR.
Note4: No condensation.
Note5: Ta = 60°C, RH = 60%
4.3 ELECTRICAL CHARACTERISTICS

4.3.1 Driving for LCD panel signal processing board

\[
\begin{array}{|c|c|c|c|c|c|c|}
\hline
\text{Parameter} & \text{Symbol} & \text{Min.} & \text{Typ.} & \text{Max.} & \text{Unit} & \text{Remarks} \\
\hline
\text{Power supply voltage} & \text{VCC} & 3.0 & 3.3 & 3.6 & \text{V} & - \\
\hline
\text{Power supply current} & \text{ICC} & - & - & 300 \text{ Note1} & 500 \text{ Note2} & \text{mA} \\
\hline
\text{Input voltage for LVDS receiver} & \text{VDRL} & 2.0 & 2.4 & - & \text{V} & - \\
\hline
\text{High VDRL} & & 0 & - & 0.8 & \text{V} & - \\
\hline
\text{Differential input threshold voltage for LVDS receiver} & \text{VTRL} & -100 & - & - & \text{mV} & \text{VOC=1.2V} \\
\hline
\text{High VTH} & & - & - & +100 & \text{mV} & \text{Note3} \\
\hline
\text{Input voltage for DPSR signal} & \text{VFDL} & 0 & - & 0.8 & \text{V} & - \\
\hline
\text{High VFDR} & & 2.0 & - & - & \text{VCC} & - \\
\hline
\end{array}
\]

\text{Note1: Checkered flag pattern (by EIAJ ED-2522)}

\text{Note2: Pattern for maximum current}

\text{Note3: Common mode voltage for LVDS receiver}

4.3.2 Working for backlight lamp

\[
\begin{array}{|c|c|c|c|c|c|c|}
\hline
\text{Parameter} & \text{Symbol} & \text{Ta} & \text{Min.} & \text{Typ.} & \text{Max.} & \text{Unit} & \text{Remarks} \\
\hline
\text{Lamp starting voltage} & \text{VS} & 0\degree \text{C} & 1.100 & - & - & \text{Vrms} & \text{Note1} \\
\hline
\text{25\degree \text{C}} & 850 & - & - & - & \text{Vrms} & \text{Note1} \\
\hline
\text{Lamp starting voltage} & \text{VBLH} & 25\degree \text{C} & - & 520 & - & \text{Vrms} & \text{Note1, Note2} \\
\hline
\text{Lamp current} & \text{IBL} & 25\degree \text{C} & 2.0 & 5.0 & 5.5 & \text{mArms} & \text{Note2, Note3} \\
\hline
\text{Lamp oscillation frequency} & \text{FO} & 25\degree \text{C} & 60 & 65 & 70 & \text{kHz} & \text{Note4} \\
\hline
\end{array}
\]

\text{Note1: The power supply voltage cycle between lamps should be kept on a same phase. "VS" and "VBLH" are the voltage value between low voltage side (Cold) and high voltage side (Hot).}

\text{Note2: The asymmetric ratio of working waveform for lamps (Power supply voltage peak ratio, power supply current peak ratio and waveform space ratio) should be less than 5 % (See the following figure.). If the waveform is asymmetric, DC (Direct current) element apply into the lamp. In this case, a lamp lifetime may be shortened, because a distribution of a lamp enclosure substance inclines toward one side between low voltage terminal (Cold terminal) and high voltage terminal (Hot terminal).}

\[
\frac{|Pa - Pb|}{Pb} \times 100 \leq 5 \%
\]

\[
\frac{|Sa - Sb|}{Sb} \times 100 \leq 5 \%
\]

\text{Pa: Supply voltage/current peak for positive, Pb: Supply voltage/current peak for negative}

\text{Sa: Waveform space for positive part, Sb: Waveform space for negative part}

\text{Note3: The lamp holder of this product contains two backlight lamps. The low voltage terminal of both lamps is connected to one contact point. Also above power supply current specification is one lamp duty. Therefore, this lamp holder becomes twice as many power supply current as above value on low voltage (Cold) line. The measurement for the power supply current value of one lamp should measure on high voltage (Hot) line to each lamp.}

\text{Note4: In case "FO" is not the recommended value, beat noise may display on the screen, because of interference between "FO" and "1/th". Recommended value of "FO" is as following.}

\[
FO = \frac{1}{4} \times \frac{1}{\text{th}} \times (2n-1)
\]

\text{th: Horizontal synchronous cycle (See "4.9.3 Timing characteristics".)}

\text{n: Natural number (1, 2, 3 \cdots\cdots)}
4.3.3 Power supply voltage ripple

This product works, even if the ripple voltage levels are beyond the permissible values as following the table, but there might be noise on the display image.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Power supply voltage</th>
<th>Ripple voltage (Measure at input terminal of power supply)</th>
<th>Note1</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCC</td>
<td>3.3 V</td>
<td>≤ 100</td>
<td></td>
<td>mVp-p</td>
</tr>
</tbody>
</table>

Note1: The permissible ripple voltage includes spike noise.

4.3.4 Fuses

<table>
<thead>
<tr>
<th>Fusing line</th>
<th>Fuse</th>
<th>Supplier</th>
<th>Rating</th>
<th>Fusing current Note1</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCC</td>
<td>TF16N2.00</td>
<td>KOA Corporation</td>
<td>2.0 A</td>
<td>4.0 A</td>
</tr>
</tbody>
</table>

Note1: The power supply capacity should be more than the fusing current. If the power supply capacity is less than the fusing current, the fuse may not blow for a short time, and then nasty smell, smoking and so on may occur.
4.4 POWER SUPPLY VOLTAGE SEQUENCE

4.4.1 Sequence for LCD panel signal processing board

Note1: In terms of voltage variation (voltage drop) while VCC rising edge is below 3.0V, a protection circuit may work, and then this product may not work.

Note2: Display (D0+/–, D1+/–, D2+/– and CK+/–) with 100Ω (Characteristic impedance) and function (DPSR) signals must be Low or High-impedance, exclude the VALID period (See above sequence diagram), in order to avoid that internal circuits is damaged.

If some of display and function signals of this product are cut while this product is working, even if the signal input to it once again, it might not work normally. If customer stops the display and function signals, they should be cut VCC.

4.4.2 Sequence for backlight inverter (Option)

Note1: These are display and function signals for LCD panel signal processing board.

Note2: The backlight inverter voltage (VDDB) should be inputted within the valid period of display and function signals, in order to avoid unstable data display.
4.5 CONNECTIONS AND FUNCTIONS FOR INTERFACE PINS

4.5.1 LCD panel signal processing board

CN1 socket (Module side): FI-SE20P-HF (Japan Aviation Electronics Industry Limited)
Adaptable plug: FI-S20S (Japan Aviation Electronics Industry Limited)

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Symbol</th>
<th>Function</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>Ground</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>DPSR</td>
<td>Select of scan direction</td>
<td>High: Reverse scan</td>
</tr>
</tbody>
</table>
|         |        |                           | Low or Open: Normal scan  | Note1
| 4       | NC     | Non connection            | -                        |
| 5       | GND    | Ground                    | -                        |
| 6       | CK+    | Pixel clock               | Note2                    |
| 7       | CK-    |                           |                          |
| 8       | GND    | Ground                    | -                        |
| 9       | D2+    | Pixel data                | Note2                    |
| 10      | D2-    |                           |                          |
| 11      | GND    | Ground                    | -                        |
| 12      | D1+    | Pixel data                | Note2                    |
| 13      | D1-    |                           |                          |
| 14      | GND    | Ground                    | -                        |
| 15      | D0+    | Pixel data                | Note2                    |
| 16      | D0-    |                           |                          |
| 17      | GND    | Ground                    |                          |
| 18      | GND    |                           |                          |
| 19      | VCC    | Power supply              |                          |
| 20      | VCC    |                           |                          |

Note1: See "4.8 SCANNING DIRECTIONS".
Note2: Twist pair wires with 100Ω (Characteristic impedance) should be connected between LCD panel signal processing board and LVDS transmitter.

CN1: Figure of socket

![CN1 Figure of socket](image)
4.5.2 Backlight lamp

CN2 plug: BHR-03VS-1 (J.S.T Mfg. Co., Ltd.)
Adaptable socket: SM03 (4.0) B-BHS-TB (J.S.T Mfg. Co., Ltd.)

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Symbol</th>
<th>Signal</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VBLC</td>
<td>Low voltage (Cold)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>VBLH</td>
<td>High voltage (Hot)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>VBLH</td>
<td>High voltage (Hot)</td>
<td></td>
</tr>
</tbody>
</table>

4.5.3 Positions of a plug and a socket

Low voltage (Cold)  Caution label

High voltage (Hot)
4.5.4 Connection between receiver and transmitter for LVDS

Note1: Recommended transmitter
See the data sheet for THC63LVDM63A (Thein Electronics Inc.).

Note2: TC4 should be fixed to “High”.

---

**Diagram:**

- **Host**
  - R0, R1, R2, R3, R4, R5
  - G0, G1, G2, G3, G4, G5
  - B0, B1, B2, B3, B4, B5
  - DE
  - CLK

- **Transmitter for LVDS**
  - THC63LVDM63A
  - VCC (+3.3V)
  - GND
  - ViFD

- **Socket CN1**
  - 1: GND
  - 2: GND
  - 3: DPSR
  - 4: NC
  - 5: GND
  - 6: CK+
  - 7: CK-
  - 8: GND
  - 9: D2+
  - 10: D2-
  - 11: GND
  - 12: D1+
  - 13: D1-
  - 14: GND
  - 15: D0+
  - 16: D0-
  - 17: GND
  - 18: GND
  - 19: VCC
  - 20: VCC

- **Receiver for LVDS**
- **Equivalent of THC63LVDF64A**
- **Panel driver**
- **LCD controller**
- **DC/DC converter**
- **LCD panel signal processing board**

---

**Legend:**
- **GND**: Ground
- **VCC**: Power supply (+3.3V)
- **ViFD**: Input reference voltage

---

**Notes:**
- **Note1**: Recommended transmitter
  See the data sheet for THC63LVDM63A (Thein Electronics Inc.).
- **Note2**: TC4 should be fixed to “High”.
4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display in equivalent to 262,144 colors in 64 scale. Also the relation between display colors and input data signals is as the following table.

<table>
<thead>
<tr>
<th>Display colors</th>
<th>Data signal (0: Low level, 1: High level)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R5</td>
</tr>
<tr>
<td>Basic colors</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>0</td>
</tr>
<tr>
<td>Blue</td>
<td>0</td>
</tr>
<tr>
<td>Red</td>
<td>1</td>
</tr>
<tr>
<td>Magenta</td>
<td>1</td>
</tr>
<tr>
<td>Green</td>
<td>0</td>
</tr>
<tr>
<td>Cyan</td>
<td>0</td>
</tr>
<tr>
<td>Yellow</td>
<td>1</td>
</tr>
<tr>
<td>White</td>
<td>1</td>
</tr>
<tr>
<td>Red scale</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>0</td>
</tr>
<tr>
<td>dark</td>
<td>0</td>
</tr>
<tr>
<td>↑</td>
<td></td>
</tr>
<tr>
<td>↓</td>
<td></td>
</tr>
<tr>
<td>bright</td>
<td>1</td>
</tr>
<tr>
<td>Red</td>
<td>1</td>
</tr>
<tr>
<td>Green scale</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>0</td>
</tr>
<tr>
<td>dark</td>
<td>0</td>
</tr>
<tr>
<td>↑</td>
<td></td>
</tr>
<tr>
<td>↓</td>
<td></td>
</tr>
<tr>
<td>bright</td>
<td>0</td>
</tr>
<tr>
<td>Green</td>
<td>0</td>
</tr>
<tr>
<td>Blue scale</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>0</td>
</tr>
<tr>
<td>dark</td>
<td>0</td>
</tr>
<tr>
<td>↑</td>
<td></td>
</tr>
<tr>
<td>↓</td>
<td></td>
</tr>
<tr>
<td>bright</td>
<td>0</td>
</tr>
<tr>
<td>Blue</td>
<td>0</td>
</tr>
</tbody>
</table>
4.7 DISPLAY POSITIONS

The following table is the coordinates per pixel (See figure of "4.8 SCANNING DIRECTIONS".).

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C( 0, 0)</td>
<td>C( 1, 0)</td>
<td>***</td>
<td>C( X, 0)</td>
<td>***</td>
</tr>
<tr>
<td>C( 0, 1)</td>
<td>C( 1, 1)</td>
<td>***</td>
<td>C( X, 1)</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C(1022, 0)</td>
<td>C(1023, 0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C( 0, Y)</td>
<td>C( 1, Y)</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C( X, Y)</td>
<td>***</td>
<td>C(1022, Y)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C(1022, 766)</td>
<td>C(1023, 766)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C( 0, 767)</td>
<td>C( 1, 767)</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C( X, 767)</td>
<td>***</td>
<td>C(1022, 767)</td>
</tr>
</tbody>
</table>

4.8 SCANNING DIRECTIONS

The following figures are seen from a front view. Also the arrow shows the direction of scan.

**Figure 1. Normal scan (DPSR: Low or Open)**

**Figure 2. Reverse scan (DPSR: High)**

**Note1**: Meaning of C (X, Y) and D (X, Y)
- C(X, Y): The coordinates of the display position (See "4.7 DISPLAY POSITIONS".)
- D(X, Y): The data number of input signal for LCD panel signal processing board
4.9 INPUT SIGNAL TIMINGS FOR LCD PANEL SIGNAL PROCESSING BOARD

4.9.1 Outline of input signal timings

- **Horizontal signal**

  ![Horizontal Signal Diagram]

  **Note1:** This diagram indicates virtual signal for set up to timing.

- **Vertical signal**

  ![Vertical Signal Diagram]

  **Note1:** This diagram indicates virtual signal for set up to timing.

  **Note2:** See "4.9.2 Input signal timing chart" for numeration of pulse.

4.9.2 Input signal timing chart

- **Outline chart**

  ![Outline Chart]

  **Note1:** X is data number from 1 to 1022. See "4.8 SCANNING DIRECTIONS".
4.9.3 Timing characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Note1</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (LVDS receiver)</td>
<td></td>
<td>tcf</td>
<td>60.0</td>
<td>65.0</td>
<td>68.0</td>
<td>MHz</td>
<td>15.4 ns (typ.) Note1</td>
</tr>
<tr>
<td>Duty</td>
<td></td>
<td>tcd</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Note1, Note2</td>
</tr>
<tr>
<td>Rise time, Fall time</td>
<td></td>
<td>tcrf</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Note1, Note2</td>
</tr>
<tr>
<td>CLK-DE</td>
<td>Note2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Setup time</td>
<td></td>
<td>tds</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Note2</td>
</tr>
<tr>
<td>Hold time</td>
<td></td>
<td>tdh</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Rise time, Fall time</td>
<td></td>
<td>tdrf</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Vertical (One frame)</td>
<td>Note1</td>
<td>Cycle</td>
<td>th</td>
<td>19.67</td>
<td>20.676</td>
<td>22.4</td>
<td>μs</td>
</tr>
<tr>
<td>Horizontal</td>
<td></td>
<td>Cycle</td>
<td>tv</td>
<td>13.3</td>
<td>16.666</td>
<td>18.5</td>
<td>ms</td>
</tr>
<tr>
<td>Display period</td>
<td></td>
<td>thd</td>
<td>1.024</td>
<td>1.344</td>
<td>-</td>
<td>CLK</td>
<td></td>
</tr>
<tr>
<td>Vertical (One frame)</td>
<td>Note1</td>
<td>Cycle</td>
<td>tv</td>
<td>780</td>
<td>806</td>
<td>-</td>
<td>H</td>
</tr>
<tr>
<td>Display period</td>
<td></td>
<td>tvd</td>
<td>768</td>
<td>768</td>
<td>-</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>CLK-DE</td>
<td>Note2</td>
<td>Setup time</td>
<td>tdes</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Hold time</td>
<td></td>
<td>tdeh</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Rise time, Fall time</td>
<td></td>
<td>tderf</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Note1: Definition of parameters is as follows.
\[ tcf = \frac{1}{tc}, \quad tcd = tch/tc = tch \times tcf, \quad tc = 1CLK, \quad th = 1H \]

Note2: See the data sheet of LVDS transmitter.

Note3: "th" must keep the fluctuation within ±1 CLK, because of avoidance of image sticking.
## 4.10 OPTICS

### 4.10.1 Optical characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Note1</th>
<th>Condition</th>
<th>Symbol</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contrast ratio</td>
<td></td>
<td>White/Black at center</td>
<td>CR</td>
<td>150</td>
<td>300</td>
<td>-</td>
<td>-</td>
<td>Note2</td>
</tr>
<tr>
<td>Luminance</td>
<td></td>
<td>White at center</td>
<td>L</td>
<td>240</td>
<td>300</td>
<td>-</td>
<td>cd/m²</td>
<td>-</td>
</tr>
<tr>
<td>Luminance uniformity</td>
<td></td>
<td></td>
<td>LU</td>
<td>-</td>
<td>1.24</td>
<td>1.40</td>
<td>-</td>
<td>Note3</td>
</tr>
<tr>
<td>Chromaticity</td>
<td></td>
<td>White</td>
<td>x coordinate</td>
<td>Wx</td>
<td>-</td>
<td>0.315</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>y coordinate</td>
<td>Wy</td>
<td>-</td>
<td>0.340</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Red</td>
<td>x coordinate</td>
<td>Rx</td>
<td>-</td>
<td>0.575</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>y coordinate</td>
<td>Ry</td>
<td>-</td>
<td>0.335</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green</td>
<td>x coordinate</td>
<td>Gx</td>
<td>-</td>
<td>0.332</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>y coordinate</td>
<td>Gy</td>
<td>-</td>
<td>0.536</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blue</td>
<td>x coordinate</td>
<td>Bx</td>
<td>-</td>
<td>0.153</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>y coordinate</td>
<td>By</td>
<td>-</td>
<td>0.150</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Color gamut</td>
<td></td>
<td>CR = 10, at center, against NTSC color space</td>
<td>C</td>
<td>35</td>
<td>40</td>
<td>-</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Response time</td>
<td></td>
<td>White to black</td>
<td>Ton</td>
<td>-</td>
<td>15</td>
<td>30</td>
<td>ms</td>
<td>Note5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Black to white</td>
<td>Toff</td>
<td>-</td>
<td>40</td>
<td>60</td>
<td>ms</td>
<td>Note6</td>
</tr>
<tr>
<td>Viewing angle</td>
<td></td>
<td>Right</td>
<td>0R = 0°, 0D = 0°, CR = 10</td>
<td>0R</td>
<td>-</td>
<td>60</td>
<td>-</td>
<td>°</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Left</td>
<td>0U = 0°, 0D = 0°, CR = 10</td>
<td>0L</td>
<td>-</td>
<td>60</td>
<td>-</td>
<td>°</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Up</td>
<td>0R = 0°, 0L = 0°, CR = 10</td>
<td>0U</td>
<td>-</td>
<td>45</td>
<td>-</td>
<td>°</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Down</td>
<td>0R = 0°, 0L = 0°, CR = 10</td>
<td>0D</td>
<td>-</td>
<td>60</td>
<td>-</td>
<td>°</td>
</tr>
</tbody>
</table>

Note1: Measurement conditions are as follows.
- Ta = 25°C, VCC = 3.3V, IBL = 5.0mA, Display mode: XGA, Horizontal cycle = 48.363kHz, Vertical cycle = 60.0Hz, DPSR = Low or Open: Normal scan
- Optical characteristics are measured at luminance saturation after 20 minutes from working the product, in the dark room. Also measurement method for luminance is as follows.

Note2: See "4.10.2 Definition of contrast ratio".
Note3: See "4.10.3 Definition of luminance uniformity".
Note4: These coordinates are found on CIE 1931 chromaticity diagram.
Note5: Product surface temperature: TopF = 25°C
Note6: See "4.10.4 Definition of response times".
Note7: See "4.10.5 Definition of viewing angles".
4.10.2 Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

\[ \text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}} \]

4.10.3 Definition of luminance uniformity

The luminance uniformity is calculated by using following formula.

\[ \text{Luminance uniformity (LU)} = \frac{\text{Maximum luminance from ① to ⑤}}{\text{Minimum luminance from ① to ⑤}} \]

The luminance is measured at near the 5 points shown below.

4.10.4 Definition of response times

Response time is measured, the luminance changes from "white" to "black", or "black" to "white" on the same screen point, by photo-detector. Ton is the time it takes the luminance change from 90% down to 10%. Also Toff is the time it takes the luminance change from 10% up to 90% (See the following diagram.).

4.10.5 Definition of viewing angles
## 5. RELIABILITY TESTS

<table>
<thead>
<tr>
<th>Test item</th>
<th>Condition</th>
<th>Judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>High temperature and humidity (Operation)</td>
<td>① 55 ± 2°C, RH = 85%, 240hours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>② Display data is black.</td>
<td></td>
</tr>
<tr>
<td>High temperature (Operation)</td>
<td>① 60 ± 2°C, 240hours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>② Display data is black.</td>
<td></td>
</tr>
<tr>
<td>Heat cycle (Operation)</td>
<td>① 0 ± 3°C…1hour 60 ± 3°C…1hour 50cycles, 4hours/cycle Display data is black.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>② 50cycles, 4hours/cycle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>③ Display data is black.</td>
<td></td>
</tr>
<tr>
<td>Thermal shock (Non operation)</td>
<td>① -20 ± 3°C…30minutes 70 ± 3°C…30minutes 100cycles, 1hour/cycle Temperature transition time is within 5 minutes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>② 100cycles, 1hour/cycle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>③ Temperature transition time is within 5 minutes.</td>
<td></td>
</tr>
<tr>
<td>ESD (Operation)</td>
<td>① 150pF, 150Ω, ±10kV 9 places on a panel surface Note2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>② 9 places on a panel surface Note2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>③ 10 times each places at 1 sec interval</td>
<td></td>
</tr>
<tr>
<td>Dust (Operation)</td>
<td>① Sample dust: No. 15 (by JIS-Z8901) 15 seconds stir 8 times repeat at 1 hour interval</td>
<td></td>
</tr>
<tr>
<td></td>
<td>② 15 seconds stir</td>
<td></td>
</tr>
<tr>
<td></td>
<td>③ 8 times repeat at 1 hour interval</td>
<td></td>
</tr>
<tr>
<td>Vibration (Non operation)</td>
<td>① 5 to 100Hz, 11.76m/s² 1 minute/cycle X, Y, Z direction 120 times each directions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>② 1 minute/cycle</td>
<td></td>
</tr>
<tr>
<td></td>
<td>③ X, Y, Z direction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>④ 120 times each directions</td>
<td></td>
</tr>
<tr>
<td>Mechanical shock (Non operation)</td>
<td>① 539m/s², 11ms  ±X, ±Y, ±Z direction 5 times each directions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>② ±X, ±Y, ±Z direction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>③ 5 times each directions</td>
<td></td>
</tr>
</tbody>
</table>

Note1: Display functions are checked under the same conditions as product inspection.

Note2: See the following figure for discharge points.
6. PRECAUTIONS

6.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. Be sure to read "6.2 CAUTIONS", after understanding this contents!

This sign has the meaning that customer will be injured by himself, if customer has wrong operations.

6.2 CAUTIONS

- Pay attention to burn injury for the working backlight! It may be over 35°C from ambient temperature.
- Do not shock and press the LCD panel and the backlight! Danger of breaking, because they are made of glass. (Shock: To be not greater 539m/s² and to be not greater 11ms, Pressure: To be not greater 19.6N)

6.3 ATTENTIONS

6.3.1 Handling of the product

① Take hold of both ends without touch the circuit board when customer pulls out products (LCD modules) from inner packing box. If customer touches it, products may be broken down or out of adjustment, because of stress to mounting parts.
② Do not hook cables nor pull connection cables such as flexible cable and so on, for fear of damage.
③ If customer puts down the product temporarily, the product puts on flat subsoil as a display side turns down.
④ Take the measures of electrostatic discharge such as earth band, ionic shower and so on, when customer deals with the product, because products may be damaged by electrostatic.
⑤ The torque for mounting screws must never exceed 0.29N·m. Higher torque values might result in distortion of the bezel.
⑥ Do not press or rub on the sensitive display surface. If customer clean on the panel surface, NEC Corporation recommends using the cloth with ethanolic liquid such as screen cleaner for LCD.
⑦ Do not push-pull the interface connectors while the product is working, because wrong power sequence may break down the product.

6.3.2 Environment

① Do not operate or store in high temperature, high humidity, dewdrop atmosphere or corrosive gases. Keep the product in antistatic pouch in room temperature, because of avoidance for dusts and sunlight, if customer stores the product.
② Do not operate in high magnetic field. Circuit boards may be broken down by it.
③ Use an original protection sheet on the product surface (polarizer). Adhesive type protection sheet should be avoided, because it may change color or properties of the polarizer.
6.3.3 Characteristics

The following items are neither defects nor failures.

① Response time, luminance and color may be changed by ambient temperature.
② The LCD may be seemed luminance non-uniformity, flicker, vertical seam or small spot by display patterns.
③ Optical characteristics (e.g. luminance, display uniformity, etc.) gradually is going to change depending on operating time, and especially low temperature, because the LCD has cold cathode fluorescent lamps.
④ Do not display the fixed pattern for a long time because it may cause image sticking. Use a screen saver, if the fixed pattern is displayed on the screen.
⑤ The display color may be changed by viewing angle because of the use of condenser sheet in the backlight unit.
⑥ Optical characteristics may be changed by input signal timings.
⑦ The interference noise of input signal frequency for this product's signal processing board and luminance control frequency of customer's backlight inverter may appear on a display. Set up luminance control frequency of backlight inverter so that the interference noise does not appear.

6.3.4 Other

① All GND, backlight inverter ground (GNDB), VCC and backlight inverter power supply voltage (VDDB) terminals should be used without a non-connected line.
② Do not disassemble a product or adjust volume without permission of NEC Corporation.
③ See "REPLACEMENT MANUAL FOR LAMPHOLDER", if customer would like to replace backlight lamps.
④ Pay attention not to insert waste materials inside of products, if customer uses screws.
7. OUTLINE DRAWINGS

7.1 FRONT VIEW

Note1: The values in parentheses are for reference.

Note2: Distance between center of CN1 and surface of front shield.

Unit: mm
7.2 REAR VIEW

Note1: The values in parentheses are for reference.

Unit: mm