

26 cm (10.4 inches), 800 × 600 pixels, 262144 colors
High luminance, Wide viewing angle

DESCRIPTION

NL8060BC26-17 is a TFT (thin film transistor) active matrix color liquid crystal display (LCD) module comprising amorphous silicon TFT attached to each signal electrode, a driving circuit, and a backlight.

NL8060BC26-17 has a built-in backlight. The backlight includes long-life-lamps and the lamps are replaceable with a holder.

The 26 cm diagonal display area contains 800 × 600 pixels and can display 262144 color simultaneously.

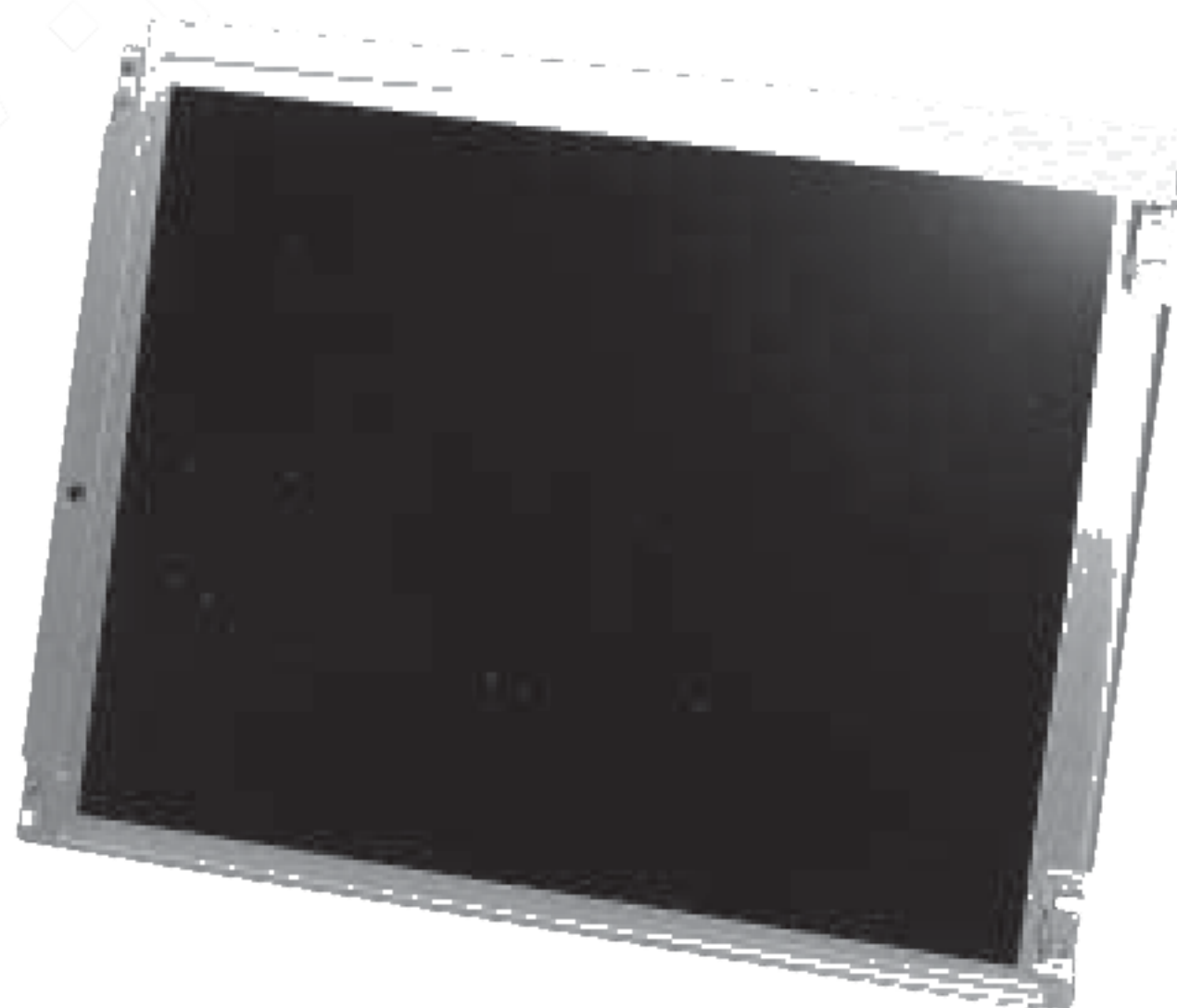
NL8060BC26-17 is suitable for industrial application use, because the viewing angle is wide and the luminance is high. Also, the viewing direction is selectable either upper or lower side by changing scan direction.

FEATURES

- High luminance (280 cd/m², typ.)
- Wide viewing angle (with Retardation film)
- Low reflection
- Reversible scan direction
- 6-bit digital RGB input signals
- Data enable (DE) function
- Edge type backlight with two long-life-time lamps (one lamp holder)
- Lamp holder replaceable
- Recommended inverter for a backlight: Part No. 104PWBR1

APPLICATIONS

- Display terminals for control system
- Monitors for process controller



The information in this document is subject to change without notice.
Please confirm with the delivery specification before statting to design the system.

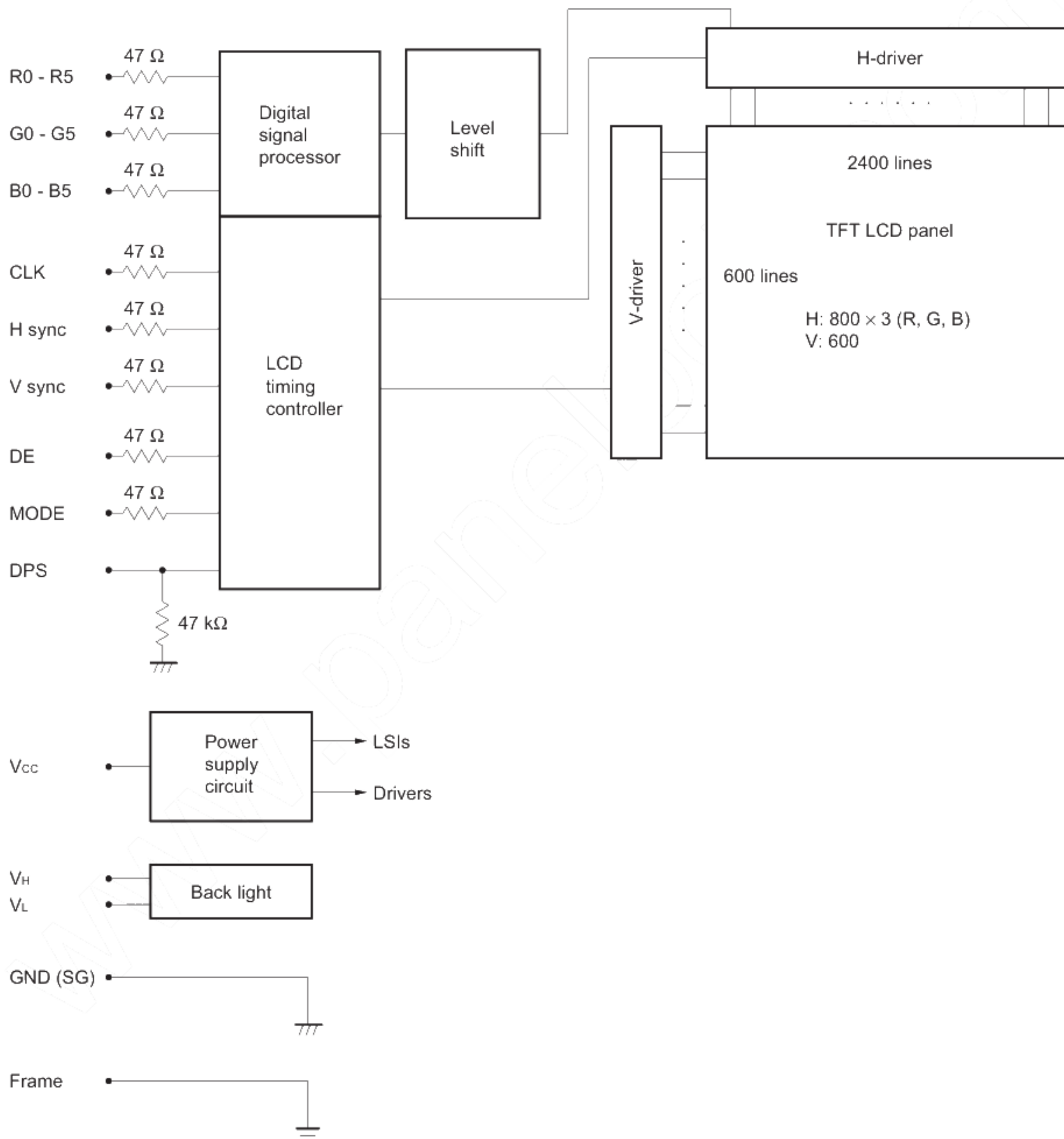
STRUCTURE AND FUNCTIONS

A color TFT (thin film transistor) LCD module is comprised of a TFT liquid crystal panel structure, LSIs for driving the TFT array, and a backlight assembly. The TFT panel structure is created by sandwiching liquid crystal material in the narrow gap between a TFT array glass substrate and a color filter glass substrate. After the driver LSIs are connected to the panel, the backlight assembly is attached to the backside of the panel.

RGB (red, green, blue) data signals from a source system is modulated into a form suitable for active matrix addressing by the onboard signal processor and sent to the driver LSIs which in turn addresses the individual TFT cells.

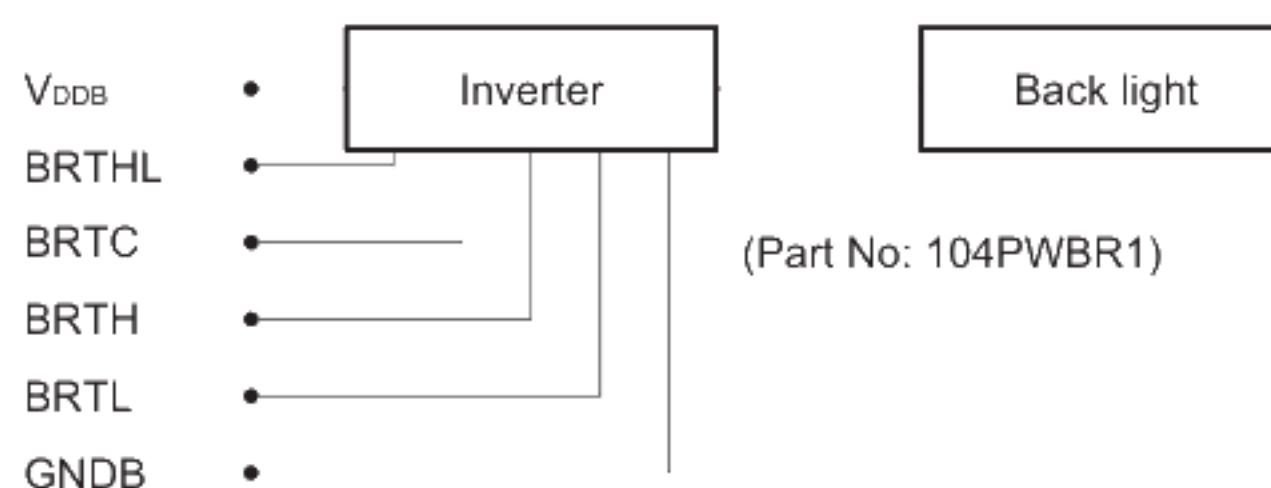
Acting as an electro-optical switch, each TFT cell regulates light transmission from the backlight assembly when activated by the data source. By regulating the amount of light passing through the array of red, green, and blue dots, color images are created with clarity.

BASIC STRUCTURE



* Frame is not connected with GND (SG).

<In case of connecting NEC recommended inverter>



OUTLINE OF CHARACTERISTICS (at room temperature)

| | |
|--|--|
| Display area | 211.2 (H) × 158.4 (V) mm |
| Drive system | a-Si TFT active matrix |
| Display colors | 262,144 colors |
| Number of pixels | 800 × 600 pixels |
| Pixel arrangement | RGB vertical stripe |
| Pixel pitch | 0.264 (H) × 0.264 (V) mm |
| Module size | 243.0 (H) × 185.1 (V) × 11.5 max. (D) mm |
| Weight | 520 (typ.) |
| Contrast ratio | 300:1 (typ.) |
| Viewing angle (more than the contrast ratio of 10:1) | Horizontal : 50° (typ. left side, right side) Vertical : 35° (typ. up side), 45° (typ. down side) |
| Designed viewing direction | <ul style="list-style-type: none"> • Wider viewing angle with contrast ratio : down side (6 o'clock, normal scan) up side (12 o'clock, reverse scan) • Wider viewing angle without image reversal : up side (12 o'clock, normal scan) down side (6 o'clock, reverse scan) • Optimum grayscale ($\gamma = 2.2$) : perpendicular |
| Color gamut | 43 % (typ. center, to NTSC) |
| Response time | 15 ms (max.), "white 100%" to "black 10%" |
| Luminance | 280 cd/m ² (typ.) (Lamp current: $I_L = 5$ mArms per lamp) |
| Signal system | 6-bit digital signals for each of RGB primary colors, synchronous signals (Hsync, Vsync), dot clock (CLK) |
| Supply voltage | 3.3 V [5.0 V] (Logic, LCD driving) |
| Backlight | Edge light type, two cold cathode fluorescent lamp in a holder, attached inverter <ul style="list-style-type: none"> • Lamp holder set: Part No.104LHS31 • Recommended inverter: Part No. 104PWBR1 |
| Power consumption | 7.0 W (typ. at 3.3 V, with a recommended inverter) |

GENERAL SPECIFICATIONS

| Item | Specification | Unit |
|-------------------|---|-------|
| Module size | 243.0 ± 0.5 (H) \times 185.1 ± 0.5 (V) \times 11.5 max. (D) | mm |
| Display area | 211.2 (H) \times 158.4 (V) | mm |
| Number of pixels | 800 (H) \times 600 (V) | pixel |
| Dot pitch | 0.088 (H) \times 0.264 (V) | mm |
| Pixel pitch | 0.264 (H) \times 0.264 (V) | mm |
| Pixel arrangement | RGB (Red, Green, Blue) vertical stripe | |
| Display colors | 262,144 | color |
| Weight | 550 (max.) | g |

ABSOLUTE MAXIMUM RATINGS

| Parameter | Symbol | Rating | Unit | Remarks | |
|-------------------------------|-----------------|--|------------------|--|------------------------|
| Supply voltage | V _{CC} | −0.3 to 6.5 | V | V _I − V _{CC} < 3.0 | T _a = 25 °C |
| Input voltage | V _I | −0.3 to 6.5 | V | | |
| Lamp voltage | V _L | 2000 | V _{rms} | T _a = 25 °C | |
| Storage temp. | T _{ST} | −20 to 60 | °C | | |
| Operating temp. | T _{OP} | 0 to 50 | °C | Module surface* | |
| Humidity (No condensation) | | ≤ 95 % relative humidity | | T _a ≤ 40 °C | |
| | | ≤ 85 % relative humidity | | 40 < T _a ≤ 50 °C | |
| | | Absolute humidity shall not exceed T _a = 50 °C, 85 % relative humidity level | | T _a > 50 °C | |

* Measured at the panel surface (including self-heat)

ELECTRICAL CHARACTERISTICS

(1) Logic, LCD driving

$T_a = 25\text{ }^{\circ}\text{C}$

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Remarks |
|-------------------------|----------|---------------------|----------------|---------------------|------|--|
| Supply voltage | V_{CC} | 3.0 (4.75) | 3.3 (5.0) | 3.6 (5.25) | V | $V_{CC} = 3.3\text{ V}$ ($V_{CC} = 5.0\text{ V}$) |
| Logic input "L" voltage | V_{IL} | 0 | — | $V_{CC} \times 0.3$ | V | CMOS level |
| Logic input "H" voltage | V_{IH} | $V_{CC} \times 0.7$ | — | V_{CC} | V | |
| Supply current | I_{CC} | — — | * 360 (270) | 550 (500) | mA | $V_{CC} = 3.3\text{ V}$ ($V_{CC} = 5.0\text{ V}$) |

* Checker flag pattern (in EIAJ ED-2522)

(2) Backlight

 $T_a = 25\text{ }^{\circ}\text{C}$

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Remarks |
|----------------------|--------|------|------|------|------|---|
| Lamp current | I_L | 2.0 | 5.0 | 5.5 | mArm | with one lamp |
| Lamp voltage | V_L | — | 510 | — | Vrms | — |
| Lamp turn on voltage | V_s | 840 | — | — | Vrms | $T_a = 25\text{ }^{\circ}\text{C} \text{ }^{\ast}2$ |
| | | 1265 | — | — | | $T_a = 0\text{ }^{\circ}\text{C} \text{ }^{\ast}2$ |
| Oscillator frequency | F_t | 50 | 54 | 58 | kHz | $^{\ast}1$ |

$^{\ast}1$: Recommended value of " F_t ".

- F_t is within the specification.

and

- $F_t = 1/4T_h \times (2n-1)$

T_h : Hsync period

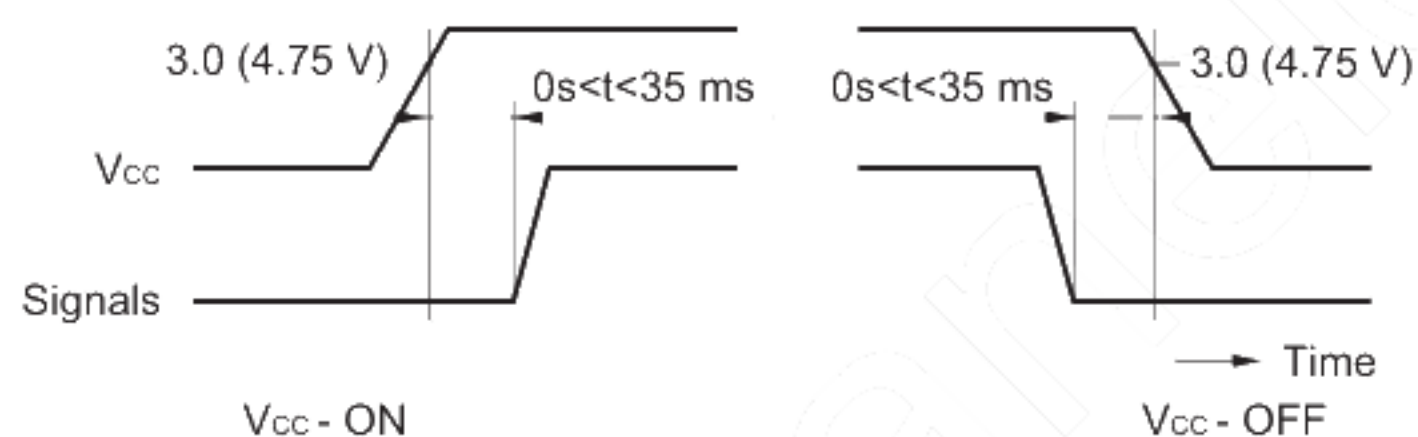
n : a natural number (1, 2, 3...)

If F_t is out of the recommended value, interference between F_t frequency and Hsync frequency may cause beat on the display.

$^{\ast}2$: When V_s is less than Min. value, lamp might be not turned on it.

$^{\ast}3$: Recommended inverter: Part No. 104PWBR1

SUPPLY VOLTAGE SEQUENCE



Signals: CLK, Hsync, Vsync, DE, R0-R5, G0-G5, B0-B5

Notes 1. The supply voltage for input signals should be the same as V_{CC} .

2. Turn on the backlight within the LCD operation period. When the backlight turns on before LCD operation or the LCD operation turns off before the backlight turns off, the display may momentarily become white.

3. When the power is off, please keep whole signals (Hsync, Vsync, CLK, DE, R0-R5, G0-G5, B0-B5) low level or high impedance.

4. Wrong power sequence may damage to the module.

5. The signal should not be down during operation. Even if signal could recover, LCD module can not be operated correctly, the display may be un-uniformity. In case signal is down, V_{CC} should be turned off, and then turn V_{CC} and signal on as above sequence.

INTERFACE AND CONNECTOR PIN ASSIGNMENT

(1) Interface signals, power supply

Module side connector

CN1 … DF9-41P-1V (No. 1 to 41)

Supplier: HIROSE ELECTRIC CO., LTD.

Mating connector

DF9-41S-1V

| Pin No. | Symbol | Function |
|---------|--------|------------------|
| 1 | GND | Ground |
| 2 | CLK | Dot clock |
| 3 | GND | Ground |
| 4 | Hsync | Horizontal sync. |
| 5 | Vsync | Vertical sync. |
| 6 | GND | Ground |
| 7 | GND | Ground |
| 8 | GND | Ground |
| 9 | R0 | Red data (LSB) |
| 10 | R1 | Red data |
| 11 | R2 | Red data |
| 12 | GND | Ground |
| 13 | R3 | Red data |
| 14 | R4 | Red data |
| 15 | R5 | Red data (MSB) |
| 16 | GND | Ground |
| 17 | GND | Ground |
| 18 | GND | Ground |
| 19 | G0 | Green data (LSB) |
| 20 | G1 | Green data |
| 21 | G2 | Green data |

| Pin No. | Symbol | Function |
|---------|-----------------|-------------------------------------|
| 22 | GND | Ground |
| 23 | G3 | Green data |
| 24 | G4 | Green data |
| 25 | G5 | Green data (MSB) |
| 26 | GND | Ground |
| 27 | GND | Ground |
| 28 | GND | Ground |
| 29 | B0 | Blue data (LSB) |
| 30 | B1 | Blue data |
| 31 | B2 | Blue data |
| 32 | GND | Ground |
| 33 | B3 | Blue data |
| 34 | B4 | Blue data |
| 35 | B5 | Blue data (MSB) |
| 36 | GND | Ground |
| 37 | DE | Data enable signal |
| 38 | DPS | Scan direction select Note 3 |
| 39 | V _{CC} | Power supply Note 1 |
| 40 | V _{CC} | Power supply Note 1 |
| 41 | MODE | Mode select Note 2 |

LSB : Least Significant Bit

MSB : Most Significant Bit

Notes 1. V_{CC}: All V_{CC} terminals should be connected to 3.3 V [5.0 V].

2. MODE: $\begin{cases} \text{H} & = \text{Fixed mode} \\ \text{L or open} & = \text{DE mode} \end{cases}$

3. DPS can change scan direction (normal scan and reverse scan).

DPS: V_{CC} = normal scan

GND or open = reverse scan

See **DISPLAY POSITION** about another way for reversible scan.

(2) Lamp connector

lamp side connector

Mating connector

CN2 ... BHR-03VS-1

SM02 (4.0) B-BHS-TB

Supplier: J.S.T TRADING COMPANY, LTD.

| Pin No. | Symbol | Function |
|---------|----------------|-----------------------|
| 1 | V _L | Low voltage terminal |
| 2 | V _H | High voltage terminal |
| 3 | V _H | High voltage terminal |

* V_H and V_L must be connected correctly. If you make a mistake to connect, you will get hurt and the module will break.

<Connection of recommended Inverter: 104PWBR1> (NEC)

Inverter side connector 1

Mating connector 1

CN1 ... LZ-5P-SL-SMT

LZ-5S-SC3

Supplier: Japan Aviation Electronics Industry Limited (JAE)

| Pin No. | Symbol | Function | Pin No. | Symbol | Function |
|---------|-------------------|---------------------|---------|--------|-------------------------|
| 1 | V _{DD} B | Power supply (12 V) | 4 | | GNDB Backlight ground |
| 2 | V _{DD} B | Power supply (12 V) | 5 | | BRTHLLuminance select * |
| 3 | GNDB | Backlight ground | | | |

* High luminance (100 %) ... BRTHL = High (+5 V) or open

Low luminance (60 %) ... BRTHL = Low (GNDB level)

Inverter side connector 2

Mating connector 2

CN3 ... IL-Z-3PL-SMTY

IL-Z-3S-S125C3

Supplier: Japan Aviation Electronics Industry Limited (JAE)

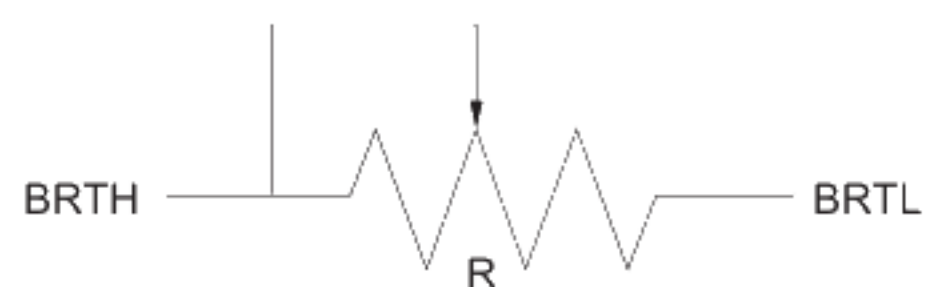
| Pin No. | Symbol | Function | |
|---------|--------|-------------------------|---------------|
| 1 | BRTC | Backlight ON/OFF signal | Note 1 |
| 2 | BRTH | Luminance control input | Note 2 |
| 3 | BRTL | Luminance control input | Note 2 |

Notes 1. TTL level

Backlight ON ... BRTC = High (+5 V) or Open

Backlight OFF ... BRTC = Low (GNDB level)

2. <1> A way of luminance control by a variable resistor.
This way works when BRTHL (No.5 pin) of CN3 is opened.

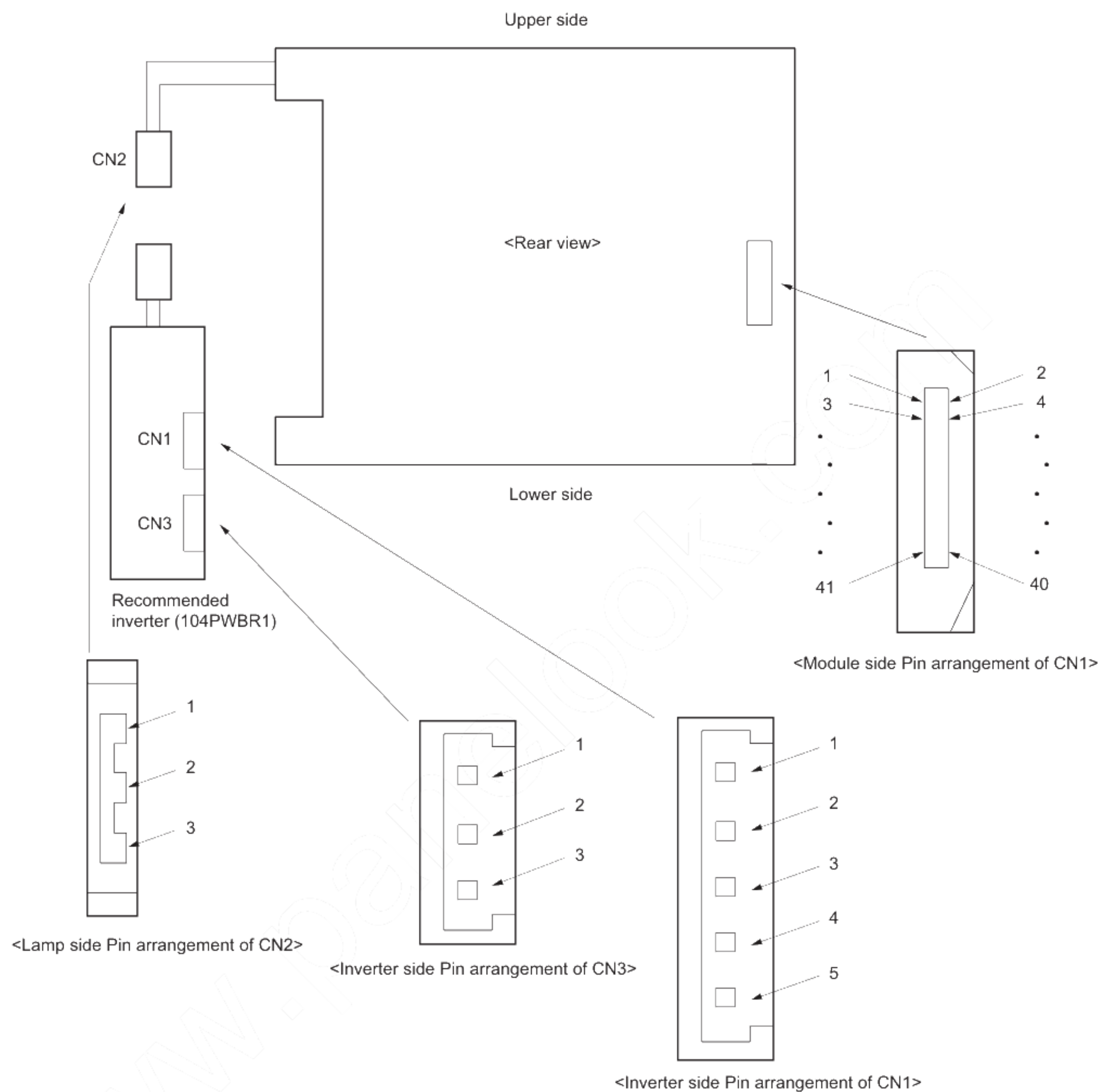


Mating variable resistor : $10\text{ K}\Omega \pm 5\%$
Minimum luminance (50 %) : $R = 0\ \Omega$
Maximum luminance (100 %) : $R = 10\text{ K}\Omega$

- <2> A way of luminance control by a voltage
This way works when BRTL is opened. The range of input voltage between BRTH and GNDB is as follows.

Minimum luminance (50 %) : 2.5 V
Maximum luminance (100 %) : $\leq 1.2\text{ V}$

(3) Connector location



DISPLAY COLORS vs. INPUT DATA SIGNALS

| Display colors | | Data signal (0: Low level, 1: High level) | | | | | | | | | | | | | | | | | |
|-----------------|---------|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | | R5 | R4 | R3 | R2 | R1 | R0 | G5 | G4 | G3 | G2 | G1 | G0 | B5 | B4 | B3 | B2 | B1 | B0 |
| Basic colors | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Blue | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Red | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Magenta | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Green | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Cyan | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | Yellow | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | White | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Red grayscale | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Dark | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | ↑ | | | | | | | | | | | | | | | | | | |
| | ↓ | | | | | | | | | | | | | | | | | | |
| | Bright | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Green grayscale | | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Red | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Dark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Blue grayscale | ↑ | | | | | | | | | | | | | | | | | | |
| | ↓ | | | | | | | | | | | | | | | | | | |
| | Bright | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Green | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

Note Colors are developed in combination with 6-bit signals (64 steps in grayscale) of each primary red, green, and blue color.

This process can result in up to 262144 (64 × 64 × 64) colors.

INPUT SIGNAL TIMING

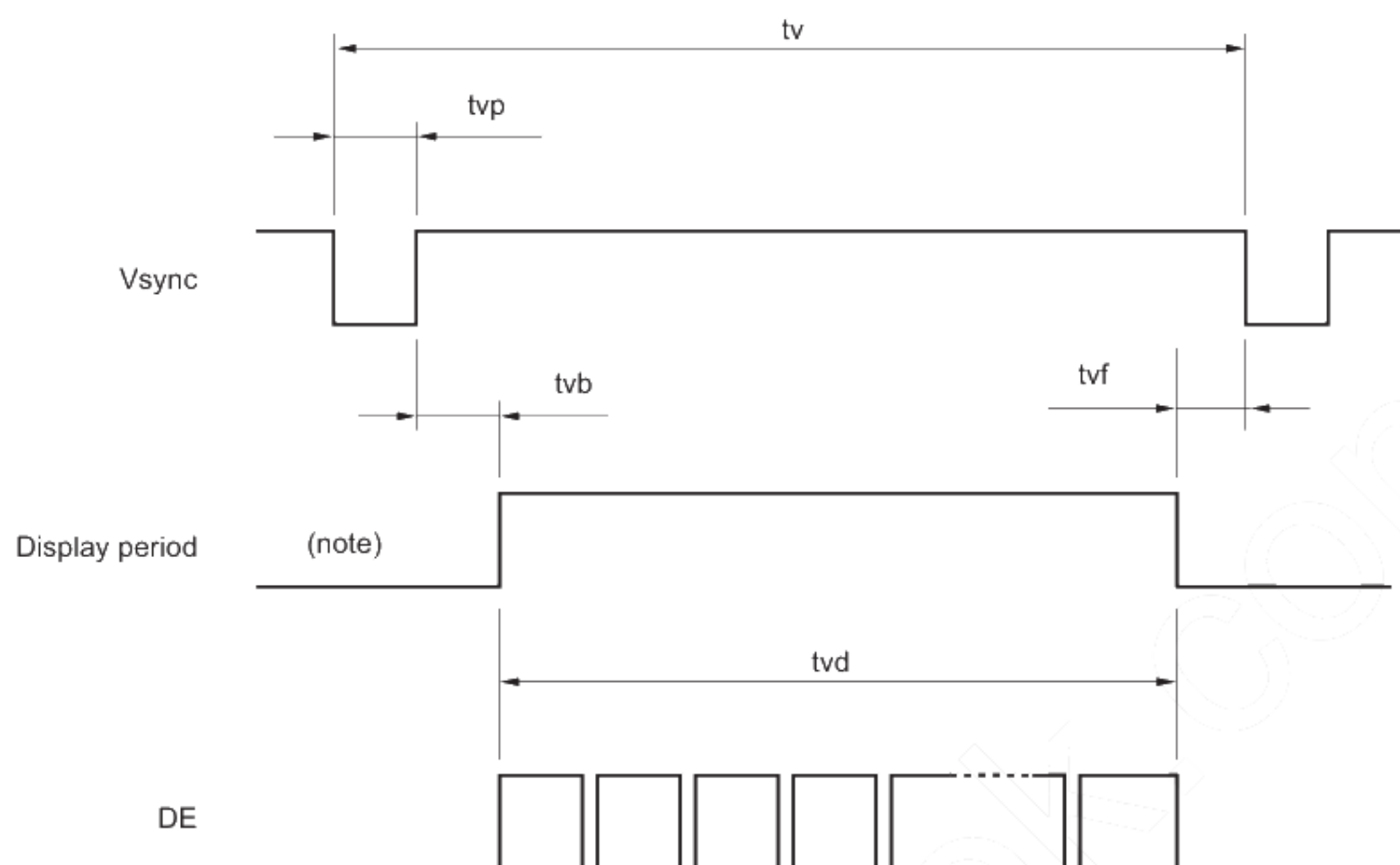
(1) Input signal specifications

| Parameter | | Symbol | Min. | Typ. | Max. | Unit | Remarks |
|---------------------------------------|--------------------|--------|------|--------|--------|------------|-------------------|
| CLK | Frequency | 1/tc | 34.0 | 38.362 | 40.0 | MHz | 26.067 ns (TYP.) |
| | Duty | tch/tc | 0.4 | 0.5 | 0.6 | — | — |
| | Rise, fall | tcrf | — | — | 10 | ns | — |
| Hsync | Period | th | 24.3 | 26.693 | — | μs | 37.468 kHz (typ.) |
| | | | — | 1024 | — | CLK | |
| | Display period | thd | 800 | | | CLK | — |
| | Front-porch | thf | — | 24 | — | CLK | Fixed mode |
| | | | 4 | 24 | — | CLK | DE mode |
| | Pulse width | thp | 2 | 72 | 127 | CLK | Fixed mode |
| | | | 2 | 72 | — | CLK | DE mode |
| | Back-porch | thb | 2 | 128 | 198 | CLK | Fixed mode |
| | | | 2 | 128 | — | CLK | DE mode |
| | thp + thb | | 200 | | | CLK | Fixed mode |
| | | | 15 | 200 | — | CLK | DE mode |
| | CLK-Hsync timing | thch | 10 | — | — | ns | — |
| | Hsync-CLK timing | thcs | 8 | — | — | ns | — |
| | Hsync-Vsync timing | thv | 1 | — | — | CLK | — |
| | Vsync-Hsync timing | tvcs | 15 | — | — | ns | — |
| | Rise, fall | thrf | — | — | 10 | ns | — |
| | Vsync | Period | tv | 16.1 | 16.683 | 17.2 | ms |
| — | | | | 625 | — | H | |
| Display period | | tvd | 600 | | | H | |
| Front-porch | | tvf | — | 1 | — | H | Fixed mode |
| | | | — | 1 | — | H | DE mode |
| Pulse width | | tvp | 1 | 2 | 23 | H | Fixed mode |
| | | | 1 | 2 | — | H | DE mode |
| Back-porch | | tvb | 1 | 22 | 23 | H | Fixed mode |
| | | | 1 | 22 | — | H | DE mode |
| tvp + tvb | | 24 | | | H | Fixed mode | |
| | | 2 | 24 | 254 | H | DE mode | |
| Rise, fall | | tvrf | — | — | 10 | ns | — |
| DATA R0 - R5 G0 - G5 B0 - B5 | CLK-DATA timing | tds | 8 | — | — | ns | — |
| | DATA-CLK timing | tdh | 12 | — | — | ns | — |
| | Rise, fall | tdrf | — | — | 10 | ns | — |
| DE | DE-CLK timing | tes | 8 | — | — | ns | — |
| | CLK-DE timing | teh | 12 | — | — | ns | |
| | Rise, fall | terf | — | — | 10 | ns | |

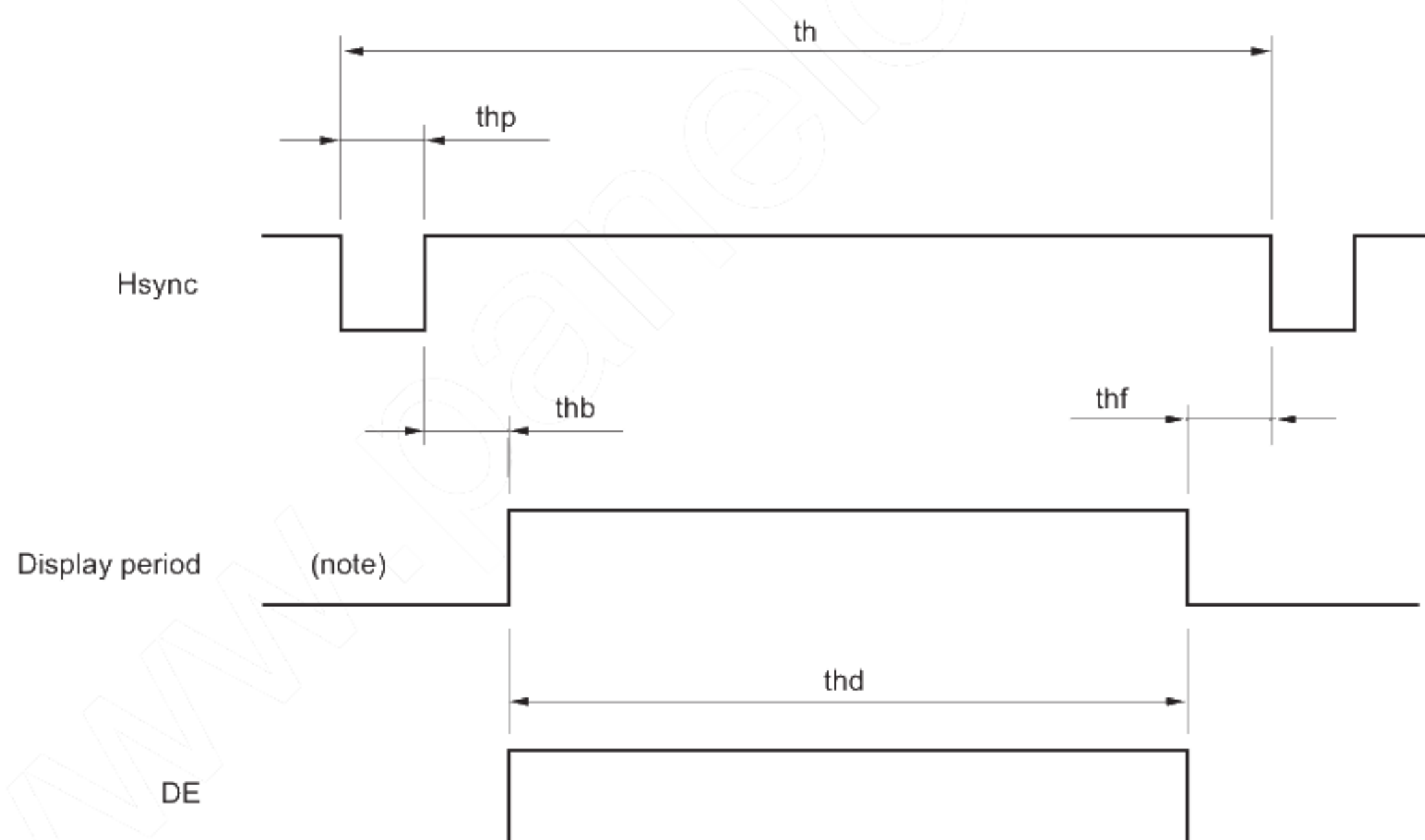
* All of parameters should be kept in the specified range.

(2) Definition of input signal timing

<Vertical>

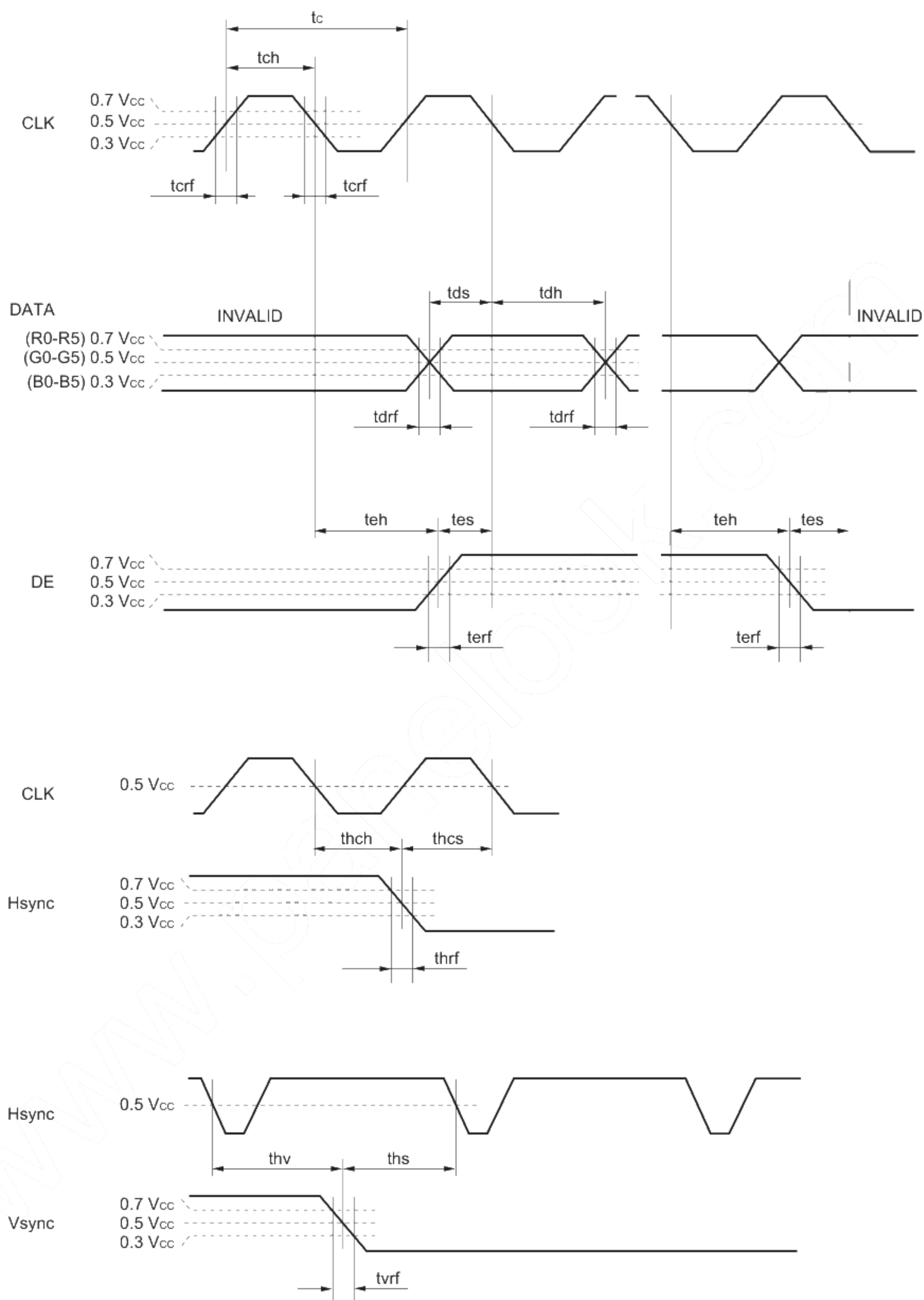


<Horizontal>

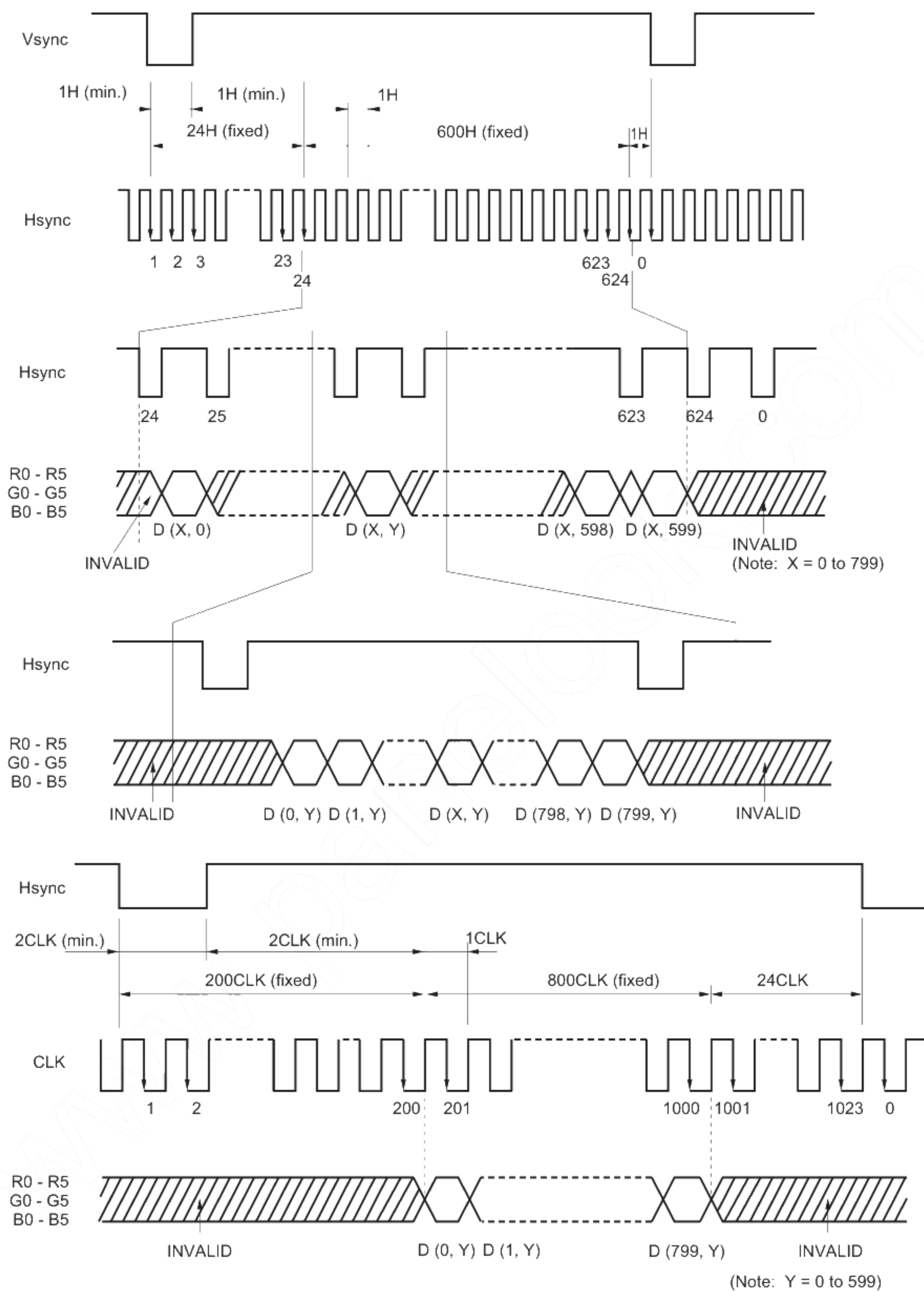


Note These do not exist as signals.

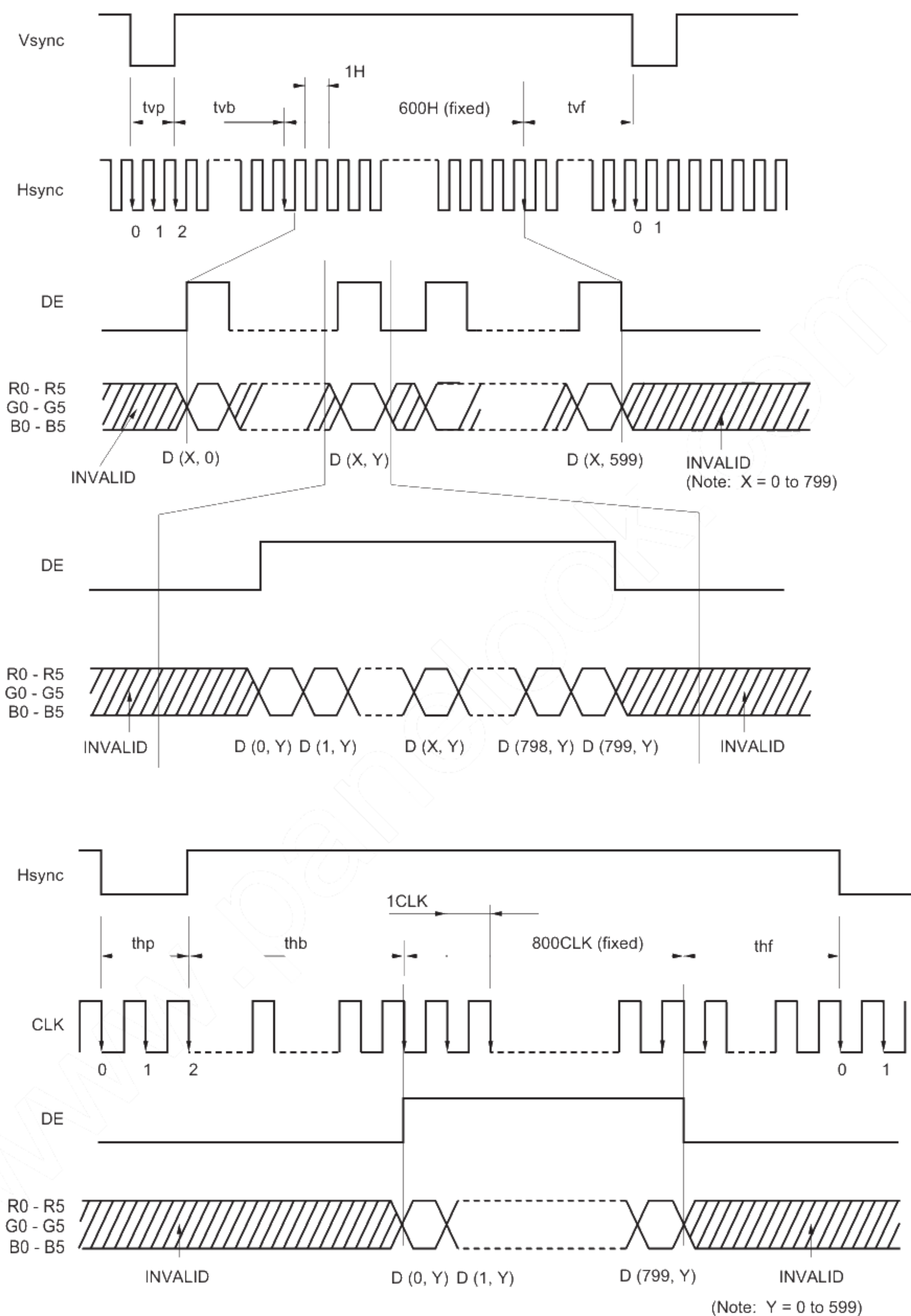
(3) Input signal timing chart



a) Fixed timing mode



b) DE mode



DISPLAY POSITION

Normal scan (DPS = "Vcc")

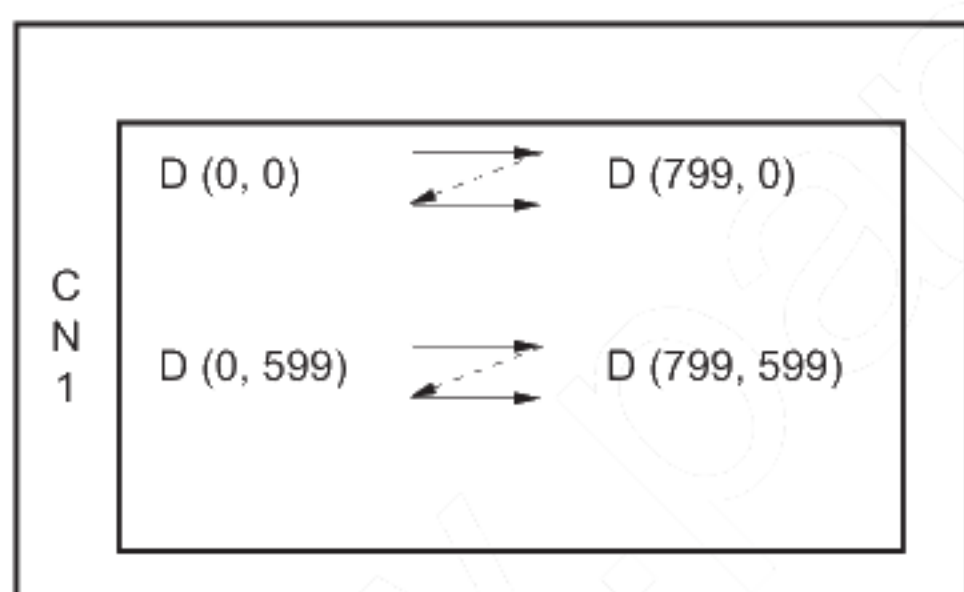
| | | | | | | |
|------------|------------|-------|------------|-------|--------------|--------------|
| D (0, 1) | D (1, 1) | ----- | D (X, 1) | ----- | D (798, 1) | D (799, 1) |
| D (0, 1) | D (1, 1) | ----- | D (X, 1) | ----- | D (798, 1) | D (799, 1) |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| D (0, Y) | D (1, Y) | ----- | D (X, Y) | ----- | D (798, Y) | D (799, Y) |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| D (0, 598) | D (1, 598) | ----- | D (X, 598) | ----- | D (798, 598) | D (799, 598) |
| D (0, 599) | D (1, 599) | ----- | D (X, 599) | ----- | D (798, 599) | D (799, 599) |

Reverse scan (DPS = "GND" or "Open")

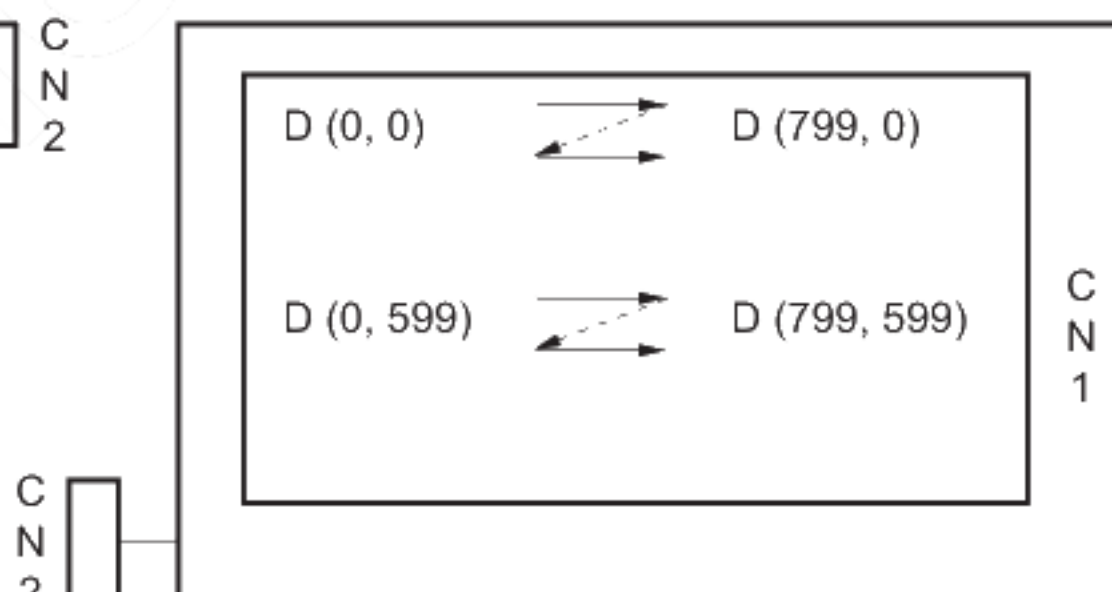
| | | | | | | |
|--------------|--------------|-------|------------|-------|------------|------------|
| D (799, 599) | D (798, 599) | ----- | D (X, 599) | ----- | D (1, 599) | D (0, 599) |
| D (799, 598) | D (798, 598) | ----- | D (X, 598) | ----- | D (1, 598) | D (0, 598) |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| D (799, Y) | D (798, Y) | ----- | D (X, Y) | ----- | D (1, Y) | D (0, Y) |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| D (799, 1) | D (798, 1) | ----- | D (X, 1) | ----- | D (1, 1) | D (0, 1) |
| D (799, 0) | D (798, 0) | ----- | D (X, 0) | ----- | D (1, 0) | D (0, 0) |

* Below drawings show relations between the scan direction and the viewing direction.

Normal scan



Reverse scan



OPTICAL CHARACTERISTICS

Ta = 25°C **Note 1**

| Item | Symbols | Conditions | Min. | Typ. | Max. | Unit | Remarks |
|----------------------|---------|---------------|------|------|------|-------------------|---------------|
| Contrast ratio | CR | Note 2 | 150 | 300 | – | – | Note 3 |
| Luminance | Lu max. | Note 2 | 200 | 280 | – | cd/m ² | Note 4 |
| Luminance uniformity | – | max./min. | – | – | 1.4 | – | Note 5 |

Reference data

| Item | Symbols | Conditions | Min. | Typ. | Max. | Unit | Remarks |
|---------------------|------------|---------------------------|------|------|------|------|---------------|
| Response time | t on | White to black 100% → 10% | – | 15 | 50 | ms | Note 6 |
| | t off | Black to white 0% → 90% | – | 65 | 80 | ms | |
| Color gamut | C | at center, to NTSC | – | 43 | – | % | – |
| Viewing angle range | Horizontal | θ_{x+} | 45 | 50 | – | deg. | Note 7 |
| | | θ_{x-} | 45 | 50 | – | deg. | |
| | Vertical | θ_{y+} | 30 | 35 | – | deg. | |
| | | θ_{y-} | 40 | 45 | – | deg. | |

Notes 1. Vcc = 3.3 V, IL = 5.0 mA rms, DPS = High at normal scan with recommended inverter.

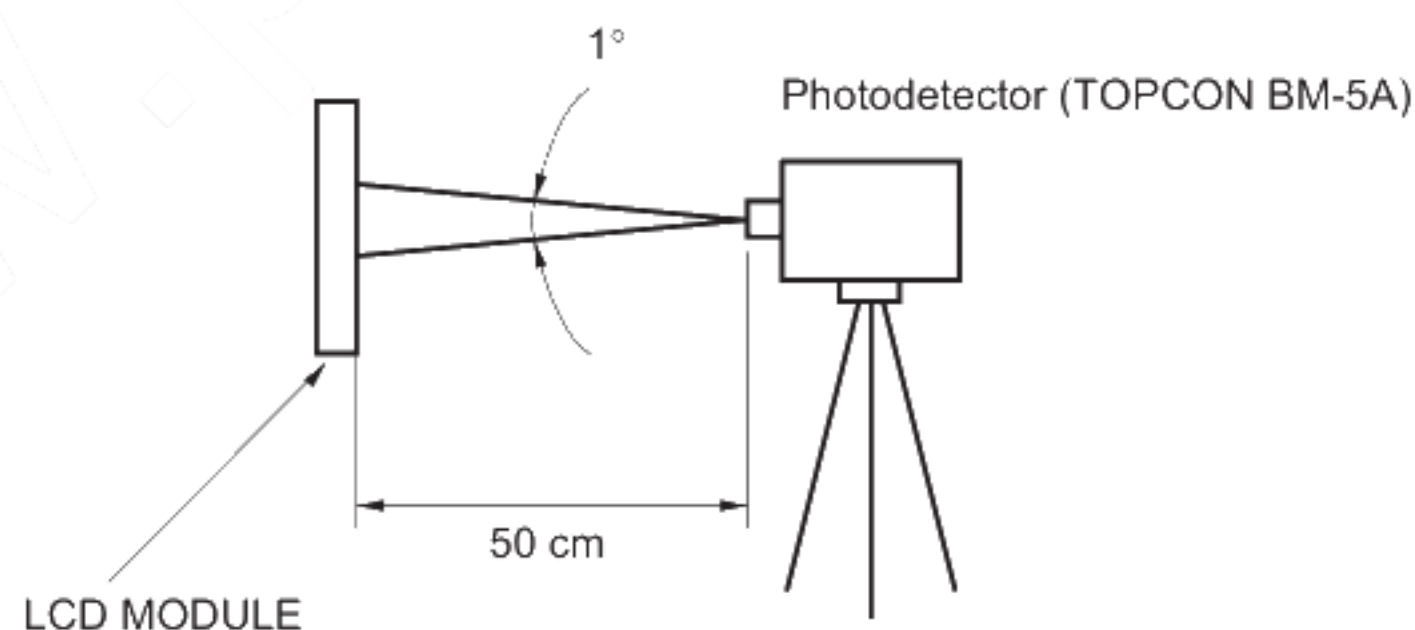
2. Viewing angle: $\theta_x = \pm 0^\circ$, $\theta_y = \pm 0^\circ$, At center.

3. The contrast ratio is calculated by using the following formula.

$$\text{Contrast ratio (CR)} = \frac{\text{Luminance with all pixels in "white"}}{\text{Luminance with all pixels in "black"}}$$

The luminance is measured in darkroom.

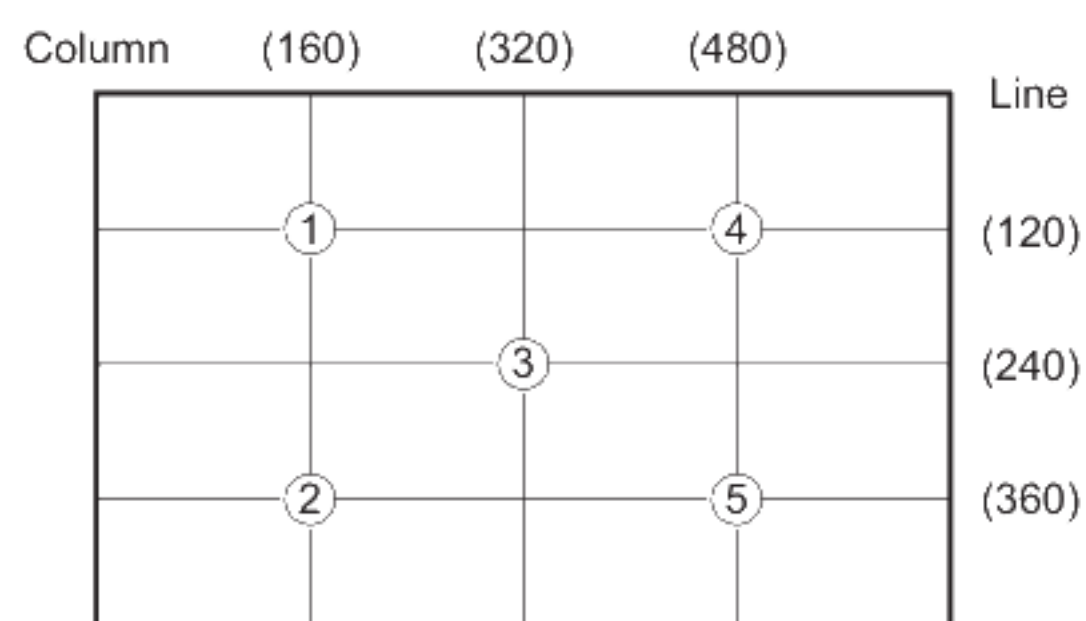
4. The luminance is measured after 20 minutes from the module works, with all pixels in "white". Typical value is measured after luminance saturation. The luminance is measured in darkroom.



5. The luminance uniformity is calculated by using following formula.

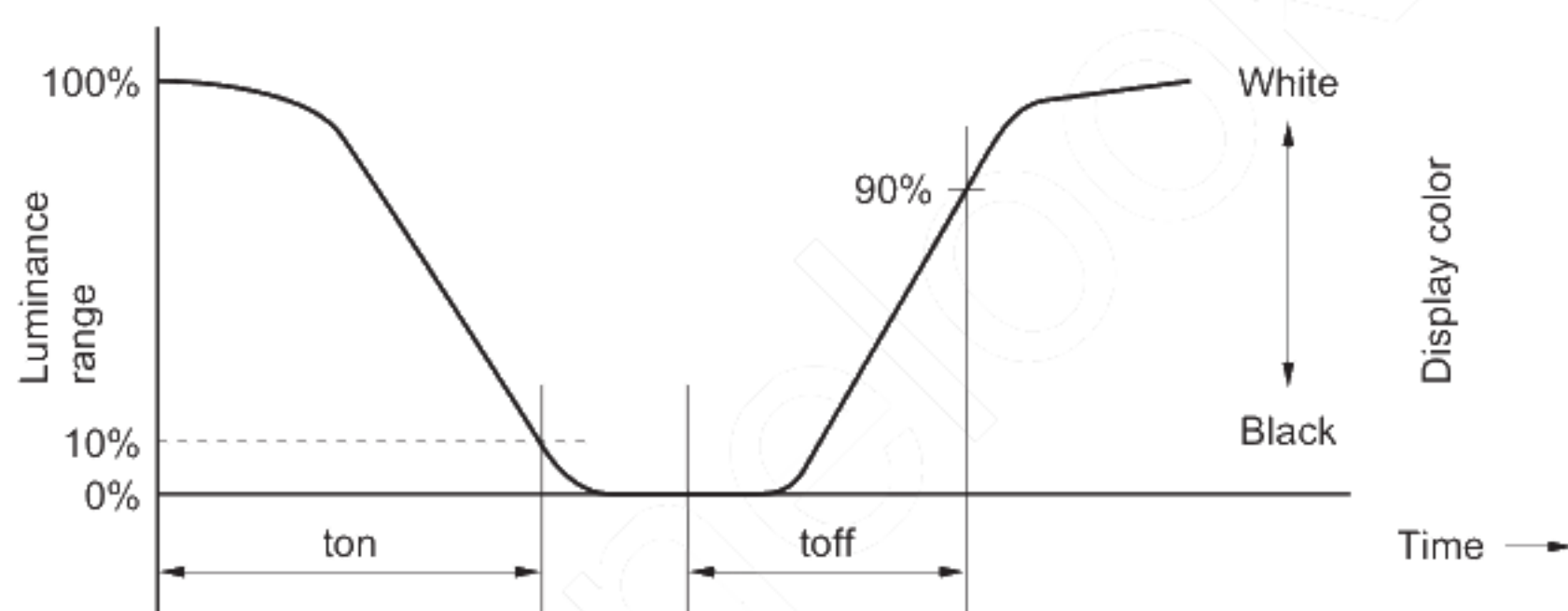
$$\text{Luminance uniformity} = \frac{\text{Maximum luminance}}{\text{Minimum luminance}}$$

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

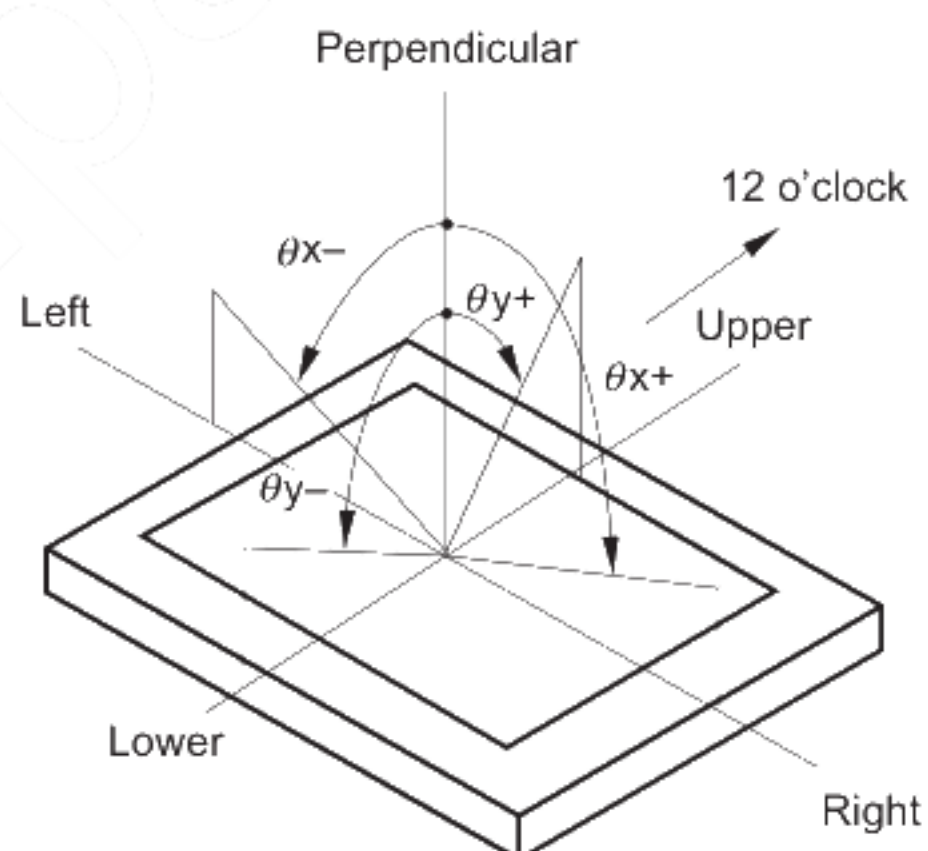


6. Definition of response time is as follows.

Photodetector output signal is measured when the Luminance changes "white" to "black" or "black" to "white".



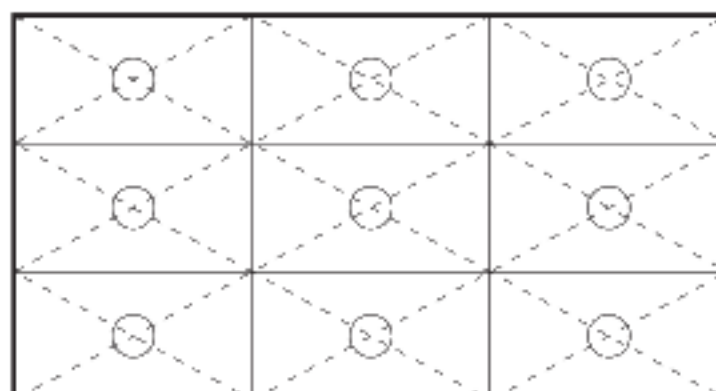
7. Definitions of viewing angle are as follows.



RELIABILITY TEST SPECIFICATIONS


| Test items | Test conditions | Judgement |
|-------------------------------------|---|--------------------------------|
| High temperature/humidity operation | $50 \pm 2^{\circ}\text{C}$, 85% relative humidity 240 hours Display data is black. | Note 1 |
| Heat cycle (operation) | <1> $0^{\circ}\text{C} \pm 3^{\circ}\text{C}$... 1 hour $55^{\circ}\text{C} \pm 3^{\circ}\text{C}$... 1 hour <2> 50 cycles, 4 hours/cycle <3> Display data is black. | Note 1 |
| Thermal shock (non-operation) | <1> $-20^{\circ}\text{C} \pm 3^{\circ}\text{C}$... 30 minutes $60^{\circ}\text{C} \pm 3^{\circ}\text{C}$... 30 minutes <2> 100 cycles <3> Temperature transition time within 5 minutes | Note 1 |
| Vibration (non-operation) | <1> 5 - 100 Hz, 19.6 m/s^2 (2G) 1 minute/cycle, X, Y, Z direction <2> 120 times each direction | Note 1 Note 2 |
| Mechanical shock (non-operation) | <1> 539 m/s^2 (55G), 11 ms X, Y, Z direction <2> 5 times each direction | Note 1 Note 2 |
| ESD (operation) | 150 pF , 150Ω , $\pm 10 \text{ kV}$ 9 places on a panel 10 times each place at one-second intervals | Note 1 Note 3 |
| Dust (operation) | 15 kinds of dust (JIS Z 8901) Hourly 15 seconds stir, 8 times repeat | Note 1 |



- Notes**
1. Display function is checked by the same condition as LCD module out-going inspection.
 2. Physical damage.
 3. Discharge points are shown as follows.



GENERAL CAUTIONS

Next figures and sentence are very important, please understand these contents as follows.

| | |
|---|--|
|  CAUTION | This figure is a mark that you will get hurt and/or the module will have damages when you make a mistake to operate. |
|---|--|

| | |
|---|---|
|  | This figure is a mark that you will get an electric shock when you make a mistake to operate. |
|  | This figure is a mark that you will get hurt when you make a mistake to operate |

CAUTION




Do not touch an inverter ...on which is stuck a caution label... while the LCD module is under the operation, because of dangerous high voltage.

(1) Caution when taking out the module

- <1> Pick the pouch only, when taking out the module from a carrier box.

(2) Cautions for handling the module

- <1> As the electrostatic discharges may break the LCD module, handle the LCD module with care against electrostatic discharges.
- <2>  As the LCD panel and backlight element are made from fragile glass material, impulse and pressure to the LCD module should be avoided.
- <3> As the surface of polarizer is very soft and easily scratched, use a soft dry cloth without chemicals for cleaning.
- <4> Do not pull the interface connectors in or out while the LCD module is operating.
- <5> Put the module display side down on a flat horizontal plane.
- <6> Handle connectors and cables with care.
- <7> When the module is operating, do not lose CLK, Hsync, or Vsync signal. If any one of these signals is lost, the LCD panel would be damaged.
- <8> The torque for mounting screw should never exceed 0.294 N·m (3 kgf·cm).
- <9> Don't push or rub the surface of LCD module please.
If you do, the scratches or the marks like rubbing marks may be left on the surface of the module.

(3) Cautions for the atmosphere

- <1> Dew drop atmosphere must be avoided.
- <2> Do not store and/or operate the LCD module in high temperature and/or high humidity atmosphere. Storage in an electro-conductive polymer packing pouch and under relatively low temperature atmosphere is recommended.
- <3> This module uses cold cathod fluorescent lamps. Therefore, the life time of lamp becomes short conspicuously at low temperature.
- <4> Do not operate the LCD module in high magnetic field.

(4) Caution for the module characteristics

- <1> Do not apply any fixed patterns data signal to the LCD module at product aging. Applying fixed pattern for a long time may cause image sticking.
- <2> This module has the retardation film which may cause the variation of the color hue in the different viewing angles. The ununiformity may appear on the screen under the high temperature operation.
- <3> The light vertical stripe may be observed depending on the display pattern. This is not defects or malfunctions.
- <4> The noise from the inverter circuit may be observed in the luminance control mode. This is not defects or malfunctions.

(5) Other cautions

- <1> Do not disassemble and/or reassemble LCD module.
- <2> Do not readjust variable resistors nor switches etc.
- <3> When returning the module for repair etc., Please pack the module properly to avoid any damages. We recommend the original shipping packages.
- <4> In case that the scan converter is used to convert VGA signal to NTSC, it is recommended using the frame-memory type, not the line-memory.

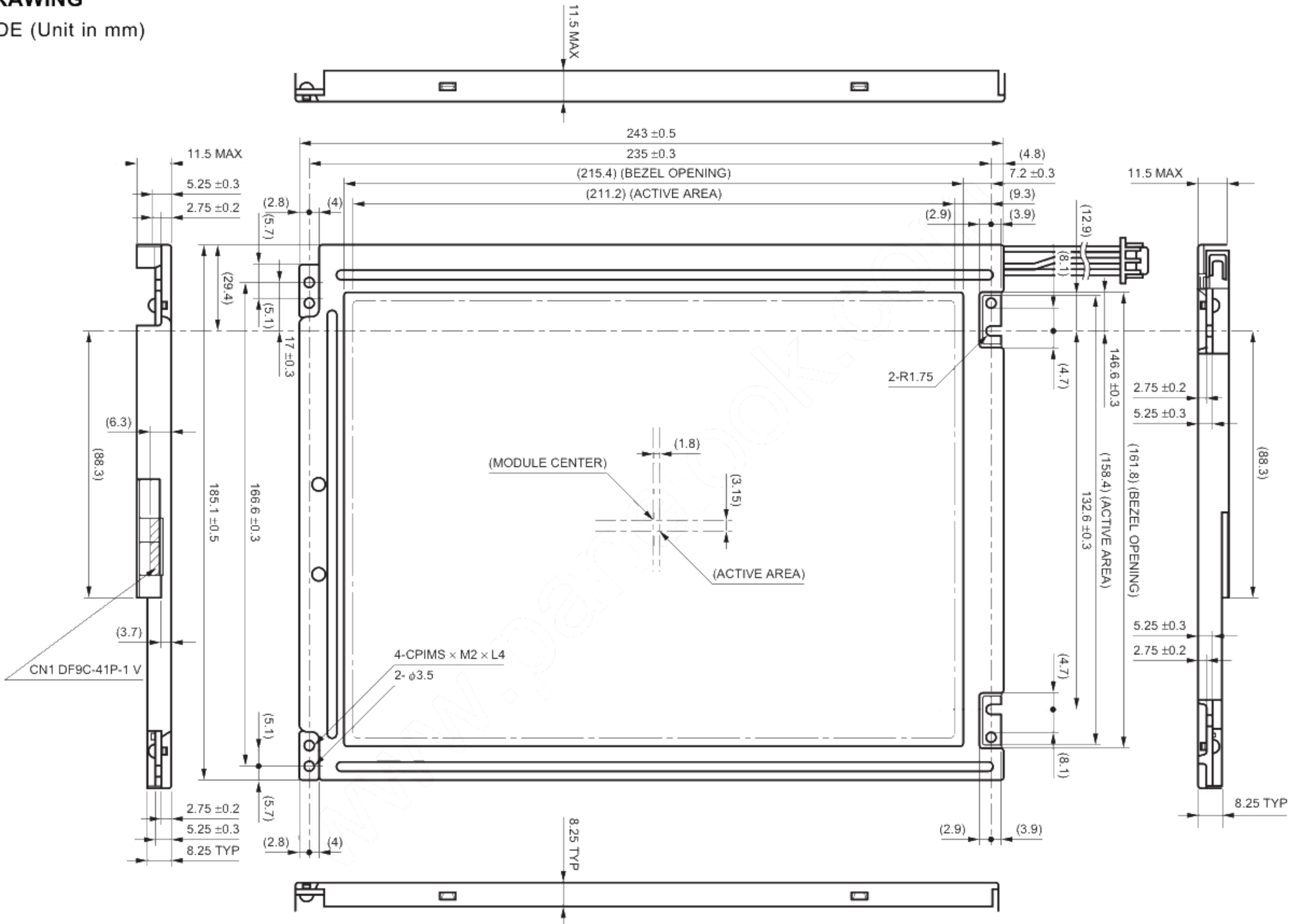
Liquid Crystal Display has the following specific characteristics. There are not defects nor malfunctions.

The display condition of the LCD module may be affected by the ambient temperature.

The LCD module uses cold cathode tube for backlighting. Optical characteristics, like luminance or uniformity, will be changed by the progress in time.

Uneven brightness and/or small spots may be observed depending on different display patterns.

OUTLINE DRAWING FRONT SIDE (Unit in mm)

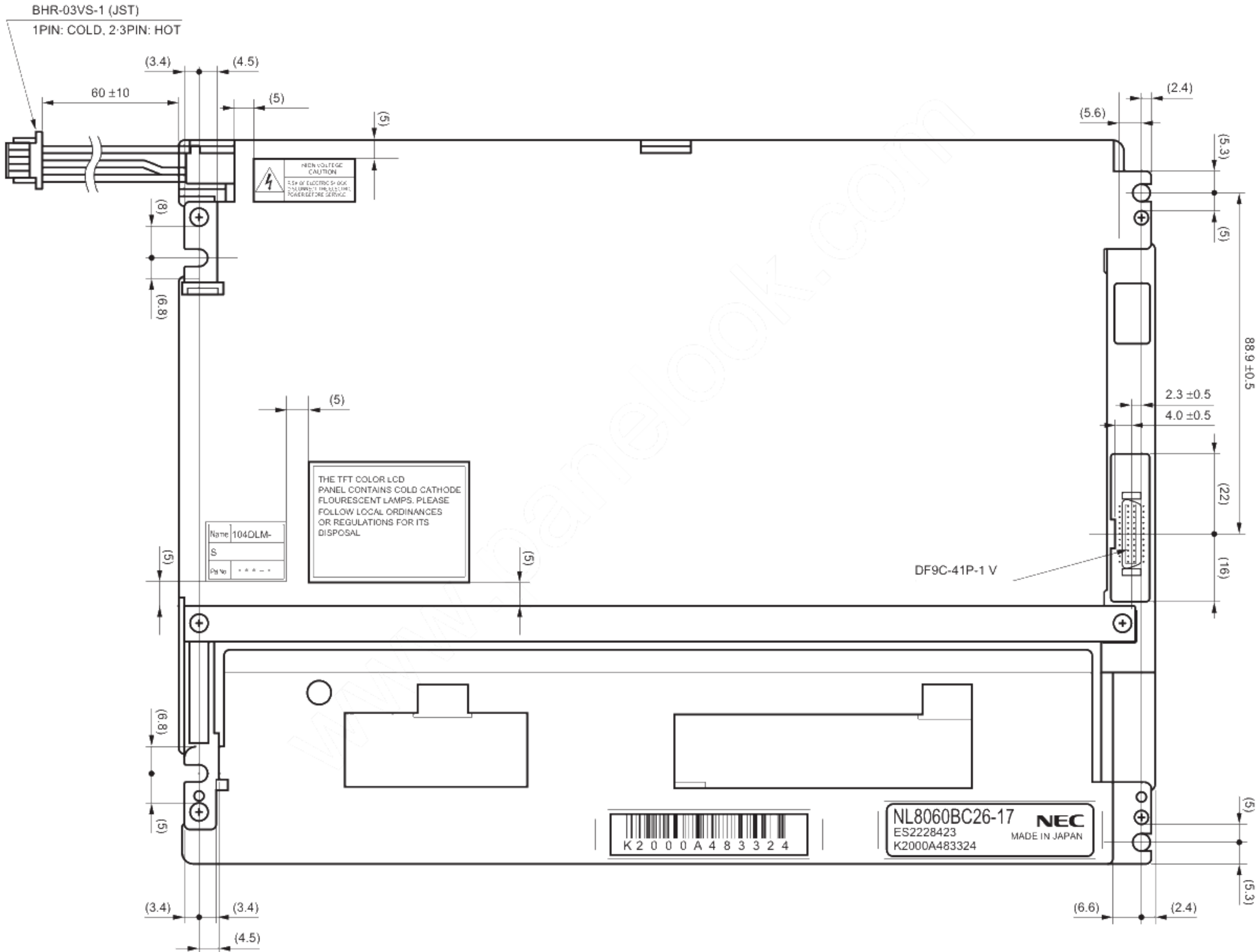


* The torque to mounting screw should never exceed 0.294 N·m (3Kgf·cm).

* The valuse in parentheses are reference.

OUTLINE DRAWING

REAR SIDE (Unit in mm)



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"Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.

Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots.

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support system or medical equipment for life support, etc.

The quality grade of NEC devices is "Standard" unless otherwise specified in NEC's Data Sheets or Data Books. If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact an NEC sales representative in advance.

Anti-radioactive design is not implemented in this product.