

NEC**TFT COLOR LCD MODULE
NL8060BC26-17**

**26 cm (10.4 type), 800 x 600 pixels, 262144 colors,
incorporated two lamps/edge-light type backlight,
wide viewing angle, high brightness**

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.

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

NL8060BC26-17 is the successor model of NL8060AC26-11 having enhanced viewing angle, brightness and other functions.

FEATURES

- Wide viewing angle (with Retardation Film)
- High luminance (280 cd/m², typ.)
- Low reflection
- Inverterless
- Recommendation inverter: type No. 104PWBR1 (NEC)
- Edge type backlight with two long-life-time lamps on one lamp holder
- Replaceable the lamp holder (Type No.: 104LHS31)
- Reversible scan direction
- 6-bit digital RGB signals
- Data enable (DE) function

APPLICATIONS

- Personal computer (PC) for factory automation
- Display terminals for control system
- Monitors for process controller
- New media

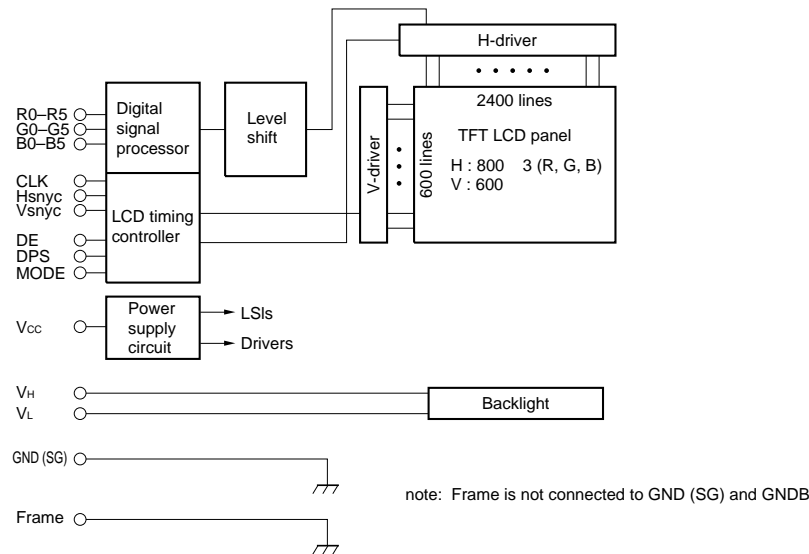
STRUCTURE AND FUNCTIONS

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.

BLOCK DIAGRAM



OUTLINE OF CHARACTERISTICS (at room temperature)

| | |
|--|--|
| Display area | 211.2 (H) x 158.4 (V) mm |
| Drive system | a-Si TFT active matrix |
| Display colors | 262144 colors |
| Number of pixels | 800 x 600 pixels |
| Pixel arrangement | RGB vertical stripe |
| Pixel pitch | 0.264 (H) x 0.264 (V) mm |
| Module size | 243.0 (H) x 185.1 (V) x 11.5 max. (D) mm |
| Weight | 550 g (max.), LCD module + 15 g (typ., attached inverter) |
| Contrast ratio | 300:1 (typ.) |
| Viewing angle (more than the contrast ratio of 10:1) | Horizontal : 50° (typ. left side, right side) Vertical : 30° (typ. up side), 50° (typ. down side) |
| Designed viewing direction | <ul style="list-style-type: none"> • Wider viewing angle with contrast ratio : down side (6 o'clock) • Wider viewing angle without image reversal: up side (12 o'clock) • Optimum grayscale (gamma = 2.2) : perpendicular |
| Color gamut | 43 % (typ. center, to NTSC) |
| Response time | 15 ms (typ.), "white" to "black" |
| Luminance | 280 cd/m ² (typ.) |
| 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 |
| Power consumption | 7.0 W (@ 3.3V w/ recommended inverter) |

GENERAL SPECIFICATIONS

| Item | Specification | Unit |
|-------------------|--|-------|
| Module size | 243.0 ± 0.5 (H) x 185.1 ± 0.5 (V) x 11.5 max.* (D) | mm |
| Inverter size | 25.0 ± 0.5 (H) x 105.0 ^{+0.7} / _{-0.3} (V) x 10.2 max. (D) | mm |
| Display area | 211.2 (H) x 158.4 (V) | mm |
| Number of pixels | 800 (H) x 600 (V) | pixel |
| Dot pitch | 0.088 (H) x 0.264 (V) | mm |
| Pixel pitch | 0.264 (H) x 0.264 (V) | mm |
| Pixel arrangement | RGB (Red, Green, Blue) vertical stripe | |
| Display colors | 262144 | color |
| Weight | Module: 550 max | g |

* D = 10.5 typ.

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 | |
| Supply voltage | V _{DDB} | -0.3 to 15.0 | V | T _a = 25°C (Recmnd Invtr 104PWBR1) |
| 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 display area

ELECTRICAL CHARACTERISTICS

(1) Logic, LCD driving

T_a = 25 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 V (V _{CC} = 5.0 V) |
| Logic input "L" voltage | V _{IL} | 0 | - | V _{CC} x 0.3 | V | |
| Logic input "H" voltage | V _{IH} | V _{CC} x 0.7 | - | 5.25 | V | |
| Supply current | I _{CC} | - - | *1 360 *1 (270) | *2 550 *2 (500) | mA | V _{CC} = 3.3 V (V _{CC} = 5.0 V) |

*1. Checker flag pattern (in EIAJ ED-2522)

*2. Theoretical maximum current pattern

(2) Backlight

T_a = 25 C

| Parameters | Symbols | MIN. | TYP. | MAX. | Unit | Remarks |
|----------------------|----------------|---------|---------|---------|-------|--|
| Lamp current | I _L | 2.0 x 2 | 5.0 x 2 | 5.5 x 2 | mArms | with two lamps (280 cd/m ²) Typ. |
| Lamp voltage | V _L | - | 510 | - | Vrms | |
| Lamp turn on voltage | V _s | 840 | - | - | Vrms | T _a = 25 C |
| | | 1265 | - | - | | T _a = 0 C |
| Oscillator frequency | F _t | 50 | 54 | 58 | kHz | Note |

Note Recommended value of "F_t".

- F_t is within the specification.

and

- $F_t = \frac{1}{4th} (2n - 1)$ th: Hsync period
n : a natural number (1, 2, 3,)

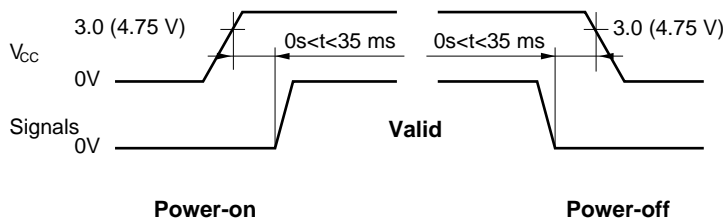
If F_t is out of the recommended value, interference between F_t frequency and Hsync frequency may cause beat on the display.

(3) Inverter (104PWBR1 NEC)

T_a = 25 C

| Parameters | Symbols | Min. | Typ. | Max. | Unit | Remarks |
|----------------|------------------|------|------|------|------|-----------------------------|
| Supply Voltage | V _{DDB} | 11.4 | 12.0 | 12.6 | V | - |
| Supply Current | I _{DDB} | - | 480 | 550 | mA | 280 cd/m ² (typ) |

SUPPLY VOLTAGE SEQUENCE



- *1 The supply voltage for input signals should be the same as V_{CC}.
- *2 Apply V_H 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, data) low level or high impedance.
- *4 If the power sequence is not kept, the LCD module will be damaged.

INTERFACE PIN CONNECTION

(1) Interface signals, power supply

Module side connector

CN1 ... DF9-41P-1V (No. 1 to 41)

Supplier: HIROSE ELECTRIC CO., LTD.

or

IL-310-T41P-VF (No. 1 to 41)

Supplier: Japan Aviation Electronics Industry limited (JAE)

Mating connector

DF9-41S-1V or DF9M-41S-1R

IL-310-T41S-VF

note: Mating connectors are possible to use all parts.

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

| Pin No. | Symbol | Function |
|---------|--------|-------------------------------------|
| 22 | GND | Ground Note 3 |
| 23 | G3 | Green data |
| 24 | G4 | Green data |
| 25 | G5 | Green data (MSB) |
| 26 | GND | Ground Note 3 |
| 27 | GND | Ground Note 3 |
| 28 | GND | Ground Note 3 |
| 29 | B0 | Blue data (LSB) |
| 30 | B1 | Blue data |
| 31 | B2 | Blue data |
| 32 | GND | Ground Note 3 |
| 33 | B3 | Blue data |
| 34 | B4 | Blue data |
| 35 | B5 | Blue data (MSB) |
| 36 | GND | Ground Note 3 |
| 37 | DE | Data enable |
| 38 | DPS | Scan direction select Note 4 |
| 39 | Vcc | Power supply Note 1 |
| 40 | Vcc | Power supply Note 1 |
| 41 | MODE | Timing mode select Note 2 |

LSB : Least Significant Bit

MSB : Most Significant Bit

- Notes**
- Vcc: All Vcc terminals should be connected to 3.3 V [5.0 V].
 - MODE: H = DE mode
L or open = Fixed mode
 - DPS can change scan direction (normal scan and reverse scan).
DPS: High = normal scan
Low or open = reverse scan

(2) Backlight

lamp side connector Mating connector
 CN2 ... BHR-03VS-1 SM02 (8.0) B-BHS-TB
 Supplier: J.S.T TRADING COMPANY, LTD.

| Pin No. | Symbol | Function |
|---------|--------|-----------------------|
| 1 | GNDB | Backlight ground |
| 2 | VH | High voltage terminal |
| 3 | VH | High voltage terminal |

Inverter side connector 1 Mating connector 1
 CN3 ... LZ-5P-SL-SMT LZ-5S-SC3
 Supplier: Japan Aviation Electronics Industry Limited (JAE)

| Pin No. | Symbol | Function | Pin No. | Symbol | Function |
|---------|------------------|------------------|---------|--------|---------------------|
| 1 | V _{DDB} | Power supply | 4 | GNDB | Backlight ground |
| 2 | V _{DDB} | Power supply | 5 | BRTHL | Luminance select *1 |
| 3 | GNDB | Backlight ground | | | |

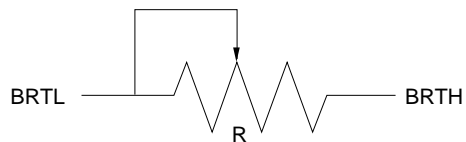
*1: High luminance (100 %) ... BRTHL = +5 V or open
 Low luminance (60 %) ... BRTHL = GND

Inverter side connector 2 Mating connector 2
 CM4 ... 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 *1 |
| 2 | BRTH | Luminance control input *2 |
| 3 | BRTL | Luminance control input *2 |

*1: TTL level
 Backlight ON ... BRTC = H or Open
 Backlight OFF ... BRTC = L

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

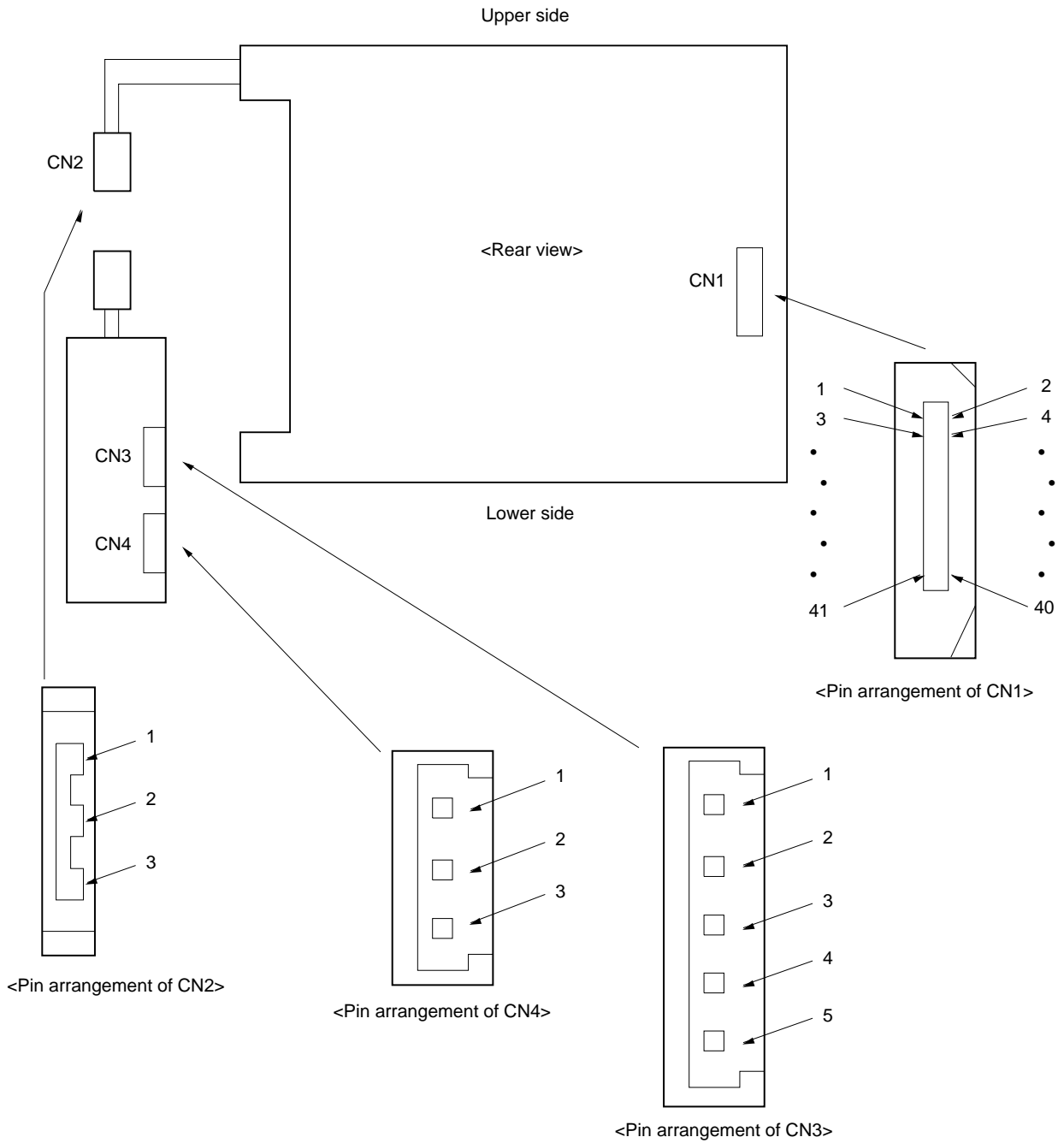


Mating variable resistor : 10 K ±5 %
 Minimum luminance (50 %) : R = 0
 Maximum luminance (100 %) : R = 10 K

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

- Minimum luminance (50 %) : 2.5 V
- Maximum luminance (100 %) : ≤ 1.2 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 |
| | 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 |
| | | 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 |
| Green grayscale | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 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 |
| | 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 |
| Blue grayscale | Black | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Dark | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | Bright | 0 | 0 | 0 | 0 | 0 | 0 | 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 |
| | Blue | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |

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

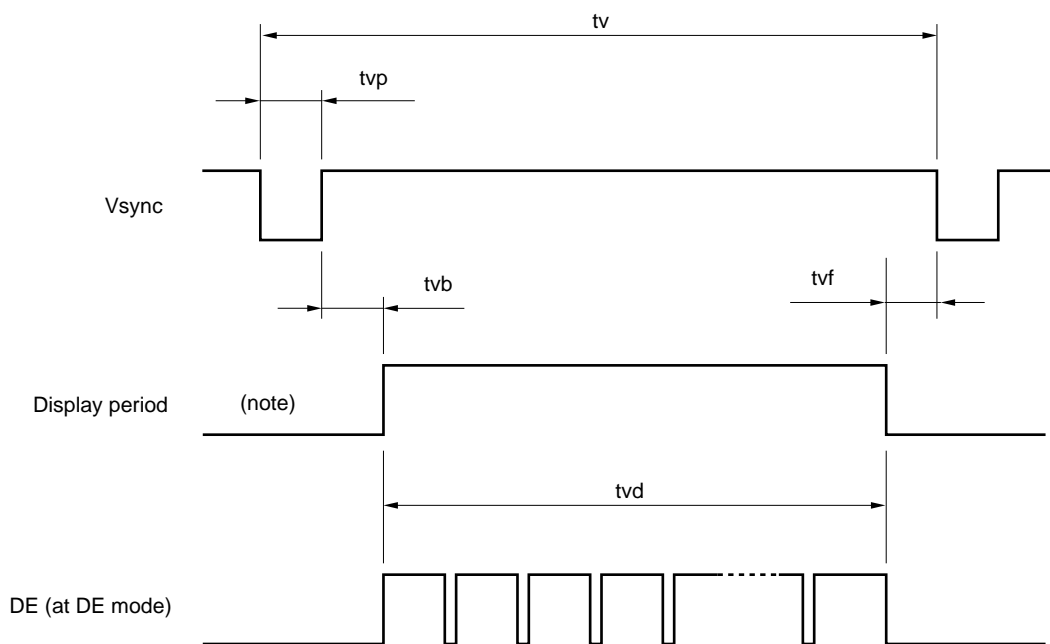
(1) Input signal specifications

| 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 | ∅ | s | 37.463 kHz (TYP.) |
| | | | ∅ | 1024 | ∅ | CLK | |
| | Display period | thd | 800 | | | CLK | |
| | Front-porch | thf | 24 | | | CLK | fixed timing mode |
| | | | 4 | 24 | ∅ | CLK | DE mode |
| | Pulse width | thp* | 2 | 72 | 127 | CLK | fixed timing mode |
| | | | 2 | 72 | 127 | CLK | DE mode |
| | Back-porch | thb* | 73 | 128 | 198 | CLK | fixed timing mode |
| | | | 13 | 128 | 509 | CLK | DE mode |
| | thp + thb* | | 200 | | | CLK | fixed timing mode |
| | | | 15 | 200 | 511 | CLK | DE mode |
| | CLK-Hsync timing | thch | 10 | ∅ | ∅ | ns | |
| | Hsync-CLK timing | thcs | 8 | ∅ | ∅ | ns | |
| | Hsync-Vsync timing | tvhh | 1 | ∅ | ∅ | CLK | |
| | Vsync-Hsync timing | tvhs | 15 | ∅ | ∅ | ns | |
| Rise, fall | thrf | ∅ | ∅ | 10 | ns | | |
| Vsync | Period | tv | 16.1 | 16.683 | 17.2 | ms | 59.94 Hz (TYP.) |
| | | | ∅ | 625 | ∅ | H | |
| | Display period | tvd | 600 | | | H | |
| | Front-porch | tvf | 1 | | | H | fixed timing mode |
| | | | 1 | 1 | ∅ | H | DE mode |
| | Pulse width | tvp* | 1 | 2 | 23 | H | fixed timing mode |
| | | | 1 | 2 | ∅ | H | DE mode |
| | Back-porch | tvb* | 1 | 22 | 23 | H | fixed timing mode |
| | | | 1 | 22 | ∅ | H | DE mode |
| tvp + tvb* | | 24 | | | H | fixed timing mode | |
| | | 2 | 24 | 24 | 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 | 10 | ∅ | ∅ | ns | |
| | Rise, fall | tdrf | ∅ | ∅ | 10 | ns | |
| DE | DE-CLK timing | tes | 8 | ∅ | ∅ | ns | DE mode |
| | CLK-DE timing | teh | 10 | ∅ | ∅ | ns | |
| | Rise, fall | terf | ∅ | ∅ | 10 | ns | |

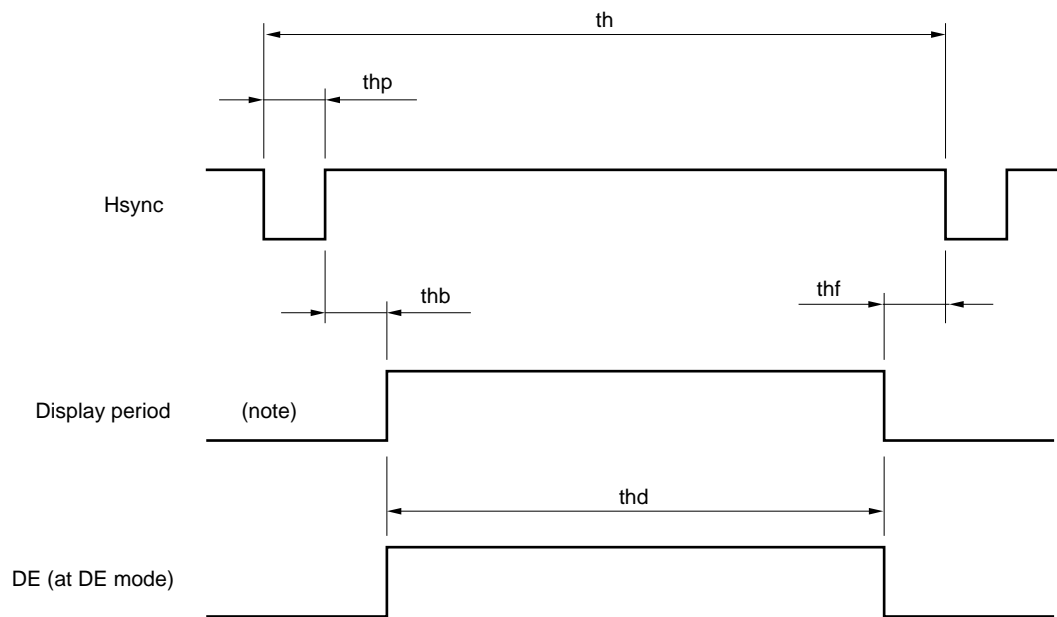
All of parameters should be kept in the specified range.

(2) Definition of input signal timing

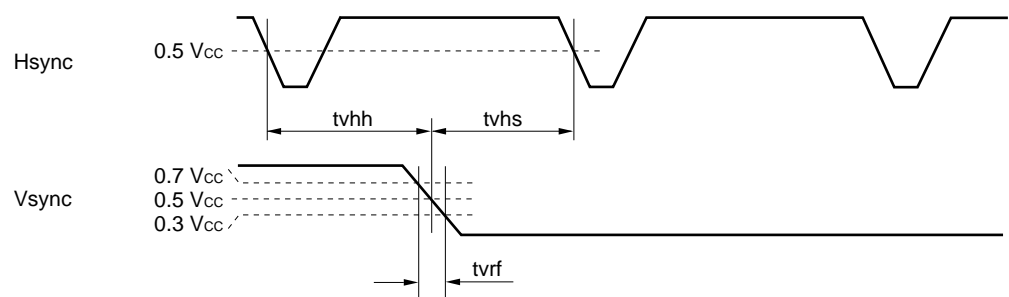
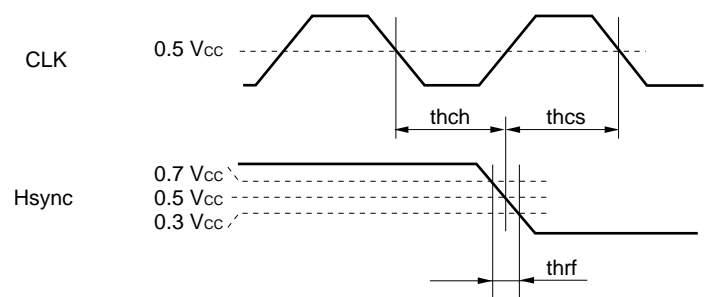
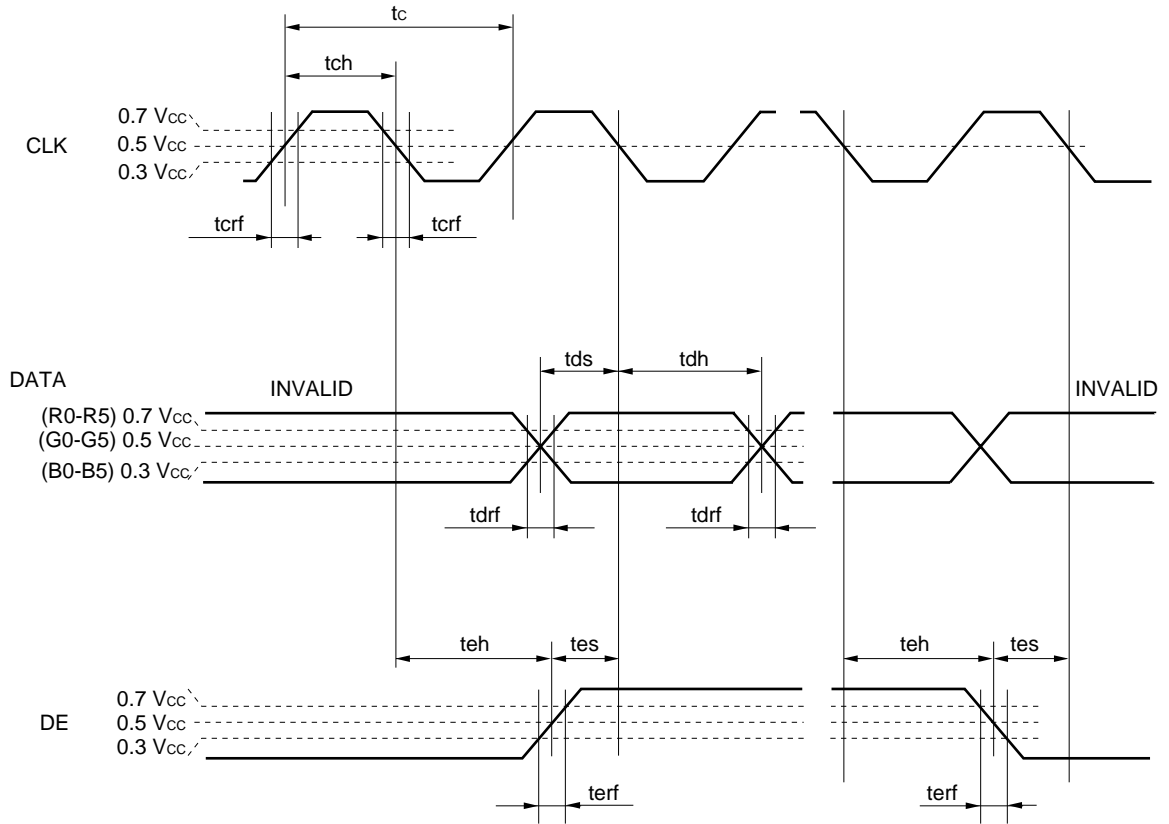
<Vertical>



<Horizontal>

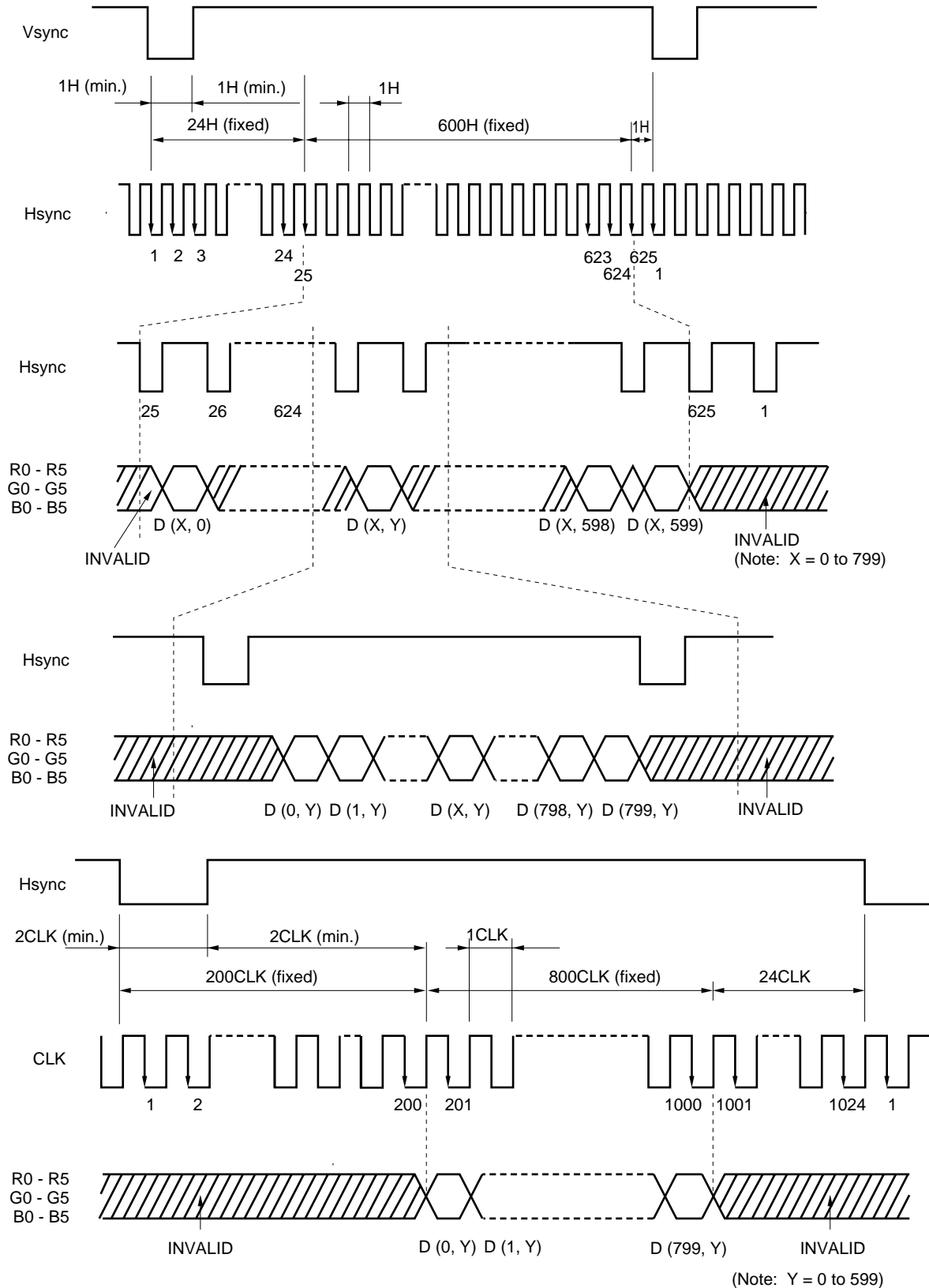


Note These do not exist as signals.

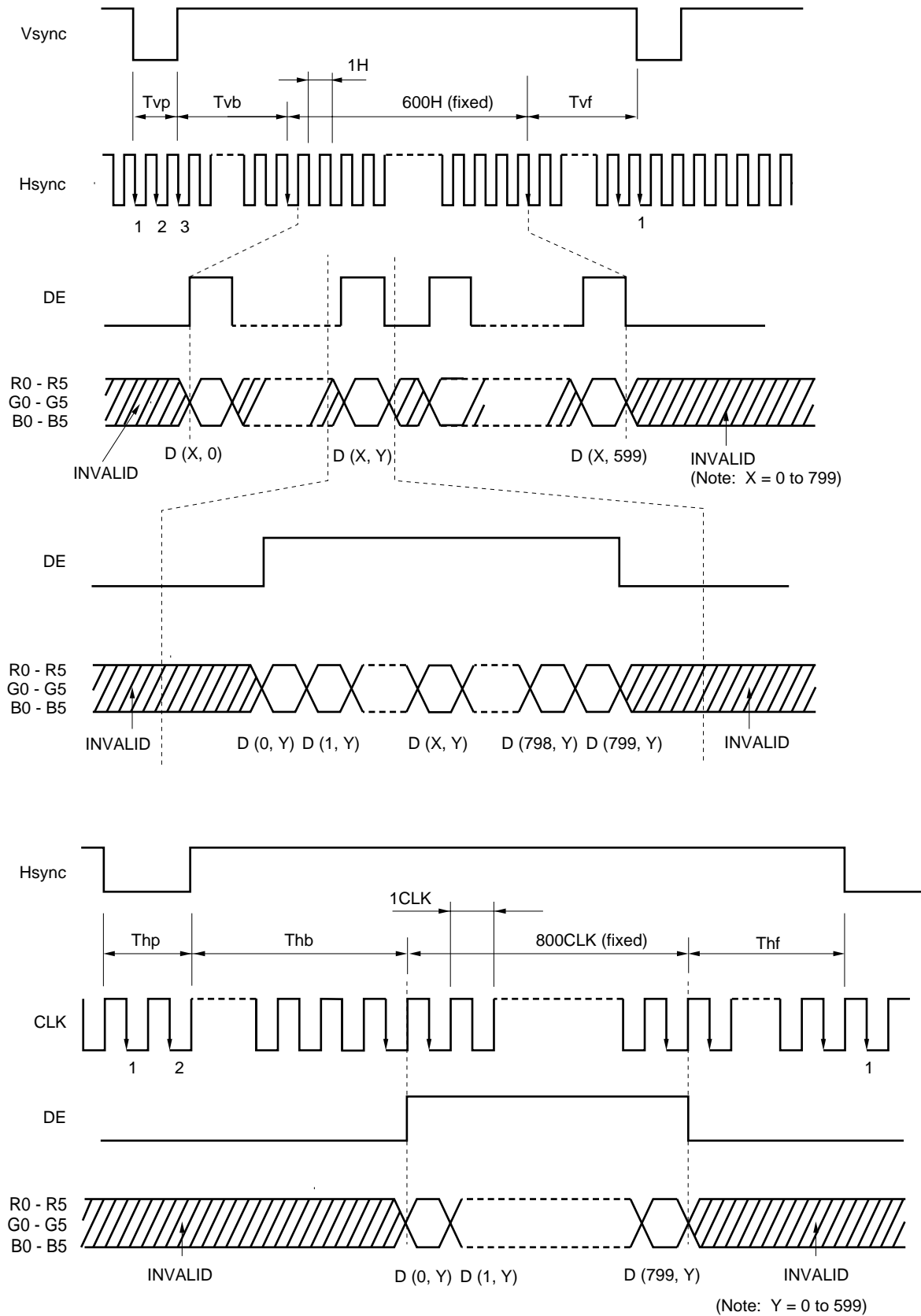


(3) Input signal timing chart

a) Fixed timing mode



b) DE mode



(4) Display position

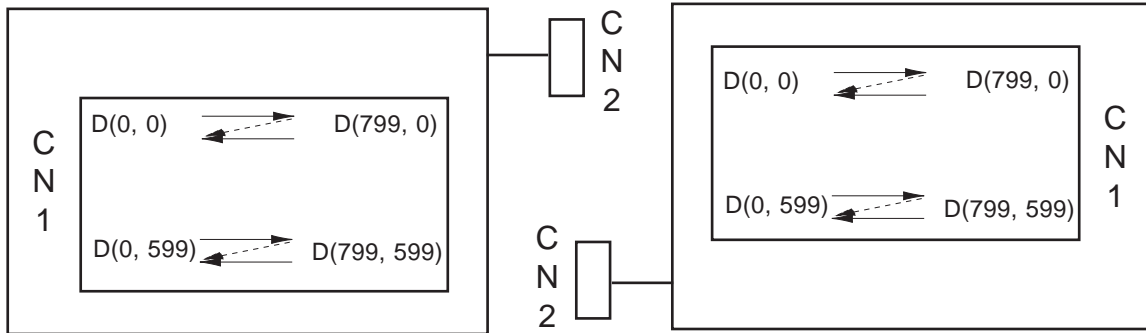
Normal scan (DPS = "VCC")

| | | | | | | |
|------------|------------|-------|------------|-------|--------------|--------------|
| D (0, 0) | D (1, 0) | ----- | D (X, 0) | ----- | D (798, 0) | D (799, 0) |
| 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) |

Note: The drawings below show the relationship between the scan direction and the viewing direction



OPTICAL CHARACTERISTICS

Vcc=3.3V, at normal scan, Ta=25°C w/ recommended inverter (VDDB = 12V)

| Parameters | Symbols | Conditions | MIN. | TYP. | MAX. | Unit | Remarks |
|----------------------|---------|-------------------------------|------|------|------|-------------------|---------------|
| Contrast ratio | CR | X = ± 0°, Y = ± 0°; at center | 150 | 300 | - | - | Note 1 |
| Luminance | L VMAX | X = ± 0°, Y = ± 0°; at center | 200 | 280 | - | cd/m ² | Note 2 |
| Luminance uniformity | - | max. /min. | - | - | 1.40 | - | Note 3 |

Reference data

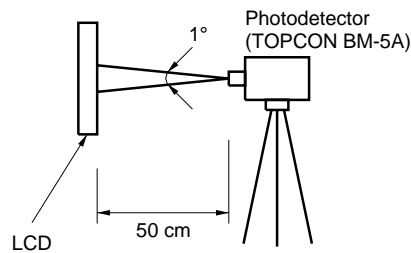
| Parameters | Symbols | Conditions | MIN. | TYP. | MAX. | Unit | Remarks | |
|---------------------|------------|--------------------|---------------------------|------|------|------|---------------|---------------|
| Viewing angle range | Horizontal | X+ | CR > 10, Y = ±0° (CR > 5) | 45 | 50 | - | deg. | Note 4 |
| | | X- | CR > 10, Y = ±0° (CR > 5) | 45 | 50 | - | deg. | |
| | Vertical | Y+ | CR > 10, X = ±0° (CR > 5) | 30 | 40 | - | deg. | |
| | | Y- | CR > 10, X = ±0° (CR > 5) | 40 | 45 | - | deg. | |
| Response time | t on | White to black | - | 15 | 50 | ms | Note 5 | |
| | t off | Black to white | - | 65 | - | ms | | |
| Color gamut | C | At center. to NTSC | 35 | 43 | - | % | | |

Notes 1. 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.

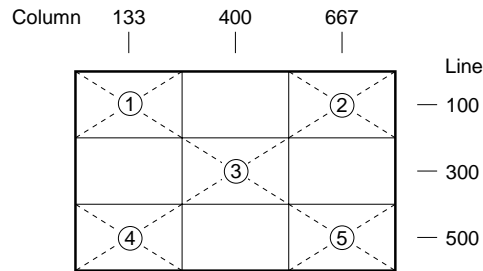
2. The luminance is measured after 20 minutes from the module works, with all pixels in white. Typical value is measured after luminance saturation.



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

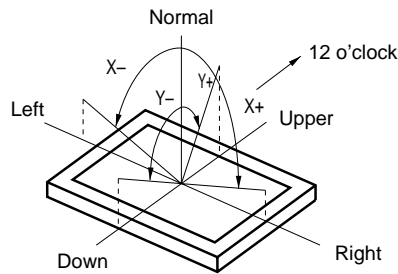
$$\text{Luminance uniformity} = \frac{\text{Maximum luminance}}{\text{Minimum luminance}}$$

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



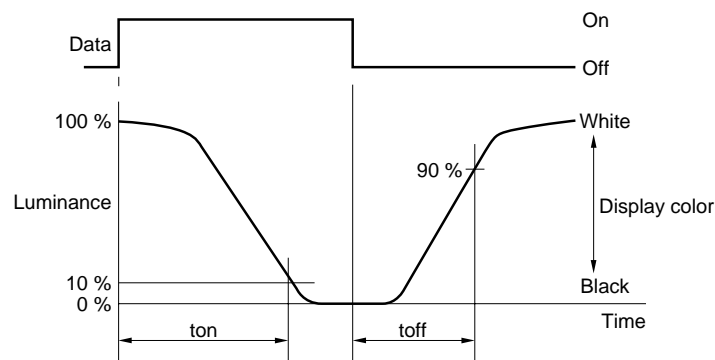
4. Definitions of viewing angle are as follows.

The viewing angles are reference.



5. Definition of response time is as follows.

Photodetector output signal is measured when the luminance changes "White" to "Black". Response time (t_{on}) is the time between 10% and 100% of the photodetector output amplitude. Response time (t_{off}) is the time between 0% and 90% of the output amplitude.



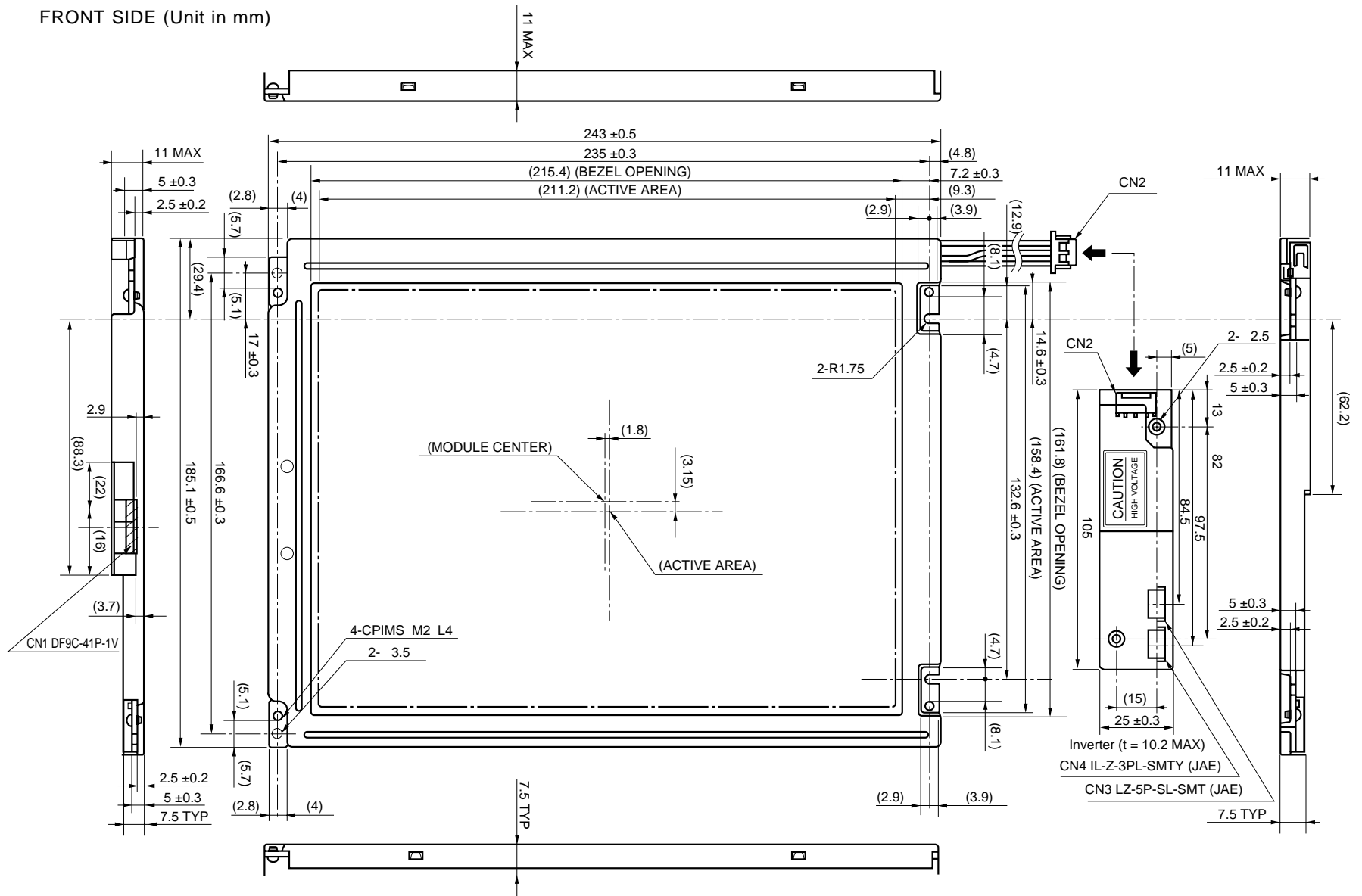
GENERAL CAUTION

- (1) Caution when taking out the module
 - 1) Pick the pouch only, when taking out module from a shipping package.
- (2) Cautions for handling the module
 - 1) As the electrostatic discharges may break the LCD module, handle the LCD module with care. Peel a protection sheet off from the LCD panel surface as slowly as possible.
 - 2) As the LCD panel and back-light 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) The torque to mounting screw should never exceed 0.294 N•m (3 Kgf•cm).
- (3) Cautions for the operation
 - 1) When the module is operating, do not lose CILK, Hsync or Vsync signals. If any one of these signals is lost, the LCD panel would be damaged.
 - 2) Obey the supply voltage sequence. If wrong sequence is applied, the module would be damaged.
- (4) Cautions for the atmosphere
 - 1) Dew drop atmosphere should be avoided.
 - 2) Do not store and/or operate the LCD module in a high temperature and/or humidity atmosphere. Storage in an electro-conductive polymer packing pouch and under relatively low temperature atmosphere is recommended.
 - 3) This module uses cold cathode fluorescent lamps. Therefore, the life time of lamps becomes short conspicuously at low temperature.
- (5) Cautions for the module characteristics
 - 1) Do not apply fixed pattern data signal to the LCD module at product aging. Applying fixed pattern for a long time may cause image sticking.
- (6) Other cautions
 - 1) Do not disassemble and/or re-assemble LCD module.
 - 2) Do not re-adjust variable resistor or switch etc.
 - 3) When returning the module for repair or etc., Please pack the module not to be broken.
We recommend to use the original shipping packages.

Liquid Crystal Display has the following specific characteristics. These are not defects or malfunctions. The display condition of LCD module may be affected by the ambient temperature. The LCD module uses cold cathode tubes for backlighting. Optical characteristics, like luminance or uniformity, will change during time. Uneven brightness and/or small spots may be noticed depending on different display patterns.

OUTLINE DRAWING

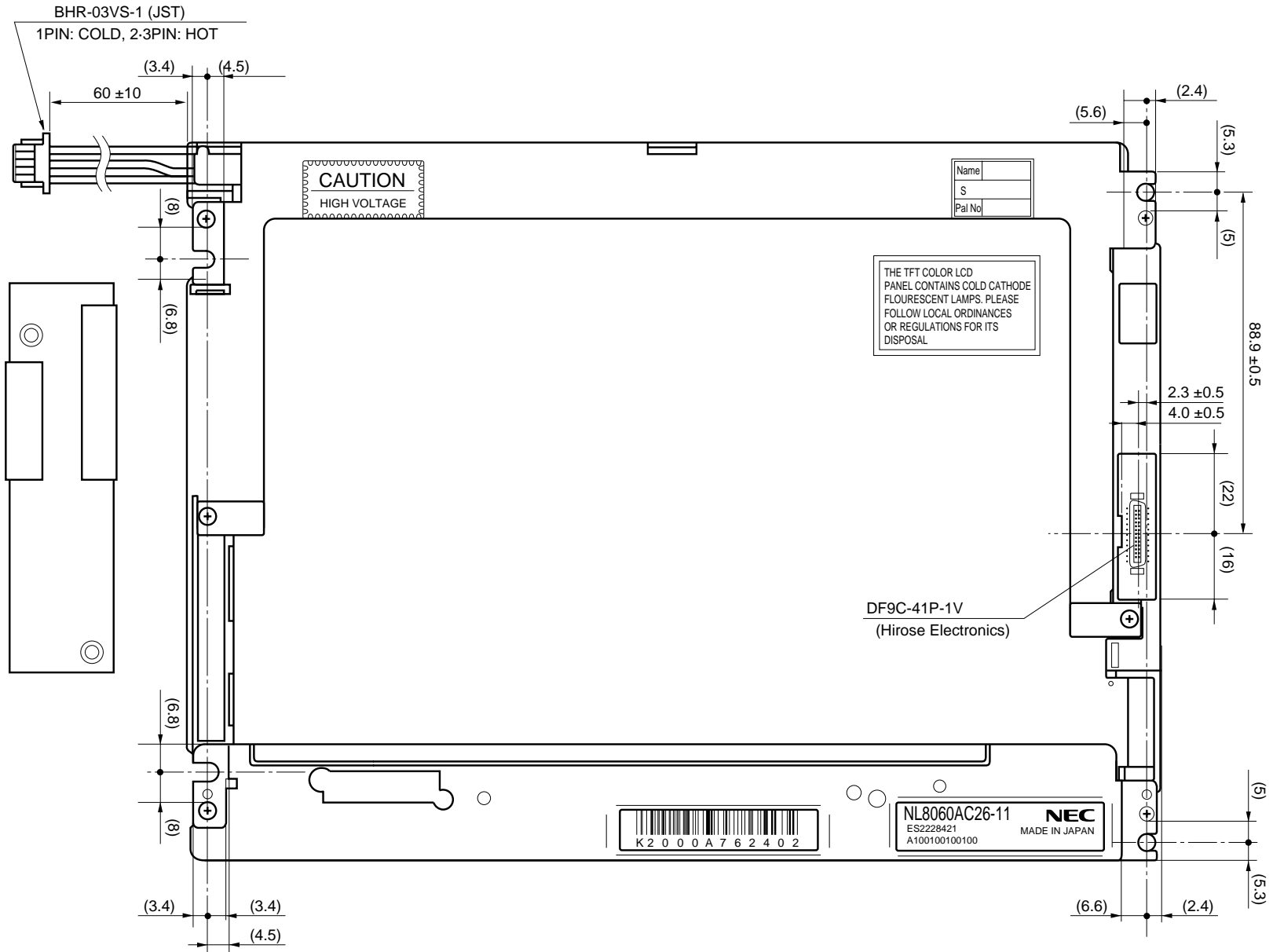
FRONT SIDE (Unit in mm)



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

OUTLINE DRAWING

REAR SIDE (Unit in mm)



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