

**26 cm (*10.2 type), 640×480 pixels, 262144 colors,
incorporated one lamp/edge-light type backlight**

DESCRIPTION

NL6448AC32-01 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 640 × 480 pixels and can display 262144 color simultaneously.

By utilizing one lamp/edge-light type backlight, a very thin profile and low power consumption have been achieved.

FEATURES

- 6-bit digital RGB signals
- 3.3 V operation (5.0V available)
- Thin and light weight
- High contrast ratio, wide color gamut
- High-speed response
- Low power consumption
- Incorporated edge light type backlight (One lamp, Inverter-less)
- Data enable function

APPLICATIONS

- Notebook personal computer (PC), word processor
- Display terminals for control system
- New media
- Monitors for process controller



*) This is a figure rounding up of least significant figure of 10.11 inches.

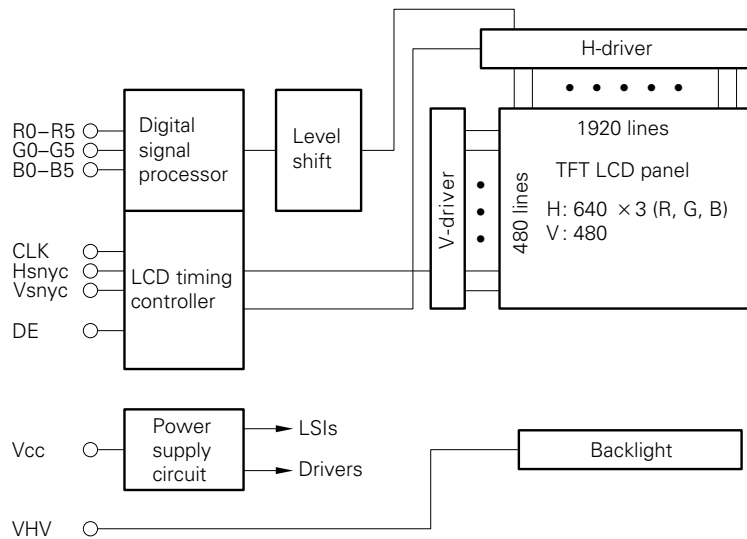
STRUCTURE AND FUNCTIONS

A TFT color LCD module comprises a TFT LCD panel, LSIs for driving liquid crystal, and the backlight. The TFT LCD panel is composed of a TFT array glass substrate superimposed on a color filter glass substrate with liquid crystal filled in the narrow gap between two substrates. The backlight apparatus is located on the backside of the LCD panel.

RGB (Red, Green, Blue) data signals are sent to LCD panel drivers after modulation into suitable forms for active matrix addressing through signal processor.

Each of the liquid crystal cells acts as an electro-optical switch that controls the light transmission from the backlight by a signal applied to a signal electrode through the TFT switch.

BLOCK DIAGRAM



OUTLINE OF CHARACTERISTICS (at room temperature)

| | |
|--|--|
| Display area | 205.44(H) × 154.08(V) mm |
| Drive system | a-Si TFT active matrix |
| Display colors | 262144 colors |
| Number of pixels | 640 × 480 pixels |
| Pixel arrangement | RGB vertical stripe |
| Pixel pitch | 0.321(H) × 0.321(V) mm |
| Module size | 264.2(H) × 180.2(V) × 9.0 max.(D) mm |
| Weight | 553 g (typ.) |
| Contrast ratio | 150 : 1 (typ.) |
| Viewing angle (more than the contrast ratio of 10 : 1) | Horizontal : 45° (typ. left side, right side) Vertical : 25° (typ. up side), 25° (typ. down side) |
| Designed viewing direction | 12 o'clock (upper direction) |
| Color gamut | 55 % (typ. center, to NTSC) |
| Response time | 40 msec. (max.), "white" to "black" |
| Luminance | 70 cd / m ² (typ.) |
| Signal system | 6-bit digital signals for each of RGB primary colors, synchronous signals (Hsync, Vsync), dot clock (CLK), DE signal |
| Supply voltages | 3.3 V or 5.0 V |
| Backlight | Edge light type, one cold cathode fluorescent lamp |
| Power consumption | 2.9 W (typ. Vcc = 3.3 V), 3.1 W (typ. Vcc = 5.0 V) |

GENERAL SPECIFICATIONS

| Item | Specification | Unit |
|-------------------|--|-------|
| Module size | 264.2±1 (H) × 180.2±1(V) × 9.0 max.(D) | mm |
| Display area | 205.44(H) × 154.08(V) | mm |
| Number of pixels | 640(H) × 480(V) | pixel |
| Dot pitch | 0.107(H) × 0.321(V) | mm |
| Pixel pitch | 0.321(H) × 0.321(V) | mm |
| Pixel arrangement | RGB(Red, Green, Blue) vertical stripe | |
| Display colors | 262144 | color |
| Weight | 579(max.) | g |

ABSOLUTE MAXIMUM RATINGS

| Parameter | Symbol | Rating | Unit | Remarks |
|-----------------|-----------------|---|------|-----------------|
| supply voltage | V _{CC} | -0.3 to 6.5 | V | Ta = 25 °C |
| Input voltage | V _I | -0.3 to V _{CC} +0.3 | V | |
| Storage temp. | T _{ST} | -20 to 60 | °C | |
| Operating temp. | T _{OP} | 0 to 50 | °C | Module surface* |
| Humidity | | ≦ 95 % relative humidity | | Ta = 40 °C |
| | | ≦ 85 % relative humidity | | Ta = 50 °C |
| | | absolute humidity shall not exceed Ta=50°C, 85 % relative humidity level | | Ta > 50 °C |

* measured at center of display area

ELECTRICAL CHARACTERISTICS

(1) Logic, LCD driving

Ta = 25 °C

| Parameter | Symbol | min. | typ. | max. | Unit | Remarks |
|-------------------------|-----------------|-----------------------|------|-----------------------|------|-------------------------|
| Supply voltage | V _{CC} | 3.0 | 3.3 | 3.6 | V | V _{CC} = 3.3 V |
| | | 4.75 | 5.0 | 5.25 | | V _{CC} = 5.0 V |
| Logic input "L" voltage | V _{IL} | 0 | - | V _{CC} × 0.3 | V | |
| Logic input "H" voltage | V _{IH} | V _{CC} × 0.7 | - | V _{CC} | V | |
| Supply current | I _{CC} | - | 400 | 600 | mA | V _{CC} = 3.3 V |
| | | - | 300 | 450 | mA | V _{CC} = 5.0 V |

* at dot-checked pattern

(2) Backlight

Ta = 25 °C

| Parameter | Symbol | min. | typ. | max. | Unit | Remarks |
|----------------------|----------------|------|------|------|------------------|-----------------------------|
| Lamp current | I _L | - | *3.5 | 5.5 | mArms | * at 70 cd / m ² |
| Lamp voltage | V _L | - | 455 | - | V _{rms} | |
| Oscillator frequency | F _t | - | 55 | - | kHz | note |

note : Recommended value of "Ft"

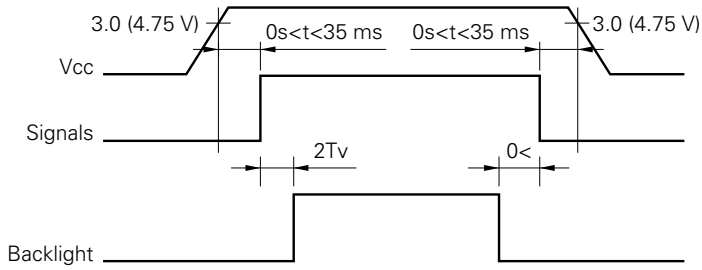
- Ft is within the specification.
- and

$$F_t = \frac{1}{4T_h} \times (2n-1)$$

T_h : Hsync period
n : a natural number (1, 2, 3, ••••)

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

SUPPLY VOLTAGE SEQUENCE



- *1 The supply voltage for input signals should be same as Vcc.
- *2 Apply VHV 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, data) low level or high impedance.

INTERFACE PIN CONNECTION

(1) Interface signals, power supply

Connector : IL-Z-15PL-SMTY (CN1) + IL-Z-14PL-SMTY (CN2)
 (No.1~No.15) (No.16~No.29)

Supplier : Japan Aviation Electronics Industry Limited (JAE)

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

| Pin No. | Symbol | Function |
|---------|--------|-----------------------|
| 16 | G2 | Green data |
| 17 | G3 | Green data |
| 18 | G4 | Green data |
| 19 | G5 | Green data (MSB) |
| 20 | GND | Signal ground |
| 21 | B0 | Blue data (LSB) |
| 22 | B1 | Blue data |
| 23 | B2 | Blue data |
| 24 | B3 | Blue data |
| 25 | B4 | Blue data |
| 26 | B5 | Blue data (MSB) |
| 27 | Vcc | Logic power supply 1) |
| 28 | Vcc | Logic power supply 1) |
| 29 | DE | Data enable |

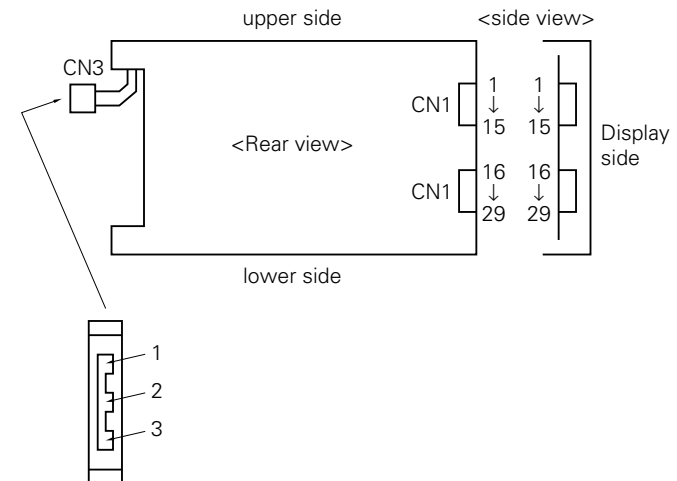
note 1) Vcc : All Vcc terminals should be connected to +3.3 V (+5.0 V)

(2) Backlight

Connector : BHR-03VS-1 ••• CN3
 Supplier : J.S.T TRADING COMPANY, LTD

| Pin No. | Symbol | Function |
|---------|--------|-----------------------|
| 1 | VHV | High voltage terminal |
| 2 | N. C. | Non-connection |
| 3 | GND | Backlight ground |

<Connector location>



<pin arrangement of CN3>

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 | 0 | 1 | 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 | 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 |
| 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 | 0 | 1 |
| | ↑ | | | | | | | | | | | | | | | | | | |
| | ↓ | | | | | | | | | | | | | | | | | | |
| | bright | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| Blue grayscale | | 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 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 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

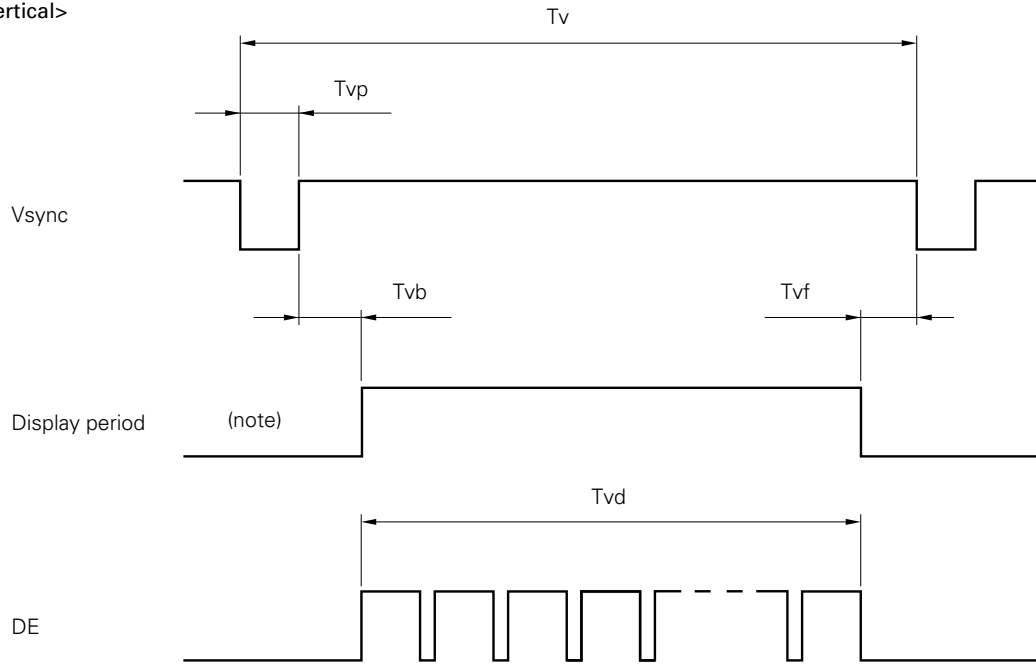
(1) Input signal specifications

| Parameter | | Symbol | min. | typ. | max. | Unit | Remarks | |
|---------------------------------|--------------------|----------|------|--------|------|------|-------------------|--|
| CLK | Frequency | 1 / Tc | 21.0 | 25.175 | 26.0 | MHz | 39.722 ns (TYP.) | |
| | Duty | Tch / Tc | 0.45 | 0.5 | 0.55 | — | | |
| | Rise, Fall | Tcrf | — | — | 10 | ns | | |
| Hsync | Period | Th | 30.0 | 31.778 | 33.6 | μs | 31.469 kHz (TYP.) | |
| | | | — | 800 | — | CLK | | |
| | Display period | Thd | — | 640 | — | CLK | 25.422 μs (TYP.) | |
| | Front-porch | Thf | 4 | 16 | — | CLK | 0.636 μs (TYP.) | |
| | Pulse width | Thp *) | 10 | 96 | — | CLK | 3.813 μs (TYP.) | |
| | Bsck-porch | Thb *) | 4 | 48 | — | CLK | 1.907 μs (TYP.) | |
| | *) Thp + Thb | | | 14 | 144 | — | CLK | |
| | CLK-Hsync timing | Thch | 12 | — | — | ns | | |
| | Hsync-CLK timing | Thcs | 8 | — | — | ns | | |
| | Hsync-Vsync timing | Tvh | 1 | — | — | CLK | | |
| | Vsync-Hsync timing | Tvs | 15 | — | — | ns | | |
| Rise, Fall | Thrf | — | — | 10 | ns | | | |
| Vsync | Period | Tv | 16.1 | 16.683 | 17.2 | ms | 59.94 Hz (TYP.) | |
| | | | — | 525 | — | H | | |
| | Display period | Tvd | — | 480 | — | H | 15.253 ms (TYP.) | |
| | Front-porch | Tvf | 1 | 12 | — | H | 0.381 ms (TYP.) | |
| | Pulse width | Tvp *) | 2 | 2 | — | H | 0.063 ms (TYP.) | |
| | Back-porch | Tvb *) | 4 | 31 | — | H | 0.985 ms (TYP.) | |
| | *) Tvp + Tvb | | | 6 | 33 | — | H | |
| 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 | | |

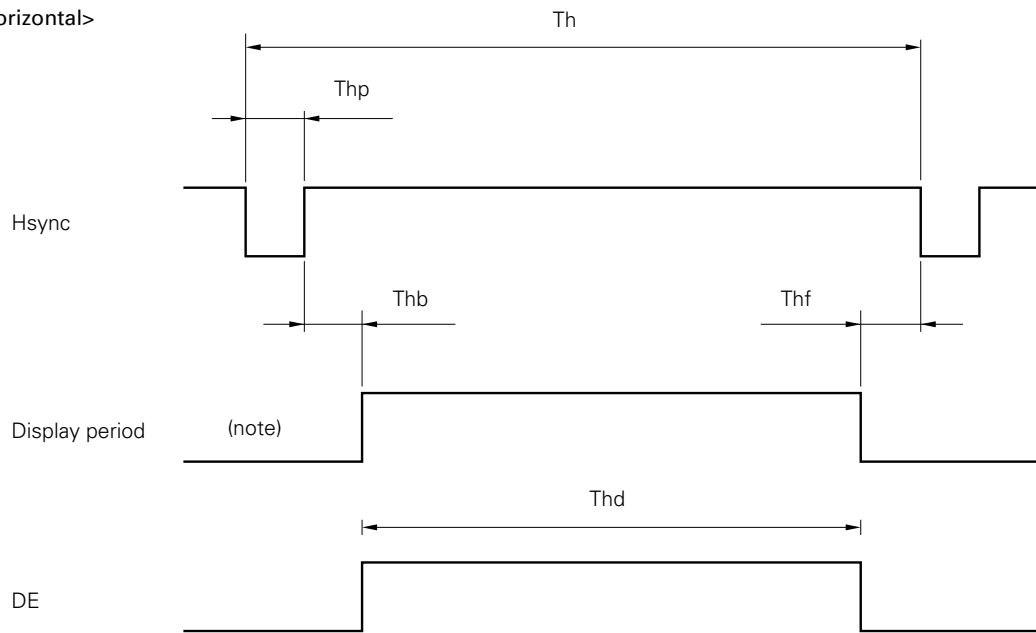
All of parameters should be kept in the specified range.

(2) Definition of input signal timing

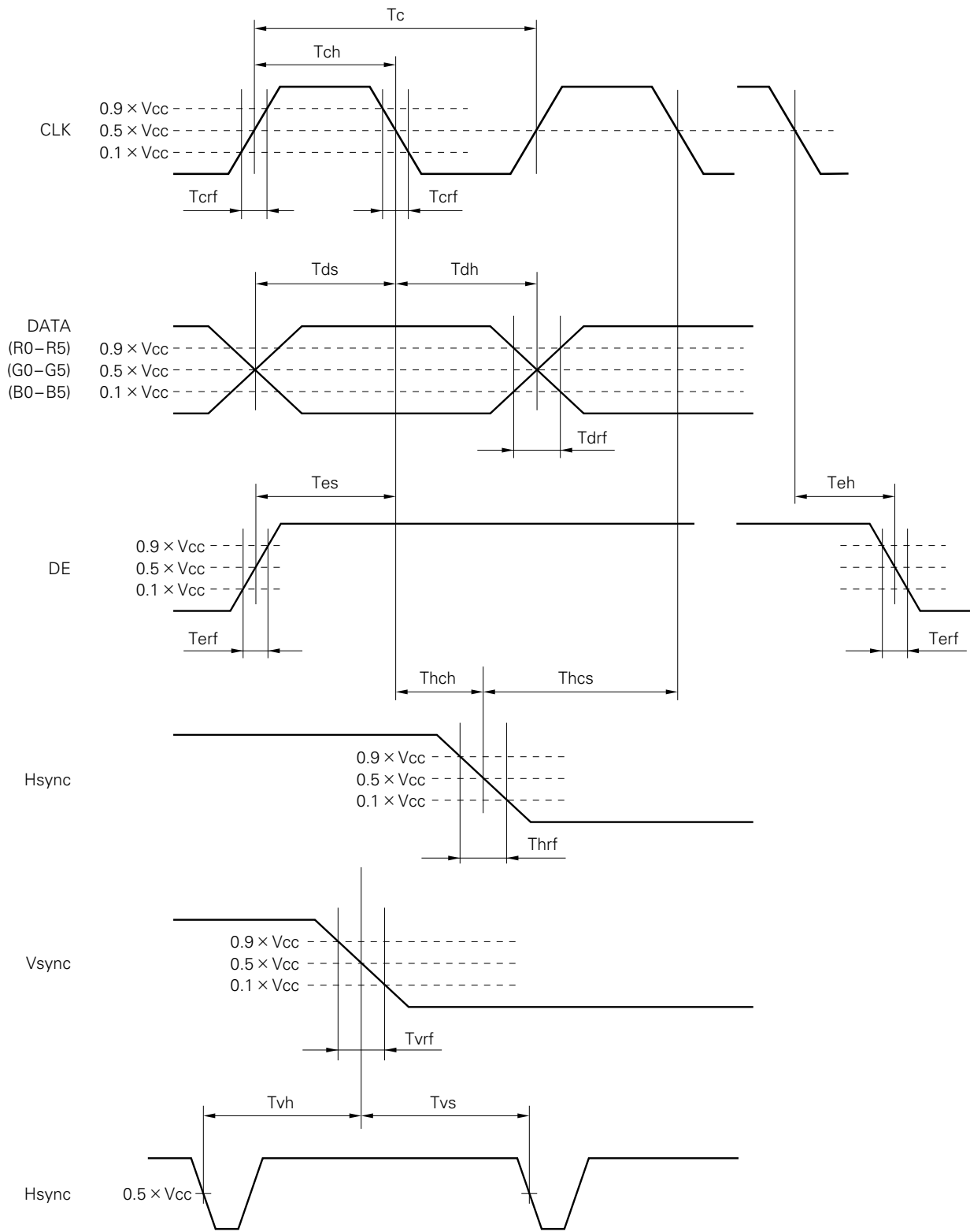
<Vertical>



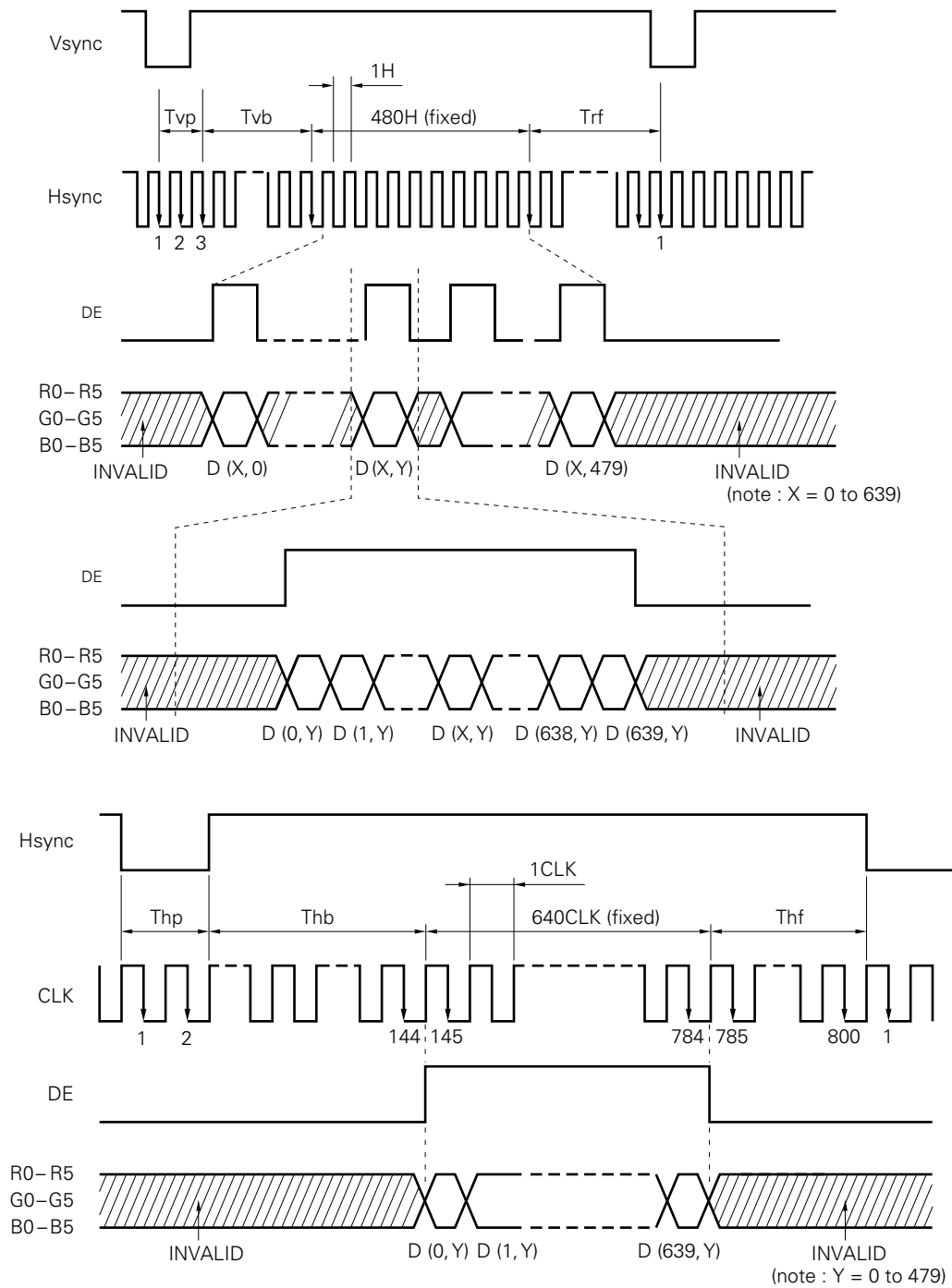
<Horizontal>



note : These do not exist as signals.



(3) Input signal timing chart (DE mode)



(4) Display position of input data

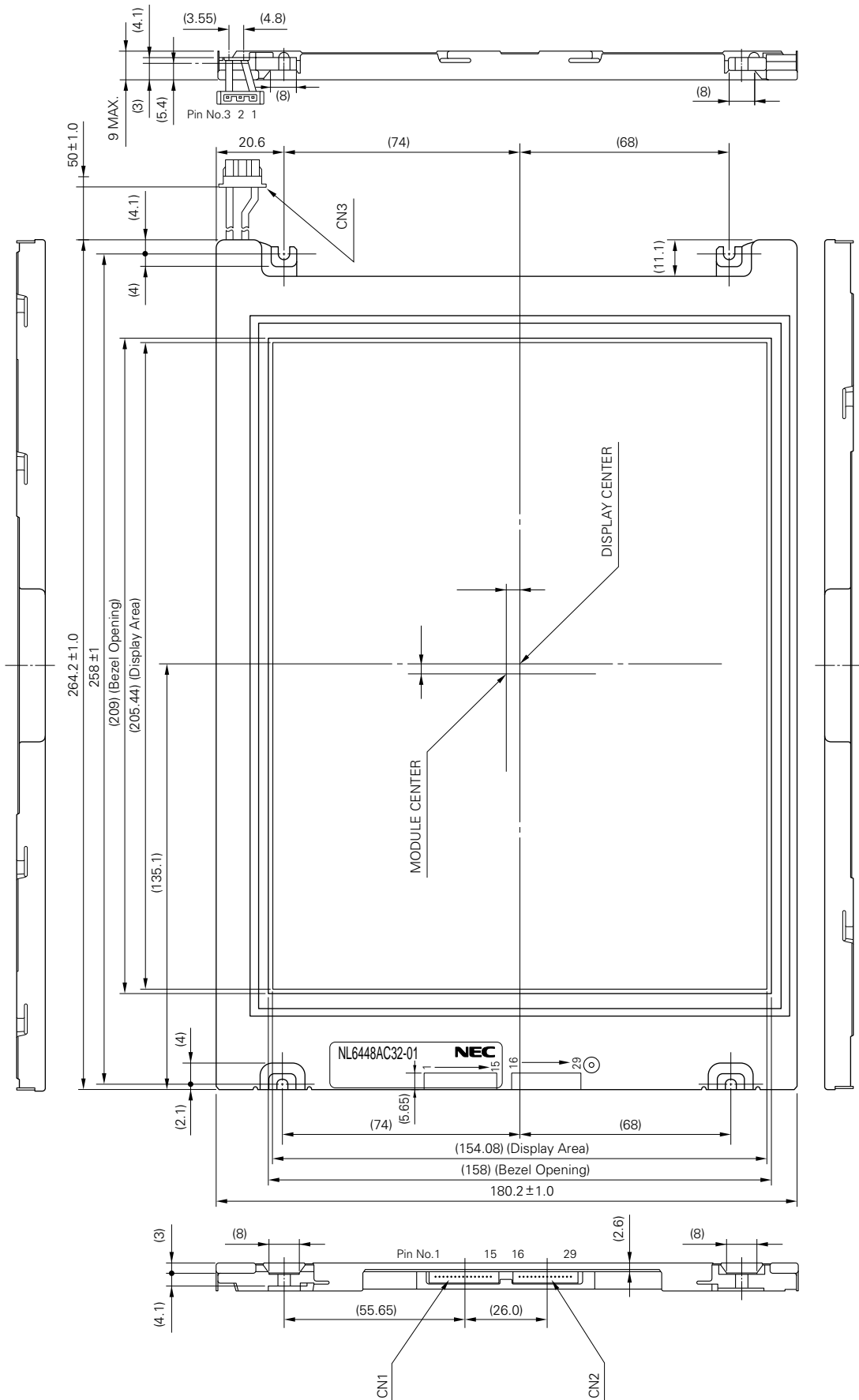
| | | | | | | |
|------------|------------|-----|------------|-----|--------------|--------------|
| D (0, 0) | D (1, 0) | --- | D (X, 0) | --- | D (638, 0) | D (639, 0) |
| D (0, 1) | D (1, 1) | --- | D (X, 1) | --- | D (638, 1) | D (639, 1) |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| D (0, Y) | D (1, Y) | --- | D (X, Y) | --- | D (638, Y) | D (639, Y) |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| D (0, 478) | D (1, 478) | --- | D (X, 478) | --- | D (638, 478) | D (639, 478) |
| D (0, 479) | D (1, 479) | --- | D (X, 479) | --- | D (638, 479) | D (639, 479) |

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.
- (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.
- (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 (Unit in mm)



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