DATA SHEET

NEC

# TFT COLOR LCD MODULE

# NL10276AC28-01L



**36 cm (14.1 inches), 1024 × 768 pixels, fullcolor, multiscan function, built-in CRT interface board**

## DESCRIPTION

The NL10276AC28-01L is a TFT (thin film transistor) active-matrix color liquid crystal display (LCD) comprising an amorphous silicon TFT attached to each signal electrode, a driving circuit, a CRT interface board, and a backlight. NL10276AC28-01L has a built-in backlight with an inverter.

The 36 cm (14.1 inch) diagonal display area contains 1024 × 768 pixels and can display fullcolor (more than 16 million colors simultaneously). Also, it has a wide viewing angle and multiscan function.

## FEATURES

- High luminance (200 cd/m$^2$ typ.)
- Low reflection
- CRT interface board
  Auto recognition of input signal:
  Analog RGB signals, synchronous signals (Hsync, Vsyn, composite)
  Digital control: e.g., brightness, display position
  Free supply voltage sequence
  Corresponds to DDCI and DDC2B
  Corresponds to VESA DPMS
- Multiscan function: e.g., XGA, SVGA, VGA, VGA-TEXT, MAC
- Incorporated edge-type backlight (two lamps into two lamp holders, inverter)
- Lamp unit replaceable

(note)

VESA: Video Electronics Standards Association
DPMS: Display Power Management Signaling
DDC1: Display Data Channel 1
DDC2B: Display Data Channel 2B

## APPLICATIONS

- Desktop PCs
- Engineering workstations
- Display terminals for control systems
- Monitors for process controllers

### On-Screen Display (OSD)

Application with the OSD function might conflict with patents in Europe and/or the U.S.A.
If you apply the OSD function, please do so in accordance with the patent regulations of your location.

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

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**STRUCTURE AND FUNCTION**

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 back side of the panel.

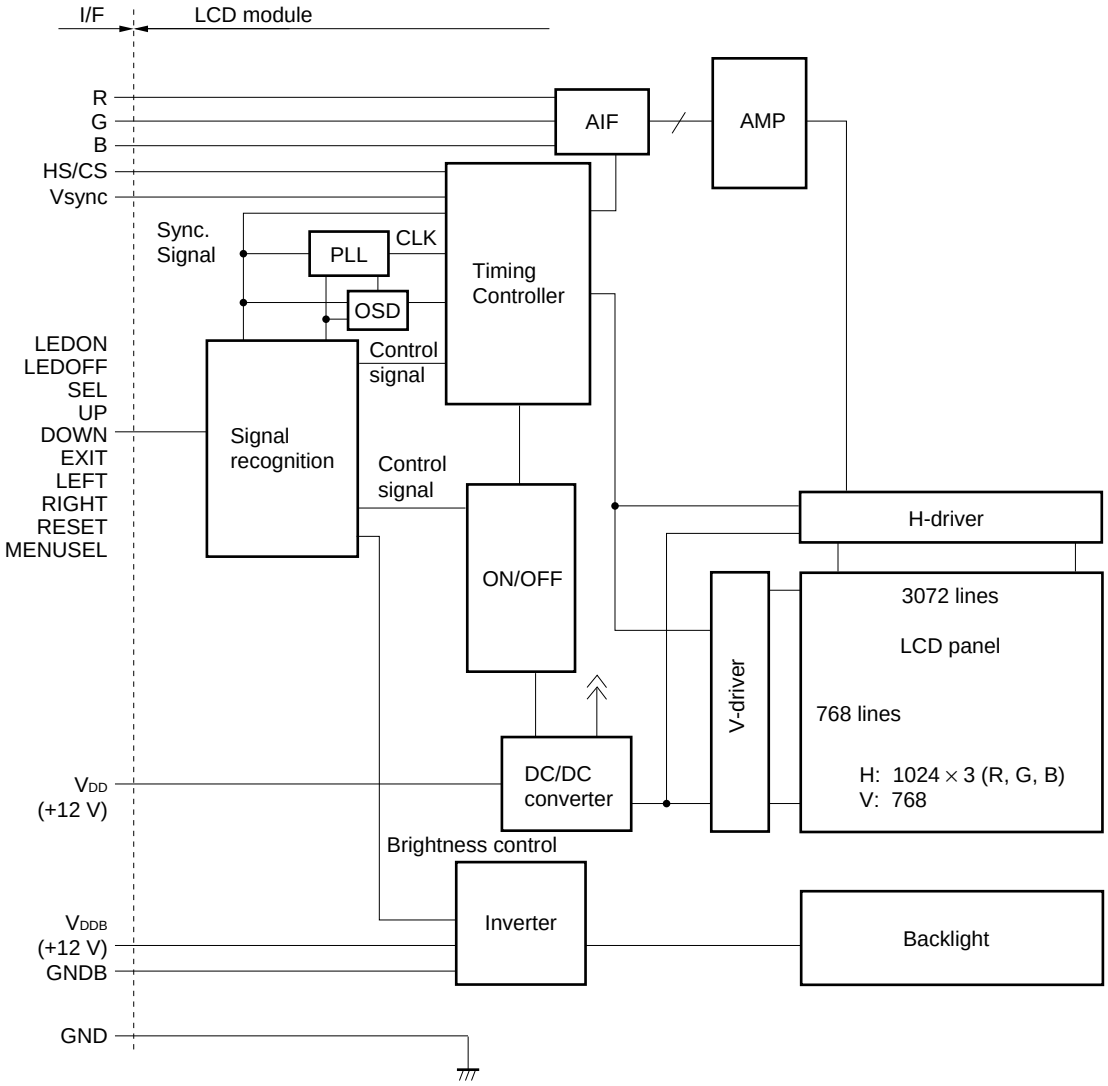
RGB (red, green, blue) data signals from a source system are modulated into a form suitable for active-matrix addressing by the onboard signal processor and sent to the driver LSIs, which in turn address the individual TFT cells.

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.

## CHARACTERISTICS (at room temperature)

| Item | Description |
|---|---|
| Display area | 285.696 (H) × 214.272 (V) mm |
| Drive system | a-Si TFT active matrix |
| Display colors | Fullcolor |
| Number of pixels | 1024 (H) × 768 (V) |
| Pixel arrangement | RGB vertical stripe |
| Pixel pitch | 0.279 (H) × 0.279 (V) mm |
| Module size | 330.0 (H) × 255.0 (V) × 19.8 (D) mm (typ.) |
| Weight | 1230 g (typ.) |
| Contrast ratio | 150:1 (typ.) |
| Viewing angle (more than the contrast ratio of 10:1) | • Horizontal: 50° (typ., left side, right side)<br>• Vertical: 20° (typ., up side), 35° (typ., down side) |
| Designed viewing direction | • Optimum gray-scale ($\gamma$ = 2.2): perpendicular<br>• Wider viewing angle with contrast ratio: down side ( 6 o'clock)<br>• Wider viewing angle without image reversal: up side (12 o'clock) |
| Color gamut | 40% (typ., at center, to NTSC) |
| Response time | 11 ms (typ.), "white 100%" to "black 10%" |
| Luminance | 200 cd/m$^2$ (typ.) |
| Input signals | Analog RGB signals, synchronous signals (Hsync and Vsync or composite) |
| Backlight | Edge light type: two cold cathode fluorescent lamps with an inverter<br>Lamp holder: 141LHS08<br>Inverter: 141PW111 |
| Supply voltage | 12 V, 12 V (logic/LCD driving, backlight) |
| Power consumption | 16.0 W (typ.) |

## BLOCK DIAGRAM




HS: Hsync

CS: Composite synchronous signal

**Note**: Neither GND nor GNDB is connected to frame. These should be connected in customers' equipment.

## GENERAL SPECIFICATIONS

| Item | Description | Unit |
|---|---|---|
| Module size | 330 ± 0.5 (H) × 255.0 ± 0.5 (V) × 20.5 (max.) (D) | mm |
| Display area | 285.696 (H) × 214.272 (V) | mm |
| Number of dots | 1024 × 3 (H) × 768 (V) | dots |
| Pixel pitch | 0.279 (H) × 0.279 (V) | mm |
| Dot pitch | 0.093 (H) × 0.279 (V) | mm |
| Pixel arrangement | RGB (red, green, blue) vertical stripe | – |
| Display colors | Full color | color |
| Weight | 1230 (typ.) 1350 (max.) | g |

## ABSOLUTE MAXIMUM RATINGS

| Parameter | Symbol | Rating | Unit | Remarks | |
|---|---|---|---|---|---|
| Supply voltage | $V_{DD}$ | –0.3 to + 14 | V | $T_a$ = 25°C | |
| | $V_{DDB}$ | –0.3 to + 14 | V | | |
| Logic input voltage | $V_{In1}$ | –0.3 to + 5.5 | V | $T_a$ = 25°C<br>$V_{DD}$ = 12 V | |
| R,G,B input voltage | $V_{In2}$ | –6.0 to + 6.0 | V | | |
| Storage temp. | Tst | –20 to + 60 | °C | – | |
| Operating temp. | Top | 0 to 50 | °C | Module surface | **Note** |
| Relative humidity (RH) | ≤ 95% | | % | Ta ≤ 40°C | No condensation |
| | ≤ 85% | | | 40 < Ta ≤ 50°C | |
| Absolute humidity | Absolute humidity shall not exceed $T_a$ = 50°C, RH = 85%. | | $g/m^3$ | Ta > 50°C | |

**Note**: Measured at the LCD panel (including self-heat.)

## ELECTRICAL CHARACTERISTICS

### (1) Logic, LCD Driving, Backlight

($T_a$ = 25°C)

| Item | Symbol | Min. | Typ. | Max. | Unit | Remarks |
|---|---|---|---|---|---|---|
| Supply voltage | $V_{DD}$ | 11.4 | 12.0 | 12.6 | V | Logic and LCD driving |
| | $V_{DDB}$ | 11.4 | 12.0 | 12.6 | V | Backlight |
| Logic input “L” voltage | $V_{IL}$ | 0 | – | 0.8 | V | HS/CS, Vsync, UP, DOWN, SEL, RESET, EXIT, RIGHT, LEFT, DDCCLK, DDCDAT |
| Logic input “H” voltage | $V_{IH}$ | 2.2 | – | 5.25 | V | |
| Logic output “L” voltage | $V_{OL}$ | – | – | 0.4 | V | DDCDAT |
| Logic output “H” voltage | $V_{OH}$ | 2.4 | – | – | V | |
| Logic input “L” current | $I_{IL}$ | –1 | – | – | μA | HS/CS, Vsync |
| Logic input “H” current | $I_{IH}$ | – | – | 1 | μA | |
| Logic output “L” current 1 | $I_{OL1}$ | – | – | 100 | μA | DDCDAT |
| Logic output “H” current 1 | $I_{OH1}$ | –100 | – | – | μA | |
| Supply current (Pixel checked pattern) | $I_{DD}$ | – | 630 | 900 | mA | $V_{DD}$ = 12.0 V |
| | | – | 170 | 200 | mA | Power-saving mode $V_{DD}$ = 12.0 V |
| | $I_{DDB}$ | – | 700 | 900 | mA | $V_{DDB}$ = 12.0 V (Max. luminance) |
| | | – | 0.3 | 10 | mA | Power-saving mode $V_{DDB}$ = 12.0 V |

### (2) Video Signal (R, G, B) Input

($T_a$ = 25°C)

| Item | Min. | Typ. | Max. | Unit | Remarks |
|---|---|---|---|---|---|
| Maximum amplitude (white–black) | 0 (black) | 0.7 (white) | *A | V p-p | **Note** |
| DC input level (black) | –0.5 | – | +2.5 | V | – |
| Sync level | –0.2 | 0.3 | *B (0.6) | V p-p | G terminal (sync on green) |
| *A + *B | – | – | 1.4 | V p-p | – |

**Note**: Contrast adjustment is needed if the amplitude exceeds 0.7 V p-p.

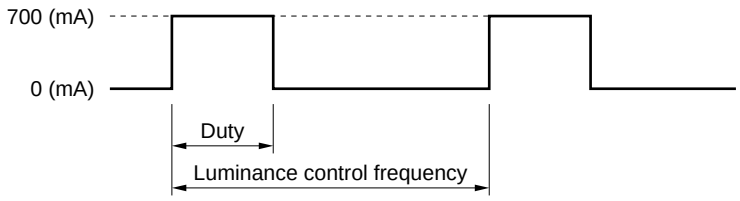
**POWER SUPPLY DESIGN**

(1) Please note that the supply voltage must not be applied to the module while the control signals (SEL, UP, DOWN, EXIT, LEFT, RIGHT, and RESET) are connected to GND. Otherwise, the module may malfunction.

(2) If the power supply voltage is applied while UP and DOWN are connected to GND, the input control signals become ineffective. To reset this mode, turn off the power once and then turn on the power while UP and DOWN are connected to GND. The mode will then be released.

(3) Do not change the MENUSEL setting while the module is being operated.
MENUSEL selection (hierarchical type or toggle type) is set when the power supply voltage is applied.

(4) Inverter current wave
The inverter current wave is as follows.




Maximum luminance control: 100% (Duty)
Minimam luminance control: 20% (Duty)
Luminance control frequency ≒ Input Vsync frequency × K
Input Vsync frequency ≤ 75 Hz: K = 4.6
Input Vsync frequency > 75 Hz: K = 3.6

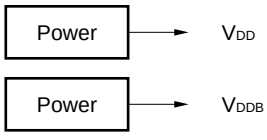
(5) Ripple of supply voltage
Please note that the ripple at the input connector of the module should be within the values shown in this table. If the ripple is beyond these values, the noise may appear on the screen.

| Supply voltage | $V_{DD}$ (for logic and LCD driver) | $V_{DDB}$ (for backlight) |
|---|---|---|
| Acceptable range | ≤ 100 mV p-p | ≤ 200 mV p-p |

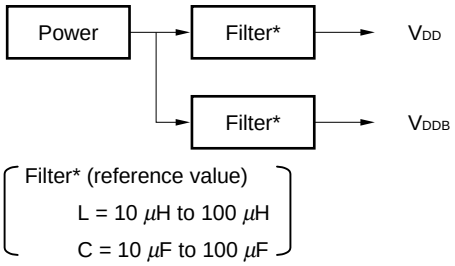
**Note**: The acceptable range of ripple voltage includes spike noise.

Example of the power supply connection

a) Separate the power supply




b) Put in the filter



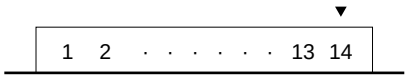
**INTERFACE AND CONNECTOR PIN ASSIGNMENT**

**(1) Logic and LCD Driving**

CN1
Part No.: 1-353119-4
Adaptable socket: 1-353068-4
Supplier: Japan AMP, Ltd.

| Pin No. | Symbol | Pin No. | Symbol |
|---|---|---|---|
| 1 | B | 8 | Vsync |
| 2 | GND | 9 | GND |
| 3 | G | 10 | HS/CS |
| 4 | GND | 11 | GND |
| 5 | R | 12 | DDCCLK |
| 6 | GND | 13 | N.C. |
| 7 | GND | 14▼ | DDCDAT |

Figure from socket view

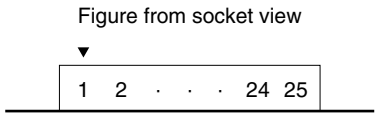



**Note:** N.C. (No connection) must be open.

CN3
Part No.: DF14A-25P-1.25H
Adaptable socket: DF14-25S-1.25C
Supplier: Hirose Electric Co., Ltd.

| Pin No. | Symbol | Pin No. | Symbol |
|---|---|---|---|
| 1▼ | LEDON | 14 | EXIT |
| 2 | LEDOFF | 15 | GND |
| 3 | GND | 16 | N.C. |
| 4 | N.C. | 17 | GND |
| 5 | N.C. | 18 | GND |
| 6 | RIGHT | 19 | MENUSEL |
| 7 | LEFT | 20 | N.C. |
| 8 | RESET | 21 | N.C. |
| 9 | N.C. | 22 | N.C. |
| 10 | GND | 23 | GND |
| 11 | SEL | 24 | N.C. |
| 12 | UP | 25 | N.C. |
| 13 | DOWN | | |

Figure from socket view




**Note:** N.C. (No connection) must be open.

CN5

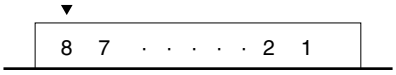
Part No.: IL-Z-8PL-SMTY

Adaptable socket: IL-Z-8S-S125C3

Supplier: Japan Aviation Electronics Industry, Limited (JAE)

| Pin No. | Symbol | Pin No. | Symbol |
|---|---|---|---|
| 1 | $V_{DD}$ | 5 | GND |
| 2 | $V_{DD}$ | 6 | GND |
| 3 | $V_{DD}$ | 7 | GND |
| 4 | $V_{DD}$ | 8▼ | GND |

Figure from socket view




**(2) Backlight**

CN201

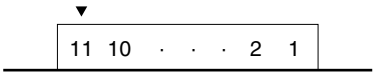
Part No.: IL-Z-11PL1-SMTY

Adaptable socket: IL-Z-11S-S125C3

Supplier: Japan Aviation Electronics Industry, Limited (JAE)

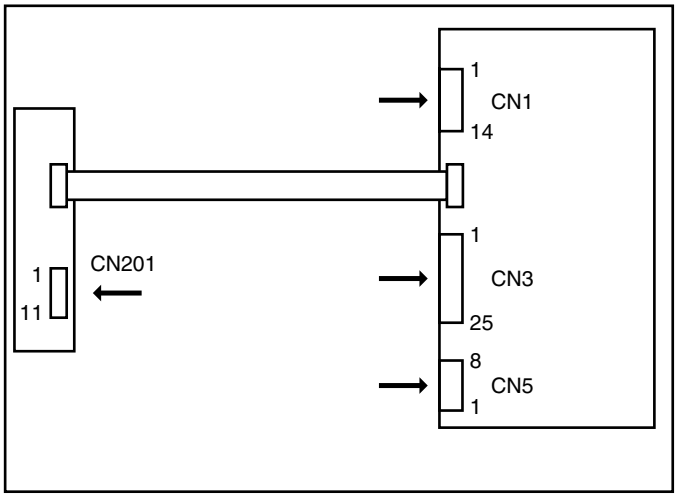
| Pin No. | Symbol | Pin No. | Symbol |
|---|---|---|---|
| 1 | $V_{DDB}$ | 7 | N.C. |
| 2 | $V_{DDB}$ | 8 | N.C. |
| 3 | $V_{DDB}$ | 9 | N.C. |
| 4 | GNDB | 10 | N.C. |
| 5 | GNDB | 11▼ | N.C. |
| 6 | GNDB | | |

Figure from socket view




**Note:** N.C. (No connection) must be open.

Rear view



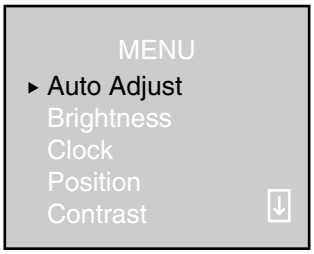
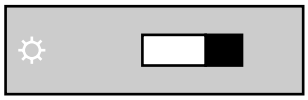
### (3) Pin Function

| Symbol | I/O | Logic | Description |
|---|---|---|---|
| HS/CS | Input | Negative | Horizontal synchronous signal input or composite synchronous signal input (TTL level), positive/negative auto recognition |
| Vsync | Input | Negative | Vertical synchronous signal input (TTL level), positive/negative auto recognition, clock input for DDC1 |
| R | Input | – | Red video signal input (0.7 Vp-p, input impedance 75 Ω) |
| G | Input | – | Green video signal input (0.7 Vp-p, input impedance 75 Ω) |
| B | Input | – | Blue video signal input (0.7 Vp-p, input impedance 75 Ω) |
| LEDON | Output | Positive | Indicator for LED power on<br>“H”: LED select; “L”: Other status |
| LEDOFF | Output | Positive | Indicator for power save mode<br>“H”: Power mode select; “L”: Other status |
| DDCCLK | Input | Positive | CLK for DDC2B |
| DDCDAT | Input/ Output | Positive | Data for DDC1/2B<br>read/write |
| SEL | Input | Negative | Control function select signal (TTL level)<br>SEL is pulled up in the module.<br>Details of the functions are mentioned in **CONTROL FUNCTIONS**, page 13.<br>“H” or “open”: SEL off; “L”: SEL on |
| UP | Input | Negative | Control signal (TTL level)<br>The signal increases the value of the functions selected.<br>UP is pulled up in the module.<br>“H” or “open”: UP off; “L”: UP on |
| DOWN | Input | Negative | Control signal (TTL level)<br>The signal decreases the value of the functions selected.<br>DOWN is pulled up in the module.<br>“H" or “open”: DOWN off; “L”: DOWN on |
| EXIT | Input | Negative | Control function exit signal (TTL level)<br>EXIT is pulled up in the module.<br>“H" or “open”: EXIT off; “L”: EXIT on |
| RIGHT[Note 1] | Input | Negative | Control signal (TTL level)<br>The signal increases the value of the functions selected.<br>RIGHT is pulled up in the module.<br>“H” or “open”: RIGHT off; “L”: RIGHT on |
| LEFT[Note 1] | Input | Negative | Control signal (TTL level)<br>The signal decreases the value of the functions selected.<br>LEFT is pulled up in the module.<br>“H” or “open”: LEFT off; “L”: LEFT on |
| RESET[Note 1] | Input | Negative | Control signal (TTL level)<br>The signal initializes the selected function.<br>RESET is pulled up in the module.<br>“H” or “open”: RESET off; “L”: RESET on |
| MENUSEL | Input | – | OSD design select signal (TTL level)<br>MENUSEL is pulled up in the module.<br>“H or open”: Hierarchical type<br>“L”: Toggle type<br>For details, see page 10, **OSD Menu Select**. |

| Symbol | I/O | Logic | Description |
|---|---|---|---|
| $V_{DD}$ | – | – | Power supply for logic and LCD driving +12 V (±5%) |
| $V_{DDB}$ | – | – | Power supply for backlight +12 V (±5%) |
| GND | – | – | Ground for system |
| GNDB | – | – | Ground for backlight |

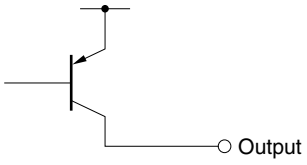
**Notes:** 1. This terminal becomes effective only when the value of Button Sel is 7.
Details of the functions are given on page 27, **Initial Value Change Functions**.
2. Grounds for system (GND) and backlight (GNDB) are not connected in the module.
3. The 12 V for the backlight should be started up within 300 ms; otherwise, the protection circuit makes the backlight turn off.

**(4) OSD Menu Select**

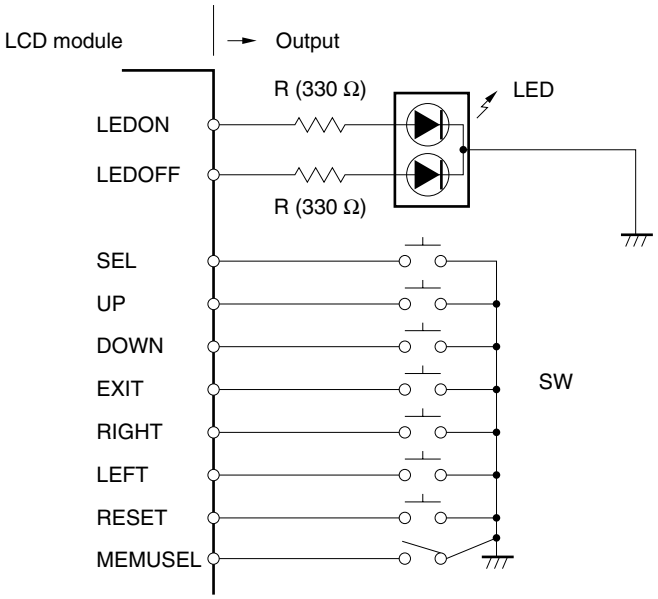
| OSD Menu Type | Hierarchical Type | Toggle Type |
|---|---|---|
| MENUSEL | "H" or "open" | "L" |
| How to adjust | For details, see page 27, **Initial Value Change Functions**.   | For details, see page 27, **Initial Value Change Functions**.  |

**Notes:** 1. If the OSD menu type is changed, the adjustment of the type becomes a default value.
Then, it takes 5 seconds to display the changed menu after the supply voltage is input again.
Indicators for both LEDON and LEDOFF are "ON" at one time during the 5 seconds.
2. The initial value of the contrast ratio is as follows.
Hierarchical type : 128:1 (typ.)
Toggle type : 100:1 (typ.)
3. On-screen Display (OSD)
Application with the OSD function might conflict with patents in Europe and/or the U.S.A.
If you apply the OSD function, please do so in accordance with the patent regulations of your location.

**(5) Equivalent circuit**

| Symbol | I/O | Equivalent Circuit |
|---|---|---|
| LEDON<br>LEDOFF | Output | RN2306 (Toshiba)<br>Or equivalent<br>  |

**Example of LED circuit**



**INPUT SIGNALS**

**(1) Synchronous Signal**

This module is corresponding to the synchronous signals below.

| Auto Recognition Mode | Synchronous Signal | | |
|---|---|---|---|
| | HS/CS | Vsync | Sync on Green |
| Separate synchronous signal mode (HS, Vsync) | Input | Input | Input or no input |
| Composite synchronous mode | Input (cs) | No input | Input or no input |
| Sync on Green mode | No input | No input | Input |
| Power-saving mode | Input (HS) | No input | Input or no input |
| | No input | Input | Input or no input |
| | No Input | No input | No input |

**Notes:** 1. Power-saving mode corresponds to VESA DPMA.

2. The module recognizes the Sync on Green signal automatically, when the FUNC in SOG Sel of Sel Data is "Y". Refer to Page 27 **Initial Value Change Functions**.
In case of Sync on Green mode, input signals (R, G, B, Sync on Green) must be inputted before power on.

**(2) Preset Timing**

The 14 types of display timing shown below are preset in this module. The input synchronous signals are automatically recognized.

| Preset No. | Display Size | Vsync (Hz) | Hsync (kHz) | System CLK (MHz) | V Pulse (H) | V B. Porch (H) | H Pulse (CLK) | H B. Porch (CLK) | Sync Logic V, H | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 640 × 400 | 56.432 | 24.830 | 21.053 | 8 | 25 | 96 | 48 | –,– | **Note 1** |
| 2 | 640 × 480 | 59.992 | 31.469 | 25.175 | 2 | 33 | 96 | 48 | –,– | VGA |
| 3 | 720 × 400 | 70.087 | 31.469 | 28.322 | 2 | 35 | 108 | 45 | +,– | VGA TXT |
| 4 | 800 × 600 | 60.317 | 37.879 | 40.000 | 4 | 23 | 128 | 88 | +,+ | VESA |
| 5 | 640 × 480 | 66.667 | 35.000 | 30.240 | 3 | 39 | 64 | 96 | S on G | Macintosh |
| 6 | 640 × 480 | 75.000 | 37.500 | 31.500 | 3 | 16 | 64 | 120 | –,– | VESA |
| 7 | 720 × 400 | 85.039 | 37.927 | 35.500 | 3 | 42 | 36 | 144 | +,– | VESA |
| 8 | 640 × 480 | 85.008 | 43.269 | 36.000 | 3 | 25 | 48 | 112 | –,– | **Note 1** |
| 9 | 1024 × 768 | 60.004 | 48.363 | 65.000 | 6 | 29 | 136 | 160 | –,– | VESA |
| 10 | 800 × 600 | 75.000 | 46.875 | 49.500 | 3 | 21 | 80 | 160 | +,+ | VESA |
| 11 | 832 × 624 | 74.565 | 49.735 | 57.283 | 3 | 39 | 64 | 224 | S on G | Macintosh |
| 12 | 800 × 600 | 85.061 | 53.674 | 56.250 | 3 | 27 | 64 | 152 | +,+ | **Note 1** |
| 13 | 1024 × 768 | 70.069 | 56.476 | 75.000 | 6 | 29 | 136 | 144 | +,+ | VESA |
| 14 | 1024 × 768 | 75.029 | 60.023 | 78.750 | 3 | 28 | 96 | 176 | +,+ | VESA |

**Notes:** 1. Out of specification.
2. Even if the preset timing is entered, a little adjustment of the functions such as horizontal period, CLK delay, and display position is required. The adjusted values are memorized in every preset number.
3. This module recognizes the synchronous signals with near preset timing of the frequency of HS, Vsync, even if signals other than the preset timing were entered. For instance, the module shows the display with presetting number 6 in the case of the following conditions: 640 × 480 dot; HS: 37.861 kHz; Vsync: 72.809 Hz. Please note that using other than the preset timings may cause incorrect magnification ratios, unfitness of control functions, or other display problems.
4. The display color scale may be different between Sync on Green input and the others.

**CONTROL FUNCTIONS**

**(1) Expansion Modes**

Expansion mode is a function by which to expand the screen size in different resolutions. For example, the VGA signal has 640 × 480 pixels. But if the display data can be expanded to 1.6 times vertically and horizontally, the VGA screen image can be displayed fully on a screen with XGA resolution.

This module automatically recognizes the timing shown in **Preset Timing** as an expansion mode.

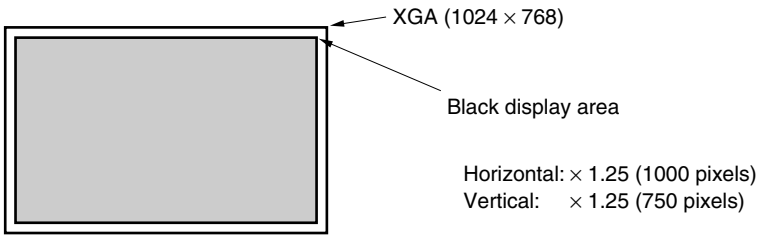
Please adopt this mode after evaluating display quality, because the appearance in expansion mode may degrade in some cases.

The following table shows display magnifications for each mode.

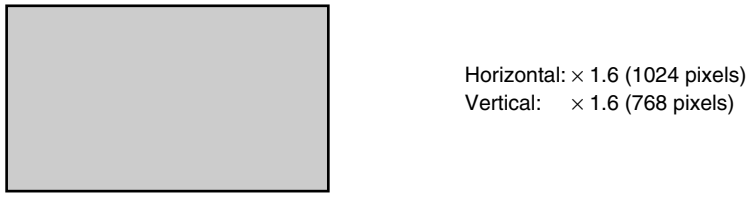
| Input Display | Number of Pixels | Magnification | |
|---|---|---|---|
| | | Vertical | Horizontal |
| XGA | 1024 × 768 | 1.0 | 1.0 |
| SVGA | 800 × 600 | 1.25 | 1.25 |
| VGA | 640 × 480 | 1.6 | 1.6 |
| VGA text | 720 × 400 | 1.92 / 1.6 hierarchical/toggle | 1.42 |
| MAC | 832 × 624 | 1.2 | 1.2 |

**Display Image**

**(a) SVGA mode (800 × 600)**

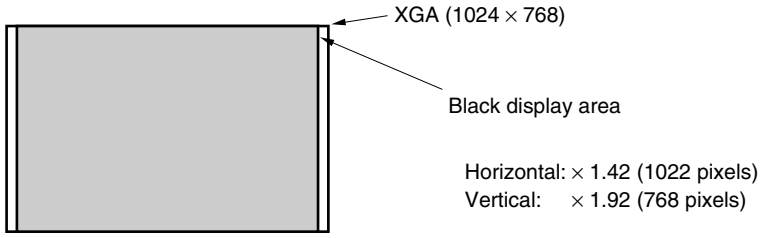



**(b) VGA mode (640 × 480)**

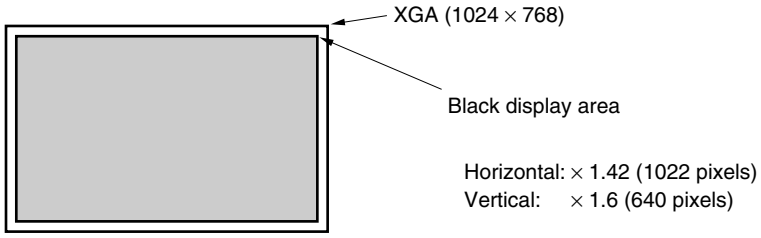



**(c) VGA text mode (720 × 400)**

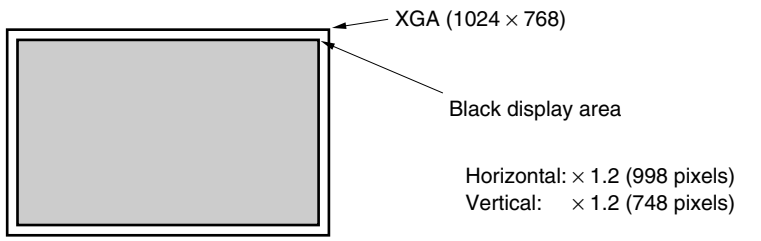
(i) Hierarchical type




(ii) Hierarchical type




**(d) 832 × 624 MAC mode (832 × 624)**



**(2) DDC Function**

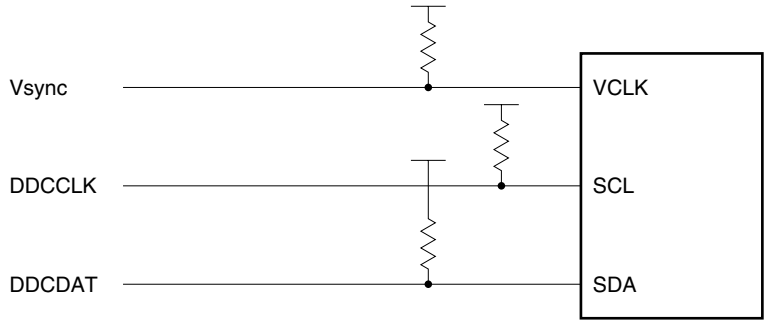
This function corresponds to VESA DDC™ and EDID™ (Structure Version 1).

Follow the specifications of the IC when you write data. Then VCLK should be fixed on "H."

Please write data into the necessary addresses in advance when you use this function. Data "55H" in address "00H" and "FFH" in other address have already been programmed upon shipping. The input equivalent circuit diagram is as follows.

EDID: Extended Display Identification Data

**Internal circuit diagram**




Product: Microchip Technology, Inc.
24LC21
or equivalent

**(3) DPMS**

This function corresponds to the VESA DPMS™ standard.

| VESA DPMS Standard | | | | | | NL10276AC28-01L | |
|---|---|---|---|---|---|---|---|
| State | Signal | | | Power Saving | Recovery Time | Power Saving | Recovery Time |
| | Horizontal | Vertical | Video | | | | |
| On | Pulses | Pulses | Active | None | Not applicable | None | Not applicable |
| Standby | No pulses | Pulses | Blanked | Minimum | Short | Maximum | Short |
| Suspend | Pulses | No pulses | Blanked | Substantial | Longer | Maximum | Short |
| Off | No pulses | No pulses | Blanked | Maximum | System dependent | Maximum | Short |

**Note.** The power consumption of the power saving mode is difference Sync on Green and others.
The power consumption of Sync. on Green is higher than others because of synchronous separation circuit.

**(4) Control Function Items**

| No. | Form | | Function Items |
|---|---|---|---|
| 1 | Auto adjust | | Clock and position auto adjust |
| 2 | Brightness | | Brightness of backlight control |
| 3 | Clock | H. Size | Horizontal display period adjust |
| | | Clock Phase | CLK phase adjust |
| 4 | Position | H. Position | Horizontal position adjust |
| | | V. Position | Vertical position adjust |
| 5 | Contrast | W, R, G, B | White level of video signals; synchronous color and each color are controllable. |
| | | W | White level of video signal synchronous color control |
| 6 | Color Level | W, R, G, B | Color level of video signals; synchronous color and each color are controllable. |
| | | W | Color level of video signal synchronous color control |
| 7 | Information | | Video signal information<br>Display multiscan function, Hsync and Vsync frequency |
| 8 | OSD Position | | OSD position adjust<br>The display position of OSD can be moved. |
| 9 | Config | | Sync on Green signal.<br>Response or nonresponse to Sync on Green signal is selected.<br>When nonresponse is selected (see page 27, **Initial Value Change Functions**), config is not displayed. |
| 10 | All Reset | | Reset to initial value.<br>The values in No. 1 to No. 6, No. 8, and No. 9 are returned to the initial values. |

Remark 1: ① In order to achieve the best picture quality, the above functions should be adjusted by setting SEL, UP, DOWN, LEFT, RIGHT, RESET and EXIT signals.
And Clock and Position adjusted value are memorized every display mode.

② The memorized values are not affected even if the power is switched off. But the selected value is not memorized in case that a selected mode is changed to another one.

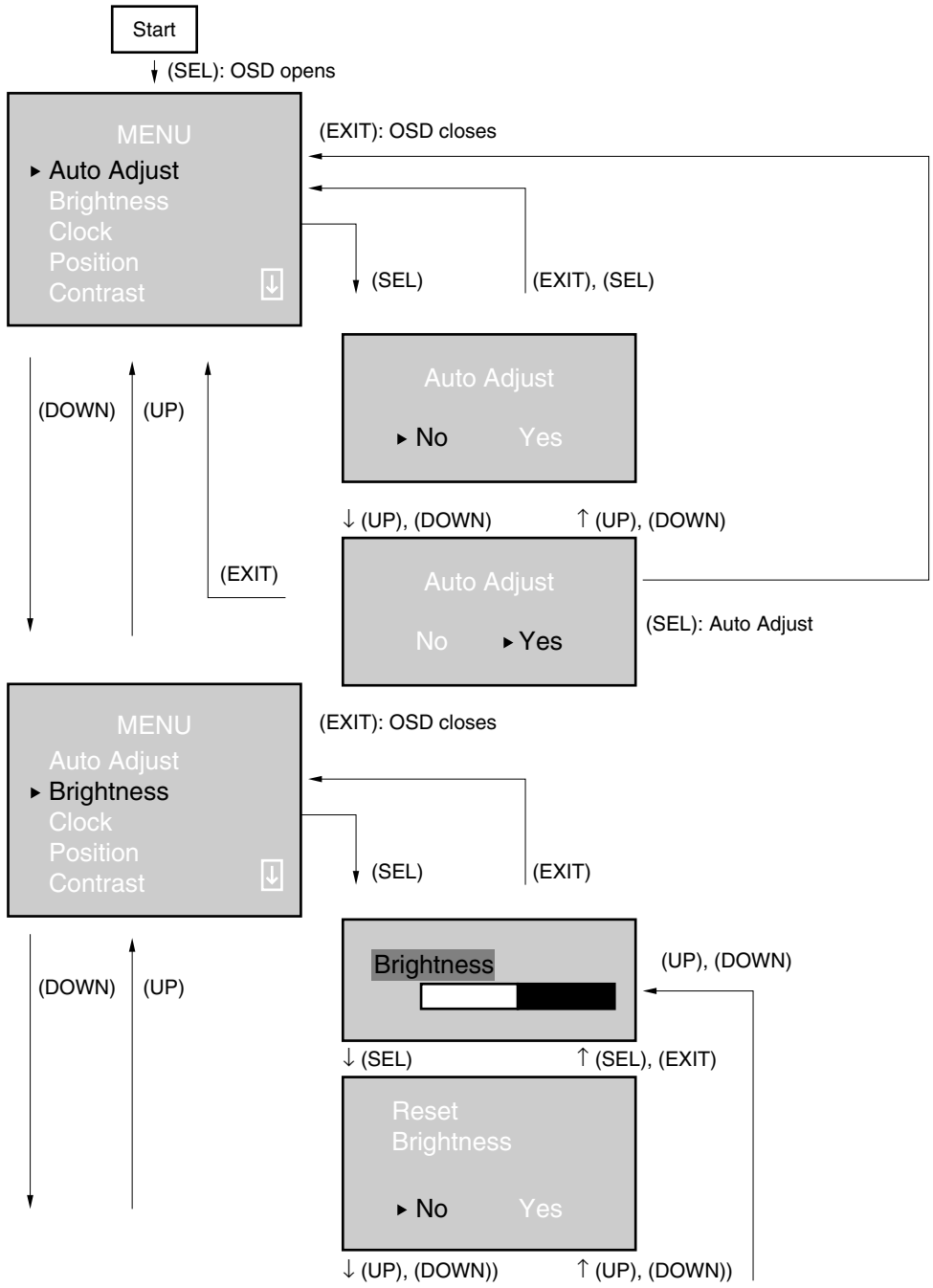
Remark 2: The Auto adjusted value may not be optimal value for the best picture quality on customer equipment and display screens. And the Auto adjust function does not work correctly when both Sync On Green signal and separate synchronous signals are inputted in this module. In those cases, please adjust each value (Clock and Position).

Remark 3: The display Image on the screen may be disturbed for a moment when each adjusted value is changed.

**(5) Control Function Flowchart**

**(a) Hierarchical type (4 switches used for adjustment: SEL; UP; DOWN; EXIT)**

For details, see page 27, **Initial Value Change Functions** – 6. Sel Data, Button Sel.

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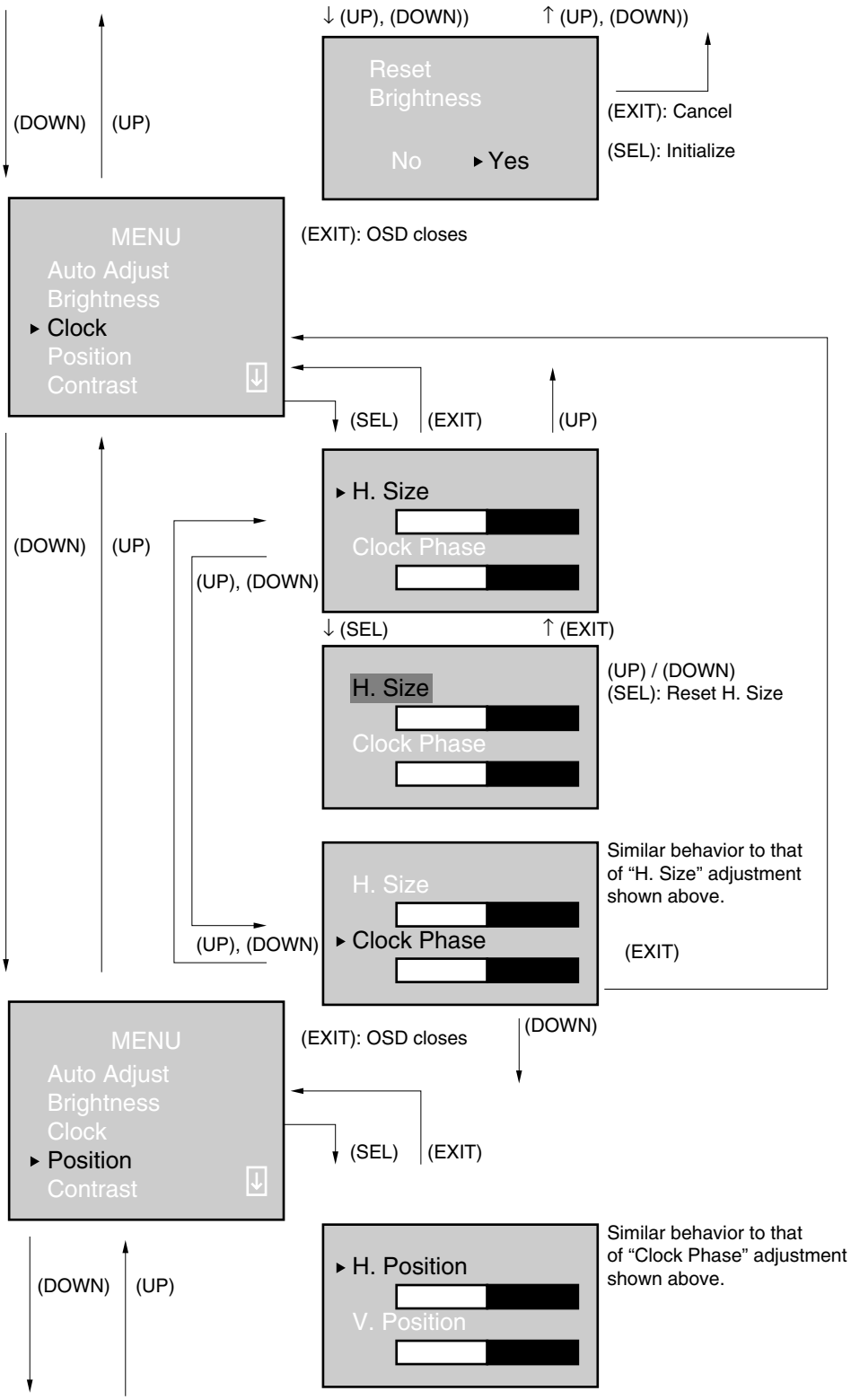


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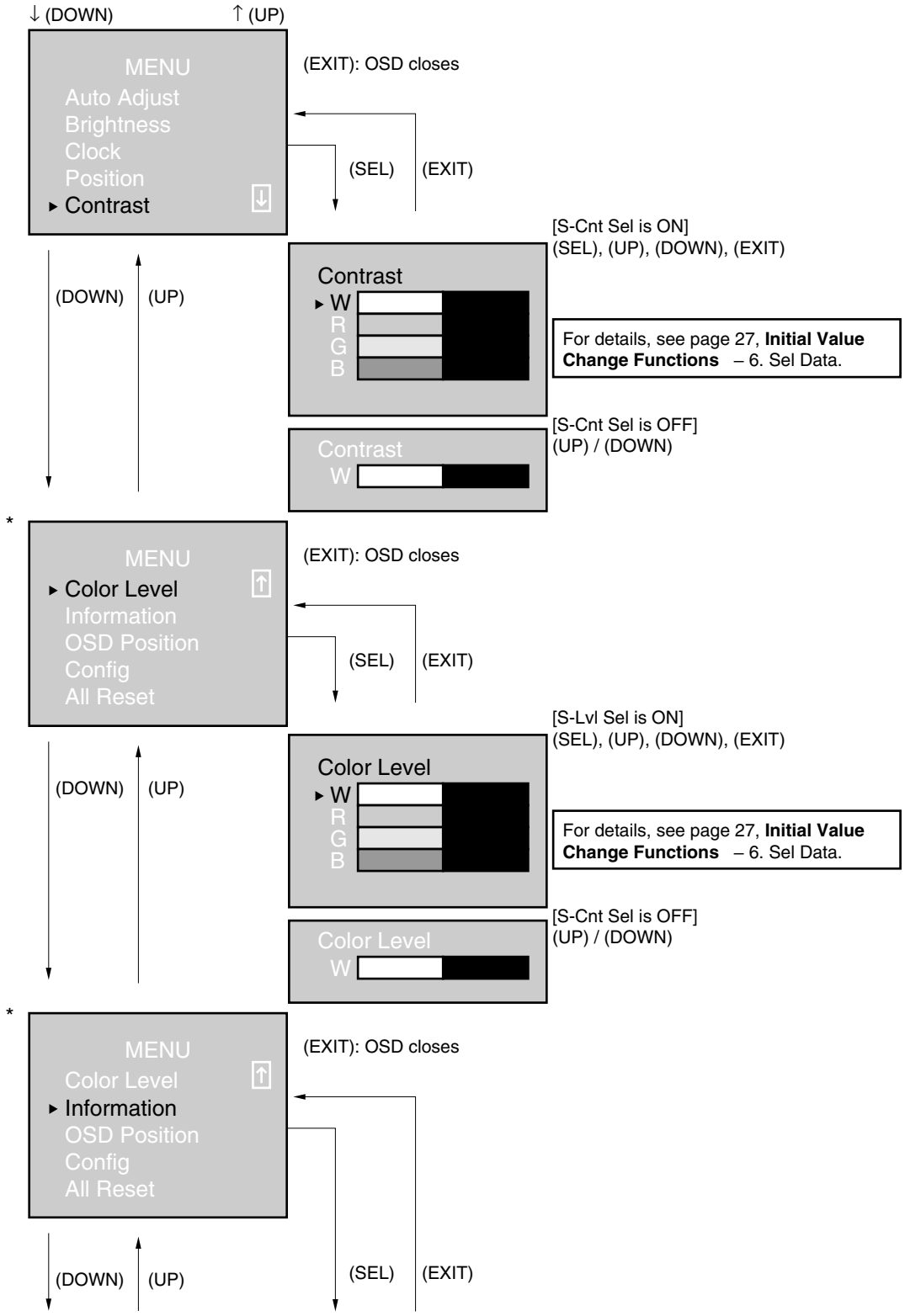


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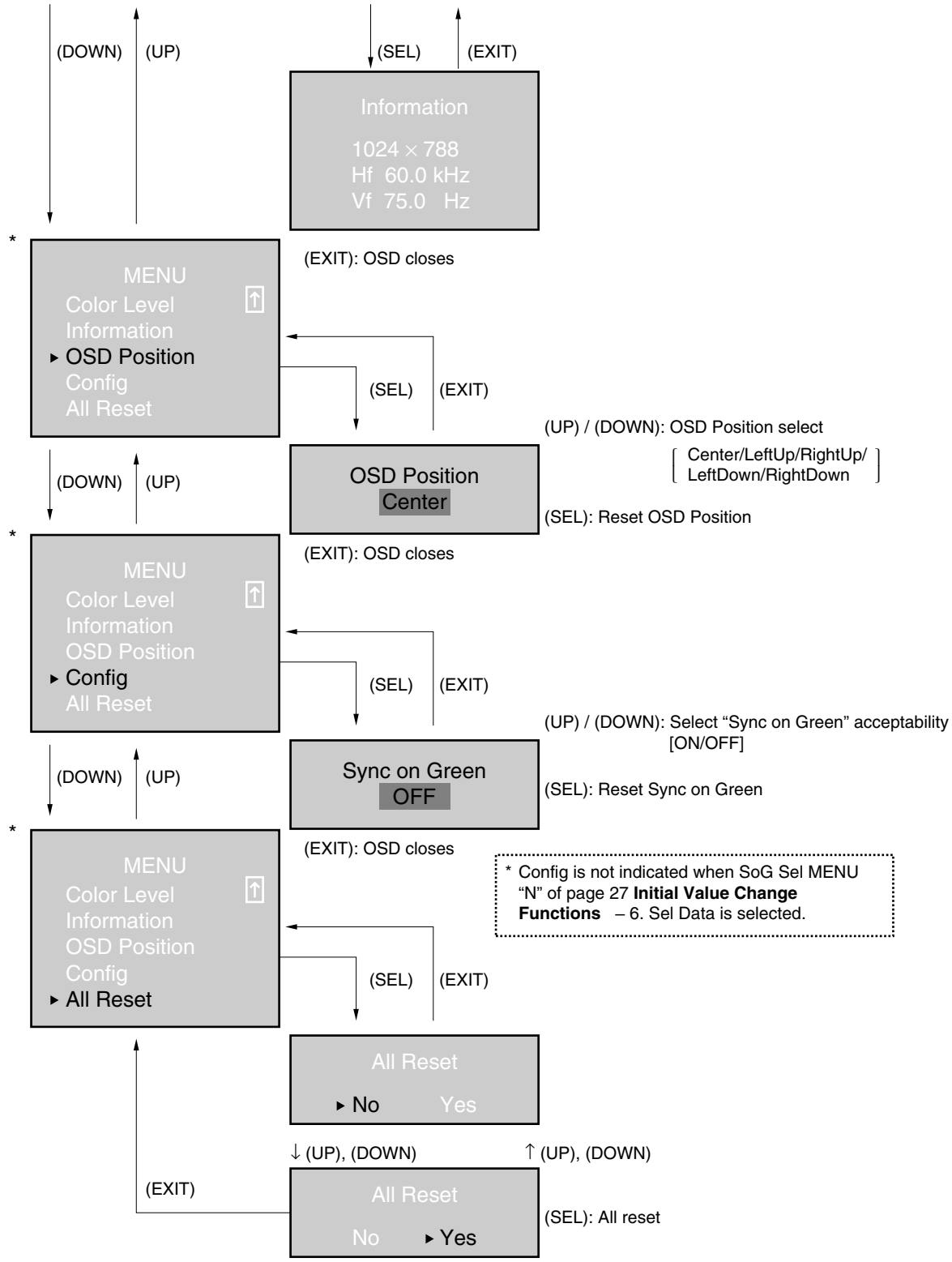
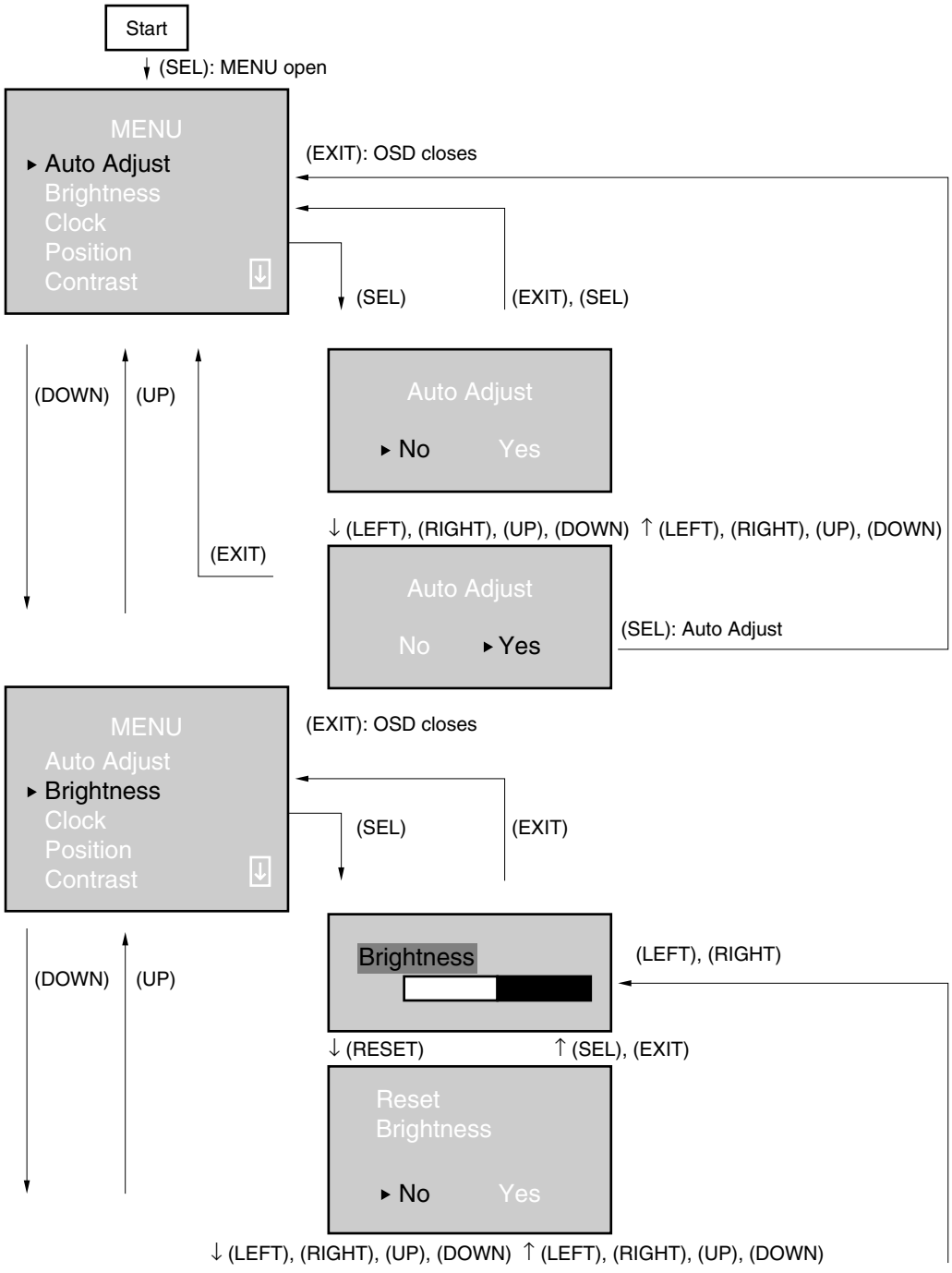

(DOWN)
(UP)
(SEL)
(EXIT)
Information
1024 × 788
Hf 60.0 kHz
Vf 75.0 Hz
*
MENU
Color Level
Information
▸ OSD Position
Config
All Reset
(EXIT): OSD closes
(SEL)
(EXIT)
(UP) / (DOWN): OSD Position select
[ Center/LeftUp/RightUp/ LeftDown/RightDown ]
OSD Position
Center
(SEL): Reset OSD Position
(EXIT): OSD closes
MENU
Color Level
Information
OSD Position
▸ Config
All Reset
(UP) / (DOWN): Select “Sync on Green” acceptability [ON/OFF]
Sync on Green
OFF
(SEL): Reset Sync on Green
(EXIT): OSD closes
* Config is not indicated when SoG Sel MENU “N” of page 27 Initial Value Change Functions – 6. Sel Data is selected.
MENU
Color Level
Information
OSD Position
Config
▸ All Reset
All Reset
▸ No Yes
↓ (UP), (DOWN)
↑ (UP), (DOWN)
All Reset
No ▸ Yes
(SEL): All reset
(EXIT)

**(b) Hierarchical type (7 switches used for adjustment: SEL; UP; DOWN; EXIT; LEFT; RIGHT; RESET)**

For details, see page 27, **Initial Value Change Functions** – 6. Sel Data, Button Sel.

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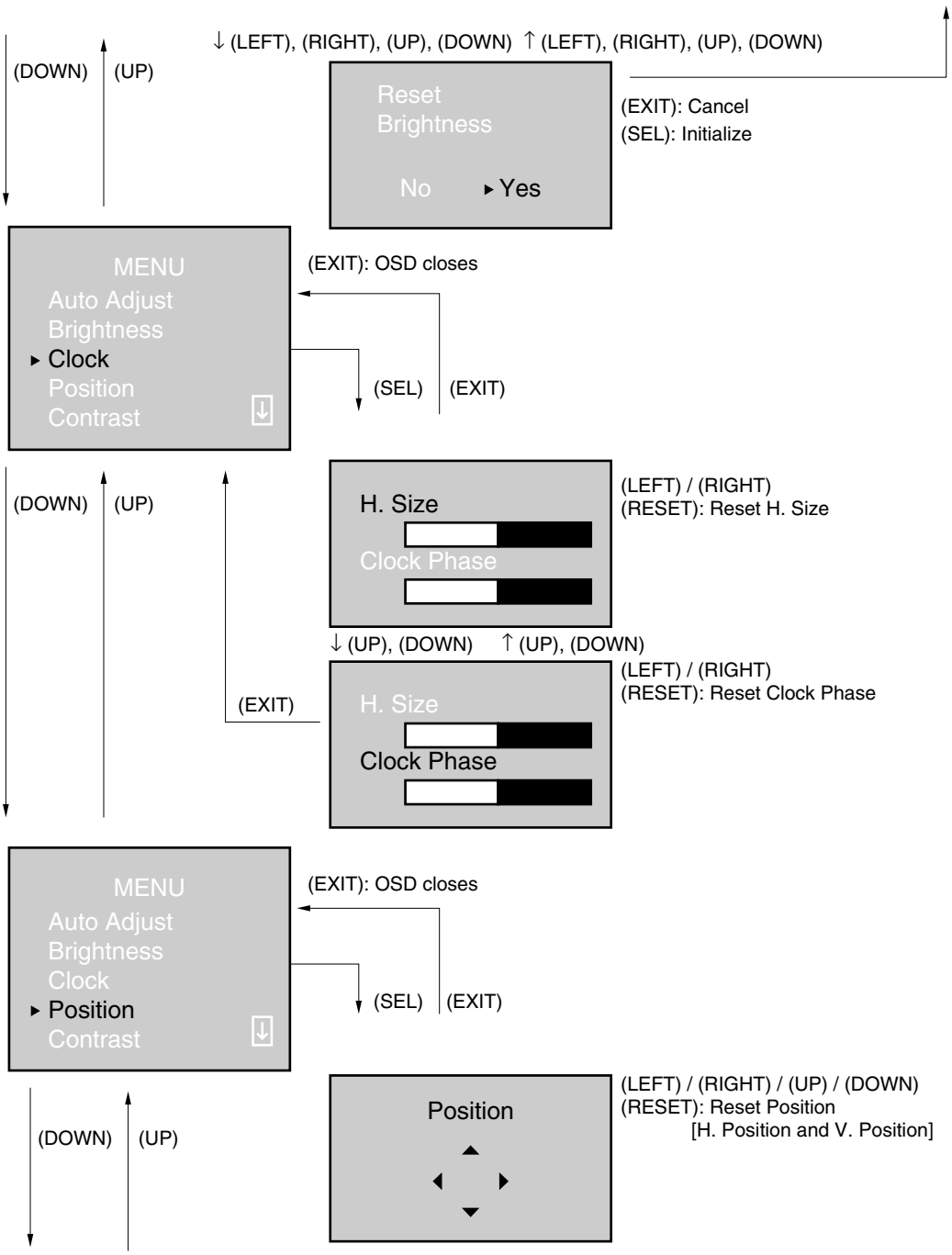


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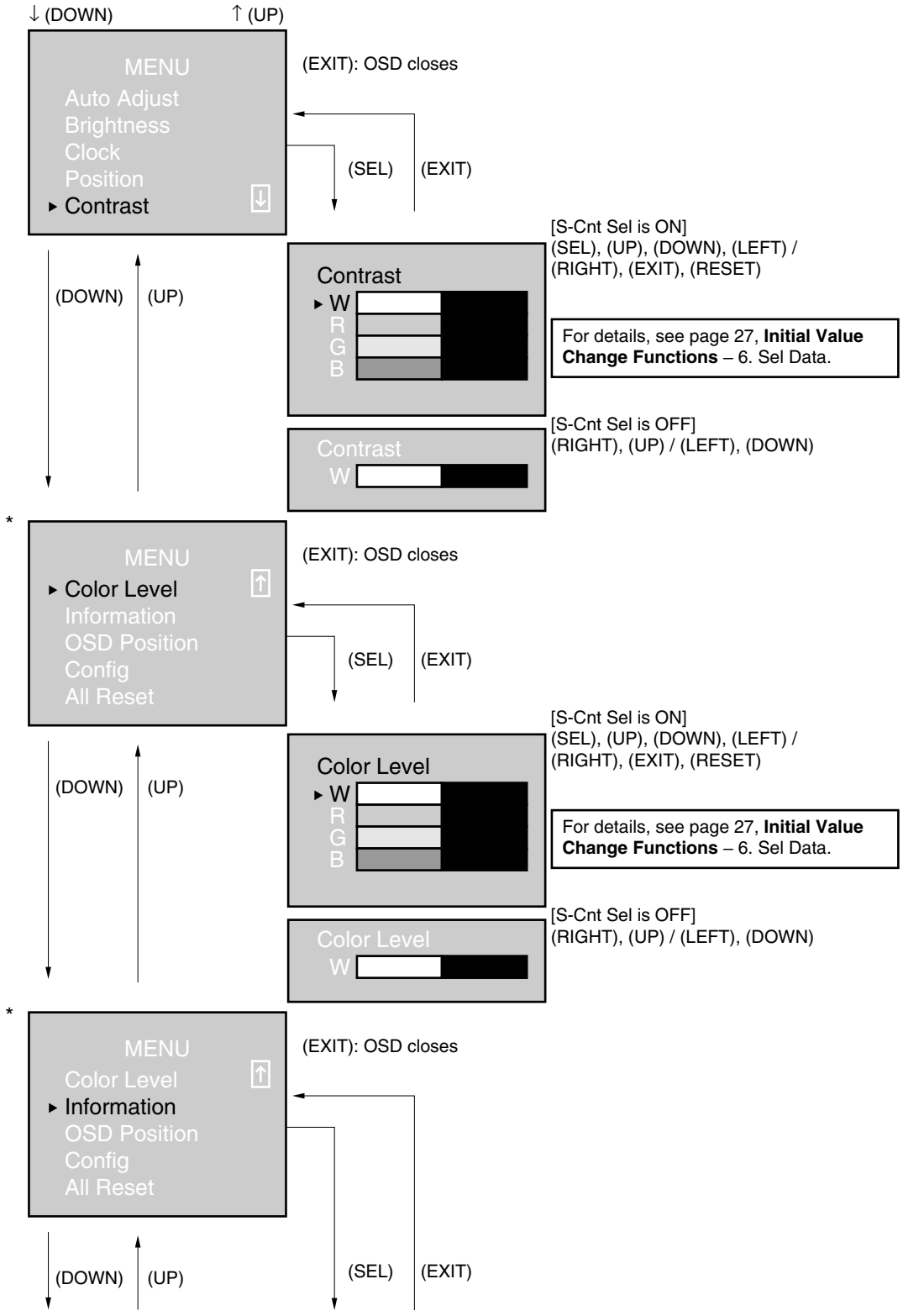


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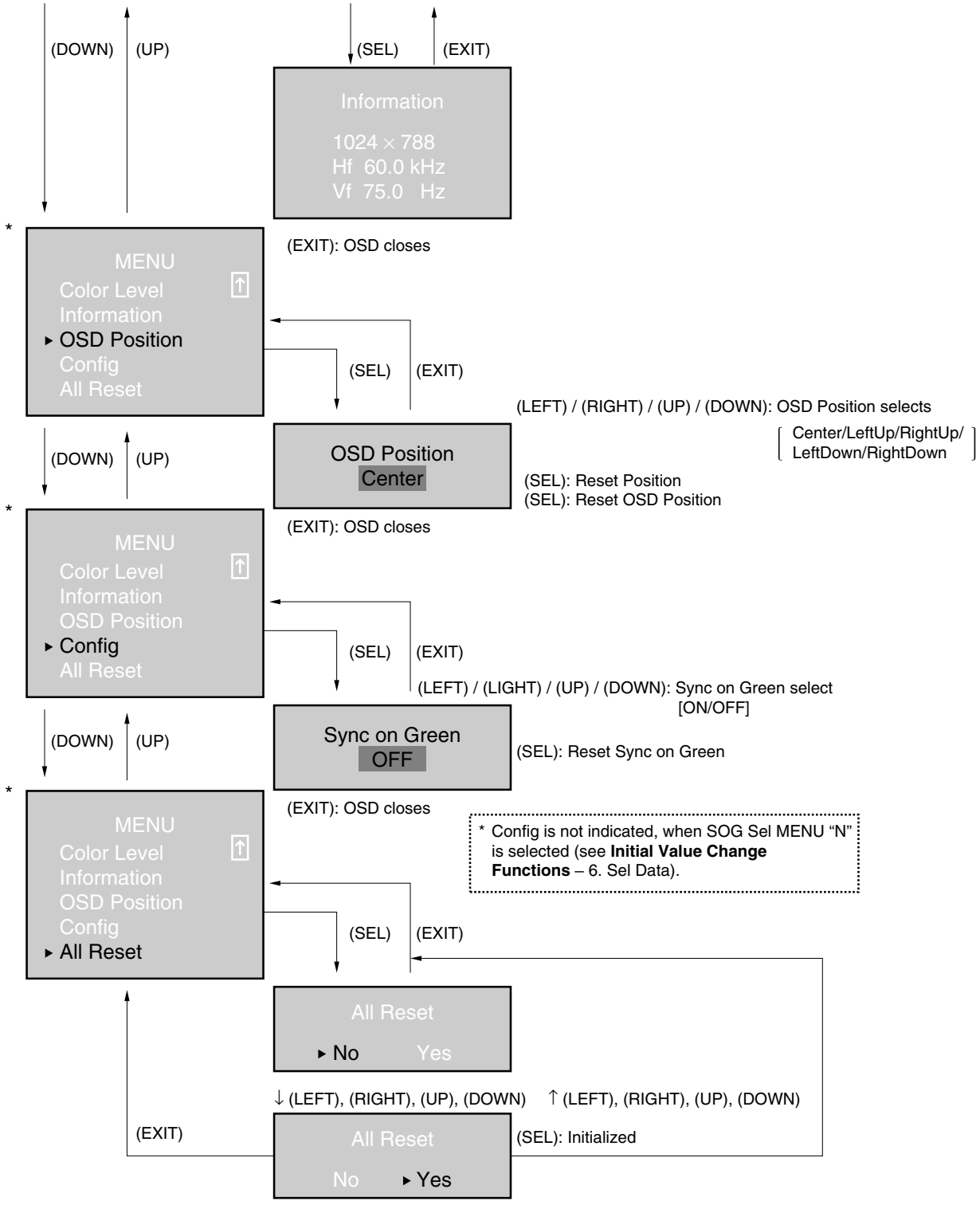
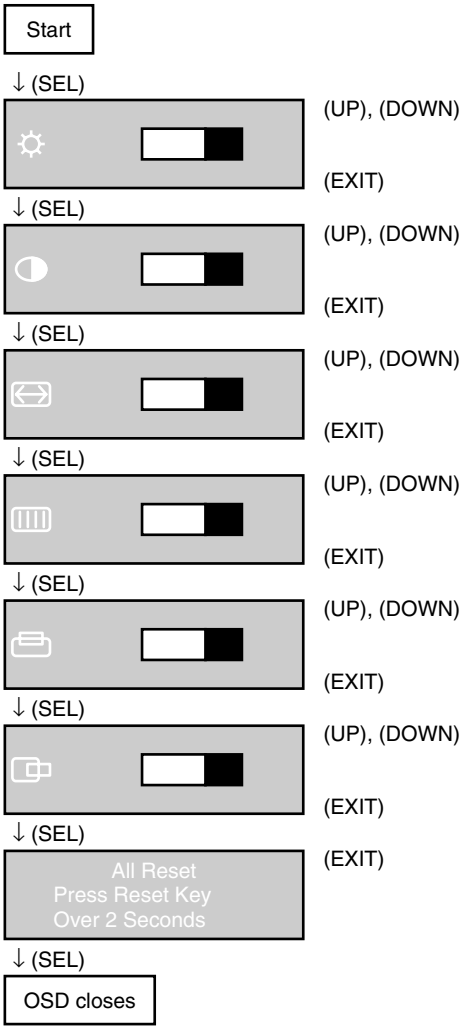

(DOWN)
(UP)
(SEL)
(EXIT)
Information
1024 × 788
Hf 60.0 kHz
Vf 75.0 Hz
*
MENU
Color Level
Information
▸ OSD Position
Config
All Reset
(EXIT): OSD closes
(SEL)
(EXIT)
(LEFT) / (RIGHT) / (UP) / (DOWN): OSD Position selects
[ Center/LeftUp/RightUp/ LeftDown/RightDown ]
OSD Position
Center
(SEL): Reset Position
(SEL): Reset OSD Position
(EXIT): OSD closes
MENU
Color Level
Information
OSD Position
▸ Config
All Reset
(LEFT) / (LIGHT) / (UP) / (DOWN): Sync on Green select [ON/OFF]
Sync on Green
OFF
(SEL): Reset Sync on Green
(EXIT): OSD closes
* Config is not indicated, when SOG Sel MENU “N” is selected (see **Initial Value Change Functions** – 6. Sel Data).
MENU
Color Level
Information
OSD Position
Config
▸ All Reset
All Reset
▸ No Yes
↓ (LEFT), (RIGHT), (UP), (DOWN)
↑ (LEFT), (RIGHT), (UP), (DOWN)
All Reset
No ▸ Yes
(SEL): Initialized

**Notes:** 1. The value of the selected signals of the LEFT, RIGHT, UP, and DOWN keys is continuously increased if the input signal is held for more than approx imately one second. If it's held less than one second, the value is increased by one.
2. The RESET signal initializes the value selected by the SEL key. The "All Reset" function initializes all the values adjusted before.
3. No key input for more than ten seconds shall be regarded as "time out."
4. Contrast W is synchronous with Contrast R, Contrast G, and Contrast B.
5. Color Level W is synchronous with Color Level R, Color Level G, and Color Level B.

**(c) Toggle type (SEL, UP, DOWN, and EXIT)**

(UP), (DOWN): + or –
(EXIT): Initialize




**Notes:** 1. The value of the signals selected by the UP and DOWN key is continuously increased if the input signal is held for more than about one second.
2. The RESET signal initializes the value selected by the SEL key. The All Reset function initializes all the values adjusted before.
3. No key input for more than five seconds shall be regarded as “time out.”
4. EXIT is valid when connected to GND for more than approximately two seconds.

**(6) Initial Value Change Functions**

Initial value, OSD items, etc., can be changed.

The changed initial value becomes the initial value in each preset timing, and is applicable when it is reset (including All Reset).

- How to transpose to **initial value change mode**.
  Hierarchical type: Connect SET and UP to GND at the same time when the OSD function is in "information" mode.
  Toggle type: Connect SEL to GND while UP is connected to GND when the OSD function is in "All Reset" mode.

- Operation
  SEL, UP, DOWN, and EXIT

- How to return to normal mode
  Connect EXIT to GND or turn off the power supply when OSD is closed.
  Both LEDON and LEDOFF become "H" when this mode is operating.

| No. | Form | | Function Items |
|---|---|---|---|
| 1 | Compatible | | It becomes valid when the toggle menu type only is selected.<br>YES: Sync on Green<br>The initial value of contrast (RGB synchronous) becomes 128.<br><br>NO: No Sync on Green<br>The initial value of contrast (RGB synchronous) becomes 100.<br>The NEC factory value: NO. |
| 2 | Brightness | | The maximum value of brightness of the backlight can be changed.<br>Initial value: 100 |
| 3 | Color Level | | The initial value of the color level can be changed.<br>Initial value: 128 |
| 4 | Contrast | | The initial value of contrast can be changed.<br>Initial value: 128<br>(When NO is selected by Compatible in the toggle menu type, the initial value of RGB synchronous only is 100.<br>As for RGB synchronous, the setup value described in this item becomes valid as the initial value regardless of the selection state of Compatible.) |
| 5 | LCD Data<br>(Note 1) | Mode | Number of preset timings is displayed. |
| | | HSE | The initial value of the Double Value can be changed. |
| | | Delay | The value of the CLK delay can be changed. (Initial value cannot be changed.)<br>Initial value: 0 |
| | | VD | The initial value of the updown position of the display position can be changed. |
| | | HD | The initial value of the leftright position of the display position can be changed. |
| | | Auto Adjust | Automatic adjustment |
| | | Par. Delay<br>(Note 2) | The compensation value of Delay of the auto adjust can be changed.<br>Valid range: 0 to 255 |
| | | Par. HD<br>(Note 3) | The compensation value of the horizontal position of the auto adjust can be changed.<br>Valid range: 0 to 127 |

Continue to next page

| No. | Form | | Function Items |
|---|---|---|---|
| 5 | LCD Data | LCD Reset | The values set in No. 5 LCD Data return to the NEC factory settings. |
| 6 | Sel Data | S – Lvl Sel | The adjustment of each individual RGB can be made impossible by the adjustment of the color level. In this case, the adjustment item of each individual RGB is not displayed on the menu screen.<br>ON: Individual adjustment is available.<br>OFF: Individual adjustment is impossible.<br>Initial value: ON. |
| | | S – Cnt Sel | Adjustment for RGB independence can be made impossible by the adjustment of the color level. In this case, the adjustment for RGB independence is not displayed on the menu screen.<br>ON: Individual adjustment is available.<br>OFF: Individual adjustment is impossible<br>Initial value: ON. |
| | | SOG Sel | Select or nonselect of Sync on Green and display or nondisplay of the select menu can be selected. When nondisplay is selected, Config is not displayed.<br>• FUNC (Y: Sync on Green selection)<br>(N: Sync on Green nonselection)<br>• MENU (Y: Select MENU display)<br>(N: Select MENU nondisplay)<br>Initial value (FUNC: Y; MENU: N)<br>* This item becomes effective only when the hierarchical menu type is selected. It becomes invalid when the toggle menu type is selected. |
| | | MENU Sel | B (blue) or S (transparency) can be selected for the background color of the OSD menu.<br>Initial value: B |
| | | Button Sel | 4 (SEL, UP, DOWN, and EXIT) or 7 (SEL, UP, DOWN, RIGHT, LEFT, EXIT, and RESET) as the number of the adjustment switch can be selected.<br>Initial value: 7 |
| | | PSOSD Sel | Display or no display for Power Save OSD can be selected.<br>(For details, see page 29, **Information Display by OSD**)<br>ON: Display OFF: No display<br>Initial value: OFF |
| 7 | Information | | Input signal information is displayed. |
| 8 | OSD Position | | The initial value of the OSD display position can be changed.<br>C: Center UL: Upper left UR: Upper right DL: Down left DR: Down right<br>Initial value: C |
| 9 | Used Time | | Used time in the normal and power save states is displayed.<br>Used time is recorded every five minutes. But it is not recorded when the power supply is cut off within five minutes. |
| 10 | Full Reset | | All values are returned to NEC factory settings. It takes about seven seconds. |

Remark 1. The selected adjustment item is displayed with OSD.

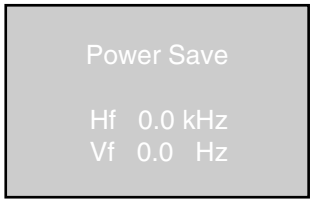
Remark 2. All adjustment values are returned to the NEC factory value when menu type is changed.

Note 1. The values of No. 5 LCD Data are memorized in every preset timing.
Data except **Auto Adjust** of No. 5 LCD Data is saved when it is returned in the extreme upper menu. But it is not saved if the power supply is cut off halfway.

Note 2. Please sufficiently evaluate the compensation values that **Par. Delay** and **Par. HD** of No. 5 LCD Data need to set up, before determining the values.

**(7) Information Display by OSD**

(a) Power save: The frequency of the horizontal and vertical synchronous signal is displayed for four seconds at a Power Save mode switchover.

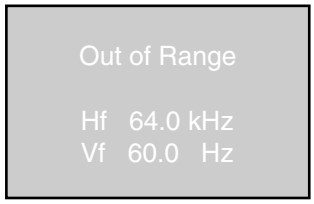



am

* It is displayed when the horizontal synchronous signal frequency (Hf) and vertical synchronous signal frequency (Vf) are as follows:
  (1) Hf < 10 KHz
  (2) Vf < 40 Hz
  (3) (1) and (2)

* It is not displayed when the “Power Save OSD no display” form is selected (see page 27**, Initial Value Change Functions** – 6. Sel Data, PSOSD Sel).

(b) Out of Range: Each frequency is displayed for four seconds when the horizontal and vertical synchronous signal outside the corresponding range is input.

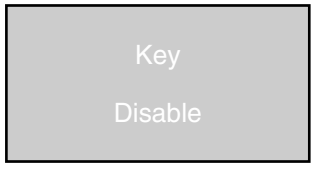



* It is displayed when the horizontal synchronous signal frequency (Hf) and vertical synchronous signal frequency (Vf) are as follows:
  (1) 10 KHz ≤ Hf < 23 KHz or 61.5 KHz < Hf
  (2) 40 Hz ≤ Vf < 50 Hz or 200 Hz < Vf
  (3) (1) and (2)

  It is not displayed when either Hf or Vf is in Power Save mode.

* Display or no display for Out of Range cannot be selected.

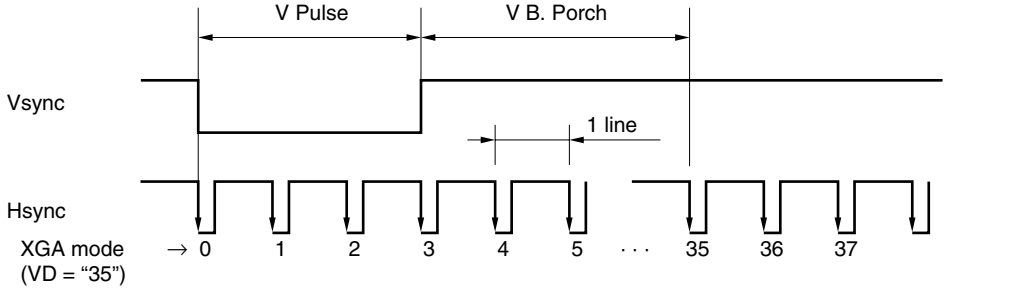
(c) Disable: It is displayed for four seconds if the switch for adjustment is Disable.

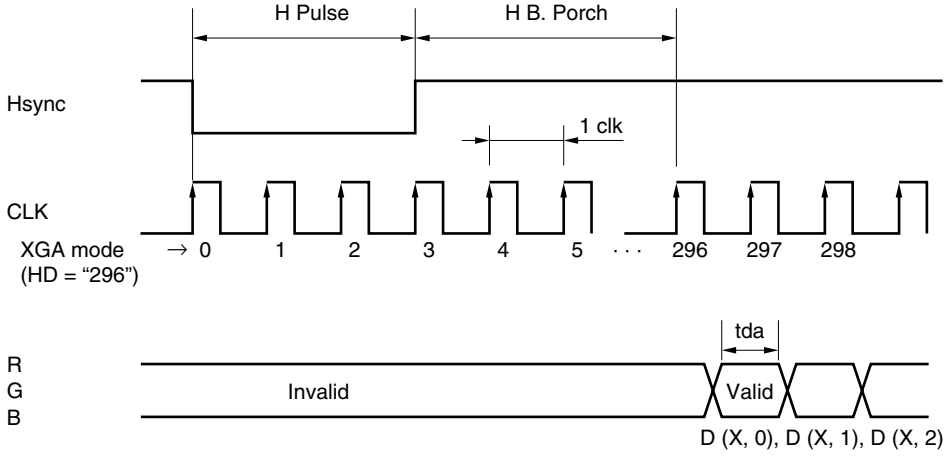


### (8) Input Signal And Display Position — XGA Standard Timing

Pixels

| | | | | |
|---|---|---|---|---|
| D (0, 0) | D (0, 1) | D (0, 2) | • • • • • • | D (1023, 0) |
| D (1, 0) | D (1, 1) | D (1, 2) | • • • • • • | D (1, 1023) |
| D (2, 0) | D (2, 1) | D (2, 2) | • • • • • • | D (1023, 2) |
| • • • • | • • • • | • • • • | | • • • • |
| D (0, 767) | D (1, 767) | D (2, 767) | • • • • • • | D (1023, 767) |




**Note**: The tda should be more than 4 ns.

**OPTICAL CHARACTERISTICS**

(Ta = 25°C, $V_{DD}$ = 12 V, $V_{DDB}$ = 12 V, **Note 1**)

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit | Remark |
|---|---|---|---|---|---|---|---|
| Contrast ratio | CR | $\gamma$ = 2.2 viewing angle<br>$\theta$R = 0°, $\theta$L = 0°, $\theta$D = 0°,<br>White/Black, at center | 80 | 150 | – | – | **Note 2** |
| Luminance | Lumax | White, at center | 150 | 200 | – | $cd/m^2$ | **Note 3** |
| Luminance uniformity | – | White | – | – | 1.30 | – | **Note 4** |

**Reference data**

(Ta = 25°C, $V_{DD}$ = 12 V, $V_{DDB}$ = 12 V, **Note 1**)

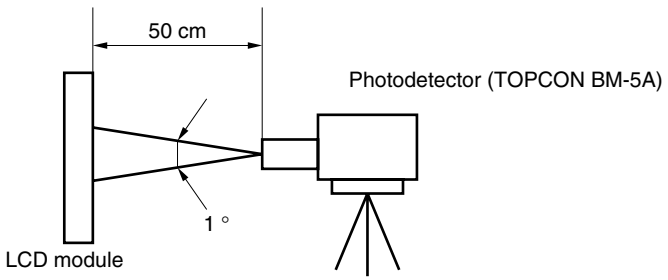
| Item | Symbol | Condition | Min. | Typ. | Max. | Unit | Remark |
|---|---|---|---|---|---|---|---|
| Contrast ratio | CR | Best contrast angle<br>$\theta$R = 0°, $\theta$L = 0°, $\theta$D = 5°<br>White/Black, at center | – | 300 | – | | **Note 2** |
| Color gamut | C | $\theta$R = 0°, $\theta$L = 0°, $\theta$U = 0°, $\theta$D = 0°<br>at center, to NTSC | 35 | 40 | – | % | – |
| Viewing angle range | $\theta$R | CR > 10, $\theta$U = 0°, $\theta$D = 0°<br>White/Black, at center | 40 | 50 | – | deg. | **Note 5** |
| | $\theta$L | | 40 | 50 | – | deg. | |
| | $\theta$U | CR > 10, $\theta$R = 0°, $\theta$L = 0°<br>White/Black, at center | 15 | 20 | – | deg. | |
| | $\theta$D | | 25 | 35 | – | deg. | |
| Response time | Ton | White (100%) to Black (10%) | – | 11 | 25 | ms | **Note 6** |
| | Toff | Black (0%) to Black (90%) | – | 40 | 80 | | |
| Luminance control range | – | Maximum luminance: 100%<br>at center | – | 30 to 100 | – | % | – |

Notes: 1. The luminance is measured after 20 minutes, with all pixels in white.
The typical value is measured after luminance saturation.
Display mode: VESA XGA-75 Hz
RGB input voltage: 0.7 V p-p
Contrast: Default

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

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

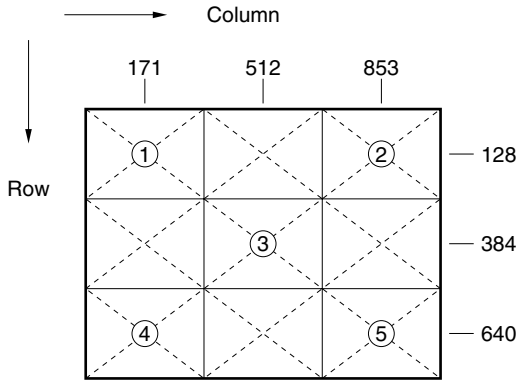
3. The luminance is measured after the module has been working for 20 minutes, with all pixels in white. The typical value is measured after luminance saturation, more than one hour after burn-in. The timing is XGA standard mode, preset No. 14.



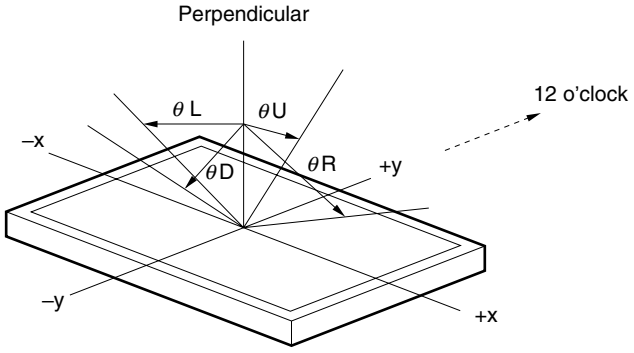
4. Luminance uniformity is calculated by using the following formula.

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

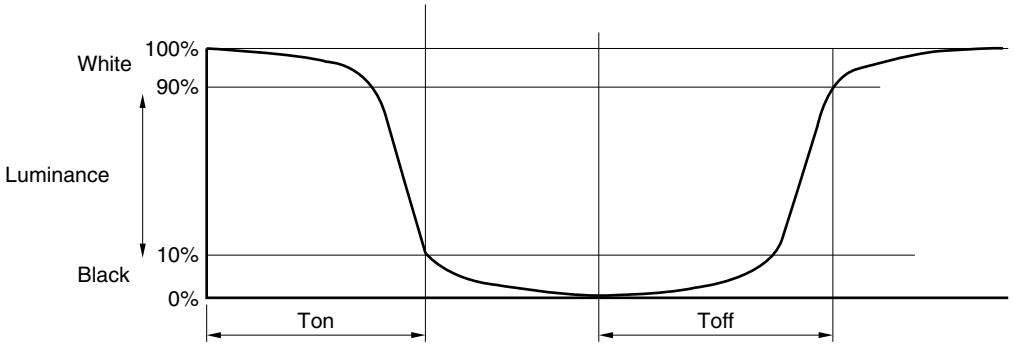
The luminance is measured at or near the five points shown below.




5. Definitions of viewing angles are as follows.



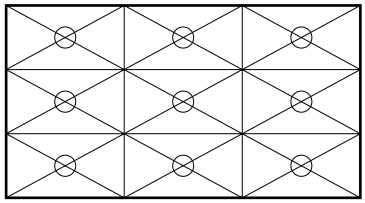

6. Definition of response time is as follows.
The photodetector output signal is measured when the luminance changes from white to black or from black to white.



**RELIABILITY TEST SPECIFICATIONS**

| Test Item | Test Condition | Notes |
|---|---|---|
| High temperature/humidity operation | 50 ±2°C, 85% relative humidity<br>240 hours; display data is black. | **Note 1** |
| Heat cycle (operation) | <1> 0°C ±3°C … 1 hour<br>55°C ±3°C … 1 hour<br><2> 50 cycles, 4 hours/cycle<br><3> Display data is black. | **Note 1** |
| Thermal shock (nonoperation) | <1> –20°C ±3°C … 30 minutes<br>60°C ±3°C … 30 minutes<br><2> 100 cycles<br><3> Temperature transition time is within 5 minutes. | **Note 1** |
| Vibration (nonoperation) | <1> 5–100 Hz, 19.6 $m/s^2$ (2G)<br>1 minute/cycle,<br>X, Y, Z direction<br><2> 50 times each direction | **Notes 1, 2** |
| Mechanical shock (nonoperation) | <1> 294 $m/s^2$ (30G), 11 ms<br>X, Y, Z direction<br><2> 3 times each direction | **Notes 1, 2** |
| ESD (operation) | 150 pF, 150 Ω, ±10 KV<br>9 places on a panel<br>10 times each place at one-second intervals | **Note 1**<br>**Note 3** |
| Dust (operation) | 15 kinds of dust (JIS-Z 8901)<br>Hourly 15 seconds stir, 8 times repeat | **Note 1** |

Notes: 1. Display function is checked by the same condition as the LCD module outgoing inspection.
2. Physical damage.
3. Discharge points are shown in the following figure.



## GENERAL CAUTIONS

Because the following figures and statements are very important, please be sure you understand their contents completely.

| | |
|---|---|
| **CAUTION** | This figure is a warning that you will get hurt and/or the module will be damaged if you make a mistake in operation. |

| | |
|---|---|
| | This figure is a warning that you will get an electric shock if you make a mistake in operation. |
| | This figure is a warning that you will get hurt if you make a mistake in operation. |

**CAUTION**

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

**(1) Caution when taking out the module**

Pickup the pouch only, when removing the module from a carrier box.

**(2) Cautions for handling the module**

a) As the electrostatic discharges may break the LCD module, handle the LCD module with care against electrostaic discharges.

b) As the LCD panel and backlight element are made from fragile glass material, impulse and pressure to the LCD module should be avoided.

c) As the surface of polarizer is very soft and easily scratched, use a soft dry cloth without chemicals for cleaning.

d) Do not pull the interface connectors in or out while the LCD module is operating.

e) Put the module display side down on a flat horizontal plane.

f) Handle connectors and cables with care.

g) When the module is operating, do not lose CLK, HS or Vsync signal. If any one of these signals is lost, the LCD panel would be damaged.

h) The torque to mounting screw should never exceed 0.392 N·m (4 kgf·cm).

**(3) Cautions regarding atmosphere**

a) Dew-drop atmosphere should be avoided.

b) Do not store and/or operate the LCD module in a high-temperature and/or high-humidity atmosphere. Storage in an electro-conductive polymer packing pouch and in a relatively low-temperature atmosphere is recommended.

c) This module uses cold cathode fluorescent lamps. The lifetime of the lamps is shortened conspicuously at low temperatures.

d) Do not operate the LCD module in a high magnetic field.

**(4) Cautions about the module characteristics**

a) Do not apply a fixed pattern for a long time to the LCD module at product aging. Applying a fixed pattern for a long time may cause image sticking.

**(5) Other cautions**

a) Do not disassemble and/or reassemble the LCD module.

b) Do not readjust any variable resistors, switches, etc.

c) When returning the module for repair, etc., please pack the module so it will not be broken. We recommend using the original shipping packages.

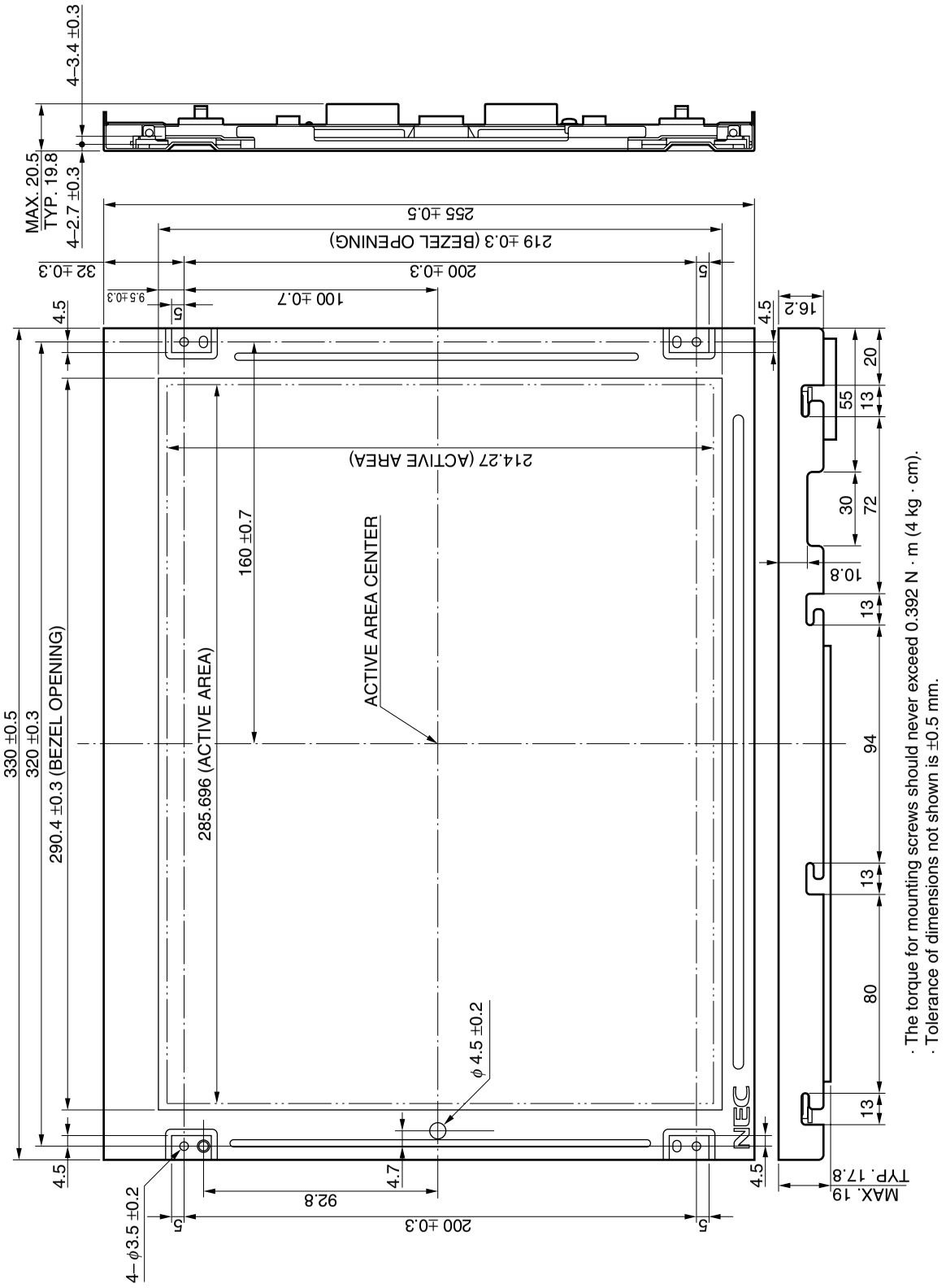
The liquid crystal display has the following specific characteristics. These are neither defects nor malfunctions.

The display condition of the LCD module may be affected by the ambient temperature.
The LCD module has cold cathode tube for backlight. Optical characteristics, like luminance or uniformity, will change over time.

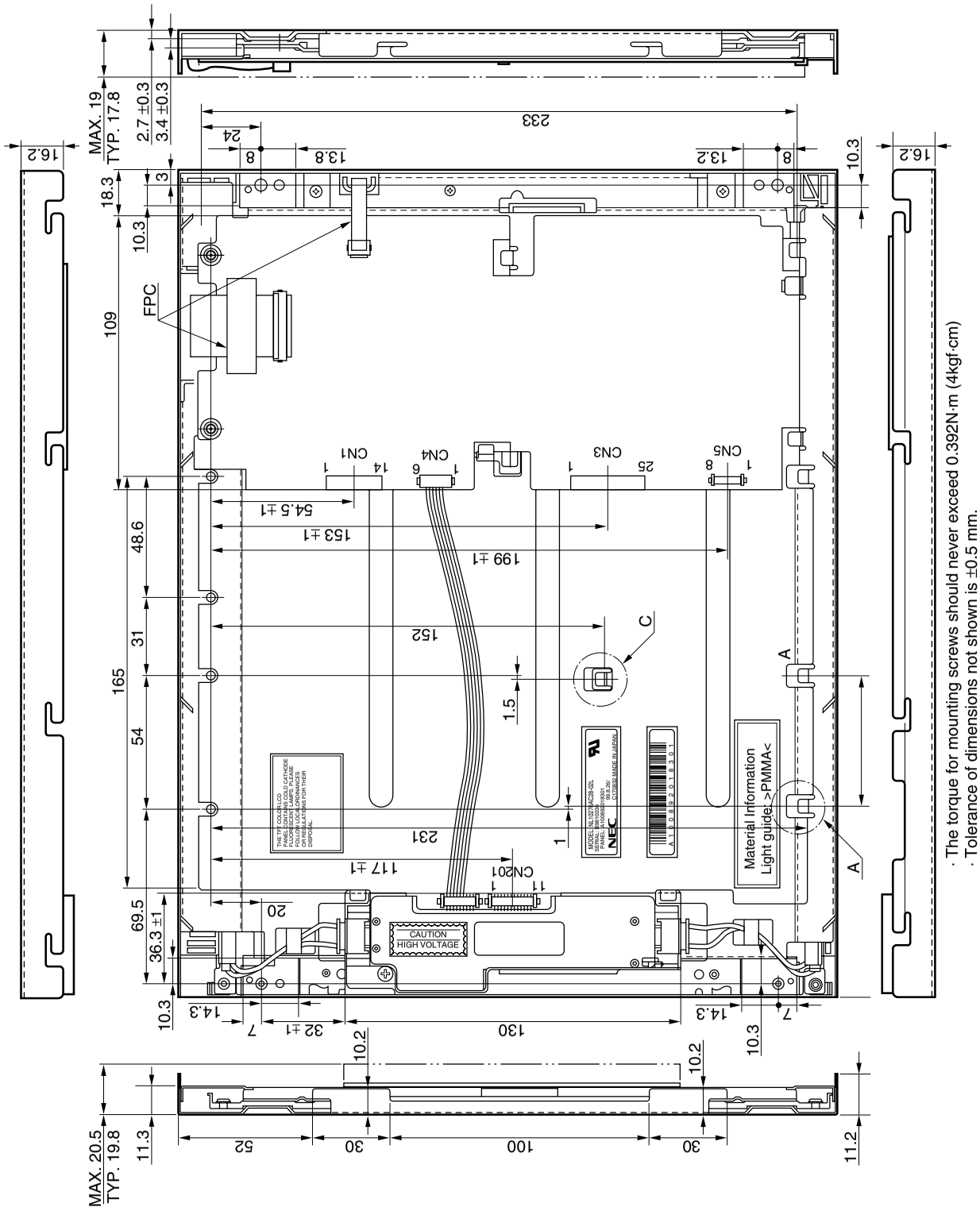
Uneven brightness and/or small spots may be noticed, depending on different display patterns.

**OUTLINE DRAWINGS**

**Front View (Unit: mm)**



**Rear View (Unit: mm)**



**[MEMO]**

**[MEMO]**