NEC

# SUPER FINE TFT COLOR LCD MODULE

## Type: NL128102AC28-01F
## 46cm(18.1type), SXGA

## SPECIFICATIONS

Third edition

**Preliminary**

This document is preliminary. All information in this document is subject to change without prior notice.

The former specifications (filed number DOD-H-7452, issued October. 19, 1999)

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| | | |
|---|---|---|
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Contents

## 1. DESCRIPTION

NL128102AC28-01F is a TFT (thin film transistor) active matrix color liquid crystal display (LCD) comprising amorphous silicon TFT attached to each signal electrode, a driving circuit, a CRT interface board and a backlight. NL128102AC28-01F has a built-in backlight with an inverter.

The 46cm(18.1" Type) diagonal display area contains 1280 × 1024 pixels and can display full-color (more than 16 million colors simultaneously). Also, it has wide viewing angle and multi-scan function. Therefore, we call this module Super Fine TFT.

NL128102AC28-01F is a model that mounted the CRT interface board on NL128102AC28-01E.

## 2. FEATURES

- Ultra-wide viewing angle with lateral electric field.
- High luminance and low reflection
- CRT interface board
  - Auto recognition of input signal
    Analog RGB signals, Sync on green, Synchronous signals (Hsync, Vsync, and Composite)
  - Digital control: e.g. Brightness, Display position
  - Free supply voltage sequence
  - Corresponding to DDC1 and DDC2B
  - Corresponding to VESA DPMS
- Multi-scan function: e.g. SXGA,XGA, SVGA, VGA, VGA-TEXT, PC-9801, MAC, SUN
- Incorporated direct type backlight (Eight lamps in a lamp unit, Inverter)
- Lamp unit replaceable (Part No. : 181LHS03)
- Approved by UL1950 Third Edition and CSA-C22.2 No.950-95
- On Screen Display

  Application with the OSD function might conflict with patents in Europe and/or the U.S.A.
  If you apply the OSD function appreciate the patents at your side.

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

## 3. APPLICATION

- Desk-top type of PCs, Engineering work stations
- Display terminals for control system
- Monitors

## 4. 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. Sandwiching liquid crystal material in the narrow gap between a TFT array glass substrate and a color filter glass substrate creates the TFT panel structure. 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.

## 5. OUTLINE OF CHARACTERISTICS (at room temperature)

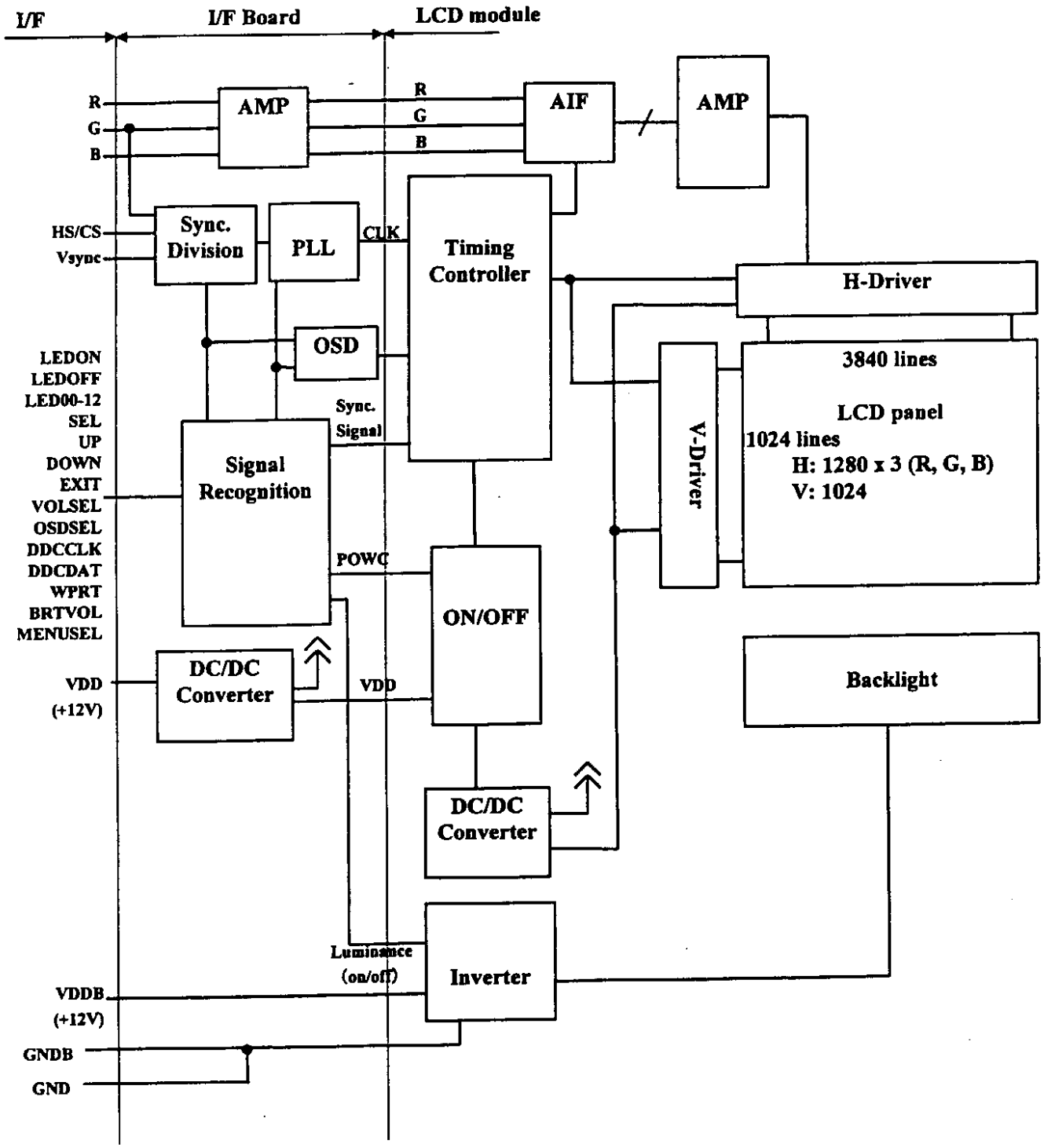
| | |
|---|---|
| Display area | 359.04 (H) × 287.232 (V) mm |
| Drive system | a-Si TFT active matrix |
| Display colors | Full-color |
| Number of pixels | 1280 × 1024 |
| Pixel arrangement | RGB vertical stripe |
| Pixel pitch | 0.2805 (H) × 0.2805 (V) mm |
| Module size | 424.0 (H) × 337.0 (V) × 41.0 (D) mm |
| Weight | 2130 g (typ.) |
| Contrast ratio | 300:1 (typ.) |

Viewing angle (more than the contrast ratio of 10:1)
- Horizontal: 85 ° (typ. , left side, right side)
- Vertical: 85 ° (typ. , up side, down side)

Designed viewing direction
- Optimum grayscale ( $\gamma$ =2.2): perpendicular

| | |
|---|---|
| Pencil hardness | 3 H (min. JIS K5400) |
| Color gamut | 60 % (typ., At center, To NTSC) |
| Response time | 40 ms (typ.), " black " to " white " |
| Luminance | 200 cd/m$^2$ (typ.) |
| Input signals | Analog RGB signals, Synchronous signals(Vsync and Hsync or Composite), Digital data |
| Backlight | Direct type: Eight cold cathode fluorescent lamps with an inverter<br><Replacement parts><br>Inverter Parts No.: 181PW031<br>Lamp holder set Parts No.: 181LHS03 |
| Supply voltage | 12 V, 12 V (Logic/LCD driving, Backlight) |
| Power consumption | 48.2 W (typ. ) |

## 6. BLOCK DIAGRAM




HS: Hsync
CS: Composite synchronous signal
Note 1: FG (Frame Ground) is not connected to GND and GNDB. GND is connected to GNDB.

# 7. SPECIFICATIONS

## 7.1 GENERAL SPECIFICATIONS

| Items | Contents | Unit |
|---|---|---|
| Module size | 424.0±1.0 (H) x 337.0±1.0 (V) x 42.0 (max.)(D) | mm |
| Display area | 359.04 (H) x 287.232(V) | mm |
| Number of dots | 1280 x 3 (H) x 1024 (V) | dots |
| Pixel pitch | 0.2805 (H) x 0.2805 (V) | mm |
| Dot pitch | 0.0935 (H) x 0.2805 (V) | mm |
| Pixel arrangement | RGB (Red, Green, Blue) vertical stripe | – |
| Display colors | Full color | color |
| Weight | 2230 (max.) | g |

## 7.2 ABSOLUTE MAXIMUM RATINGS

| Parameters | Symbols | Ratings | Unit | Remarks |
|---|---|---|---|---|
| Supply voltage | VDD | -0.3 to +14 | V | Ta=25℃ |
| | VDDB | -0.3 to +14 | V | |
| Logic input voltage | Vin1 | -0.3 to +5.5 | V | Ta=25℃ |
| R,G, B input voltage | Vin2 | -6.0 to +6.0 | V | VDD=12V |
| CLK input voltage | Vin3 | -7.0 to +7.0 | V | |
| Storage temp. | Tst | -20 to +60 | ℃ | – |
| Operating temp. | Top | 0 to +55 | ℃ | Module surface Note 1 |
| Relative humidity (RH) Note 2 | | ≦ 95% | % | Ta≦40 ℃ |
| | | ≦ 85% | % | 40<Ta≦50 ℃ |
| | | ≦ 70% | % | 50<Ta≦55 ℃ |
| Absolute humidity Note 2 | | Absolute humidity ($g/m^3$) shall not exceed Ta=55℃, RH=70% level. | $g/m^3$ | Ta>55 ℃ |

Note 1: Measured at the LCD panel.

Note 2: No condensation

## 7.3 ELECTRICAL CHARACTERISTICS

(1) Logic, LCD driving, Backlight (Ta=25℃)

| Items | Symbols | Min. | Typ. | Max. | Unit | Remarks |
|---|---|---|---|---|---|---|
| Supply voltage | VDD | 11.4 | 12.0 | 12.6 | V | Logic and LCD driving |
| | VDDB | 11.4 | 12.0 | 12.6 | V | Backlight |
| Logic input " L " voltage | ViL | 0 | — | 0.8 | V | HS/CS, Vsync, SEL, UP, DOWN, EXIT, VOLSEL DDCCLK, DDCDAT, OSDSEL, WPRT, MENUSEL |
| Logic input " H " voltage | ViH | 2.2 | — | 5.25 | V | |
| Logic output " L " voltage | VoL1 | — | — | 0.4 | V | LED00/01/02/10/11/12 |
| Logic output " H " voltage | VoH1 | 2.4 | — | — | V | |
| Logic input " L " current | IiL | -1 | — | — | μA | HS/CS, Vsync |
| Logic input " H " current | IiH | — | — | 1 | μA | |
| Supply current | IDD | — | 1050 note 1 | 1500 note 2 | mA | VDD=12.0V |
| | | — | 45 note 1 | 65 note 2 | mA | Power saving mode VDD=12.0V |
| | IDDB | — | 2550 | 3500 | mA | VDDB=12.0V (Max. luminance) |
| | | — | 1 | 10 | mA | Power saving mode VDDB=12.0V |

note 1: Checker flag pattern ( in EIAJ ED-2522)
note 2: Pixel checkered pattern

(2)Video signal (R, G, B) input (Ta=25℃)

| Items | Min. | Typ. | Max. | Unit | Remarks |
|---|---|---|---|---|---|
| Maximum amplitude (white – black) | 0 (black) | 0.7 (white) | *A | Vp-p | note 1 |
| DC input level ( black ) | -0.5 | — | +2.5 | V | — |
| Sync level | 0.2 | 0.3 | *B | Vp-p | G terminal (Sync On Green) |
| *A+*B | — | — | 1.1 | Vp-p | — |

note 1: Need to adjust contrast if the input is more than 0.7 Vp-p.

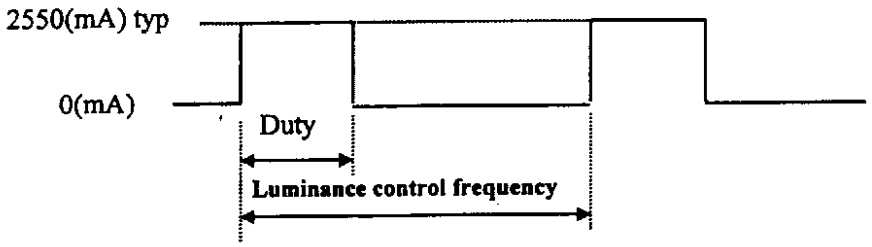
## 7.4 POWER SUPPLY DESIGN

(1) 12V for backlight should be started up within 800ms, otherwise, the protection circuit makes the backlight turns off.

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

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

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




Maximum luminance control: 100%
Minimum luminance control: 20%
Luminance control frequency ≒ Input Vsync frequency × K
Input Vsync frequency ≦ 75Hz : K=4.6
〃 > 75Hz : K=3.6

Please set up like above diagram.

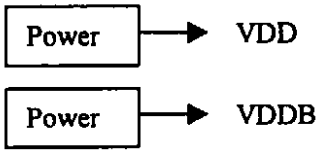
(5)Ripple of supply voltage

| | VDD (for logic and LCD driver) | VDDB (for backlight) |
|---|---|---|
| Acceptable range | ≦ 100mVp-p | ≦ 200mVp-p |

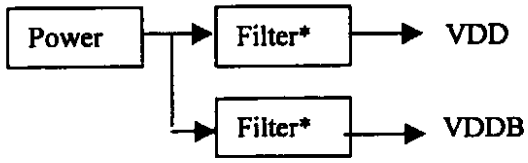
Note 1: The acceptable range of ripple voltage includes spike noise.

Example of the power supply connection

a) Separate the power supply




b) Put the filter




Filter* (Reference value)
L = 10 μH to 100 μH
C = 10 μF to 100 μF

(6) Fuse

| Supply voltage | Part No. | Supplier | Ratings | Remarks |
|---|---|---|---|---|
| VDD | CCF1NTE 3.15A | KOA | 3.15A | - |
| VDDB | ① R429005 | LITTEL FUSE | 5A | ① or ② is used. |
| | ② MMC75A | SOC | 5A | |

Remarks: Before the power is designed, the fuses should be considered. The power capacity should be use more than 2 times of fuse rating.
In case of small power capacity, the module should be evaluated enough.

## 7.5 INTERFACE

### 7.5.1 INTERFACE CONNECTORS

(1) CN101

Part No.: MRF03-6R-SMT

Adaptable socket : MRF03-2×6P-1.27(For cable type) or MRF03-6PR-SMT(For board to board type)

Supplier: HIROSE ELECTRIC CO., LTD. (coaxial type)

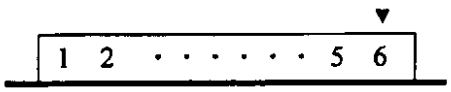
Coaxial cable: UL20537PF75VLAS

Supplier: HITACHI CO., LTD.

Note 1: A coaxial cable shield should be connected with GND.

| Pin No. | Symbols | Pin No. | Symbols |
|---|---|---|---|
| 1 | B | 4 | Vsync |
| 2 | G | 5 | HS/CS |
| 3 | R | 6 | N.C. |

Figure from socket view




(2) CN102

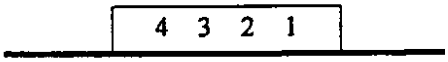
Part No.: IL-Z-4PL-SMTY

Adaptable socket: IL-Z-4S-S125C3

Supplier: Japan Aviation Electronics Industry Limited (JAE)

| Pin No. | Symbols | Pin No. | Symbols |
|---|---|---|---|
| 1 | DDCCLK | 3 | MENUSEL |
| 2 | DDCDAT | 4 | GND |

Figure from socket view




(3) CN103

Part No.: DF14A-25P-1.25H

Adaptable socket: DF14-25S-1.25C

Supplier: HIROSE ELECTRIC CO., LTD.

| Pin No. | Symbols | Pin No. | Symbols |
|---|---|---|---|
| 1 | LEDON | 14 | EXIT |
| 2 | LEDOFF | 15 | GND |
| 3 | GND | 16 | BRTVOL |
| 4 | LED00 | 17 | GND |
| 5 | LED01 | 18 | VOLSEL |
| 6 | LED02 | 19 | OSDSEL |
| 7 | LED10 | 20 | WPRT |
| 8 | LED11 | 21 | N. C. |
| 9 | LED12 | 22 | N. C. |
| 10 | GND | 23 | GND |
| 11 | SEL | 24 | N. C. |
| 12 | UP | 25 | N. C. |
| 13 | DOWN | | |

Figure from socket view


Note 1: N. C. (No connection) must be open.

(4) CN104

Part No.: IL-Z-8PL-SMTY
Adaptable socket: IL-Z-8S-S125C3
Supplier: Japan Aviation Electronics Industry Limited (JAE)

| Pin No. | Symbols | Pin No. | Symbols |
|---|---|---|---|
| 1 | VDD | 5 | GND |
| 2 | VDD | 6 | GND |
| 3 | VDD | 7 | GND |
| 4 | VDD | 8 | GND |

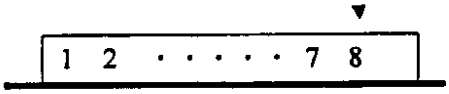
Figure from socket view


(5) CN201

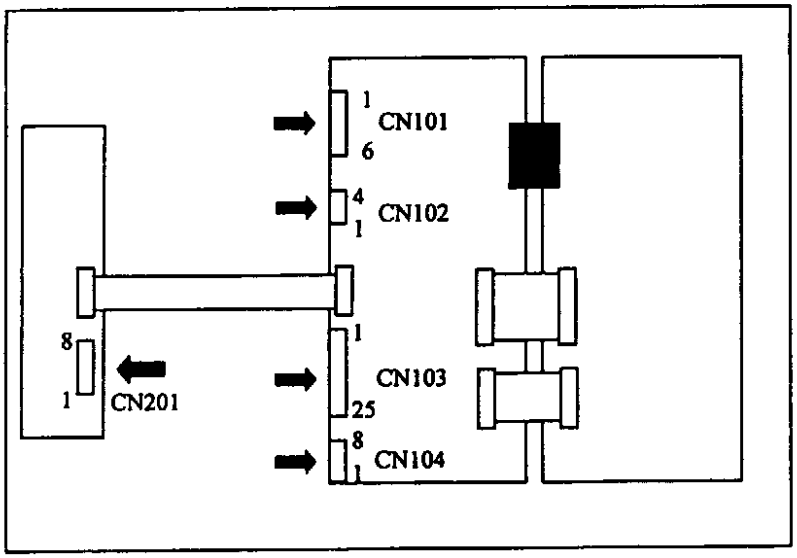
Part No.: DF3-8P-2H
Adaptable socket: DF3-8S-2C
Supplier: HIROSE ELECTRIC CO,. LTD.

| Pin No. | Symbols | Pin No. | Symbols |
|---|---|---|---|
| 1 | GNDB | 5 | VDDB |
| 2 | GNDB | 6 | VDDB |
| 3 | GNDB | 7 | VDDB |
| 4 | GNDB | 8 | VDDB |

Figure from socket view




Rear view



7.5.2 PIN FUNCTIONS

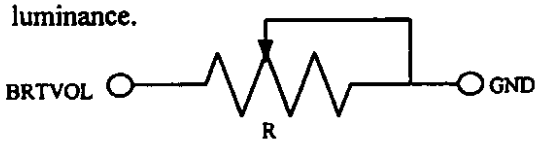
| Symbols | I/O | Logic | Description |
|---|---|---|---|
| HS /CS | Input | Negative | Horizontal synchronous signal input or composite synchronous signal input (TTL level), Positive/Negative auto recognition |
| Vsync | Input | Negative | Vertical synchronous signal input (TTL level)<br>Positive/Negative auto recognition, Clock input for DDC1 |
| R | Input | – | Red video signal input (0.7Vp-p, input impedance 75Ω) |
| G | Input | – | Green video signal input (0.7Vp-p, input impedance 75Ω) |
| B | Input | – | Blue video signal input (0.7Vp-p, input impedance 75Ω) |
| SEL | Input | Negative | Control function select signal (TTL level)<br>SEL is pulled up in the module.<br>Detail of the functions are mentioned in **7.7.CONTROL FUNCTIONS**<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 signal (TTL level)<br>The signal initializes the selected function.<br>EXIT is pulled up in the module.<br>"H or open ": EXIT off "L" : EXIT on |
| OSDSEL | Input | – | Display select signal (TTL level)<br>OSDSEL is pulled up in the module.<br>"H or open": OSD display off (light on LED)<br>"L": OSD display on (light off LED)<br>Detail of the functions are mentioned in **7.5.4 FUNCTION DISPLAY SELECT** |
| MENUSEL | Input | – | OSD design select signal (TTL level)<br>MENUSEL is pulled up in the module.<br>"H or open": OSD display No.2<br>"L": OSD display No.1(Transparent background)<br>Detail of the functions are mentioned in **7.5.5 OSD DESIGN SELECT** |
| BRTVOL | Input | – | Luminance control pin<br>Detail of the functions are mentioned in **7.5.3 LUMINANCE CONTROL SELECT** |
| VOLSEL | Input | – | Luminance control select signal<br>VOLSEL is pulled up in the module.<br>Detail of the functions are mentioned in **7.5.4 LUMINANCE CONTROL SELECT** |
| DDCCLK | Input | Positive | CLK for DDC2B |
| DDCDAT | Input/ Output | Positive | Data for DDC1/2B<br>Read/write |
| WPRT | Input | Positive | Select signal for DDC<br>"H" or "Open": Reading mode, "L": Writing mode |

| Symbols | I/O | Logic | Description |
|---|---|---|---|
| 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 save mode select, "L": Other status |
| LED00 | Output | Positive | See detail of **7.5.6 EQUIVALENT CIRCUIT FOR LED and 7.7.CONTROL FUNCTIONS** |
| LED01 | Output | Positive | |
| LED02 | Output | Positive | |
| LED10 | Output | Negative | |
| LED11 | Output | Negative | |
| LED12 | Output | Negative | |
| VDD | – | – | Power supply for Logic and LCD driving +12V ( ±5%) |
| VDDB | – | – | Power supply for backlight. +12V ( ±5%) Note 2 |
| GND | – | – | GND for logic and LCD driving (VDD) |
| GNDB | – | – | Ground for backlight power supply (VDDB) |

Note1: FG (Frame Ground) is not connected to GND and GNDB. GND is connected to GNDB.

Note2: 12V for backlight should be started up within 800ms, otherwise, the protection circuit makes the backlight turn off.

### 7.5.3 LUMINANCE CONTOLOL SELECT

| Form | PWM adjust | Variable resister adjust |
|---|---|---|
| How to adjust | VOLSEL= "L" | VOLSEL= "Open" |
| | See 7.7 CONTROL FUNCTIONS | The variable resistor for luminance control should be 10 kΩ type, and zero point of the resistor corresponds to the minimum of luminance.<br>  <br><br>Maximum luminance (100%): R= 10 KΩ<br>Minimum luminance (30%): R= 0 Ω<br>Mating variable resistor: 10 KΩ ±5%,<br>B curve, 1/10W |

Note1: The status of VOLSEL is valid when the power is switched on.

### 7.5.4 FUNCTION DISPLAY SELECT

| Form | OSD Display | LED Display |
|---|---|---|
| How to adjust | OSDSEL= "L" | OSDSEL= "Open" |
| | See 7.7 CONTROL FUNCTIONS | See Example of LED circuit.(Next page) |

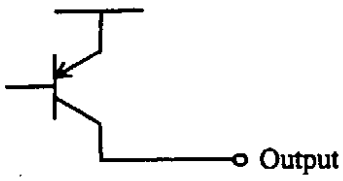
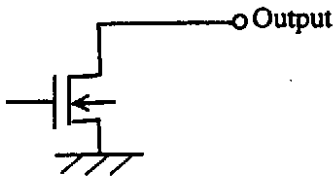
Note1: The status of OSDSEL is valid when the power is switched on.

### 7.5.5 OSD DESIGN SELECT

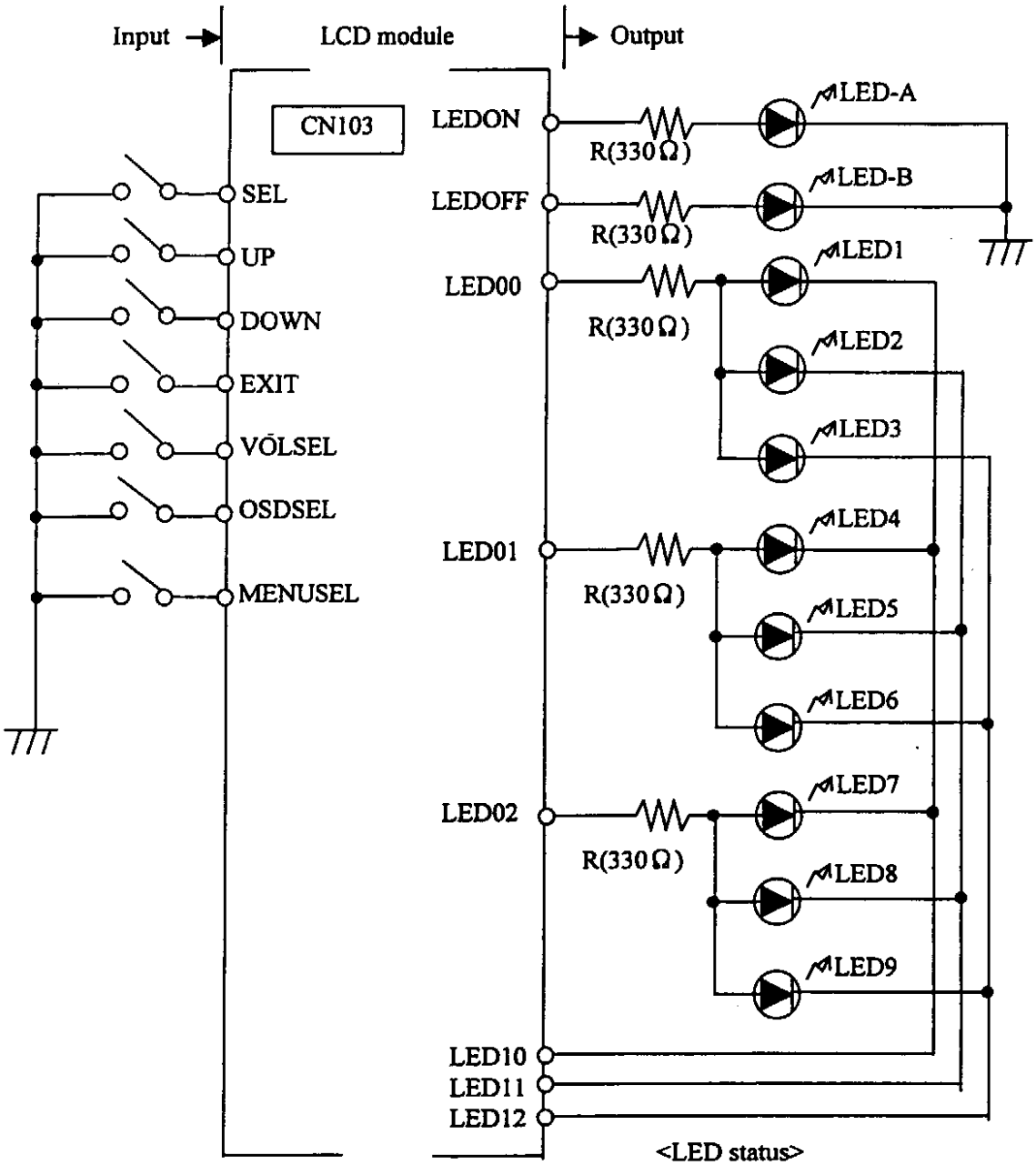
| Form | OSD display No.1 | OSD display No.2 |
|---|---|---|
| How to adjust | MENUSEL= "L" | MENUSEL= "Open" |
| | **See 7.7 CONTROL FUNCTIONS (OSD background is transparent)** | **See 7.7 CONTROL FUNCTIONS** |

Note1: The status of MENUSEL is valid when the power is switched on.

### 7.5.6 EQUIVALENT CIRCUIT FOR LED

| Symbols | I/O | Equivalent circuit |
|---|---|---|
| LEDON<br>LEDOFF<br>LED00<br>LED01<br>LED02 | Output | RN2306(Toshiba)<br>Or equivalent<br>  |
| LED10<br>LED11<br>LED12 | Output | N-ch Open-drain Output<br>  |

<Example of LED circuit>




<LED status>

LED-A: Power on
LED-B: Power-save mode
LED1: Luminance
LED2: Contrast
LED3: Horizontal display period
LED4: CLK delay
LED5: Vertical position
LED6: Horizontal position
LED7: Reserve
LED8: All reset
LED9: Reserve

## 7.6 INPUT SYNCHRONOUS SIGNALS

This module is corresponding to the synchronous signals below.

| Auto recognition mode | Synchronous signals | | |
|---|---|---|---|
| | HS/CS | Vsync | Sync On Green |
| Separate synchronous signal mode (Hsync, Vsync) | Input | Input | Input or no input |
| Composite synchronous mode | Input | No input | Input or no input |
| Sync On Green mode | No input | No input | Input |
| Power save mode | No input | No input | No input |

note 1: Power save mode corresponds to VESA DPMA.

## 7.7 CONTROL FUNCTIONS

### 7.7.1 FUNCTION ITEMS

(1) The function for OSD or LED

1. Brightness : Brightness of backlight Control
2. Contrast : white-level of video signal Control
3. Horizontal display period : horizontal display period Adjust
4. CLK delay : CLK-phase Adjust
5. Vertical position : vertical position Adjust
6. Horizontal position : horizontal position Adjust
7. All Reset : Reset to factory-default value

(2) The function for OSD

1. Sub Brightness : Brightness with each video signal Control
2. Sub Contrast : white-level with each video signal Control
3. Video signal information : Display multi-scan function, Hsync and Vsync frequency

Each selected value is memorized into LCD memory after SEL signal input or time out. The memorized values are not affected even if the power is turned off. But the selected value is not memorized in case that a selected mode is changed another one before time out or power is turned off before time out.
Regarding the brightness, the brightness value can not be memorized while the variable volume resistor is selected.
This function does not work while the power save mode.

### 7.7.2 INDICATOR OF THE FUNCTIONS

The selected functions can be indicated either LED or OSD (On Screen Display) by setting OSDSEL signal.

OSDSEL="H or "OPEN" : LED
OSDSEL="L" : OSD

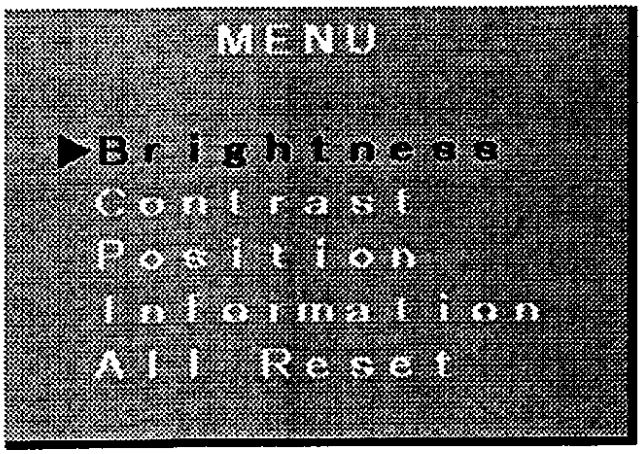
LED state show below table. Please see the recommendation circuit diagram.

| Select function | LED00 | LED01 | LED02 | LED10 | LED11 | LED12 |
|---|---|---|---|---|---|---|
| Default (no-select condition) | L | L | L | H | H | H |
| Brightness | H | L | L | L | H | H |
| Contrast | H | L | L | H | L | H |
| Horizontal display period | H | L | L | H | H | L |
| CLK delay | L | H | L | L | H | H |
| Vertical position | L | H | L | H | L | H |
| Horizontal position | L | H | L | H | H | L |
| Auto control | L | L | H | L | H | H |
| All reset | L | L | H | H | L | H |
| Reserve (no-use) | L | L | H | H | H | L |

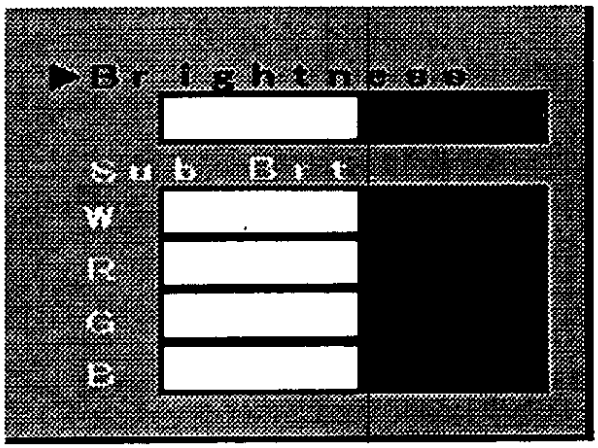
### 7.7.3 SELECTION BY OSD

The following pictures appear on the screen by pushing the SEL key. Adjust the each value in best position by pushing UP and DOWN key.

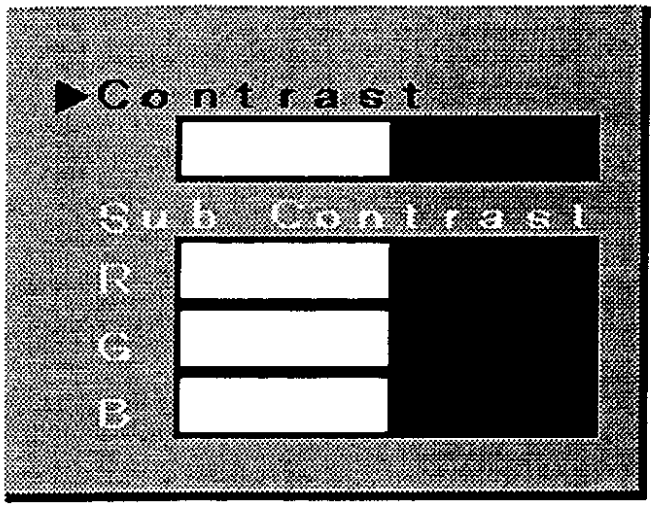
1)Menu



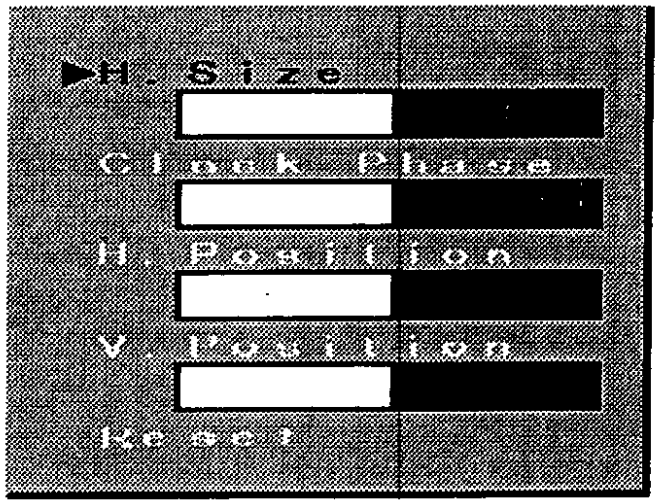

2) Brightness and Sub Brightness



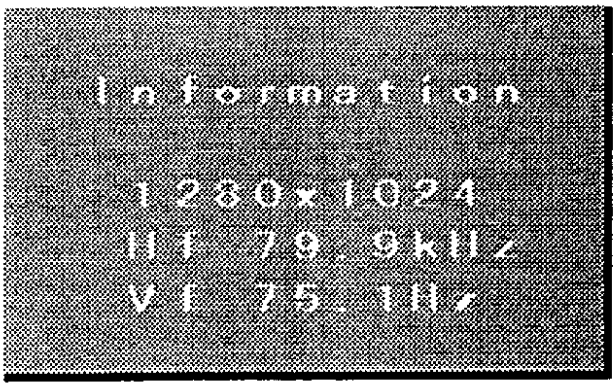
3) Contrast and Sub Contrast



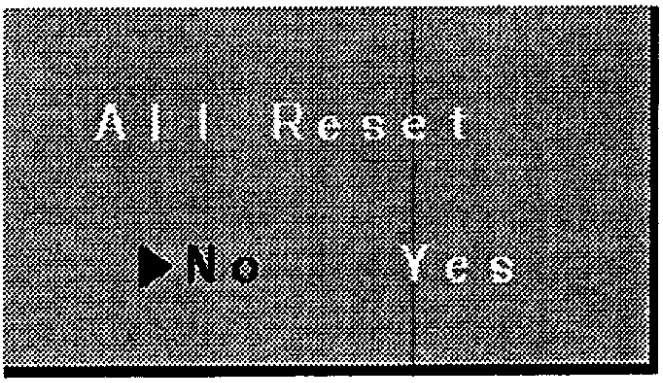

4)Horizontal display period, Clock delay, Vertical display position and Horizontal display position




5) Information

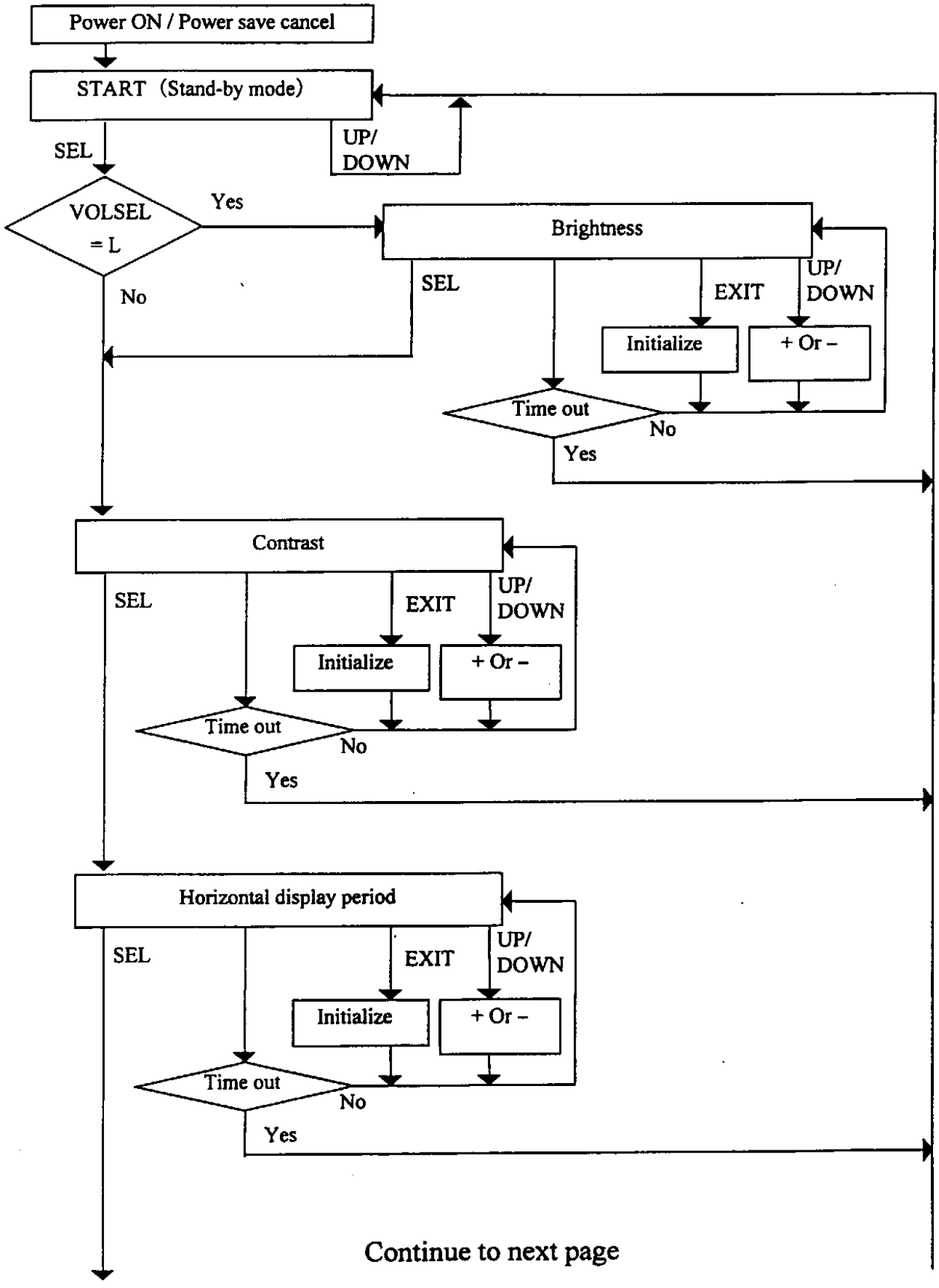



6) All Reset

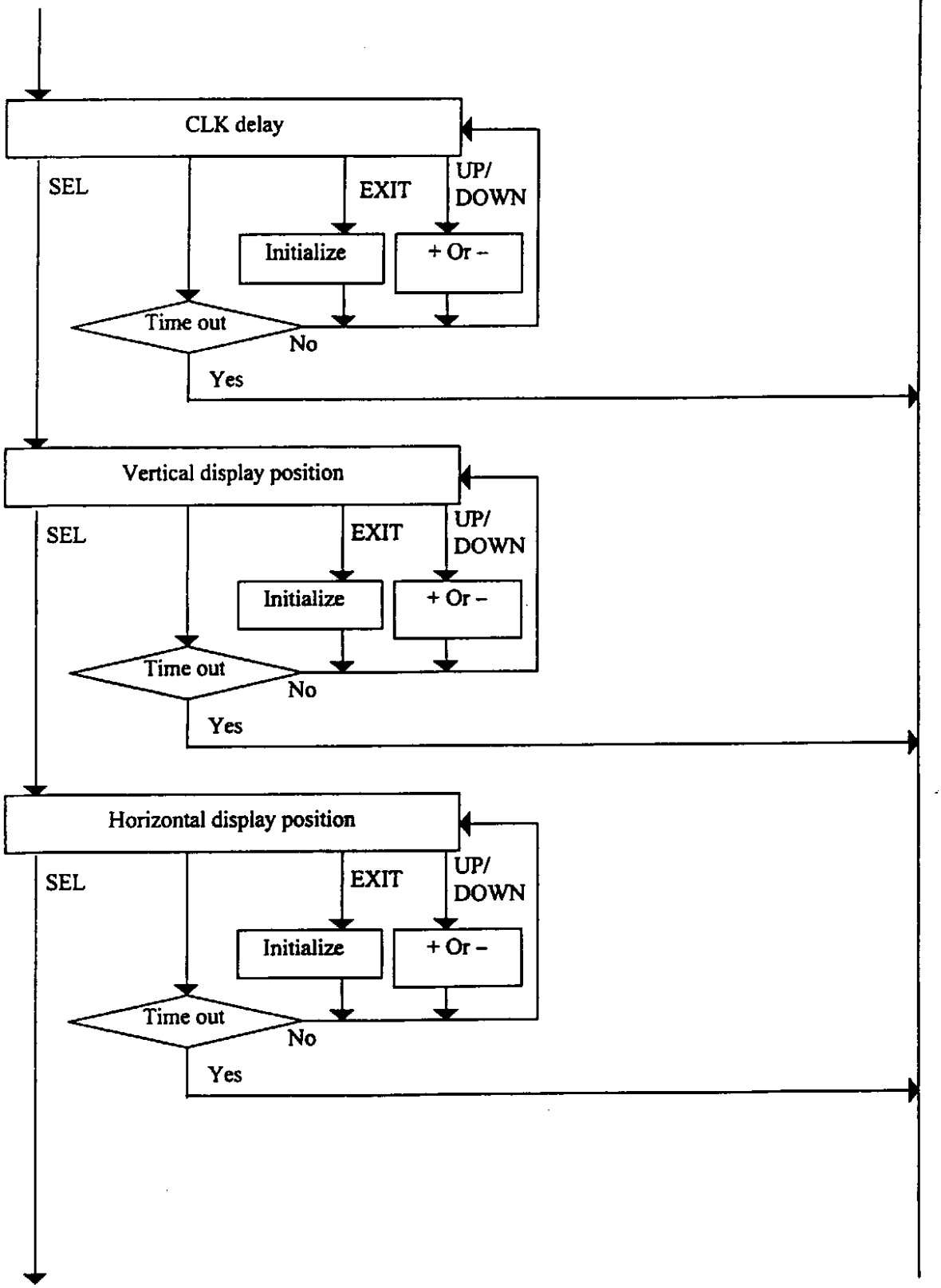


### 7.7.4 FLOW CHART OF CONTROL FUNCTIONS FOR SEL, UP, DOWN AND EXIT

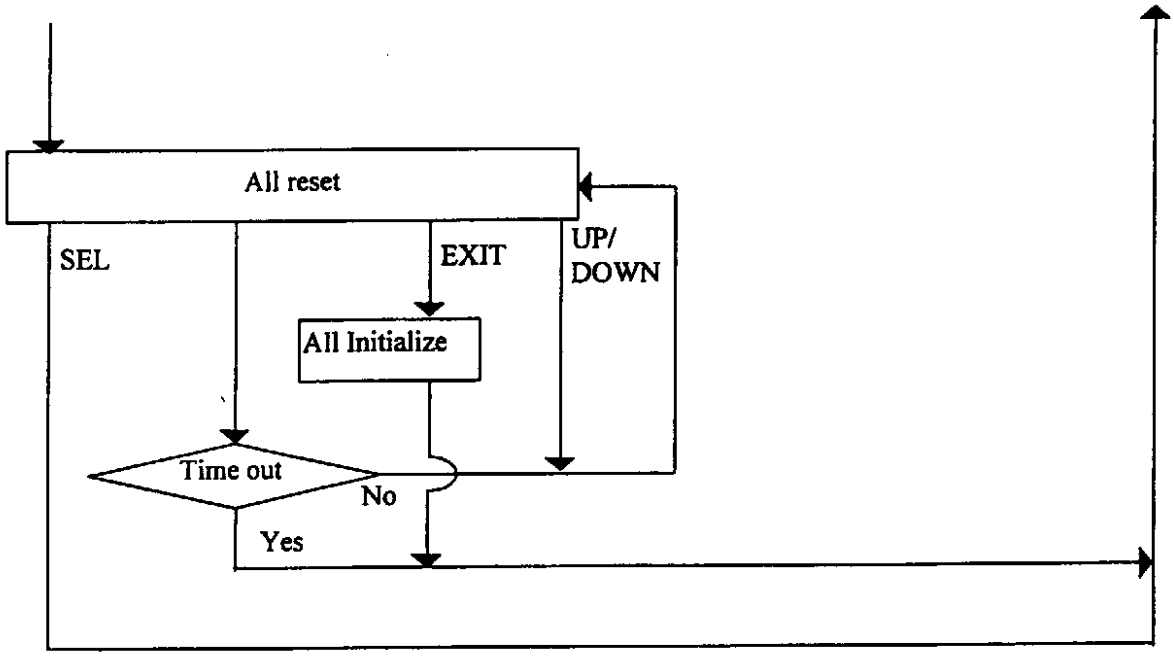
〈LED display〉




Continue to next page




Continue to next page

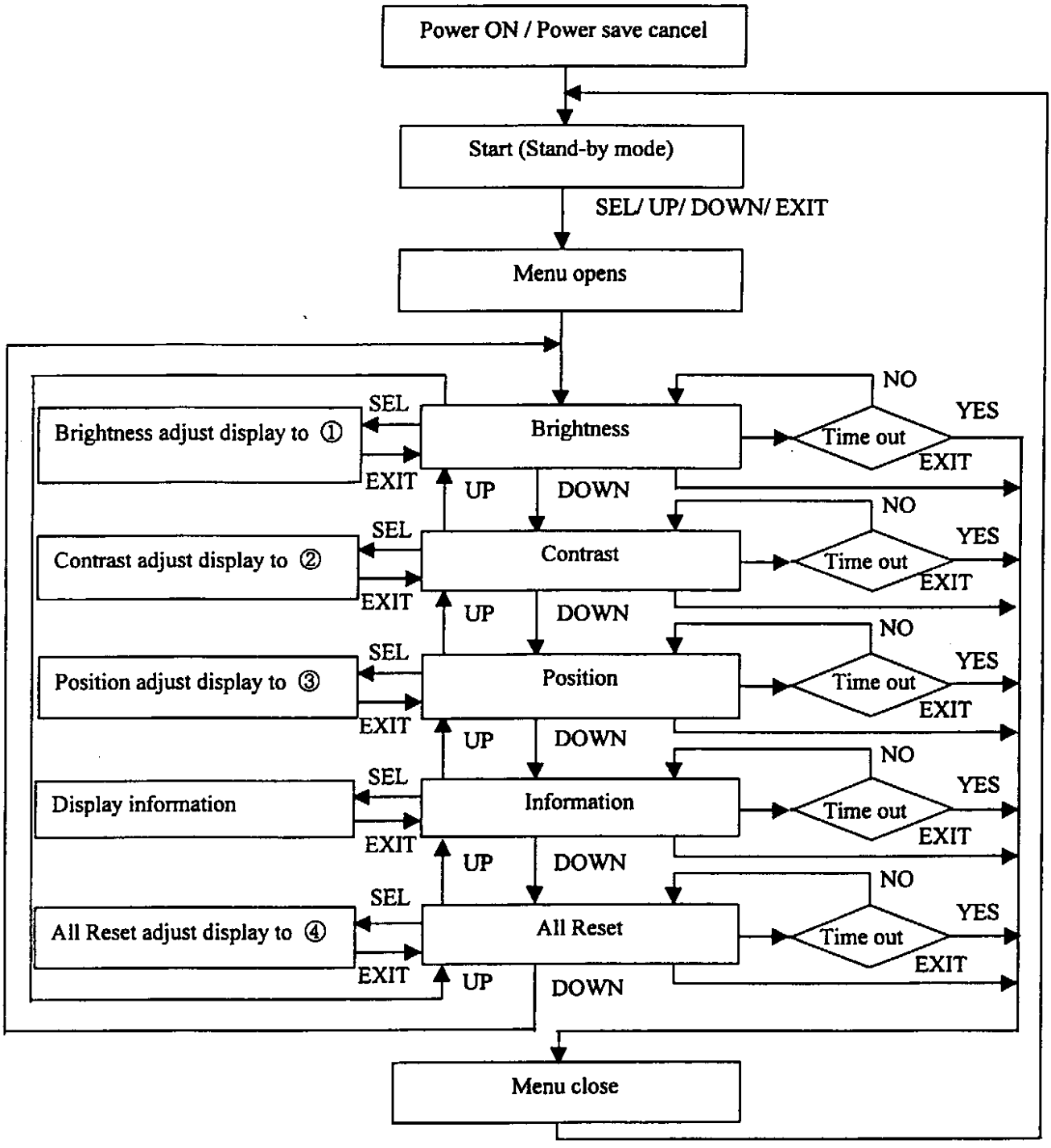



Note 1: The value of the selected signals by UP and DOWN key is continuously incremented if the input signal is held more than approx. one second. If it's less than one second, the value is incremented by one.

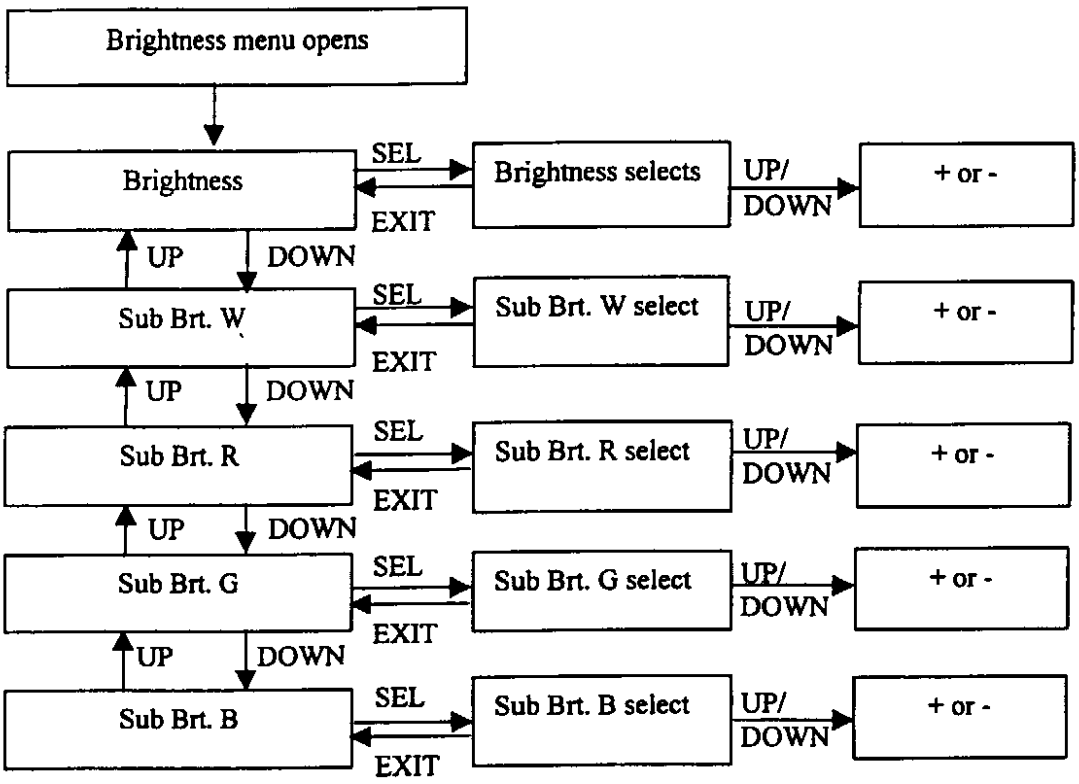
Note 2: RESET signal initializes the value selected by SEL key. All reset function initializes all the values adjusted already.

Note 3: No key input for more than ten seconds shall be regarded "Time out".

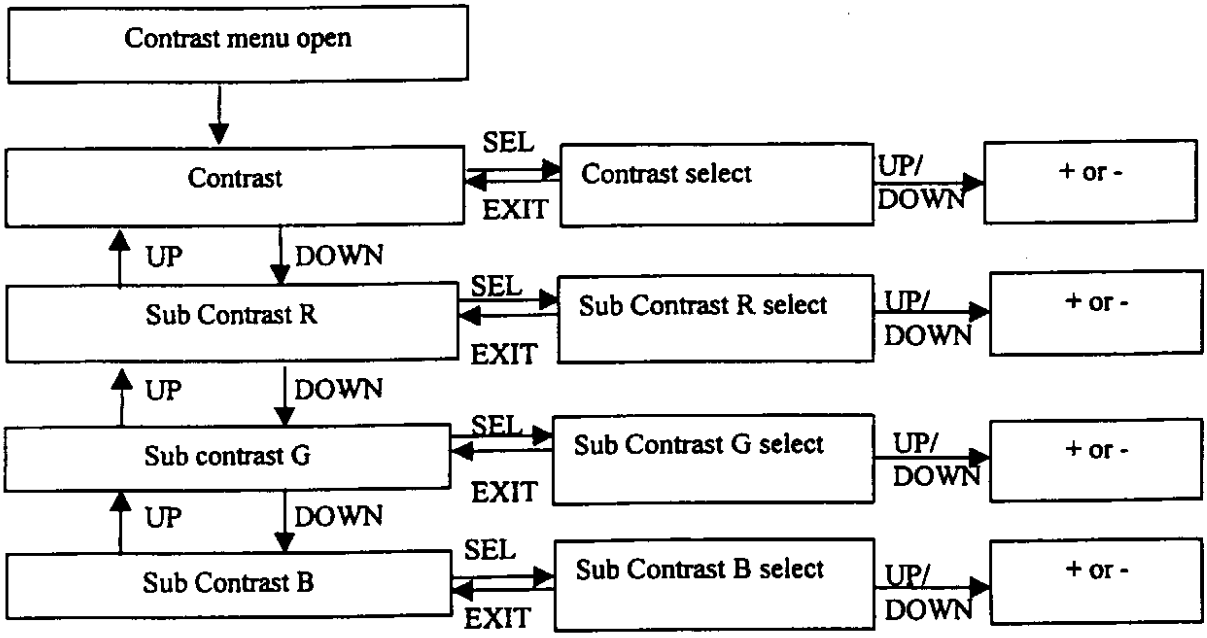
〈OSD display〉


Power ON / Power save cancel
Start (Stand-by mode)
SEL/ UP/ DOWN/ EXIT
Menu opens
Brightness
Brightness adjust display to ①
Contrast
Contrast adjust display to ②
Position
Position adjust display to ③
Information
Display information
All Reset
All Reset adjust display to ④
SEL
EXIT
UP
DOWN
NO
YES
Time out
Menu close

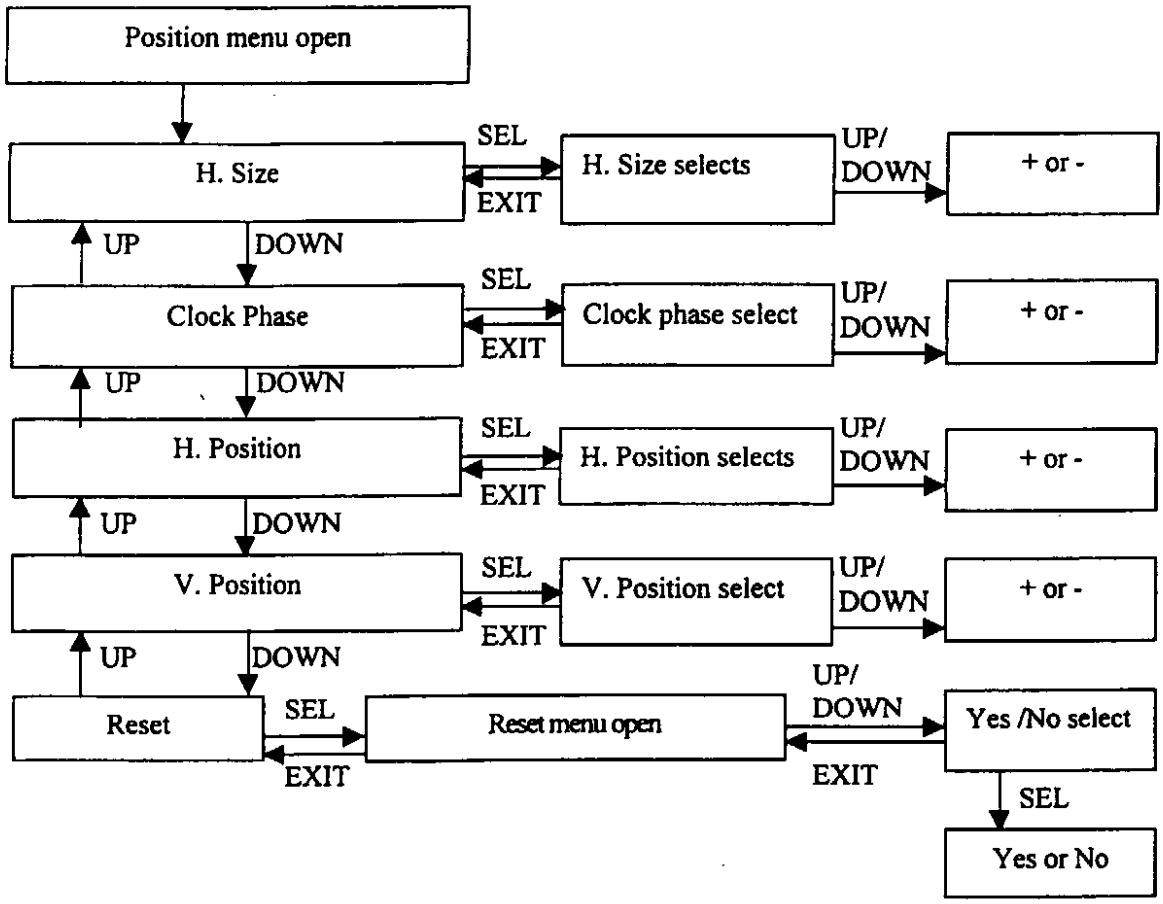
① Brightness adjustment



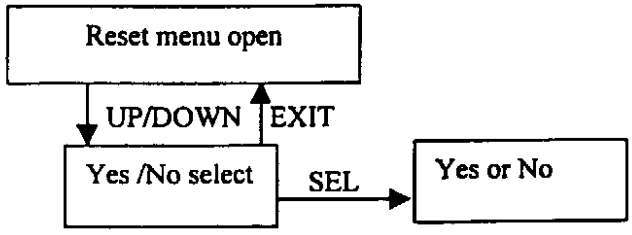

② Contrast adjustment



③ Position adjustment




④ All Reset




Note 1: The value of the selected signals by UP and DOWN key is continuously incremented if the input signal is held more than approx. one second. If it's less than one second, the value is incremented by one.

Note 2: EXIT signal initializes the value selected by SEL key. All reset function initializes all the values adjusted already.

Note 3: No key input for more than ten seconds shall be regarded "Time out".

### 7.8 PRESET TIMINGS

The fourteen kinds of timings below are already programmed in this module. The input synchronous signals are automatically recognized.

| No. | Display size | System CLK (MHz) | Hsync (KHz) | Vsync (Hz) | V Pulse (H) | V B.porch (H) | H Pulse (Dotclk) | V B.porch (Dotclk) | Sync Logic V,H | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 640 × 400 | 21.053 | 24.830 | 56.432 | 8 | 25 | 96 | 48 | -,- | NEC PC98 |
| 2 | 640 × 480 | 25.175 | 31.469 | 59.992 | 2 | 33 | 96 | 48 | -,- | VGA |
| 3 | 720 × 400 | 28.322 | 31.469 | 70.087 | 2 | 35 | 108 | 45 | +,- | VGA TEXT |
| 4 | 800 × 600 | 40.000 | 37.879 | 60.317 | 4 | 23 | 128 | 88 | +,+ | VESA |
| 5 | 640 × 480 | 30.240 | 35.000 | 66.667 | 3 | 39 | 64 | 96 | SonG type A | Macintosh |
| 6 | 640 × 480 | 31.500 | 37.500 | 75.000 | 3 | 16 | 64 | 120 | -,- | VESA |
| 7 | 720 × 400 | 35.500 | 37.927 | 85.039 | 3 | 42 | 36 | 144 | +,- | VESA *1 |
| 8 | 640 × 480 | 36.000 | 43.269 | 85.008 | 3 | 25 | 48 | 112 | -,- | VESA *1 |
| 9 | 1024 × 768 | 65.000 | 48.363 | 60.004 | 6 | 29 | 136 | 160 | -,- | VESA |
| 10 | 800 × 600 | 49.500 | 46.875 | 75.000 | 3 | 21 | 80 | 160 | +,+ | VESA |
| 11 | 832 × 624 | 57.283 | 49.735 | 74.565 | 3 | 39 | 64 | 224 | SonG type A | Macintosh |
| 12 | 800 × 600 | 56.250 | 53.674 | 85.061 | 3 | 27 | 64 | 152 | +,+ | VESA *1 |
| 13 | 1024 × 768 | 75.000 | 56.476 | 70.069 | 6 | 29 | 136 | 144 | -,- | VESA |
| 14 | 1024 × 768 | 78.750 | 60.023 | 75.029 | 3 | 28 | 96 | 176 | -,- | VESA |
| 15 | 1280 × 1024 | 108.000 | 63.981 | 60.020 | 3 | 38 | 112 | 248 | +,+ | VESA |
| 16 | 1152 × 900 | 94.500 | 61.846 | 60.003 | 4 | 31 | 128 | 208 | CS(-) | SUN |
| 17 | 1024 × 768 | 84.375 | 62.040 | 77.068 | 4 | 31 | 128 | 176 | CS(-) | SUN |
| 18 | 1280 × 1024 | 117.000 | 71.691 | 67.189 | 8 | 33 | 112 | 224 | CS(-) | SUN |
| 19 | 1152 × 900 | 108.000 | 71.809 | 76.149 | 8 | 33 | 128 | 192 | CS(-) | SUN |
| 20 | 1280 × 1024 | 135.000 | 79.976 | 75.025 | 3 | 38 | 144 | 248 | +,+ | VESA |

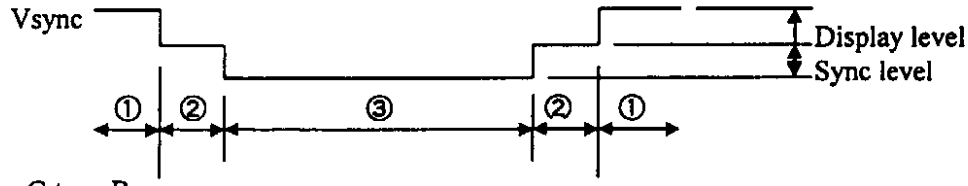
Note *1: Out of specification. These modes are less display quality than other guaranteed modes.

Even if the preset timing is entered, a little adjustment of the functions such as Horizontal period, CLK-delay and display position, are required. The adjusted values are memorized in every preset No.
This module recognizes the synchronous signals with near preset timing of the frequency of HS, Vsync, even in the case that the signals other than the preset timing that were entered. For instance, it is displayed with presetting number 6 in the case of 640 × 480 dot, HS: 37.861kHz, Vsync: 72.809Hz an example).
Adopt the evaluation, because adjustment may not fit, in the case that the magnifying ratio differs, in the case that you use it with except for the display timing that was preset.

Note *2: Sync on Green signal type

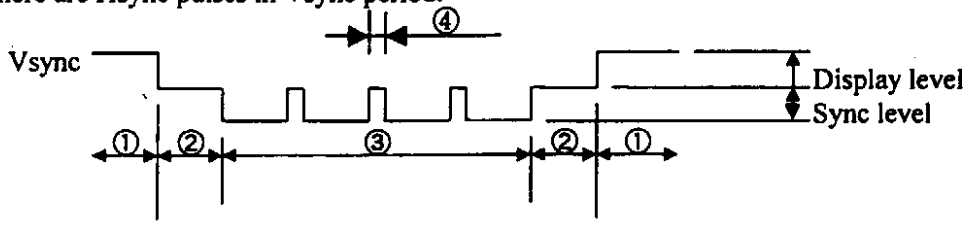
(1) SonG type A

There are no Hsync pulses in Vsync Period.




(2) SonG type B

There are Hsync pulses in Vsync period.




①: Display level, ②: Black level period, ③Vsync period, ④Hsync pulse(equivalent)

## 7.9 DDC FUNCTION

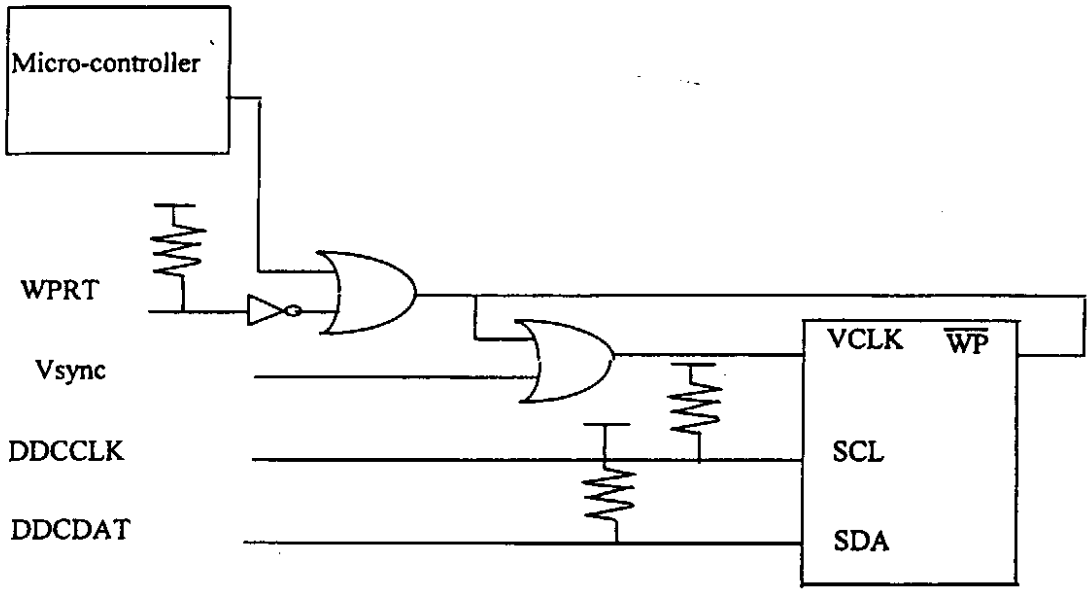
This function is corresponding to VESA DDC™ and EDID™ (Structure Version 1).

- Writing mode: WPRT= "L"
- Reading mode: WPRT= "H" or Open

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

EDID: Extended Display Identification Data

<Internal circuit diagram>




Product: Microchip Technology Inc.
24LCS21 or equivalent

## 7.10 DPMS

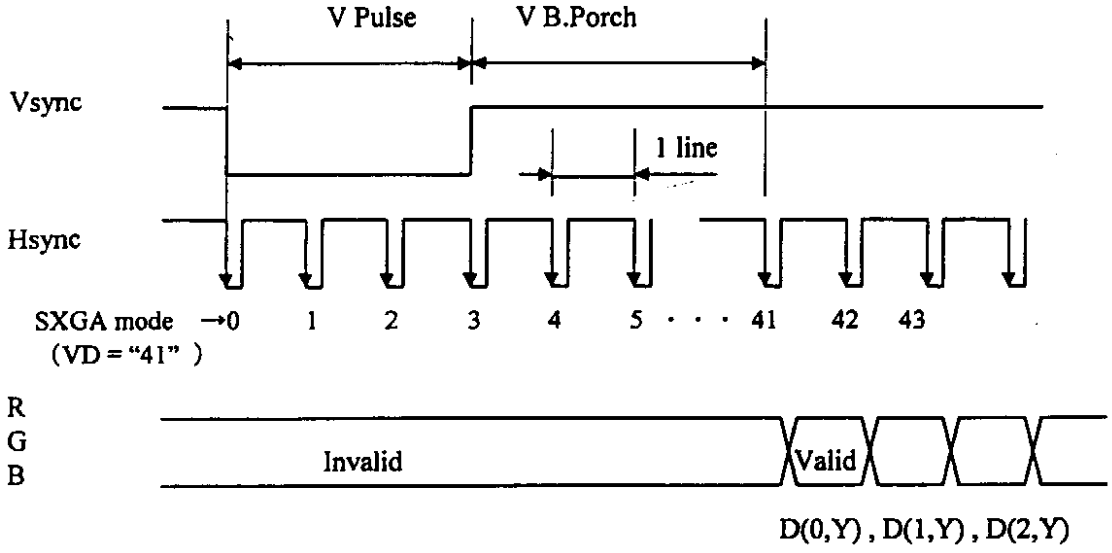
This function is corresponding to VESA DPMS™ Standard.

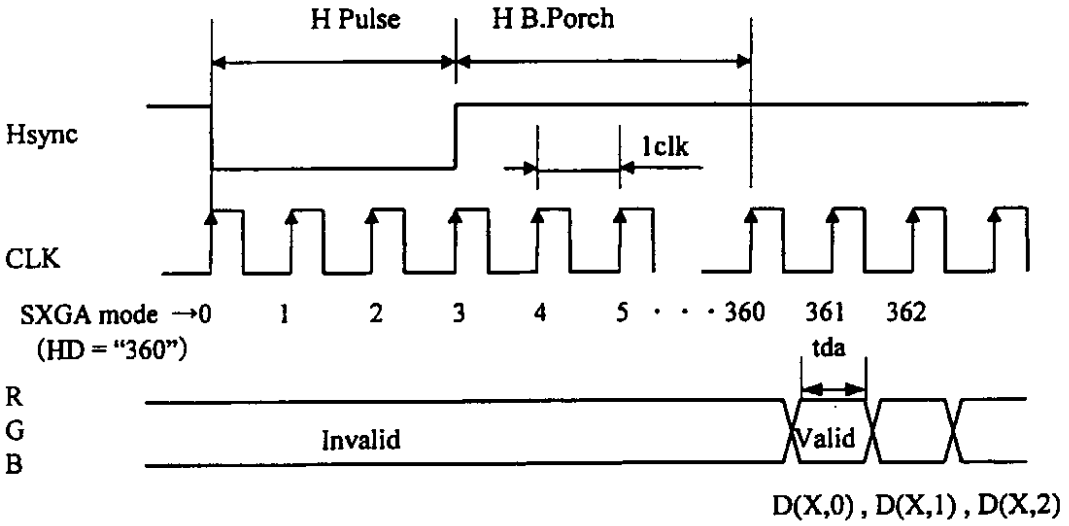
| VESA DPMS Standard | | | | | | NL128102AC28-01F | |
|---|---|---|---|---|---|---|---|
| State | Signal | | | Power saving | Recovery time | Power saving | Recovery time |
| | Horizontal | Vertical | Video | | | | |
| On | Pulses | Pulses | Active | None | Not applicable | None | Not applicable |
| Stand-by | 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 |

## 7.11 INPUT SIGNALS AND DISPLAY POSITIONS -SXGA STANDARD TIMING-

Pixels

| | | | | |
|---|---|---|---|---|
| D(0,0) | D(1,0) | D(2,0) | · · · · · · | D(1279,0) |
| D(0,1) | D(1,1) | D(2,1) | · · · · · · | D(1279,1) |
| D(0,2) | D(1,2) | D(2,2) | · · · · · · | D(1279,2) |
| · | · | · | | · |
| · | · | · | · · · | · |
| · | · | · | | · |
| · | · | · | | · |
| D(0,1023) | D(1,1023) | D(2,1023) | · · · · · · | D(1279,1023) |




note 1: The tda should be more than 4ns

## 7.12 EXPANSION FUNCTION (REFERENCE)

### 7.12.1 HOW TO USE EXPANSION MODES

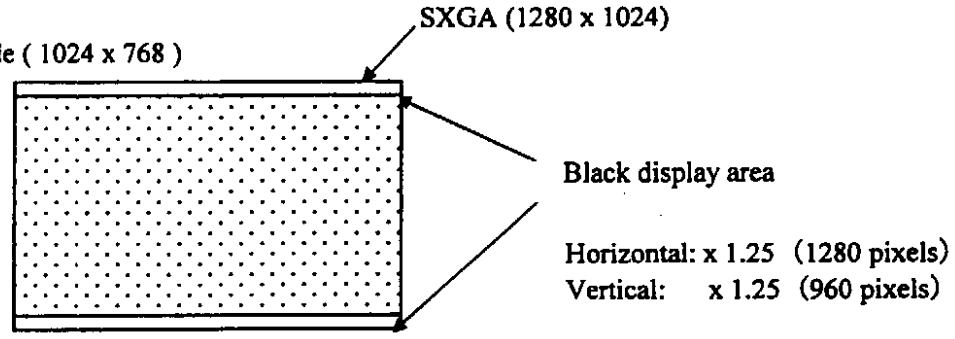
Expansion mode is a function to expand screen. For example, VGA signal has 640 × 480 pixels. But, if the display data can expanded to 2.0 times vertically and horizontally, VGA screen image can be displayed fully on the screen of SXGA resolution. This module automatically recognizes the timing shown in item 7.8 as an expansion mode.
Please adopt this mode after evaluating display quality, because the appearance in the expansion mode is happened to become bad in some cases.

The followings show display magnifications for each mode.

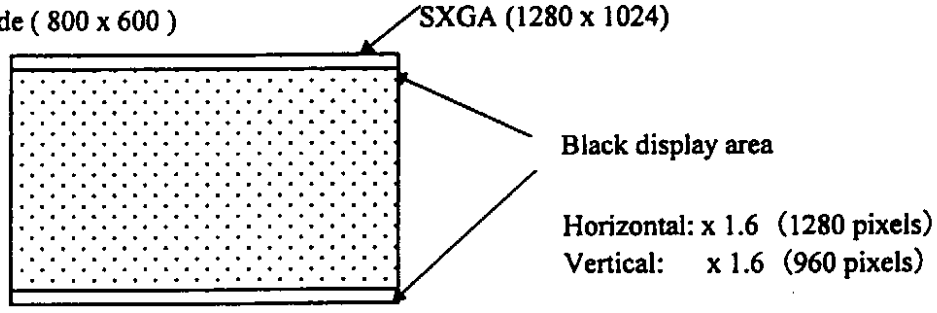
| Input display | Number of pixels | Magnification | |
|---|---|---|---|
| | | Vertical | Horizontal note 1 |
| SXGA | 1280 x 1024 | 1 | 1 |
| XGA | 1024 x 768 | 1.25 | 1.25 |
| SVGA | 800 x 600 | 1.6 | 1.6 |
| VGA | 640 x 480 | 2.0 | 2.0 |
| VGA text | 720 x 400 | 2.5 | 1.7 |
| PC9801 | 640 x 400 | 2.5 | 2.0 |
| MAC | 832 x 624 | 1.6 | 1.5 |
| SUN | 1152 x 900 | 1.1 | 1.1 |

### 7.12.2 DISPLAY IMAGES

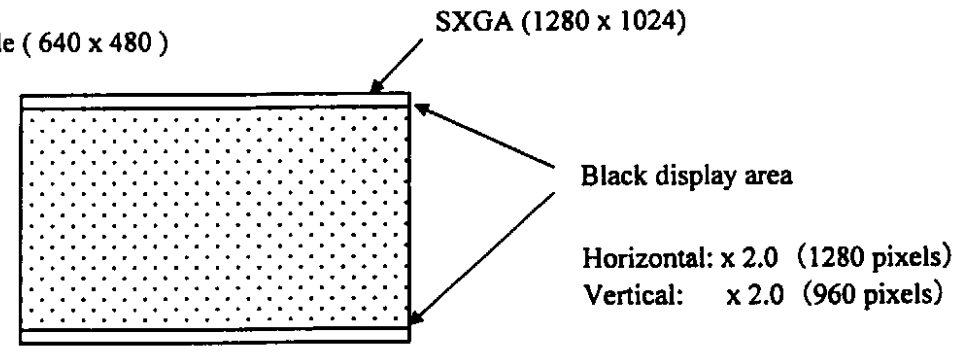
1) XGA mode ( 1024 x 768 )



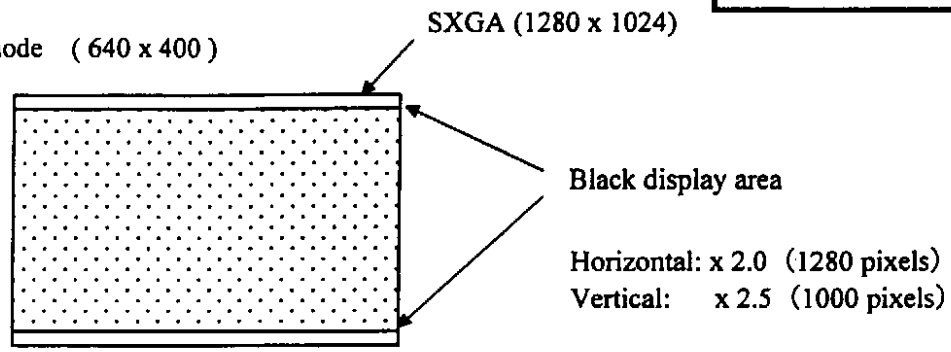

2) SVGA mode ( 800 x 600 )



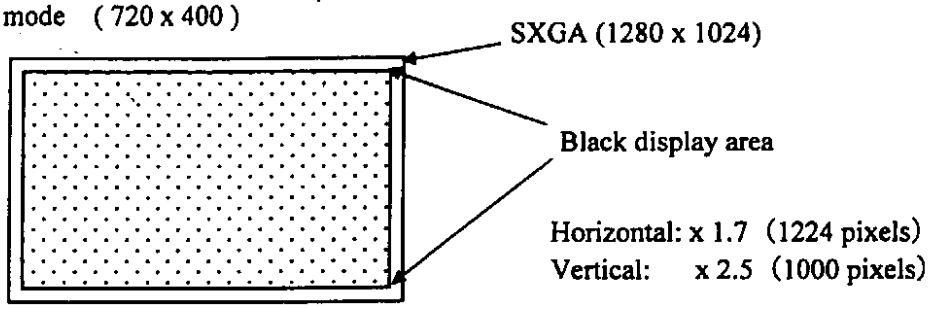

3) VGA mode ( 640 x 480 )



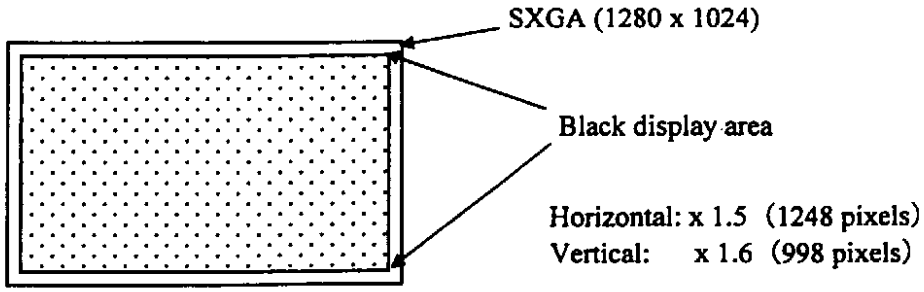
4) PC9801 mode ( 640 x 400 )



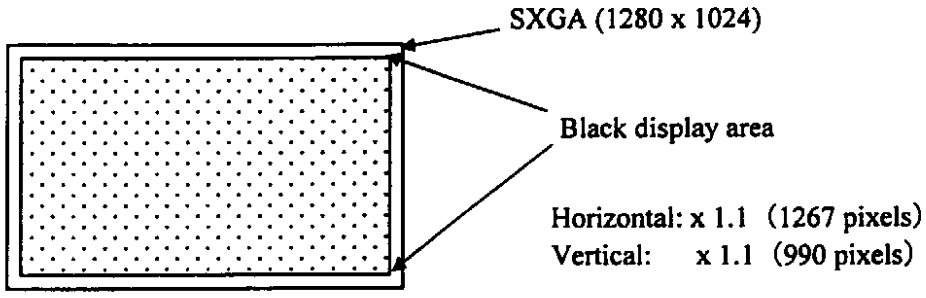

5) VGA text mode ( 720 x 400 )




6) 832 x 624 MAC mode ( 832 x 624 )




7) SUN mode ( 1152 x 900 )



## 8. OPTICAL CHARACTERISTICS

( Ta = 25℃, VDD = 12V, VDDB = 12V )

| Items | Symbols | Condition | Min. | Typ. | Max. | Unit | Remarks |
|---|---|---|---|---|---|---|---|
| Contrast ratio | CR | γ=2.2 viewing angle θx±=0°, θy-=0°, White/Black, at center | 200 | 300 | - | - | note 1 |
| Luminance | Lvmax | White, at center | 150 | 200 | - | $cd/m^2$ | note 2 |
| Luminance uniformity | — | White | - | 1.1 | 1.30 | - | note 3 |

Reference data

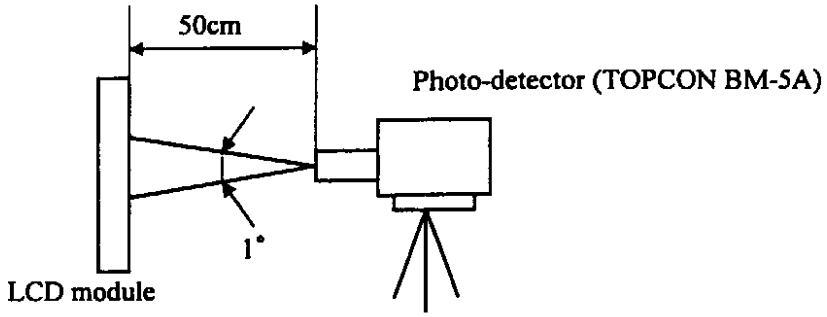
( Ta = 25℃, VDD = 12V, VDDB = 12V )

| Items | Symbols | Condition | Min. | Typ. | Max. | Unit | Remarks |
|---|---|---|---|---|---|---|---|
| Color gamut | C | θx±=0°, θy±=0°, at center, to NTSC | 50 | 60 | - | % | - |
| Chromaticity Coordinates | W | White (x, y) | - | 0.302, 0.312 | - | - | - |
| | R | Red (x, y) | - | 0.618, 0.339 | - | - | - |
| | G | Green (x, y) | - | 0.311, 0.584 | - | - | - |
| | B | Blue (x, y) | - | 0.143, 0.095 | - | - | - |
| Viewing angle range (CR>10) | θx+ | CR > 10, θy+=0°, θy-=0° | 70 | 85 | - | deg. | note 4 |
| | θx- | | 70 | 85 | - | deg. | |
| | θy+ | CR > 10, θx+=0°, θx-=0° | 70 | 85 | - | deg. | |
| | θy- | | 70 | 85 | - | deg. | |
| Viewing angle range (CR>5) | θx+ | CR > 5, θy+=0°, θy-=0° | - | 85 | - | deg. | |
| | θx- | | - | 85 | - | deg. | |
| | θy+ | CR > 5, θx+=0°, θx-=0° | - | 85 | - | deg. | |
| | θy- | | - | 85 | - | deg. | |
| Response time (Module surface temperature =29℃) | Ton | Black to White | - | 40 | 70 | ms | note 5 |
| | Toff | White to Black | - | 35 | 60 | | |
| Luminance control range | — | Maximum luminance: 100% | - | 30 to 100 | - | % | - |

note 1: The contrast ratio is calculated by using the following formula.

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

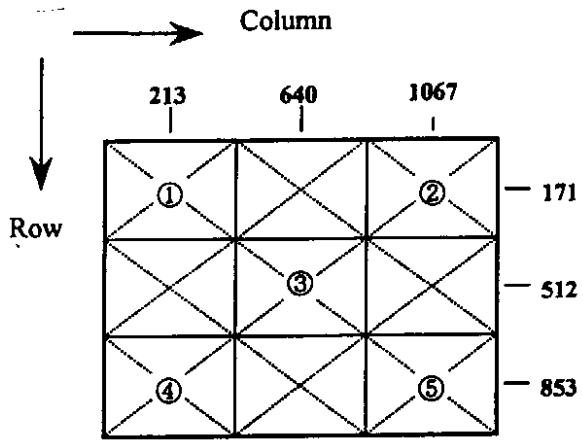
note 2: The luminance is measured after 20 minutes from the module works, with all pixels in "white". The typical value is measured after luminance saturation, more than one hour after burn-in. The timing is SXGA 60Hz mode, preset timing No. 15. See detail **7.8 PRESET TIMINGS.**



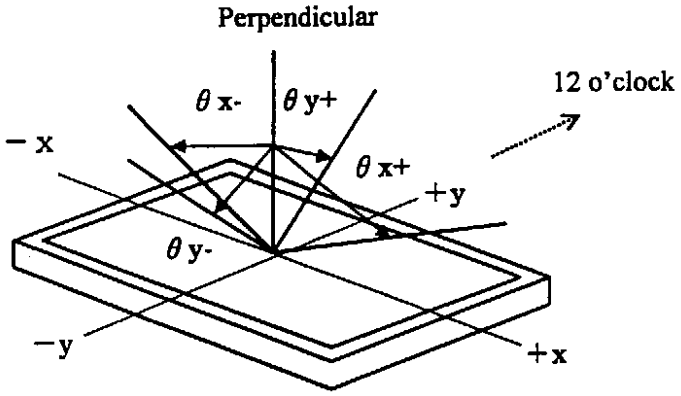
note 3: Luminance uniformity is calculated by using the following formula.

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

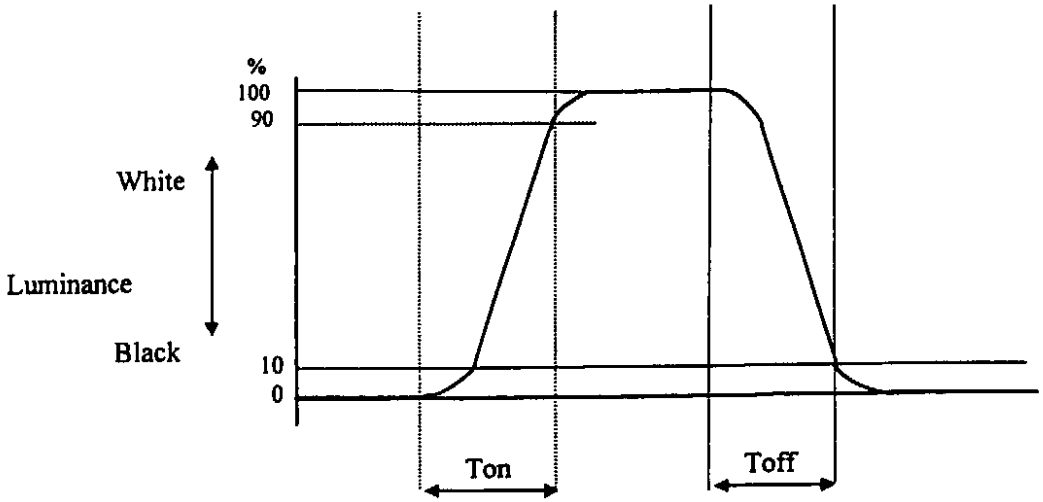
The luminance is measured at near the five points shown below.




note 4: Definitions of viewing angle are as follows.




note 5: Definitions of response time is as follows.
Photo-detector output signal is measured when the luminance changes "black" to "white" or "white" to "black".



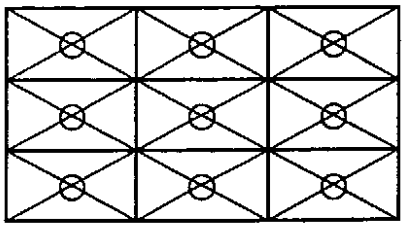
## 9. RELIABILITY TEST

| Test items | Test condition | Judgment |
|---|---|---|
| High temperature/humidity operation | 60±2℃, RH=60%<br>240 hours, Display data is white. | *1 |
| Heat cycle (operation) | ① 0℃±3℃···1 hour<br>55℃±3℃···1 hour<br>② 50 cycles , 4 hours/cycle<br>③ Display data is white. | *1 |
| Thermal shock (non-operation) | ① -20℃±3℃···30 minutes<br>60℃±3℃···30 minutes<br>② 100 cycles<br>③ Temperature transition time is within 5 minutes. | *1 |
| Vibration (non-operation) | ① 5-100Hz, 11.76m/s$^2$(1.2G)<br>1 minute/cycle,<br>X,Y,Z direction<br>② 10 times each direction | *1, *2 |
| Mechanical shock (non-operation) | ① 294m/s$^2$(30G), 11ms<br>X,Y,Z direction<br>② 3 times each direction | *1, *2 |
| ESD (operation) | 150pF, 150Ω, ±10kV<br>9 places on a panel *3<br>10 times each place at one-second intervals | *1 |
| Dust (operation) | 15 kinds of dust (JIS-Z 8901)<br>Hourly 15 seconds stir, 8 times repeat | *1 |

*1: Display function is checked by the same condition as LCD module out-going inspection.

*2: Physical damage

*3: Discharge points are shown in the figure.



## 10. EXPECTED LIFE-TIME OF THE BARE LAMP

| | Bare Lamp |
|---|---|
| Condition | Luminance Maximum<br>Room temp. (25±2℃) , Continuous operation |
| Expected value (MTTF) | 45,000 h |
| Criteria | Half value luminance (compared with initial value.) |

Note 1: The life-time is expected value (reference).

Note 2: This expected value is based on the test results with a bare lamp operation.
The MTTF for the module might be different from these values, because of the influence of ambient and clamshell conditions.

Note 3: The life-time becomes short if the module is operated under the low temperature environment.

## 11. GENERAL CAUTIONS

Because next figures and sentences are very important, please understand these contents as follows.

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

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

 **CAUTIONS**

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

(1) Caution when taking out the module

a Pick a pouch only, when taking out the module from the 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 electrostatic 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 or more of these signals is lost, the LCD panel would be damaged.

h The torque for mounting screws should never exceed 0.451 N·m(4.6kgf·cm).

i Don't push or rub the surface of LCD module please.
If you do the scratches or the rubbing marks may be left on the surface of the module.

(3) Cautions for the atmosphere

a Dew drop atmosphere must be avoided.

b Do not store and/or operate the LCD module in high temperature and/or high humidity atmosphere. Storage in an anti-static pouch and under the room temperature atmosphere is recommended.

c This module uses cold cathode fluorescent lamps. Therefore, the life of lamps becomes short if the module is operated in the low temperature environment.

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

(4) Cautions for the module characteristics

a Do not apply the fixed patterns for a long time to the LCD module. It may cause image sticking. Use the screen savers if the display pattern is fixed for a long time.

b This module has the retardation film which may cause the variation of the color hue in the different viewing angles. The ununiformity may appear on the screen under the high temperature operation.

c The light vertical stripe may be observed depending on the display pattern. This is not defects nor malfunctions.

d The noise from the inverter circuit may be observed in the luminance control mode. This is not defects nor malfunctions.

(5) Other cautions

a Do not disassemble and/or reassemble LCD module.

b Do not readjust any variable resistors nor switches etc..

c When returning the module for repair or etc., pack the module properly to avoid any damages. We recommend using the original shipping packages.

d In case that the scan converter is used to convert VGA signal to NTSC, it is recommended using the frame-memory type, not the line-memory.

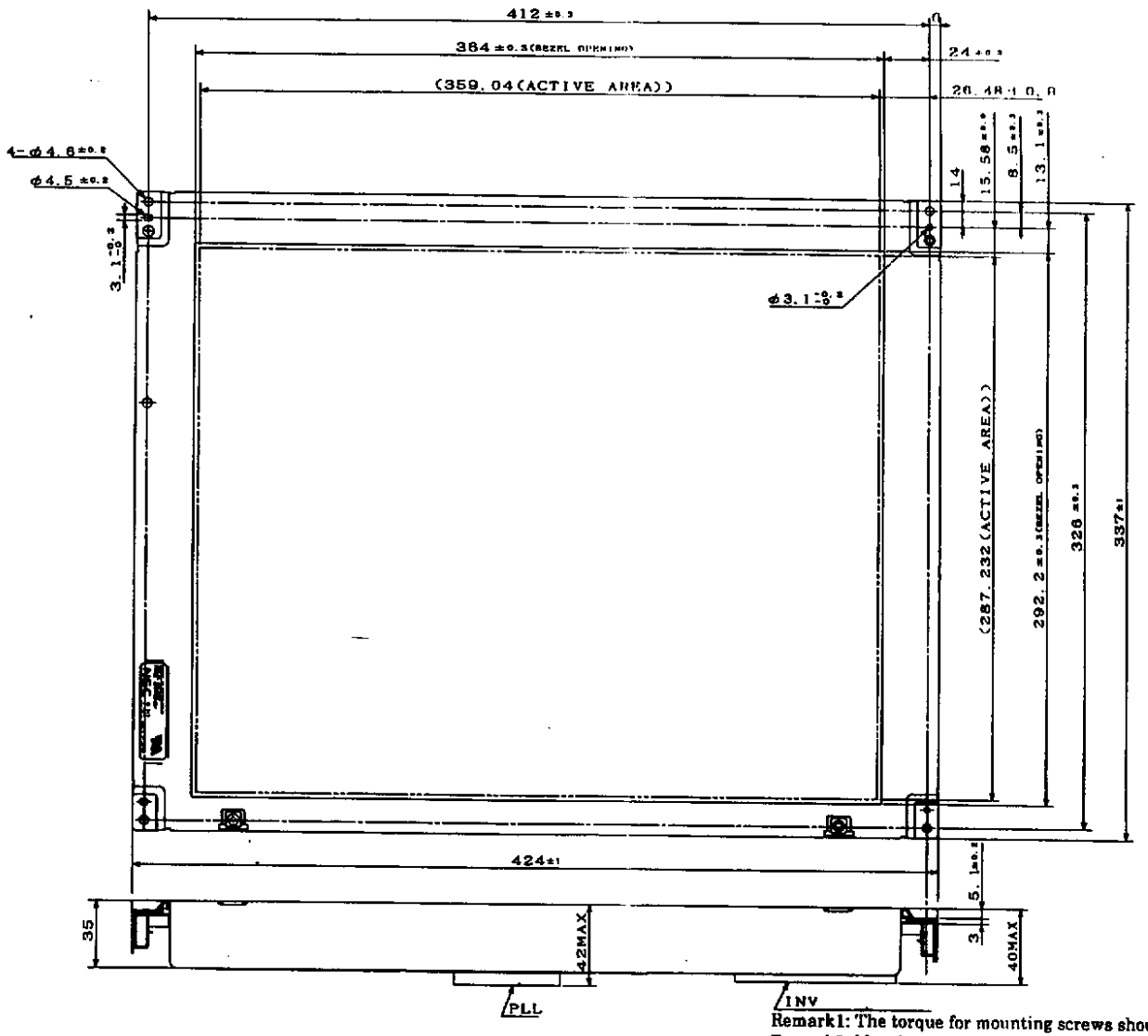
Liquid Crystal Display has the following specific characteristics. These are not defects nor malfunctions.

The ambient temperature may affect the optical characteristics of the module.
This module has cold cathode tube for backlight. Optical characteristics, like luminance or uniformity, will be changed by the progress in time.

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

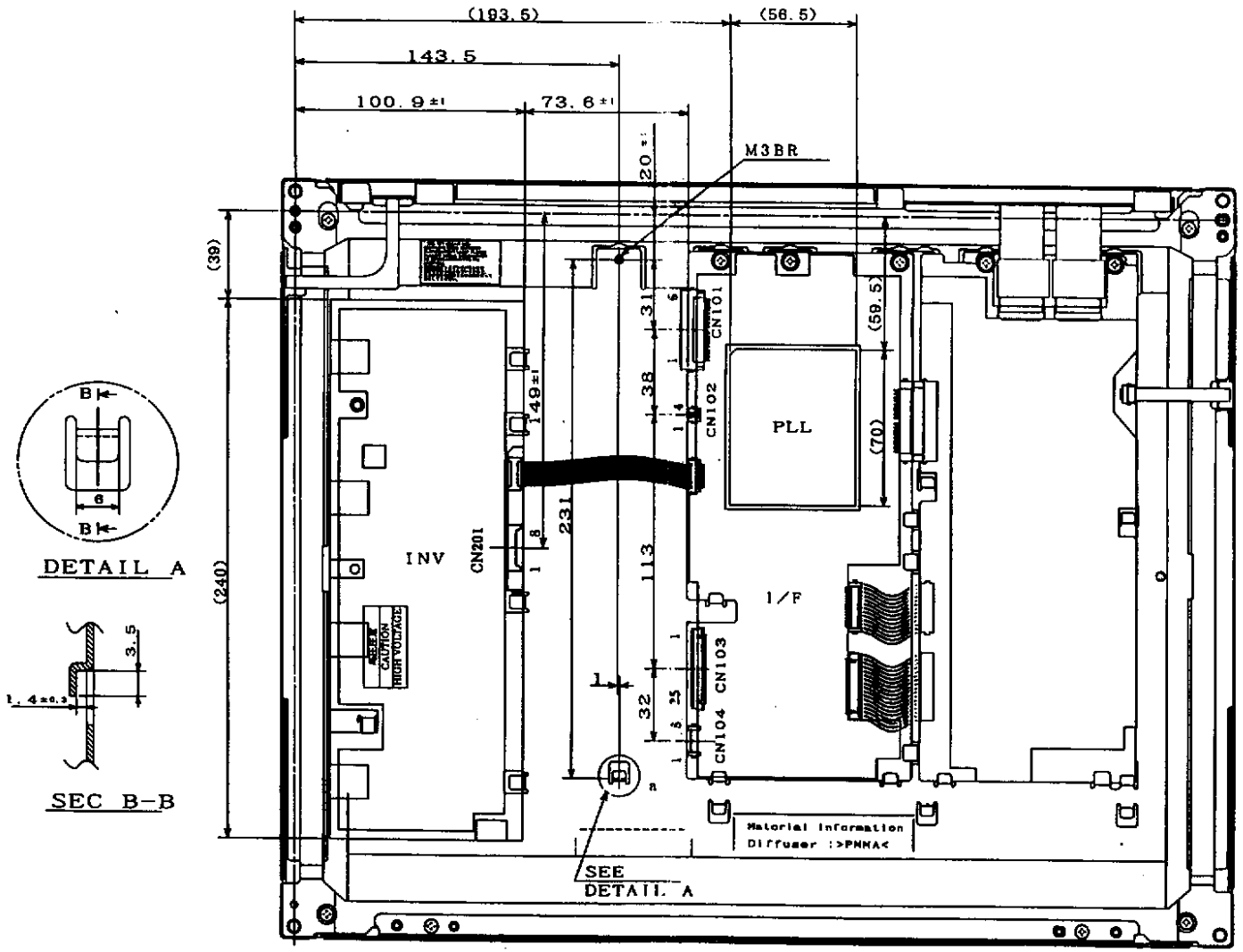
12. OUTLINE DRAWINGS (Unit in mm)

12.1 FRONT VIEW




Remark1: The torque for mounting screws should never exceed 0.451 N·m (4.6kgf·cm).
Remark2: Not shown tolerance of the dimensions are ±0.5 mm.

12.2 REAR VIEW



Revision History

| Rev. | Prepared Date | Revision contents | Approved | Checked | Prepared | Issued date |
|---|---|---|---|---|---|---|
| 1 | July. 8, 1999 | DOD-H-7271 (abstract) | H.Tachimoto | T. Kusanagi | Y. Okuda | - |
| 2 | Oct. 19 1999 | DOD-H-7452<br>P5,34 Response time 40 ms →45 ms (typ.)<br>P7 ·Operating temp 50 → 55℃<br>·Humidity 85% → 66.6%<br>P9 (1) is added.<br>P25 V B.porch is added.<br>P28 INPUT SIGNALS TIMING is deleted.<br>P29 note 1 is deleted.<br>P36 High temperature/humidity operation<br>·50℃, RH=85%→ 60℃, RH=55%<br>·1.2G→11.76m/s$^2$(1.2G),<br>·30G→294m/s$^2$(30G) | H.Tachimoto | T. Kusanagi | Y. Okuda | - |
| 3 | April 11, 2000 | DOD-H-7841<br>P3,33 THE LAMP → THE BARE LAMP<br>P4,5 ·Lamp holder set → Backlight unit<br>·181LHS02 → 181LHS03<br>P5 ·Module size: 40.0 (D) → 41.0 (D)<br>·Weight: 2330 → 2230<br>·Contrast ratio: 150 → 300<br>·Inverter: 181PW021 → 181PW031<br>·Power consumption: 52.8 → 48.2<br>P5,31 Response time: 45 → 40<br>P6,13 Note1:GND=FG → GND≠FG<br>GNDB≠FG<br>P7 ·Weight: 2400 → 2130<br>·Humidity:<br>66.6%(40<Ta≦55)→85%(40<Ta≦50)<br>70%(50<Ta≦55)<br>P8 Supply current<br>·IDDB: (3200) → 2550<br>·IDD : (1200) → 1050<br>·IoL1 and IoH1 are deleted.<br>P9 (6) Fuse is added.<br>P25 *1 is deleted.<br>P28 Pixels are corrected.<br>D(0,1), D(0,2) …→ D(1,0), D(2,0)…<br>D(0,X), D(1,X)…→ D(0,Y), D(1,Y)…<br>P31 ·Contrast ratio: 100, 150 → 200, 300<br>·Chromaticity Coordinates<br>W: (0.305, 0.311) → (0.302,0.312)<br>R: (0.609, 0.339) → (0.618,0.339)<br>G: (0.319, 0.598) → (0.311,0.584)<br>B: (0.146, 0.094) → (0.143,0.095)<br>·Viewing angle (CR>5): Min → Typ<br>·LCD surface tmp. is added.<br>·Note2<br>The timings: 75 → 60Hz<br>Preset timings No.: 20 → 15<br>P31,32 $\theta$ R, L, U, D→ $\theta$ x±, $\theta$ y±<br>P33 ·RH:55→ 60%<br>·Backlight → Bare Lamp<br>·Expected value: 50000h → 45000h<br>·Notes are added. | H.Tachimoto | T. Kusanagi | Y. Okuda | |