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DEVICE SPECIFICATION for
 Passive Matrix LCD Unit
 (240x 128 dots)

Model No.
LM24P20

CUSTOMER'S APPROVAL

DATE _____

PRESENTED

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1. Application

This data sheet is to introduce the specification of **LM24P20**,

Passive Matrix **type** LCD Unit.

(240x 128 dot, **TSTN**, **negative type**, with backlight system by cold cathode fluorescent tube (**CCFT**).)

2. Construction and Outline

Construction : 240x 128 full dot graphic display unit

Out line : See **Fig. 8**.

Connection : See Fig. 8, and Table, 5,

There shall be no scratches, stains, chips, distortions and other external drawbacks that may affect the display function,

Rejection criteria shall be noted in Inspection Standard S-U-012-01,

3. Mechanical Specifications

Table 1

| Parameter | Specification | Unit |
|------------------------|---|------|
| Outline dimensions | 176 (W) x 96 (H) x 19MAX (D) Note1 | mm |
| Effective viewing area | 134 (W) x 76 (H) | mm |
| Display format | 240 (W) x 128 (H) full dot | — |
| Dot size | 0.49 (w) x 0.49 (H) | mm |
| Dot spacing | 0.04 | mm |
| Character color | White Note2, 3 | - |
| Background color | Black Note2 | — |
| Weight | Approx. 430 | g |

Note1 : Excluded the mounting tab and connector. (See Fig. 8)

Note2 : Due to the characteristics of the LC Material, the colors vary with environmental temperature.

Note3 : Display data 'High' : White (ON)
 'Low' : Black (OFF)

4. Absolute Maximum Ratings

4-1. Electrical Absolute Maximum Ratings

Table 2

| Parameter | Symbol | Min | MAX | Unit | Remark |
|-----------------------------|-------------------|-----|------|--------|---------|
| Supply voltage (Logic) | $V_{DD} - V_{SS}$ | 0 | 7.0 | v | Ta=25°C |
| Supply voltage (LCD Driver) | $V_{DD} - V_{EE}$ | 0 | 27.0 | v | |
| Input voltage | V_{IN} | 0 | VDD | v | |
| Back Light | V_{CCFT} | 0 | 1000 | Vrms | |
| | I_{CCFT} | 0 | 5.0 | mA rms | |

4-2. Environmental Condition

Table 3

| Item | Tstg | | Topr | | Remark |
|---------------------|--------|-------|--------|-------|----------------------------|
| | MIN. | MAX. | MIN. | MAX. | |
| Ambient temperature | -25°C | +60°C | 0°C | +45°C | |
| Humidity | Note 1 | | Note 1 | | No condensation |
| Vibration | Note 2 | | Note 2 | | 3 directions (X/Y/Z) |
| Shock | Note 3 | | Note 3 | | 6 directions (±X/±Y/±Z) |

Note 1) $T_a \leq 40^\circ\text{C}$95% RH Max
 $T_a > 40^\circ\text{C}$Absolute humidity shall be less than
 $T_a = 40^\circ\text{C} / 95\% \text{ RH}$

Note 2) These test conditions are in accordance with 'IEC 68-2-6'
 Frequency : 10 ~ 55Hz
 Vibration width : 1.5mm
 Interval : 10Hz ~ 55Hz ~ 10Hz
 (1 rein)
 2 hours for each direction of X/Y/Z (6 hours as total)

Note 3) Acceleration : 490m/s^2
 Pulse width : 11ms
 3 times for each direction of ±X/±Y/±Z.

Note 4) Care should be taken so that the LCD Unit may not be
 exposed the temperature ranges out of this specifications,

5. Electrical Specifications

5.1 Electrical characteristics

Table 4

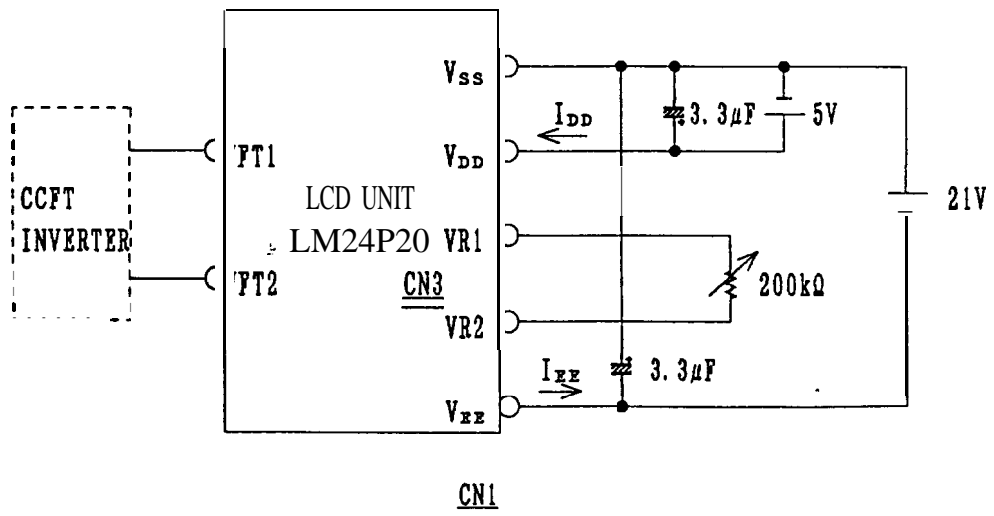
$T_a=25^{\circ}\text{C}, V_{DD}=5\text{V} \pm 5\%$

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|----------------------------|-----------------|--|--------------|-------|--------------|---------------|
| Supply voltage (Logic) | $V_{DD}-V_{SS}$ | | 4.75 | 5.0 | 5.25 | v |
| Supply voltage (LCD drive) | $V_{XX}-V_{SS}$ | $V_{DD}=5\text{V}$ (Note 1) | -22.0 | -21.0 | -20.0 | V |
| Input signal voltage | V_{IN} | *H' level | $V_{DD}-0.8$ | - | V_{DD} | "v |
| | | *L' level | 0 | - | 0.2 V_{DD} | v |
| Input leakage current | I_{IL} | *H' level | | - | 20 | μA |
| | | *L' level | -20.0 | - | - | μA |
| Supply current (Logic) | I_{DD} | $V_{DD}=5\text{V}, V_{XX}=-21\text{V}$ | - | 5 | 8 | mA |
| Supply current (LCD) | I_{XX} | $V_R=100\text{k}\Omega$ | | 3 | 5 | mA |
| Power consumption (LCD) | P_{dLCD} | $F=80\text{HZ}$ (Note 2) | | 90 | 145 | mW |
| Start voltage (B/L) | V_{FTS} | Inverter | 900 | - | - | V_{rms} |
| Supply voltage (B/L) | V_{FTL} | LM000101 | 250 | 290 | 330 | V_{rms} |
| Supply current (B/L) | I_{FT} | Input voltage 24V | 4.3 | 4.4 | 4.5 | mA $_{rms}$ |
| Power consumption (B/L) | P_{dFT} | | | 1.5 | - | W |

Note 1) The viewing angle (θ) where obtains the maximum contrast can be set by adjusting variable resistor between VR1 and VR2.

Refer to Fig. 4 for the definition of θ .

Note 2) Display high frequency pattern.



The voltage applied to LCD unit is increased by the increase of 'Vref' value.

5-2. Interface signals

CN1

Table 5

| Pin No. | Symbols | Description | Level |
|---------|---------|--------------------------------------|-----------------|
| 1 | s | Scan start-up signal | “ H ” |
| 2 | CP1 | Input data latch signal | H→L |
| 3 | CP2 | Data input clock signal | H→L |
| 4 | NC | — | |
| 5 | NC | — | - |
| 6 | VDD | Power supply for logic and LCD (+5v) | - |
| 7 | VSS | Ground potential (0v) | — |
| 8 | VEE | Power supply for LCD (-21v) | |
| 9 | D1 | Display data signal | H (ON), L (OFF) |
| 10 | D2 | | |
| 11 | D3 | | |
| 12 | D4 | | |

CN2

| Pin No,*1 | Symbols | Description |
|-----------|---------|--------------------------------------|
| 1 | GND | Power supply for CCFT back light ● 3 |
| 2 | NC | — |
| 3 | Vout | Power supply for CCFT back light *3 |

CN3

| Pin No. | Symbols | Description |
|---------|---------|-----------------------|
| 1 | VR1 | LCD Contrast Adjust • |
| 2 | VR2 | LCD Contrast Adjust • |

*1 : Pin No. and its location are shown in Fig. 8.

*2 : ● NC' terminals should not be connected with any signals,

*3 : Recommending CCFT Inverter

CX1301-1 (COPAL)

LM000101 (SHARP)

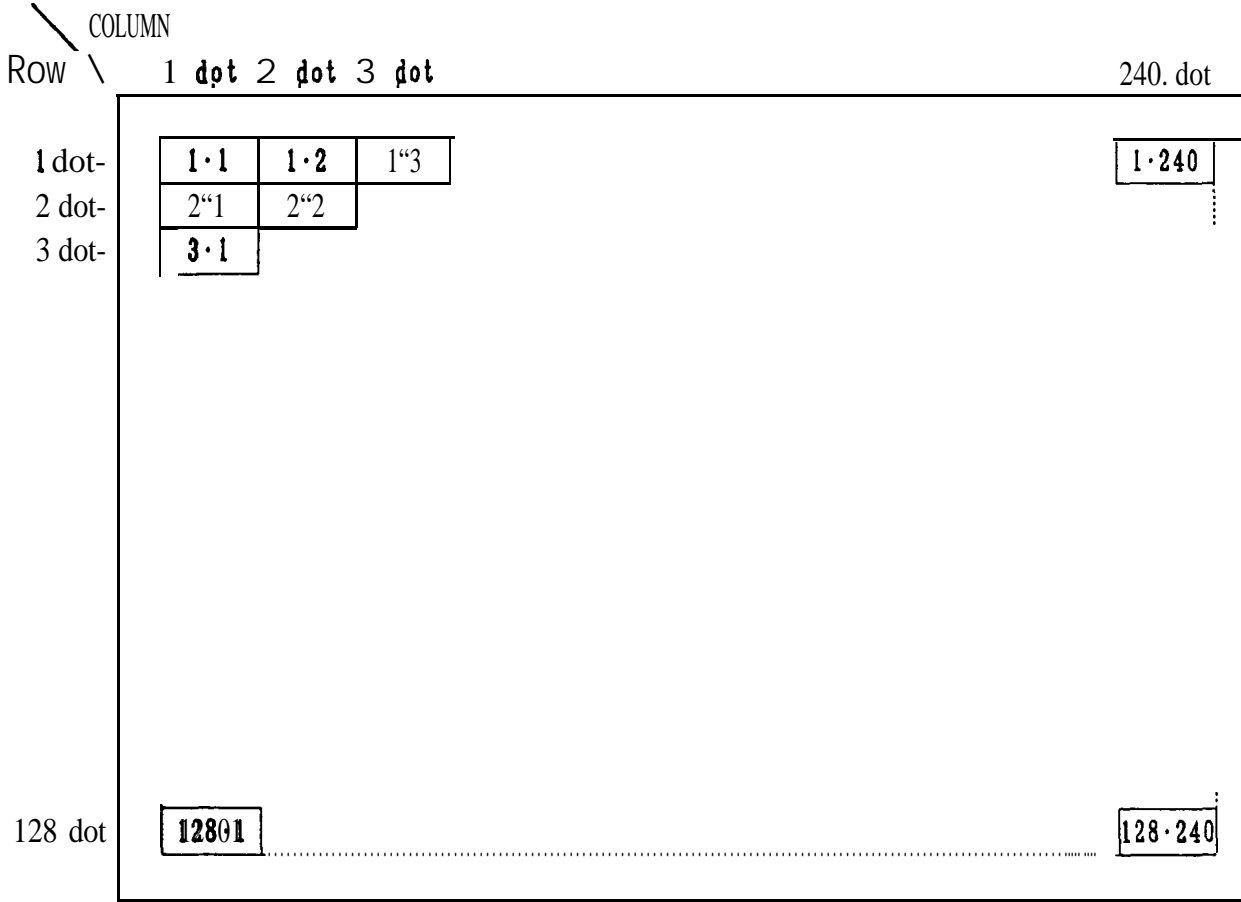
●4 : Recommending resistance: 200kΩ

*5 : Used connector

CN1 : 5046 -12 A (12Pins molex)

CN2 : 5046-03A (3Pins molex)

CN3 : 5046 -02A (2Pins molex)



Note) 1.2 means 1st row 2nd column dot.

Fig.1 Dot Chart of Display Area

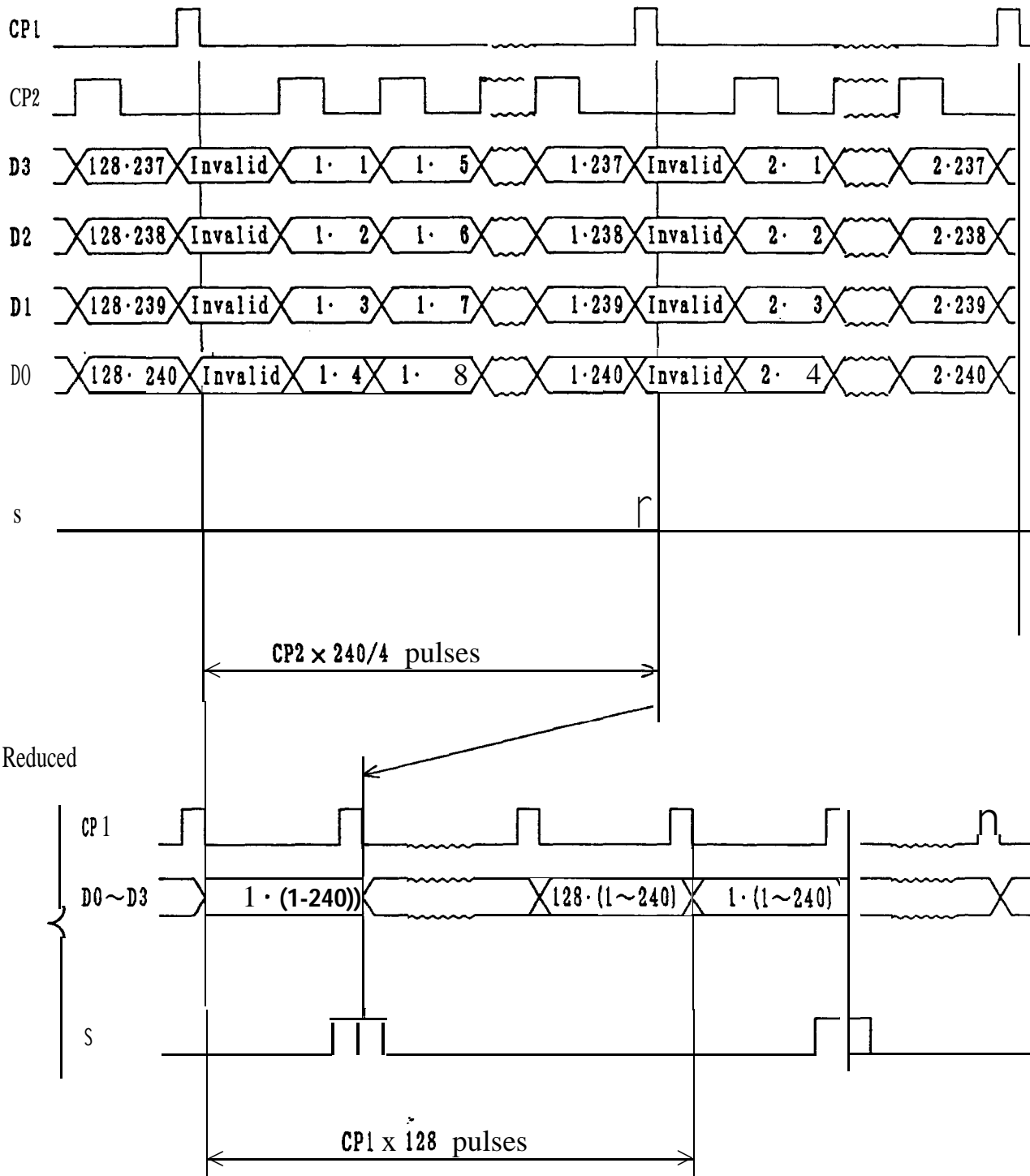


Fig. 2 Data Input Timing

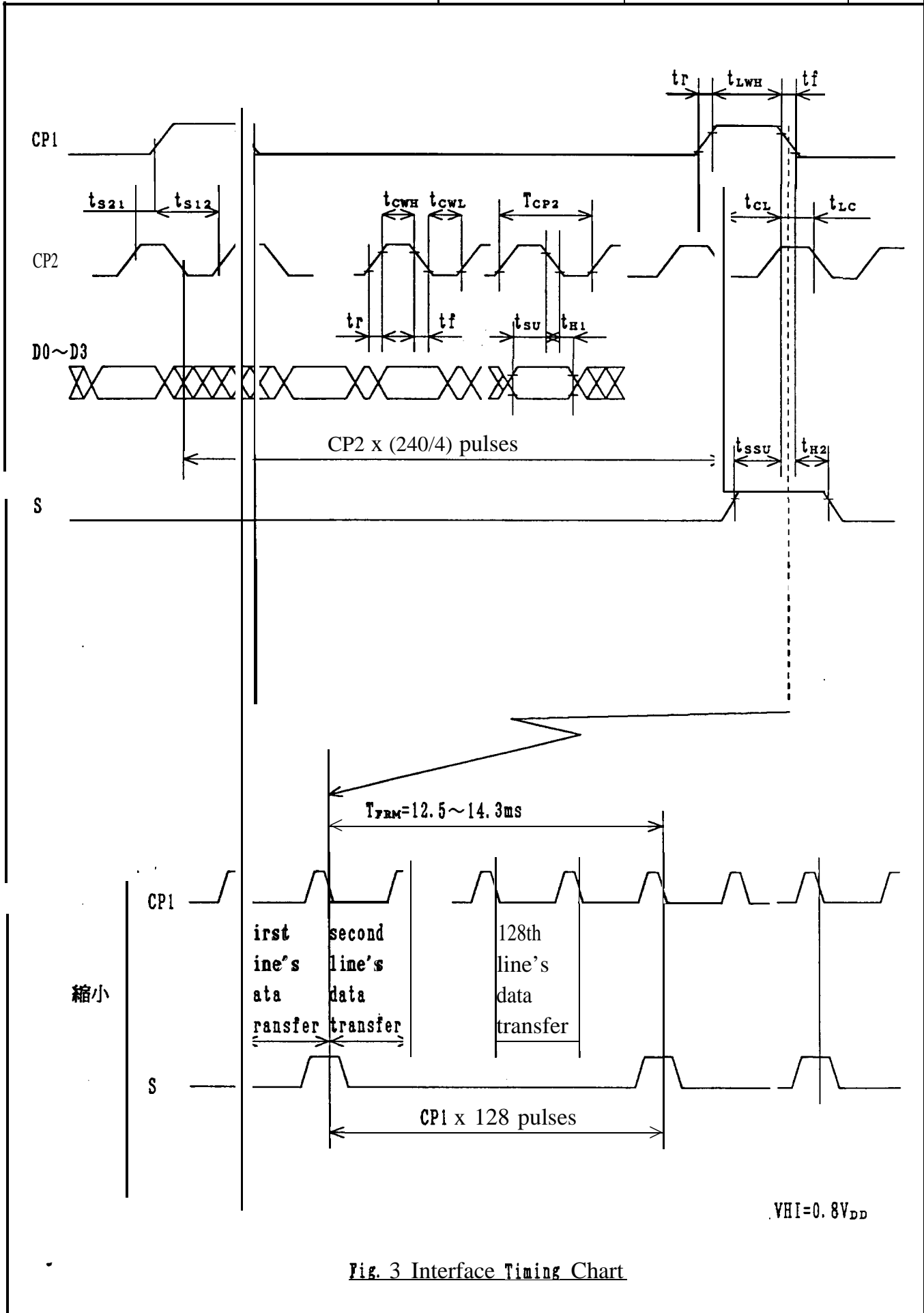


Fig. 3 Interface Timing Chart

Table. 6 Interface timing ratings

| Item | Symbol | Rating | | | Unit |
|---|------------|--------|------|------|------|
| | | MIN. | TYP. | MAX. | |
| Frame cycle | T_{FRM} | 12.5 | | 14.3 | ms |
| CP2 clock cycle | T_{CP2} | 200 | | - | ns |
| 'H' level clock width | t_{CWH} | 100 | | | ns |
| 'L' level clock width | t_{CWL} | 100 | | | ns |
| 'H' level latch clock width | t_{LWH} | 100 | | | ns |
| Data set up time | t_{SU} | 80 | | | ns |
| Data hold time | t_{H1} | 60 | | - | ns |
| CP1 \uparrow clock allowance time from CP2 \uparrow | t_{S21} | 0 | | | ns |
| CP2 \uparrow clock allowance time from CP1 \uparrow | t_{S12} | 70 | | | ns |
| CP1 \downarrow clock allowance time from CP2 \downarrow | t_{CL} | 70 | | | ns |
| CP2 \downarrow clock allowance time from CP1 \downarrow | t_{LC} | 70 | | | ns |
| Clock rise/fall time | t_r, t_f | - | | 50 | ns |
| S Signal Data set up time | t_{SSU} | 125 | | | ns |
| S Signal Data hold time | t_{SH2} | 160 | | | ns |

6. Unit Driving Method

6-1. Circuit Configuration

Fig. 7 shows the block diagram of the Unit's circuitry.

6-2. Display Face Configuration

The display face electrically consists of signal display segment of 240 x 128 dots.

6-3. Input Data and Control Signal

The LCD driver is 80 bits LSI, consisting of shift registers, latch circuits and LCD drivers,

Display data which are externally divided into data for each row (240 dots) will be sequentially transferred in the form of 4-bit parallel data through shift registers by Clock Signal CP2 from the left top of the display face,

When data of one row (240 dots) have been inputted, then latched in the form of parallel data for 240 lines of signal electrodes by Latch Signal CP1. Then the corresponding drive signal will be transmitted to the 240 lines of column electrodes of the LCD panel by the LCD drive circuits.

At this time, scan start-up signal S has been transferred from the scan signal driver to the 1st row of scan electrodes, and the contents of the data signals are displayed on the 1st rows of the display face according to the combinations of voltages applied to the scan and signal electrodes of the LCD.

While the 1st rows of data are being displayed, the 2nd rows of data are entered, when 240 dots of data have been transferred then latched on the falling edge of CP1 clock, the display face proceeds to the 2nd rows of display,

Such data input will be repeated up to the 128th row of each display segment, from upper to lower rows, to complete one frame of display by time sharing ● method, Then data input proceeds to the next display face,

Scan start-up Signal S generates scan signal to drive horizontal electrodes,

The unit shall be driven at the speed of 70~80Hz/frame to avoid flickering,

Since DC voltage, if applied to LCD panel, causes chemical reaction which will deteriorate LCD panel, drive waveform shall be inverted to prevent the generation of such DC voltage. And to prevent such problem, AC waveform circuit" generated by counting **CP1** (Generator) is built in this circuit,

Because of the characteristics of the CMOS driver **LSI**, the power consumption of the unit goes UP as the operating frequency **CP2** increases. Thus the driver **LSI** applies the **system** of transferring 4-bit parallel data through the 4 lines of shift registers to reduce the data transfer speed **CP2**. Thanks to the **LSI**, the power consumption of the unit will be minimized.

In this circuit configuration, 4-bit display data shall be therefore inputted to data input pins of **D0~D3**.

Furthermore the LCD unit adopts bus line system for data input to minimize the power consumption. In this system data input terminal of each driver **LSI** is activated only when relevant data input is fed,

Data input for **column** electrodes of display segment and chip select of driver **LSI** are made as follows.

. The driver **LSI** at the left end of the **display** face is first selected, and the adjacent driver **LSI** of the right side is selected when 80 dots data (20 **CP2**) is fed. This process is sequentially continued until data is fed to the driver **LSI** at the right end of the display face,

This process is simultaneously followed at the column driver **LSI's** of display segments. Thus data input for display segments must be fed through **4-bit** bus line sequentially from the left end of the display face,

Since this graphic display unit contains no **refresh** RAM, it requires data and timing pulse inputs even for static display,

The timing chart of input signals are shown in Fig, 3,

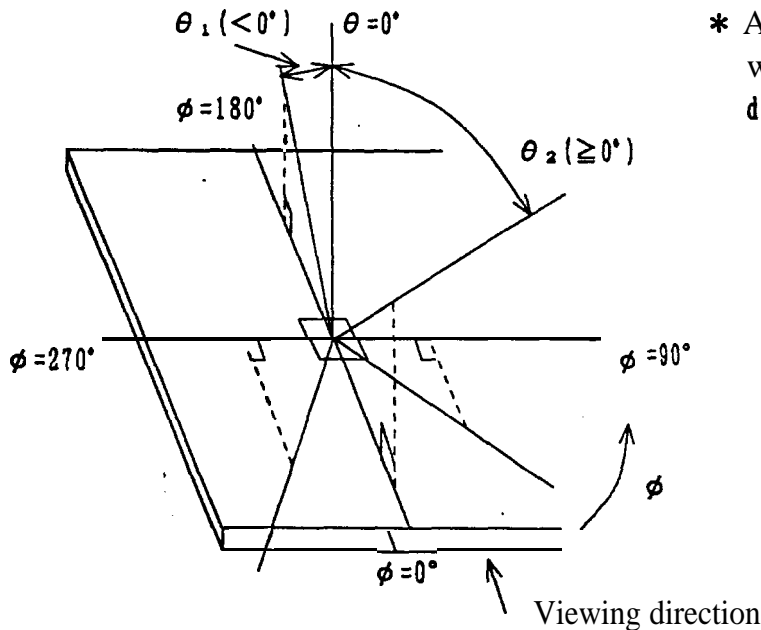
7. Optical Characteristics

(Table 7 shows the optical characteristics when the viewing angle obtaining the maximum contrast (ϕ) is adjusted to 0 degrees,]

Table 7 VDD=5V, Ta=25°C

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit | Remark | | | |
|---------------------|-----------------------|------------------------------------|-------------------|----------------|-----------------------|------|--------|--------|--------|--------|
| Viewing angle range | $\theta_2 - \theta_1$ | $\phi = 0^\circ$ | $C_o \geq 4.0$ | 35 | - | - | dgr. | Note 1 | | |
| | θ_1 | $\theta_1 (\theta_2)$ | $C_o = 4.0$ | - | - | -10 | dgr. | Note 1 | | |
| | θ_2 | | | 20 | - | - | dgr. | Note 1 | | |
| | Viewing angle range | e s - e , | $\phi = 90^\circ$ | $C_o \geq 4.0$ | 45 | - | - | dgr. | Note 1 | |
| | | θ_1 | | | $C_o = 4.0$ | - | - | -20 | dgr. | Note 1 |
| | | θ_2 | | | $\theta_1 (\theta_2)$ | 20 | - | - | dgr. | Note 1 |
| Contrast ratio | C_o | $\theta = 0^\circ, \phi = 0^\circ$ | 15s0 | 20.0 | - | | Note 2 | | | |
| Response speed | τr | $\theta = 0^\circ, \phi = 0^\circ$ | - | 250 | 400 | ms | Note 3 | | | |
| | τd | $\theta = 0^\circ, \phi = 0^\circ$ | - | 150 | 250 | ms | Note 3 | | | |

Note 1) The viewing angle range may be defined as shown below,



* Angles θ_1, θ_2 and ϕ shall fall within the range over which the displayed character each be read.

Fig. 4 Definition of Viewing Angle

Note 2) Contrast ratio maybe defined as follows:

Contrast ratio is calculated by using the following formula when the waveform voltage (Fig. 6) is applied in optical characteristics test method (Fig. 5).

$$\text{Contrast ratio} = \frac{\text{Photo-detector output voltage with select waveform being applied}}{\text{Photo-detector output voltage with non-select waveform being applied}}$$

Note 3) The response characteristics of photo-detector output are measured as shown in **Fig. 6**, assuming that input signals are **applied** so as to select and deselect the dots to be measured, in the optical characteristics test method shown in Fig. 5.

Note 4) Table 7 shown the optical characteristics detected when the LCD applied voltage waveforms are in the highest frequency ● ,

- The most critical condition for the characteristics of LCD.

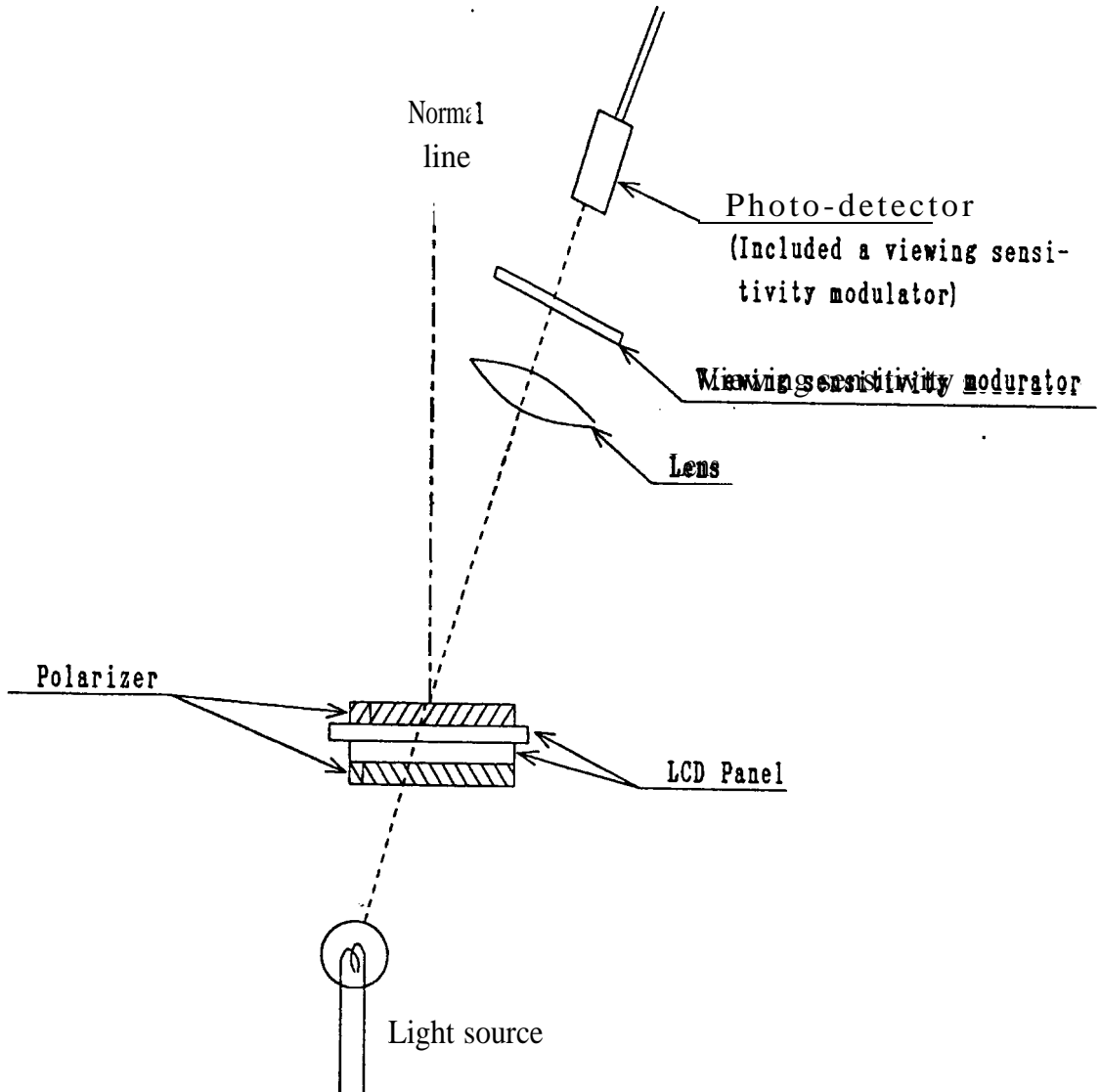
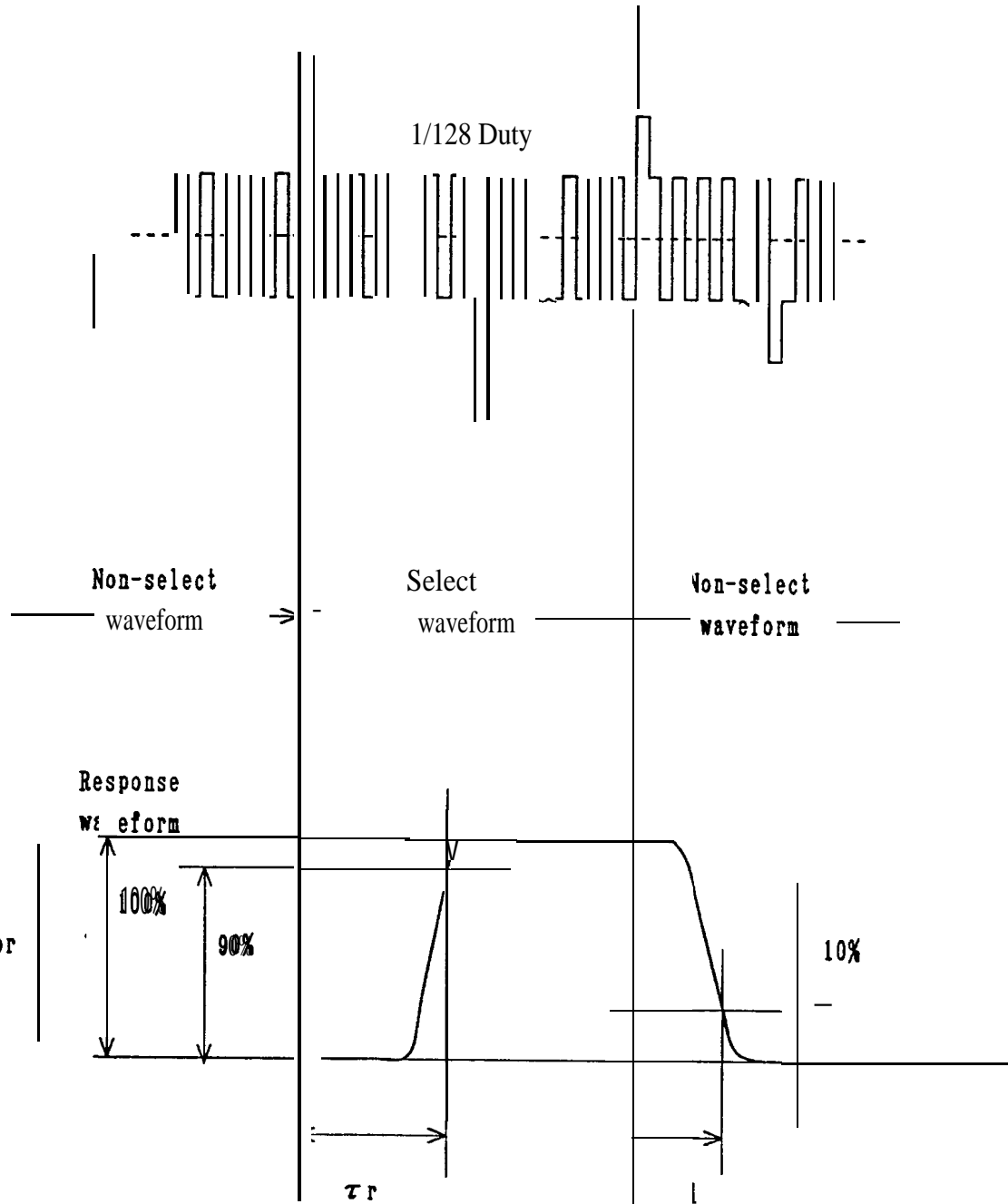


Fig. 5 Optical Characteristics Test Method

[Drive waveform]



τ_r : Rise time
 τ_d : Decay time

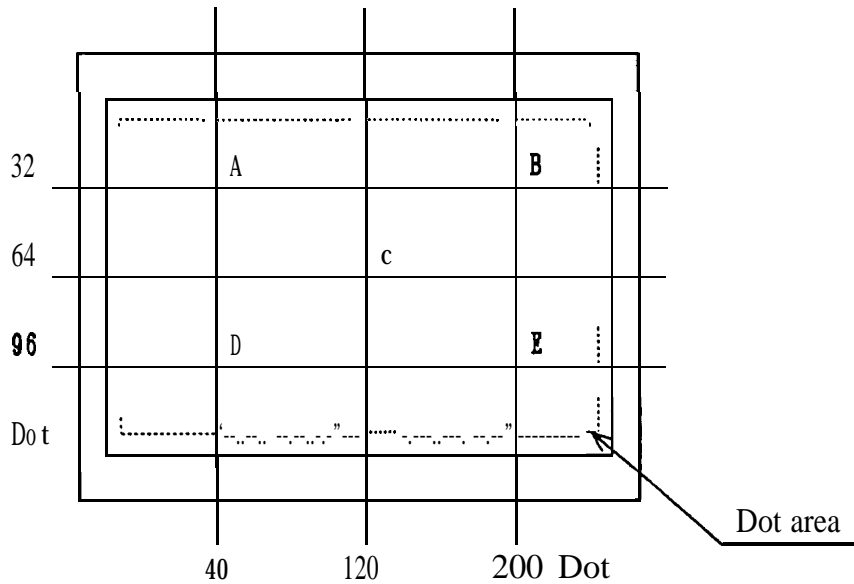
Fig. 6 Definition of Response Time

7-2. Characteristics of Backlightit

(a) Brightness

| Parameter | Min. | Typ. | Max. | Unit |
|------------|------|------|------|-------------------|
| Brightness | 20 | 50 | - | cd/m ² |

Rating are defined as the average brightness at 5 measurement points,



(b) Measurement condition

CCFT inverter : LMOOO101

INPUT voltage : 24.0V

LCD unit Condition : LCD is full dot ON (White]

VEE=-21.0V,

Temperature : Ta=25°C, 30 minutes after turning on.

Measurement equipment : BM-7 (TOPCON Corporation)

(C) Operating life time

The operating life time is 20,000 hours more under the following conditions.

CCFT inverter is

INPUT voltage : 24.0V

Ta=25 ± 5°C

The operating life time is defined as having ended when any of the following conditions occur.

-When the illuminance or quantity of light has decreased to 50% of the initial value.

-When the light of CCFT goes to flicker remarkable.

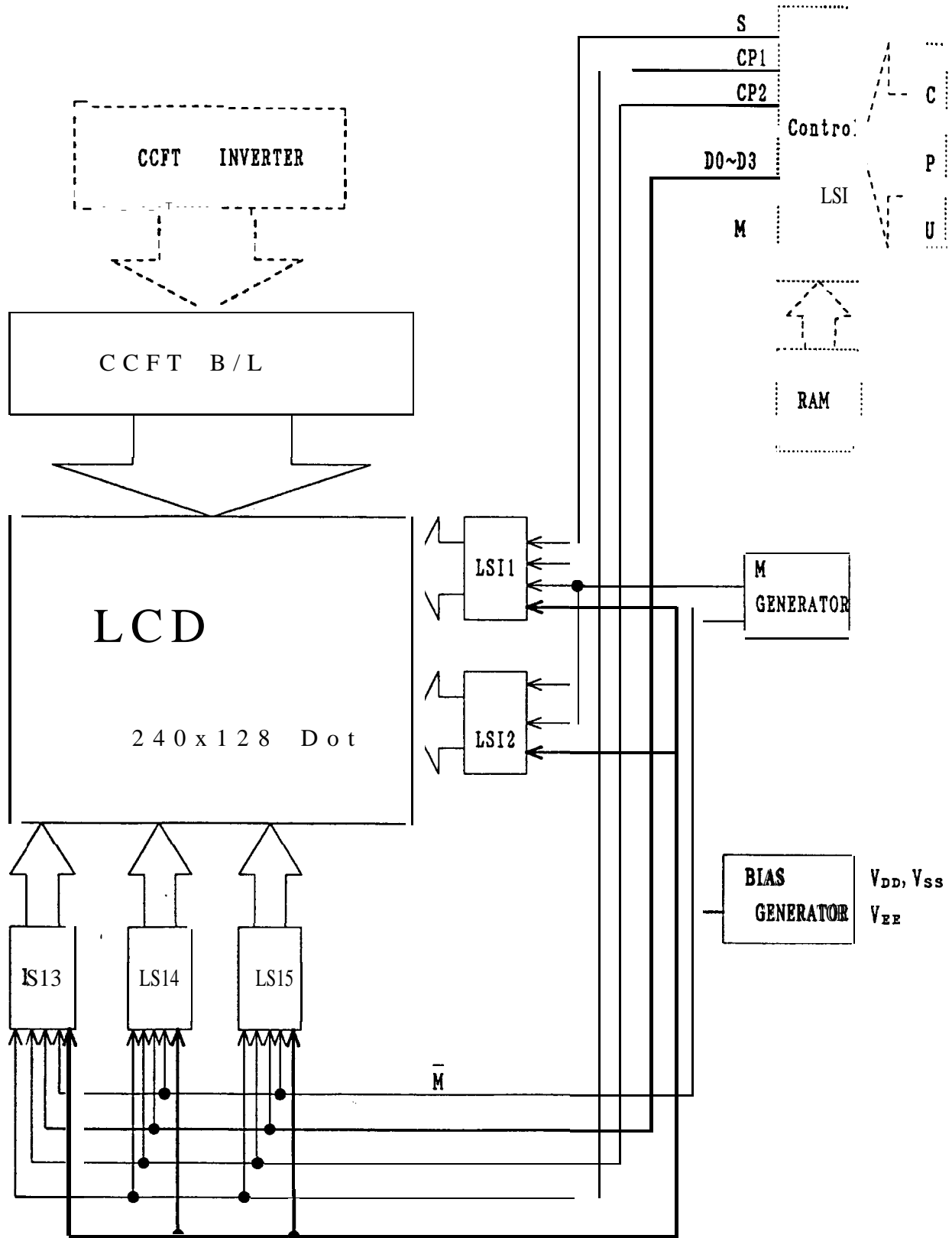


Fig. 7 Circuit Block Diagram

8. Precautions

8-1. Angle when installing the unit

This unit's viewing angle is illustrated in Fig. 9.

$$\theta_1 < \text{viewing range} < \theta_2 (\theta_1 < 0^\circ, \theta_2 \geq 0^\circ)$$

Please consider the optimum viewing conditions according to the purpose when installing the unit,

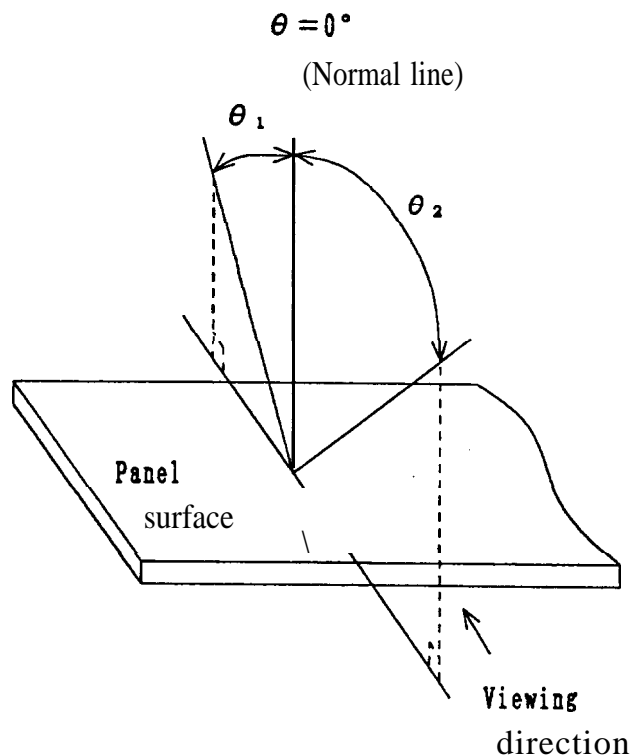


Fig. 9 Dot matrix LCD viewing angle

8-2. Handling cautions

This unit is installed using mounting tabs at the four corners of PCB or bezel,

When installing the unit, pay attention and handle carefully **not** to allow any undue stress such as twist or bend.

A transparent acrylic resin board or other type of protective panel should be attached to the front of the unit to protect the polarizer, LCD cells, etc.

8-3. Notes on attachment

- (1) Since the front polarizer is easily **damaged**, please pay attention not to scratch on its face. And an acrylic sheet, or the like, may be used to protect the LCD panel at mounting LCD unit,
- (2) If the **surface of the LCD cells need to be cleaned**, wipe it swiftly with cotton or other soft cloth. If still not completely clear, blow on it and wipe.
- (3) **Water** droplets, etc. must be wiped off immediately since they may cause color changes, staining, etc. if remained for a long time.
- (4) Since LCD is made of **grass** plates, dropping the unit or banging it against hard objects may cause cracking or fragmentation,
- (5) CMOS **LSIs** are equipped in this unit, so care must be taken to avoid the **electro** static charge, by earthing human body, etc. Take the following measures, to protect the unit from the electric discharge via mounting tabs from the main system electrifies with static electricity.
 - (1) Earth the metallic case of the main system (contact of the unit and main system),
 - (2) Insulate **the unit** and main system by attaching insulating washers made of **backlite** or nylon, etc.

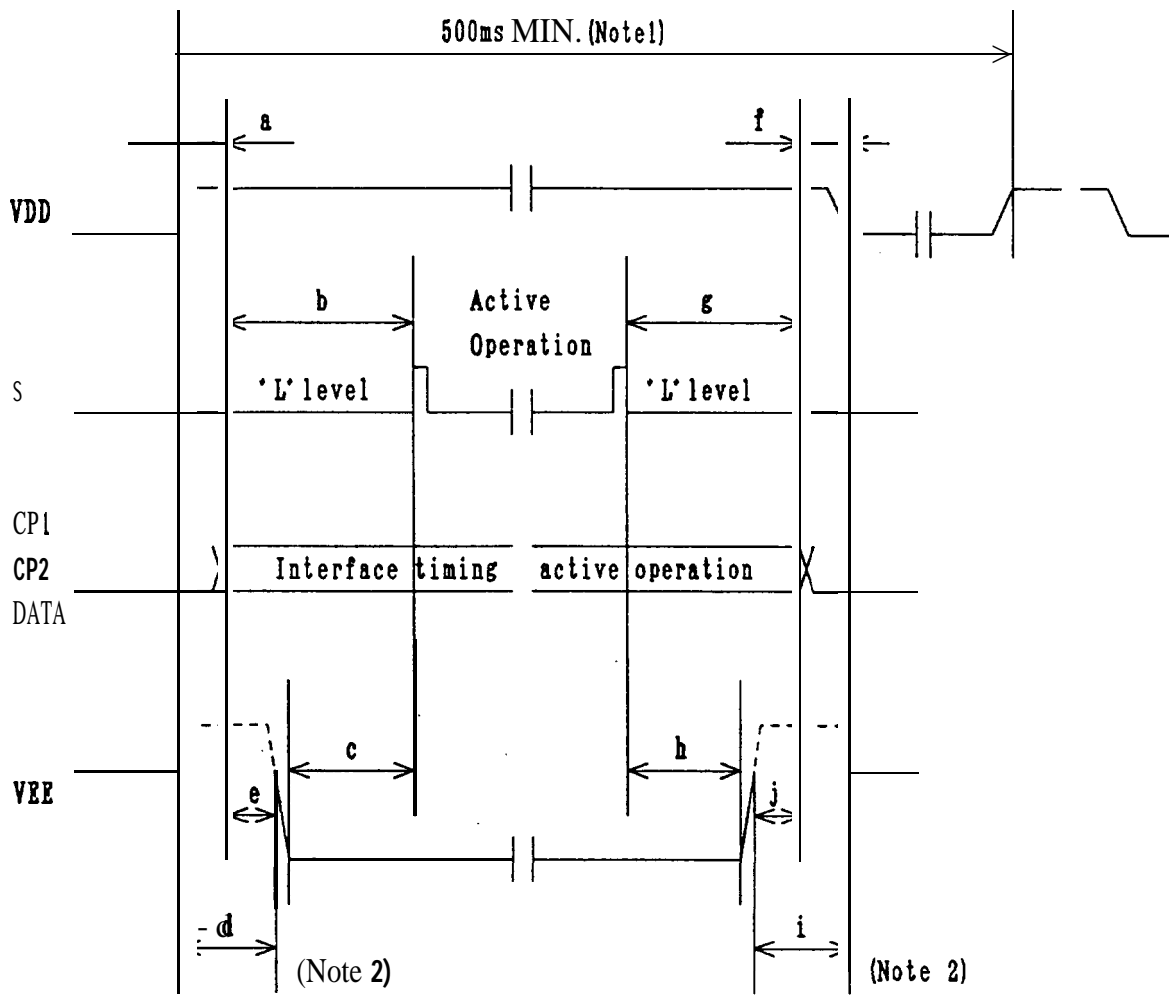
8-4. Notes on operation

- (1) The unit should be driven according to the specified ratings to avoid malfunction of permanent damage. DC voltage drive leads to rapid deterioration of LC, so ensure that the drive is alternating waveform by continuous application of the signal M. Especially the power **ON/OFF** sequence shown on next page shall be followed to avoid latch-up of driver **LSIs** and application of DC voltage to LCD panel,

8-5, Others

- (1) Avoid to expose the unit to the direct sun-light, strong ultra-violet light, etc. for a long time,
- (2) If stored at temperatures below specified **strage** temperature, the **LC** may freeze and be deteriorated, If **strage** temperature exceed the specified rating, the molecular orientation of the **LC** may change to that of a liquid, and they may not **revert** to their original state, As far as possible always store at normal room temperature,
- (3) If the LCD panel is removed from the LCD unit, it may cause the poor contact. So please avoid to dismantle the unit,
- (4) **Do'nt** use any materials which emit following gas from epoxy resin (**amines** hardener) and silicon adhesive agent (deal **cohol** or **deoxym**) to prevent change polarizer color owing to gas,

Power ON/OFF sequence



1) POWER ON

| Symbol | Rating | | | Unit |
|--------|--------|-------|------|------|
| | MIN. | TYP. | MAX. | |
| a | 0 | - | 20 | ms |
| b | 20 | - | - | ms |
| c | 0 | - | - | ms |
| d | | Note2 | | ms |
| e | 0 | - | 100 | ms |

2) POWER OFF

| Symbol | Rating | | | Unit |
|--------|--------|-------|------|------|
| | MIN. | TYP. | MAX. | |
| f | 0 | - | 20 | ms |
| g | 20 | " | - | ms |
| h | 0 | - | - | ms |
| i | | Note2 | | ms |
| j | 100 | - | - | ms |

(Note 1) Power ON/OFF cycle time. All signals and power line shall be in accordance with above sequence in case of power ON/OFF.

(Note 2) VEE to be set at 'VDD level' or 'open'. VEE should be in accordance with the dotted line.