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SPECIFICATION FOR
 Passive Matrix LCD Module

Model No.
LM20 X212

CUSTOMER'S APPROVAL

DATE _____

BY _____

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1. Overview

The **LM20X212**, dot-matrix LCD module consists of a 5 × 7-dot 20-character 2-line dot-matrix LCD panel, LCD driver, controller LSI and yellow green backlight LED fabricated on a single PCB. Incorporating mask ROM-based character generator and display data RAM in the controller LSI, the module can efficiently display the desired characters under microprocessor control. LCD is positive type.

(Features)

- (1) The LCD of the module is STHC(Super Twisted High Contrast) yellow green transmissive type.
- (2) Low power **consumption** with the dot-matrix LCD panel and CMOS LSI. Built-in backlight LED with high luminance and stable radiation.
- (3) Thin, lightweight design permits easy installation in a variety of equipment.
- (4) Allowing for being connected at general-purpose CMOS signal level, the module can be easily interfaced to a microprocessor with common 4-bit and 8-bit parallel inputs and outputs.
- (5) Built-in character generator ROM and RAM, and display data RAM:

Character generator ROM

160 different 5 X 7 dot-matrix character patterns
(Alphanumeric and symbols)

Character generator RAM

-8 different user **programmed** 5 X 7 dot-matrix patterns

Display data RAM

80 X 8 bits

- (6) Numerous instructions
Display clear, Cursor home, Display ON/OFF, Cursor ON/OFF,
Blink character, Cursor shift, Display shift
- (7) Built-in reset circuit is triggered at power ON.
(For the operating conditions, refer to the separate user's manual "Dot-Matrix LCD modules with built-in controllers".)
- (8) The module operates from a single 5v power supply.

* As to the packing, refer to the separate
"COMMON PACKING SPECIFICATION FOR LM202A02 series".

2. Construction and Outline

Construction : 5 X 7 dots + cursor, 20-character 2-line
dot-matrix display module (Built-in Yellow-green
backlight LED, positive type)

Outline : See Fig.7.

Interface signals : See Table 5.

Character pattern details : See **Fig.7**.

Character codes : See Table 9.

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 | 115(w) x 36(H) x 16 MAX(D) | mm |
| Effective display area | 83(W) X 18.6(H) | mm |
| Display format | 20 characters X 2 lines | |
| Character format | 5 X 7 dots with cursor | - |
| Character size | 3.2(w) X 4.85(H) (5 X 7 dots) | mm |
| Dot size | 0.6(w) X 0.65(H) | mm |
| Dot spacing | 0.05 | mm |
| Character color * | Dark blue | - |
| Backlight color | Yellow green | |
| Weight • | Approx. 50 | g |

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

4. Electrical Specifications

4.1 Absolute maximum ratings

Table 2

| Parameter | Symbo 1 | Min. | Max . | Unit | Remark |
|--|-----------|------|-------------|------|---------|
| Supply voltage (Logic) | VDD-VSS | -0.3 | +6.5 | v | |
| Supply voltage (LCD drive) | Vo-vss | 0 | +6.5 | v | VDD>V0 |
| Supply current (Backlight LED) | ILED | | 260 | mA | Ta=25°C |
| Input voltage | VIN | -0.3 | VDD+0.3 | v | |
| Storage temperature | Tstg | -25 | +70 | "C | |
| Operating temperature | Topr | 0 | +50 | "C | |
| Reverse voltage (Backlight LED) | VLED-VLSS | -5 | | v | |

4.2 Electrical characteristics

Table 3

(Ta=25°C)

| Parameter | Symbo 1 | Min. | Typ. | Max. | Unit | Condition |
|--|-----------|------|-------|--------|------|-------------------------------|
| Supply voltage (Logic) | VDD VSS | 4.75 | 5 | 5.25 | v | |
| Supply voltage (LCD drive) | Vo -Vss | - | 0.65* | - | v | VDD=5V |
| Input voltage | "L" | VIL | -0.3 | 0.6 | v | |
| | "H" | VIH | 2.2 | VDD | v | |
| output vo l t age | "L" | VOL | | 0.4 | v | IOL=1.2mA |
| | "H" | VOH | 2.4 | - | v | -IOH=0.205mA |
| Input leakage current | IIL | | | 1 | uA | |
| Internal oscillating frequency | fosc | - | 250 | - | KHz | |
| Supply current | IDD | | 1.8 | 2.5 | mA | VDD=5v, V0=0V |
| | ILED | | 220 | 260 | mA | VLED-VLSS=5V |
| Power dissipation | Pd | | 1109 | 1312.5 | mW | VDD=5V, V0=0V VLED-VLSS=5V |
| Supply voltage (Backlight LED) | VLED-VLSS | 4.75 | 5 | 5.25 | v | |

* Note. After over a hour since backlight begin lighting.

4.3 Timing characteristics

Table 4

VDD=5.0V±5%
Ta=0~50°C

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|-----------------------|--------------|------|------|------|-----------|
| Enable cycle time | tcycE | 1000 | | | ns |
| Enable pulse width | PWEH | 450 | | | ns |
| Enable rise/fall time | tEr, tEf | | | 25 | ns |
| RS,R/W setup time | tAS | 140 | | | ns |
| Address hold time | tAH | 10 | | | ns |
| Data setup time | tDSW | 195 | | | ns |
| Data delay time | tDDR | | | 320 | ns |
| Data hold time(write) | tH | 10 | | | ns |
| Data hold time(read) | tDHR | 20 | — | | ns |

Timing chart: See Fig.1.

4.4 Interface signals

Table 5

| Pin No. | Symbol | Description | Connection |
|---------|--------|--|--|
| I 1 I | VSS | Ground potential | GND:0V |
| 2 | VDD | Power supply | + 5V |
| 3 | Vo | Contrast adjustment voltage | Adjust the contrast by changing the Supply voltage from 0V to 5V. |
| 4 | RS | Register select signal | Control signal inputs (For details, see section 6 and 7.) |
| 5 | R/W | Read/write select signal | |
| 6 | E | Operation(data read/write enable signal) | |
| 7 | DB0 | Code 1/0 data LSB | Data bus line :DB7 may also be used to check the busy flag. :Lines DB0~DB3 are not used when interfacing with a 4-bit microprocessor. (For details, see section 6 and 7.) |
| 8 | DB1 | Code 1/0 data 2nd bit | |
| 9 | DB2 | Code 1/0 data 3rd bit | |
| 10 | DB3 | Code I/O data 4th bit | |
| 11 | DB4 | Code I/O data 5th bit | |
| 12 | DB5 | Code 1/0 data 6th bit | |
| 13 | I DB6 | Code 1/0 data 7th bit | |
| 14 | DB7 | Code 1/0 data MSB | |
| 15 | VLED | Power supply (+) | 5V power supply between VLED and VLSS. |
| 16 | VLSS | Power supply (-) | |

5. Optical Characteristics

5.1 When backlight LED is OFF state

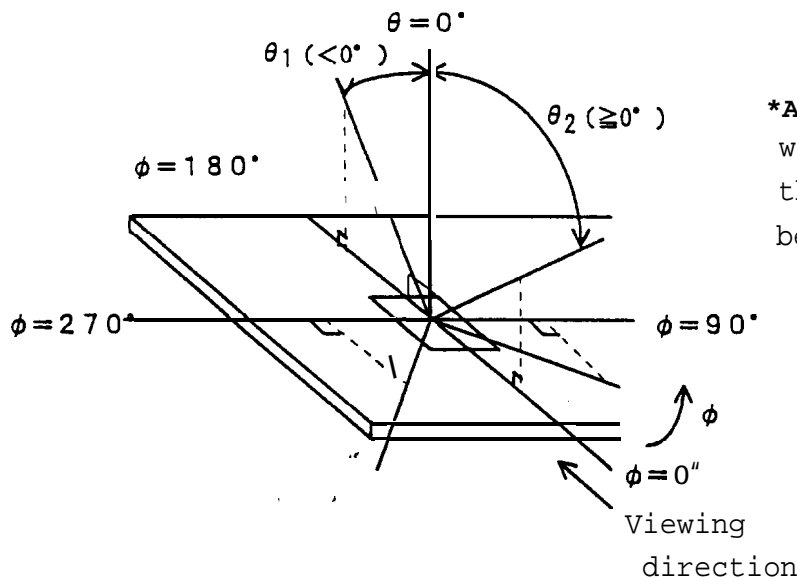
Table 6 shows the optical characteristics when LCD drive voltage is adjusted to the maximum contrast in $\theta=0^\circ$.

Table 6

(Ta=25°C)

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit | Remark | | |
|---------------------|-----------------------|---|---|---------------|------|------|--------|--------|--------|
| Viewing angle range | $\theta_2 - \theta_1$ | $\phi=0^\circ$ $\theta_1 < \theta_2$ | $Co \geq 2.0$ | 60 | - | - | dgr. | Note 1 | |
| | θ_1 | | $Co=2.0$ | - | - | -25 | dgr. | Note 1 | |
| | θ_2 | | | 25 | - | - | | | |
| | | $\theta_2 - \theta_1$ | $\phi=45^\circ$ 315° $\theta_1 < \theta_2$ | $Co \geq 2.0$ | 60 | - | - | dgr. | Note 1 |
| | | e_1 | | $Co=2.0$ | - | - | -25 | dgr. | Note 1 |
| | | θ_2 | | | 25 | - | - | | |
| Contrast ratio | Co | $\theta=0^\circ, \phi=0^\circ$ | 5 | 8 | - | - | Note 2 | | |
| Response time | Rise | tr | | 150 | 250 | ms | Note 3 | | |
| | Decay | td | | 150 | 250 | ms | Note 3 | | |

Note 1) The viewing angle range is defined as shown below.



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

Fig 2 Definition of viewing angle

Note 2) Contrast ratio is defined as follows:

When input signal is applied to the module to select (turn on) the LCD dots (pixels) to be measured in the optical characteristics test method as defined in Fig.3.

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

Note 3 When input signal for selecting or non-selecting the dots to be measured are applied using the optical characteristics test method shown in Fig.3. The response characteristics of the photo-detector output are measured as shown in Fig.4.

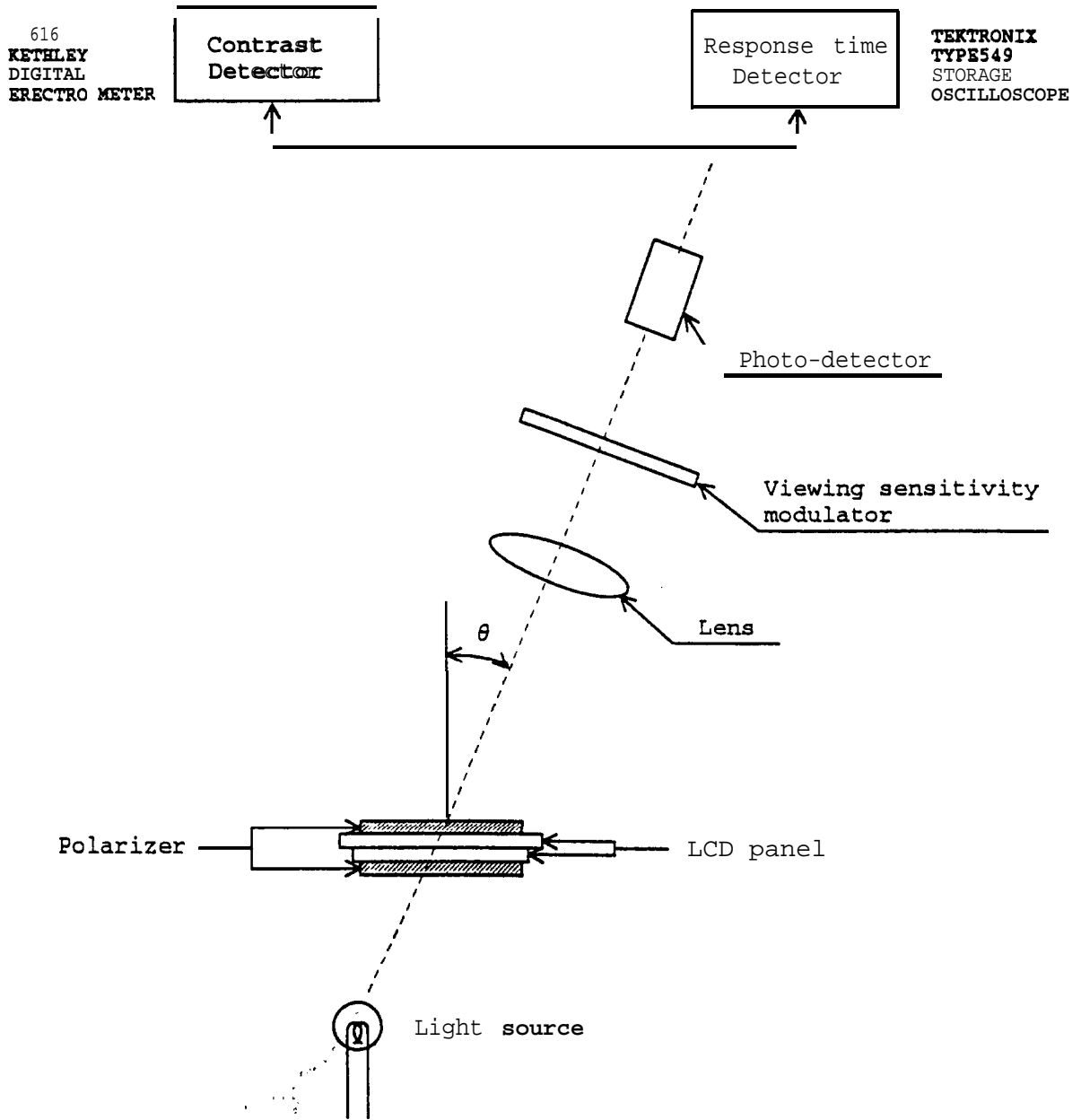


Fig.3 optical Characteristics Test Method

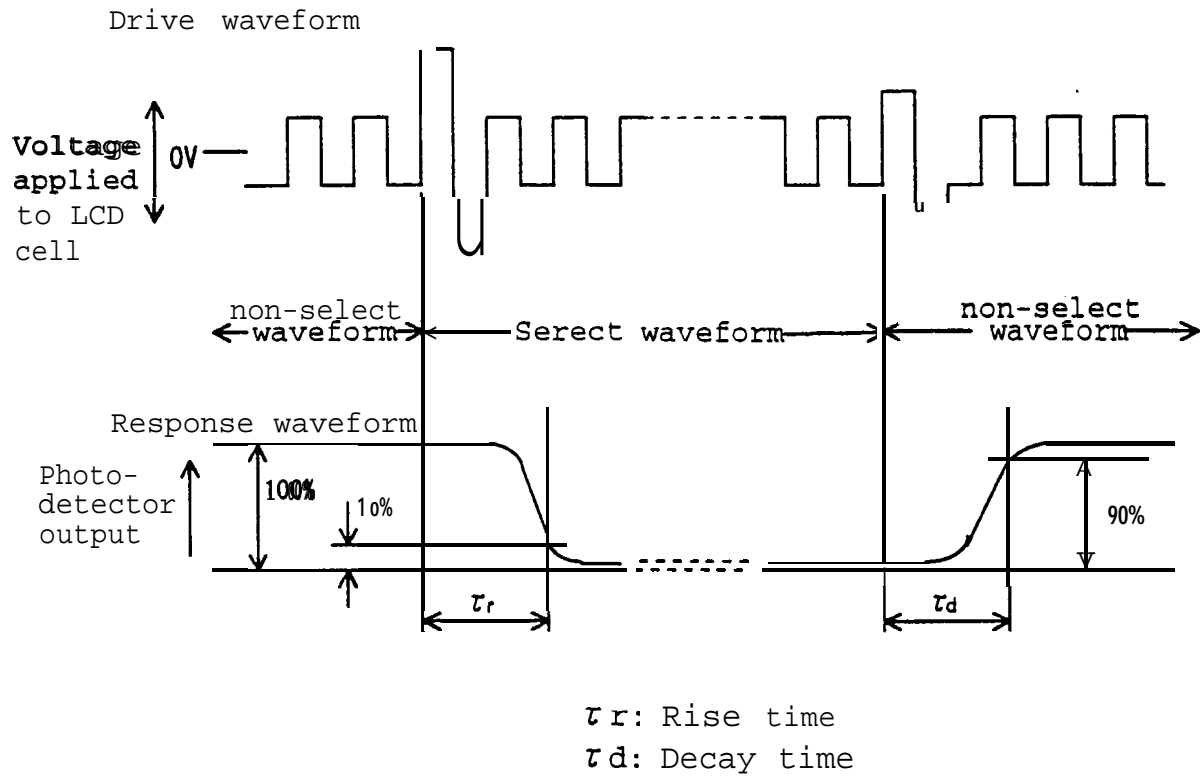


Fig.4 Definition of Response Time

5.2 Characteristics of Backlight LED (When LCD is OFF state)

Table 7

Ta=25°C

VLED-VLSS=5V

| Parameter | Min. | Typ. | Max. | Unit | remark |
|------------------------------|------|------|------|-------------------|--------|
| Luminance * | 9 | 25 | - | cd/m ² | |
| Peak emission wavelength | | 565 | - | nm | |
| Spectrum radiation bandwidth | | 30 | - | nm | |

* Note. Center of the module with LED backlight lit.

6. Pin Description

1) VDD and VSS Pins

VDD and VSS pins are for power supply. VSS pin is grounded, **and** VDD pin is supplied with **+5V**. Each **voltage necessary** to drive LCD is generated in the module.

2) RS Pin

The controller LSI has two 8-bit registers; an instruction register (**IR**) and a data register (**DR**). RS signal selects these registers.

IR stores instruction codes such as display clear, shift, etc. and also stores address information for the display data RAM (DD RAM), **character** generator RAM (CG RAM);

DR is used for temporarily storing data to be written into DD RAM and CG RAM.

" 0 " :Instruction register (when writing)

Busy flag **register**;address counter (when reading)

" 1 " :Data register (read/write)

3) R/W Pin

Read or write select signal Pin.

" 0 " :Writing

" 1 " :Reading

4) E Pin

Data read or write operation enable signal pin.

5) DB0~DB7 Pins

Data-bus with three-state, hi-directional function for use in data transactions with MPU. DB7 may also be used to check the busy flag.

DB0~DB3 are **not used** when interfacing with a 4-bit microprocessor .'

6) Vo Pin

Viewing angle is varied and contrast is adjusted by changing voltage between **+5V~0V** by applying bias voltage to the LCD driver.

7) VLED and VLSS

Power supply for LED backlight. (BY changing the supply voltage, backlight luminance can be adjusted.)

VLED is plus and VLSS is minus.

7. Instruction Set

Table 8

| instruction | | | | | | | | | | | Function | |
|--------------------------------|----|-----|------------|-----|-----|-----|-----|-----|----------------------------------|-----|---|---|
| | IS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 | | |
| Display clear | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Clear entire display area, restore display from shift, and load address counter with DD RAM address 00H. |
| Display/cursor home | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | * | Restore display from shift and load address counter with DD RAM address 00H. |
| Entry mode set | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | I/D | | S | Specify cursor advance direction and display shift mode. This operation takes place after each data transfer. |
| Display ON/OFF | 0 | 0 | 0 | 0 | 0 | 0 | 1 | D | c | B | S | Specify activation of display (D), cursor (C), and blinking of character at cursor position (B). |
| Display/cursor shift | 0 | 0 | 0 | 0 | 0 | 1 | S/C | R/L | * | * | * | Shift display or move cursor. |
| Function set | 0 | 0 | 0 | 0 | 1 | DL | 1 | 0 | * | * | * | Set interface data length. |
| CG RAM address set | 0 | 0 | 0 | 1 | ACG | | | | | | | Load the address counter with a CG RAM address. Subsequent data is CG RAM data. |
| ID RAM address set | 0 | 0 | 1 | ADD | | | | | | | Load the address counter with a CG RAM address. Subsequent data is DO RAM data. | |
| Busy flag/address counter read | 0 | 1 | BF | AC | | | | | | | Read busy flag (BF) and contents of address counter. | |
| CG RAM/DD RAM data write | 1 | 0 | Write data | | | | | | Write data to CG RAM or DD RAM. | | | |
| CG RAM/DD RAM data read | 1 | 1 | Read data | | | | | | Read data from CG RAM or DD RAM. | | | |

| | | | |
|---|---|---------------------------------|---------------------------------|
| I/D=1: Increment | I/D=0: Decrement | S/C=1: Shift display | S/C=0: Move cursor |
| S=1: Shift display | S=0: Freeze display | R/L=1: Shift right | R/L=0: Shift left |
| D=1: Display ON | D=0: Display OFF | DL=1: 8-bit | DL=0: 4-bit |
| c=1: Cursor ON | c=0: Cursor OFF | BF=1: During Internal operation | BF=0: End of internal operation |
| B=1: Character at cursor position blinks. | B=0: Character at cursor position unblinks. | | |

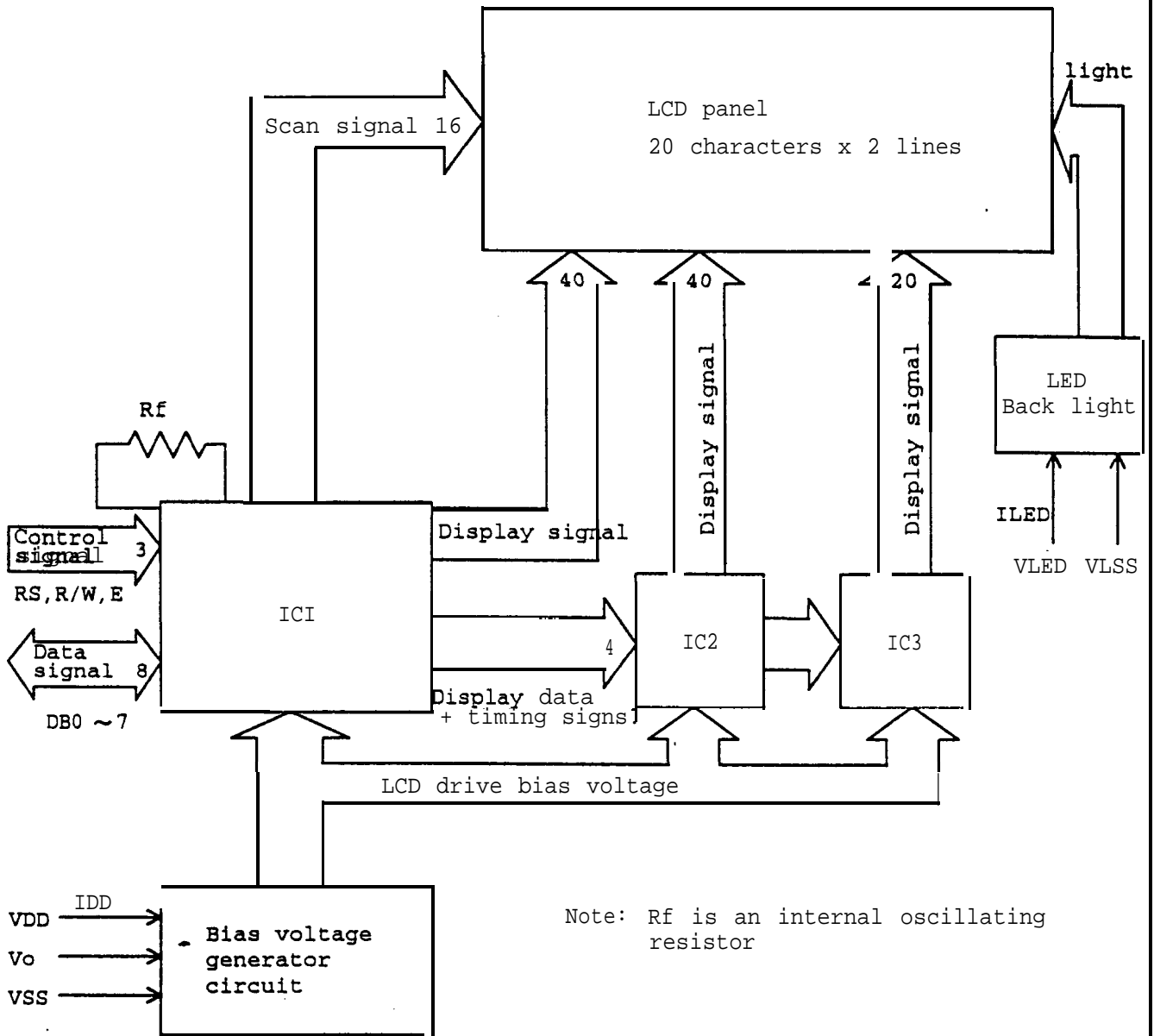


Fig. 5 Block Diagram

IC1:KS0066F00 (SAMSUNG)

IC2:MSM5259 (OKI)

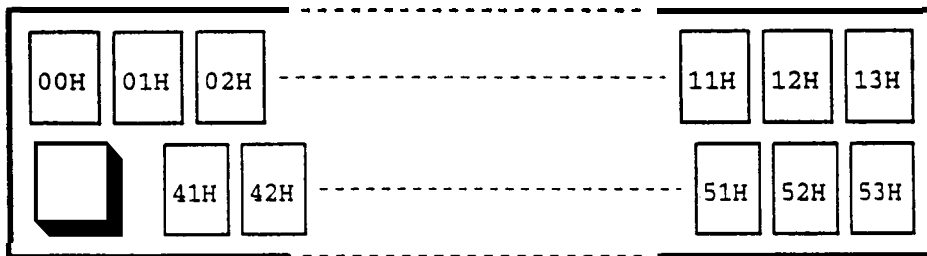


Fig.6 Display Address (When the display is not shifted)

E. Precautions

8.1 Angle when installing the module

This module's viewing angle is illustrated in Fig.2.

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

(For the specific values of θ_1 , θ_2 , refer to the Table 6.

Please consider the optimum viewing conditions according to the purpose when installing the module.

8.2 Handling cautions

This module is installed using mounting tabs at the four corners of PCB or bezel.

When installing the module, 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 module 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 module.
- (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 glass plates, dropping the module or banging it against hard objects may cause cracking or fragmentation.
- (5) CMOS LSIS are equipped in **this module**, so care must be taken to avoid the electric static **charge**, by earthing human **body, etc. Take** the following **measures**, to protect the module from the electric discharge via mounting tabs from the main system electrifies with static electricity.

8.4 Notes on operation

The module should be driven according to the specified ratings to avoid malfunction of permanent damage.

8.5 Others

- (1) Avoid to expose the module to the direct **sun-light, strong ultra-violet light, etc.** for a long time.
- (2) If stored at temperatures below specified storage temperature, the LC may freeze and be deteriorated. If storage 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 **module, it** may cause the poor contact. So please avoid to dismantle the module.
- (4) Don't use any materials which emit following gas from epoxy **resin(amines hardener)** and silicon adhesive agent (**dealcohol or deoxym**) to prevent change polarizer color owing to gas.

Table 0 Input Code vs. Character Pattern

| *1 *2 4bit | 0000 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
|------------------|------------|------|------|------|------|------|------|------|------|------|------|------|------|
| xxxx0000 | CG RAM (1) | | | | | | | | | | | | * |
| xxxx0001 | (2) | | | | | | | | | | | | * |
| xxxx0010 | (3) | | | | | | | | | | | * | |
| xxxx0011 | (4) | | | | | | | | | | | | |
| xxxx0100 | (5) | | | | | | | | | | | * | |
| xxxx0101 | (6) | | | | | | | | | | | | |
| xxxx0110 | (7) | | | | | | | | | | | * | |
| xxxx0111 | (8) | | | | | | | | | | | * | |
| xxxx1000 | (1) | | | | | | | | | | | | |
| xxxx1001 | (2) | | | | | | | | | | | * | |
| xxxx1010 | (3) | | | | | | | | | | | * | |
| xxxx1011 | (4) | | | | | | | | | | | | |
| xxxx1100 | (5) | | | | | | | | | | | | |
| xxxx1101 | (6) | | | | | | | | | | | | |
| xxxx1110 | (7) | | | | | | | | | | | | |
| xxxx1111 | (8) | | | | | | | | | | | | * |

Note 1. CG RAM is character generator RAM in which user-definable character patterns are stored.

Note 2. X mark: prohibition of input

*1 High-order *2 Low-order

