EPSON DOT MATRIX LCD MODULE

EA-C20017AR

TENTATIVE SPECIFICATIONS

REVISION VOL. 1

FEBRUALY / 28 / 1985

EPSON CORPORATION

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		Before Revision	After Revision	
1	8	(1) 6.1 No.1/D2 bit is "0" (2) 6.1 [NOTE]	6.1 No. 1/D2 bit is "1" 6.1 "DISP ON/OFF" command is added	Feb/28/85
	18	t comd 16/ϕ (MHZ)	t comd 16/CLOCK (HZ)	
	20	T WCYC 16/ϕ (MHZ)	T WCYC 16/CLOCK (HZ)	

CONTENTS

1. INTRODUCTION

The EA-C20017AR is a dot matrix liquid crystal display (LCD) module capable of generating 20 characters per line. The on-chip driver configuration provides the TCM-A0077-3 with two attractive features -- very compact design and very low cost.

The built-in memories include a 20-word data RAM, a 160-character CG ROM, and a 4-character CG RAM. Data from the MPU or others can be programmed in the data RAM for convenient display.
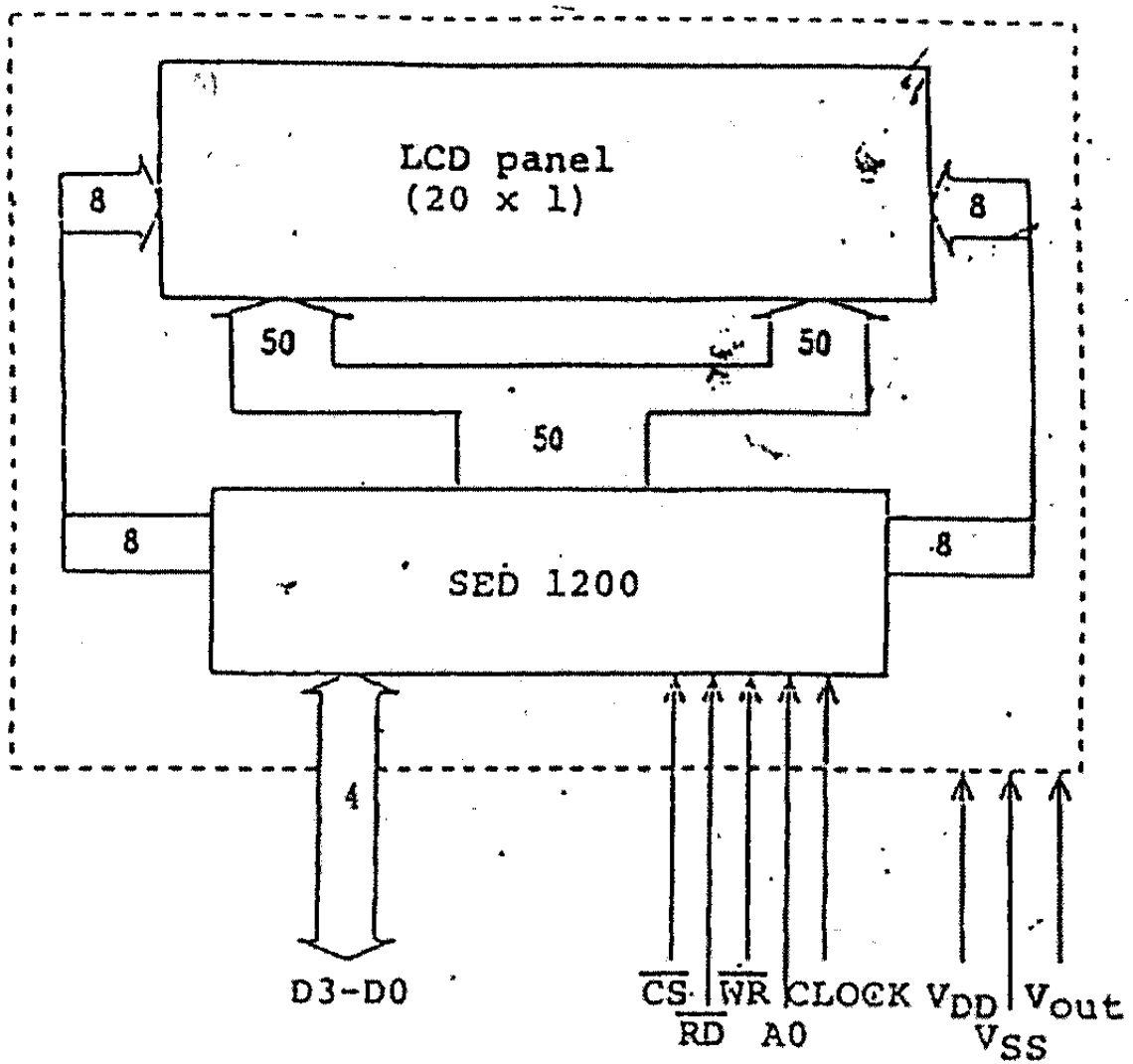
The MPU is responsible for only display data and commands and is not required to control any other display functions This means that, with the EA-C20017AR , the MPU workload is reduced.

1.1 Features

(1) On-chip display data RAM : 20 words (8 bits/word)

(2) On-chip CG ROM : 96 ASCII character codes + 64 special letters

(3) On-chip CG RAM : 4 characters (5 x 8 dots, allowing pseudo-graphics display)

(4) Character font : 5 x 7 dots + cursor line

(5) Cursor font : Underline or all dot blinking (selectable)

(6) Commands : 13 different commands (including System Set and Cursor Control)

(7) Interface : Possible with 4-bit or 8-bit MPU

(8) Power supply : 5VDC single power

(9) Display : TN-FEM positive display, reflection type, 1/16 duty

3. BLOCK DIAGRAM

LCD panel
(20 x 1)

8

8

50

50

50

8

SED 1200

.8

4

D3-D0

$\overline{CS}$ $\overline{WR}$ CLOCK V_{DD} V_{out}

$\overline{RD}$ A0 V_{SS}

A8 for SMC 2

4. FUNDAMENTAL OPERATIONS

(1) The module consists of an on-chip character display control driver, a CR oscillator and an LCD panel. The LCD supply voltage dividing resistors are built into the chip.

(2) The contrast of the LCD panel has temperature and visual angle characteristics. The contrast and visual angle can be adjusted by a variable resistor of specific value connected between V_{SS} and V_{out} of the I/O connector, so that the module may be used under an optimum condition in the operating environment.

(3) The module operates from a +5V single power supply.

(4) The controller contains a display data RAM and a character generator (CG) which produces 96 ASCII character codes and 64 special letters... The MPU controls only display data and commands and nothing more. This leads to a reduction in MPU workload.

(5) All display functions for display data, address data and the cursor are controlled by 13 different commands entered via the data bus.

(6) Two cursor display formats are available: underlining and all-dot blinking.

(7) Other functions include system reset and display on-off.

5. INPUT/OUTPUT PINS
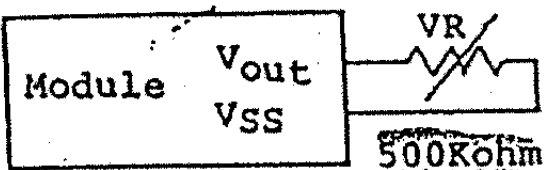
5.1 Pin Configuration

Top View
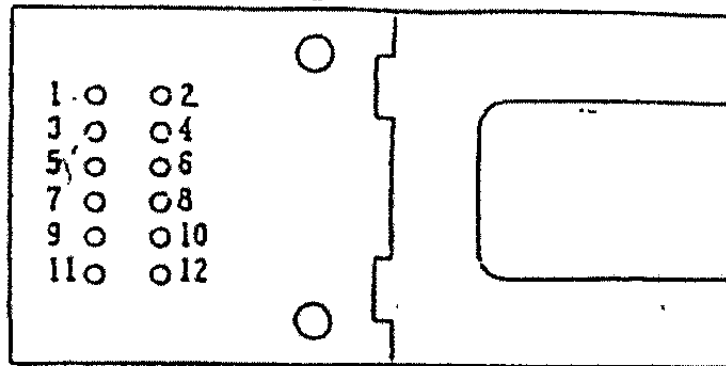
No.	Symbol name
1	V_{DD}
2	V_{SS}
3	V_{out}
4	CLOCK
5	$\overline{CS}$
6	A0
7	$\overline{WR}$
8	$\overline{RD}$
9	D3
10	D2
11	D1
12	D0

5.2 Pin Description

No.	Symbol	I/O	Name	Function
1	V_{DD}	I	Power input	+5V ±5%
2	V_{SS}	I	Power input	0V (GND)
3	V_{out}	I	LCD contrast adjustment	Contrast adjustment Module V_{out} V_{SS} —VR— 500Kohm
4	CLOCK	I	Command clock input	System clock input pin (1 to 3.2 MHz)
5	$\overline{CS}$	I	Chip select	Active "L"
6	A0	I	Display data/ command input selection	A0 = "H": display data A0 = "L": command
7	$\overline{WR}$	I	Write enable input	Active "L"
8	$\overline{RD}$	I	Read enable input	Active "L"
9 ~ 12	D3–D0	I/O	Data input (D3 only: input/ output)	8 bits, consisting of upper 4 bits and lower 4 bits

6. COMMANDS

6.1 Command List

No.	Command name	CS	WR	RD	A0	D7	D6	D5	D4	D3	D2	D1	D0	Remarks
1	SET CURSOR DIRECTION	0	0	1	0	0	0	0	0	0	1	0	D/I	D/I=1 decrement D/I=0 increment
2	CURSOR ADDRESS -1/+1	0	0	1	0	0	0	0	0	0	1	1	-1/+1	-1/+1=1 cursor address -1 -1/+1=0 cursor address +1
3	CURSOR FONT SELECT	0	0	1	0	0	0	0	0	1	0	0	A/U	A/U=1 all dots blinking A/U=0 underlining
4	CURSOR BLINK ON/OFF	0	0	1	0	0	0	0	0	1	0	1	ON/OFF	ON/OFF=1 ON ON/OFF=0 OFF
5	DISPLAY ON/OFF	0	0	1	0	0	0	0	0	1	1	0	ON/OFF	ON/OFF=1 ON ON/OFF=0 OFF
6	CURSOR ON/OFF	0	0	1	0	0	0	0	0	1	1	1	ON/OFF	ON/OFF=1 ON ON/OFF=0 OFF
7	SYSTEM RESET	0	0	1	0	0	0	0	1	0	0	0	0	Data RAM and CG RAM are not affected.
8	LINE SELECT	0	0	1	0	0	0	0	1	0	0	1	1	Set for 1/16 duty & 20 x 1 line
9	SET CGRAM ADDRESS	0	0	1	0	0	0	1	0	(lower address)				Upper address fixed to 0H
10	SET CGRAM DATA	0	0	1	0	0	1	0	(CG RAM data)					
11	SET CURSOR ADDRESS	0	0	1	0	(character address code)								See character address code, section 7.
12	SET CHARACTER CODE	0	0	1	1	(character code)								See character code map, section 7.
13	BUSY FLAG CHECK	0	1	0	0	BF	*	*	*	BF	*	*	*	BF=1 busy BF=0 not busy (*:high impedance)

[NOTE]   Entry of any command other than those listed above may cause an instruction or internal flag status to change. Always use commands that are specified.
Please input "SYSTEM SET", "LINE SELECT" and "DISPLAY ON/OFF" commands all the time at the stage of initial setting.

6.2 Command Description

(1) SET CURSOR DIRECTION

MSB(D7)   LSB(D0)

A0 : [0]   W̄R̄ : [0] | 0 0 0 0 | 0 1 0 0 | Increment
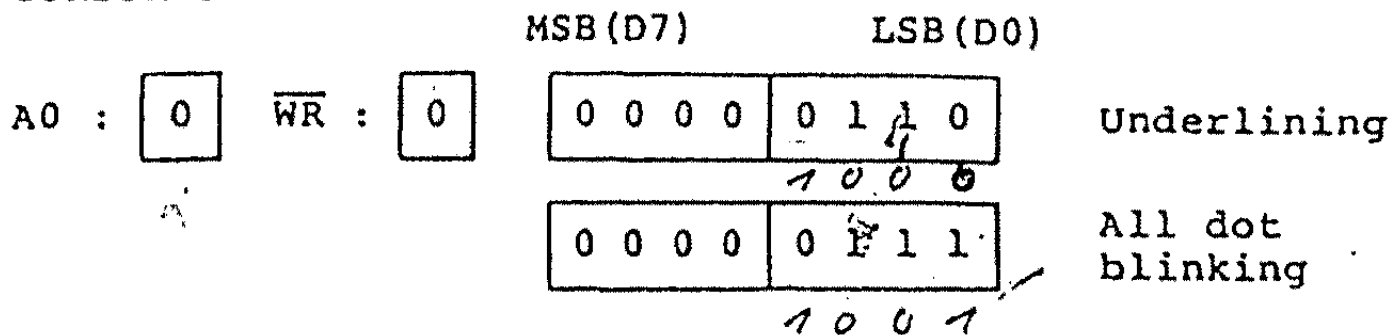
| 0 0 0 0 | 0 1 0 1 | Decrement

This command specifies the direction in which the cursor
moves. Writing 04H brings cursor increment mode.
Writing 05H brings cursor decrement mode.
With a cursor direction set, the cursor address register
(data RAM address) is set for increment or decrement
direction. Each time a SET CHARACTER CODE command is:
executed, the address changes automatically in the
set direction.

(2) CURSOR ADDRESS -1/+1

MSB(D7)   LSB(D0)

A0 : [0]   W̄R̄ : [0] | 0 0 0 0 | 0 1 1 0 | +1

| 0 0 0 0 | 0 1 1 1 | -1

This command adds 1 to, or subtracts 1 from, the
cursor address. Writing 06H causes the cursor address
to be incremented by 1. Writing 07H causes the
address to be decremented by 1. The command enables
only cursor movement, and is useful for editing.

(3) CURSOR FONT SELECT

MSB(D7)   LSB(D0)

A0 : | 0 | $\overline{\text{WR}}$: | 0 | | 0 0 0 0 | 0 1 1 0 | Underlining

| 0 0 0 0 | 0 1 1 1 | All dot blinking

This command selects a cursor format. Writing 08H brings underlining mode. Writing 09H brings all dot blinking mode.(in which case blinking cannot be turned off)

(4) CURSOR BLINK ON/OFF

MSB(D7)   LSB(D0)

A0 : | 0 | $\overline{\text{WR}}$: | 0 | | 0 0 0 0 | 1 0 1 0 | Off

| 0 0 0 0 | 1 0 1 1 | On
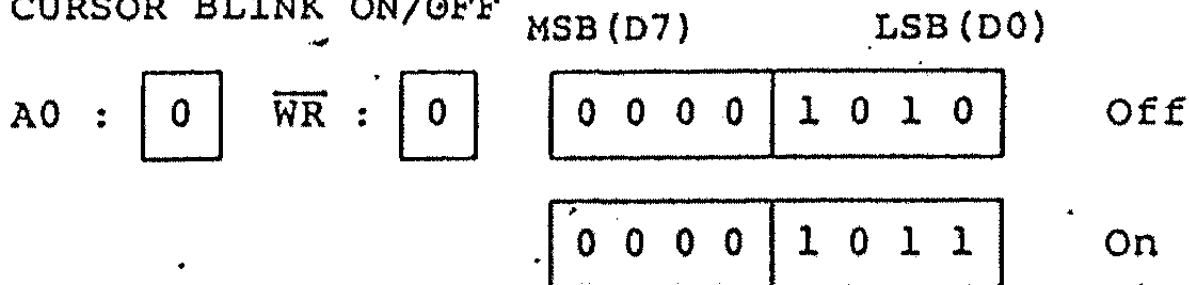
This command turns on or off underline blinking when the cursor is used in underline format. Writing 0AH turns off the blinking of the cursor. Writing 0BH turns on the blinking of the cursor.

(5) DISPLAY ON/OFF

MSB(D7)   LSB(D0)

A0 : | 0 | $\overline{\text{WR}}$: | 0 | | 0 0 0 0 | 1 1 0 0 | Off

| 0 0 0 0 | 1 1 0 1 | On
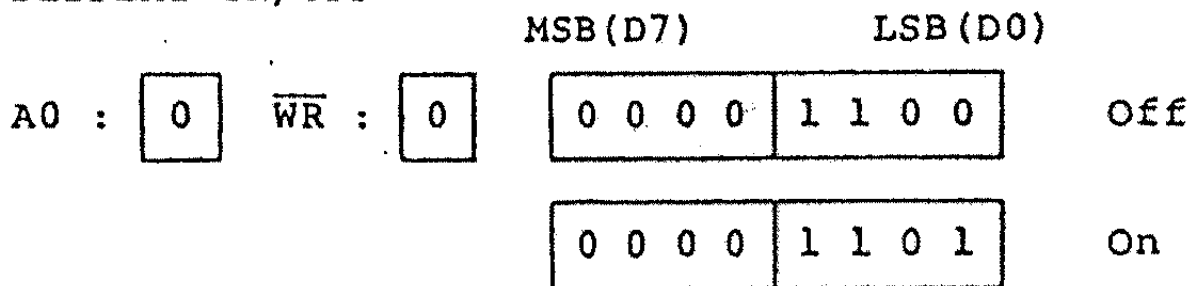
This command turns on or off the display. Writing 0CH turns off the display. Writing 0DH turns on the display. With the display off, the contents of the data RAM are not cleared.

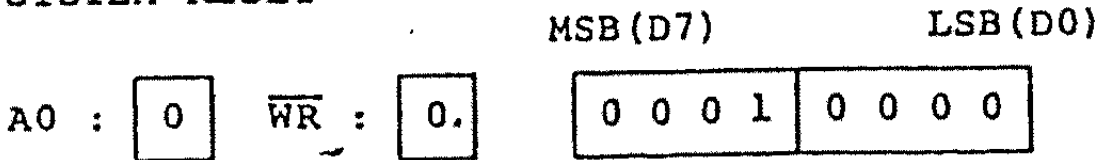## (6) CURSOR ON/OFF

MSB(D7)   LSB(D0)

A0 : [0] $\overline{WR}$: [0] | 0 0 0 0 | 1 1 1 0 | Off

| 0 0 0 0 | 1 1 1 1 | On
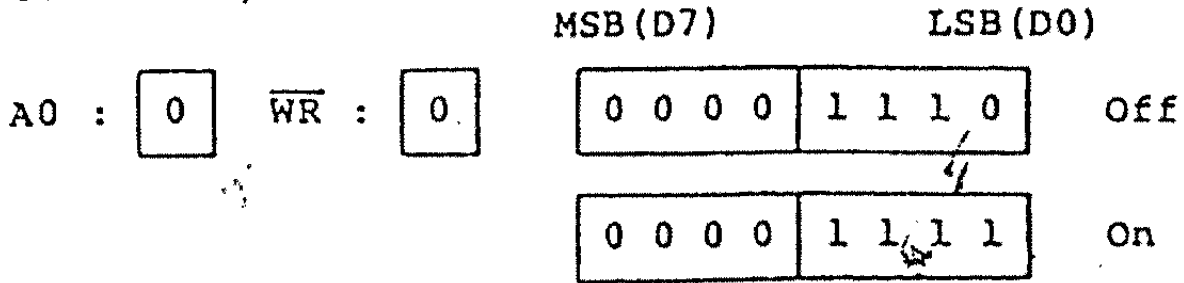
This command turns on or off the cursor. Writing 0EH turns off the cursor. Writing 0FH turns on the cursor.

(7) SYSTEM RESET

MSB(D7)   LSB(D0)

A0 : [0] $\overline{WR}$: [0.] | 0 0 0 1 | 0 0 0 0 |

This command initializes the system. (However, it does not affect the data RAM and CG RAM.) Writing 10H causes the instruction commands to be set as follows:

```
SET CURSOR DIRECTION ---------------------- Increment
CURSOR FONT SELECT ------------------------ Underlining
CURSOR BLINK ON/OFF ----------------------- Off
DISPLAY ON/OFF ---------------------------- Off
CURSOR ON/OFF ----------------------------- Off
LINE SELECT ------------------------------- One line display
SET CURSOR ADDRESS ------------------------ Line 1, address (
```

(8) LINE SELECT

MSB(D7)   LSB(D0)

A0 : [0] $\overline{WR}$: [0] | 0 0 0 1 | 0 0 1 1 |
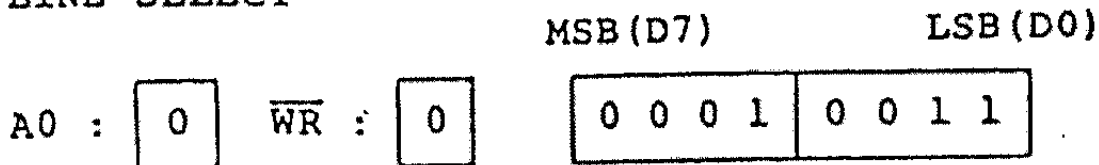
This command specifies the number of lines to be displayed (LCD drive duty). 13H is set as this module is of 1/16 duty driving.

(1) (2) SET CURSOR ADDRESS

AO : [0] $\overline{WR}$: [0]   MSB(D7) ─────── LSB(D0)
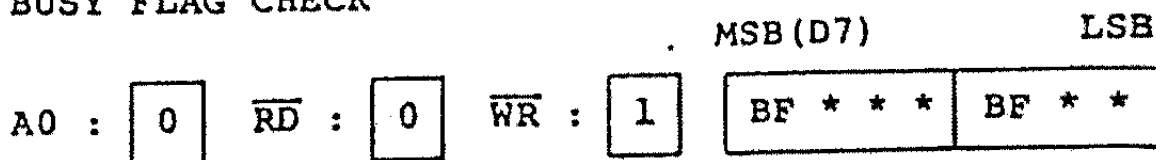[character address code]
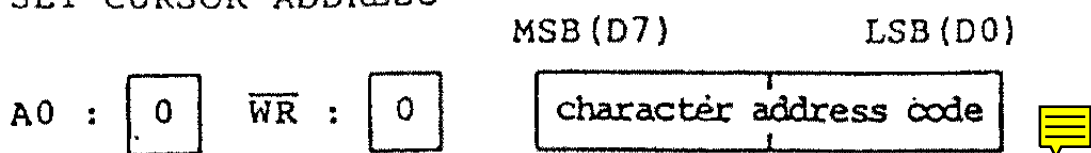
This command presets the address of the cursor. Use the character address code to preset the cursor address. (See Character Address Code, section 7.)

(2) (10) SET CHARACTER CODE

AO : [1]   WR : [0]   MSB(D7) ─────── LSB(D0)
[character code]

This command writes a character code into the data (See Character Code Map, section 7.)

(3) (11) BUSY FLAG CHECK

AO : [0] $\overline{RD}$: [0] $\overline{WR}$: [1]   MSB(D7) ─── LSB
[BF * * * | BF * *]

*:high impedance

This command checks the status of the module. The flag showing whether the internal condition busy or not busy appears at pin D3. (In this c─── D2, D1 and D0 are at high impedance.)

To check the internal condition of the module external unit, read the value appearing at pi─── If pin D3 is set the system is busy. Then ─── the BUSY FLAG CHECK command. If pin D3 is low the system is not busy. I─── another command can be written. Unlike the others, the BUSY FLAG CHECK comm─── terminate when read once.

AO : | 0 | $\overline{WR}$: | 0 | | 0 0 1 0 ⌐ |

This command specifies a CG RAM address (character code). Four CG RAM addresses are available: 00H, 01H, 02H and 03H. Only the lower addresses must be used for setting: 0H, 1H, 2H and 3H.
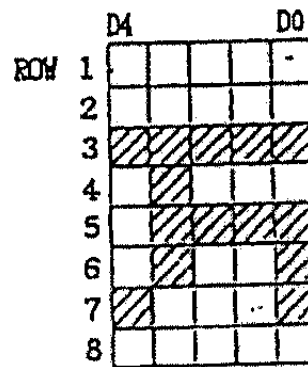
(13) SET CGRAM DATA

MSB(D7)   LSB(D0)

AO : | 0 | $\overline{WR}$: | 0 | | 0 1 0 (CGRAM data) |

This command registers a pattern (5 x 8 dots) at a preset address (set by the SET CGRAM ADDRESS command). Data, in bit image, is to be set at D4 through D0. ('1' -- on, '0' -- off)

[Example]

Register pattern "ㅋ" at CG RAM address 01H.

Step	AO	$\overline{WR}$	Data	Contents
1.	0	0	21H	Set CG RAM address.
2.	0	0	40H	Set ROW1 data.
3.	0	0	40H	" 2 "
4.	0	0	5FH	" 3 "
5.	0	0	48H	" 4 "
6.	0	0	4FH	" 5 "
7.	0	0	49H	" 6 "
8.	0	0	51H	" 7 "
9.	0	0	40H	" 8 "

[NOTE] The BUSY FLAG CHECK command is omitted from the step.

Assignment of the address codes to the characters on the display is shown.

Character positions

5 dots

8 dots

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |

Address codes

00H 01H 02H 83H 04H 05H 06H 07H 08H 09H C0H C1H C2H C3H C5H C6H C7H C0H C2H
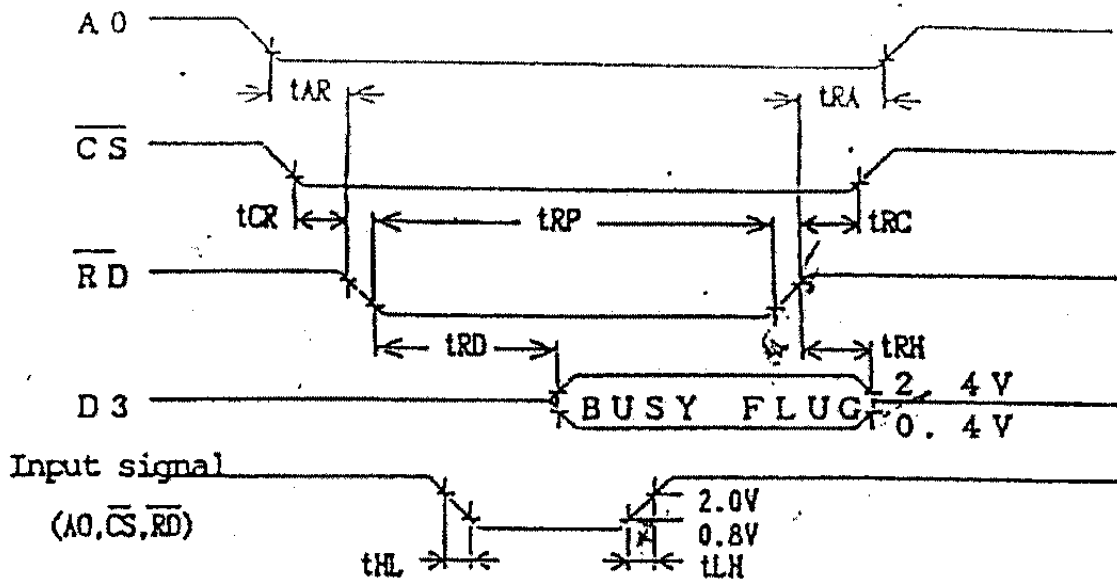
* Character Code Map

		Lower 4 bit (D0 to D3) of Character Code (Hexadecimal)														
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Upper 4 bit (D4 to D7) of Character Code (Hexadecimal)	0	CG RAM AREA 5 x 8 DOTS															
	2																
	3																
	4																
	5																
	6																
	7																
	A																
	B																
	C																
	D																
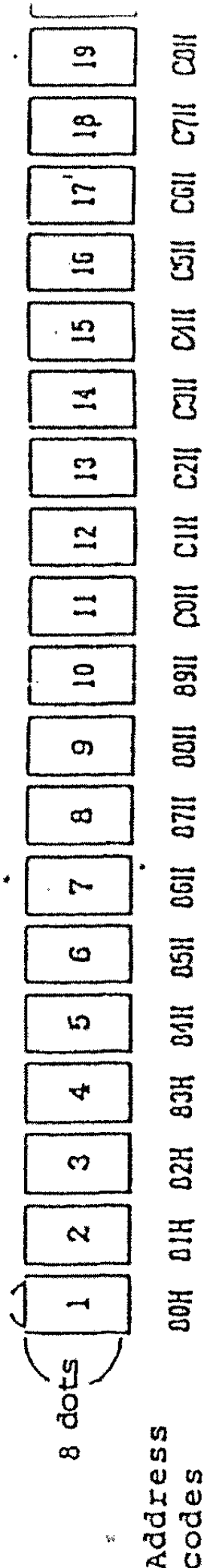
9.2.1 Read Timing (BUSY Flag)

(Ta = 0 ～ 50°C V_{DD}=5V±5%)

Parameter	Symbol	Standard			Unit	Remarks
		Min.	Typ.	Max.		
A0 → $\overline{RD}$ set time	t_{AR}	0	--	--	nsec	
$\overline{CS}$ → $\overline{RD}$ set time	t_{CR}	0	--	--	nsec	
Output delay time from $\overline{RD}$	t_{RD}	--	--	250	nsec	D3 load CL=100pF
$\overline{RD}$ → A0 hold time	t_{RA}	20	--	--	nsec	
$\overline{RD}$ → $\overline{CS}$ hold time	t_{RC}	20	--	--	nsec	
Data hold time	t_{RH}	10	--	--	nsec	
Read pulse width	t_{RP}	350	--	--	nsec	
Input fall time	t_{HL}	--	--	50	nsec	
Input rise time	t_{LH}	--	--	50	nsec	

9.2.2 Write Timing

$Ta = 0 \sim 50°C \quad V_{DD} = 5V \pm 5\%$
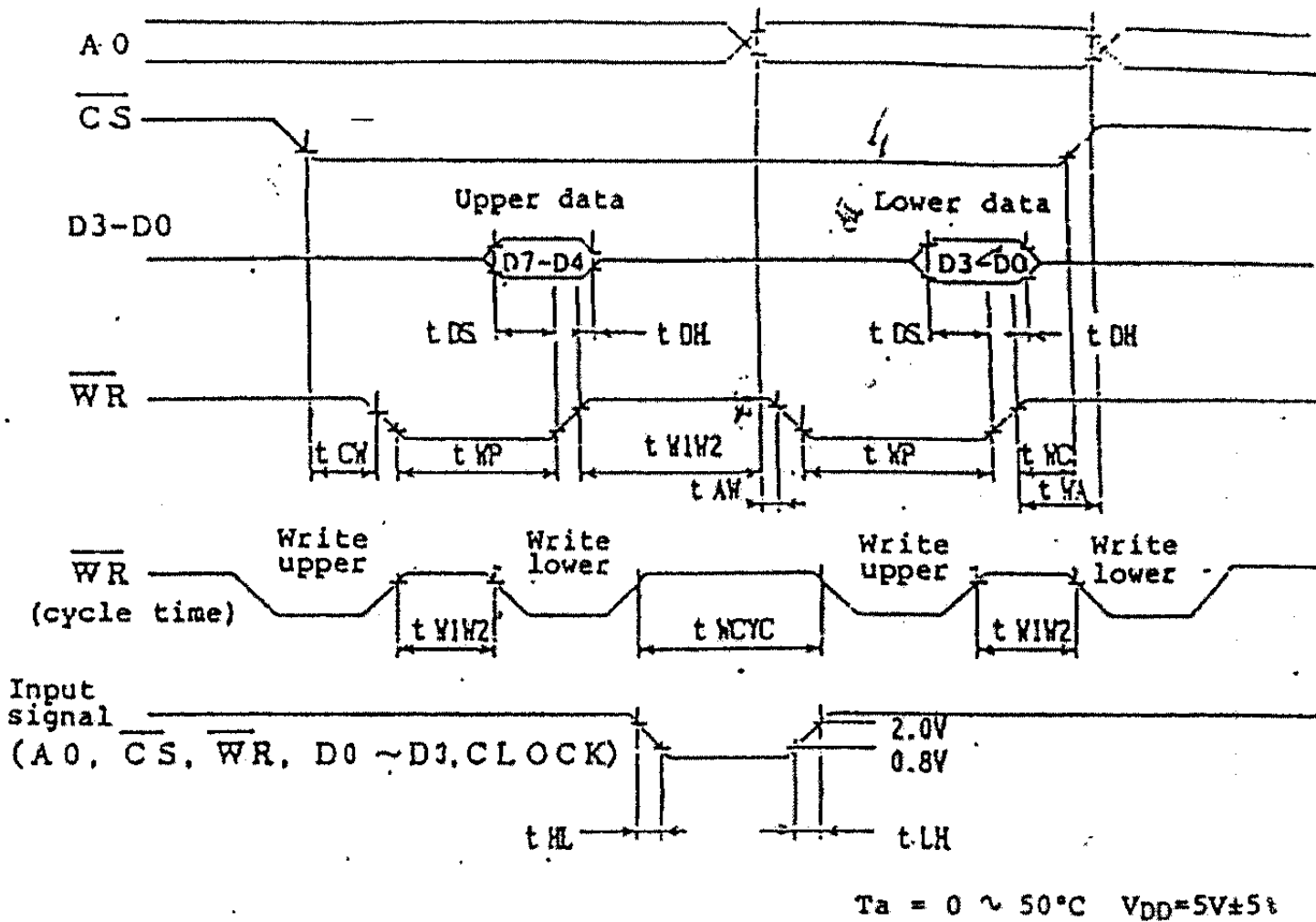
Parameter	Symbol	Standard			Unit
		Min.	Typ.	Max.	
A0 → $\overline{WR}$ set time	t_{AW}	0	--	--	nsec
$\overline{CS}$ → $\overline{WR}$ set time	t_{CW}	0	--	--	nsec
Data set-up time	t_{DS}	120	--	--	nsec
$\overline{WR}$ → A0 hold time	t_{WA}	20	--	--	nsec
$\overline{WR}$ → $\overline{CS}$ hold time	t_{WC}	20	--	--	nsec
Data hold time	t_{DH}	20	--	--	nsec
Write pulse width	t_{WP}	200	--	--	nsec
Upper write → lower write time	t_{W1W2}	200	--	--	nsec
Lower write → upper write time	t_{WCYC}	16/CLOCK (Hz)	--	--	μsec
Input fall time	t_{HL}	--	--	50	nsec
	t_{LH}	--	--	50	nsec

Fig. 1 Definition of Vth

Brightness (Nit)

$\phi=60°$, $\theta=270°$ off-time voltage

$\phi=80°$, $\theta=270°$ on-time voltage

Vth1   Vth2

Significantly low contrast   Operating zone   Significantly crosstalk
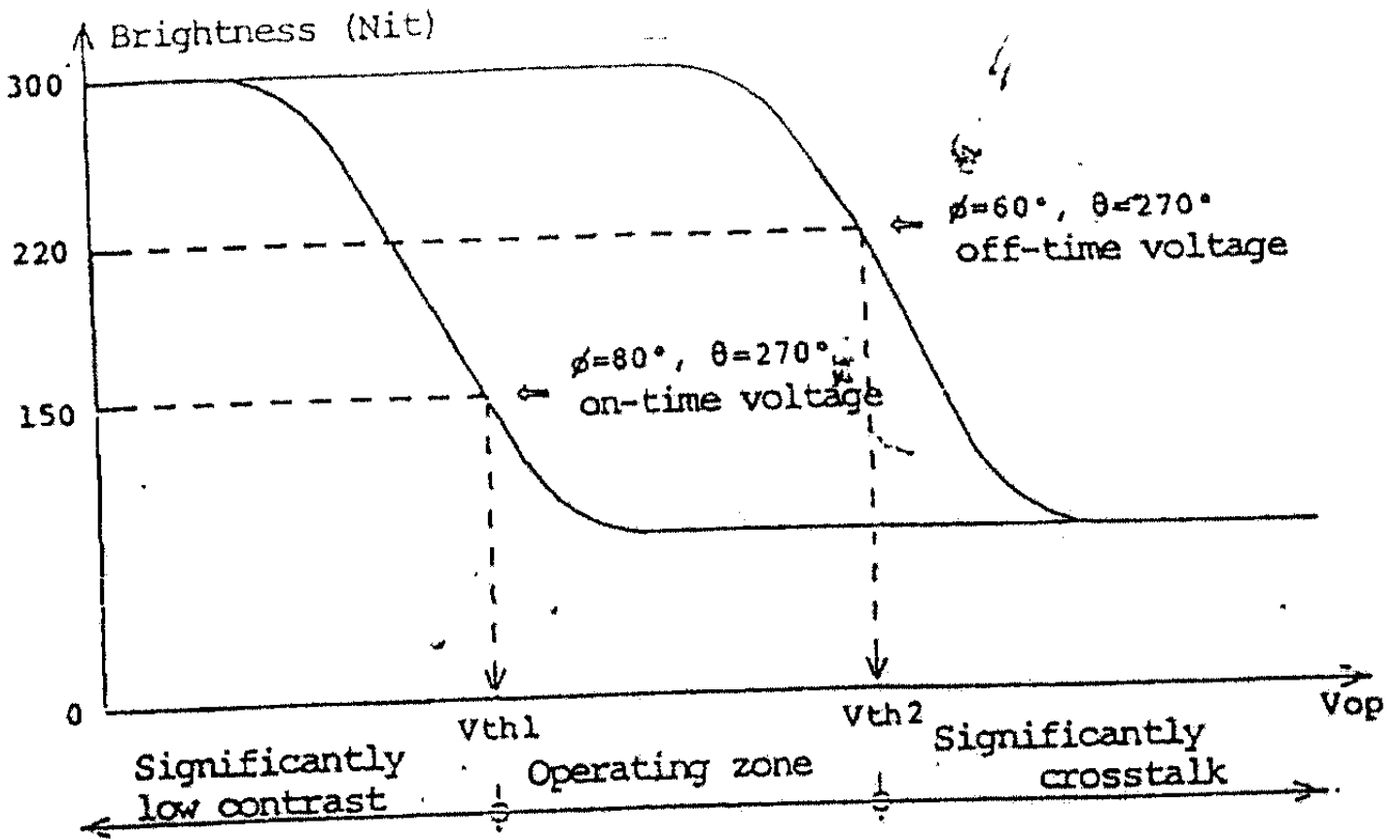
Fig. 2 V_{op} - Temperature Curves

Vop(V)

5.0 — 4.90
4.75
4.60

4.41
4.25

4.12

3.92 Vth2
3.79 Vop
3.64 Vth1

4.0 —

Ta (°C)

0   10   20   25   30   40   50
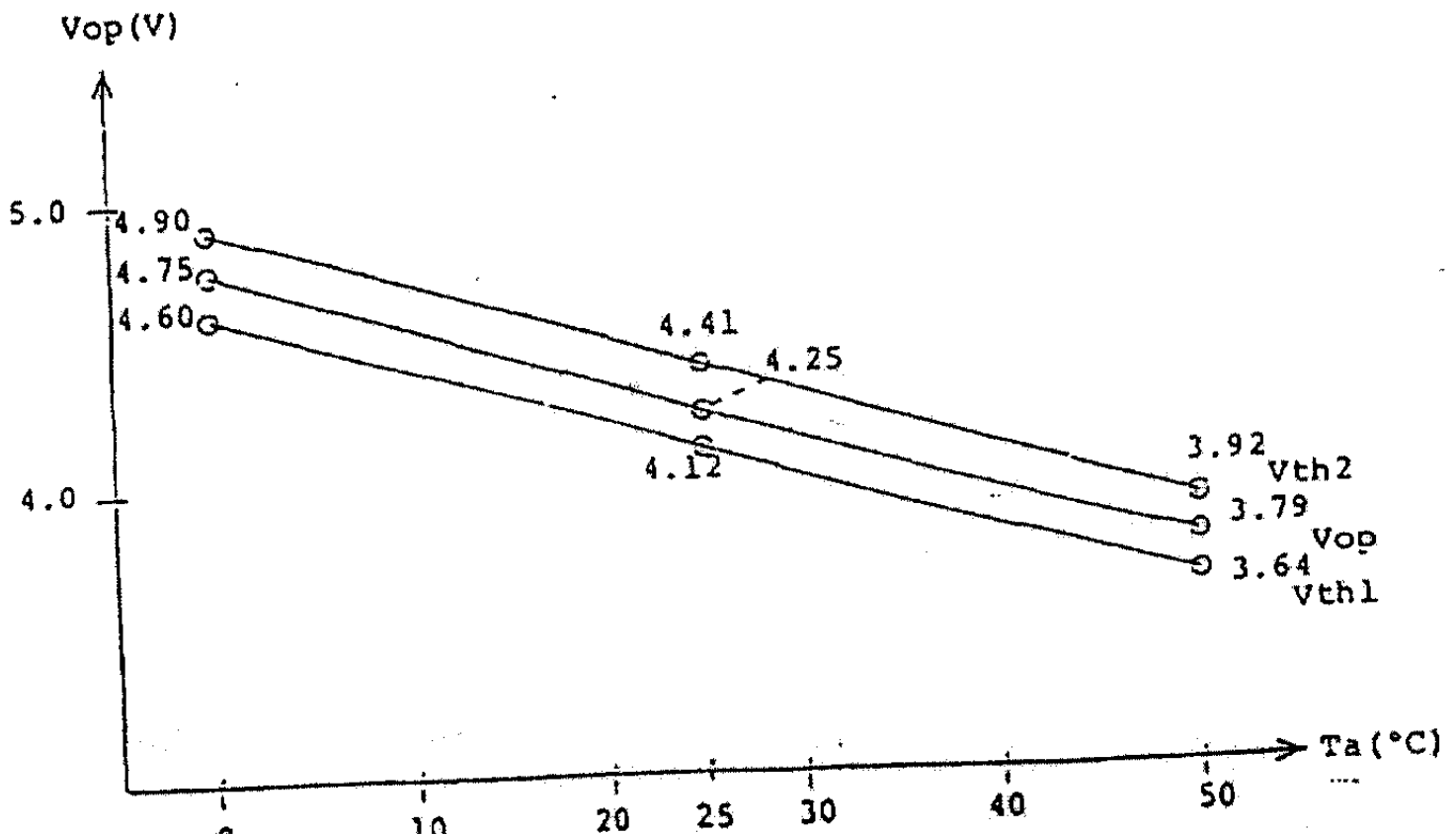
10. OPTICAL CHARACTERISTICS

10.1 Drive Conditions

(Ta=25°C)

Parameter	Voltage	Duty	Bias
Specification	4.25V	1/16	1/5

10.2 Electro-Optical Characteristics

No.	Parameter	Symbol	Temperature °C		Standard			Unit	Remarks
					Min.	Typ.	Max.		
1	Drive voltage (V_{DD}-V_{LCD})	V_{OP}	0	Vth 2	4.65	4.90	--	V	Fig. 1 Fig. 2
				Vth 1	--	4.60	4.83		
			25	Vth 2	4.19	4.41	--		
				Vop	--	4.25	--		
				Vth 1	--	4.12	4.33		
			50	Vth 2	3.60	3.92	--		
				Vth 1	--	3.64	3.80		
2	Response time	tr	Low temp. (0)		--	500	700	ms	Note 2
					--	--	--		
			25		--	170	250		
		tf	Low temp. (0)		--	350	550		
					--	--	--		
			25		--	150	250		
3	Range of viewing angles — Longitudinal	$\phi 1$			60	--	80	DEG	Note 3
	Range of viewing angles — Lateral	$\phi 2$			60	--	120	DEG	
4	Contrast ratio	K	25		--	3	--		Note 4

[NOTE 1] Definition of frame frequency:

1 period ≈ common side supply waveform

(1) Optical Measuring Apparatus

· Specifications: Brightness meter   Canon LC-2S

Light source   Halogen lamp

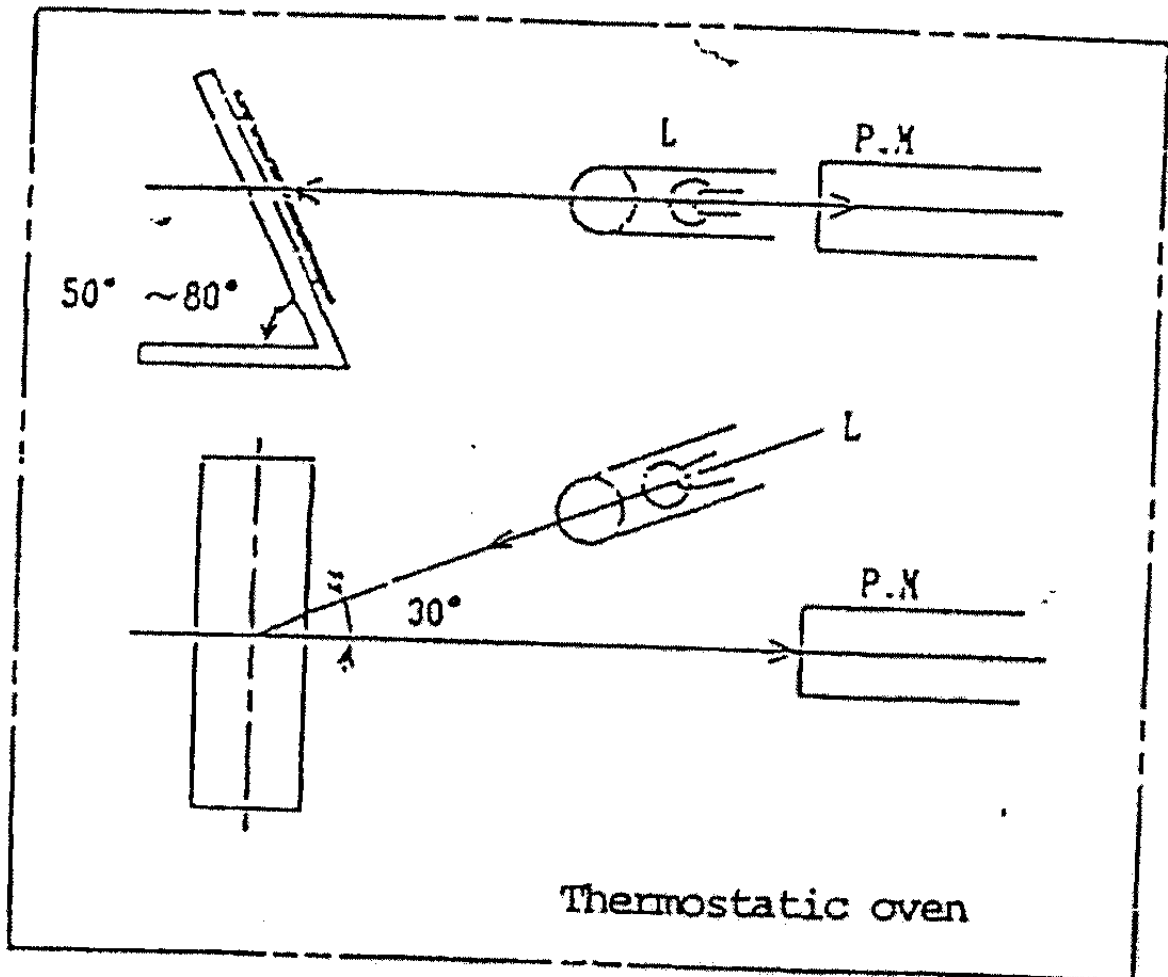Measuring conditions:

Brightness measuring
spot diameter   ∅0.3
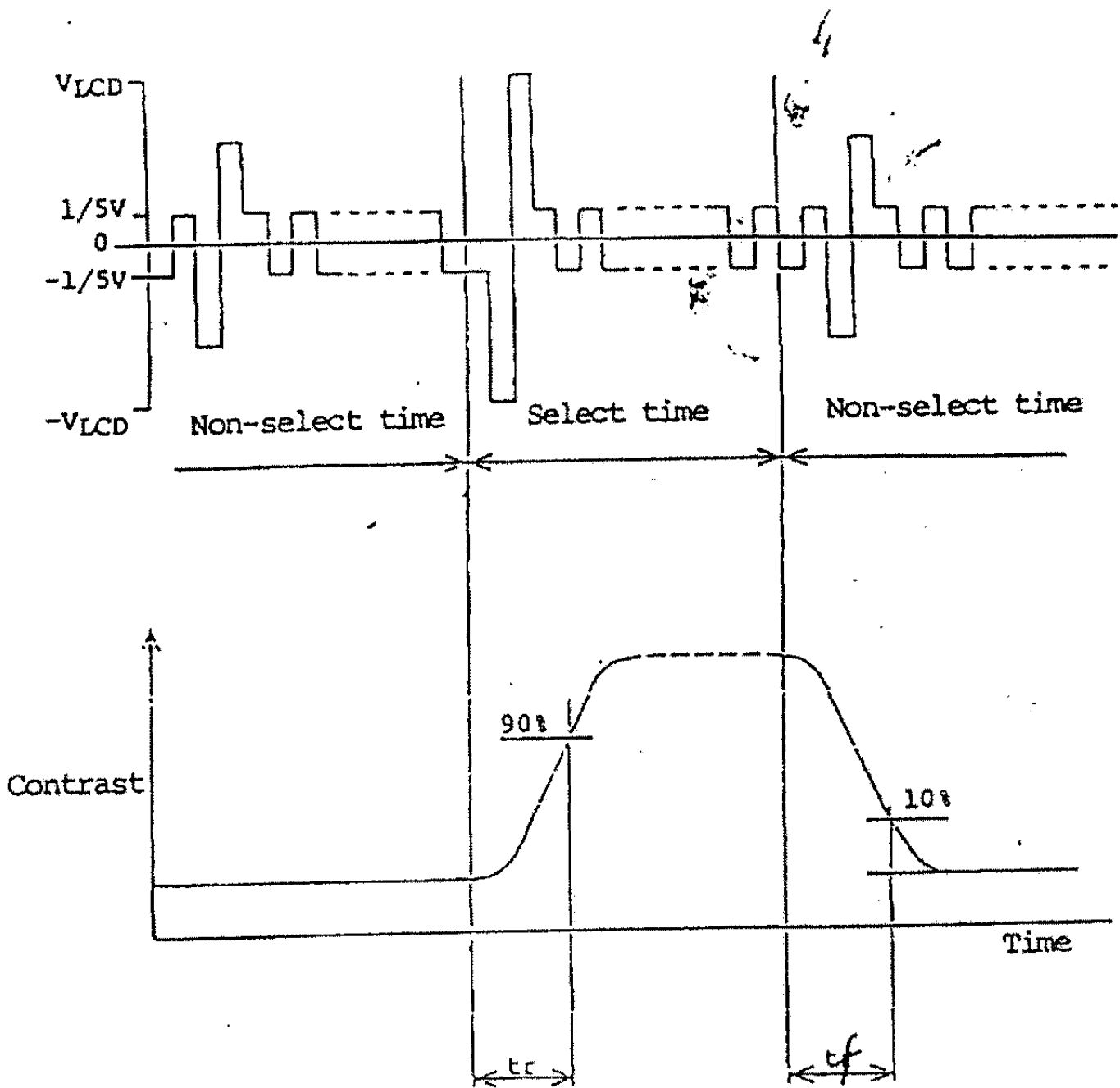
Light source
irradiation spot   ∅10mm

L : Light source

P.M.: Brightness meter photo receiver

50° ~80°

L

P.M

L

30°

P.M

Thermostatic oven

[NOTE 2] Definition of Response Time, and Measuring Conditions

[tr·tf] The segment whose response is the lowest is to be measured under the following conditions:

a) Ambient temperature   : 0°C and 25°C

b) Frame frequency (f_F)   : 64 Hz

c) Viewing angle   : 70°

d) Drive voltage V_{OP} : 4.25V

[NOTE 3] Definition of Viewing Angle Range

	Conditions	Min.	Max.	Unit
Front - rear ∅	θ = 270°	60	80	DEG
Right - left ∅2	θ = 180°	60	120	DEG

±30°
about Z
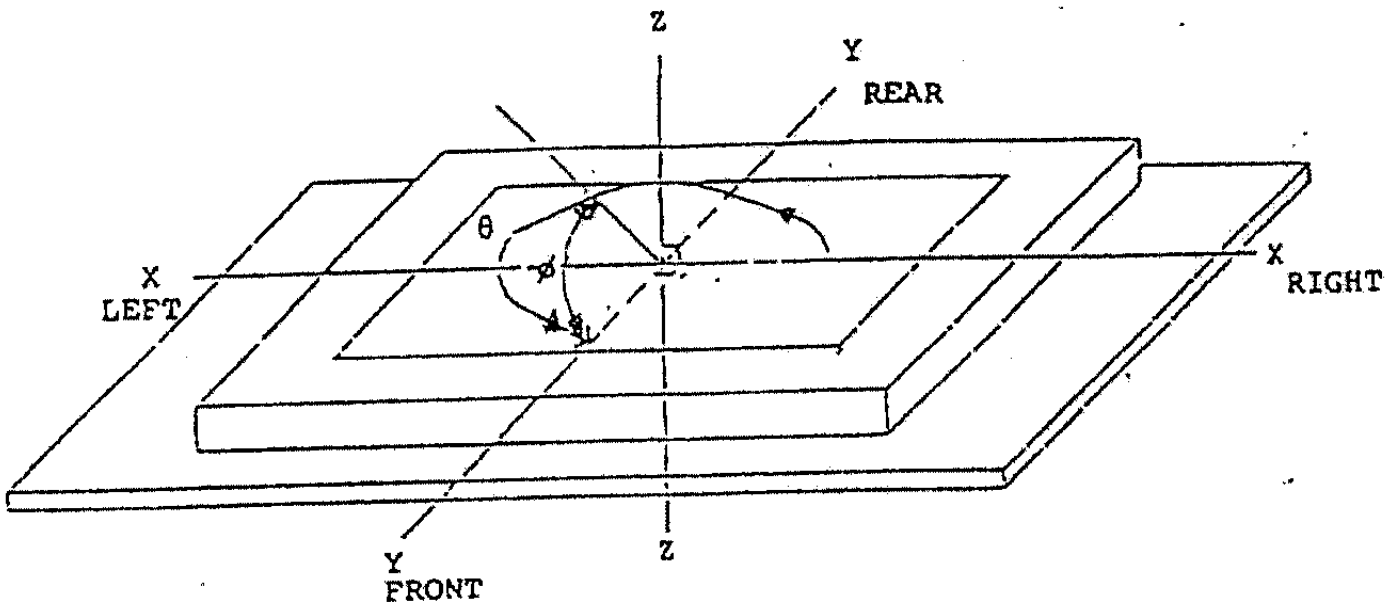
[NOTE 4] Definition of Contrast Ratio

· Definition

$$\text{Contrast ratio} = \frac{\text{Brightness with OFF voltage applied}}{\text{Brightness with ON voltage applied}}$$

. Measuring conditions

a) Drive voltage $V_{op} = 4.25V$

b) Ambient temperature $T_a = 25°C$

c) Viewing angle $θ = 270°$

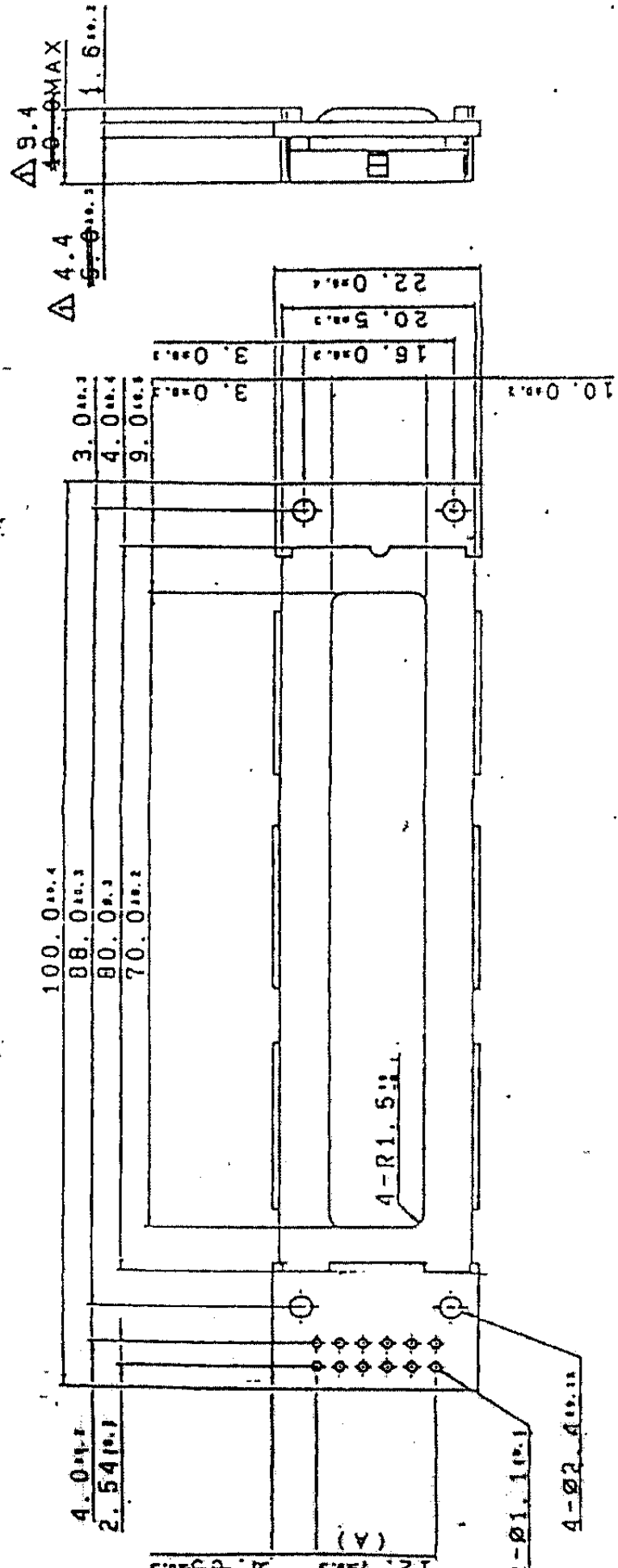 $∅ = 70°$

11. HANDLING PRECAUTIONS

(1) The display panel of the module is covered with a U.V. cut polarizer. Use extreme care when handling the panel because it is very vulnerable.

(2) If the display panel gets dirty, clean it lightly with soft cloth (e.g., gauze) impregnated with one of the following solvents:

- isopropyl alcohol
- ethanol
- trichloro-trifluoro-ethane

Avoid using cloth or gauze alone that can damage the surface of the polarizer. Do not use the following solvents:

- water
- ketones
- aromatics

(3) Observe the following as the module uses CMOS LSI.

(a) Connect any unused input pins to V_{DD} or V_{SS}.
(b) Do not apply input signals to the module with no supply voltage applied.
(c) When doing assembly, use utmost care not to cause damage by electrostatic charge.

(4) Avoid applying strong shock to the module or letting it fall from a height. It does use liquid crystal display

(5) Avoid using or storing modules exposed direct to sunshine or high temperature/humidity which otherwise will shorten the life of LCD.

Outline Drawing

(DWG. NO. TD-270019-A)

NOTES

(A) PITCH 2.54mm×(16−1)

△ Revision Date : 27th May, 85

△9.4 MAX

△4.4

22.0

20.5

16.0

3.0

3.0

4.0

9.0

10.0

100.0

88.0

80.0

70.0

4−R1.5

4.0

2.54

12.7

4.63

2−Ø1.1

4−Ø2.4

(A)

PIN ARRANGEMENT

1 Ø Ø 2
3 Ø Ø 4
5 Ø Ø 6
7 Ø Ø 8
9 Ø Ø 10
11 Ø Ø 12
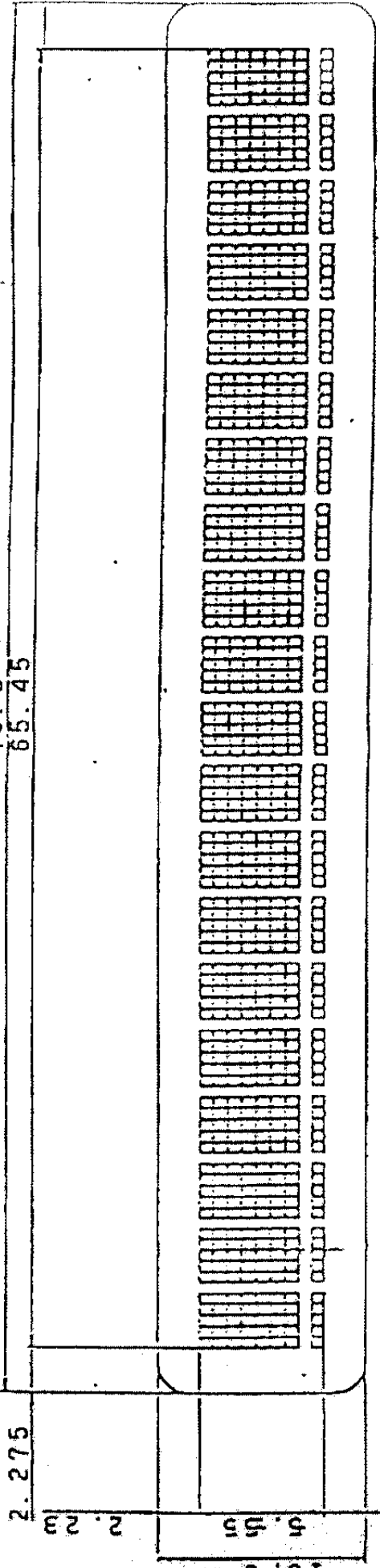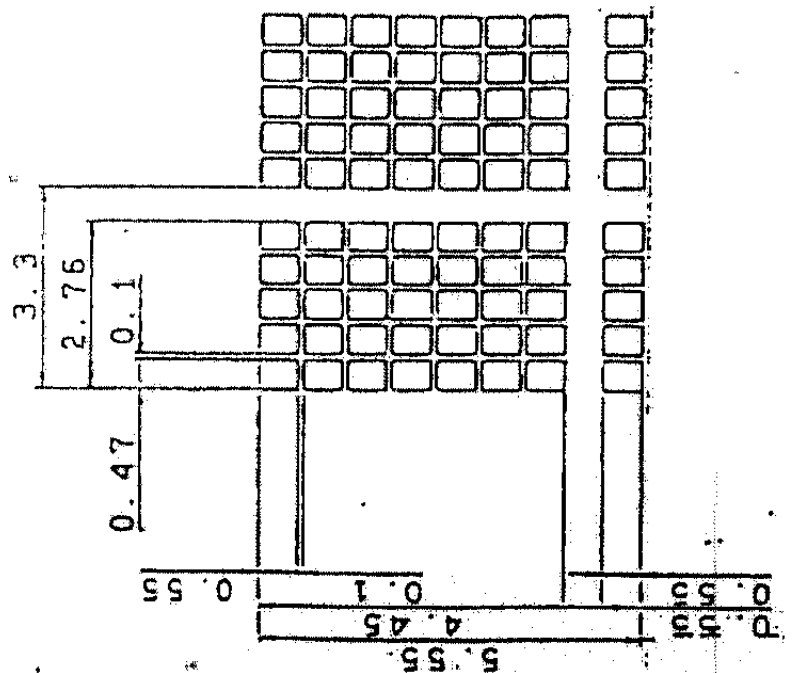
Outline Drawing
(DWG. No. TD-270020-A)

NOTE
(1) DO NOT SCALE

EA-C20017AR   TENTATIVE SPECIFICATIONS   No. SB-6002.

Prepared on October 18, 1984.

Issued by EPSON CORPORATION

Display Division, Toyoshina Branch

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SPECIFICATIONS is subject to changes without
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