For evaluation	Issued date	JUNE 15, 1993
	Spec. No.	MG1216B1N000-002

LIQUID CRYSTAL DISPLAY MODULE

G 1 2 1 6 B 1 N 0 0 0

PRODUCT SPECIFICATION

APPROVAL

Seiko Instruments Inc.

Display Division

Seiko Instruments Inc.	QA	
Akita Seimitsu Denshi Kogyo Co.,Ltd	QA	
	Design	

CONTENTS

[REVISION RECORD]

DATE	ITEM	CONTENT	(Rev.)	
'93.5.15		Issued	(001)	
'93.6.15	cover	Modification of title	(002)	Design improvement

1. SCOPE

This specification covers the engineering requirements for the G1216B1N000 liquid crystal module delivered by Seiko Instruments Inc. to _____.

2. PRODUCT SPECIFICATIONS

2.1 General

- 128 × 64 dot matrix
- 1/64 duty, 1/9 bias drive
- 4096 × 2 bit display data RAM
- 8-bit MPU interface
- Built-in oscillator circuit
- Super New-TN LCD (Gray Mode)
- Transflective type
- Positive type (Display data "H" : Display ON : Blue, "L" : Display OFF : Gray)
- Wide viewing angle type
- Wide temperature range type
- Built in LED backlight (LED color : yellow green)
- Dual power supply : V_{DD},V_{LC}

2.2 Mechanical Characteristics

Item	Characteristic
Dot configuration	128 × 64 dots
Dot dimensions [mm]	0.4×0.4
Dot spacing [mm]	0.03
Module dimensions (Horizontal x Vertical x Thickness, [mm])	75.0 ×52.7 ×8.9 max.
Viewing area (Horizontal x Vertical, [mm])	60.0 × 32.5
Active display area (Horizontal x Vertical, [mm])	55.01 × 27.49
Weight [g]	45 Max.

2.3 Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Standard		Unit
			Min.	Max.	
Power supply voltage	V_{DD}	T_a = 25℃ 50 ± 10%RH	−0.3	7.0	V
	V_{LC}		V_{DD} − 19.0	V_{DD} + 0.3	V
Input voltage	V_{in}		−0.3	V_{DD} + 0.3	V
Operating temperature	T_{opr}		−20	+70	℃
Storage temperature	T_{stg}		−30	+80	℃
Storage humidity		≤48 hrs	+20	+85	%RH
		≤1000 hrs	+20	+65	%RH

2.4 Electrical Characteristics

V_{DD} = 5.0 V ±5% V_{SS} = 0 V, T_a = −20 ~ 70°C

Item		Sym-bol	Conditions	Standard			Unit
				Min.	Typ.	Max.	
Input voltage (CMOS) *1	High	V_{IHC}		0.7V_{DD}	−	V_{DD}	V
	Low	V_{ILC}		0	−	0.3V_{DD}	V
Input voltage (TTL) *2	High	V_{IHT}		2.0	−	V_{DD}	V
	Low	V_{ILT}		0	−	0.8	V
Output voltage*3	High	V_{OH}	I_{OH} = − 205 μA	2.4	−	−	V
	Low	V_{OL}	I_{OL} = 1.6 mA	−	−	0.4	V
Power supply voltage (operating voltage)		V_{DD}		4.75	5.00	5.25	V
		V_{LC}		−12.0	−8.0	−3.0	V
Current consumption*4		I_{DD}	V_{DD} = 5.0V, T_a = 25°C	−	2.0	3.0	mA
		I_{LC}	V_{LC} = −8.0V, T_a = 25°C	−	1.8	3.0	mA
Frame frequency		f_{FRM}		−	71.4	−	Hz

*1 Applied to RST
*2 Applied to R/W,D/I,E,CS1, CS2,DB0~DB7
*3 Applied to DB0~DB7
*4 Display pattarn : Checkered pattarn

2.5 Optical Characteristics

2.5.1 Optical characteristics

1/64 duty, 1/9 bias, f_{FLM} = 71.4 Hz, Vopr = $V_{DD} - V_{LC}$

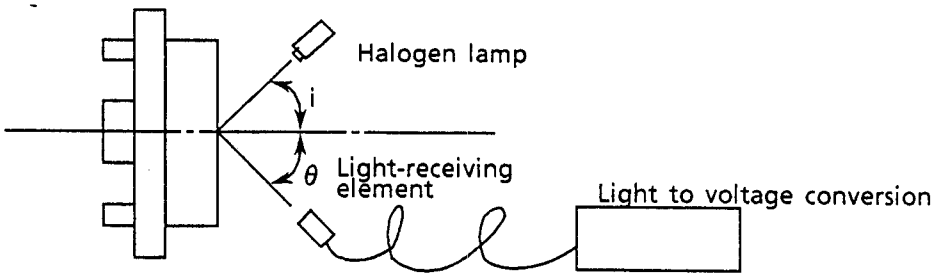
Item	Symbol	Conditions	Temp.	Min.	Typ.	Max.	Unit
Contrast*	C	θ = 0° ∅ = 0° Vopr = 13.0V	25℃	2.5	3.5	–	
Viewing angle	θ_1	C ≧ 2.0 ∅ = 0° Vopr = 13.0V	25℃	–	–	– 15	deg.
	θ_2			15	–	–	
	$\theta_2 - \theta_1$			30	–	–	
	θ_1	C ≧ 2.0 ∅ = 270° Vopr = 13.0V	25℃	–	–	– 20	
	θ_2			50	–	–	
	$\theta_2 - \theta_1$			70	–	–	
Response time**	t_{on}	θ = 0° ∅ = 0° Vopr = 13.0V	25℃	–	40	100	ms
	t_{off}			–	100	200	
	t_{on}	θ = 0° ∅ = 0° Vopr = 14.0V	– 20℃	–	630	1000	
	t_{off}			–	2300	3500	
Chromaticity*** Coordinates (x,y)	x	θ = 0° ∅ = 0°	25℃	0.290	–	0.340	
	y			0.320	–	0.360	
Color difference****	Δ E	θ = 0° ∅ = 0°	25℃	–	–	5	
Recommanded operating voltage	Vopr		– 20℃	–	14.0	15.0	V
			25℃	–	13.0	–	
			70℃	9.0	10.0	–	

(LED backlight : OFF)

Measurement equipment : Canon illuminometer LC-3S

* Contrast measurement

Direct a halogen lamp at the display dot section, receive the reflected light with a light-receiving element, convert the quantity of reflected light to voltage, and measure the contrast.



** Response time measurement

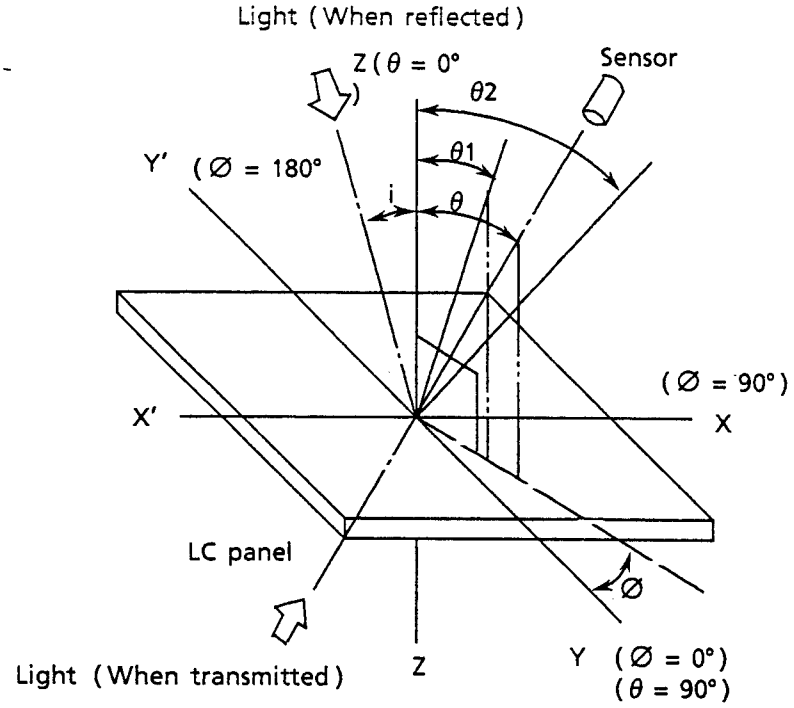
Use a transmissive panel to measure the response time.

*** CIE 1931 XYZ Color system (Measuring instrument : MINOLTA CR-100)

****CIE 1976 L*a*b* Uniform color space.

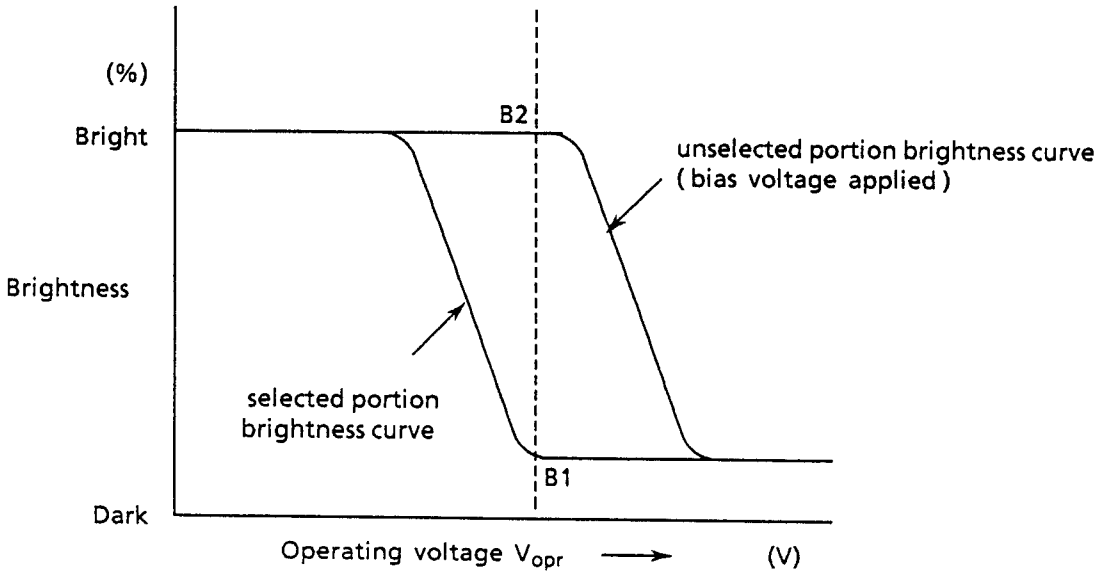
2.5.2 Definition of optical characteristics

*Definition of angles Ø and θ

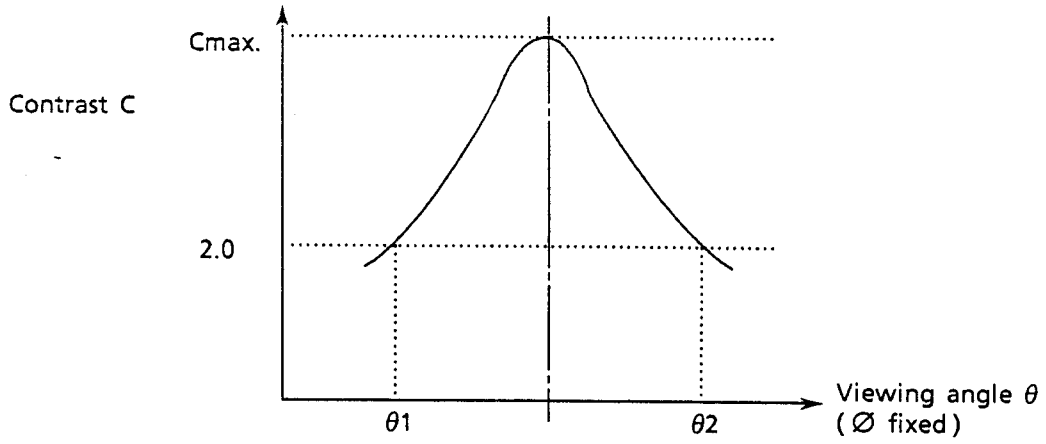


*Definition of contrast C

$$C = \frac{B2}{B1} = \frac{\text{Brightness (reflection) of unselected portion}}{\text{Brightness (reflection) of selected portion}}$$

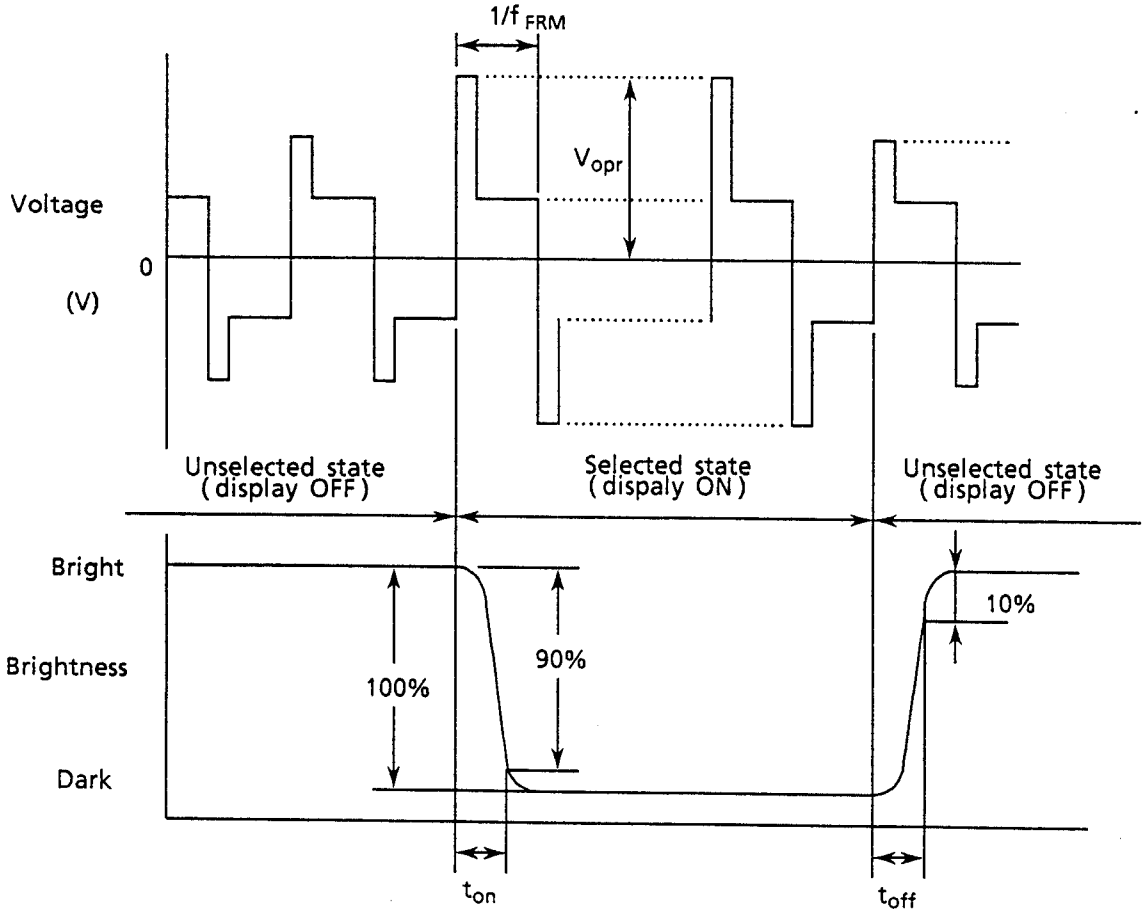


* Definition of viewing angles θ1 and θ2



Note : Optimum vision with the naked eye and viewing angle θ at Cmax above are not always the same.

* Definition of response time (Reflective type)



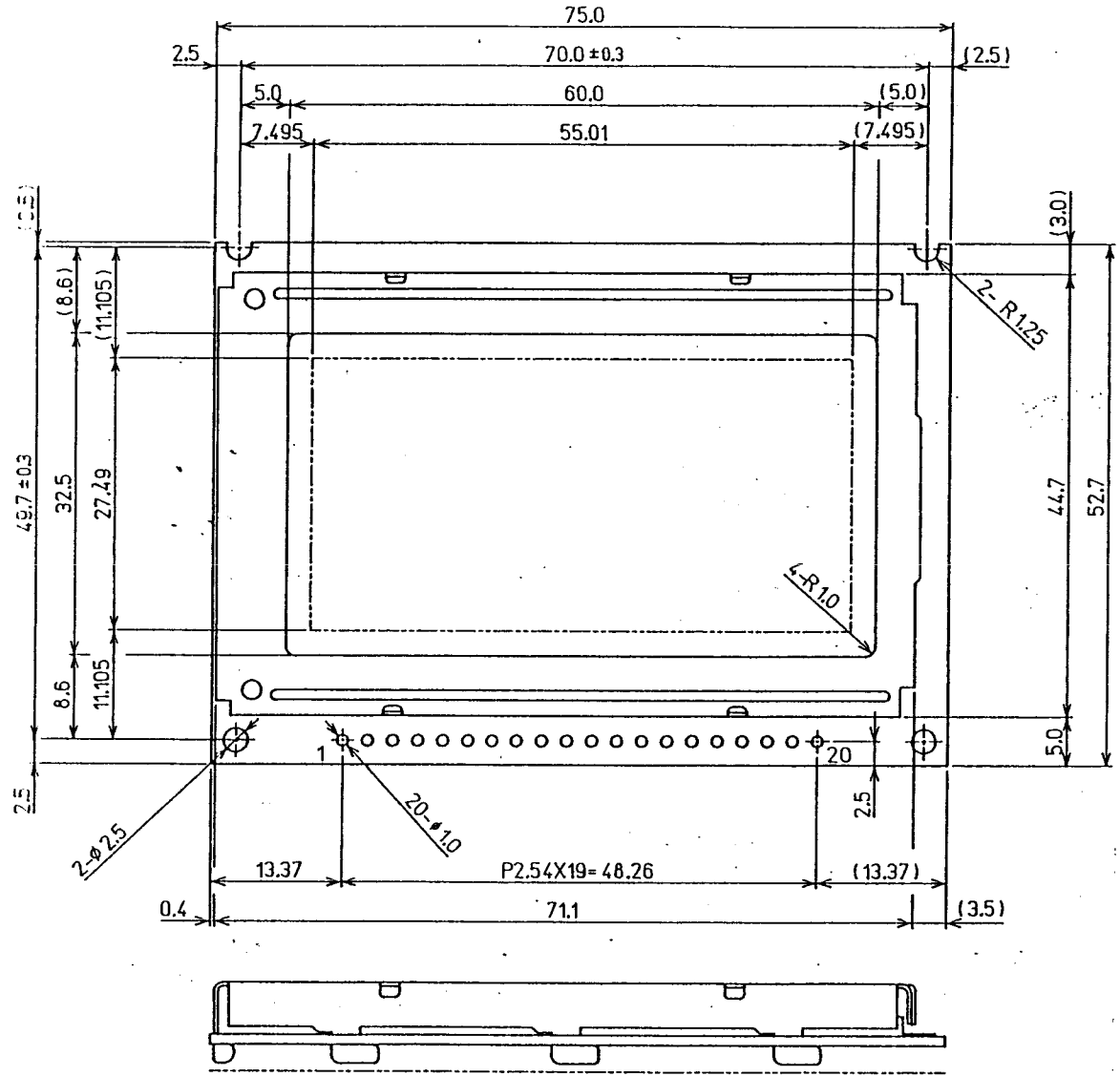
V_{opr} : Operating voltage [V]

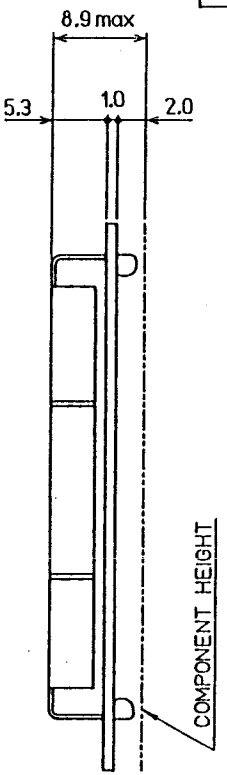
f_{FRM} : Frame frequency [Hz]

t_{on} : Response time (rise) [ms]

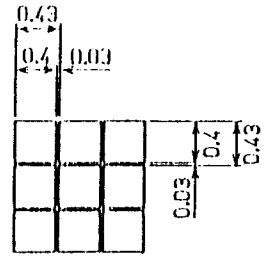
t_{off} : Response time (fall) [ms]

GENERAL TOLERANCE ±0.5
寸法一般公差





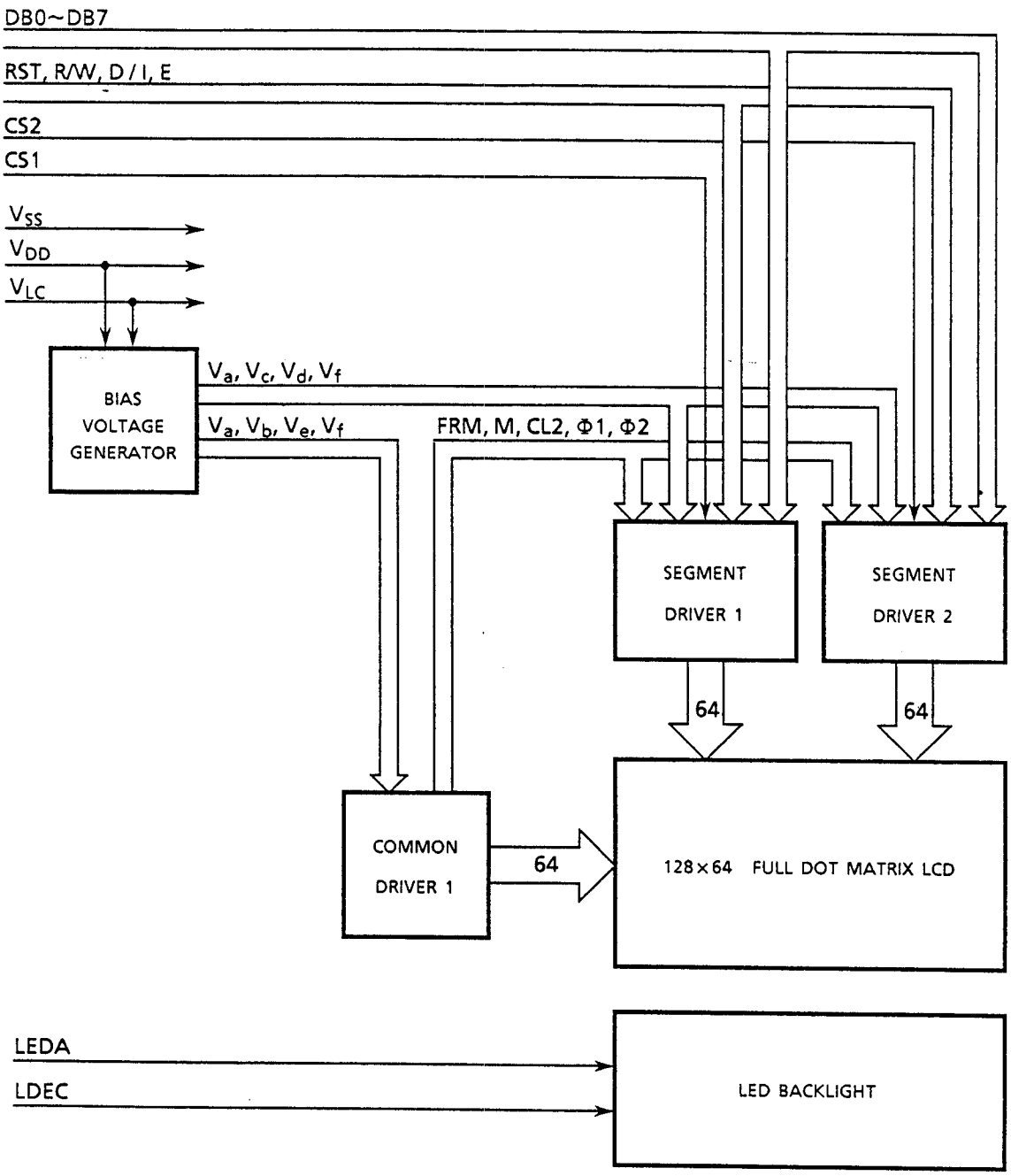
NO.	SYMBOL
1	VDD
2	VSS
3	VLC
4	DB0
5	DB1
6	DB2
7	DB3
8	DB4
9	DB5
10	DB6
11	DB7
12	CS1
13	CS2
14	RST
15	R/W
16	D/I
17	E
18	FGND
19	LEDA
20	LEDC



DOT DETAIL(20/1)

93A013	1993.12.21	重複検定	1	Oyake.	CUSTOMER		MATERIAL	DRAWING NUMBER	G1216B1N000	DATE DEC.10.1992	SHEET No.	REV. 1
93A001	1993.12.22	試作検定	A		DRIVER		Q'TY 1			TITLE 2.6 Dimensions		PAGE 151
		作成			SCALE 1/1	UNIT mm	LEADER BY	DESIGNED Hirayama	PART NUMBER			
							CHECKED BY Oyake	DRAWN		Seiko Instruments Inc.		

2.7 Circuit Block Diagram

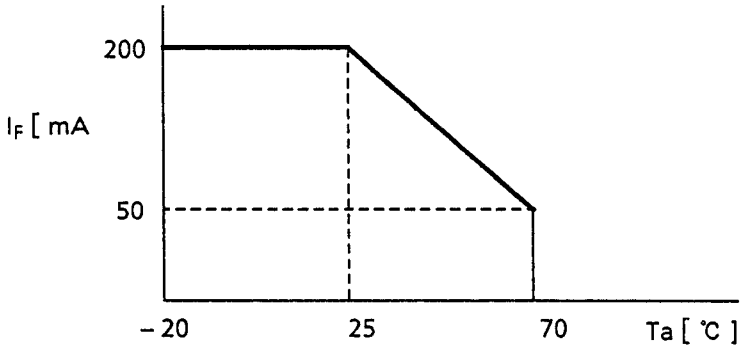


2.8 LED Backlight Characteristics

2.8.1 Absolute Maximum Ratings

Item	symbol	Standaed	Unit
Forward DC current	I_F	200*	mA
Reverse DC voltage	V_R	8	V
Allowable loss	P_D	860	mW
Operating temperature	T_{opr}	− 20 ~ + 70	℃
Storage temperature	T_{stg}	− 30 ~ + 80	℃

*Forward DC current vs. temperature characteristic

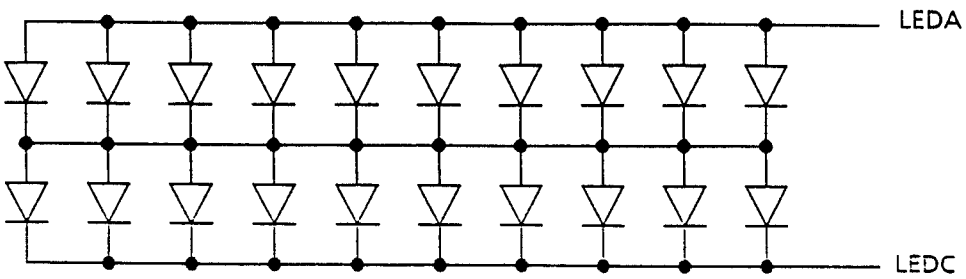


2.8.2 Electrical and Optical Characteristics

T_A = 25°C

Item	Sym-bol	Conditions	Standard			Unit
			Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 90 mA	3.8	4.1	4.4	V
Reverse current	I_R	V_F = 8V	–	–	0.9	mA
Peak emitting wavelength	λ_P	I_F = 90 mA	–	567	–	nm
Spectral half-width	$\Delta\lambda$	I_F = 90 mA	–	30	–	nm

2.8.3 Connection of LED



Total Number of LED = 2 x 10 = 20

2.8.4 Optical characteristics

Item	Symbol	Condition	Standard			Unit
			Min.	Typ.	Max.	
Surface brightness*1*2*3	B_P	Ta = 25 ± 3°C	1.0	2.0	–	nit
Distribution of brightness*1*2*4	$\triangle B_P$	30~85%RH	–	–	40	%

*1 Measurement, 30 minutes after turning on of LED

*2 Measurement equipment : BM - 7 (TOPCON)

LED driving conditions : I_F = 90 mA

LCD driving conditions: V_{opr} = Optimum operating voltage, f_{FLM} = 71.4 Hz

LCD display pattern: All OFF display (all data = "L")

*3 Initial brightness of LCD panel center

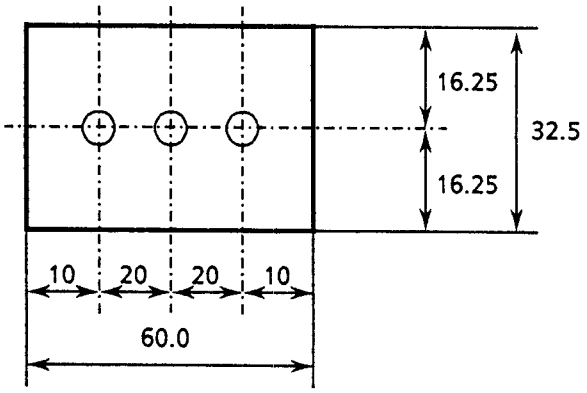
*4 Definition of $\triangle B_P$ (Distribution of brightness)

$$\triangle B_P = (B_P (max.) - B_P (min.)) / B_P (max.) \times 100 (\%)$$

B_P (max.) = Maximum brightness of 3 measuring points

B_P (min.) = Minimum brightness of 3 measuring points

3 measuring points



Unit: mm

2.8.5 Life

Item	Condition*2	Standard		Unit
		Min.	Max.	
Life*1	Ta = 25 ± 10°C	50000	–	hrs

*1 Time until the decreases to half of the initial brightness

*2 LED backlight lighting condition: I_F = 90 mA

3. RELIABILITY

3.1 Reliability

Test item	Test conditions	Evaluation and assessment
Operation at high temperature and humidity*	60°C ± 2°C 90% RH for 500 hours	No abnormalities in functions** and appearance***
Operation at high temperature*	80°C ± 2°C for 500 hours	No abnormalities in functions** and appearance***
Heat shock*	−30°C ⇄ +80°C Left for 1 hour at each temperature, transition time 5 min, repeated 10 times	No abnormalities in functions** and appearance***
Low temperature*	−30 ± 2°C for 500 hours	No abnormalities in functions** and appearance***
Vibration	Sweep for 1 min at 10 Hz, 55 Hz, 10 Hz, amplitude 1.5 mm 2 hrs each in the X, Y, and Z directions	No abnormalities in functions** and appearance***
Drop shock	Dropped onto a board from a height of 30 cm	No abnormalities in functions** and appearance***

* Evaluation and assessment are decided after 2 hours from each test is finished.
** Dissipation current, contrast and display functions
*** Polarizing filter deterioration, other appearance defects

3.2 Liquid crystal panel service life

100,000 hours minimum at 25°C ±10°C, 65%RH maximum.

3.3 Definition of panel service life

- Contrast becomes 30% of initial value
- Current consumption becomes three times higher than initial value
- Remarkable alignment deterioration occurs in LCD cell layer
- Unusual operation occurs in display functions

4. OPERATING INSTRUCTIONS

4.1 Terminal Functions

Signal name	No. of Terminals	I/O	Desti – nation	Function
DB0~DB7	8	I/O	MPU	Tristate bidirectional data buses.
RST	1	Input	MPU	The following registers can be initiarized by setting RST signal to "0" level. (1) ON/OFF register 0 set (display OFF) (2) Display start line register 0 line set.
E	1	Input	MPU	Operation start signal: The signal activates data write or read. At write (R/W = 0): Data of DB0 to DB7 is latched by the falling edge trigger of E. At read (R/W = 1): Data appears at DB0 to DB7 while E = "1".
R/W	1	Input	MPU	Read/Write selection signal. R/W = "1": Data appears at DB0 to DB7 and can be read to the MPU when E = "1" and CS1,CS2 = "0". R/W = "0": Data of DB0 to DB7 can be written to the module when CS1,CS2 = "0"
D/I	1	Input	MPU	Data/Instruction selection signal D/I = "1": Indicates that the data of DB0 to DB7 is display data. D/I = "0": Indicates that the data of DB0 to DB7 is display control data.
CS1,CS2	2	Input	MPU	CSn = "1": Non-selected CSn = "0": Selected, read/write enable (n = 1,2)
VDD	1	–	Power supply	Power supply terminal for logic circuit.
VSS	1	–	Power supply	Ground terminal
VLC	1	–	Power supply	Power supply terminal for driving liquid crystal display
LEDA	1	–	Power supply	Power supply terminal for driving LED backlight
LEDC	1	–	Power supply	Ground terminal for driving LED backlight
FGND*1	1	–	*1	Ground terminal for frame

*1:FGND is connected to the LCM metal vesel. Use this FGND terminal to ground the LCM vesel.

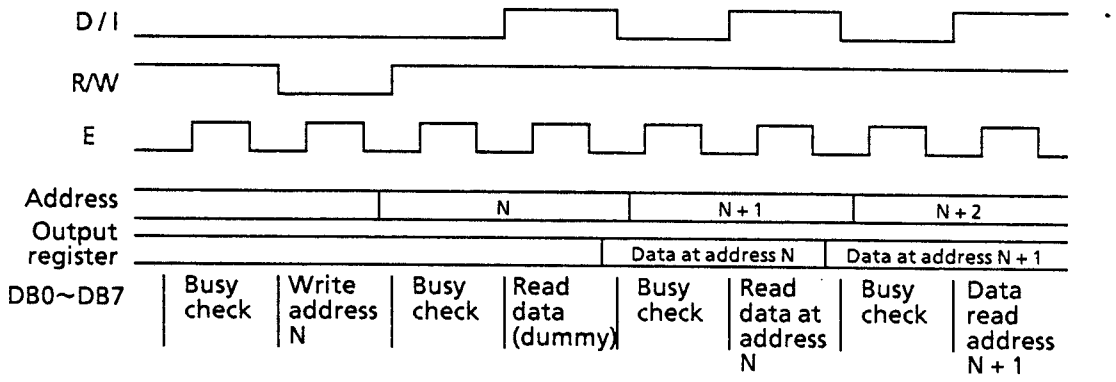
4.2 Basic Operations

4.2.1 Input register

The input register receives 8-bit data from the MPU. The 8-bit data is distinguished into the instruction data or display data by D/I signal and then operation starts. Data is received by the falling edge trigger of E signal when the CS1,CS2 is in the select state and R/W is write state.

4.2.2 Output register

The output register holds the data read from the display data RAM. After display data is read, the display data at the address now indicated is set in the output register. After that, the address is incremented or decremented by 1. Therefore, when an address is set, the correct data doesn't appear at the read of the first display data. The data at a specified address appears at the second read of data.



4.2.3 X,Y address counter

The X,Y address counter holds an address for reading/writing display data RAM. An address is set in it by the instruction. The Y address register is composed of a 64-bit UP/DOWN counter. The address is incremented or decremented by 1 by the read/write operaiton of display data. The UP/DOWN mode can be determined by the instruction or RST signal. The Y address register loops the values of 0 to 63 to count. The X address register has no count function.

4.2.4 Display ON/OFF flip flop

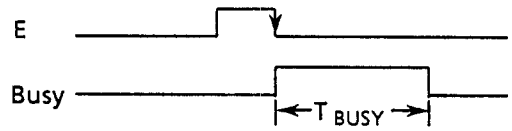
The flip flop is set to ON or OFF state by the instruction or RST signal. In the OFF state, the display data disappears as the latch of display data RAM output is held reset and the display data output is set to 0. In the ON state, the display data appears according to the data in the RAM. The display data in the RAM is independent of the display ON/OFF.

4.2.5 Display start line register

The display start line register holds the 6-bit data that indicates a display start line. This value is preset to the lower 6 bits of the Z address counter by the FRM signal. This value indicates the value of the display RAM line displayed at the top of the screen.

4.2.6 Busy flag

After the instruction except Status Read is accepted, the busy flag is set during internal operations, and reset when the instruction is executed. The value can be read out on DB7 by the Status Read instruction.
The LCD module cannot accept any other instructions than the Status Read in the busy state. Make sure the busy flag is reset before excuting an instruction.



$$\frac{1}{F\emptyset} \leq T_{BUSY} \leq \frac{3}{F\emptyset}$$

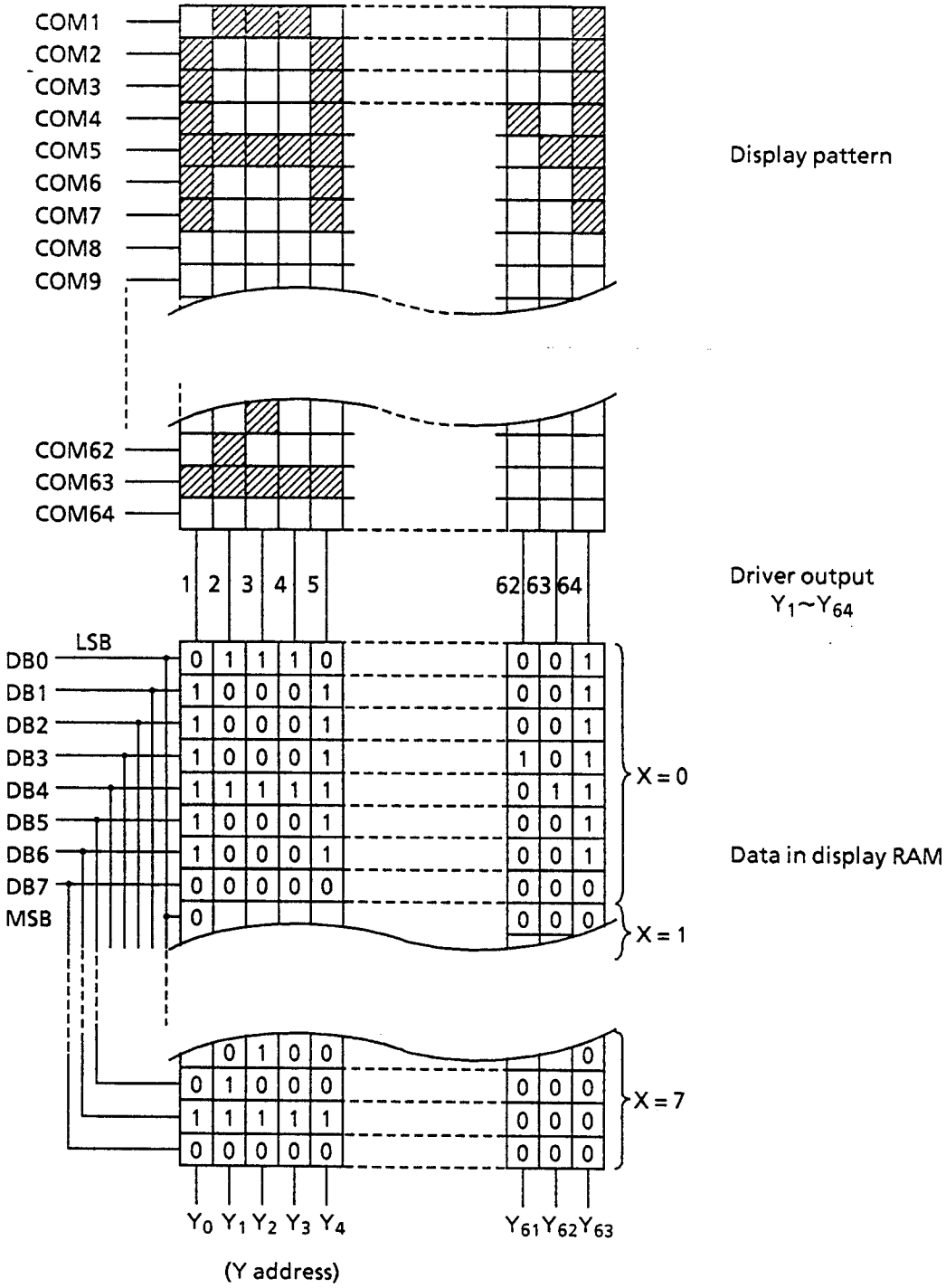
FØ is Ø1, Ø2 frequency (half of common driver HD61203 oscillation frequency) : (225) kHz typ.

4.2.7 Z address counter

The Z address counter generates addresses for outputting the display data syncronized with the common signal. This counter consists of 6-bit and counts up at the fall of CL signal. With "1" level of FRM, the contents of the display start line register is preset at the Z counter.

4.2.8 Display RAM

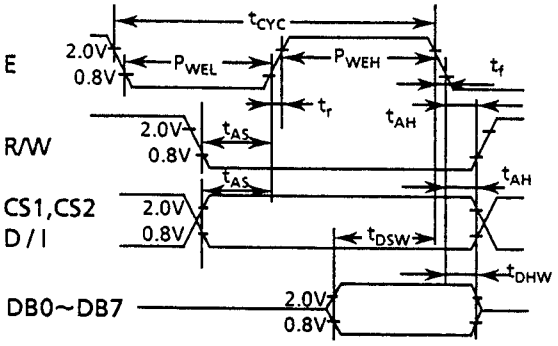
Relationship between data and display RAM of one driver.



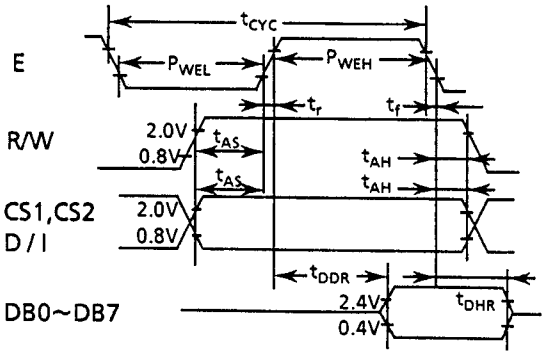
4.3 Timming Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit	Note
E cycle time	t_{CYC}	1000	-	-	ns	1, 2
E high level width	P_{WEH}	450	-	-	ns	1, 2
E low level width	P_{WEL}	450	-	-	ns	1, 2
E rise time	t_r	-	-	25	ns	1, 2
E fall time	t_f	-	-	25	ns	1, 2
Address setup time	t_{AS}	140	-	-	ns	1, 2
Address hold time	t_{AH}	10	-	-	ns	1, 2
Data setup time	t_{DSW}	200	-	-	ns	1
Data delay time	t_{DDR}	-	-	320	ns	2, 3
Data hold time at write	t_{DHW}	10	-	-	ns	1
Data hold time at read	t_{DHR}	20	-	-	ns	2

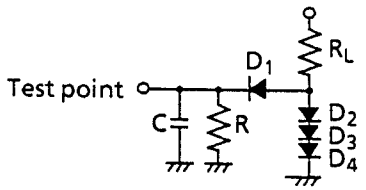
Note 1: Data write from MPU to module



Note 2: Data read from module to MPU



Note 3: DB0 to DB7 load circuits

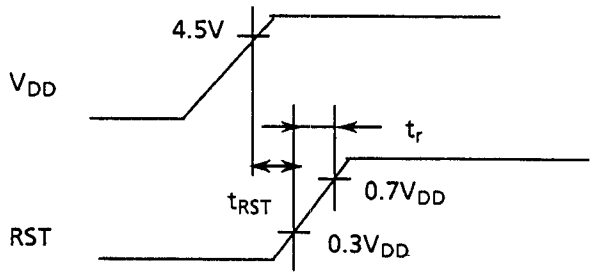


R_L = 2.4 kΩ
R = 11 kΩ
C = 130 pF
Diodes D1 to D4 are all 1S2074Ⓗ

4.4 Reset

The system can be initialized by setting RST terminal at "0" level when turning power ON (Display OFF, set display start line register 0 line). While RST is in "0" level, any instruction except Status Read cannot be accepted. Therefore, carry out other instructuons after making sure that DB4="0" (clear RESET) and DB7="0" (Ready) by status read instruction. The conditions of power supply at initial power up are as follows.

Item	Symbol	Min	Typ.	Max	Unit
Reset time	t_{RST}	1.0	–	–	μs
Rise time	t_r	–	–	200	ns



Do not fail to set the system again because RESET during operation may destroy the data in all the register except ON/OFF register and in RAM.

4.5 Instruction

4.5.1 Read/Write display data

		MSB							LSB	
R/W	D/I	7	6	5	4	3	2	1	0	
1	1	(Display data)								Read (MPU ← LCD module)
0	1	(Display data)								Write (MPU → LCD module)

Sends data to or receives data from the display RAM addressed in advance. However, the dummy read may be required for reading display data. (See 4.2.2 Output register)

4.5.2 Display ON/OFF

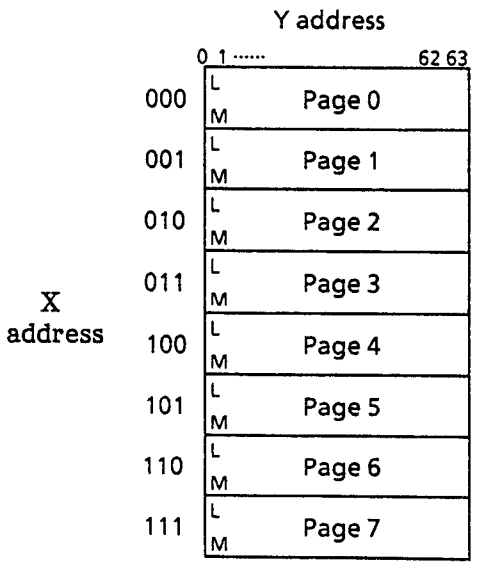
		MSB							LSB	
R/W	D/I	7	6	5	4	3	2	1	0	
0	0	0	0	1	1	1	1	1	1	Display ON
0	0	0	0	1	1	1	1	1	0	Display OFF

Controls the ON/OFF of display. RAM data is not affected.

4.5.3 Set X address

		MSB							LSB
R/W	D/I	7	6	5	4	3	2	1	0
0	0	1	0	1	1	1	A	A	A

X address AAA (binary) of the display data RAM is set at the X address register. After that, writing or reading to or from MPU is excuted in this specified page until next page is set.



Display Data RAM of one driver.

4.5.4 Set Y address

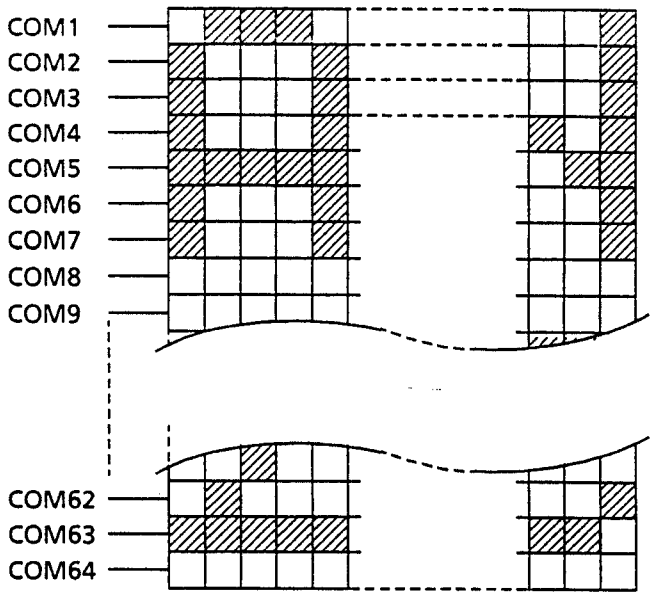
		MSB							LSB
R/W	D/I	7	6	5	4	3	2	1	0
0	0	0	1	A	A	A	A	A	A

Y address AAAAAA (binary) of the display data RAM is set at the Y address counter. After that, Y address counter is incremented by 1 every time the data is written or read to or from MPU.

4.5.5 Display start line

		MSB							LSB
R/W	D/I	7	6	5	4	3	2	1	0
0	0	1	1	A	A	A	A	A	A

Z address AAAAAA (binary) of the display data RAM is set at the display start line register and displayed at the top of the screen. Fig.1 and 2 are the examples of display (1/64 duty) when the start line=0-3. The data of total line number of LCD screen, from the line specified by display start line instruction, is displayed.



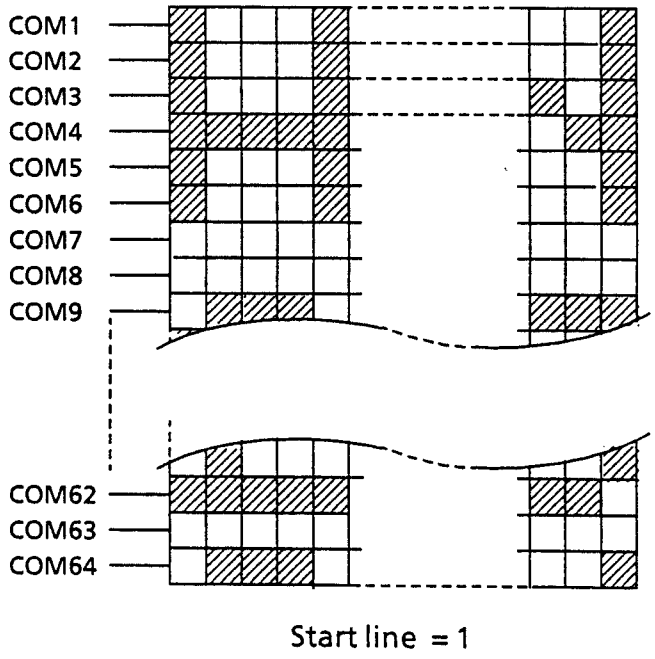


Fig.1 Relation between Start Line and Display

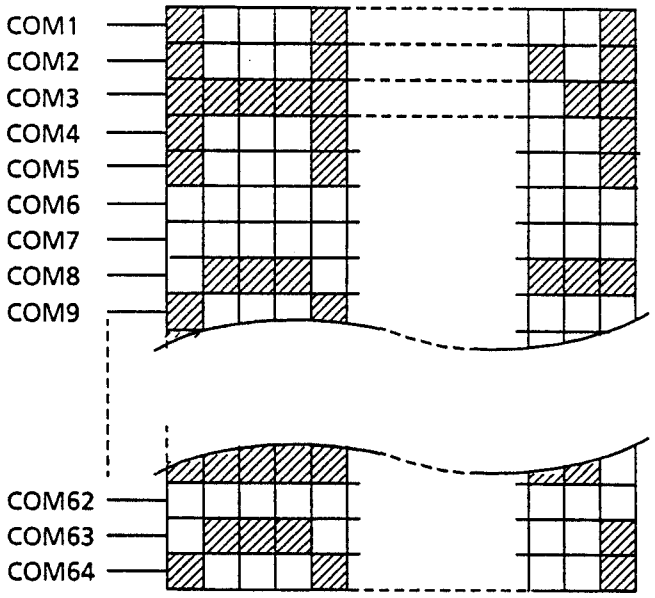


Fig.2 Relation between Start Line and Display

4.5.6 Status read

		MSB							LSB
R/W	D/I	7	6	5	4	3	2	1	0
1	0	BUSY	0	OFF/ON	RESET	0	0	0	0

BUSY: When BUSY is "1", the LSI is in internal operation. No instructions are accepted while BUSY is "1", so BUSY="0" should be made sure before writing the next instruction.

ON/OFF: This bit shows the liquid crystal display condition is ON or OFF. When ON/OFF is "1", the display is in OFF condition. When ON/OFF is "0", the display is in ON condition.

RESET: RESET="1" shows that the system is being initialized. In this condition, any instructions except Status Read instruction cannot be accepted. RESET="0" shows that initializing has finished and the system is in the usual operation.

5. NOTES

Safety

- If the LCD panel breaks, be careful not to get the liquid crystal in your mouth. If the liquid crystal touches your skin or clothes, wash it off immediately using soap and plenty of water.

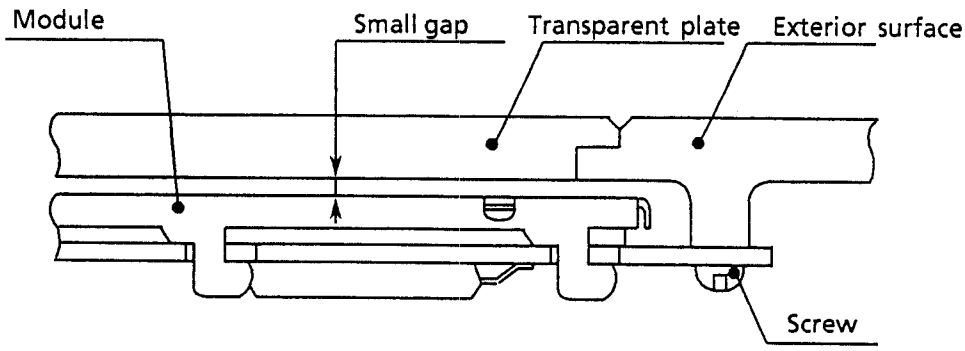
Handling

- Avoid static electricity as this can damage the CMOS LSI.
- The LCD panel is plate glass; do not hit or crush it.
- Do not remove the panel or frame from the module.
- The polarizing plate of the display is very fragile; handle it very carefully

Mounting and Design

- Mount the module by using the specified mounting part and holes.
- To protect the module from external pressure, place a transparent plates (e.g. acrylic or glass), leaving a small gap, over the display surface, frame, and polarizing plate.

☆Example



- Design the system so that no input signal is given unless the power-supply voltage is applied.
- Keep the module dry. Avoid condensation, otherwise the transparent electrodes may break.

Storage

- Store the module in a dark place where the temperature is 25°C ±10°C and the humidity below 65% RH.
- Do not store the module near organic solvents or corrosive gases.
- Do not crush, shake, or jolt the module (including accessories).

Cleaning

- Do not wipe the polarizing plate with a dry cloth, as it may scratch the surface.
- Wipe the module gently with a soft cloth soaked with a petroleum benzine.
- Do not use ketonic solvents (ketone and acetone) or aromatic solvents (toluene and xylene), as they may damage the polarizing plate.

6. OPERATION PRECAUTIONS

Any changes that need to be made in this specification or any problems arising from it will be dealt with quickly by discussion between both companies.