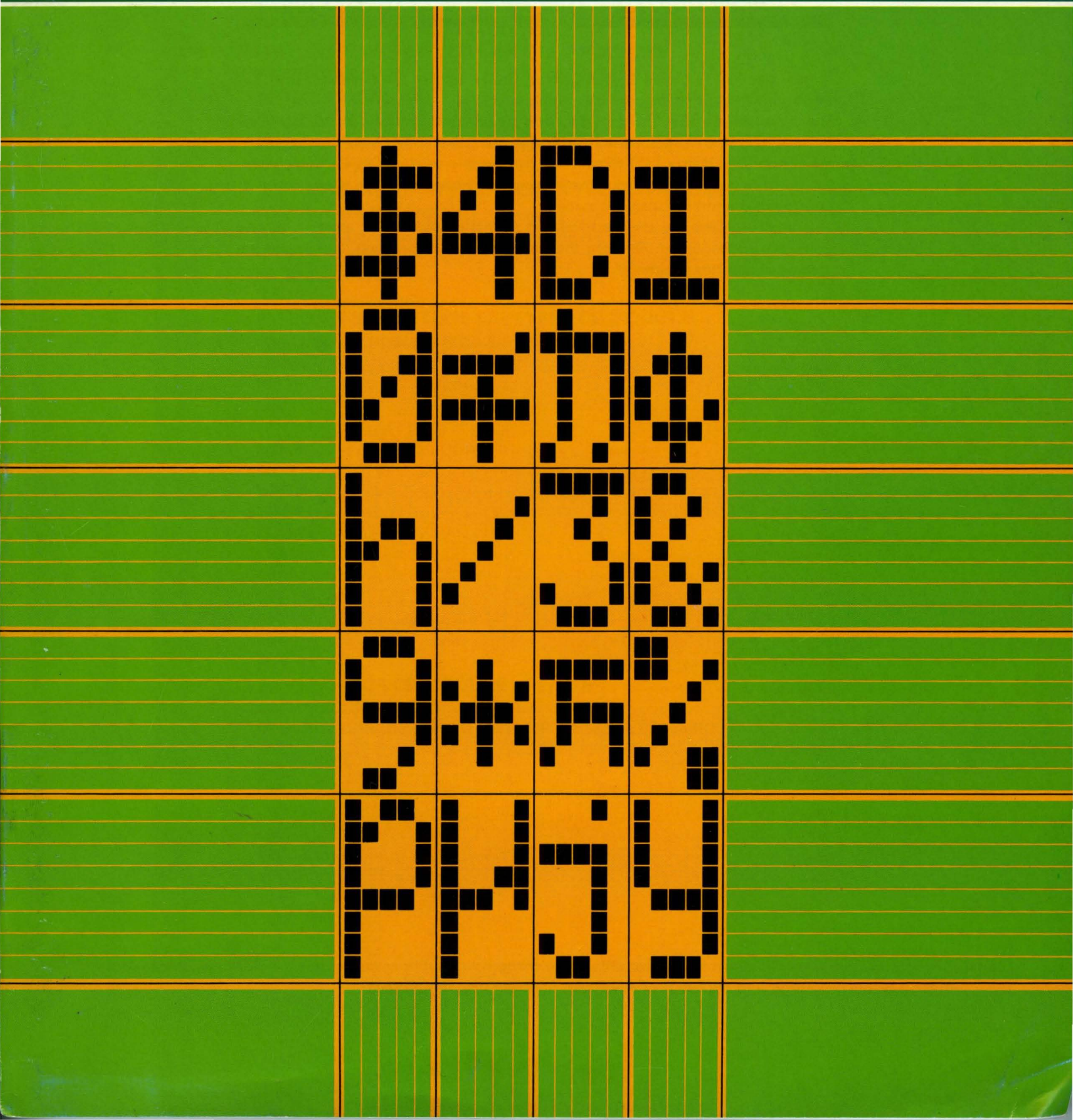


HITACHI DOT MATRIX LIQUID CRYSTAL DISPLAY



PREFACE

Hitachi Dot Matrix Liquid Crystal Display (LCD) Module was developed to display numerals, alphabet, symbols, graphics, etc.

The twist-nematic type liquid crystal, with a high contrast ratio was used. Due to its small size, light weight, low voltage, low power consumption, easy handling, etc., the Hitachi Dot Matrix LCD Module has been widely used as a display component for portable data terminal equipment, word processors and high class electronic tabletop calculators in Japan and abroad.

This brochure describes the electrical and optical characteristics, external dimensions and precautions in handling the standard type of products, and it can be used when selecting equipment.

Note: The information contained herein is tentative and may be changed without prior notice. It is therefore advisable to contact Hitachi before proceeding with the design of equipment in incorporating this product.

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TABULATED DATA FOR HITACHI DOT MATRIX LIQUID CRYSTAL

Type	Type No.	Number of display character	External dimensions W x H x T (mm)	Effective viewing area W x H (mm)	Character dimensions W x H (mm)	Driving method duty	
Character type (Control LSI attachment type)	H2532A	16 x 1 line	84 x 44 x 15 max.	61 x 15.8	2.9 x 5.5	1/8 D	
	H2535	16 x 2 lines	84 x 44 x 15 max.	61 x 15.8	2.9 x 4.1	1/16 D	
	H2538A	40 x 1 line	220 x 50 x 15 max.	163 x 17	3.15 x 5.5	1/8 D	
	H2539	40 x 2 lines	220 x 50 x 15 max.	163 x 17	3.15 x 4.45	1/16 D	
Character type (Built-in control LSI type)	1 line series	LM054	8 x 1 line	84 x 44 x 13 max.	61 x 15.8	6.45 x 9.4	1/8 D
		H2570	16 x 1 line	80 x 36 x 12 max.	64.5 x 13.8	3.15 x 7.9	1/11 D
		LM015	16 x 1 line	80 x 36 x 12 max.	64.5 x 13.8	3.15 x 5.5	1/8 D
		LM020L	16 x 1 line	80 x 36 x 12 max.	64.5 x 13.8	3.07 x 5.73	1/16 D
		LM038	20 x 1 line	182 x 35.5 x 13 max.	154.4 x 15.8	6.7 x 9.4	1/8 D
		LM027	24 x 1 line	126 x 36 x 12 max.	100 x 13.8	3.15 x 7.9	1/11 D
		H2571	32 x 1 line	174.5 x 33 x 13.4 max.	132.5 x 14	3.15 x 7.9	1/11 D
		H2572	40 x 1 line	182 x 35.5 x 13 max.	154.4 x 15.8	3.15 x 7.9	1/11 D
	2 lines series	LM052L	16 x 2 lines	80 x 36 x 12 max.	64.5 x 13.8	2.95 x 3.8	1/16 D
		LM016L	16 x 2 lines	84 x 44 x 12 max.	61 x 15.8	2.95 x 4.86	1/16 D
		LM032L	20 x 2 lines	116 x 37 x 13 max.	83 x 18.6	3.2 x 4.85	1/16 D
		LM017L	32 x 2 lines	174.5 x 33 x 13.4 max.	141.2 x 16.75	3.45 x 4.85	1/16 D
		LM018L	40 x 2 lines	182 x 35.5 x 13 max.	154.4 x 15.8	3.2 x 4.85	1/16 D
	4 lines series	LM041L	16 x 4 lines	87 x 60 x 12 max.	61.8 x 25.2	2.95 x 4.15	1/16 D
		LM044L	20 x 4 lines	98 x 60 x 12 max.	76 x 25.2	2.95 x 4.15	1/16 D
	Full dot type (Graphic type)	H2525	20 dot x 239 dot	220 x 53 x 15 max.	163 x 17	—	1/20 D
LM021		24 dot x 479 dot	290 x 60 x 13 max.	245 x 19	—	1/24 D	
LM200		64 dot x 240 dot	180 x 75 x 15 max.	132 x 39	—	1/32 D	
LM213B		64 dot x 256 dot	184 x 75 x 12 max.	149.6 x 43	—	1/64 D	
LM211		64 dot x 480 dot	270 x 82 x 13 max.	240 x 38	—	1/64 D	
LM212		48 dot x 640 dot	270 x 63 x 14 max.	241 x 25	—	1/48 D	
LM215		128 dot x 480 dot	270 x 110 x 15 max.	242 x 69	—	1/64 D	

Note 1. Transflective reflector (T-type), and character display type LCM of wider temperature range (at operating: $-10^{\circ}\text{C} \sim +70^{\circ}\text{C}$, at storage: $-40^{\circ}\text{C} \sim +80^{\circ}\text{C}$) (H-type), are available in request.

Note 2. Applicable only for replacement: LM020, LM016, LM032, LM017, LM018, LM041, LM044

DISPLAY MODULE

	Recommended power supply		Power consumption typ. (mW)	Operating temperature (°C)	Storage temperature (°C)	Weight (g)	Power supply	LSI for LCD driving (Built in)	Recommendable control LSI	Page
	V _{DD} - V _{SS} (V)	V _{EE} - V _{SS} (V)								
	+5	-5	10	0 ~ +50	-20 ~ +60	40	-	HD44100	HD43160A	13
	+5	-5	10	0 ~ +50	-20 ~ +60	40				15
	+5	-5	10	0 ~ +50	-20 ~ +60	100				17
	+5	-5	10	0 ~ +50	-20 ~ +60	100				19
	+5	-	10	0 ~ +50	-20 ~ +70	25	Single	HD44780	Built-in type	31
	+5	-	10	0 ~ +50	-20 ~ +70	25		HD44780 + HD44100		34
	+5	-	10	0 ~ +50	-20 ~ +70	25		HD44780		36
	+5	-	10	0 ~ +50	-20 ~ +70	25		HD44780		39
	+5	-	10	0 ~ +50	-20 ~ +70	65		HD44780 + HD44100		42
	+5	-	10	0 ~ +50	-20 ~ +70	40		HD44780 + HD44100		45
	+5	-	10	0 ~ +50	-20 ~ +70	60		HD44780 + HD44100		48
	+5	-	10	0 ~ +50	-20 ~ +70	65		HD44780 + HD44100		51
	+5	-	15	0 ~ +50	-20 ~ +70	25		Single		HD44780 + HD44100	Built-in type	54
	+5	-	15	0 ~ +50	-20 ~ +70	25	HD44780 + HD44100		57	
	+5	-	15	0 ~ +50	-20 ~ +70	50	HD44780 + HD44100		60	
	+5	-	15	0 ~ +50	-20 ~ +70	60	HD44780 + HD44100		63	
	+5	-	15	0 ~ +50	-20 ~ +70	65	HD44780 + HD44100		66	
	+5	-	15	0 ~ +50	-20 ~ +70	60	Single	HD44780 + HD44104	Built-in type	69
	+5	-	15	0 ~ +50	-20 ~ +70	65		HD44780 + HD44104		72
	+5	-5	10	0 ~ +50	-20 ~ +60	100	-	HD44104	Attachment type CB1020R (HD61830)	82
	+5	-5	20	0 ~ +50	-20 ~ +60	150		HD44100		85
	+5	-5	20	0 ~ +50	-20 ~ +60	150		HD44104		88
	+5	-9	80	0 ~ +40	-20 ~ +60	150		HD61830 + HD44104	Built-in type	91
	+5	-9	60	0 ~ +40	-20 ~ +60	180		HD44104	Attachment type CB1026R (HD61830)	93
	+5	-	50	0 ~ +40	-20 ~ +60	170	Single	HD44104		96
	+5	-10	(100)	0 ~ +40	-20 ~ +60	320	-	HD61100 + HD61103	Attachment type CB1030R (HD61830)	100

PHOTOGRAPHS OF LCD MODULE PRODUCTS

CONTROL LSI ATTACHMENT TYPE LCD MODULE



• H2532A



• H2538A



• H2535



• H2539

BUILT-IN CONTROL LSI TYPE LCD MODULE



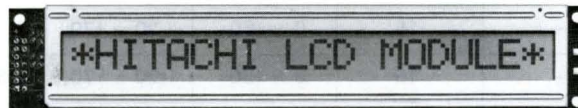
• LM054



• LM032



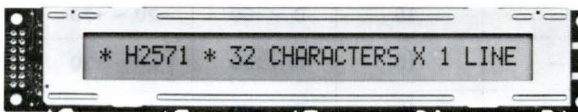
• H2570



• LM038



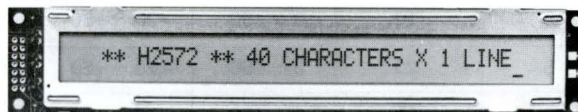
• LM015



• H2571



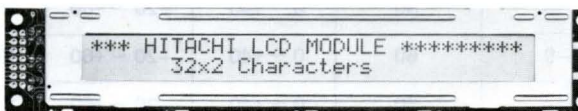
• LM027



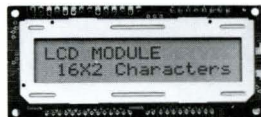
• H2572



• LM020L



• LM017L



• LM052L



• LM018L



• LM016L

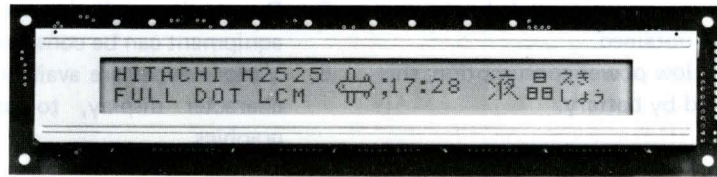


• LM041L



• LM044L

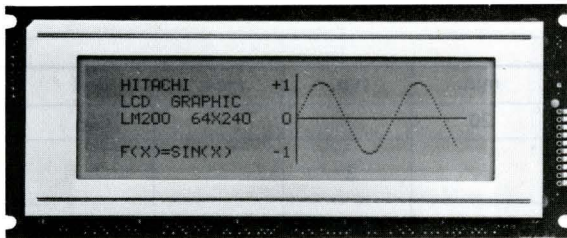
GRAPHIC LCD MODULE



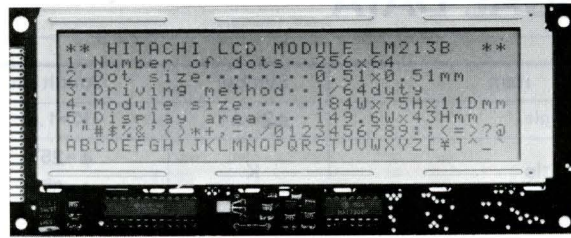
• H2525



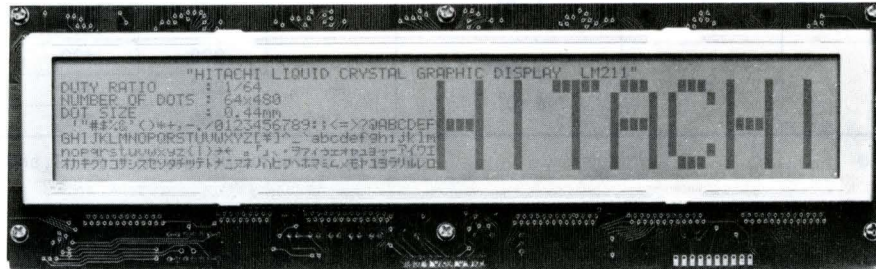
• LM021



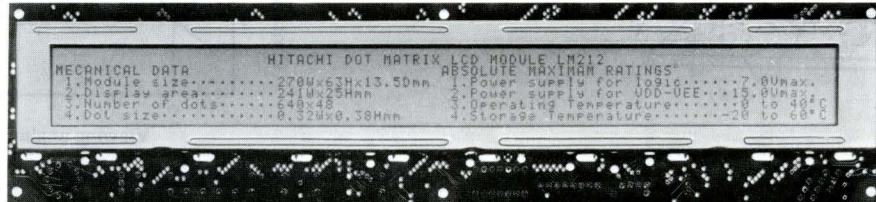
• LM200



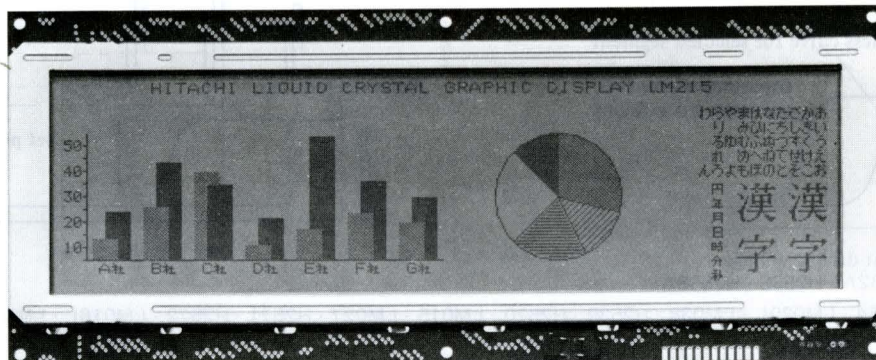
• LM213B



• LM211



• LM212



• LM215

FEATURES

1. By the combination of dots, numerals, alphabets, symbols, graphics, etc. can be displayed.
2. Due to the twist-nematic type liquid crystal, bright and high-contrast displays can be obtained.
3. Due to low drive voltage and low power consumption, this LCD module may be operated by battery.
4. An LSI is loaded exclusively for the LCD element drive. Also, a type containing a control LSI is available.
5. Due to its small size and light weight, compact display equipment can be constructed.
6. Various types are available, from small-sized modules for character display, to large-sized display module for graphics.

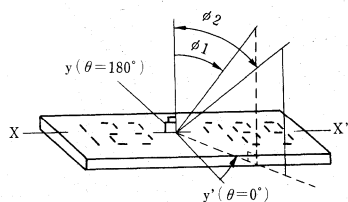
APPLICATIONS

- Portable data terminal equipment
- Word processor
- High class electronic tabletop calculator
- POS terminal equipment
- Measuring instruments
- Other display devices

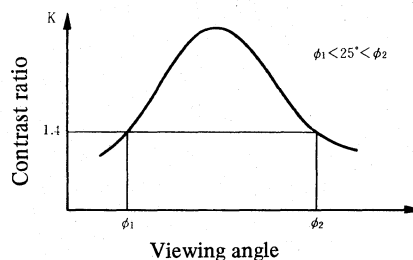
OPTICAL DATA

Item	Symbol	Condition	min.	typ.	max.	Unit	Note
Viewing angle	$\phi 2 - \phi 1$	$K=1.4$	20	—	—	deg.	1, 2, 8
Contrast ratio	K	$\phi = 25^\circ$ $\theta = 0^\circ$	—	3	—	—	3
Response time (rise)	t_r	$\phi = 25^\circ$ $\theta = 0^\circ$	—	200	400	ms	4, 5
				250	400		4, 6
				150	250		4, 7
Response time (fall)	t_f	$\phi = 25^\circ$ $\theta = 0^\circ$	—	200	400	ms	4, 5
				250	400		4, 6
				150	250		4, 7

Note 1. Definition of θ and ϕ

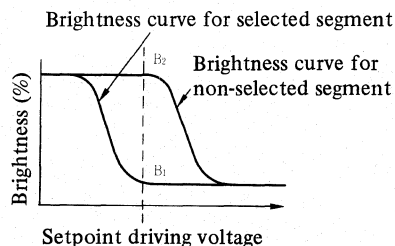


Note 2. Definition of viewing angle ϕ_1 , and ϕ_2

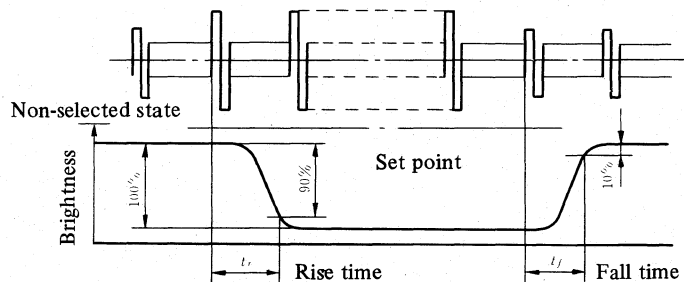


Note 3. Definition of contrast "K"

$$K = \frac{\text{Brightness of non-selected segment (B}_2\text{)}}{\text{Brightness of selected segment (B}_1\text{)}}$$



Note 4. Definition of optical response



Note 5. Applied type: H2532A · H2535 · H2538A ·

Note 6. Applied type: LM054 · LM020L · LM038 · H2539 · H2570 · LM015 · LM027 · H2571 · H2572 · LM016L · LM032L · LM017L · LM018L · LM041L · LM044L · LM052L

Note 7. Applied type: H2525 · LM200 · LM021 · LM213B · LM211 · LM212 · LM215

Note 8. Viewing angle of LM200 · LM213B · LM211 · LM212 · LM215; typical 20 deg.

HOW TO HANDLE THE LIQUID CRYSTAL DISPLAY MODULE

This module is composed of the liquid crystal display device and the CMOS LSI drive unit. When using LCM, please observe the following precautions.

1. Since this module uses a CMOS LSI, the same careful attention should be paid to static electricity as for an ordinary CMOS IC.
 - (1) Make certain that you are grounded when handling LCM.
 - (2) Before removing LCM from its packing case or incorporating it into a set, be sure that the module and your body have the same electric potential.
 - (3) When soldering the terminal of LCM, make certain that the AC power source for the soldering iron does not leak.
 - (4) When using an electric screwdriver to attach LCM, the screwdriver should be of ground potential. Try to minimize as much as possible any transmission of electromagnetic waves produced by sparks coming from the commutator of the motor.
 - (5) As far as possible make the electric potential of your work clothes and that of the work bench the ground potential.
 - (6) To reduce the generation of static electricity, be careful that the air in the work area does not become too dry. (A relative humidity of at least 50% is recommended.)
2. Be sure to handle the module carefully so as not to scratch or damage the glass and polarizer (plastic film) of LCM.
 - (1) Do not drop, bend or twist LCM.
 - (2) Do not strike or rub the display surface with a hard object, because the polarizer can easily be exposed and be damaged. Also, touching the module with bare hands is one cause of contamination.
 - (3) Do not allow any foreign matter like oils and resins to stick to the module.
 - (4) In case any dust or dirt should stick on the display surface, wipe it off gently with soft gauze. Avoid wiping the display surface with solvents including thinner, IPA and trichloroethane. When wiping the display surface, use petroleum benzine (special class) made by Nihon Sekiyu Co. or an equivalent product.
 - (5) Avoid placing any object directly on the display surface for any length of time because it may leave marks.
3. Since LCM has been assembled and adjusted with a high degree of precision, avoid applying excessive shocks to the module or making any alterations or modifications to it.
 - (1) Do not alter, modify or change the shape of the clips on the metal frame.
 - (2) Do not drill attachment holes in the printed circuit board, modify its shape or change the positions of components to be attached.
 - (3) Do not damage or modify the pattern wiring on the printed circuit board.
 - (4) Absolutely do not modify or change the interconnector (conductive rubber) or touch it with another object.
 - (5) Except for soldering the interface, do not make any alterations or modifications with a soldering iron.

The precautions that should be observed when handling LCM have been explained above. If any points are unclear or if you have any requests, please contact Hitachi.

CONTROL LSI ATTACHMENT TYPE LCD MODULE

This module consists of LCD device, drive LSI, PC board, and other parts.

By attaching the control LSI HD43160A, numerals, alphabets, Kana, and symbols can be displayed.

Control LSI HD43160AH for LCD Module

H2532A	(16 x 1 line)
H2535	(16 x 2 lines)
H2538A	(40 x 1 line)
H2539	(40 x 2 lines)

CONTROL LSI HD43160AH FOR LCD MODULE

- Controller with built-in character generator
- Applicable type: H2532 · H2535 · H2538A · H2539

The HD43160AH receives character data written in the ASCII code or JIS code from microcomputer and stores them in its RAM which has 80 words capacity.

The HD43160AH converts these data into serial character pattern, then transfers them to LCD drivers. It also generates other signals for LCD.

1. CHARACTER DISPLAY

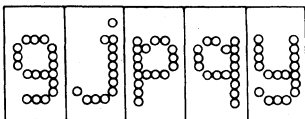
- Alphanumeric character; A ~ Z, a ~ z, @, #, %, &, etc.
- Japanese Character (katakana)
- 160 characters by internal character generator (ROM). (Max. 256 characters by external ROM)

2. CHARACTER DOT PATTERNS

- 5 x 7
- The bottom lines of the English small characters "g, i, p, q, y," are on the cursor line.

		Character code lower 4 bits (hexadecimal)															
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Character code upper 4 bits (hexadecimal)	2		o	oo	ooo	oooo	oooo	oooo	oooo	oooo	oooo	oooo	oooo	oooo	oooo	oooo	oooo
	3	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p
	4	q	r	s	t	u	v	w	x	y	z	0	1	2	3	4	5
	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L
	6	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	[]
	7	{	}	~	^	_	`	~	~	~	~	~	~	~	~	~	~
	A	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
	B	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
	C	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
	D	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~

- 5 x 11
- Only English small character "g, j, p, q, y," are displayed as below, the others are in the same way as that of 5 x 7.



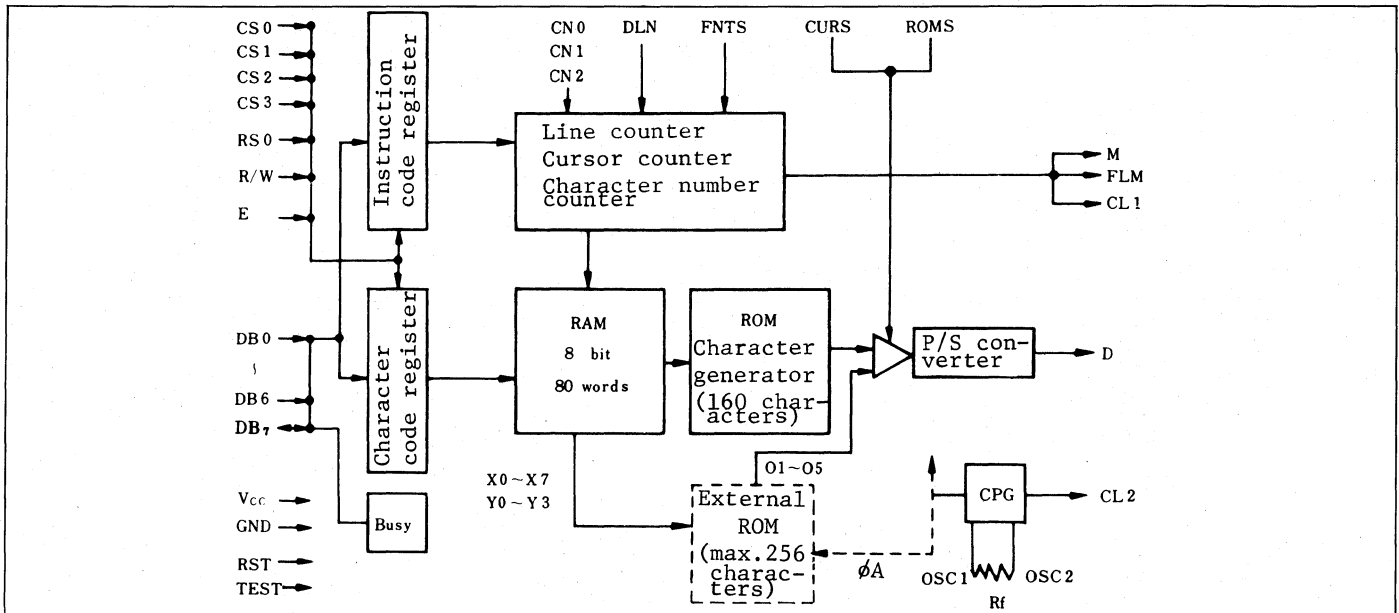
- Cursor 5 dots: ●●●●●
- 1 dot : ●

The cursor is displayed on the 8th or 12th line.

3. OTHER FUNCTION CONTROLLED BY MICROCOMPUTER

- Display clear
- Cursor ON/OFF
- Cursor position preset (Character position)
- Cursor return

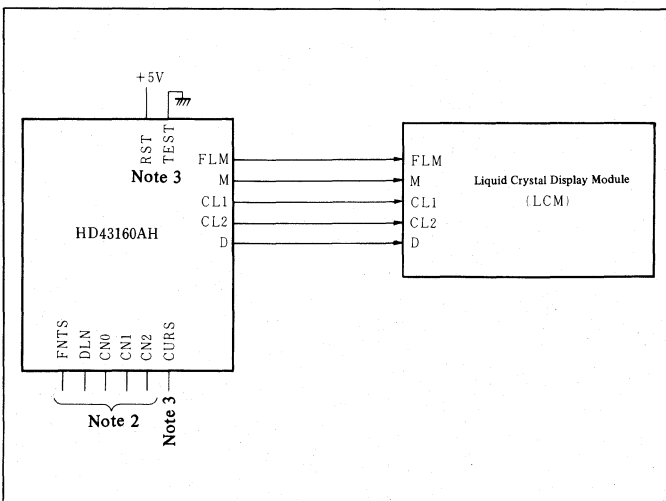
4. BLOCK DIAGRAM



5. The HD43160A is a CMOS LSI developed to control the LCD module described below, and contains a character generator and character data memory.

Applied type: H2532A, H2535, H2538A, H2539, H2555, and H2568.

Example of a connection between HD43160AH and LCD module.



Note 1: When CURS = "1", the cursor has a 5 x 1 dot constitution. (■■■■■)
When CURS = "0", the cursor has a 1 x 1 dot constitution. (□■□□)

Note 2: Treatment examples for all types are shown in the table below.

0: GND
1: V_{DD} (+5V)

Type No.	Terminal	FNTS	DLN	CN0	CN1	CN2
H2532A		0	0	0	1	0
H2535		0	1	0	0	1
H2538A		0	0	1	0	1
H2539		0	1	1	1	1

Note 3: The test terminal is fixed at the "0" level.
The RST terminal is normally at the "1" level.
When set at the "0" level, oscillation is stopped and DC voltage is loaded to the liquid crystal.

H2532A

- 16 Character x 1 line
- Control LSI HD43160AH attachment type (see page 11)

MECHANICAL DATA (nominal dimensions)

Module size 84W x 44H x 15D (max) mm
 Effective display area 61W x 15.8H mm
 Character size (5x7 dots) 2.9W x 5.5H mm
 Pitch 3.6 mm
 Dot size 0.5W x 0.7H mm
 Weight about 40 g

ABSOLUTE MAXIMUM RATINGS

Supply voltage ($V_{DD} - V_{SS}$) 7 V max.
 ($V_{DD} - V_{EE}$) 13.5 V max.
 Input voltage (CL1, CL2, D, M, FLM) . . . $V_{SS} \leq V_{IN} \leq V_{DD}$
 Operating temperature (T_a) 0 to 50°C
 Storage temperature (T_{stg}) -20 to 60°C

ELECTRICAL CHARACTERISTICS

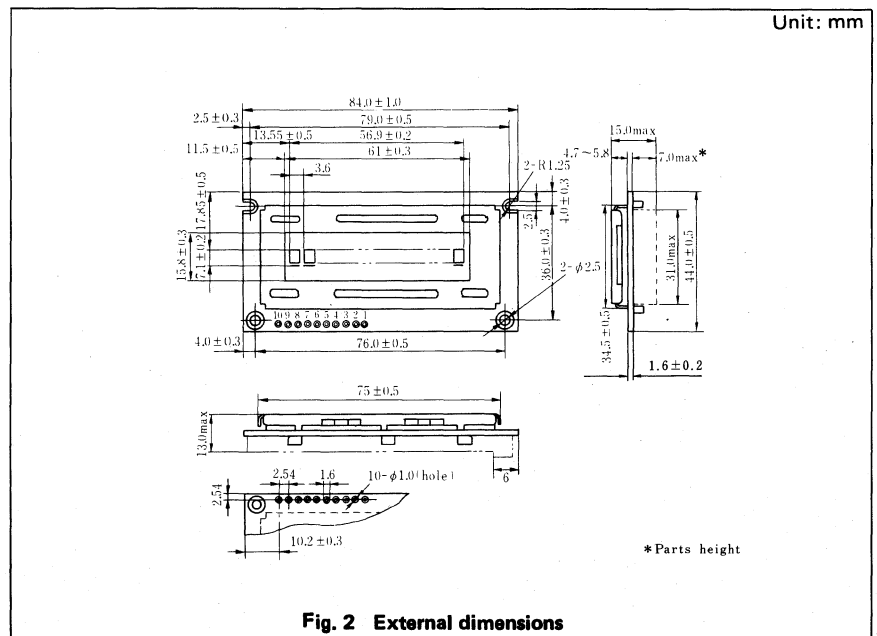
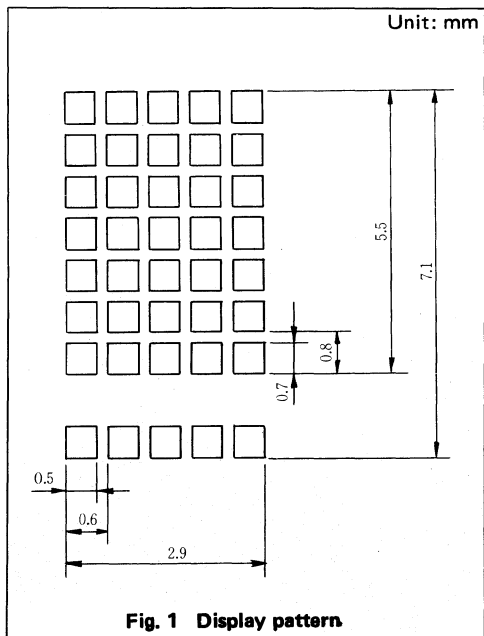
Power supplies ($V_{DD} - V_{SS}$) +5 ±0.25V
 Power supplies ($V_{EE} - V_{SS}$) -5 ±0.5 V
 Current consumption +5V 1 mA max.
 -5V 1 mA max.
 Input high voltage 0.7 V_{DD} V min.
 Input low voltage 0.3 V_{DD} V max.
 Power supply for LCD drive (Recommended) ($V_O - V_{EE}$)
 at $T_a = 0^\circ\text{C}$ 5.3 V typ.
 at $T_a = 25^\circ\text{C}$ 4.5 V typ.
 at $T_a = 50^\circ\text{C}$ 3.7 V typ.

OPTICAL DATA See page 8

INTERNAL PIN CONNECTION

Pin No.	Symbol	Level	Function
1	FLM	H	The FLM signal indicates the beginning of each display cycle.
2	M	H/L	Control signal for a.c. driving.
3	CL1	H→L	The CL1 latches the serial data in the shift registers.
4	D	H/L	Serial row data of each character.
5	CL2	H→L	Clock signal for shifting the serial data.
6	V_{DD}	-	Power supply for logic circuit.
7	V_{SS}	-	Ground.
8	V_{EE}	-	Power supply for LC driving.
9	V_O	-	Operating voltage for LC driving.
10	NC	-	No connection.

Connector: Module side 1L-10P-S3FP2-1
 Control side 1L-10S-S3L-(N) (Housing)
 1L-C2-1-5000 (Socket contact)
 Made by JAE (Japan)



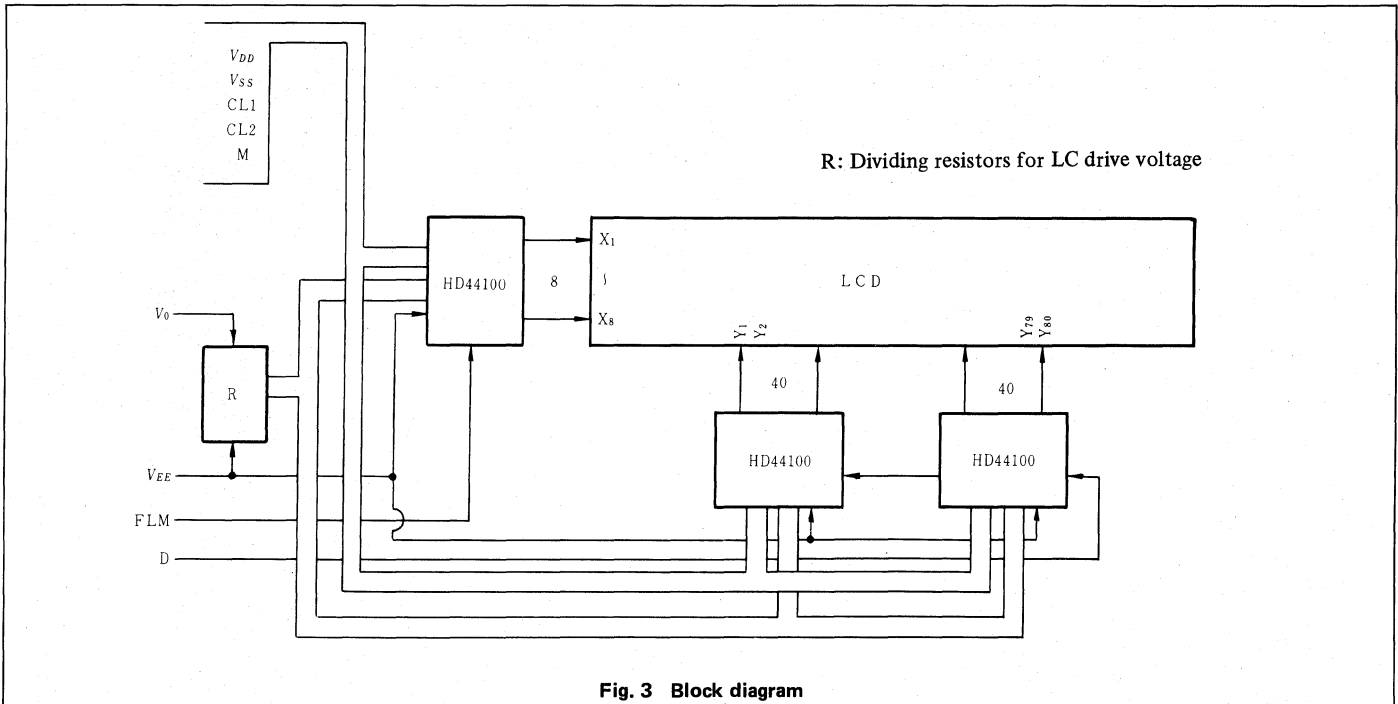


Fig. 3 Block diagram

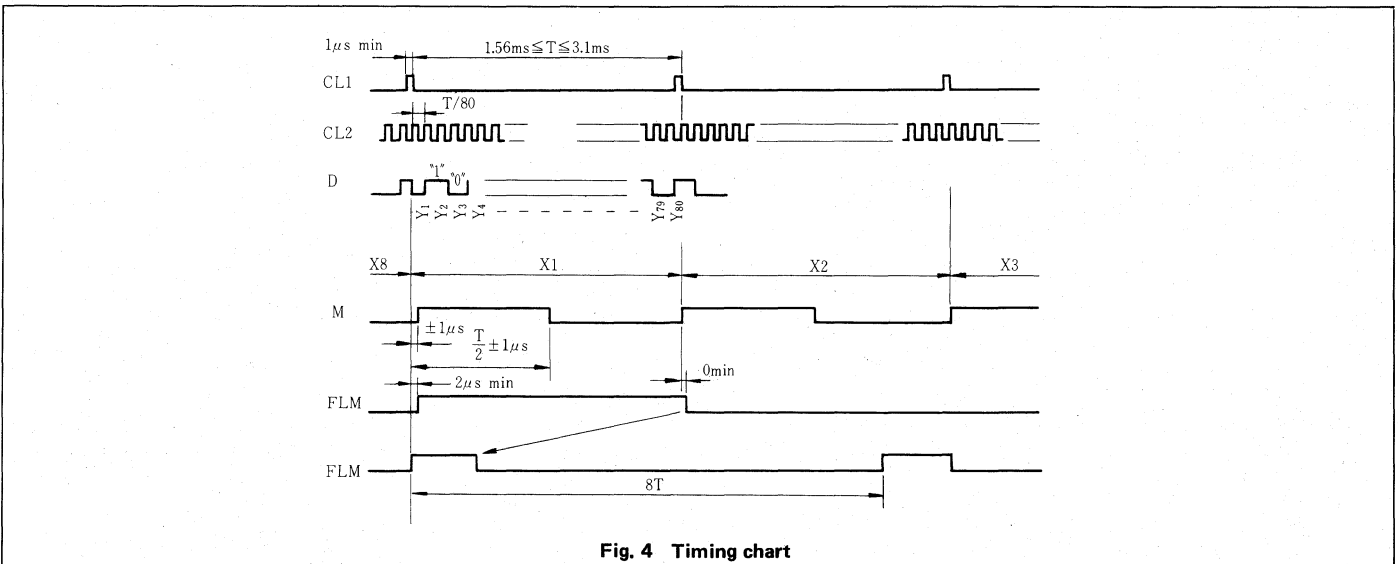


Fig. 4 Timing chart

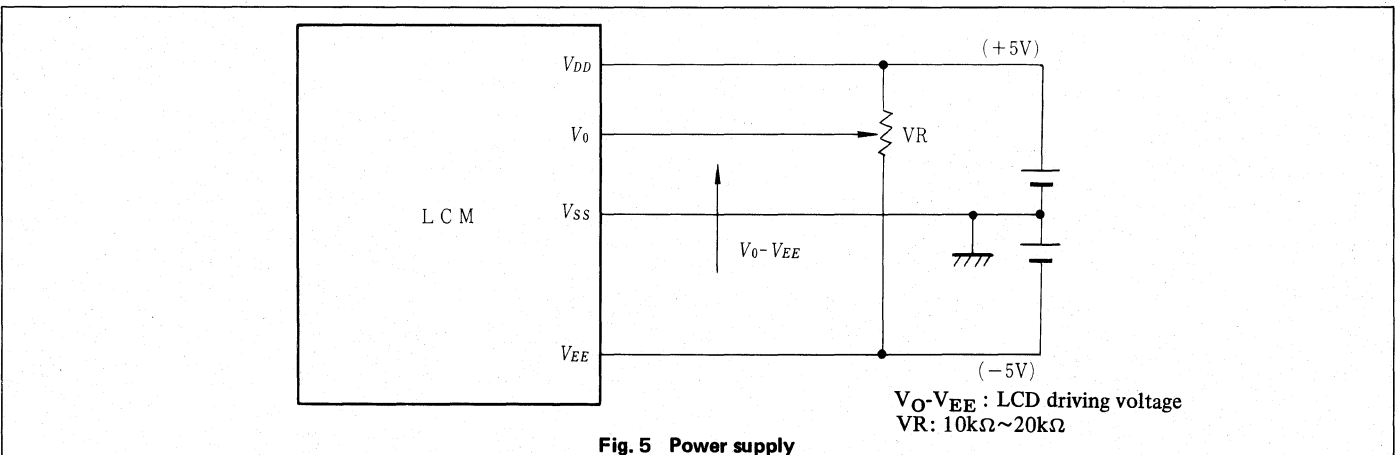


Fig. 5 Power supply

H2535

- 16 Character x 2 lines
- Control LSI HD43160AH attachment type (see page 11)

MECHANICAL DATA (Nominal dimensions)

Module size 84W x 44H x 15D (max) mm
 Effective display area 61W x 15.8H mm
 Character size (5 x 7 dots) 2.9W x 4.1H mm
 Pitch 3.6 mm
 Dot size 0.5W x 0.5H mm
 Weight about 40 g

ABSOLUTE MAXIMUM RATINGS

Supply voltage ($V_{DD}-V_{SS}$) 7 V max.
 ($V_{DD}-V_{EE}$) 13.5 V max.
 Input voltage (CL1, CL2, D, M, FLM) . . . $V_{SS} \leq V_{IN} \leq V_{DD}$
 Operating temperature (T_a) 0 to 50°C
 Storage temperature (T_{stg}) -20 to 60°C

ELECTRICAL CHARACTERISTICS

Power supplies ($V_{DD}-V_{SS}$) +5±0.25 V
 ($V_{EE}-V_{SS}$) -5±0.5 V
 Current consumption +5V 1 mA max.
 -5V 1 mA max.
 Input high voltage 0.7 V_{DD} V min.
 Input low voltage 0.3 V_{DD} V max.
 Power supply for LCD drive (Recommended) (V_O-V_{EE})
 at $T_a = 0^\circ\text{C}$ 6.7 V typ.
 at $T_a = 25^\circ\text{C}$ 5.7 V typ.
 at $T_a = 50^\circ\text{C}$ 4.7 V typ.

OPTICAL DATA See page 8

INTERNAL PIN CONNECTION

Pin No.	Symbol	Level	Function
1	FLM	H	The FLM signal indicates the beginning of each display cycle.
2	M	H/L	Control signal for a.c. driving.
3	CL1	H→L	The CL1 latches the serial data in the shift registers.
4	D	H/L	Serial row data of each character.
5	CL2	H→L	Clock signal for shifting the serial data.
6	V_{DD}	-	Power supply for logic circuit.
7	V_{SS}	-	Ground.
8	V_{EE}	-	Power supply for LC driving.
9	V_O	-	Operating voltage for LC driving.
10	NC	-	No connection.

Connector: Module side 1L-10P-S3FP2-1
 Control side 1L-10S-S3L-(N) (Housing)
 1L-C2-1-5000 (Socket contact)
 Made by JAE (Japan)

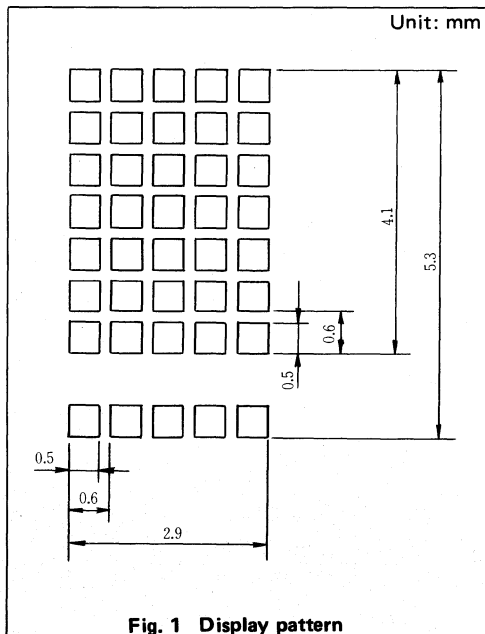


Fig. 1 Display pattern

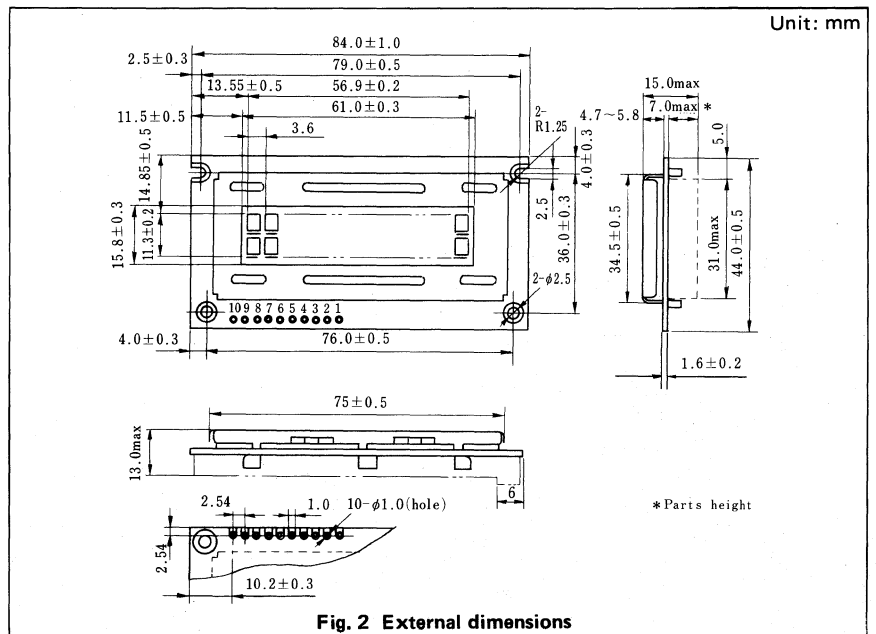
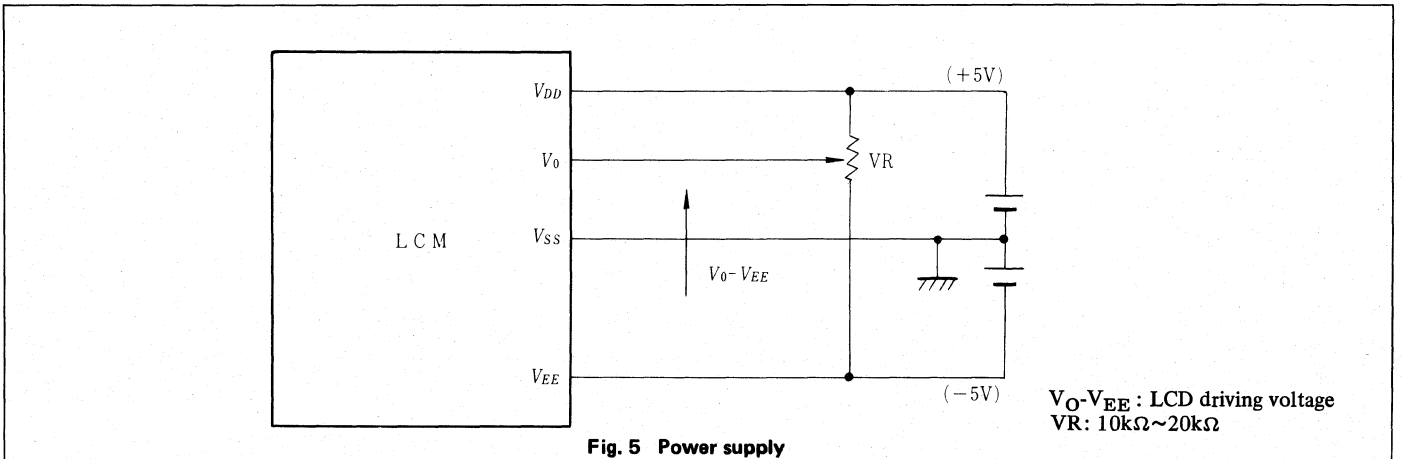
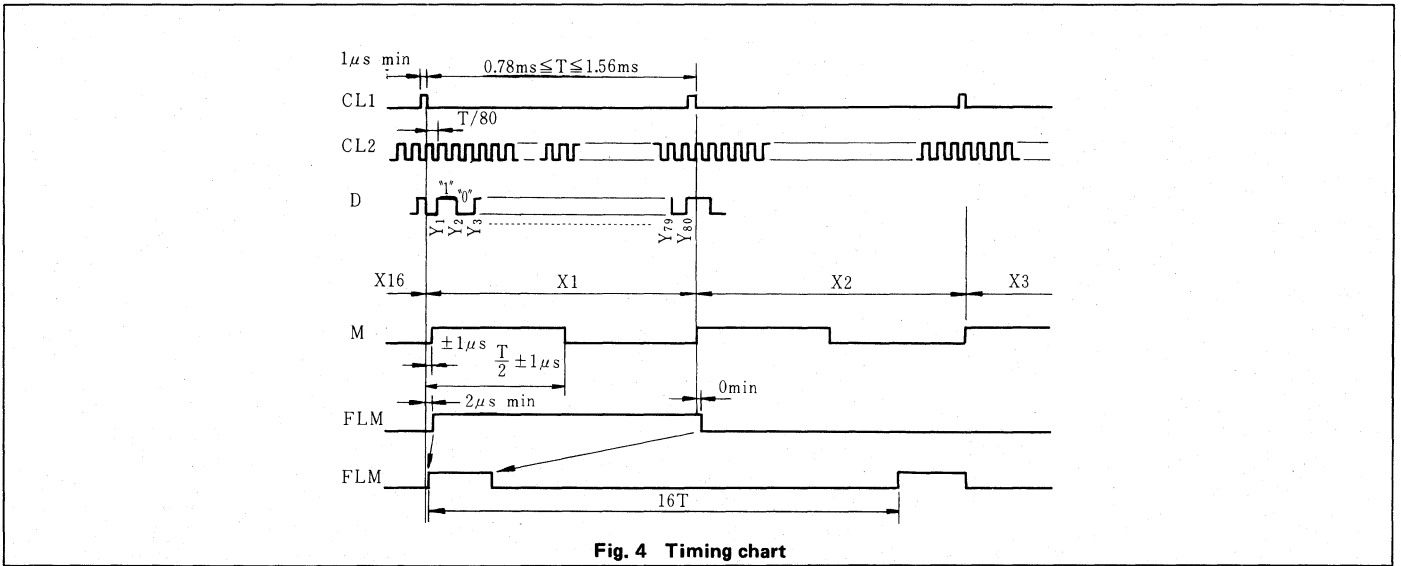
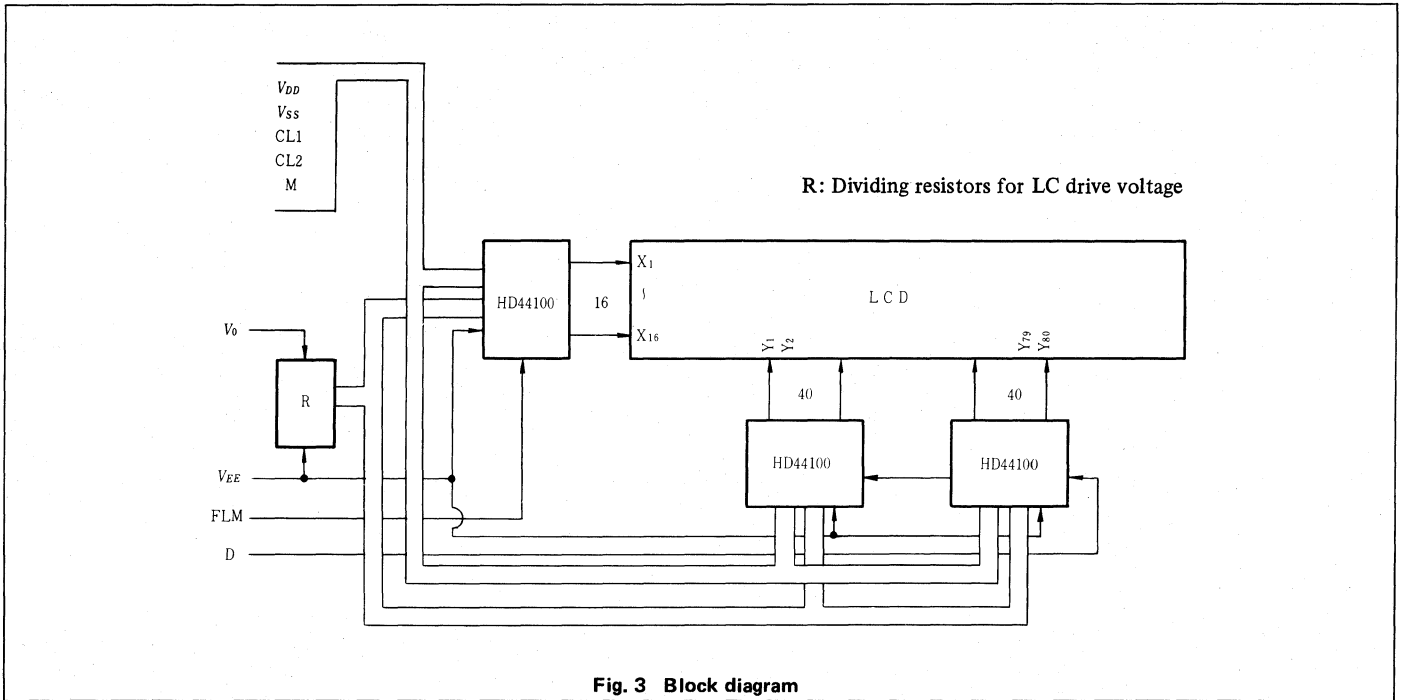


Fig. 2 External dimensions



H2538A

- 40 Character x 1 line
- Control LSI HD43160AH attachment type (see page 11)

MECHANICAL DATA (Nominal dimensions)

Module size 220W x 50H x 15D (max) mm
 Effective display area 163W x 17H mm
 Character size (5 x 7 dots) 3.15W x 5.5H mm
 Pitch 3.9 mm
 Dot size 0.55W x 0.7H mm
 Weight about 100 g

ABSOLUTE MAXIMUM RATINGS

Supply voltage ($V_{DD}-V_{SS}$) 7 V max.
 ($V_{DD}-V_{EE}$) 13.5 V max.
 Input voltage (CL1, CL2, D, M, FLM) . . . $V_{SS} \leq V_{IN} \leq V_{DD}$
 Operating temperature (T_a) 0 to 50°C
 Storage temperature (T_{stg}) -20 to 60°C

ELECTRICAL CHARACTERISTICS

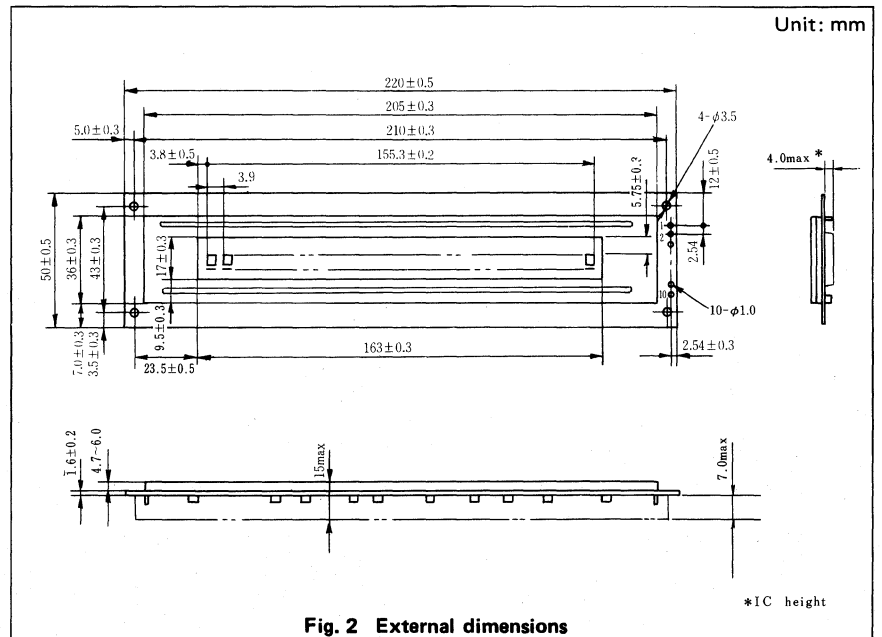
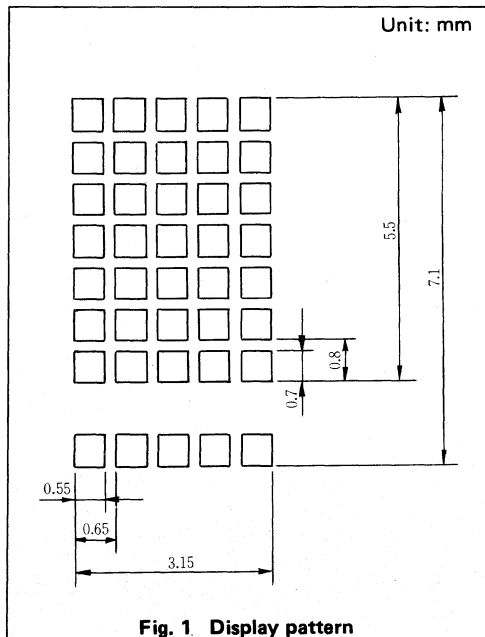
Power supplies ($V_{DD}-V_{SS}$) +5±0.25 V
 ($V_{EE}-V_{SS}$) -5±0.5 V
 Current consumption +5V 1 mA max.
 -5V 1 mA max.
 Input high voltage 0.7 V_{DD} V min.
 Input low voltage 0.3 V_{DD} V max.
 Power supply for LCD drive (Recommended) (V_O-V_{EE})
 at $T_a = 0^\circ\text{C}$ 5.3 V typ.
 at $T_a = 25^\circ\text{C}$ 4.5 V typ.
 at $T_a = 50^\circ\text{C}$ 3.7 V typ.

OPTICAL DATA See page 8

INTERNAL PIN CONNECTION

Pin No.	Symbol	Level	Function
1	FLM	H	The FLM signal indicates the beginning of each display cycle.
2	M	H/L	Control signal for a.c. driving.
3	CL1	H→L	The CL1 latches the serial data in the shift registers.
4	D	H/L	Serial row data of each character.
5	CL2	H→L	Clock signal for shifting the serial data.
6	V_{DD}	-	Power supply for logic circuit.
7	V_{SS}	-	Ground.
8	V_{EE}	-	Power supply for LC driving.
9	V_O	-	Operating voltage for LC driving.
10	NC	-	No connection.

Connector: Module side IL-10P-S3FP2-1
 Control side IL-10S-S3L-(N) (Housing)
 IL-C2-1-5000 (Socket contact)
 Made by JAE (Japan)



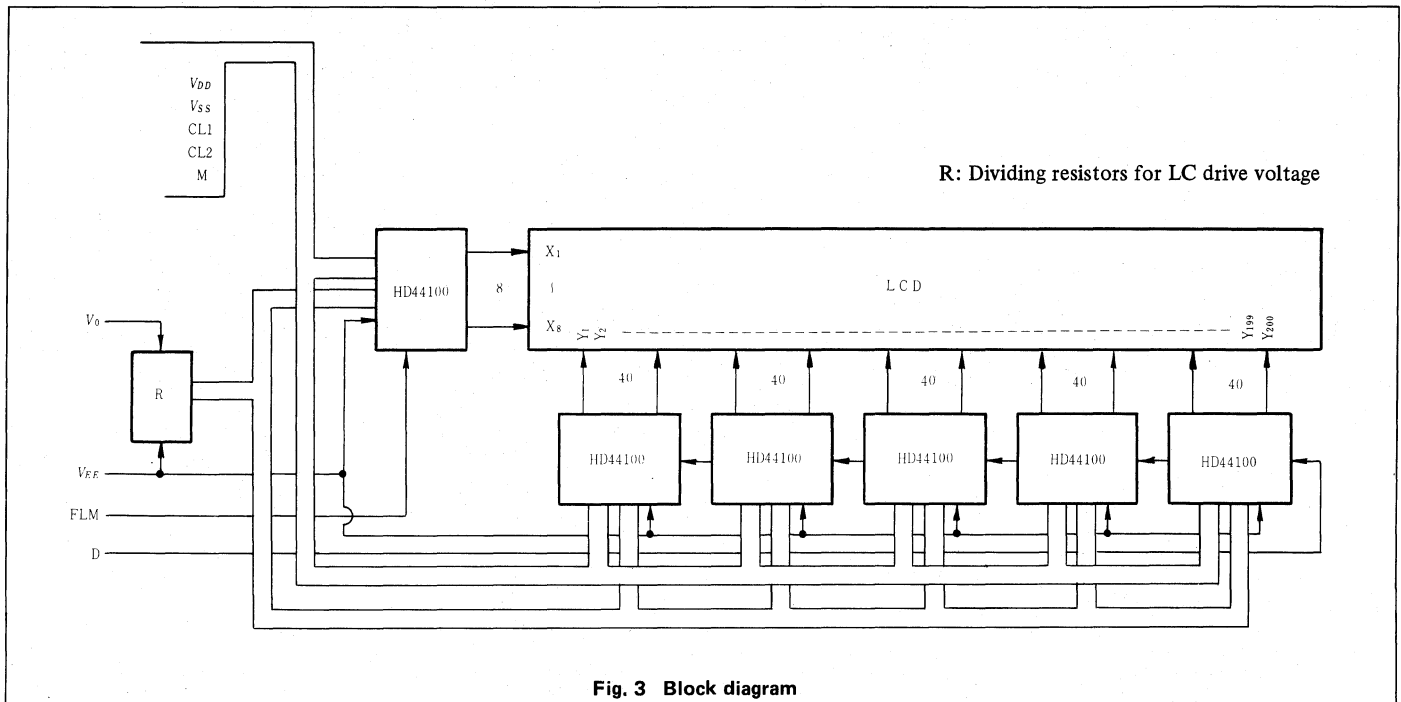


Fig. 3 Block diagram

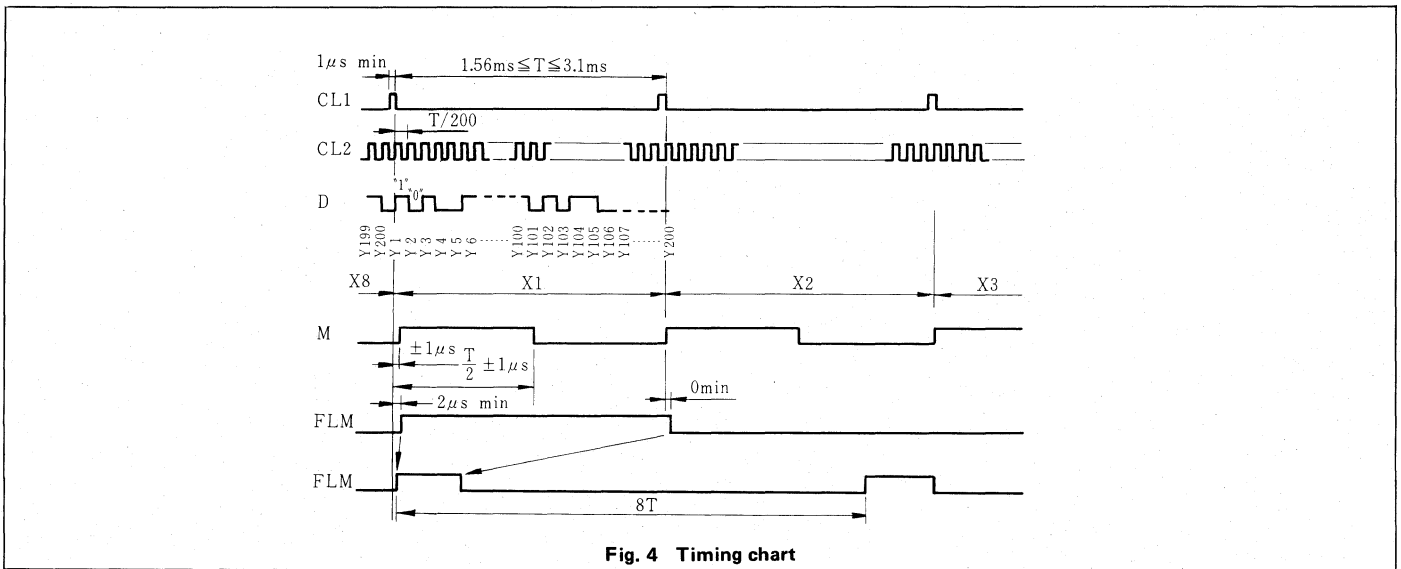


Fig. 4 Timing chart

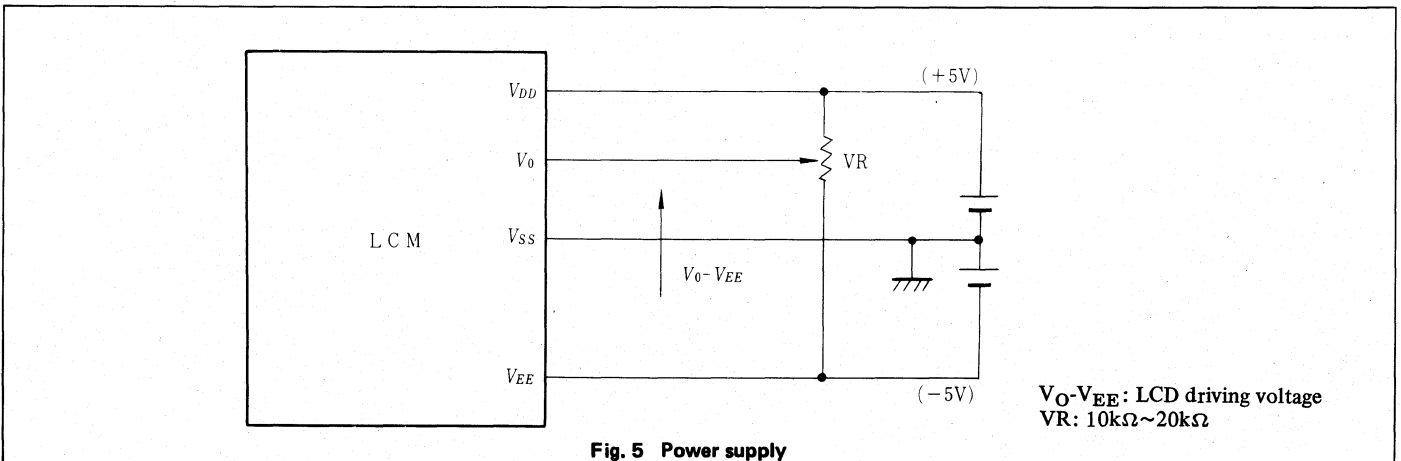


Fig. 5 Power supply

H2539

- 40 Character x 2 lines
- Control LSI HD43160AH attachment type (see page 11)

MECHANICAL DATA (Nominal dimensions)

Module size 220W x 50H x 15D (max) mm
 Effective display area 163W x 17H mm
 Character size (5 x 7 dots) 3.15W x 4.45H mm
 Pitch 3.9 mm
 Dot size 0.55W x 0.55H mm
 Weight about 100 g

ABSOLUTE MAXIMUM RATINGS

Supply voltage ($V_{DD}-V_{SS}$) 7 V max.
 ($V_{DD}-V_{EE}$) 13.5 V max.
 Input voltage (CL1, CL2, D, M, FLM) . . . $V_{SS} \leq V_{IN} \leq V_{DD}$
 Operating temperature (T_a) 0 to 50°C
 Storage temperature (T_{stg}) -20 to 60°C

ELECTRICAL CHARACTERISTICS

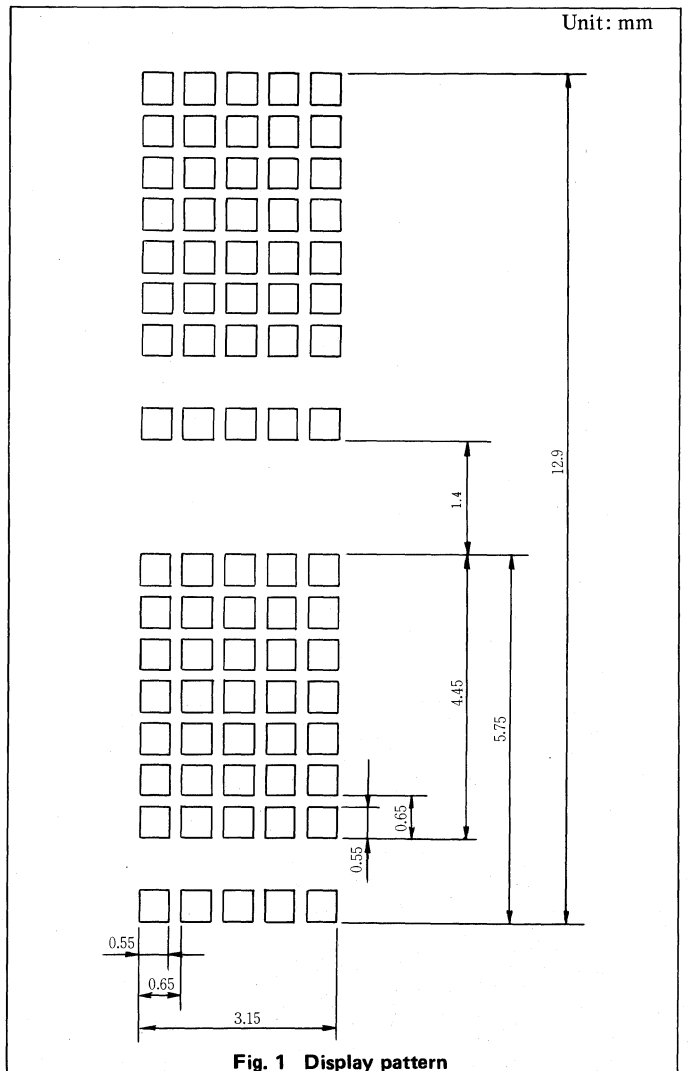
Power supplies ($V_{DD}-V_{SS}$) +5±0.25 V
 ($V_{EE}-V_{SS}$) -5±0.5 V
 Current consumption +5V 1 mA max.
 -5V 1 mA max.
 Input high voltage 0.7 V_{DD} V min.
 Input low voltage 0.3 V_{DD} V max.
 Power supply for LCD drive (Recommended) (V_O-V_{EE})
 at $T_a = 0^\circ\text{C}$ 6.7 V typ.
 at $T_a = 25^\circ\text{C}$ 5.7 V typ.
 at $T_a = 50^\circ\text{C}$ 4.7 V typ.

OPTICAL DATA See page 8

INTERNAL PIN CONNECTION

Pin No.	Symbol	Level	Function
1	FLM	H	The FLM signal indicates the beginning of each display cycle.
2	M	H/L	Control signal for a.c. driving.
3	CL1	H→L	The CL1 latches the serial data in the shift registers.
4	D	H/L	Serial row data of each character.
5	CL2	H→L	Clock signal for shifting the serial data.
6	V_{DD}	-	Power supply for logic circuit.
7	V_{SS}	-	Ground.
8	V_{EE}	-	Power supply for LC driving.
9	V_O	-	Operating voltage for LC driving.
10	NC	-	No connection

Connector: Module side IL-10P-S3FP2-1
 Control side IL-10S-S3L-(N) (Housing)
 IL-C2-1-5000 (Socket contact)
 Made by JAE (Japan)



Unit: mm

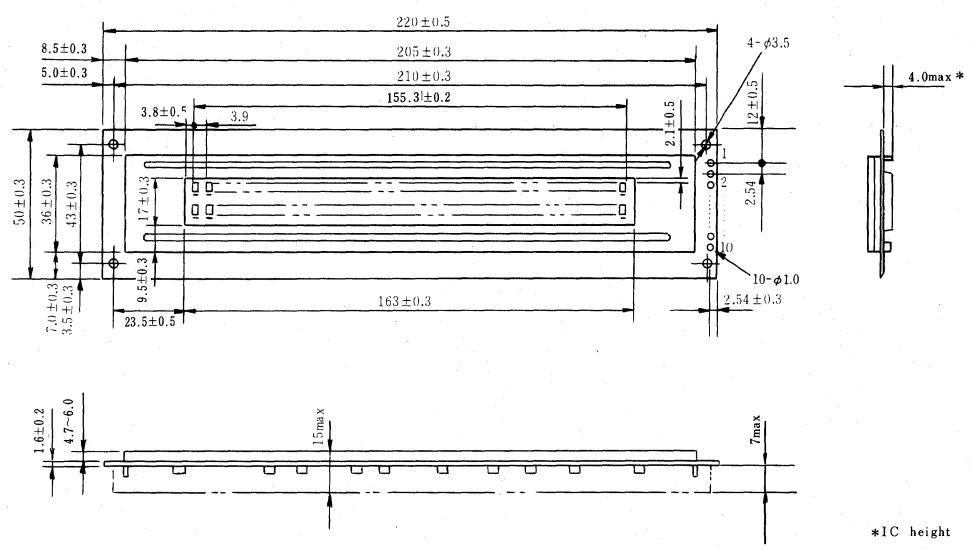
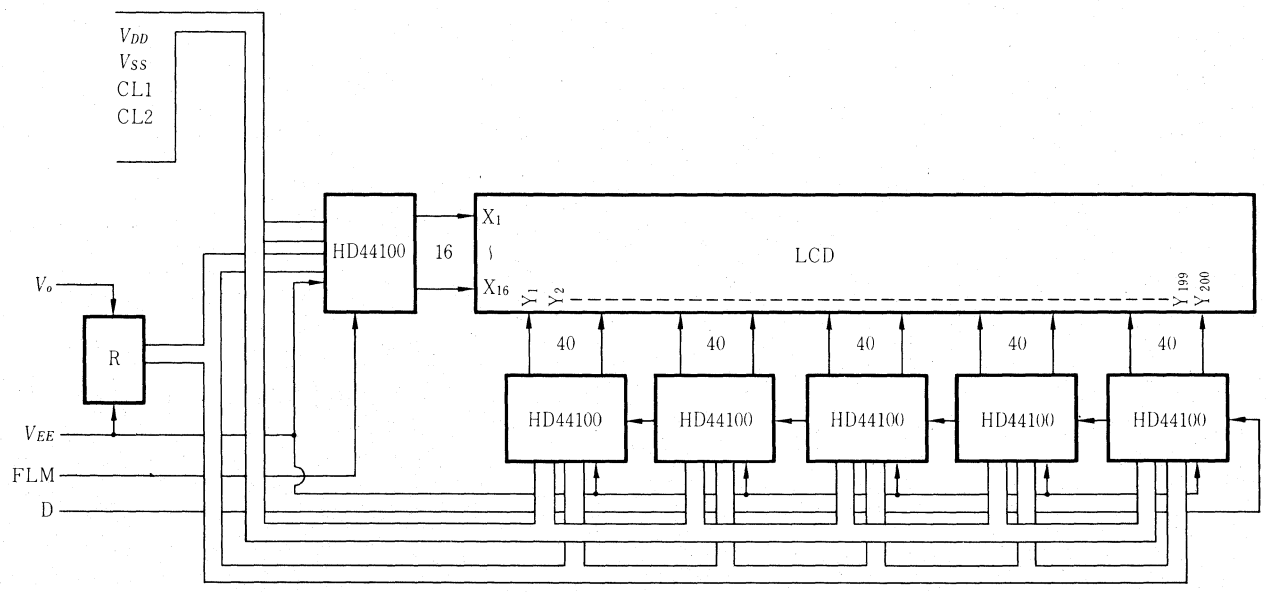


Fig. 2 External dimensions



R: Dividing resistors for LC drive voltage.

Fig. 3 Block diagram

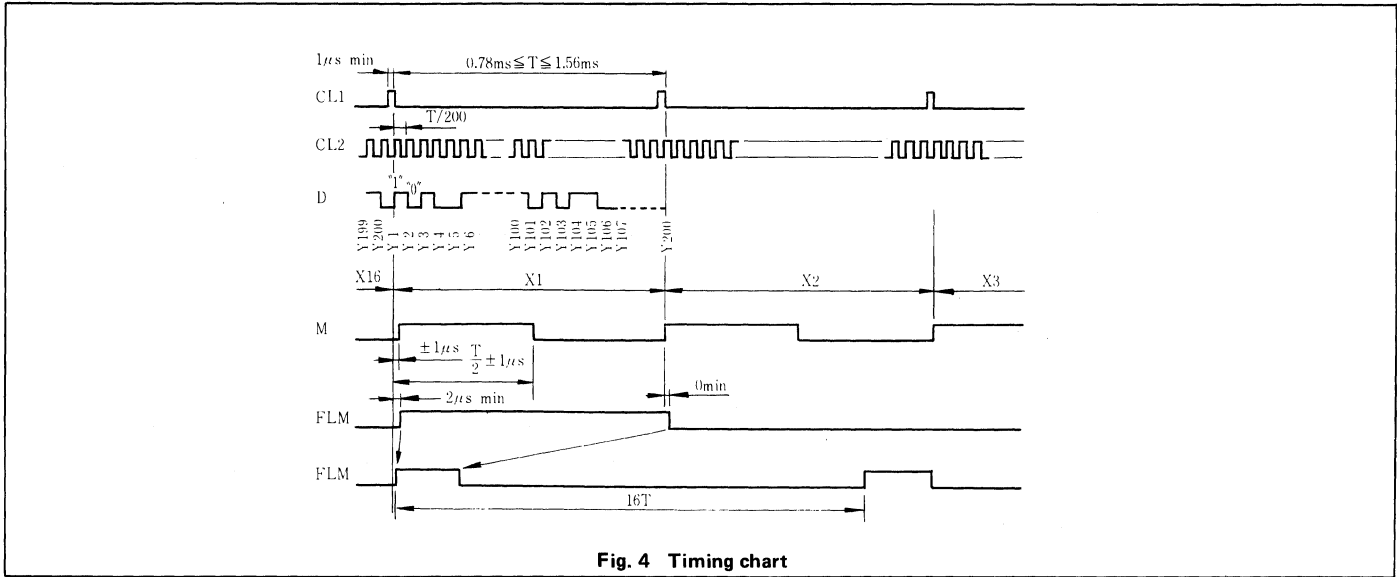


Fig. 4 Timing chart

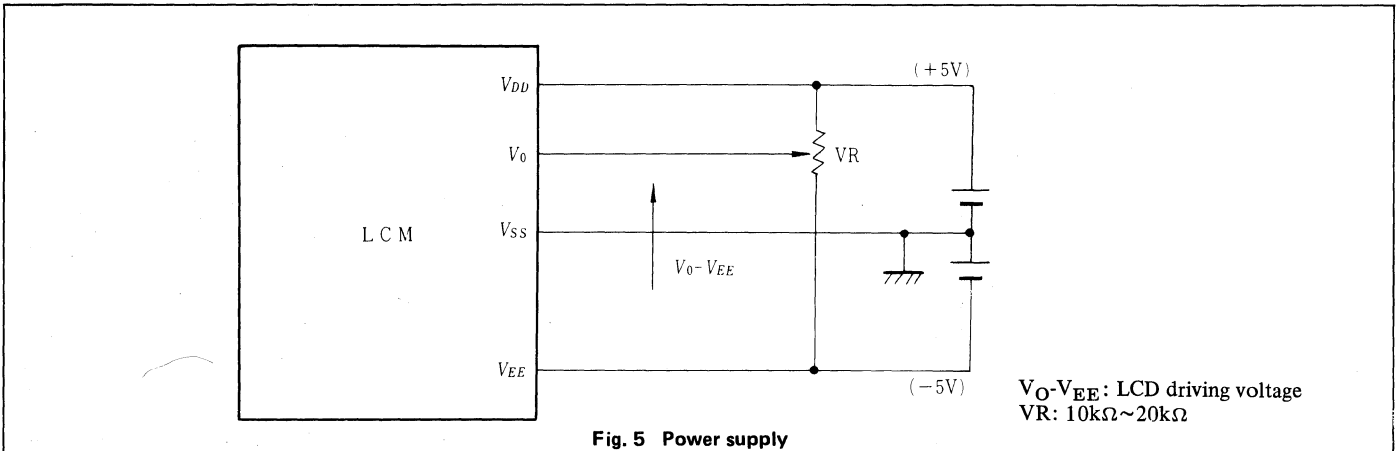


Fig. 5 Power supply

$V_0 - V_{EE}$: LCD driving voltage
 VR : $10\text{k}\Omega \sim 20\text{k}\Omega$

BUILT-IN CONTROL LSI TYPE LCD MODULE

This is a dot matrix LCD module containing the control LSI HD44780 (LCD-II) for character display. Functions such as control, refresh, and display are operated by the built-in control LSI, HD44780 (LCD-II).

This LCD module can display 160 type JIS characters and symbols and 32 type special characters and symbols. This LCD module can be interfaced to the 4-bit or 8-bit MPU, so the character display and the display shift can be easily operated by using control commands. This LCD module also contains the character generator RAM, hence user's patterns can be displayed.

Control LSI HD44780 (LCD-II)

LM054 (8 x 1 line)	LM052L (16 x 2 lines)
H2570 (16 x 1 line)	LM016L (16 x 2 lines)
LM015 (16 x 1 line)	LM032L (20 x 2 lines)
LM020L (16 x 1 line)	LM017L (32 x 2 lines)
LM038 (20 x 1 line)	LM018L (40 x 2 lines)
LM027 (24 x 1 line)	LM041L (16 x 4 lines)
H2571 (32 x 1 line)	LM044L (20 x 4 lines)
H2572 (40 x 1 line)	

CONTROL LSI HD44780 (LCD-II)

- 5 x 7 and 5 x 10 dot LCD module controller driver
- Applicable type: LM054 · H2570 · LM015 · LM020L · LM038 · LM027 · H2571 · H2572 · LM052L · LM016L · LM032L · LM017L · LM018L · LM041L · LM044L

The HD44780 (LCD-II) is a dot matrix liquid crystal display controller & driver LSI that displays alphanumerics, kana characters and symbols. It drives dot matrix liquid crystal display under 4-bit or 8-bit microcomputer or microprocessor control. All the functions required for dot matrix liquid crystal display drive are internally provided on one chip. The user can complete dot matrix liquid crystal display system with less number of chips by using the HD44780. If a driver LSI HD44100H is externally connected to the HD44780, up to 80 characters can be displayed.

The HD44780 is produced in the CMOS process. Therefore, the combination of the HD44780 with a CMOS microcomputer or microprocessor can accomplish a portable battery-drive device with lower power dissipation.

■ FEATURES

- 5 x 7 and 5 x 10 dot matrix liquid crystal display controller driver
- Capable of interfacing to 4-bit or 8-bit MPU.
- Display data RAM 80 x 8 bits (80 characters, max.)
- Character generator ROM
 - Character font 5 x 7 dots: 160 characters
 - Character font 5 x 10 dots: 32 characters

CORRESPONDENCE BETWEEN CHARACTER CODES AND CHARACTER PATTERN

2.1 FONT TABLE

(1) 5 x 10 dot, applied type: H2570, H2571, H2572, LM027

Higher Lower 4bit 4bit	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)		0	a	P	'	P		-	3	E	e	p
xxxx0001	(2)	!	1	A	Q	a	q	.	7	+	4	a	q
xxxx0010	(3)	"	2	B	R	b	r	'	4	W	x	p	e
xxxx0011	(4)	#	3	C	S	c	s	,	7	T	E	e	w
xxxx0100	(5)	\$	4	D	T	d	t	,	I	T	t	p	a
xxxx0101	(6)	%	5	E	U	e	u	=	7	+	1	e	u
xxxx0110	(7)	&	6	F	V	f	v	9	7	+	7	p	z
xxxx0111	(8)	'	7	G	W	g	w	7	+	7	7	g	w
xxxx1000	(1)	(	8	H	X	h	x	4	7	+	7	j	x
xxxx1001	(2)	)	9	I	Y	i	y	9	7	+	7	"	y
xxxx1010	(3)	*	#	J	Z	j	z	z	7	+	7	j	*
xxxx1011	(4)	+	#	K	K	(	*	7	+	7	7	*	K
xxxx1100	(5)	,	<	L	#	l	l	+	7	+	7	7	K
xxxx1101	(6)	-	=	M	I	m	)	7	+	7	7	7	+
xxxx1110	(7)	.	>	N	^	n	+	7	+	7	7	7	7
xxxx1111	(8)	/	?	O	_	o	+	7	+	7	7	7	7

Note: CGRAM is a CHARACTER GENERATOR RAM having a storage function of character pattern which enable to change freely by users program.

(2) 5 x 7 dot, applied type: LM054, H2570, LM015, LM020L, LM038, LM027, H2571, H2572, LM052L, LM016L, LM032L, LM017L, LM018L, LM041L, LM044L

Higher Lower 4bit 4bit	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)		0	A	P	\	P	-	9	E	0	0	
xxxx0001	(2)	!	1	A	a	a	a	7	7	4	3	a	a
xxxx0010	(3)	"	2	R	r	r	r	7	7	x	a	a	
xxxx0011	(4)	#	3	S	s	s	s	0	7	E	a	a	
xxxx0100	(5)	\$	4	T	t	t	t	.	7	7	h	u	a
xxxx0101	(6)	%	5	E	e	e	e	.	7	7	7	a	0
xxxx0110	(7)	&	6	F	f	f	f	7	7	7	7	a	2
xxxx0111	(8)	'	7	G	g	g	g	7	7	7	7	a	7
xxxx1000	(1)	(	8	H	h	h	h	7	7	7	7	7	7
xxxx1001	(2)	)	9	I	i	i	i	7	7	7	7	7	7
xxxx1010	(3)	*	:	J	j	j	j	7	7	7	7	7	7
xxxx1011	(4)	+	;	K	k	k	k	7	7	7	7	7	7
xxxx1100	(5)	,	<	L	l	l	l	7	7	7	7	7	7
xxxx1101	(6)	-	=	M	m	m	m	7	7	7	7	7	7
xxxx1110	(7)	.	>	N	n	n	n	7	7	7	7	7	7
xxxx1111	(8)	/	?	0	_	a	e	w	y	7	7	7	7

Note: CGRAM is a CHARACTER GENERATOR RAM having a storage function of character pattern which enable to change freely by users program.

2.2 INSTRUCTION AND DISPLAY CORRESPONDENCE

- (1) 8-bit operation, 8-digit x 1-line display (using internal reset)

Table 2.1 shows an example of 8-bit x 1-line display in 8-bit operation. The HD44780 functions must be set by Function Set prior to display. Since the display data RAM can store data for 80 characters, as explained before, the RAM can be used for displays like the lightening board when combined with display shift operation.

Since the display shift operation changes display position only and DD RAM contents remain unchanged, display data entered first can be output when the return home operation is performed.

- (2) 4-bit operation, 8-digit x 1-line display (using internal reset)

The program must set functions prior to 4-bit operation. Table 2.2 shows an example. When power is turned on, 8-bit operation is automatically selected and the first write is performed as an 8-bit operation. Since nothing is connected to $DB_0 \sim DB_3$, a rewrite is then required. However, since one operation is completed in two accesses of 4-bit operation, a rewrite is needed as a function (see Table 8).

Thus, $DB_4 \sim DB_7$ of the function set is written twice.

- (3) 8-bit operation, 8-digit x 2-line display

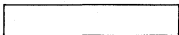
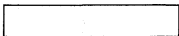

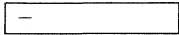
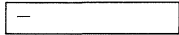
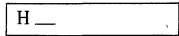
For 2-line display, the cursor automatically moves from the first to the second line after the 40th digit of the 1st line has been written. Thus, if there are only 8 characters in the first line, the DD RAM address must again be set after the 8th character is completed. (See Table 2.3) Note that the first and second lines of the display shift are performed. In the example, the display shift is performed when the cursor is on the second line. However, if shift operation is performed when the cursor is on the first line, both the first and second lines move together. When you repeat the shift, the display of the second line will not move to the first line, the same display will only move within each line many times.

(Note) When using the internal reset, the conditions in "Power Supply Condition Using Internal Reset Circuit" must be satisfied. If not, the HD44780 must be initialized by instruction. (See "Initializing by Instruction")

Table 2.1 8-bit Operation, 8-digit 1-line Display Example (Using Internal Reset)

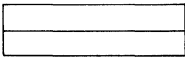
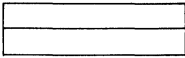
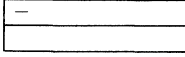
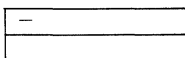
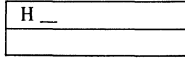
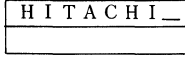
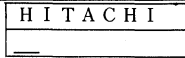
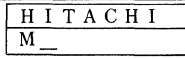




No.	Instruction	Display	Operation
1	Power supply ON (HD44780 is initialized by the internal reset circuit)	<input type="text"/>	Initialized. No display appears.
2	Function Set RS R/W DB ₇ ————— DB ₀ 0 0 0 0 1 1 0 0 * *	<input type="text"/>	Sets to 8-bit operation and selects 1-line display lines and character font. (Number of display lines and character fonts cannot be changed hereafter.)
3	Display ON/OFF Control 0 0 0 0 0 0 1 1 1 0	<input type="text"/>	Turns on display and cursor. Entire display is in space mode because of initialization.
4	Entry Mode Set 0 0 0 0 0 0 0 1 1 0	<input type="text"/>	Sets mode to increment the address by one and to shift the cursor to the right at the time of write to the DD/CG RAM. Display is not shifted.
5	Write Data to CG RAM/DD RAM 1 0 0 1 0 0 1 0 0 0	<input type="text"/>	Write "H". The DD RAM has already been selected by initialization when the power is turned on. The cursor is incremented by one and shifted to the right.
6	Write Data to CG RAM/DD RAM 1 0 0 1 0 0 1 0 0 1	<input type="text"/>	Writes "I".
7			
8	Write Data to CG RAM/DD RAM 1 0 0 1 0 0 1 0 0 1	<input type="text"/>	Writes "I".
9	Entry Mode Set 0 0 0 0 0 0 0 1 1 1	<input type="text"/>	Sets mode for display shift at the time of write.
10	Write Data to CG RAM/DD RAM 1 0 0 0 1 0 0 0 0 0	<input type="text"/>	Writes "Space".
11	Write Data to CG RAM/DD RAM 1 0 0 1 0 0 1 1 0 1	<input type="text"/>	Writes "M".
12			
13	Write Data to CG RAM/DD RAM 1 0 0 1 0 0 1 1 1 1	<input type="text"/>	Writes "O".
14	Cursor or Display Shift 0 0 0 0 0 1 0 0 * *	<input type="text"/>	Shifts only the cursor position to the left.
15	Cursor or Display Shift 0 0 0 0 0 1 0 0 * *	<input type="text"/>	Shifts only the cursor position to the left.
16	Write Data to CG RAM/DD RAM 1 0 0 1 0 0 0 0 1 1	<input type="text"/>	Writes "C" (correction). The display moves to the left.
17	Cursor or Display Shift 0 0 0 0 0 1 1 1 * *	<input type="text"/>	Shifts the display and cursor position to the right.
18	Cursor or Display Shift 0 0 0 0 0 1 0 1 * *	<input type="text"/>	Shifts display and cursor position to the right.
19	Write Data to CG RAM/DD RAM 1 0 0 1 0 0 1 1 0 1	<input type="text"/>	Writes "M".
20			
21	Return Home 0 0 0 0 0 0 0 0 1 0	<input type="text"/>	Returns both display and cursor to the original position (Address 0).

Table 2.2 4-bit Operation, 8-digit 1-line Display Example (Using Internal Reset)

No.	Instruction	Display	Operation
1	Power supply ON (HD44780 is initialized by the internal reset circuit)		Initialized. No display appears.
2	Function Set RS R/W DB ₇ ————— DB ₄ 0 0 0 0 1 0		Sets to 4-bit operation. In this case, operation is handled as 8 bits by initialization, and only this instruction completes with one write.
3	Function Set 0 0 0 0 1 0 0 0 0 0 * *		Sets 4-bit operation and selects 1-line display and 5 x 7 dot character font. 4-bit operation starts from this point on and resetting is needed. (Number of display lines and character fonts cannot be changed hereafter.)
4	Display ON/OFF Control 0 0 0 0 0 0 0 0 1 1 1 0		Turns on display and cursor. Entire display is in space mode because of initialization.
5	Entry Mode Set 0 0 0 0 0 0 0 0 0 1 1 0		Sets mode to increment the address by one and to shift the cursor to the right, at the time of write, to the DD/CG RAM. Display is not shifted.
6	Write Data to CG RAM/DD RAM 1 0 0 1 0 0 1 0 1 0 0 0		Writes "H". The cursor is incremented by one and shifts to the right.

Hereafter, control is the same as 8-bit operation.

Table 2.3 8-bit Operation, 8-digit x 2 line Display Example (Using Internal Reset)

No.	Instruction	Display	Operation
1	Power supply ON (HD44780 is initialized by the internal reset circuit)		Initialized. No display appears.
2	Function Set RS R/W DB ₇ ————— DB ₀ 0 0 0 0 1 1 1 0 * *		Sets to 8-bit operation and selects 2-line display and 5 x 7 dot character font.
3	Display ON/OFF Control 0 0 0 0 0 0 1 1 1 0		Turns on display and cursor. All display is in space mode because of initialization.
4	Entry Mode Set 0 0 0 0 0 0 0 1 1 0		Sets mode to increment the address by one and to shift the cursor to the right, at the time of write, to the DD/CG RAM. Display is not shifted.
5	Write Data to CG RAM/DD RAM 1 0 0 1 0 0 1 0 0 0		Write "H". The DD RAM has already been selected by initialization when the power is turned on. The cursor is incremented by one and shifted to the right.
6	⋮	⋮	
7	Write Data to CG RAM/DD RAM 1 0 0 1 0 0 1 0 0 1		Writes "I".
8	Set DD RAM Address 0 0 1 1 0 0 0 0 0 0		Sets RAM address so that the cursor is positioned at the head of the 2nd line.
9	Write Data to CG RAM/DD RAM 1 0 0 1 0 0 1 1 0 1		Writes "M".
10	⋮	⋮	
11	Write Data to CG RAM/DD RAM 1 0 0 1 0 0 1 1 1 1		Writes "O".
12	Entry Mode Set 0 0 0 0 0 0 0 1 1 1		Sets mode for display shift at the time of write.
13	Write Data to CG RAM/DD RAM 1 0 0 1 0 0 1 1 0 1		Writes "M". Display is shifted to the right. The first and second lines' shift are operated at the same time.
14	⋮	⋮	
15	Return Home 0 0 0 0 0 0 0 0 1 0		Returns both display and cursor to the original position (Address 0).

2.3 INSTRUCTION

Instruction	Code										Description	Execution time (when fosc is 250 kHz) Note 1	Execution time (when fosc is 160 kHz) Note 2	
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0				
Clear display	0	0	0	0	0	0	0	0	0	1	Clears all display and returns the cursor to the home position (Address 0).	82 μ s ~ 1.64 ms	120 μ s ~ 4.9 ms	
Return home	0	0	0	0	0	0	0	0	0	1	Returns the cursor to the home position (Address 0). Also returns the display being shifted to the original position. DD RAM contents remain unchanged.	40 μ s ~ 1.6 ms	120 μ s ~ 4.8 ms	
Entry mode set	0	0	0	0	0	0	0	0	1	I/D	S	Sets the cursor move direction and specifies or not to shift the display. These operations are performed during data write and read.	40 μ s	120 μ s
Display ON/OFF control	0	0	0	0	0	0	0	1	D	C	B	Sets ON/OFF of all display (D), cursor ON/OFF (C), and blink of cursor position character (B).	40 μ s	120 μ s
Cursor and display shift	0	0	0	0	0	0	1	S/C	R/L	*	*	Moves the cursor and shifts the display without changing DD RAM contents	40 μ s	120 μ s
Function set	0	0	0	0	0	1	DL	N	F	*	*	Sets interface data length (DL) number of display lines (L) and character font (F).	40 μ s	120 μ s
Set CG RAM address.	0	0	0	0	1	ACG					Sets the CG RAM address. CG RAM data is sent and received after this setting.	40 μ s	120 μ s	
Set DD RAM address	0	0	0	1	ADD					Sets the DD RAM address. DD RAM data is sent and received after this setting.	40 μ s	120 μ s		
Read busy flag & address	0	1	BF	AC					Reads Busy flag (BF) indicating internal operation is being performed and reads address counter contents.	1 μ s	1 μ s			
Write data to CG or DD RAM	1	0	Write Data								Writes data into DD RAM or CG RAM.	40 μ s	120 μ s	
Read data to CG or DD RAM	1	1	Read Data								Reads data from DD RAM or CG RAM.	40 μ s	120 μ s	
I/D = 1: Increment (+1) I/D = 0: Decrement (-1) S = 1: Accompanies display shift. S/C = 1: Display shift. S/C = 0: Cursor move R/L = 1: Shift to the right. R/L = 0: Shift to the left. DL = 1: 8 bits DL = 0: 4 bits N = 1: 2 lines N = 0: 1 line F = 1: 5 x 10 dots F = 0: 5 x 7 dots BF = 1: Internally operating BF = 0: Can accept instruction											DD RAM: Display data RAM CG RAM: Character generator RAM ACG: CG RAM address ADD: DD RAM address AC: Address counter used for both of DD and CG RAM address.	Execution time changes when frequency changes. (Example) When fosc is 270 kHz: $40 \mu\text{s} \times \frac{250}{270} = 37 \mu\text{s}$		

Note 1. 1/8 Duty, 1/11 Duty (LM054, H2570, LM015, LM038, LM027, H2571, H2572)

Note 2. 1/16 Duty (LM020L, LM052L, LM016L, LM032L, LM017L, LM018L, LM041L, LM044L)

* Don't care For details, refer to "HITACHI MICROCOMPUTER SYSTEM: DOT MATRIX LIQUID CRYSTAL DISPLAY CONTROLLER & DRIVER LCD-II (HD44780) USER'S MANUAL".

Unit: mm

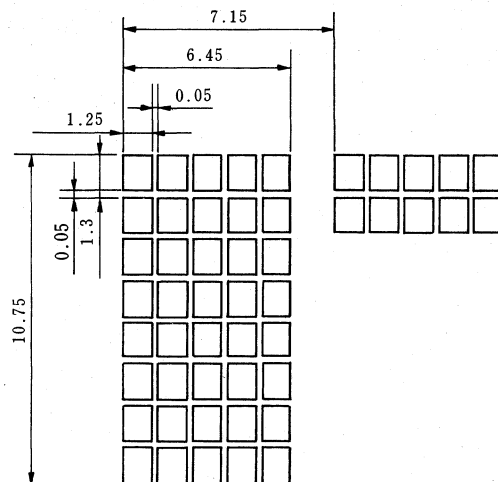


Fig. 2 Display pattern

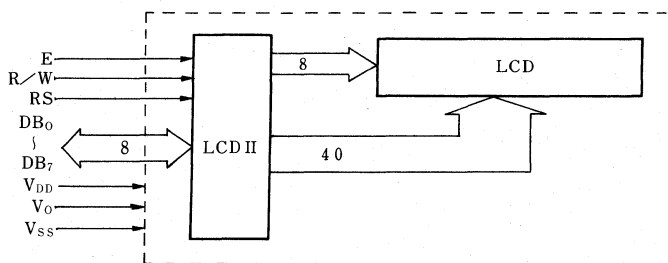


Fig. 3 Block diagram

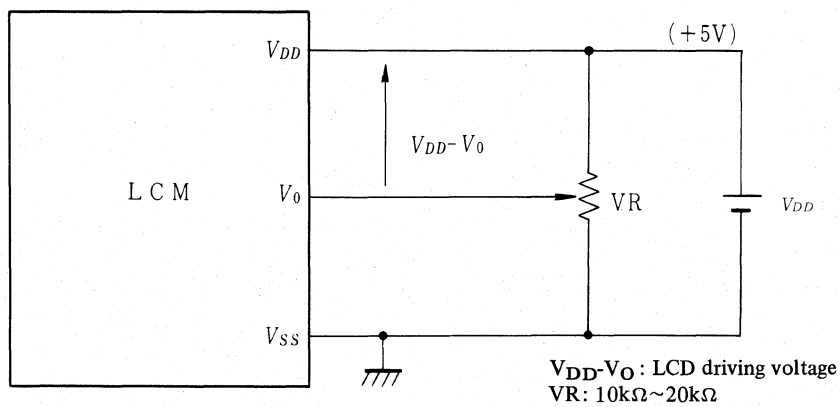


Fig. 4 Power supply

TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns

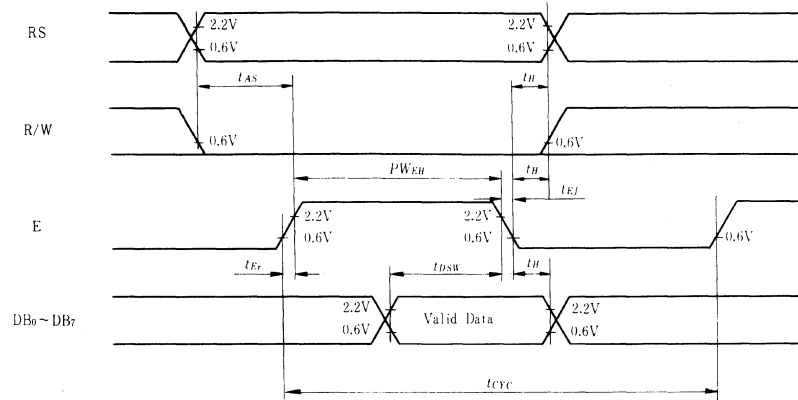


Fig. 5 Interface timing (data write)

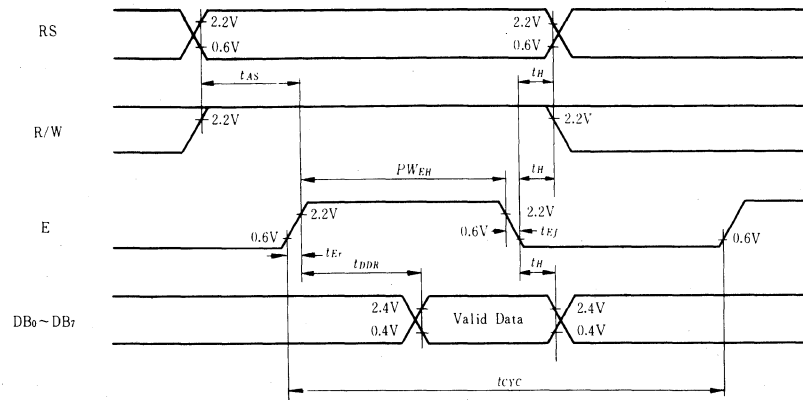


Fig. 6 Interface timing (data read)

H2570

- 16 Character x 1 line
- Built-in control LSI HD44780 type (see page 23)
- +5V single power supply

MECHANICAL DATA (Nominal dimensions)

Module size 80W x 36H x 12D (max) mm
 Effective display area 64.5W x 13.8H mm
 Character size (5 x 10 dots) 3.15W x 7.9H mm
 Pitch 3.7 mm
 Dot size 0.55W x 0.7H mm
 Weight about 25g

ABSOLUTE MAXIMUM RATINGS

	min.	max.
Power supply for logic ($V_{DD}-V_{SS}$) . . .	0	7.0 V
Power supply for LCD drive ($V_{DD}-V_O$) . . .	0	13.5 V
Input voltage (V_i)	V_{SS}	V_{DD} V
Operating temperature (T_a)	0	50°C
Storage temperature (T_{stg})	-20	70°C

ELECTRICAL CHARACTERISTICS

$T_a = 25^\circ\text{C}$, $V_{DD} = 5.0\text{ V} \pm 0.25\text{ V}$

Input "high" voltage (V_{iH})	2.2 V min.
Input "low" voltage (V_{iL})	0.6 V max.
Output high voltage (V_{OH}) ($-I_{OH} = 0.2\text{ mA}$) . . .	2.4 V min.
Output low voltage (V_{OL}) ($I_{OL} = 1.6\text{ mA}$) . . .	0.4 V max.
Power supply current (I_{DD}) ($V_{DD} = 5.0\text{ V}$) . .	0.5 mA typ. 2.0 mA max.
Power supply for LCD drive (Recommended) ($V_{DD}-V_O$)	
	Du=1/8 Du=1/11
at $T_a = 0^\circ\text{C}$	4.0 4.2 V typ.
at $T_a = 25^\circ\text{C}$	3.7 3.8 V typ.
at $T_a = 50^\circ\text{C}$	3.3 3.3 V typ.

OPTICAL DATA See page 8

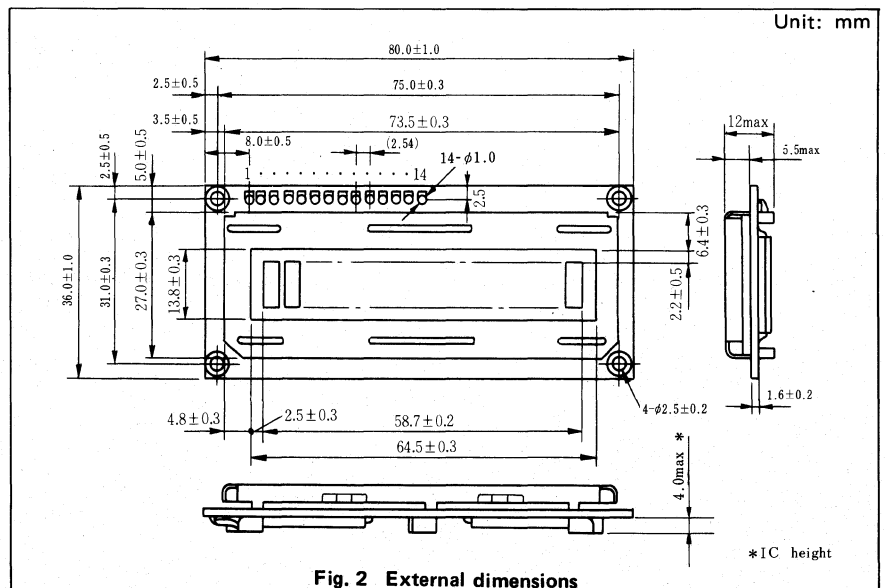
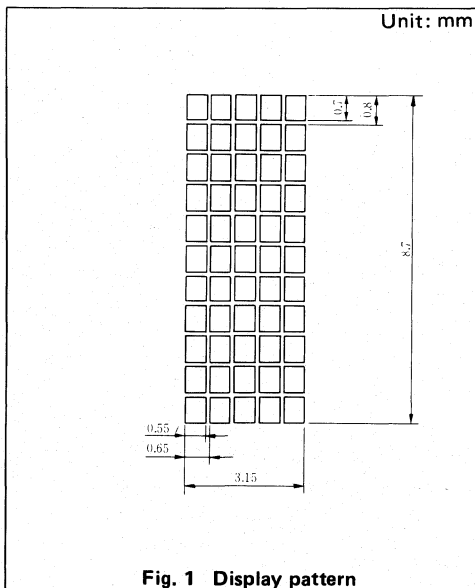
INTERNAL PIN CONNECTION

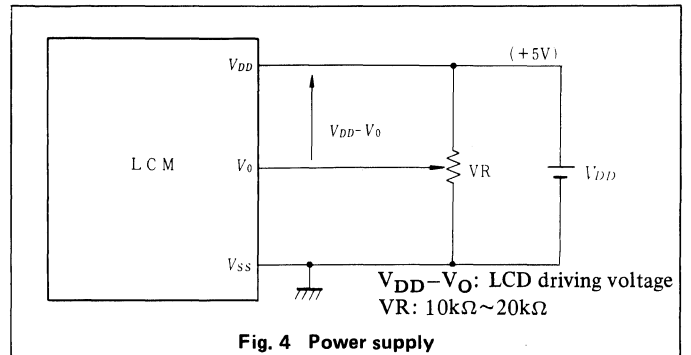
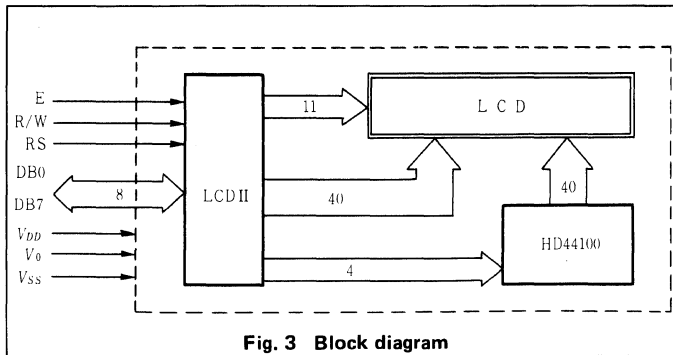
Pin No.	Symbol	Level	Function
1	V_{SS}	—	0V
2	V_{DD}	—	+5V
3	V_O	—	—
4	RS	H/L	L: Instruction code input H: Data input
5	R/W	H/L	H: Data read (LCD module→MPU) L: Data write (LCD module←MPU)
6	E	H, H→L	Enable signal
7	DB0	H/L	Data bus line Note (1), Note (2)
8	DB1	H/L	
9	DB2	H/L	
10	DB3	H/L	
11	DB4	H/L	
12	DB5	H/L	
13	DB6	H/L	
14	DB7	H/L	

Note:

In the HD44780, the data can be sent in either 4-bit 2-operation or 8-bit 1-operation so that it can interface to both 4 and 8 bit MPU's.

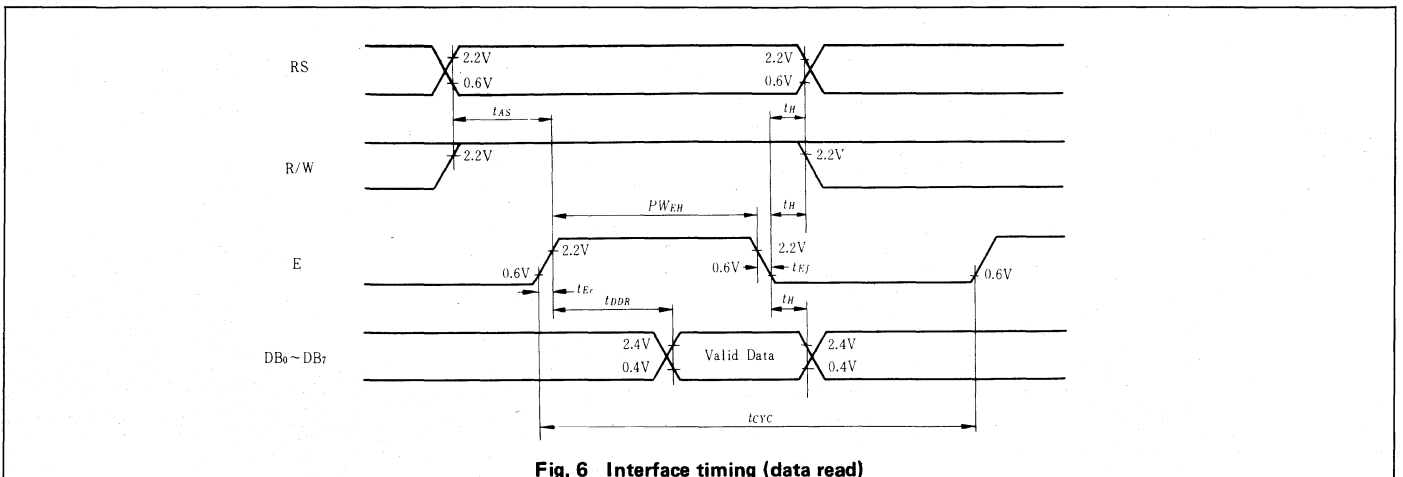
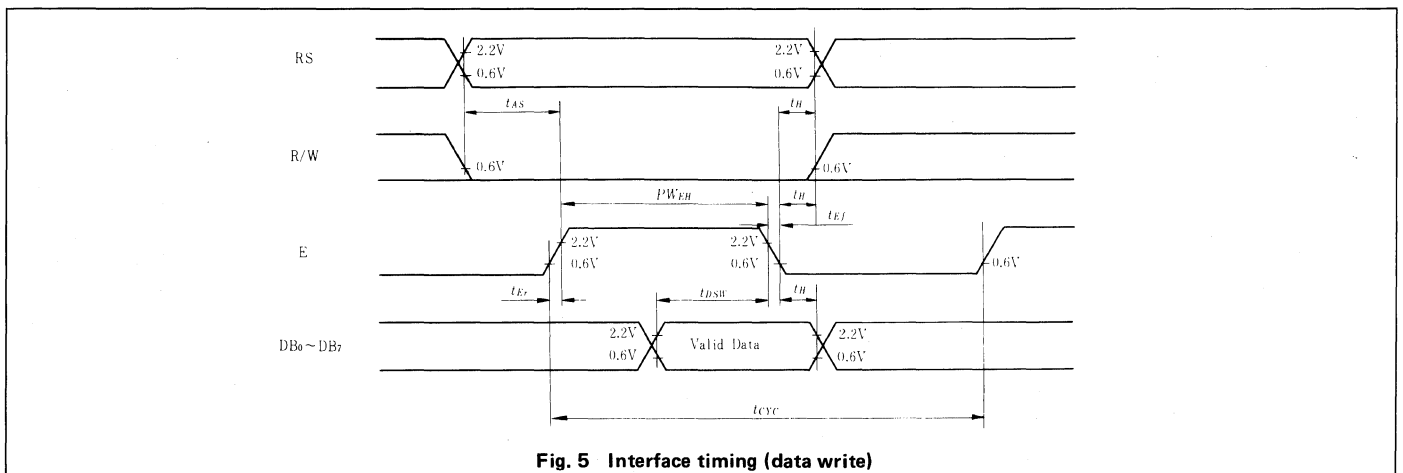
- (1) When interface data is 4 bits long, data is transferred using only 4 buses of $DB_4 \sim DB_7$, and $DB_0 \sim DB_3$ are not used. Data transfer between the HD44780 and the MPU completes when 4-bit data is transferred twice. Data of the higher order 4 bits (contents of $DB_4 \sim DB_7$, when interface data is 8 bits long) is transferred first and then lower order 4 bits (contents of $DB_0 \sim DB_3$, when interface data is 8 bits long).
- (2) When interface data is 8 bits long, data is transferred using 8 data buses of $DB_0 \sim DB_7$.





TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns



LM015

- 16 Character x 1 line
- Built-in control LSI HD44780 type (see page 23)
- +5V single power supply

MECHANICAL DATA (Nominal dimensions)

Module size 80W x 36H x 12D (max) mm
 Effective display area 64.5W x 13.8H mm
 Character size (5 x 7 dots) 3.15W x 5.5H mm
 Pitch 3.7 mm
 Dot size 0.55W x 0.7H mm
 Weight about 25 g

ABSOLUTE MAXIMUM RATINGS

	min.	max.
Power supply for logic ($V_{DD}-V_{SS}$) . . .	0	7.0 V
Power supply for LCD drive ($V_{DD}-V_O$) . .	0	13.5 V
Input voltage (V_i)	V_{SS}	V_{DD} V
Operating temperature (T_a)	0	50°C
Storage temperature (T_{stg})	-20	70°C

ELECTRICAL CHARACTERISTICS

$T_a = 25^\circ\text{C}$, $V_{DD} = 5.0\text{V} \pm 0.25\text{V}$

Input "high" voltage (V_{iH}) 2.2 V min.
 Input "low" voltage (V_{iL}) 0.6 V max.
 Output high voltage (V_{OH}) ($-I_{OH} = 0.2\text{ mA}$) . . 2.4 V min.
 Output low voltage (V_{OL}) ($I_{OL} = 1.6\text{ mA}$) 0.4 V max.
 Power supply current (I_{DD}) ($V_{DD} = 5.0\text{ V}$) . . 1.0 mA typ.
 2.0 mA max.
 Power supply for LCD drive (Recommended) ($V_{DD}-V_O$)
 $Du=1/8$

at $T_a = 0^\circ\text{C}$	4.0 V typ.
at $T_a = 25^\circ\text{C}$	3.7 V typ.
at $T_a = 50^\circ\text{C}$	3.3 V typ.

OPTICAL DATA See page 8

INTERNAL PIN CONNECTION

Pin No.	Symbol	Level	Function
1	V_{SS}	-	0V
2	V_{DD}	-	+5V
3	V_O	-	-
4	RS	H/L	L: Instruction code input H: Data input
5	R/W	H/L	H: Data read (LCD module→MPU) L: Data write (LCD module←MPU)
6	E	H, H→L	Enable signal
7	DB0	H/L	Data bus line Note (1), Note (2)
8	DB1	H/L	
9	DB2	H/L	
10	DB3	H/L	
11	DB4	H/L	
12	DB5	H/L	
13	DB6	H/L	
14	DB7	H/L	

Note:

In the HD44780, the data can be sent in either 4-bit 2-operation or 8-bit 1-operation so that it can interface to both 4 and 8 bit MPU's.

- (1) When interface data is 4 bits long, data is transferred using only 4 buses of $DB_4 \sim DB_7$, and $DB_0 \sim DB_3$ are not used. Data transfer between the HD44780 and the MPU completes when 4-bit data is transferred twice. Data of the higher order 4 bits (contents of $DB_4 \sim DB_7$, when interface data is 8 bits long) is transferred first and then lower order 4 bits (contents of $DB_0 \sim DB_3$, when interface data is 8 bits long).
- (2) When interface data is 8 bits long, data is transferred using 8 data buses of $DB_0 \sim DB_7$.

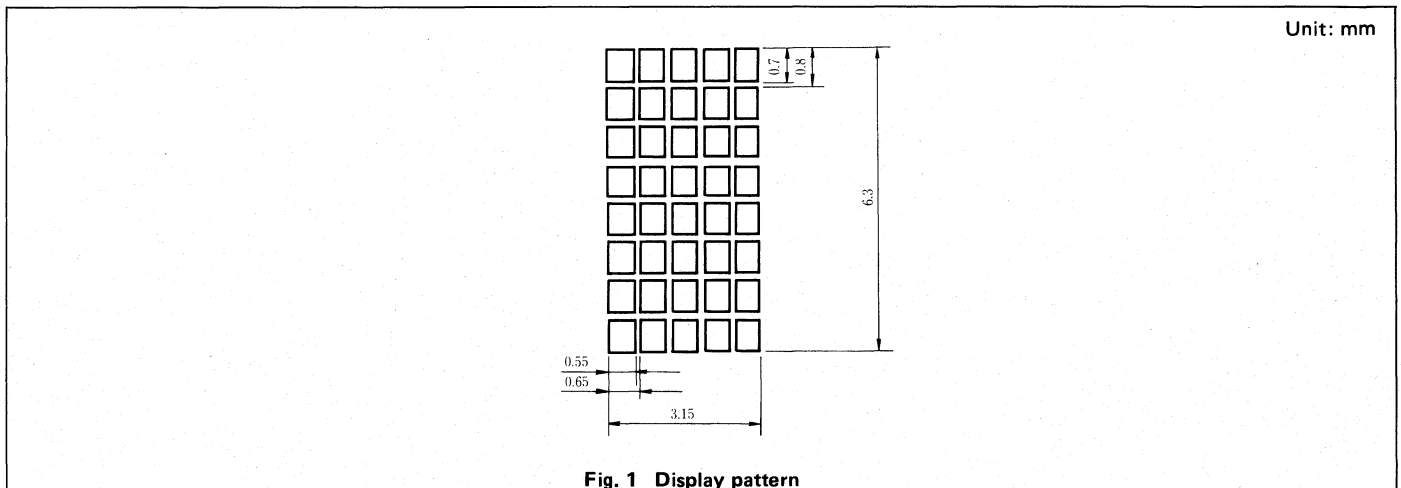


Fig. 1 Display pattern

Unit: mm

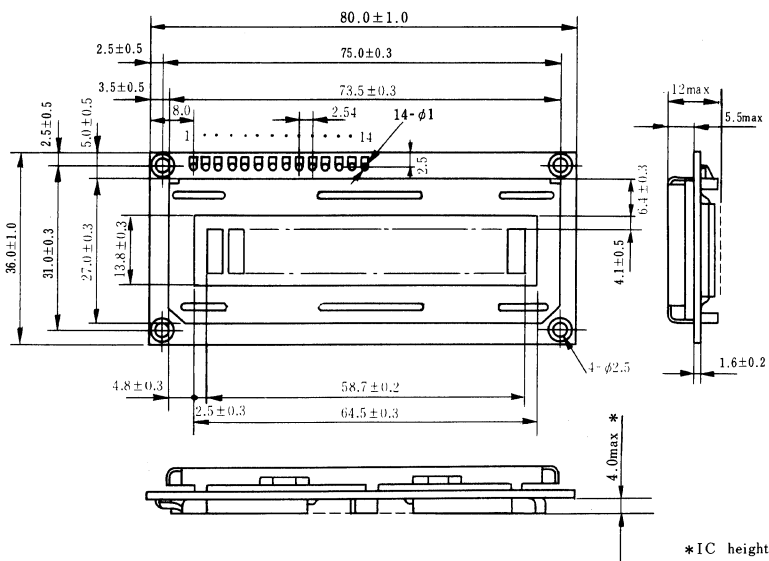


Fig. 2 External dimensions

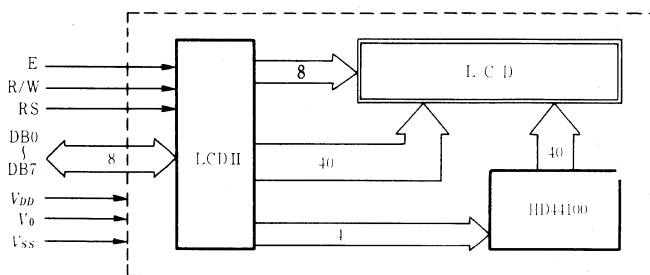


Fig. 3 Block diagram

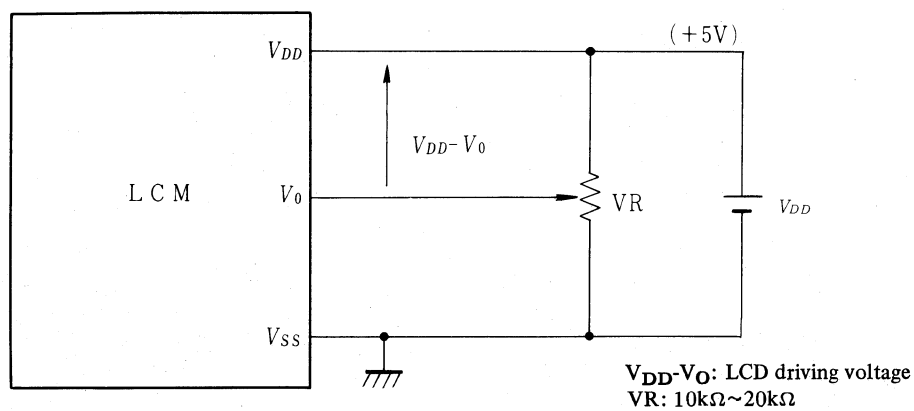


Fig. 4 Power supply

TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns

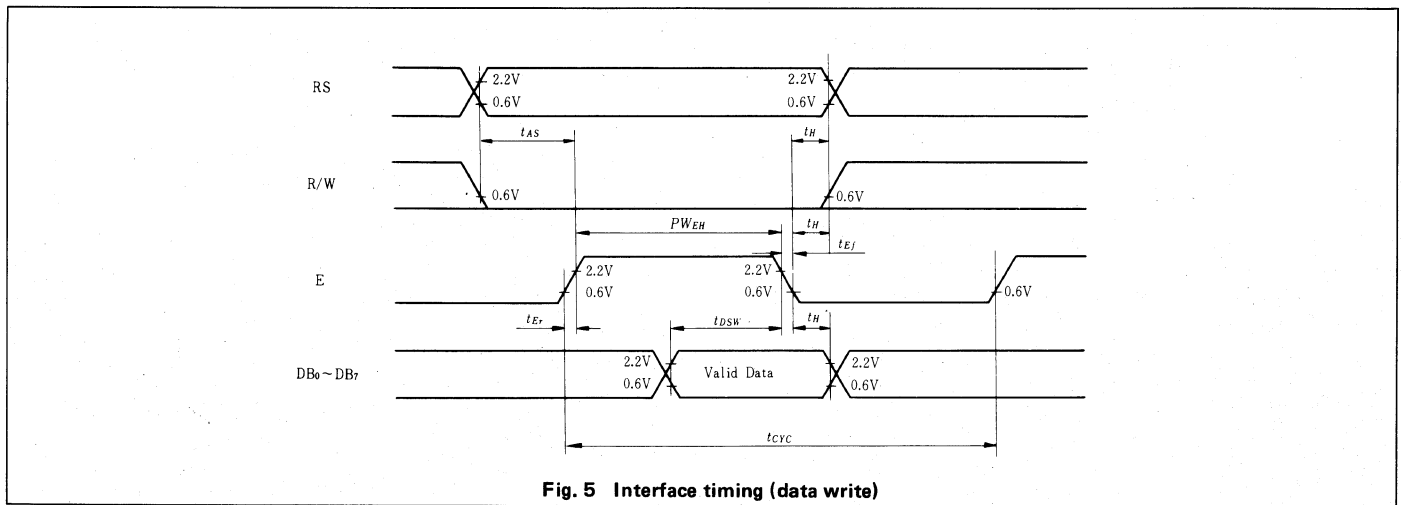


Fig. 5 Interface timing (data write)

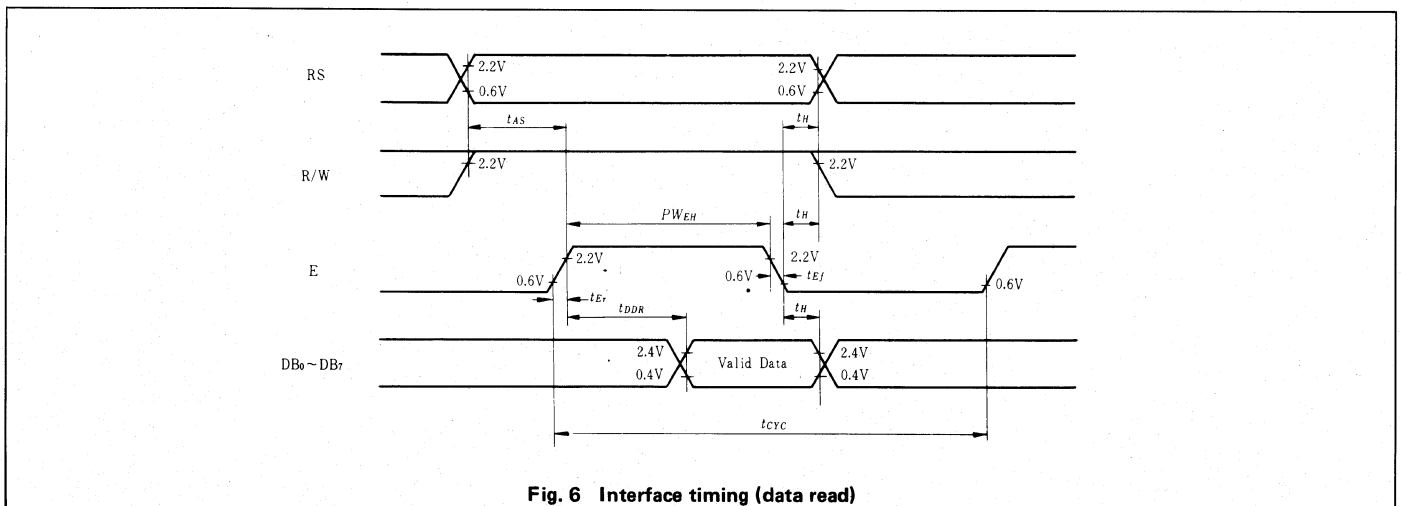
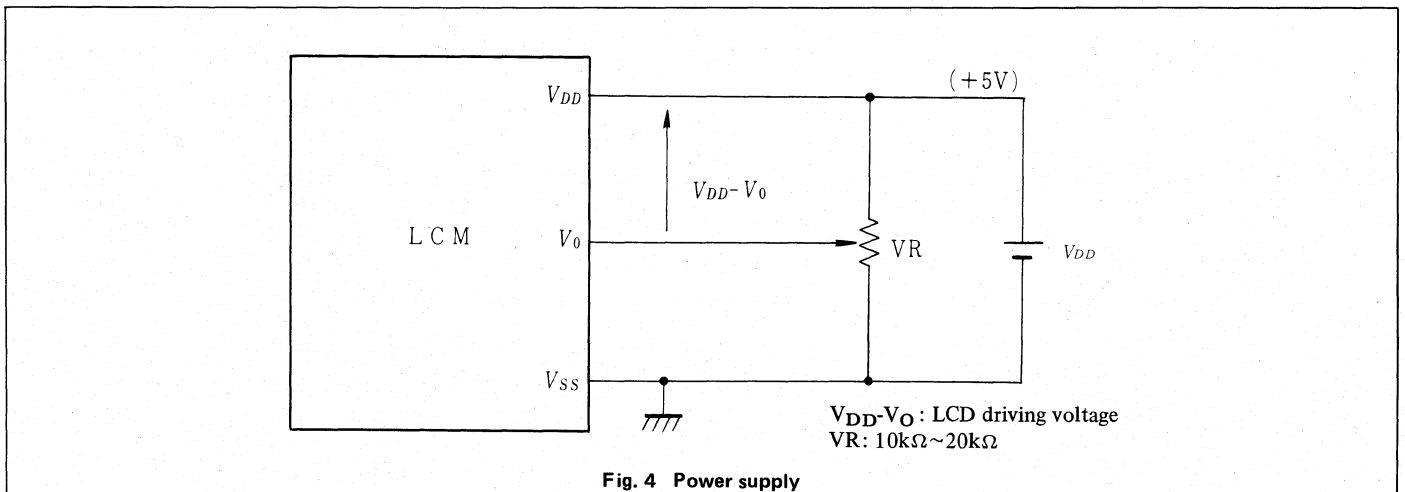
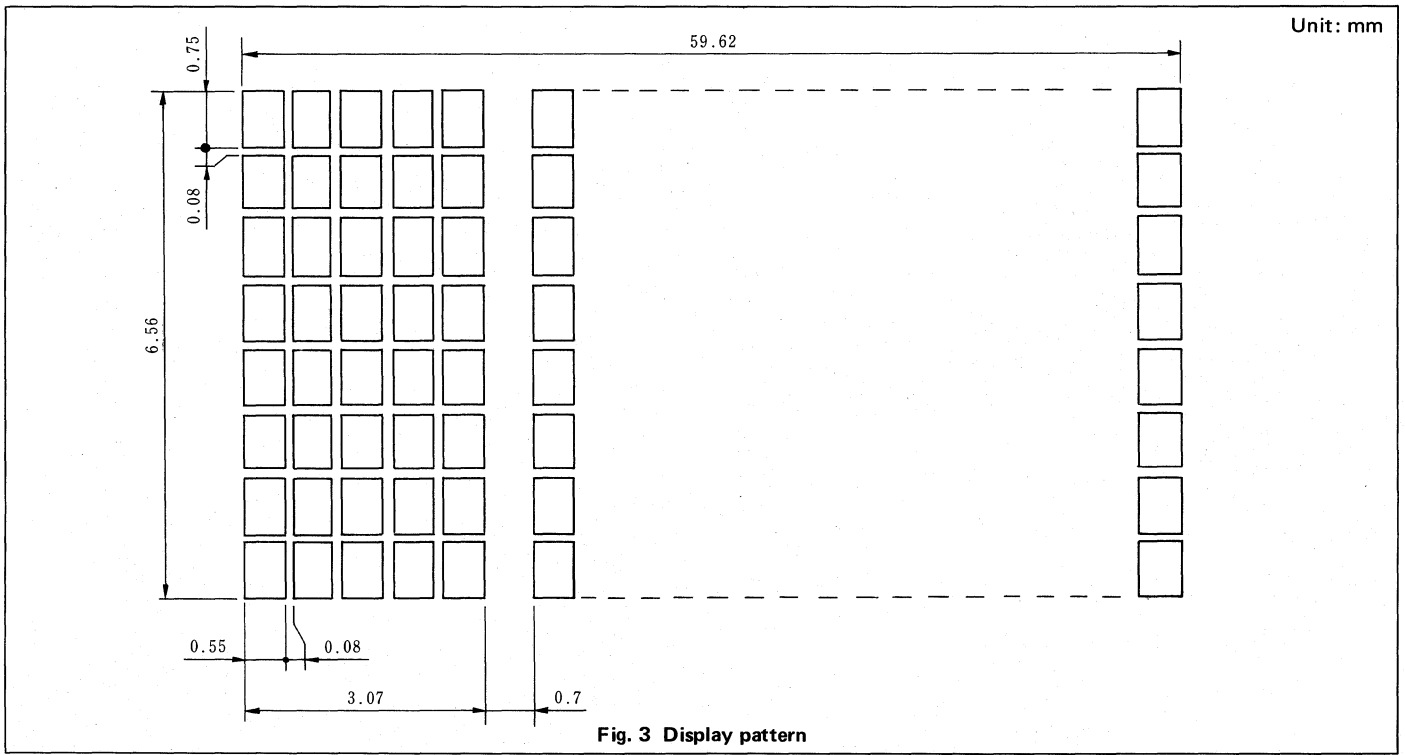
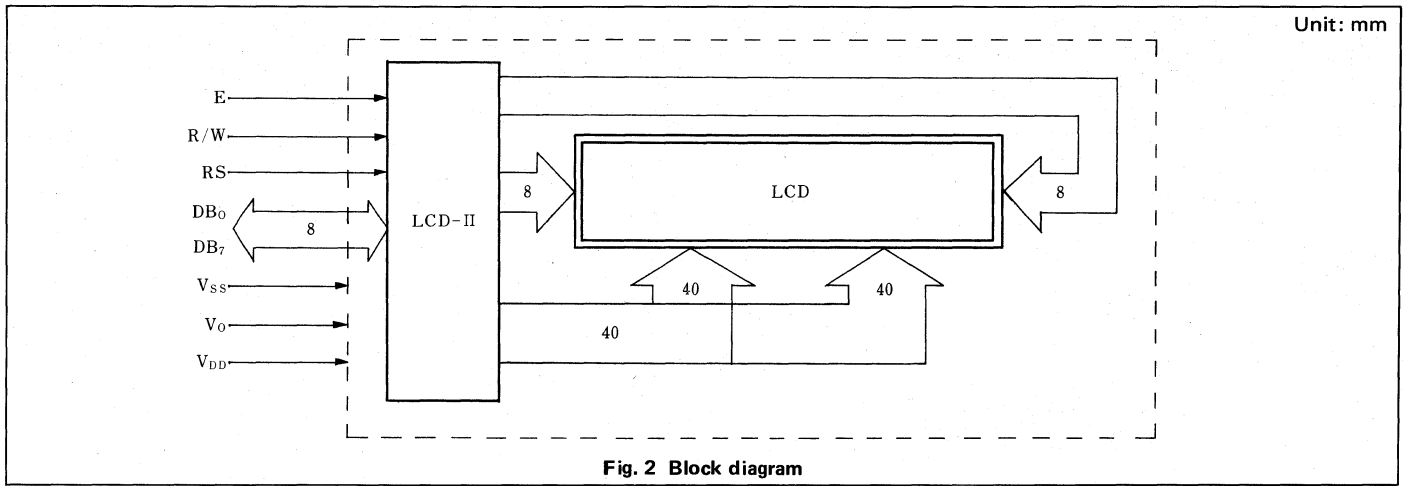


Fig. 6 Interface timing (data read)



TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns

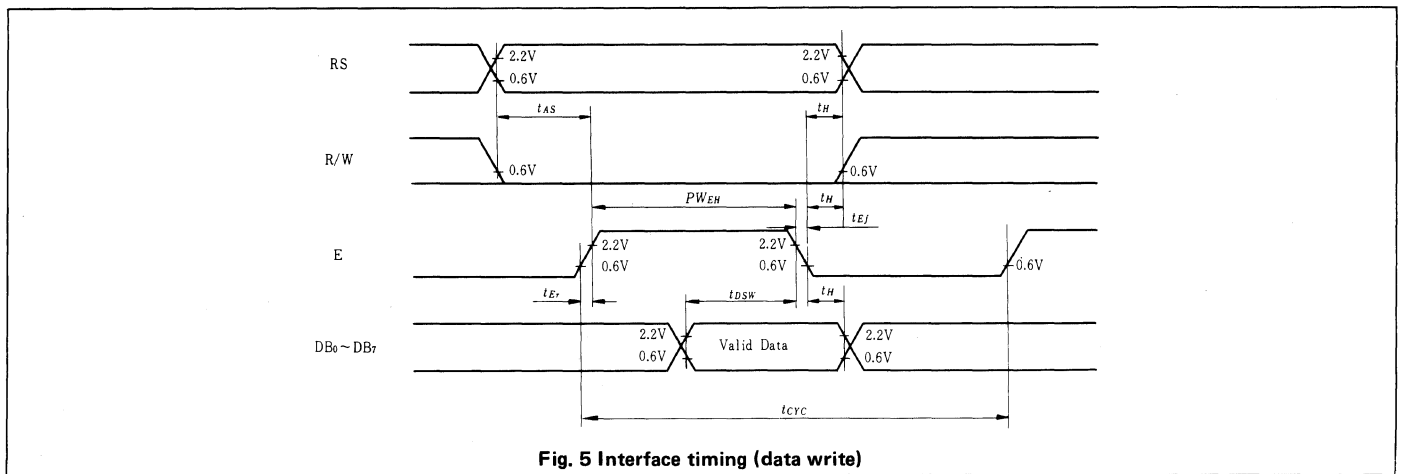


Fig. 5 Interface timing (data write)

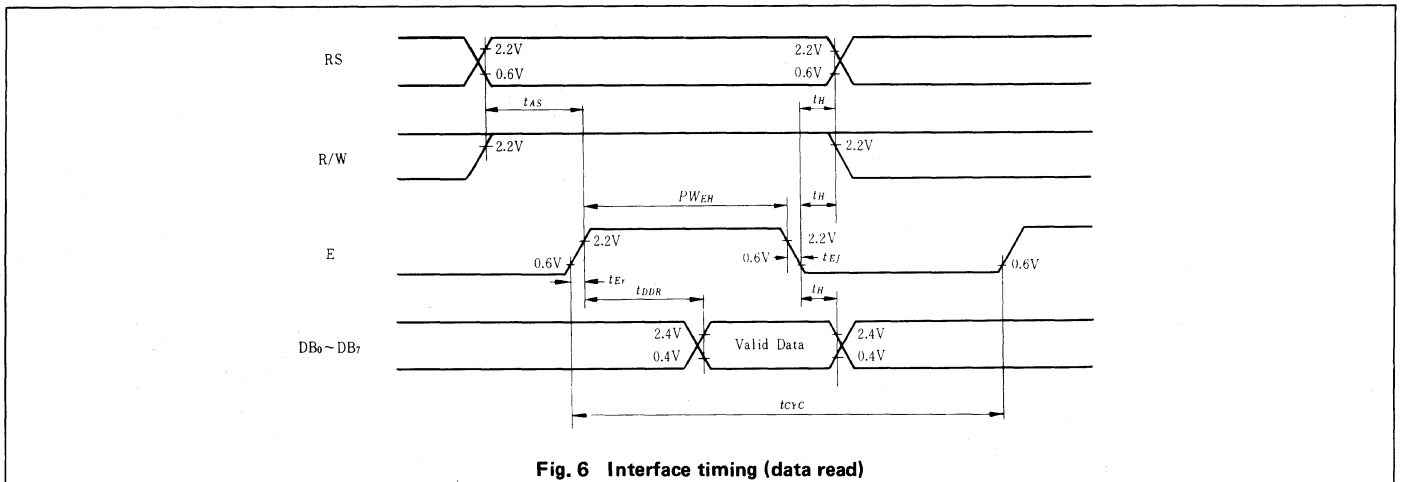


Fig. 6 Interface timing (data read)

Unit: mm

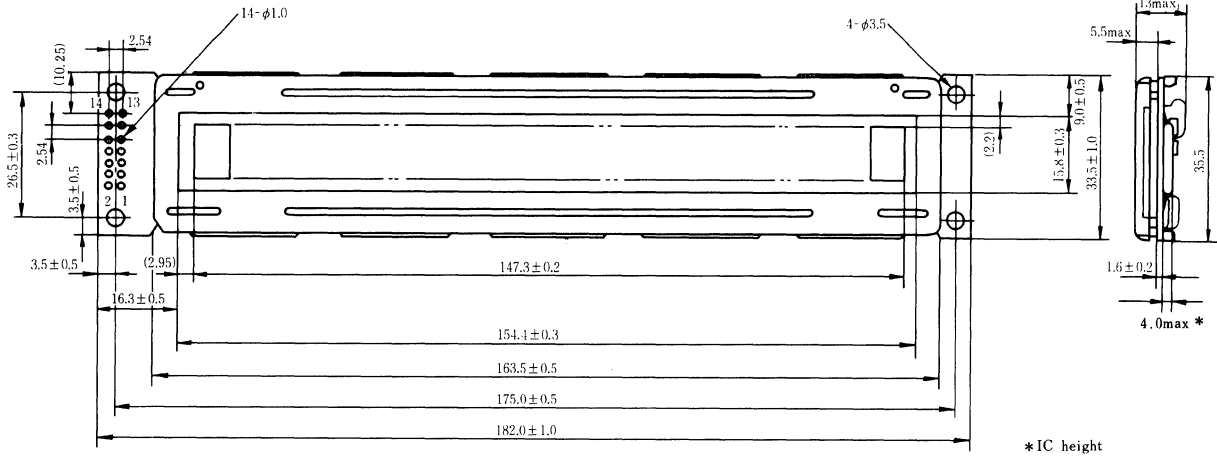
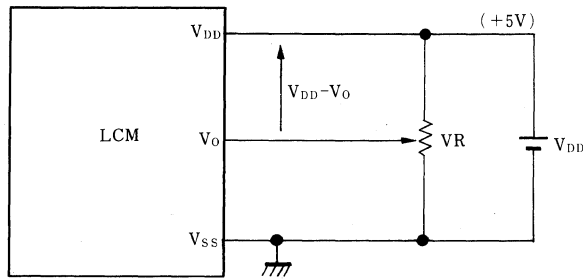


Fig. 2 External dimension

Unit: mm



V_{DD}-V₀: LCD driving voltage
VR: 10 k Ω ~ 20 k Ω

Fig. 3 Power supply

Unit: mm

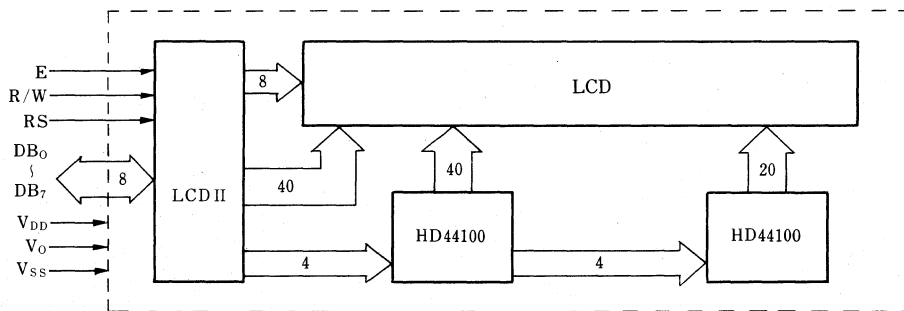


Fig. 4 Block diagram

TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns

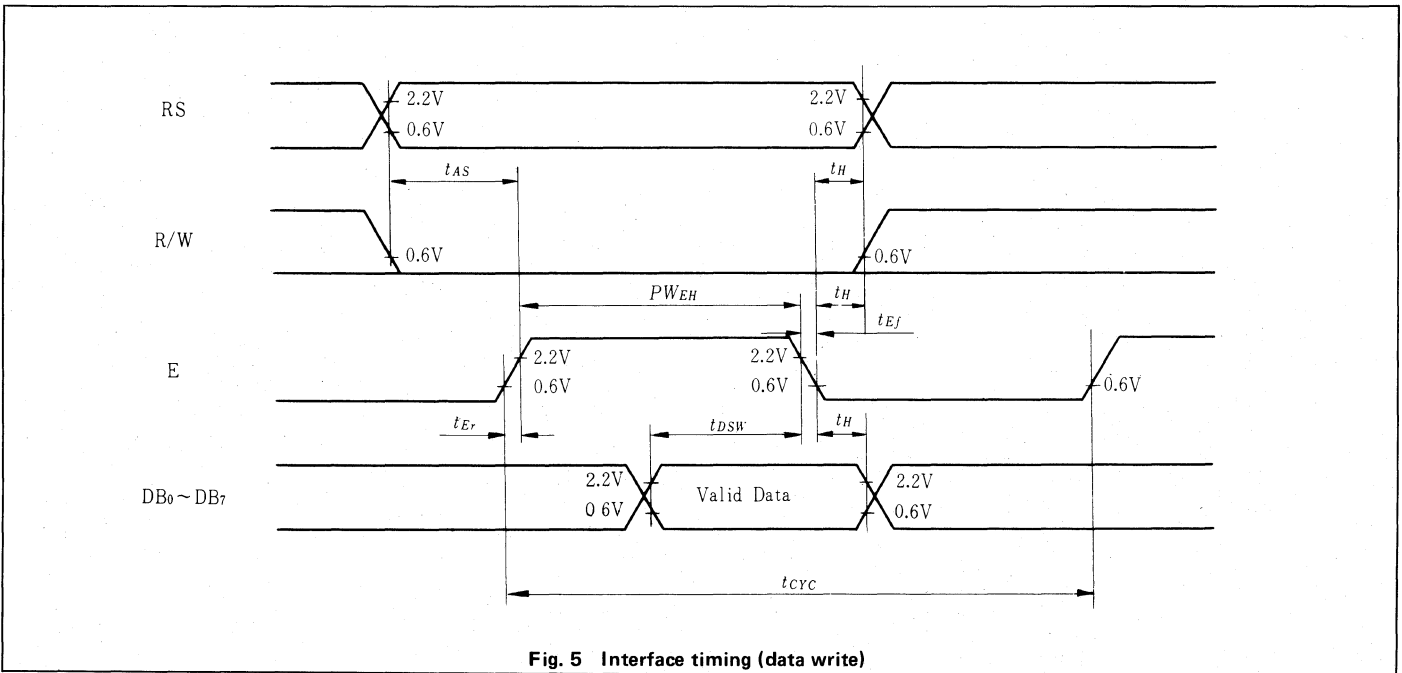


Fig. 5 Interface timing (data write)

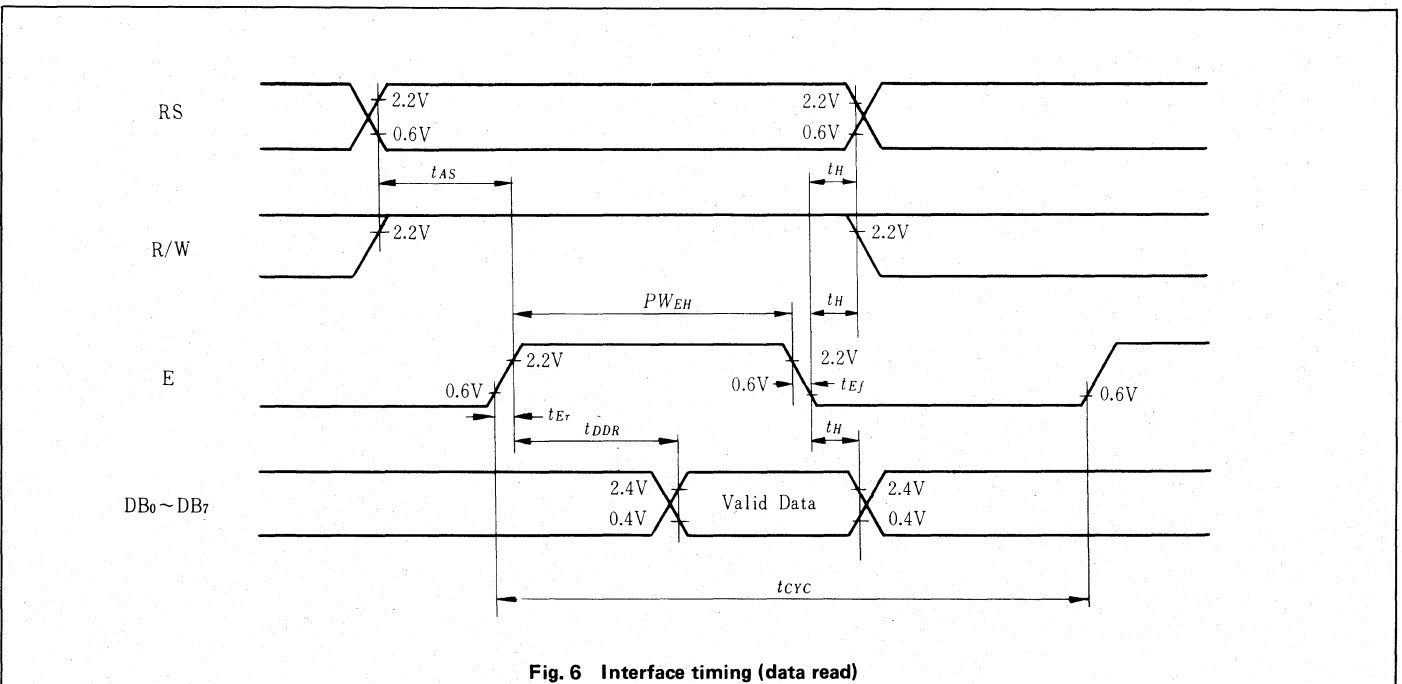


Fig. 6 Interface timing (data read)

LM027

- 24 Character x 1 line
- Built-in control LSI HD44780 type (see page 23)
- +5V single power supply

MECHANICAL DATA (Nominal dimensions)

Module size	.....	126W x 36H x 12D (max) mm
Effective display area	.....	100W x 13.8H mm
Character size (5 x 10 dots)	.....	3.15W x 7.9H mm
Pitch	.....	3.75 mm
Dot size	.....	0.55W x 0.7H mm
Weight	.....	about 40 g

ABSOLUTE MAXIMUM RATINGS

	min.	max.
Power supply for logic ($V_{DD}-V_{SS}$)	..... 0	7.0 V
Power supply for LCD drive ($V_{DD}-V_O$)	..... 0	13.5 V
Input voltage (V_i)	..... V_{SS}	V_{DD} V
Operating temperature (T_a)	..... 0	50°C
Storage temperature (T_{stg})	..... -20	70°C

ELECTRICAL CHARACTERISTICS

$T_a = 25^\circ\text{C}$, $V_{DD} = 5.0 \text{ V} \pm 0.25 \text{ V}$

Input "high" voltage (V_{iH})	.....	2.2 V min.
Input "low" voltage (V_{iL})	.....	0.6 V max.
Output high voltage (V_{OH}) ($-I_{OH}=0.2 \text{ mA}$)	..	2.4 V min.
Output low voltage (V_{OL}) ($I_{OL} = 1.2 \text{ mA}$)	...	0.4 V max.
Power supply current (I_{DD}) ($V_{DD} = 5.0 \text{ V}$)	..	0.5 mA typ. 2.0 mA max.

Power supply for LCD drive (Recommended) ($V_{DD}-V_O$)		
	Du=1/8	Du=1/11
at $T_a = 0^\circ\text{C}$	..... 4.0	4.2 V typ.
at $T_a = 25^\circ\text{C}$	..... 3.7	3.8 V typ.
at $T_a = 50^\circ\text{C}$	..... 3.3	3.3 V typ.

OPTICAL DATA..... See page 8

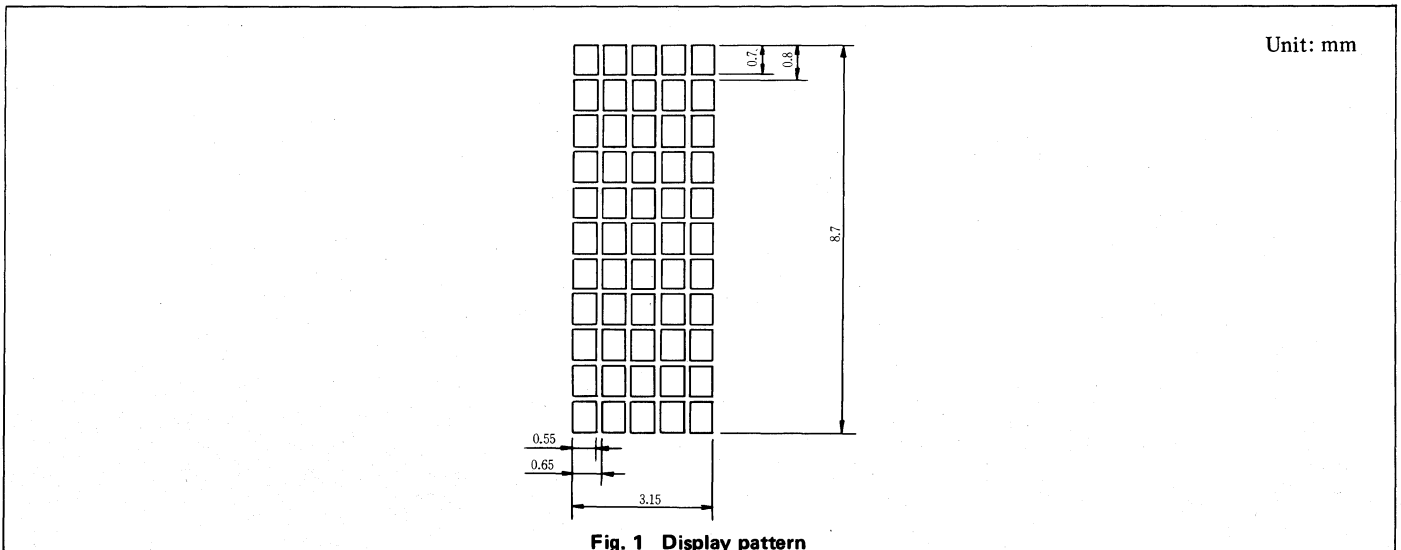
INTERNAL PIN CONNECTION

Pin No.	Symbol	Level	Function
1	V_{SS}	-	0V
2	V_{DD}	-	+5V
3	V_O	-	-
4	RS	H/L	L: Instruction code input H: Data input
5	R/W	H/L	H: Data read (LCD module→MPU) L: Data write (LCD module←MPU)
6	E	H, H→L	Enable signal
7	DB0	H/L	Data bus line Note (1), Note (2)
8	DB1	H/L	
9	DB2	H/L	
10	DB3	H/L	
11	DB4	H/L	
12	DB5	H/L	
13	DB6	H/L	
14	DB7	H/L	

Note:

In the HD44780, the data can be sent in either 4-bit 2-operation or 8-bit 1-operation so that it can interface to both 4 and 8 bit MPU's.

- (1) When interface data is 4 bits long, data is transferred using only 4 buses of $DB_4 \sim DB_7$, and $DB_0 \sim DB_3$ are not used. Data transfer between the HD44780 and the MPU completes when 4-bit data is transferred twice. Data of the higher order 4 bits (contents of $DB_4 \sim DB_7$, when interface data is 8 bits long) is transferred first and then lower order 4 bits (contents of $DB_0 \sim DB_3$, when interface data is 8 bits long).
- (2) When interface data is 8 bits long, data is transferred using 8 data buses of $DB_0 \sim DB_7$.



Unit: mm

Fig. 1 Display pattern

Unit: mm

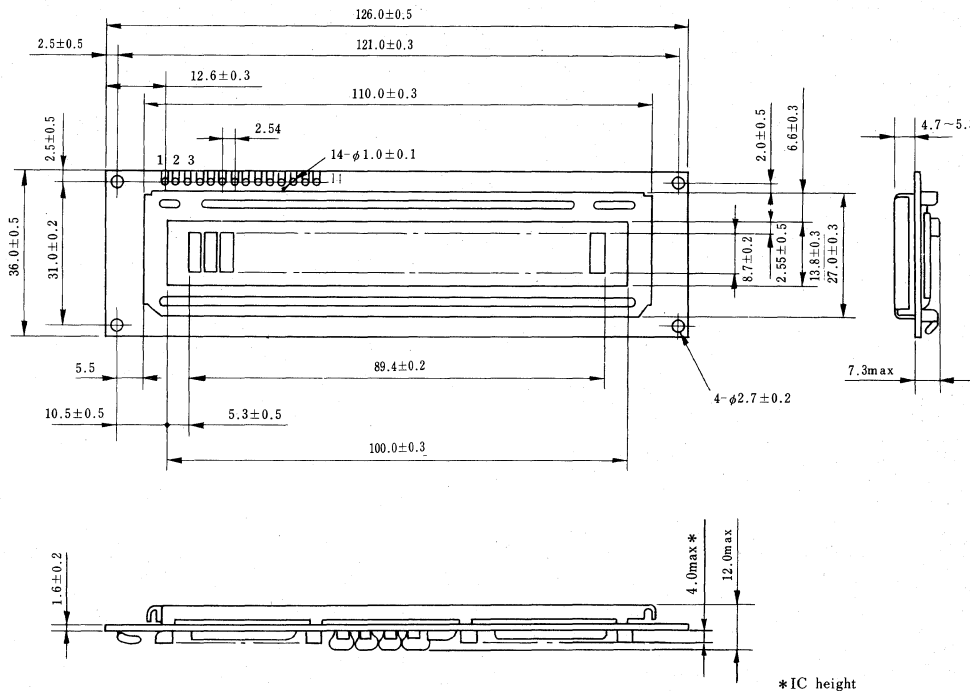


Fig. 2 External dimensions

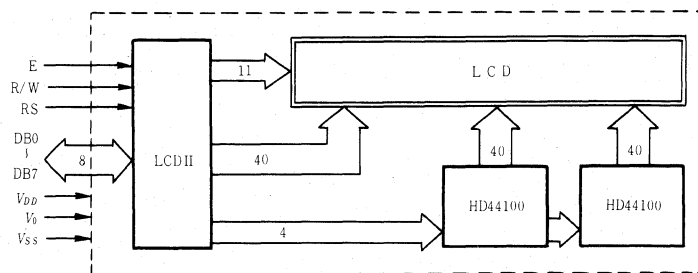


Fig. 3 Block diagram

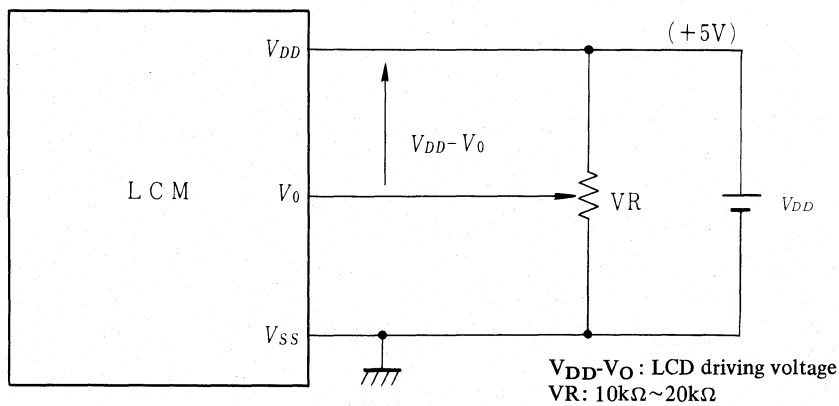


Fig. 4 Power supply

TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns

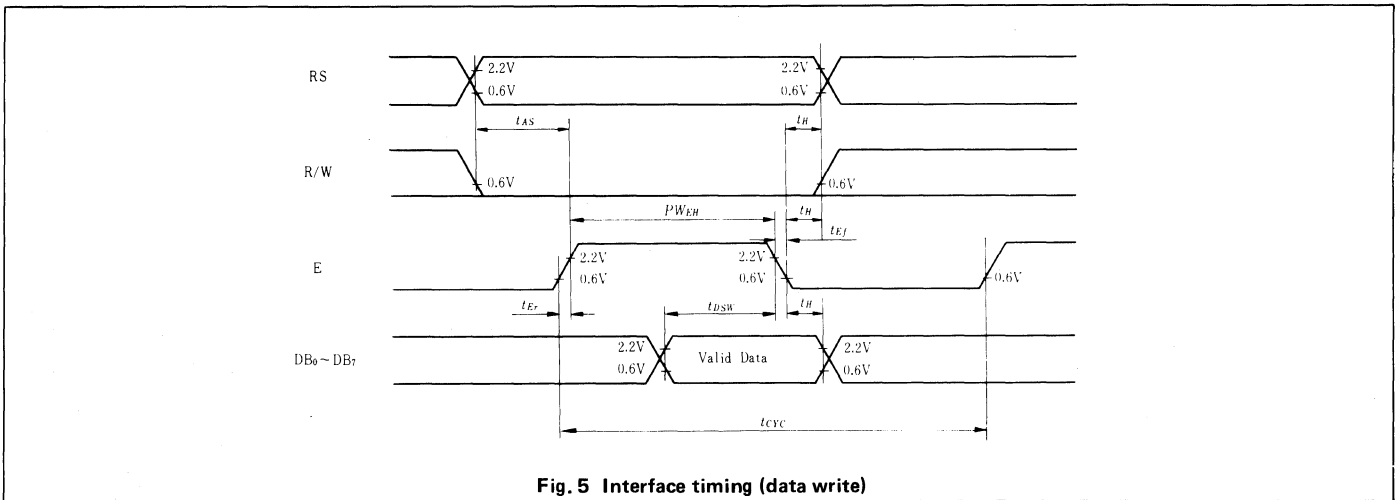


Fig. 5 Interface timing (data write)

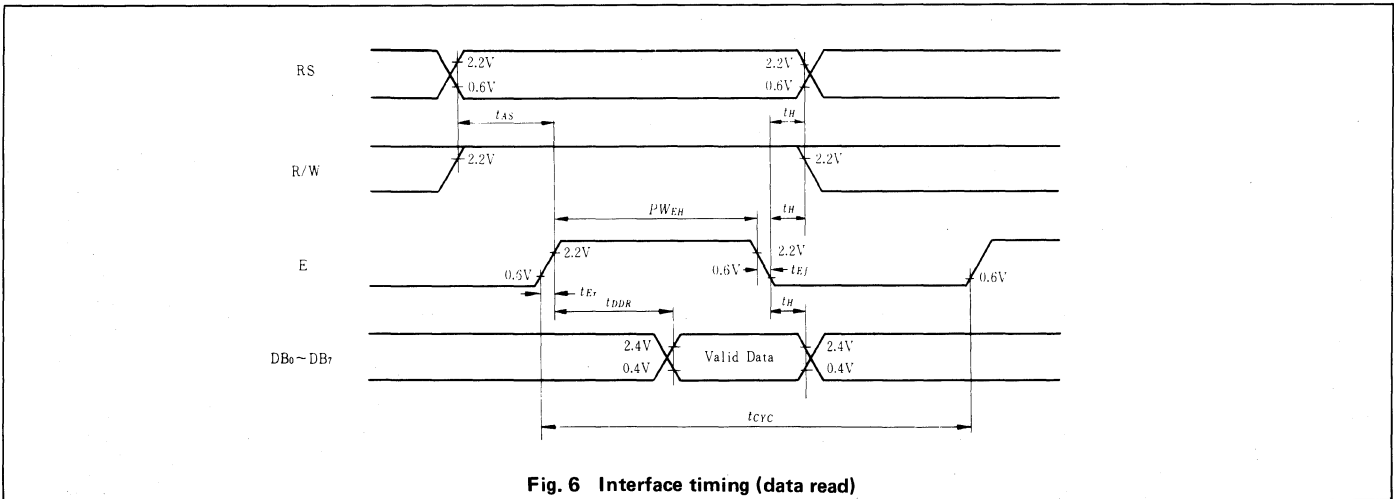


Fig. 6 Interface timing (data read)

H2571

- 32 character x 1 line
- Built-in control LSI HD44780 type (see page 23)
- +5V single power supply

MECHANICAL DATA (Nominal dimensions)

Module size . . . 174.5W x 33.0H (max.) x 13.4D (max.) mm
 Effective display are 132.5W x 14.0H mm
 Character size (5 x 10 dots) 3.15W x 7.9H mm
 Pitch 3.85 mm
 Dot size 0.55W x 0.7H mm
 Weight about 60 g

ABSOLUTE MAXIMUM RATINGS

	min.	max.
Power supply for logic ($V_{DD}-V_{SS}$)	0	7.0 V
Power supply for LCD drive ($V_{DD}-V_O$)	0	13.5 V
Input voltage (V_i)	V_{SS}	V_{DD} V
Operating temperature (T_a)	0	50°C
Storage temperature (T_{stg})	-20	70°C

ELECTRICAL CHARACTERISTICS

$T_a = 25^\circ\text{C}$, $V_{DD} = 5.0 \text{ V} \pm 0.25 \text{ V}$

Input "high" voltage (V_{iH})	2.2 V min.
Input "low" voltage (V_{iL})	0.6 V max.
Output high voltage (V_{OH}) ($-I_{OH} = 0.2\text{mA}$)	2.4 V min.
Output low voltage (V_{OL}) ($I_{OL} = 1.6 \text{ mA}$)	0.4 V max.
Power supply current (I_{DD}) ($V_{DD} = 5.0 \text{ V}$)	1.0 mA typ. 2.0 mA max.
Power supply for LCD drive (Recommended) ($V_{DD}-V_O$)	
	$D_u=1/8$ $D_u=1/11$
at $T_a = 0^\circ\text{C}$	4.0 4.2V typ.
at $T_a = 25^\circ\text{C}$	3.7 3.8V typ.
at $T_a = 50^\circ\text{C}$	3.3 3.3V typ.

OPTICAL DATA See page 8

INTERNAL PIN CONNECTION

Pin No.	Symbol	Level	Function
1	V_{SS}	-	0V
2	V_{DD}	-	+5V
3	V_O	-	-
4	RS	H/L	L: Instruction code input H: Data input
5	R/W	H/L	H: Data read (LCD module → MPU) L: Data write (LCD module ← MPU)
6	E	H, H → L	Enable signal
7	DB0	H/L	Data bus line Note (1), Note (2)
8	DB1	H/L	
9	DB2	H/L	
10	DB3	H/L	
11	DB4	H/L	
12	DB5	H/L	
13	DB6	H/L	
14	DB7	H/L	

Note:

In the HD44780, the data can be sent in either 4-bit 2-operation or 8-bit 1-operation so that it can interface to both 4 and 8 bit MPU's.

- (1) When interface data is 4 bits long, data is transferred using only 4 buses of $DB_4 \sim DB_7$, and $DB_0 \sim DB_3$ are not used. Data transfer between the HD44780 and the MPU completes when 4-bit data is transferred twice. Data of the higher order 4 bits (contents of $DB_4 \sim DB_7$, when interface data is 8 bits long) is transferred first and then lower order 4 bits (contents of $DB_0 \sim DB_3$, when interface data is 8 bits long).
- (2) When interface data is 8 bits long, data is transferred using 8 data buses of $DB_0 \sim DB_7$.

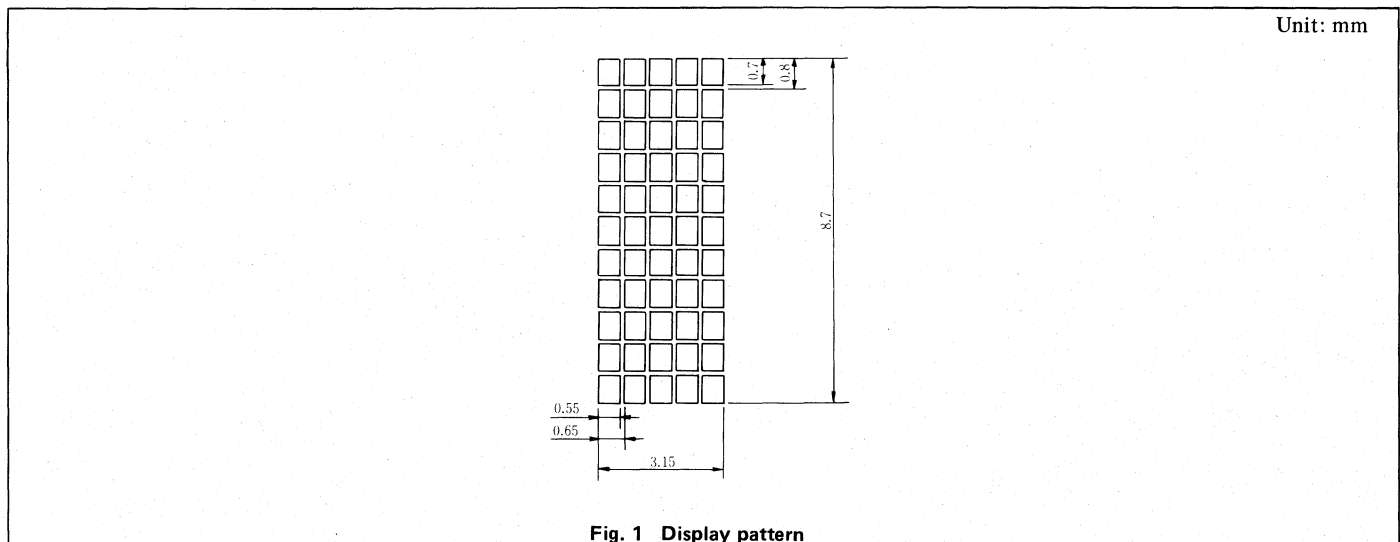


Fig. 1 Display pattern

Unit: mm

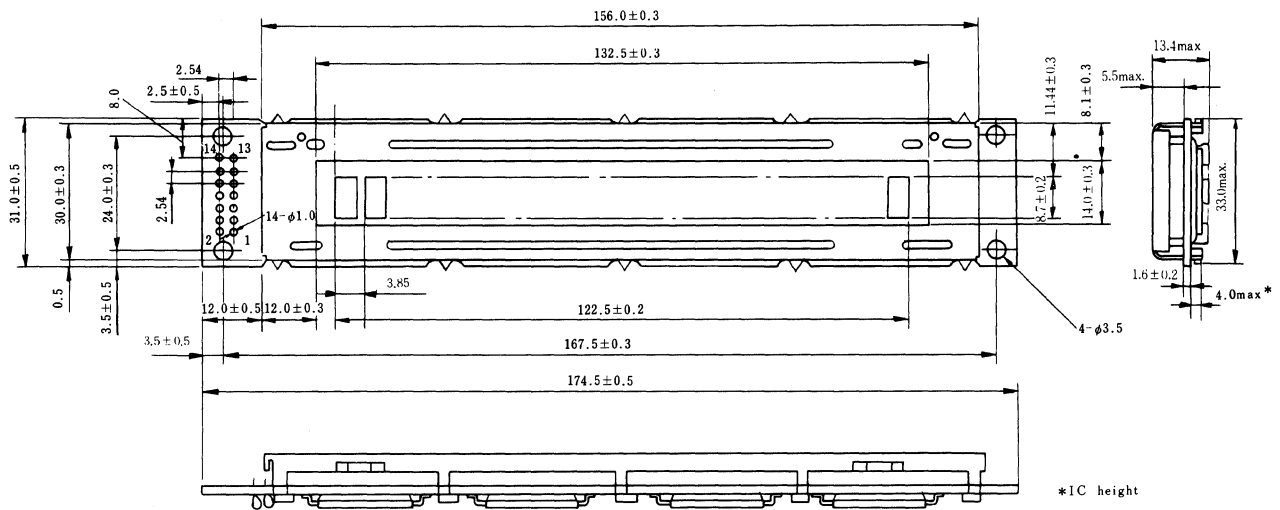


Fig. 2 External dimensions

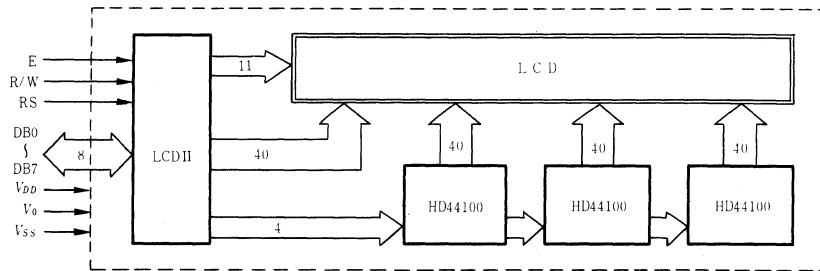


Fig. 3 Block diagram

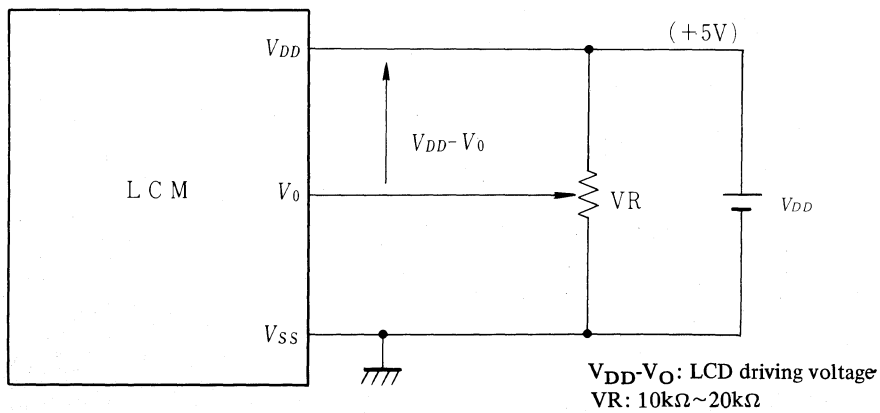


Fig. 4 Power supply

TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns

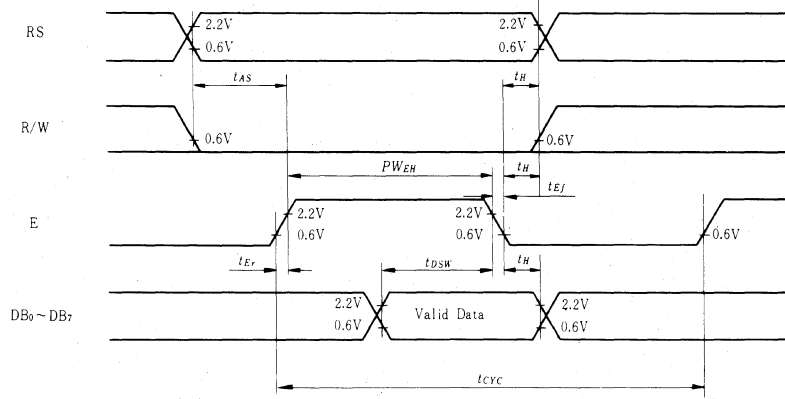


Fig. 5 Interface timing (data write)

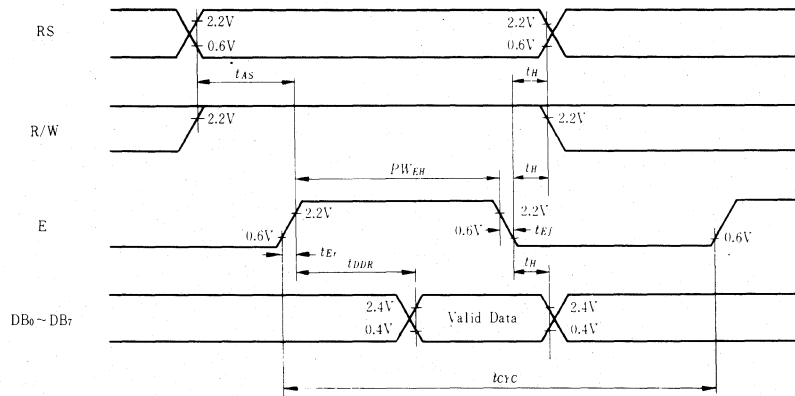


Fig. 6 Interface timing (data read)

H2572

- 40 Character x 1 line
- Built-in control LSI HD44780 type (see page 23)
- +5V single power supply

MECHANICAL DATA (Nominal dimensions)

Module size 182W x 35.5H (max.) x 13D (max.) mm
 Effective display area 154.4W x 15.8H mm
 Character size (5 x 10 dots) 3.15W x 7.9H mm
 Pitch 3.75 mm
 Dot size 0.55W x 0.7H mm
 Weight about 65 g

ABSOLUTE MAXIMUM RATINGS

	min.	max.
Power supply for logic ($V_{DD}-V_{SS}$)	0	7.0 V
Power supply for LCD drive ($V_{DD}-V_O$)	0	13.5 V
Input voltage (V_i)	V_{SS}	V_{DD} V
Operating temperature (T_a)	0	50°C
Storage temperature (T_{stg})	-20	70°C

ELECTRICAL CHARACTERISTICS

$T_a = 25^\circ\text{C}$, $V_{DD} = 5.0 \text{ V} \pm 0.25 \text{ V}$

Input "high" voltage (V_{iH})	2.2 V min.
Input "low" voltage (V_{iL})	0.6 V max.
Output high voltage (V_{OH}) ($-I_{OH}=0.2\text{mA}$)	2.4 V min.
Output low voltage (V_{OL}) ($I_{OL}=1.6 \text{ mA}$)	0.4 V max.
Power supply current (I_{DD}) ($V_{DD} = 5.0 \text{ V}$)	1.0 mA typ. 2.0 mA max.
Power supply for LCD drive (Recommended) ($V_{DD}-V_O$)	
Du=1/8 Du=1/11	
at $T_a = 0^\circ\text{C}$	4.0 4.2 V typ.
at $T_a = 25^\circ\text{C}$	3.7 3.8 V typ.
at $T_a = 50^\circ\text{C}$	3.3 3.3 V typ.

OPTICAL DATA See page 8

INTERNAL PIN CONNECTION

Pin No.	Symbol	Level	Function
1	V_{SS}	—	0V
2	V_{DD}	—	+5V
3	V_O	—	—
4	RS	H/L	L: Instruction code input H: Data input
5	R/W	H/L	H: Data read (LCD module → MPU) L: Data write (LCD module ← MPU)
6	E	H, H → L	Enable signal
7	DB0	H/L	Data bus line Note (1), Note (2)
8	DB1	H/L	
9	DB2	H/L	
10	DB3	H/L	
11	DB4	H/L	
12	DB5	H/L	
13	DB6	H/L	
14	DB7	H/L	

Note:

In the HD44780, the data can be sent in either 4-bit 2-operation or 8-bit 1-operation so that it can interface to both 4 and 8 bit MPU's.

- (1) When interface data is 4 bits long, data is transferred using only 4 buses of $DB_4 \sim DB_7$, and $DB_0 \sim DB_3$ are not used. Data transfer between the HD44780 and the MPU completes when 4-bit data is transferred twice. Data of the higher order 4 bits (contents of $DB_4 \sim DB_7$, when interface data is 8 bits long) is transferred first and then lower order 4 bits (contents of $DB_0 \sim DB_3$, when interface data is 8 bits long).
- (2) When interface data is 8 bits long, data is transferred using 8 data buses of $DB_0 \sim DB_7$.

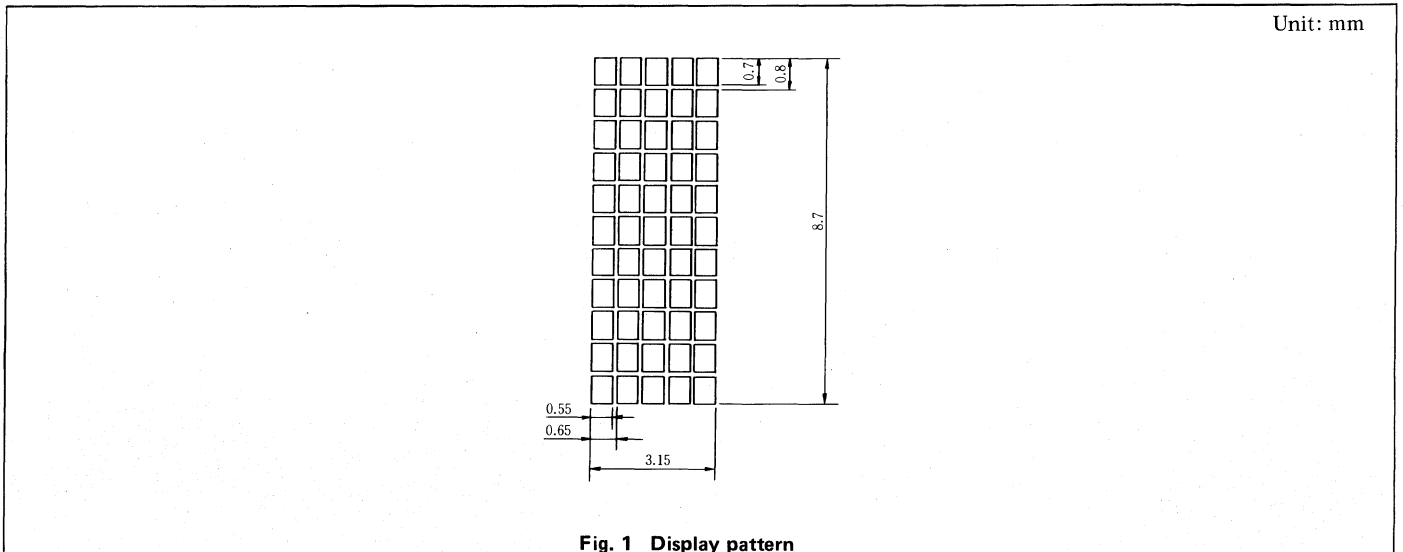
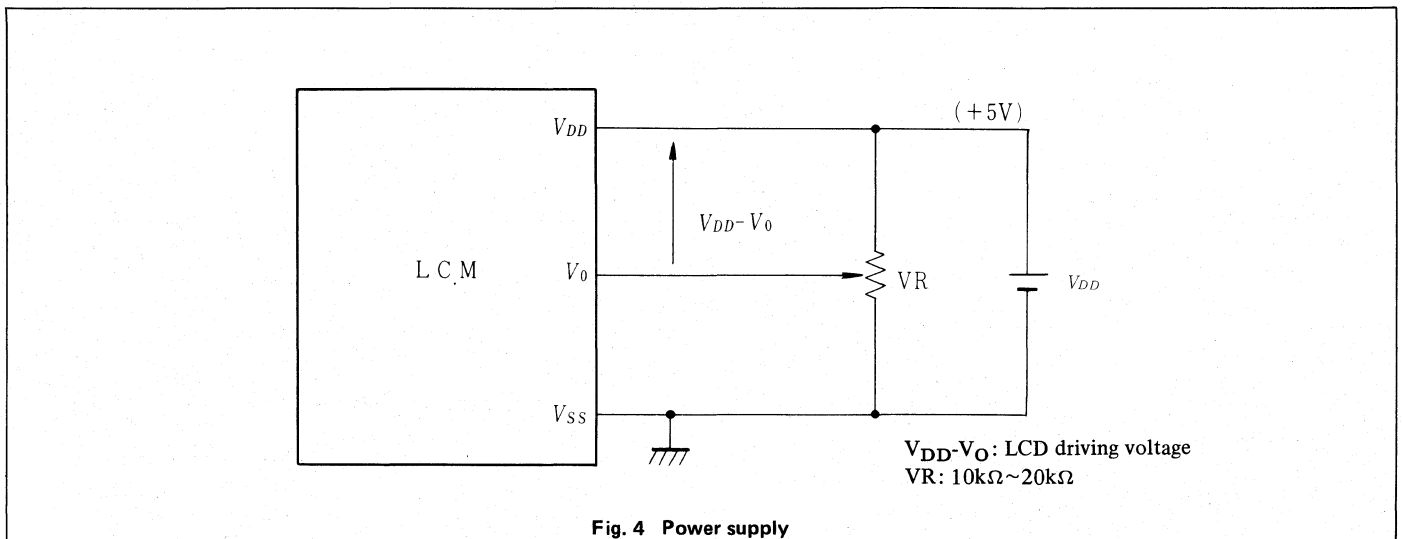
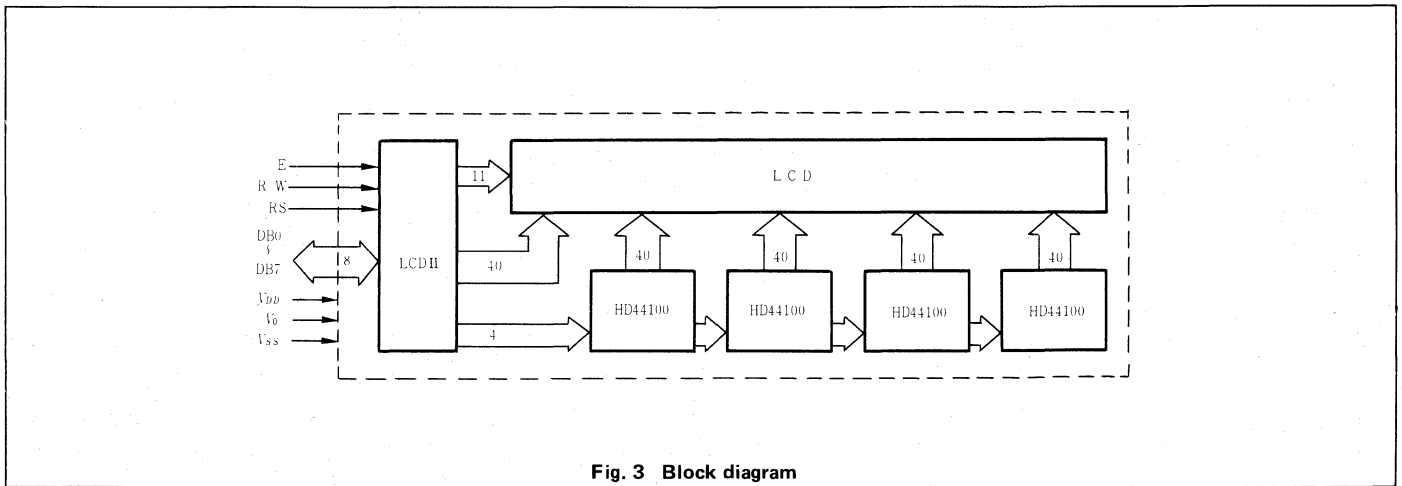
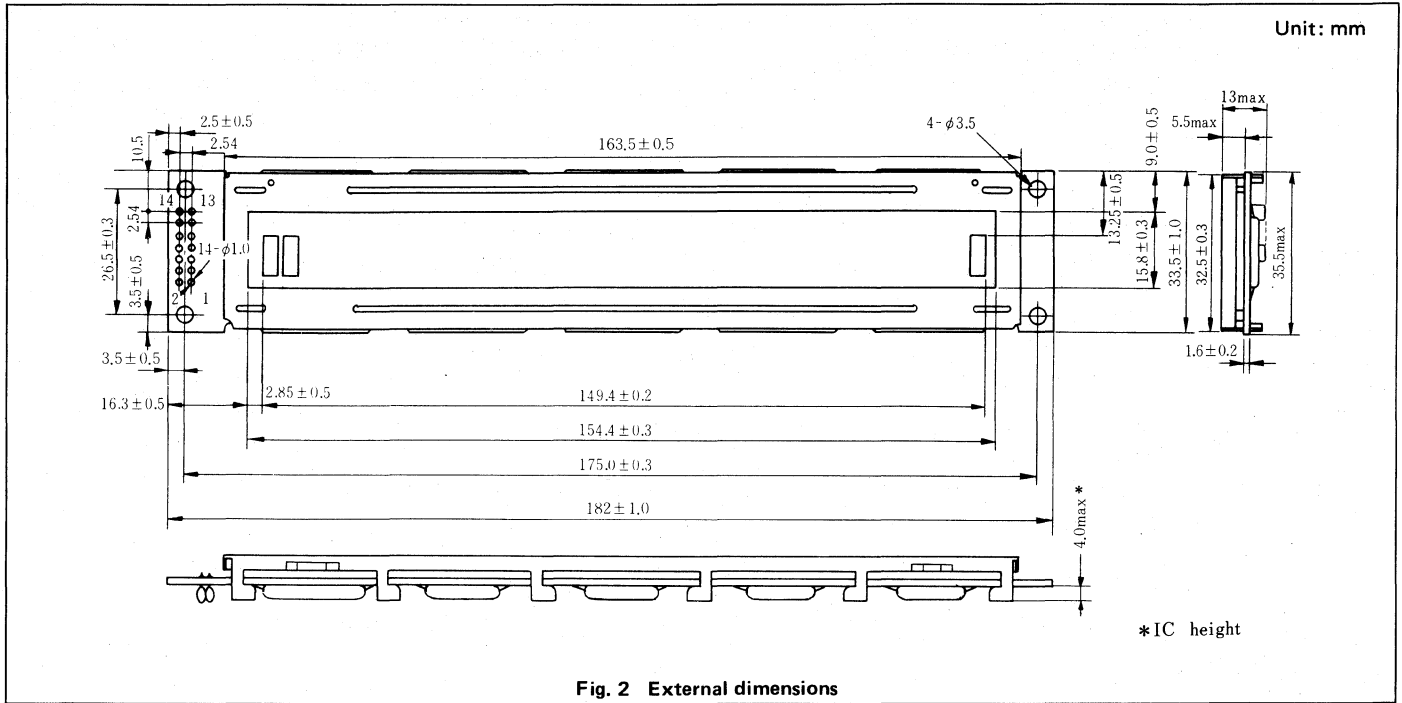


Fig. 1 Display pattern



TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns

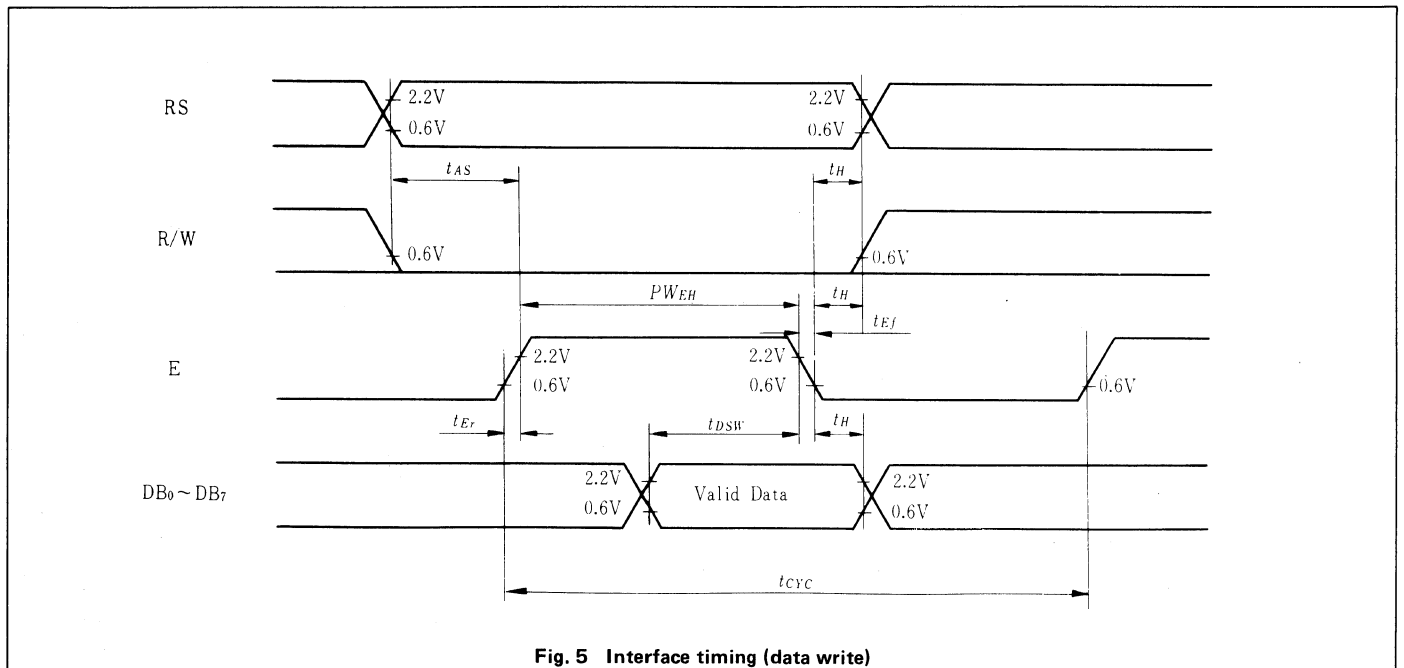


Fig. 5 Interface timing (data write)

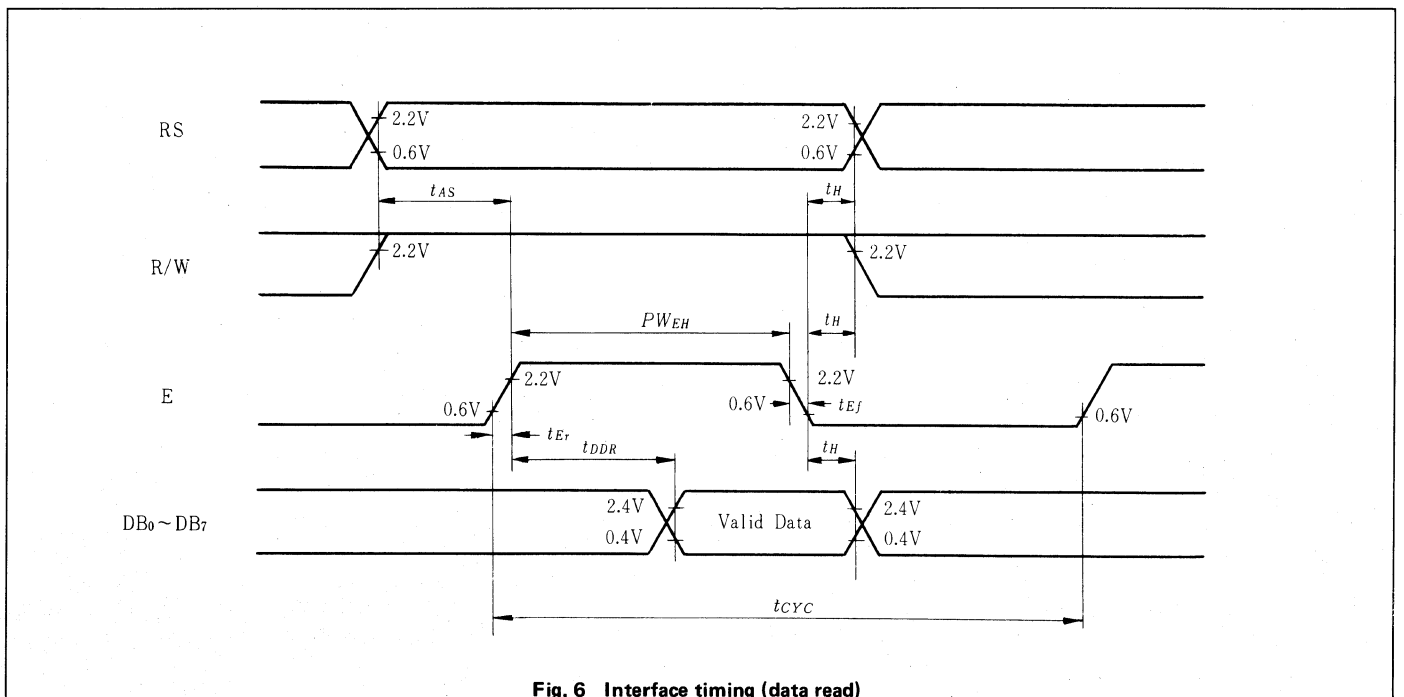


Fig. 6 Interface timing (data read)

LM052L

- 16 Character x 2 lines
- Built-in control LSI HD44780 type (see page 23)
- +5V single power supply

MECHANICAL DATA (Nominal dimensions)

Module size	80W x 36H x 12D (max.) mm
Effective display area	64.5W x 13.8H mm
Character size (5 x 10 dots)	2.95W x 3.8H mm
Pitch	3.65 mm
Dot size	0.55W x 0.5H mm
Weight	about 25 g

ABSOLUTE MAXIMUM RATINGS

	min.	max.
Power supply for logic ($V_{DD}-V_{SS}$)	0	7.0 V
Power supply for LCD drive ($V_{DD}-V_O$)	0	13.5 V
Input voltage (V_i)	V_{SS}	V_{DD} V
Operating temperature (T_a)	0	50°C
Storage temperature (T_{stg})	-20	70°C

ELECTRICAL CHARACTERISTICS

$T_a = 25^\circ\text{C}$, $V_{DD} = 5.0 \text{ V} \pm 0.25 \text{ V}$

Input "high" voltage (V_{iH})	2.2 V min.
Input "low" voltage (V_{iL})	0.6 V max.
Output high voltage (V_{OH}) ($-I_{OH} = 0.2 \text{ mA}$)	2.4 V min.
Output low voltage (V_{OL}) ($I_{OL} = 1.2 \text{ mA}$)	0.4 V max.
Power supply current (I_{DD}) ($V_{DD} = 5.0 \text{ V}$)	1.0 mA typ. 3.0 mA max.
Power supply for LCD drive (Recommended) ($V_{DD}-V_O$)	$Du=1/16$
at $T_a = 0^\circ\text{C}$	4.2 V typ.
at $T_a = 25^\circ\text{C}$	4.0 V typ.
at $T_a = 50^\circ\text{C}$	3.6 V typ.

OPTICAL DATA See page 8

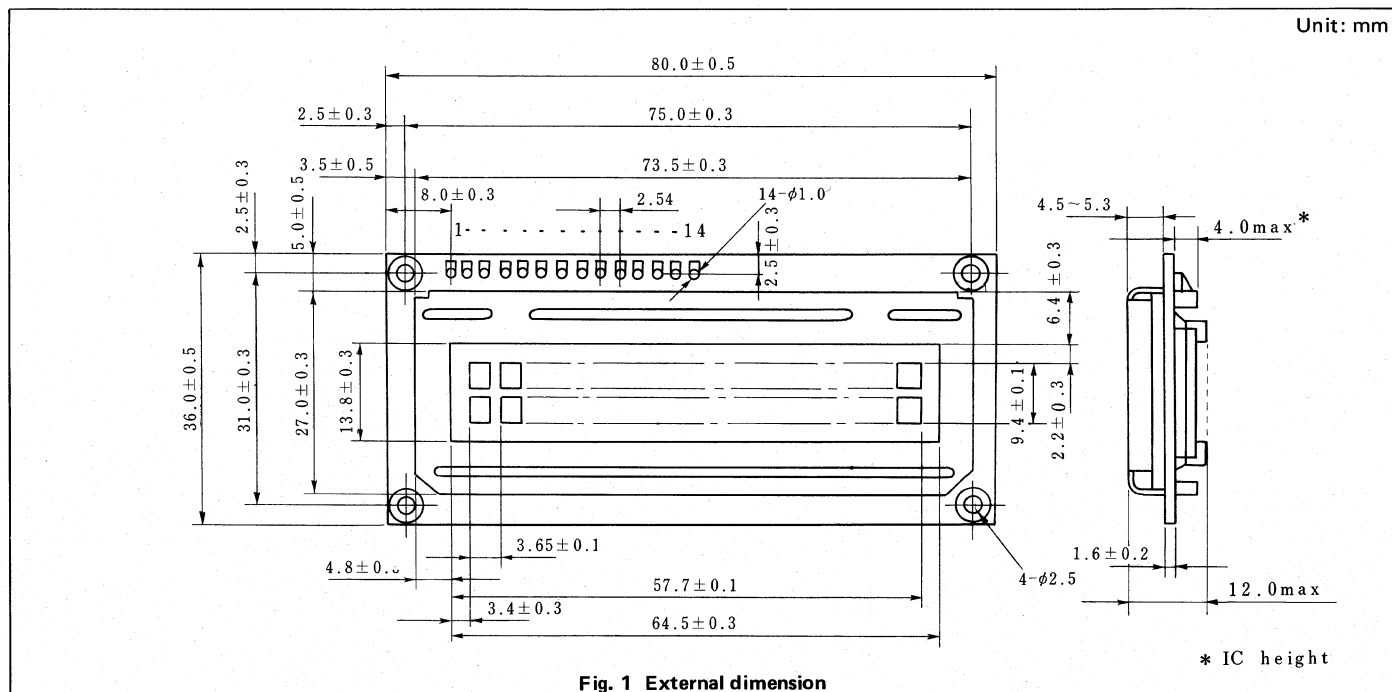
INTERNAL PIN CONNECTION

Pin No.	Symbol	Level	Function
1	V_{SS}	—	0V
2	V_{DD}	—	+5V
3	V_O	—	—
4	RS	H/L	L: Instruction code input H: Data input
5	R/W	H/L	H: Data read (LCD module \rightarrow MPU) L: Data write (LCD module \leftarrow MPU)
6	E	H, H \rightarrow L	Enable signal
7	DB0	H/L	Data bus line Note (1), Note (2)
8	DB1	H/L	
9	DB2	H/L	
10	DB3	H/L	
11	DB4	H/L	
12	DB5	H/L	
13	DB6	H/L	
14	DB7	H/L	

Note:

In the HD44780, the data can be sent in either 4-bit 2-operation or 8-bit 1-operation so that it can interface to both 4 and 8 bit MPU's.

- (1) When interface data is 4 bits long, data is transferred using only 4 buses of $DB_4 \sim DB_7$, and $DB_0 \sim DB_3$ are not used. Data transfer between the HD44780 and the MPU completes when 4-bit data is transferred twice. Data of the higher order 4 bits (contents of $DB_4 \sim DB_7$, when interface data is 8 bits long) is transferred first and then lower order 4 bits (contents of $DB_0 \sim DB_3$, when interface data is 8 bits long).
- (2) When interface data is 8 bits long, data is transferred using 8 data buses of $DB_0 \sim DB_7$.



Unit: mm

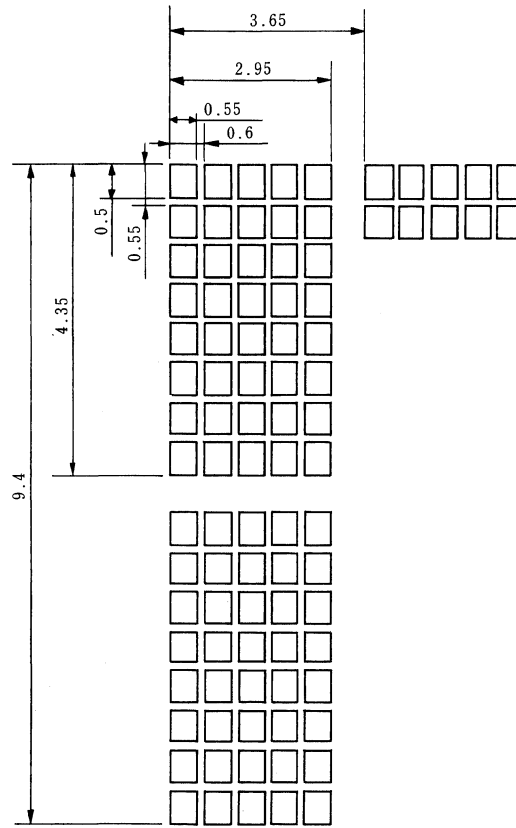


Fig. 2 Display pattern

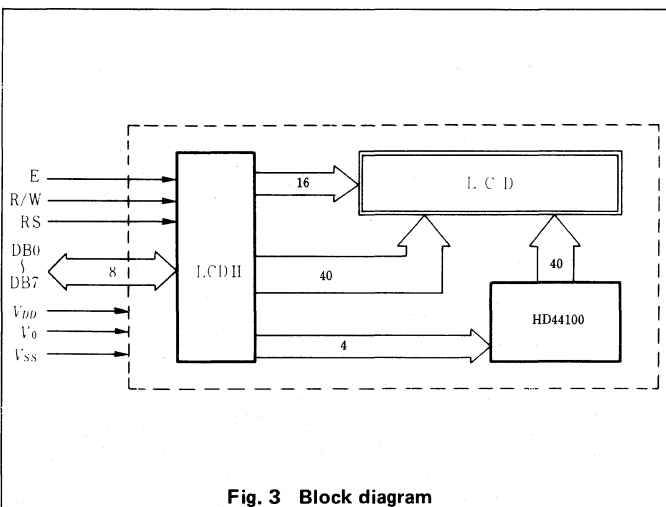


Fig. 3 Block diagram

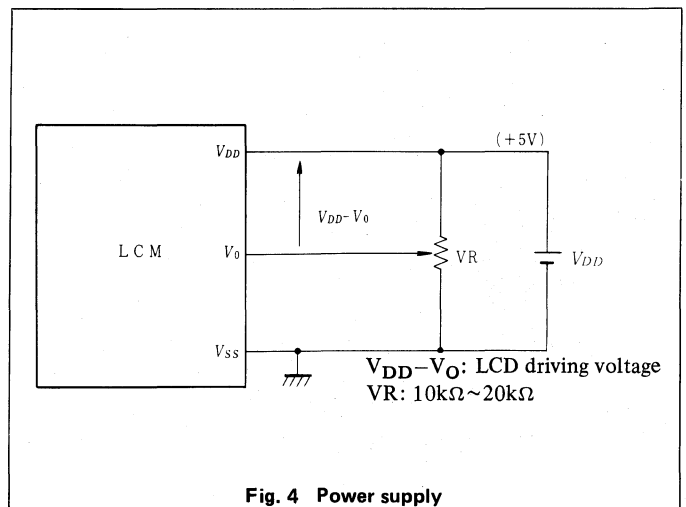


Fig. 4 Power supply

TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns

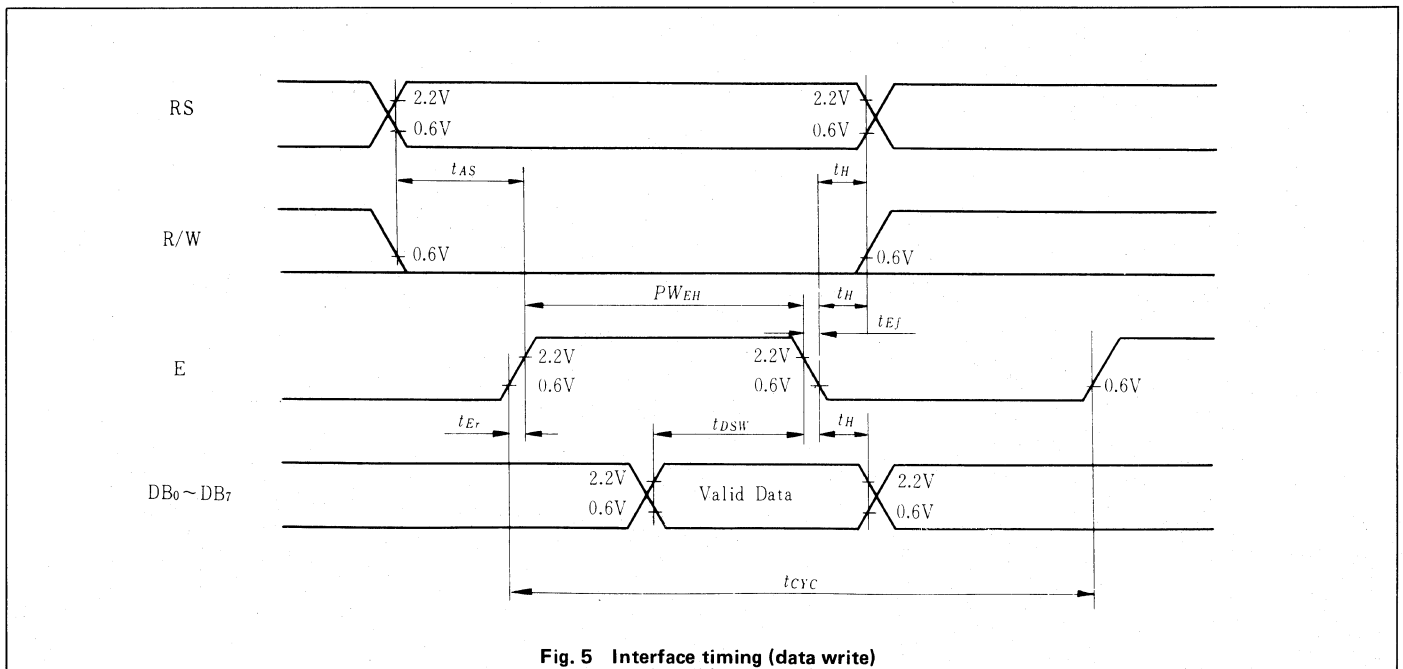


Fig. 5 Interface timing (data write)

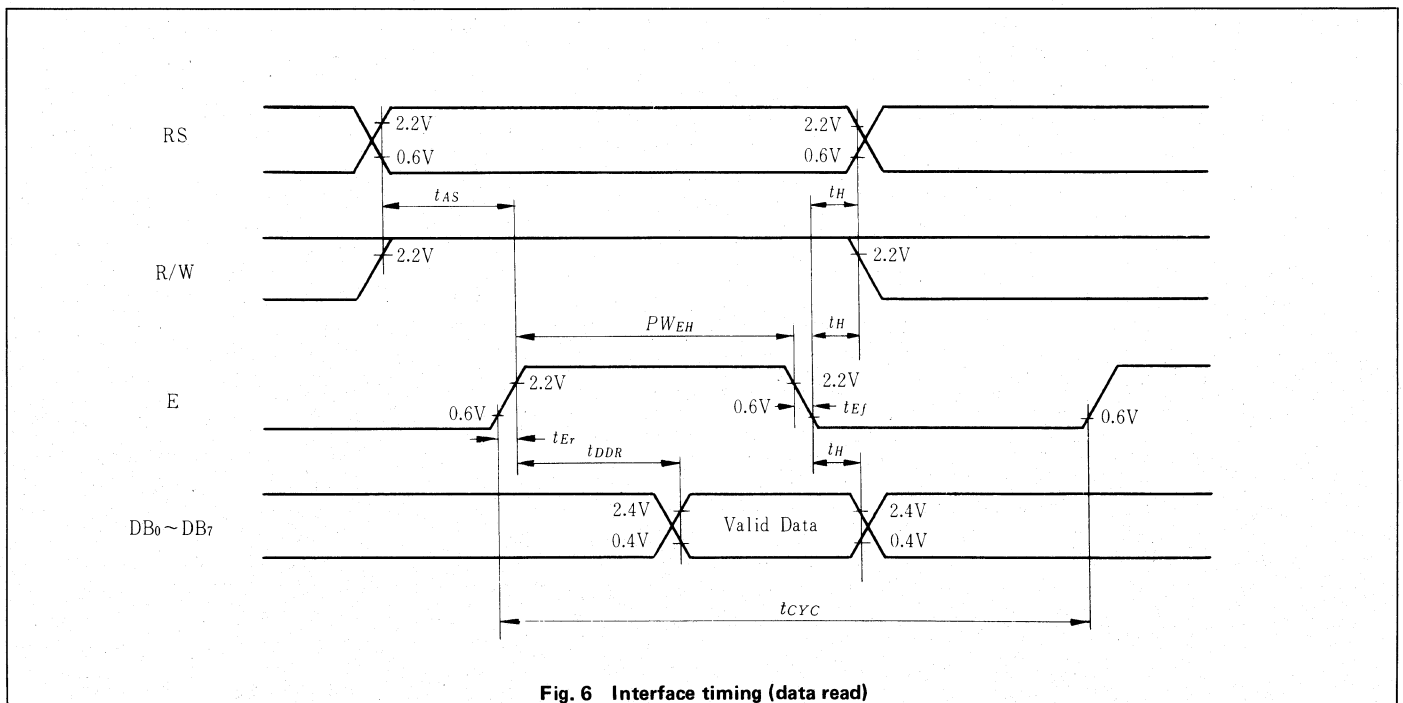


Fig. 6 Interface timing (data read)

LM016L

- 16 Character x 2 lines
- Built-in control LSI HD44780 type (see page 23)
- +5V single power supply

MECHANICAL DATA (Nominal dimensions)

Module size 84W x 44H x 12D (max.) mm
 Effective display area 61W x 15.8H mm
 Character size (5 x 7 dots) 2.96W x 4.86H mm
 Pitch 3.55 mm
 Dot size 0.56W x 0.66H mm
 Weight about 25 g

ABSOLUTE MAXIMUM RATINGS

	min.	max.
Power supply for logic ($V_{DD}-V_{SS}$)	0	7.0 V
Power supply for LCD drive ($V_{DD}-V_O$)	0	13.5 V
Input voltage (V_i)	V_{SS}	V_{DD} V
Operating temperature (T_a)	0	50°C
Storage temperature (T_{stg})	-20	70°C

ELECTRICAL CHARACTERISTICS

$T_a = 25^\circ\text{C}$, $V_{DD} = 5.0 \text{ V} \pm 0.25 \text{ V}$
 Input "high" voltage (V_{iH}) 2.2 V min.
 Input "low" voltage (V_{iL}) 0.6 V max.
 Output high voltage (V_{OH}) ($-I_{OH} = 0.2 \text{ mA}$) 2.4 V min.
 Output low voltage (V_{OL}) ($I_{OL} = 1.2 \text{ mA}$) 0.4 V max.
 Power supply current (I_{DD}) ($V_{DD} = 5.0 \text{ V}$) 1.0 mA typ.
 3.0 mA max.
 Power supply for LCD drive (Recommended) ($V_{DD}-V_O$)
 $Du=1/16$
 at $T_a = 0^\circ\text{C}$ 4.6 V typ.
 at $T_a = 25^\circ\text{C}$ 4.4 V typ.
 at $T_a = 50^\circ\text{C}$ 4.2 V typ.

OPTICAL DATA See page 8

INTERNAL PIN CONNECTION

Pin No.	Symbol	Level	Function
1	V_{SS}	—	0V
2	V_{DD}	—	+5V
3	V_O	—	—
4	RS	H/L	L: Instruction code input H: Data input
5	R/W	H/L	H: Data read (LCD module→MPU) L: Data write (LCD module←MPU)
6	E	H, H→L	Enable signal
7	DB0	H/L	Data bus line Note (1), Note (2)
8	DB1	H/L	
9	DB2	H/L	
10	DB3	H/L	
11	DB4	H/L	
12	DB5	H/L	
13	DB6	H/L	
14	DB7	H/L	

Note:

In the HD44780, the data can be sent in either 4-bit 2-operation or 8-bit 1-operation so that it can interface to both 4 and 8 bit MPU's.

- (1) When interface data is 4 bits long, data is transferred using only 4 buses of $DB_4 \sim DB_7$ and $DB_0 \sim DB_3$ are not used. Data transfer between the HD44780 and the MPU completes when 4-bit data is transferred twice. Data of the higher order 4 bits (contents of $DB_4 \sim DB_7$ when interface data is 8 bits long) is transferred first and then lower order 4 bits (contents of $DB_0 \sim DB_3$ when interface data is 8 bits long).
- (2) When interface data is 8 bits long, data is transferred using 8 data buses of $DB_0 \sim DB_7$.

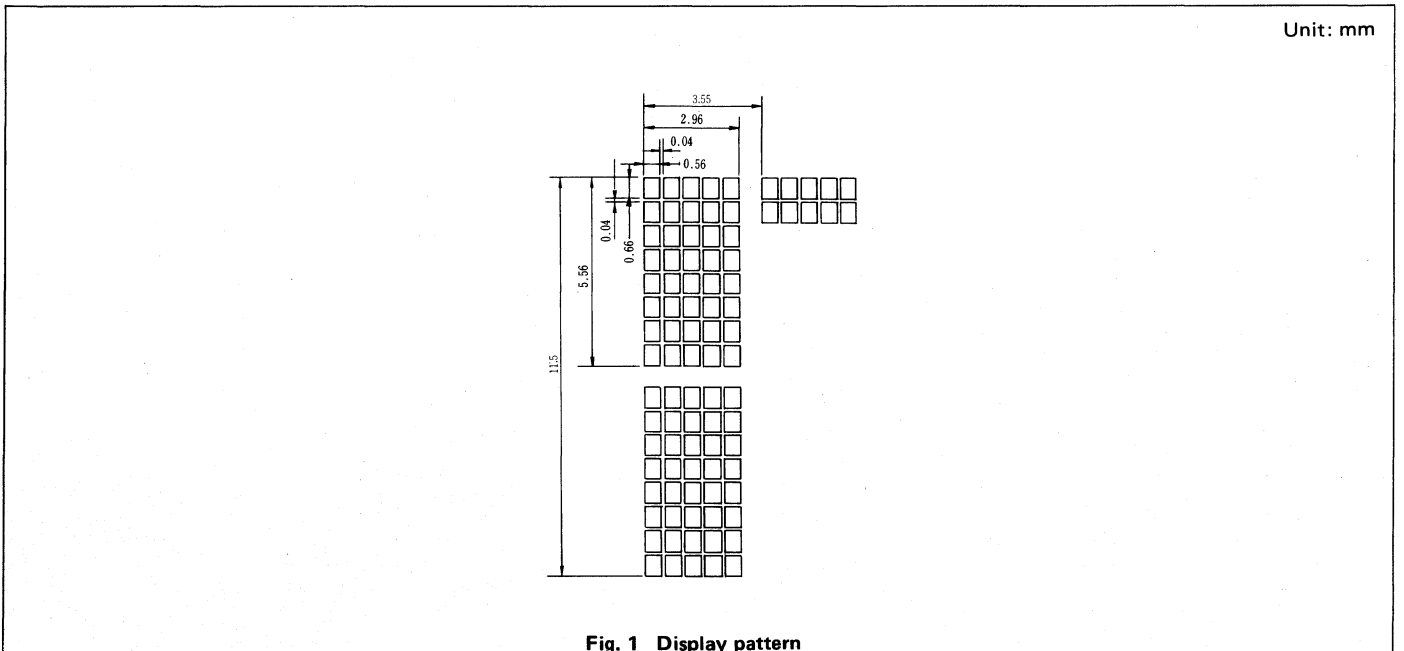


Fig. 1 Display pattern

Unit: mm

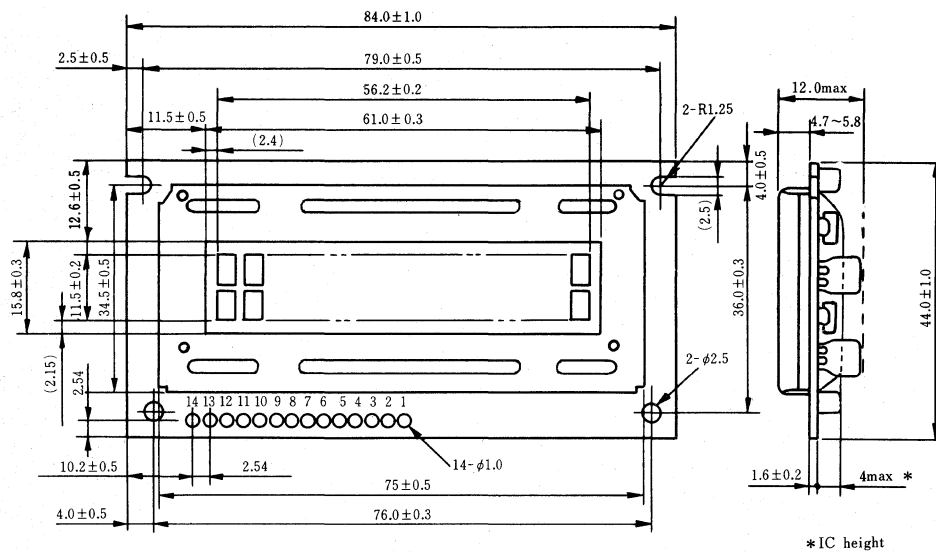


Fig. 2 External dimensions

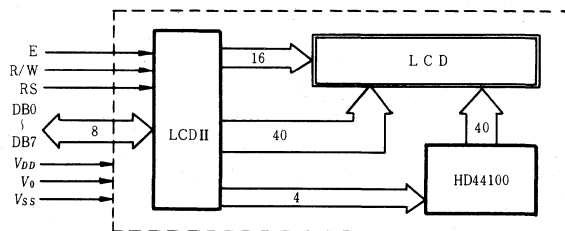


Fig. 3 Block diagram

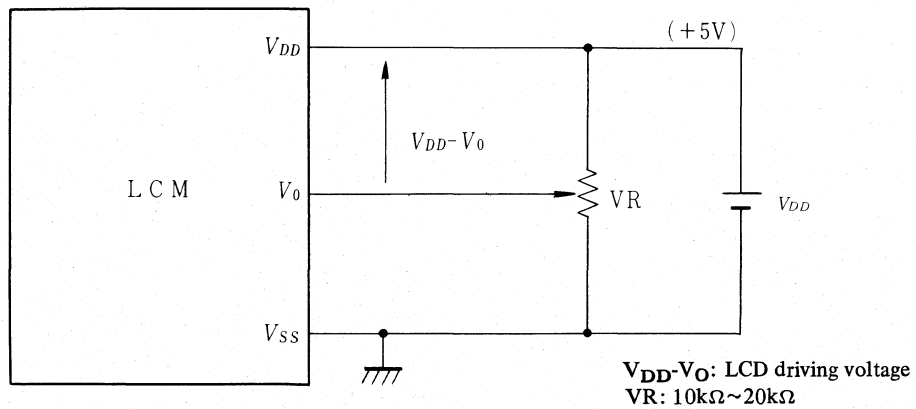


Fig. 4 Power supply

TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns

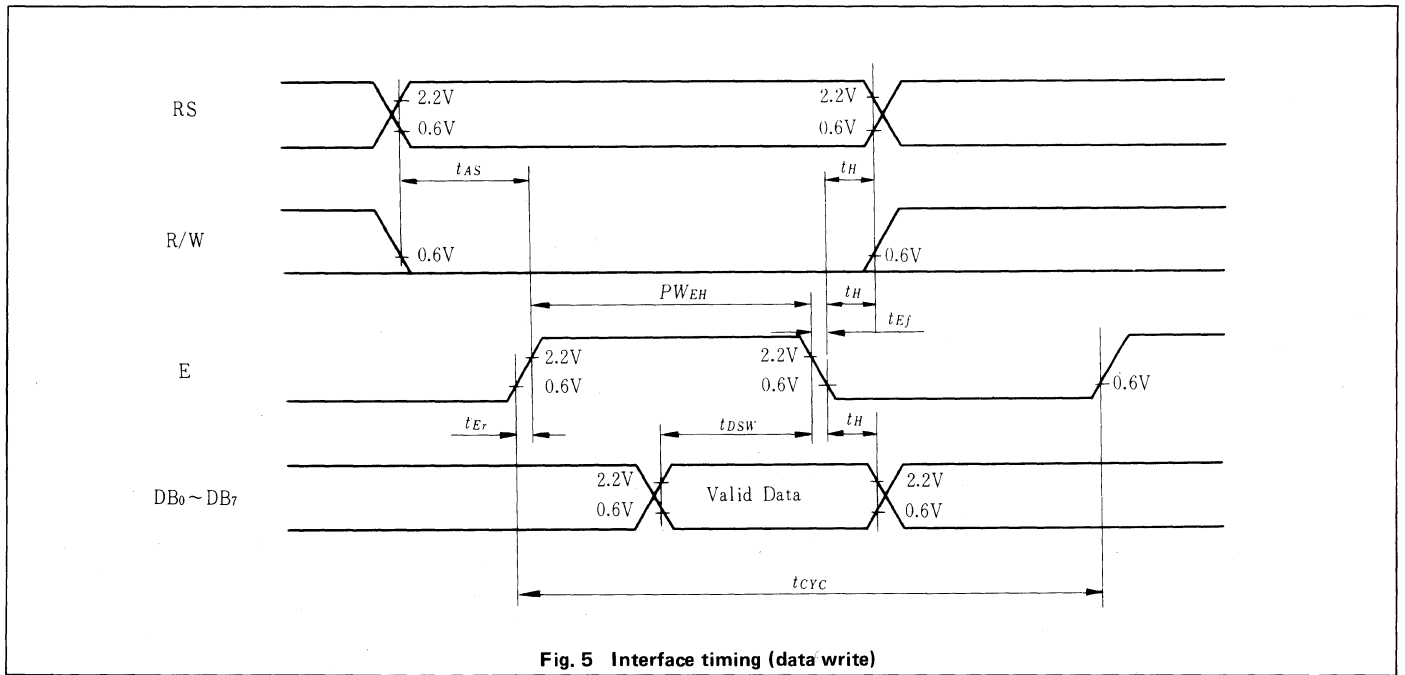


Fig. 5 Interface timing (data write)

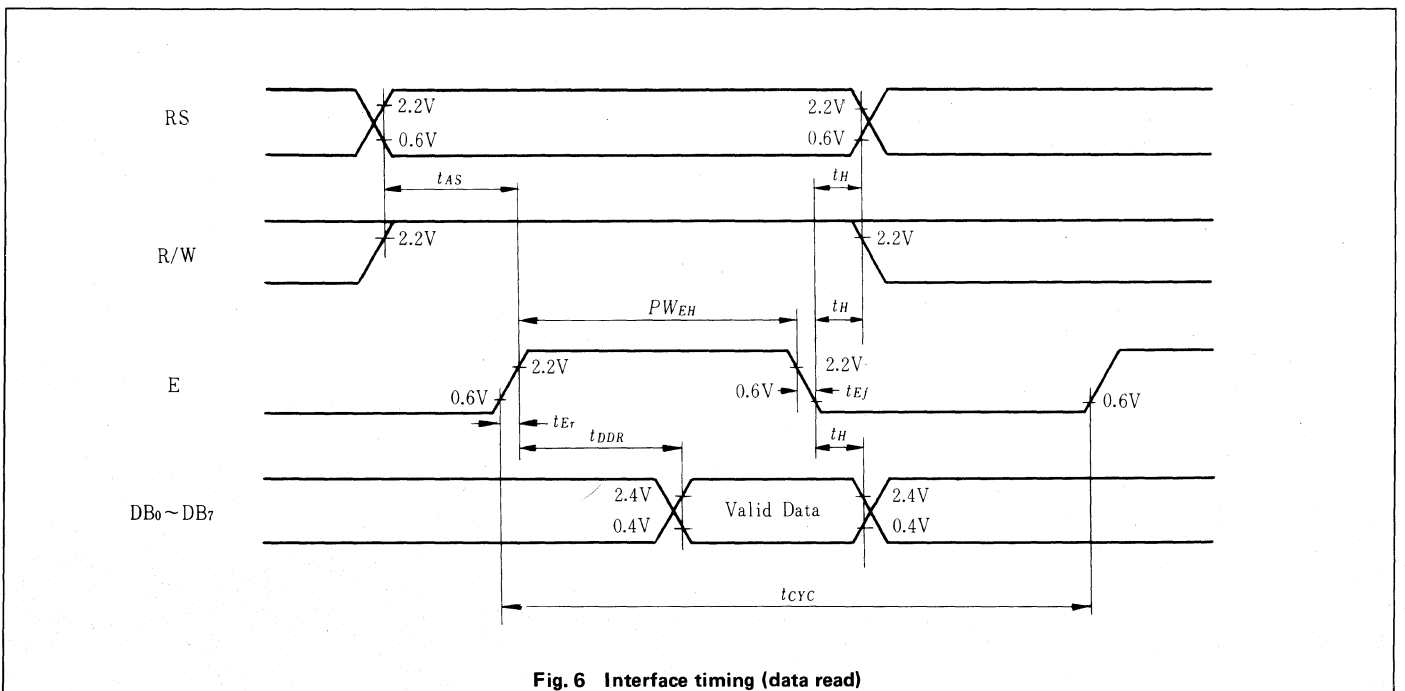


Fig. 6 Interface timing (data read)

LM032L

- 20 Character x 2 lines
- Built-in control LSI HD44780 type (see page 23)
- +5V single power supply

MECHANICAL DATA (Nominal dimensions)

Module size 116W x 39H (max.) x 13D (max.) mm
 Effective display area 83W x 18.6H mm
 Character size (5 x 7 dots) 3.2W x 4.85H mm
 Pitch 3.7 mm
 Dot size 0.6W x 0.65H mm
 Weight about 50 g

ABSOLUTE MAXIMUM RATINGS	min.	max.
Power supply for logic ($V_{DD}-V_{SS}$)	0	7.0 V
Power supply for LCD drive ($V_{DD}-V_O$)	0	13.5 V
Input voltage (V_i)	V_{SS}	V_{DD} V
Operating temperature (T_a)	0	50°C
Storage temperature (T_{stg})	-20	70°C

ELECTRICAL CHARACTERISTICS

$T_a = 25^\circ\text{C}$, $V_{DD} = 5.0 \text{ V} \pm 0.25 \text{ V}$
 Input "high" voltage (V_{iH}) 2.2 V min.
 Input "low" voltage (V_{iL}) 0.6 V max.
 Output high voltage (V_{OH}) ($-I_{OH} = 0.2 \text{ mA}$) . . . 2.4 V min.
 Output low voltage (V_{OL}) ($I_{OL} = 1.2 \text{ mA}$) 0.4 V max.
 Power supply current (I_{DD}) ($V_{DD} = 5.0 \text{ V}$) . . . 2.0 mA typ.
 3.0 mA max.
 Power supply for LCD drive (Recommended) ($V_{DD}-V_O$)
 $Du=1/16$
 at $T_a = 0^\circ\text{C}$ 4.8 V typ.
 at $T_a = 25^\circ\text{C}$ 4.4 V typ.
 at $T_a = 50^\circ\text{C}$ 3.6 V typ.

OPTICAL DATA See page 8

INTERNAL PIN CONNECTION

Pin No.	Symbol	Level	Function
1	V_{SS}	-	0V
2	V_{DD}	-	+5V
3	V_O	-	-
4	RS	H/L	L: Instruction code input H: Data input
5	R/W	H/L	H: Data read (LCD module→MPU) L: Data write (LCD module←MPU)
6	E	H, H→L	Enable signal
7	DB0	H/L	Data bus line Note (1), Note (2)
8	DB1	H/L	
9	DB2	H/L	
10	DB3	H/L	
11	DB4	H/L	
12	DB5	H/L	
13	DB6	H/L	
14	DB7	H/L	

Note:

- In the HD44780, the data can be sent in either 4-bit 2-operation or 8-bit 1-operation so that it can interface to both 4 and 8 bit MPU's.
- (1) When interface data is 4 bits long, data is transferred using only 4 buses of $DB_4 \sim DB_7$, and $DB_0 \sim DB_3$ are not used. Data transfer between the HD44780 and the MPU completes when 4-bit data is transferred twice. Data of the higher order 4 bits (contents of $DB_4 \sim DB_7$, when interface data is 8 bits long) is transferred first and then lower order 4 bits (contents of $DB_0 \sim DB_3$, when interface data is 8 bits long).
 - (2) When interface data is 8 bits long, data is transferred using 8 data buses of $DB_0 \sim DB_7$.

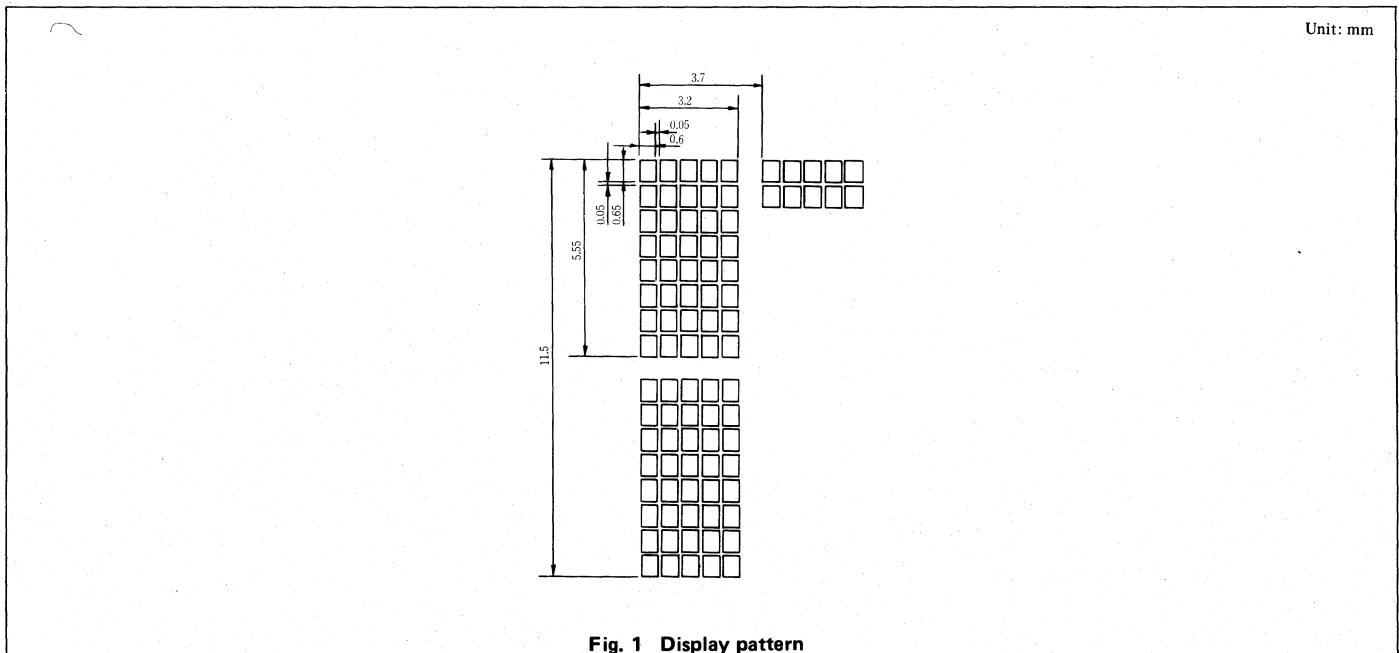
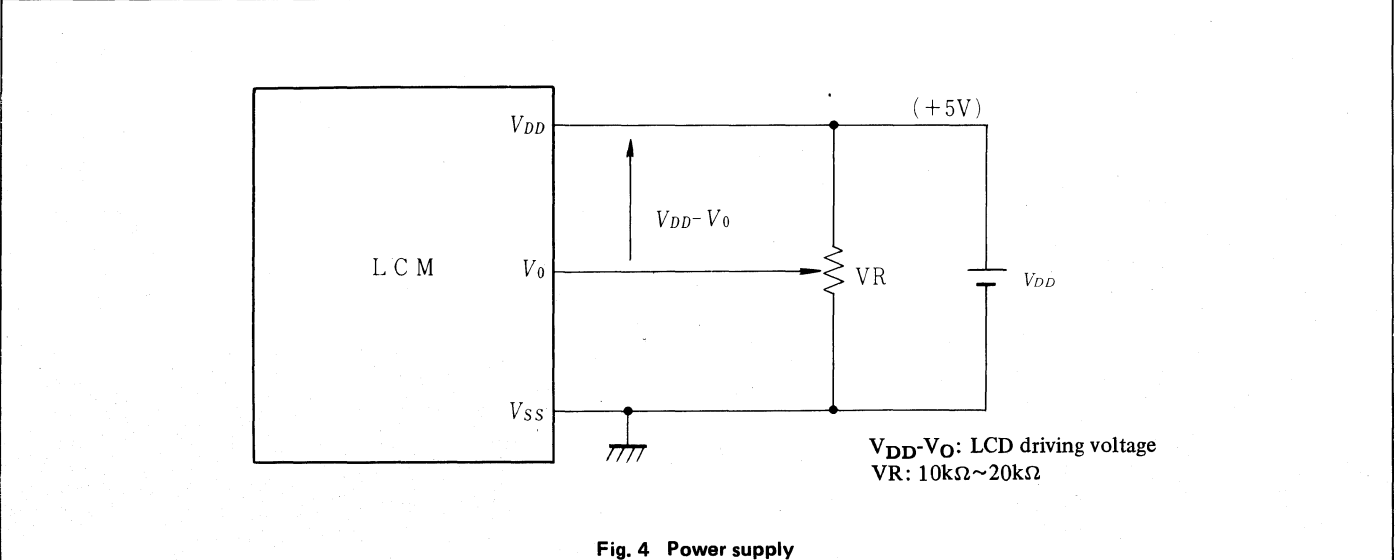
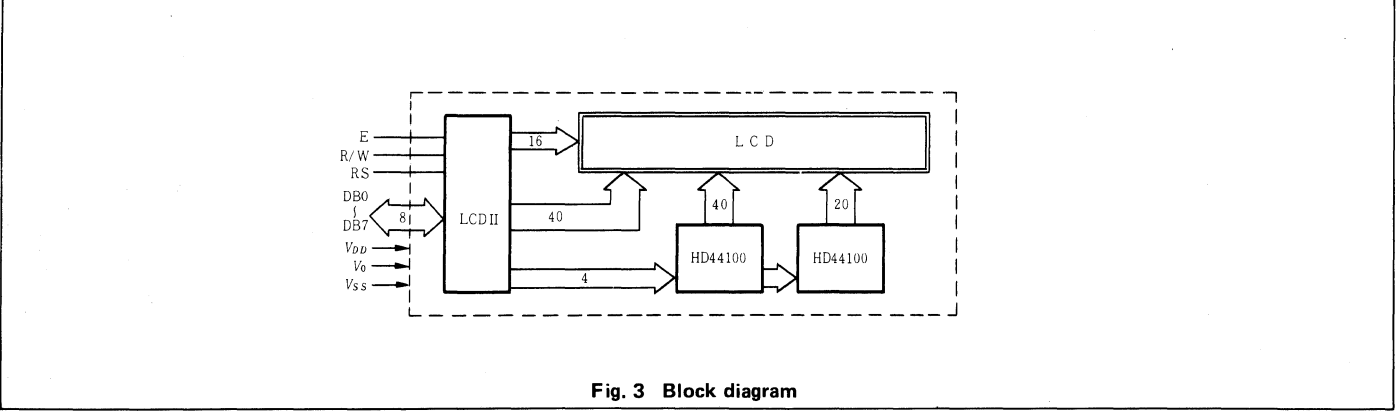
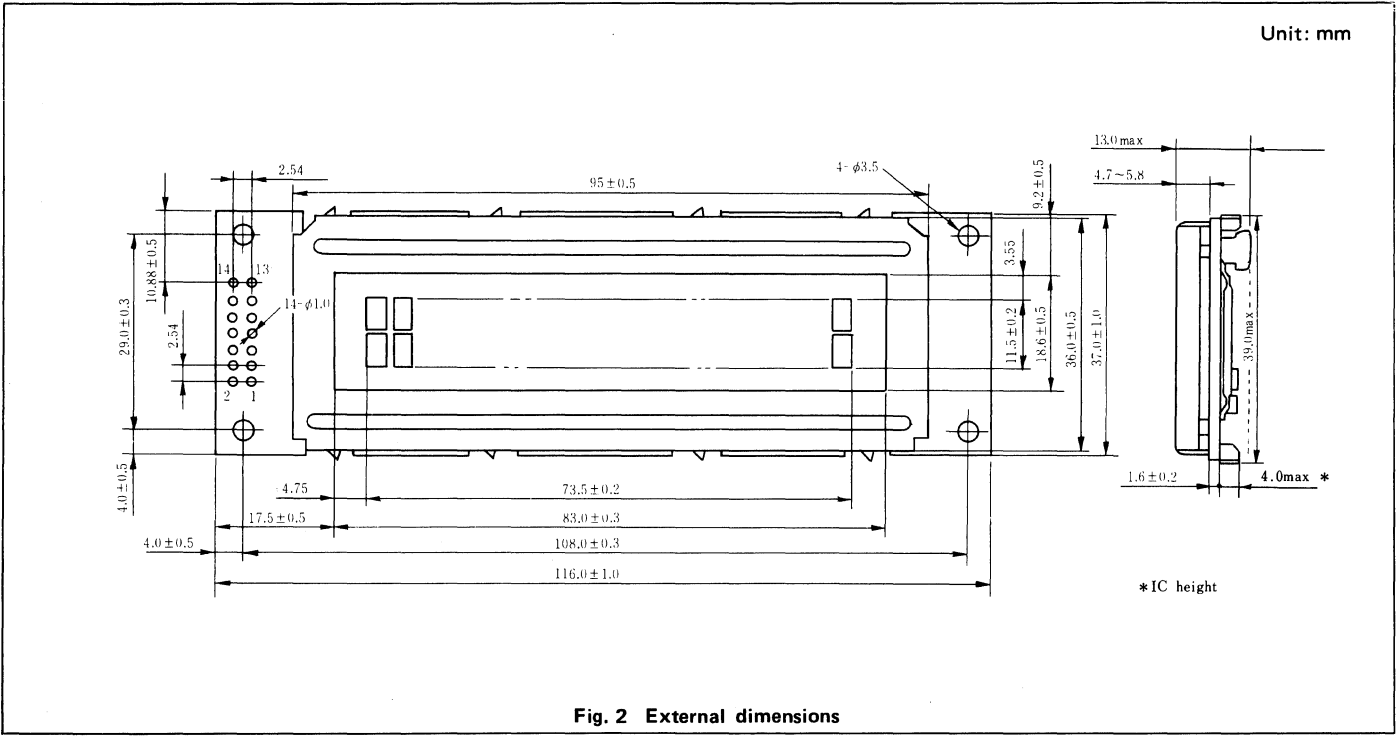


Fig. 1 Display pattern



TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns

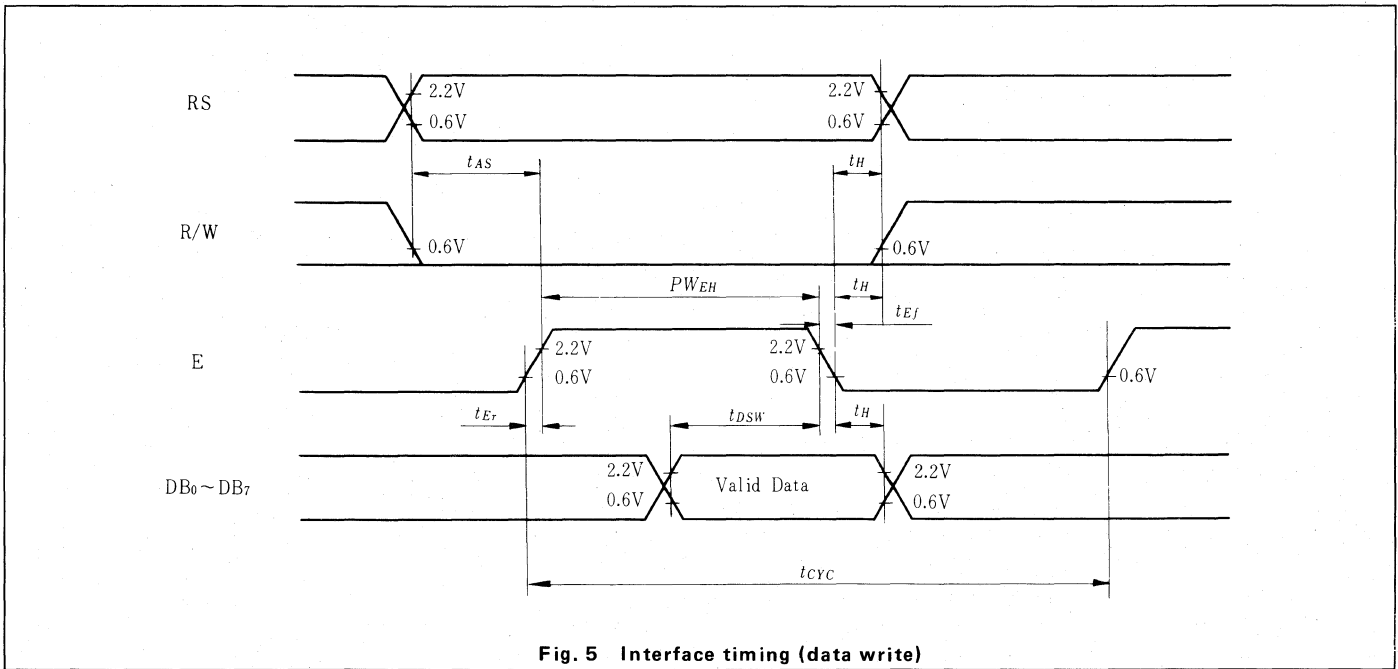


Fig. 5 Interface timing (data write)

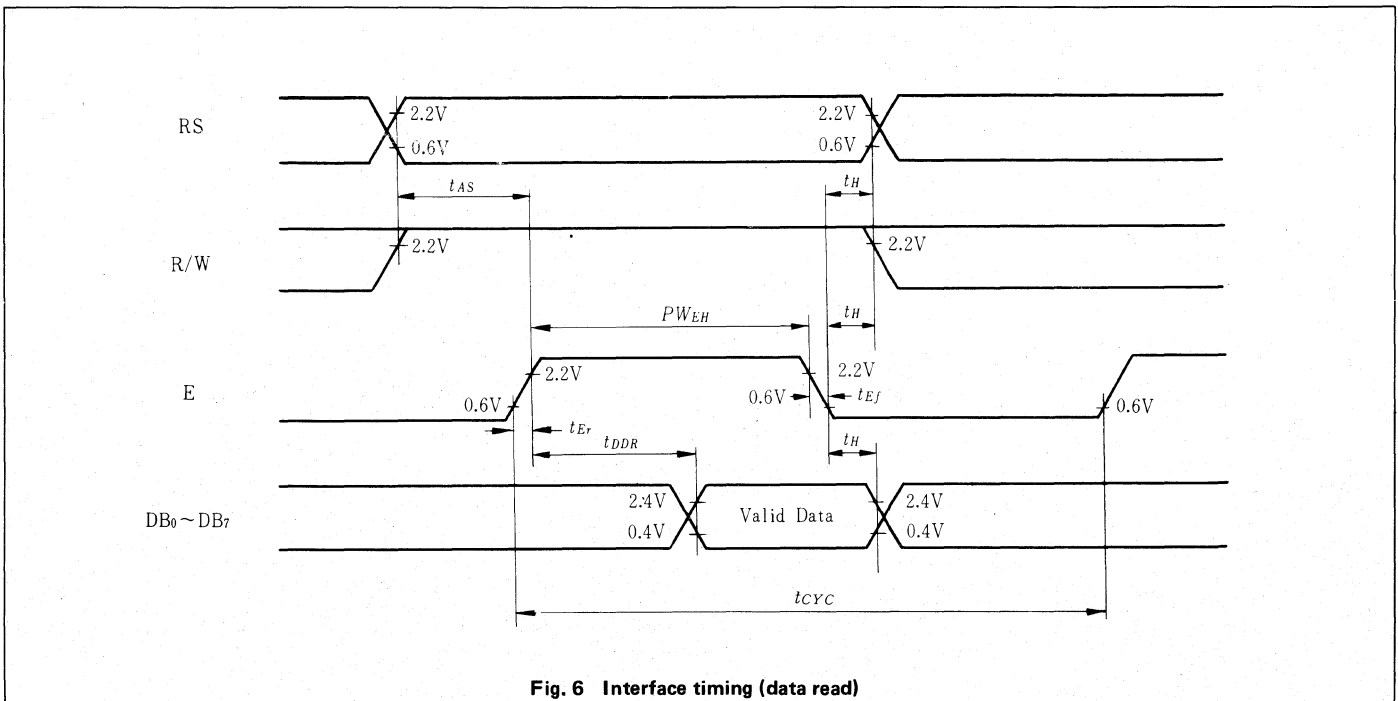


Fig. 6 Interface timing (data read)

Unit: mm

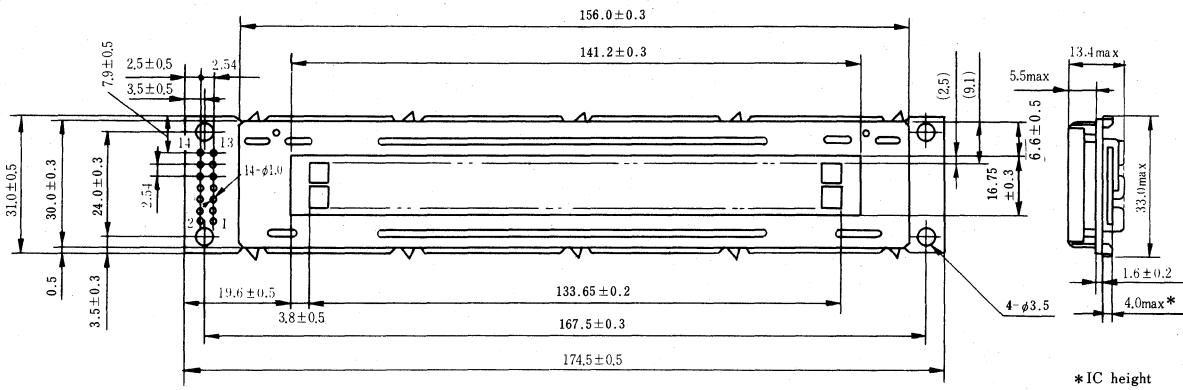


Fig. 2 External dimensions

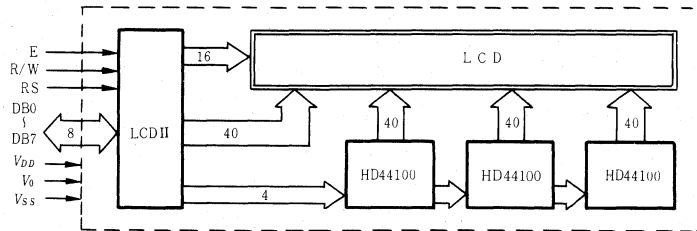


Fig. 3 Block diagram

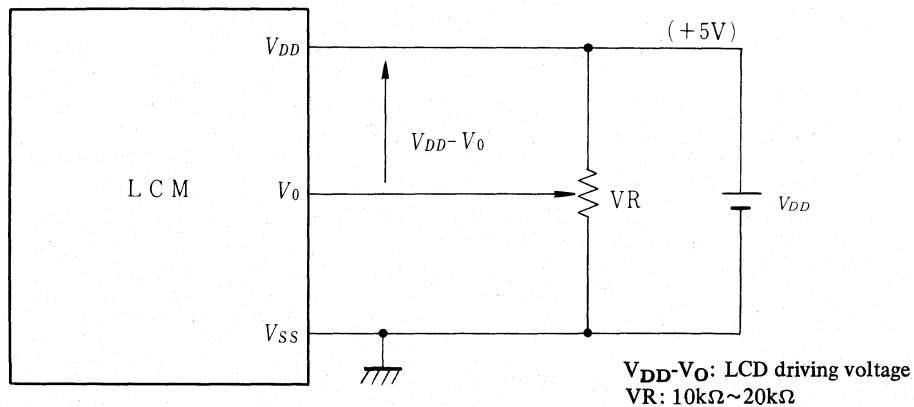


Fig. 4 Power supply

TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns

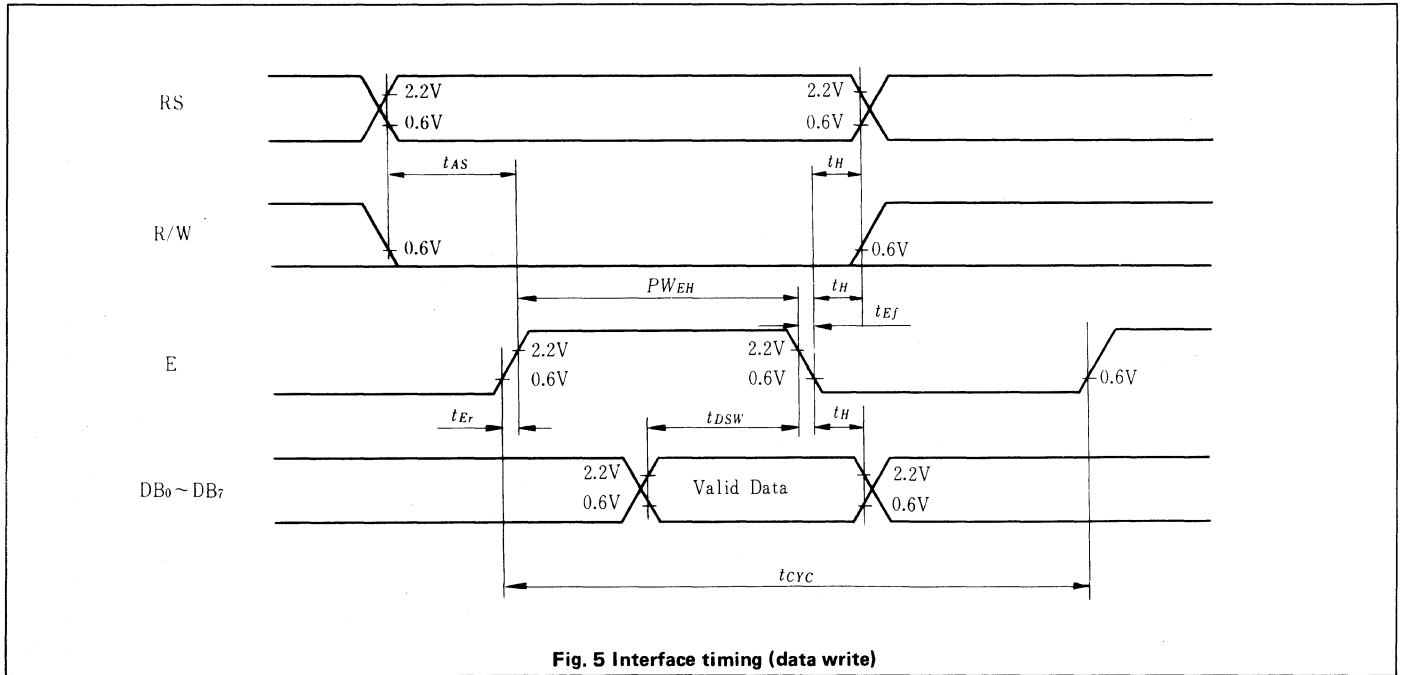


Fig. 5 Interface timing (data write)

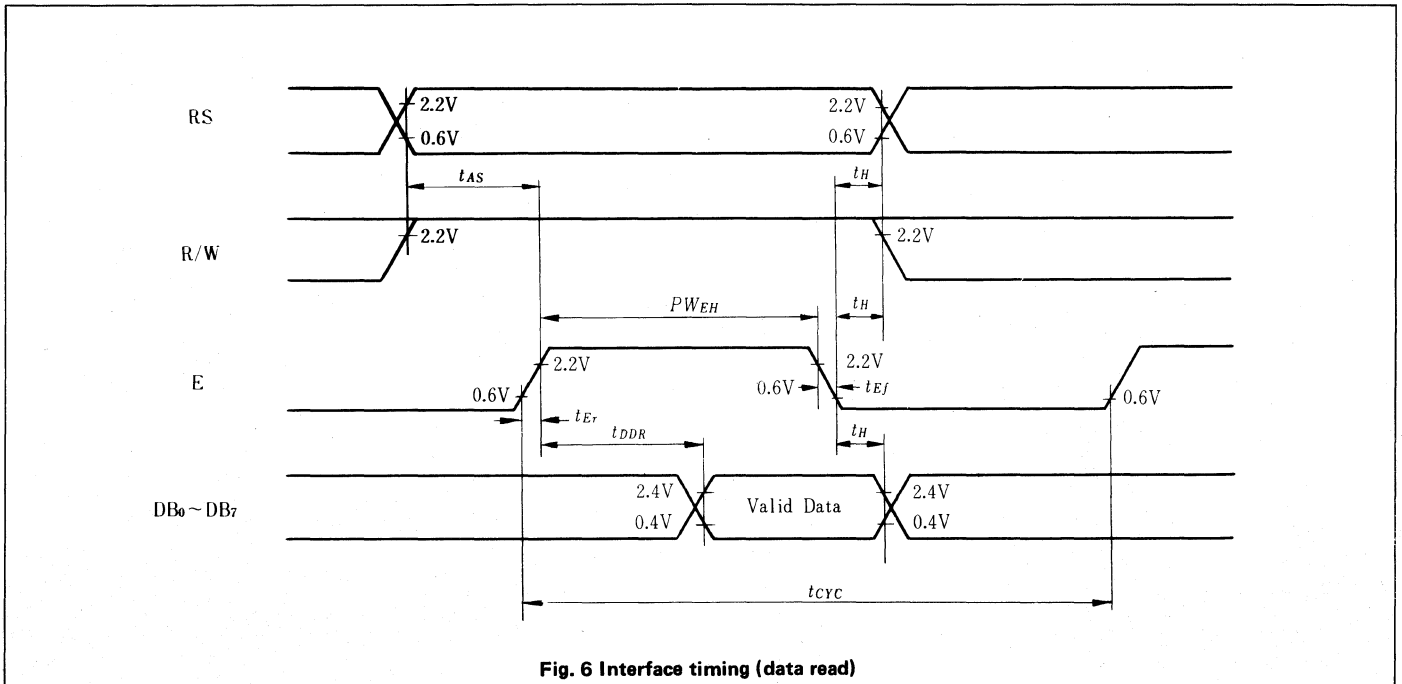
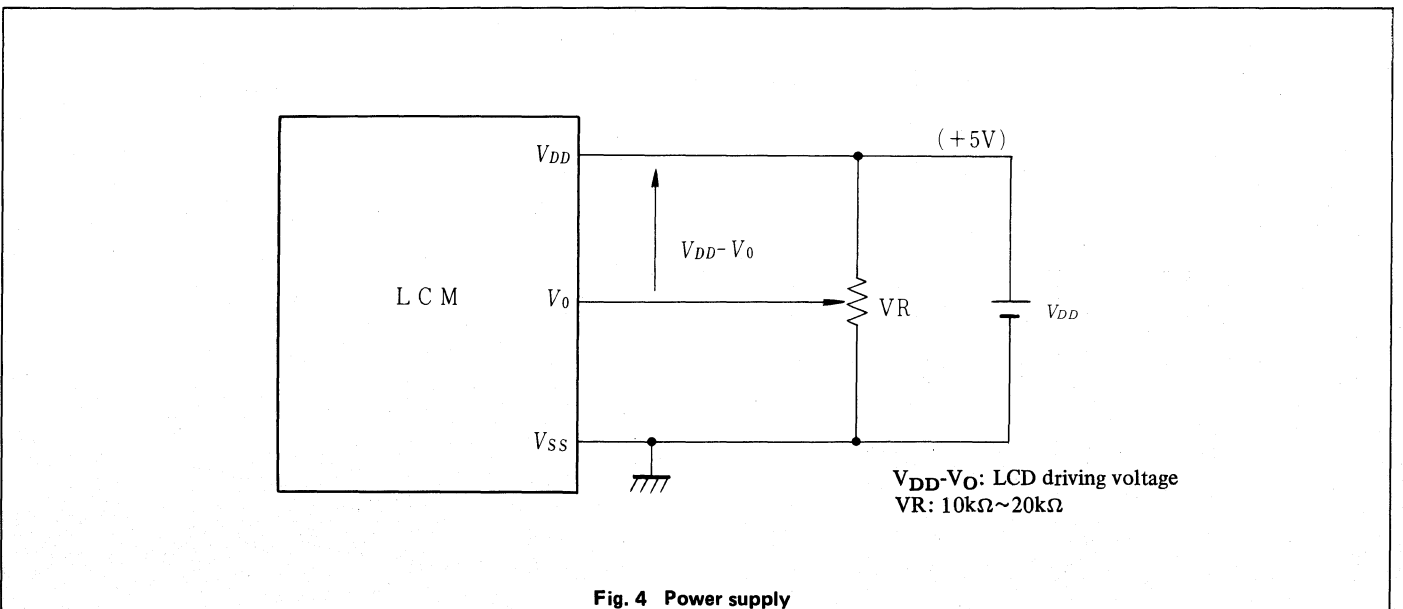
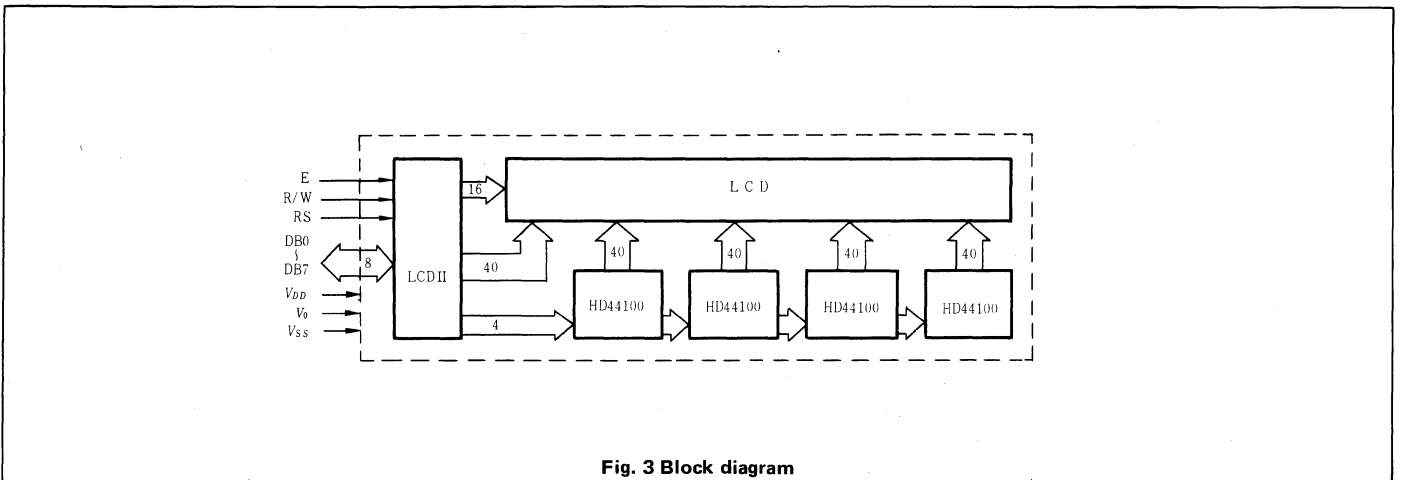
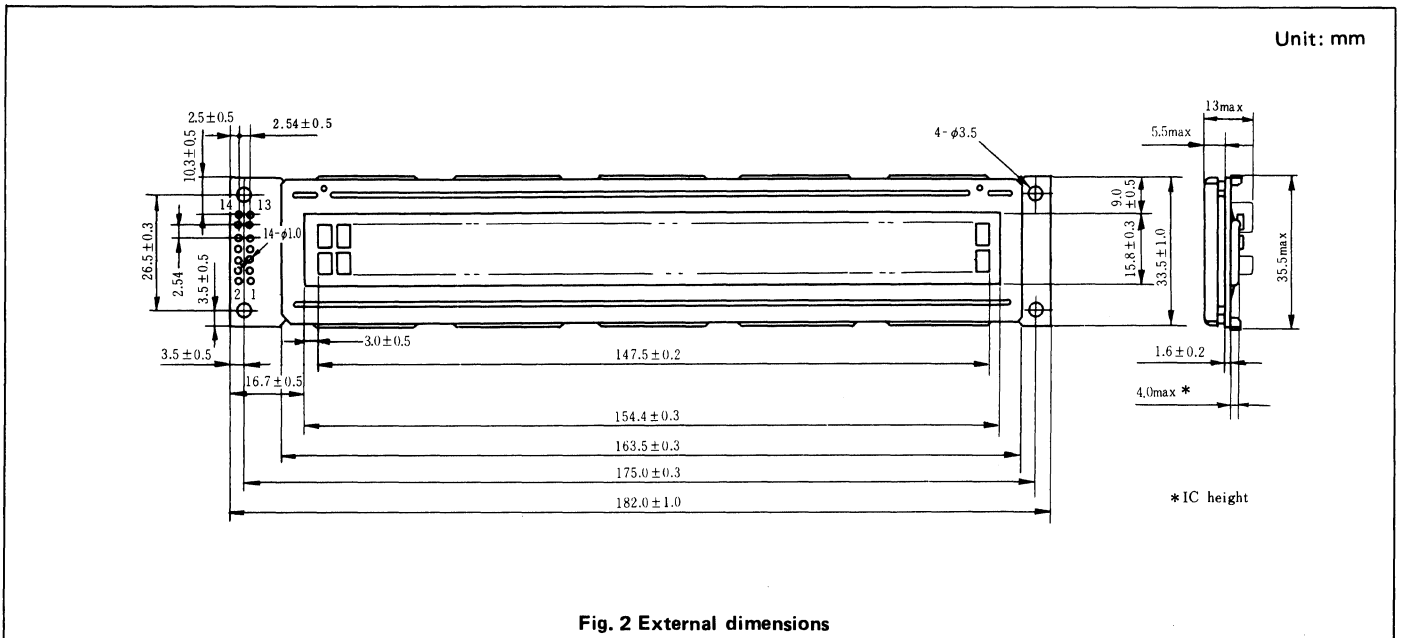


Fig. 6 Interface timing (data read)



TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns

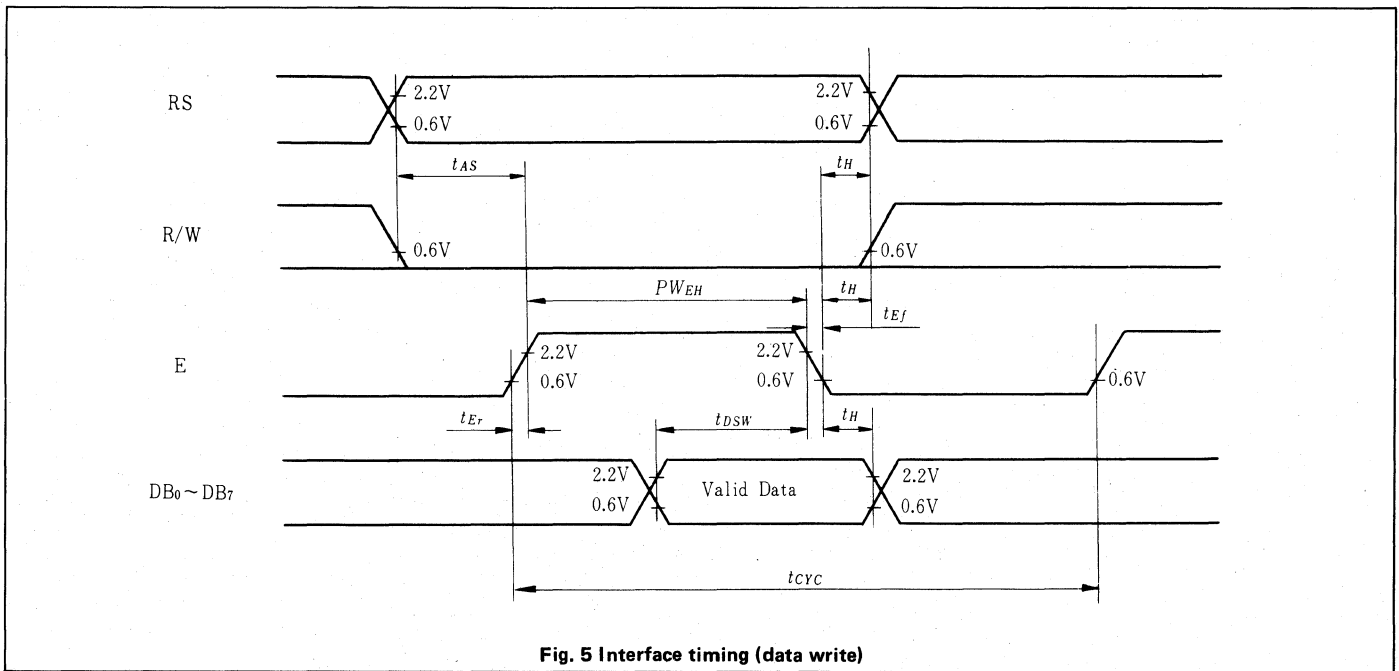


Fig. 5 Interface timing (data write)

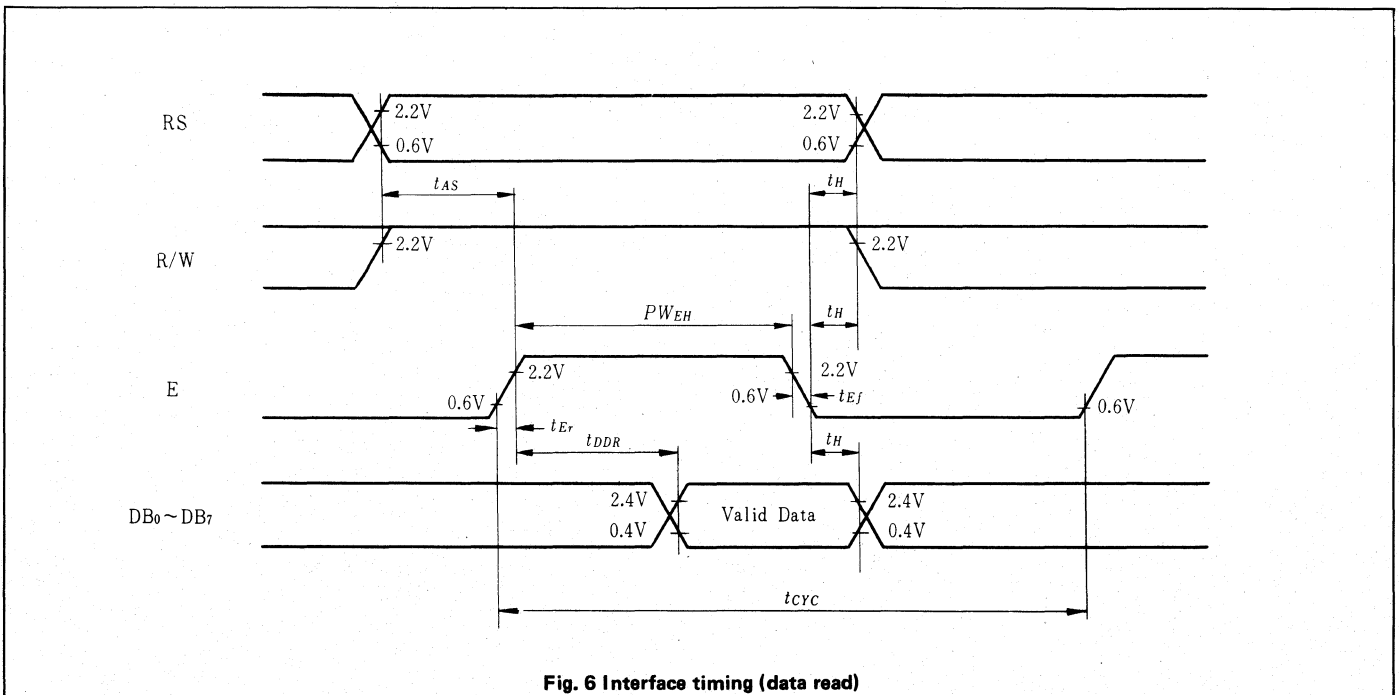


Fig. 6 Interface timing (data read)

LMO41L

- 16 Character x 4 lines
- Built-in control LSI HD44780 type (see page 23)
- +5V single power supply

MECHANICAL DATA (Nominal dimensions)

Module size	87W x 60H x 12D (max.) mm
Effective display area	61.8W x 25.2H mm
Character size (5 x 7 dots)	2.95W x 4.15H mm
Pitch	3.55 mm
Dot size	0.55W x 0.55H mm
Weight	about 60g

ABSOLUTE MAXIMUM RATINGS

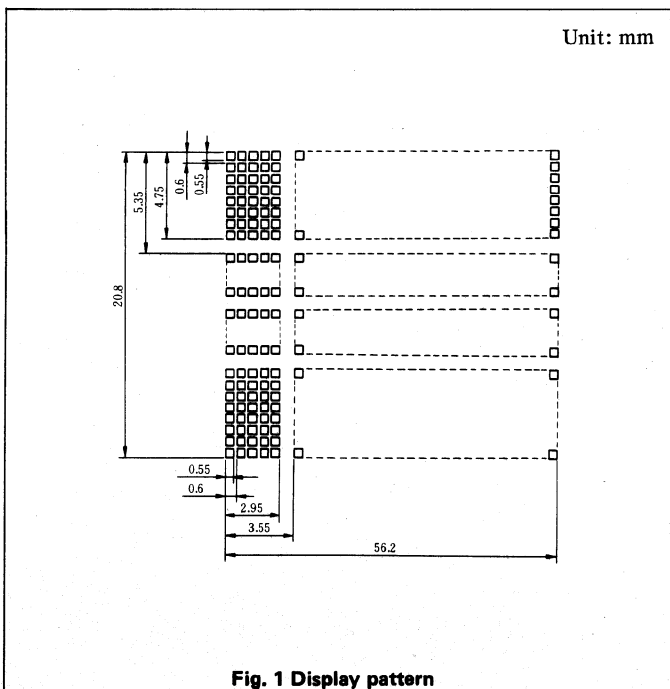
	min.	max.
Power supply for logic ($V_{DD} - V_{SS}$)	0	7.0V
Power supply for LCD drive ($V_{DD} - V_O$)	0	13.5V
Input voltage (V_i)	V_{SS}	V_{DD} V
Operating temperature (T_a)	0	50°C
Storage temperature (T_{stg})	-20	70°C

ELECTRICAL CHARACTERISTICS

$T_a=25^\circ\text{C}$, $V_{DD}=5.0V \pm 0.25V$

Input "high" voltage (V_{IH})	2.2V min.
Input "low" voltage (V_{IL})	0.6V max.
Output high voltage (V_{OH}) ($-I_{OH}=0.2\text{mA}$)	2.4V max.
Output low voltage (V_{OL}) ($I_{OL}=1.2\text{mA}$)	0.4V max.
Power supply current (I_{DD}) ($V_{DD}=5.0V$)	1.0 mA typ. 3.0mA max.
Power supply for LCD drive (Recommended) ($V_{DD} - V_O$)	$Du=1/16$
at $T_a=0^\circ\text{C}$	4.6 V typ.
at $T_a=25^\circ\text{C}$	4.4 V typ.
at $T_a=50^\circ\text{C}$	4.2 V typ.

OPTICAL DATA See page 8



INTERNAL PIN CONNECTION

Pin No.	Symbol	Level	Function
1	V_{SS}	—	0V
2	V_{DD}	—	+5V
3	V_O	—	—
4	RS	H/L	L: Instruction code input H: Data input
5	R/W	H/L	H: Data read (LCD module → MPU) L: Data write (LCD module ← MPU)
6	E	H, H → L	Enable signal
7	DB0	H/L	Data bus line Note (1), Note (2)
8	DB1	H/L	
9	DB2	H/L	
10	DB3	H/L	
11	DB4	H/L	
12	DB5	H/L	
13	DB6	H/L	
14	DB7	H/L	

Note:

In the HD44780, the data can be sent in either 4-bit 2-operation or 8-bit 1-operation so that it can interface to both 4 and 8 bit MPU's.

- (1) When interface data is 4 bits long, data is transferred using only 4 buses of $DB_4 \sim DB_7$ and $DB_0 \sim DB_3$ are not used. Data transfer between the HD44780 and the MPU completes when 4-bit data is transferred twice. Data of the higher order 4 bits (contents of $DB_4 \sim DB_7$, when interface data is 8 bits long) is transferred first and then lower order 4 bits (contents of $DB_0 \sim DB_3$ when interface data is 8 bits long).
- (2) When interface data is 8 bits long, data is transferred using 8 data buses of $DB_0 \sim DB_7$.

DISPLAY POSITION AND DD RAM ADDRESS

Character No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1st line	80	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F
2nd line	C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	CA	CB	CC	CD	CE	CF
3rd line	90	91	92	93	94	95	96	97	98	99	9A	9B	9C	9D	9E	9F
4th line	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	DA	DB	DC	DD	DE	DF

Note:

- (1) 80 ~ DF are described in hexadecimal for DD RAM address.
- (2) The set to HD44780 are "N = "1", F = "0" (2 lines 5 x 7 + cursor)."
- (3) DD RAM address is no series in line. Address set is necessary to change the lines.
- (4) Circuit is equal to 32 characters by 2 lines type.
- (5) In case of executing shift, first line and third line are shifted continuously, also second line and fourth line. Therefore it happens that display of third line is transferred to first line.

Unit: mm

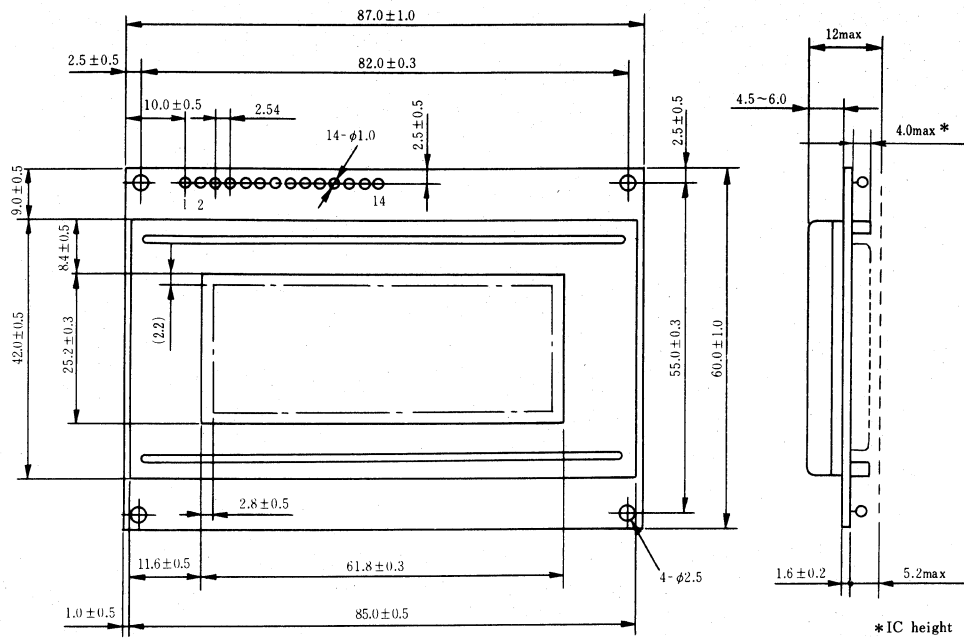


Fig. 2 External dimensions

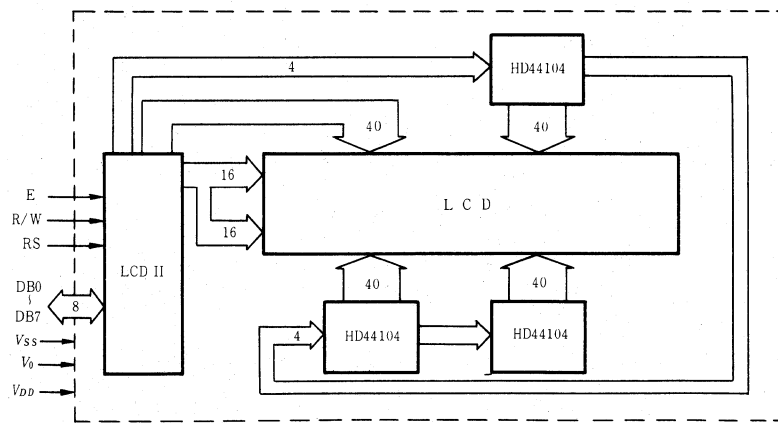


Fig. 3 Block diagram

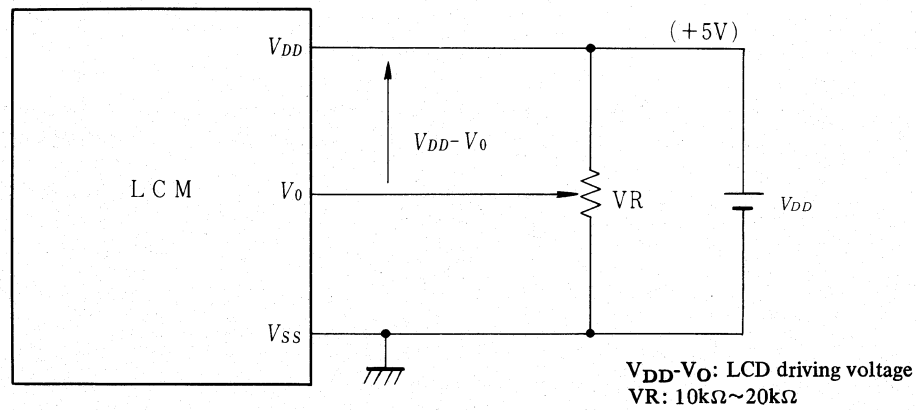


Fig. 4 Power supply

TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns

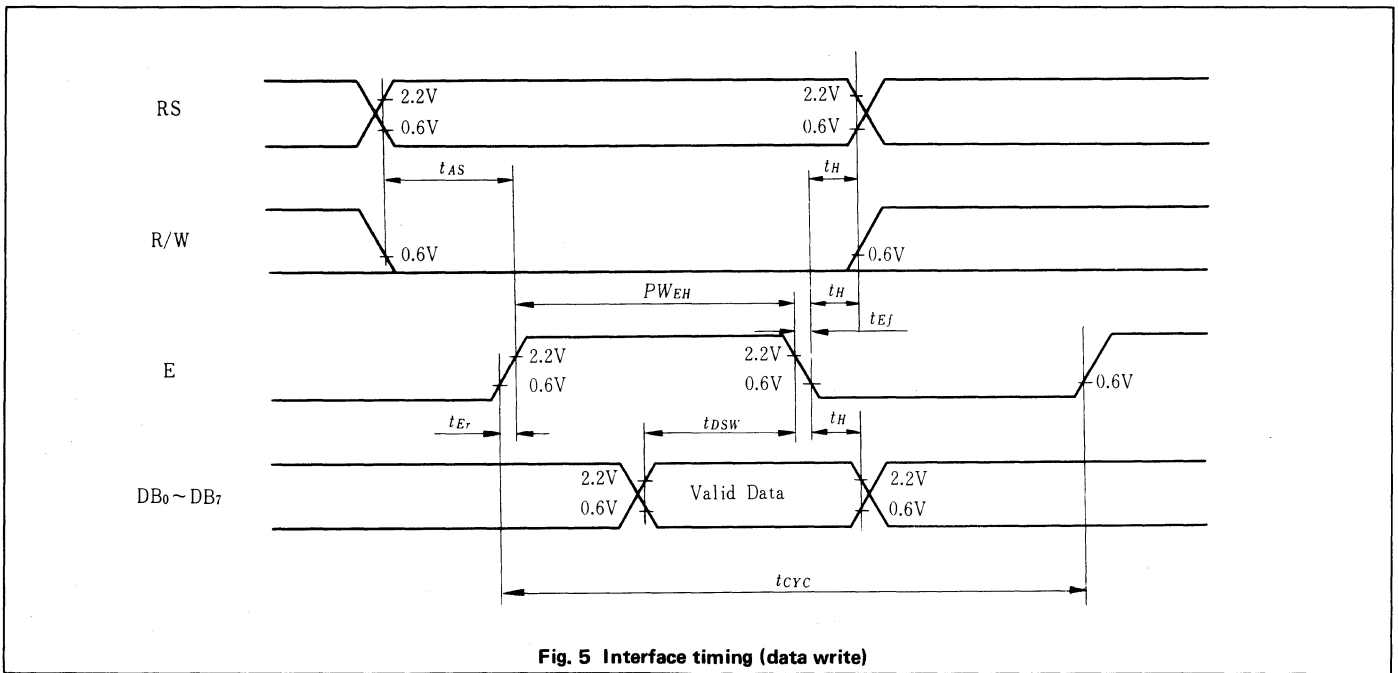


Fig. 5 Interface timing (data write)

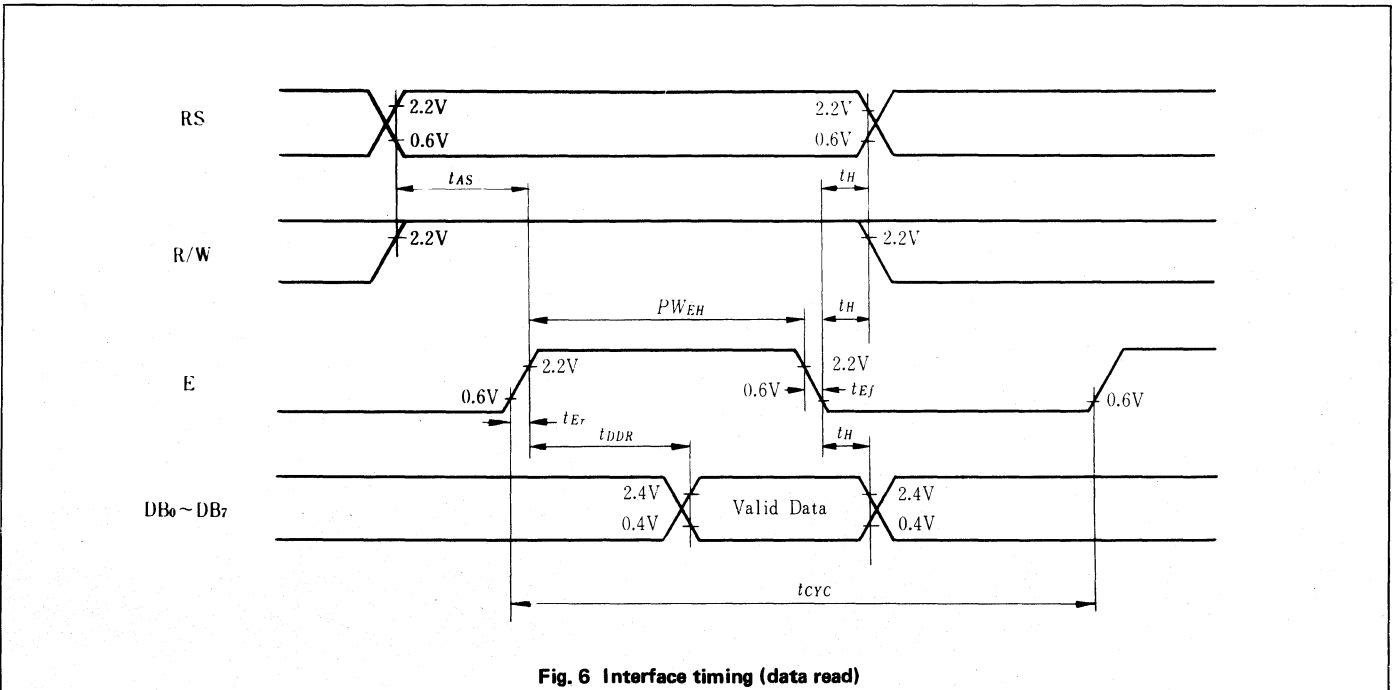


Fig. 6 Interface timing (data read)

LMO44L

- 20 Character x 4 lines
- Built-in control LSI HD44780 type (see page 23)
- +5V single power supply

MECHANICAL DATA (Nominal dimensions)

Module size 98W x 60H x 12D (max.) mm
 Effective display area 76.0W x 25.2H mm
 Character size (5 x 7 dots) 2.95W x 4.15H mm
 Pitch 3.55 mm
 Dot size 0.55W x 0.55H mm
 Weight about 65 g

ABSOLUTE MAXIMUM RATINGS

	min.	max.
Power supply for logic ($V_{DD}-V_{SS}$)	0	7.0 V
Power supply for LCD drive ($V_{DD}-V_O$)	0	13.5 V
Input voltage (V_i)	V_{SS}	V_{DD} V
Operating temperature (T_a)	0	50°C
Storage temperature (T_{stg})	-20	70°C

ELECTRICAL CHARACTERISTICS

$T_a = 25^\circ\text{C}$, $V_{DD} = 5.0\text{ V} \pm 0.25\text{ V}$

Input "high" voltage (V_{IH}) 2.2 V min.
 Input "low" voltage (V_{IL}) 0.6 V max.
 Output high voltage (V_{OH}) ($-I_{OH} = 0.2\text{ mA}$) . . . 2.4 V min.
 Output low voltage (V_{OL}) ($I_{OL} = 1.2\text{ mA}$) . . . 0.4 V max
 Power supply current (I_{DD}) ($V_{DD} = 5.0\text{ V}$) . . . 1.0 mA typ.
 3.5 mA max.
 Power supply for LCD drive (Recommended) ($V_{DD}-V_O$)
 $Du=1/16$
 at $T_a = 0^\circ\text{C}$ 4.6 V typ.
 at $T_a = 25^\circ\text{C}$ 4.4 V typ.
 at $T_a = 50^\circ\text{C}$ 4.2 V typ.

OPTICAL DATA See page 8

INTERNAL PIN CONNECTION

Pin No.	Symbol	Level	Function
1	V_{SS}	-	0V
2	V_{DD}	-	+5V
3	V_O	-	-
4	RS	H/L	L: Instruction code input H: Data input
5	R/W	H/L	H: Data read (LCD module→MPU) L: Data write (LCD module←MPU)
6	E	H, H→L	Enable signal
7	DB0	H/L	Data bus line Note (1), Note (2)
8	DB1	H/L	
9	DB2	H/L	
10	DB3	H/L	
11	DB4	H/L	
12	DB5	H/L	
13	DB6	H/L	
14	DB7	H/L	

Note:

In the HD44780, the data can be sent in either 4-bit 2-operation or 8-bit 1-operation so that it can interface to both 4 and 8 bit MPU's.

- (1) When interface data is 4 bits long, data is transferred using only 4 buses of $DB_4 \sim DB_7$, and $DB_0 \sim DB_3$ are not used. Data transfer between the HD44780 and the MPU completes when 4-bit data is transferred twice. Data of the higher order 4 bits (contents of $DB_4 \sim DB_7$, when interface data is 8 bits long) is transferred first and then lower order 4 bits (contents of $DB_0 \sim DB_3$, when interface data is 8 bits long).
- (2) When interface data is 8 bits long, data is transferred using 8 data buses of $DB_0 \sim DB_7$.

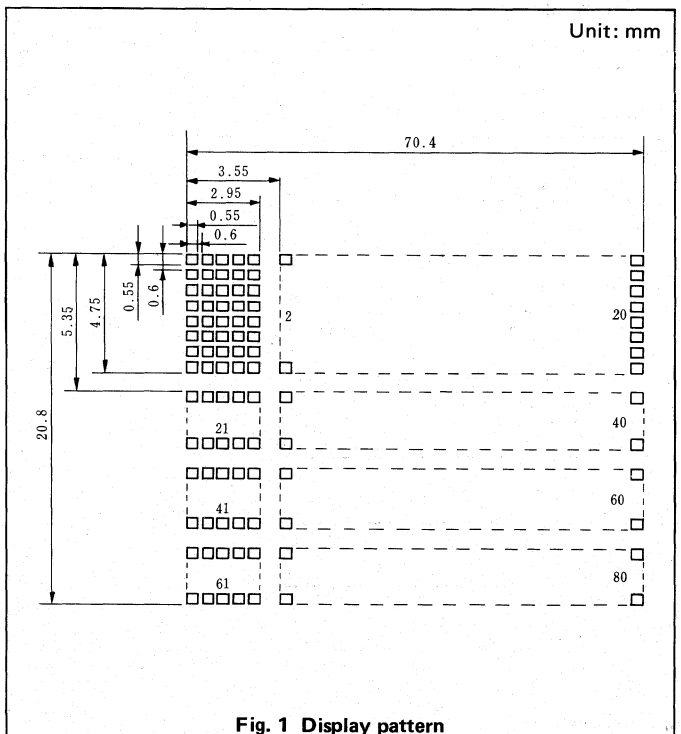


Fig. 1 Display pattern

DISPLAY POSITION AND DD RAM ADDRESS

Character No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1st line	80	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F	90	91	92	93
2nd line	C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	CA	CB	CC	CD	CE	CF	D0	D1	D2	D3
3rd line	94	95	96	97	98	99	9A	9B	9C	9D	9E	9F	A0	A1	A2	A3	A4	A5	A6	A7
4th line	D4	D5	D6	D7	D8	D9	DA	DB	DC	DD	DE	DF	E0	E1	E2	E3	E4	E5	E6	E7

Note:

- (1) 80 ~ E7 are described in hexadecimal for DD RAM address.
- (2) The set to HD44780 are "N = "1", F = "0" (2 lines 5 x 7 + cursor)."
- (3) DD RAM address is no series in line. Address set is necessary to change the lines.
- (4) Circuit is equal to 40 characters by 2 lines type.
- (5) In case of executing shift, first line and third line are shifted continuously, also second line and fourth line. Therefore it happens that display of third line is transferred to first line.

Unit: mm

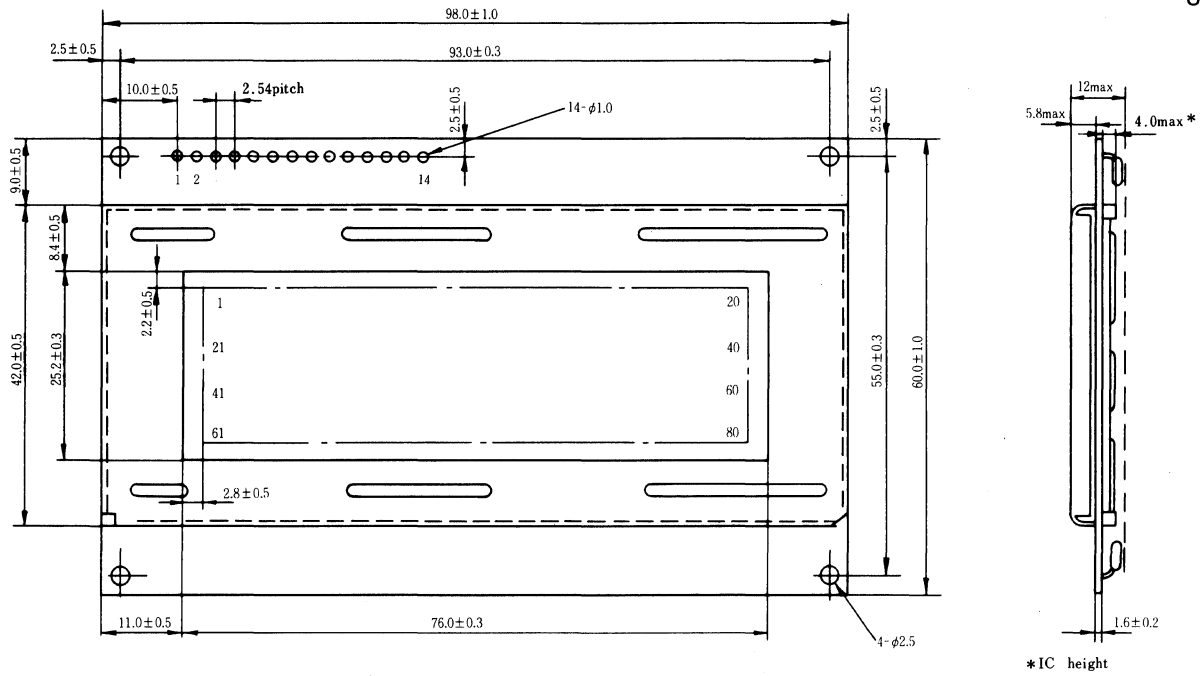


Fig. 2 External dimension

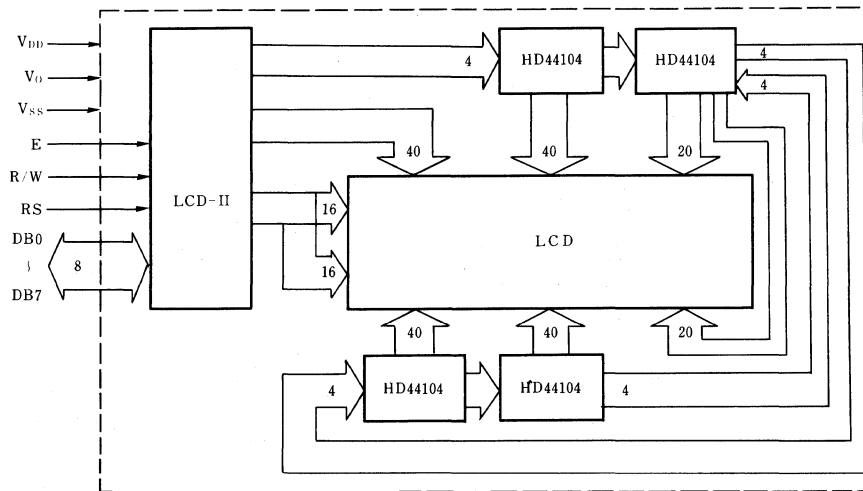
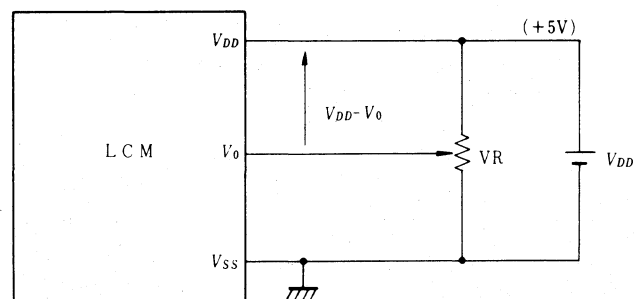


Fig. 3 Block diagram



$V_{DD} - V_0$: LCD driving voltage
 VR : $10k\Omega \sim 20k\Omega$

TIMING CHARACTERISTICS

Item	Symbol	Test condition	min.	typ.	max.	Unit
Enable cycle time	t_{cyc}	Fig. 5, Fig. 6	1.0	—	—	μs
Enable pulse width	P_{WEH}	Fig. 5, Fig. 6	450	—	—	ns
Enable rise/fall time	t_{Er}, t_{Ef}	Fig. 5, Fig. 6	—	—	25	ns
RS, R/W set up time	t_{AS}	Fig. 5, Fig. 6	140	—	—	ns
Data delay time	t_{DDR}	Fig. 6	—	—	320	ns
Data set up time	t_{DSW}	Fig. 5	195	—	—	ns
Hold time	t_H	Fig. 5, Fig. 6	20	—	—	ns

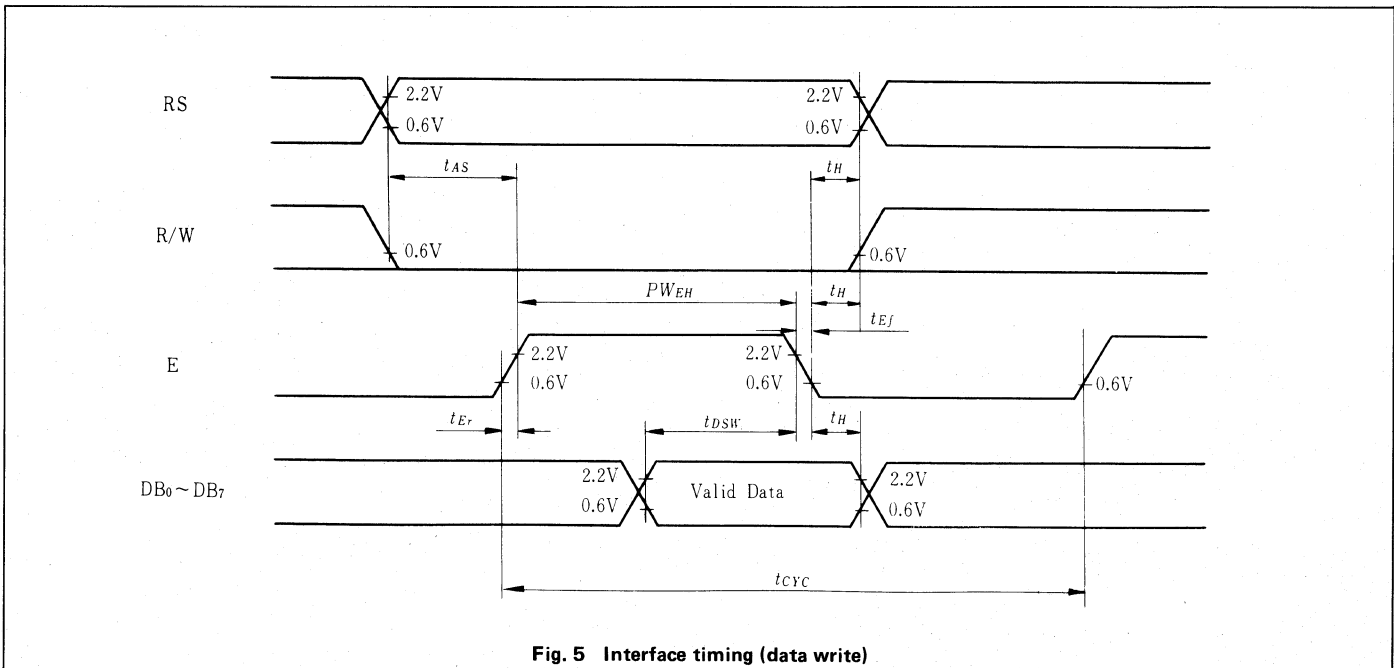


Fig. 5 Interface timing (data write)

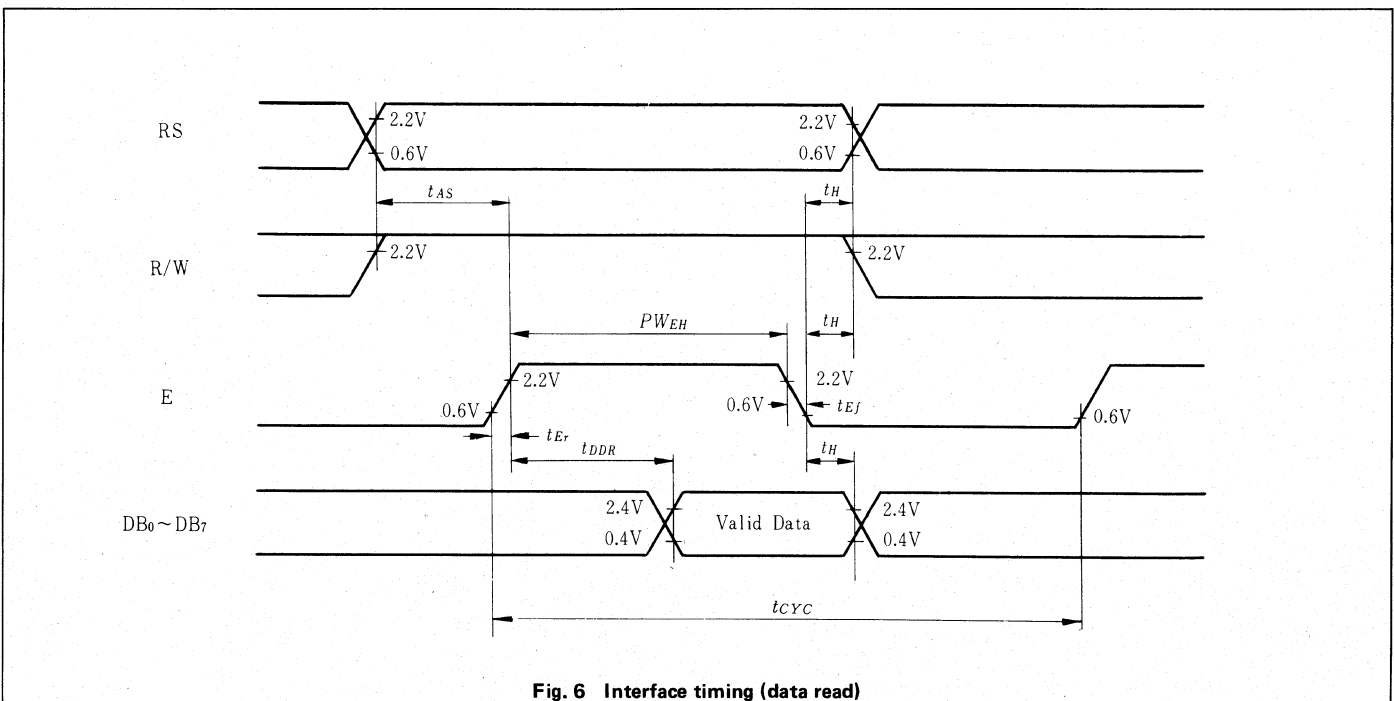


Fig. 6 Interface timing (data read)

GRAPHIC LCD MODULE

This module consists of LCD device, drive LSI, PC board, and other parts.

By attaching the control LSI HD61830, graphics, numerals, alphabets, Japanese, and symbols can be displayed.

CONTROL LSI HD61830
CONTROL CIRCUIT BOARD CB-SERIES (CB1020R,
CB1026R, CB1030R)

H2525	(239 x 20 DOT)
LM021	(479 x 24 DOT)
LM200	(240 x 64 DOT)
LM213B	(256 x 64 DOT, BUILT-IN CONTROLLER)
LM211	(640 x 64 DOT)
LM212	(640 x 48 DOT)
LM215	(480 x 128 DOT)

CONTROL LSI HD61830

- Graphic LCD Module controller driver
- Applicable type: H2525 · LM021 · LM200 · LM211 · LM212 · LM215
LM213B (Built-in controller)

The HD61830 is a dot matrix liquid crystal graphic display controller LSI that stores the display data sent from an 8-bit microcomputer in the external RAM to generate dot matrix liquid crystal driving signals.

It is possible to select the graphic mode in which the 1-bit data of the external RAM corresponds to the ON/OFF state of 1 dot on liquid crystal display and the character mode in which characters are displayed by storing character codes in the external RAM and developing them into the dot patterns with the internal character generator ROM. Both modes can be provided for various applications.

The HD61830 is produced in the CMOS process. Thus, the combination with a CMOS microcomputer can accomplish a liquid crystal display device with lower power dissipation.

■ FEATURES

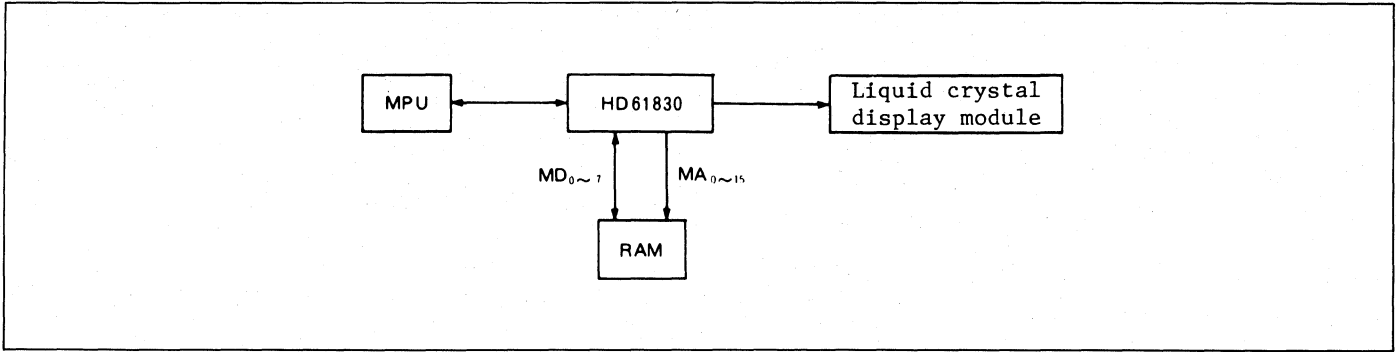
- Dot matrix liquid crystal graphic display controller
- Display control capacity
 - Graphic mode 512 k dots (2¹⁶ bytes)
 - Character mode 4096 characters (2¹² characters)
- Internal character generator ROM 7360 bits
 - 160 types of 5 x 7 dot character fonts
 - 32 types of 5 x 10 dot character fontsTotal 192 types
(Can be extended to 256 types (4 k bytes max.) by external ROM)
- Interfaceable to 8-bit MPU
- Display duty (Can be selected by a program)
Static to 1/128 duty selectable
- Various instruction functions
Scroll, Cursor ON/OFF/blink, Character blink, Bit manipulation
- Display method Selectable A or B types
- Internal oscillator (with external resistor and capacitor)
- Low power dissipation
- Power supply: Single +5V
- CMOS process
- 60-pin flat plastic package

Internal Character Generator Patterns and Character Codes

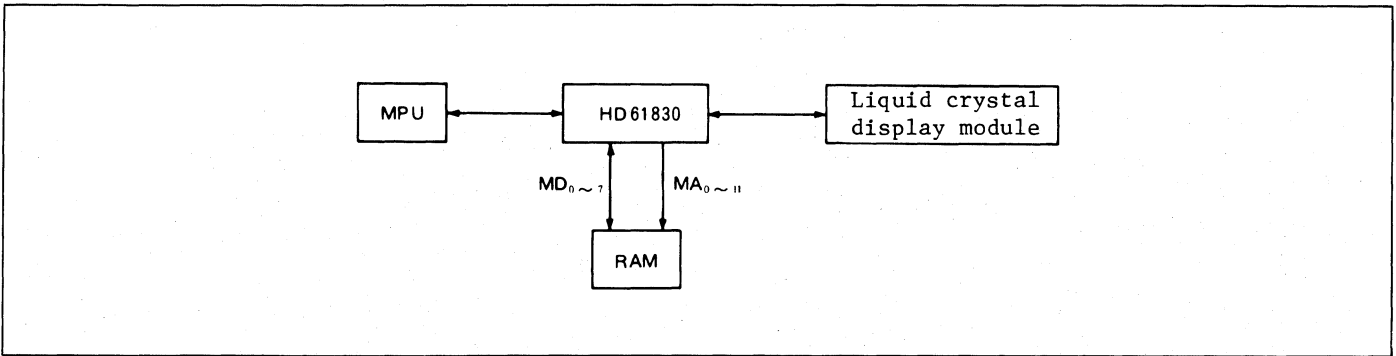
Higher Lower 4bit 4bit	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
xxx0000		0	a	P	'	P	-	9	E	o	p	
xxx0001	!	1	A	Q	a	q	2	3	4	a	q	
xxx0010	"	2	B	R	b	r	"	4	5	p	a	
xxx0011	#	3	C	S	c	s	#	5	6	e	o	
xxx0100	\$	4	D	T	d	t	\$	6	7	y	o	
xxx0101	%	5	E	U	e	u	%	7	8	e	o	
xxx0110	&	6	F	V	f	v	&	8	9	p	z	
xxx0111	'	7	G	W	g	w	'	9	0	g	π	
xxx1000	(	8	H	X	h	x	(	0	1	r	x	
xxx1001	)	9	I	Y	i	y	)	1	2	'	y	
xxx1010	*	:	J	Z	j	z	*	2	3	j	π	
xxx1011	+	;	K	L	k	l	+	3	4	*	π	
xxx1100	,	<	L	*	l	*	,	4	5	o	π	
xxx1101	-	=	M	I	m	i	-	5	6	t	+	
xxx1110	.	>	N	^	n	^	.	6	7	n		
xxx1111	/	?	O	_	o	_	/	7	8	o		

EXAMPLE OF CONFIGURATION

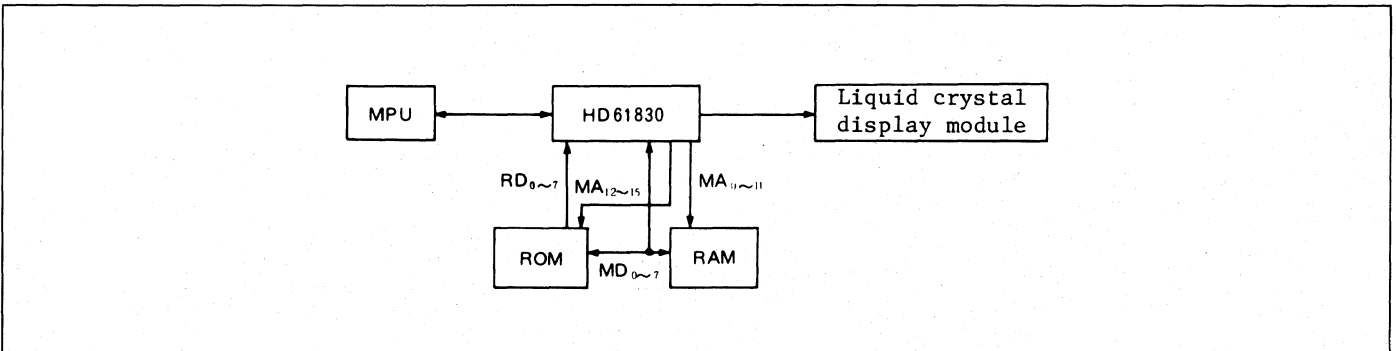
- Graphic Mode



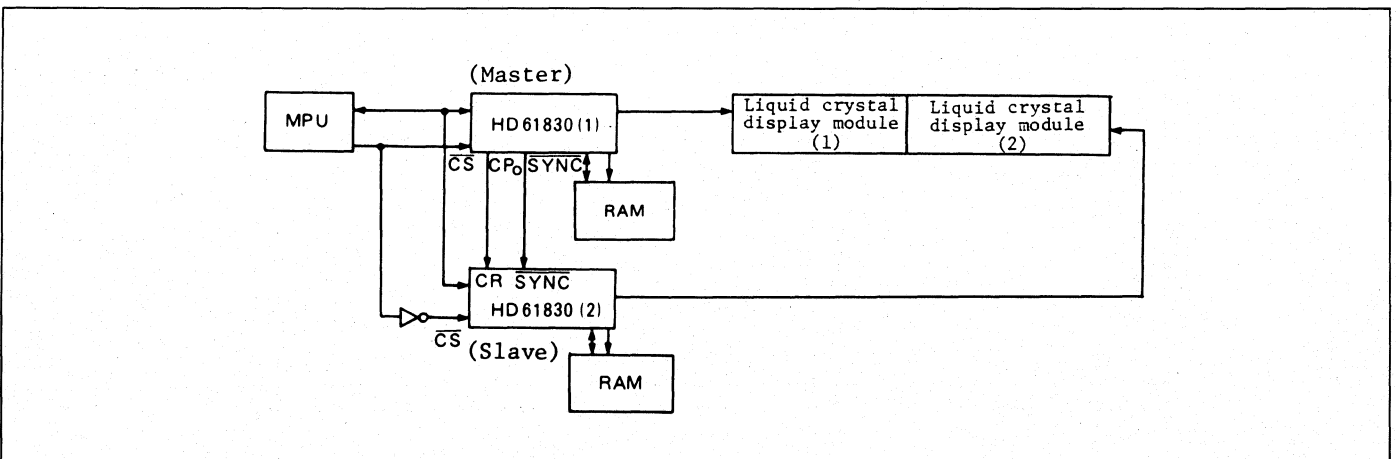
- Character Mode (1) (Internal Character Generator)

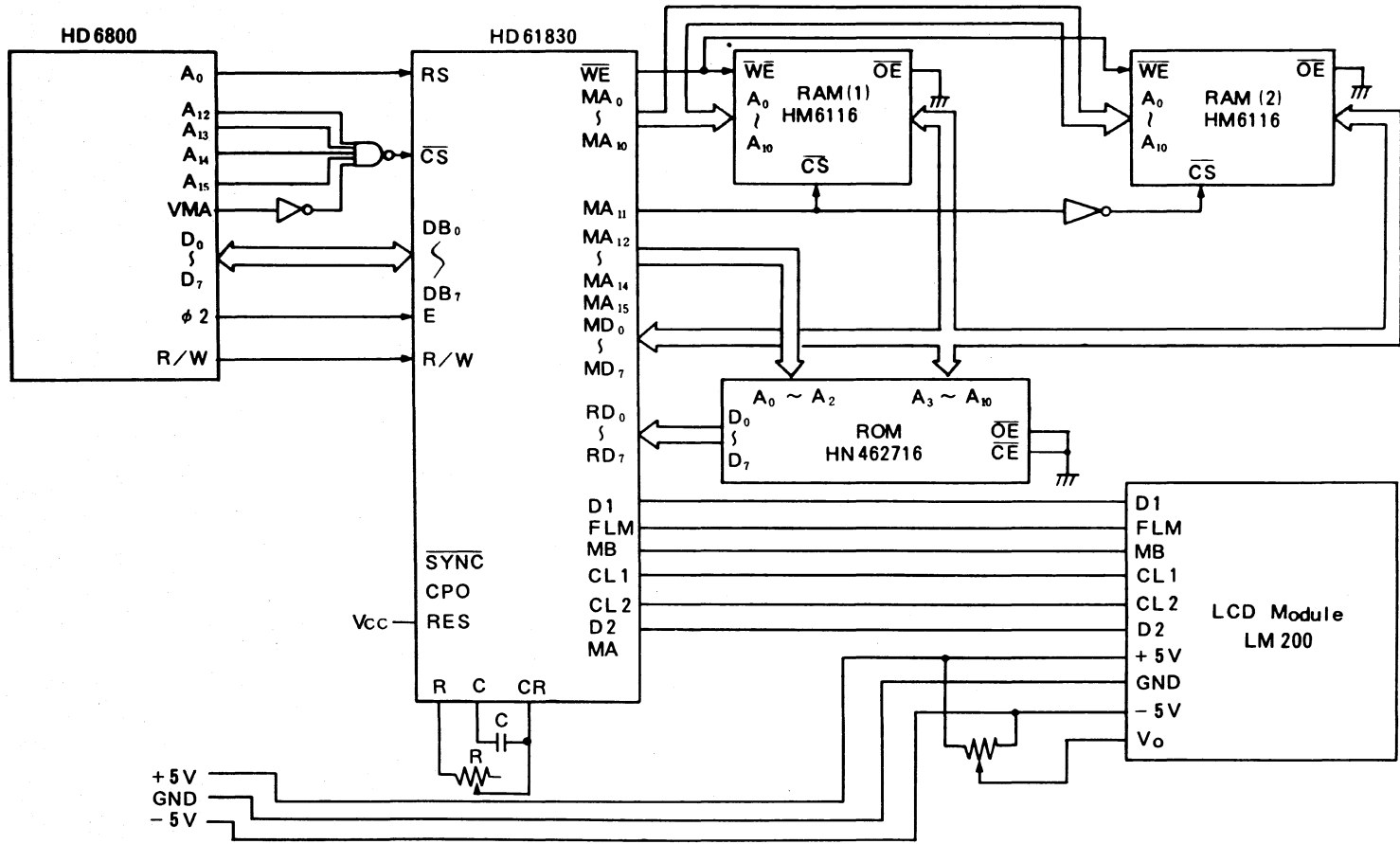


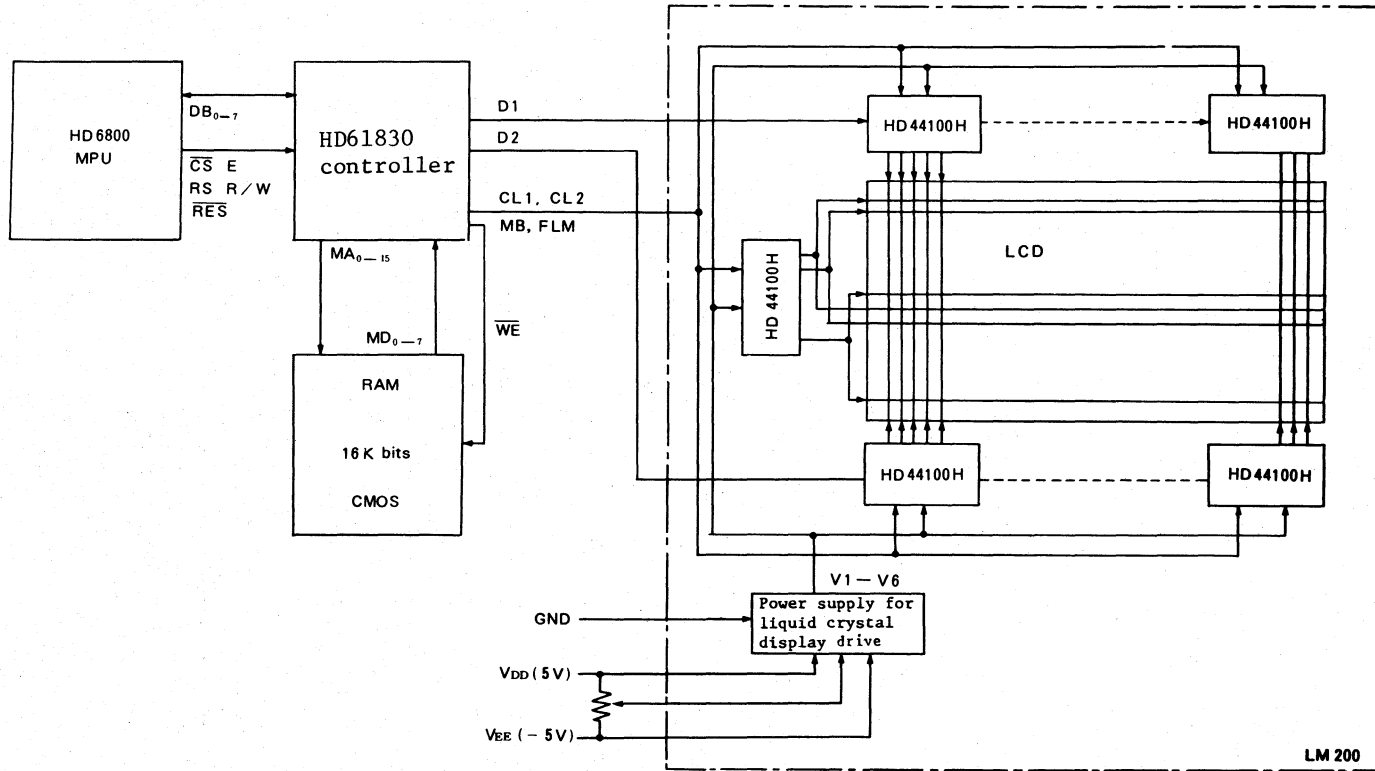
- Character Mode (2) (External Character Generator)



- Parallel Operation







CONTROL CIRCUIT BOARD CB-SERIES CB1020R·CB1026R·CB1030R

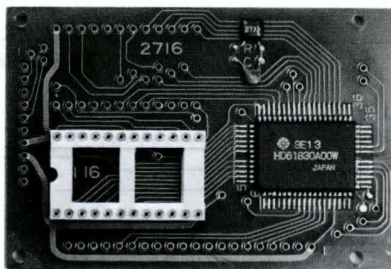
These CB-SERIES (mounted with control LSI HD61830 and a socket for the refresh memory) is a control circuit board for graphic display modules.

These CB-SERIES allows direct connection to the MPU bus line. The HD61830 controls timing signal generation and data conversion required for a liquid crystal display (LCD) module, resulting in simplification of the graphic display system configuration. These CB-SERIES operates in the graphic and character modes. In the graphic mode, the con-

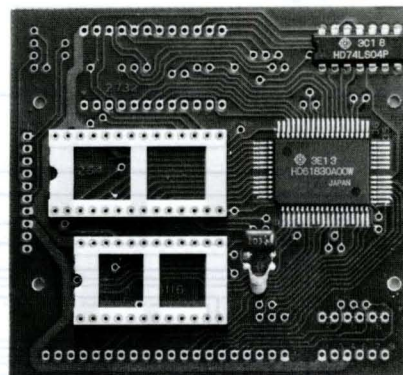
tents of the refresh memory are displayed as is on the LCD to allow display of figures, graphs, and pictures.

In the character mode, the 8-bit parallel code for each character is converted to the corresponding dot pattern by the character generator in these CB-SERIES and displayed on the LCD. The built-in character generator converts 192 characters consisting of 160 JIS characters and 32 special pattern characters. An additional character general for character patterns required by the customer may also be mounted.

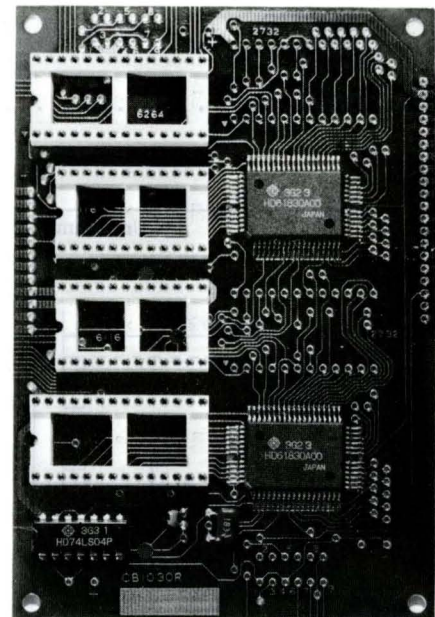
Item \ Type No.	CB1020R	CB1026R	CB1030R
Controller	HD61830, 1 piece	HD61830, 1 piece	HD61830D, 2 pieces
Refresh RAM	2 k bytes	4 k bytes	8 k bytes
Attachable ROM	2 k bytes	4 k bytes	4 k bytes
External dimension	78 x 53 mm	82 x 76 mm	125 x 85 mm
Object of LCM	LM021, H2525, LM200	LM021, H2525, LM200, LM211, LM212	LM021, H2525, LM200, LM211, LM212, LM215



CB1020R



CB1026R



CB1030R

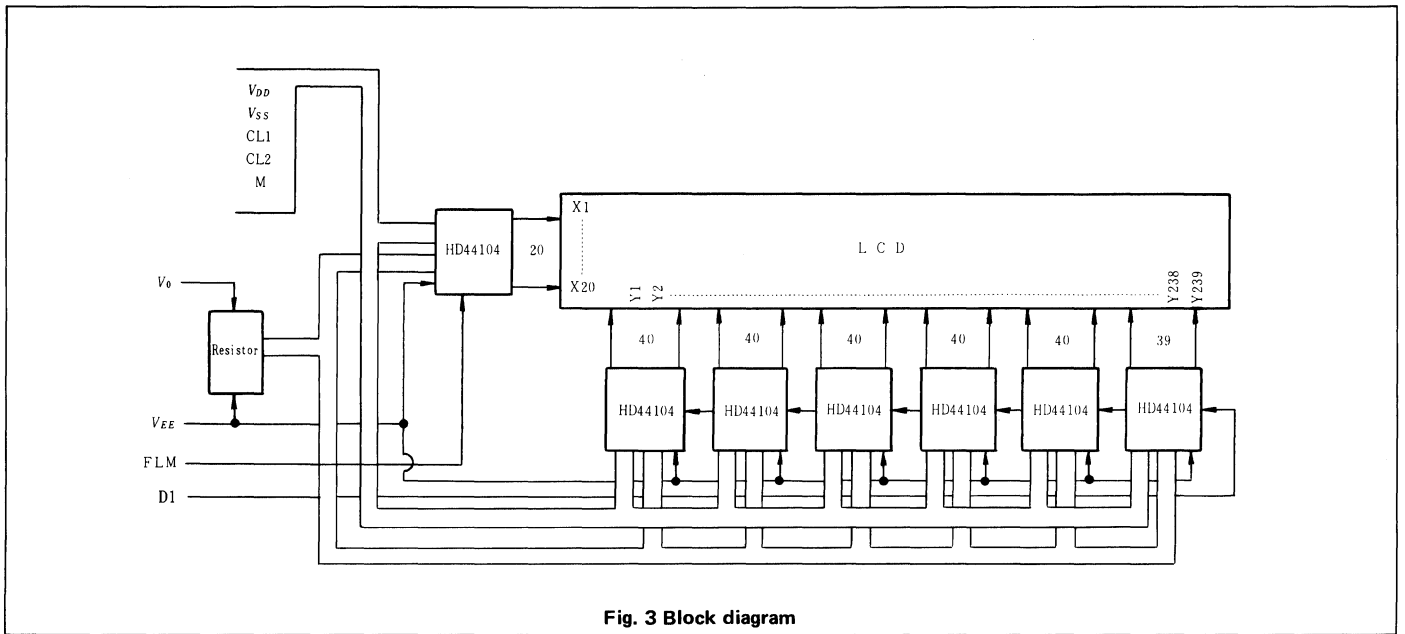


Fig. 3 Block diagram

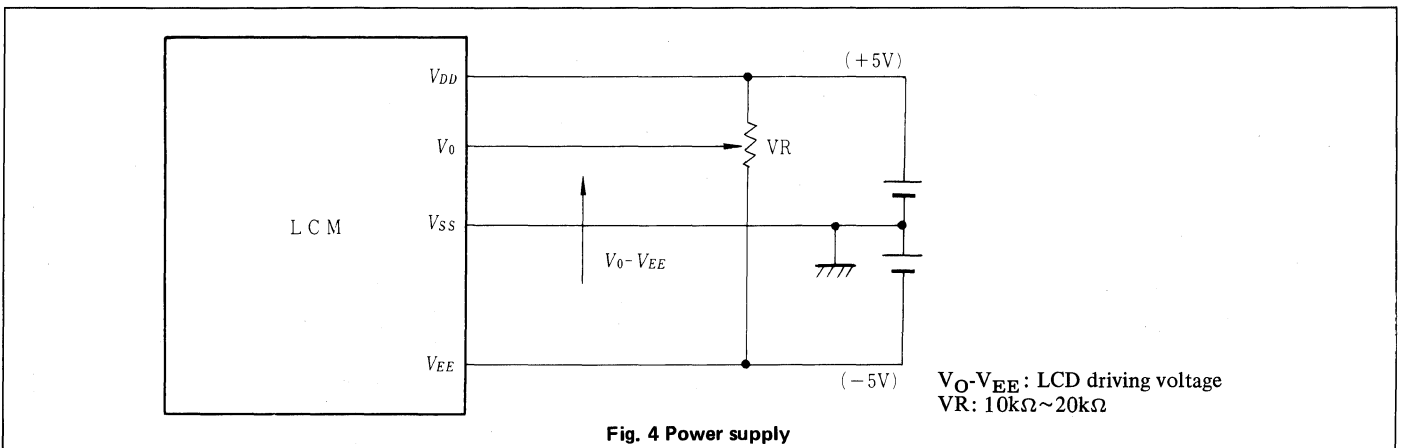


Fig. 4 Power supply

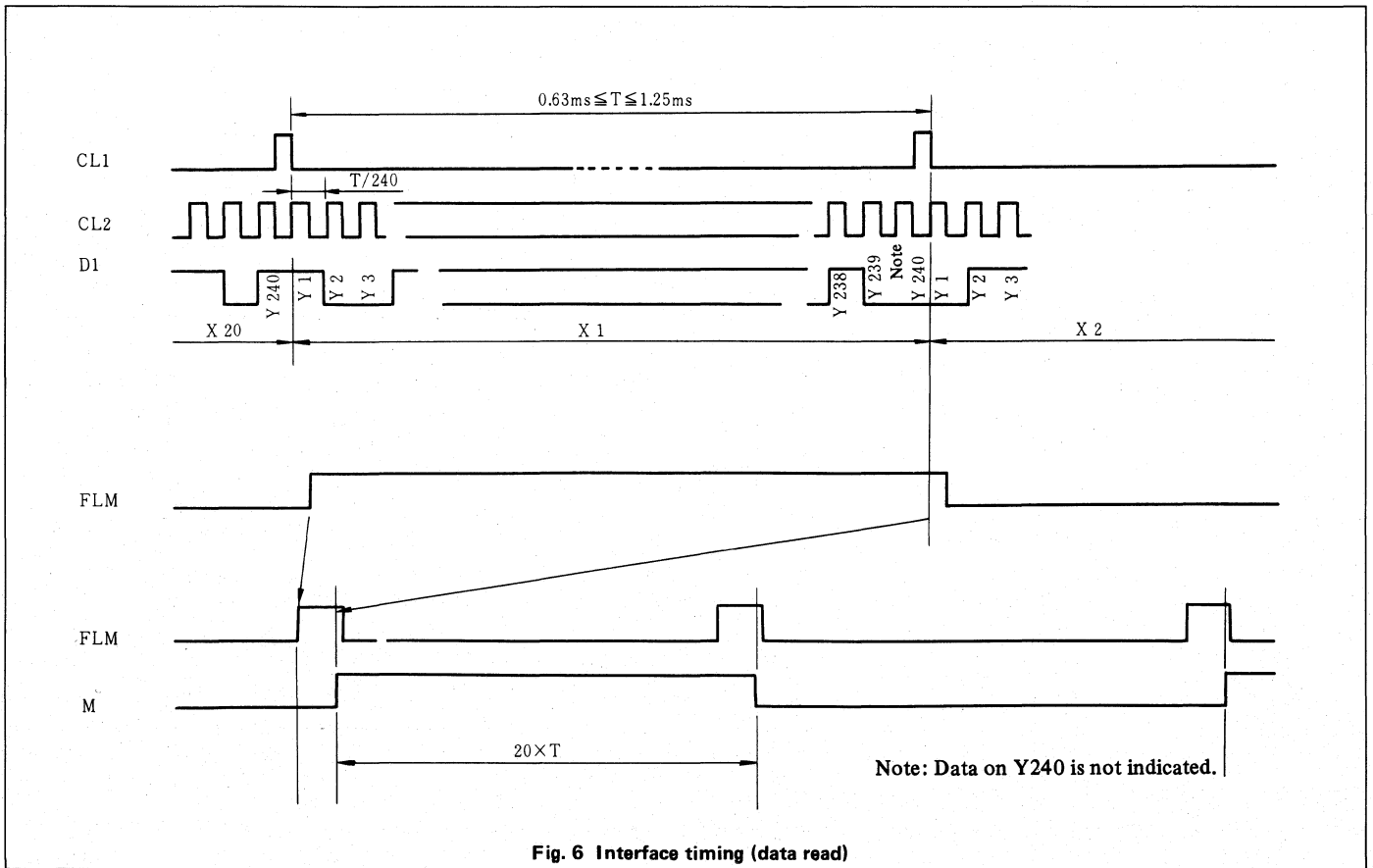
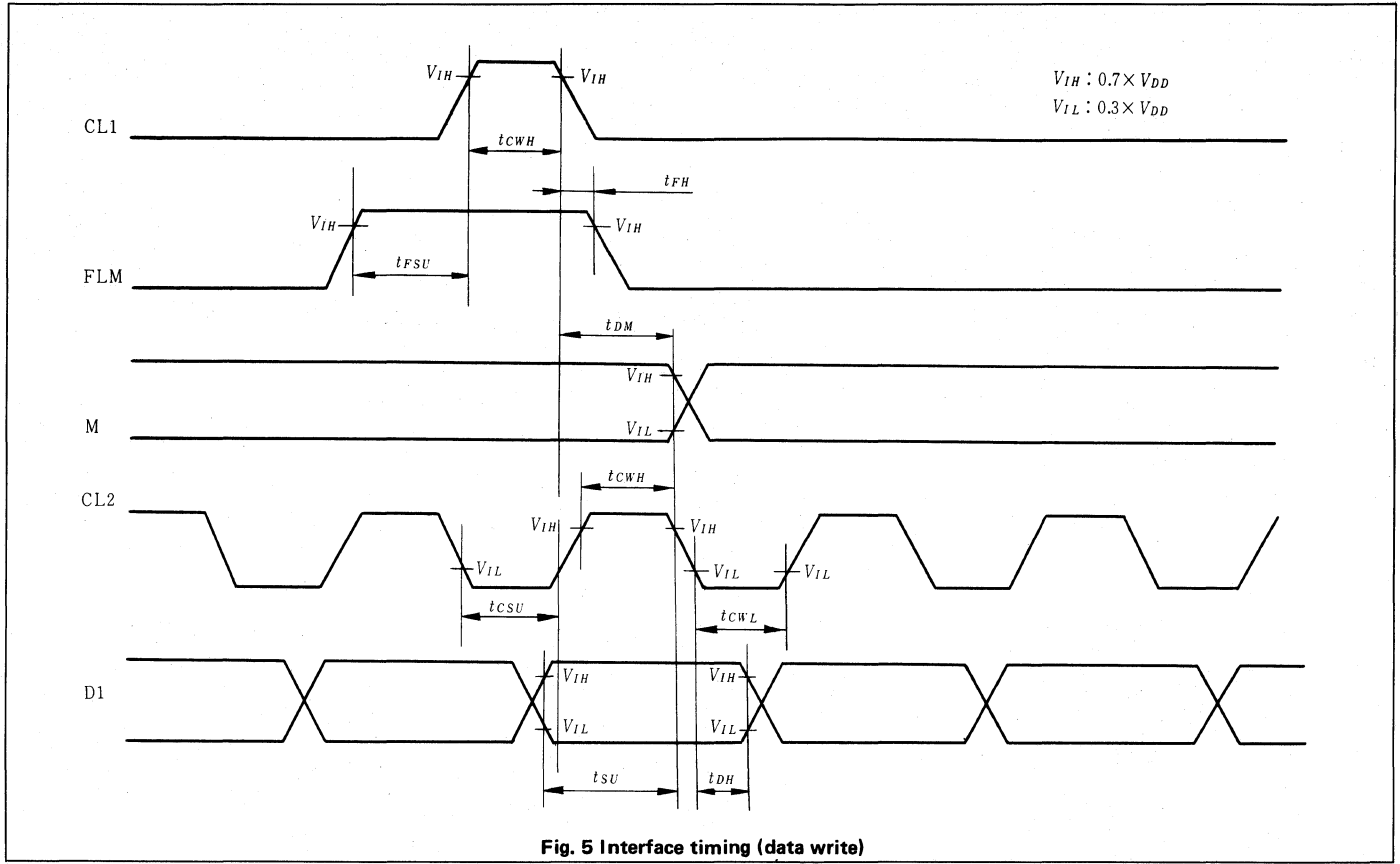
TIMING CHARACTERISTICS

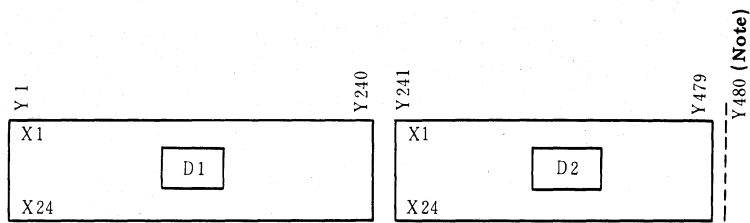
Item	Symbol	min.	typ.	max.	Unit
Clock frequency	f_{CL2}	—	—	500	kHz (Note 1)
Clock pulse width (High level)	t_{CWH}	800	—	—	ns
Clock pulse width (Low level)	t_{CWL}	800	—	—	ns
Clock set up time	t_{CSU}	500	—	—	ns
Data set up time	t_{SU}	300	—	—	ns
FLM set up time	t_{FSU}	300	—	—	ns
M delay time	t_{DM}	-1000	0	+1000	ns (Note 2)
FLM hold time	t_{FH}	0	—	—	ns
Data hold time	t_{DH}	300	—	—	ns

Note 1. Optimum frequency for the highest contrast is different by the type of module.

Note 2. Timing of M signal to CLI may be in the range of ± 1000 ns.

Note 3. In adjusting FLM frequency, avoid setting it around the commercial frequency ($50\text{Hz} \pm 2\text{Hz}$ or $60\text{Hz} \pm 2\text{Hz}$) to prevent LCD flicker.





Note: Y480 is a dummy line.

Fig. 3 Comparison of display and data

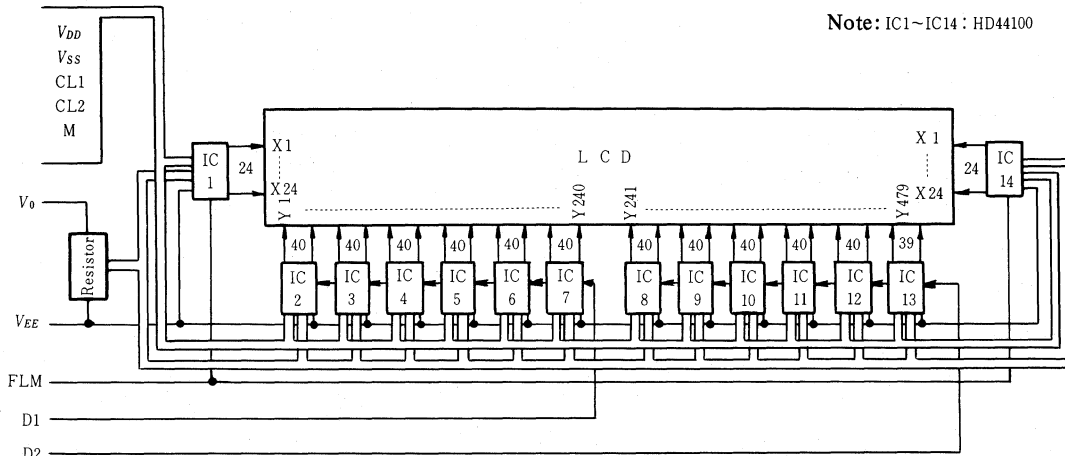


Fig. 4 Block diagram

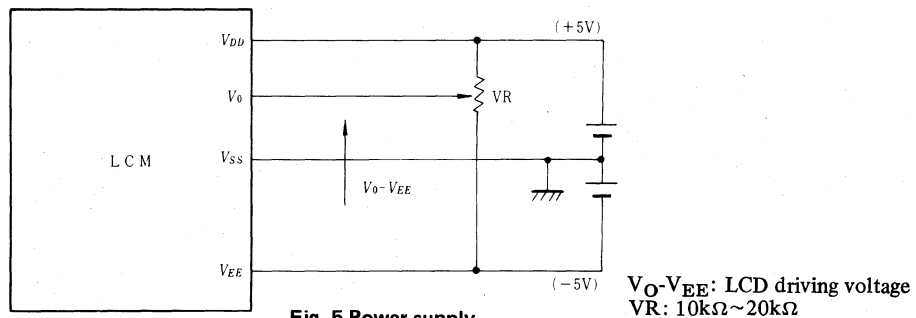


Fig. 5 Power supply

$V_0 - V_{EE}$: LCD driving voltage
 VR : $10k\Omega \sim 20k\Omega$

TIMING CHARACTERISTICS

Item	Symbol	min.	typ.	max.	Unit
Clock frequency	f_{CL2}	—	—	500	kHz (Note 1)
Clock pulse width (High level)	t_{CWH}	800	—	—	ns
Clock pulse width (Low level)	t_{CWL}	800	—	—	ns
Clock set up time	t_{CSU}	500	—	—	ns
Data set up time	t_{SU}	300	—	—	ns
FLM set up time	t_{FSU}	300	—	—	ns
M delay time	t_{DM}	-1000	0	+1000	ns (Note 2)
FLM hold time	t_{FH}	0	—	—	ns
Data hold time	t_{DH}	300	—	—	ns

Note 1. Optimum frequency for the highest contrast is different the type of module.

Note 3. In adjusting FLM frequency, avoid setting it around the commercial frequency ($50Hz \pm 2Hz$ or $60Hz \pm 2Hz$) to prevent LCD flicker.

Note 2. Timing of M signal to CLI may be in the range of $\pm 1000ns$.

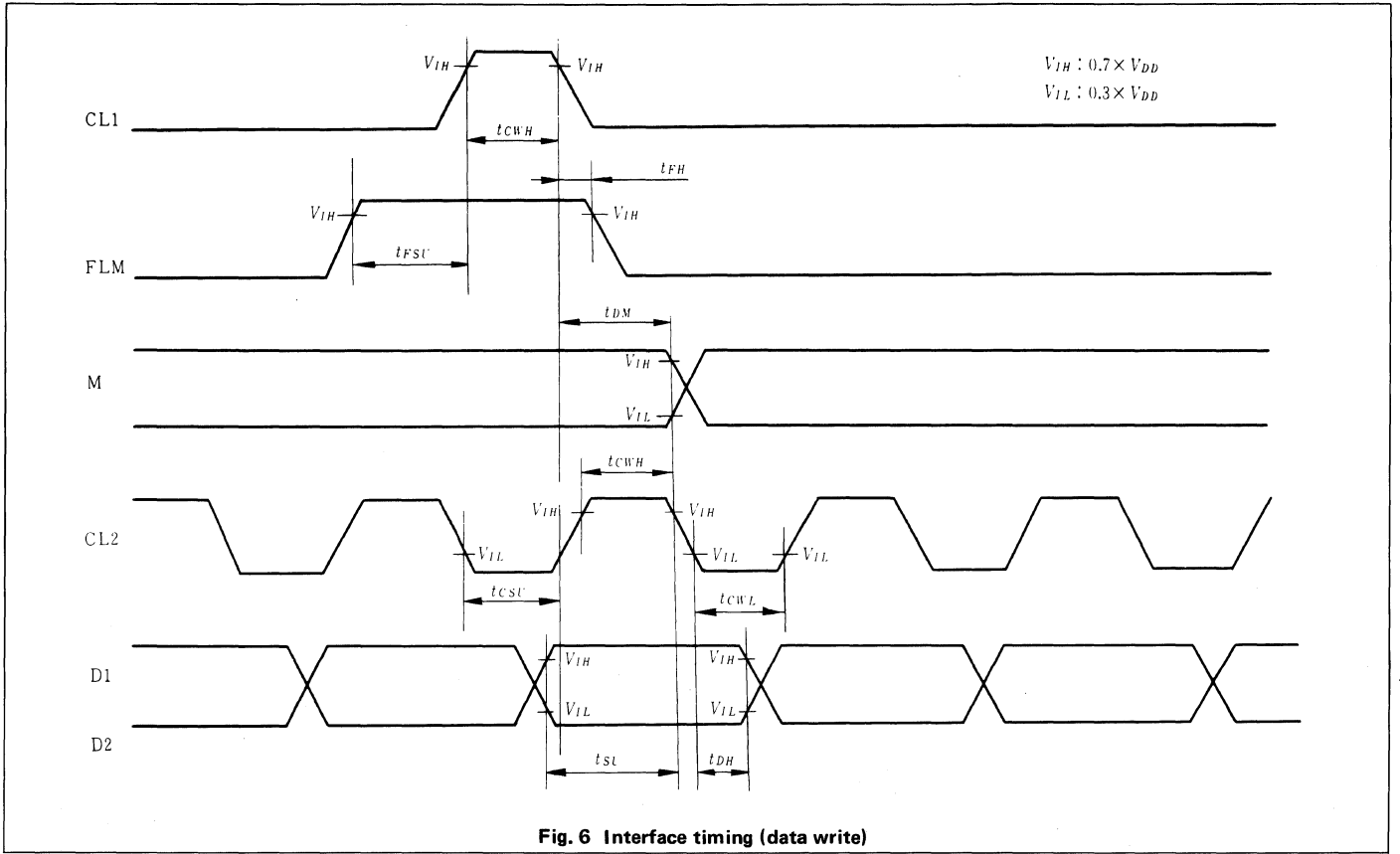


Fig. 6 Interface timing (data write)

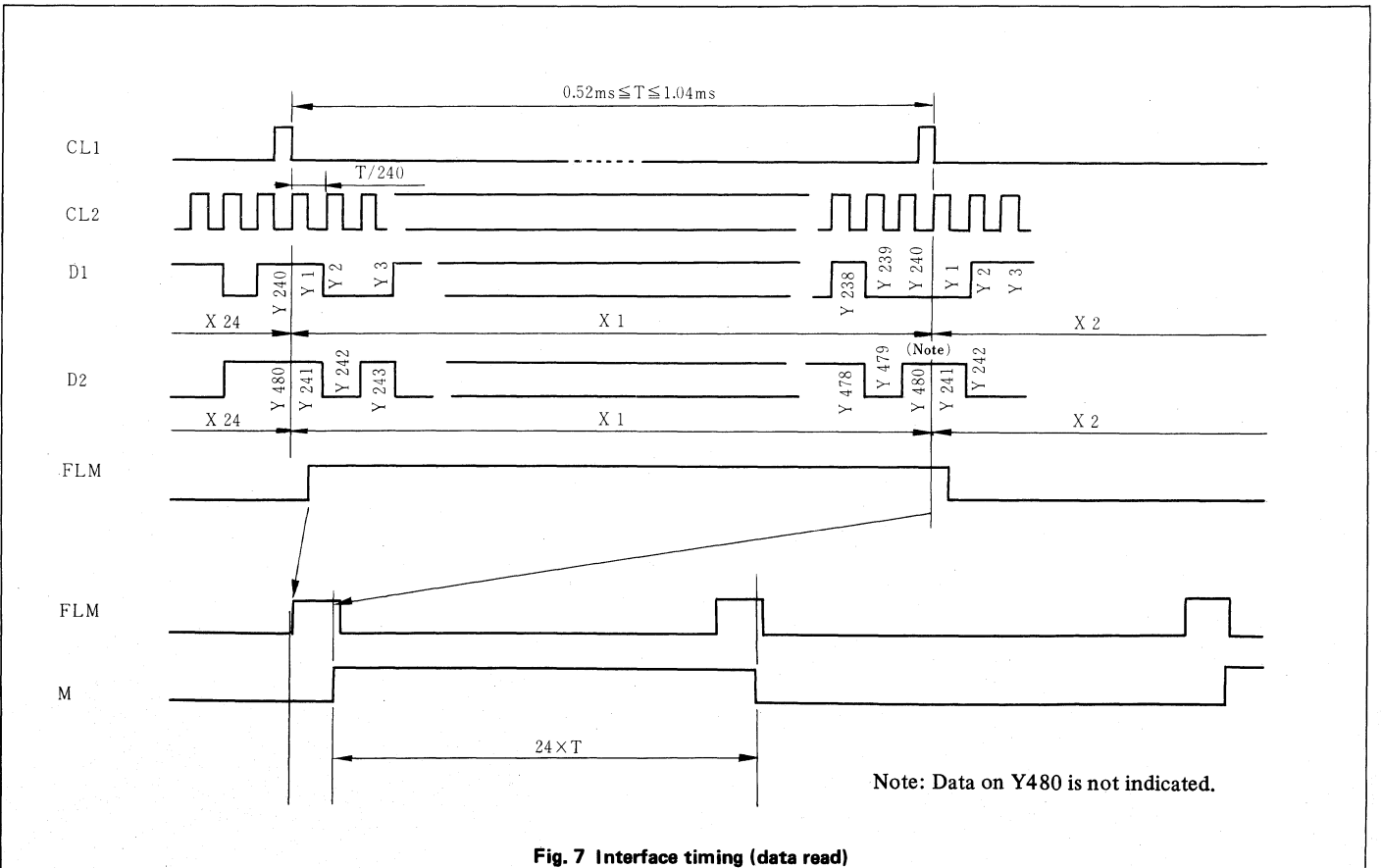


Fig. 7 Interface timing (data read)

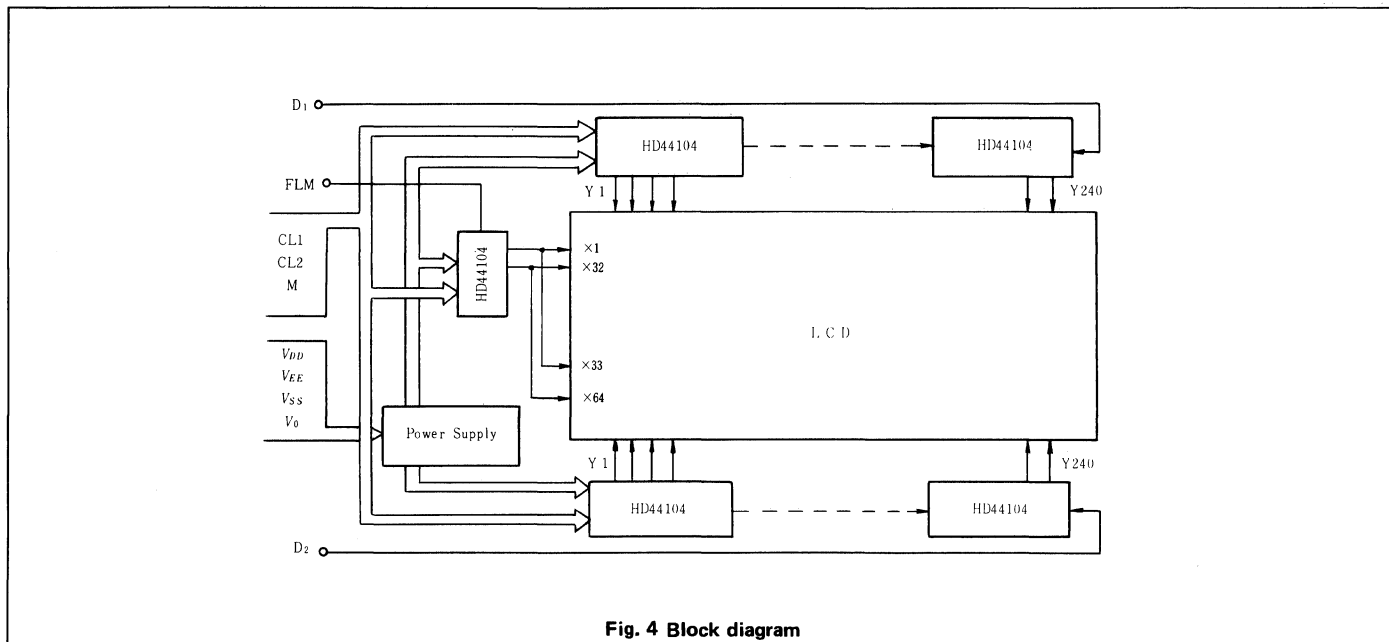


Fig. 4 Block diagram

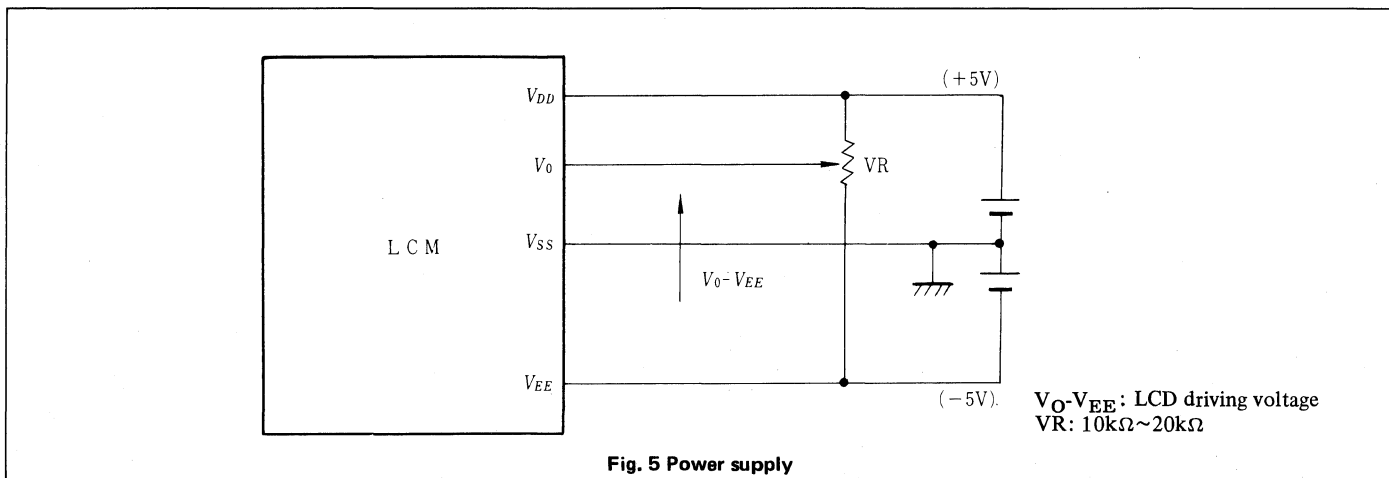


Fig. 5 Power supply

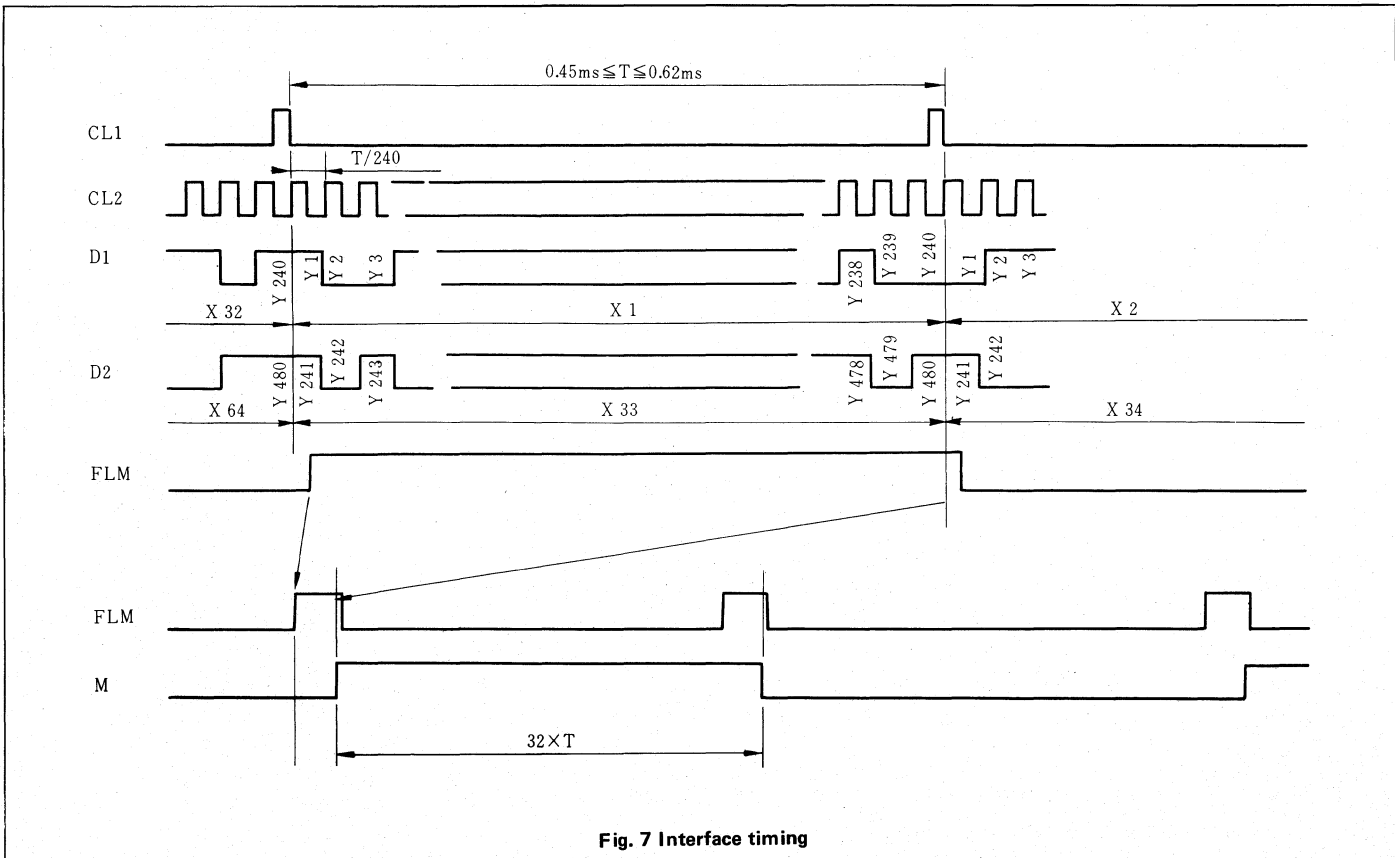
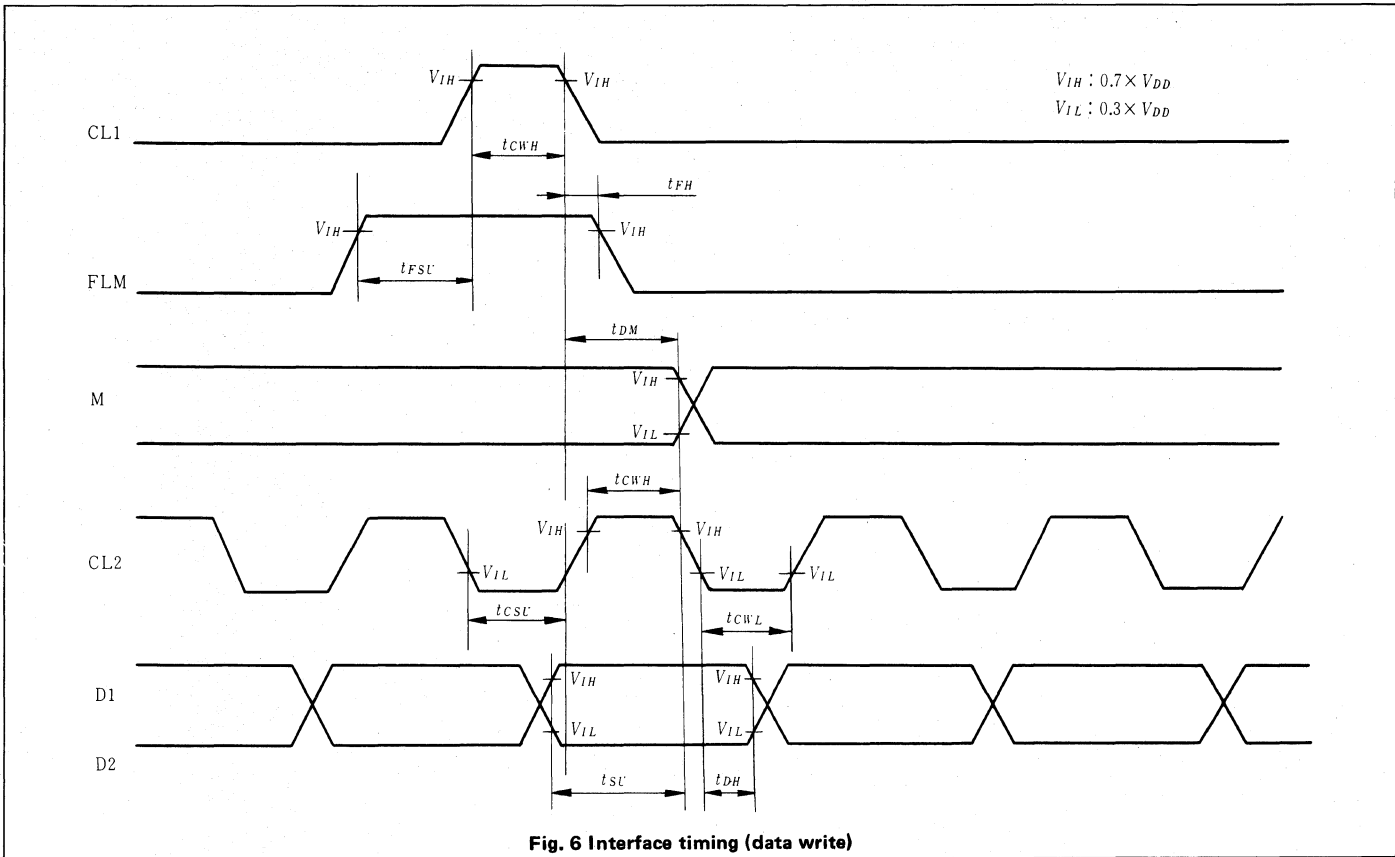
TIMING CHARACTERISTICS

Item	Symbol	min.	typ.	max.	Unit
Clock frequency	f_{CL2}	—	—	520	kHz (Note 1)
Clock pulse width (High level)	t_{CWH}	800	—	—	ns
Clock pulse width (Low level)	t_{CWL}	800	—	—	ns
Clock set up time	t_{CSU}	500	—	—	ns
Data set up time	t_{SU}	300	—	—	ns
FLM set up time	t_{FSU}	300	—	—	ns
M delay time	t_{DM}	-1000	—	+1000	ns (Note 2)
FLM hold time	t_{FH}	0	—	—	ns
Data hold time	t_{DH}	300	—	—	ns

Note 1. Optimum frequency for the highest contrast is different by the type of module.

Note 2. Timing of M signal to CLI may be in the range of ± 1000 ns.

Note 3. In adjusting FLM frequency, avoid setting it around the commercial frequency (50Hz \pm 2Hz or 60Hz \pm 2Hz) to prevent LCD flicker.



LM213B

- 256 dot(W) x 64 dot(H) graphic and alpha-numeric display
- Built-in control LSI HD61830 type (see page 76)

MECHANICAL DATA (Nominal dimensions)

Module size 184W x 75H x 12D (max.) mm
 Effective display area 149.6W x 43H mm
 Number of dots 256W x 64H mm
 Dot size 0.51W x 0.51H mm
 Pitch 0.56W x 0.56H mm
 Weight about 150 g

ABSOLUTE MAXIMUM RATINGS

	min.	max.
Power supply for logic ($V_{DD}-V_{SS}$)	0	7.0 V
Power supply for LCD drive ($V_{DD}-V_{EE}$)	0	15.0 V
Input voltage (V_i)	V_{SS}	V_{DD} V
Operating temperature (T_a)	0	40°C
Storage temperature (T_{stg})	-20	60°C

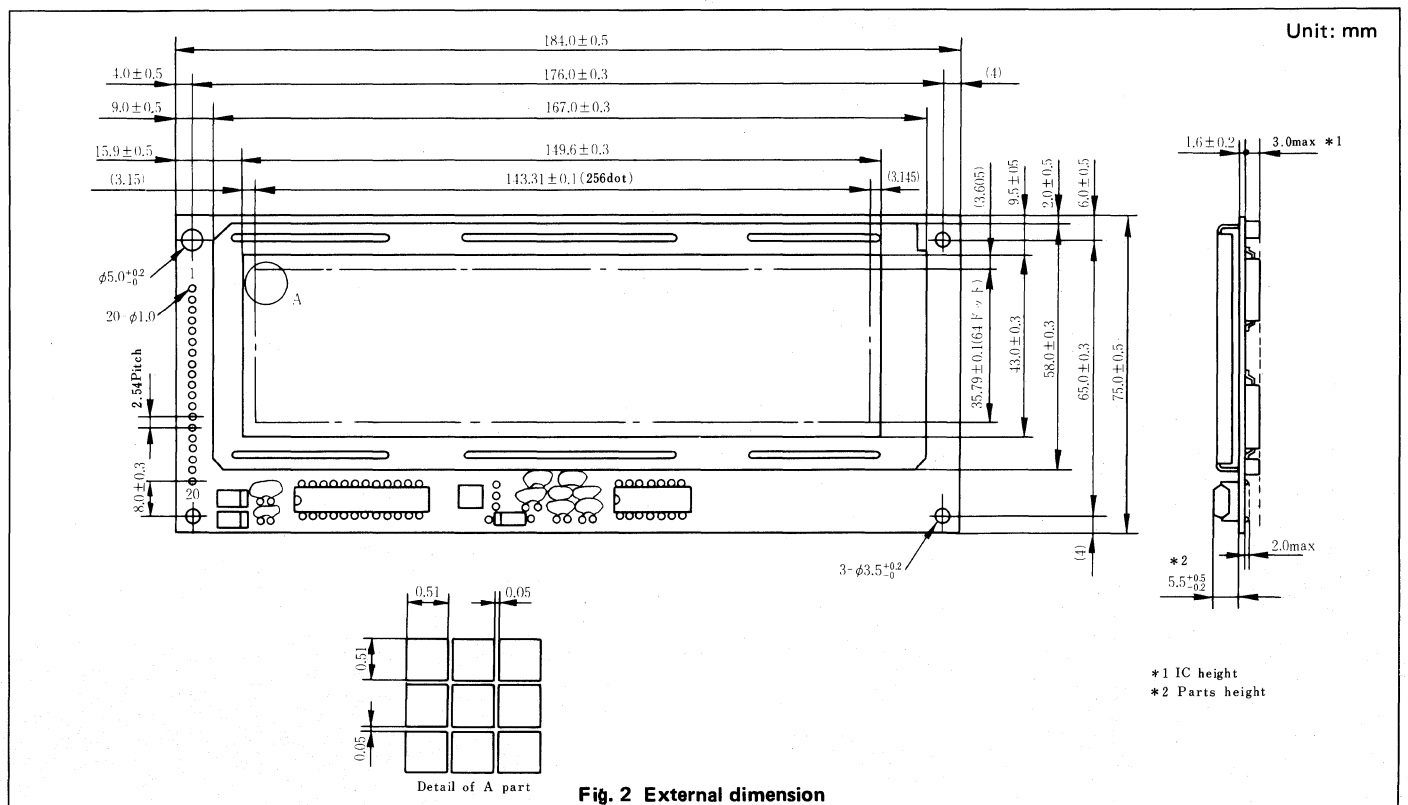
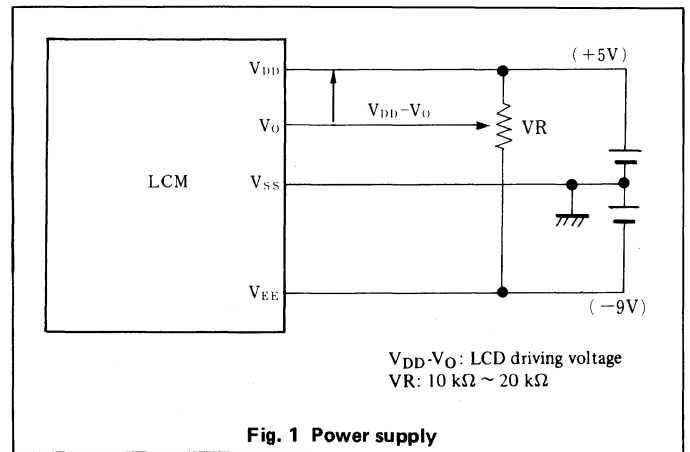
ELECTRICAL CHARACTERISTICS

$T_a = 25^\circ\text{C}$, $V_{DD} = 5.0 \text{ V} \pm 0.25 \text{ V}$,
 $V_{EE} = -9.0\text{V} \begin{matrix} +5\% \\ -10\% \end{matrix}$
 Operating internal frequency F_{CP1} 500 kHz
 F_{CP2} 1.2 MHz
 Dissipation current 80 mW
 Power supply for LCD drive (Recommended) ($V_{DD} - V_O$)
 $Du=1/64$
 at $T_a = 0^\circ\text{C}$ 13.2 V typ.
 at $T_a = 25^\circ\text{C}$ 11.7 V typ.
 at $T_a = 40^\circ\text{C}$ 10.2 V typ.

OPTICAL DATA See page 8

INTERFACE TABLE

Pin No.	Symbol	Pin No.	Symbol
1	V_{SS} (GND)	11	DB4
2	V_{DD} (5 V)	12	DB5
3	V_O	13	DB6
4	RS	14	DB7
5	R/W	15	\overline{CS}
6	E	16	\overline{RES}
7	DB0	17	V_{EE} (-9 V)
8	DB1	18	N.C
9	DB2	19	N.C
10	DB3	20	N.C



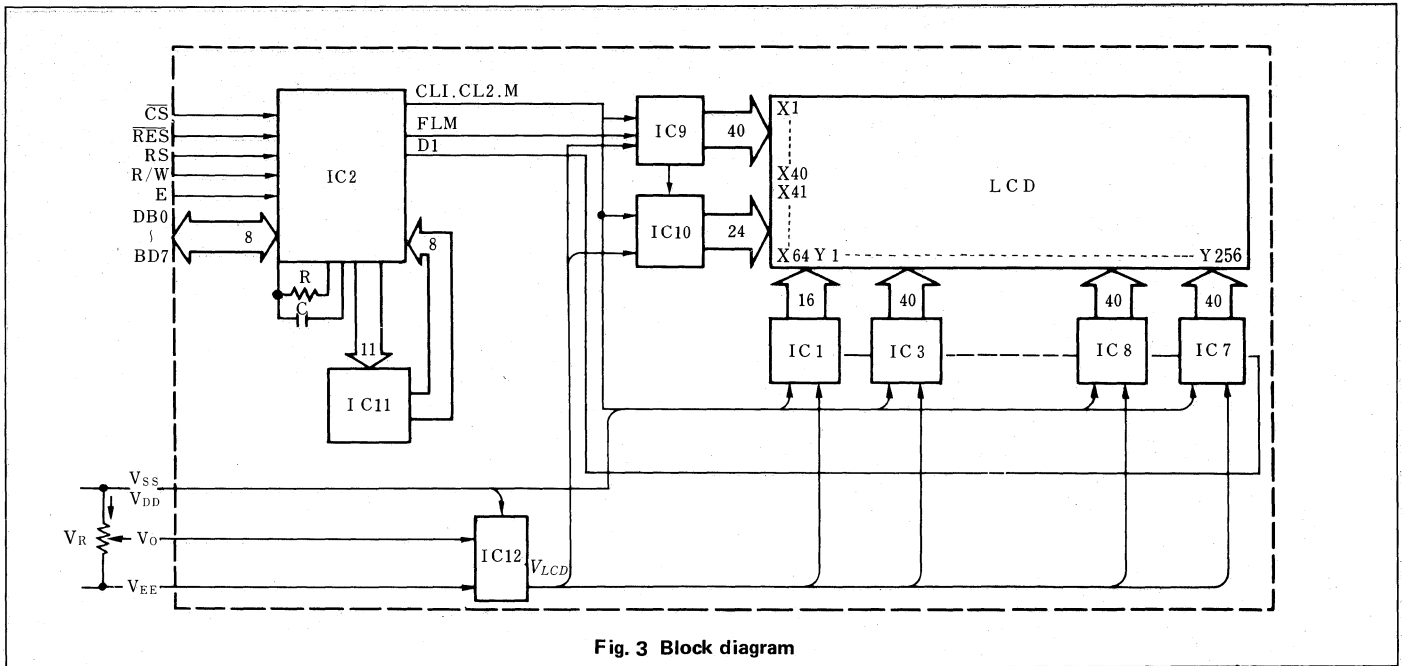


Fig. 3 Block diagram

TIMING CHARACTERISTICS

Item	Symbol	min.	typ.	max.	Unit
Cycle time of 'E'	t_{CYC}	1.0	—	—	μs
Pulse width of 'E'	H level	t_{WEH}	0.45	—	μs
	L level	t_{WEL}	0.45	—	μs
Pulse raise time of 'E'	t_{Er}	—	—	25	ns
Pulse fall time of 'E'	t_{Ef}	—	—	25	ns
Set up time of CS, R/W, RS	t_{AS}	140	—	—	ns
Set up time of Input Data	t_{DIS}	225	—	—	ns
Data delay time	t_{DD}	—	—	225	ns
Hold time of Data	t_H	10	—	—	ns
Hold time of CS, R/W, RS	t_{AH}	10	—	—	ns

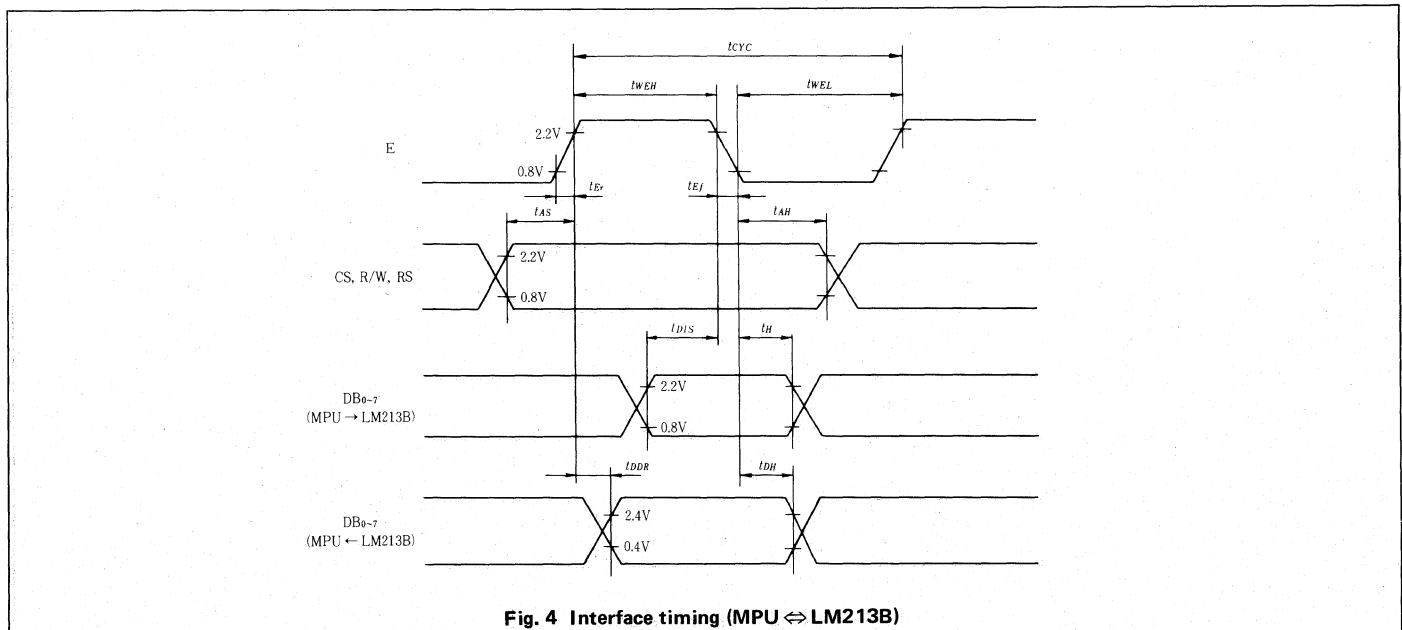
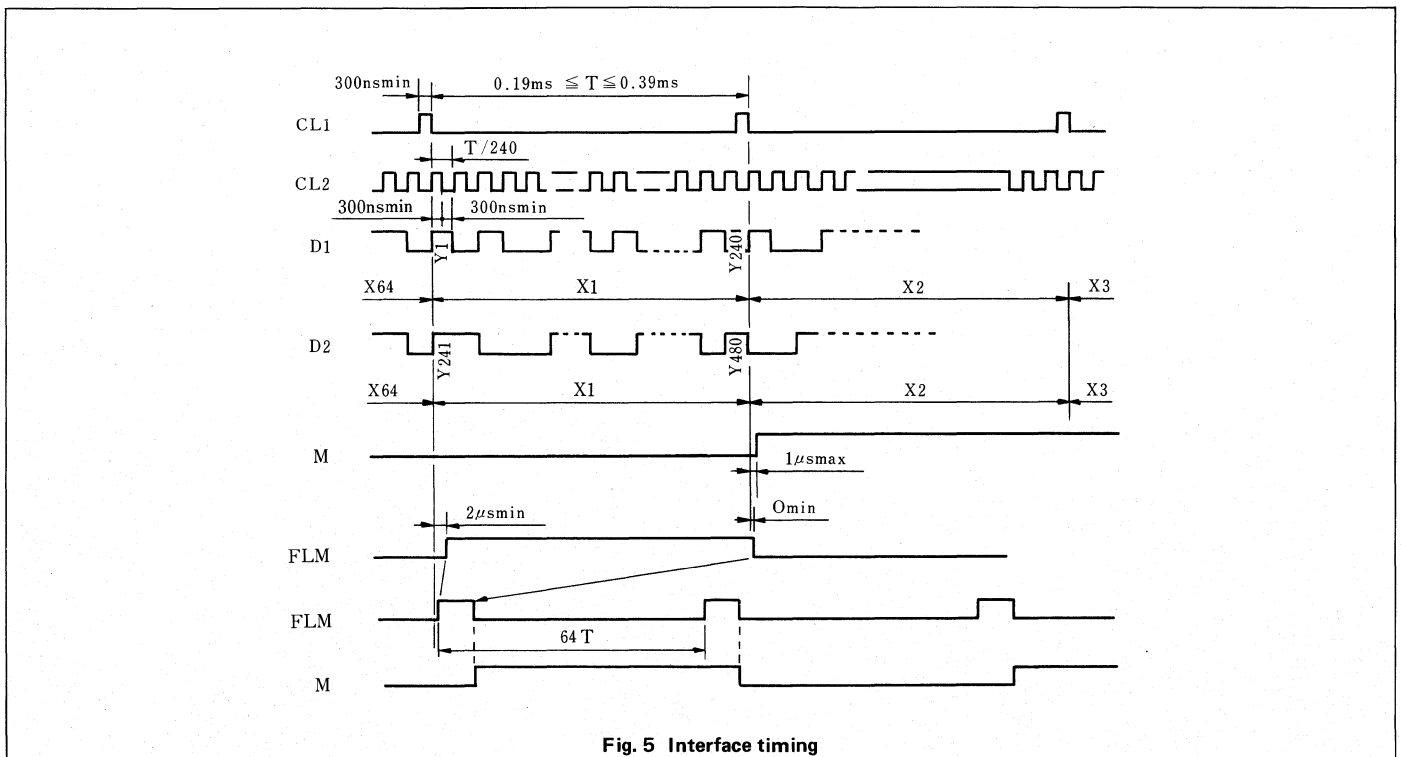
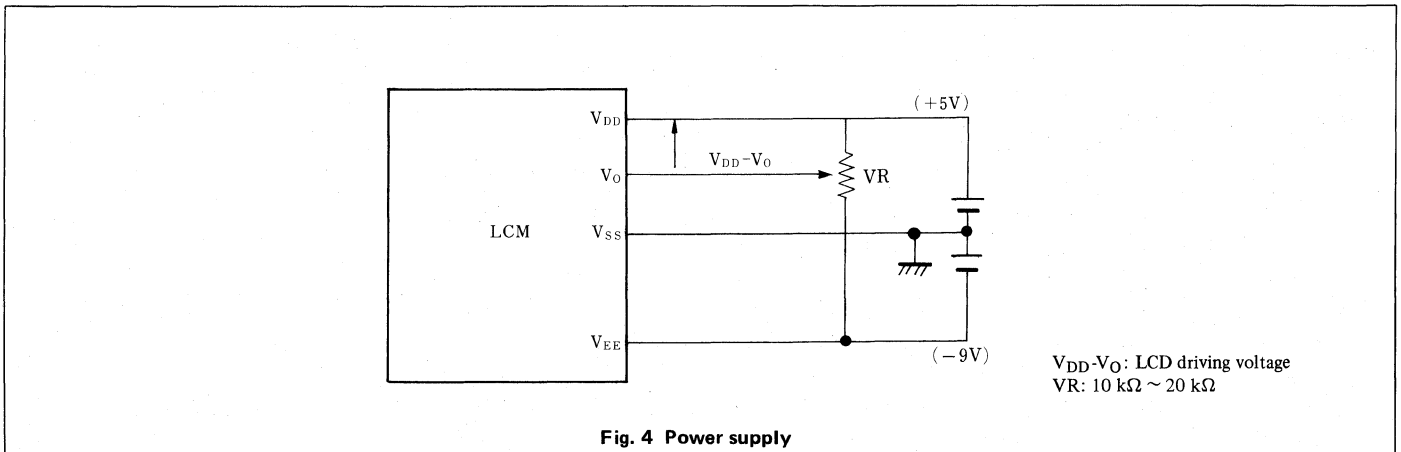
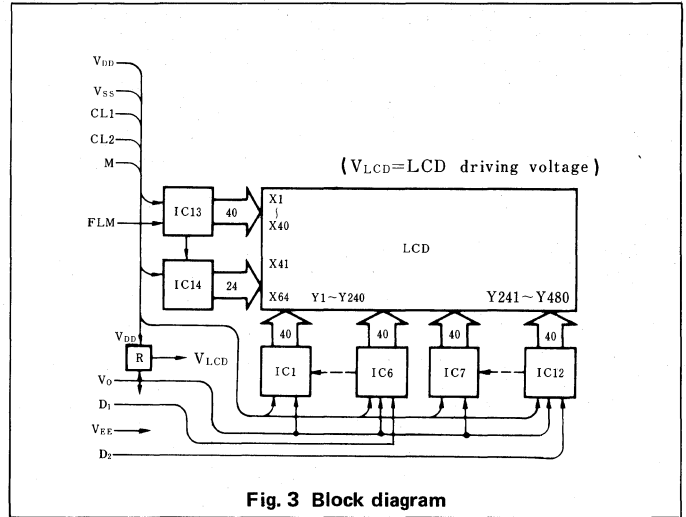
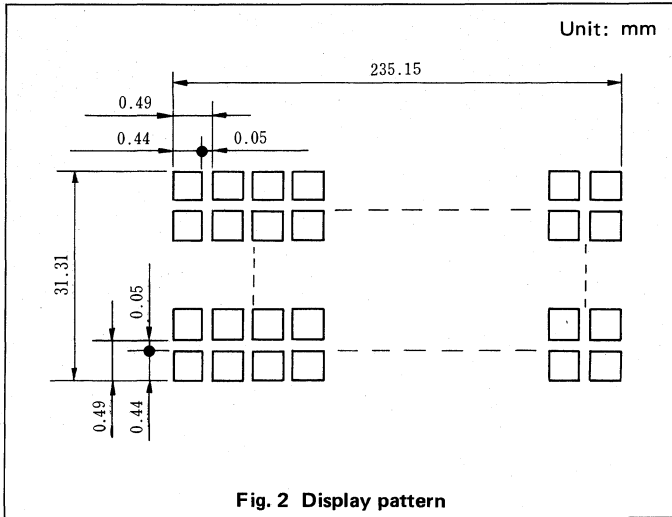


Fig. 4 Interface timing (MPU \leftrightarrow LM213B)



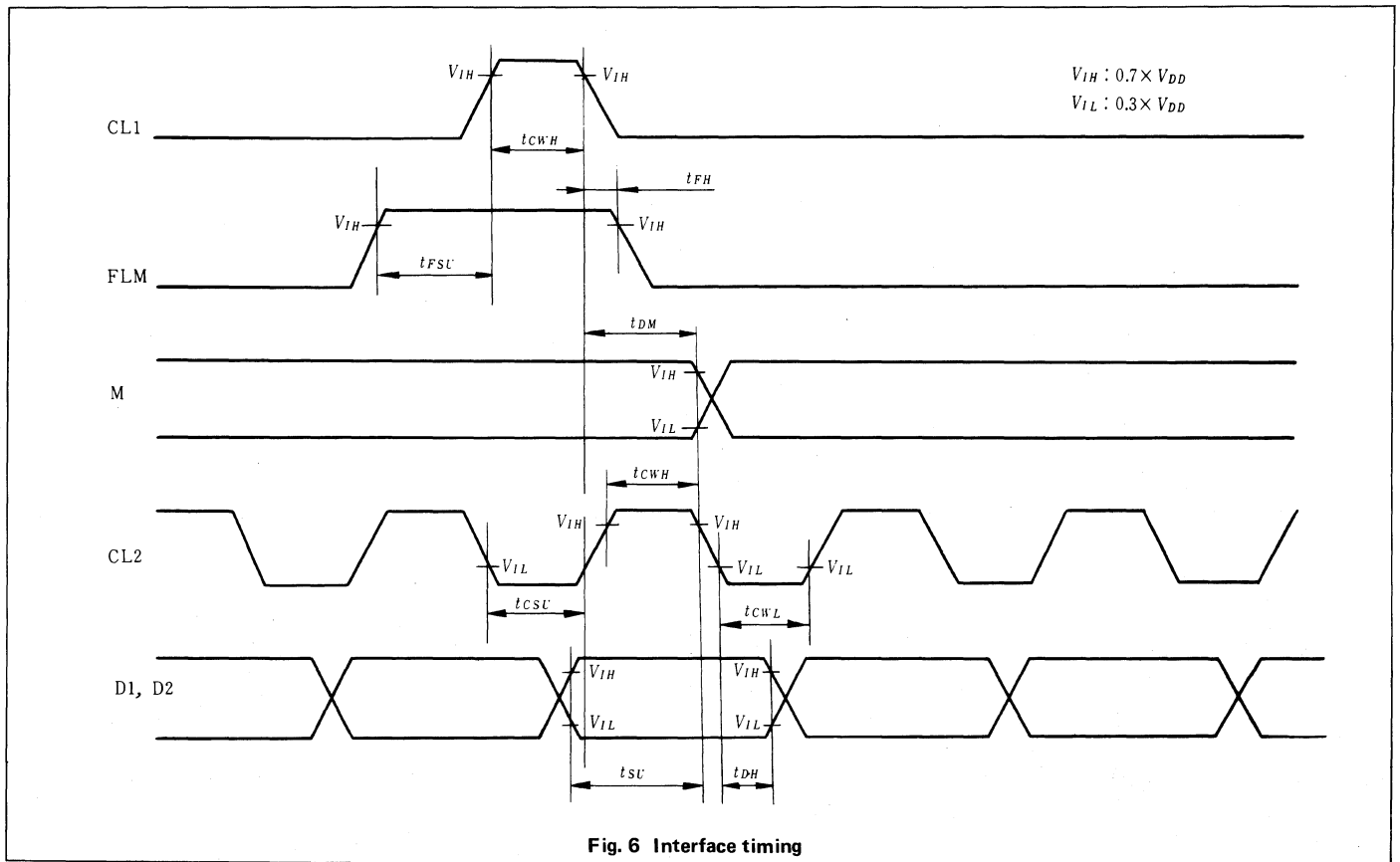
TIMING CHARACTERISTICS

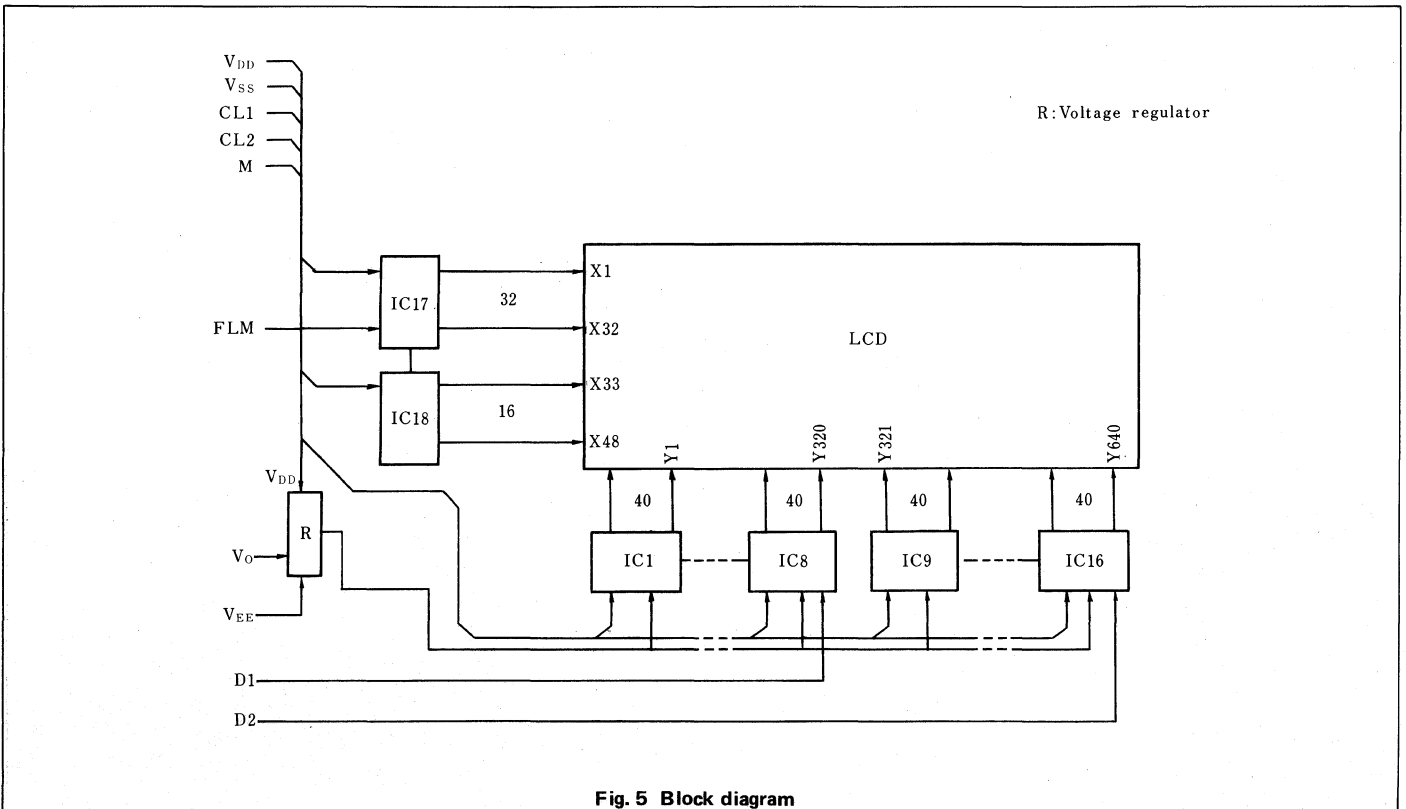
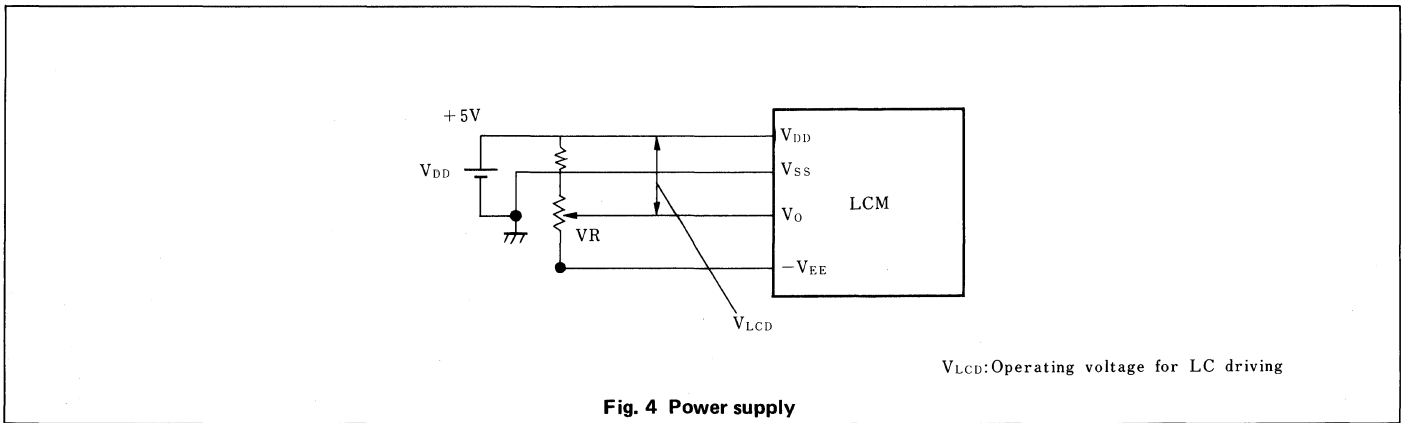
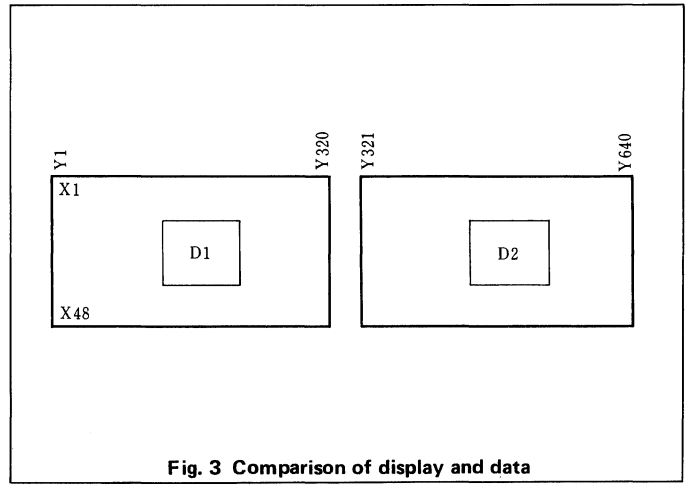
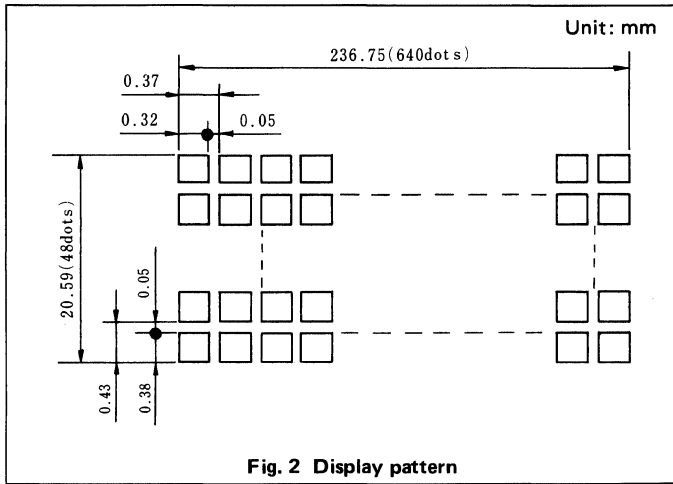
Item	Symbol	min.	typ.	max.	Unit
Clock frequency	f_{CL2}	—	—	1200	kHz (Note 1)
Clock pulse width (High level)	t_{CWH}	300	—	—	ns
Clock pulse width (Low level)	t_{CWL}	300	—	—	ns
Clock set up time	t_{CSU}	300	—	—	ns
Data set up time	t_{SU}	200	—	—	ns
FLM set up time	t_{FSU}	200	—	—	ns
M delay time	t_{DM}	-1000	—	+1000	ns (Note 2)
FLM hold time	t_{FH}	0	—	—	ns
Data hold time	t_{DH}	200	—	—	ns

Note 1. Optimum frequency for the highest contrast is different by the type of module.

Note 2. Timing of M signal to CL1 may be in the range of ± 1000 ns.

Note 3. In adjusting FLM frequency, avoid setting it around the commercial frequency (50 Hz \pm 2 Hz or 60 Hz \pm 2 Hz) to prevent LCD flicker.





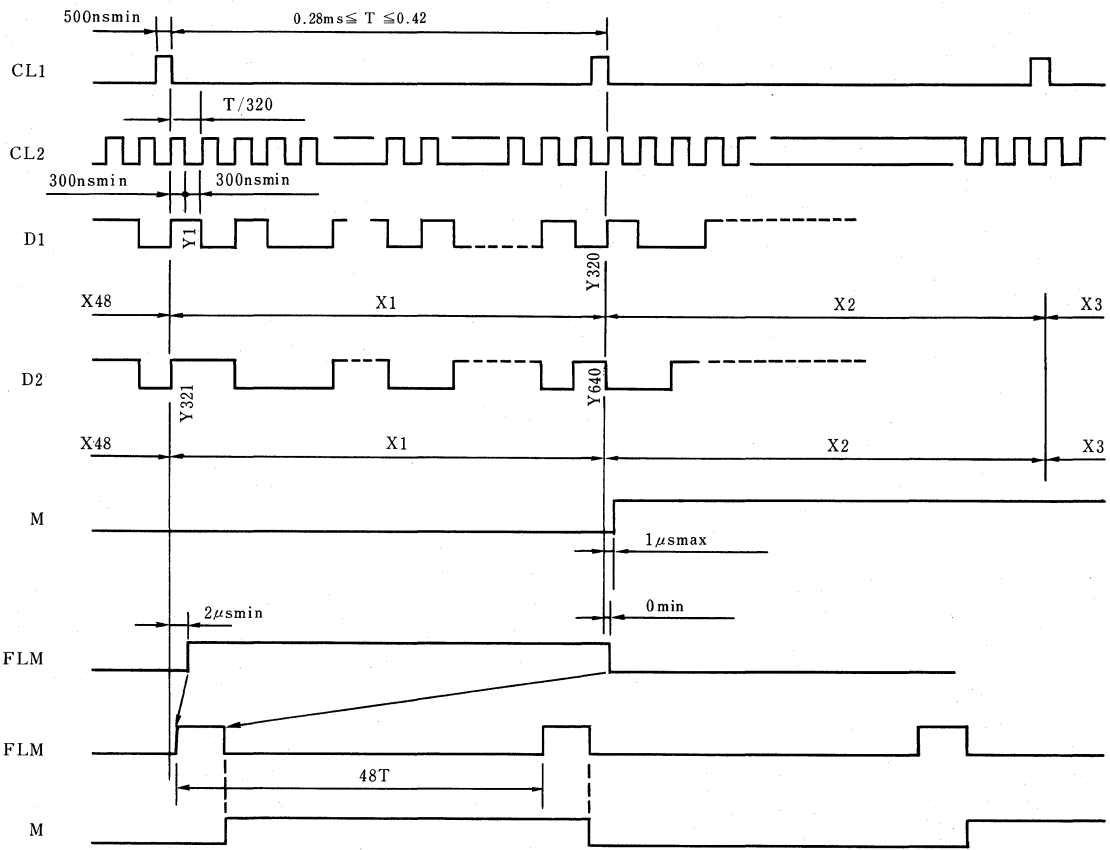


Fig. 6 Interface timing

TIMING CHARACTERISTICS

Item	Symbol	min.	typ.	max.	Unit
Clock frequency	f_{CL2}	—	—	1228	kHz (Note 1)
Clock pulse width (High level)	t_{CWH}	200	—	—	ns
Clock pulse width (Low level)	t_{CWL}	300	—	—	ns
Clock set up time	t_{CSU}	500	—	—	ns
Data set up time	t_{SU}	40	—	—	ns
FLM set up time	t_{FSU}	100	—	—	ns
M delay time	t_{DM}	-1000	—	+1000	ns (Note 2)
FLM hold time	t_{FH}	800	—	—	ns
Data hold time	t_{DH}	400	—	—	ns

Note 1. Optimum frequency for the highest contrast is different by the type of module.

Note 2. Timing of M signal to CL1 may be in the range of ± 1000 ns.

Note 3. In adjusting FLM frequency, avoid setting it around the commercial frequency (50 Hz \pm 2 Hz or 60 Hz \pm 2 Hz) to prevent LCD flicker.

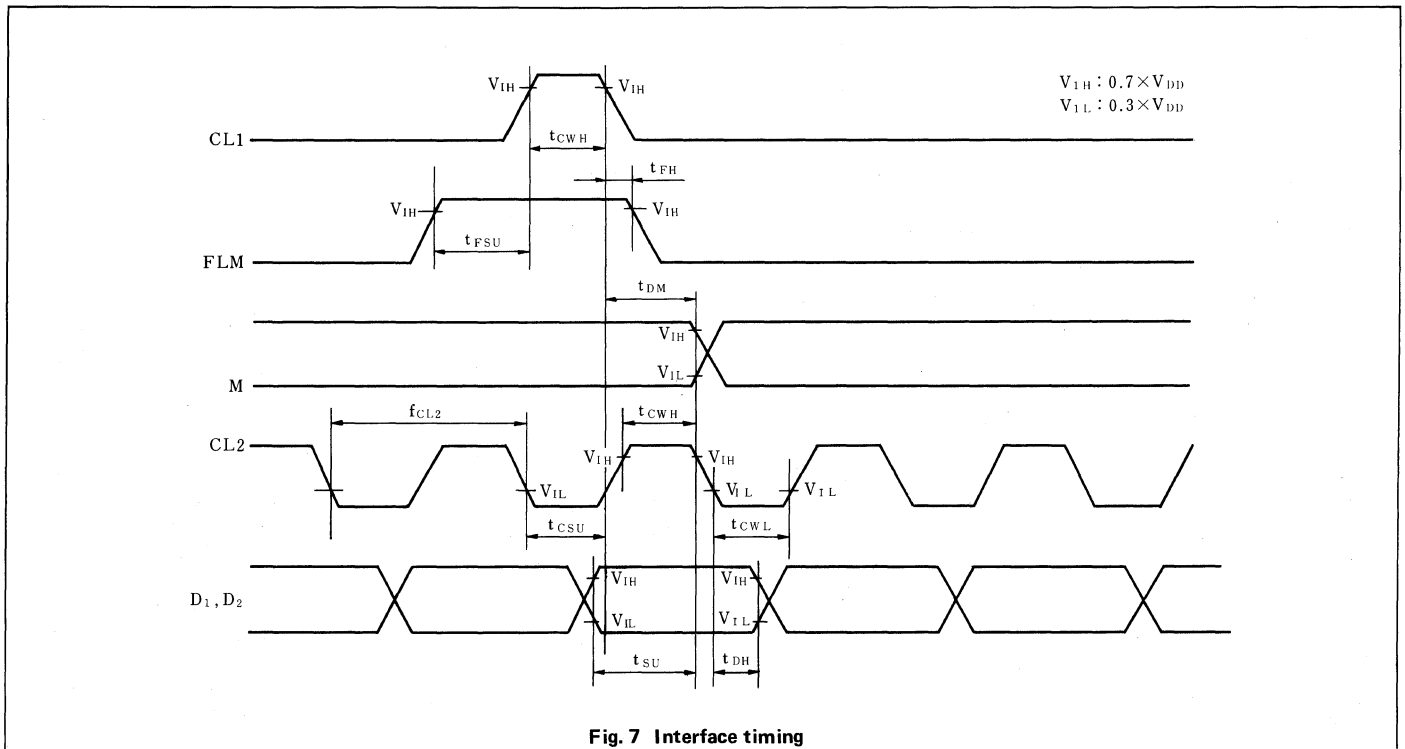
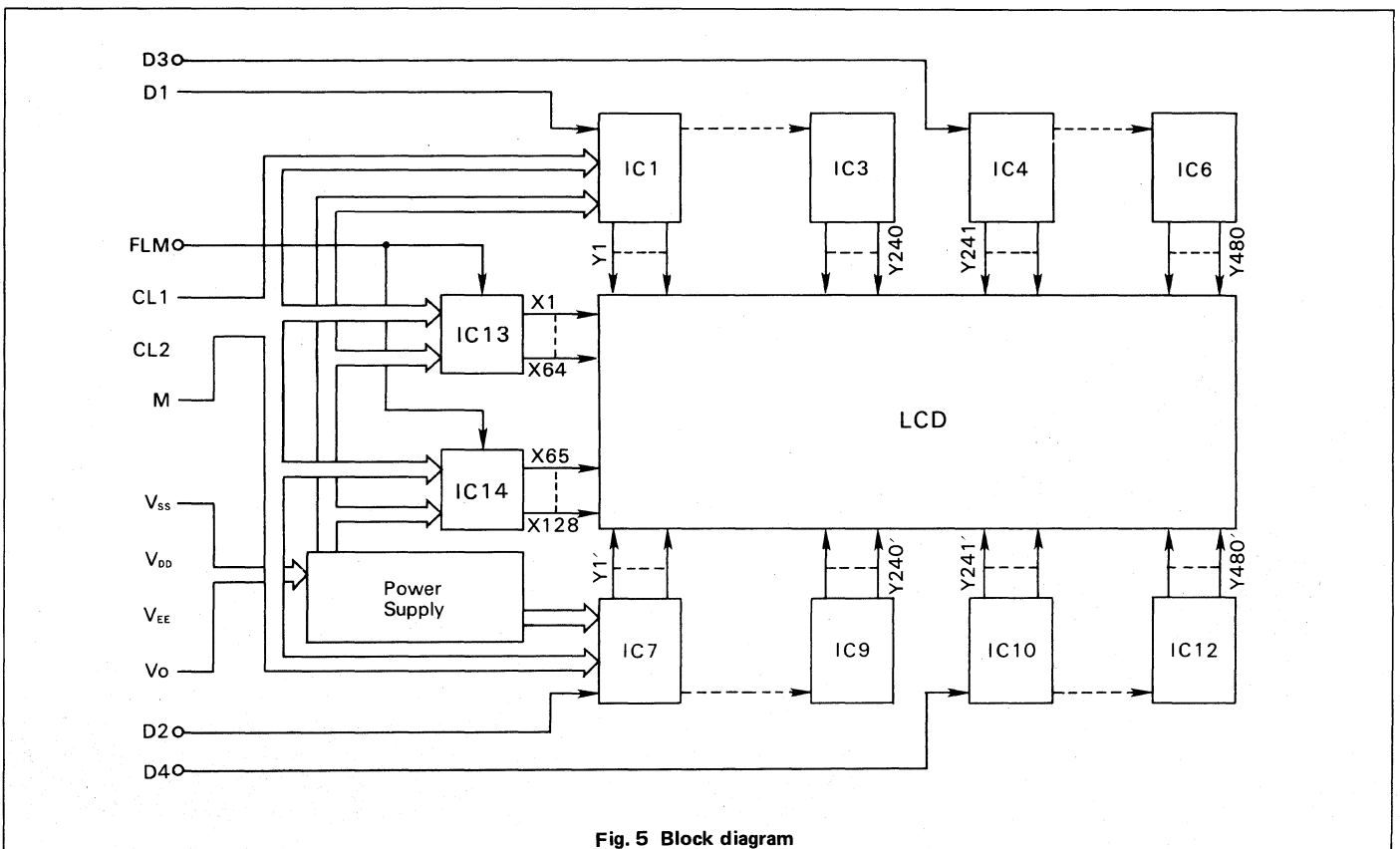
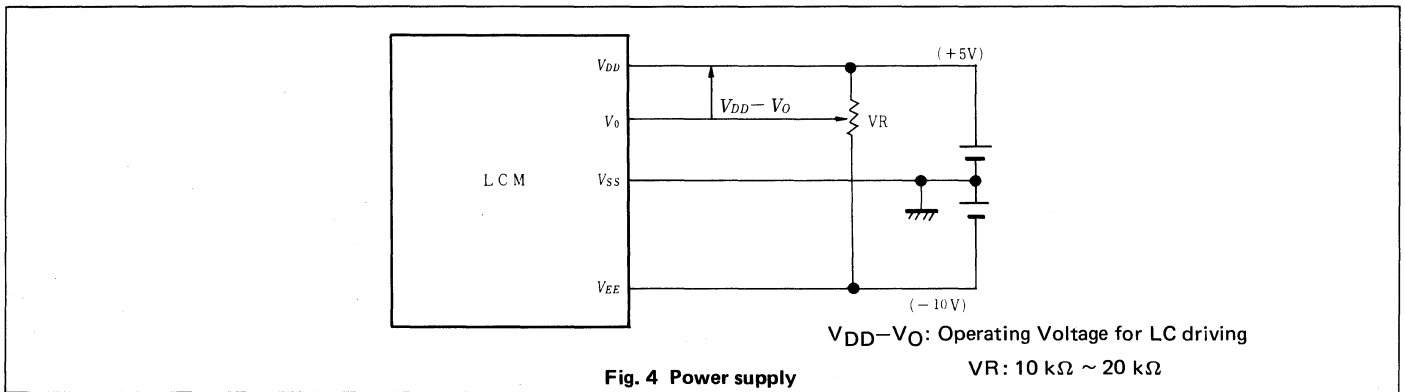
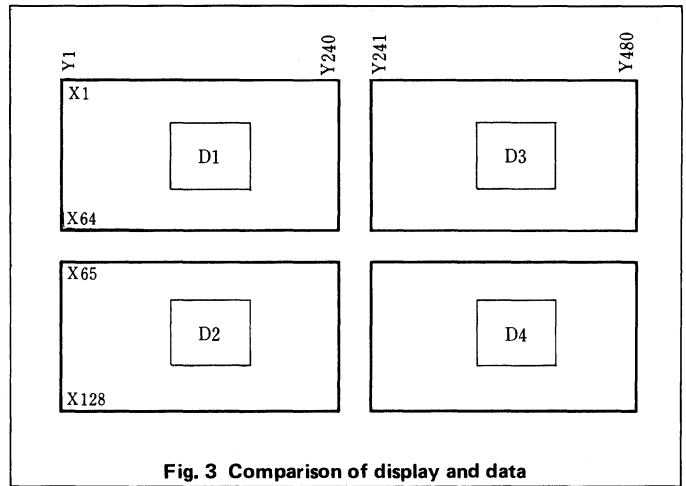
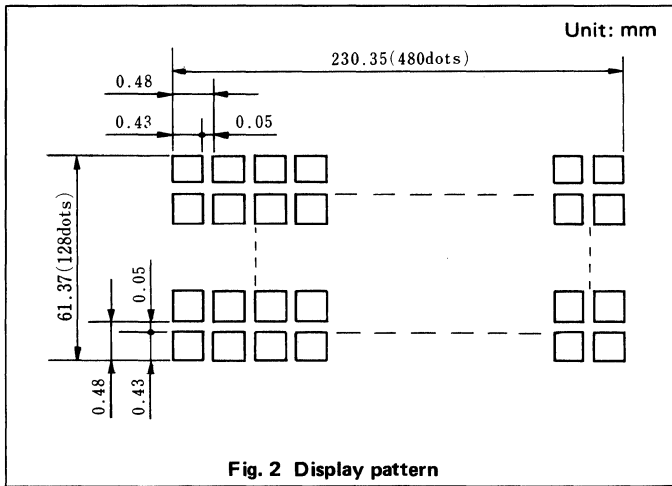


Fig. 7 Interface timing



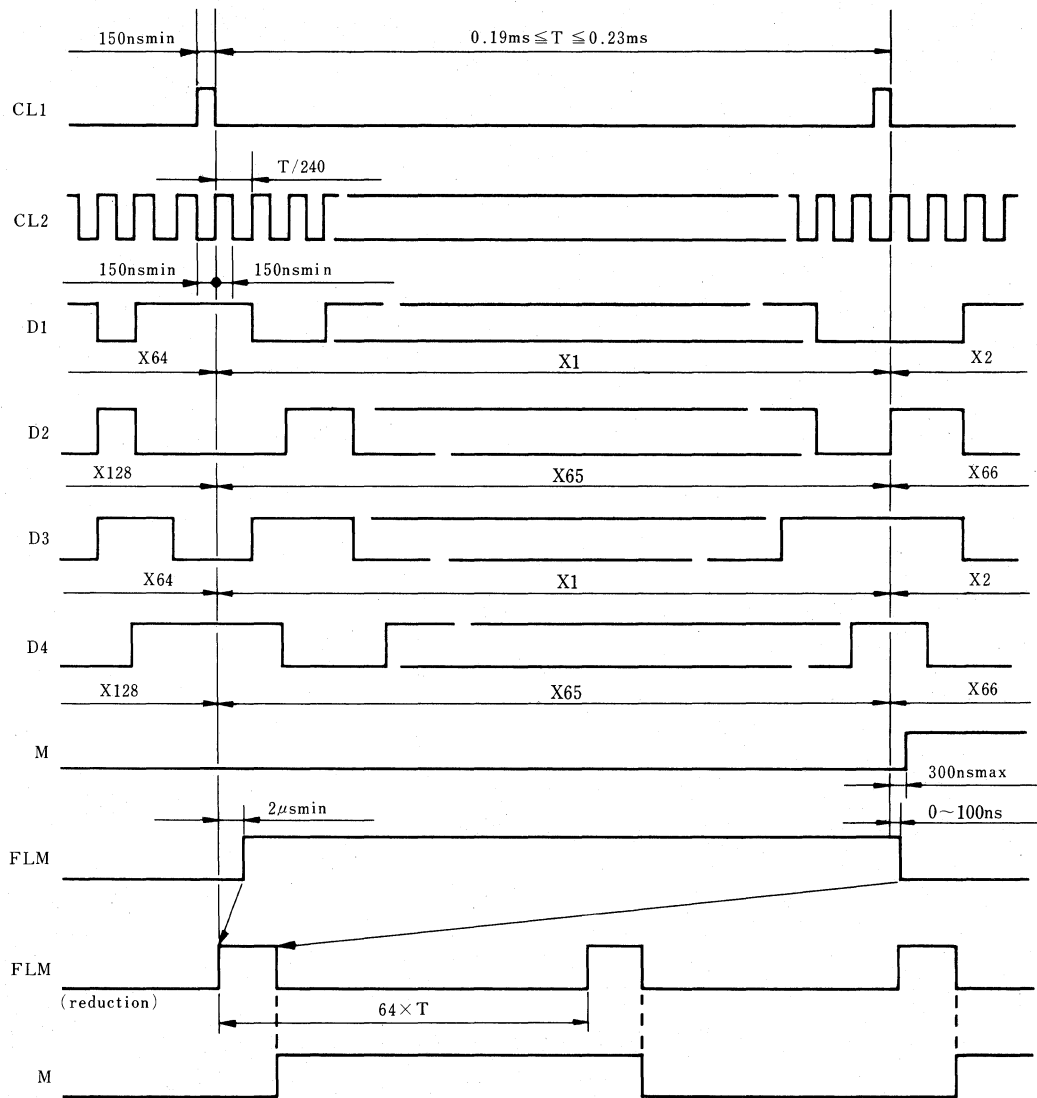


Fig. 6 Interface timing

TIMING CHARACTERISTICS

Item	Symbol	min.	typ.	max.	Unit
CL2 cycle time	t_{CYC}	810	—	—	ns
CL2 pulse width (H)	t_{CWH}	150	—	—	ns
CL2 pulse width (L)	t_{CWL}	150	—	—	ns
CL1 set up time (1)	t_{SCL1}	150	—	—	ns
CL1 set up time (2)	t_{HCL1}	150	—	—	ns
Clock rise/fall time	t_r, t_f	—	—	30	ns
Data set up time	t_{DSU}	100	—	—	ns
Data hold time	t_{DH}	100	—	—	ns
CL1 delay time	t_{CL}	150	—	—	ns
M delay time	t_{CM}	—	—	300	ns
FLM set up time	t_{FS}	100	—	—	ns
FLM hold time	t_{FH}	100	—	—	ns

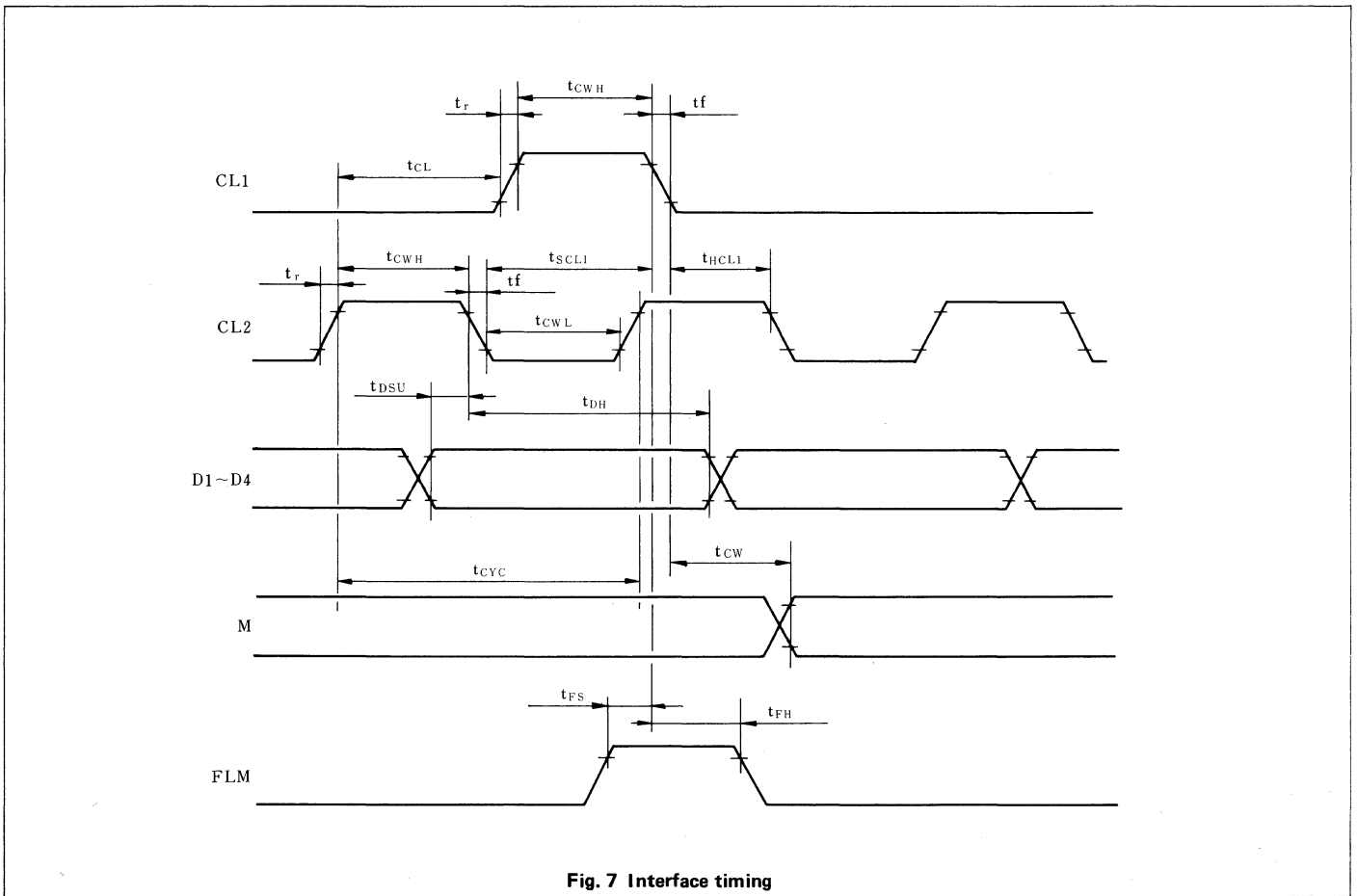


Fig. 7 Interface timing



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