

PREPARED BY: _____ DATE _____	SHARP LIQUID CRYSTAL DISPLAY GROUP SHARP CORPORATION SPECIFICATION	SPEC No. LC95705
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		APPLICABLE DIVISION
		☒ DUTY PANEL DEVELOPMENT CENTER ☐ TFT DEVELOPMENT CENTER ☐ LCD PRODUCTS DEVELOPMENT CENTER ☐ EL PRODUCT 10N DEPT.

SPECIFICATION FOR
Passive Matrix LCD Module

Model No.

LM162551

☐ CUSTOMER'S APPROVAL

DATE _____

BY _____

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1. Overview

The LM162551, dot-matrix LCD module consists of a combination of a 5 X 7-dot 16-character 2-line dot-matrix LCD panel, LCD driver and controller LSI mounted on a single PCB. Incorporating mask ROM-based character generator and display data RAM in the controller LSI, the module is capable of efficiently displaying the desired characters under microcomputer control.

(Features)

- (1) Power dissipation is extremely low because of the dot-matrix LCD panel and CMOS LSI.
- (2) With the LCD panel and driver mounted on a single PCB, the module is very thin for ease of tacking into appliances.
- (3) Allowing for being connected at general-purpose CMOS signal level, the module can be easily interfaced to a microcomputer with common 4-bit and 8-bit parallel inputs and outputs.
- (4) Internal character generator ROM and RAM and display data RAM:
 - Character generator ROM-
 - 5 X 7 dots, 160 kinds of characters
(alphanumeric and symbols)
 - Character generator --
 - 5 X 7 dots, 8 characters
(write capability by program)
 - Display data RAM-
 - 80 X 8 bits
- (5) Extensive instruction set:
 - Display clear, Cursor home, Display ON/OFF, Cursor ON/OFF, Blink character, Cursor shift, Display shift
- (6) Internal automatic reset circuit at power-on.
Refer to the separated users manual for the operating conditions.
- (7) Since the module operates from a single 5v power supply, it provides highly stable display over a wide range of temperature.

* As to the packing, refer to the separate
"COMMON PACKING SPECIFICATION FOR LM16255 series".

2. Construction and Outline

Construction : 5 X 7 dots + cursor, 16-character 2-lines
dot-matrix LCD module

Outline : See Fig.7.

Connection : See Table 5.

Character details : See Fig.7.

Character pattern : See Table 8.

There shall be no scratches, stains, chips, distortions and other external drawbacks that may affect the display function. Rejection criteria shall be noted in Inspection Standard (S-A-082).

3. Mechanical Specifications

Table 1

Parameter	Specification	Unit
Outline dimensions	84(W) X 44(H) X 11 MAX(D)	mm
Effective display area	61(w) X 15.8(H)	mm
Display format	16 characters X 2 lines	
Character format	5 X 7 dots with cursor	
Character size	2.96(w) X 4.86(H) (5 X 7 dots)	mm
Dot size	0.56(W) X 0.66(H)	mm
Dot spacing	0.04	mm
Character color	Dark blue	
Background color	White	
Weight	Approx. 28	g

4. Electrical Specifications

4.1 Absolute maximum ratings

Table 2

Parameter	symbol	Min.	Max .	Unit	Remark
Supply voltage(Logic)	VDD-VSS	-0.3	+6.5	v	
Supply voltage(LCD drive)	V0-VSS	0	+6.5	v	VDD>V0
Input voltage	VIN	-0.3	VDD+0.3	v	
Storage temperature	Tstg	-25	+70	"C	
Operating temperature	Topr	0	+50	"C	

4.2 Electrical characteristics

Table 3

(Ta=25°C)

Parameter		Symbo 1	Min.	Typ.	Max.	Unit	Conditions
Supply voltage(Logic)		VDD-VSS	4.75	5	5.25	v	
Supply voltage (LCD drive)		Vo -Vss	-	1	-	v	VDD=5V
Input voltage	"L"	VIL	-0.3	-	0.6	v	
	"H"	VIH	2.2	-	VDD	v	
output voltage	"L"	VOL			0.4	v	IOL=1.2mA
	"H"	VOH	2.4	-	-	v	-IOH=0.205mA
Input leakage current		IIL			1	uA	
Internal oscillating frequency		fosc	-	250	-	KHz	
Supply current (Logic)		IDD		1.6	2.2	mA	VDD= 5v Vo=0v
Power dissipation		Pd		a	11	mW	

4.3 Timing characteristics

Table 4

VDD=5.0V $\pm$ 5%
Ta=0~50°C

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

Timing chart: See Fig.1.

4.4 Pin Connections

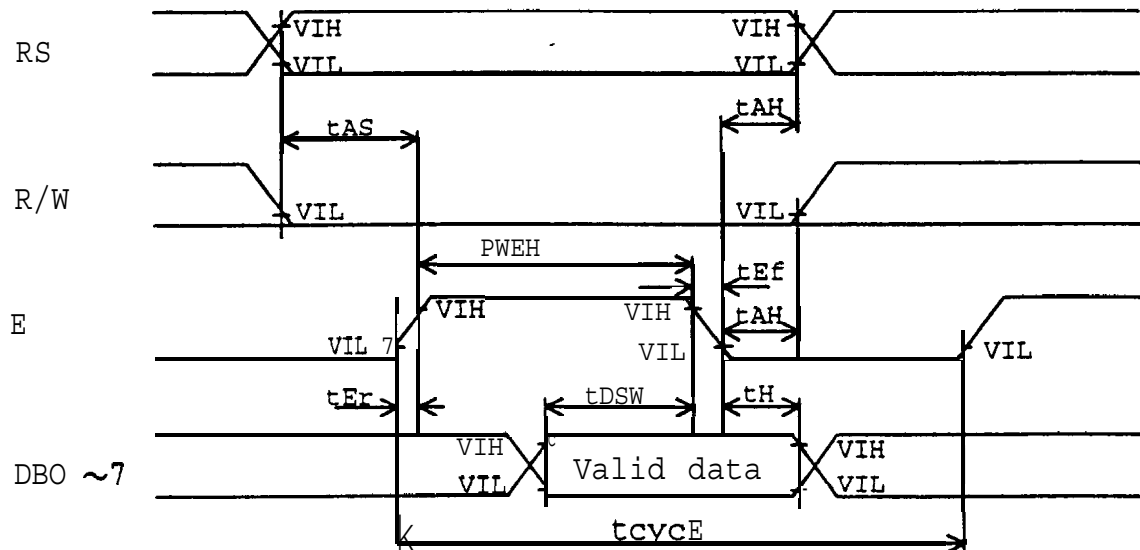
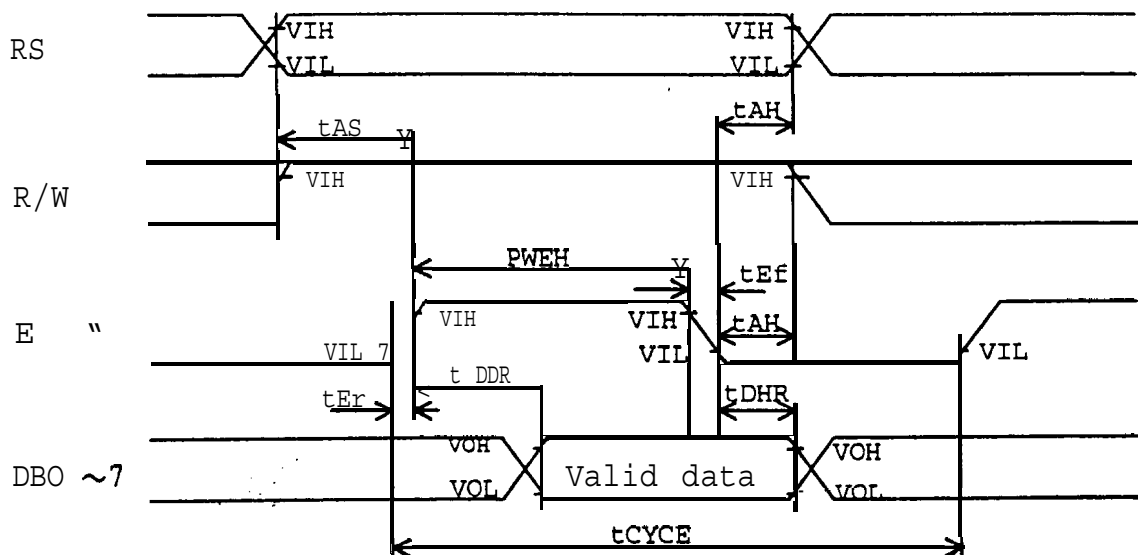
Table 5

Pin No.	Symbol	Description	Connection
1	VSS	Ground	IGND: 0V
2	VDD	Power supply (Logic)	+5V power supply
3	V0	Contrast adjustment vo 1 tage	Adjust contrast by supplying 0~5V.
4	RS	Register select pin	Control signal inputs (For details, refer to Paragraph 6 and 7.)
5	R/W	Read/write pin	
6	E	Enable pin	
7	DB0	Code 1/0 data LSB	Data bus line :DB7 doubles as busy flag output . :When the module is interfaced to a microcomputer with 4-bit parallel outputs, pins DB0~DB3 are not used. . (For details, refer to the paragraph 6 and 7.)
8	DB1	Code 1/0 data 2nd bit	
9	DB2	Code 1/0 data 3rd bit	
10	DB 3	Code 1/0 data 4th bit	
11	DB4	Code 1/0 data 5th bit	
12	DB 5	Code 1/0 data 6th bit	
13	DB6	Code 1/0 data 7th bit	
14	DB7	Code I/O data MSB	

4.5 Recommendable connector

Usable connector	Correspondable connector	Manufacturer
W-P5014	W-F1914	Showa Musen Kogyo K.K.
5267-14A	5264-14	Mo lex
FCN-724P014-AU/S	FCN-723J014/1	Fujitsu
65507-114	6539-023	Berg

*FCN-723J014/1 and 6539-023 are exchangeable.

Write OperationRead OperationFig.1 Timing Chart

S. Optical Characteristics

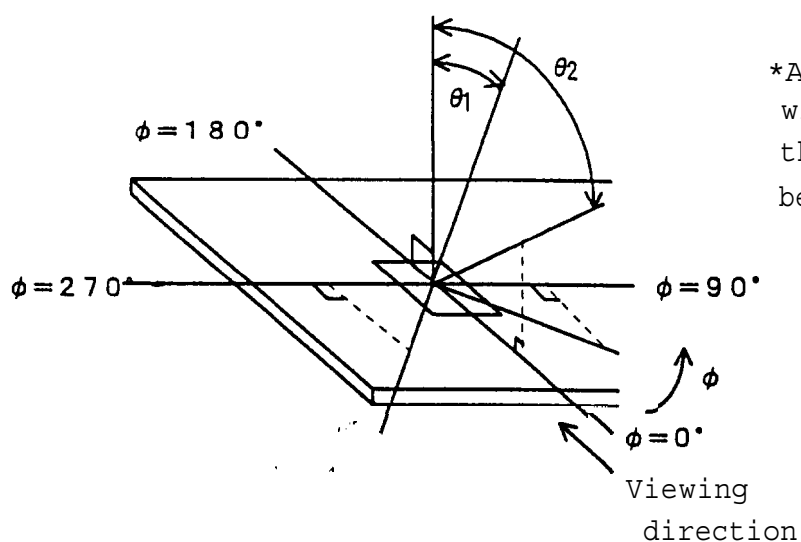
Table 6

VDD-V0=4.0V

Ta=25°C

Parameter	symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Viewing angle range	$\theta_2 - \theta_1$	$\phi = 0^\circ$	30	-	-	dgr .	Note 1
	θ_1	$\theta_1 < \theta_2$					
	θ_2						
	$\theta_2 - \theta_1$	$\phi = 45^\circ$	30	-	-	dgr .	Note 1
	θ_1	$\theta_1 < \theta_2$					
	θ_2						
Contrast ratio	co	$\theta = 15^\circ$	2	3	-	-	Note 2
Response time	Rise	tr		150	300	ms	Note 3
	Decay	td		200	400	ms	Note 3

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



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

Fig.2 Definition of viewing angle

Note 2) Contrast ratio is defined as follows:

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

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

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

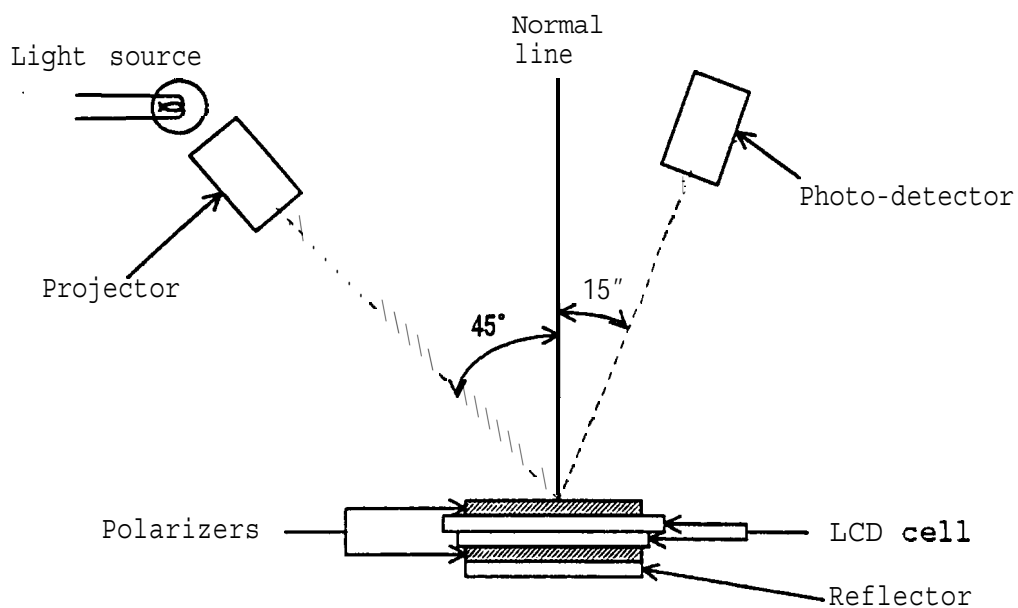


Fig.3 Optical Characteristics Test Method

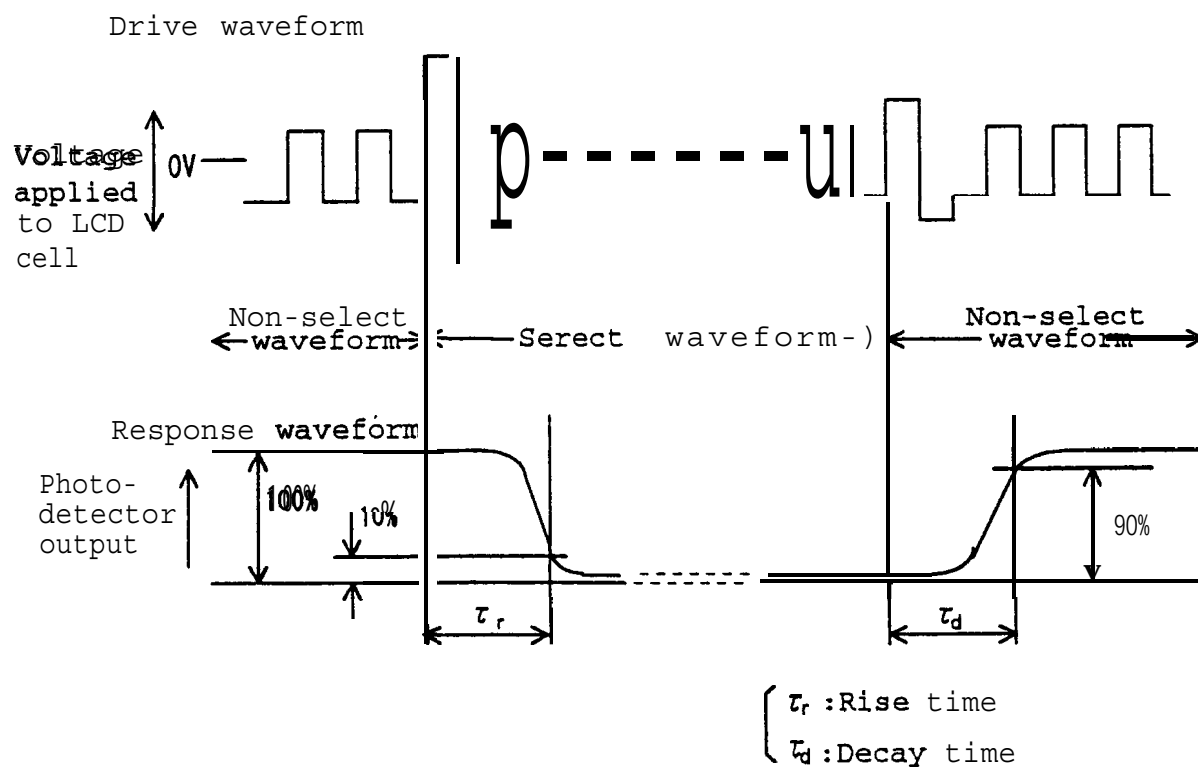


Fig.4 Definition of Response Time

6. Pin Description

1) VDD and VSS Pins

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

2) RS Pin

The controller LSI contains two 8-bit registers; instructions register (IR) and data register (DR) .

RS pin selects these registers. IR serves to store instruction codes for display clear, **shift, etc. and** address information for display data RAM (DD RAM), character generator RAM (CG RAM); DR serves to **temporarily** store data to be written into DD RAM and CG RAM.

" 0 " :Instruction register (write)

Busy flag register; address counter (read)

" 1 " :Data register (read/write)

3) R/W Pin

Read or write selection signal Pin.

" 0 " :Write

" 1 " : Read

4) E Pin

Data read or write operation enable signal pin.

5) DB0~DB7 Pins

Tri-state bi-directional data bus pins. The bus allows data to be transmitted to or received from the external circuit. DB7 serves also as busy flag output. When the module is interfaced to a microcomputer with 4-bit parallel outputs, DB0~DB3 pins are not used. :

6) Vo Pin

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

7. Instruction Set

Table 7

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

I/D=1:Increment

S □1":Shift display

D =1:Display ON

C =1:Cursor ON

B =1:Character at
cursor position
blinks.

I/D=0:Decrement

S =0:Freeze display

D =0:Display OFF

C =0:Cursor OFF

B =0:Character at
cursor position
unblinks.

S/C=1:Shift display

R/L=1:Shift right

DL=1:8-bit

BF=1:During internal
operation

S/C=0:Move cursor

R/L=0:Shift left

DL =0:4-bit

BF =0:End of Internal
operation

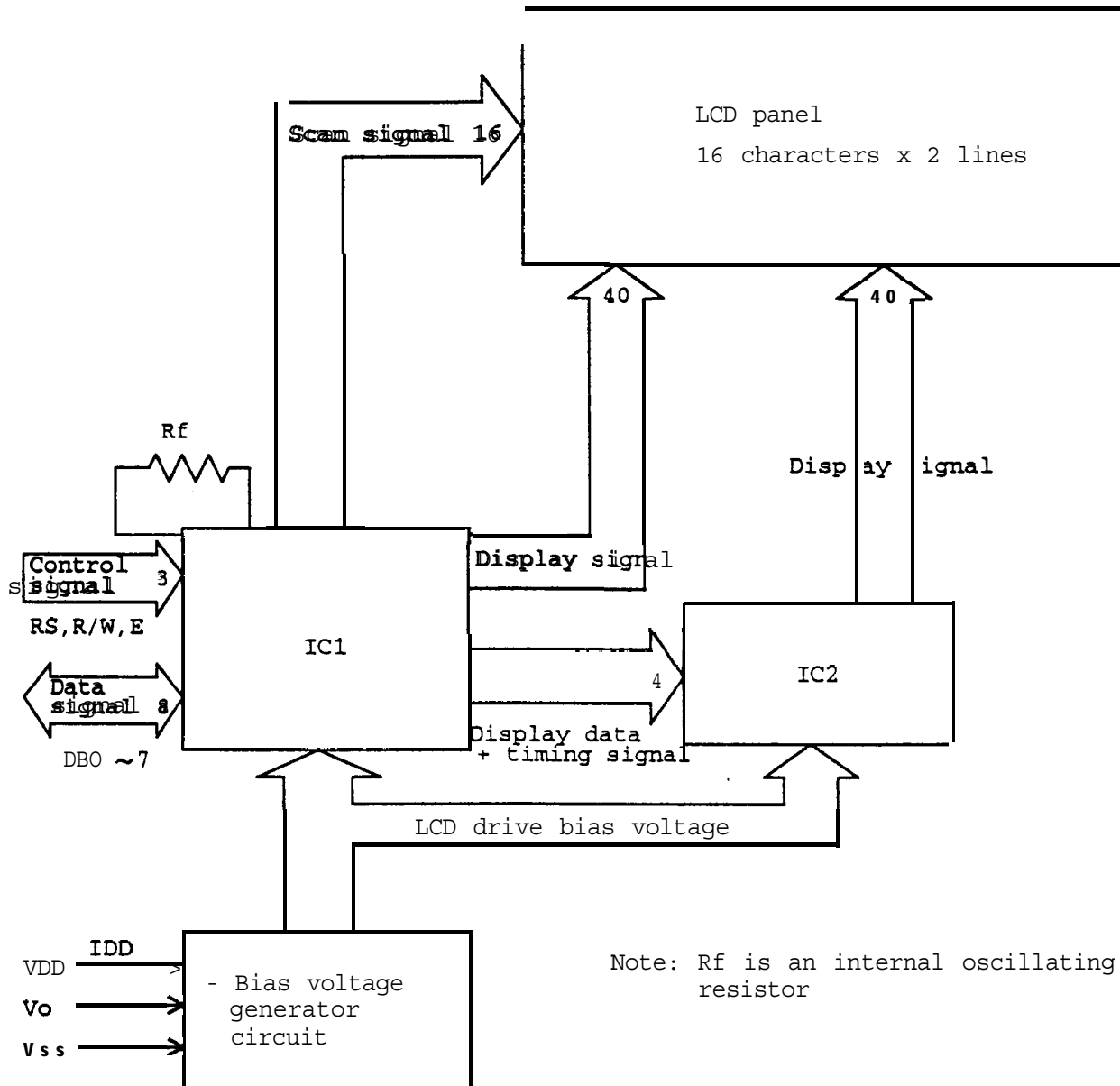


Fig. 5 Block Diagram

IC1:HD44780UA (HITACHI)
IC2:MSM5259 (OKI)

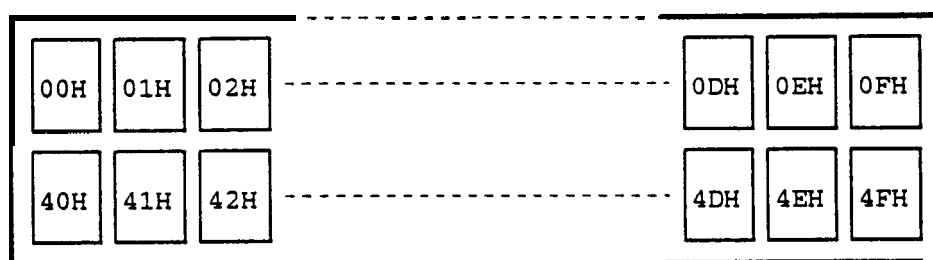


Fig.6 Display Address (When the display is not shifted)

8. Precautions

8.1 Angle when installing the module

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

$$\theta 1 < \text{viewing range} < \theta 2$$

(For the specific values of $\theta 1$, $\theta 2$, refer to the Table 6.)

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

8.2 Handling cautions

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

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

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

8.3 Notes on attachment

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

8.4 Notes on operation

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

8.5 Others

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

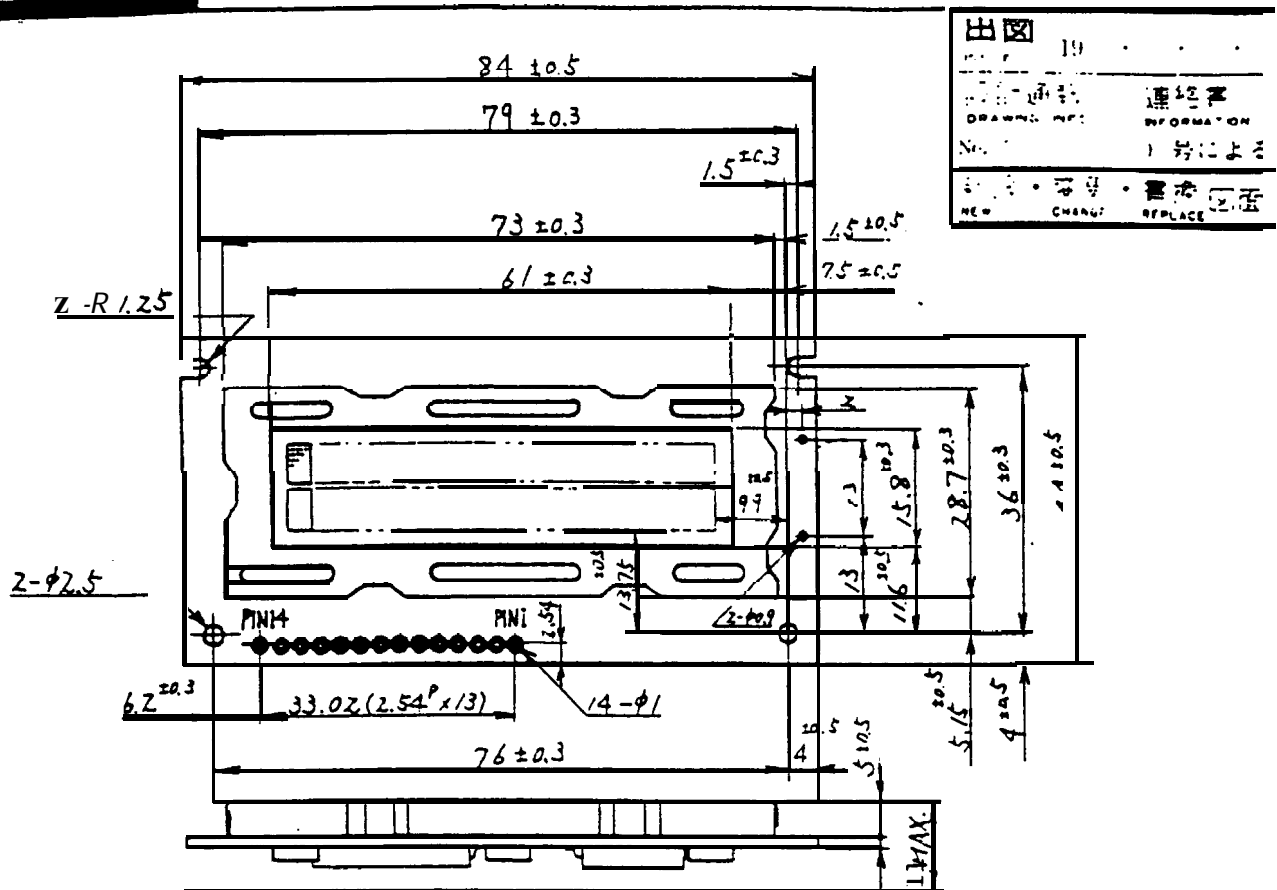
Table 8 Input Code vs. Character Pattern

*1 *2 4bit	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)		0	1	2	3	4	5	6	7	8	9	*
xxxx0001	(2)		1	2	3	4	5	6	7	8	9	*	
xxxx0010	(3)		"	2	3	4	5	6	7	8	9	*	0
xxxx0011	(4)		#	3	4	5	6	7	8	9	*	1	
xxxx0100	(5)		\$	4	5	6	7	8	9	*	2		
xxxx0101	(6)		%	5	6	7	8	9	*	3			
xxxx0110	(7)		&	6	7	8	9	*	4				
xxxx0111	(8)		'	7	8	9	*	5					
xxxx1000	(1)		(	8	9	*	6						
xxxx1001	(2)		)	9	*	7							*
xxxx1010	(3)		*										*
xxxx1011	(4)		+										*
xxxx1100	(5)		,										*
xxxx1101	(6)		-										*
xxxx1110	(7)		.										*
xxxx1111	(8)		/										*

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

Note 2. X mark: prohibition of input

*1 High-order *2 Low-order



序	符号
1	V_{SS}
2	V_{DD}
3	V_o
4	RS
5	R/W
6	E
7	DB ₀
8	DB ₁
9	DB ₂
10	DB ₃
11	DB ₄
12	DB ₅
13	DB ₆
14	DB ₇

```
* Pin No.
** Display signal
```

Character Pattern
Details
(S = 5/1)

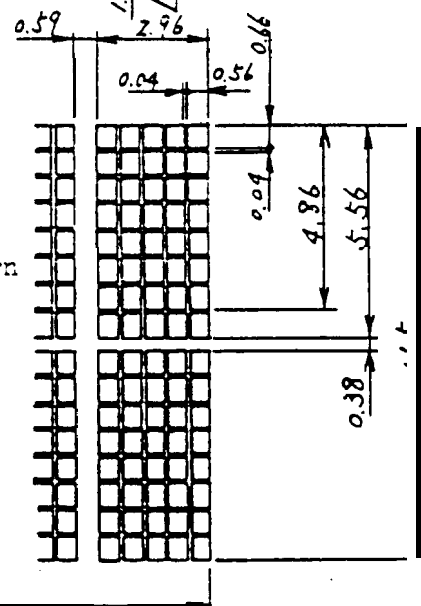


Fig.7 Module Outline Dimension.

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△ 19 . .				LM 16255/		名 稱 NAME	Outline Dimensions and Pin Connections
△ 19 . .				LM 16255			
年 月 日 DATE		訂 正 記 事 REVISION		設計No. DESIGN NO.	用 出 PREPARED	通 用 機 種 MODEL	
材 質 MATERIAL		厚 度 THICKNESS	材 質 FINISH		尺 度 SCALE		記 號 SYMBOL
					1/1		
						部 品 代 號 PARTS CODE	
設 計 DESIGN	檢 查 CHECK	檢 查 CHECK	檢 查 CHECK	檢 查 CHECK	SHARP CORPORATION		年 月 日 DATE
神 戶		野 村	中 村	中 村	SHARP CORPORATION		年 月 日 DATE
					Display Division		部 品 代 號 PARTS CODE
					樣式図 44-A 4		0D16255-0012

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			ISSUE Apr. 8, 1988
			PAGE 16 Pages
		REPRESENTATIVE DIVISION ☐ IC DIV. ☐ SEMICONDUCTOR APPLICATION DIV. ☒ LCD DIV. ☐ ELECTRONIC COMPONENTS DIV. a	

DEVICE SPECIFICATION FOR

Dot Matrix LCD Unit
(16-character/2-line Display
built in a LED backlight)

MODEL No.

LM16X21A

☐ CUSTOMER' S APPROVAL

DATE _____

BY _____

PRESENTED

BY

H. Nakajima

H. Nakajima
Department General Manager
Engineering Department
LCD Division
ELECOM Group
SHARP CORPORATION

SHARP

LM16X21A

1. Overview

The LM16X21A, dot-matrix LCD unit consists of a 5 x 7-dot 16-character 2-line dot-matrix LCD panel, LCD driver, controller LSI and yellow green backlight LED fabricated on a single PCB. Incorporating mask ROM-based character generator and display data RAM in the controller LSI, the unit can efficiently display the desired characters under microprocessor control. LCD is positive type.

(Features)

- (1) The LCD of the unit is STHC (Super Twisted High Contrast) yellow green transmissive type.
 - (2) Low power consumption with the dot-matrix LCD panel and CMOS LSI. Built-in backlight LED with high luminance and stable radiation.
 - (3) Thin, lightweight design permits easy installation in a variety of equipment.
 - (4) Allowing for being connected at general-purpose CMOS signal level, the unit can be easily interfaced to a microprocessor with common 4-bit and 8-bit parallel inputs and outputs.
 - (5) Built-in character generator ROM and RAM, and display data RAM:
 - Character generator ROM
 - 160 different 5 x 7 dot-matrix character patterns
 - (Alphanumeric and symbols)
 - Character generator RAM
 - 8 different user programmed 5 x 7 dot-matrix patterns
 - Display data RAM
 - 80 x 8 bits
 - (6) Numerous instructions
 - Display clear, Cursor home, Display ON/OFF, Cursor ON/OFF, Blink character, Cursor shift, Display shift
 - (7) Built-in reset circuit is triggered at power ON.
 - (For the operating conditions, refer to the separate user's manual "Dot-Matrix LCD Units with built-in controllers".)
 - (8) The unit operates from a single 5V power supply.
- * As to the packing, refer to the separate "COMMON PACKING SPECIFICATION FOR LM16255 series".

SHARP**2. Construction and Outline**

Construction : 5 x 7 **dots** + cursor, 16-character 2-line **dot-matrix** display unit (Built-in Yellow-green backlight LED, **positive type**)

Outline : See Fig. 1.

Interface signals : See Table 5.

Character pattern details : See Fig. 7.

Character codes : See Table 9.

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

Rejection criteria shall be noted in Inspection Standard (S-U-009).

3. Mechanical Specifications**Table 1**

Parameter	Specification	Unit
Outline dimensions	84(W) X 44(H) X16 MAX(D)	mm
Effective display area	61(W) X 15.8(H)	mm
Display format	16 characters X 2 lines	
Character format	5 X 7 dots with cursor	
Character size	2.96(W) X 4.86(H) (5 X 7 dots)	mm
Dot size	0.56(W) X 0.66(H)	mm
Dot spacing	0.04	mm
Character color *	Dark blue	
Backlight color	Yellow green	
Weight	Approx. 40	g

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

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4. Electrical Specifications

4.1 Absolute maximum ratings

Table 2

Parameter	Symbol	Min.	Max.	Unit	Remark
Supply voltage (Logic)	$V_{DD}-V_{SS}$	-0.3	+6.5	V	
Supply voltage (LCD drive)	V_O-V_{SS}	0	+6.5	V	$V_{DD}>V_O$
Supply current (Backlight LED)	I_{LED}		240	mA	$T_a=25^{\circ}\text{C}$
Input voltage	V_{IN}	-0.3	$V_{DD}+0.3$	V	
Storage temperature	T_{stg}	-25	+70	$^{\circ}\text{C}$	
Operating temperature	T_{opr}	0	+50	$^{\circ}\text{C}$	
Reverse voltage (Backlight LED)	$V_{LED}-V_{LSS}$	-5	-	V	

4.2 Electrical characteristics

Table 3

($T_a = 25^{\circ}\text{C}$)

Parameter		Symbol	Min.	Typ.	Max.	Unit	Condition
Supply voltage (Logic)		$V_{DD}-V_{SS}$	4.75	5.0	5.25	V	
Supply voltage (LCD drive)		V_O-V_{SS}		0.65		V	$V_{DD}=5.0\text{V}$
Input voltage	" L "	V_{IL}	-0.3		0.6	V	
	" H "	V_{IH}	2.2		V_{DD}	V	
Output voltage	" L "	V_{OL}	-		0.4	V	$I_{OL}=1.2\text{mA}$
	" H "	V_{OH}	2.4			V	$-I_{OH}=0.205\text{mA}$
Input leakage current		I_{IL}			f	μA	
Internal oscillating frequency		f_{osc}		250		KHz	
Supply current		I_{DD}		1.6	2.2	mA	$V_{DD}=5\text{V}, V_O=0\text{V}$
		I_{LED}		120	180	mA	$V_{LED}-V_{LSS}=5.0\text{V}$
Power dissipation		P_d		608	911	mW	$V_{DD}=5\text{V}, V_O=0\text{V}$
							$V_{LED}-V_{LSS}=5.0\text{V}$
Supply voltage (Backlight LED)		$V_{LED}-V_{LSS}$	4.75	5.0	5.25	V	

* Note. After over 30 minutes since backlight begin lighting.

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4.3 Timing characteristics

Table 4

 $V_{DD}=5.0V \pm 5\%$ $T_a = 0 \sim 50^\circ C$

Parameter	Symbol	Min.	Typ.	Max.	Unit
Enable cycle time	t_{cycE}	1000	-	-	ns
Enable pulse width	P_{WEH}	450	-	-	ns
Enable rise/fall time	t_{Er}, t_{Ef}	-	-	25	ns
KS, R/W setup time	t_{AS}	140	-	-	ns
Address hold time	t_{AH}	10	-	-	ns
Data setup time	t_{DSW}	195	-	-	ns
Data delay time	t_{DDR}	-	-	320	ns
Data hold time(write)	t_{H}	10	-	-	ns
Data hold time(read)	t_{DHR}	20	-	-	ns

Timing chart: See Fig. 1.

4.4 Interface signals

Table 5

Pin No.	Symbol	Description	Connection
1	V_{SS}	Ground potential	GND : 0V
2	V_{DD}	Power supply	+5V
3	V_0	Contrast adjustment voltage	Adjust the contrast by changing the supply voltage from 0V to 5V.
4	KS	Register select signal	Control signal inputs (For details, see section 6 and 7.)
5	R/W	Read/write select signal	
6	E	Operation (data read/write enable signal)	
7	DB_0	Code I/O data LSB	Data bus line DB_7 may also be used to check the busy flag. Lines $DB_0 \sim DB_3$ are not used when interfacing with a 4-bit microprocessor. (For details, see section 6 and 7.)
8	DB_1	Code I/O data 2nd bit	
9	DB_2	Code I/O data 3rd bit	
10	DB_3	Code I/O data 4th bit	
11	DB_4	Code I/O data 5th bit	
12	DB_5	Code I/O data 6th bit	
13	DB_6	Code I/O data 7th bit	
14	DB_7	Code I/O data MSB	5V power supply between V_{LED} and V_{ISS} .
15	V_{LED}	Power supply(+)	
16	V_{ISS}	Power supply (-)	

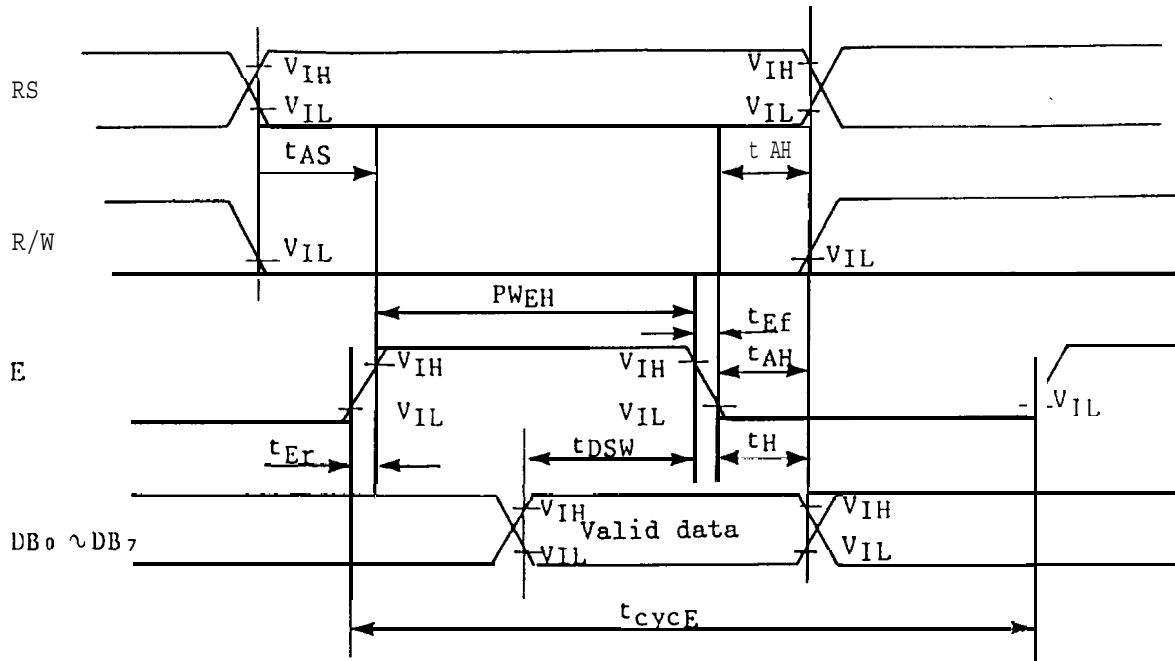
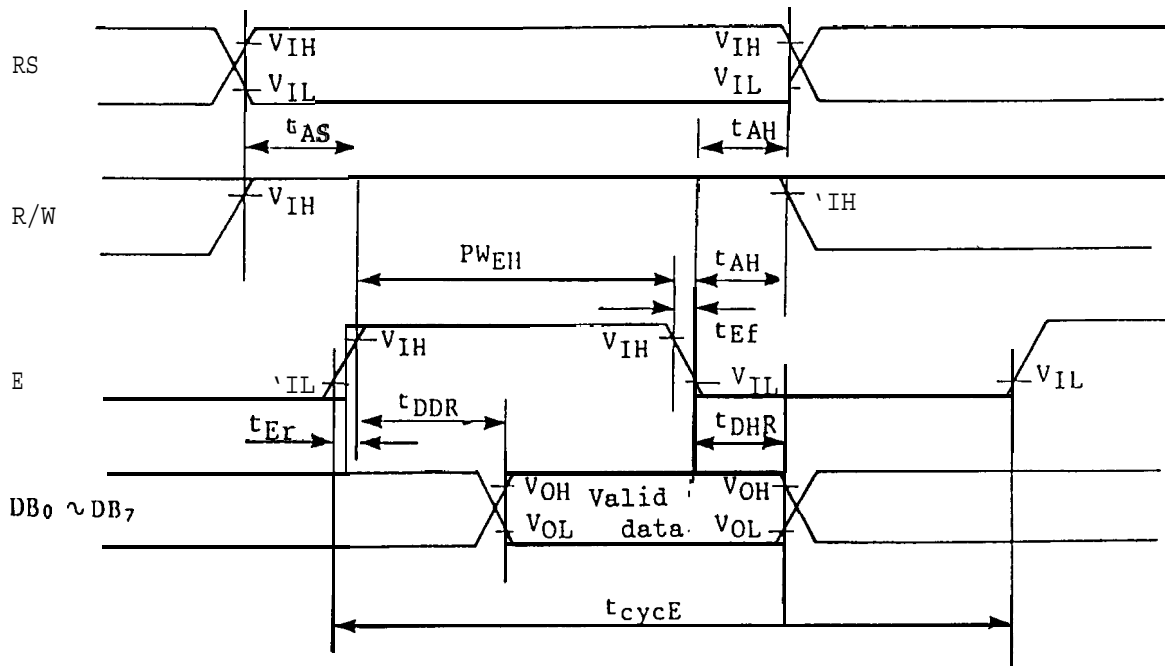
SHARPWrite OperationRead Operation

Fig. 1 Timing Chart