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APPROVED BY: _____ DATE _____		FILE No. _____ ISSUED Jul.21.1995 PAGE 16 Pages APPLICABLE DIVISION <input checked="" type="checkbox"/> DUTY PANEL DEVELOPMENT CENTER <input type="checkbox"/> ITFT Development CENTER <input type="checkbox"/> LCD PRODUCTS DEVELOPMENT CENTER <input type="checkbox"/> IEL PRODUCTION DEPT.
	SPEC I F I CAT 10N	

SPEC I F I CAT 10N FOR
 Passive Matrix LCD Module

Model No.
LM16A211

CUSTOMER'S APPROVAL

DATE _____

BY _____

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RECORDS OF REVISION				SPEC No. LC 95704	MODEL No. LM16A211
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IDENT. DATA No.					
DATA	SPEC REVI SED No.	REVI SED No.	REF. PAGE	SUMMARY	CHECK & APPROVAL
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I. Overview

The **LM16A211**, dot-matrix LCD module consists of a 5 × 7-dot 16-character 2-line dot-matrix LCD panel, LCD driver and controller LSI fabricated on a single **PCB**.

Incorporating mask ROM-based character generator and display data RAM in the controller LSI, the module can efficiently display the desired characters under microprocessor control.

(Features)

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

RAM:

Character generator ROM

160 different 5 X 7 dot-matrix character patterns

(**Alphanumeric** and symbols)

Character generator RAM

8 different user programmed 5 X 7 dot-matrix patterns

Display data RAM

'80 X 8 bits

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

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

2. Construction and Outline

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

Outline : See Fig.7.

Interface signals : See Table 5.

Character pattern details : See Fig.7.

Character codes : 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-U-012-01).

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	10.56(w) X 0.66(H)	mm
Dot spacing	0.04	mm
Character color *	Dark blue	
Background color *	Gray	
Weight	Approx. 28	g

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

4. Electrical Specifications

4.1 Absolute maximum ratings

Table 2

Parameter	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	Symbol	Min.	Typ.	Max.	Unit	Condition	
Supply voltage(Logic)	VDD-VSS	4.75	5	5.25	v		
Supply voltage (LCD drive)	Vo -Vss	-	0.5	-	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	IDD	-	1.6	2.2	mA	VDD=5V Vo=ov	
Power dissipation	Pd	-	8	11	mW		

4.3 Timing characteristics

Table 4

VDD=5.0V±5%
Ta=0~50°C

Parameter	Symbol	Min.	Typ.	Max.	Unit
Enable cycle time	t _{cyce}	1000			ns
Enable pulse width	PWEH	450			ns
Enable rise/fall time	t _{Er} , t _{Ef}			25	ns
RS,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

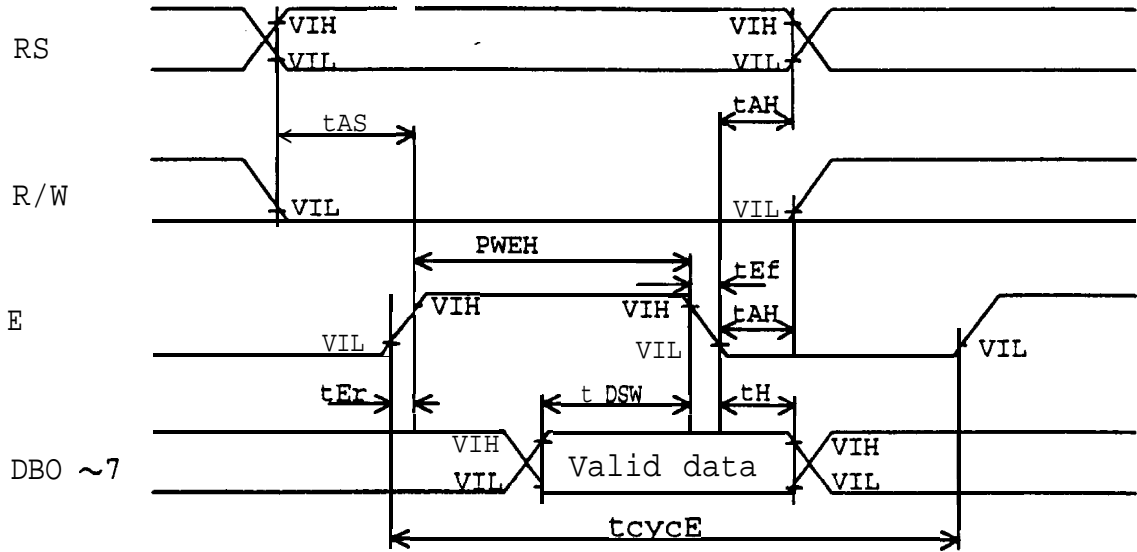
Timing chart: See Fig.1.

4.4 Interface signals

Table 5

Pin No.	Symbol	Description	Connection
1	VSS	Ground potential	GND: 0V
2	VDD	Power supply	+ 5V
3	V0	Contrast adjustment voltage	Adjust the contrast by changing the Supply voltage from 0V to 5V.
4	RS	Register select signal	Control signal inputs (For details, see section 6 and 7.)
5	R/W	Read/write select. signal	
6	E	Operation(data read/write enable signal)	
7	DB0	Code 1/0 data LSB	Data bus line :DB7 may also be used to check the busy flag. :Lines DB0~DB3 are not used when interfacing with a 4-bit microprocessor. (For details, see section 6 and 7.)
8	DB1	Code 1/0 data 2nd bit	
9	DB2	Code 1/0 data 3rd bit	
10	DB3	Code 1/0 data 4th bit	
11	DB4	Code 1/0 data 5th bit	
12	DB5	Code 1/0 data 6th bit	
13	DB6	Code 1/0 data 7thbit	
14	DB7	Code 1/0 data MSB	

Write Operation



Read Operation

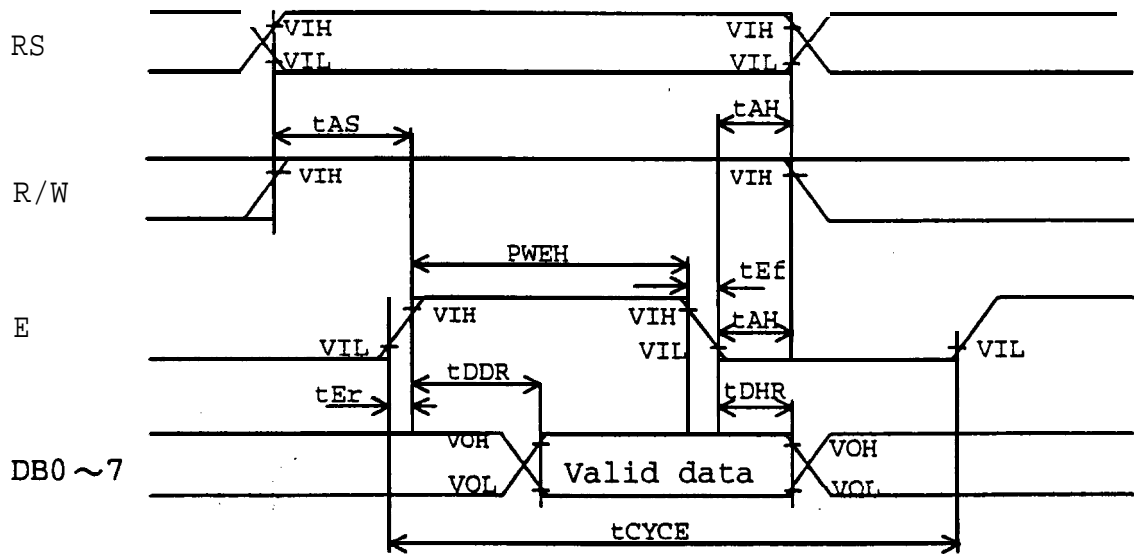


Fig.1 Timing Chart

5. Optical Characteristics

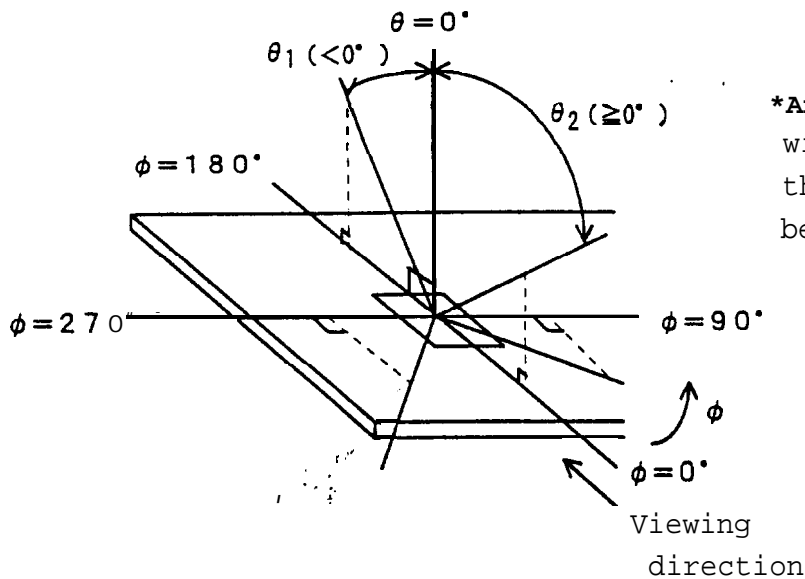
Table 6 shows the optical characteristics when LCD drive voltage is adjusted to the maximum contrast in $\theta=0^\circ$.

Table 6

(Ta=25°C)

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

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



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

Fig 2 Definition of viewing angle

Note 2) Contrast ratio is defined as follows:

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

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

Measurement wave length $\lambda = 580 \text{ nm}$

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.

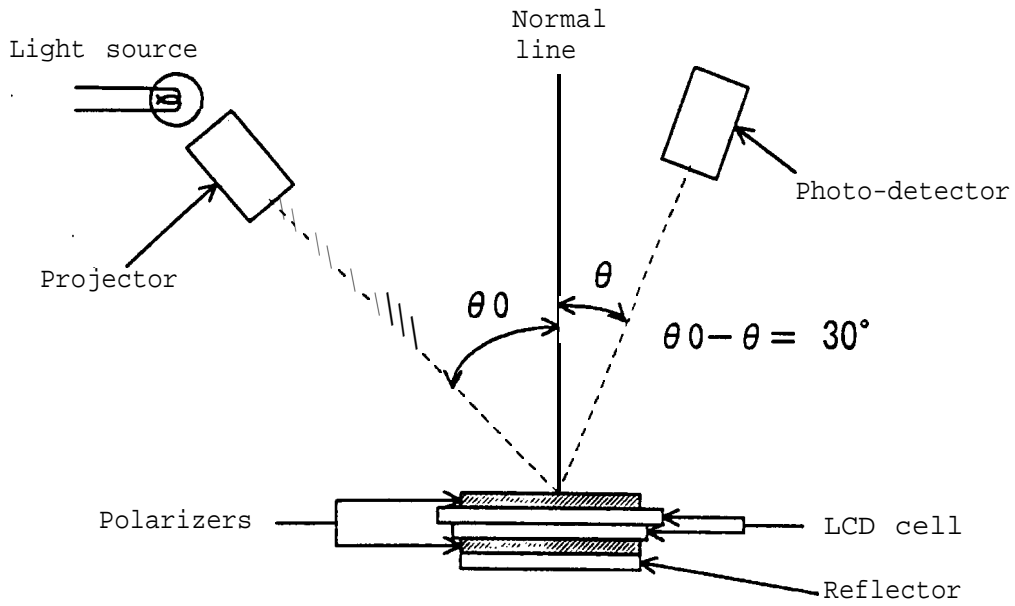


Fig.3 Optical Characteristics Test Method

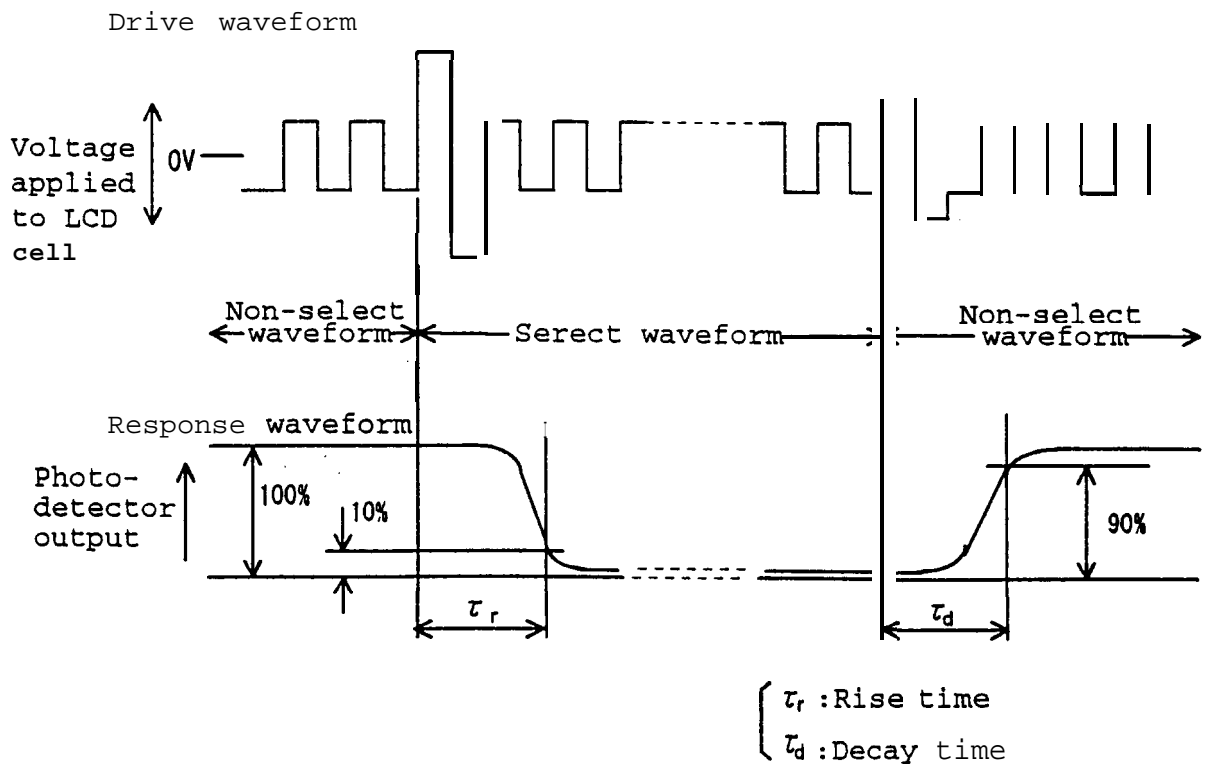


Fig.4 Definition of Response Time

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 hi-directional data bus **pins.** The bus allows data to be transmitted to or received from the external circuit. DB7 series 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 content: of address counter.	
CG RAM/DD RAM data write	1	0	Write data							Write data to CG RAM or DD RAM.	
CG RAM/DD RAM data read	1	1	Read data							Read data from CG RAM or DD RAM.	

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

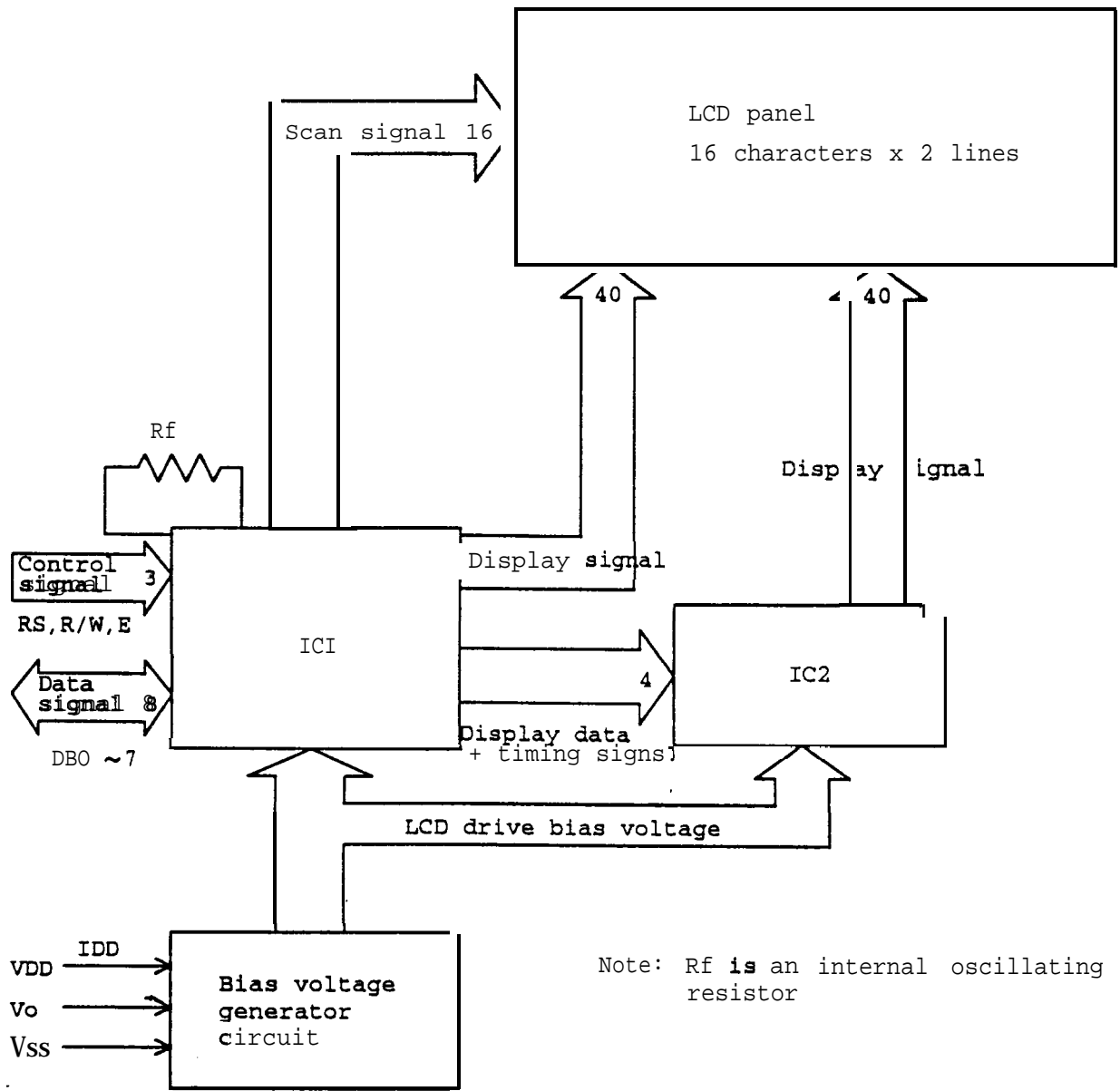


Fig.5 Block Diagram

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

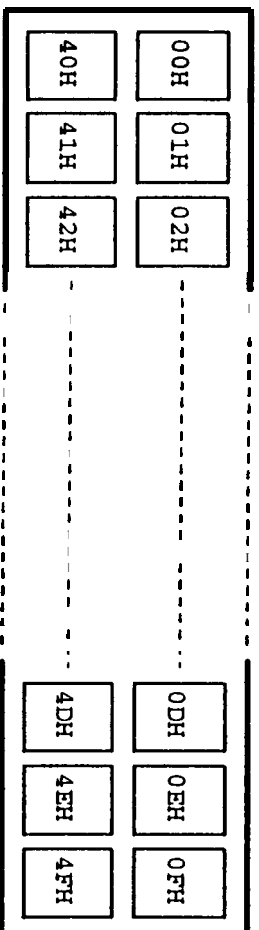


Fig. 6 Display Address (When the display is not shifted).

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8. Precautions

8.1 Angle when installing the module

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

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

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

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

8.2 Handling cautions

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

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

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

8.3 Notes on attachment

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

8.4 Notes on operation

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

8.5 "Others

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

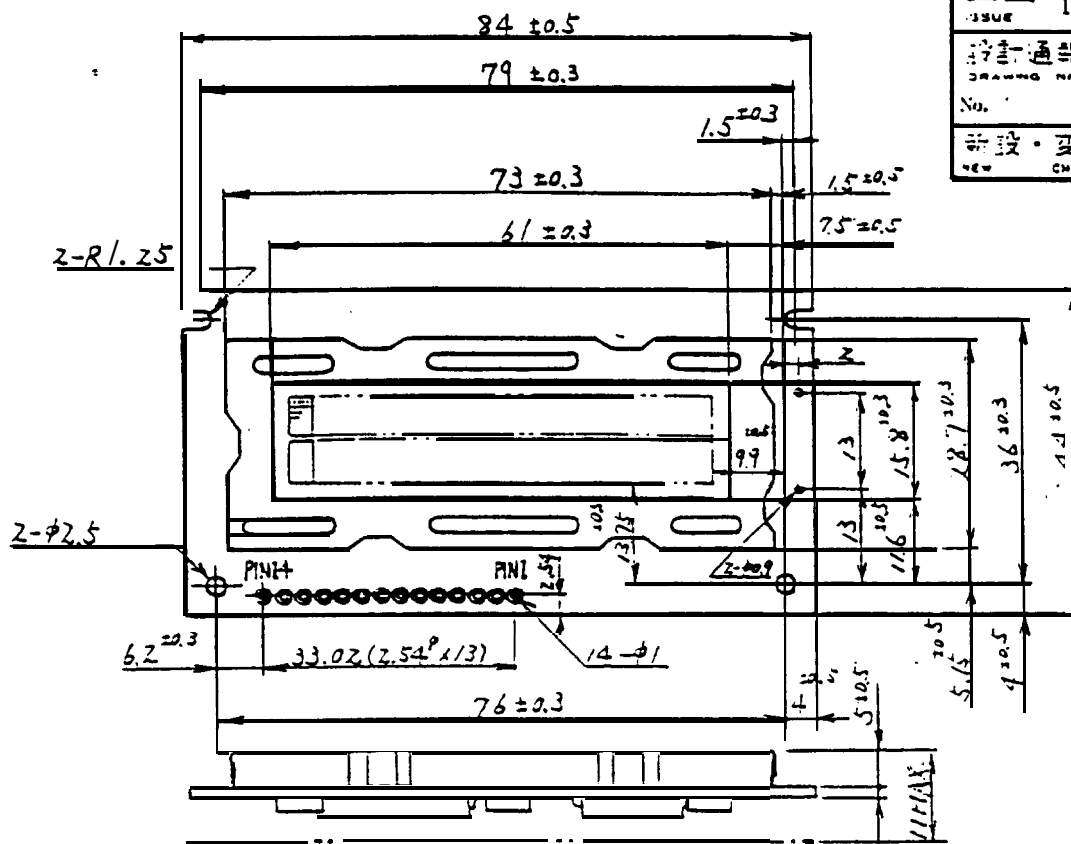
Table 8 Input Code vs. Character Pattern

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

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

Note 2. X mark: prohibition of input

*1 High-order *2 Low-order

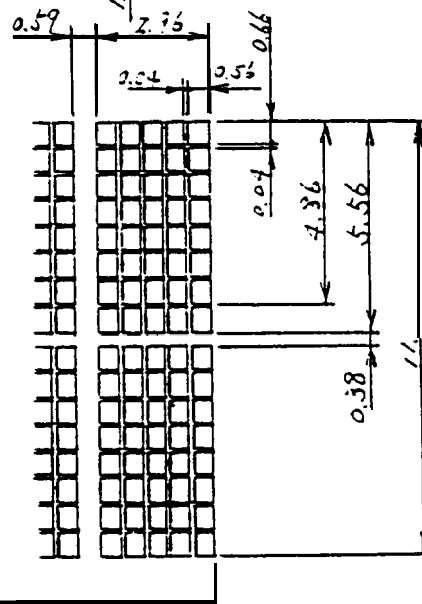


出図	19
設計種別	連絡書
DRAWING NO.	INFORMATION
No.	171255
新設・変更・替換図面	NEW CHANGE REPLACE

*	**
1	V _{SS}
2	V _{DD}
3	V ₂
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 tie.
**Display signal

Character Pattern Details
(S=5/1)



19 . .		LM16A21		指示なき場合は公差は UNSPECIFIED TO BE	
19 . .		LM16Z55		NAME	
年月日		訂正記号		Outline Dimensions and Pin Connections	
MATERIAL		THICKNESS		FINISH	
SCALE		1/1		SYMBOL	
PARTS CODE		DATE		1985 . 3 . 4 .	
SHARP CORPORATION				7916Z55-0012	
LCD Division				図面番号	
株式会社 シャープ				図式総 44-A1	

Fig. 7 Module Outline Dimension.