

PREPARED BY: _____	DATE _____	<h1>SHARP</h1> <p>ELECTRONIC COMPONENTS GROUP SHARP CORPORATION</p> <h2>SPECIFICATION</h2>	SPEC No. LC63607
APPROVED BY: _____	DATE _____		FILE No. _____
_____			ISSUE Jun. 9, 1988
_____			PAGE 16 Pages
			REPRESENTATIVE DIVISION <input type="checkbox"/> IC DIV. <input type="checkbox"/> SEMICONDUCTOR APPLICATION DIV. <input checked="" type="checkbox"/> LCD DIV. <input type="checkbox"/> ELECTRONIC COMPONENTS DIV. 0

DEVICE SPECIFICATION FOR

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

MODEL No. LM40X21 B

CUSTOMER'S APPROVAL

DATE _____

BY _____

PRESENTED
BY H. Nakajima

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

SHARPLM40X21B1. Overview

The **LM40X21B**, dot-matrix LCD unit consists of a 5 x 7-dot 40-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 negative type.

(Features)

- (1) The LCD of the unit is **STHC (Super Twisted High Contrast) violetnegative** 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 **these separate** user's manual "Dot-Matrix LCD Units with built-in control lers".)
- (8) The unit operates from a single 5V power supply.

,* As to the **packing**, refer to the separate
"COMMON PACKING SPECIFICATION FOR LM402A01 series".

↓

SHARP

2. Construction and Outline

Construction : 5 x 7 dots + cursor, 40-character 2-line dot-matrix display unit (Built-in Yellow-green backlight LED, negative type)

Outline : See Fig. 7.

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.

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

3. Mechanical Specifications

Table 1

Parameter	Specification	Unit
Outline dimensions	182(W) X 33.5(11) x16 MAX(D)	mm
Effective display area	154.4(W) X 15.8(11)	mm
Display format	40 characters X 2 lines	
Character format	5 X 7 dots with cursor	
Character size	3.2(W) X 4.85(11)(5 X 7 dots)	mm
Dot size	0.6(W) X 0.65 (H)	mm
Dot spacing	0.05	mm
Character color *	Yellow green	
Background color*	Dark blue	
Weight	Approx. 90	g

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

SHARP4. 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)	$V_0 -V_{SS}$	0	+6.5	V	$V_{DD}>V_0$
Supply current (Backlight LED)	I_{LED}	-	3 0 0	mA	$T_a=25^{\circ}C$
Input voltage	V_{IN}	-0.3	$V_{DD}+0.3$	v	
Storage temperature	T_{stg}	-25	+70	"C	
Operating temperature	T_{opr}	0	+50	"C	
Reverse voltage (Backlight LED)	$V_{LED}-V_{LSS}$	-5	-	V	

4.2 Electrical characteristics

Table 3

(Ta = 25°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)	$V_0 -V_{SS}$		0.65*		V	$V_{DD}=5.0V$	
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	$I_{OL}=1.2mA$
	" H "	V_{OH}	2.4			v	$-I_{OH}=0.205mA$
Input leakage current	I_{IL}	-		1	μA		
Internal oscillating frequency	f_{osc}	1	160		KHz		
Supply current	I_{DD}		2.4	3.5	mA	$V_{DD}=5V, V_0=0V$	
	I_{LED}		200	300	mA	$V_{LED}-V_{LSS}=5.0V$	
Power dissipation	P_d		1012	1517.5	mW	$V_{DD}=5V, V_0=0V$ $V_{LED}-V_{LSS}=5.0V$	
Supply voltage (Backlight LED)	$V_{LED}-V_{LSS}$	4.75	5.0	5.25	V		

* Note. After over a hour since backlight begin lighting.

SHARP

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	PW_{EH}	450	-	-	ns
Enable rise/fall time	t_{Er}, t_{Ef}			25	ns
RS, R/R setup time	t_{AS}	{40	-	-	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.

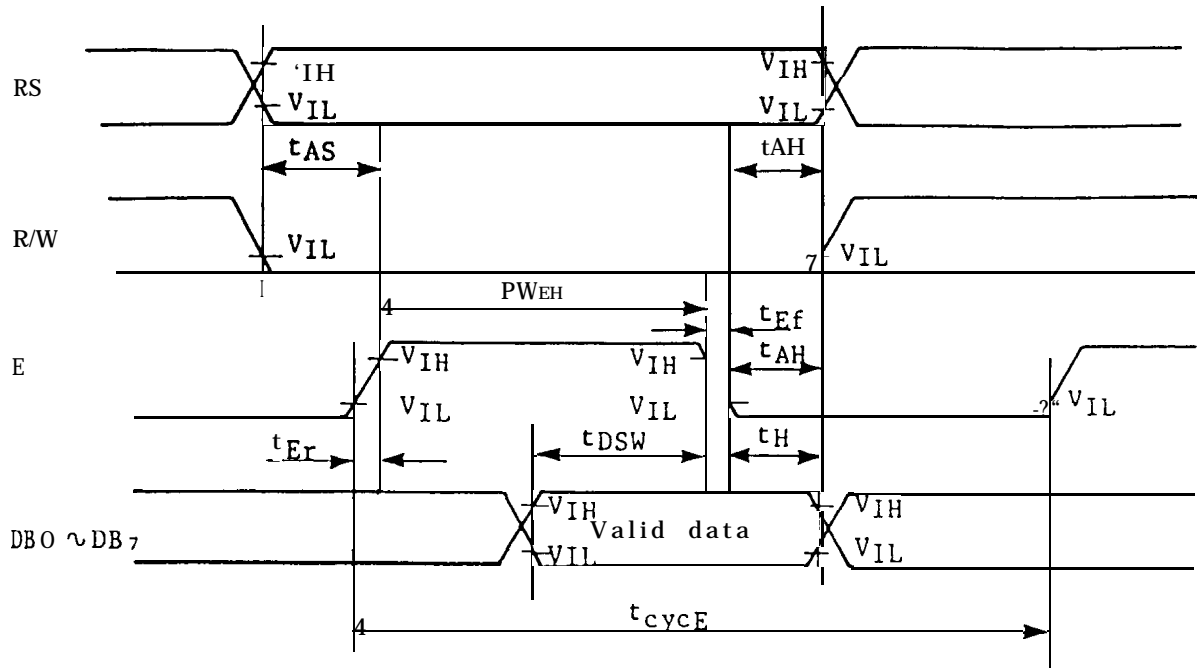
4.4 Interface signals

Table 5

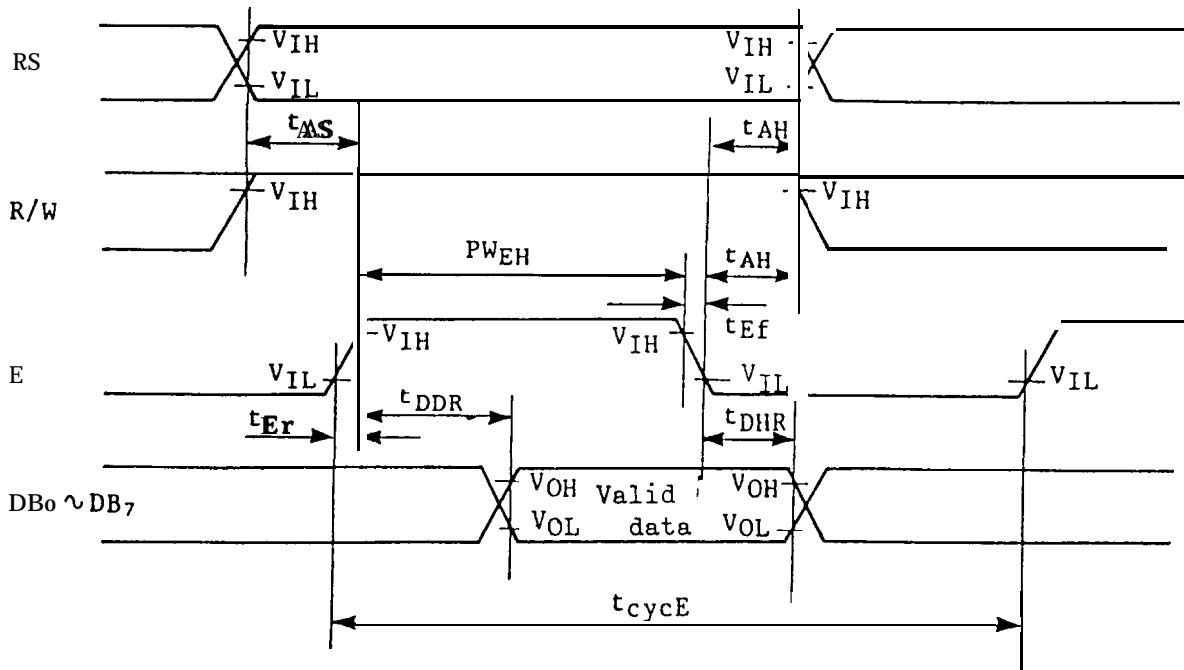
Pin No.	Symbol	Description	Connection
1	V_{SS}	Ground potential	GND : 0V
2	V_{DD}	Power supply	+5V
3	V_0	Contrast adjustment voltage	Adjust the contrast by changing the supply voltage from 0V to 5V.
4	RS	Register select signal	Control signal inputs (For details, see section 6 and 7.)
5	R/W	Read/write select signal	
6	E	Operation (data read/write enable signal)	
7	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	
15	V_{LED}	Power supply (+)	5V power supply between V_{LED} and V_{LSS} .
16	V_{LSS}	Power supply (-)	

SHARP

Write Operation



Read Operation



SHARP

5. Optical Characteristics

5.1 When backlight LED is OFF state

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	$\theta_2 - \theta_1$	$\phi = 0^\circ$ $C_0 \geq 4.0$	60	-	-	dgr.	Note 1	
	θ_1	$\theta_1 < \theta_2$ $C_0 = 4.0$	-	-	-25	dgr.	Note 1	
	θ_2		25	-	-			
		$\theta_2 - \theta_1$	$\phi = 45^\circ$ $C_0 \geq 4.0$	60	-	-	dgr.	Note 1
		θ_1	315° $C_0 = 4.0$	-	-	-25	dgr.	Note 1
		θ_2		$\theta_1 < \theta_2$	25	-	-	
Contrast ratio	C_0	$e = 0, \phi = 0^\circ$	7.0	10	-		Note 2	
Response time	Rise	$\theta = 0^\circ, \phi = 0^\circ$	-	150	250	ms	Note 3	
	Decay	$\theta = 0^\circ, \phi = 0^\circ$	-	150	250	ms	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.

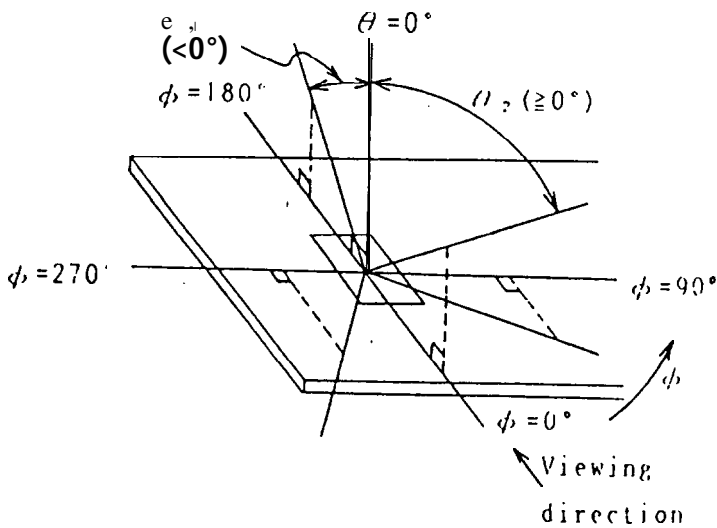


Fig.2 Definition of viewing angle

SHARP

Note 2) Contrast ratio is defined as follows:

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

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

Measurement wave length $\lambda = 540\text{nm}$

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.

SHARP

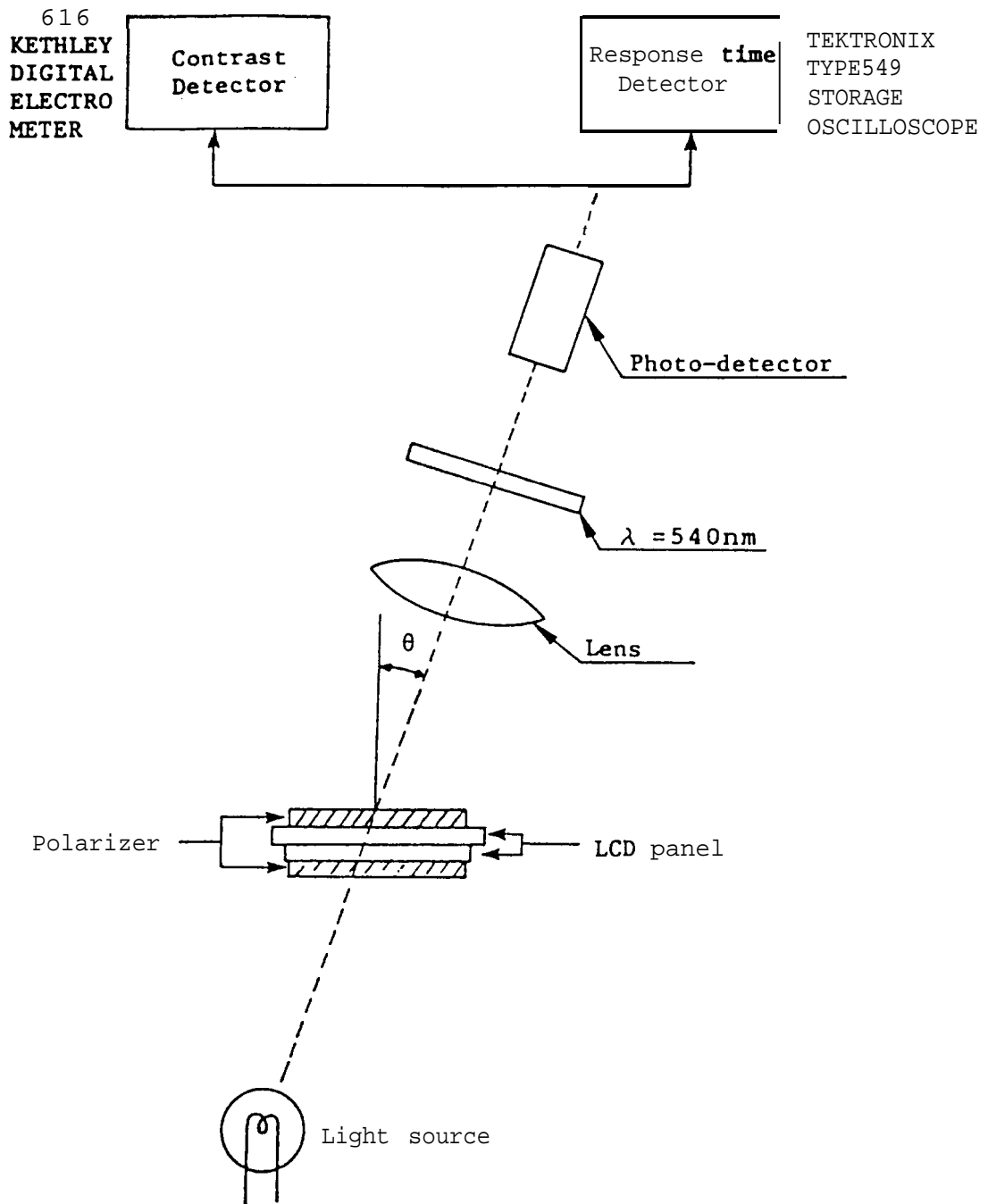


Fig. 3 Optical Characteristics Test Method

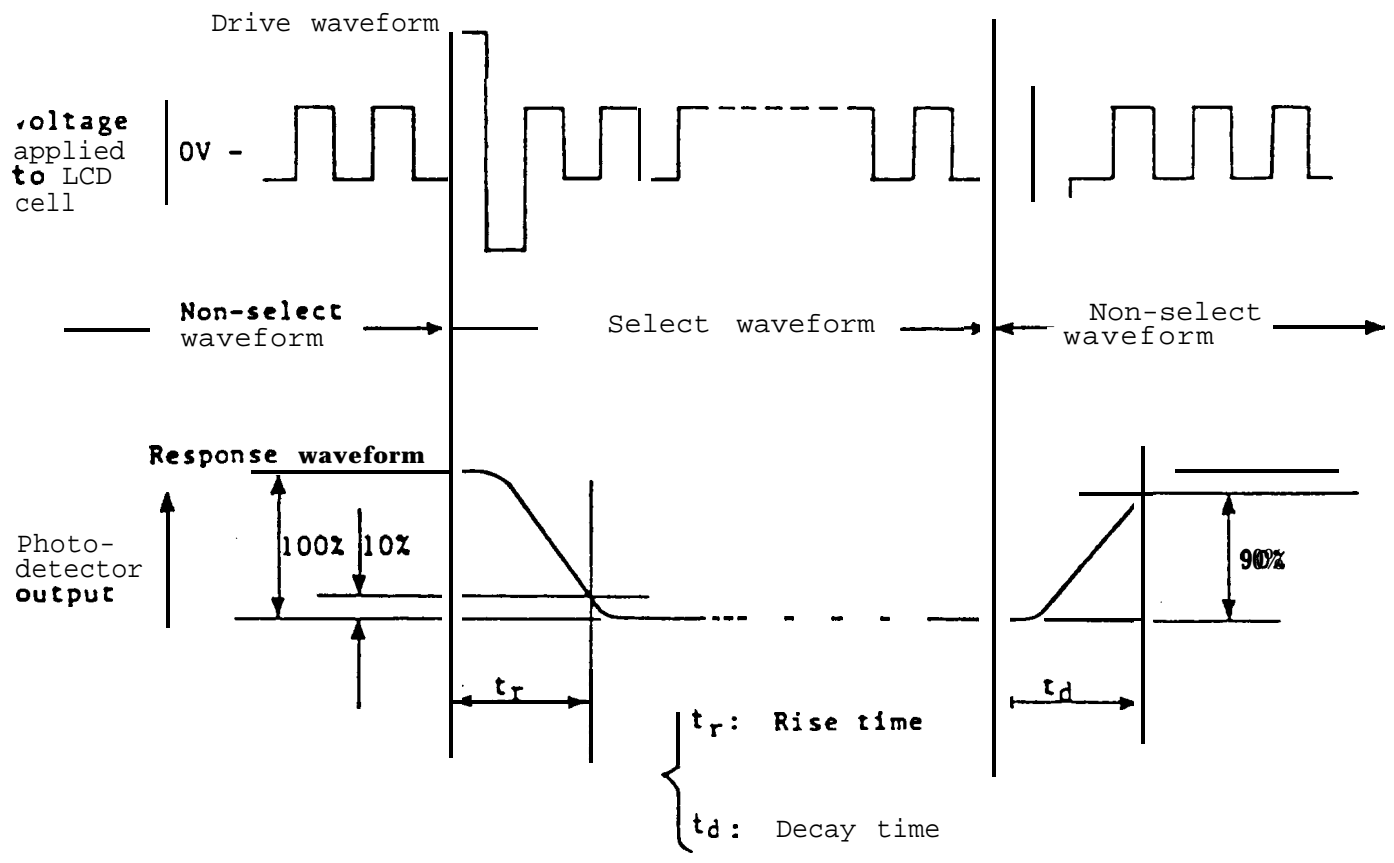


Fig. 4 Definition of Response Time

SHARP

5.2 Characteristics of Backlight LED (When LCD is ON state)

Table 7

Ta=25°C

V_{LED}-V_{LSS}=5V

Parameter	Min.	Typ.	Max.	Unit	remark
Luminance *	6	20	-	cd/m ²	
Peak emission wavelength		565	-	nm	
Spectrum radiation bandwidth		30	-	nm	

* Note. Center of the unit with LED backlight. lit.

LCD is full dot on.

Non free air state.

After over a hour since LED backlight begin lighting.

LCD drive voltage is adjusted to the maximum contrast in $\theta = 0^\circ$.

SHARP

6. Pin Description

1) V_{DD} and, V_{SS} pins

V_{DD} and V_{SS} pins are for power supply. V_{SS} pin is grounded, and V_{DD} pin is supplied with +5V. Each voltage necessary to drive LCD is generated in the unit.

2) RS Pin

The controller LSI has two 8-bit registers; an instruction register (IR) and a data register (DR). RS signal selects these registers.

IR stores instruction codes such as display clear, shift, etc. and also stores address information for the display data RAM (DD RAM), character generator RAM (CG RAM); DR is used for Temporarily storing data to be written into DD RAM and CG RAM.

" 0 " : Instruction register (when writing)

Busy flag register; address counter (when reading)

" , " : Data register (read/write)

3) R/k' Pin

Read or write select signal pin.

" 0 " : Writing

" , " : Reading

4) E Pin

Data read or write operation enable signal pin.

5) $DB_0 \sim DB_7$ Pins

Data bus with three-state, bidirectional function for use in data transactions with MPU. DB_7 may also be used to check the busy flag.

$DB_0 \sim DB_3$ are not used when interfacing with a 4-bit microprocessor.

6) V_0 Pin

Viewing angle is varied and contrast is adjusted by changing voltage between +5V ~ 0V by applying bias voltage V_0 to the LCD driver.

7) V_{LED} and V_{LSS}

Power supply for LED backlight. (By changing the supply voltage, backlight luminance can be adjusted.) V_{LED} is plus and V_{LSS} is minus.

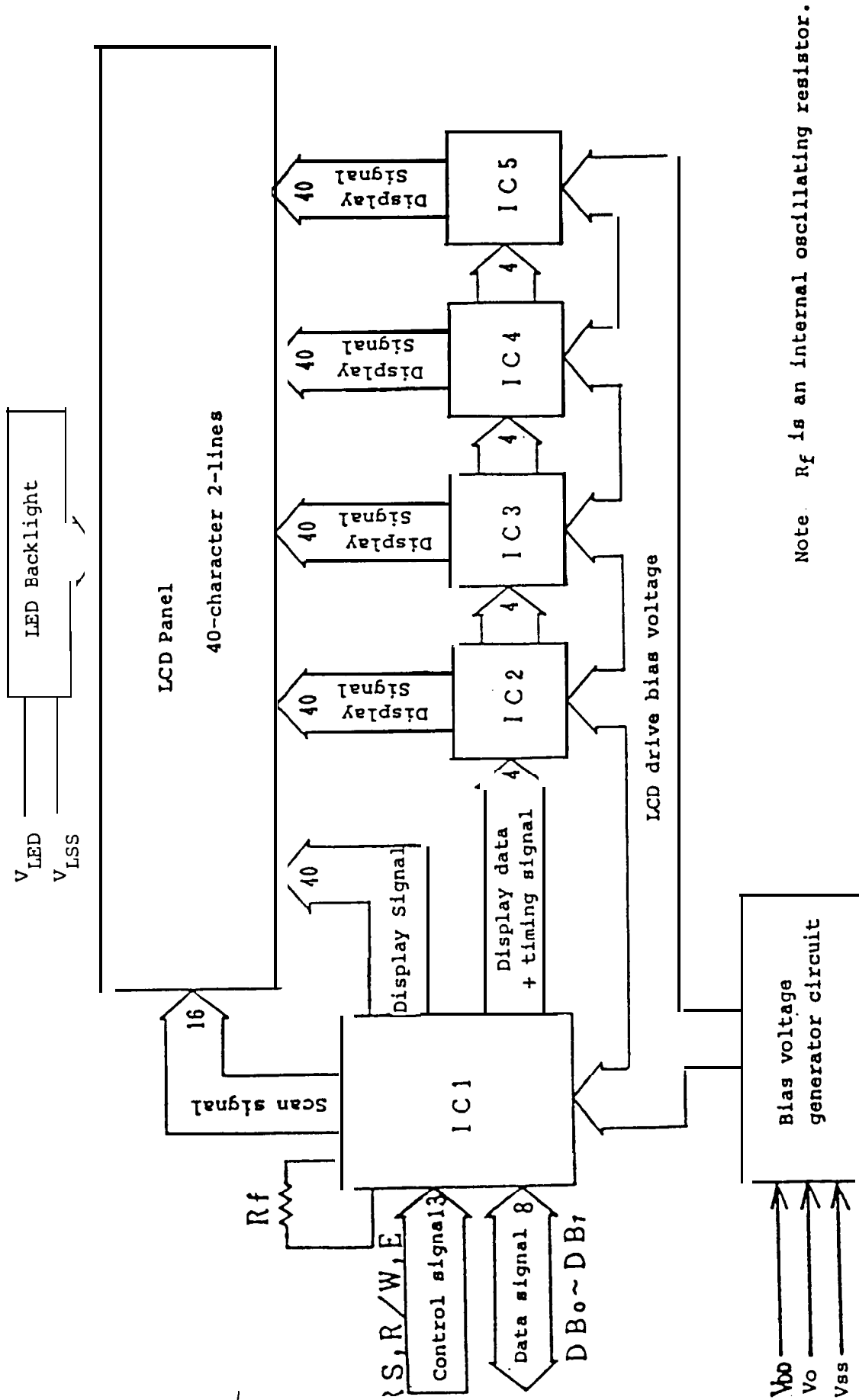


Fig.5 Block Diagram

SHARP

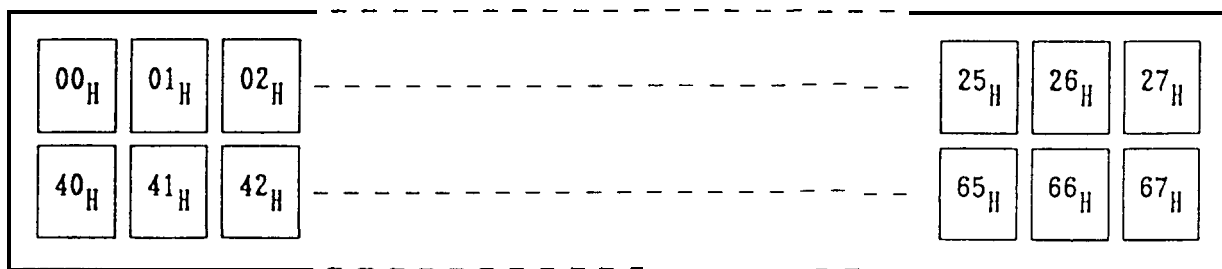


Fig . 6 Display Address (When the display **is** not shifted)

Table 9. Input Code vs. Character Pattern

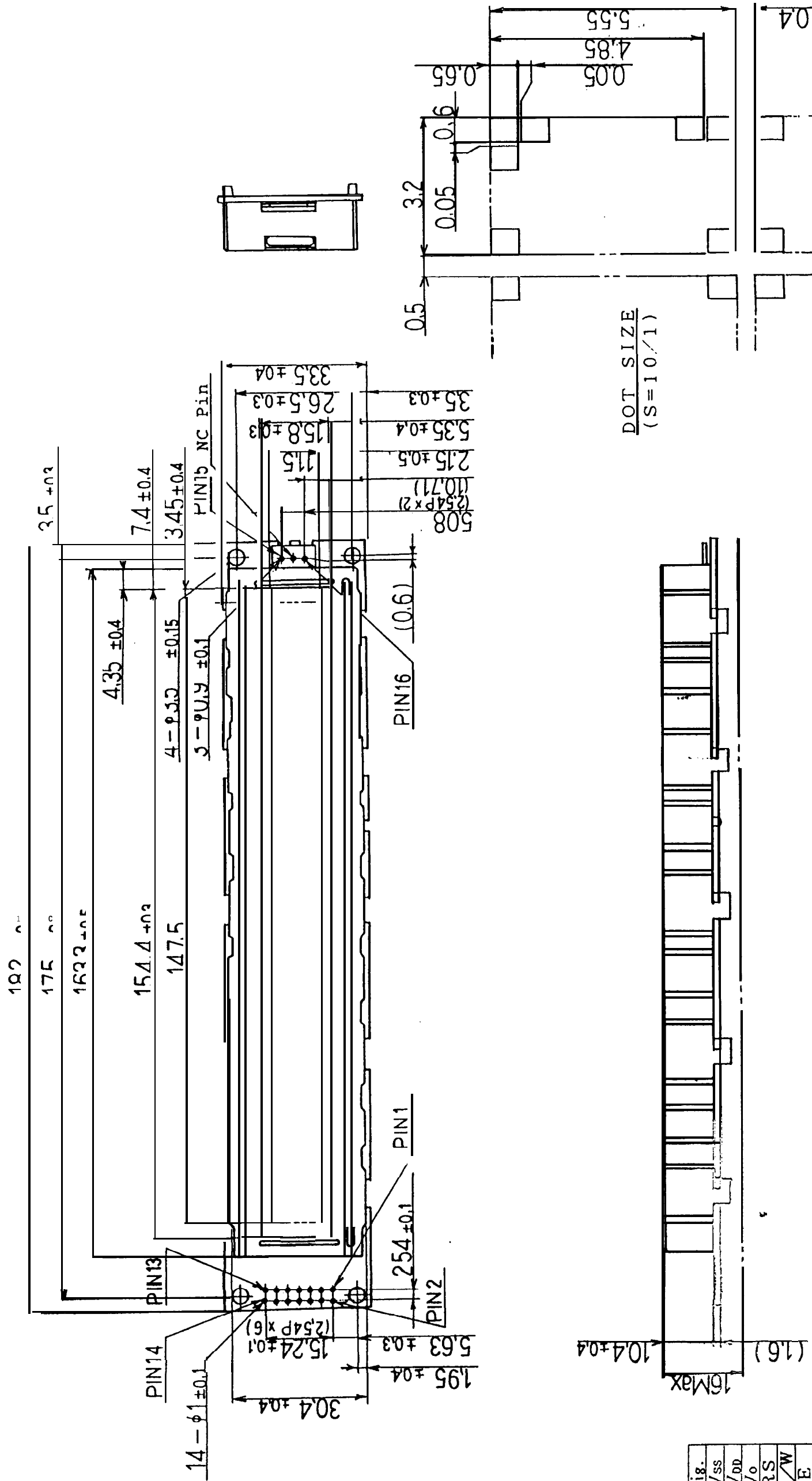
*1 #2 4bit	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)												*
xxxx0001	(2)												*
xxxx0010	(3)											*	
xxxx0011	(4)												
xxxx0100	(5)											*	
xxxx0101	(6)												
xxxx0110	(7)											*	
xxxx0111	(8)											*	
xxxx1000	(1)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

Fig.7 Unit Outline Dimensions



PIN No.	Sig.
1	V _{SS}
2	V _{DD}
3	V ₀
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
15	V _{LED}
16	V _{SS}

呼び分け	積層	19	LM40X21B	40-character 2-line LCD Unit
4層以下	±0.07	年	LM40X21B	Outline Dimensions
16層以下	±0.10	月	LM40X21B	
63層以下	±0.15	日	LM40X21B	
120層以下	±0.20		LM40X21B	
250層以下	±0.25		LM40X21B	
40層以上	±0.30		LM40X21B	

指示なき寸法公差は、
UNSPECIFIED TOL TO BE
アレス曲げ角度許容差 (度)

曲げ角度区分	公差
重角曲げ	±0.5
単角曲げ	±1.0
その他の曲げ	±1.5

設計
高岡

検査
村田

承認
村田

SHARP CORPORATION
発行部門 LCD Division
図番 OD:40X21A:310110
DATE 1988.6.1
様式 60-A3

Note 1 Rezel plated hv white-zinc