

PREPARED BY: \_\_\_\_\_ DATE \_\_\_\_\_

APPROVED BY: \_\_\_\_\_ DATE \_\_\_\_\_

# SHARP

ELECTRONIC COMPONENTS GROUP  
SHARP CORPORATION

## SPECIFICATION

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PAGE 16 Pages

REPRESENTATIVE DIVISION

IC DIV.

SEMICONDUCTOR APPLICATION DIV.

LCD DIV.

ELECTRONIC COMPONENTS DIV.

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DEVICE SPECIFICATION FOR

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

MODEL No.

LM40X21A

CUSTOMER'S APPROVAL

DATE \_\_\_\_\_

BY \_\_\_\_\_

PRESENTED

BY

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SHARP CORPORATION

**SHARP**LM40X21A1. Overview

The LM40X21A, 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 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 LM402A01 series".

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2. Construction and Outline

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

Rejection 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(H) X 16 MAX(D)	mm
Effective display area	154.4(W) X 15.8(H)	mm
Display format	40 characters X 2 lines	-
Character format	5 X 7 dots with cursor	-
Character size	3.2(W) X 4.85(H) (5 X 7 dots)	mm
Dot size	0.6(W) X 0.65 (H)	mm
Dot spacing	0.05	mm
Character color *	Dark blue	-
Backlight color	Yellow green	-
Weight	Approx. 90	g

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



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)	$V_0-V_{SS}$	0	+6.5	V	$V_{DD}>V_0$
Supply current (Backlight LED)	$I_{LED}$	-	400	mA	$T_a=25^\circ C$
Input voltage	$V_{IN}$	-0.3	$V_{DD}+0.3$	V	
Storage temperature	$T_{stg}$	-25	+70	$^\circ C$	
Operating temperature	$T_{opr}$	0	+50	$^\circ C$	
Reverse voltage (Backlight LED)	$V_{LED}-V_{LSS}$	-5	-	V	

4.2 Electrical characteristics

Table 3

( $T_a = 25-C$ )

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"	$V_{IH}$	2.22	-	$V_{DD}$	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	$\mu A$		
Internal oscillating frequency	$f_{osc}$		160		KHz		
Supply current	$I_{DD}$		2.4	3.5	mA	$V_{DD}=5V, V_0=0V$	
	$I_{LED}$		300	400	mA	$V_{LED}-V_{LSS}=5.0V$	
Power dissipation	$P_d$		1512	2017.5	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.

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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	$PW_{EH}$	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.

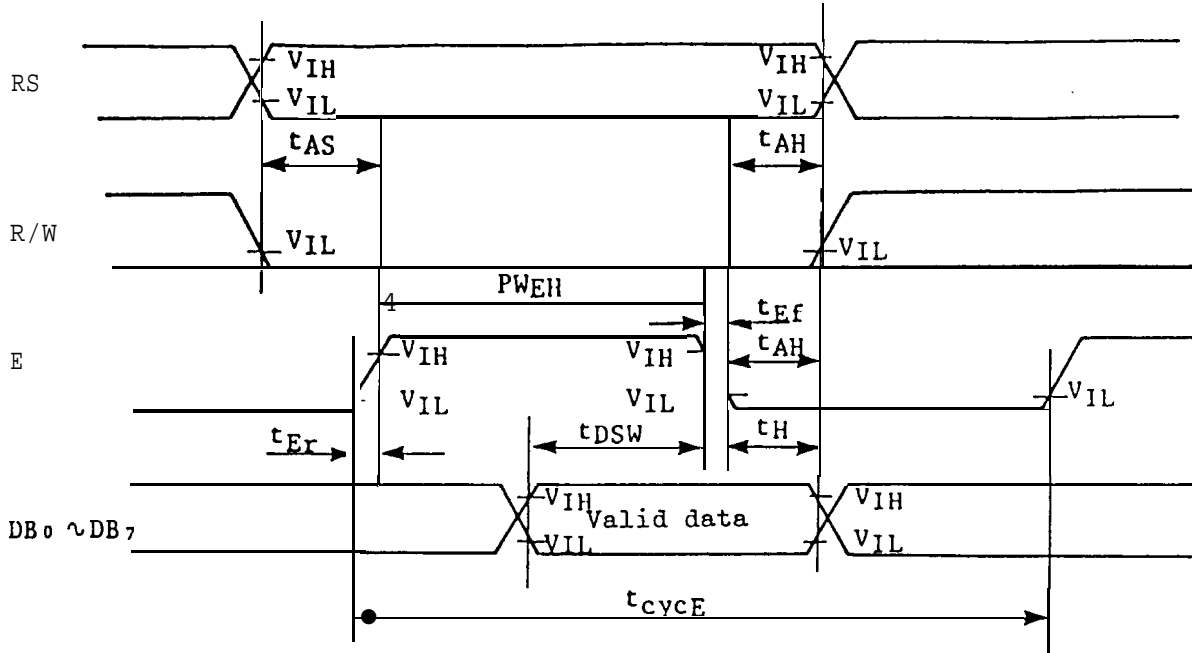
4.4 Interface signals

Table 5

Pin No.	Symbol	Description	Connection
1	$V_{SS}$	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/h'	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 (-)	

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Write Operation



Read Operation

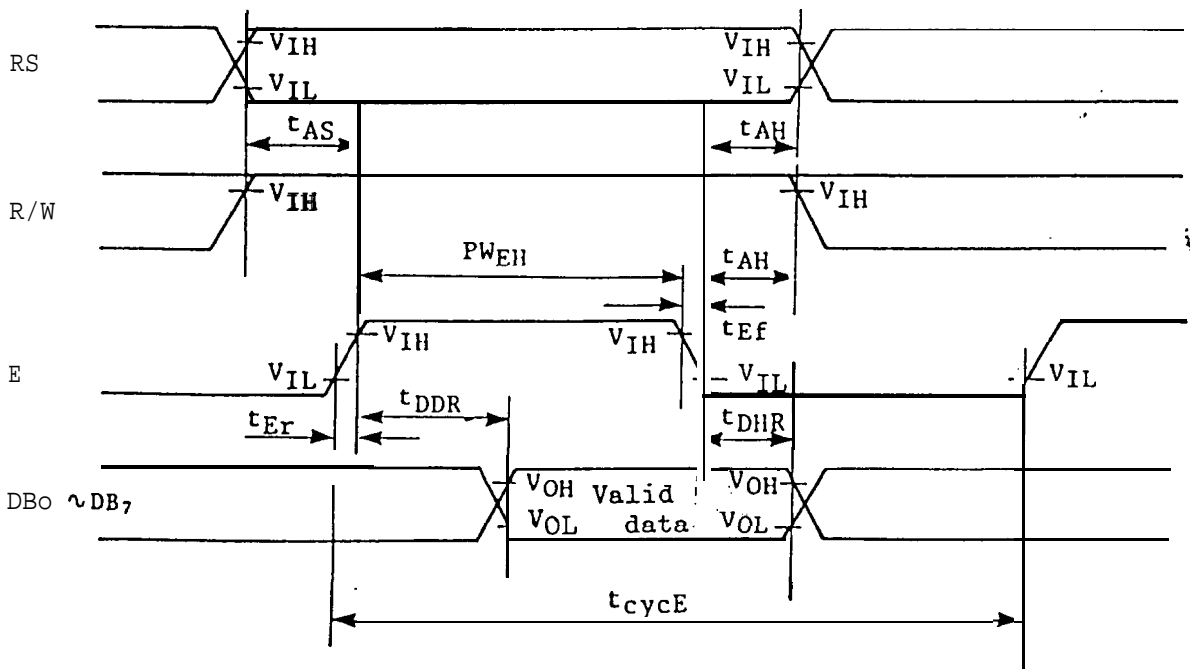


Fig. 1 Timing Chart



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	$\theta_2 - \theta_1$	$\phi = 0^\circ$ $C_0 \geq 2.0$	60	-	-	dgr.	Note 1	
	$\theta_1$	$\theta_1 < \theta_2$ $C_0 = 2.0$	-	-	-25	dgr.	Note 1	
	$\theta_2$		25	-	-			
	Viewing angle range	$\theta_2 - \theta_1$	$\phi = 45^\circ$ $C_0 \geq 2.0$	60	-	-	dgr.	Note 1
		$\theta_1$	315° $\theta_1 < \theta_2$ $C_0 = 2.0$	-	-	-25	dgr.	Note 1
		$\theta_2$		25	-	-		
Contrast ratio	$C_0$	$\theta = 0^\circ, \phi = 0^\circ$	5.0	8.0	-		Note 2	
Response time	Rise	$t_r$	-	150	250	ms	Note 3	
	Decay	$t_d$	-	150	250	ms	Note 3	

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

\* Angles  $\theta_1, \theta_2$  and  $\phi$  shall fall within the range over which the displayed character can be read.

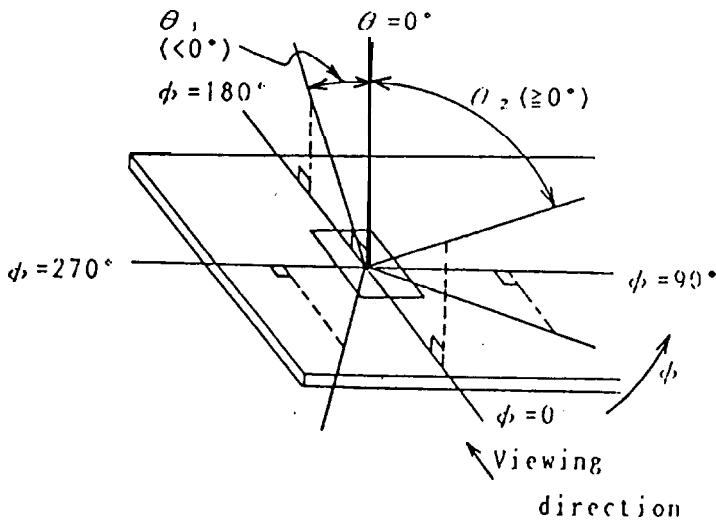


Fig.2 Definition of viewing angle

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Note 2) Contrast ratio is defined as follows:

**When** input signal is applied 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.

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

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.



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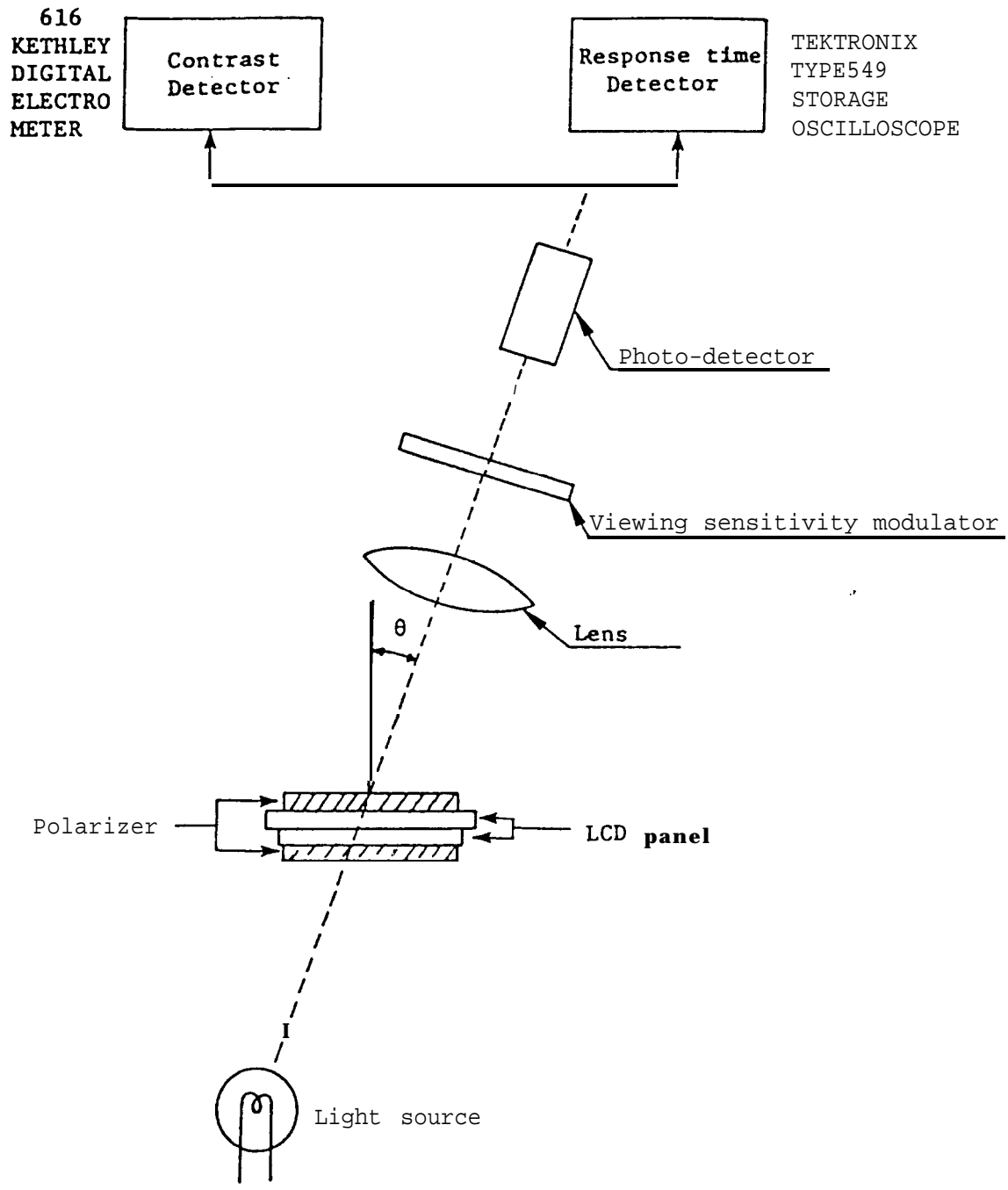
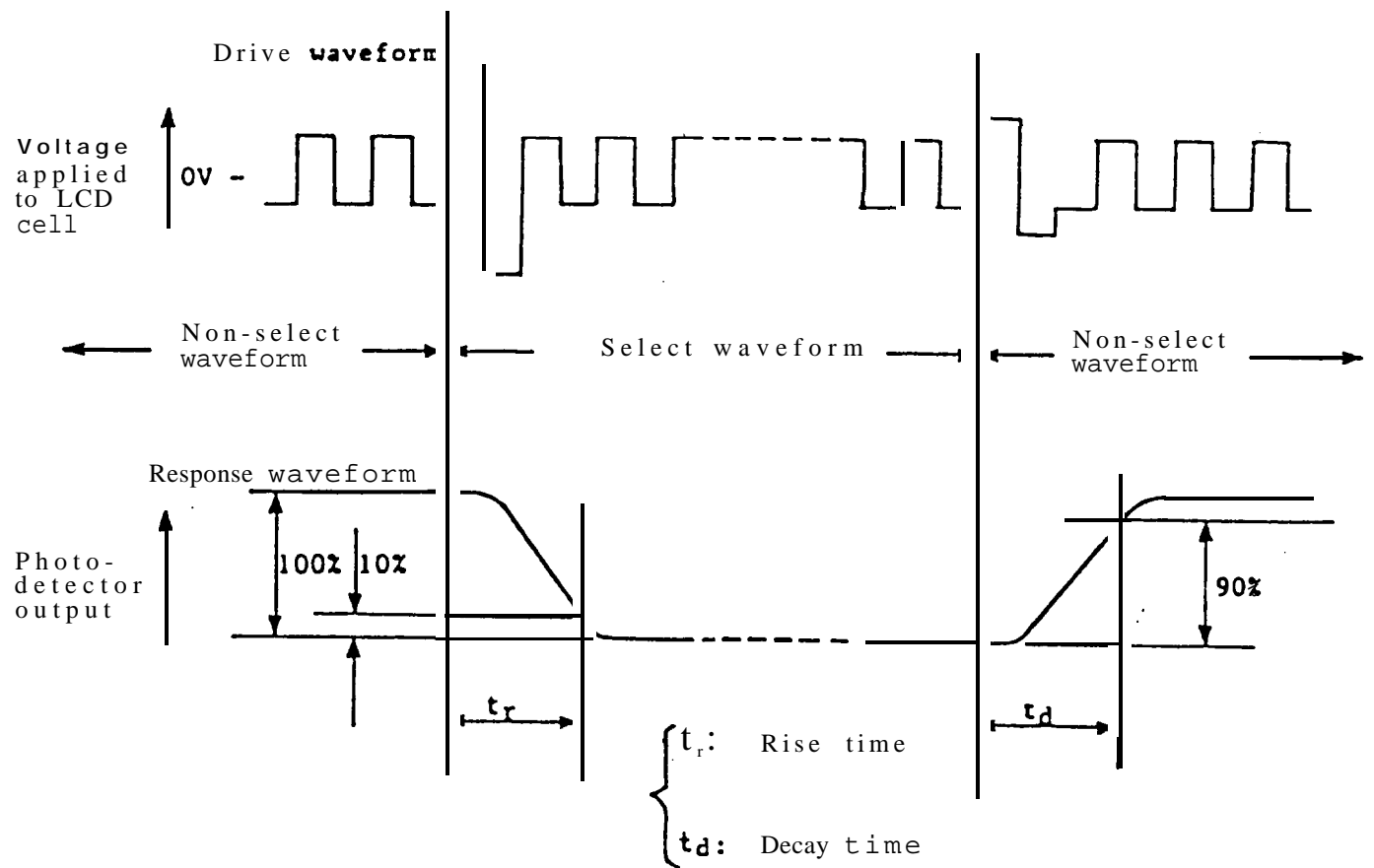


Fig. 3 Optical Characteristics Test Method

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**Fig. 4 Definition of Response Time**

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

Table 7

Ta=25°C

V<sub>LED</sub>-V<sub>LSS</sub>=5V

Parameter	Min.	Typ.	Max.	Unit	remark
Luminance *	7	22	-	cd/m <sup>2</sup>	
Peak emission wavelength		565	-	nm	
Spectrum radiation bandwidth		30	-	nm	

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

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## 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)

" 1 " : Data register (read/write)

### 3) R/W Pin

Read or write-select signal pin.

" 0 " : Writing

" 1 " : 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 to the LCD driver.

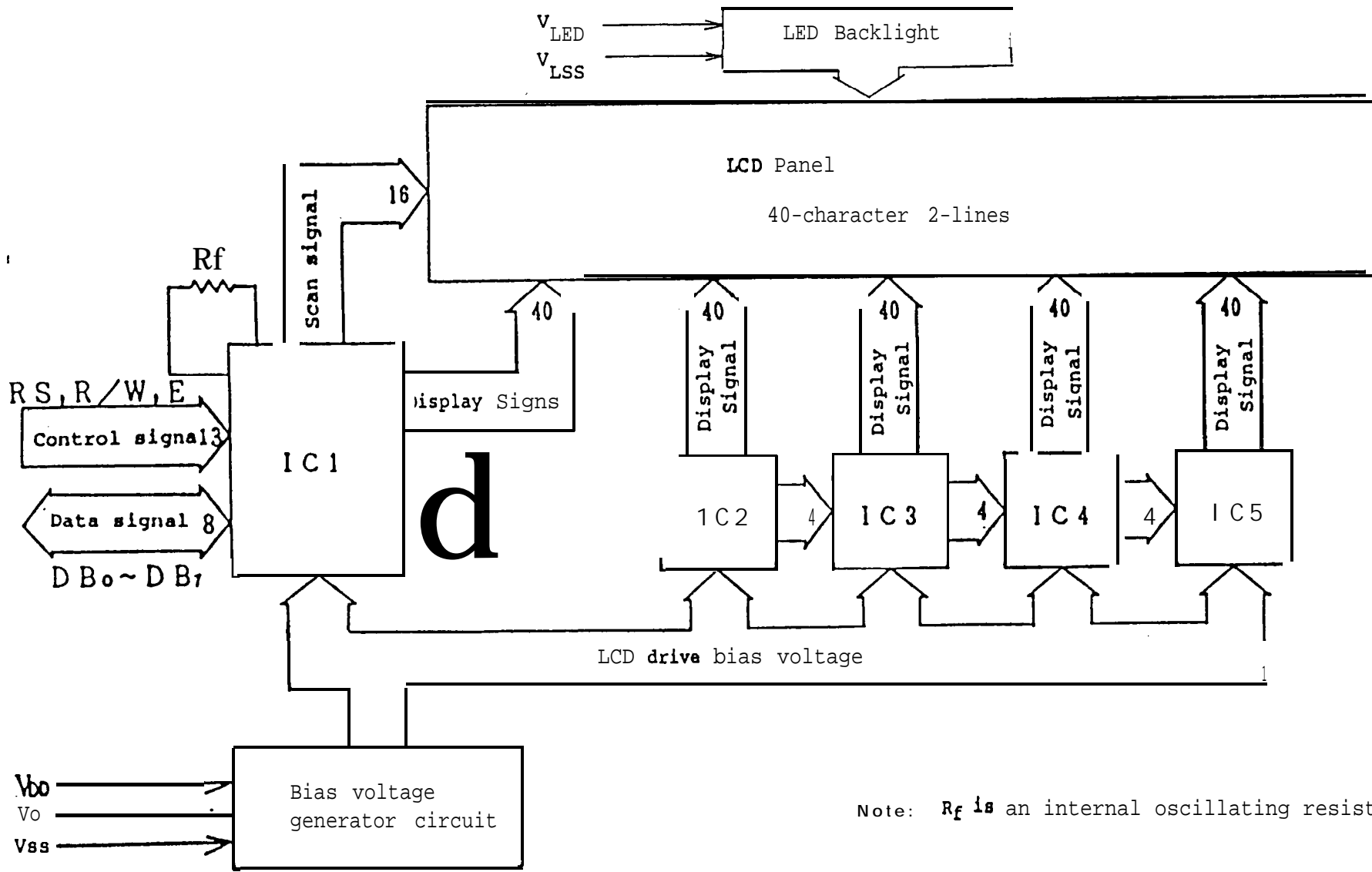
### 7) $V_{LED}$ and $V_{LSS}$

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

7. Instruction Set

Table 8

Instruction	Code										Function	
	RS	R/W	DB <sub>7</sub>	DB <sub>6</sub>	DB <sub>5</sub>	DB <sub>4</sub>	DB <sub>3</sub>	DB <sub>2</sub>	DB <sub>1</sub>	DB <sub>0</sub>		
Display clear	0	0	0	0	0	0	0	0	0	1	Clear entire display ● rea, restore display from shift, and load ● ddress counter with DD RAM address 00H.	
Display/cursor home	0	0	0	0	0	0	0	0	1	*	Restore display from shift and load ● ddress counter with DD RAM ● ddress 00H.	
Entry □ ode set	0	0	0	0	0	0	0	1	I/D	s	Specify cursor advance direction and display shift mode. This operation takes place ● fter 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 (DL).	
CC RAM address set	0	0	0	1	ACG							Load the ● ddrees counter with a CC RAM address. Subsequent data is CC RAM data.
DD RAM address set	0	0	1	ADD							Load the address counter with ● DD 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 (AC).	
CC RAM/DD RAM data write	1	0	Write data							Write data to CC RAM or DD RAM.		
CC RAM/DD RAM data read	1	1	Read data							Read data from CC RAM or DD RAM.		
<p>I/D-1: Increment,                      I/D-0: <b>Decrement</b></p> <p>s = 1: Shift display,                  s = 0: Freeze display</p> <p>D = 1: Display ON,                    D = 0: Display OFF</p> <p>c = 1: Cursor ON,                      c = 0: Cursor OFF</p> <p>B = 1: Character at cursor position blinks,      B = 0: Character at cursor position <b>blinks</b></p> <p>S/C = 1: Shift display,                S/C = 0: <b>Move cursor</b></p> <p>R/L-1: Shift right,                    R/L = 0: Shift left</p> <p>DL = 1: <b>8-bit</b>,                          DL = 0: <b>4-bit</b></p> <p>BF = 1: During internal operation,      BF = 0: End of <b>internal</b> operation</p>												



Note:  $R_f$  is an internal oscillating resistor.

Fig.5 Block Diagram

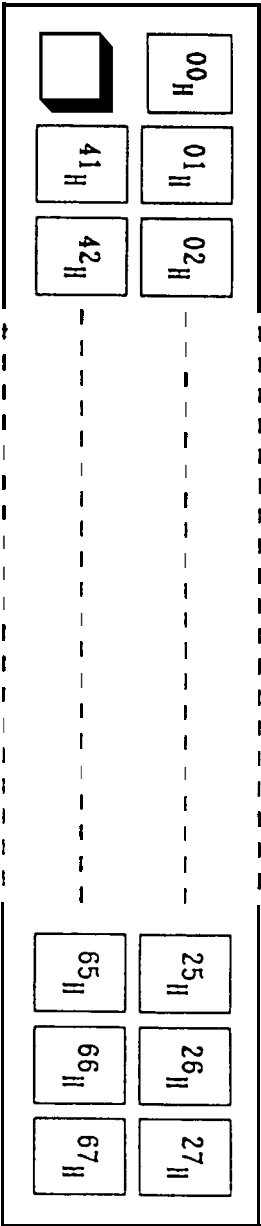


Fig. 6 Display Address (When the display is not shifted)

Table 9. Input Code vs. Character Pattern

*1 4bit	*2 4bit	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
XXXX0000	CG RAM (1)													*
	(2)													*
XXXX0010	(3)												*	
	(4)													
XXXX0100	(5)												*	
	(6)													
XXXX0110	(7)												*	
	(8)													
XXXX1000	(1)												*	
	(2)													*
XXXX1010	(3)												*	
	(4)													
XXXX1100	(5)												*	
	(6)													*
XXXX1110	(7)												*	
	(8)													*

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

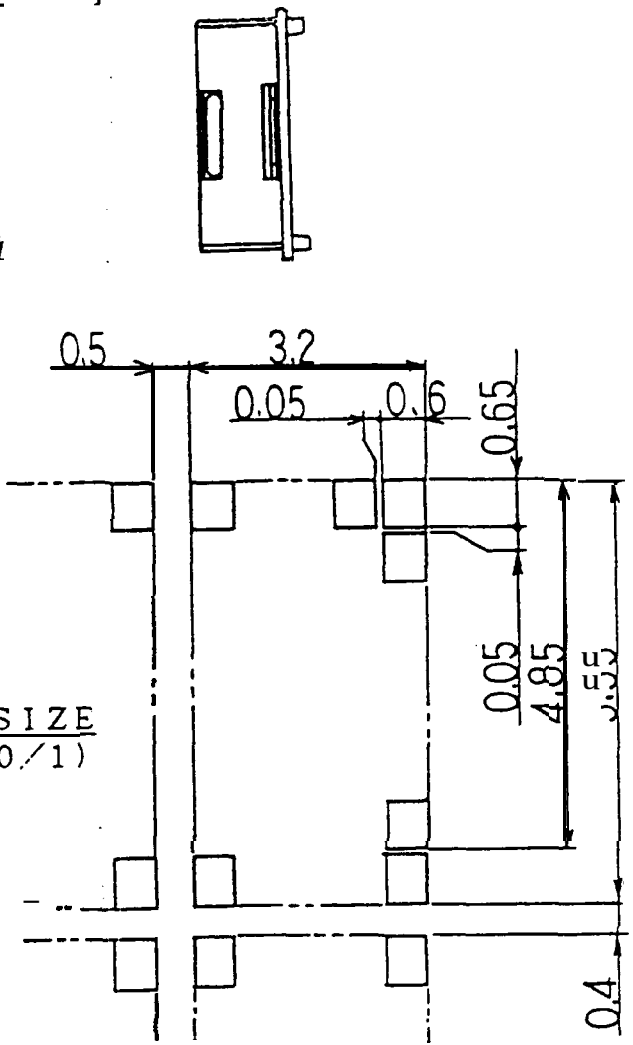
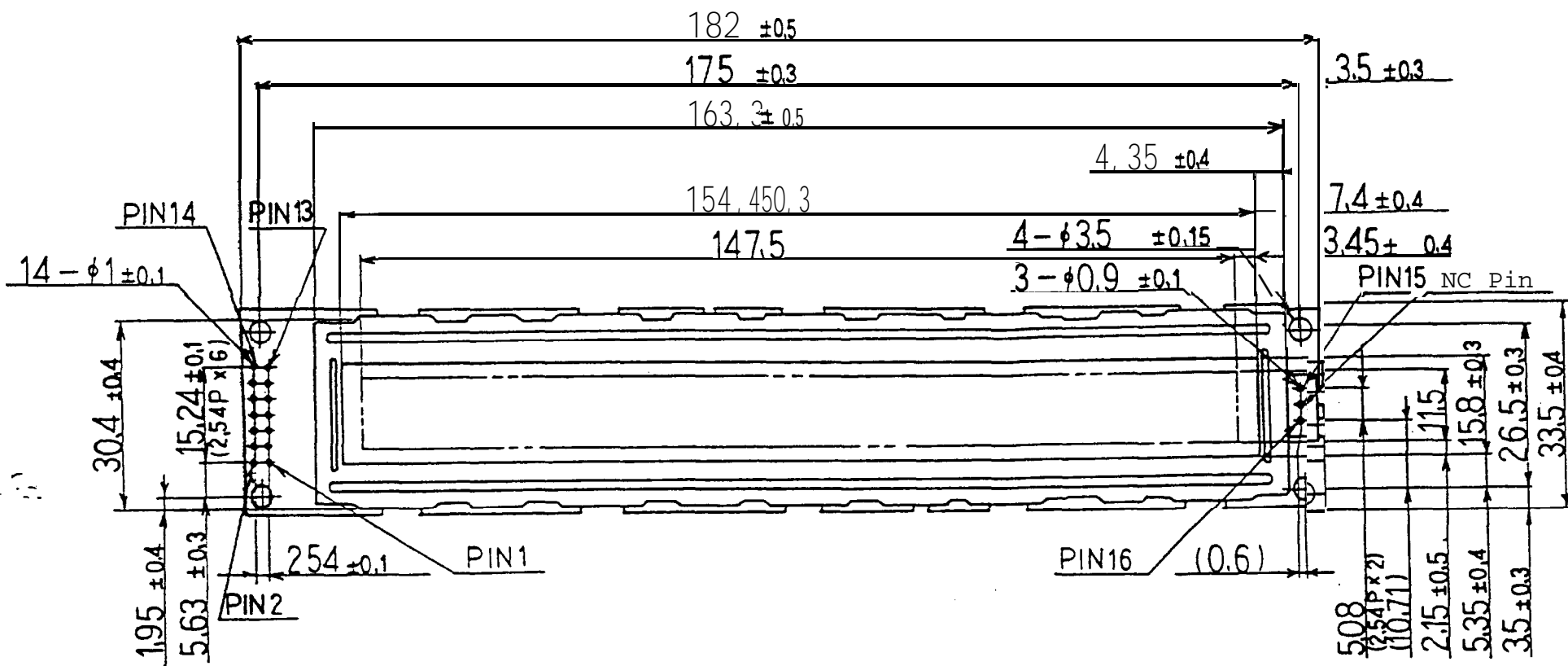
Note 2. X mark: prohibition of input

\*1 High-order \*2 Low-order



Fig.7 Unit Outline Dimensions

No. ( ) 号による  
新設・変更・書換 図面  
NEW CHANGE REPLACE



DOT SIZE  
(S=10/1)

PIN No.	Sig.
1	VSS
2	VDD
3	Vo
4	RS
5	R/W
6	E
7	DB <sub>0</sub>
8	DB <sub>1</sub>
9	DB <sub>2</sub>
10	DB <sub>3</sub>
11	DB <sub>4</sub>
12	DB <sub>5</sub>
13	DB <sub>6</sub>
14	DB <sub>7</sub>
15	VLED
16	VSS

呼び寸法区分	種	番	19 . . .	LM40X21B	名称	40-character 2-line LCD Unit
1以上 4以下	±0.05	±0.10	19 . . .	LM40X21A	NAME	Outline Dimensions
4をこえ 16以下	±0.07	±0.15	年月日	訂正記事	設計NO.	担当
16をこえ 63以下	±0.10	±0.25	DATE	REVISION	CODE	NUMBER
63をこえ 120以下	±0.15	±0.35	材	質	板厚	仕
120をこえ 250以下	±0.20	±0.50	MATERIAL	THICKNESS	FINISH	上
250をこえ 400以下	±0.25	±0.65	1	1	1	1
400をこえ	±0.30	±0.80	設計	検図	検図	承認
指示なき寸法公差は	とする		SHARP CORPORATION	図番		
UNSPECIFIED TOL TO BE			発行部門	DATE		
プレス曲げ角原形公差 (度)			LCD Division	19 88 . 6 . 1		
曲げ角度区分	種	番	様式誌 60-A3			
直角曲げ	±0.5	±1.0				
45°曲げ	±0.7	±1.5				

Note 1 . Bezel plated by white-zinc.