# PRODUCT SPECIFICATIONS

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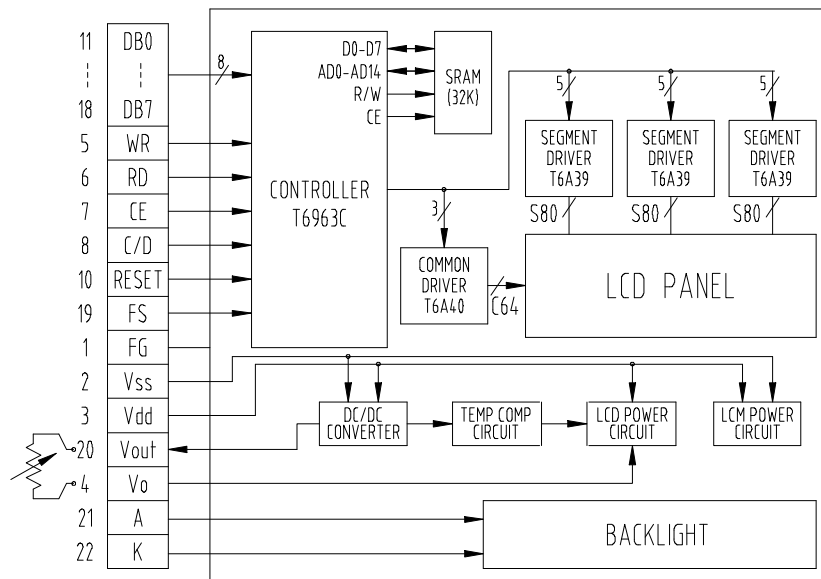- PRECAUTIONS FOR USING LCD MODULES
- USING LCD MODULES

■ PHYSICAL DATA

Item	Contents	Unit
LCD type	STN / FSTN	---
LCD duty	1/64	---
LCD bias	1/9	---
Viewing direction	6 / 12	o'clock
Module size (W×H×T)	180 × 65 × 11.0 MAX (14.0 MAX W/LED BACKLIGHT)	mm
Viewing area (W×H)	132.6 × 39	mm
Number of dots	240 × 64	dots
Dot size (W×H)	0.48 × 0.48	mm
Dot pitch (W×H)	0.53 × 0.53	mm

■ EXTERNAL DIMENSIONS
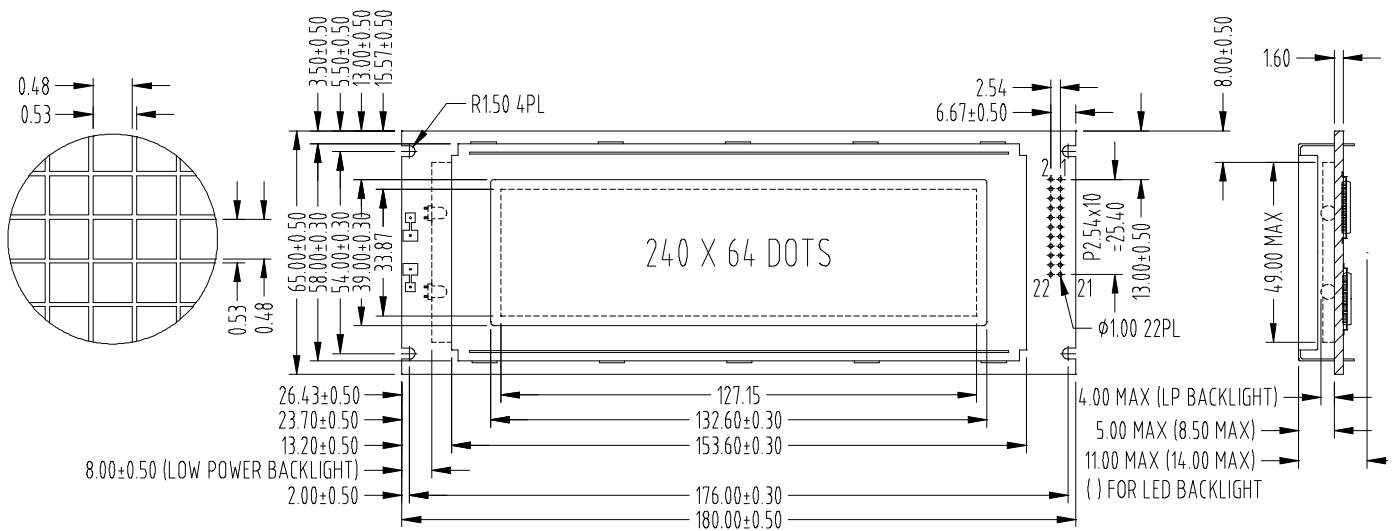
■ BLOCK DIAGRAM

■ ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)

Parameter	Symbol	Min	Max	Unit
Supply voltage for logic	VDD	-0.3	7.0	V
Supply voltage for LCD	VDD - VO	-0.3	28	V
Input voltage	VI	-0.3	VDD+0.3	V
Normal operating temperature	TOP	0	50	°C
Normal storage temperature	TST	-10	60	°C
Wide operating / storage temperature (except FSTN)	TOP / TST	-30	80	°C
Wide operating / storage temperature (FSTN)	TOP / TST	-30	70	°C

■ ELECTRICAL CHARACTERISTICS (VDD = +5V±10% , VSS = 0V, Ta = 25°C)

◆ DC Characteristics

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply voltage for logic	VDD	---	4.5	5.0	5.5	V
Supply current for logic	IDD	---	---	22	26	mA
Operating voltage for LCD	VDD - VO	25°C	12	12.7	13.4	V
Input voltage ' H ' level	VIH	---	VDD - 2.2	---	VDD	V
Input voltage ' L ' level	VIL	---	0	---	0.8	V

● Backlight operating information (Ta = 25°C)

LED Backlight	Supply voltage VF (V)			Supply current IF (mA)		
	Min	Typ	Max	Min	Typ	Max
Side lit backlight Y/G (-2)	---	4.2	4.6	---	300	500
White (-3LP)	---	3.4	3.5	---	40	50
Blue (-4LP)	---	3.4	3.5	---	40	50
Green (-5LP)	---	3.4	3.5	---	40	50
Amber (-6LP)	---	1.8	1.9	---	40	50
EL Backlight	EL Enable voltage EON (VAC)			EL frequency LF (Hz)		
	Min	Typ	Max	Min	Typ	Max
EL (B)	---	100	150	---	400	1000

◆ AC Characteristics

● AC Characteristics (1)

Parameter	Symbol	Min	Max	Unit
Operating frequency	f_{SCP}	---	2.75	MHz
SCP pulse width	t_{CWH}, t_{CWL}	150	---	ns
SCP rise/fall time	t_r, t_f	---	30	ns
LP set up time	t_{LSU}	150	290	ns
LP hold time	t_{LHD}	5	40	ns
Data set up time	t_{DSU}	170	---	ns
Data hold time	t_{DHD}	80	---	ns
FR delay time	t_d	0	90	ns
CDATA set up time	t_{CSU}	450	850	ns
CDATA hold time	t_{CHD}	450	950	ns
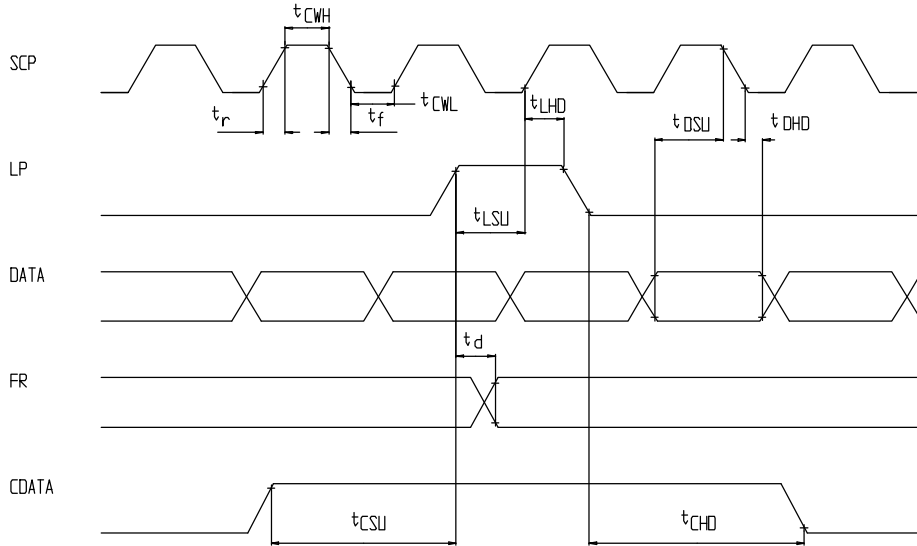
● AC Characteristics (2)

Parameter	Symbol	Min	Max	Unit
C/D set up time	t_{CDS}	100	---	ns
C/D hold time	t_{CDH}	10	---	ns
CE, RD, WR pulse width	t_{CE}, t_{RD}, t_{WR}	80	---	ns
Data set up time	t_{DS}	80	---	ns
Data hold time	t_{DH}	40	---	ns
Access time	t_{ACC}	---	150	ns
Output hold time	t_{OH}	10	50	ns
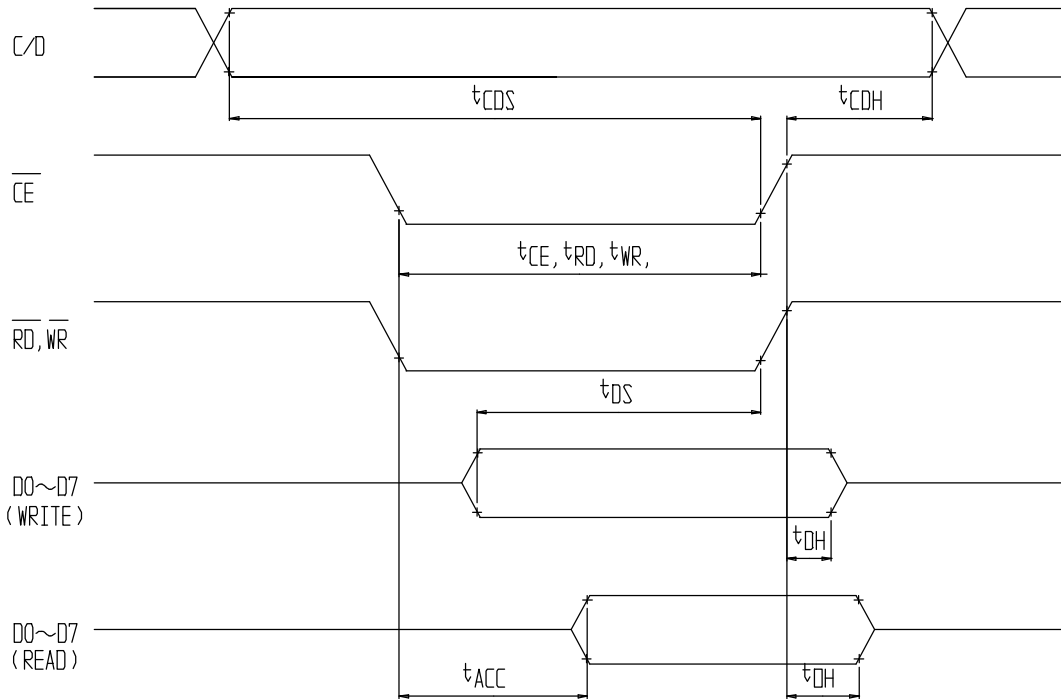
■ OPERATING PRINCIPLES & METHODS

◆ Flowchart of Communications with MPU

● Status Read

Before sending data (Read/Write) command, it is necessary to check the status.

Status check

Status of T6963C can be read from data lines.

RD	L
WR	H
CE	L
C/D	H
D0-D7	Status word

T6963C status word format is following.

MSB   LSB

STA7 D7	STA6 D6	STA5 D5	STA4 D4	STA3 D3	STA2 D2	STA1 D1	STA0 D0

STA0	Check capability of command execution	0 : Disable 1 : Enable
STA1	Check capability of data read/write	0 : Disable 1 : Enable
STA2	Check capability of auto mode data read	0 : Disable 1 : Enable
STA3	Check capability of auto mode data write	0 : Disable 1 : Enable
STA4	Not use	
STA5	Check capability of controller operation	0 : Disable 1 : Enable
STA6	Error flag. Using screen peek/copy command	0 : No error 1 : Error
STA7	Check the condition blink	0 : Display off 1 : Normal display

Note 1 : It is necessary to check STA0 and STA1 at the same time. The error is happened by sending data at executing command.
Note 2 : The status check will be enough to check STA0/STA1.
Note 3 : STA2/STA3 are valid in auto mode STA0/STA1 are invalid.
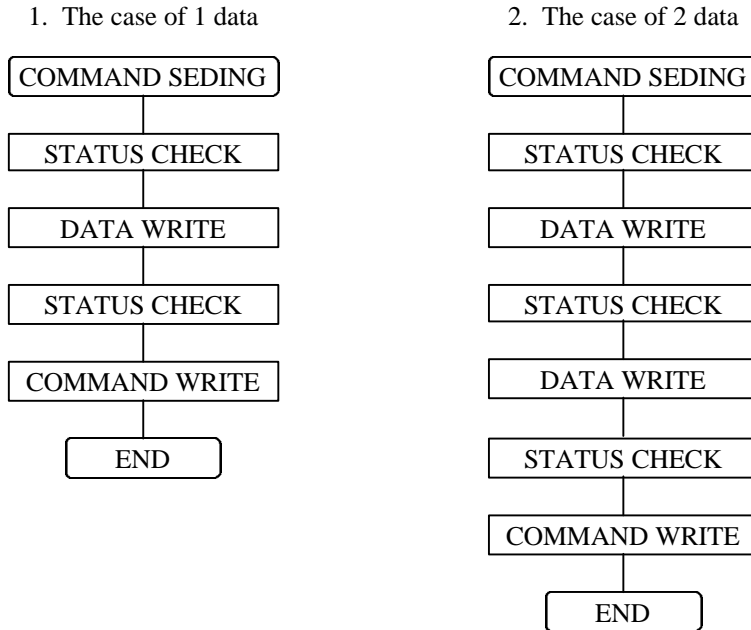
Status checking flow
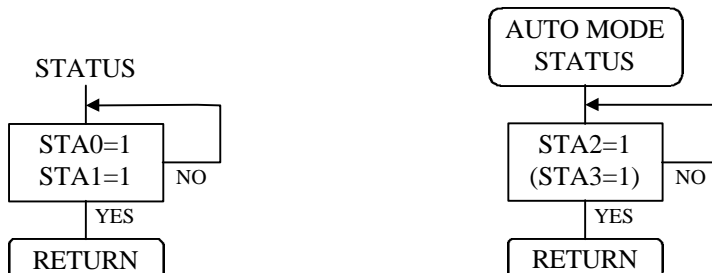
Note 4 : It is impossible to save status check in the case of command of MSB0. To have the delay time cannot be save status check. The interrupt of hardware is happened at the end of lines. If command of MSB0 is sent in this period, the command executing is waited. The state of waiting doesn't be known without to check status. The sending next command or data is disregarded or rewrites data of waiting command.

● Data Set

In T6963C, the data have been set and command executes.

The order of procedure of command sending

| 1. The case of 1 data | 2. The case of 2 data |

```
  COMMAND SEDING              COMMAND SEDING
        |                           |
   STATUS CHECK                STATUS CHECK
        |                           |
   DATA WRITE                   DATA WRITE
        |                           |
   STATUS CHECK                STATUS CHECK
        |                           |
  COMMAND WRITE                 DATA WRITE
        |                           |
       END                     STATUS CHECK
                                    |
                              COMMAND WRITE
                                    |
                                   END
```

Note : In case of over 2 data sending, the last data (or last 2 data) is valid.
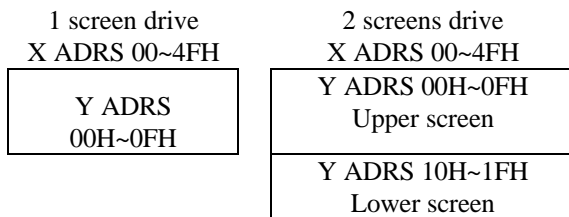
◆ Description of Command

● Register Set

Code	Hex	Function	D1	D2
00100001	21H	Cursor Pointer Set	X ADRS	Y ADRS
00100010	22H	Offset Register Set	Data	00H
00100100	24H	Address Pointer Set	Low ADRS	High ADRS

(1) Cursor Pointer Set

The position of cursor is specified by X ADRS, Y ADRS. The cursor position is moved only by this command. The cursor pointer doesn't have the function of increment and decrement. The shift of cursor are set by this command. X ADRS, Y ADRS are specified following.

X ADRS   00H~4FH (Lower 7bits are valid)
Y ADRS   00H~1FH (Lower 5bits are valid)

| 1 screen drive | 2 screens drive |
| X ADRS 00~4FH | X ADRS 00~4FH |

| Y ADRS 00H~0FH | Y ADRS 00H~0FH Upper screen |
| | Y ADRS 10H~1FH Lower screen |

(2) Offset Register Set

The offset register is used to determine external character generator RAM area.

T6963C has 16 bit address lines as follow.

MSB   LSB

ad15	ad14	ad13	ad12	ad11	ad10	ad9	ad8	ad7	ad6	ad5	ad4	ad3	ad2	ad1	ad0

The upper 5 bit (ad15~ad11) are determined by offset register. The middle 8 bit (ad10~ad3) are determined by character code. The lower 3 bit (ad2~ad0) are determined by vertical counter. The lower 5 bit of D1 (data) are valid. The data format of external character generator RAM.

The ralationship of display RAM address and offset register

Data of offset register	CG RAM HEX address(start-end)
00000	0000-07FFH
00001	0800-0FFFH
00010	1000-17FFH
11100	E000-E7FFH
11101	E800-EFFFH
11110	F000-F7FFH
11111	F800-FFFFH

(Example 1)

Offset register	02H
Character code	80H
Character generator RAM start address	0001 0100 0000 0000
	1 4 0 0 H

(Address)	(Data)
1400H	00H
1401H	1FH
1402H	04H
1403H	04H
1404H	04H
1405H	04H
1406H	04H
1407H	00H

(Example 2)

The relationship of display RAM data and display character

A B γ D E ζ G H I J K L M

Display character

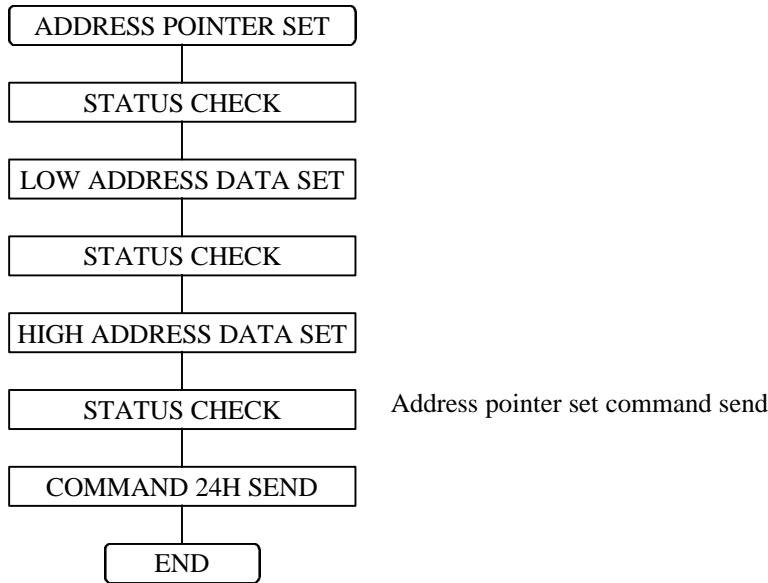| (RAM Data)	(Character)
21H	A
22H	B
83H	γ
24H	D
25H	E
86H	ζ

Note : γ and ζ are displated by character generator RAM.

(3) Address Pointer Set

The address pointer set command is used to indicate the start address for writing (or reading) to external RAM.

The flow chart address pointer set command

```
        ┌─────────────────────────┐
        │  ADDRESS POINTER SET     │
        └─────────────────────────┘
                    │
        ┌─────────────────────────┐
        │     STATUS CHECK         │
        └─────────────────────────┘
                    │
        ┌─────────────────────────┐
        │  LOW ADDRESS DATA SET    │
        └─────────────────────────┘
                    │
        ┌─────────────────────────┐
        │     STATUS CHECK         │
        └─────────────────────────┘
                    │
        ┌─────────────────────────┐
        │  HIGH ADDRESS DATA SET   │
        └─────────────────────────┘
                    │
        ┌─────────────────────────┐
        │     STATUS CHECK         │        Address pointer set command send
        └─────────────────────────┘
                    │
        ┌─────────────────────────┐
        │   COMMAND 24H SEND       │
        └─────────────────────────┘
                    │
            ┌───────────────┐
            │     END       │
            └───────────────┘
```

● Control Word Set

Code	Hex	Function	D1	D2
01000000	40H	Text home address set	Low address	High address
01000001	41H	Text area set	Columns	00H
01000010	42H	Graphic home address set	Low address	High address
01000011	43H	Graphic area set	Columns	00H

The home address and column size are defined by this command.

(1) Text Home Address Set
The starting address of external display RAM for Text display is defined by this command. The text home address shows the left end and most upper position.

The relationship of external display RAM address and display position

TH		TH+CL
TH+TA		TH+TA+CL
(TH+TA)+TA		TH+2TA+CL
(TH+2TA)+TA		TH+3TA+CL
TH+(n-1)TA		TH+(n-1)TA+CL

TH : Text home address
TA : Text area number (columns)
CL : Columns are fixed by hardware. (pin-programmable)

(Example)
Text home address	:	0000H
Text area	:	0020H
MD2=H, MD3=L	:	32 columns
DUAL=H, MDX=L, MD0=L, MD1=H	:	4 lines

0000H	0001H		001EH	001FH
0020H	0021H		003EH	003FH
0040H	0041H		005EH	005FH
0060H	0061H		007EH	007FH

(2) Graphic Home Address Set

      The starting address of external display RAM for Graphic display is defined by this command. The graphic home address shows the left end most upper line.

The relationship of external display RAM address and display position

GH		GH+CL	
GH+GA		GH+GA+CL	
(GH+GA)+GA		GH+2GA+CL	
(GH+2GA)+GA		GH+3GA+CL	
GH+(n-1)GA		GH+(n-1)GA+CL	

GH : Graphic home address
GA : Graphic area number (colums)
CL : Columns are fixed by hardware. (pin-programmable)

(Example)
Graphic home address	:	0000H
Graphic area	:	0020H
MD2=H, MD3=L	:	32 columns
DUAL=H, MDS=L, MD0=H, MD1=H	:	2 lines

0000H	0001H		001EH	001FH
0020H	0021H		003EH	003FH
0040H	0041H		005EH	005FH
0060H	0061H		007EH	007FH
0080H	0081H		009EH	009FH
00A0H	00A1H		00BEH	00BFH
00C0H	00C1H		00DEH	00DFH
00E0H	00E1H		00FEH	00FFH
0100H	0101H		011EH	011FH
0120H	0121H		013EH	013FH
0140H	0141H		015EH	015FH
0160H	0161H		017EH	017FH
0180H	0181H		019EH	019FH
01A0H	01A1H		01BEH	01BFH
01C0H	01C1H		01DEH	01DFH
01E0H	01E1H		01FEH	01FFH

(3) Text Area Set

The columns of display are defined by the hardware setting. This command can be used to adjust columns of display.

(Example)
LCD size	:	20 columns, 4 lines
Text home address	:	0000H
Text area	:	0014H
MD2=H, MD3=L	:	32 columns
DUAL=H, MDS=L, MD0=L, MD1=H	:	4 lines

0000	0001	------	0013	0014	------	001F
0014	0015	------	0027	0028	------	0033
0028	0029	------	003B	003C	------	0047
003C	003D	------	004F	0050	------	005B

———————→   LCD   ←———————

(4) Graphic Area Set

The columns of display are defined by the hardware setting. This command can be used to adjust columns of graphic display.

(Example)
LCD size	:	20 columns, 2 lines
Text home address	:	0000H
Text area	:	0014H
MD2=H, MD3=L	:	32 columns
DUAL=H, MDS=L, MD0=H, MD1=H	:	2 lines

0000	0001	------	0013	0014	------	001F
0014	0015	------	0027	0028	------	0033
0028	0029	------	003B	003C	------	0047
003C	003D	------	004F	0050	------	005B
0050	0051	------	0063	0064	------	006F
0064	0065	------	0077	0078	------	0083
0078	0079	------	008B	008C	------	0097
008C	008D	------	009F	00A0	------	00AB
00A0	00A1	------	00B3	00B4	------	00BF
00B4	00B5	------	00C7	00C8	------	00D3
00C8	00C9	------	00DB	00DC	------	00E7
00DC	00DD	------	00EF	00F0	------	00FD
00F0	00F1	------	0103	0104	------	011F
0104	0105	------	0127	0128	------	0123
0128	0129	------	013B	013C	------	0147
013C	013D	------	014F	0150	------	015B

———————→   LCD   ←———————

The address in graphic area can be continuous and RAM area can be used without ineffective area, if graphic area is defined the same number as the actual column number of LCD display.

● Mode Set

Code	Function	Operand
1000x000	"OR" Mode	---
1000x001	"EXOR" Mode	---
1000x011	"AND" Mode	---
1000x100	"TEXT ATTRIBUTE" Mode	---
10000xxx	Internal Character Generator Mode	---
10001xxx	External Character Generator Mode	---

x : Don't care

The display mode is defined by this command. The display mode don't have changed until to send next this command. Logically "OR" , "EXOR", "AND" of text and graphic dispaly can be displayed.

When internal character generator mode is selected, character code 00H~7FH are selected from built-in character generator ROM. The character code 80H~FFH are automatically selected external character generator RAM.

(Example)

Graphic   Text

"OR"   "AND"   "EXOR"
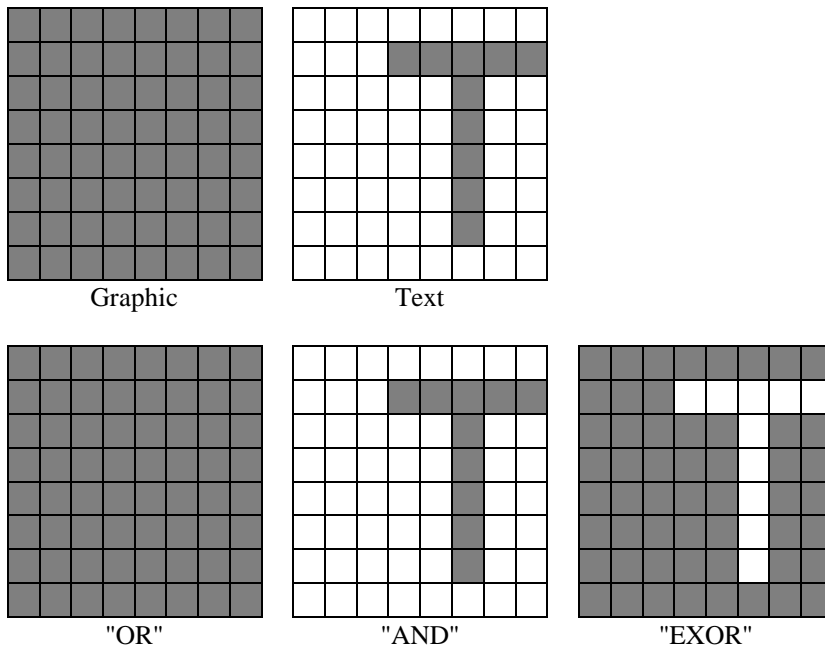
Note : Only text display is attributed, because attribute data is located in graphic RAM area.

Attribute function

"Reverse display", "Character blink" and "Inhibit" are called "Attribute". The attribute data is written in the graphic area defined by control word set command. The mode set command selects text display only and graphic display cannot be displayed.

The attribute data of the lst character in text area is written at the lst byte in graphic area, and attribute data of n-th character is written at the n-th byte in graphic area. Attribute function is defined as follow.

Attribute RAM byte | x | x | x | x | d3 | d2 | d1 | d0 |

d3	d2	d1	d0	Function
0	0	0	0	Normal display
0	1	0	1	Reverse display
0	0	1	1	Inhibit display
1	0	0	0	Blink of normal display
1	1	0	1	Blink of reverse display
1	0	1	1	Blink of inhibit display

● Display Mode

Code	Function	Operand
10010000	Display off	---
1001xx10	Cursor on, blink off	---
1001xx11	Cursor on, blink on	---
100101xx	Text on, graphic off	---
100110xx	Text off, graphic on	---
100111xx	Text on, graphic on	---

1	0	0	1	d3	d2	d1	d0

d0:   Cursor blink   on : 1, off : 0
d1:   Cursor display   on : 1, off : 0
d2:   Text display   on : 1, off : 0
d3:   Graphic display   on : 1, off : 0

Note : It is necessary to turn on "Text display" and "Graphic display" in following case.
1) Combination of text/graphic display,   2) Attribute function.

● Cursor Pattern Select

Code	Function	Operand
10100000	1 line cursor	---
10100001	2 lines cursor	---
10100010	3 lines cursor	---
10100011	4 lines cursor	---
10100100	5 lines cursor	---
10100101	6 lines cursor	---
10100110	7 lines cursor	---
10100111	8 lines cursor	---

When cursor display is ON, this command selects the cursor pattern from 1 line to 8 lines. The cursor address is defined by cursor pointer set command.

1 line cursor   2 lines cursor   8 lines cursor
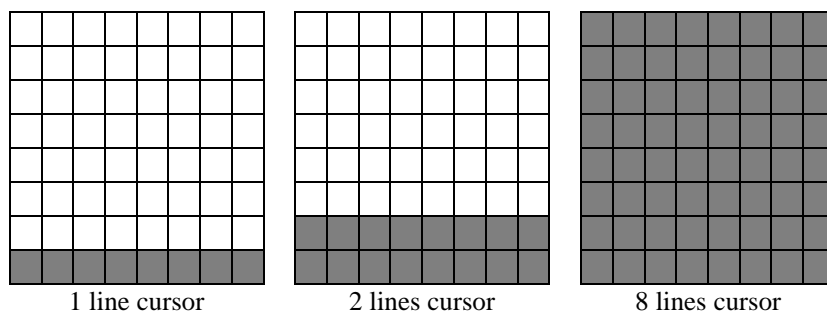
● Data Auto Read/Write

Code	Hex	Function	Operand
10110000	B0H	Data auto write set	---
10110001	B1H	Data auto read set	---
10110010	B2H	Auto reset	---

This command is convenient to send full screen data from external display RAM. After setting auto mode, "Data write (or read)" command is not necessary between each data. "Data auto write (or read)" command should follow the "Address pointer set" and address pointer is automatically increment by + 1 after each data. After sending (or receiving) all data "Auto reset" is necessary to return normal operation because all data is regarded "Display data" and no command can be accepted in the auto mode.

Note : Status check for auto mode (STA2,STA3) should be checked between each data. Auto reset should be performed after checking STA3=1 (STA2=1). Please refer following flow chart.

AUTO MODE START

STATUS CHECK 1

LOWER ADDRESS DATA

STATUS CHECK 1

UPPER ADDRESS DATA

STATUS CHECK 1

ADDRESS POINTER SET 24H

STATUS CHECK 1

DATA AUTO WRITE B0H

STATUS CHECK 2

DISPLAY DATA SEND

STATUS CHECK 2

DISPLAY DATA SEND

STATUS CHECK 2

AUTO RESET B2H

END

STATUS CHECK 1

STA0=1, STA2=1?   NO

YES

RETURN

STATUS CHECK 2

STA2=1, (STA3=1)?   NO

YES

RETURN
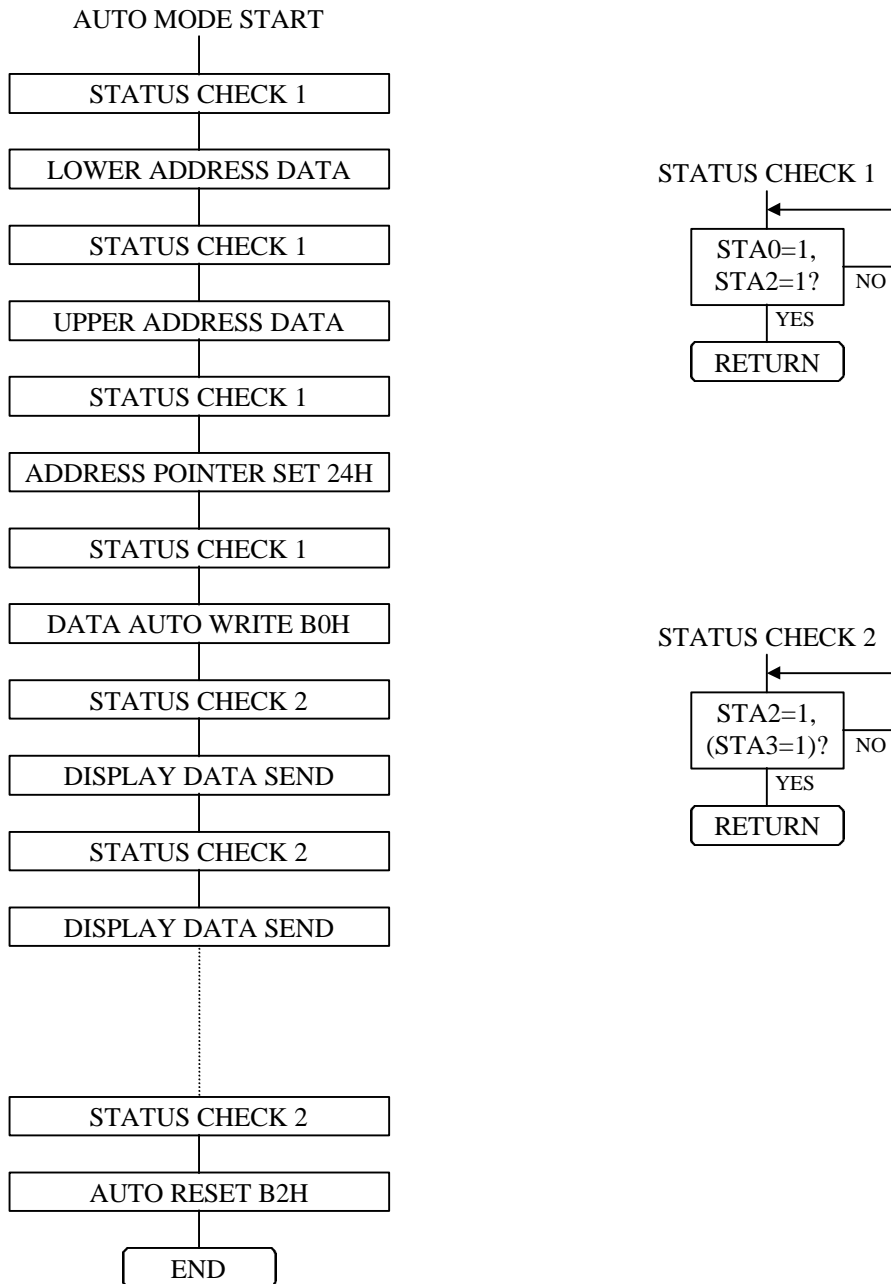
● Data Read Write

Code	Hex	Function	Operand
11000000	C0H	Data write and ADP increment	Data
11000001	C1H	Data read and ADP increment	---
11000010	C2H	Data write and ADP decrement	Data
11000011	C3H	Data read and ADP decrement	---
11000100	C4H	Data write and ADP nonvariable	Data
11000101	C5H	Data read and ADP nonvariable	---

This command is used for data write from MPU to external display RAM, and data read from external display RAM to MPU. Data write/data read should be executed after setting address by address pointer set command. Address pointer can be automatically increment or decrement by setting this command.

Note : This command is necessary for each 1 byte data. Please refer following flow chart.

DATA WRITE START

STATUS CHECK 1

LOWER ADDRESS DATA

STATUS CHECK 1

UPPER ADDRESS DATA

STATUS CHECK 1

ADDRESS POINTER SET 24H

STATUS CHECK 1

WRITE DATA SET

STATUS CHECK 1

DATA WRITE C0H

END

DATA READ

ADDRESS POINTER SET

STATUS CHECK 1

DATA READ C1H

END
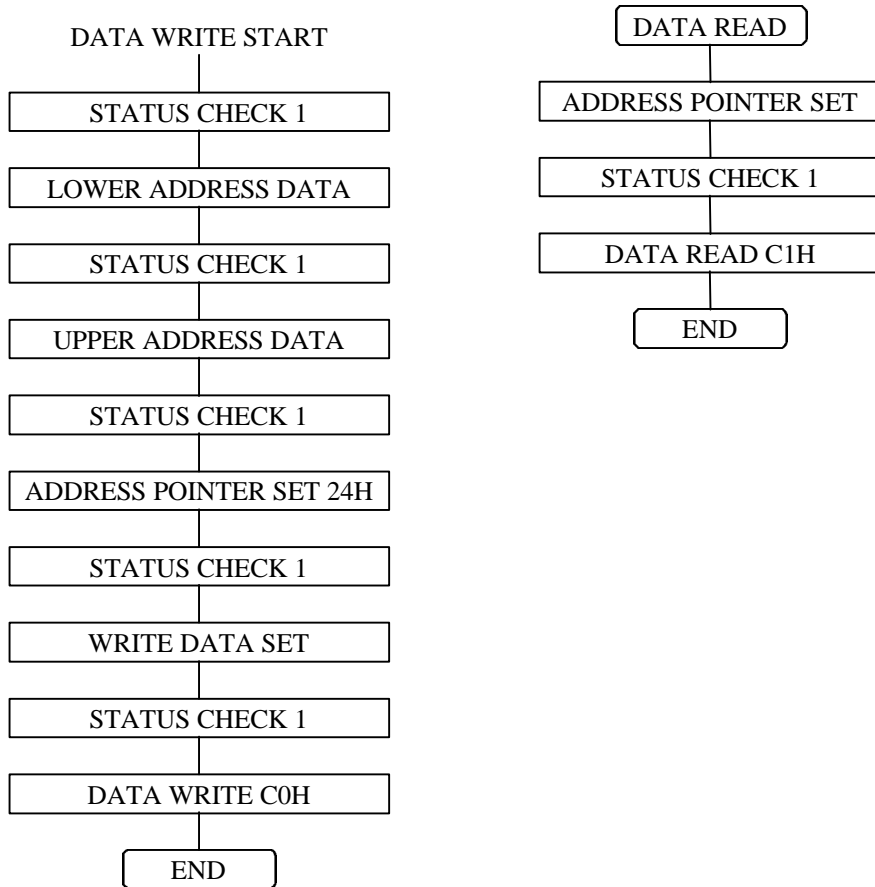
● Screen Peek

Code	Hex	Function	Operand
11100000	E0H	Screen Peek	---

This command is used to transfer displayed 1 byte data to data stack, and this 1 byte data can be read from MPU by data access. The logical combination data of text and graphic display on LCD screen can be read by this command.

The status (STA6) should be checked just after "Screen peek" command. If the address determined by "Address pointer Set" command is not in graphic area, this command ignored and status flag (STA6) is set. Please refer following flow chart.

SCREEN PEEK START

STATUS CHECK 1

LOWER ADDRESS DATA

STATUS CHECK 1

UPPER ADDRESS DATA

STATUS CHECK 1

ADDRESS POINTER SET 24H

STATUS CHECK 1

SCREEN PEEK E0H

STATUS CHECK STA6=0?   NO

YES

STATUS CHECK 1

DATA ACCESS

END
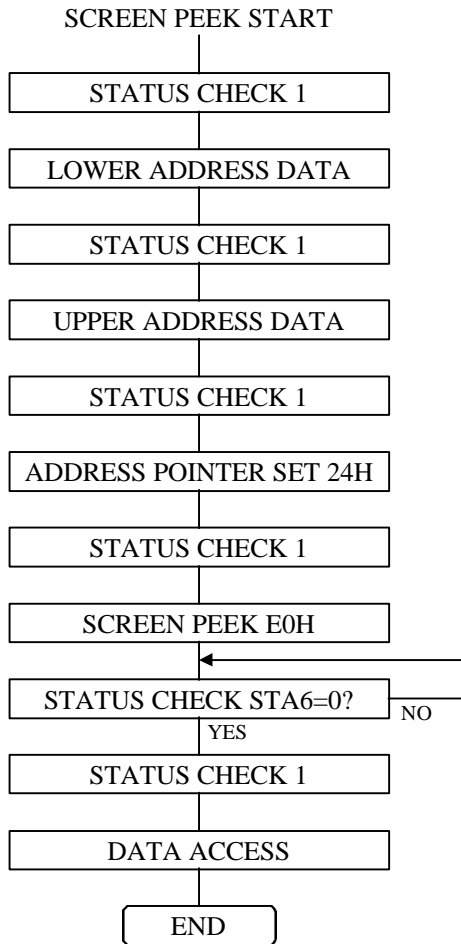
● Screen Copy

Code	Hex	Function	Operand
11101000	E8H	Screen copy	---

This command is used to copy displayed 1 line data to graphic area. The start point of 1 line data in the screen is determined by the address pointer. Please refer following flow chart.

Note 1 : In attribute function, this command is invalid. (Because attribute data is in the graphic area.)
Note 2 : In case of 2 screen drive, this command is invalid. (Because T6963C cannot separate upper screen data and lower screen data.)

SCREEN COPY START

STATUS CHECK 1

LOWER ADDRESS DATA

STATUS CHECK 1

UPPER ADDRESS DATA

STATUS CHECK 1

ADDRESS POINTER SET 24H

STATUS CHECK 1

SCREEN COPY E8H

STATUS CHECK STA6=0?　　YES

NO

STATUS CHECK STA0/1=1?

NO

YES

END
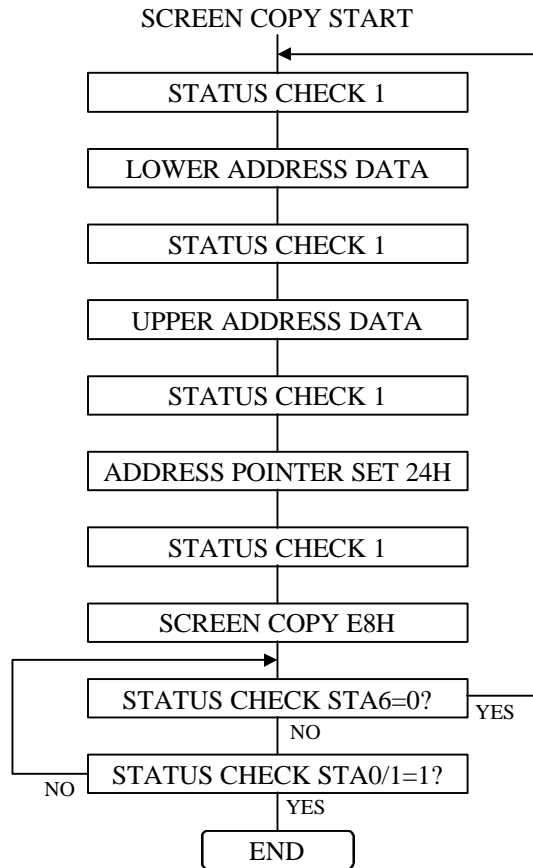
● Bit Set/Reset

Code	Function	Operand
11110xxx	bit reset	---
11111xxx	bit set	---
1111x000	bit 0 (LSB)	---
1111x001	bit 1	---
1111x010	bit 2	---
1111x011	bit 3	---
1111x100	bit 4	---
1111x101	bit 5	---
1111x110	bit 6	---
1111x111	bit 7 (MSB)	---

   This command is used to set or reset a bit of 1 byte is specified by address pointer. Plural bits in the 1 byte data cannot be set/reset at a time. Please refer following flow chart.

BIT SET/RESET

STATUS CHECK 1

LOWER ADDRESS DATA

STATUS CHECK 1

UPPER ADDRESS DATA

STATUS CHECK 1

ADDRESS POINTER SET 24H

STATUS CHECK 1

WRITE DATA SET

STATUS CHECK 1

BIT SET (RESET)

END
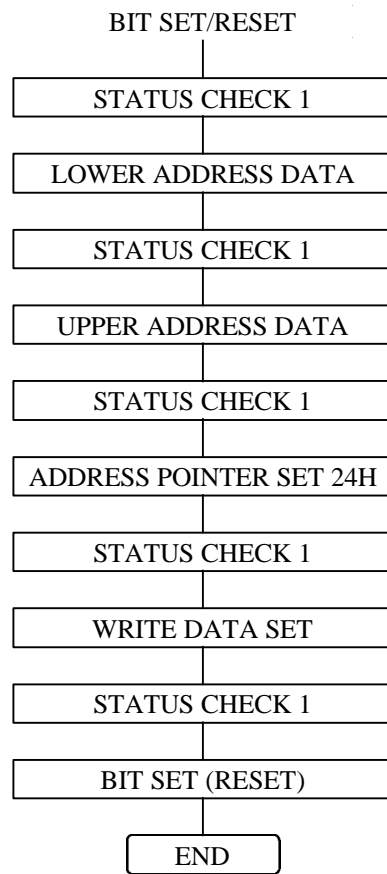
◆ **Command List**

Command	Code	D1	D2	Function
Register Set	00100001	X address	Y address	Cursor pointer set
	00100010	Data	00H	Offset register set
	00100100	Low address	High address	Address pointer set
Control Word Set	01000000	Low address	High address	Text home address set
	01000001	Columns	00H	Text area set
	01000010	Low address	High address	Graphic home address set
	01000011	Columns	00H	Graphic area set
Mode Set	1000x000	---	---	"OR" mode
	1000x001	---	---	"EXOR" mode
	1000x011	---	---	"AND" mode
	1000x100	---	---	"Text attribute" mode
	10000xxx	---	---	Internal CG ROM mode
	10001xxx	---	---	External CG RAM mode
Display Mode	10010000	---	---	Display off
	1001xx10	---	---	Cursor on, blink off
	1001xx11	---	---	Cursor on, blink on
	100101xx	---	---	Text on, graphic off
	100110xx	---	---	Text off, graphic on
	100111xx	---	---	Text on, graphic on
Cursor Pattern Select	10100000	---	---	1 line cursor
	10100001	---	---	2 lines cursor
	10100010	---	---	3 lines cursor
	10100011	---	---	4 lines cursor
	10100100	---	---	5 lines cursor
	10100101	---	---	6 lines cursor
	10100110	---	---	7 lines cursor
	10100111	---	---	8 lines cursor
Data Auto Read/Write	10110000	---	---	Data auto write set
	10110001	---	---	Data auto read set
	10110010	---	---	Auto reset
Data Read Write	11000000	Data	---	Data write and ADP increment
	11000001	---	---	Data read and ADP increment
	11000010	Data	---	Data write and ADP decrement
	11000011	---	---	Data read and ADP decrement
	11000100	Data	---	Data write and ADP nonvariable
	11000101	---	---	Data read and ADP nonvariable
Screen Peek	11100000	---	---	Screen peek
Screen Copy	11101000	---	---	Screen copy
Bit Set/Reset	11110xxx	---	---	bit reset
	11111xxx	---	---	bit set
	1111x000	---	---	bit 0 (LSB)
	1111x001	---	---	bit 1
	1111x010	---	---	bit 2
	1111x011	---	---	bit 3
	1111x100	---	---	bit 4
	1111x101	---	---	bit 5
	1111x110	---	---	bit 6
	1111x111	---	---	bit 7 (MSB)

◆ **Character Code Map**

ROM CODE 0101

■ ELECTRO-OPTICAL CHARACTERISTICS (V_{OP} = 13.8V, Ta = 25°C)

LCD mode	Typ response time Tr (ms)		Typ response time Tf (ms)		Typ contrast ratio Cr	Typ viewing angle φ (deg)			
	Normal temp	Wide temp	Normal temp	Wide temp		Æ = 0°	Æ = 90°	Æ = 180°	Æ = 270°
STN Y/G (B)	331	167	91	66	14	55	30	34	28
STN Blue (C)					4	47	24	29	23
STN Grey (D)					7	54	28	32	28
FSTN (F)					21	60	45	53	43
FSTN Negative (G)					9	48	24	30	23

Note1: Definition of response time.
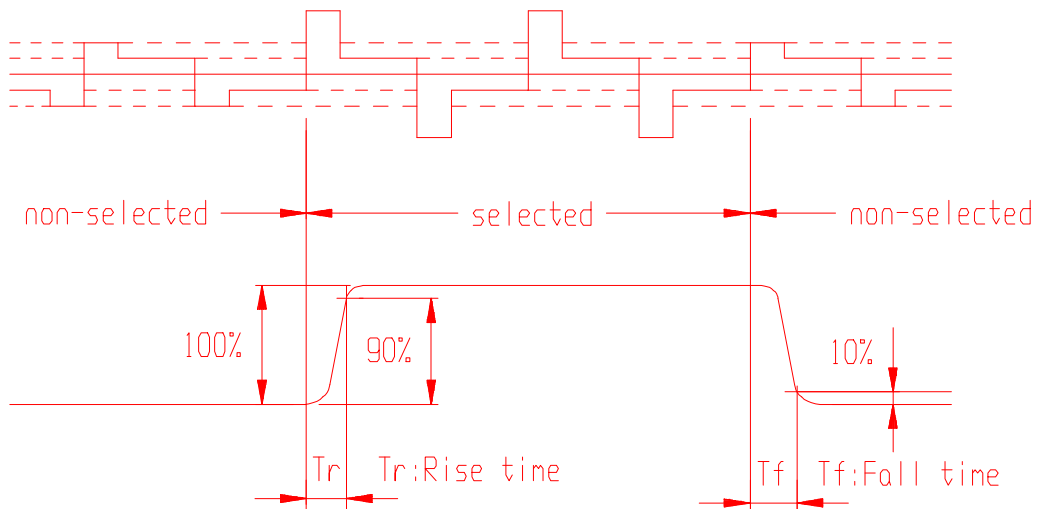
Note2: Definition of contrast ratio 'Cr'   .
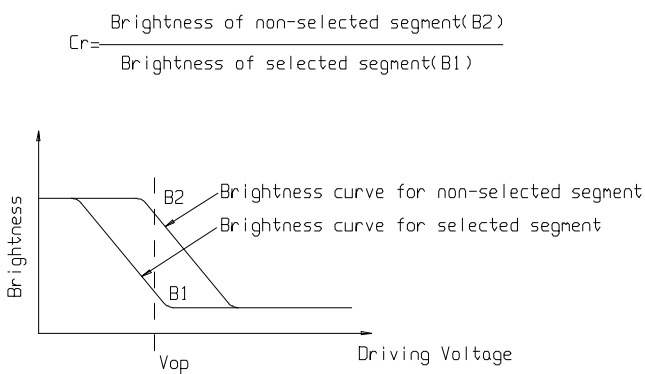
Note3: Definition of viewing angle range 'θ'.
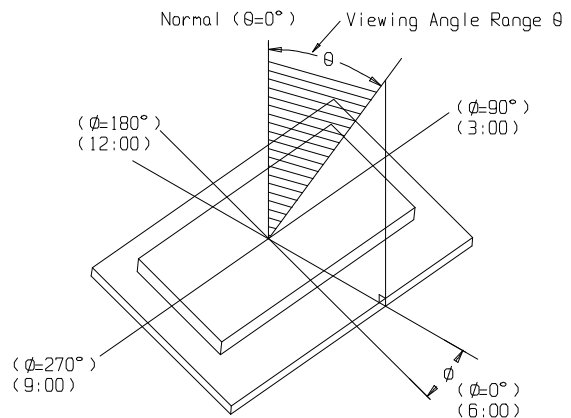
■ INTERFACE PIN CONNECTIONS

Pin No.	Symbol	Level	Description
1	FG	0V	Frame ground
2	VSS	0V	Ground
3	VDD	5.0V	Supply voltage for logic
4	VO	---	Input voltage for LCD
5	WR	L	Write signal
6	RD	L	Read signal
7	CE	L	Chip enable signal
8	C/D	H/L	H : Instruction signal, L : Data signal
9	NC	---	No connection
10	RESET	L	Reset signal
11	DB0	H/L	Data bit 0
12	DB1	H/L	Data bit 1
13	DB 2	H/L	Data bit 2
14	DB 3	H/L	Data bit 3
15	DB 4	H/L	Data bit 4
16	DB 5	H/L	Data bit 5
17	DB 6	H/L	Data bit 6
18	DB 7	H/L	Data bit 7
19	FS	H/L	Font select signal (H : 6 x 8 dots, L : 8 x 8 dots)
20	VOUT	-15V	Output voltage for LCD
21	A	---	Side light anode
22	K	---	Side light cathode

■ CIRCUIT DIAGRAM
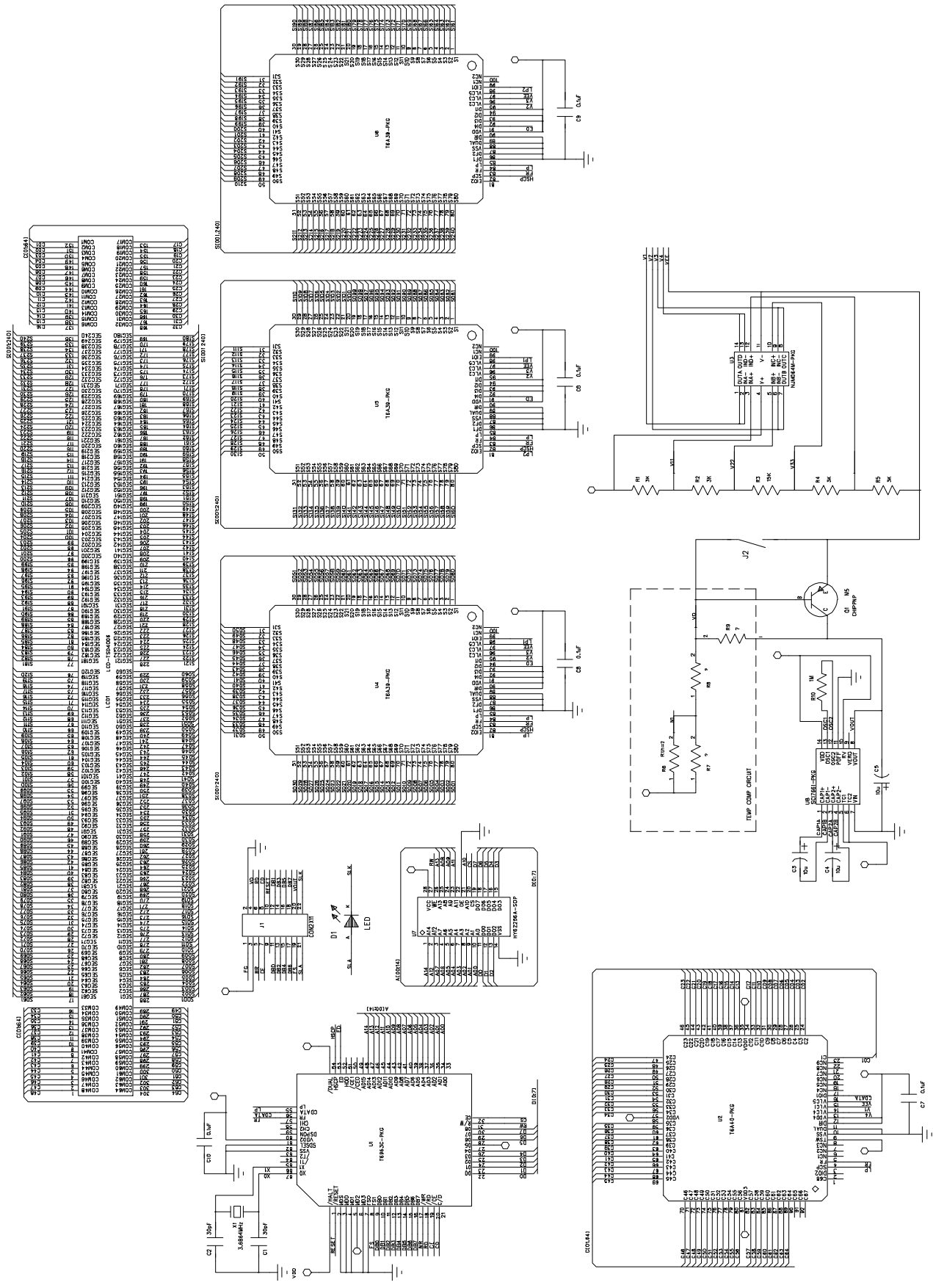
■ RELIABILITY

◆ Content of Reliability Test

No.	Test Item	Content of Test	Test Condition	Applicable Standard
\<td colspan=5 align=center>**Environmental Test**\</td>				
1	High temperature storage	Endurance test applying the high storage temperature for a long time.	60 °C 200 hrs	------
2	Low temperature storage	Endurance test applying the low storage temperature for a long time.	-10 °C 200 hrs	------
3	High temperature operation	Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.	50 °C 200 hrs	------
4	Low temperature operation	Endurance test applying the electric stress under low temperature for a long time.	0 °C 200 hrs	------
5	High temperature / Humidity storage	Endurance test applying the high temperature and high humidity storage for a long time.	60 °C , 90 %RH 96 hrs	MIL-202E-103B JIS-C5023
6	High temperature / Humidity operation	Endurance test applying the electric stress (Voltage & Current) and temperature / humidity stress to the element for a long time.	40 °C , 90 %RH 96 hrs	MIL-202E-103B JIS-C5023
7	Temperature cycle	Endurance test applying the low and high temperature cycle. -10°C ⇌ 25°C ⇌ 60°C 30min 5min. 30min ← 1 cycle →	-10°C / 60°C 10 cycles	------
\<td colspan=5 align=center>**Mechanical Test**\</td>				
8	Vibration test	Endurance test applying the vibration during transportation and using.	10~22Hz → 1.5mmp-p 22~500Hz → 1.5G Total 0.5hrs	MIL-202E-201A JIS-C5025 JIS-C7022-A-10
9	Shock test	Constructional and mechanical endurance test applying the shock during transportation.	50G half sign wave 1l msedc 3 times of each direction	MIL-202E-213B
10	Atmospheric pressure test	Endurance test applying the atmospheric pressure during transportation by air.	115 mbar 40 hrs	MIL-202E-105C
\<td colspan=5 align=center>**Others**\</td>				
11	Static electricity test	Endurance test applying the electric stress to the terminal.	VS=800V , RS=1.5 kΩ CS=100 pF 1 time	MIL-883B-3015.1

∗∗∗ Supply voltage for logic system = 5V. Supply voltage for LCD system = Operating voltage at 25°C.

◆ Failure Judgement Criterion

Criterion Item	Test Item No.											Failure Judgment Criterion
	1	2	3	4	5	6	7	8	9	10	11	
Basic specification												Out of the Basic Specification
Electrical characteristic												Out of the DC and AC Characterstic
Mechanical characterstic												Out of the Mechanical Specification Color change : Out of Limit Apperance Specification
Optical characterstic												Out of the Apperance Standard

■ QUALITY GUARANTEE

◆ Acceptable Quality Level

Each lot should satisfy the quality level defined as follows.
- Inspection method : MIL-STD-105E LEVEL II Normal one time sampling
- AQL

Partition	AQL	Definition
A: Major	0.4%	Functional defective as product
B: Minor	1.5%	Satisfy all functions as product but not satisfy cosmetic standard

◆ Definition of 'LOT'

One lot means the delivery quantity to customer at one time.

◆ Conditions of Cosmetic Inspection

● Environmental condition

The inspection should be performed at the 1m of height from the LCD module under 2 pieces of 40W white fluorescent lamps (Normal temperature 20~25°C and normal humidity 60±15%RH).

● Inspection method

The visual check should be performed vertically at more than 30cm distance from the LCD panel.

● Driving voltage

The V_O value which the most optimal contrast can be obtained near the specified V_O in the specification. (Within ±0.5V of the typical value at 25°C.).

■ INSPECTION CRITERIA

◆ Module Cosmetic Criteria

No.	Item	Judgement Criterion	Partition
1	Difference in Spec.	None allowed	Major
2	Pattern peeling	No substrate pattern peeling and floating	Major
3	Soldering defects	No soldering missing	Major
		No soldering bridge	Major
		No cold soldering	Minor
4	Resist flaw on substrate	Invisible copper foil (∅0.5mm or more) on substrate pattern	Minor
5	Accretion of metallic Foreign matter	No soldering dust	Minor
		No accretion of metallic foreign matters (Not exceed ∅0.2mm)	Minor
6	Stain	No stain to spoil cosmetic badly	Minor
7	Plate discoloring	No plate fading, rusting and discoloring	Minor
8	Solder amount 1. Lead parts	a. Soldering side of PCB Solder to form a 'Filet' all around the lead. Solder should not hide the lead form perfectly. (too much) b. Components side (In case of 'Through Hole PCB') Solder to reach the Components side of PCB.	Minor
	2. Flat packages	Either 'toe' (A) or 'heal' (B) of the lead to be covered by 'Filet'. Lead form to be assume over solder.	Minor
	3. Chips	$(3/2) H \geq h \geq (1/2) H$	Minor

◆ **Screen Cosmetic Criteria (Non-Operating)**

No.	Defect	Judgement Criterion	Partition
1	Spots	In accordance with *Screen Cosmetic Criteria (Operating) No.1*.	Minor
2	Lines	In accordance with *Screen Cosmetic Criteria (Operating) No.2*.	Minor
3	Bubbles in polarizer	<table><tr><td>Size : d mm</td><td>Acceptable Qty in active area</td></tr><tr><td>d ≤ 0.3</td><td>Disregard</td></tr><tr><td>0.3 < d ≤ 1.0</td><td>3</td></tr><tr><td>1.0 < d ≤ 1.5</td><td>1</td></tr><tr><td>1.5 < d</td><td>0</td></tr></table>	Minor
4	Scratch	In accordance with spots and lines operating cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable.	Minor
5	Allowable density	Above defects should be separated more than 30mm each other.	Minor
6	Coloration	Not to be noticeable coloration in the viewing area of the LCD panels. Back-lit type should be judged with back-lit on state only.	Minor
7	Contamination	Not to be noticeable.	Minor
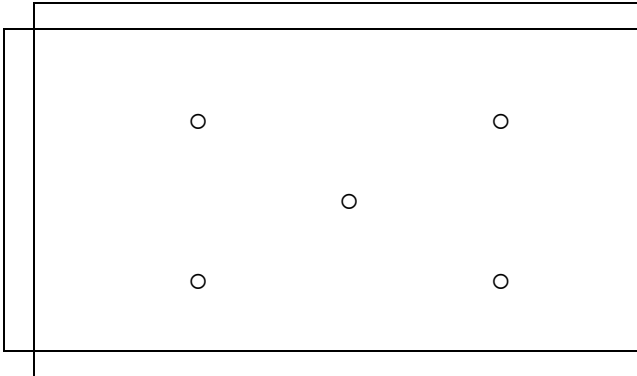
◆ **Screen Cosmetic Criteria (Operating)**

No.	Defect	Judgement Criterion	Partition
1	Spots	A) Clear <table><tr><td>Size : d mm</td><td>Acceptable Qty in active area</td></tr><tr><td>d ≤ 0.1</td><td>Disregard</td></tr><tr><td>0.1 < d ≤ 0.2</td><td>6</td></tr><tr><td>0.2 < d ≤ 0.3</td><td>2</td></tr><tr><td>0.3 < d</td><td>0</td></tr></table> Note : Including pin holes and defective dots which must be within one pixel size. B) Unclear <table><tr><td>Size : d mm</td><td>Acceptable Qty in active area</td></tr><tr><td>d ≤ 0.2</td><td>Disregard</td></tr><tr><td>0.2 < d ≤ 0.5</td><td>6</td></tr><tr><td>0.5 < d ≤ 0.7</td><td>2</td></tr><tr><td>0.7 < d</td><td>0</td></tr></table>	Minor
2	Lines	A) Clear L 5.0 ┐ ∞ │ (0) 2.0 │ (6) │ See No. 1 └─────── W 0.02　0.05　　0.1 Note : ( ) - Acceptable Qty in active area 　　L - Length (mm) 　　W - Width (mm) 　　∞ - Disregard B) Unclear L 10.0 ┐ ∞ │ (0) (6) 2.0 │ See No. 1 └─────── W 0.05　　　0.3　　　0.5	Minor

'Clear'　　 = The shade and size are not changed by V$_O$.
'Unclear' = The shade and size are changed by V$_O$.

◆ **Screen Cosmetic Criteria (Operating) (Continued)**

No.	Defect	Judgement Criterion	Partition
3	Rubbing line	Not to be noticeable.	
4	Allowable density	Above defects should be separated more than 10mm each other.	Minor
5	Rainbow	Not to be noticeable.	Minor
6	Dot size	To be 95% ~ 105% of the dot size (Typ.) in drawing. Partial defects of each dot (ex. pin-hole) should be treated as 'spot'. (see *Screen Cosmetic Criteria (Operating) No.1*)	Minor
7	Uneven brightness (only back-lit type module)	Uneven brightness must be BMAX / BMIN $\leq$ 2 - BMAX : Max. value by measure in 5 points - BMIN : Min. value by measure in 5 points Divide active area into 4 vertically and horizontally. Measure 5 points shown in the following figure. ○ : Measuring points	Minor

Note :

    (1) Size : d = (long length + short length) / 2

    (2) The limit samples for each item have priority.

    (3) Complexed defects are defined item by item, but if the number of defects are defined in above table, the total number should not exceed 10.

    (4) In case of 'concentration', even the spots or the lines of 'disregarded' size should not allowed. Following three situations should be treated as 'concentration'.

        - 7 or over defects in circle of ∅5mm.

        - 10 or over defects in circle of ∅10mm.

        - 20 or over defects in circle of ∅20mm.

■ PRECAUTIONS FOR USING LCD MODULES

◆ **Handing Precautions**

    (1) The display panel is made of glass. Do not subject it to a mechanical shock by dropping it or impact.

    (2) If the display panel is damaged and the liquid crystal substance leaks out, be sure not to get any in your mouth. If the substance contacts your skin or clothes, wash it off using soap and water.

    (3) Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.

    (4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.

    (5) If the display surface becomes contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, moisten cloth with one of the following solvents :

        - Isopropyl alcohol

        - Ethyl alcohol

    (6) Solvents other than those above-mentioned may damage the polarizer. Especially, do not use the following.

        - Water

        - Ketone

        - Aromatic solvents

    (7) Exercise care to minimize corrosion of the electrode. Corrosion of the electrodes is accelerated by water droplets, moisture condensation or a current flow in a high-humidity environment.

(8) Install the LCD Module by using the mounting holes. When mounting the LCD module make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the I/O cable or the backlight cable.

(9) Do not attempt to disassemble or process the LCD module.

(10) NC terminal should be open. Do not connect anything.

(11) If the logic circuit power is off, do not apply the input signals.

(12) To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

- Be sure to ground the body when handling the LCD modules.

- Tools required for assembling, such as soldering irons, must be properly grounded.

- To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions.

- The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated.

◆ Storage Precautions

When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps. Keep the modules in bags (avoid high temperature / high humidity and low temperatures below 0°C). Whenever possible, the LCD modules should be stored in the same conditions in which they were shipped from our company.

◆ Others

Liquid crystals solidify under low temperature (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subject to a low temperature.

If the LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.

To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity etc., exercise care to avoid holding the following sections when handling the modules.

- Exposed area of the printed circuit board.

- Terminal electrode sections.

■ USING LCD MODULES

◆ Liquid Crystal Display Modules

LCD is composed of glass and polarizer. Pay attention to the following items when handling.

(1) Please keep the temperature within specified range for use and storage. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature and high humidity.

(2) Do not touch, push or rub the exposed polarizers with anything harder than an HB pencil lead (glass, tweezers, etc.).

(3) N-hexane is recommended for cleaning the adhesives used to attach front/rear polarizers and reflectors made of organic substances which will be damaged by chemicals such as acetone, toluene, ethanol and isopropylalcohol.

(4) When the display surface becomes dusty, wipe gently with absorbent cotton or other soft material like chamois soaked in petroleum benzin. Do not scrub hard to avoid damaging the display surface.

(5) Wipe off saliva or water drops immediately, contact with water over a long period of time may cause deformation or color fading.

(6) Avoid contacting oil and fats.

(7) Condensation on the surface and contact with terminals due to cold will damage, stain or dirty the polarizers. After products are tested at low temperature they must be warmed up in a container before coming is contacting with room temperature air.

(8) Do not put or attach anything on the display area to avoid leaving marks on.

(9) Do not touch the display with bare hands. This will stain the display area and degradate insulation between terminals (some cosmetics are determinated to the polarizers).

(10) As glass is fragile. It tends to become or chipped during handling especially on the edges. Please avoid dropping or jarring.

◆ Installing LCD Modules

The hole in the printed circuit board is used to fix LCM as shown in the picture below. Attend to the following items when installing the LCM.

(1) Cover the surface with a transparent protective plate to protect the polarizer and LC cell.
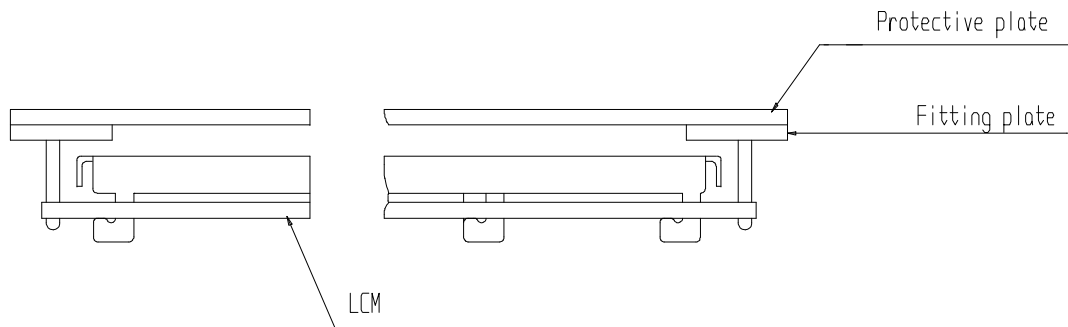
(2) When assembling the LCM into other equipment, the spacer to the bit between the LCM and the fitting plate should have enough height to avoid causing stress to the module surface, refer to the individual specifications for measurements. The measurement tolerance should be ±0.1mm.

◆ Precaution for Handing LCD Modules

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 the shape of the tab on the metal frame.

(2) Do not make extra holes on the printed circuit board, modify its shape or change the positions of components to be attached.

(3) Do not damage or modify the pattern writing on the printed circuit board.

(4) Absolutely do not modify the zebra rubber strip (conductive rubber) or heat seal connector.

(5) Except for soldering the interface, do not make any alterations or modifications with a soldering iron.

(6) Do not drop, bend or twist LCM.

◆ Electro-Static Discharge Control

Since this module uses a CMOS LSI, the same careful attention should be paid to electrostatic discharge as for an ordinary CMOS IC.

(1) Make certain that you are grounded when handing LCM.

(2) Before remove LCM from its packing case or incorporating it into a set, be sure the module and your body have the same electric potential.

(3) When soldering the terminal of LCM, make certain 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 potentiality to minimize as much as possible any transmission of electromagnetic waves produced 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 is not too dried. A relative humidity of 50%-60% is recommended.
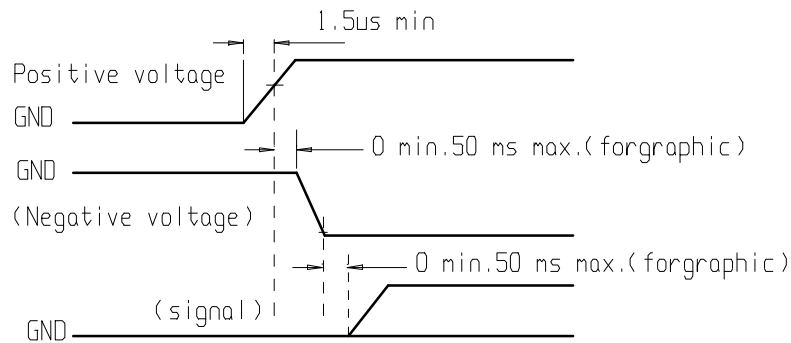
◆ Precaution for soldering to the LCM

(1) Observe the following when soldering lead wire, connector cable and etc. to the LCM.

     - Soldering iron temperature : 280°C ± 10°C.

     - Soldering time : 3-4 sec.

     - Solder : eutectic solder.

If soldering flux is used, be sure to remove any remaining flux after finishing to soldering operation. (This does not apply in the case of a non-halogen type of flux.) It is recommended that you protect the LCD surface with a cover during soldering to prevent any damage dur to flux spatters.

(2) When soldering the electroluminescent panel and PC board, the panel and board should not be detached more than three times. This maximum number is determined by the temperature and time conditions mentioned above, though there may be some variance depending on the temperature of the soldering iron.

(3) When remove the electoluminescent panel from the PC board, be sure the solder has completely melted, the soldered pad on the PC board could be damaged.

◆ **Precautions for Operation**

(1) Viewing angle varies with the change of liquid crystal driving voltage (V_O). Adjust V_O to show the best contrast.

(2) Driving the LCD in the voltage above the limit shortens its life.

(3) Response time is greatly delayed at temperature below the operating temperature range. However, this does not mean the LCD will be out of the order. It will recover when it returns to the specified temperature range.

(4) If the display area is pushed hard during operation, the display will become abnormal. However, it will return to normal if it is turned off and then back on.

(5) Condensation on terminals can cause an electrochemical reaction disrupting the terminal circuit. Therefore, it must be used under the relative condition of 40°C , 50% RH.

(6) When turning the power on, input each signal after the positive/negative voltage becomes stable.

```
                        1.5us min
                       |←───────→|
                       |    |
    Positive voltage   |    |_____
    GND _____/|
                            | |
                        →|  |←── 0 min.50 ms max.(forgraphic)
    GND _____|\  |
                        | \ |
    (Negative voltage)  |  \|_____
                        |    |
                      →|    |←── 0 min.50 ms max.(forgraphic)
                       |    |
           (signal)    |    |_____
    GND _____/
```

◆ **Storage**

When storing LCDs as spares for some years, the following precaution are necessary.

(1) Store them in a sealed polyethylene bag. If properly sealed, there is no need for dessicant.

(2) Store them in a dark place. Do not expose to sunlight or fluorescent light, keep the temperature between 0°C and 35°C.

(3) The polarizer surface should not come in contact with any other objects. (We advise you to store them in the container in which they were shipped.)

(4) Environmental conditions :

    - Do not leave them for more than 168hrs. at 60°C.

    - Should not be left for more than 48hrs. at -20°C.

◆ **Safety**

(1) It is recommended to crush damaged or unnecessary LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned.

(2) If any liquid leakes out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

◆ **Limited Warranty**

Unless agreed between DISPLAYTECH and customer, DISPLAYTECH will replace or repair any of its LCD modules which are found to be functionally defective when inspected in accordance with DISPLAYTECH LCD acceptance standards (copies available upon request) for a period of one year from date of shipments. Cosmetic/visual defects must be returned to DISPLAYTECH within 90 days of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of DISPLAYTECH limited to repair and/or replacement on the terms set forth above. DISPLAYTECH will not be responsible for any subsequent or consequential events.

◆ **Return LCM under warranty**

No warranty can be granted if the precautions stated above have been disregarded. The typical examples of violations are :

    - Broken LCD glass.

    - PCB eyelet's damaged or modified.

    - PCB conductors damaged.

    - Circuit modified in any way, including addition of components.

    - PCB tampered with by grinding, engraving or painting varnish.

    - soldering to or modifying the bezel in any manner.

Module repairs will be invoiced to the customer upon mutual agreement. Modules must be returned with sufficient description of the failures or defects. Any connectors or cable installed by the customer must be removed completely without damaging the PCB eyelet's, conductors and terminals.