深圳市华远显示器件有限公司
SHENZHEN HUAYUAN DISPLAY CO.,LTD.

液晶显示模块规格书
Specification for Liquid Crystal Display Module

HYG2406402C-bT62L-VA

Prepared By	Reviewed By	Approved By
Date:	Date:	Date:

REVISION HISTORY

The following table tracks the history of the changes made to this document.

SN	Rev.	Content	Date	Design
1	R00	Origin Released	2011-12-21	

CONTENTS

1. 0 GENERAL DESCRIPTION

The HYG2406402C-bT62L-VA is a 240x64 dots dot-matrix LCD module. It has a STN panel composed of 240 segments and 64 commons. The LCM can be easily accessed by microcontroller via 8080 series interface.
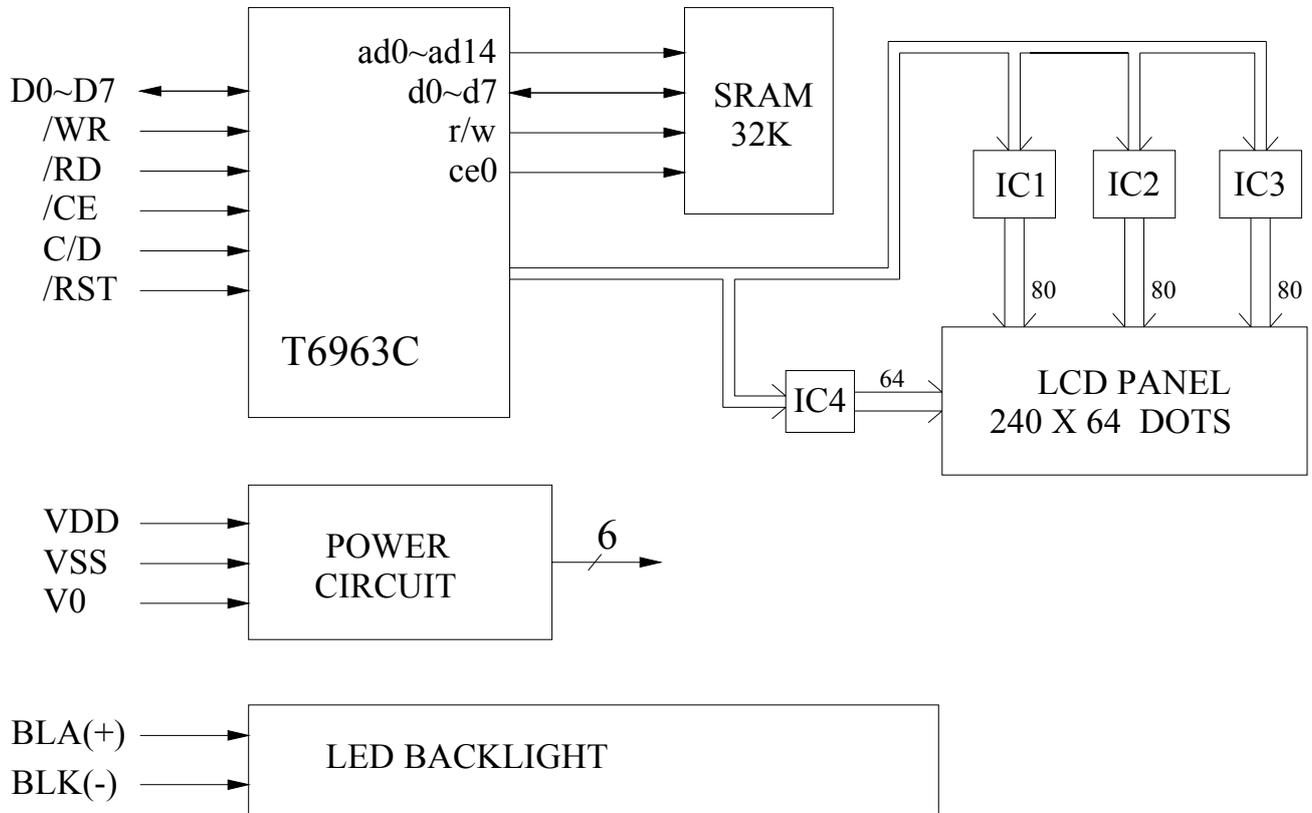
2. 0 FEATURES

Display Format	240 x 64 dots
LCD Type	STN-BLUE-NEGATIVE
Polarizer Mode	TRANSMISSIVE
Drive Method	1/64 Duty, 1/9 Bias
Viewing Direction	6 O'clock
Controller	T6963C
Interface	8080 Series 8-Bit Parallel Interface
Backlight	White LED Backlight

3. 0 MECHANICAL SPECIFICATION

Item	Description	Unit
Module Dimension	180.0(W) × 65.0(H) × 13.0(Max)(T)	mm
Viewing Area	132.0(W) × 39.0(H)	mm
Active Area	127.16(W) × 33.88(H)	mm
Dot Size	0.49(W) × 0.49(H)	mm
Dot Pitch	0.53(W) × 0.53(H)	mm
Character Size	——	mm

4. 0 BLOCK DIAGRAM

5.0   EXTERNAL DIMENSIONS

The diagram shows external dimensions of the LCD module with 240X64 DOTS display.

Key dimensions:
- 13.00 (max)
- 7.90±0.3
- 1.60±0.15
- 0.53, 0.49
- P2.54*10=25.40
- 13.00
- 4.25
- 2.54
- 0.49, 0.53
- 4-R1.75
- 22-?1.00
- 180.00±0.5 (PCB)
- 173.00±0.2
- 162.20±0.3 (BEZAL)
- 132.00±0.2 (VA)
- 127.16±0.15 (AA)
- 33.88±0.15 (AA)
- 39.00±0.2 (VA)
- 53.20±0.3 (BEZAL)
- 54.00±0.2
- 65.00±0.5 (PCB)

PIN No	1	2	3	4	5	6	7	8	9	10	11~18	19	20	21	22
Symbol	FG	VSS	VDD	V0	/WR	/RD	CE	C/D	NC	/RST	DB0~DB7	FS	VOUT	BLA	BLK

NOTE:
1. LCD TYPE: STN,BLUE,NEGATIVE
2. POLARIZER MODE: TRANSMISSIVE
3. DRIVE METHOD: 1/64 DUTY, 1/9 BIAS, Vop=12.0V
4. VIEWING DIR.: 6:00
5. OP. TEMP.: -20°C~70°C
6. ST. TEMP.: -30°C~80°C
7. BACKLIGHT: WHITE, Vf=5.0V, If=200mA,
8. LCD CONTROLLER: T6963C, VDD=5.0V

6. 0   INTERFACE PIN DESCRIPTIONS

PIN No.	Symbol	Level	Description
1	FG	—	Frame Ground
2	V_{SS}	P	Ground
3	V_{DD}	P	Power supply for logic(+5.0V)
4	V0	P	Power supply for LCD
5	/WR	H/L	Data Write. Write data into T6963C when /WR = L.
6	/RD	H/L	Data Read. Read data fromT6963C when RD = L.
7	/CE	H/L	Chip Enable for T6963C. /CE must be L when CPU communicates with T6963C.
8	C/D	H/L	/WR =L － C/D = H: Command Write C/D = L: Data Write /RD =L － C/D = H: Status Read C/D = L: Data Read
9	NC	--	No Connection
10	/RST	H/L	H ······ Normal (T6963C has internal pull−up resistor) L ······ Initialize T6963C. Text and graphic have addresses and text and graphic area settings are retained.
11	D0	H/L	Data Bit 0
12	D1	H/L	Data Bit 1
13	D2	H/L	Data Bit 2
14	D3	H/L	Data Bit 3
15	D4	H/L	Data Bit 4
16	D5	H/L	Data Bit 5
17	D6	H/L	Data Bit 6
18	D7	H/L	Data Bit 7
19	FS	H/L	Selection of font. FS= H:6*8 FS=L:8*8
20	VOUT	P	Built-in Negative Voltage Output
21	BLA	P	Power supply for LED Backlight (+5.0V)
22	BLK	P	Power supply for LED Backlight (0V)

7. 0 ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min.	Max.	Unit
Supply Voltage (Logic)	V_{DD}	-0.3	7.0	V
Supply Voltage (LCD)	V_{DD}	--	20.0	V
Input Voltage	VI	-0.3	V_{DD}+0.3	V
Operating Temperature	Topr	-20	70	℃
Storage Temperature	Tstg	-30	80	℃

8. 0 ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply voltage for Logic	V_{DD}	--	4.5	5.0	5.5	V
LCD Operating Voltage	V_{DD}-V5	-20℃				V
		+25℃	11.8	12.0	12.3	V
		+70℃				V
Input voltage H level	V_{IH}	--	V_{DD}-2.2	---	V_{DD}	V
Input voltage L level	V_{IL}	--	0	---	0.8	V
Output High Voltage	V_{OH}	--	V_{DD}-0.3	---	V_{DD}	V
Output Low Voltage	V_{OL}	--	0	---	0.3	V
Input Pull−up Resistance	RPU	--	50	100	200	KΩ
Operating Frequency	f_{OSC}	--	0.4	---	5.5	MHz

9. 0   OPTICAL CHARACTERISTICS

Item	Symbol	Condition		Min	Typ	Max	Unit
Response time	Ton	θ=0 ° and Ta=-20℃			--		ms
		θ=0 ° and Ta=+25℃			--		ms
		θ=0 ° and Ta=+70℃			--		ms
	Toff	θ=0 ° and Ta=-20℃			--		ms
		θ=0 ° and Ta=+25℃			--		ms
		θ=0 ° and Ta=+70℃			--		ms
Contrast ration	CR(MAX)	Ta=25℃		5	10		---
Viewing Angle	Ø	Deg θ=0 °	CR≥2.0 Ta=25℃		50		Deg
		Deg θ=90 °			35		
		Deg θ=180 °			30		
		Deg θ=270 °			35		
Crosstalk		Ta=25℃			1.2		---

9.1   Viewing Angle θ , Ø and Viewing Angle Range: △Ø =|Ø2-Ø1|
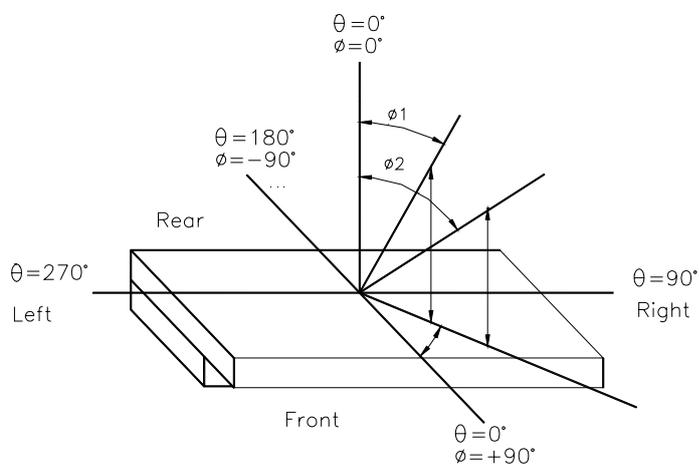
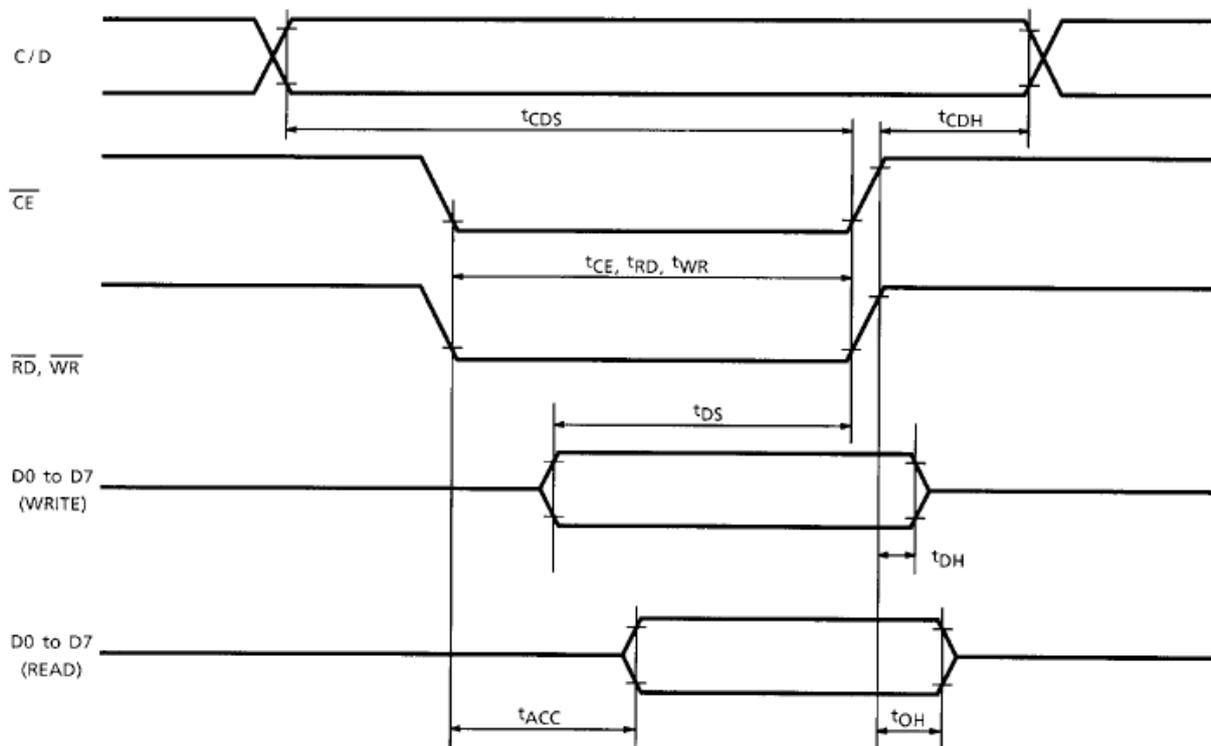## 9.2   Contrast ratio(CR)
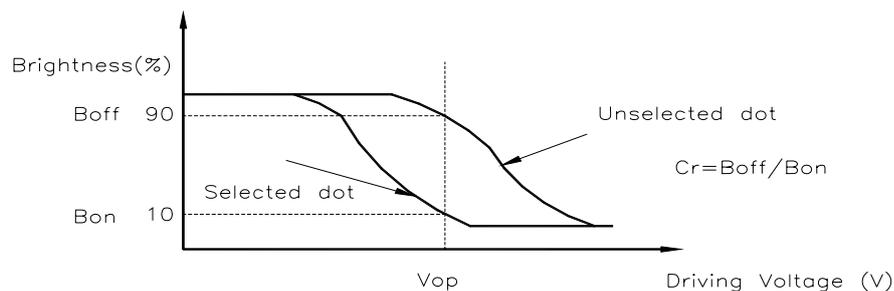
9.3   Response Time
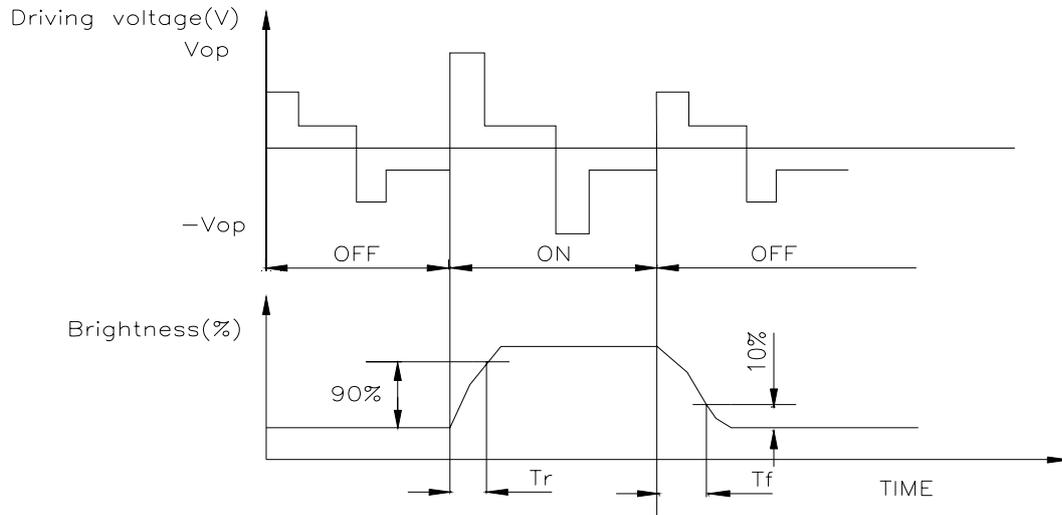
9.4   Optical Measurement System
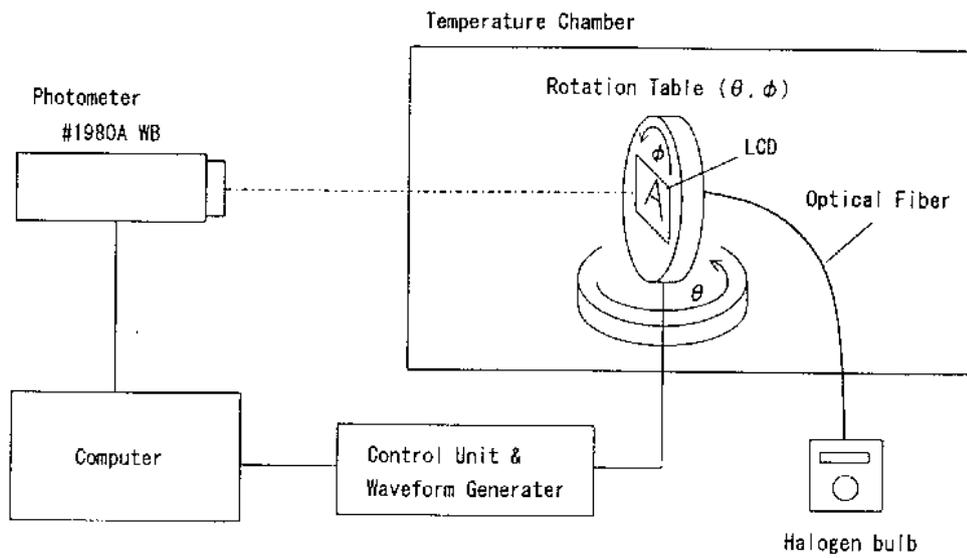
10. 0 TIMING CHARACTERICS

10.1 Microcontroller interface timing

Item	Symbol	Test Conditions	Min	Max	Unit
C / D Set-up Time	tCDS	—	100	—	ns
C / D Hold Time	tCDH	—	10	—	ns
/CE, /RD, /WR Pulse Width	tCE, tRD, tWR	—	80	—	ns
Data Set-up Time	tDS	—	80	—	ns
Data Hold Time	tDH	—	40	—	ns
Access Time	tACC	—	—	150	ns
Output Hold Time	tOH	—	10	50	ns

11. 0   BACKLIGHT CHARACTERISTICS

11.1   ABSOLUTE MAXIMUM RATINGS

(Ta=25℃)

Item	Symbol	Condition	Rating	Unit
Reverse Voltage	Vr		5.0	V
Absolute maximum forward current	Ifm		250	mA
Forward Current	If	Vf=5.0V	200	mA
Power Description	Pd		600	mW
Operating temperature range	Topr		-20~+70	^{0}C
Storage temperature range	Tst		-30~+80	^{0}C

11.2   ELECTRICAL/OPTLCAL CHARACTERISTICS

(Ta=25℃)

Item	Symbol	Min	Typ	Max	Unit	Condition
Forward Voltage	Vf	4.8	5.0	5.1	V	If=200mA
Reverse Current	Ir		200		uA	Vr=5.0V
Dominant wave length	λp				nm	If=200mA
Spectral Line Half width	△ λ					If=200mA
Luminance	Lv				cd/m^2	If=200mA
Color Coordinate	X		WHITE			If=200mA
	Y					

12. 0   OPERATING PRINCIPLES & METHODS

12.1   State after RESET/HALT

TERMIAL	HALT	RESET
D0 to D7	F	F
d0 to d7	F	F
r/w	H	H
ce	H (Note1)	H (Note1)
ad0 to ad15	H (Note2)	H (Note2)
ce0,ce1	H (Note1)	H (Note1)
ED,HOD	Final data	Final data
HSCP	L	L
LP	L	L
CDATA	H	H
FR	H	H
CH1	L	KO
CH2	L	VEND
DSPON	L	L
XO	H	OSC clock

H: level H

L: level L

F: Floating (high impedance)

K0: Test signal

VEND: Test signal

(Note 1): In Attribute mode, H or L according to state of graphic pointer

(Note 2): in Attribute mode, data of graphic pointer

● Alter power on, it is necessary to reset. RESET is kept L between 5 clocks up (oscillation clock).

● When HALT=L, the oscillation stops. The power supply for the LCD must now be turned off, to protect the LCD from DC bias.

● The HALT function includes the RESET function.

12.2   RAM Interface

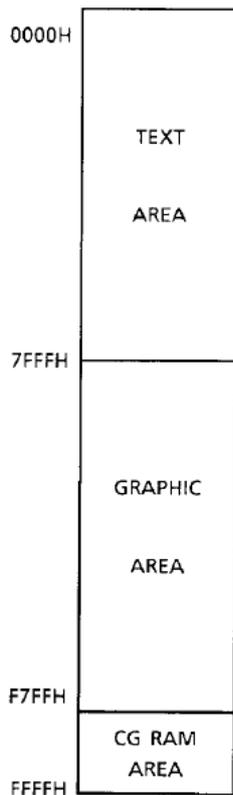The external RAM is used to store display data (text, graphic and external CG data).

With single-scan, text data, graphic data and external CG data can be freely allocated to the memory area (64KB max.)

With dual-scan, LCD Ⅰ is allocteed to 0000H to 7FFFH (32 KB max.), LCDⅡ is allocated to 8000H to FFFFH (32 KB max.). Text data, graphic data and external CG data can be freely allocated in LCDⅠ. In LCDⅡ,the same address must be allocated as in LCDⅠ, except ad15. ad15 determines selection of LCDⅠ or LCDⅡ.

It can be use the address decoded signals ce0(0000 to 07FFH),ce1(0800 to 0FFFH) within 4 KB.ce0 and ce1 allow decoding of addresses in the ranges (0000 to 07FFH) and (0800 to 0FFFH) respectively within a 4-KB memory space.

(Example)

(1) Single-Scan

(2) Dual-Scan
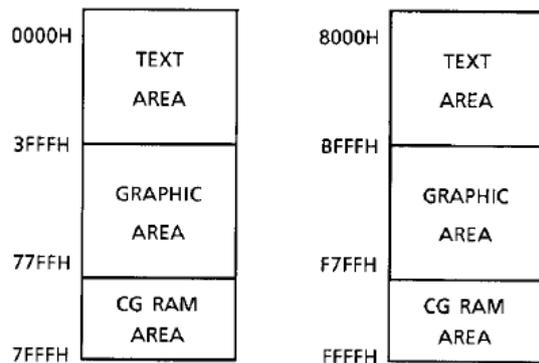
CG : Character Generator

12.3 Flowchart of communications with MPU

12.3.1 Status Read

A status check must be performed before data is read or written.

Status check

The Status of T6963C can be read from the data lines.

RD L

WR H

CE L

C/D H

D0 to D7 Status word

The T6963C status word format is as follows:

MSB   LSB

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

|		
STA0	Check command execution capability	0: Disable 1: Enable
STA1	Check data read/write capability	0: Disable 1: Enable
STA2	Check Auto mode data read capability	0: Disable 1: Enable
STA3	Check Auto mode data write capability	0: Disable 1: Enable
STA4	Not used	
STA5	Check controller operation capability	0: Disable 1: Enable
STA6	Error flag. Used for screen peek and screen copy commands.	0: Disable 1: Enable
STA7	Check the blink condition	0: Disable 1: Enable

(Note 1) it is necessary to check STA0 and STA1 at the same time. There is a possibility of erroneous operation due to a hardware interrupt.

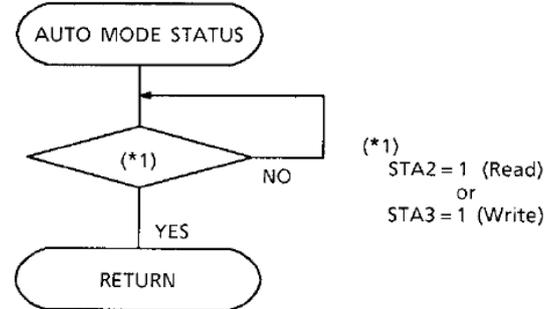(Note 2) for most modes STA0/STA1 are used as a status check.

(Note 3) STA2 and STA3 are valid in Auto mode; STA0 and STA1 are invalid.

Status checking flow

a)
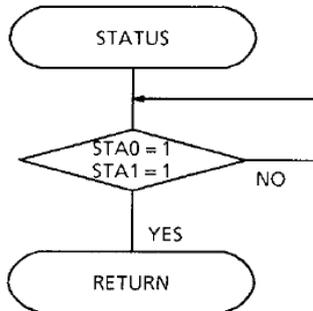
b)

(Note 4) When using the MSB=0 command, a status read must be performed.

If a status check is not carried out, the T6963C can not operate normally, even after a delay time.

The hardware interrupt occurs during the address calculation period (at the end of each line).

If a MSB=0 command is sent to the T6963C during this period, the T6963C enters wait status.
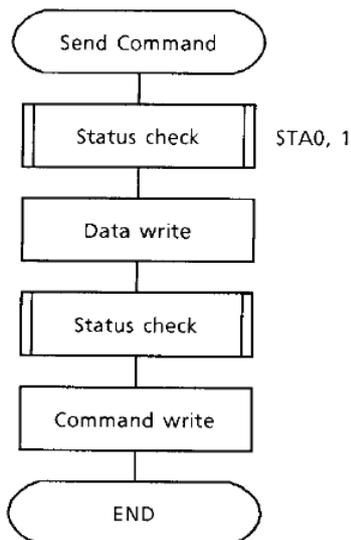
If a status check is not carried out in this state before the next command is sent, There is the possibility that the command or data will not be received.
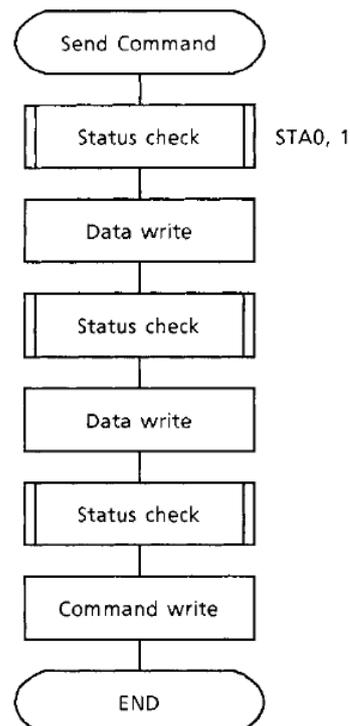
12.3.2 Setting data

When using the T6963C, first set the data, then set the command.

Procedure for sending a command

a) The case of 1 data

b) The case of 2 data

(Note) When sending more than two data, the last datum (or last two data) is valid.

12.4 Character Font Table

The relation between character codes and character pattern (CG ROM TYPE 0101)

13. 0　INSTRUCTION DESCRIPTION

13.1　COMMAND DEFINITIONS

COMMAND	CODE	D1	D2	FUNCTION
REGIDTERS SETTING	00100001	X address	Y address	Set Cursor Pointer
	00100010	Data	00H	Set Offset Register
	00100100	Low address	High address	Set Address Pointer
SET CONTROL WORD	01000000	Low address	High address	Set Text Home Address
	01000001	Columns	00H	Set Text Area
	01000010	Low address	High address	Set Graphic Home Address
	01000011	Columns	00H	Set Graphic Area
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- line cursor
	10100010	—	—	3- line cursor
	10100011	—	—	4- line cursor
	10100100	—	—	5- line cursor
	10100101	—	—	6- line cursor
	10100110	—	—	7- line cursor
	10100111			8- line cursor
DATA AUTO READ/WRITE	10110000	—	—	Set Data Auto Write
	10110001	—	—	Set Data Auto Read
	10110010	—	—	Auto Reset
DATA READ/WRITE	11000000	Data	—	Data Write and Increment ADP
	11000001	—	—	Data Read and Increment ADP
	11000010	Data	—	Data Write and Decrement ADP
	11000011	—	—	Data Read and Decrement ADP
	11000100	Data	—	Data Write and Nonvariable ADP
	11000101	—	—	Data Read and Nonvariable ADP

续表

COMMAND	CODE	D1	D2	FUNCTION
SCREEN PEEK	1110000	—	—	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)

13.2   DESCRIPTION OF INSTRUCTION

13.2.1   Setting registers

CODE	HEX	FUNCTION	D1	D2
00100001	21H	SET CURSOR POINTER	X ADRS	Y ADRS
00100010	22H	SET OFFSET REGISTER	DATA	00H
00100100	24H	SET ADDRESS POINTER	LOW ADRS	HIGH ADRS

(1) Set Cursor Pointer

The position of the cursor is specified by X ADRS and Y ADRS. The cursor position can only be moved by this command. Data read/write from the MPU never change the cursor pointer. X ADRS and Y ADRS are specified as follows.

ADRS and Y ADRS are specified as follows.

X ADRS 00H to 4FH (lower 7 bits are valid)

Y ADRS 00H to 1FH (lower 5 bits are valid)

a) Single- Scan
   X ADRS 00 to 4FH

Y ADRS 00H to 0FH

b) Dual- Scan
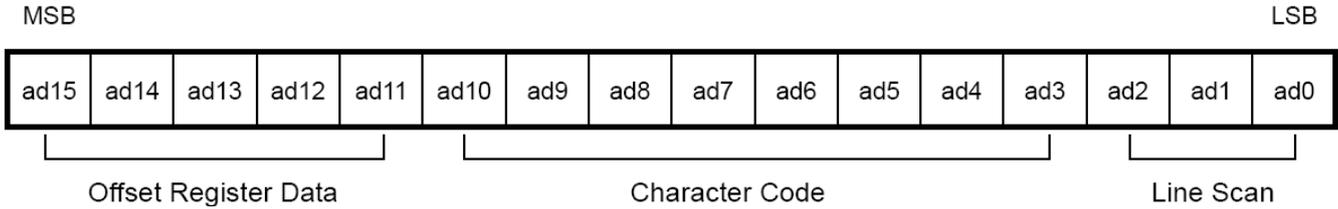   X ADRS 00H to 4FH

Y ADRS 00H to 0FH
Upper screen

Y ADRS 10H to 1FH
Lower screen

(2) Set Offset Register

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

The T6963C has a 16-bit address bus as follows.

MSB   LSB

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

Offset Register Data   Character Code   Line Scan

T6963C assign External character generator, when character code set 80H to FFH in using internal character generator. Character code 00H to 80H assign External character generator, when External generator mode.

The senior five bits define the start address in external memory of the CG RAM area. The next eight bits represent the character code of the character. In internal CG ROM mode, character codes 00H to 7FH represent the predefined "internal" CG RAM mode, character codes 80H to FFH represent the user's own "external" characters. In external CG RAM mode, all 256 codes from 00H to FFH can be used to represent the user's own character. The three least significant bits indicate one of the eight rows of eight dots that define the character's shape.

**The relationship between display RAM address and offset register**

Offset register data	CG RAM hex. address (start to end)
00000	0000 to 07FFH
00001	0800 to 0FFFH
00010	1000 to 17FFH
11100	E000 to E7FFH
11101	E800 to EFFFH
11110	F000 to F7FFH
11111	F800 to FFFFH

Example 1)
Offset register   02H
Character code   80H
Character generator RAM start address 0001   0100   0000   0000

(address)	(data)
1400H	00H
1401H	1FH
1402H	04H
1403H	04H
1404H	04H
1405H	04H
1406H	04H
1407H	00H

The relationship between display RAM data and display characters

ABγDEζGHIJKLM

Display character

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

γ and ζ are displayed by character generator RAM.

(3) Set Address Pointer

The Set Address Pointer command is used to indicate the start address for writing to (or reading from) external RAM.

The flowchart for set address pointer command
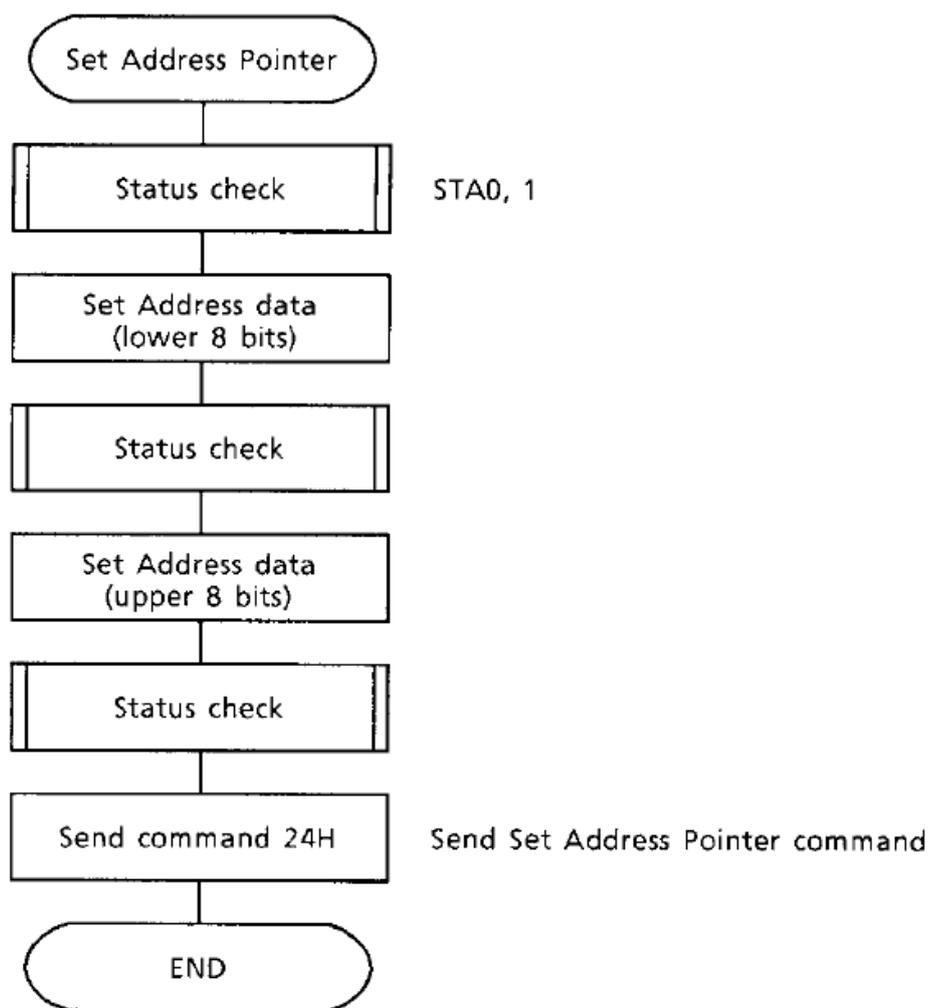
13.2.2   Set Control Word

CODE	HEX	FUNCTION	D1	D2
01000000	40H	Set Text Home Address	Low address	High address
01000001	41H	Set Text Area	Columns	00H
01000010	42H	Set Graphic Home Address	Low address	High address
01000011	43H	Set Graphic Area	Columns	00H

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

(1) Set Text Home Address

      The starting address in the external display RAM for text display is defined by this command. The text home address indicates the leftmost and uppermost position.

The text home address indicates the leftmost and uppermost 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=H	: 32 columns	
DUAL=H, MDS=L,MD0=L,MD1=H	: 4 lines	

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

(2)Set Graphic Home Address

      The starting address of the external display RAM used for graphic display is defined by this command. The graphic home address indicates the leftmost and uppermost position.

The relationship between 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 (columns)

CL: Columns are fixed by hardware (pin-programmable)

Example)
Graphic home address   : 0000H
Graphic area   : 0020H

MD2=H,MD3=H   : 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) Set Text Area

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

(Example)
LCD size   : 20 columns, 4 line
Text home address   : 0000H
Text area   : 0014H
MD2=H,MD3=H   : 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) Set Graphic Area

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

(Example)

LCD size   : 20 columns, 2 line
Graphic home address   : 0000H
Graphic area   : 0014H
MD2=H,MD3=H   : 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 →

If the graphic area setting is set to match the desired number of columns on the LCD, the addressing scheme will be automatically modified so that the start address of each line equals the end address of the previous line +1.

13.2.3   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: invalid

The display mode is defined by this command. The display mode does not change until the next command is sent. The logical OR, EXOR, AND of text or graphic display can be displayed.

In Internal Character Generator mode, character codes 00H to 7FH are assigned to the built-in character generator ROM. The character codes 80H to FFH are automatically assigned to the external character generator RAM.

(Example)
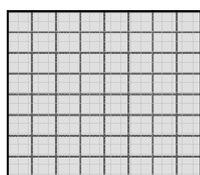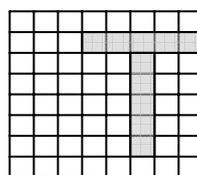
GRAPHIC   TEXT
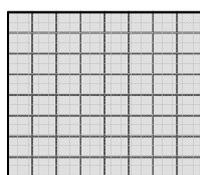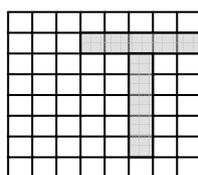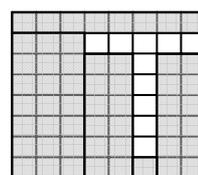
"OR"   "AND"   "EXOR"

(Note) Attribute functions can only be applied to text display, since the attribute data is placed in the graphic RAM area.

Attribute functions

The attribute operations are Reverse display, Character blink and Inhibit. The attribute data is written into the graphic area which was defined by the Set Control Word command. Only text display is possible in Attribute Function mode; graphic display is automatically disabled. However, the Display Mode command must be used to turn both Text and Graphic on in order for the Attribute function to be available.

The attribute data for each character in the text area is written to the same address in the graphic area. The Attribute function is defined as follows.

Attribute RAM 1byte | 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

X: invalid

13.2.4 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	—

X: invalid

| 1 | 0 | 0 | 1 | D3 | D2 | D1 | D0 |

Cursor blink   on: 1, off: 0
Cursor display   on: 1, off: 0
Text display   on: 1, off: 0
Graphic display   on: 1, off: 0
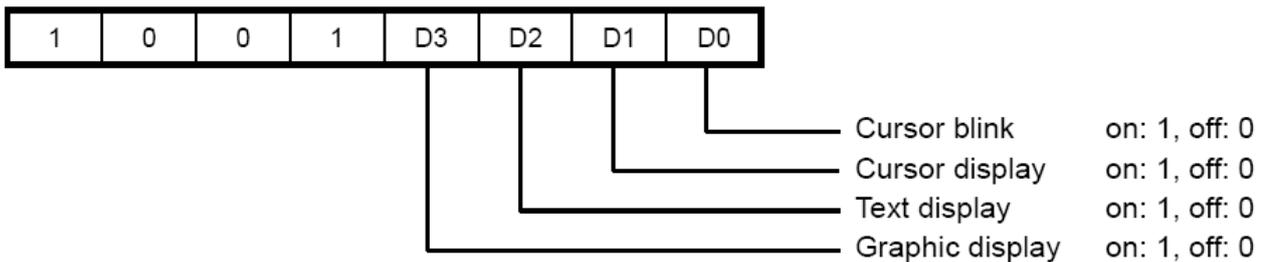
(Note) It is necessary to turn on "Text display" and "Graphic display" in the following cases.
a) Combination of text/graphic display
b) Attribute function

13.2.5   Cursor Pattern Select

CODE	FUNCTION	OPERAND
10100000	1-line cursor	—
10100001	2-line cursor	—
10100010	3-line cursor	—
10100011	4-line cursor	—
10100100	5-line cursor	—
10100101	6-line cursor	—
10100110	7-line cursor	—
10100111	8-line cursor	—

When cursor display is ON, this command selects the cursor pattern in the range 1 line to 8 lines. The cursor address is defined by the Cursor Pointer Set command.
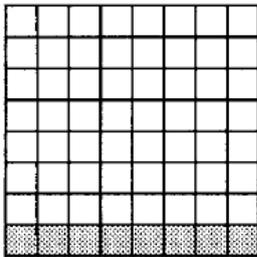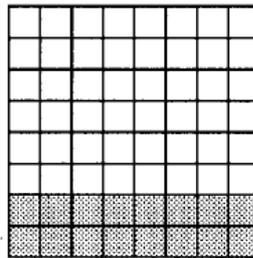
1-line cursor   2-line cursor   8-line cursor
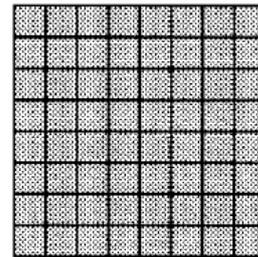
13.2.6 Data Auto Read/Write

CODE	HEX	FUNCTION	OPERAND
10110000	B0H	Set Data Auto Write	—
10110001	B1H	Set Data Auto Read	—
10110010	B2H	Auto Reset	—

This command is convenient for sending a full screen of data from the external display RAM. After setting Auto mode, a Data Write (or Read) command is need not be sent between each datum. A Data Auto Write (or Read) command must be sent after a Set Address Pointer command. After this command, the address pointer is automatically incremented by 1 after each datum. In Auto mode, the T6963C cannot accept any other commands.

The Auto Reset command must be sent to the T6963C after all data has been sent, to clear Auto mode.

Status check for Auto mode

(STA2,STA3 should be checked between sending of each datum. Auto Reset should be performed after checking STA3=1 (STA2=1). Refer to the following flowchart.

a) Auto Read mode
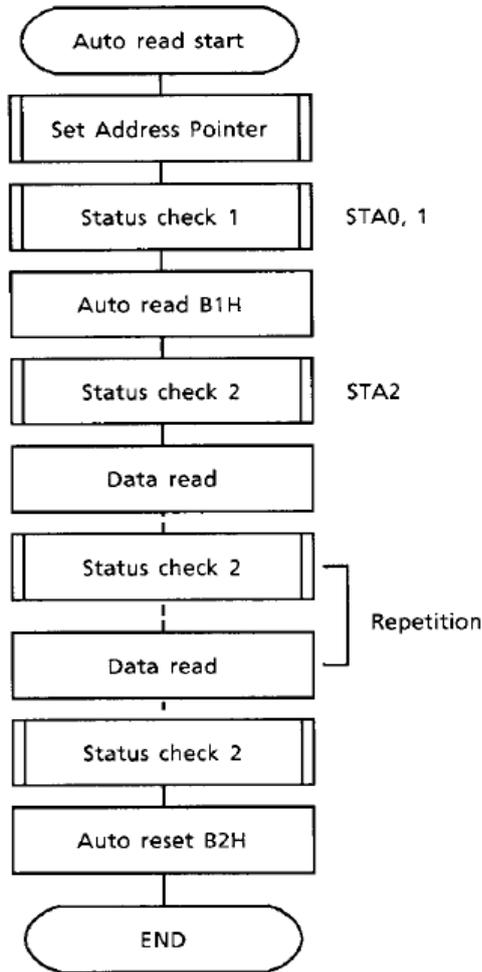
b) Auto Write mode
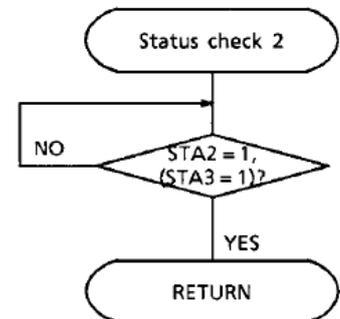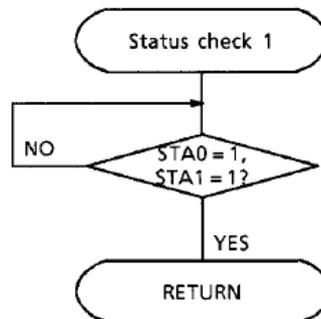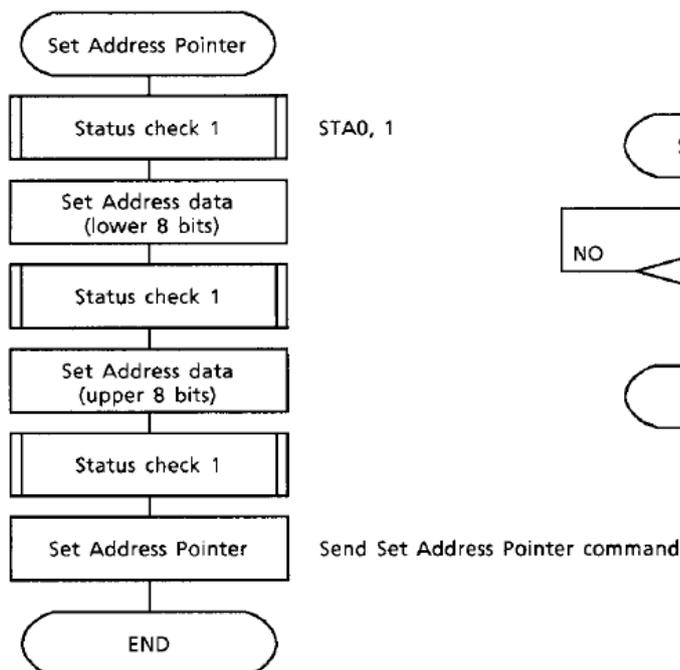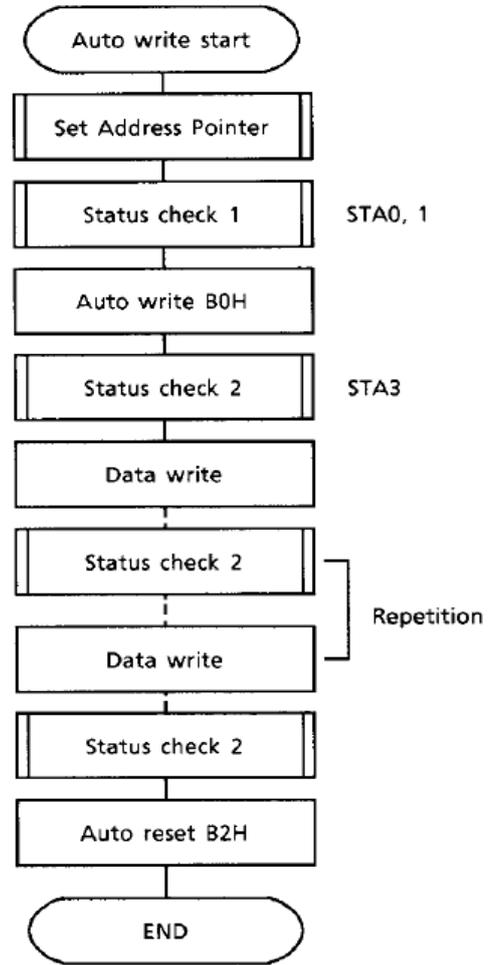
13.2.7 Data Read/Write

CODE	HEX	FUNCTION	OPERAND
11000000	C0H	Data Write and Increase ADP	Data
11000001	C1H	Data Read and Increase ADP	—
11000010	C2H	Data Write and Decrease ADP	Data
11000011	C3H	Data Read and Decrease ADP	—
11000100	C4H	Data Write and Nonvarible ADP	Data
11000101	C5H	Data Read and Nonvarible ADP	—

This command is used to for writing data from the MPU to external display RAM, and reading data from external display RAM to the MPU. Data Write/Data Read should be executed after setting address using Set Address Pointer command. The address pointer can be automatically incremented or decremented using this command.

(Note) This command is necessary for each 1-byte datum.

Refer to the following flowchart.
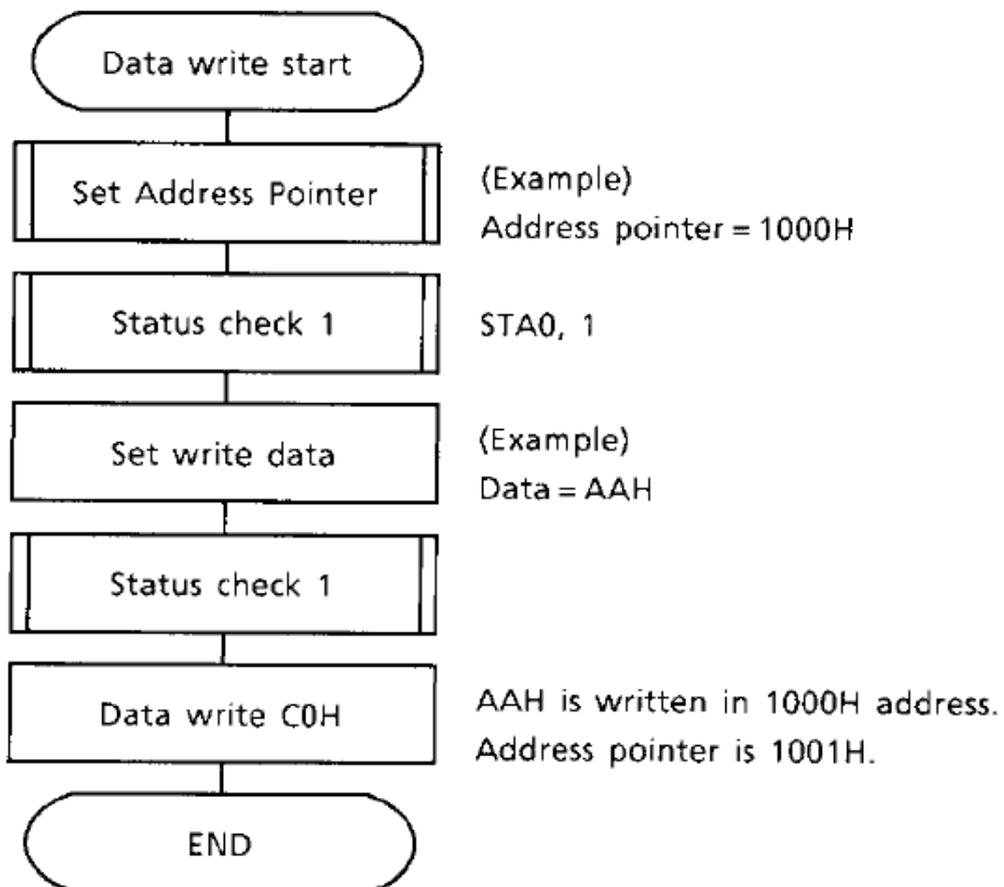
13.2.8 Screen Peek

CODE	HEX	FUNCTION	OPERAND
11100000	E0H	Screen Peek	—

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

The status (STA6) should be checked just after Screen Peek command. If the address determined by the Set Address Pointer command is not in the graphic area, this command is ignored and a status flag (STA6) is set

Refer to the following flowchart.
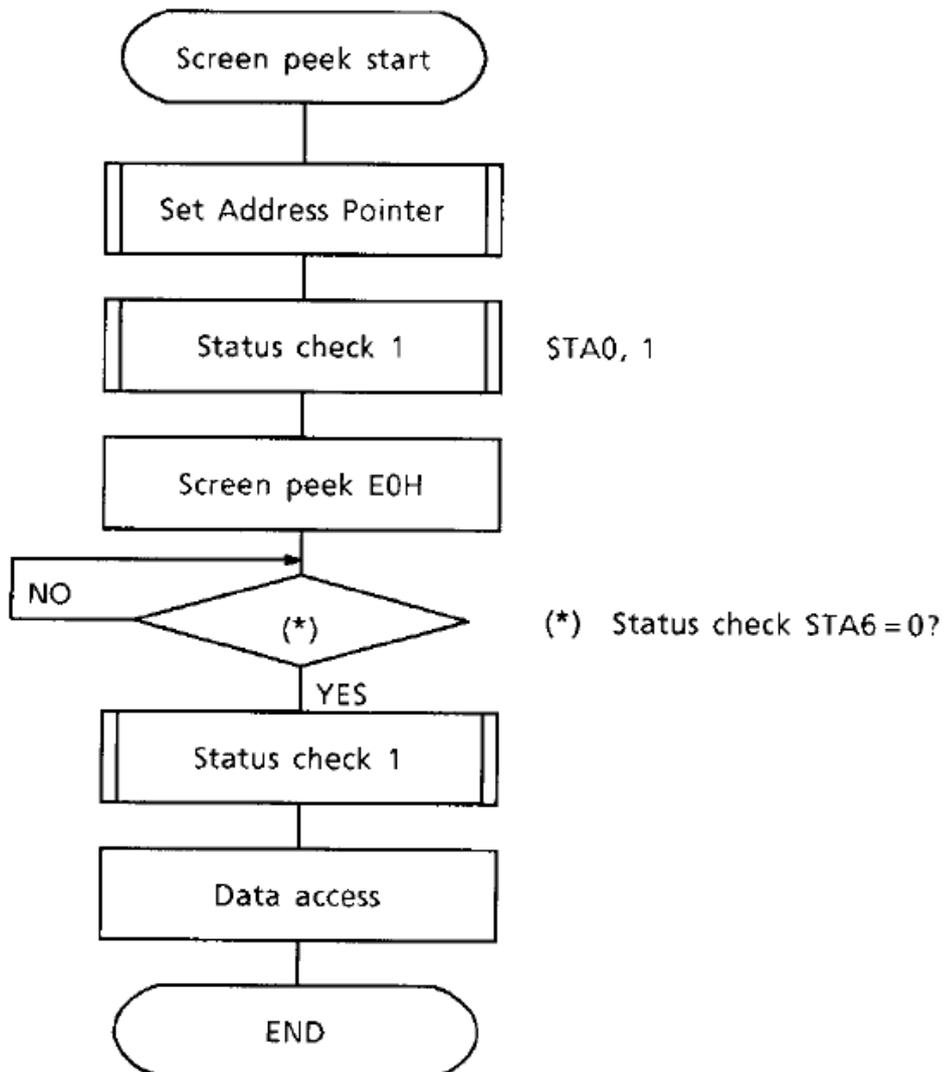
(Note) This command is available when hardware column number and software column number are the same. Hardware column number is related to MD2 and MD3 setting.

Software column number is related to Set Text Area and Set Graphic Area command.

13.2.9 Screen copy

CODE	HEX	FUNCTION	OPERAND
11101000	E8H	Screen Copy	—

This command copies a single raster line of data to the graphic area.

The start point must be set using the set address pointer command.

(Note 1) If the attribute function is being used, this command is not available.(With Attribute data is graphic area data.)

(Note 2) With Dual-scan, this command cannot be used (because the T6963C cannot separate the upper screen data lower screen data).

Refer to the following flowchart.
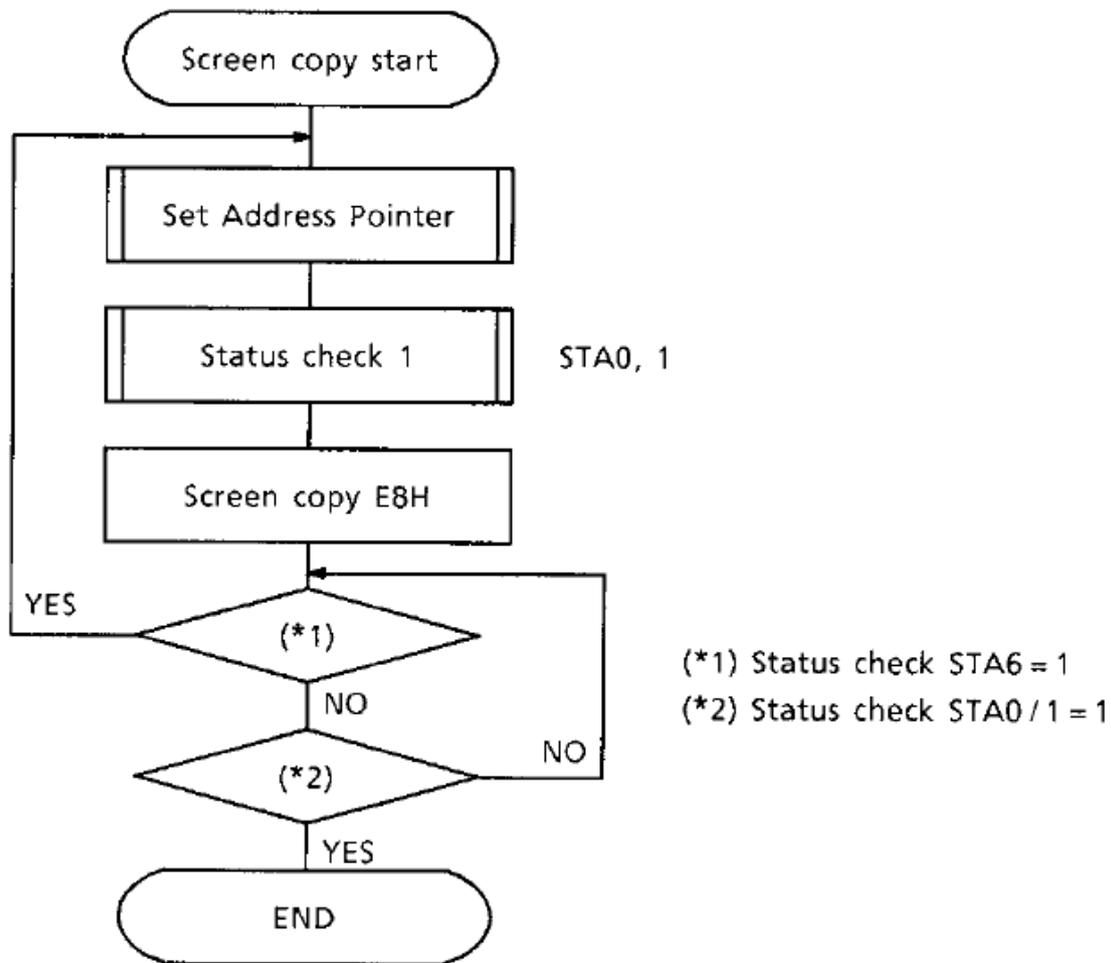
(*1) Status check STA6 = 1
(*2) Status check STA0 / 1 = 1

(Note) This command is available when hardware column number and software column number are the same. Hardware column number is related to MD2 and MD3 setting. Software column number to Set Text Area and Set Graphic Area command.

13.2.10   Bit set/reset

CODE	FUNCTION	OPERAND
11110xxx	Bit Reset	—
11111xxx	Bit Set	—
1111x001	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)	—

X: invalid

This command use to set or reset a bit of the byte specified by the address pointer.Only one bit can be set/reset at a time.

Refer to the following flowchart.
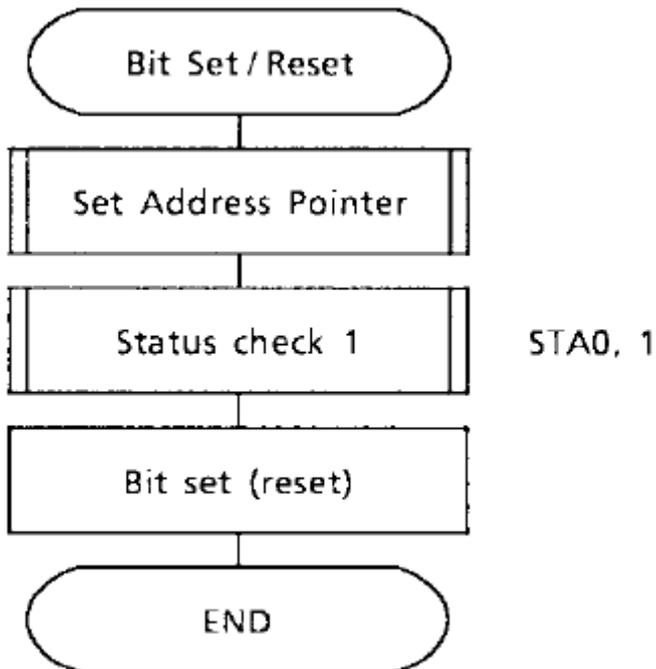
14. 0   QUALITY GUARANTEE

14.1   ACCEPTABLE QUALITY LEVEL

Inspection items	Sampling procedures	AQL
Visual-operating (Electro-optical)	GB2828-81 Inspection level Ⅱ Normal inspection Single sample inspection	0.65
Visual-not operating	GB2828-81 Inspection level Ⅱ Normal inspection Single sample inspection	1.5
Dimension measurement	GB2828-81 Inspection level Ⅱ Normal inspection Single sample inspection	1.5

14.2   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℃ 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 V0 value which the most optimal contrast can be obtained near the specified V0 in the specification. (Within ±0.5V of the typical value at 25℃.).

14.3   Definition of inspection zone in LCD

Zone A: character/Digit area
Zone B: viewing area except Zone A (ZoneA+ZoneB=minimum Viewing area)
Zone C: Outside viewing area (invisible area after assembly in customer's product)
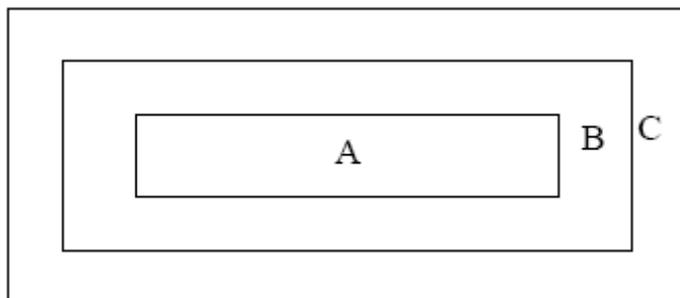
Note: As a general rule, visual defects in Zone C are permissible, when it is no trouble for quality and assembly of customer's product.
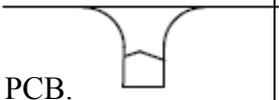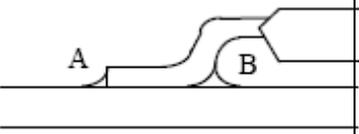
14.4 Inspection Standard

● **Major Defect**

Item No	Items to be inspected	Inspection Standard	Classification of defects
1	All functional defects	1) No display 2) Display abnormally 3) Missing vertical，horizontal segment 4) Short circuit 5) Back-light no lighting, flickering and abnormal lighting.	Major
2	Missing	Missing component	
3	Outline dimension	Overall outline dimension beyond the drawing is not allowed.	

● **Module Cosmetic Criteria**

No.	Item	Judgment 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 No soldering bridge No cold soldering	Major Major Minor
4	Resist flaw on substrate	Invisible copper foil ($\varnothing$0.5mm or more) on substrate pattern	Minor
5	Accretion of metallic Foreign matter	No soldering dust No accretion of metallic foreign matters (Not exceed $\varnothing$0.2mm)	Minor 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 'Seal' (B) of the lead to be covered by 'Filet'. Lead form to be assume over solder.	Minor

No.	Item	Judgment Criterion		Partition
8	3. Chips	$(3/2) H \geq h \geq (1/2) H$		Minor
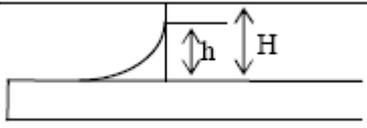
- **Screen Cosmetic Criteria (Non-Operating)**

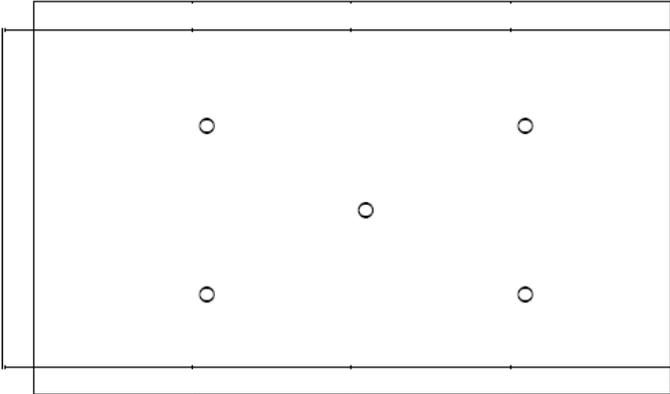| No.	Defect	Judgement Criterion	Partition
1	Spots	In accordance with *Screen Cosmetic Criteria (Operating) No.1*.	Minor
2	Lines	In accordance with *Screen Cosmetic Criteria (Operating) No.2*.	Minor
3	Bubbles in polarizer	<table><tr><td>Size : d</td><td>mm</td><td>Acceptable Qty in active area</td></tr><tr><td>d</td><td>≤ 0.3</td><td>Disregard</td></tr><tr><td>0.3 < d</td><td>≤ 1.0</td><td>3</td></tr><tr><td>1.0 < d</td><td>≤ 1.5</td><td>1</td></tr><tr><td>1.5 < d</td><td></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

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

● **Screen Cosmetic Criteria (Operating)**

No.	Defect	Judgment Criterion	Partition
1	Spots	A) Clear Note : Including pin holes and defective dots which must be within one pixel size. B) Unclear	Minor
2	Lines	A) Clear Note : ( ) - Acceptable Qty in active area L - Length (mm) W - Width (mm) ∞ - Disregard B) Unclear 'Clear' = The shade and size are not changed by Vop. 'Unclear' = The shade and size are changed by Vop.	Minor

No. 1 Spots A) Clear

Size : d mm	Acceptable Qty in active area
d ≤ 0.1	Disregard
0.1 < d ≤ 0.2	6
0.2 < d ≤ 0.3	2
0.3 < d	0

No. 1 Spots B) Unclear

Size : d mm	Acceptable Qty in active area
d ≤ 0.2	Disregard
0.2 < d ≤ 0.5	6
0.5 < d ≤ 0.7	2
0.7 < d	0

No. 2 Lines A) Clear

L 5.0 — ∞ — (0)
2.0 — (6) — See No. 1
W : 0.02 0.05 0.1

No. 2 Lines B) Unclear

L 10.0 — ∞ — (0)
(6)
2.0 — See No. 1
W : 0.05 0.3 0.5

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

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

No.	Defect	Judgment Criterion	Partition
3	Rubbing line	Not to be noticeable.	Minor
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 pot'. (see *Screen Cosmetic Criteria (Operating) No.1*)	Minor
7	Uneven brightness (only back-lit type module)	Uneven brightness must be BMAX / BMIN ≤ 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) The limit samples for each item have priority.

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

(3) 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 Æ5mm.

- 10 or over defects in circle of Æ10mm.

- 20 or over defects in circle of Æ20mm.

15. 0   RELIABILITY

15.1   Content of Reliability Test

No.	Test Item	Test Condition	Inspection after test
1	High Temperature Storage	80℃±2℃/200 hours	Inspection after 2~4hours storage at room temperature, the sample shall be free from defects: 1.Air bubble in the LCD; 2.Sealleak; 3.Non-display; 4.missing segments; 5.Glass crack; 6.Current Idd is twice higher than initial value.
2	Low Temperature Storage	-30℃±2℃/200 hours	
3	High Temperature Operating	70℃±2℃/120 hours	
4	Low Temperature Operating	-20℃±2℃/120 hours	
5	Temperature Cycle	-20℃±2℃~25~70℃±2℃×10cycles (30min.) (5min.) (30min.)	
6	High Temperature / Humidity operation	50℃±5℃×90%RH/120 hours	
7	Vibration Test	Frequency ： 10Hz~55Hz~10Hz Amplitude：1.5mm, X，Y，Z direction for total 3hours (Packing condition)	
8	Drooping test	Drop to the ground from 1m height, one time, and every side of carton. (Packing condition)	
9	Static electricity test	Voltage:±8KV R: 330Ω C: 150pF Air discharge, 10time	

Remark:

1. The test samples should be applied to only one test item.

2. Sample size for each test item is 5~10pcs.

3. For Damp Proof Test, Pure water(Resistance＞10MΩ) should be used.

4. In case of malfunction defect caused by ESD damage, if it would be recovered to normal state after resetting, it would be judge as a good part.

5. EL evaluation should be excepted from reliability test with humidity and temperature: Some defects such as black spot/blemish can happen by natural chemical reaction with humidity and Fluorescence EL has.

6. Failure Judgment Criterion: Basic Specification, Electrical Characteristic, Mechanical Characteristic, Optical Characteristic.

16. 0   PRECAUTIONS FOR USING LCD MODULES

16.1   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.

16.2   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.

16.3 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.

17. 0   USING LCD MODULES

17.1   About 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 polarizer 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 polarizer and reflectors made of organic substances which will be damaged by chemicals such as acetone, toluene, ethanol and isopropyl alcohol.

(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 polarizer. 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 determinate to the polarizer).

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

17.2   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.
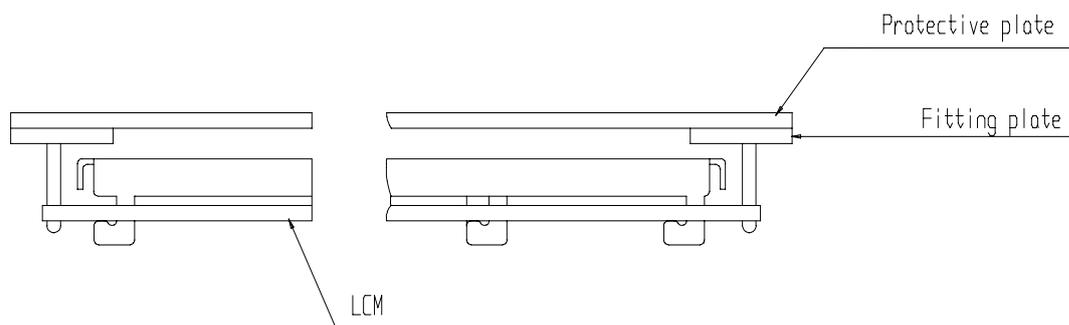
(2) When assembling the LCM into other equipment, the spacer to the bit between the LCM and the fitting plate should have enough height to avoid causing stress to the module surface, refer to the

individual specifications for measurements. The measurement tolerance should be ±0.1mm.

17.3 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 commutation 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.

17.4 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 electroluminescent panel from the PC board, be sure the solder has completely melted, the soldered pad on the PC board could be damaged.

17.5 Operation

(1) Viewing angle varies with the change of liquid crystal driving voltage (VO). Adjust VO 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.
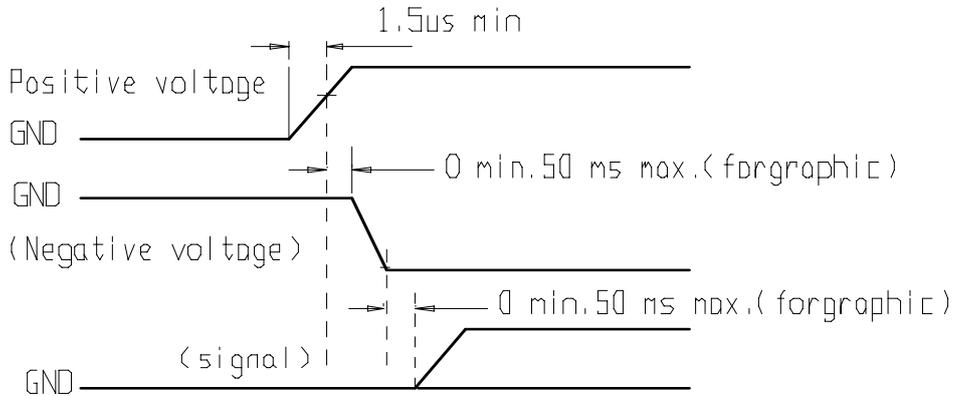
17.6 Storage

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.

17.7 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.

17.8 Limited Warranty

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

17.9   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, conductors and terminals.

18. 0   APPENDIX

18.1   Initialization Code

```
//Write Instruction Code
#pragma disable
void wr_cmd(uchar cmd)
{
    RD_Port = 1;
    WR_Port = 1;
    CD_Port = 1;
    CE_Port = 0;
    WR_Port = 0;
    DataPort = cmd;
    _nop_();
    _nop_();
    WR_Port = 1;
    CE_Port = 1;
}

//Write Display RAM Data
#pragma disable
void wr_dat(uchar dat)
{
    RD_Port = 1;
    WR_Port = 1;
    CD_Port = 0;
    CE_Port = 0;
    WR_Port = 0;
    DataPort = dat;
    _nop_();
    _nop_();
    WR_Port = 1;
    CE_Port = 1;
}

//Write 2 Para Command
#pragma disable
void wr_cmd2para(uchar dat1,uchar dat2,uchar cmd)
{
    wr_dat(dat1) ;
    wr_dat(dat2) ;
    wr_cmd(cmd);
}
```

```
//T6963C Initial
#pragma disable
void initial()
{
    wr_cmd2para(0x00,0x50,0x40);        //Text home address set = 0000H
    wr_cmd2para(0x00,0x00,0x42);        //Graphic home address set = 0000H
    wr_cmd2para(0x1E,0x00,0x41);        //Text area set = 16 columns
    wr_cmd2para(0x1E,0x00,0x43);        //Graphic area set = 16 columns
    wr_cmd(0x9C);                       //(Display mode)Text on, graphics on, cursor off
    wr_cmd(0x80);                       //(Mode set)"OR" mode, internal character generator mode
    wr_cmd2para(0x02,0x00,0x22);        //Offset register set
}
```

18.2   LCM Application Circuit