

LIQUID CRYSTAL DISPLAY MODULE

Product Specification

DENSITRON	STANDARD LCD MODULE	
PRODUCT NUMBER	LWM12864D-SERIES	
DEFINITION	Display 128*64 dots	Date 28/01/08

INTERNAL APPROVALS				
Quality Mgr	Product Mgr	Project Leader	Mech. Eng	Electr. Eng
Date:	Date:	Date:	Date:	Date:

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REVISION RECORD

Rev.	Date	Page	Chapt.	Comment	ECR no.
1	28/01/2008			Initial Specification	

PART NUMBERING SYSTEM

LWM **12864D - BG - WCY ***
 Densitron mono module ① ② ③ ④ ⑤ ⑥

① Characters x Row format

② Model serials number

③ Display mode and backlight type :

A = Reflective (without backlight) =

B* = Transflective positive LEDS array type backlight (BG, BA, BW, BR, BT ...)

B*(E) = Transflective LEDS edge type backlight (BGE, BAE, BWE, BR...)

B = Transflective CFL

C* = Transflective positive EL backlight (CB, CW)

D* = Transmissive negative EL backlight (DB, DW)

E = CFL

E* = Transmissive negative LEDS array type backlight (EG, EA, EW, ER...)

E*(E) = Transmissive negative LEDS edge type backlight (EGE, EAE, EWE, ERE...)

(* color LED or EL backlight = G/ yellow-green, A/ amber, W/ white, R/ red, B/blue ,T/ tricolour)

④ Temperature range and power supply

D = Standard temperature range; negative supply voltage required (0°C~+50°C)

S = Standard temperature range; on board negative voltage generator (0°C~+50°C)

H= Wide temperature range; negative supply voltage required (-20°C ~+70°C)

W= Wide temperature range; on board negative voltage generator (-20°C ~+70°C)

⑤ Fluid type and compensation circuit option

NY = STN yellow-green glass, without temperature compensation circuit

CY = STN yellow green glass, with temperature compensation circuit on board

NG = STN gray glass without temperature compensation circuit

CG = STN gray glass with temperature compensation circuit

NB = STN blue glass, without temperature compensation circuit

CB = STN blue glass with temperature compensation circuit

NF = FSTN black and white glass without temperature compensation circuit

CF = FSTN black and white glass with temperature circuit on board

⑥ Special code for customized features

Please refer to our commercial office

Remarks and definitions :

1°) Display mode and backlight type :

- Reflective polarizer, no backlight, usable only in good ambient light conditions.
- Transflective polarizer uses a background backlight and a mirror reflector, usable in all lighting conditions.
- Transmissive polarizer needs the backlight switched on continuously, usable mostly in low ambient light conditions
- EL (electro-luminescent), uniform brightness, short life time (8000 hours max), needs EL inverter, low current consumption, low thickness.
- LED (light emitting diode), uniform brightness, long lifetime (100 000 hours), doesn't need inverter, reliable in vibration and shock environment, different colors available.

Array version is a direct lighting type, available in standard form, uniform and good brightness on all the active area.

Edge version is an edge lighting type providing a low consumption backlight, has a low thickness and brightness.

- Positive mode has dark pixels on a light background
- Negative mode has light pixels in a dark background and is normally used only with a transmissive polarizer as it needs a backlight on to be visible.

2°) Fluid type :

- STN yellow green or grey LCD has a yellow green or grey background with dark blue pixels and offers a good contrast.
- FSTN LCD is to produce very high contrast with black and white pixels using a film polarizer

2. MAIN FEATURES

ITEM	CONTENTS
Display Format	128 x 64 dots
Overall Dimensions	78.0 x 70.0 x 14.3(MAX)
Viewing Area	62.0 x 44.0
LCD type	STN / FSTN
Mode	Available in Reflective / Transflective / Transmissive
Viewing Angle	6 o'clock
Duty	1/64
Driver IC	TOSHIBA T6963C or equivalent
Backlight type	None / LED
Backlight colour	Yellow Green / White / Amber / Blue/ Green/ Red and tri-colour
DC/DC converter	None or Included
Operating temperature	-20°/+70°C
Storage temperature	-30°/+80°C

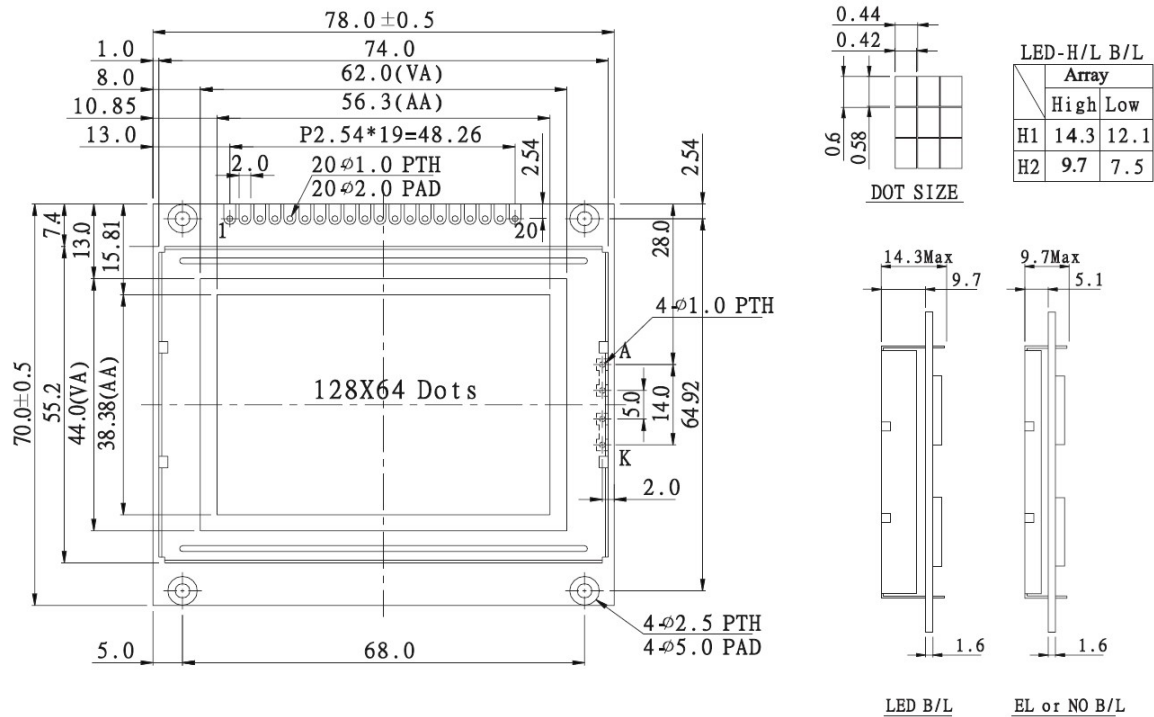
3. MECHANICAL SPECIFICATION

3.1 MECHANICAL CHARACTERISTICS

Item	Dimension	Unit
Number of Characters	128 x 64 dots	
Module dimension	78.0 x 70.0 x 14.3(MAX) LED BL	mm
	78.0 x 70.0 x 9.7(MAX) EL OR No BL	
View area	62.0 x 44.0	mm
Active area	56.3 x 38.38	mm
Dot size	0.42 x 0.58	mm
Dot pitch	0.44 x 0.60	mm

3.2 MECHANICAL DRAWING

Version LED, EL



DENSITRON TECHNOLOGIES plc. reserves the right to make changes to their products without notice, and advise customers to obtain the latest version of the relevant product to verify compatibility.

4 ELECTRICAL SPECIFICATION

4.1 ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min	Typ	Max	Unit
Operating Temperature	T_{OP}	-20	—	+70	°C
Storage Temperature	T_{ST}	-30	—	+80	°C
Input Voltage	V_I	V_{SS}	—	V_{DD}	V
Supply Voltage For Logic	$V_{DD}-V_{SS}$	-0.3	—	+7	V
Supply Voltage For LCD	$V_{DD}-V_0$	0	—	15	V
Negative Voltage Output	V_{EE}	—	10	—	V

Note 1: Background colour changes slightly depending on ambient temperature. This phenomenon is reversible. $T_a \leq 70$ °C: 75% RH max Note 2: $T_a \leq 80$ °C: 75% RH max

4.2 ELECTRICAL CHARACTERISTICS

Item	Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage For Logic	$V_{DD}-V_{SS}$	—	4.75	5.0	5.25	V
Supply Voltage For LCD	$V_{DD}-V_0$	$T_a = -20^\circ\text{C}$	—	—	9.8	V
		$T_a = 25^\circ\text{C}$	—	8.5	—	V
		$T_a = +70^\circ\text{C}$	7.6	—	—	V
Input High Volt.	V_{IH}	—	$V_{DD} - 2.2$	—	V_{DD}	V
Input Low Volt.	V_{IL}	—	0	—	0.8	V
Output High Volt.	V_{OH}	—	$V_{DD} - 0.3$	—	V_{DD}	V
Output Low Volt.	V_{OL}	—	0	—	0.3	V
Supply Current	I_{DD}	$V_{DD} = 5\text{V}$	11	12	13	mA

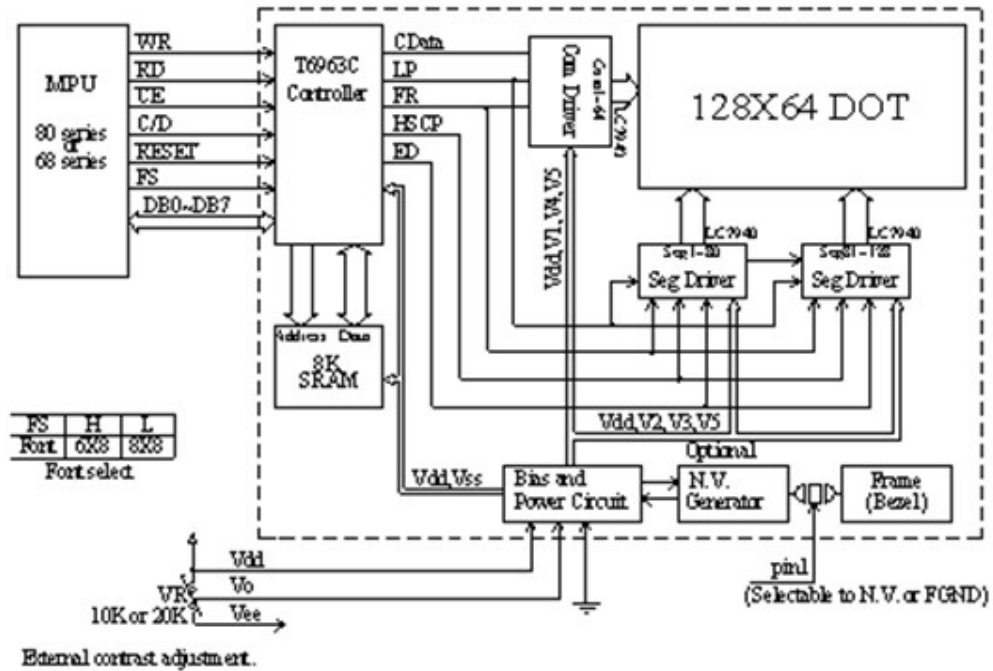
* I_{DD} measurement condition is for all pattern ON; $V_{SS} = 0\text{ V}$, $T_a = 25^\circ\text{C}$

4.3 INTERFACE PIN ASSIGNMENT

Pin No.	Symbol	Level	Description
1	V_{EE}		Negative Voltage Output
2	V_{SS}		GND
3	V_{DD}		Power supply (+5 V)
4	V_0		Power supply for LCD driver
5	WR	L	Data write. Write data into T6963C when WR = L

6	RD	L	Data read. Read data from T6963C when RD = L
7	CE	L	L : Chip enable
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	RESET	H / L	H : Normal ; L : Initialize T6963C
10	DB0	H / L	Data bus line
11	DB1	H / L	Data bus line
12	DB2	H / L	Data bus line
13	DB3	H / L	Data bus line
14	DB4	H / L	Data bus line
15	DB5	H / L	Data bus line
16	DB6	H / L	Data bus line
17	DB7	H / L	Data bus line
18	FS	H / L	Pins for selection of font ; H : 6 * 8 , L : 8 * 8
19	K		Power supply for LED B/L -
20	A		Power supply for LED B/L +

4.4 Interface Block Diagram



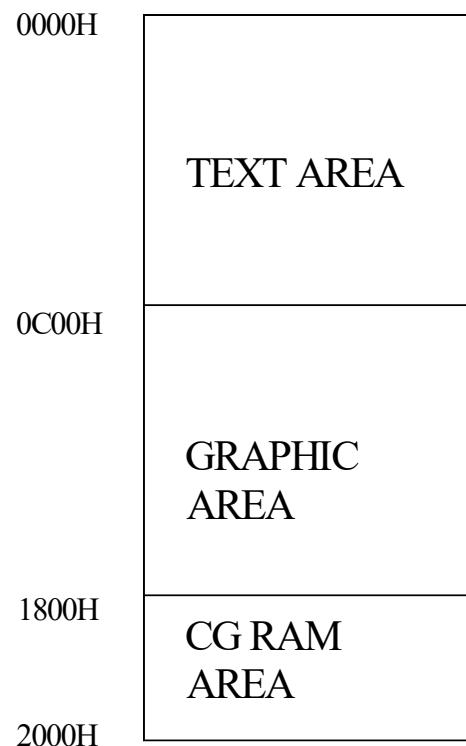
4.5 DISPLAY CONTROL INSTRUCTION

The LCD Module has built in a T6963C LSI controller, It has an 8-bit parallel data bus and control lines for writing or reading through an MPU interface, it has a 128-word character generator ROM (refer to Table 1.), which can control an external display RAM of up to 8K bytes. Allocation of text, graphics and external character generator RAM can be made easily and the display window can be moved freely within the allocated memory range.

RAM Interface

The external RAM is used to store display data (text, graphic and external CG data). It can be freely allocated to the memory area (8 K byte max).

Recommended:



Flowchart of communications with MPU

(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.

$\overline{RD}$	L
$\overline{WR}$	H
$\overline{CE}$	L
C/D	H
Do to D7	H

The T6963C status word format is as follows:

MSB				LSB			
STA7	STA6	STA5	STA4	STA3	STA2	STA1	STA0
D7	D6	D5	D4	D3	D2	D1	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:No error 1:Error
STA7	Check the blink condition	0:Disable off 1:Normal display

(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.

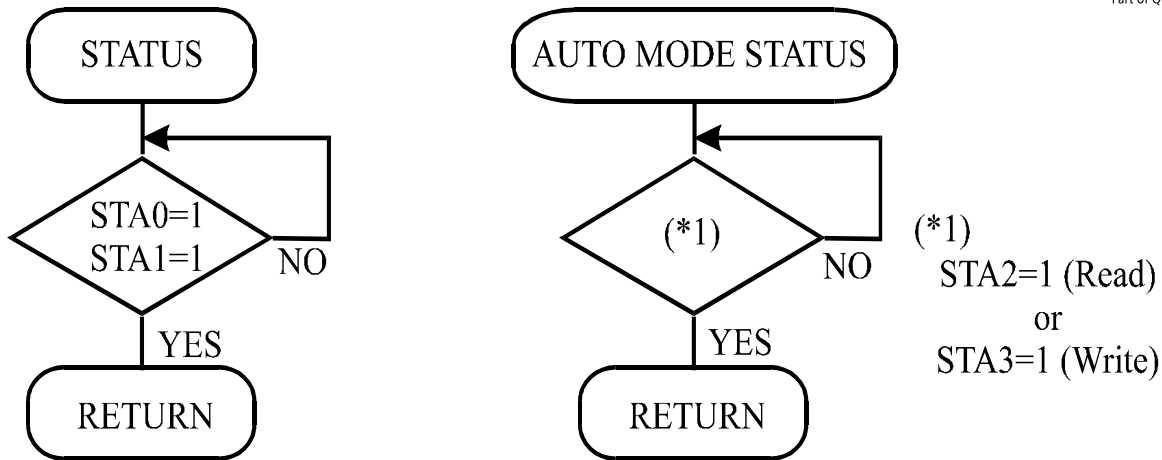
(Note 2) For most modes STA0/STA1 are used as a status check.

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

Status Check 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 cannot operate normally, even after a delay time.

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

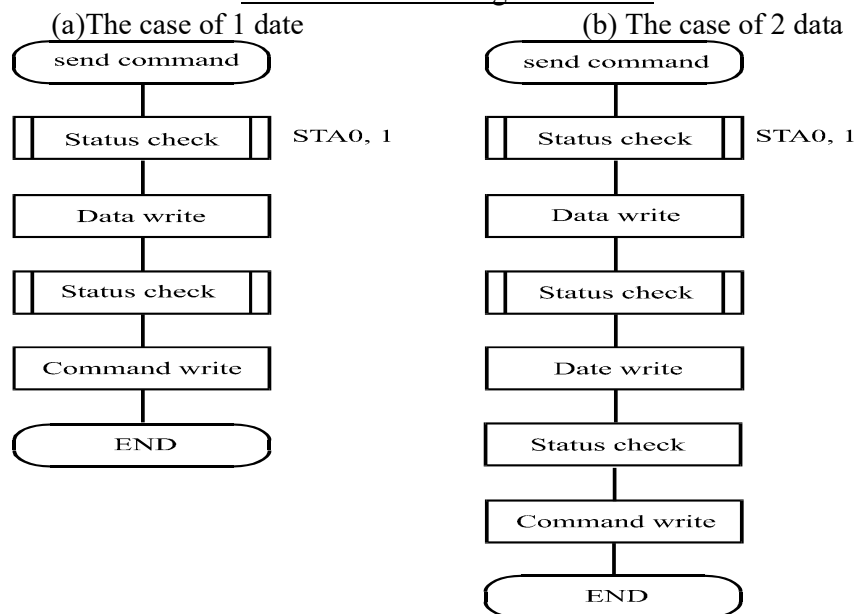
If a MSB=0 command is sent to the T6963C during this period, the T6963C enters Wait status.

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 date will not be received.

(2) Setting date

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

Procedure for sending a command



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

COMMAND DEFINITIONS

COMMAND	CODE	D1	D2	FUNCTION
REGISTERS SETTING	00100001	X address	Y address	Set Cursor Pointer
	00100010	Date	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	1000×000	—	—	OR mode
	1000×001	—	—	EXOR mode
	1000×011	—	—	AND mode
	1000×100	—	—	Text Attribute mode
	10000×××	—	—	Internal CG ROM mode
	10001×××	—	—	External CG RAM mode
		—	—	
DISPLAY MODE	10010000	—	—	Display off
	1001××10	—	—	Cursor on, blink off
	1001××11	—	—	Cursor on, blink on
	100101××	—	—	Text on, graphic off
	100110××	—	—	Text off, graphic on
	100111××	—	—	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 Write and Nonvariable ADP
	11000101	Data	—	Data Read and Nonvariable ADP
		—	—	
SCREEN PEEK	11100000	—	—	Screen Peek

X : invalid

COMMAND	CODE	D1	D2	FUNCTION
SCREEN COPY	11101000	—	—	Screen Copy
BIT SET/RESET	11110xxx	—	—	Bit Reset
	11111xxx	—	—	Bit Set
	1111x 001	—	—	Bit 0 (LSB)
	1111x 001	—	—	Bit 1
	1111x 010	—	—	Bit 2
	1111x 011	—	—	Bit 3
	1111x 100	—	—	Bit 4
	1111x 101	—	—	Bit 5
	1111x 110	—	—	Bit 6
	1111x 110	—	—	Bit 7 (MSB)

X: invalid

Setting registers

CODE	HEX.	FUNCTION	D1	D2
00100001	21H	SET CURSOR POINTER	X ADRS	Y ADRS
00100010	23H	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 changes the cursor pointer. X 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)

Single-Scan

X ADRS 00 to 4FH

Y ADRS 00H to 0FH

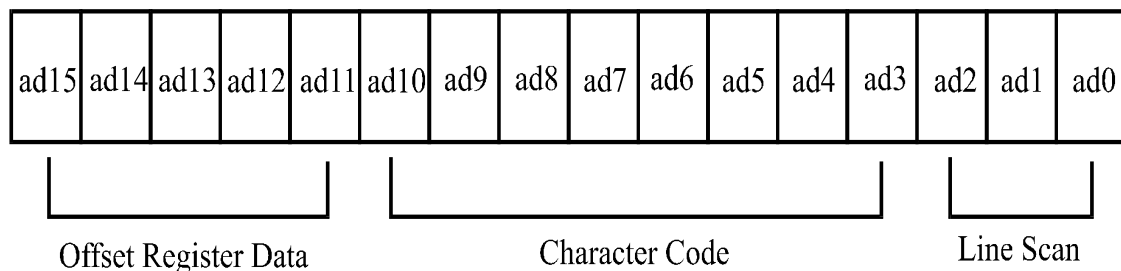
(2) Set Offset Register

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



T6963C assigns 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 in 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, character codes 00H to 7FH represent the predefined “internal” CG ROM characters, and codes 80H to FFH represent the user’s own “external” characters. In external CG ROM mode, all 256 codes from 00H to FFH can be used to represent the user’s own characters. 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 07 FFH
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
	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 between display RAM data and display characters

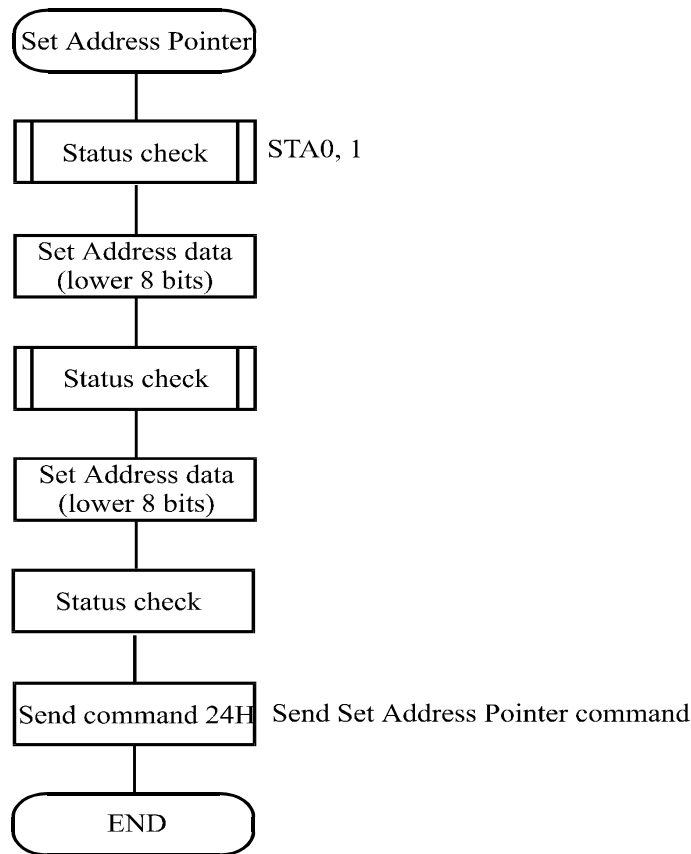
	(RAM DATA)	(Character)
AB γ DE ζ GHIJKLM	21H	A
.	22H	B
.	83H	γ
.	24H	D
.	25H	E
.	86H	ζ
Display character		

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



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 relationship between 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

: 32 Columns

: 4 Lines

0000H	0001H	—	001EH	001FH
0020H	0021H	—	003EH	002FH
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	—	$GH+GL$
$GH+GA$	—	$GH+GA+CL$
$(GH+GA)+GA$	—	$GH+2GA+CL$
$(GH+2GA)+GA$	—	$GH+3GA+CL$
—	—	—
$GH+(n-1) GA$	—	$GH+(n-1) GA+CL$

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

: 32 Columns

: 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	014FH
0160H	0161H	—	017EH	017FH
0180H	0181H	—	109EH	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 used to adjust the columns of the display.

(Example)

LCD size 20 columns, 4lines

Text home address 0000H

Text area 0014H

Set 32 columns, 4 Lines

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

(4) Set Graphic Area

← LCD →

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, 2lines

Graphic home address : 0000H

Graphic are : 0014H

Set 32 columns, 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	0013C	.....	00147
013C	013D	.....	014F	0150	.....	015B

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.

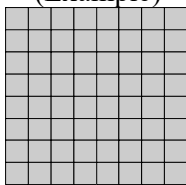
Mode set

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	—

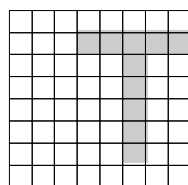
X: invalid

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.

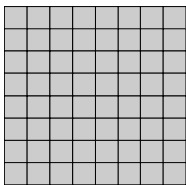
(Example)



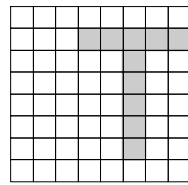
GRAPHIC



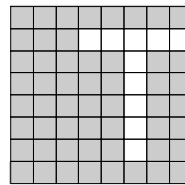
TEXT



“OR”



“AND”



“TXOR”

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

Attribute function

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

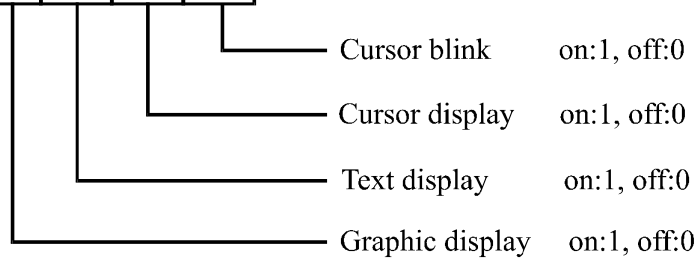
·Display

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
---	---	---	---	----	----	----	----



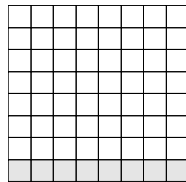
(Note) It is necessary to turn on “Text display” and “Graphic display” in the following cases.

- Combination of text/graphic display
- Attribute function

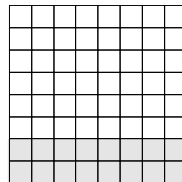
Cursor pattern select

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	—

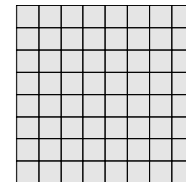
When cursor display is ON, this command selects the cursor pattern in the range 1 line to 8 lines. The cursor address is defined by the Cursor Pointer Set command.



1-line cursor



2-line cursor



8-line cursor

Data Auto Read/Write

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

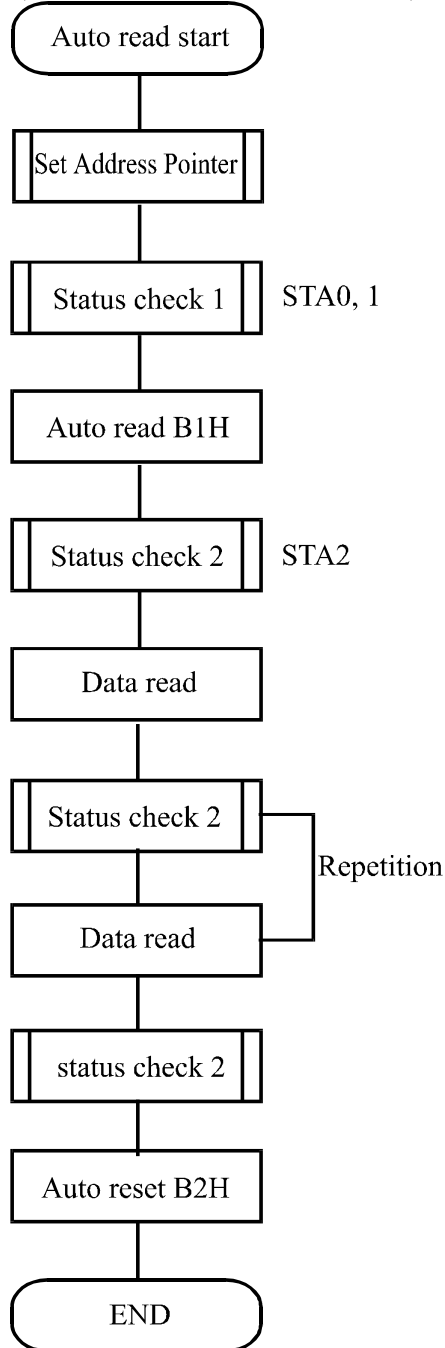
The command is convenient for sending a full screen of data from the external display RAM. After setting Auto mode, a Data Write (or Read) command is need not be sent between each datum. A Data Auto Write (or Read) command must be sent after a Set Address Pointer command. After this command, the address 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 T69963C after all data has been sent, to clear Auto mode.

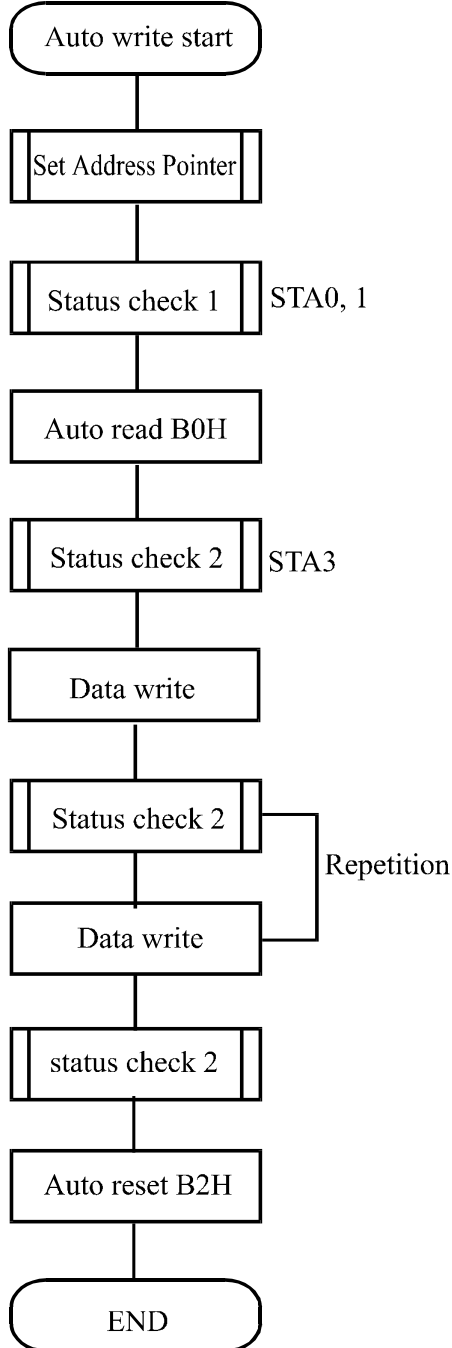
(Note) A Status check for Auto mode

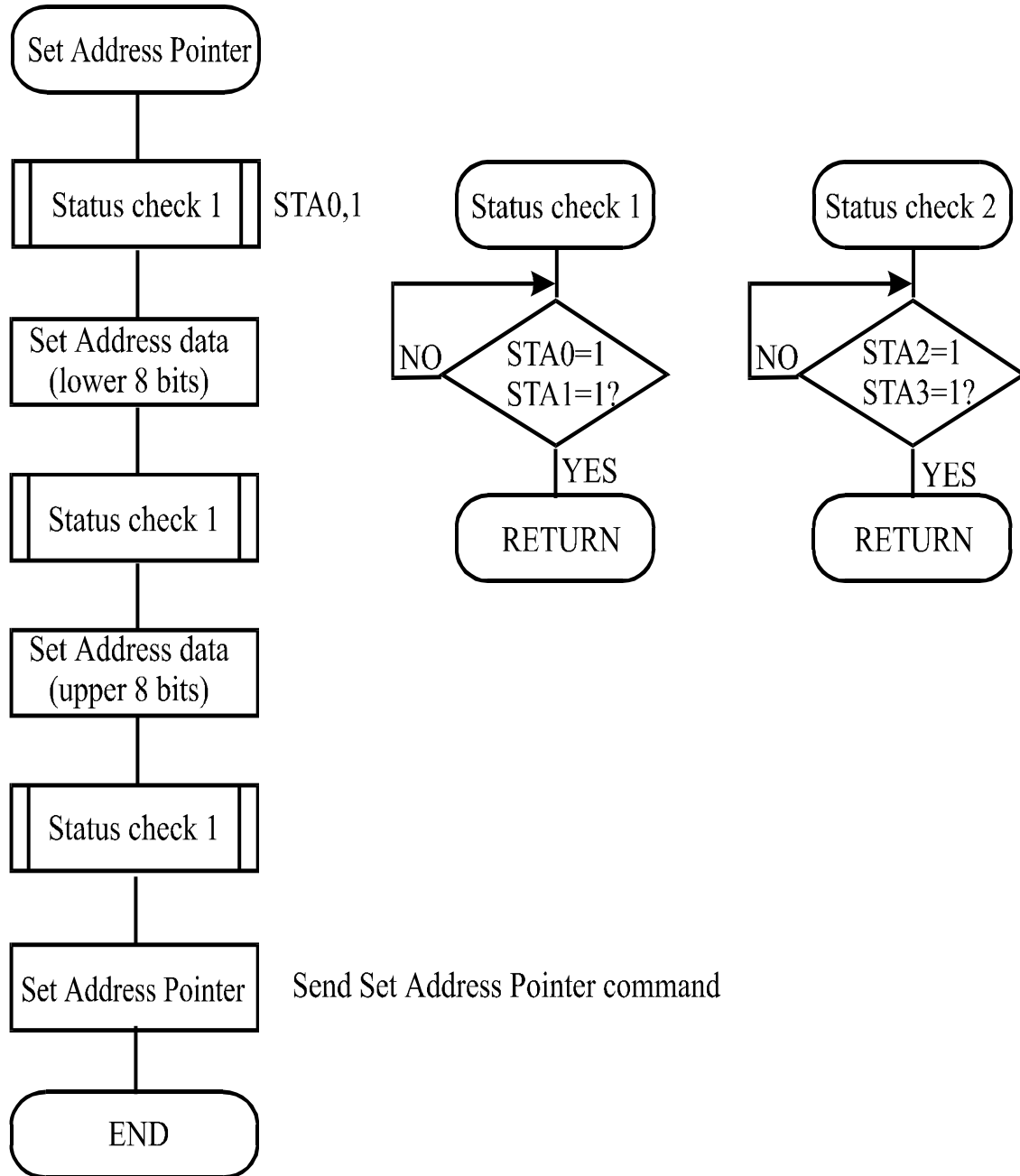
(STA2, STA3 should be checked between sending of each datum. Auto Reset should be performed after checking STA3=1 (STA2=1.) Refer to the following flowchart.

a)Auto Read mode



b)Auto Write mode





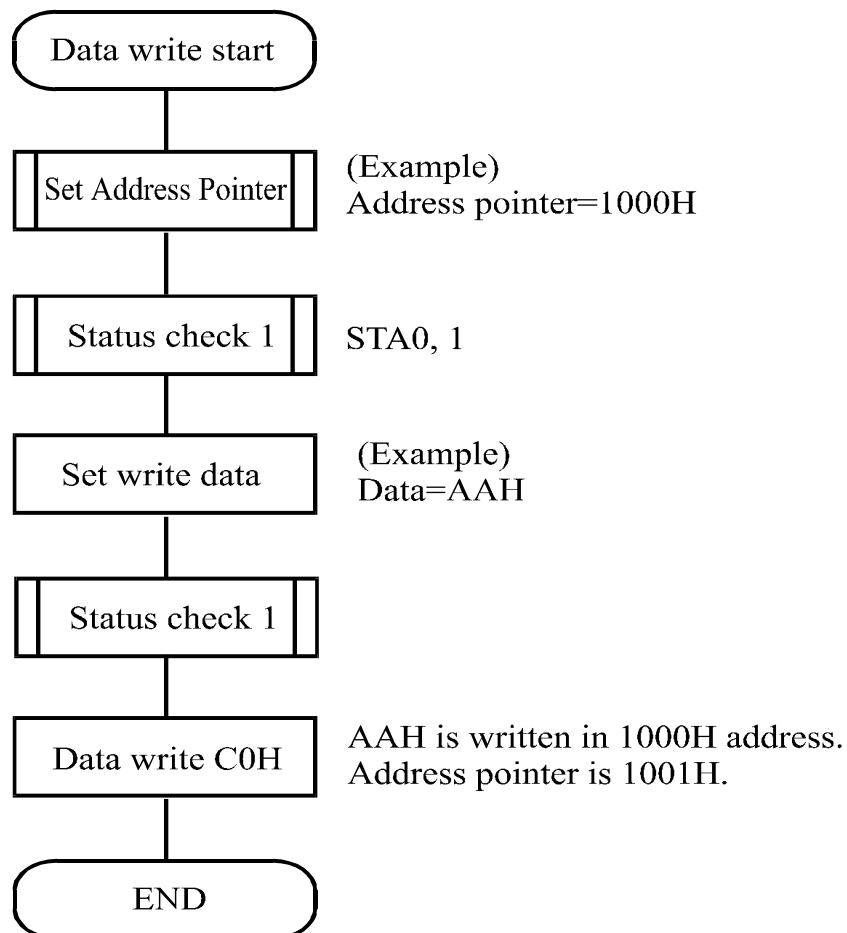
Date Read/Write

CODE	HEX.	FUNCTION	OPERAND
11000000	C0H	Data Write and Increment ADP	Data
11000001	C1H	Data Read and Increment ADP	—
11000010	C2H	Data Write and Decrement ADP	Data
11000011	C3H	Data Read and Decrement ADP	—
11000100	C4H	Data Write and Non-variable ADP	Data
11000101	C5H	Data Read and Non-variable ADP	—

This command is used 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:



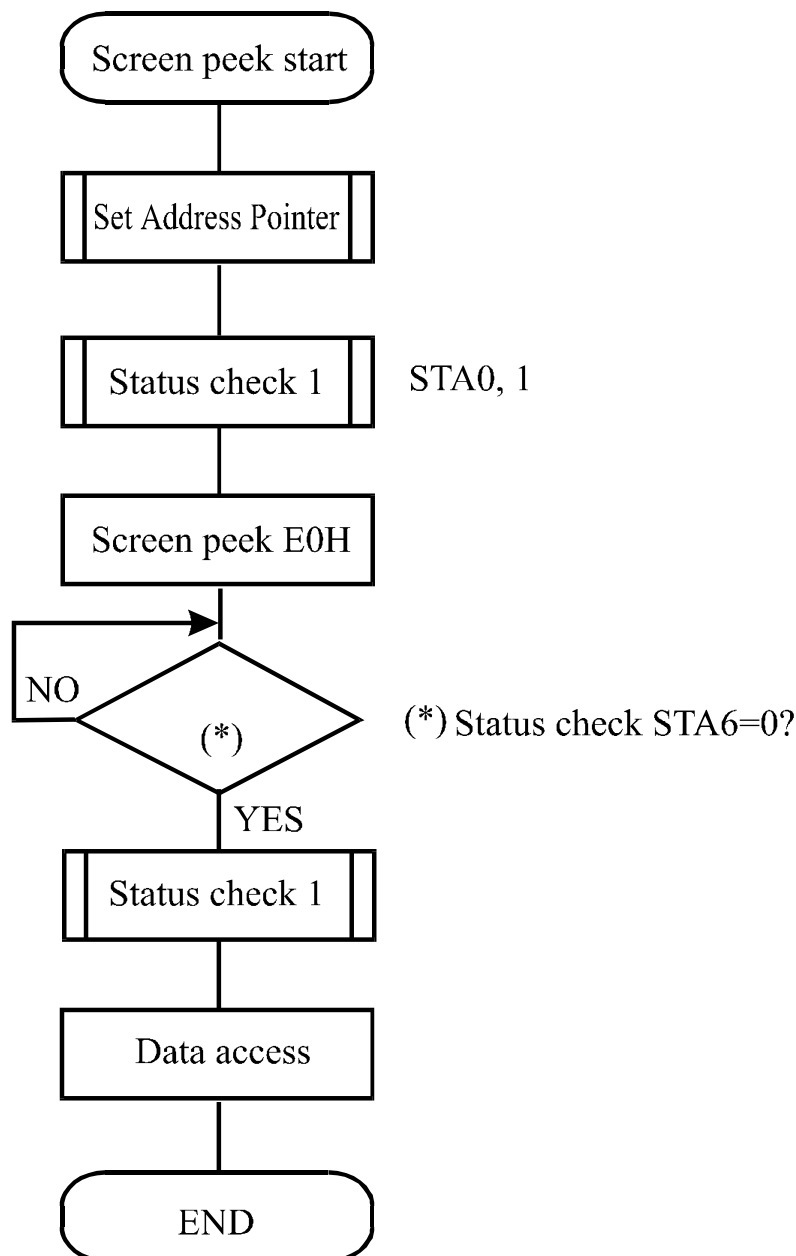
Screen Peek

CODE	HEX.	FUNCTION	OPERAND
11100000	E0H	Screen Peek	— c

This command is used to transfer 1 byte of displayed 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 the 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.



Screen Copy

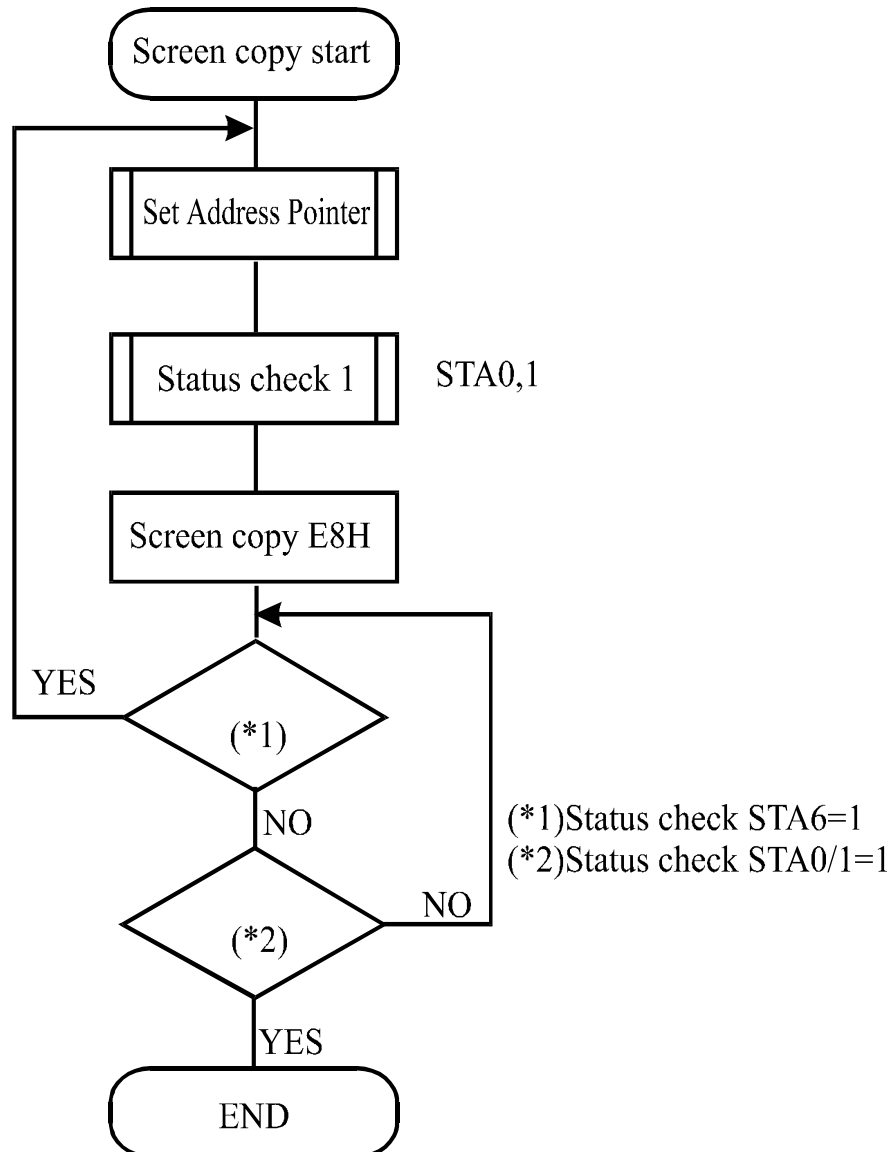
CODE	HEX.	FUNCTION	OPERAND
11101000	E8H	Screen Copy	—

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.)

Refer to the following flowchart:

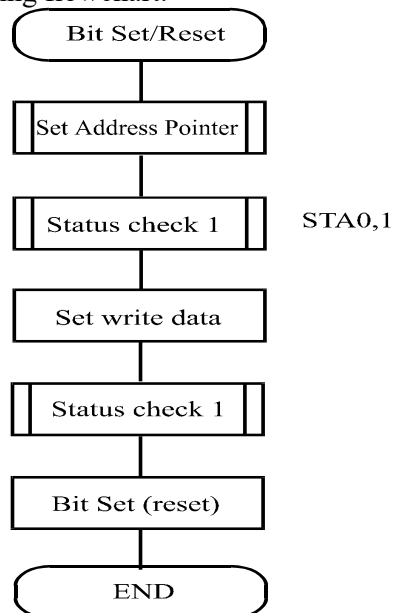


Bit Set/Reset

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)	—

X: invalid

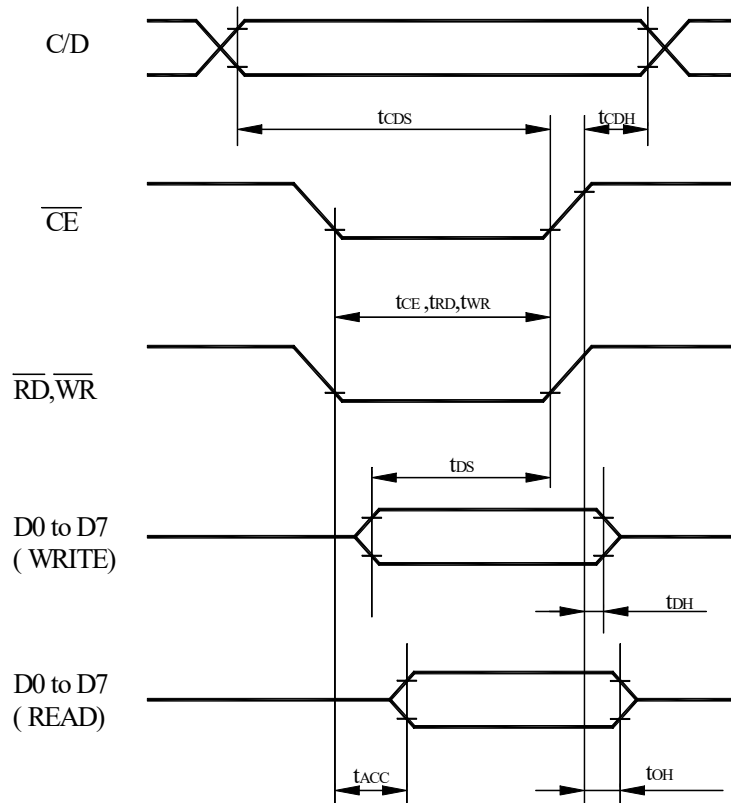
This command use to set or reset a bit of the byte specified by the address pointer. Only one bit can be set/reset at a time. Refer to the following flowchart:



Upper 4 bit Lower 4 bit	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH
LLLL		0	0	P	'	7	5	6
LLLH	!	1	A	0	a	7	c	2
LLHL	"	2	B	R	b	r	e	8
LLHH	#	3	O	S	c	s	a	3
LHLL	*	4	D	T	t	a	a	4
LHLH	%	5	E	U	e	u	a	5
LHHL	&	6	F	V	f	v	a	6
LHHH	"	7	G	W	w	s	c	
HLLL	<	8	H	X	h	x	a	9
HLLH	>	9	I	Y	i	w	e	0
HLHL	*	#	J	Z	j	z	a	0
HLHH	+	:	K	C	k	c	i	0
HALL	,	<	L	\	l	l	i	0
HHLH	—	=	M	I	m	i	a	*
HHHL	.	>	N	^	n	^	a	R
HHHH	/	?	O	_	o		a	/

Timing Characteristics

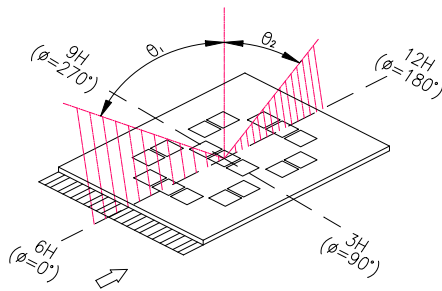
Item	Symbol	Min	Typ	Max	Unit
C/D Set-up Time	tCDS	100	-	-	ns
C/D Hold Time	tCDH	10	-	-	ns
CE,RD,WR Pulse Width	tCDS,tRD,tWR	80	-	-	ns
Data Set-up Time	tDS	80	-	-	ns
Data Hold Time	tDH	40	-	-	ns
Access Time	tACC	-	-	150	ns
Output Hold Time	tOH	10	-	50	ns



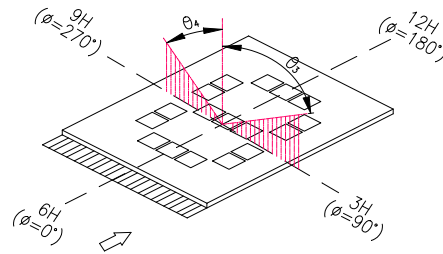
7. OPTICAL SPECIFICATION (STN characteristics)

Item	Symbol	Condition	Min	Typ	Max	Unit
View Angle	(V) θ	$CR \geq 2$	10	—	105	deg
	(H) φ	$CR \geq 2$	-30	—	30	deg
Contrast Ratio	CR	—	-	3	—	—
Response Time	T rise	—	—	200	300	ms
	T fall	—	—	200	300	ms

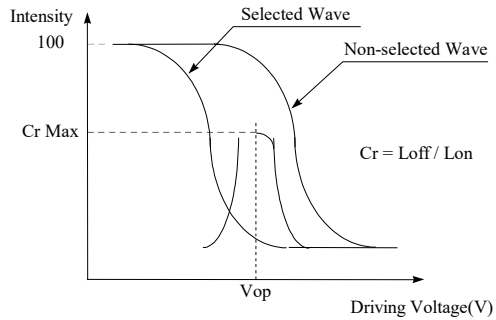
Note 1: definition of viewing angle θ_1 & θ_2



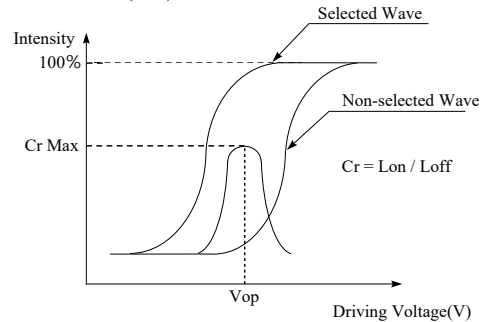
Note 2: definition of viewing angle θ_3 & θ_4



Note 3: definition of contrast ratio (CR)

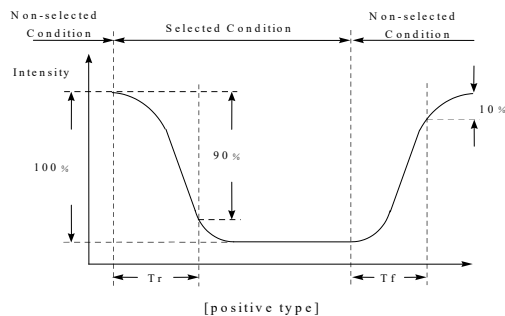


[positive type]

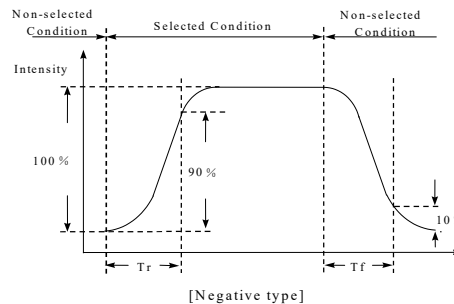


[Negative type]

Note 4: definition of response time

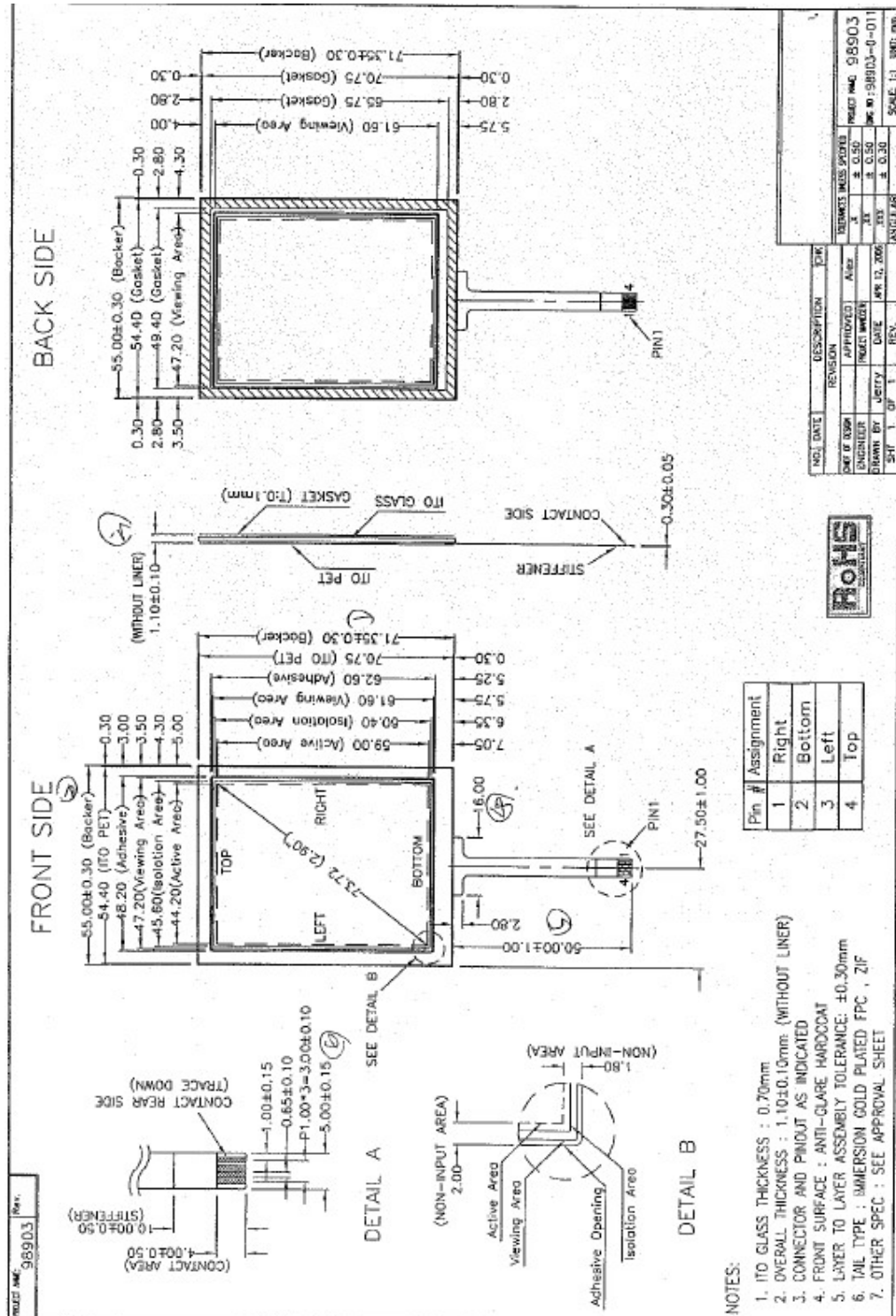


[positive type]



[Negative type]

6. TOUCH SCREEN SPECIFICATION



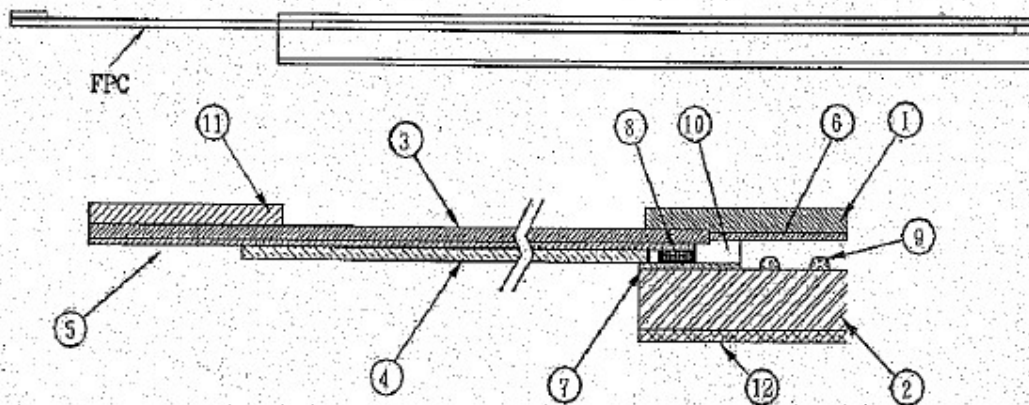
1. Mechanical Dimensions and Construction

1.1 General: Analog Resistive touch screen is laminated by ITO PET to ITO glass.

1.2 Construction :

Item	Description	Material	Remarks
1	Top layer	0.188mm ITO PET	Anti-glare coating Surface hardness: 3H Resistance: 300~600 $\Omega/\square$
2	Bottom layer	0.7mm ITO Glass	Resistance: 300~600 $\Omega/\square$
3	Tail Base	Polyimide	Separated Tail
4	Tail Coverlay	Polyimide	
5	Conductor	Copper	
6	Top layer circuit	Silver ink	
7	Bottom layer circuit	Silver ink	
8	Layer to layer contacted	Silver Glue	
9	Dot spacer	UV ink	
10	Isolation Layer	Double Side Adhesive	
11	Stiffener	Polyester	
12	Rear Side Gasket	Double Side Adhesive	

Touch screen side view:



1.3 Input Method and Activation Force

Input Method	Average Activation Force
1.6mm dia. Delrin stylus	0.10~0.70N
16mm dia. Silicon "finger"	0.10~0.80N

2. Typical Optical Characteristics

2.1 Visible Light Transmission: >80%

2.2 Haze:< 13%

3. Electrical Specifications

3.1 Operating Voltage: 5.5V or less

3.2 Contact current: 20mA (maximum)

3.3 Circuit close resistance: X : 200~700 Ω
Y : 300~900 Ω

3.4 Circuit open resistance: > 10M Ω at 25VDC

3.5 Contact bounce: < 10ms

3.6 Capacitance: 100nF (maximum)

3.7 Electrostatic Discharge Protection : (per EN 61000-4-2)

The touch screen withstands of 15KV air discharge and 8KV contact discharge.

4. Linearity

4.1 Linear Test Specification

Direction X: <2.0 %

Direction Y: <1.5 %

4.2 Linearity Test

Apply voltage (DC5V) to upper (or lower) electrodes, output voltage Vx (see Fig.4-1) or Vy (see Fig.4-2) on the other electrodes is measured at every regular intervals.

Linearity is the value of max. error voltage (see Fig. 4-3).

7 BACKLIGHT SPECIFICATION

7.1 LED BACKLIGHT CHARACTERISTICS

7.1.1 WHITE EDGE STANDARD LED BACKLIGHT CHARACTERISTICS

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	TEST CONDITION
Supply Current	I _{LED}	64	80	120	mA	V=3.5V
Supply Voltage	V	3.4	3.5	3.6	V	
Reverse Voltage	V _R	—	—	8	V	
Luminous Intensity	I _V	30	40	—	CD/M ²	I _{LED} =80mA
Wave Length	λ _p				nm	I _{LED} =80mA
Life Time		—	50K	—	Hr.	I _{LED} ≤ 80mA
Color	White					

7.1.2 YELLOW GREEN STANDARD LED BACKLIGHT CHARACTERISTICS

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	TEST CONDITION
Supply Current	I _{LED}	—	350	700	mA	V=4.2V
Supply Voltage	V	—	4.2	4.6	V	
Reverse Voltage	V _R	—	—	8	V	
Luminous Intensity	I _V	160	200	—	CD/M ²	I _{LED} =350mA
Wave Length	λ _p		570		nm	I _{LED} =350mA
Life Time		—	100000	—	Hr.	V ≤ 4.6V
Color	Yellow Green					

7.2 EL BACKLIGHT CHARACTERISTICS

7.2.1 WHITE EL BACKLIGHT CHARACTERISTICS

PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT	TEST CONDITION
Drive Voltage	V _{max}	—	110	120	V _{rms}	25℃
Drive Wave	F _{max}	—	400	1000	Hz	25℃
Brightness		25	—	—	cd/m ²	110~120V _{rms} /300~400Hz
Power Consumption		—	68.2	—	mW	110~120V _{rms} /300~400Hz
Chromatism	X	—	0.330	—	—	110~120V _{rms} /300~400Hz
	Y	—	0.365	—	—	110~120V _{rms} /300~400Hz
Life time		5000			hour	110~120V _{rms} /300~400Hz
Color		White			—	—

8 QUALITY ASSURANCE SPECIFICATION

8.1 CONFORMITY

The performance, function and reliability of the shipped products conform to the Product Specification.

8.2 DELIVERY ASSURANCE

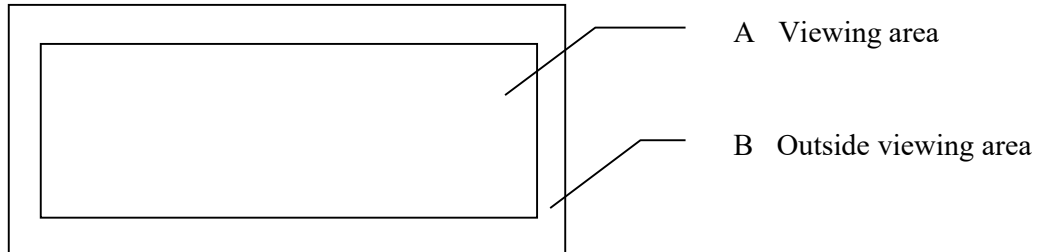
8.2.1 Delivery inspection standards.

- MIL-STD-105E, general inspection level II, single sampling level;
- IPC-AA610 rev. C, class 2 electronic assemblies standard

The quality assurance levels are shown below:

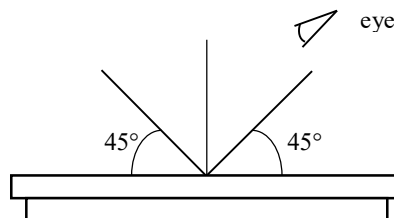
Rank	Item Inspected	Defect type	AQL	Remark
Critical defect	Display	Non display	0.65%	Display malfunction
		Over current		
		Missing segment		
		Wrong viewing direction		
		Backlight OFF		
	Dimension	PCB and bezel out of specification	0.65%	Assembly failure
Major defect	Display	Incorrect operating	1.0%	
	Backlight	Flashing, dust		
		Wrong colour		
Minor defect	LCD	Black and white spot	2.5%	Appearance defect
		Black and white lines		
		Polariser scratch		
		Bubbles in polariser		
		Segment deformation, pin hole		
		Colour uniformity		
		Glass chip		
	COB	Wire bond pad exposed		
		Insufficient covering with resin (wire bond line exposed)		
		Bubble, dust on COB		
	PCB	Dust, solder ball on PCB		
		Pad scratch		
Total			2.5%	

8.2.2 Zone definition



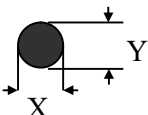
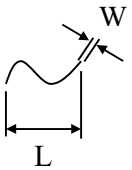
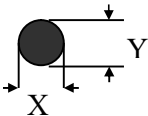
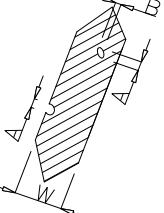
8.2.3 Visual inspection

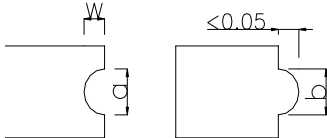
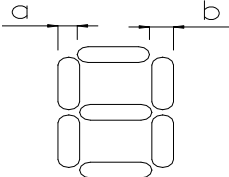
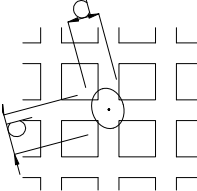
- Inspect under 2x20W or 40W fluorescent lamp (approximately 3000 lux) leaving 25 to 30 cm between the module and the lamp and 30 cm between the module and the eye (measuring position).
- Appearance is inspected at the best contrast voltage (best contrast is adjusted considering clearness and crosstalk on screen).
- Inspect the module at 45° right and left, top and bottom.
- Use the optimum viewing angle during the contrast inspection.



8.2.4 Standard of appearance inspection

Units: mm

No	Item	Criteria																																			
1	Black spot, white spot, dust	Round type: as per following drawing $\varnothing = (X+Y)/2$  <table><tr><th colspan="3">Acceptable quantity</th></tr><tr><th>Size</th><th>Zone A</th><th>Zone B</th></tr><tr><td>$\varnothing < 0.1$</td><td>Any number</td><td rowspan="4">Any number</td></tr><tr><td>$0.1 < \varnothing < 0.2$</td><td>6</td></tr><tr><td>$0.2 < \varnothing < 0.3$</td><td>2</td></tr><tr><td>$0.3 < \varnothing$</td><td>0</td></tr></table> Line type: as per following drawing  <table><tr><th colspan="4">Acceptable quantity</th></tr><tr><th>Length</th><th>Width</th><th>Zone A</th><th>Zone B</th></tr><tr><td>--</td><td>$W \leq 0.02$</td><td>Any number</td><td rowspan="4">Any number</td></tr><tr><td>$L \leq 3.0$</td><td>$0.02 < W \leq 0.03$</td><td rowspan="2">2</td></tr><tr><td>$L \leq 2.5$</td><td>$0.03 < W \leq 0.05$</td></tr><tr><td>--</td><td>$0.05 < W$</td><td>As round type</td></tr></table> Total acceptable quantity: 3	Acceptable quantity			Size	Zone A	Zone B	$\varnothing < 0.1$	Any number	Any number	$0.1 < \varnothing < 0.2$	6	$0.2 < \varnothing < 0.3$	2	$0.3 < \varnothing$	0	Acceptable quantity				Length	Width	Zone A	Zone B	--	$W \leq 0.02$	Any number	Any number	$L \leq 3.0$	$0.02 < W \leq 0.03$	2	$L \leq 2.5$	$0.03 < W \leq 0.05$	--	$0.05 < W$	As round type
Acceptable quantity																																					
Size	Zone A	Zone B																																			
$\varnothing < 0.1$	Any number	Any number																																			
$0.1 < \varnothing < 0.2$	6																																				
$0.2 < \varnothing < 0.3$	2																																				
$0.3 < \varnothing$	0																																				
Acceptable quantity																																					
Length	Width	Zone A	Zone B																																		
--	$W \leq 0.02$	Any number	Any number																																		
$L \leq 3.0$	$0.02 < W \leq 0.03$	2																																			
$L \leq 2.5$	$0.03 < W \leq 0.05$																																				
--	$0.05 < W$	As round type																																			
2	Polariser scratch	Scratch on protective film is permitted Scratch on polariser: same as No. 1																																			
3	Polariser bubble	$\varnothing = (X+Y)/2$  <table><tr><th colspan="3">Acceptable quantity</th></tr><tr><th>Size</th><th>Zone A</th><th>Zone B</th></tr><tr><td>$\varnothing < 0.3$</td><td>Any number</td><td rowspan="4">Any number</td></tr><tr><td>$0.3 < \varnothing < 1.0$</td><td>3</td></tr><tr><td>$1.0 < \varnothing < 1.5$</td><td>1</td></tr><tr><td>$1.5 < \varnothing$</td><td>0</td></tr></table> Total acceptable quantity: 4	Acceptable quantity			Size	Zone A	Zone B	$\varnothing < 0.3$	Any number	Any number	$0.3 < \varnothing < 1.0$	3	$1.0 < \varnothing < 1.5$	1	$1.5 < \varnothing$	0																				
Acceptable quantity																																					
Size	Zone A	Zone B																																			
$\varnothing < 0.3$	Any number	Any number																																			
$0.3 < \varnothing < 1.0$	3																																				
$1.0 < \varnothing < 1.5$	1																																				
$1.5 < \varnothing$	0																																				
4	Segment deformation	1.a. Pin hole on segmented display W: segment width $\varnothing = (A+B)/2$  <table><tr><th colspan="2">Acceptable quantity</th></tr><tr><th>Width</th><th>$\varnothing$</th></tr><tr><td>$W \leq 0.4$</td><td>$\varnothing \leq 0.2$ and $\varnothing \leq 1/2W$</td></tr><tr><td>$W > 0.4$</td><td>$\varnothing \leq 0.25$ and $\varnothing \leq 1/3W$</td></tr></table> Total acceptable quantity: 1 defect per segment Pin holes with $\varnothing$ under 0.10 mm are acceptable	Acceptable quantity		Width	$\varnothing$	$W \leq 0.4$	$\varnothing \leq 0.2$ and $\varnothing \leq 1/2W$	$W > 0.4$	$\varnothing \leq 0.25$ and $\varnothing \leq 1/3W$																											
Acceptable quantity																																					
Width	$\varnothing$																																				
$W \leq 0.4$	$\varnothing \leq 0.2$ and $\varnothing \leq 1/2W$																																				
$W > 0.4$	$\varnothing \leq 0.25$ and $\varnothing \leq 1/3W$																																				

No	Item	Criteria																												
4	Segment deformation	1b. Pin hole on dot matrix display  <table><tr><th colspan="2">Acceptable quantity</th></tr><tr><th>Size</th><th></th></tr><tr><td>$a, b < 0.1$</td><td>Any number</td></tr><tr><td>$(a+b)/2 \leq 0.1$</td><td>Any number</td></tr><tr><td>$0.5 < \varnothing < 1.0$</td><td>3</td></tr></table> Total acceptable quantity: 7 2. Segments / dots with different width  <table><tr><th colspan="2">Acceptable</th></tr><tr><td>$a \geq b$</td><td>$a/b \leq 4/3$</td></tr><tr><td>$a < b$</td><td>$a/b > 4/3$</td></tr></table> 3. Alignment layer defect $\varnothing = (a+b)/2$  <table><tr><th colspan="2">Acceptable quantity</th></tr><tr><th>Size</th><th></th></tr><tr><td>$\varnothing \leq 0.4$</td><td>Any number</td></tr><tr><td>$0.4 < \varnothing \leq 1.0$</td><td>5</td></tr><tr><td>$1.0 < \varnothing \leq 1.5$</td><td>3</td></tr><tr><td>$1.5 < \varnothing \leq 2.0$</td><td>2</td></tr></table> Total acceptable quantity: 7	Acceptable quantity		Size		$a, b < 0.1$	Any number	$(a+b)/2 \leq 0.1$	Any number	$0.5 < \varnothing < 1.0$	3	Acceptable		$a \geq b$	$a/b \leq 4/3$	$a < b$	$a/b > 4/3$	Acceptable quantity		Size		$\varnothing \leq 0.4$	Any number	$0.4 < \varnothing \leq 1.0$	5	$1.0 < \varnothing \leq 1.5$	3	$1.5 < \varnothing \leq 2.0$	2
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5	Colour uniformity	Level of sample for approval set as limit sample																												
6	Backlight	The backlight colour should correspond to the product specification Flashing and or unlit backlight is not allowed Dust larger than 0.25 mm is not allowed																												
7	COB	Exposed wire bond pad is not allowed Insufficient covering with resin is not allowed (wire bond line exposed) Dust or bubble on the resin are not allowed																												
8	PCB 	No unmelted solder paste should be present on PCB Cold solder joints, missing solder connections, or oxidation are not allowed No residue or solder balls on PCB are allowed Short circuits on components are not allowed																												

9 RELIABILITY SPECIFICATION

Test Item	Test Condition	Description
High Temperature Operation	50°C or 70°C 200hrs	Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.
Low Temperature Operation	0°C or -20°C 200hrs	Endurance test applying the electric stress under low temperature for a long time.
High Temperature Storage	70°C or 80°C 200hrs	Endurance test applying the high storage temperature for a long time.
Low Temperature Storage	-20°C or -30°C 200hrs	Endurance test applying the high storage temperature for a long time.
High Temperature & High Humidity Storage	80°C,90%RH 96hrs	Endurance test applying the high temperature and high humidity storage for a long time.
Thermal Shock Test	$\xleftarrow{30^{\circ}\text{C}} \quad 25^{\circ}\text{C} \quad \xrightarrow{80^{\circ}\text{C}}$ 30min 5min 30min For 10 cycles	Endurance test applying the low and high temperature cycle. Burn In Test.
Vibration	10~22Hz→1.5mmp-p 22~500Hz→1.5G Total 0.5hrs	Endurance test applying the vibration during transportation and using.
ESD	VS=800V,RS=1.5kΩ CS=100pF	Endurance test applying the electric stress to the terminal.
Shock Test	50G Half sign wave 11 msdc 3 times of each direction	Constructional and mechanical endurance test applying the shock during transportation.

10 HANDLING PRECAUTIONS

Safety

If the LCD panel breaks, be careful not to get the liquid crystal fluid in your mouth or in your eyes.

If the liquid crystal touches your skin or clothes, wash it off immediately using soap and plenty of water.

Mounting and Design

Place a transparent plate (e.g. acrylic, polycarbonate or glass) on the display surface to protect the display from external pressure. Leave a small gap between the transparent plate and the display surface.

When assembling with a zebra connector, clean the surface of the pads with alcohol and keep the surrounding air very clean.

Design the system so that no input signal is given unless the power supply voltage is applied.

Caution during LCD cleaning

Lightly wipe the display surface with a soft cloth soaked with Isopropyl alcohol, Ethyl alcohol or Trichlorotrifluoroethane.

Do not wipe the display surface with dry or hard materials that will damage the polariser surface.

Do not use aromatic solvents (toluene and xylene), or ketonic solvents (ketone and acetone).

Caution against static charge

As the display uses C-MOS LSI drivers, connect any unused input terminal to VDD or VSS. Do not input any signals before power is turned on.

Also, ground your body, work/assembly table and assembly equipment to protect against static electricity.

Packaging

Displays use LCD elements, and must be treated as such. Avoid strong shock and drop from a height.

To prevent displays from degradation, do not operate or store them exposed directly to sunshine or high temperature/humidity.

Caution during operation

It is indispensable to drive the display within the specified voltage limit since excessive voltage shortens its life.

Direct current causes an electrochemical reaction with remarkable deterioration of the display quality. Give careful consideration to prevent direct current during ON/OFF timing and during operation.

Response time is extremely delayed at temperatures lower than the operating temperature range while, at high temperatures, displays become dark. However, this phenomenon is reversible and does not mean a malfunction or a display that has been permanently damaged.

If the display area is pushed on hard during operation, some graphics will be abnormally displayed but returns to a normal condition after turning off the display once.

Even a small amount of condensation on the contact pads (terminals) can cause an electro-chemical reaction which causes missing rows and columns. Give careful attention to avoid condensation.

Storage

Store the display in a dark place where the temperature is $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$ and the humidity below 50%RH.

Store the display in a clean environment, free from dust, organic solvents and corrosive gases.

Do not crash, shake or jolt the display (including accessories).