SPECIFICATION FOR LCD MODEL

REV1.0

Data : 2005 年 01 月 20 日

Customer :

Model No. : RICH240128-03

Prepared by : Forest Gump

Checked by :

Approved by :

CUSTOMER APPROVAL
☐ Accept ☐ Reject
Comment:

CONTENTS

1. REVSION RECORD

No.	DATE	REV.	CONTENTS	WRITTEN
1	2005.01.20	1.0	INITIAL RELEASE	ALGAN

2. MODEL NUMBER

Model Number : RICH240128-03

3. FEATURES

3.1 . Display mode : STN/Yellow-Green Transflective Positive

3.2 . Display color : Display color*1 : Dark Blue

Background*2 : Yellow - Green

3.3 . Display format : 240 Dots X 128 Dots

3.4 . Viewing direction : 6 O'clock

3.5 . Controller : TOSHIBA T6963C, T6A40 and T6A39

3.6 . Driving method : 1/128 Duty,1/13 Bias

3.7 . MPU Interface : 8-Bit

3.8 . LCD Operating Voltage : 18.0V VDD : 5.0V(Built-in DC/DC Converter)

3.9 . Blacklight : LED Unit 04 (Yellow-Green)

*1 Color tone is slightly changed by temperature and driving voltage.

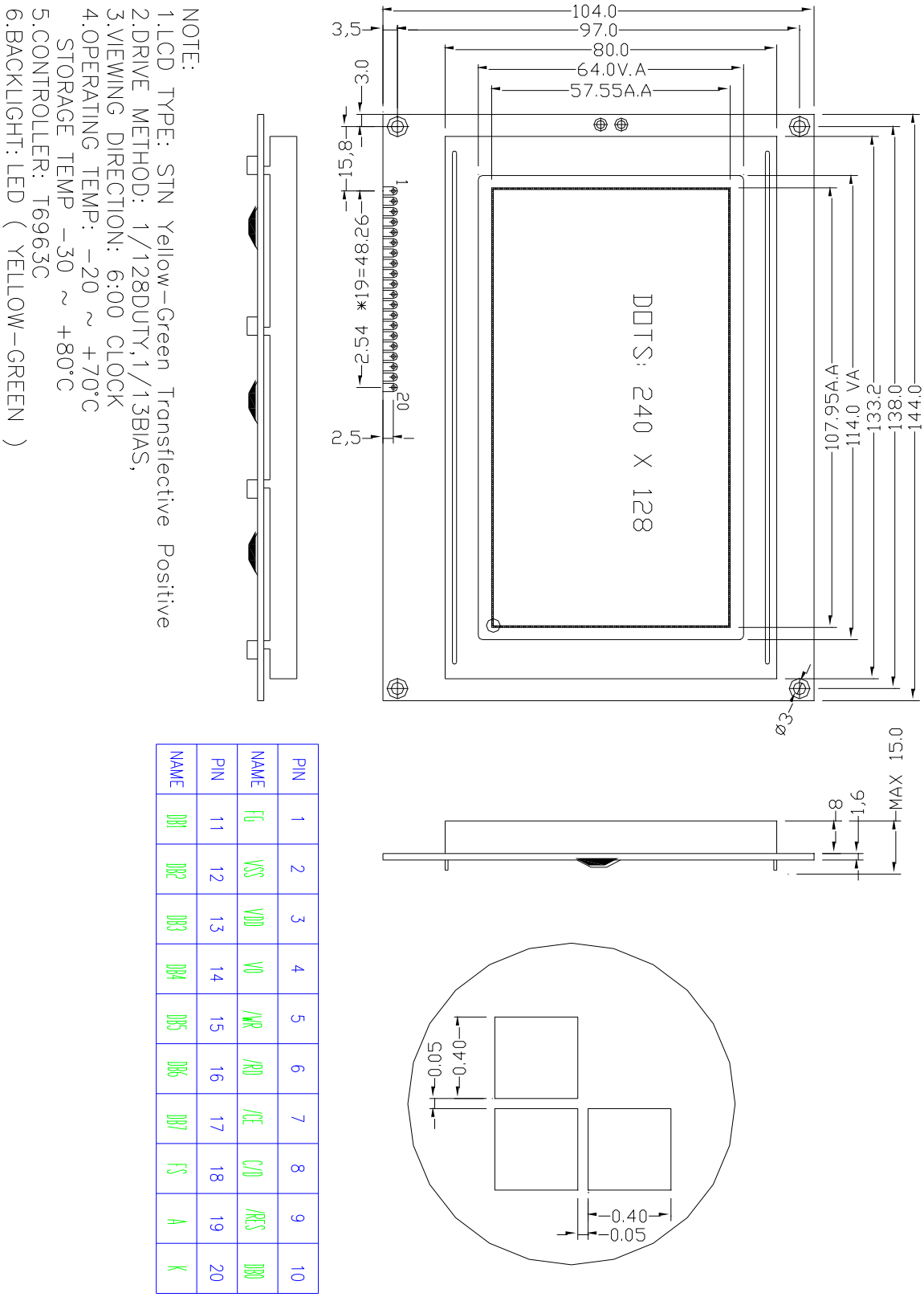
*2 Color tone will be changed by backlight.

4. MECHANICAL DIMMENSIONS

Items	Dimension	Unit
Outline Dimension	144(W) X 104(H) X 15.0MAX.(T)	mm
Number of Dots	240X 128 Dots	/
Viewing Area	114(W) X 64(H)	mm
Active Area	107.95(W) X 57.55(H)	mm
Dots Pitch	0.45(W) X 0.45(H)	mm
Dots size	0.30(W) X 0.30(H)	mm

5. MODULE OUTLINE

MECHANICAL OUTLINE



PIN	NAME	PIN	NAME
1	FG	11	DB1
2	VSS	12	DB2
3	VDD	13	DB3
4	VO	14	DB4
5	/WR	15	DB5
6	/RD	16	DB6
7	/CE	17	DB7
8	C/D	18	FS
9	/RES	19	A
10	DB0	20	K

6. ELECTRICAL CHARACTERISTICS

6.1 ABSOLUTE MAXIMUM RATING

Items	Symbol	Min.	Max.	Unit	Note
Supply Voltage	V_{DD}- V_{SS}	-0.3	7.0	V	
Input Voltage	V_{IN}	-0.3	V_{DD}+0.3	V	
Supply Voltage For LCD	V_{LCD} =V_{DD}- V_{EE}	V_{DD}+0.3	V_{DD}-30	V	
Operating Temperature	T_{OP}	-20	+70	°C	
Storage Temperature	T_{STG}	-30	+80	°C	
Humidity	-	-	90%	%RH	1)

Note 1) Wet bulb temperature should be 29°C Max., and. no condensation of water.

6.2 ELECTRICAL CHARACTERISTICS

Items	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply Voltage	V_{DD}-V_{SS}	-	4.5	5.0	5.5	V
Supply Current	I_{DD}	V_{DD}=5.0		7.23	10.0	mA
Supply Voltage For LCD	V_{LCD}	T_A= 25 °C	17.5	18.0	18.5	V
‘High’ Level Input Voltage	V_{IH}		V_{DD}-0.8	-	V_{DD}	V
‘Low’ Level Input Voltage	V_{IL}		0		0.8	V
‘High’ Level Output Voltage	V_{OH}	I_{OH}=-0.5mA	V_{DD}-0.5	-	V_{DD}	V
‘Low’ Level Output Voltage	V_{OL}	I_{OL}=0.5mA	-	-	0.5	V

NOTE : 1.)Duty ratio=1/128 ,Bias=1/13

2.) Measured in Dots ON-state

6.3 BACKLIGHT

6.3.1. Absolute Maximum Ratings

Item	Symbol	Condition	Min.	Typ.	Max	Unit
Forward Current	IF	Ta= 25℃	-	1190	-	mA
Reverse Voltage	VR		-	-	8	V
Power Dissipation	Pd	Ta= 25℃	-	8450	-	mW

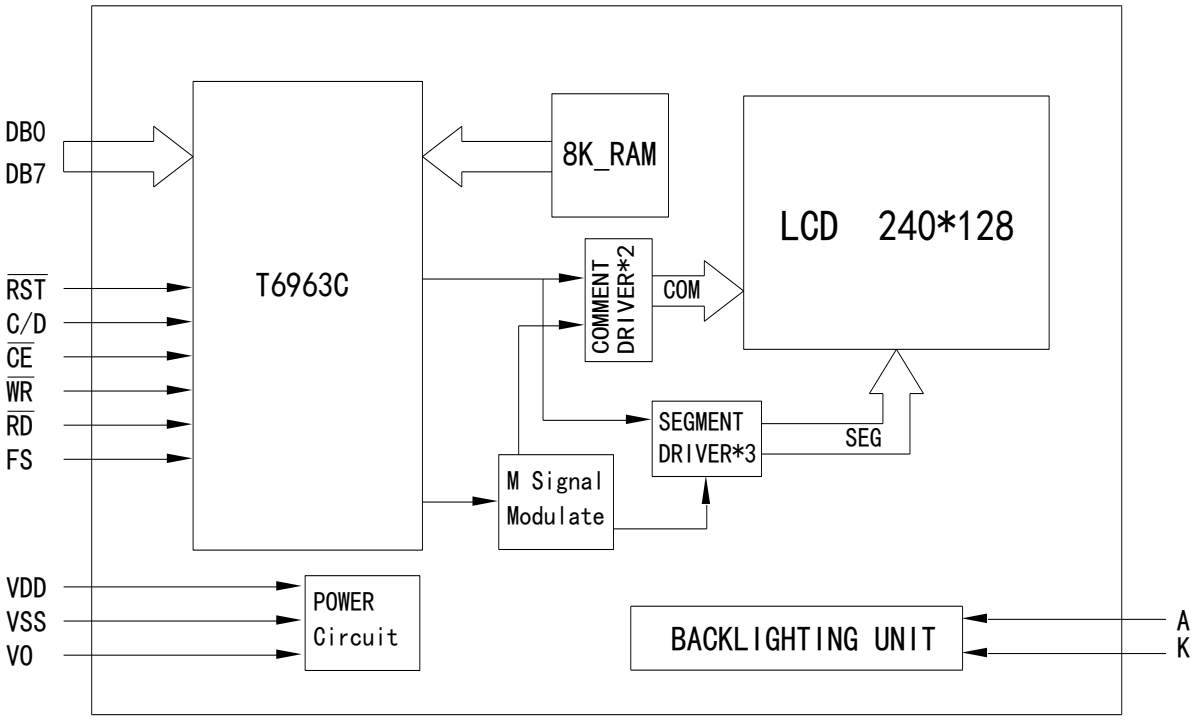
6.3.2. Opto-electronic Characteristics

Item	Symbol	Condition	Min.	Typ.	Max	Unit
Forward Voltage	VF	Ta= 25℃	4.0	4.2	4.4	V
Emission wave Length	λ P	IF=	570	572	575	nm
Luminous	Iv	1190mA	-	100	-	cd/m²

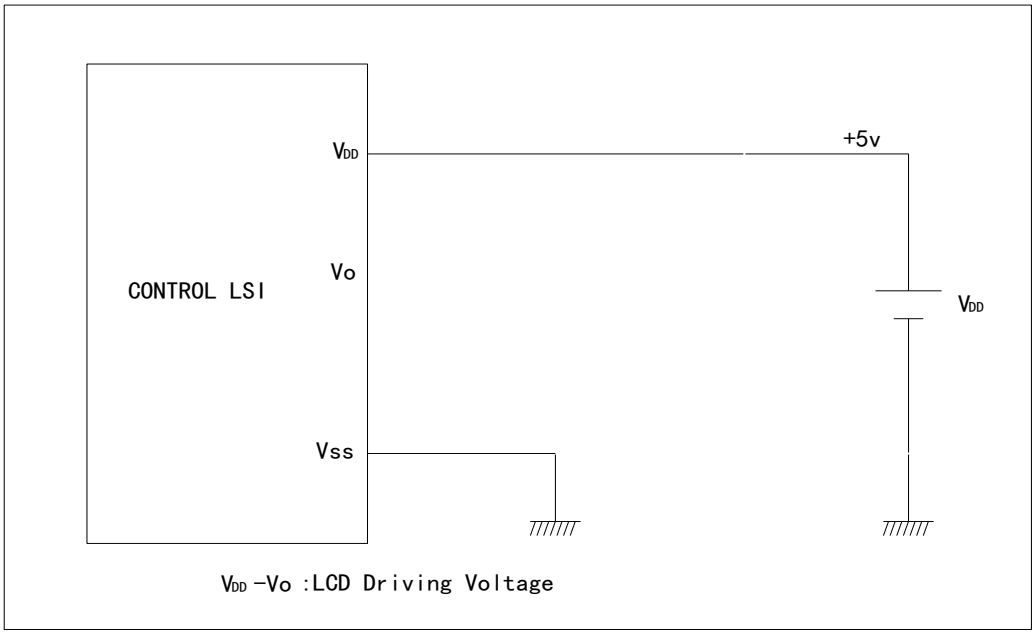
6.4 PIN ASSIGNMENT

Pin NO.	Symbol	Description
1	FG	Frame Ground (connect to bezel)
2	VSS	Ground(0V)
3	VDD	Power supply for logic circuit
4	V0	/
5	/WR	Data write
6	RD	Data read
7	/CE	Chip enable
8	C/D	Code/data select
9	RES	Reset signal (Active “LOW”).
10	DB0	Data bus (D0: LSB; D7: MSB)
11	DB1	
12	DB2	
13	DB3	
14	DB4	
15	DB5	
16	DB6	
17	DB7	
18	FS	Font select FS = "H": 6x8 character font Font FS ="L" : 8x8 character font
19	A	Backlight (+)
20	K	Backlight (-)

6.5 MODULE BLOCK DIAGRAM



6.6 POWER SUPPLY

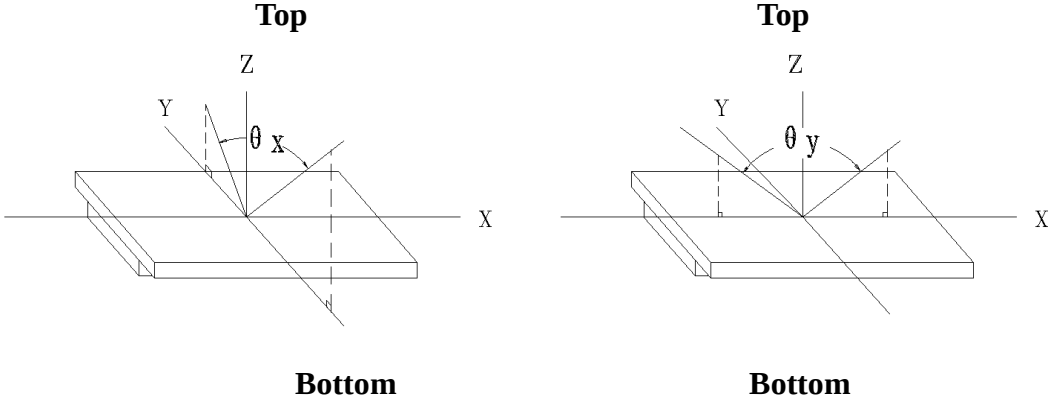


7. ELECTRO-OPTICAL CHARACTERISTICS

7.1 ELECTRO-OPTICAL CHARACTERISTICS

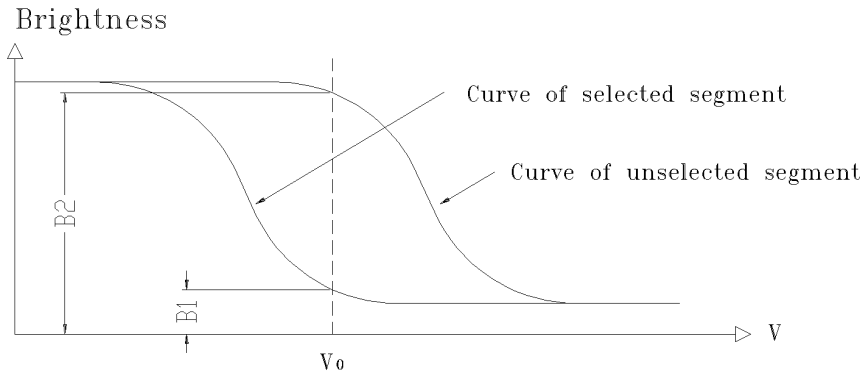
Items	Symbol		Condition		Min.	Typ.	Max.	Unit
Viewing Angle	θ x		Cr≥2	θy=0°	-35 -- 20			Deg
	θ y			θx=0°	-30 -- 30			
Contrast Ratio	Cr		θx=0° θy=0°		4	-	-	
Response Time	Turn on	Ton	θx=0° θy=0°		-	120	250	ms
	Turn off	Toff			-	160	250	

7.2 DEFINITION OF VIEWING ANGLE

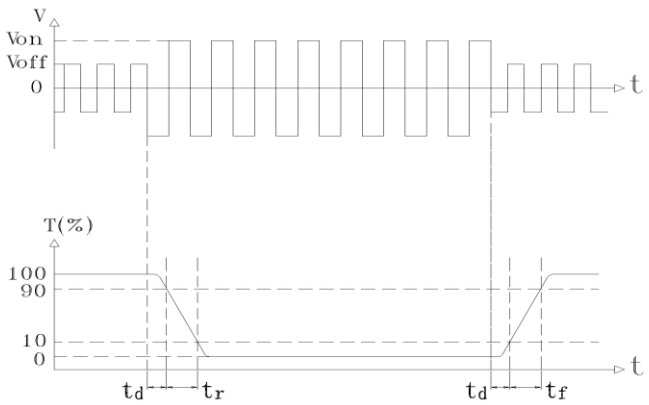


7.3 DEFINITION OF CONTRAST RATIO

$$\text{Contrast Ratio} = B2/B1 = \frac{\text{unselected state brightness}}{\text{selected state brightness}}$$



7.4 DEFINITION OF RESPONSE TIME



Turn on time: ton = td + tr Turn off time: toff = td + tf

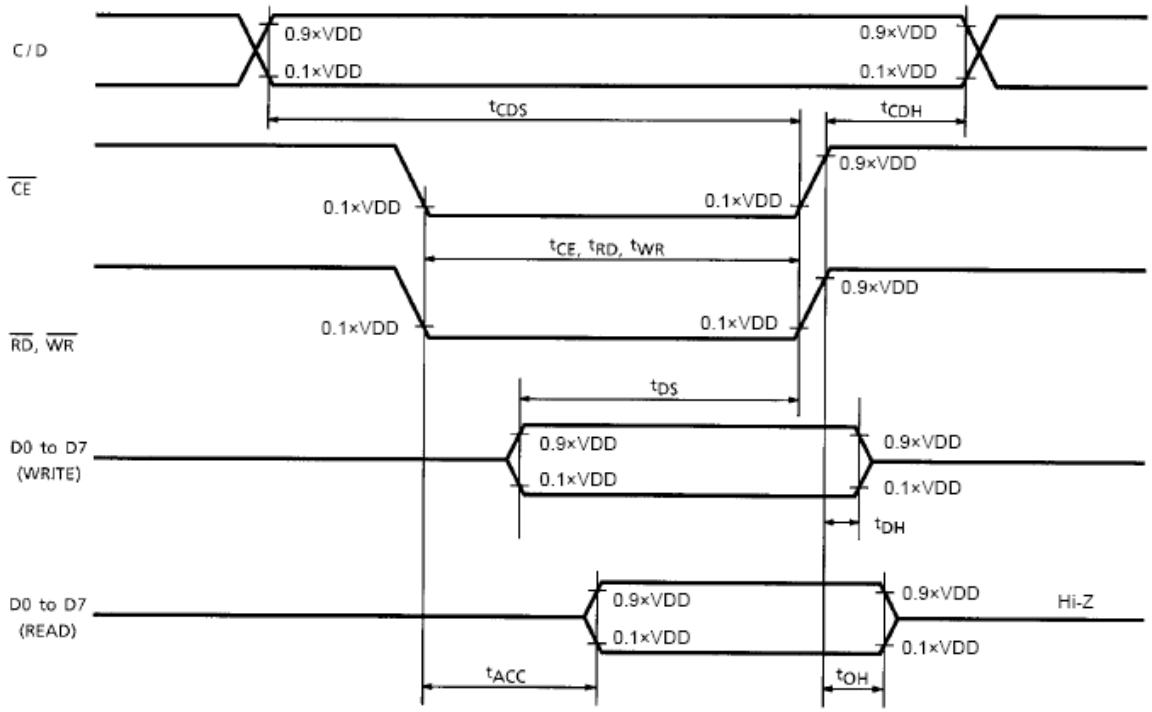
Measuring Condition:

1) Operating Voltage: 18.0V 2) Frame frequency: 70.0Hz

8. OPERATING PRINCIPLES & METHODS

8.1 TIMING CHARACTERISTICS

Bus Timing



Test Conditions (Unless Otherwise Noted, V_{DD} = 5.0 V ± 10%, V_{SS} = 0 V, Ta = −20 to 75°C)

Item	Symbol	Test Conditions	Min	Max	Unit
C / D Set−up Time	t_{CDS}	—	100	—	ns
C / D Hold Time	t_{CDH}	—	10	—	ns
$\overline{CE}$, $\overline{RD}$, $\overline{WR}$ Pulse Width	t_{CE}, t_{RD}, t_{WR}	—	80	—	ns
Data Set−up Time	t_{DS}	—	80	—	ns
Data Hold Time	t_{DH}	—	40	—	ns
Access Time	t_{ACC}	(Note)	—	150	ns
Output Hold Time	t_{OH}	—	10	50	ns

8.2 LCD DRIVER INSTRUCTION TABLE

Command	Code	D1	D2	Function
REGISTERS SETTING	00100001 00100010 00100100	X address Data Low address	Y address 00H High address	Set Cursor Pointer Set Offset Register Set Address Pointer
SET CONTROL WORD	01000000 01000001 01000010 01000011	Low address Columns Low address Columns	High address 00H High address 00H	Set Text Home Address Set Text Area Set Graphic Home Address Set Graphic Area
MODE SET	1000X000 1000X001 1000X011 1000X100 10000XXX 10001XXX	— — — — — —	— — — — — —	OR mode EXOR mode AND mode Text Attribute mode Internal CG ROM mode External CG RAM mode
DISPLAY MODE	10010000 1001XX10 1001XX11 100101XX 100110XX 100111XX	— — — — — —	— — — — — —	Display off Cursor on, blink off Cursor on, blink on Text on, graphic off Text off, graphic on Text on, graphic on
CURSOR PATTERN SELECT	10100000 10100001 10100010 10100011 10100100 10100101 10100110 10100111	— — — — — — — —	— — — — — — — —	1−line cursor 2−line cursor 3−line cursor 4−line cursor 5−line cursor 6−line cursor 7−line cursor 8−line cursor
DATA AUTO READ / WRITE	10110000 10110001 10110010	— — —	— — —	Set Data Auto Write Set Data Auto Read Auto Reset
DATA READ / WRITE	11000000 11000001 11000010 11000011 11000100 11000101	Data — Data — Data —	— — — — — —	Data Write and Increment ADP Data Read and Increment ADP Data Write and Decrement ADP Data Read and Decrement ADP Data Write and Nonvariable ADP Data Read and Nonvariable ADP
SCREEN PEEK	11100000	—	—	Screen Peek
SCREEN COPY	11101000			Screen Copy
BIT SET / RESET	11110XXX 11111XXX 1111X000 1111X001 1111X010 1111X011 1111X100 1111X101 1111X110 1111X111	— — — — — — — — — —	— — — — — — — — — —	Bit Reset Bit Set Bit 0 (LSB) Bit 1 Bit 2 Bit 3 Bit 4 Bit 5 Bit 6 Bit 7 (MSB)

X: invalid

8.3 Setting Registers

Code	HEX.	Function	D1	D2
00100001	21H	Set cursor point	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 moved by this command. Data read/write from MPU never change 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)

a) Single-scan

X ADRS 00 to 4FH

Y ADRS 00H to 0FH

b) Dual-scan

X ADRS 00 to 4FH

Y ADRS 00H to 0FH
Upper Screen

Y ADRS 00H to 0FH
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 codes 00H to 80H assign External character generator, when External generator mode.

The senior 5 bits define the start address in external memory of CG RAM area. The next 8

bits represent the character code of character. In internal CG ROM mode, character codes 00H to 7FH represent the predefined “internal” CG ROM characters, and codes 80H to FFH represent the user’s own “external” characters. The 3 lease significant bits indicate one of the 8 rows of 8 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	0000H to 07FFH
00001	0800H to 0FFFH
00010	1000H to 17FFH
…	…
11100	E000H to E7FFH
11101	E800H to EFFFH
11110	F000H to F7FFH
11111	F800H to FFFFH

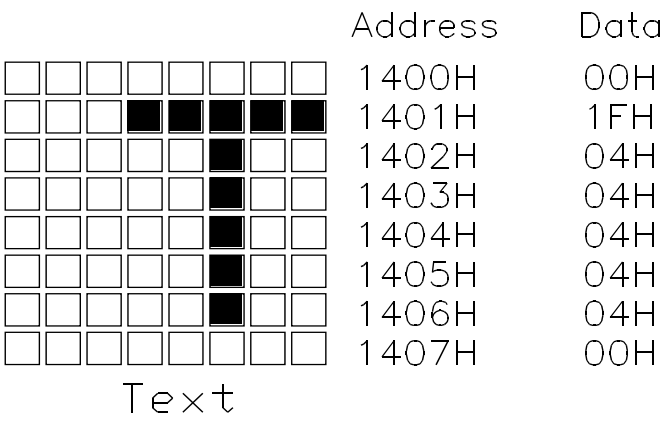
(Example 1)

Offset register 02H

Character code 80H

Character generator RAM start address 0001 0100 0000 0000

1 4 0 0 H



(Example 2)

The relationship between display RAM data and display characters

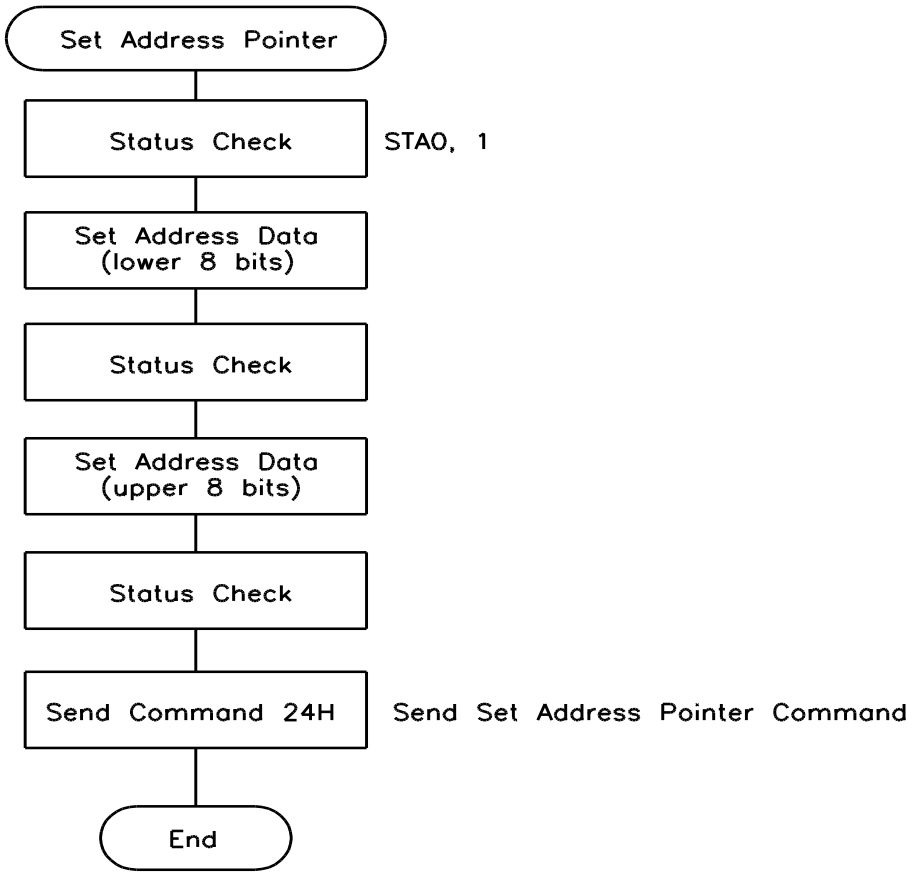
A B γ D E ζ G H I J K L M	(RAM Data)	(Character)
|	21H	A
|	22H	B
|	83H	γ
|	24H	D
|	25H	E
	86H	ζ

γ andζ 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:



8.4 Set Control Word

Code	HEX.	Function	D1	D2
01000000	40H	Set Text Home Address	Lower Address	High Address
01000001	41H	Set Text Area	Columns	00H
01000010	42H	Set Graphic Home Address	Lower 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+TA)+TA+CL
(TH+2TA)+TA		(TH+2TA)+TA+CL
…		…
TH+(N-1)TA		TH+(N-1)TA+CL

TH：Text home address

TA：Text area number(Columns)

CL：Column 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		GA+CL
GH+GA		GH+GA+CL
(GH+GA)+GA		(GH+GA)+GA+CL
(GH+2GA)+GA		(GH+2GA)+GA+CL
…		…
GH+(N-1)GA		GTH+(N-1)GA+CL

GH：Graphic home address

GA：Graphic area number(Columns)

CL：Column are fixed by hardware(pin-programmable).

(Example)

Graphic Mode 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. The command can be

used to adjust the columns of the display.

(Example)

LCD Size ： 20 columns, 4 lines

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

(3) Set Graphic Area

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

(Example)

LCD Size ： 20 columns, 2 lines

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	……..	00FB

00F0	00F1	……..	0103	0104	……..	011F
0104	0105	……..	0127	0128	……..	0123
0128	0129	……..	013B	013C	……..	0147
013C	013D	……..	014F	0150	……..	015B
LCD						

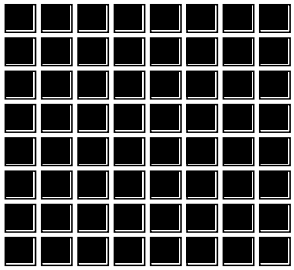
If the graphic area setting is set to match the desire number of columns on the LCD, the addressing scheme will be automatically modified so that the start address of each line equals the end address of the previous line + 1.

8.5 Mode Set

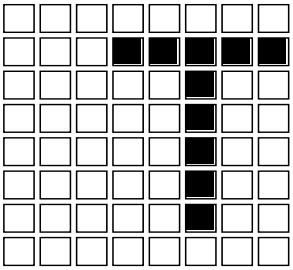
Code	Function	Operand
1000x000	OR mode	-
1000x001	EXOR mode	-
1000x011	AND mode	-
1000x100	TEXT ATTRIBUTE mode	-
10000xxx	Internal character generator mode	-
10001xxx	External character generator mode	-

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 80H to FFH are automatically assigned the build-in character generator ROM. The character codes 80H to FFH are automatically assigned to the external character generator RAM.

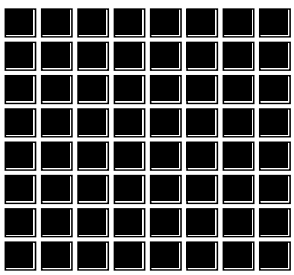
(Example)



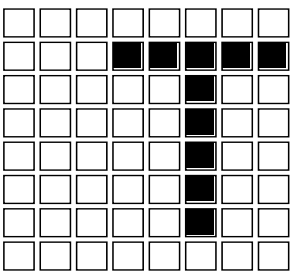
Graphic



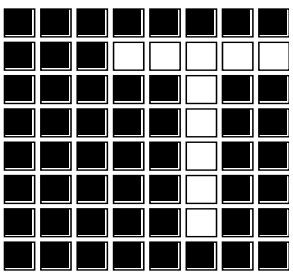
Text



"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 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 into the same address in the graphic area. The Attribute function is defined as follows.

Attribute RAM 1 byte	x	x	x	x	d3	d2	d1	d0

d3	d2	d1	d0	
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

8.6 Display Mode

Code	Function	Operand
1001000	Display Off	-
1001xx10	Cursor on, blink off	-
1001xx11	Cursor on, blink on	-
100101xx	Text on, graphic off	-
100110xx	Text off, graphic on	-
100111xx	Text on, graphic on	-

1	0	0	1	D3	D2	D1	D0

D3: Cursor blink 1: on, 0:off

D2: Cursor display 1: on, 0:off

D3: Text display 1: on, 0:off

D3: Graphic display 1: on, 0:off

(Note)

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

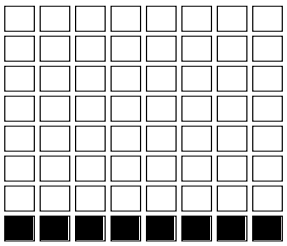
a) Combination of text/graphic display

b) Attribute function

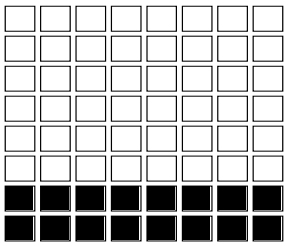
Cursor pattern select

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	-

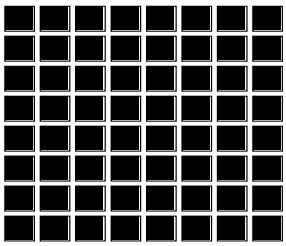
When cursor display is on, this command selects the cursor pattern in the range 1-line to 8-line. The cursor address is defined by the Cursor Pointer Set command.



1-line cursor



2-line cursor



8-line cursor

8.7 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 must be sent between each datum. In Auto mode, the LCM cannot accept any other command.

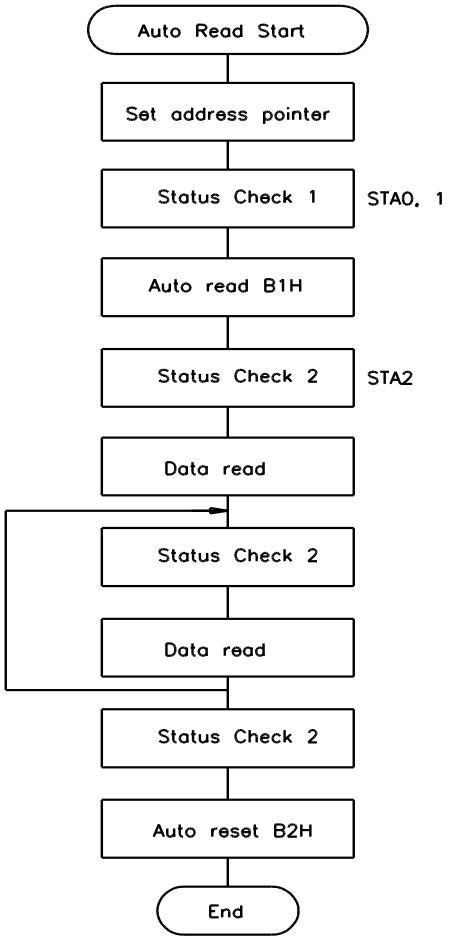
The Auto Reset command must be sent to the LCM after all data has been sent, to clear Auto mode.

(Note)

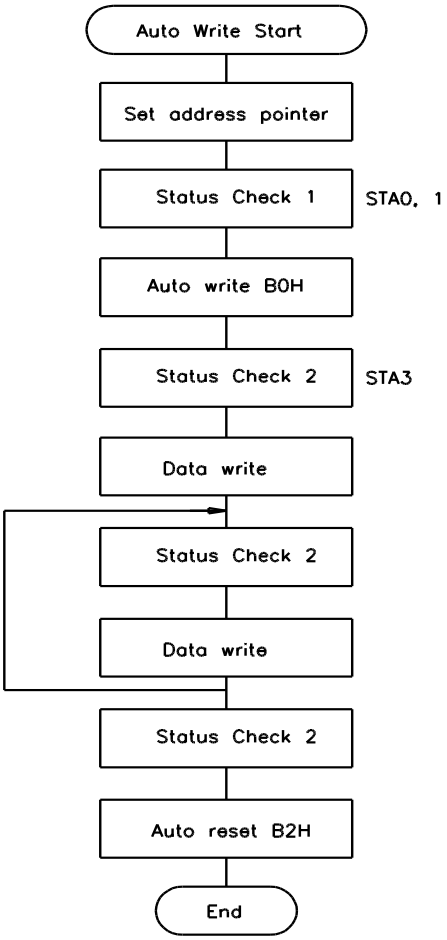
a status check for Auto mode

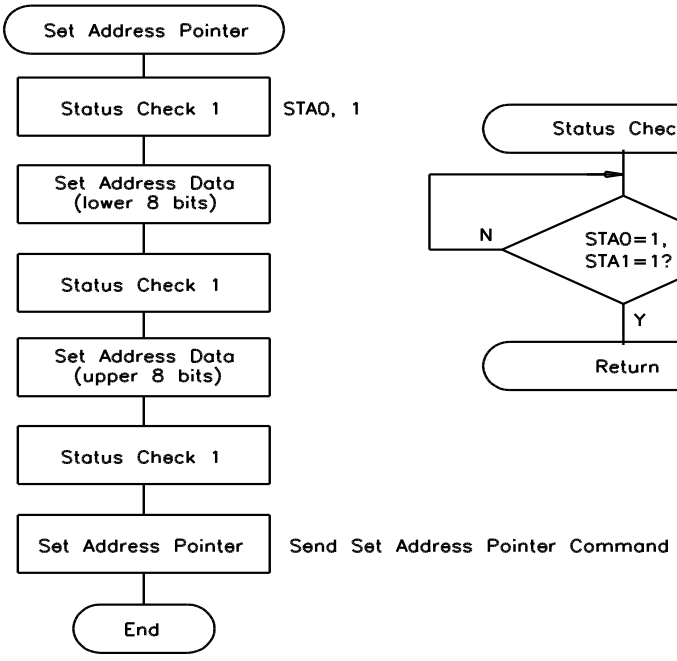
(STA2, STA3 should be checked between sending of each datum. Auto Reset should be performed after checking STA3=1(STA2=1). Refer to the flowchart next page.

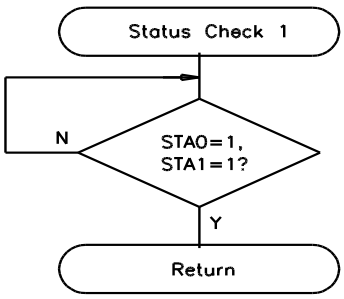
Auto Read Mode

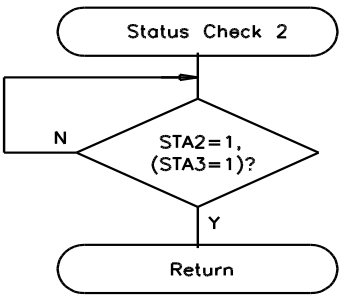


Auto Write Mode









Data Read/Write

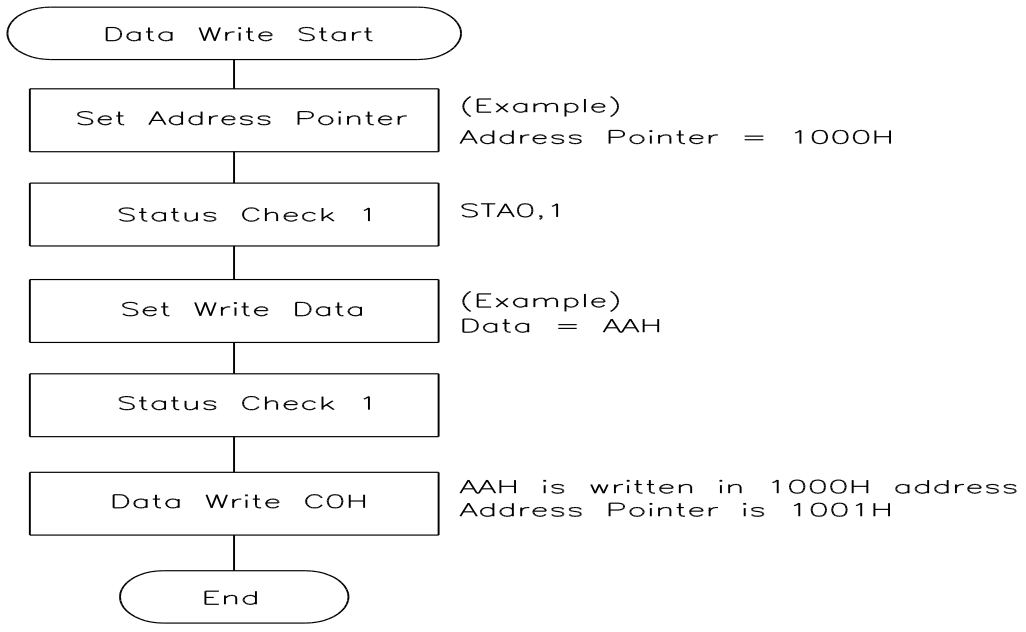
Code	HEX.	Function	Operand
11000000	C0H	Data Write and increment ADP	Data
11000001	C1H	Data Read and increment ADP	-
11000010	C2H	Data Write and decrement ADP	Data
11000011	C3H	Data Read and decrement ADP	-
11000100	C4H	Data Write and Nonvariable ADP	Data
11000101	C5H	Data Read and Nonvariable ADP	-

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 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-bit datum.

Refer to the following flowchart:



Screen Peak

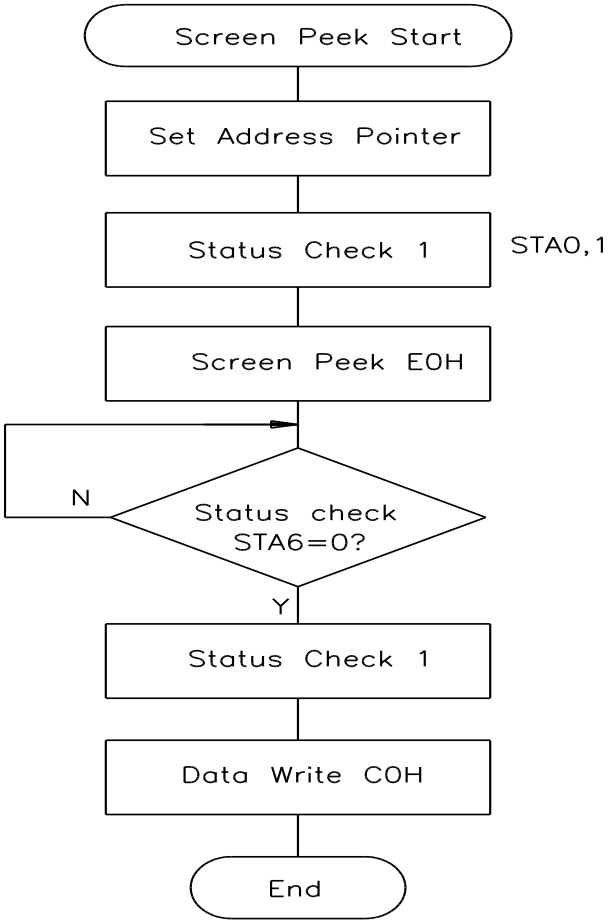
Code	HEX.	Function	Operand
11100000	E0H	Screen Peek	-

This command is used to transfer 1 byte of display data to the data stack; this byte can then be read from MPU by data access. The logical combination 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 (STA6) flag 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 Set Text Area and Set Graphic Area command.

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 using the Set Address Pointer command.

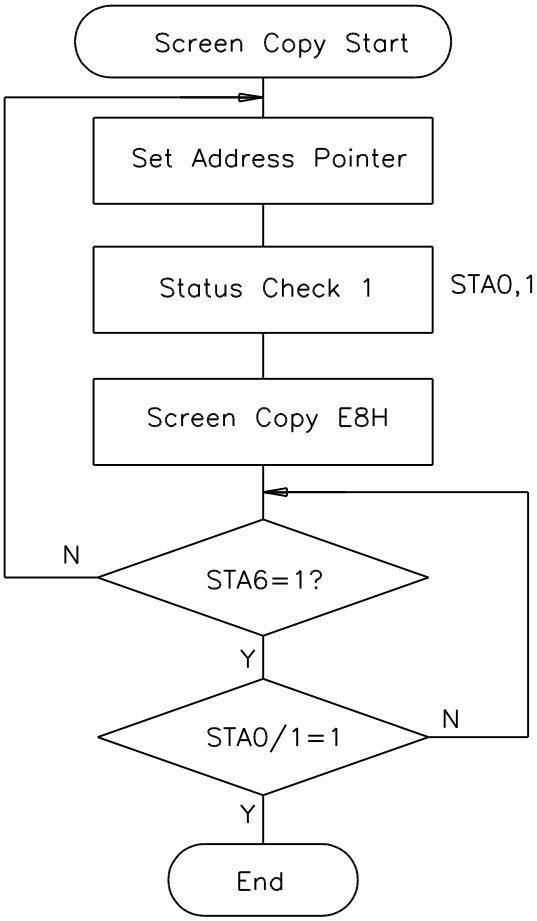
(Note 1)

If the attribute function is being used, this command is not available.

(With attribute data is graphic area data)

(Note 2)

This command is not working for Dual-Scan because the controller IC T6963C cannot separate the upper screen data and lower screen.



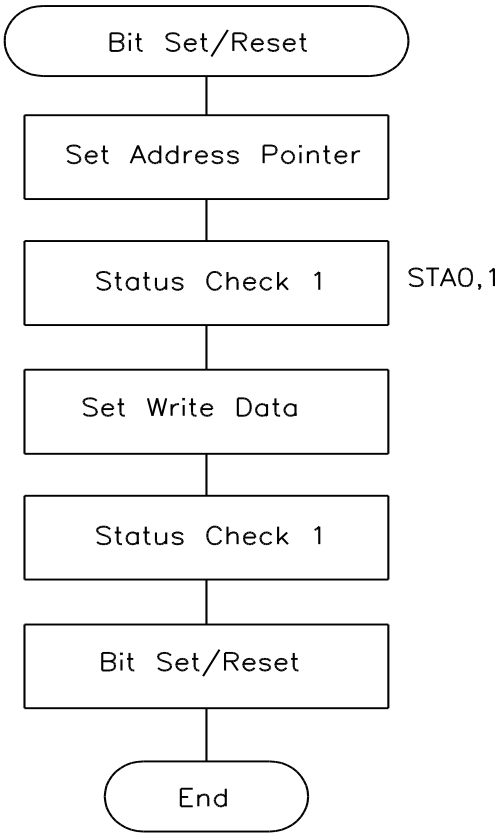
(Note)

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.

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	-

This command use to set or reset a bit of byte specified by the address pointer. Only 1 bit can be set/reset at a time. Refer to the following flowchart:



8.8 FONT BALE