

AMOTEC

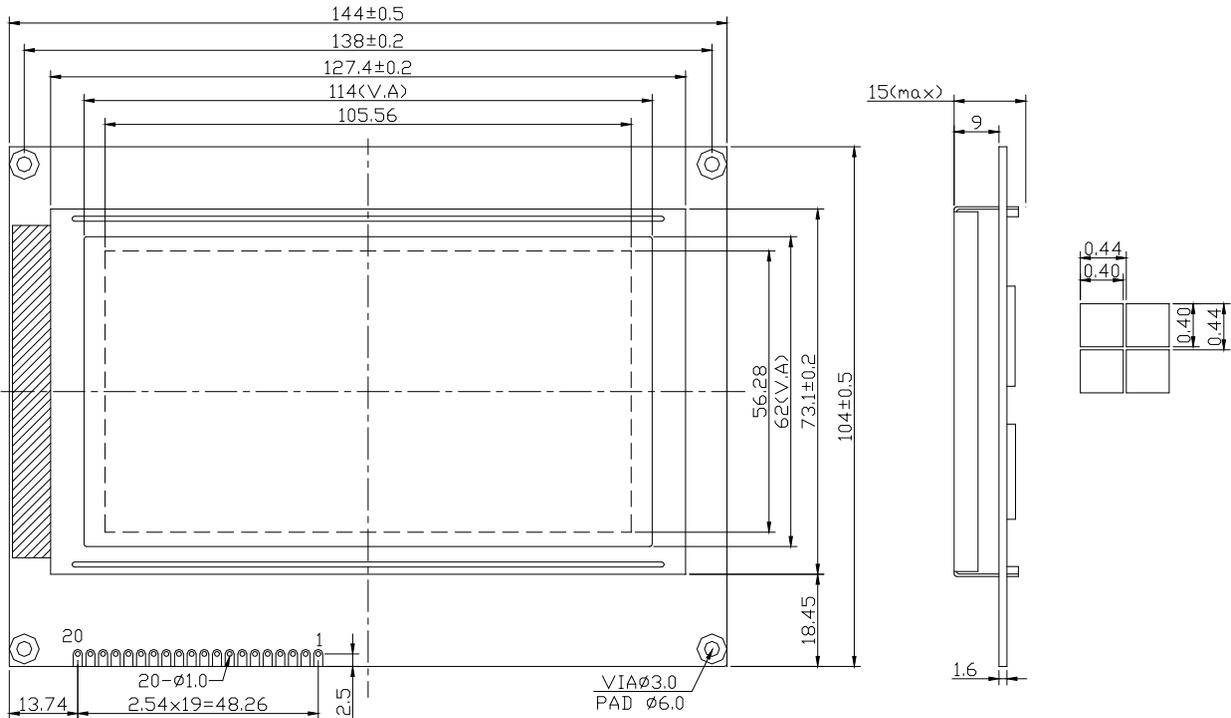
ADM240128C

SPECIFICATIONS OF LCD MODULE

1.Features

- a) 128x128 dots graphic LCD module
- b) Built-in controller (T6963C or Equivalent)
- c) Low power consumption
- d) Easy interface with 8-bit MPU
- e) +5V power supply
- f) 1/128 duty cycle
- g) LED BKL Optional
- h) Negative voltage option

2.Outline dimension

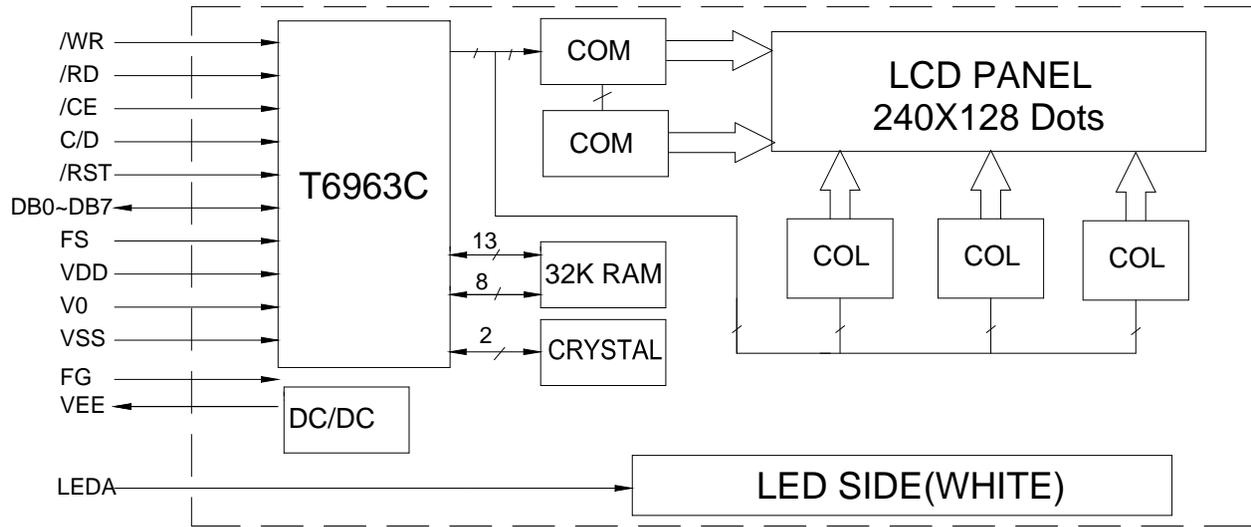


Unit: mm

3.Absolute maximum ratings

Item	Symbol	Standard	Unit
Power voltage	$V_{DD}-V_{SS}$	0 - 7.0	V
Input voltage	V_{IN}	V_{SS} - V_{DD}	V
Operating temperature range	Top	-20 - +70	°C
Storage temperature range	Tst	-30 - +80	°C

4. Block diagram



5. Interface pin description

Pin No.	Symbol	External connection	Function
1	V _{SS}	Power supply	Signal ground for LCM (GND)
2	V _{DD}		Power supply for logic (+5V) for LCM
3	V ₀		Operating voltage for LCD
4	C/D	MPU	H: Instruction L: Data
5	/RD	MPU	Read enable signal
6	/WR	MPU	Write enable signal
7~14	DB0~DB7	MPU	Data bus line
15	/CE	MPU	Chip enable signal
16	/RST	MPU	Reset signal
17	VEE		Negative voltage output
18	MD2		Selection of number of columns:H-32,L-40
19	FS	MPU	Font selection: H=6x8 dot matrix, L=8x8 dot matrix
20	LEDA	BKL power supply	Power supply for BKL

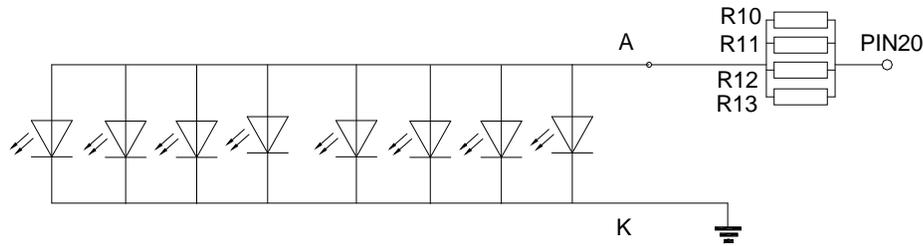
6. Optical characteristics

➤ STN type display module (Ta=25 °C, VDD=5.0V)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Viewing angle	θ	C _r ≥ 2	-60	-	35	Deg
	Φ		-40	-	40	
Contrast ratio	C _r		-	8	-	-
Response time (rise)	T _r	-	-	200	250	ms
Response time (fall)	T _r	-	-	300	350	

7.Electrical characteristics

➤ BACKLIGHT CIRCUIT DIAGRAM(LIGHT 2X4)



Colour: white

➤ Led ratings

Supply with PIN20= 5V,

Item	Symbol	Min	Typ.	Max	Unit
Forward Voltage	V_F	2.8	3.0	3.2	V
Forward current	I_f	-	-	120	mA
Power	P			700	mW
Peak wave length	ρ				nm
Luminance	L_v		150		Cd/m^2

➤ DC characteristics

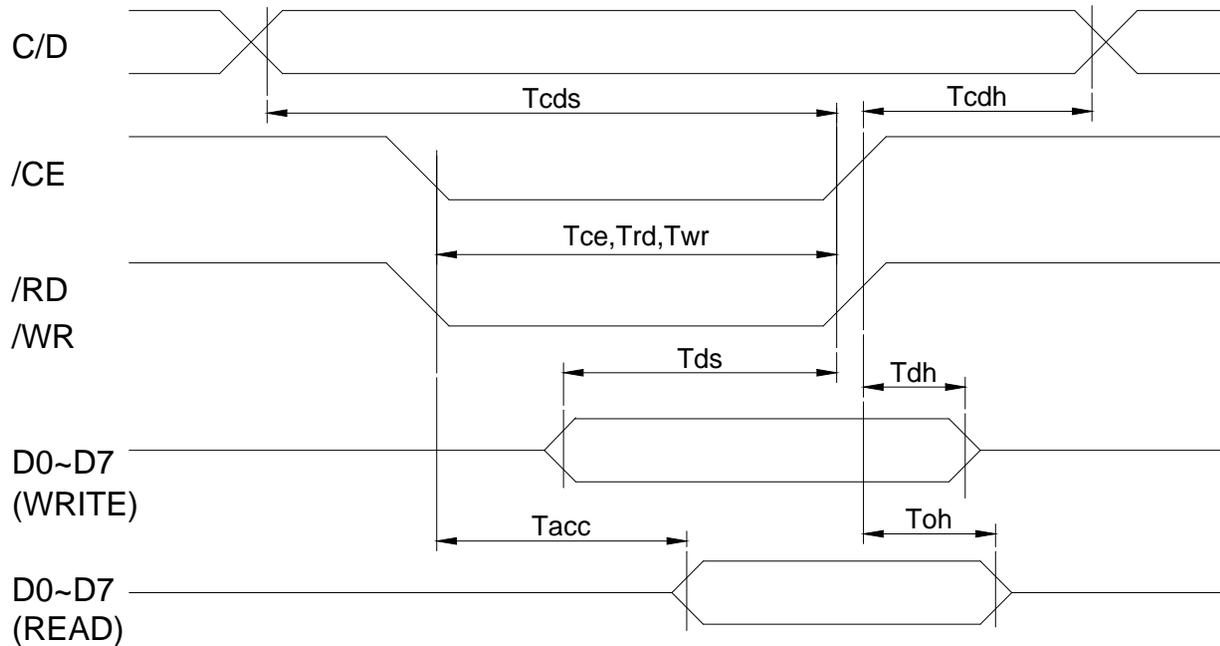
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply voltage for LCD	$V_{DD}-V_0$	$T_a = 25^\circ C$	—	18.5	—	V
Input voltage	V_{DD}		4.7	5.0	5.5	V
Supply current	I_{DD}	$T_a = 25^\circ C, V_{DD} = 5.0V$	—	15	18	mA
Input leakage current	I_{LKG}		—	—	1.0	μA
“H” level input voltage	V_{IH}		2.2	—	V_{DD}	V
“L” level input voltage	V_{IL}	Twice initial value or less	0	—	0.6	
“H” level output voltage	V_{OH}	$LOH = -0.25mA$	2.4	—	—	
“L” level output voltage	V_{OL}	$LOH = 1.6mA$	—	—	0.4	
Backlight supply voltage	V_F		-	-	-	mA
Supply current	I_F		-	-	-	

➤ Switching characteristics

($T_a = 25^\circ C, V_{DD} = 5.0V$)

Item	Symbol	Test conditions	Min.	Typ.	Max.	Unit
C/D set-up time	T_{cds}	—	100	—	—	ns
C/D hold time	T_w		10	—	—	
/CE, /RD, /WR pulse width	T_{ce}, T_{rd}, T_{wr}		80	—	—	
Data set-up time	T_{ds}		80	—	—	
Data hold time	T_{dh}		40	—	—	
Access time	T_{acc}		—	—	150	
Output hold time	T_{oh}		10	—	50	

Bus timing diagram



8.Flowchart of communications with MPU

Status read

A status check must be performed before data is read or written. The status word format is as follows:

/RD	/WR	/CE	C/D	STA7	STA5	STA5	STA4	STA3	STA2	STA1	STA0
0	1	0	1	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0

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: display off	1: normal display

Notes:

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.
2. For most modes STA0 / STA1 are used as a status check.
3. STA2 and STA3 are valid in auto mode; STA0 and STA1 are invalid.

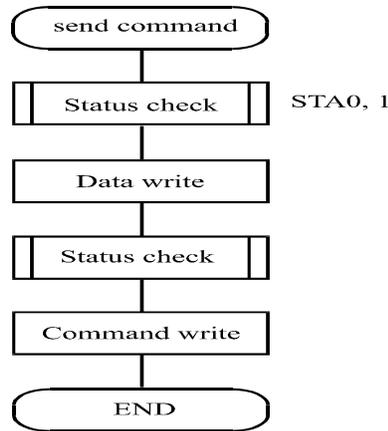
When using the STA7=0 command, a status read must be performed. If a status check is not carried out, the T6963C cannot operate normally, even after a delay time. The hardware interrupt occurs during the address calculation period (at the end of each line). If a STA7=0 command is sent to the T6963c during 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.

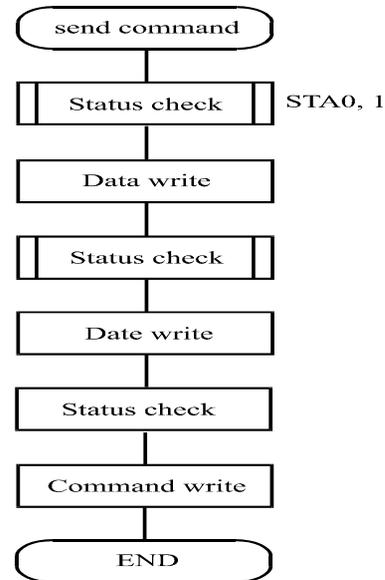
Setting data

When using the T6963C, first set the data, and 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.

9.Command definitions

Command	Code	D1	D2	Function
Registers 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

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	10100100 10100101 10100110 10100111			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 no variable ADP Data read and no variable 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)

Note:

When an MPU program with checking the busy flag (DB7) is made, it must be necessary 1/2fosc is necessary for executing the next instruction by the falling edge of the "E" signal after the busy flag (DB7) goes to "Low".

X: invalid

Contents

1). Setting registers

D1	D2	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
X	X	0	0	1	0	0	N2	N1	N0

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

➤ Set cursor pointer

X ADRS and Y ADRS specify the position or the cursor. 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)

a) Single-scan

X ADRS 00H to 4FH

Y ADRS 00H to 0FH

b) Dual-scan

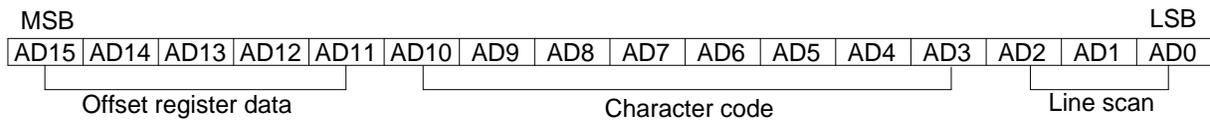
X ADRS 00H to 4FH

Y ADRS 00H to 0FH(upper screen)

Y ADRS 10H to 1FH(lower screen)

➤ 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:



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.

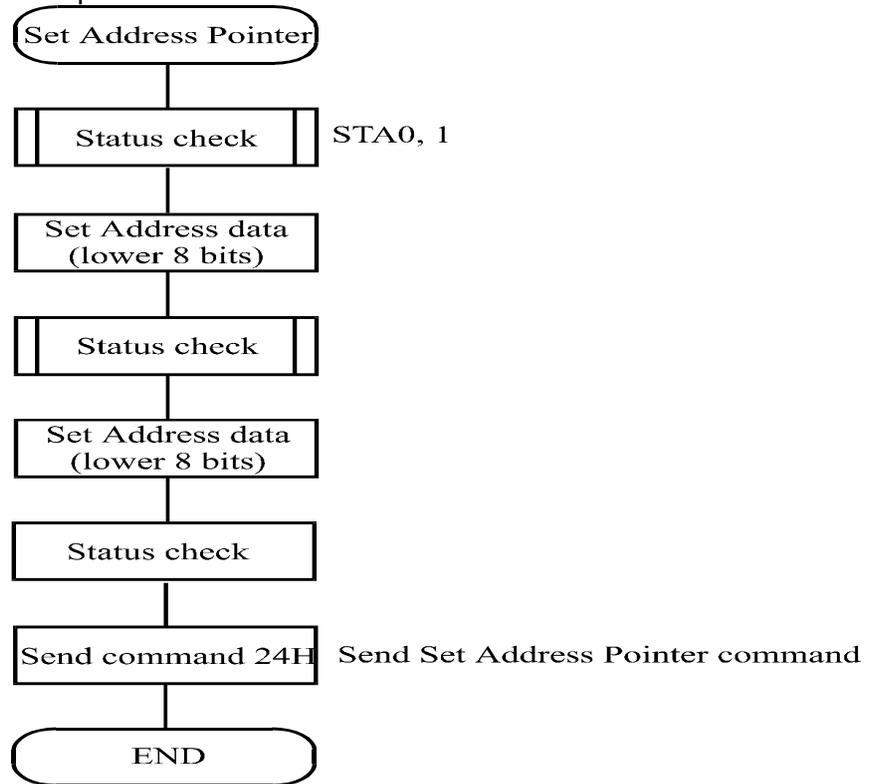
The senior five bits define the start address in external memory of the CGRAM area. The next eight bits represent the character code of the character. In internal CGRAM mode, character codes 00H to 7FH represent the predefined "internal" CGRAM characters, and codes 80H to FFH represent the user's own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

The relationship between display RAM address and offset register

➤ **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:



2). Set control word

(upper 8 bits)

D1	D2	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
X	X	0	1	0	0	0	0	N1	N0

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
01000000	43H	Set graphic area	Columns	00H

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

➤ **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 ate fixed by hardware (pin -programmable)

➤ **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 +2 GA +CL
(GH +2 GA)+ GA		GH +3 GA +CL
/		/
GH +(N-1) GA		GH +(N-1) GA +CL

GH: Graphic home address

GA: Graphic area number (columns)

CL: columns ate fixed by hardware (pin -programmable)

➤ **Set text area**

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

➤ **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.

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.

3). Mode set

CODE	FUNCTION	OPERAND
1000X000	OR Mode	—
1000X001	EXOR Mode	—

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1000X011	AND Mode	—
1000X100	TEXT Attribute Mode	—
10000XXX	Internal character Mode	—
10001XXX	External character 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 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.

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	DB3	DB2	DB1	DB0
DB3	DB2	DB1	DB0	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							

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	—

1	0	0	1	DB3	DB2	DB1	DB0
---	---	---	---	-----	-----	-----	-----

DB0: cursor blink on: 1 off: 0

DB1: cursor display on: 1 off: 0

DB2: text display on: 1 off: 0

DB3: 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

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	

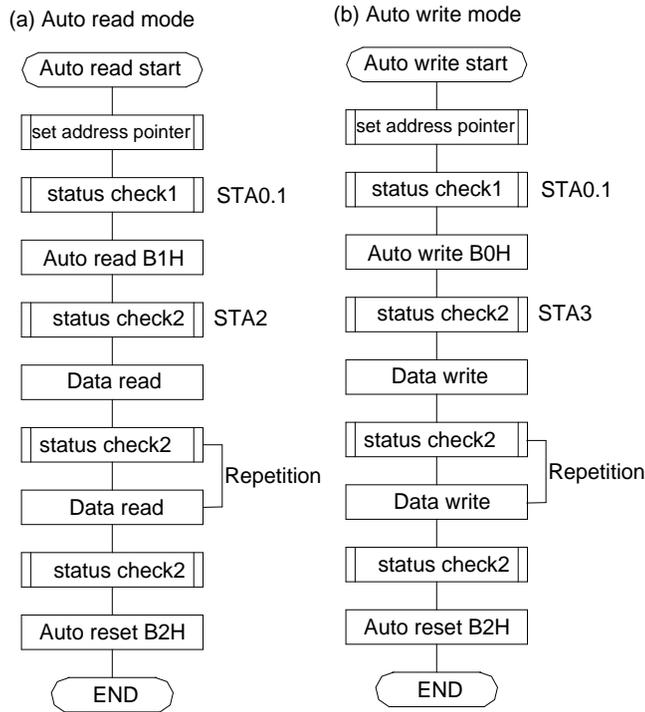
When cursor display is on, this command selects the cursor pattern in the range 1 line to 8 lines. The cursor pointer set command defines the cursor addresses.

6). Data auto read / write

CODE	HEX.	FUNCTION	OPERAND
10110000	B0H	Set data auto write	—
10110001	B1H	Set data auto read	—
10110010	B2H	Auto rest	—

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 send 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.

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.

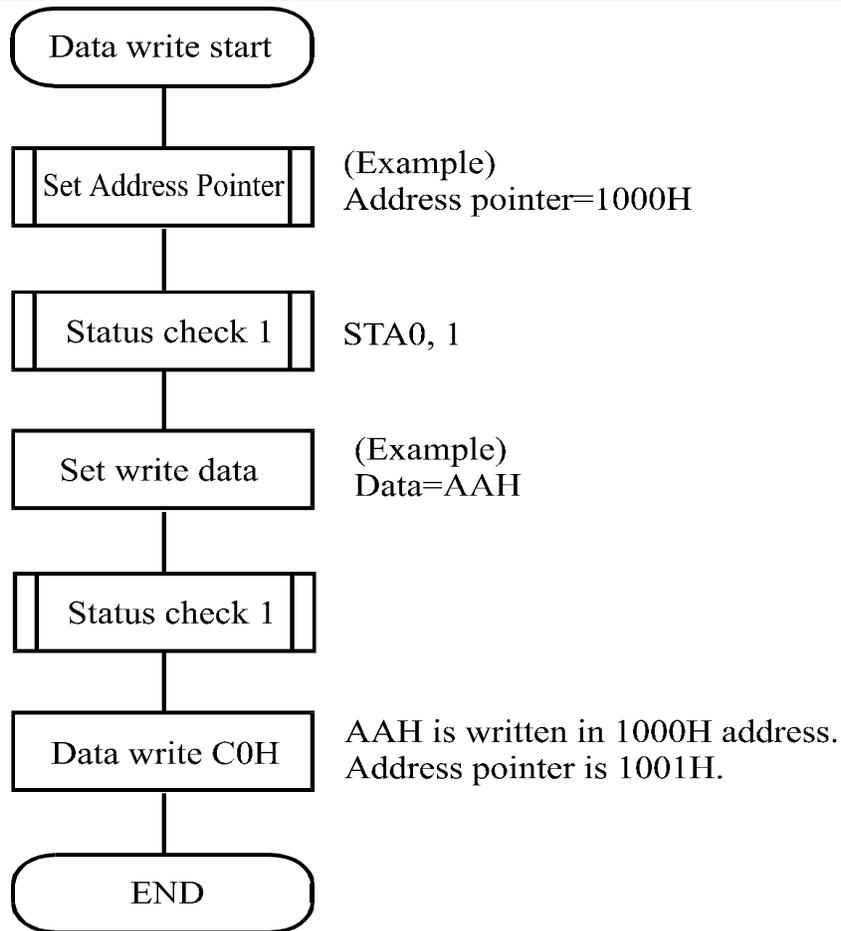


7). Data read / write

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 no variable ADP	Data
11000101	C5H	Data read and no 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 ser 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.



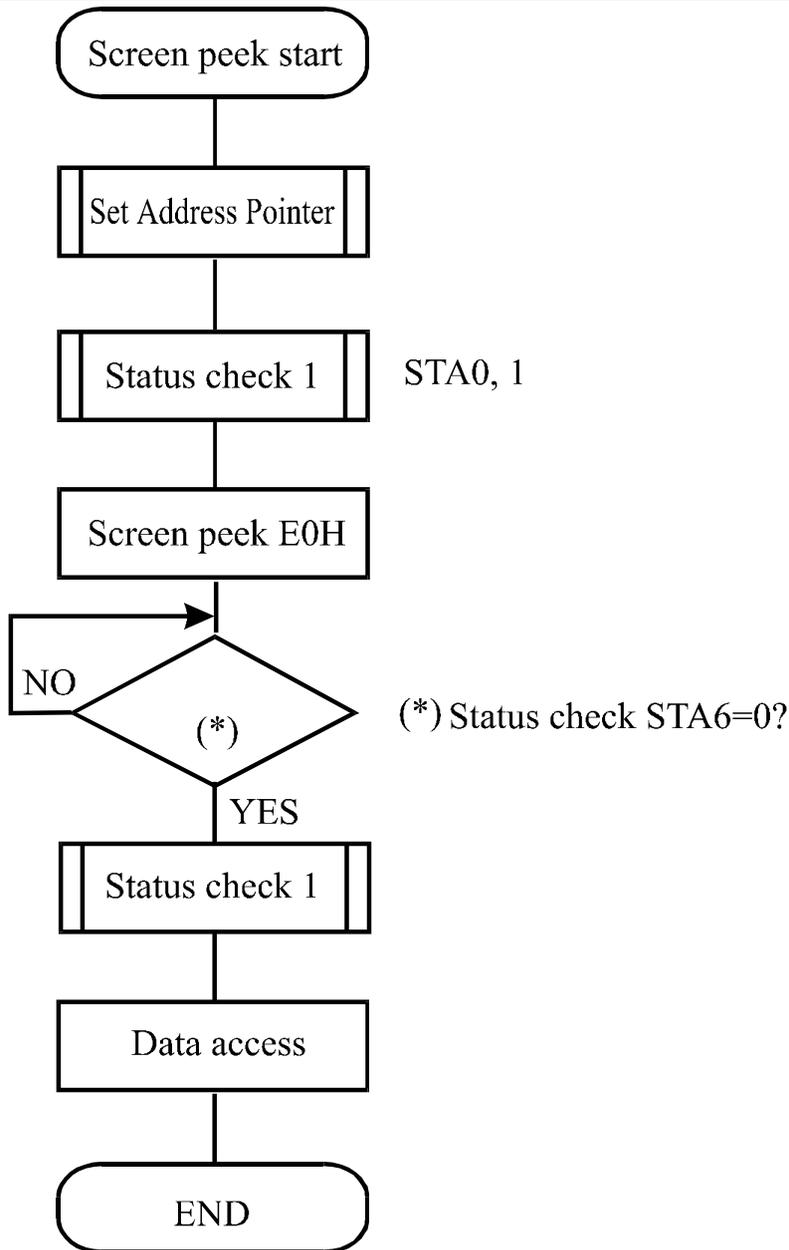
8). Screen peek

CODE	HEX.	FUNCTION	OPERAND
11100000	E0H	Screen peek	—

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 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.



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 ser text area and set graphic area command.

9). Screen copy

CODE	HEX.	FUNCTION	OPERAND
11101000	E8H	Screen copy	—

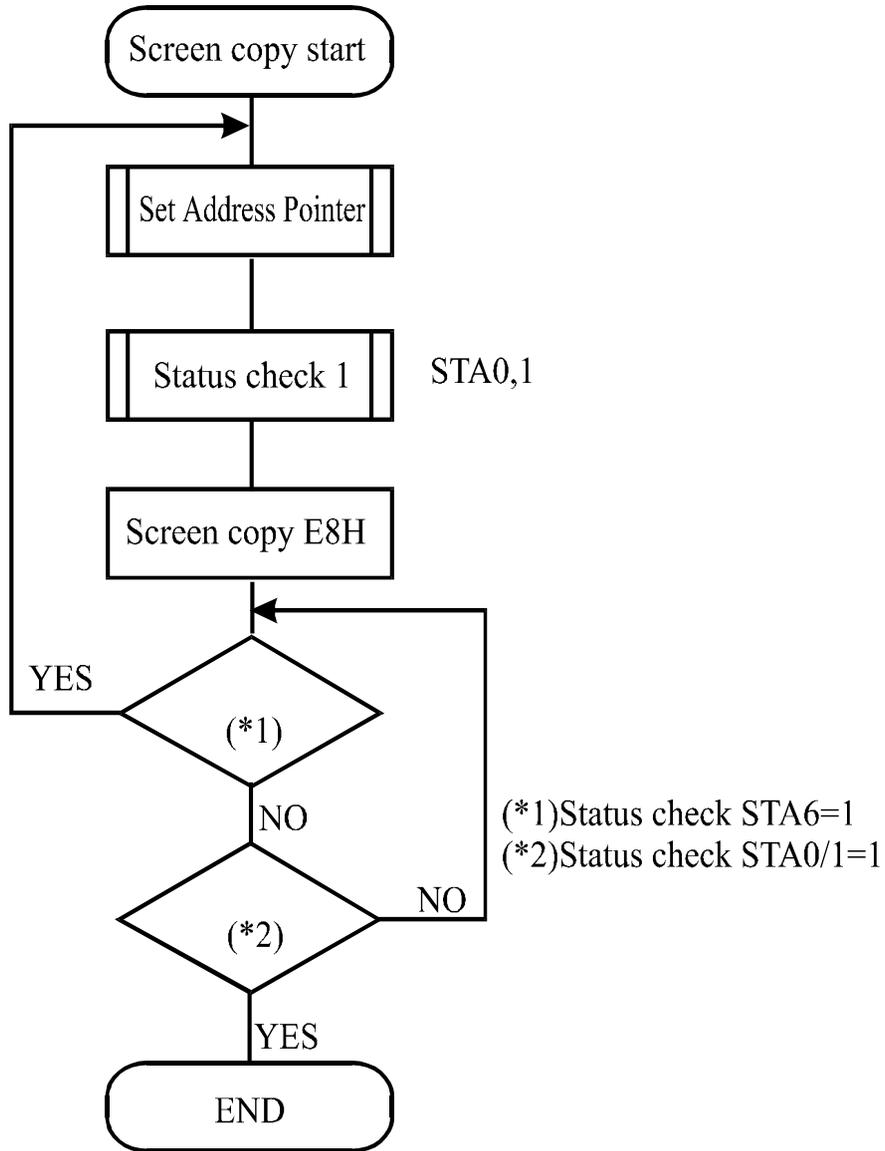
This command copies a raster line of data to the graphic area. The start point must be set using the set address pointer command.

Note:

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

graphic area data.)

With dual-scan, this command cannot be used (because the T6963C cannot separate the upper screen data and lower screen data). Refer to the following flowchart.



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.

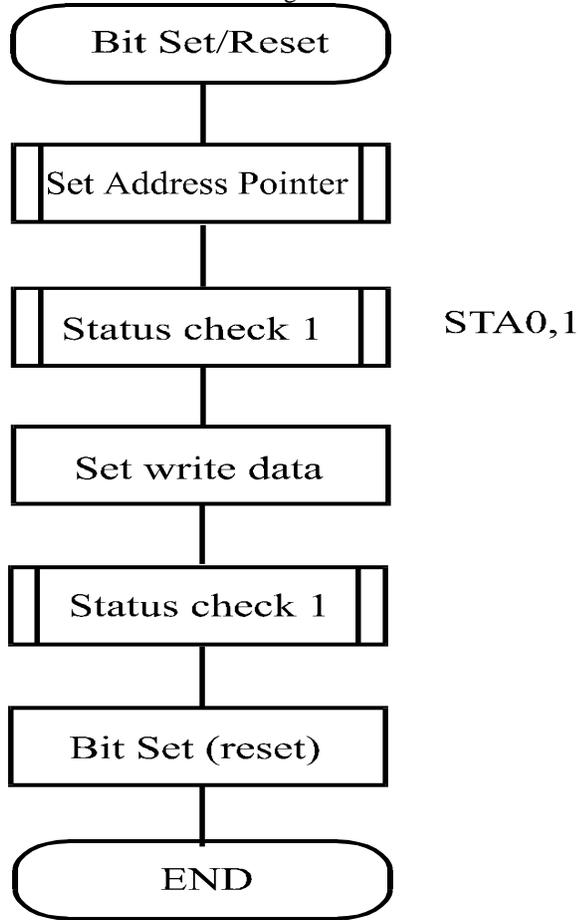
10). Bit set /reset

CODE	FUNCTION	OPERAND
11110XXX	Bit reset	---
11111XXX	Bit set	---
1111X000	Bit 0 (LSB0)	---
1111X001	Bit 1	---
1111X010	Bit 2	---
1111X011	Bit 3	---
1111X100	Bit 4	---

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1111X101	Bit 5	—
1111X110	Bit 6	—
1111X111	Bit 7 (LSB0)	—

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.



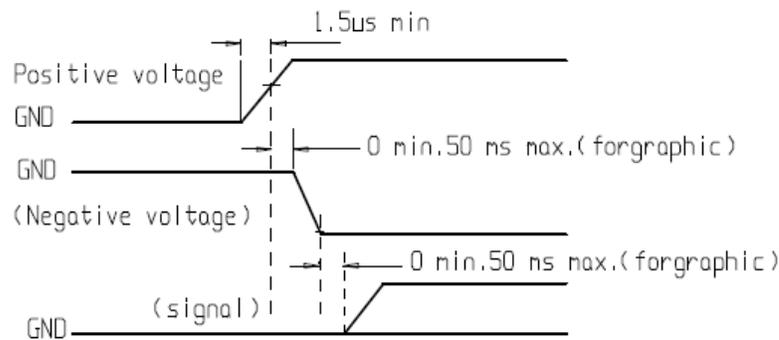
10、 LCM Operation Precautions

- (1) It is an indispensable condition to drive LCD within the specified voltage limit since the higher voltage than the limit causes the shorter LCD life. An electrochemical reaction due to direct current causes LCD's undesirable deterioration, so that the use of direct current driver should be avoided.
- (2) Response time will be extremely delayed at lower temperature than the specified operating temperature range and on the other hand LCD's show dark blue color in the higher temperature. However, those phenomena do not mean any malfunction or display out of order with LCD's, which will come back in the specified operation temperature range.
- (3) If the display area is pushed hard during operation, some fonts will be abnormally displayed. But it resumes normal condition after turning off once.
- (4) A slight dew depositing on terminals could be a cause for electrochemical reaction resulting in terminal open circuit.
- (5) Display contrast varies with the change of liquid crystal driving voltage (V_o). Adjust V_o to show the best contrast.
- (6) Condensation on terminals can cause an electrochemical reaction disrupting the terminal circuit. Therefore, it is

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suggested to use the LCD under the relative condition of 40°C, 85% RH.

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



(8) The backlight must be operated within the condition of specification. The overload current or too high voltage will reduce the life time or destroy the backlight.

11、Handling 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. Please handle the 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 IO 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

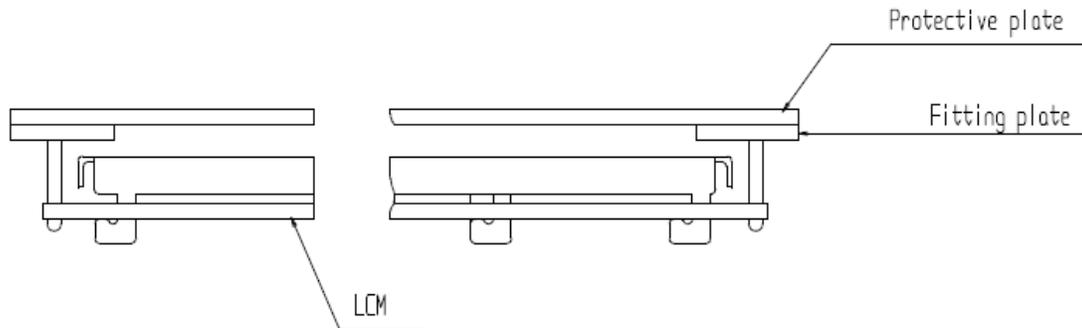
conditions.

- 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.

12、Installing Precautions

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.

13、Storage Precautions

In case of storing for a long period of time for the purpose of replacement use, the following ways are recommended.

(1) Storage in a polyethylene bag with the opening sealed so as not to enter fresh air outside in it, and with no desiccant.

(2) Placing in a dark place where neither exposure to direct sunlight nor light is, keeping temperature in the range from -30°C to 80°C

(3) Storing with no touch on polarizer surface by anything else. (It is recommended to store them as they have been contained in the inner container at the time of delivery from us.)

14、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 leaks out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

15、Others

Liquid crystals solidify under low temperature (below the storage temperature range) leading to defective orientation or

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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.