

Files	JL160128A
Ver	2.0

LCD MODUEL

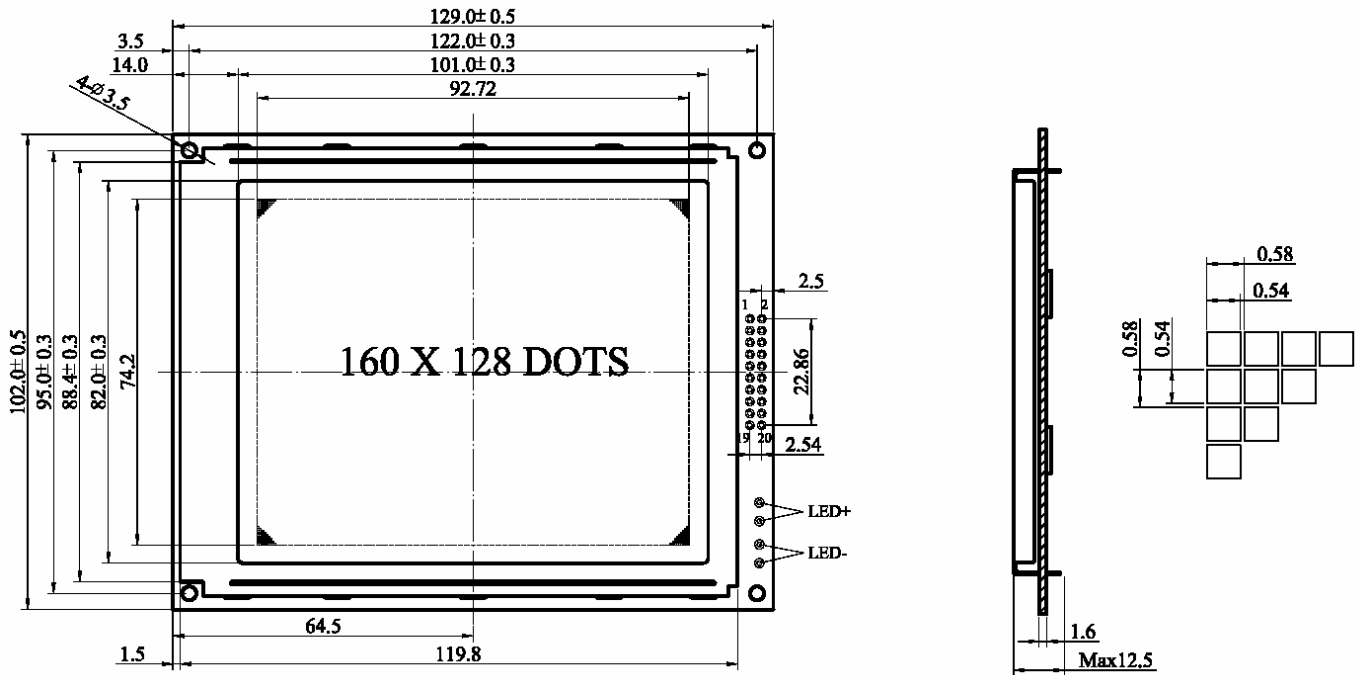
JL160128A

1、FEATURES

- Module: 160 x 128 Dots
- Glass Type: STN (Yellow/Green)
- Display Mode: Positive
- Viewing Direction: 6 O'clock
- Polarizer Mode: Tran
- Driving Method: 1/128 Duty, 1/12 Bias
- Dot Size: 0.54mm × 0.54mm
- Dot Pitch: 0.58mm × 0.58mm

2、MECHANICAL CHARACTERISTICS

Item	Description	Unit
Outline Dimension	129.0 (L) x 102.0 (W) x 12.5 (H)	mm
Viewing area	101(L) x 82.0(W)	mm



3. Hardware

3.1 PIN ASSIGNMENT

Pin No.	Symbol	Level	Description
1	FG	0V	Frame ground
2	VSS	0V	Ground
3	VDD	5.0V	Supply voltage for logic
4	VO	---	Input voltage for LCD
5	VOOUT	-15V	Output voltage for LCD
6	WR	L	Write signal
7	RD	L	Read signal
8	CE	L	Chip enable signal
9	C/D	H/L	H : Instruction Code, L : Data
10	RST	L	Reset signal
11	NC		
12	DB0	H/L	Data bit 0
13	DB1	H/L	Data bit 1
14	DB2	H/L	Data bit 2
15	DB3	H/L	Data bit 3
16	DB4	H/L	Data bit 4
17	DB5	H/L	Data bit 5
18	DB6	H/L	Data bit 6
19	DB7	H/L	Data bit 7
20	NC		
21	A	0V	Ground for LED
22	K	5.0V	+5.0V for LED

3.2 Absolute Maximum Ratings

Item	Symbol	Min.	Max.	Unit
Power Supply for Logic	Vdd	0	+5.5	V
Power supply for LCD Drive	Vlcd	0	+7.0	V
Input Voltage	Vi	Vss	Vdd	V

3.3 Electrical Characteristics (Ta=25°C; Vdd=5.0V ± 5%, otherwise specified)

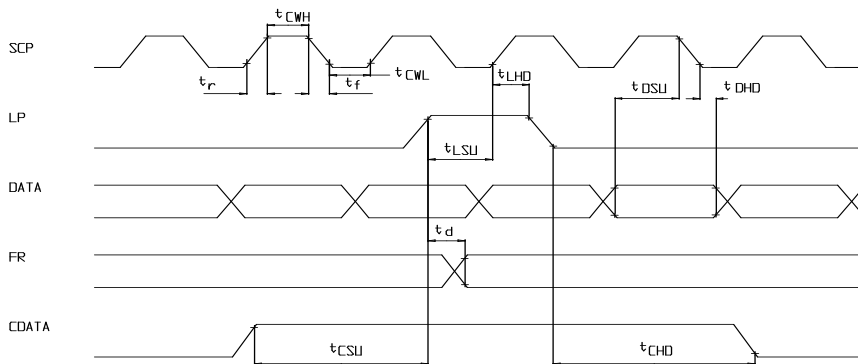
Item	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Input "high" voltage	Vih	--	0.7Vdd	--	Vdd	V
Input "low" voltage	Vil	--	0	--	0.3Vdd	V
Output "high" voltage	Voh	-Ioh=0.2mA	Vdd-0.4	--	--	V
Output "low" voltage	Vol	Iol=1.2mA	--	--	0.4	V
Power supply current(logic)	Idd	Vdd=5.0v	--	--	--	mA
Recommended LCD Driving Voltage	V0-V4 Duty=1/128 φ =25°	Ta=0°C	--	12.4	--	V
		Ta=25°C	--	12.0	--	V
		Ta=50°C	--	11.6	--	V

3. 4 AC Characteristics and Input Timing Characteristics

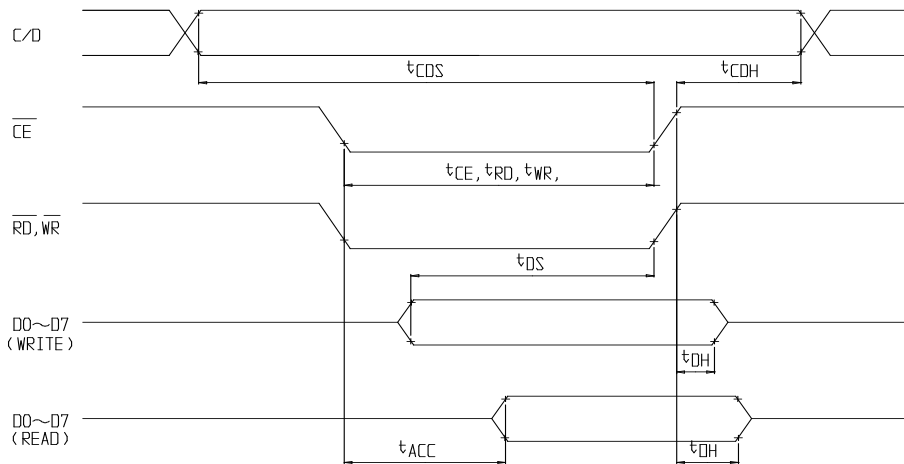
3. 4. 1 AC characteristics ($V_{DD}=5V \pm 10\%$, $V_{SS}=0V$ $T_a=25^\circ C$)

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

3. 4. 2 Timing Characteristics



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



4.SOFTWARE

◆ Flowchart of Communications with MPU

● Status Read

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

Status check

Status of T6963C can be read from data lines.

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

T6963C status word format is following.

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

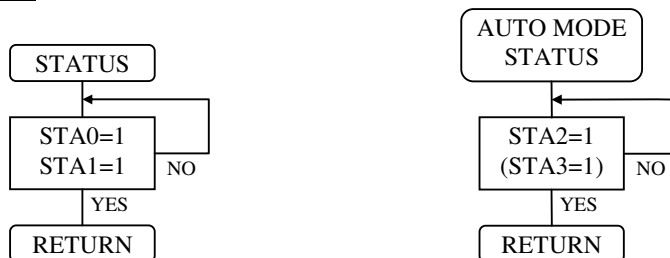
STA0	Check capability of command execution	0 : Disable 1 : Enable
STA1	Check capability of data read/write	0 : Disable 1 : Enable
STA2	Check capability of auto mode data read	0 : Disable 1 : Enable
STA3	Check capability of auto mode data write	0 : Disable 1 : Enable
STA4	Not use	
STA5	Check capability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

Note 1 : It is necessary to check STA0 and STA1 at the same time. The error is happened by sending data at executing command.

Note 2 : The status check will be enough to check STA0/STA1.

Note 3 : STA2/STA3 are valid in auto mode STA0/STA1 are invalid.

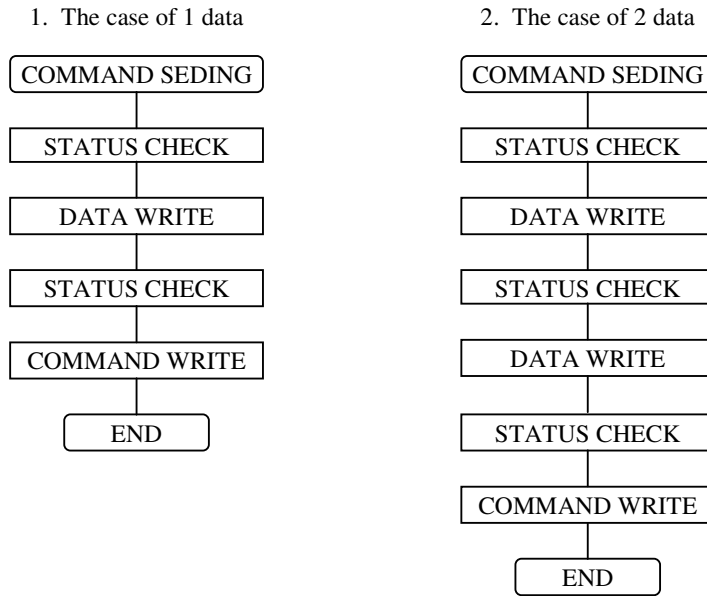
Status checking flow



Note 4 : It is impossible to save status check in the case of command of MSB0. To have the delay time cannot be save status check. The interrupt of hardware is happened at the end of lines. If command of MSB0 is sent in this period, the command executing is waited. The state of waiting doesn't be known without to check status. The sending next command or data is disregarded or rewrites data of waiting command.

● Data Set

In T6963C, the data have been set and command executes.
The order of procedure of command sending



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

Description of Command

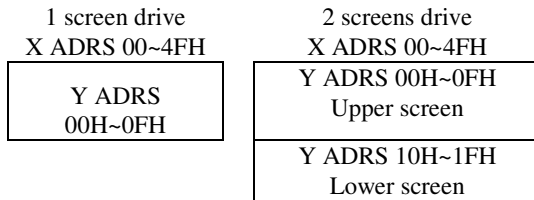
● Register Set

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

(1) Cursor Pointer Set

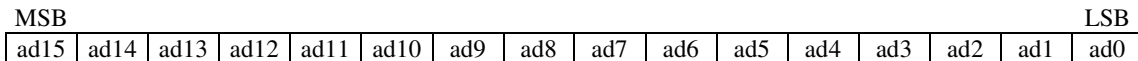
The position of cursor is specified by X ADRS, Y ADRS. The cursor position is moved only by this command. The cursor pointer doesn't have the function of increment and decrement. The shift of cursor are set by this command. X ADRS, Y ADRS are specified following.

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



(2) Offset Register Set

The offset register is used to determine external character generator RAM area.
 T6963C has 16 bit address lines as follow.



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

The relationship of display RAM address and offset register

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

(Example 1)

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

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

(Example 2)

The relationship of display RAM data and display character

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

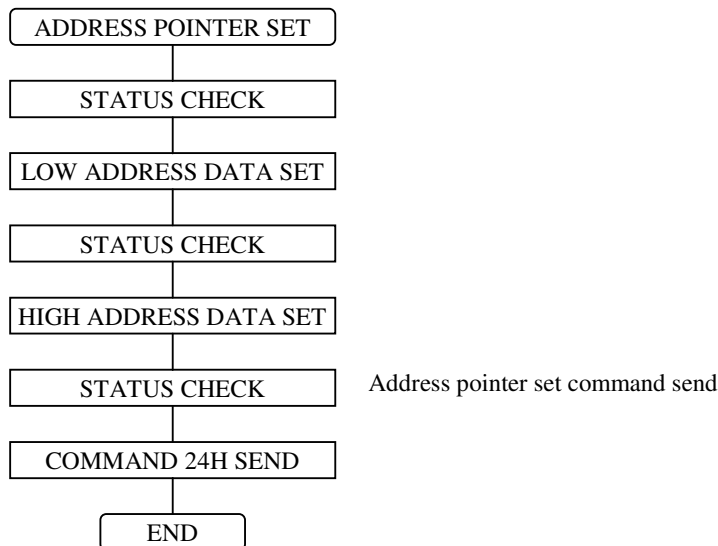
Display character

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

(3) Address Pointer Set

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

The flow chart address pointer set command



● Control Word Set

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

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

(1) Text Home Address Set

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

The relationship of external display RAM address and display position

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

TH : Text home address

TA : Text area number (columns)

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

(Example)

Text home address : 0000H
 Text area : 0020H
 MD2=H, MD3=H : 32 columns
 DUAL=H, MDS=L, MD0=L, MD1=L : 16 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

(2) Graphic Home Address Set

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

The relationship of external display RAM address and display position

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

GH : Graphic home address

GA : Graphic area number (columns)

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

(Example)

Graphic home address : 0000H
 Graphic area : 0020H
 MD2=H, MD3=H : 32 columns
 DUAL=H, MDS=L, MD0=L, MD1=L : 16 lines

0000H	0001H	.....	001EH	001FH
0020H	0021H	.....	003EH	003FH
0040H	0041H	.....	005EH	005FH
0060H	0061H	.....	007EH	007FH
⋮	⋮	⋮	⋮	⋮
0F80H	0F81H	.....	0F9EH	0F9FH
0FA0H	0FA1H	.....	0FBEH	0FBFH
0FC0H	0FC1H	.....	0FDEH	0FDFH
0FE0H	0FE1H	.....	0FFEH	0FFFH

(3) Text Area Set

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

(Example)

Text home address : 0000H
 Text area : 001EH
 MD2=H, MD3=H : 32 columns
 DUAL=H, MDS=L, MD0=L, MD1=L : 16 lines

0000H	0001H	.....	001DH	001EH	001FH
001EH	001FH	.....	003BH	003CH	003DH
003CH	003DH	.....	0059H	005AH	005BH
005AH	005BH	.....	0077H	0078H	0079H
0078H	0079H	.....	0095H	0096H	0097H
0096H	0097H	.....	00B3H	00B4H	00B5H
00B4H	00B5H	.....	00D1H	00D2H	00D3H
00D2H	00D3H	.....	00EFH	00F0H	00F1H
00F0H	00F1H	.....	010DH	010EH	010FH
010EH	010FH	.....	012BH	012CH	012DH
012CH	012DH	.....	0149H	014AH	014BH
014AH	014BH	.....	0167H	0168H	0169H
0168H	0169H	.....	0185H	0186H	0187H
0186H	0187H	.....	01A3H	01A4H	01A5H
01A4H	01A5H	.....	01C1H	01C2H	01C3H
01C2H	01C3H	.....	01DFH	01E0H	01E1H



(4) Graphic Area Set

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

(Example)

Text home address : 0000H
 Text area : 001EH
 MD2=H, MD3=H : 32 columns
 DUAL=H, MDS=L, MD0=L, MD1=L : 16 lines

0000H	0001H	.....	001DH	001EH	001FH
001EH	001FH	.....	003BH	003CH	003DH
003CH	003DH	.....	0059H	005AH	005BH
005AH	005BH	.....	0077H	0078H	0079H
.....
0E88H	0E89H	.....	0EA5H	0EA6H	0EA7H
0EA6H	0FA7H	.....	0EC3H	0EC4H	0EC5H
0EC4H	0FC5H	.....	0EE1H	0EE2H	0EE3H
0EE2H	0FE3H	.....	0EFFH	0F00H	0F01H



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

● Mode Set

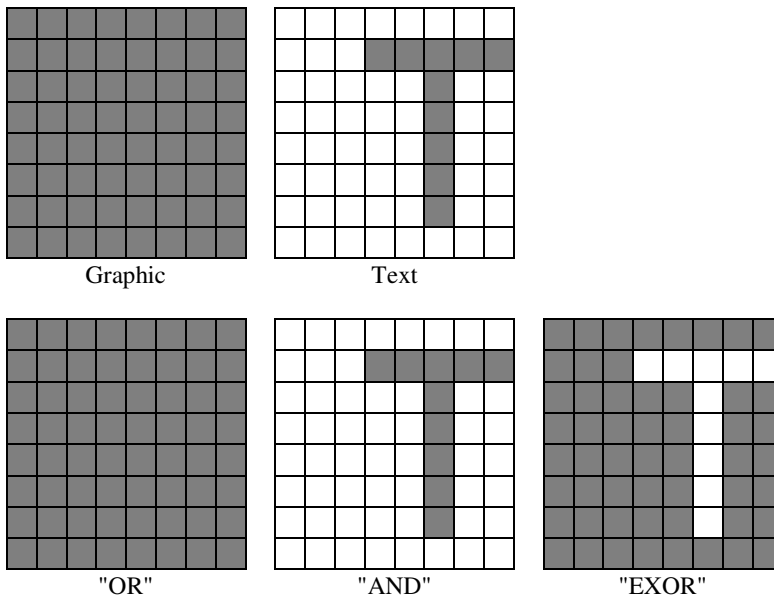
Code	Function	Operand
1000x000	"OR" Mode	---
1000x001	"EXOR" Mode	---
1000x011	"AND" Mode	---
1000x100	"TEXT ATTRIBUTE" Mode	---
10000xxx	Internal Character Generator Mode	---
10001xxx	External Character Generator Mode	---

x : Don't care

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

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

(Example)



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

Attribute function

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

The attribute data of the 1st character in text area is written at the 1st byte in graphic area, and attribute data of n-th character is written at the n-th byte in graphic area. Attribute function is defined as follow.

Attribute RAM byte

x	x	x	x	d3	d2	d1	d0
---	---	---	---	----	----	----	----

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

● Display Mode

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

1	0	0	1	d3	d2	d1	d0
---	---	---	---	----	----	----	----

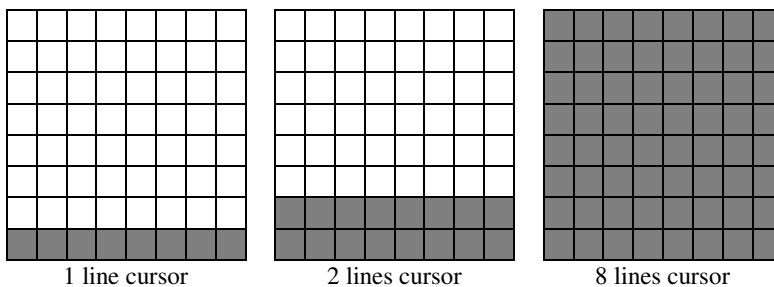
d0: Cursor blink on : 1, off : 0
d1: Cursor display on : 1, off : 0
d2: Text display on : 1, off : 0
d3: Graphic display on : 1, off : 0

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

● Cursor Pattern Select

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

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

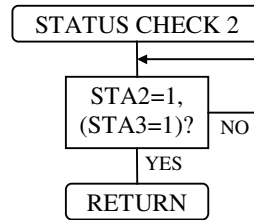
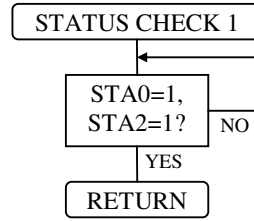
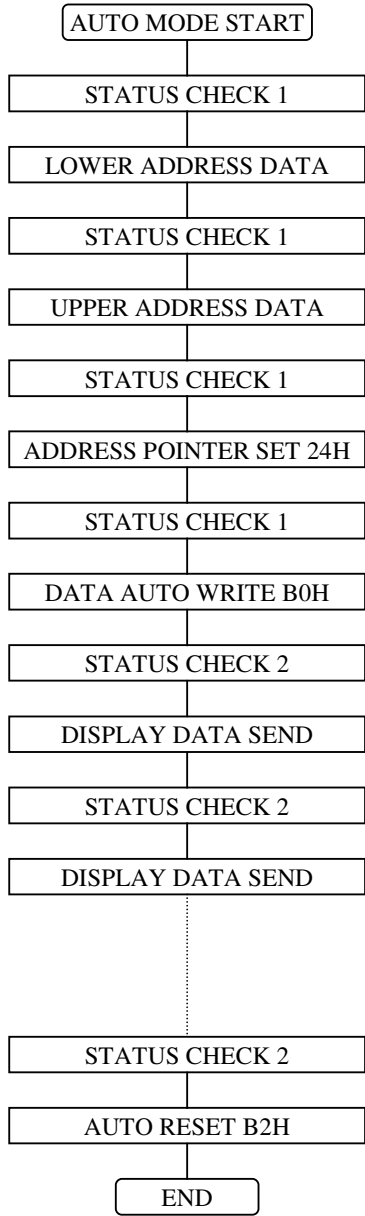


● Data Auto Read/Write

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

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

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

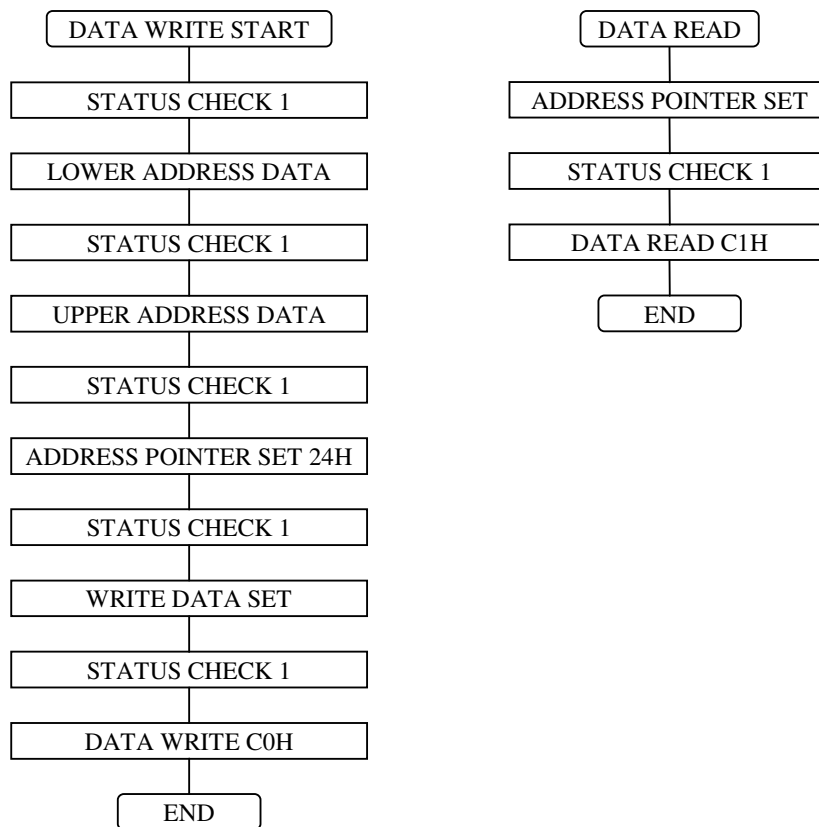


● Data Read Write

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

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

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

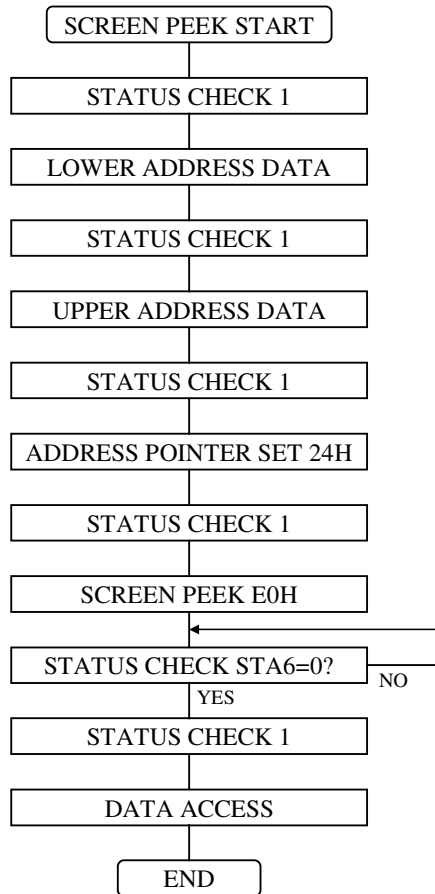


● Screen Peek

Code	Hex	Function	Operand
11100000	E0H	Screen Peek	---

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

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



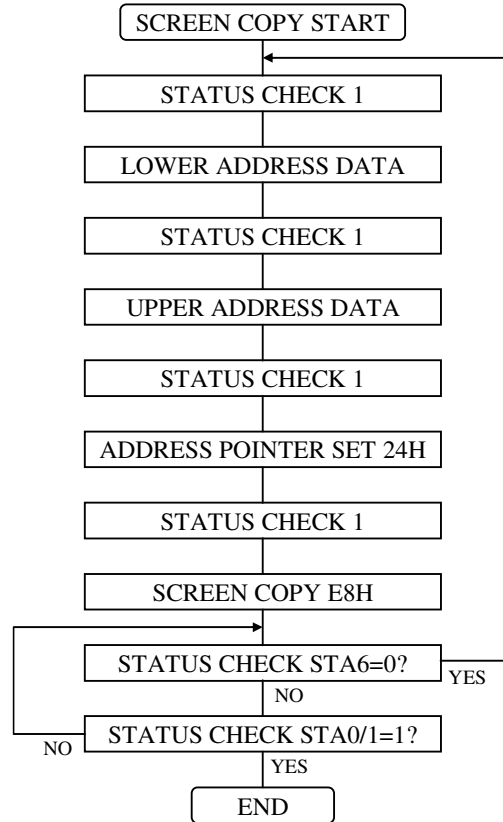
● Screen Copy

Code	Hex	Function	Operand
11101000	E8H	Screen copy	---

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

Note 1 : In attribute function, this command is invalid. (Because attribute data is in the graphic area.)

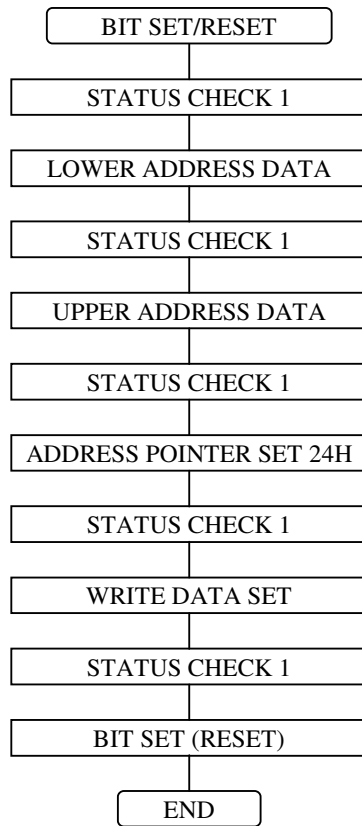
Note 2 : In case of 2 screen drive, this command is invalid. (Because T6963C cannot separate upper screen data and lower screen data.)



● Bit Set/Reset

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

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



Command List

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

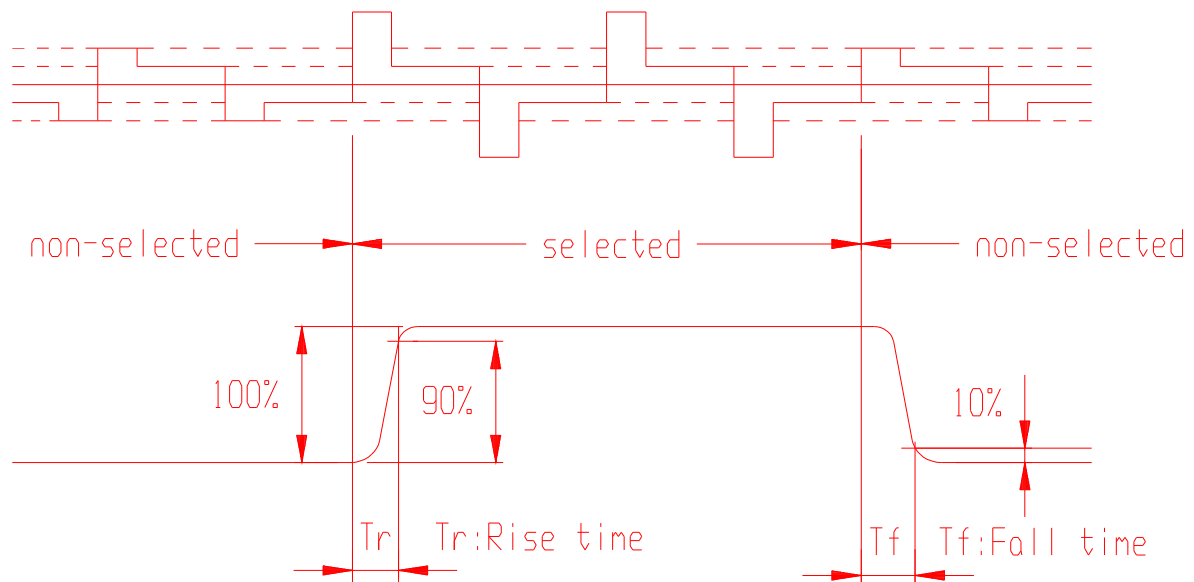
Character Code Map

LSB MSB	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0		!	"	#	\$	%	&	'	()	*	+	,	-	.	/
1	@	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
2	P	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
3	P	Q	R	S	T	U	U	W	X	Y	Z	[\]	^	_
4	'	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
5	P	q	r	s	t	u	v	w	x	y	z	{	|	}	~	
6	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
7	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E

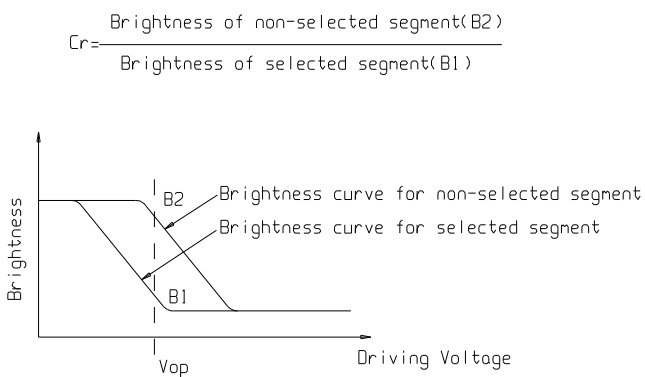
■ ELECTRO-OPTICAL CHARACTERISTICS ($V_{OP} = 17.5V$, $T_a = 25^\circ C$)

Item	Symbol	Condition	Min	Typ	Max	Unit	Remarks	Note
Response time	Tr	---	---	200	---	ms	---	1
	Tf	---	---	246	---	ms	---	1
Contrast ratio	Cr	---	---	7.4	---	---	---	2
Viewing angle range	θ	$Cr \geq 2$	44	---	---	deg	$\varnothing = 90^\circ$	3
			49	---	---	deg	$\varnothing = 270^\circ$	3
			42	---	---	deg	$\varnothing = 0^\circ$	3
			37	---	---	deg	$\varnothing = 180^\circ$	3

Note1: Definition of response time.



Note2: Definition of contrast ratio 'Cr'.



Note3: Definition of viewing angle range 'θ'.

