
FUNCTIONAL DEFINITION

- a. After power on, it is necessary to reset./RESET is kept L between 5 clocks up(oscillation clock).
- b. When /HALT=L, the oscillation stops. The power supply for the LCD must now be turned off, to protect the LCD from DC bias.
- c. The HALT function includes the RESET function.
- d. The column/line counter and display register are cleared by RESET. (Other registers are not cleared.) Disable the display using the clear-display register.
- e. The status must be checked at the data or commands are sent. The MSB=0 status check must be done in particular. There is a possibility of erroneous operation due to a hard interrupt.
- f. STA0 and STA1 must be checked at the same time. When a command is executed, data transmission errors may occur.
- g. The T6963C can only handle one byte per machine cycle(16 clocks). It is impossible to send more than two data in a machine cycle.
- h. When using a command with operand data, it important to send the data first, and then execute the command.
- i. The character codes used by the T6963C are different from ASCII codes.
- j. State after RESET/HALT

TERMINAL	HALT	RESET
D0 to D7	F	F
d0 to d7	F	F
r/w	H	H
/ce	H(Note 1)	H(Note 1)
ad0 to ad15	H(Note 2)	H(Note 2)
/ce0,/ce1	H(Note 1)	H(Note 1)
ED,HOD	Final data	Final data
HSCP	L	L
LP	L	L
CDATA	H	H
FR	H	H
CH1	L	K0
CH2	L	VEND
DSPON	L	L
XO	H	OSC clock

H : Level H

L : Level L

F : Floating(high impedance)

K0 : Test signal

VENT : Test signal

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

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

- k. The relationship between number of row/column and oscillation clock

The frequency of the crystal oscillation is adjusted by the following formula.

fOSC: Frequency of oscillation

fSCP: Frequency of shift clock($fSCP=fOSC/2$)

fR : Frequency of Frame

M : Number of characters on one line(number of dots on one line=8M)

For all font sizes(e.g.7X8,6X8,5X8) the oscillation frequency remains constant.

N : Number of rows(duty=1/8N)

$$8M / f_{SCP} \times 8N = 1/fR$$

$$f_{OSC} = fR \times 64 \times 2 \times M \times N$$

(fR = 60 Hz)

UNIT:[MHz]

M N	32	40	64	80	duty
2	0.492	0.614	0.893	1.229	1/16
	0.983	1.229	1.996	2.458	
4	0.983	1.229	1.996	2.458	1/32
	1.996	2.458	3.932	4.915	
6	1.475	1.843	2.949	3.686	1/48
	2.949	3.686	5.898	7.372	
8	1.966	2.458	3.932	4.915	1/64
	3.932	4.915	7.864	9.830	
10	2.458	3.072	4.915	6.144	1/80
	4.915	6.144	9.830	12.288	
12	2.949	3.686	5.898	7.373	1/96
	5.898	7.373	11.776	14.746	
14	3.440	4.300	6.881	8.602	1/112
	6.881	8.601	13.763	17.203	
16	3.932	4.915	7.864	9.830	1/128
	7.864	9.830	15.729	19.660	

(Note 1) Upper... Single-Scan, lower... Dual-Scan at fR=60Hz

Upper
Lower

I. RAM Interface

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

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

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

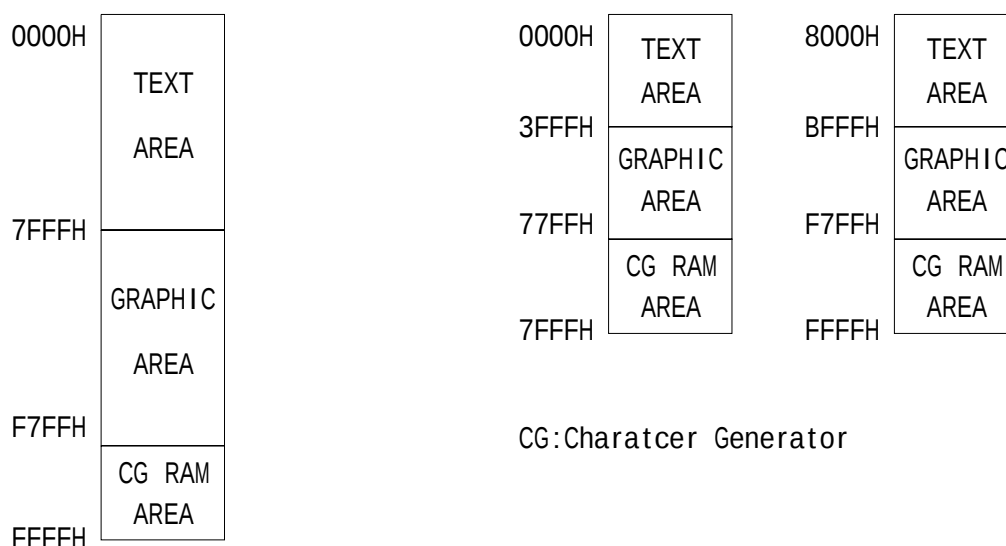
It can be use the address decoded signal /ce0(0000 to 07FFH), /ce1(0800 to 0FFFH) within 4 KB.

/ce0 and /ce1 allow decoding of address in the ranges(0000 to 07FFH) and(0800 to 0fffH) respectively within a 4-KB memory space.

(Example)

(1) Single-Scan

(2) Dual-Scan



m. 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.

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

The T6963C status word format is as follows:

MSB							LSB
STA7	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:Display off 1:Normal display

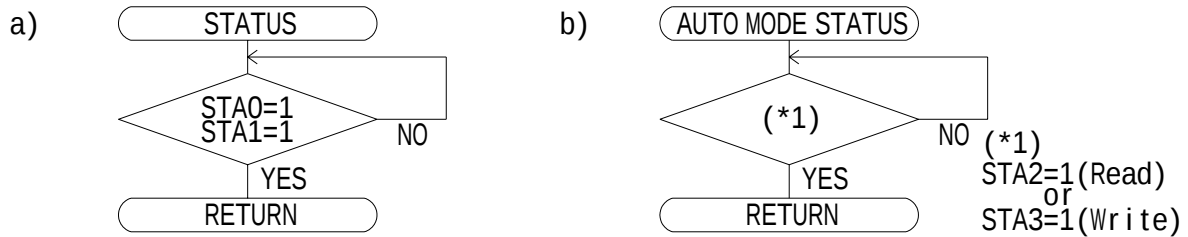
(Note 1) It is necessary to check STA0 and STA1 at the same time.

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 checking flow



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

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

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

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

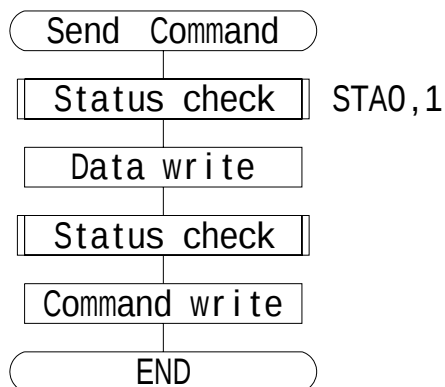
If a status check is not carried out in this state before the next command is sent, there is the possibility that the command or data will not be received.

(2) Setting data

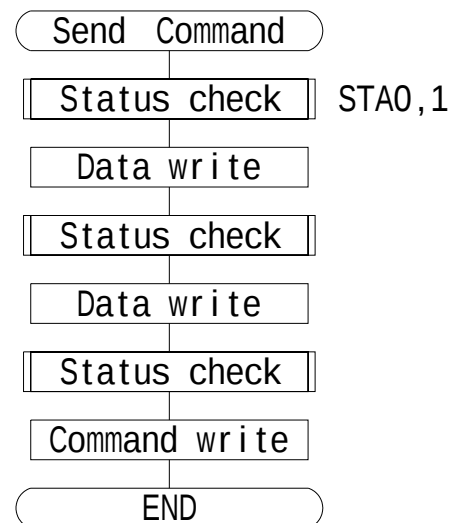
When using the T6963C, first set the data, then set the command.

Procedure for sending a command

a) The case of 1 data



b) The case of 2 data



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

COMMAND DEFINITIONS

(X: invalid)

COMMAND	CODE	D1	D2	FUNCTION
REGISTER 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
	00100011	Columns	00H	Set Graphic Area

MODE SET	1000X000	-	-	OR mode
	1000X001	-	-	EXOR mode
	1000X011	-	-	AND mode
	1000X100	-	-	Text Attribute mode
	10000XXX	-	-	Internal CG ROM mode
	10001XXX	-	-	External CG RAM mode
DISPLAY MODE	10010000	-	-	Display off
	1001XX10	-	-	Cursor on, blink off
	1001XX11	-	-	Cursor on, blink on
	100101XX	-	-	Text on, graphic off
	100110XX	-	-	Text off, graphic on
	100111XX	-	-	Text on, graphic on
CURSOR PATTERN SELECT	10100000	-	-	1- line cursor
	10100001	-	-	2- line cursor
	10100010	-	-	3- line cursor
	10100011	-	-	4- line cursor
	10100100	-	-	5- line cursor
	10100101	-	-	6- line cursor
	10100110	-	-	7- line cursor
	10100111	-	-	8- line cursor
DATA AUTO READ/ WRITE	10110000	-	-	Set Data Auto Write
	10110001	-	-	Set Data Auto Read
	10110010	-	-	Auto Reset
DATA READ/WRITE	11000000	Data	-	Data Write and Increment ADP
	11000001	-	-	Data Read and Increment ADP
	11000010	Data	-	Data Write and Decrement ADP
	11000011	-	-	Data Read and Decrement ADP
	11000100	Data	-	Data Write and Nonvariable ADP
	11000101	-	-	Data Read and Nonvariable ADP
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)

Setting register

CODE	HEX.	FUNCTION	D1	D2
00100001	21H	SET CURSOR POINTER	X ADRS	Y ADRS
00100010	22H	SET OFFSET POINTER	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. 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 00 to 4FH

Y ADRS 00H to 0FH

b) Dual-Scan

X ADRS 00H to 4FH

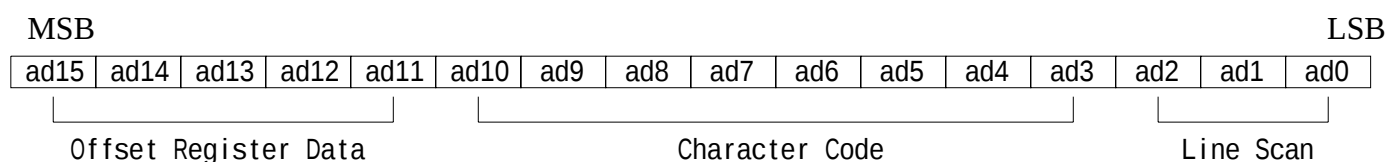
Y ADRS 00H to 0FH
Upper screen

Y ADRS 10H to 1FH
lower screen

(2) Set Offset Register

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

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



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

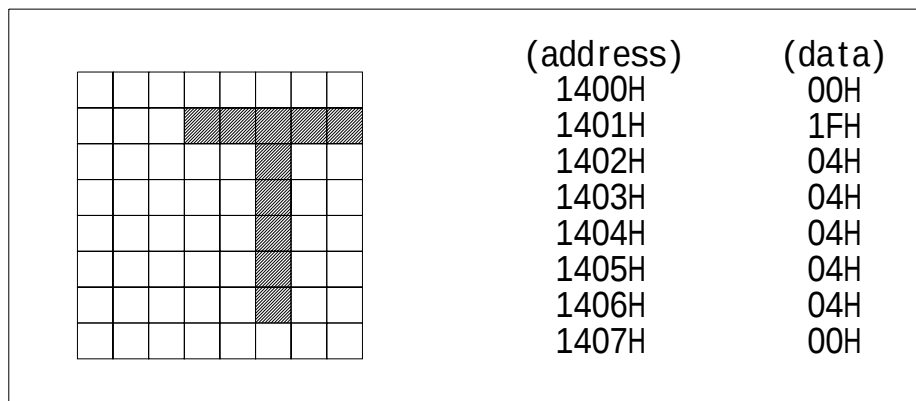
The senior five bits define the start address in external memory of the CG RAM area. The next eight bits represent the character code of the character. In internal CG ROM mode, character codes 00H to 7FH represent the predefined “internal” CG ROM characters, and codes 80H to FFH represent the user’s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

The relationship between display RAM address and offset register

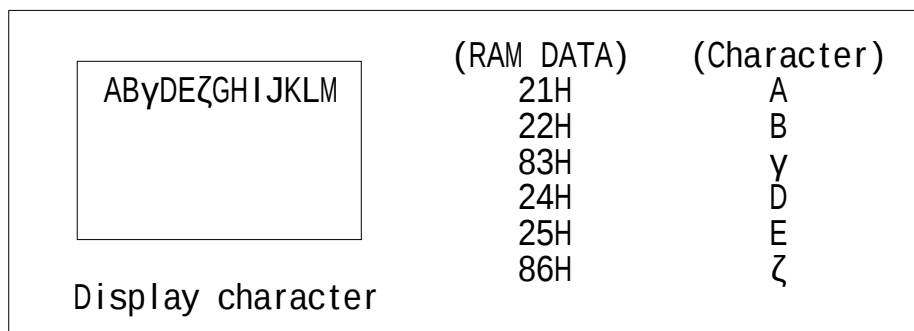
Offset register data	CG RAM hex. address(start to end)
00000	0000 to 07FFh
00001	0800 to 0FFFh
00010	1000 to 17FFh
11100	E000 to E7FFh
11101	E800 to EFFFh
11110	F000 to F7FFh
11111	F800 to FFFFh

(Example 1)

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



(Example 2) The relationship between display RAM data and display character

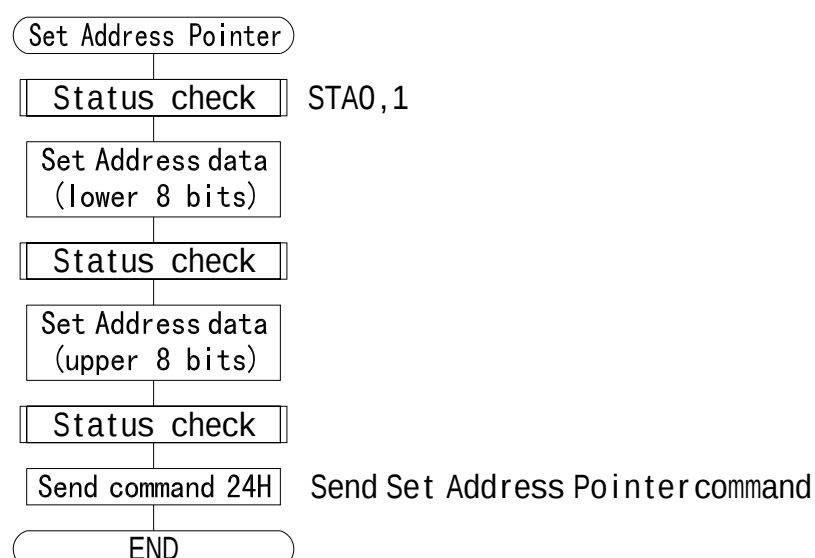


γ and ζ are displayed by character generator RAM

(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

MD2=H, MD3=H : 32 columns

/DUAL=H, MDS=L, MD0=L, MD1=H : 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 indication the leftmost and uppermost position.

The relationship between external display RAM address and display position

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

GH : Graphic home address

GA : Graphic area number(columns)

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

(Example)

Graphic home address : 0000H

Graphic area : 0020H

MD2=H, MD3=H : 32 columns

/DUAL=H, MDS=L, MD0=H, MD1=H : 2 lines

0000H	0001H		001EH	001FH
0020H	0021H		003EH	003FH
0040H	0141H		005EH	005FH
0060H	0161H		007EH	007FH
0080H	0181H		009EH	009FH
00A0H	00A1H		00BEH	00BFH
00C0H	00C1H		00DEH	00DFH
00E0H	00E1H		00FEH	00FFH
0100H	0101H		011EH	011FH
0120H	0121H		013EH	013FH
0140H	0141H		015EH	015FH
0160H	0161H		017EH	017FH
0180H	0181H		019EH	019FH
01A0H	01A1H		01BEH	01BFH
01C0H	01C1H		01DEH	01DFH
01E0H	01E1H		01FEH	01FFH

(3) Set Text Area

The display columns are defined by the hardware setting. This command can be 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 ← ----- |

(4) Set Graphic Area

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

(Example)

LCD size : 20 columns, 2 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	.....	00FD
00F0	00F1	.....	0103	0104	.....	011F
0104	0105	.....	0127	0128	.....	0123
0128	0129	.....	013B	013C	.....	0147
013C	013D	.....	014F	0150	.....	015B

| ----- → LCD ← ----- |

If the graphic area setting is set 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

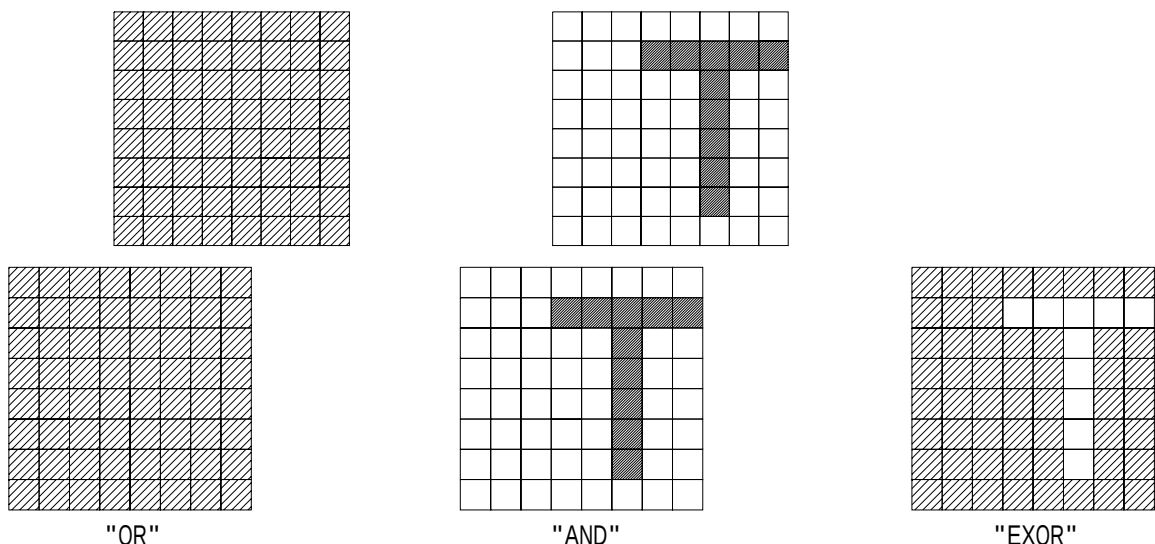
CODE	FUNCTION	OPERAND
1000X000	OR Mode	-
1000X001	EXOR Mode	-
1000X011	AND Mode	-
1000X100	TEXT ATTRIBUTE Mode	-
10000XXX	Internal Character Generator Mode	-
10001XXX	External Character Generator Mode	-

X : invalid

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

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)



(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



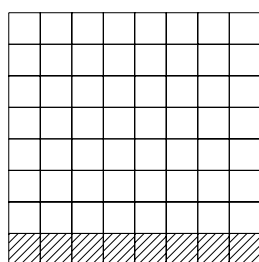
(Note) It is necessary to turn on “Text display” and “Graphic display” in the following cases.

- Combination of text/graphic display
- Attribute function

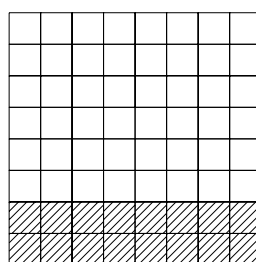
Cursor pattern select

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	-

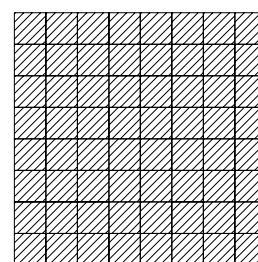
When cursor display is ON, this command select the cursor pattern in the range 1 line to 8 lines. The cursor address is defined by the Cursor Pointer Set command.



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	-

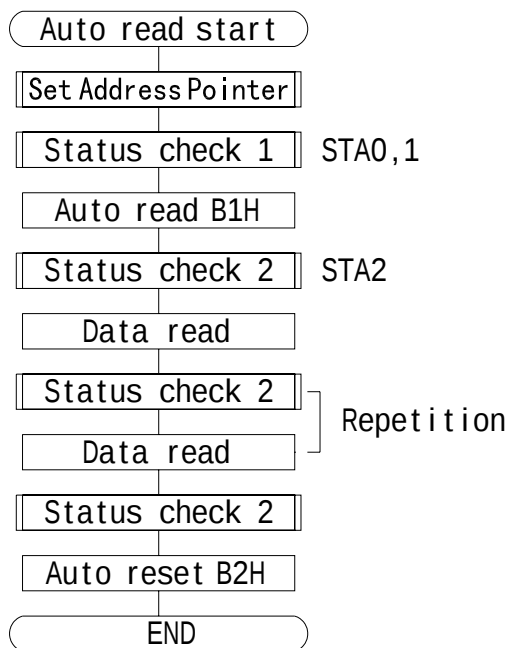
This command is convenient for sending a full screen of data from the external display RAM. After setting Auto mode, a Data Write (or Read) command is need not be sent between each datum. A Data Auto Write (or Read) command must be sent after a Set Address Pointer command. After this command, the address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

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

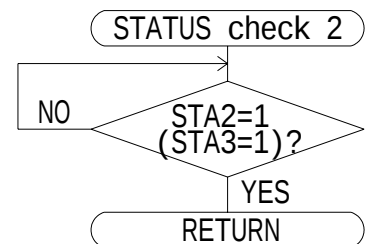
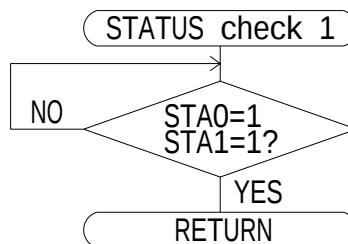
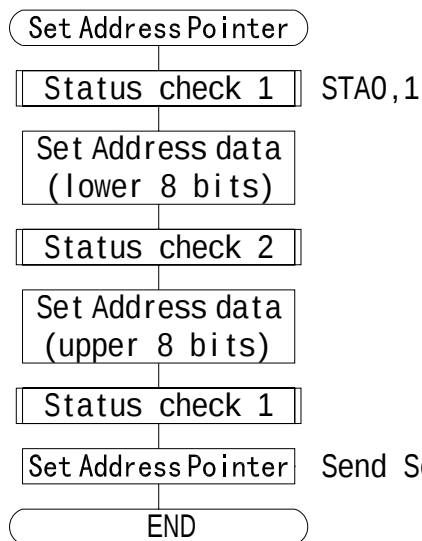
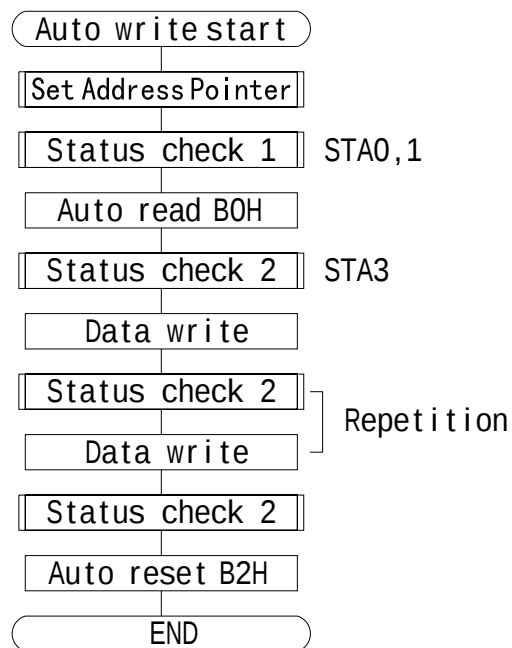
(Note) A Status check for Auto mode

(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.

a) Auto Read mode



b) Auto Write mode



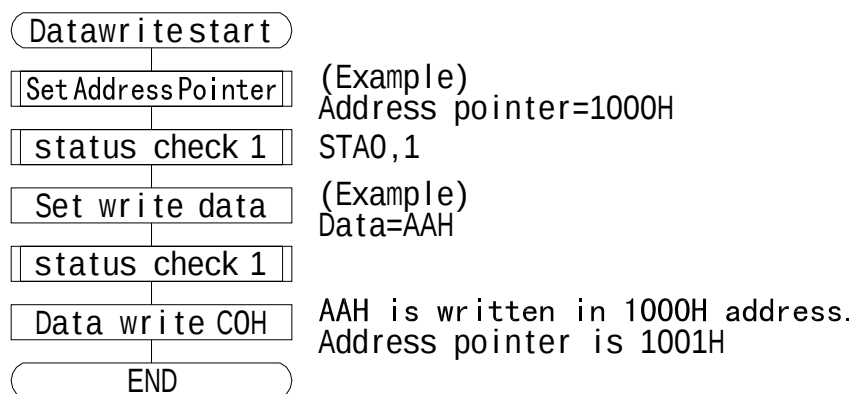
Data Read/Write

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 Write/Data Read should be executed after setting address using Set Address Pointer command.

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

Refer to the following flowchart.



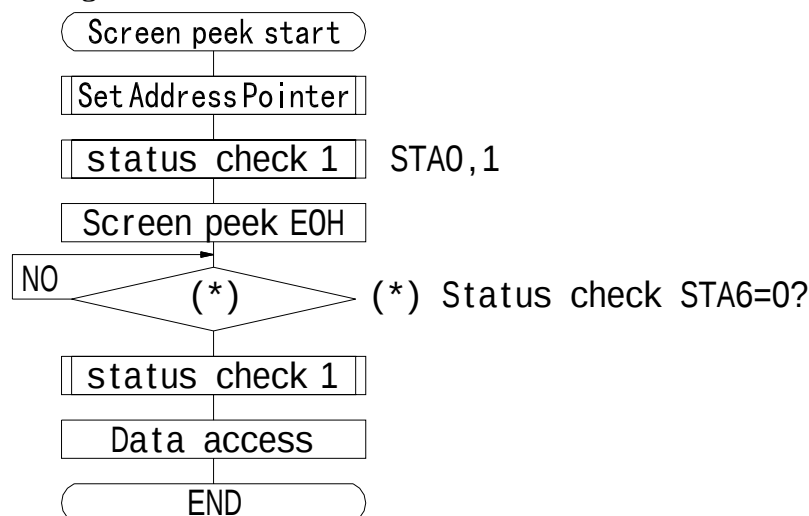
Screen Peek

CODE	HEX.	FUNCTION	OPERAND
11100000	E0H	Screen Peek	-

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 in 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.



(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.

Screen Copy

CODE	HEX.	FUNCTION	OPERAND
11101000	E8H	Screen Copy	-

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

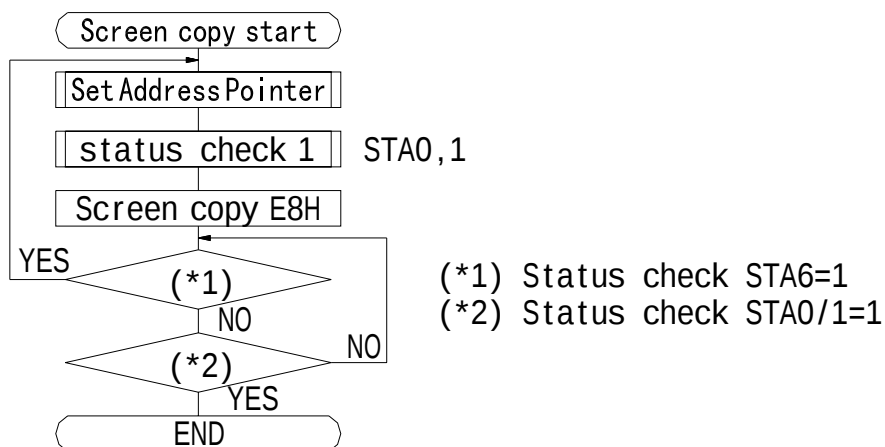
The start point must be set using the Set Address Pointer command.

(Note 1) If the attribute function is being used, this command is not available.

(With Attribute data is graphic area data.)

(Note 2) With Dual-Scan, this command can not be used(because the T6963C can not separate the

upper screen data and lower screen data).
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 the MD2 and MD3 setting. Software column number is related to Set Text Area and Set Graphic Area command.

Bit Set/Reset

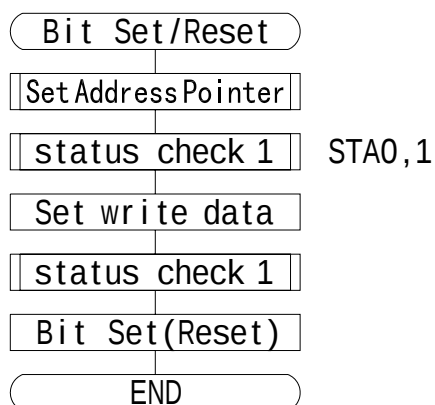
CODE	FUNCTION	OPERAND
11110XXX	Bit Reset	-
11111XXX	Bit Set	-
1111X000	Bit 0(LSB)	-
1111X001	Bit 1	-
1111X010	Bit 2	-
1111X011	Bit 3	-
1111X100	Bit 4	-
1111X101	Bit 5	-
1111X110	Bit 6	-
1111X111	Bit 7(MSB)	-

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.



ABSOLUTE MAXIMUM RATINGS (Ta=25)

ITEM	SYMBOL	RATING	UNIT
Supply Voltage	V _{DD} (Note)	-0.3 to 7.0	V
Input Voltage	V _{IN}	-0.3 to V _{DD} +0.3	V
Operating Temperature	T _{opr}	-20 to 70	
Storage Temperature	T _{stg}	-55 to 125	

(Note) Referenced to V_{SS}=0V

ELECTRICAL CHARACTERISTICS

DC CHARACTERISTICS

TEST CONDITIONS (Unless otherwise noted, V_{SS}=0V, V_{DD}=5.0V ± 10%, T_a=-20 to 75)

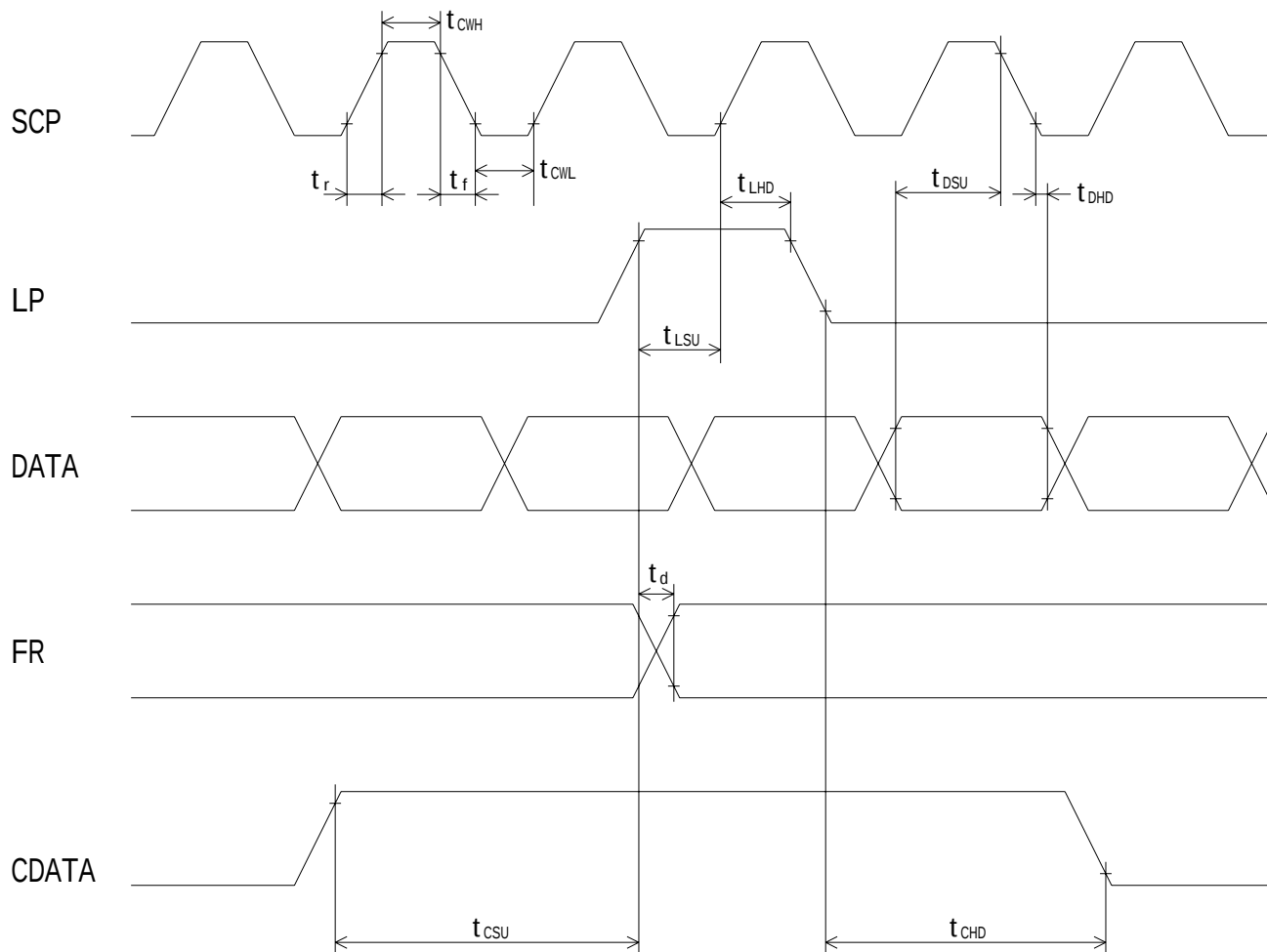
ITEM		SYMBOL	TEST CIRCUIT	TEST CONDITIONS	MIN	TYP	MAX	UNIT	PIN NAME
Operating Voltage		V _{DD}	-	-	4.5	5.0	5.5	V	V _{DD}
Input	H Level	V _{IH}	-	-	V _{DD} -2.2	-	V _{DD}	V	Input pins
	L Level	V _{IL}	-	-	0	-	0.8	V	Input pins
Output Voltage	H Level	V _{OH}	-	-	V _{DD} -0.3	-	V _{DD}	V	Output pins
	L Level	V _{OL}	-	-	0	-	0.3	V	Output pins
Output Resistance	H Level	R _{OH}	-	V _{OUT} =V _{DD} -0.5V	-	-	400	Ω	Output pins
	L Level	R _{OL}	-	V _{OUT} =0.5V	-	-	400	Ω	Output pins
Input Pull-up Resistance		R _{PU}	-	-	50	100	200	kΩ	(Note 1)
Operating Frequency		F _{osc}	-	-	0.4	-	5.5	MHz	
Current Consumption (Operating)		I _{DD} (1)	-	V _{DD} =5.0V (Note2) f _{osc} =3.0MHz	-	3.3	6	mA	V _{DD}
Current Consumption(Halt)		I _{DD} (2)	-	V _{DD} =5.0V	-	-	3	μA	V _{DD}

(Note 1) Applied /T1,/T2 /RESET

(Note 2) MDS=L, MD0=L, MD1=L, MD2=H, MD3=H, FS0=L, FS1=L, /SDSEL=L, /DUAL=H,
D7 to D0=LHLHLHLH

AC CHARACTERISTICS

Switching Characteristics(1)

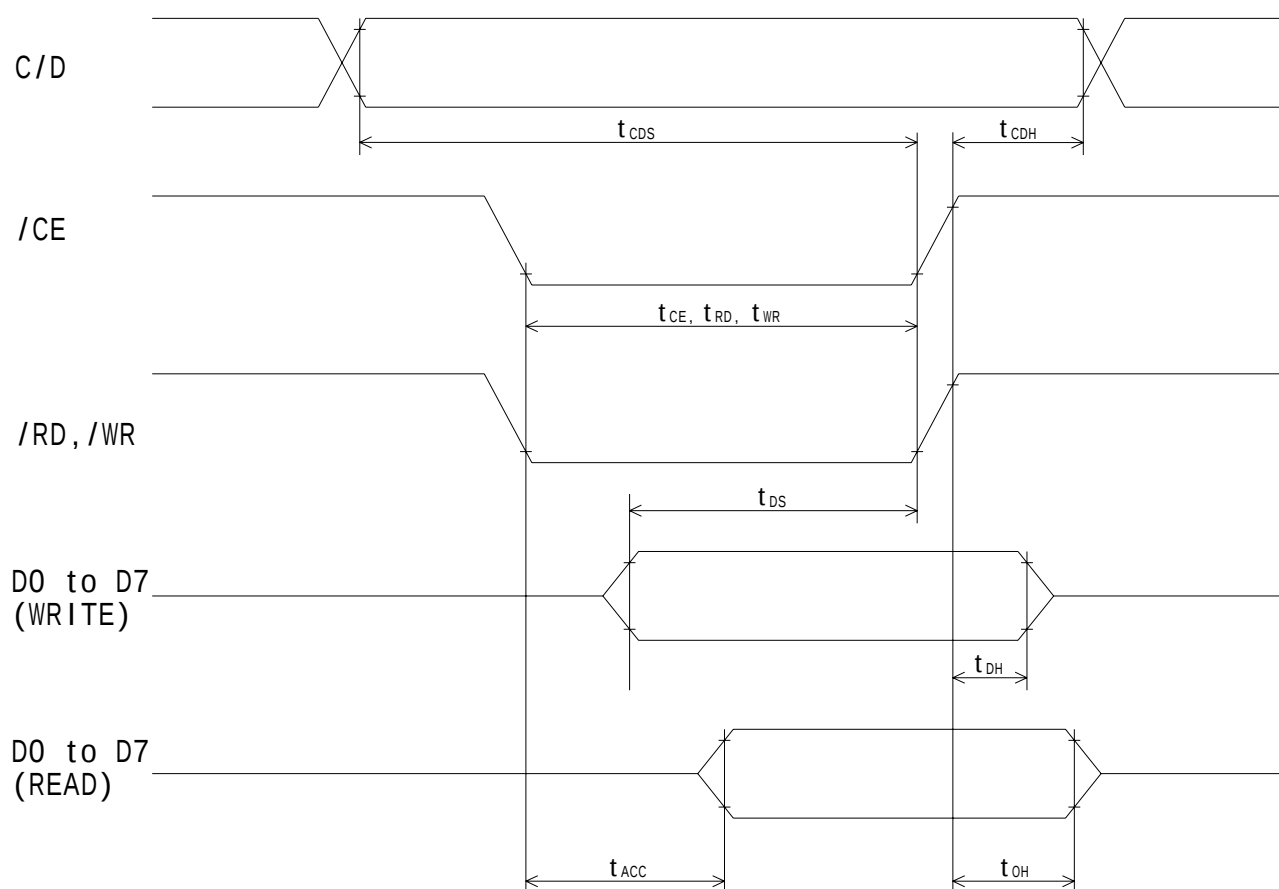


TEST CONDITIONS (Unless otherwise noted, $V_{DD}=5.0V \pm 10\%$, $V_{SS}=0V$, $T_a=-20$ to 70)

ITEM	SYMBOL	TEST CONDITIONS	MIN	MAX	UNIT
Operating Frequency	fSCP	$T_a=-10$ to 70	-	2.75	MHz
SCP Pulse Width	tCWH,tCWL	-	150	-	ns
SCP Rise/Fall Time	t _r ,t _f	-	-	30	ns
LP Set-up Time	tLSU	-	150	290	ns
LP Hold Time	tLHD	-	5	40	ns
Data Set-up Time	tDSU	-	170	-	ns
Data Hold Time	tDHD	-	80	-	ns
FR Delay Time	t _d	-	0	90	ns
CDATA Set-up Time	tCSU	-	450	850	ns
CDATA Hold Time	tCHD	-	450	950	ns

Switching Characteristics(2)

Bus Timing

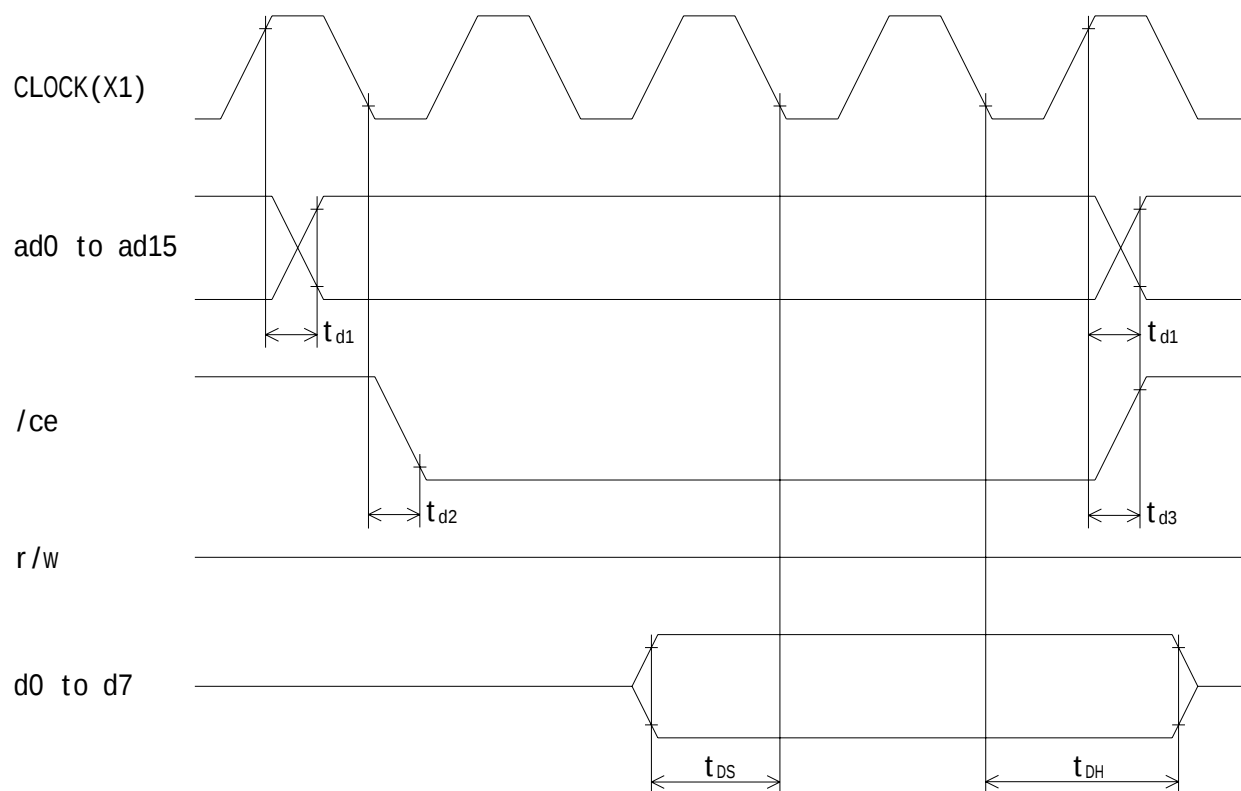


TEST CONDITION (Unless otherwise noted, $V_{DD}=5.0V \pm 10\%$, $V_{SS}=0V$, $T_a=-20$ to 75)

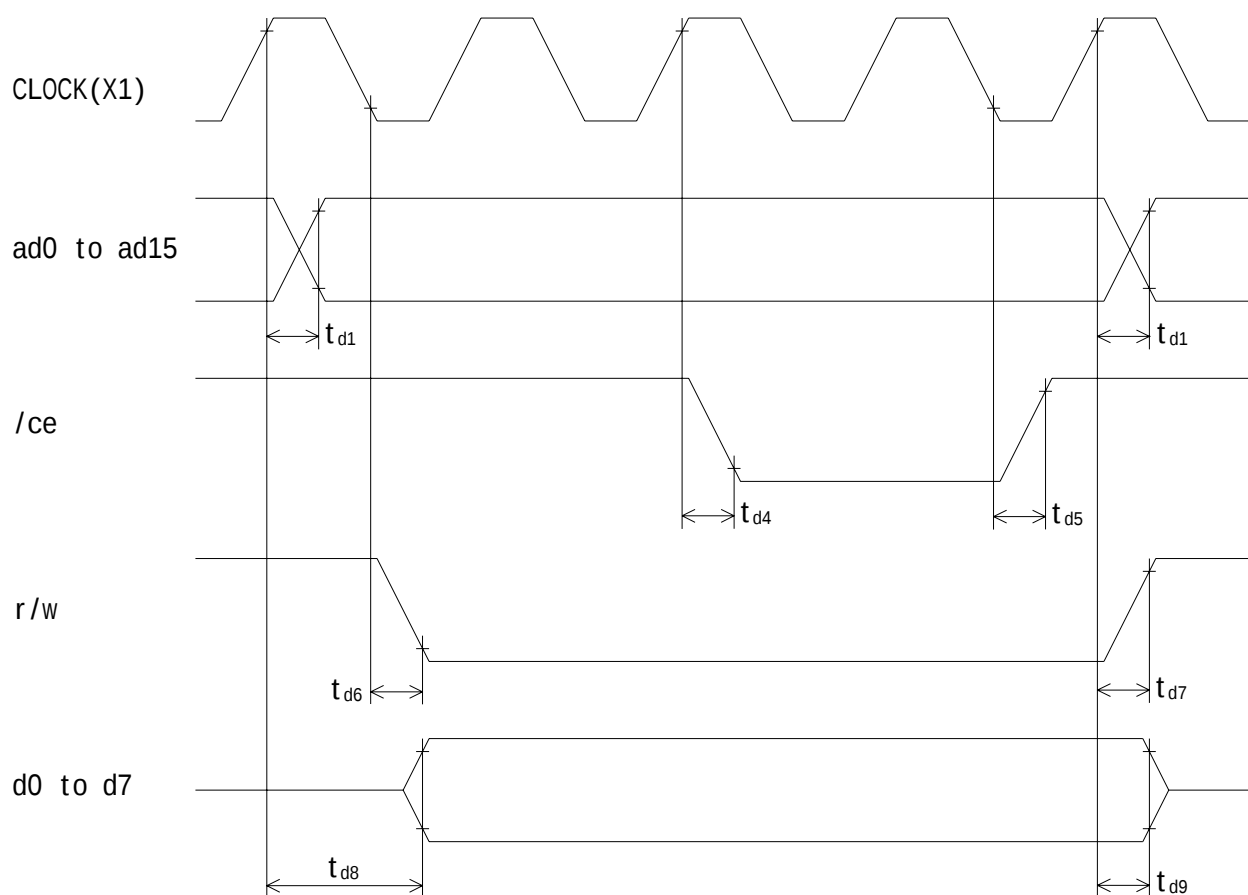
ITEM	SYMBOL	TEST CONDITIONS	MIN	MAX	UNIT
C/D Set-up Time	t_{CDS}	-	100	-	ns
C/D Hold Time	t_{CDH}	-	10	-	ns
/CE,/RD,/WR Pulse Width	t_{CE}, t_{RD}, t_{WR}	-	80	-	ns
Data Set-up Time	t_{DS}	-	80	-	ns
Data Hold Time	t_{DH}	-	40	-	ns
Access Time	t_{ACC}	-	-	150	ns
Output Hold Time	t_{OH}	-	10	50	ns

Switching Characteristics(3)

(1) External RAM mode



(2) External RAM Write mode



TEST CONDITIONS(Unless otherwise noted, VDD=5.0V $\pm$ 10%, VSS=0V, Ta=-20 to 70)

ITEM	SYMBOL	TEST CONDITIONS	MIN	MAX	UNIT
Address Delay Time	td1	-	-	250	ns
/ce Fall Delay Time(Read)	td2	-	-	180	ns
/ce Rise Delay Time(Read)	td3	-	-	180	ns
Data Set-up Time	tdS	-	0	-	ns
Data Hold Time	tdH	-	30	-	ns
/ce Fall Delay Time(Write)	td4	-	-	200	ns
/ce Rise Delay Time(Write)	td5	-	-	200	ns
r/w Fall Delay Time	td6	-	-	180	ns
r/w Rise Delay Time	td7	-	-	180	ns
Data Stable Time	td8	-	-	450	ns
Data Hole Time	td9	-	-	200	ns

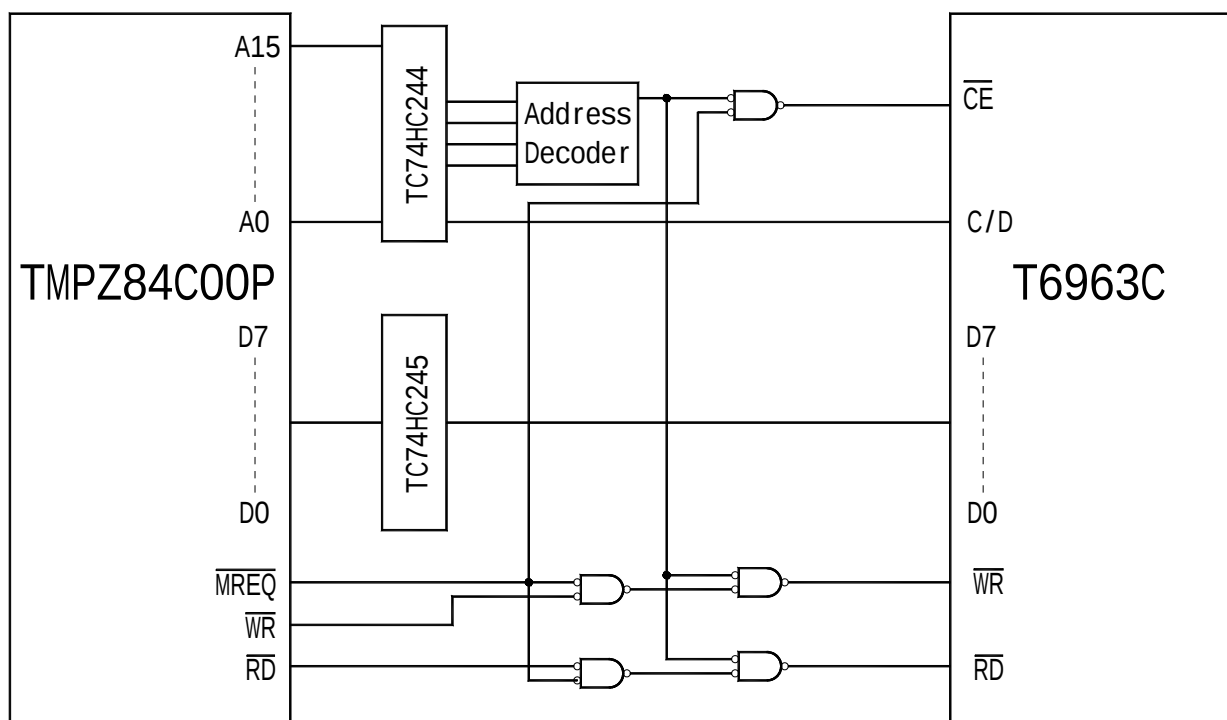
T6963C EXAMPLE OF APPLICATION CIRCUIT

The T6963C can be directly connected to a TMPZ84C00A (Z80 (Note 1) CMOS). The T6963C can be used with a TMPZ84C00A as show in the following application circuit.

MPU memory address mapping

Data is transferred to the T6963C using a memory request signal.

	ADDRESS
DATA(I/O)	XXXXH
Command/Status	XXXX+1H

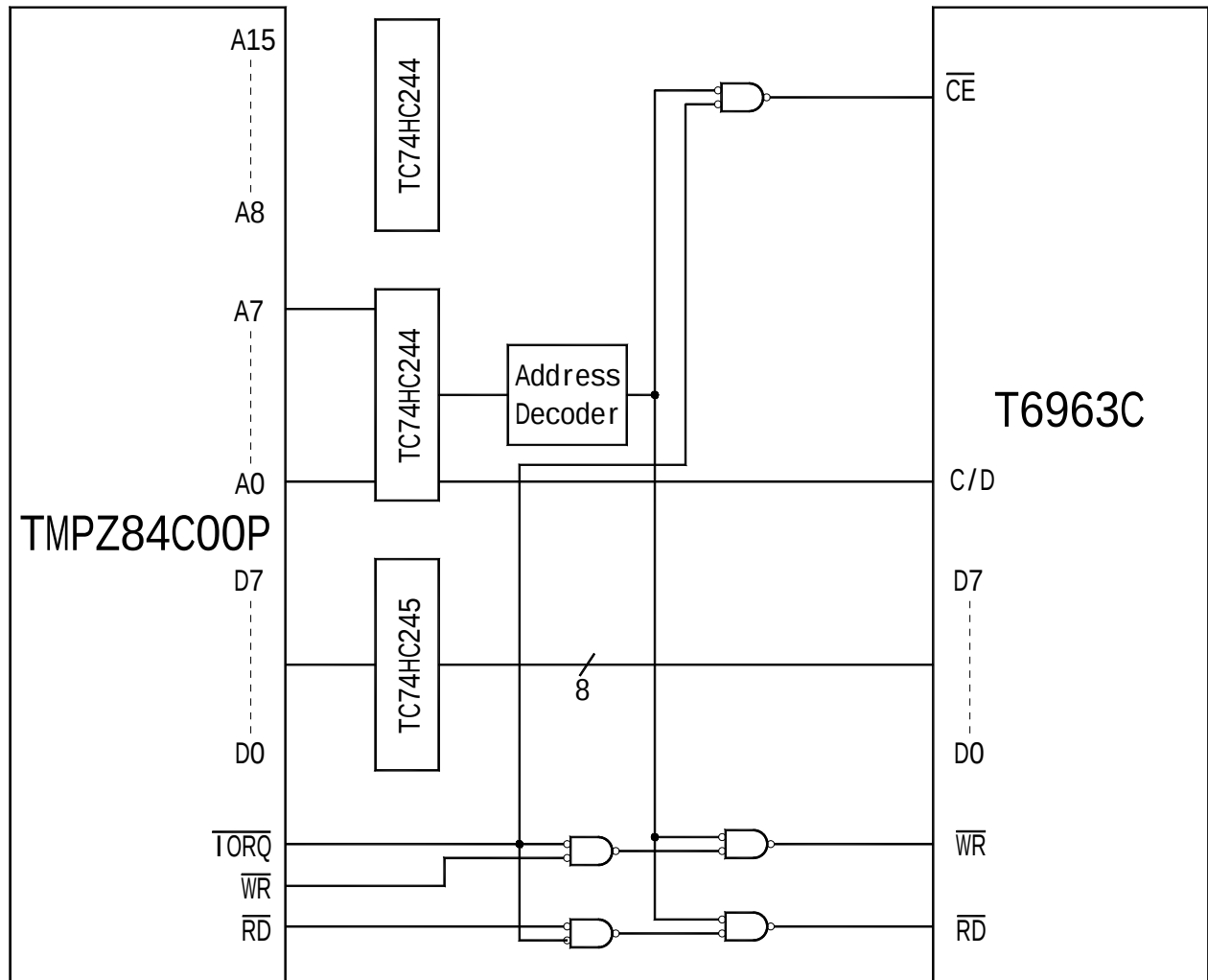


(Note 1) Z80 is a trademark of Zilog Inc.

MPU I/O addressing

Data is transferred to the T6963C using an I/O request signal.

	I/O ADDRESS
DATA	XXH
Command/Status	XX+1H



When using PPI LSI(TMP82C55)

The T6963C can be connected to a PPI LSI.

The port S connects to the data bus.

The port C connects to the control bus.(C/D,/CE,/WR,/RD)

