NEC
ELECTRON DEVICES

MOS DIGITAL INTEGRATED CIRCUIT
μPD6105C-002

CMOS LSI FOR CHARACTER DISPLAY ON SCREEN

DESCRIPTION

The μPD6105C-002 is a character display CMOS LSI used in combination with a microcomputer; it displays characters such as the time and channel number on a TV screen. If this LSI is used in a video camera or a VTR, the date, time, and so forth can be recorded overlapping the video signals. 5 X 7 dots format. The characters are made easy to see with the smoothing function for smoothing connection between dots and the background function for display on a black square background and black fringe.

FEATURES

• Number of display characters :	5 lines X 14 columns
• Character set :	64 (5 X 7 dots) with smoothing function to join dots
• Cursor :	Cursor indication is available for character display position corresponding to the write address
• Character color :	Three colors may be specified line by line using commands. Colors may also be specified in the same line using color change data and color select data.
• Character size :	Two character heights of 14 H, 28 H, 42 H, or 56 H may be specified for each line.
• Display position :	32 horizontal positions by 12/fosc (MHz), and 32 vertical positions by 9 H.
• Background :	No background, square background, fringe, or solid background may be selected.
• Line space :	Vertical line spacing may be set in 16 grades from 2 dots to 2 dots + 30 H.
• Control input :	Display control and display data control are possible using 8 bit serial input data. (Three input terminals for data, clock, and strobe)
• Display output :	Three character data output terminals (R, G, and B), and a blank output terminal.
• Display on/off :	All display data may be set on or off, or it may be set line by line using commands. Some display data may also be set to off by display off data.
• Supply voltage :	+5 V
• Package :	22 pin molded plastic DIP

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ABSOLUTE MAXIMUM RATINGS (T_a=25 °C)

Supply Voltage	$V_{DD}-V_{SS}$	7	V
Input Voltage	V_{IN}	$V_{SS}-0.3<V_{IN}<V_{DD}+0.3$	V
Output Voltage	V_{OUT}	$V_{SS}-0.3<V_{OUT}<V_{DD}+0.3$	V
Operating Temperature	V_{opt}	−20 ~ +75	°C
Storage Temperature	V_{stg}	−40 ~ +125	°C
Power Dissipation	P_d	100	mW
Output Current	I_o	±5	mA

RECOMMENDED OPERATING CONDITIONS

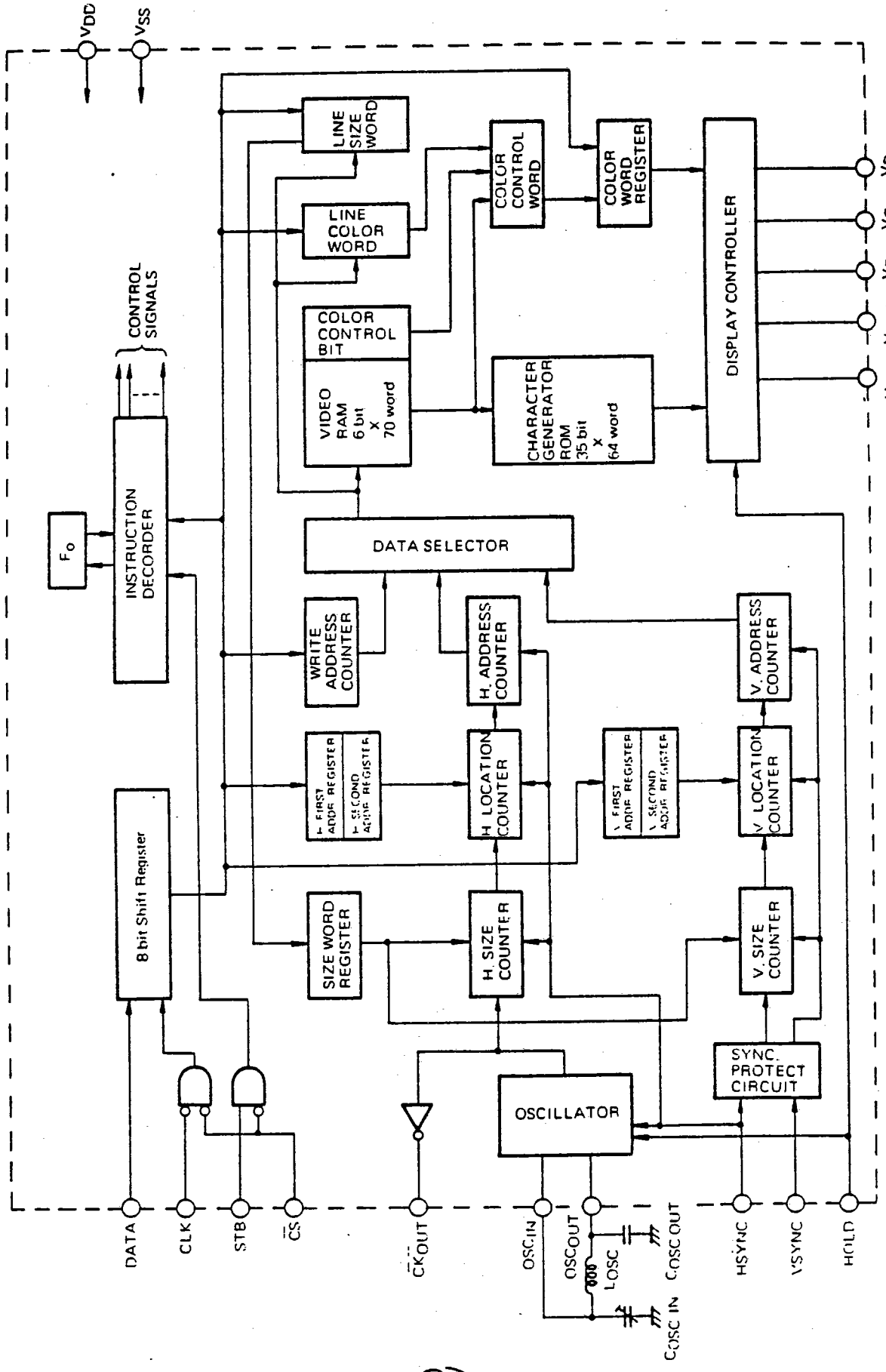
CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage	$V_{DD}-V_{SS}$	4.5	5.0	5.5	V
Oscillation Frequency	f_{OSC}	4.5	5.0	5.5	MHz
Operating Temperature	T_{opt}	−10	+25	+60	°C
DATA, CLK, STB, $\overline{CS}$ High Level Input Voltage	V_{IH}	2.4			V
DATA, CLK, STB, $\overline{CS}$ Low Level Input Voltage	V_{IL}			0.8	V
$\overline{VSYNC}$ High Level Input Voltage	V_{IH}	2.4			V
$\overline{VSYNC}$ Low Level Input Voltage	V_{IL}			0.8	V
$\overline{HSYNC}$ $\overline{HOLD}$ High Level Input Voltage	V_{IH}	4.5			V
$\overline{HSYNC}$ $\overline{HOLD}$ Low Level Input Voltage	V_{IL}			1.0	V
$\overline{VSYNC}$ Pulse Width	t_{VWL}	4			μs
$\overline{HSYNC}$ Pulse Width	t_{HWL}	4			μs

ELECTRICAL CHARACTERISTICS

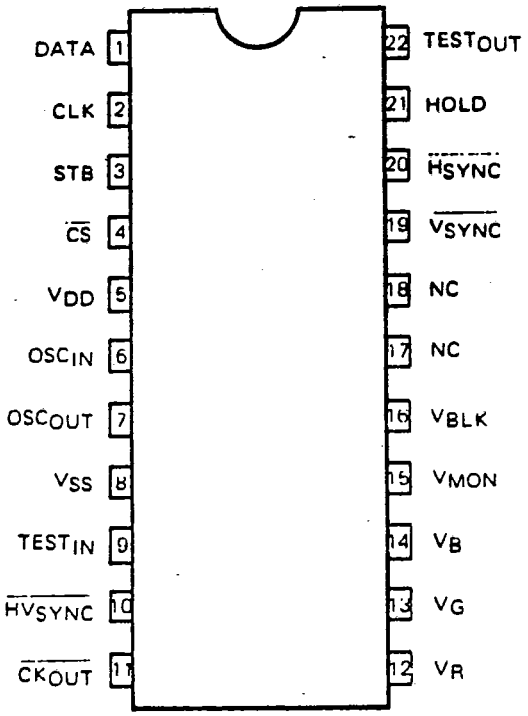
(T_a=25 °C, V_{DD}=5.0 V, V_{SS}=0 V, L_{OSC}=56 μH, $C_{OSC\ IN}$=5 ~ 30 pF, $C_{OSC\ OUT}$=30 pF)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Current Consumption	I_{DD}	$C_{OSC\ IN}$=20 pF		5	10	mA
High Level Output Voltage	V_{OH}	I_{OH}=−1 mA	4.5			V
Low Level Output Voltage	V_{OL}	I_{OL}=1 mA			0.5	V

BLOCK DIAGRAM

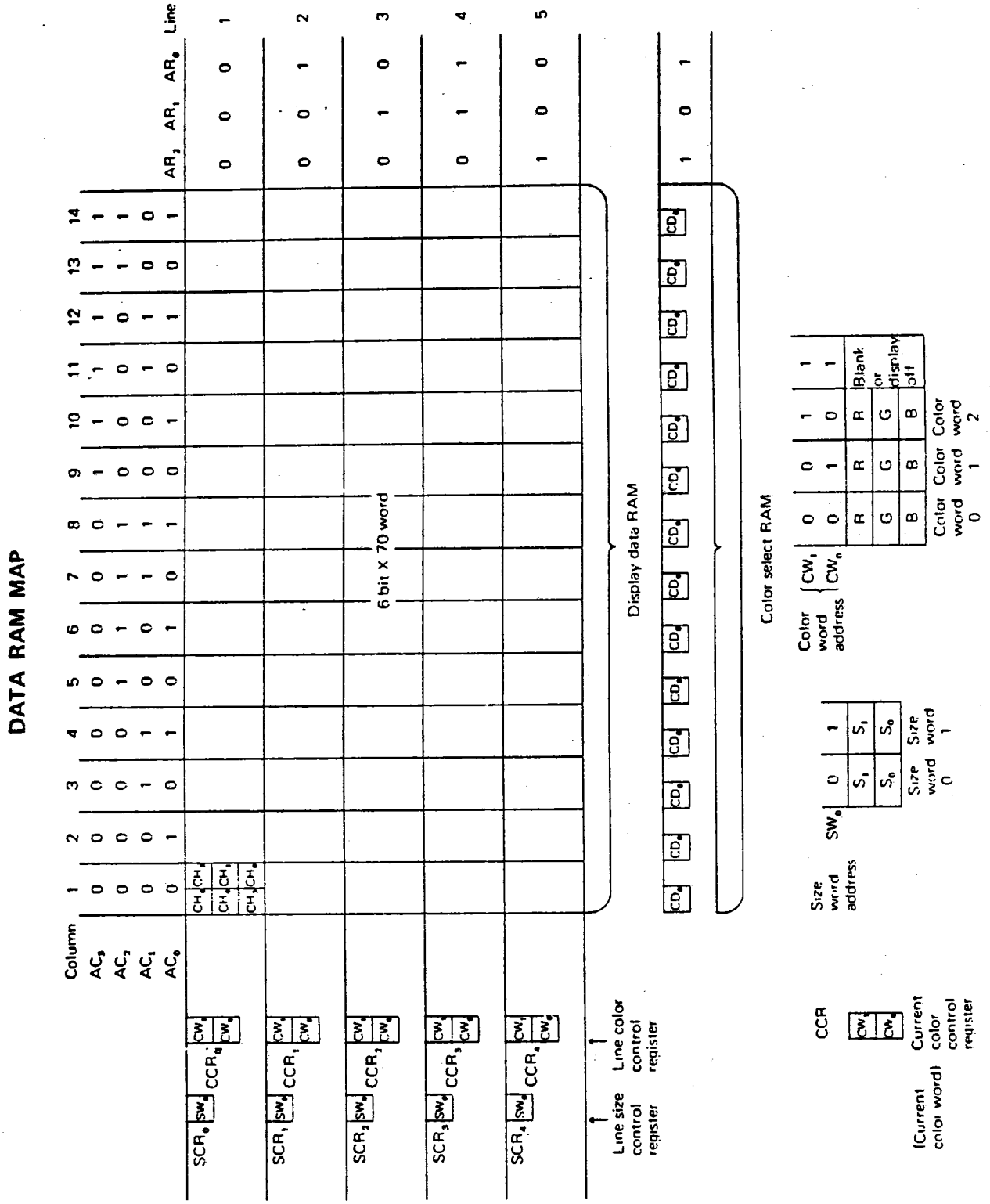


CONNECTION DIAGRAM (Top View)



PIN DESCRIPTION

SYMBOL	PIN NAME	FUNCTION
V_{DD}	Power supply terminal	Supplies +5.V.
V_{SS}	Ground terminal	Provides system grounding.
DATA	Serial data input terminal	Control data input terminal. Data is read in synchronization with clock signals sent to CLK terminal.
CLK	Clock input pin	Data read clock input pin. Data input to the DATA pin is read at the clock leading edge.
STB	Strobe input terminal	Terminal for strobe input after serial data input. Eight bit data is read on the leading edge of the pulse sent to STB terminal. If the 8 bit data is character data, the data address is increased on the trailing edge of the pulse.
$\overline{CS}$	Chip select terminal	Normal operation in low level; shift clock input (CLK) and strobe input (STB) input inhibited at the high level.
OSC IN OSC OUT	Oscillation terminal	Terminal that connects an oscillation capacitor and coil.
$\overline{H_{SYNC}}$	Horizontal synchronization signal input terminal	Horizontal synchronization signal input terminal. Oscillated when $\overline{H_{SYNC}}$ is at the high level. Oscillation is synchronized with the change to high of $\overline{H_{SYNC}}$. Operates during active low state.
$\overline{V_{SYNC}}$	Vertical synchronization signal input terminal	Vertical synchronization signal input terminal. Operates during active high state.
V_R V_G V_B	Character signal output terminal	Character data output terminal that corresponds to R, G, or B. Output during active high state.
V_{BLK}	Blanking signal output terminal	Terminal for output of blanking signal that inhibits video signal. Output during active high state.
HOLD	Hold terminal	Stops oscillation during low state. At this time, output of V_R, V_G, B_B and V_{BLK} is low. (Normally, these states are set to high.)
V_{MON}	Character signal output monitor terminal	Output in high state, when R, G, or B character signal output is high.
$\overline{CK_{OUT}}$	Clock out terminal	Inverse output of OSC OUT. If another μPD6104, μPD6105 is connected in parallel, the terminal should be connected to its OSC IN.
$TEST_{IN}$	TEST CLOCK input terminal	TEST CLOCK input terminal. (Normally, this should be connected to V_{SS}.)
$\overline{HV_{SYNC}}$	V/H synchronization circuit switching terminal	In the low state, receives horizontal synchronization signals in synchronization with vertical synchronization signals. In the high state, receives horizontal synchronization signals as they are.
$TEST_{OUT}$	TEST output terminal	Output terminal for LSI TEST. Normally, this terminal is open.


DATA RAM MAP
Column
AC5 AC2 AC1 AC0
1 2 3 4 5 6 7 8 9 10 11 12 13 14
AR3 AR1 AR0 Line
SCR0 SW0 CCR0 CW1 CW0
SCR1 SW1 CCR1 CW1 CW0
SCR2 SW2 CCR2 CW1 CW0
SCR3 SW3 CCR3 CW1 CW0
SCR4 SW4 CCR4 CW1 CW0
CH4 CH3 CH2 CH1 CH0
6 bit X 70 word
Line size control register
Line color control register
Display data RAM
CD0 CD1 CD2 CD3 CD4 CD5 CD6
Color select RAM
Color word address
CW1 CW0
Color word 0
Color word 1
Color word 2
R G B
Blank or display off
Size word address
SW0
Size word 0
Size word 1
S1 S0
CCR
CW1 CW0
(Current color word)
Current color control register

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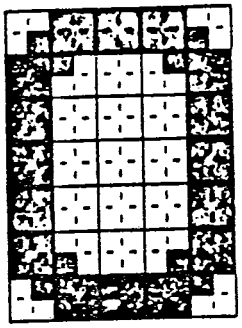
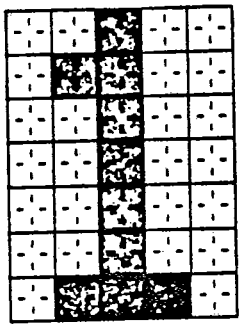
TYPE OF CHARACTERS

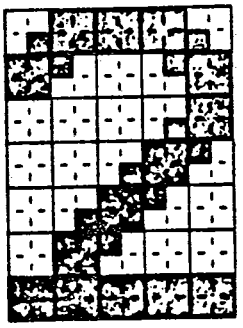
0H



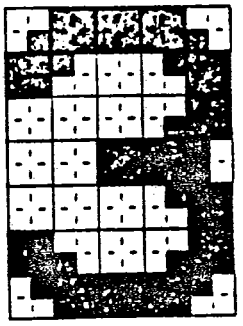
1H



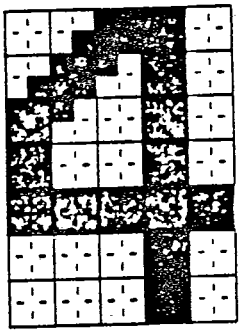
2H



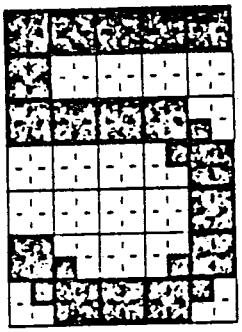
3H



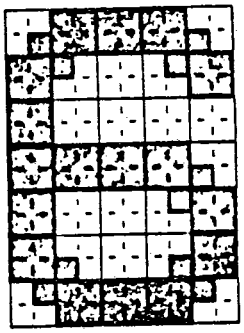
4H



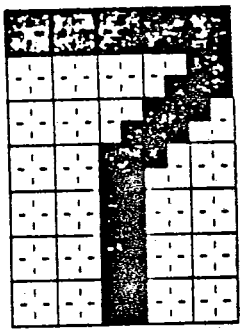
5H



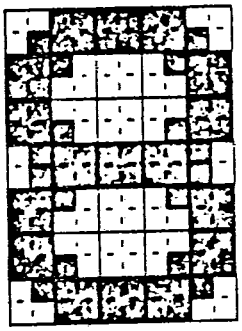
6H



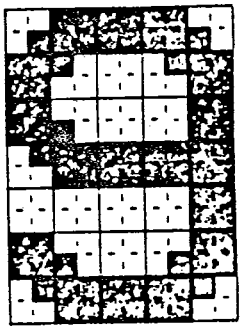
7H



8H



9H



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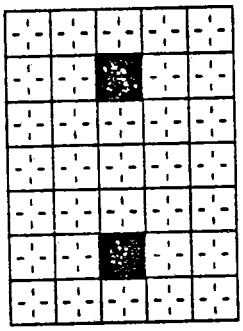

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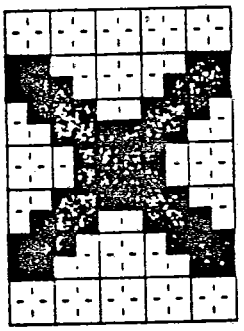
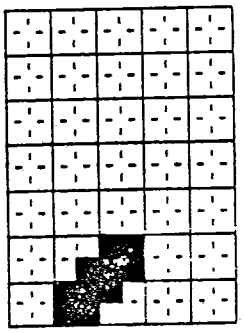
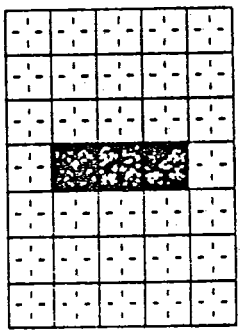


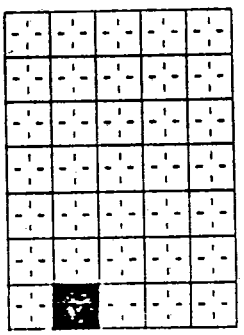
CH



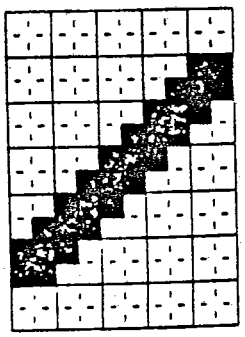
DH



EH



FH



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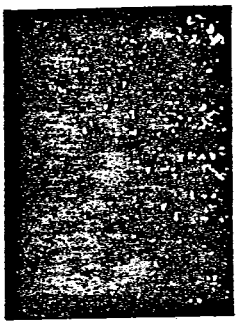
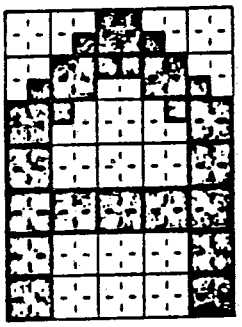
10 H



11 H



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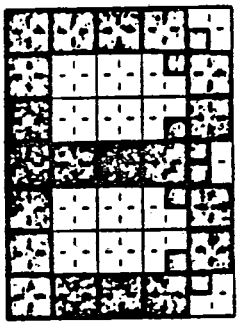

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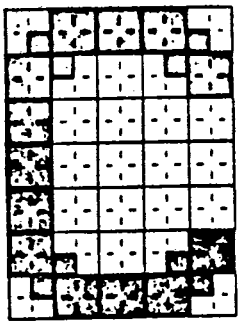

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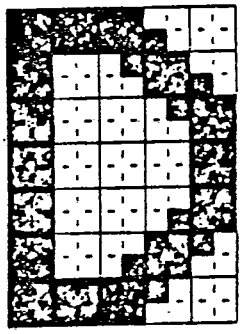

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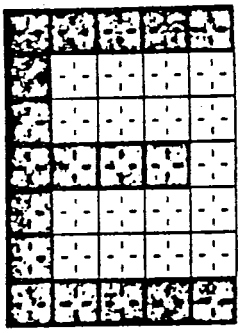

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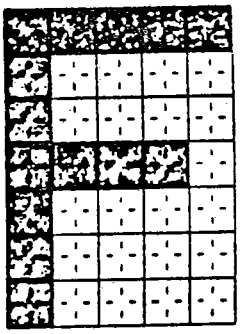

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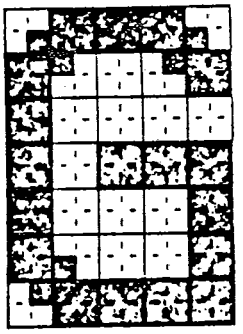

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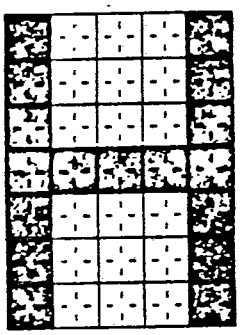

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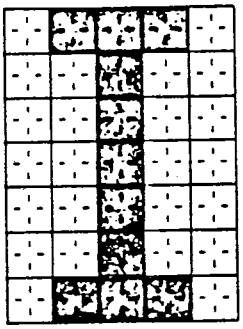

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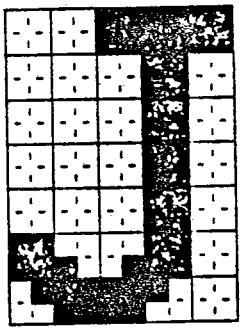

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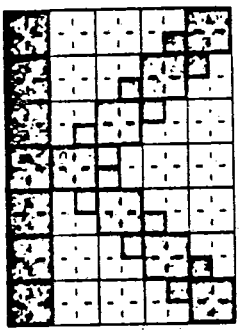

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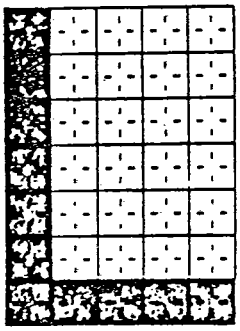

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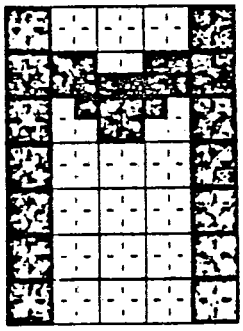

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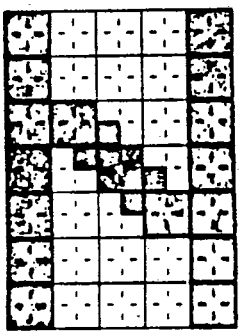

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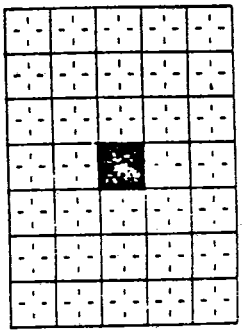

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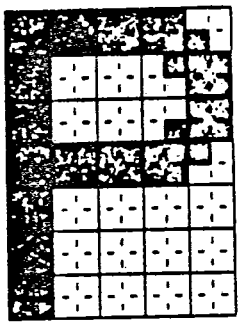

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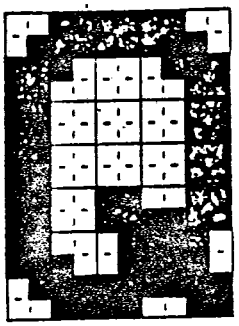

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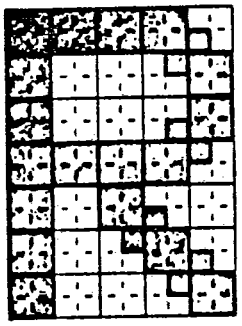

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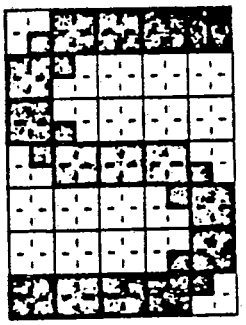

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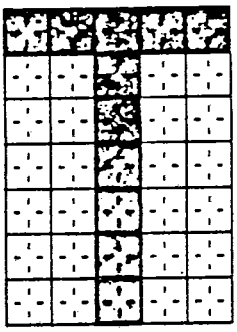

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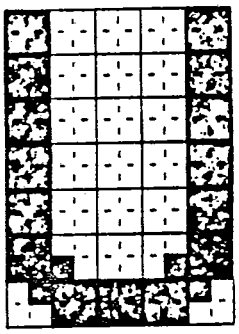

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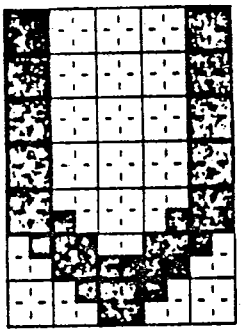

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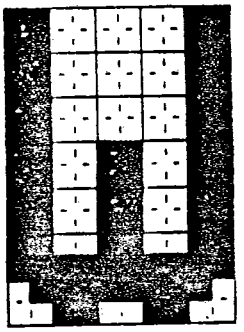

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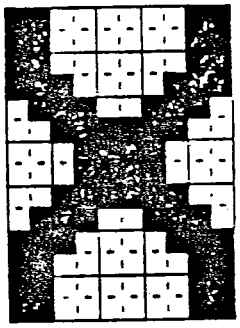
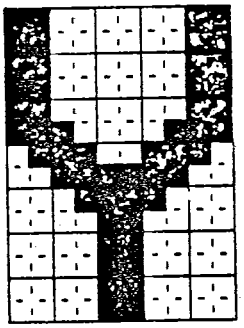
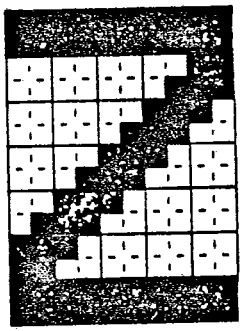


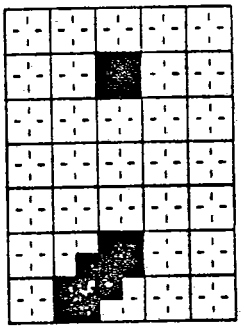
29 H



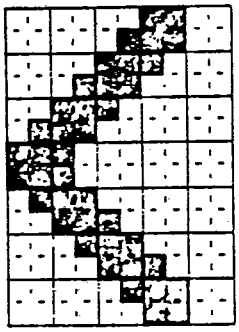
2 AH



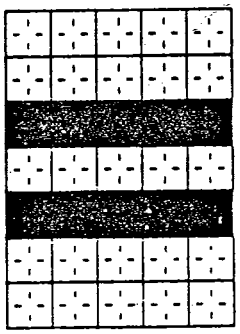
2 BH



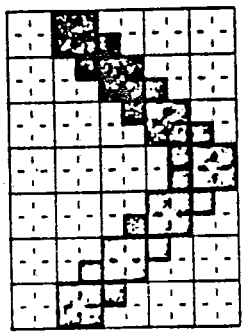
2 CH



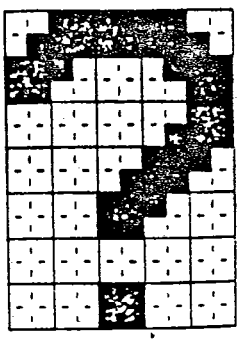
2 DH



2 EH



2 FH



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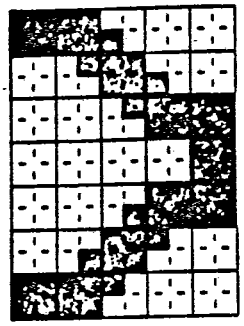
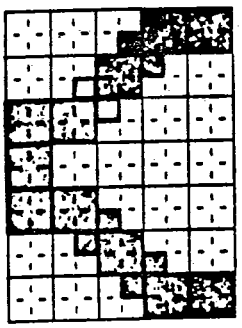
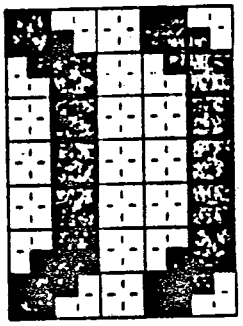
30 H



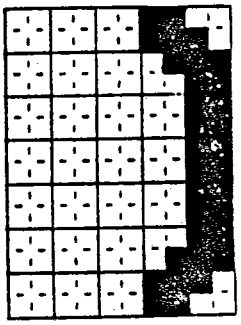
31 H



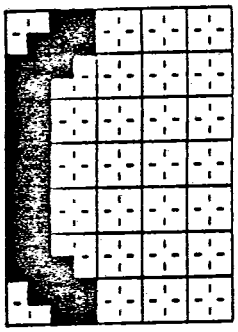
32 H



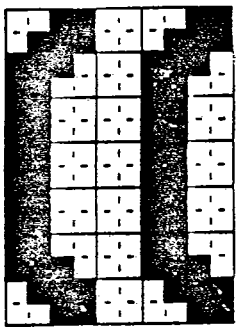
33 H



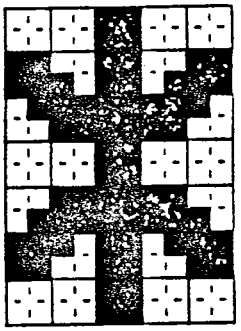
34 H



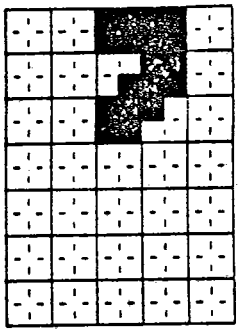
35 H



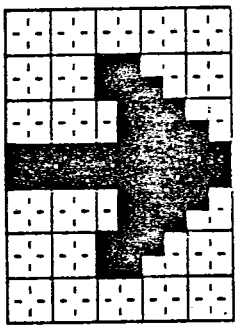
36 H



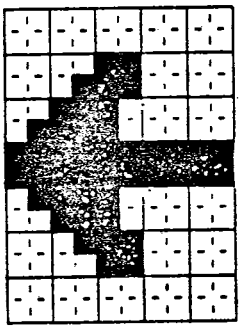
37 H



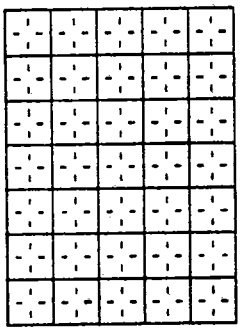
38 H



39 H

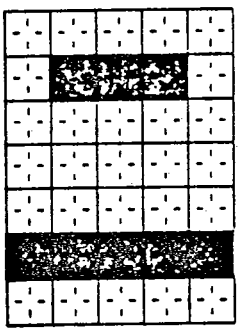


3 AH

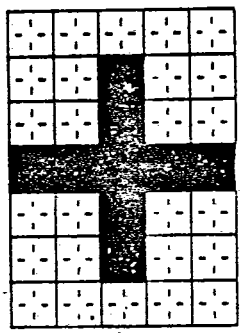


(Blank)

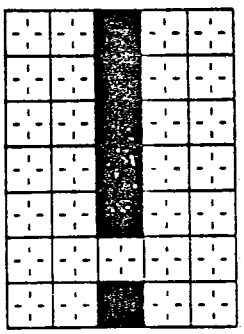
3 BH



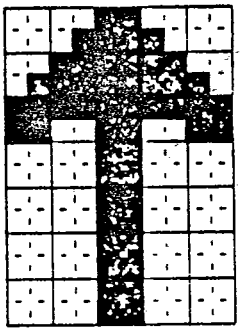
3 CH



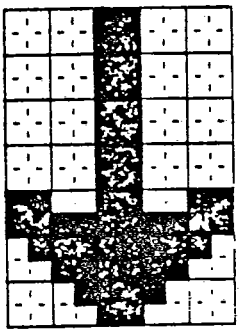
3 DH



3 EH



3 FH



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$(CH_5, CH_4, CH_3, CH_2, CH_1, CH_0) = (1, 1, 1, 0, 1, 0)$..... Blank

In the case of square background :

$(CH_5, CH_4, CH_3, CH_2, CH_1, CH_0) = (1, 1, 1, 0, 1, 1)$..... Display OFF data

When FS_1 (D_1) of the function select command is 0 :

$(CH_5, CH_4, CH_3, CH_2, CH_1, CH_0) = (1, 1, 1, 1, 0, 0)$,
$(1, 1, 1, 1, 0, 1)$,
$(1, 1, 1, 1, 1, 0)$..... Color data

$(CH_5, CH_4, CH_3, CH_2, CH_1, CH_0) = (1, 1, 1, 1, 1, 1)$..... OFF data in line

LIST OF μPD6105C COMMANDS

BANK	F_0	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	CONTENT
0	0	0	0	CH_5	CH_4	CH_3	CH_2	CH_1	CH_0	Character data
	0	0	1	0	0	AC_3	AC_2	AC_1	AC_0	Write column address
	0	0	1	1	0	CF_0	AR_2	AR_1	AR_0	Write line address
	0	0	1	1	1	X	X	X	X	TEST
	0	1	0	CW_1	CW_0	0	R	G	B	Color word specification
	0	1	0	X	SW_0	1	X	S_1	S_0	Size word specification
	0	1	1	0	0	BS_1	BS_0	CW_1	CW_0	Background specification
	0	1	1	0	1	0	DO_0	X	X	Display ON/OFF
	0	1	1	0	1	1	CO_0	X	X	Cursor ON/OFF*
	0	1	1	1	0	FS_3	FS_2	FS_1	FS_0	Function select*
	X	1	1	1	1	1	1	F_0	F_R	Format specification
1	1	0	0	0	H_4	H_3	H_2	H_1	H_0	First horizontal start address setting
	1	0	0	1	H_4	H_3	H_2	H_1	H_0	Second horizontal start address setting*
	1	0	1	0	V_4	V_3	V_2	V_1	V_0	First vertical start address setting
	1	0	1	1	V_4	V_3	V_2	V_1	V_0	Second vertical start address setting*
	1	1	0	CW_1	CW_0	0	AR_2	AR_1	AR_0	Line color specification*
	1	1	1	0	SW_0	X	AR_2	AR_1	AR_0	Line size specification*
	1	1	1	1	0	RS_3	RS_2	RS_1	RS_0	Vertical line spacing*

X : Don't care

* : The command is reset by resetting the format

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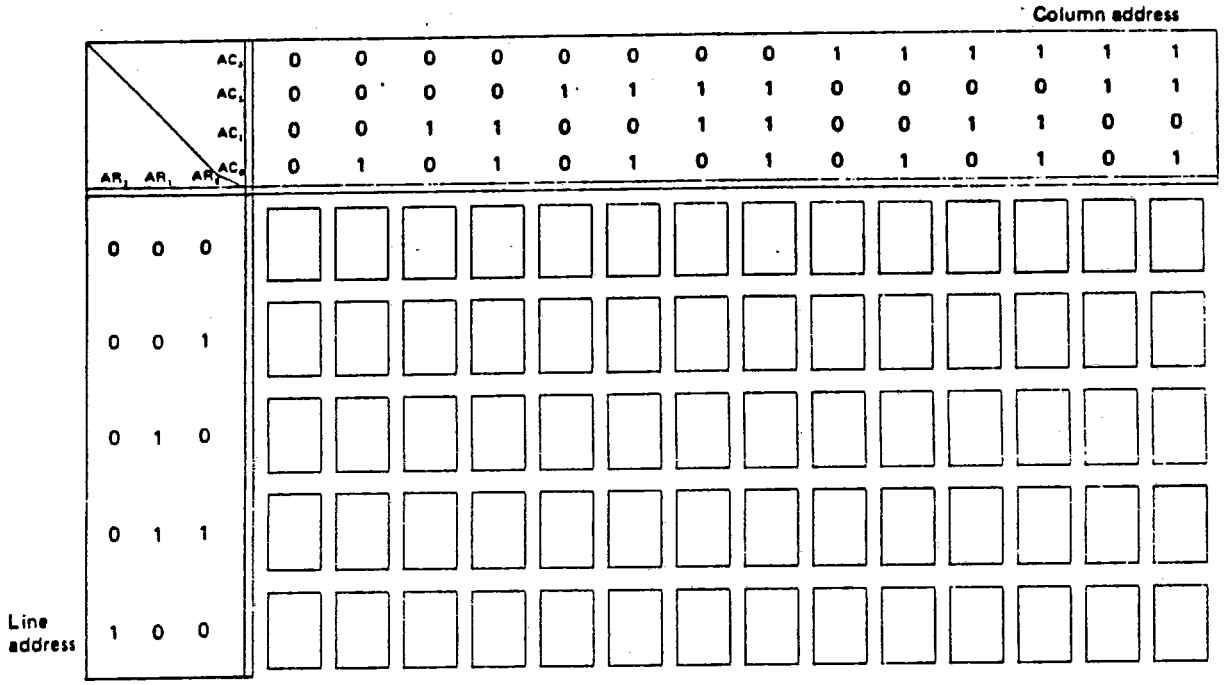
INDEX

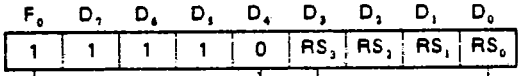
1. CHARACTER DISPLAY

Seventy characters are displayed in 5 lines X 14 columns as shown below.



The space between characters is one dot, and the space between lines can be specified in 16 grades by 2 H (from 2 dots to 2 dots +30 H) using the line spacing command.

Line Spacing Command



LINE SPACE SELECTION BIT				
RS_3	RS_2	RS_1	RS_0	Line space
0	0	0	0	2 dots
0	0	0	1	2 dots + 2 H
⋮				⋮
1	1	1	1	2 dots + 30 H

Indicates a line spacing command.

Line spacing does not depend on character size. After format resetting, the command is set for (RS_3, RS_2, RS_1, RS_0)=(0,0,0,0). (line space: 2 dots)

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2. FORMAT SPECIFICATIONS

Each μPD6105 command consists of nine bits, and the shift register for the external serial interface consists of eight bits. There are two types of commands-display format specification mode commands, and normal mode commands. Switching of command type is performed using bit 1 (F_0) of the format specification command.

Normal mode command (F_0=0)

- Character data
- Write column address
- Write line address
- Word color specification
- Word size specification
- Background specification
- Display ON/OFF
- Cursor ON/OFF
- Function selection

Display format specification commands (F_0=1)

- Horizontal No. 1 start address setting
- Horizontal No. 2 start address setting
- Vertical No. 1 start address setting
- Vertical No. 2 start address setting
- Line color specification
- Line size specification
- Vertical line spacing

3. FORMAT RESET (F_R=1)

Specify bit (F_R) of the format specification command to clear the test command mode and reset the contents of the next command. Format resetting is not latched.

(1) Set the contents of line color control register ($CCR_{0\ to\ 4}$) to (CW_1, CW_0)=(0,0).

(2) Set the contents of line size control register ($SCR_{0\ to\ 4}$) to (SW_0)=(0).

(3) Set the contents of the vertical spacing selection bit to (RS_3, RS_2, RS_1, RS_0)=(0,0,0,0).
(Line space is 2 dots.)

(4) Set horizontal No. 2 start address to
(H_4, H_3, H_2, H_1, H_0)=(1,1,1,1,1).
(Divided horizontal OFF display.)

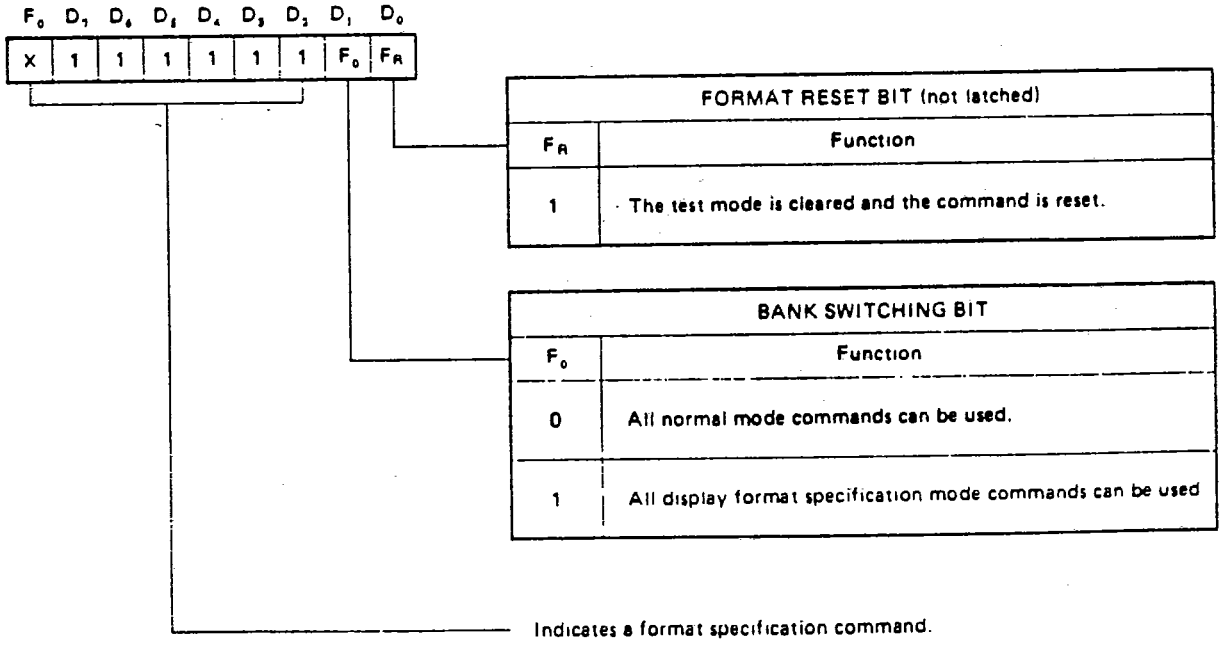
(5) Set vertical No. 2 start address to
(V_4, V_3, V_2, V_1, V_0)=(1,1,1,1,1).
(Divided vertical OFF display.)

(6) Set the contents of the function selection command to (FS_3, FS_2, FS_1, FS_0)=(1,0,0,0).
- Smoothing feature
- Division OFF for second to third lines
- Color specification possible in one line using color change data
- Blank selection by a display control command

(7) Set the cursor control bit to (CO_0)=(0).
(The cursor is set to off.)

(8) Set (color flag bit) of the write line address command to (CF_0)=(0).
(The color change function by color select data is cleared.)

Format Specification Command



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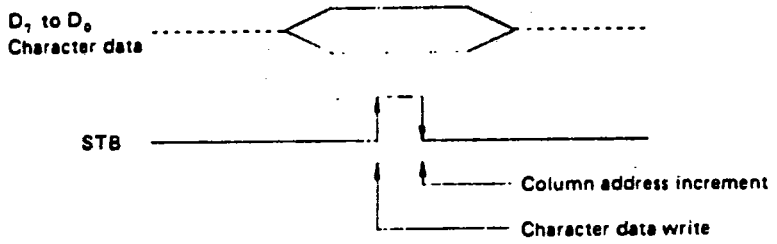
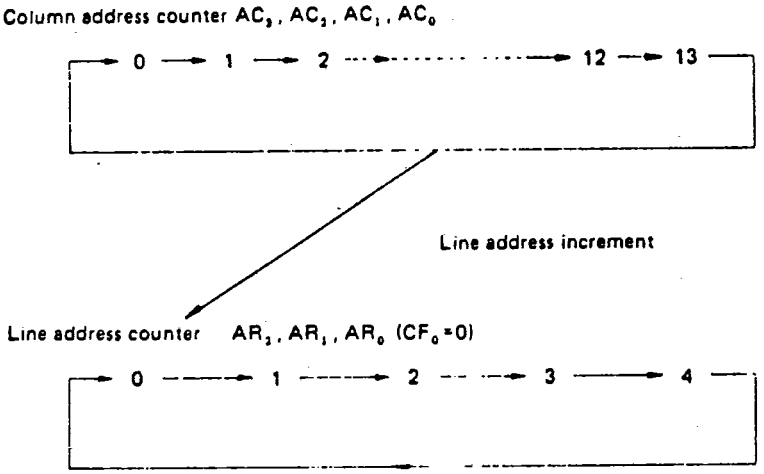
4. DATA WRITING

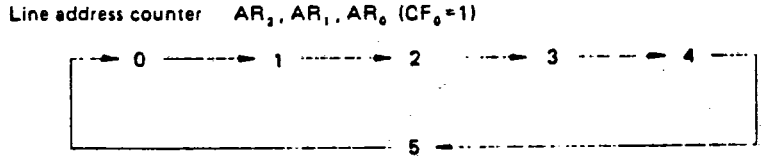
A data write address can be placed in the address counter using a write line address setting command and a write column address setting command.

If data is written by means of a character data command after specifying the address, the address is automatically increased.





If the function to change colors in one line using color selection data* is set on (CF_0=1), the line address counter uses base 6 notation, and the line address (AR_2, AR_1, AR_0)=(1,0,1) stores color select data.



* For details, see the section explaining color specification in one line using color select data.

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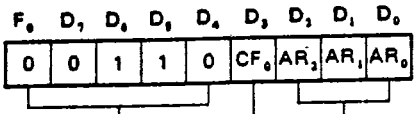
Write Line Address Setting Command



LINE ADDRESS SPECIFICATION BIT	
AR_2 AR_1 AR_0	Function
0 0 0	Specifies first line.
0 0 1	Specifies second line.
⋮	⋮
1 0 0	Specifies fifth line.
1 0 1	Specifies sixth line.* (Writing color select data)

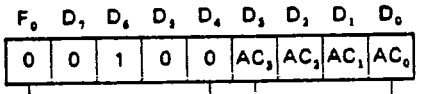
Addresses 0 to 5 may be set.

COLOR FLAG BIT*	
CF_0	Function
0	Clears function of changing color using color select data.
1	Performs function of color changing using color select data.

* See section explaining color specification in one line using color select data.

Indicates a write line address setting command.

Write Column Address Setting Command



COLUMN ADDRESS SPECIFICATION BIT	
AC_3 AC_2 AC_1 AC_0	Function
0 0 0 0	Specifies first column.
0 0 0 1	Specifies second column.
⋮	⋮
1 1 0 1	Specifies 14th column.

Addresses 0 to D may be set.

Indicates a write column address setting command.

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5. CHARACTER SIZE

A character size can be specified for each line. It is possible to store any two 14 H, 28 H, 42 H, or 56 H character heights in the two bit size word register. Each line has a single-bit line size control register. The character size of a line corresponds to the size stored in the size word register (SWR), and may be specified by the SWR that corresponds to the line.

5.1 WRITING OF SIZE WORD REGISTER (SWR)

The following size word setting command is used to store the character size in the size word register.

Size Word Setting Command

F_0	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
0	1	0	X	SW_0	1	X	S_1	S_0

CHARACTER SIZE STORAGE BIT

S_1	S_0	Character size (dot size) to be stored			
0	0	Vertical	14 H (2 H)	Horizontal	5 t_{dot} (t_{dot})
0	1		28 H (4 H)		10 t_{dot} (2 t_{dot})
1	0		42 H (6 H)		15 t_{dot} (3 t_{dot})
1	1		56 H (8 H)		20 t_{dot} (4 t_{dot})

$$t_{dot} = \frac{2}{f_{osc}\ (MHz)}\ \mu s$$

SIZE WORD ADDRESS

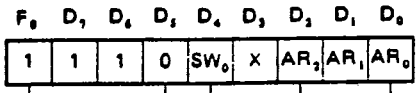
SW_0	Size word register to be selected
0	Size word register 0
1	Size word register 1

Indicates a size word setting command.

5.2 WRITING IN THE SIZE CONTROL REGISTER (SCR)

The line size specification command stores the size word address (SW_0) of the size word register (SWR) that stores a character size in line size control register ($SCR_{0\ to\ 4}$) corresponding to a line.

Line Size Specification Command



LINE ADDRESS SELECTION BIT			
AR_2	AR_1	AR_0	Line address to be selected
0	0	0	Specifies first line.
0	0	1	Specifies second line.
	↓		↓
1	0	0	Specifies fifth line.

Addresses 0 to 4 may be set.

SIZE WORD ADDRESS	
SW_0	Size word register to be specified
0	Size word register 0
1	Size word register 1

Indicates a line size specification command.

After the format is reset, the contents of register ($SCR_{0\ to\ 4}$) for each line is set to (SW_0)=(0).

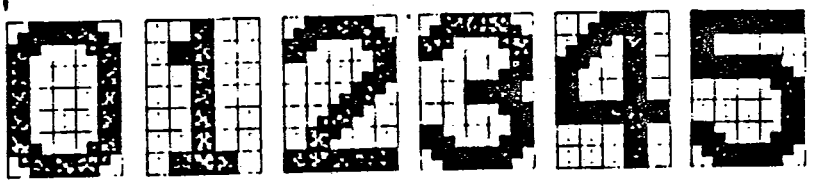
Example

Display the first, third, and fourth line characters with character height 14 H, and the second and fifth line characters with character height 28 H.

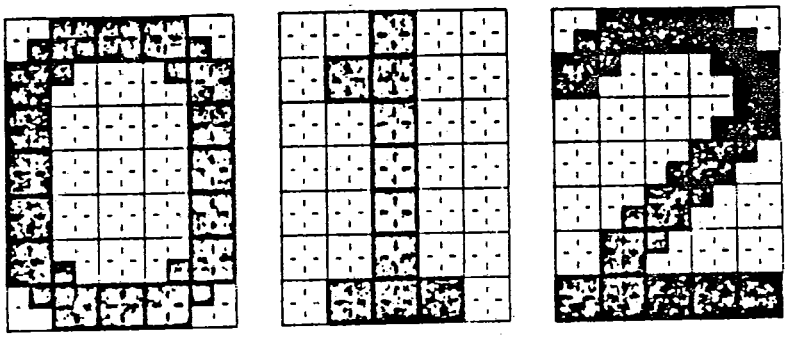
Horizontal No. 1 start address
(H_4, H_3, H_2, H_1, H_0)

Line size control register

SCR_0
SW_0 0

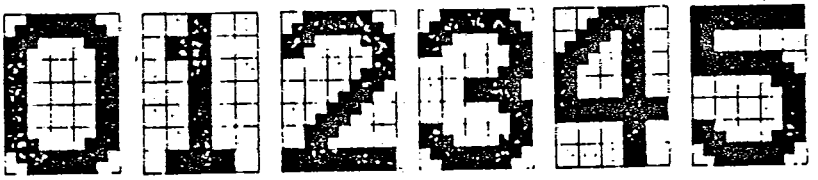


SCR_1
SW_0 1

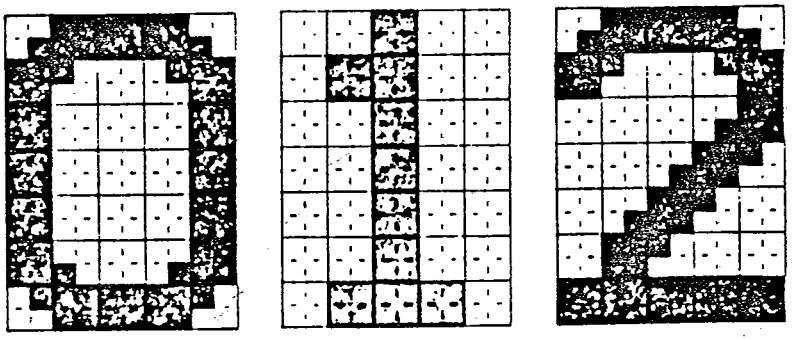


SCR_2
SW_0 0

SCR_3
SW_0 0



SCR_4
SW_0 1



Size word register

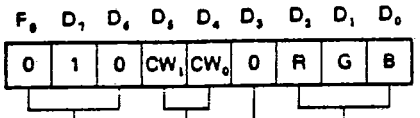
Size specification bit		SWR_0	SWR_1
	S_1	0	0
	S_0	0	1
Size word address	SW_0	0	1

6. CHARACTER COLOR

The color of a character may be one of three kinds depending on which color word registers (CWR), bit R, G, or B, is specified.

The color word register (CWR) can specify three of the following colors: red, blue, green, yellow, purple, light blue, white or black. Specification is made using the color word setting command.

Color Word Setting Command



CHARACTER COLOR DATA BIT			
R	G	B	Character color
0	0	0	Black
0	0	1	Blue
0	1	0	Green
0	1	1	Light blue
1	0	0	Red
1	0	1	Purple
1	1	0	Yellow
1	1	1	White

COLOR WORD ADDRESS		
CW_1	CW_0	Color word register to be selected
0	0	Color word register 0
0	1	Color word register 1
1	0	Color word register 2
1	1	Blank or display off*

* See the section explaining line display OFF/Blank.

Indicates a color word setting command.

Character color specification

The characters color can be specified in the following three ways:

- Specifying one color for each line
- Specifying different colors in the same line using color change data
- Specifying different colors in the same line using color selection data

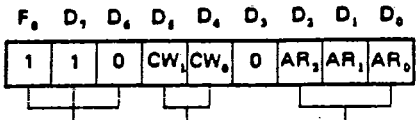
6.1 SPECIFYING ONE COLOR FOR EACH LINE

Each line has a two-bit line color control register ($CCR_{0\ to\ 4}$). The character color of a line corresponds to the color stored in the color word register (CWR) and is specified by the contents (CW_1, CW_0).

Writing in color control register ($CCR_{0\ to\ 4}$)

The line color specification command stores the color word address (CW_1, CW_0) of the color word register (CWR) that stores the color of the characters in the line color control register ($CCR_{0\ to\ 4}$) corresponding to the line.

Line Color Specifying Command



LINE ADDRESS SELECTION BIT			
AR_2	AR_1	AR_0	Line address to be selected
0	0	0	Specifies first line.
0	0	1	Specifies second line.
	⋮		⋮
1	0	0	Specifies fifth line.

Addresses 0 to 4 may be set.

COLOR WORD ADDRESS		
CW_1	CW_0	Color word register to be specified
0	0	Color word register 0
0	1	Color word register 1
1	0	Color word register 2
1	1	Blank or display off*

* See the section explaining line display OFF/Blank.

Indicates a line color specifying command.

After format reset, the contents of the line color control register ($CCR_{0\ to\ 4}$) for each line is set to (CW_1, CW_0) = (0,0).

Example

When displaying blue characters in the nth line.

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CCR
Current color control register (Shows currently specified color word.)

Column	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CW_1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CW_0	1	1	1	1	1	1	1	1	1	1	1	1	1	1

RAM data

Character data

Display

Characters (blue)

Nth line color control register

CCRn

CW_1	0
CW_0	1

Color word register

		CWR_0	CWR_1	CWR_2
Color specification bit	R	1	0	0
	G	Red 0	Blue 0	Green 1
	B	0	1	0
Color word address	CW_1	0	0	1
	CW_0	0	1	0

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6.2 SPECIFYING DIFFERENT COLORS IN THE SAME LINE USING COLOR CHANGE DATA

It is possible to specify different colors in the same line using the following data in the character data command:

(CH_5, CH_4, CH_3, CH_2, CH_1, CH_0)=(1,1,1,1,0,0): Color change data 1
[Change the color to the color of the color word address (CW_1, CW_0)=(0,0).]

(CH_5, CH_4, CH_3, CH_2, CH_1, CH_0)=(1,1,1,1,0,1): Color change data 2
[Change the color to the color of the color word address (CW_1, CW_0)=(0,1).]

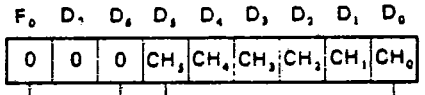
(CH_5, CH_4, CH_3, CH_2, CH_1, CH_0)=(1,1,1,1,1,0): Color change data 3
[Change the color to the color of the color word address (CW_1, CW_0)=(1,0).]

If any color change data is found when scanning a data RAM, it is possible to change the contents of the current color control register (CCR) to the color word address specified by the lower two bits (CH_1, CH_0) of the color change data from the address of the data RAM to the end of the line independent of the content of the line color control register ($CCR_{0\ to\ 4}$). The address that specifies the color change data becomes blank or is put in the display off* status (specified by the first bit (FS_0) of the function selection command).

Color change data can be used an arbitrary number of times for the same line. It can be switched to character data with the FS_1 bit of a FUNCTION SELECT command.

* For an explanation of the difference between blank and DISPLAY OFF, see the section Line Display OFF/Blank.

Character Data Command

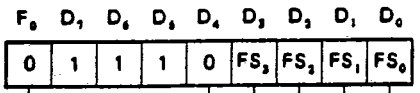


CHARACTER DATA BIT							
CH_5	CH_4	CH_3	CH_2	CH_1	CH_0	Display data	
0	0	0	0	0	0	Character data, 58 kinds	
↓							
1	1	1	0	0	1		
1	1	1	0	1	0	Blank	
1	1	1	0	1	1	Dispaly OFF/character data[1]	
1	1	1	1	0	0	Color change data 1 Change to the color of (CW_1, CW_0)=(0,0)	Character data
1	1	1	1	0	1	Color change data 2 Change to the color of (CW_1, CW_0)=(0,1)	
1	1	1	1	1	0	Color change data 3 Change to the color of (CW_1, CW_0)=(1,0)	
1	1	1	1	1	1	OFF data in the line/character data[2]	

1) See the section explaining the display OFF/Blank for each character.
2) See the section explaining the display OFF/Blank in one line.

Indicates a character data command.

Function Selection Code



BLANK/OFF SELECTION BIT	
FS_0	Function
0	The address that specifies the color change data becomes blank. The line having the register contents (CW_1, CW_0)=(1,1), and the portion from the address in which the OFF data in the line, is written to the end of the line, and is put in the display OFF status.
1	The address that specifies the color change data is put in the display OFF status. The line having register contents (CW_1, CW_0)=(1,1), and the section from the address in which the OFF data in the line is written, to the end of the line is put in the display OFF status.

DATA SWITCHING BIT	
FS_1	Function
0	(CH_5,CH_4,CH_3,CH_2,CH_1,CH_0)= (1,1,1,1,0,0), (1,1,1,1,0,1), (1,1,1,1,1,0) is color changing data, and (CH_5,CH_4,CH_3,CH_2,CH_1,CH_0)=(1,1,1,1,1,1) is Off data* for the line.
1	(CH_5,CH_4,CH_3,CH_2,CH_1,CH_0)= (1,1,1,1,0,0) ~ (1,1,1,1,1,1) is character data.

* See the section explaining display ON/OFF control.

FS_2: Lines 2 to 3 division on/off switching bit
(See the section explaining the display position.)

FS_3: Smoothing function on/off bit
(See the section explaining the smoothing function.)

F_0: Indicates a function selection command.

After format resetting, FS_1=0 (color changing data and OFF data in the line are available*), and FS_0=0 (blank selection) are set.

* See the section explaining display ON/OFF control.

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Example

Changing the character color of the nth line from blue to green and red in one line.

CCR
Current color control register
(Shows the currently specified color word.)

Column	1	2	3	4	5	6	7	8	9	10	11	12	13	14
CW_1	0	0	0	0	1	1	1	1	0	0	0	0	0	0
CW_0	1	1	1	1	0	0	0	0	0	0	0	0	0	0

RAM data

Character data	Color control data	Character data	Color control data	Character data

$(CH_5, CH_4, CH_3, CH_2, CH_1, CH_0)$ =(1,1,1,1,1,0)

$(CH_5, CH_4, CH_3, CH_2, CH_1, CH_0)$ =(1,1,1,1,0,0)

Display

Character (blue)	Blank or display off	Character (green)	Blank or display off	Character (red)

Nth line color control register

CCRn

CW_1	0
CW_0	1

Color word register

		CWR_0	CWR_1	CWR_2
Color specification bit	R	1	0	0
	G	Red 0	Blue 0	Green 1
	B	0	1	0
Color word address	CW_1	0	0	1
	CW_0	0	1	0

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6.3 SPECIFYING DIFFERENT COLORS IN ONE LINE USING COLOR SELECTION DATA

Colors in one line can be changed using one-bit color selection data written in line address (AR_2, AR_1, AR_0) =(1,0,1).

The display data RAMs are scanned sequentially from line addresses (AR_2, AR_1, AR_0)=(0,0,0) to (AR_2, AR_1, AR_0)=(1,0,0). Each time the display data RAM of a line is scanned, the color selection data RAM of line address (AR_2, AR_1, AR_0)=(1,0,1) is scanned.

If the contents of the current color control register is (CW_1, CW_0)=(0,0), the RGB output is changed to the color of color word (CW_1, CW_0)=(0,1), for the column of the color selection data which is 1.

The color selection data uses the LSB (lowest digit) of the data to be written in each column of line address (AR_2, AR_1, AR_0)=(1,0,1). Writing is performed in the same way as character data. This function can be set ON/OFF using bit 1 of the write line address setting command.

Write Line Address Setting Command

F_0	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
0	0	1	1	0	CF_0	AR_2	AR_1	AR_0

LINE ADDRESS SELECTION BIT			
AR_2	AR_1	AR_0	Function
0	0	0	Specifies lines 1 to 5. Character data is written here.
↓			
1	0	0	
1	0	1	Specifies line 6. One-bit color selection data is written here.

COLOR FLAG BIT	
CF_0	Function
0	Color selection data can be written, even if the color selection data is "1". No color change operation, however, is performed.
1	Detects color selection data. A logical one changes the color.

Indicates a write line address setting command.

Example

Alternately displays red and blue characters.

	Column	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Color selection data RAM	CD_0	0	1	1	0	0	0	1	1	0	1	0	1	1	1

CCR
Current color control register (Indicates currently specified color word.)

CW_1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
CW_0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Display data RAM

Character data	Color change data	Character data

$(CH_5, CH_4, CH_3, CH_2, CH_1, CH_0)$
$= (1,1,1,1,0,0)$

Display

Character	Blank or display off	Character					
Green		Red	Blue	Red	Blue	Red	Blue

Color word register

CCRn			CWR_0	CWR_1	CWR_2
CW_1	1	Color specification bit: R	1	0	0
CW_0	0	G	Red 0	Blue 0	Green 1
		B	0	1	0
		Color word address: CW_1	0	0	1
		CW_0	0	1	0

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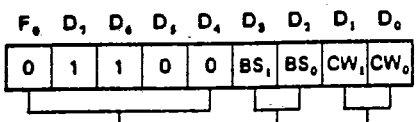
7. BACKGROUND SPECIFICATIONS

The type of background (no background, Fringe, Square background, solid background and its color (color stored in color word registers 0 to 2, or black) may be specified with the background specification command.

· Background Specification Command



BACKGROUND COLOR SPECIFICATION BIT		
CW_1	CW_0	Function
0	0	The background color becomes the color written in word register 0.
0	1	The background color becomes the color written in word register 1.
1	0	The background color becomes the color written in word register 2.
1	1	Background color is black.

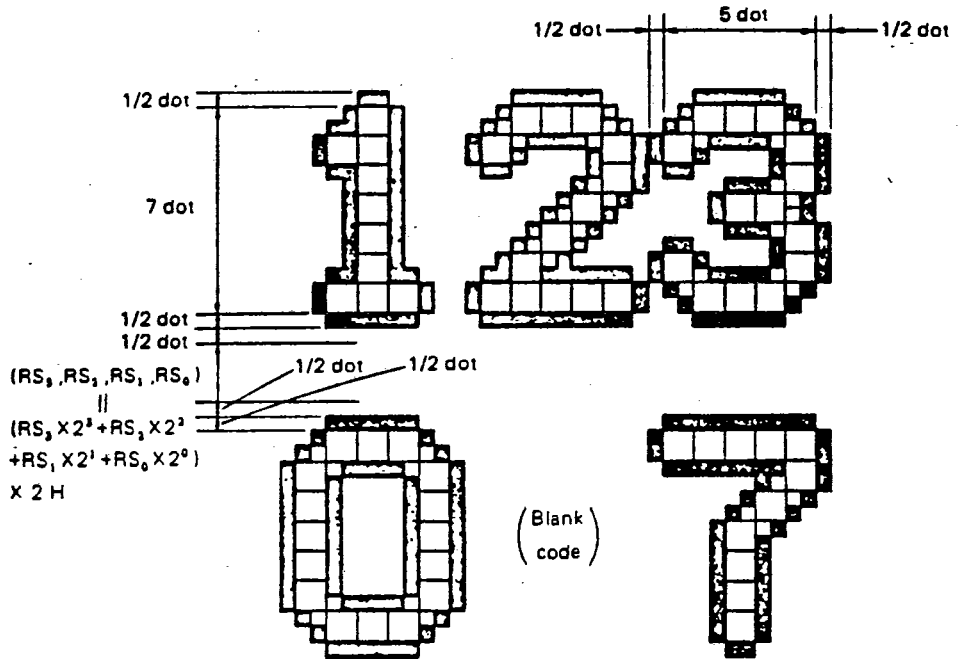
BACKGROUND TYPE SPECIFICATION BIT		
BS_1	BS_0	Function
0	0	No background
0	1	Fringe
1	0	Square background
1	1	Solid background

Indicates a background specification command.

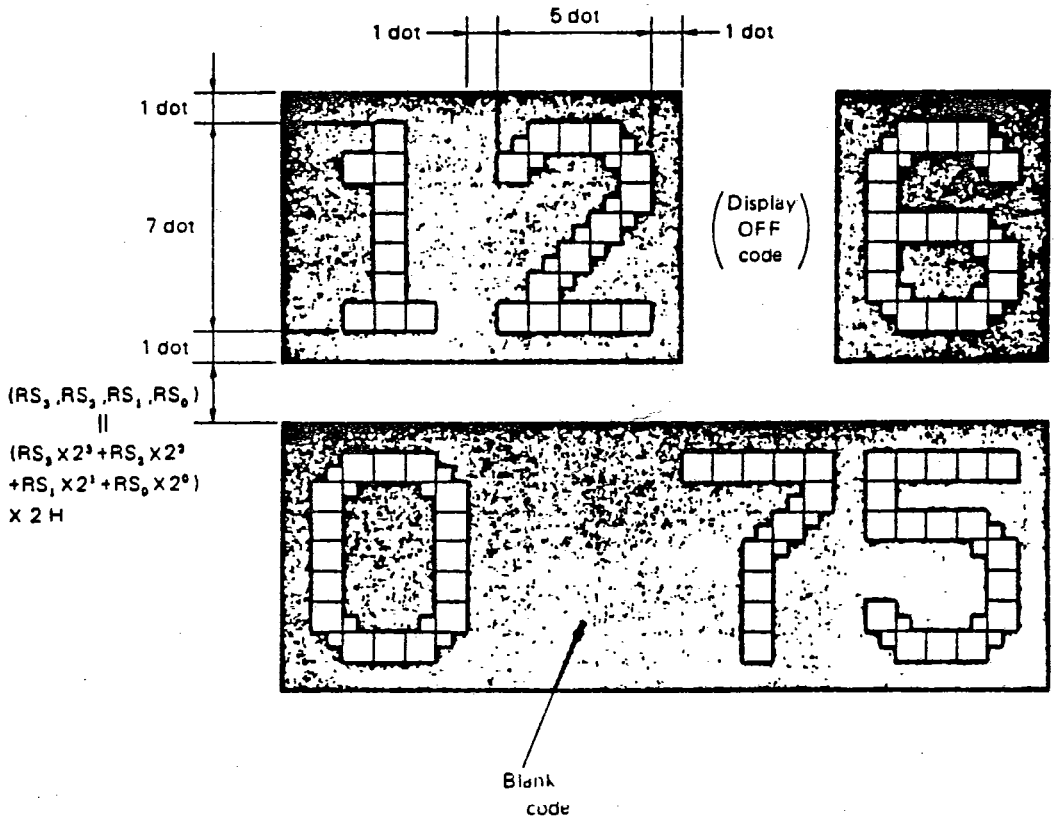
In the case of no background, $\{(BS_1, BS_0)=(0,0)\}$ sets the color specification bit to $(CW_1, CW_0)=(1,1)$.

Background

Fringe



Square Background



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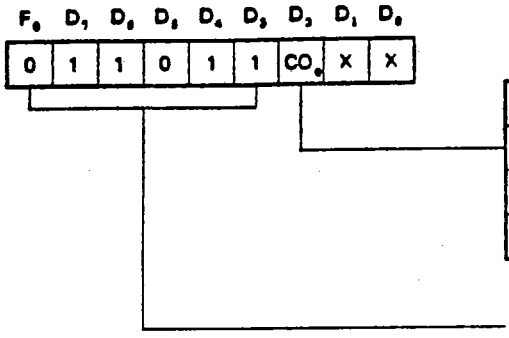
Solid Background

The solid background is same type as square background, and all video signals are changed to the background color.

8. CURSOR INDICATION

With the μPD6105C, a cursor indicates the address in which data is to be written. The cursor position is decided by the write address counter. Control the ON/OFF state of the cursor using the cursor control command.

Cursor Control Command



CURSOR CONTROL BIT	
CO_0	Function
0	The cursor is cut off.
1	The cursor is set to on.

When the display of a line is set to OFF from the beginning of the line, or in the line with line display OFF data, the cursor does not appear even if the writing address is set in the portion where the display is cut OFF. The cursor can be set to ON if the display is cut OFF by Display OFF or blank data.

After format resetting, CO_0=0 is set (cursor is cut OFF).

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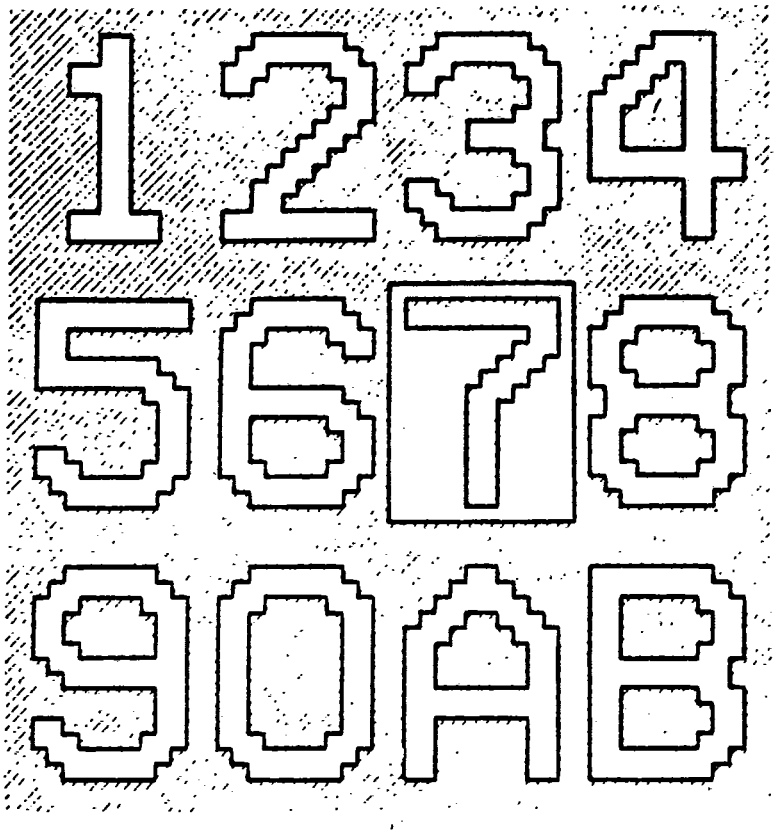
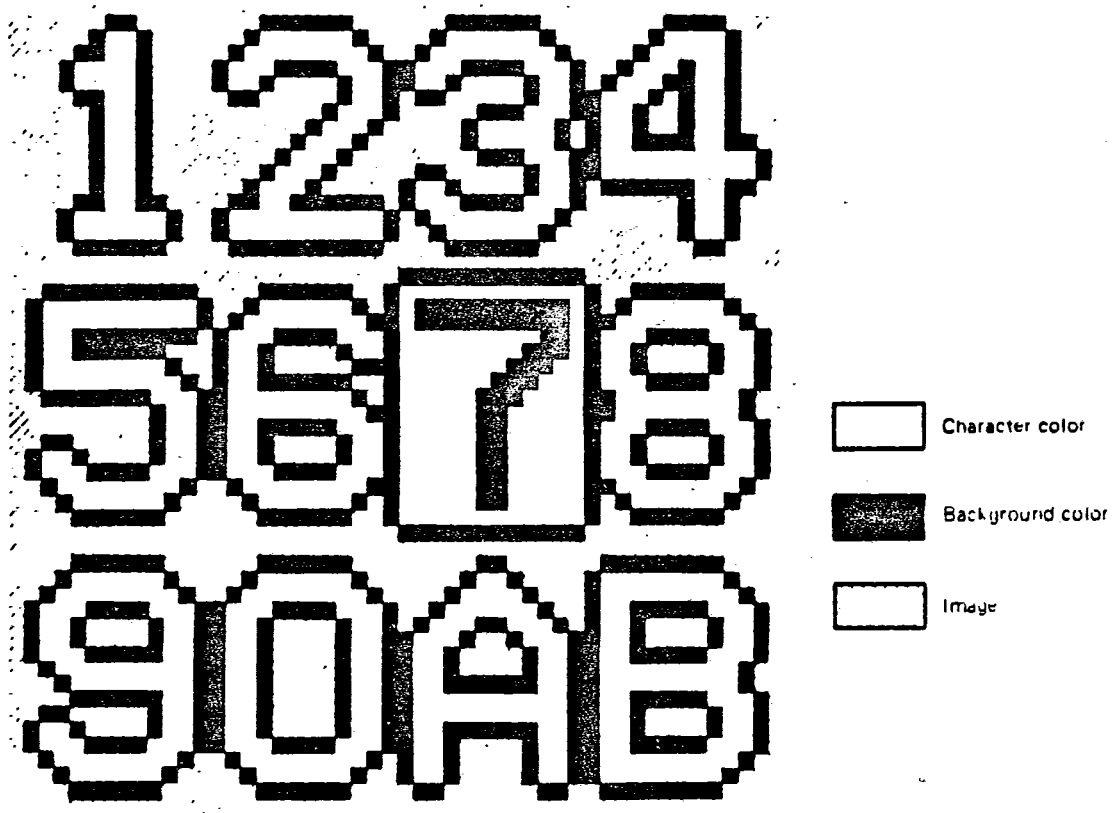
CURSOR

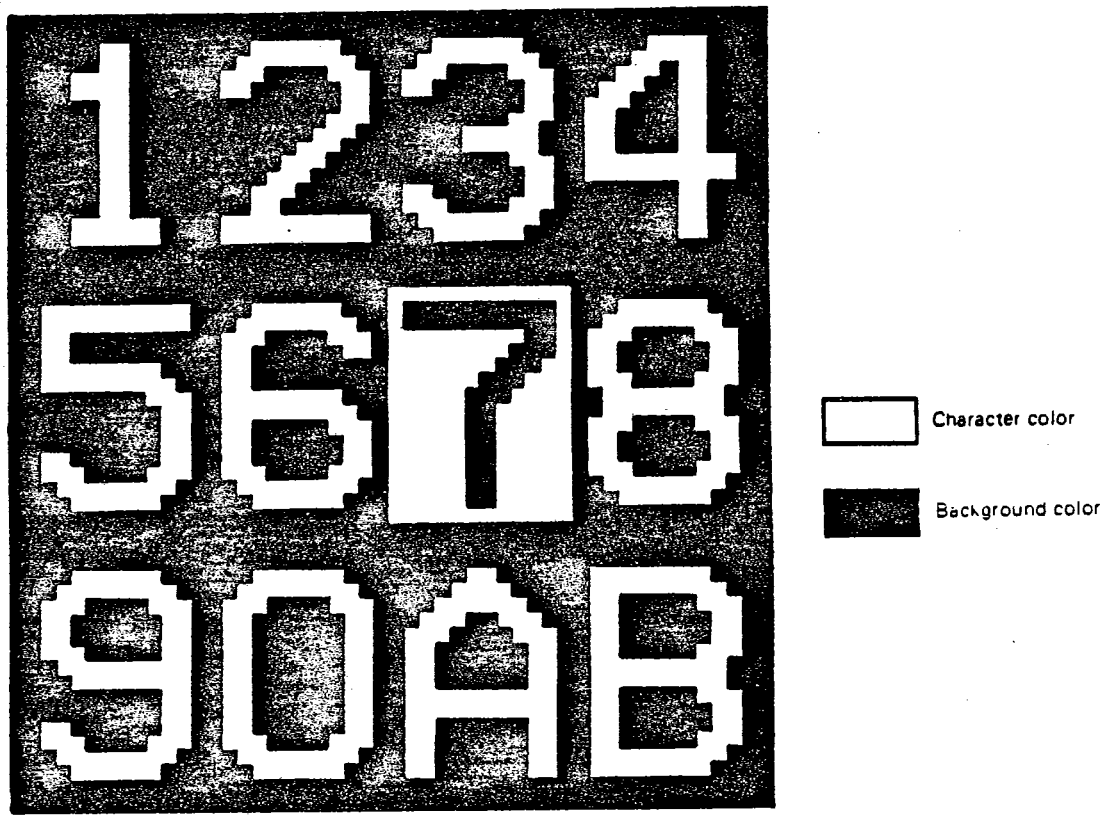
No Background



Fringe

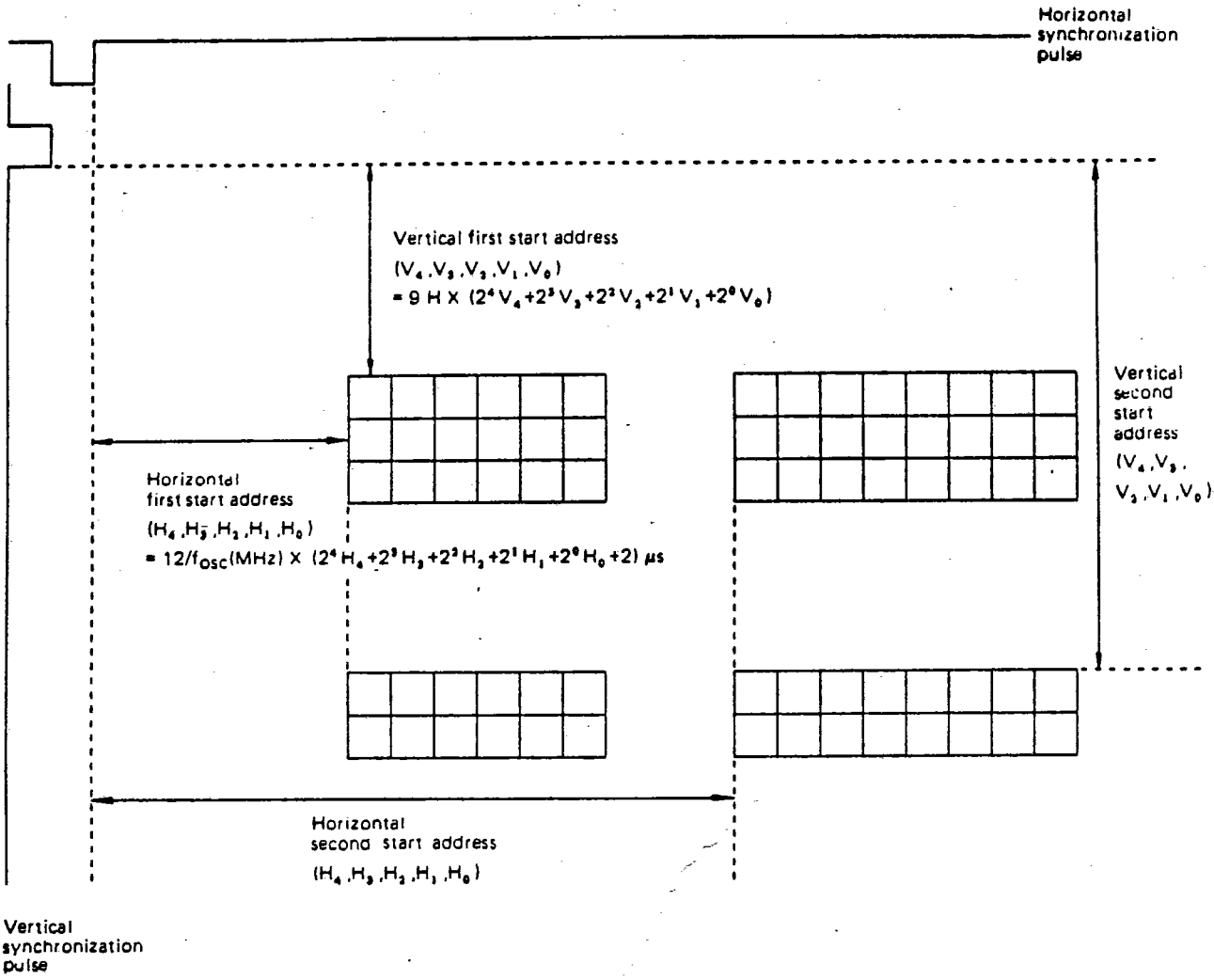


Square Background/Solid Background



9. DISPLAY POSITION

A character can be diaplayed in 32 horizontal positions [12/fosc(MHz)μs] for the minimum character size (character height is 14 H), and in 32 vertical positions, each half the minimum character size (9 H). The display can be divided into six and eight characters, and two or more lines by specifying the appropriate addresses with the horizontal first and second start address setting commands, and vertical first and second start address setting commands. The second start address must not set specify an address that overlaps display characters starting in the first start address.

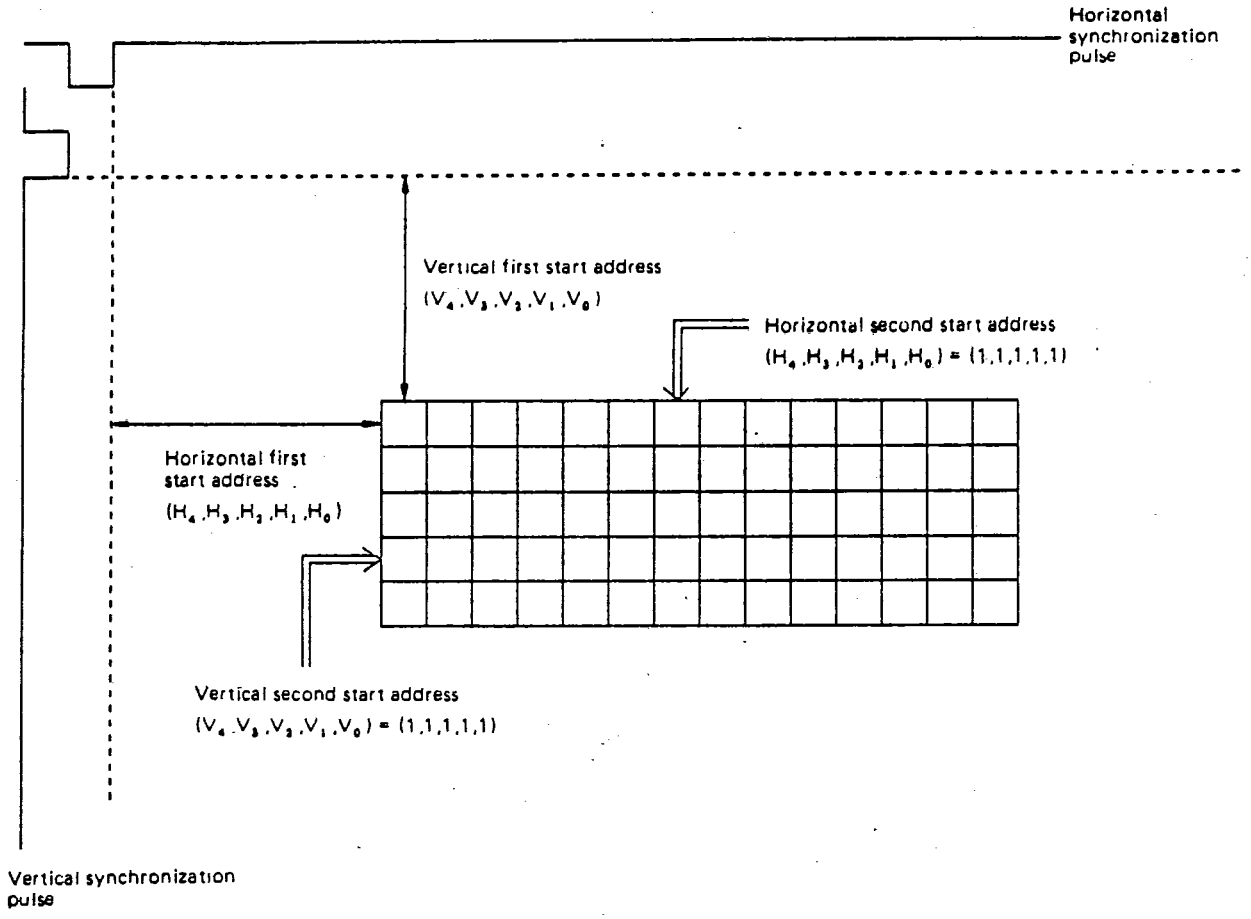


9.1 DISPLAYING FIVE LINES OR 14 CHARACTERS WITHOUT DIVISION

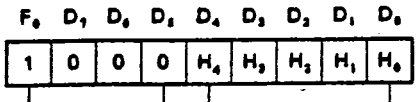
If (1,1,1,1,1) is set in both the horizontal and vertical second start addresses, display is made with five vertical lines or 14 horizontal characters undivided. If, for example, $(H_4, H_3, H_2, H_1, H_0)$=(1,1,1,1,1) is set in the horizontal second start address, 14 characters are displayed horizontal without division. In the same manner, if $(V_4, V_3, V_2, V_1, V_0)$=(1,1,1,1,1) is set in the vertical second start address, five lines are displayed without division.

Example

$(H_4, H_3, H_2, H_1, H_0)$=(1,1,1,1,1) and
$(V_4, V_3, V_2, V_1, V_0)$=(1,1,1,1,1) are set in the horizontal and vertical second start addresses.



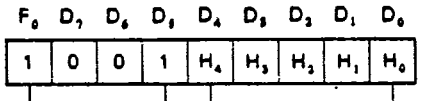
Horizontal First Start Address Setting Command



HORIZONTAL START ADDRESS SPECIFICATION BIT					
H_4	H_3	H_2	H_1	H_0	Start address
0	0	0	0	0	After the horizontal synchronization pulse $12/f_{osc}$ (MHz) X 3 [μs]
0	0	0	0	1	After the horizontal synchronization pulse $12/f_{osc}$ (MHz) X 4 [μs]
⟨				⟩	
1	1	1	1	1	After the horizontal synchronization pulse $12/f_{osc}$ (MHz) X 33 [μs]

Indicates a horizontal first start address setting command.

Horizontal Second Start Address Setting Command

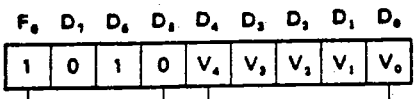


HORIZONTAL START ADDRESS SPECIFICATION BIT					
H_4	H_3	H_2	H_1	H_0	Start address
0	0	1	1	1	After the horizontal synchronization pulse $12/f_{osc}$ (MHz) X 9 [μs]
0	1	0	0	0	After the horizontal synchronization pulse $12/f_{osc}$ (MHz) X 10 [μs]
⟨				⟩	
1	1	1	1	0	After the horizontal synchronization pulse $12/f_{osc}$ (MHz) X 32 [μs]
1	1	1	1	1	Fourteen characters are displayed horizontally without division

The second start address must not specify an address that overlaps the display part (six characters) starting from the first start address No address can be set if the (second start address) − (first start address) is less than 6.

Indicates a horizontal second start address setting command.

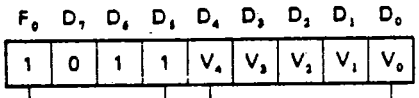
Vertical First Start Address Setting Command



VERTICAL START ADDRESS BIT					Start address
V_4	V_3	V_2	V_1	V_0	
0	0	0	0	0	After the vertical synchronization pulse 9 X 0 H
0	0	0	0	1	After the vertical synchronization pulse 9 X 1 H
⟨				⟩	
1	1	1	1	1	After the vertical synchronization pulse 9 X 31 H

Indicates a vertical first start address setting command.

Vertical Second Start Address Setting Command



VERTICAL START ADDRESS BIT					Start address
V_4	V_3	V_2	V_1	V_0	
0	0	1	1	1	After the vertical synchronization pulse 9 X 7 H
0	1	0	0	0	After the vertical synchronization pulse 9 X 8 H
⟨				⟩	
1	1	1	1	0	After the vertical synchronization pulse 9 X 30 H
1	1	1	1	1	Five lines are displayed without division.

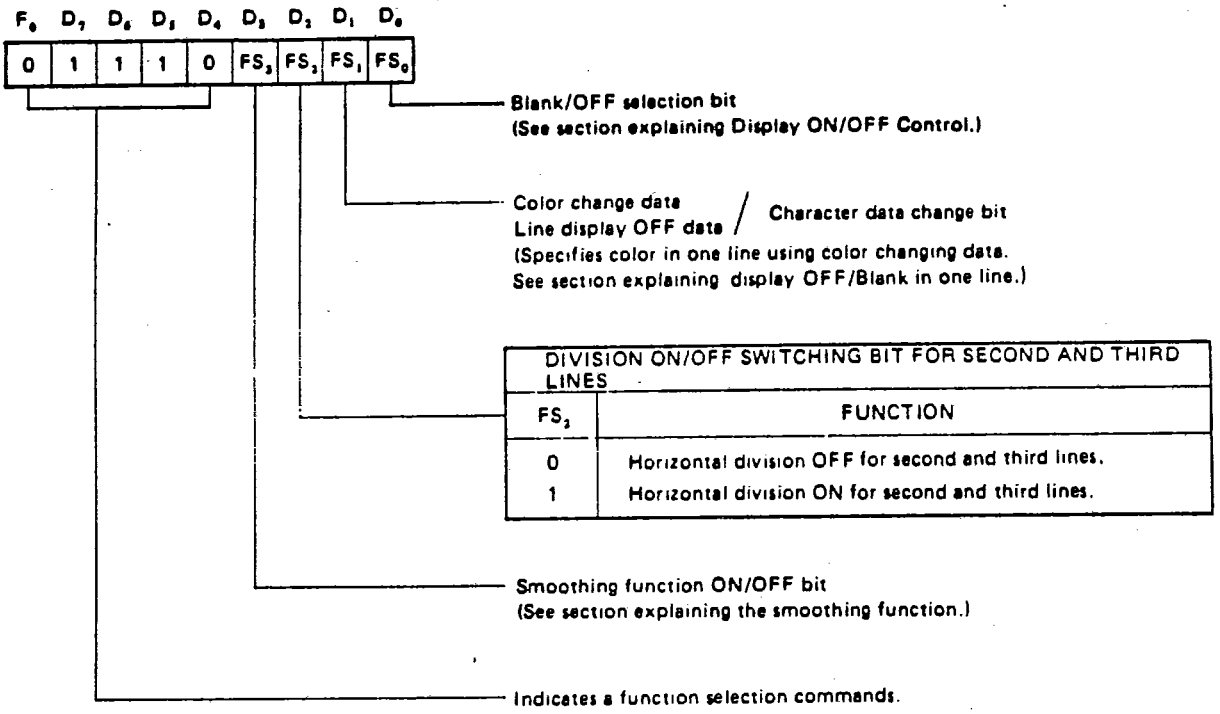
The second start address must not set an address that overlaps the display part (three lines) starting from the first start address.

Indicates a vertical second start address setting command.

9.2 DISPLAYING THE SECOND AND THIRD LINES WITH NO DIVISION

Horizontal and vertical display is divided into four parts with the horizontal and vertical second start addresses. Use bit 1 (FS_2) of the function selection command to specify if the second and third lines are to be divided or not (independent of other lines).

Function Selection Command



DIVISION ON/OFF SWITCHING BIT FOR SECOND AND THIRD LINES	
FS_2	FUNCTION
0	Horizontal division OFF for second and third lines.
1	Horizontal division ON for second and third lines.

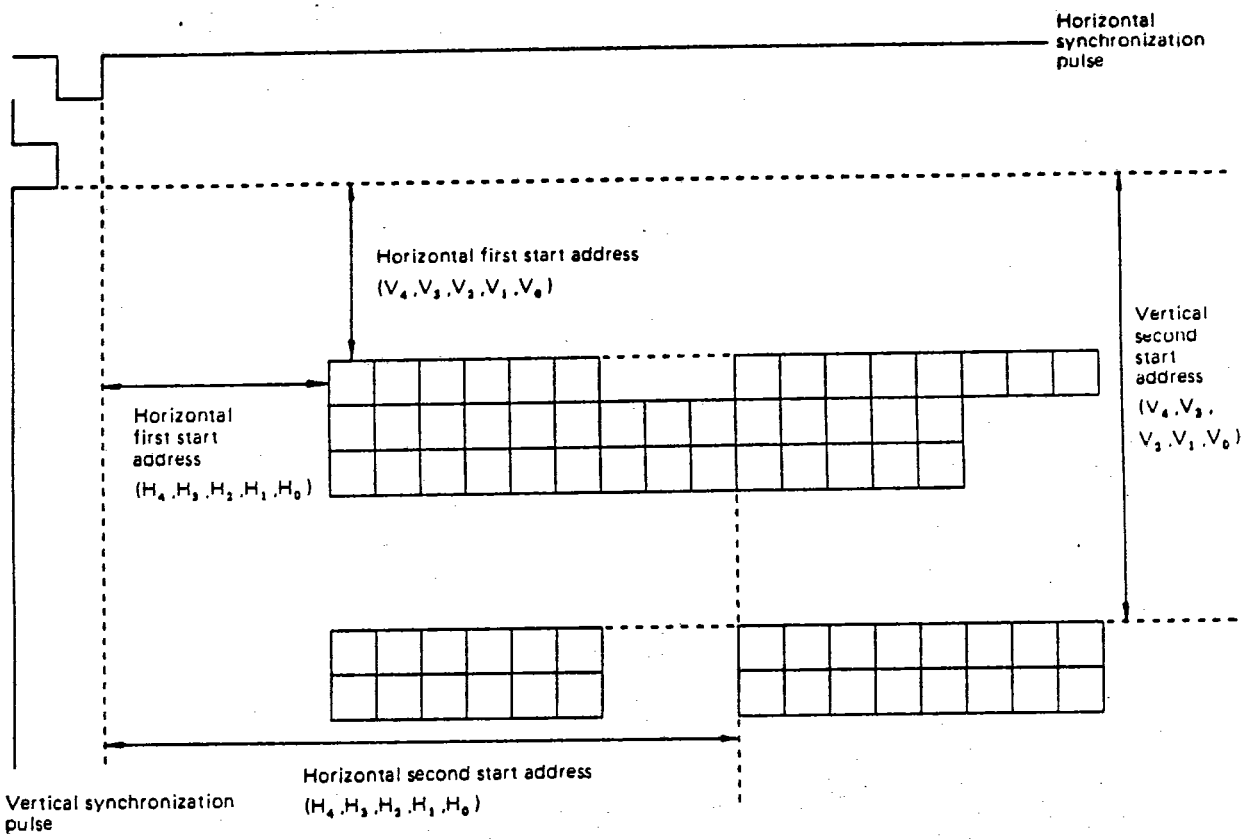
After format resetting, FS_2=0 is set. (Division OFF for second and third lines.)

Example

Division OFF (FS_2=0) for second and third lines

$(H_4, H_3, H_2, H_1, H_0)=(1,1,1,1,1)$

$(V_4, V_3, V_2, V_1, V_0)=(1,1,1,1,1)$



10. DISPLAY ON/OFF CONTROL

There are four method of controlling display as follows:

- Entire display ON/OFF
- Line display OFF/Blank
- Display OFF/Blank in one line
- Character display OFF/Blank

10.1 ENTIRE DISPLAY ON/OFF

Use the display ON/OFF command to display all characters on the screen or erase them. Even when the display is in the off state, it is possible to write characters.

Display ON/OFF Command

F_0	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
0	1	1	0	1	0	DO_1	X	X

DISPLAY ON/OFF BIT	
DO_1	Function
0	Entire display OFF
1	Entire display ON

Indicates a Display ON/OFF command.

10.2 LINE DISPLAY OFF/BLANK

It is possible to display an entire line or erase it by writing color word address (CW_1, CW_0)=(1,1) in line color control register ($CCR_{0\ to\ 4}$). The address is written using the line color specification command. (See section explaining line color specification.)

The display is set to off or blank using bit 1 (FS_0)* of the function selection command.

Blank: For no background or fringe background, no character or fringe is output. For square background or solid background, no characters are output, but the background remains.

Display OFF: For square background, no characters or background is output. For no background/fringe/solid background, the display is made blank the same way as above.

10.3 DISPLAY OFF/BLANK IN ONE A LINE

If it is not necessary to dispaly data in one line, it is possible to display or make the display blank beginning from an address to the end of the line by writing line display OFF data (CH_5, CH_4, CH_3, CH_2, CH_1, CH_0)=(1,1,1,1,1,1,) at the address. Specify to display or make it blank using bit (FS_0)* of the function selection command (as for B-line display OFF/Blank. Like color change data, line display OFF data can be changed to character data with bit (FS_1)* of the function selection command.

* For an explanation of the function selection command, see section on color specification in one line by color changing data

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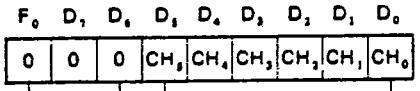
10.4 SINGLE CHARACTER DISPLAY OFF/BLANK

A displayed character can be erased by setting blank data (CH_5, CH_4, CH_3, CH_2, CH_1, CH_0)=(1,1,1,0,1,0) in the display address to be made blank using character data command. If the display address in which the blank data is set has no background or a fringe background, no character is output. Otherwise, the background remains, but no character is output.

In the case of square background, if no character or background is to be output, set display OFF data (CH_5, CH_4, CH_3, CH_2, CH_1, CH_0)=(1,1,1,0,1,1) using character data command. For other cases, a character is output even if the display OFF data is set.

Character Data Command



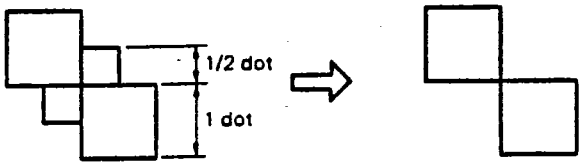
CHARACTER DATA BIT						Display data
CH_5	CH_4	CH_3	CH_2	CH_1	CH_0	
0	0	0	0	0	0	Character data (58 types)
⋮	⋮	⋮	⋮	⋮	⋮	
1	1	1	0	0	1	
1	1	1	0	1	0	Blank
1	1	1	0	1	1	Display OFF (square background)/ Character data (no background, fringe, or solid background)
1	1	1	1	0	0	Color change data/character data[1]
1	1	1	1	0	1	
1	1	1	1	1	0	
1	1	1	1	1	1	Line display OFF data/character data[2]

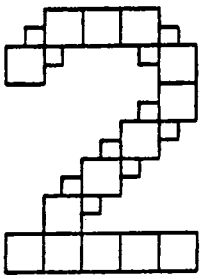
1) See section explaining line character color specification using color changing data.
2) See section explaining display OFF/Blank in one line.

Indicates character data command.

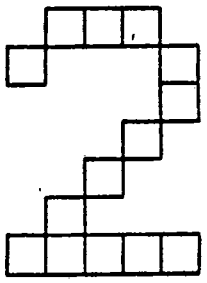
11. SMOOTHING FUNCTION

Display is made in a 5X7 dot matrix. The μPD6105C can initiate the smoothing function using bit (FS_3) of the function selection command.



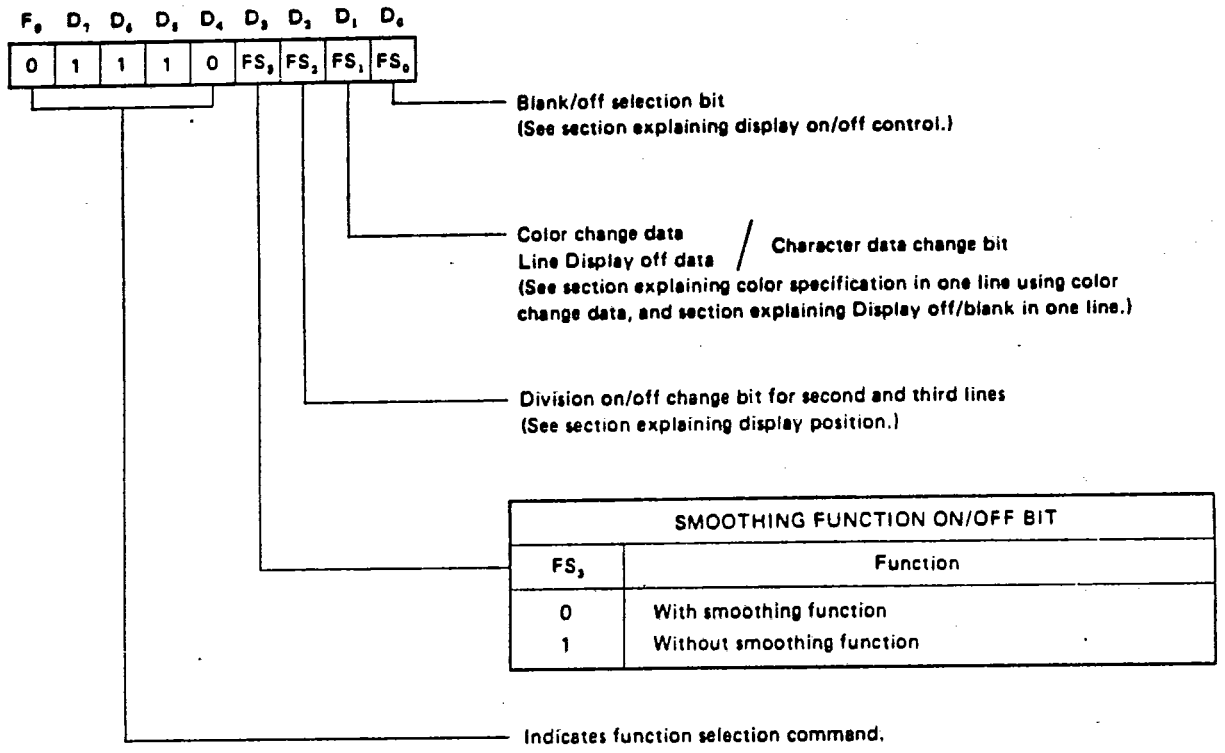


With smoothing function
μPD6104C
μPD6105C
(FS_3=1)



Without smoothing function
μPD6105C
(FS_3=0)

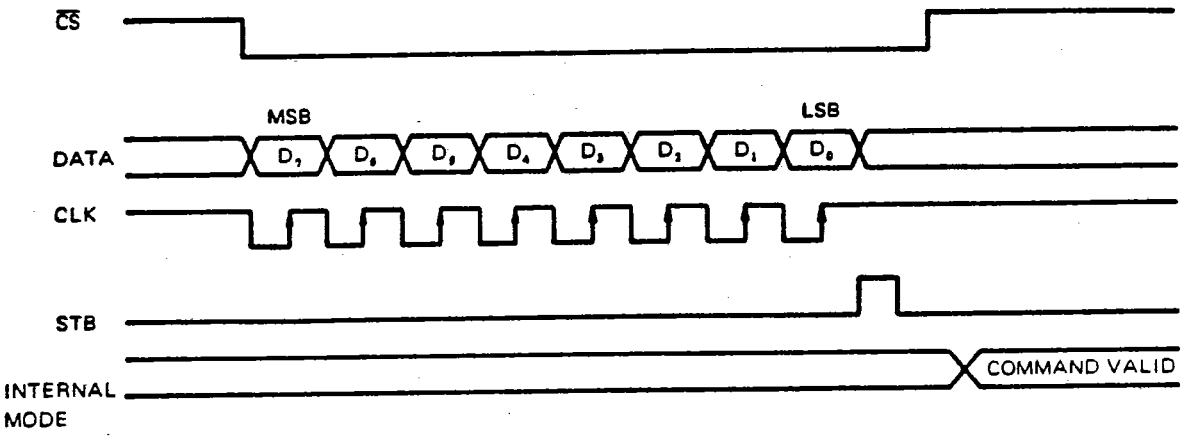
Function Selection Command

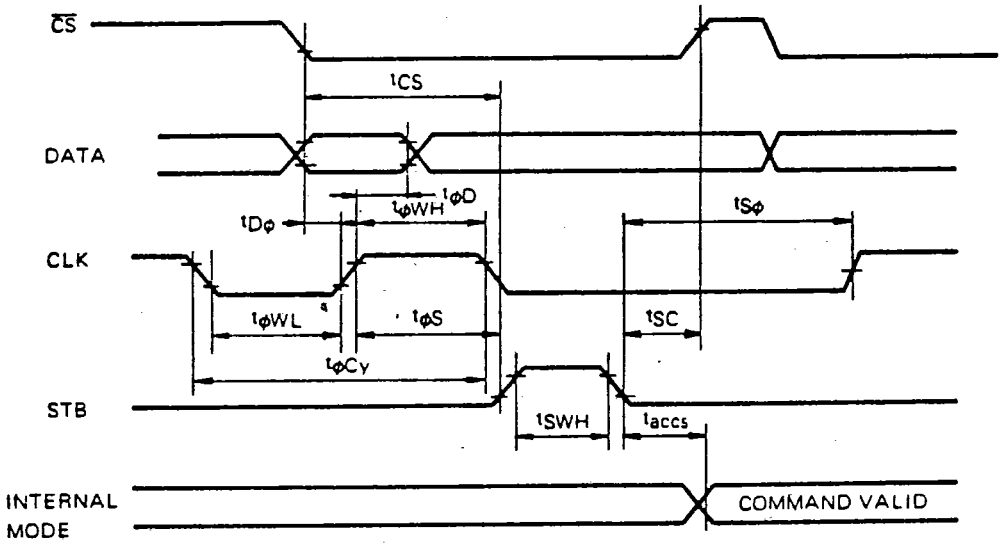


SMOOTHING FUNCTION ON/OFF BIT	
FS_3	Function
0	With smoothing function
1	Without smoothing function

After format resetting, FS_3=1 is set (with smoothing function).

TIMING DIAGRAM OF DATA INPUT

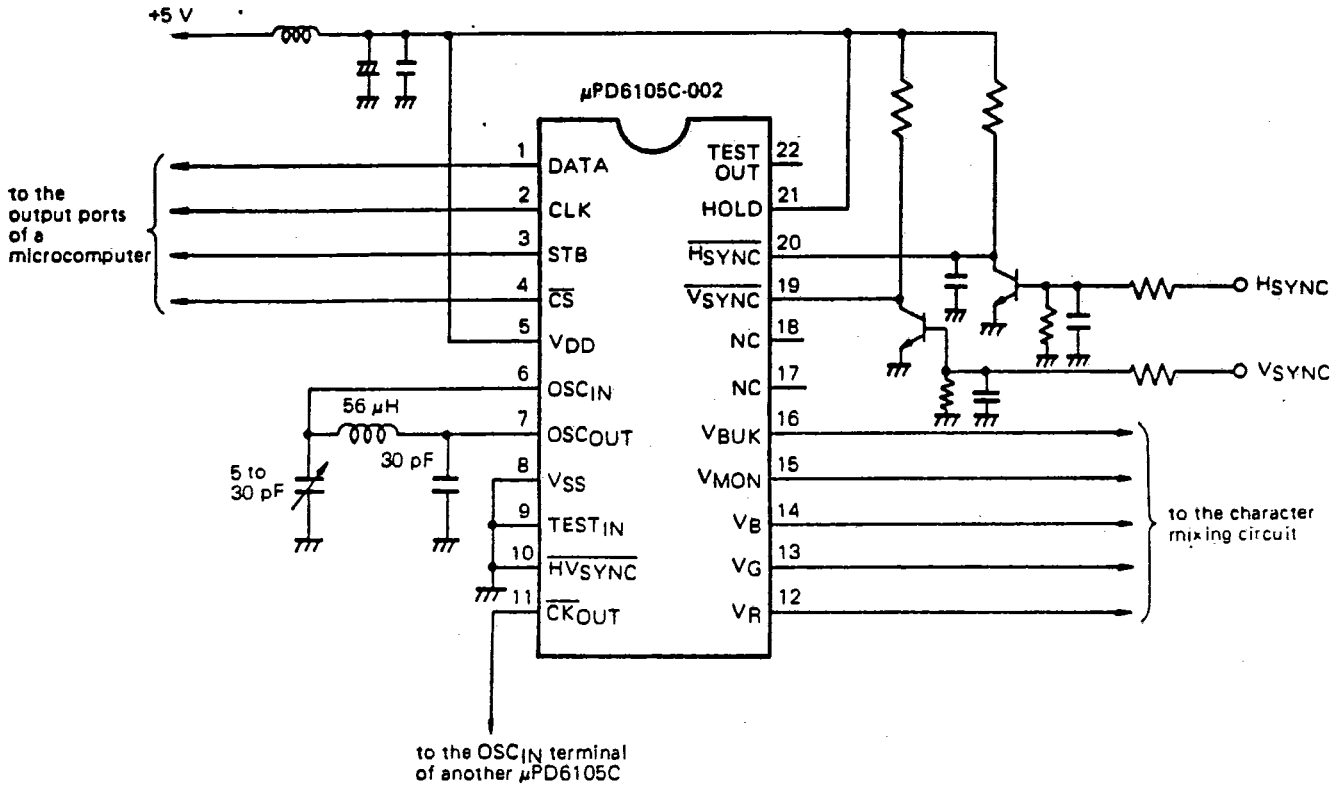




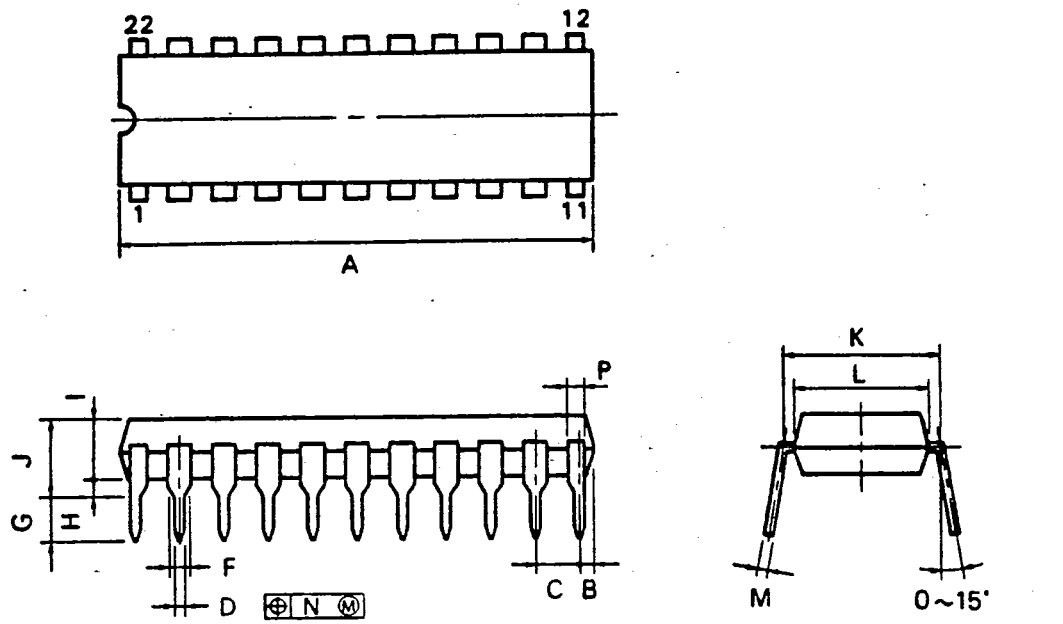
SYMBOL	MIN.	TYP.	MAX.	UNIT
$t_{D\phi}$	200			ns
$t_{\phi D}$	200			ns
$t_{\phi WL}$	700			ns
$t_{\phi WH}$	700			ns
$t_{\phi S}$	400			ns
t_{SWH}	1			μs
t_{CS}	400			ns
t_{SC}	200			ns
t_{acc}	1			μs
$t_{\phi cy}$	1.6			μs
$t_{S\phi}$	4			μs

(T_a=25 °C, $V_{DD}-V_{SS}$=5.0 V)

APPLICATION CIRCUIT



22PIN PLASTIC DIP (400 mil)



P22C-100-400B

NOTES

1) Each lead centerline is located within 0.25 mm (0.01 inch) of its true position (T.P.) at maximum material condition.

2) Item "K" to center of leads when formed parallel.

ITEM	MILLIMETERS	INCHES
A	27.94 MAX.	1.100 MAX.
B	1.27 MAX.	0.050 MAX.
C	2.54 (T.P.)	0.100 (T.P.)
D	$0.50^{+0.10}$	$0.020^{+0.004}_{-0.005}$
F	1.2 MIN.	0.047 MIN.
G	$3.5^{+0.3}$	$0.138^{+0.012}$
H	0.51 MIN.	0.020 MIN.
I	4.31 MAX.	0.170 MAX.
J	5.72 MAX.	0.226 MAX.
K	10.16 (T.P.)	0.400 (T.P.)
L	8.6	0.339
M	$0.25^{+0.10}_{-0.05}$	$0.010^{+0.004}_{-0.003}$
N	0.25	0.01
P	0.8 MIN.	0.031 MIN.

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