# MOS DIGITAL INTEGRATED CIRCUIT
# μPD6104C-001

## CMOS LSI FOR CHARACTER DISPLAY ON SCREEN

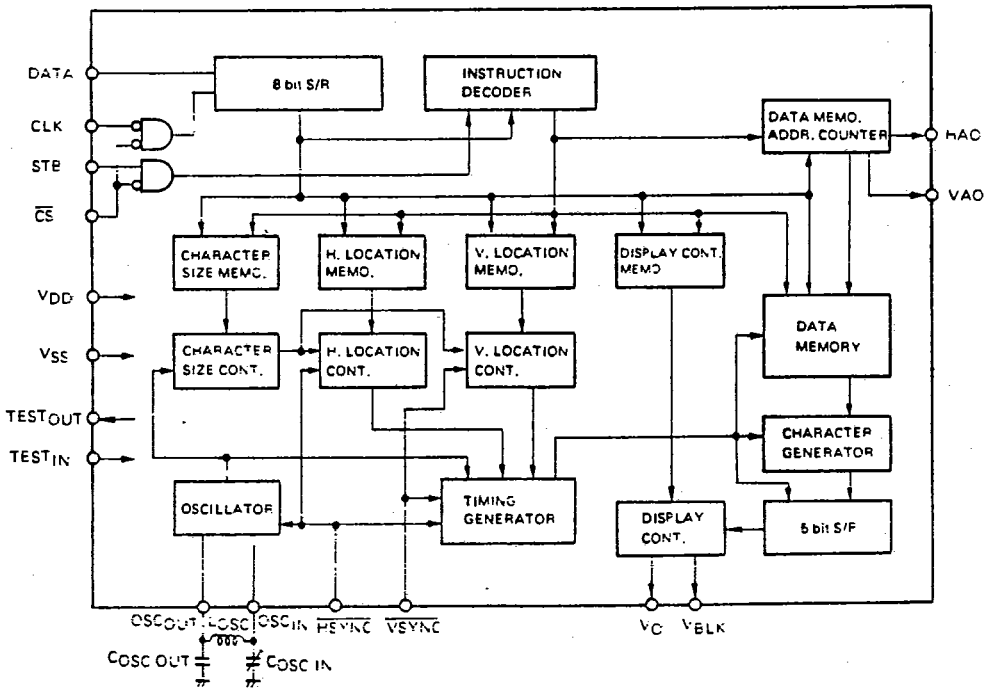
### DESCRIPTION

The μPD6104C-001 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 characters displayed: 2 lines x 6 columns
- Number of character types: 16
- Character size: 14 H, 28 H, 42 H, or 56 H (selective)
- Display position: 32 horizontal positions and 16 vertical positions (selective)
- Character format: 5 x 7 dots with smoothing function
- Address output terminals for specifying the color for four independent blocks
- No background, black square background, or black fringe can be selected.
- 8-bit serial input for easy interfacing with a microcomputer
- Single +5 V supply voltage, CMOS with low power requirement 16-Pin dual in-line package (DIP).

### BLOCK DIAGRAM






NEC Corporation

## ABSOLUTE MAXIMUM RATINGS ($T_a$=25 °C)

| | | | |
|---|---|---|---|
| Supply Voltage | $V_{DD}-V_{SS}$ | 7 | V |
| Input Voltage | $V_{IN}$ | $V_{DD}+0.3>V_{IN}>V_{SS}-0.3$ | V |
| Output Voltage | $V_{OUT}$ | $V_{DD}+0.3>V_{OUT}>V_{SS}-0.3$ | V |
| Operating Temperature | $T_{opt}$ | −20 to +75 | °C |
| Strage Temperature | $T_{stg}$ | −40 to +125 | °C |
| Power Dissipation | $P_d$ | 250 | mW |
| Output Current | $I_O$ | 5 | mA |

## RECOMMENDED OPERATING CONDITIONS ($T_a$=0~45 °C)

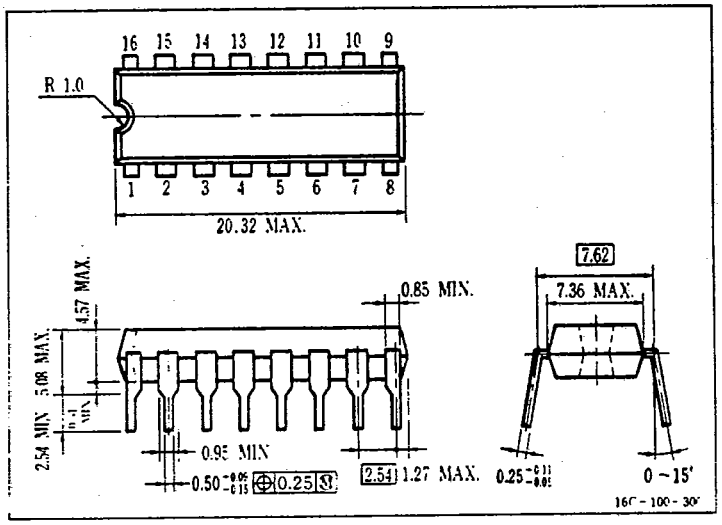
| CHARACTERISTIC | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}-V_{SS}$ | 4.5 | 5.0 | 5.5 | V |
| Oscillation Frequency | $f_{OSC}$ | | 4.8 | 5.2 | MHz |

## ELECTRICAL CHARACTERISTICS ($T_a$=25 °C, $V_{DD}-V_{SS}$=5 V, $V_{SS}$=0 V)

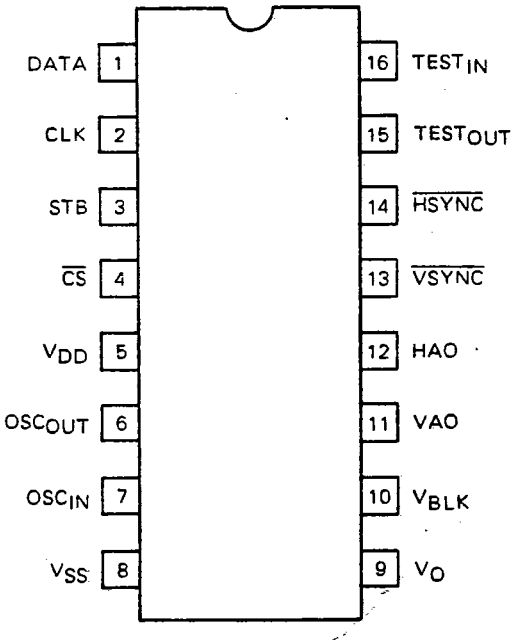
| CHARACTERISTIC | SYMBOL | TEST CONDITION | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Operating Voltage | $V_{DD}-V_{SS}$ | $f_{OSC}$=4.8 MHz | 4.5 | 5.0 | 5.5 | V |
| Current Consumption | $I_{DD}$ | No Load, $L_{OSC}$=56 μH, $C_{OSC\ IN}$=5~30 pF, $C_{OSC\ OUT}$=300 pF | | | 15 | mA |
| DATA, CLK, $TEST_{IN}$, STB, $\overline{CS}$ High Level Input Current | $I_{IH}$ | $V_{IH}$=2.4 V | | | 200 | μA |
| DATA, CLK, $TEST_{IN}$, STB, $\overline{CS}$ Low Level Input Current | $I_{IL}$ | $V_{IL}$=0.8 V | | | 300 | μA |
| $\overline{VSYNC}$, $\overline{HSYNC}$ High Level Input Current | $I_{IH}$ | $V_{IH}$=3.0 V | | | 200 | μA |
| $\overline{VSYNC}$, $\overline{HSYNC}$ Low Level Input Current | $I_{IL}$ | $V_{IL}$=0.8 V | | | 300 | μA |
| VO, VBLK High Level Output Voltage | $V_{OH}$ | $I_{OH}$=−2 mA | 4.5 | | | V |
| VO, VBLK Low Level Output Voltage | $V_{OL}$ | $I_{OL}$=2 mA | | | 0.5 | V |
| LC Oscillation Frequency | $f_{OSC}$ | $L_{OSC}$=56 μH, $C_{OSC\ IN}$=5~30 pF, $C_{OSC\ OUT}$=300 pF | | 4.8 | | MHz |
| High Level Input Leak Current | $I_{LH}$ | Except $TEST_{IN}$ | | | 1 | μA |
| Low Level Input Leak Current | $I_{LL}$ | | | | 1 | μA |
| VAO HAO High Level Output Voltage | $V_{OH}$ | $I_{OH}$=−1 mA | 4.5 | | | V |
| VAO HAO Low Level Output Voltage | $V_{OL}$ | $I_{OL}$=1 mA | | | 0.5 | V |

## PACKAGE DIMENSIONS (Unit: mm)

16 PIN PLASTIC DIP (300 mil)




## CONNECTION DIAGRAM (Top View)

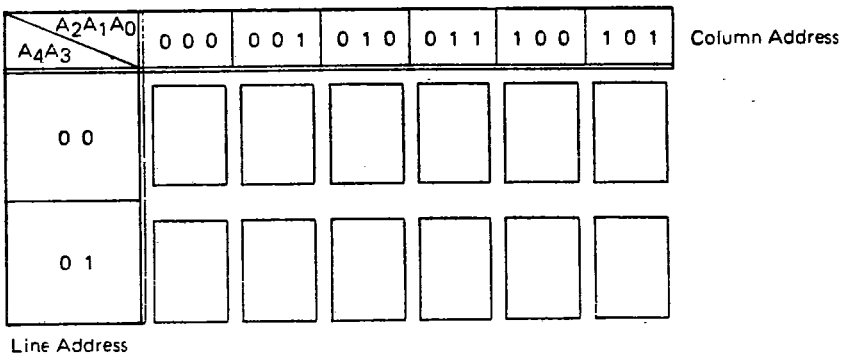


## Pin description

| Symbol | Pin name | Function |
|---|---|---|
| $V_{DD}$ | Power supply | +5 V Power supply terminal |
| $V_{SS}$ | Ground | System ground |
| DATA | Serial data input | Control data input terminal. Data is read in synchronization with the clocks input to the CLK terminal |
| CLK | Shift clock input | Data read clock input terminal. The data input to the DATA terminal is read at the leading edge of the clock. (Normally, set this pin at the high level.) |
| STB | Strobe input | This pin is used to input strobe signals after inputting serial data. Eight-bit data is read at the leading edge of a pulse input to the STB pin. In case of the 8 bit data is a character data the data address is incremented at the STB pulse trailing edge. (Normally, set this pin at the low level.) |
| $\overline{CS}$ | Chip selection | When this pin is at the low level, ordinary operation is performed; when set at the high level, shift clock input (CLK) and strobe input (STB) are inhibited. |
| $OSC_{IN}$<br>$OSC_{OUT}$ | Oscillation pins | These pins are connected to oscillation LC. The oscillator starts oscillation at the $\overline{HSYNC}$ leading edge. |
| $\overline{HSYNC}$ | Horizontal synchronization signal input | Use to input horizontal synchronization signals. When It is at the low level, oscillation stops. |
| $\overline{VSYNC}$ | Vertical synchronization signal input | Use to input vertical synchronization signal |
| $V_O$ | Character signal output | This pin generates character signal. The signal is active when high. |
| $V_{BLK}$ | Back ground signal output | This pin generates a back ground signal for cutting video signals. The signal is active when high. |
| HAO<br>VAO | Horizontal address output<br>Vertical address output | These pins generate the address information of the character currently being displayed. The address information (HAO, VAO) is output as follows according to the address where the character currently displayed.<br>HAO: L (columns 1-4), H (columns 5 and 6)<br>VAO: L (line 1), H (line 2) |
| $TEST_{IN}$<br>$TEST_{OUT}$ | Test terminals | Normally, connect $TEST_{IN}$ to $V_{SS}$ and open $TEST_{OUT}$. |

## Display format

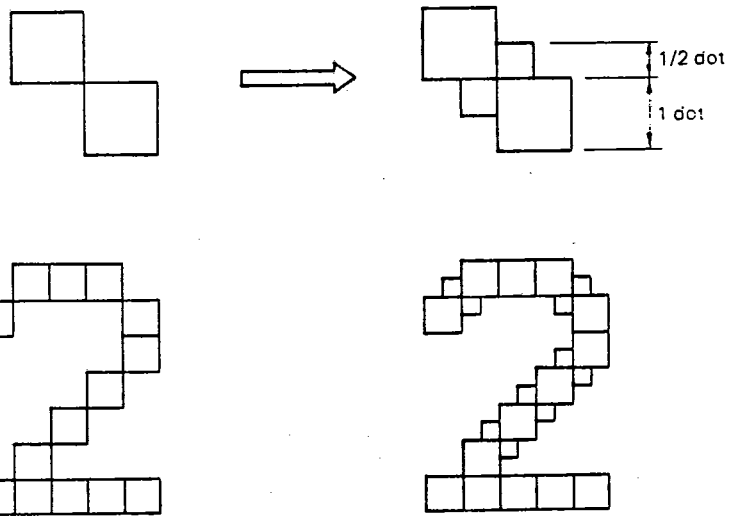
The number of characters displayed is 12 (2 lines x 6 columns) as shown in the following figure. There is a one-dot space between characters and a two-dot space between lines.




## Character format

A character is displayed in the 5 x 7 dot matrix format.

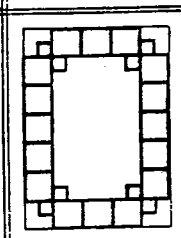
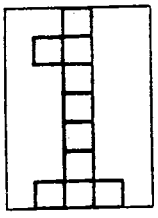
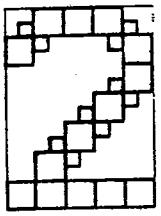
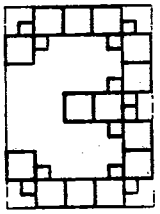
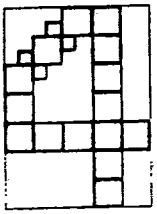
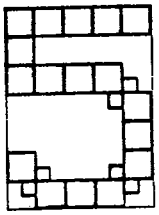
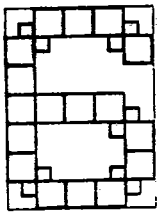
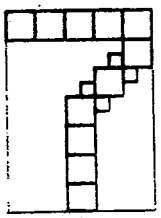
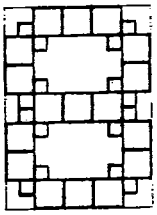
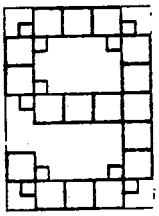
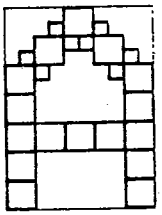
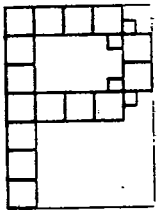
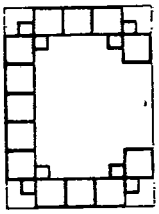
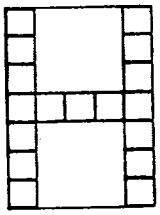
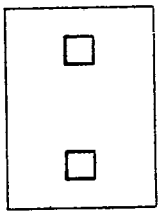
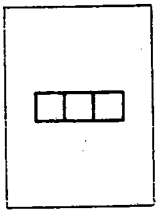
The smoothing function for smoothing connection between dots makes the displayed characters easy to see.




Without smoothing function

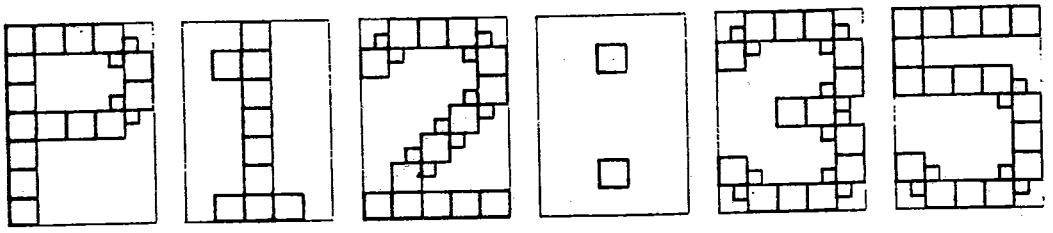
With smoothing function
(μPD6104C-001)

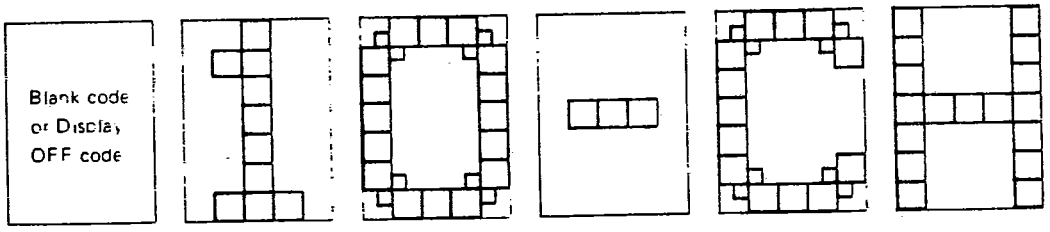
## Type of Characters

| $C_4C_3C_2$ \ $C_1C_0$ | 0 0 | 0 1 | 1 0 | 1 1 |
|---|---|---|---|---|
| 0 0 0 |  |  |  |  |
| 0 0 1 |  |  |  |  |
| 0 1 0 |  |  |  |  |
| 0 1 1 |  |  |  |  |

In addition to the above characters, a blank code ($C_4C_3C_2C_1C_0$=11110) and a display off code ($C_4C_3C_2C_1C_0$ =11111) are provided as display character data.

## Example of Display





## Command format

A control command is input in the 8-bit serial format.

Character data, display address, display location character size, and background can be controlled with control commands.

**Command Specification**

| $D_7$ | $D_6$ | $D_5$ | $D_4$ | $D_3$ | $D_2$ | $D_1$ | $D_0$ | FUNCTION |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | $C_4$ | $C_3$ | $C_2$ | $C_1$ | $C_0$ | Character Data |
| 0 | 0 | 1 | $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | Display Address Data |
| 0 | 1 | 0 | $V_4$ | $V_3$ | $V_2$ | $V_1$ | $V_0$ | Vertical Location Address |
| 0 | 1 | 1 | $H_4$ | $H_3$ | $H_2$ | $H_1$ | $H_0$ | Horizontal Location Address |
| 1 | 0 | 1 | $S_4$ | $S_3$ | X | X | X | Character Size Specification |
| 1 | 1 | 0 | 0 | 0 | X | X | X | Display off (Test Mode Reset) |
| 1 | 1 | 0 | 0 | 1 | X | X | X | Display on |
| 1 | 1 | 0 | 1 | 0 | X | X | X | Without Back Ground |
| 1 | 1 | 0 | 1 | 1 | X | X | X | With Back Ground |
| 1 | 1 | 1 | 0 | 0 | X | X | X | Black Square Back Ground |
| 1 | 1 | 1 | 0 | 1 | X | X | X | Black Fringe Back Ground |
| 1 | 0 | 0 | 1 | 0 | X | X | X | Test Mode Set |

X : 1 or 0

## Character Data

$(D_7, D_6, D_5) = (0, 0, 0)$

| $C_4$ | $C_3$ | $C_2$ | $C_1$ | $C_0$ | |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 16 types |
| | | ⌇ | | | |
| 0 | 1 | 1 | 1 | 1 | |
| 1 | 1 | 1 | 1 | 1 | Display off (The display at the address having this code is set off.) |
| 1 | 1 | 1 | 1 | 0 | Blank (For black square background display, only characters are set off and the background is displayed.) |

## Display Address Data

$(D_7, D_6, D_5) = (0, 0, 1)$

| $A_4$ | $A_3$ | $A_2$ | $A_1$ | $A_0$ | HEXA | |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 00 | 6 digits of first line |
| 0 | 0 | 0 | 0 | 1 | 01 | |
| | | ⌇ | | | ⌇ | |
| 0 | 0 | 1 | 0 | 1 | 05 | |
| 0 | 1 | 0 | 0 | 0 | 08 | 6 digits of second line |
| 0 | 1 | 0 | 0 | 1 | 09 | |
| | | ⌇ | | | ⌇ | |
| 0 | 1 | 1 | 0 | 1 | 0D | |

## Display Address Asignment

| line \ column | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| $A_3 = 0$ | 0 | 1 | 2 | 3 | 4 | 5 |
| $A_3 = 1$ | 8 | 9 | A | B | C | D |

## Display Location

### Vertical Location Address

$(D_7, D_6, D_5) = (0, 1, 0)$

| $V_4$ | $V_3$ | $V_2$ | $V_1$ | $V_0$ | HEXA | V. Location |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 0 | 0 | 0 | 1 | 0 | 2 | 2 |
| | | ⌇ | | | ⌇ | ⌇ |
| 0 | 1 | 1 | 0 | 0 | C | 12 |
| 0 | 1 | 1 | 0 | 1 | D | 13 |
| 0 | 1 | 1 | 1 | 0 | E | 14 |
| 0 | 1 | 1 | 1 | 1 | F | 15 |

### Horizontal Location Address

$(D_7, D_6, D_5) = (0, 1, 1)$

| $H_4$ | $H_3$ | $H_2$ | $H_1$ | $H_0$ | HEXA | H. Location |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 00 | 0 |
| 0 | 0 | 0 | 0 | 1 | 01 | 1 |
| 0 | 0 | 0 | 1 | 0 | 02 | 2 |
| | | ⌇ | | | ⌇ | ⌇ |
| 0 | 1 | 1 | 1 | 1 | 0F | 15 |
| 1 | 0 | 0 | 0 | 0 | 10 | 16 |
| | | ⌇ | | | ⌇ | ⌇ |
| 1 | 1 | 1 | 1 | 0 | 1E | 30 |
| 1 | 1 | 1 | 1 | 1 | 1F | 31 |

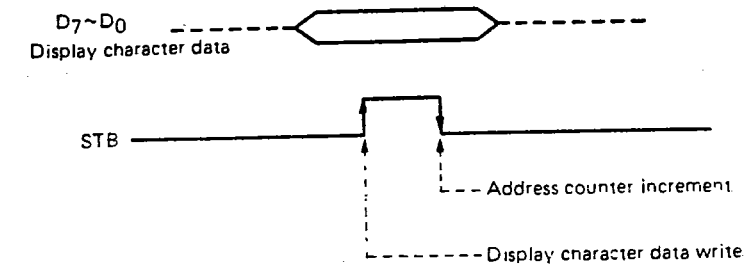
## Data write

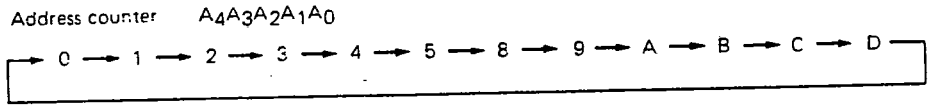
The character data write address can be set directly in the address counter by data address set command as follows. (Only 0–5, 8–D addresses can be set.)

$(D_7D_6D_5D_4D_3D_2D_1D_0) = (0\ 0\ 1\ C_4C_3C_2C_1C_0)$

After setting the address, the address is automatically incremented by writing a display character data command as follows:

$(D_7D_6D_5D_4D_3D_2D_1D_0) = (0\ 0\ 0\ C_4C_3C_2C_1C_0)$




## Character size

The character size can be specified in a character size specification command as follows:

$(D_7D_6D_5D_4D_3D_2D_1D_0) = (1\ 0\ 1\ S_4S_3\ x\ x\ x)$

| Code | | Character size (dots) | |
|---|---|---|---|
| $S_4$ | $S_3$ | Vertical | Horizontal |
| 0 | 0 | 14 H (2 H) | 5 $t_{dot}$ ($t_{dot}$) |
| 0 | 1 | 28 H (4 H) | 10 $t_{dot}$ ($2t_{dot}$) |
| 1 | 0 | 42 H (6 H) | 15 $t_{dot}$ ($3t_{dot}$) |
| 1 | 1 | 56 H (8 H) | 20 $t_{dot}$ ($4t_{dot}$) |

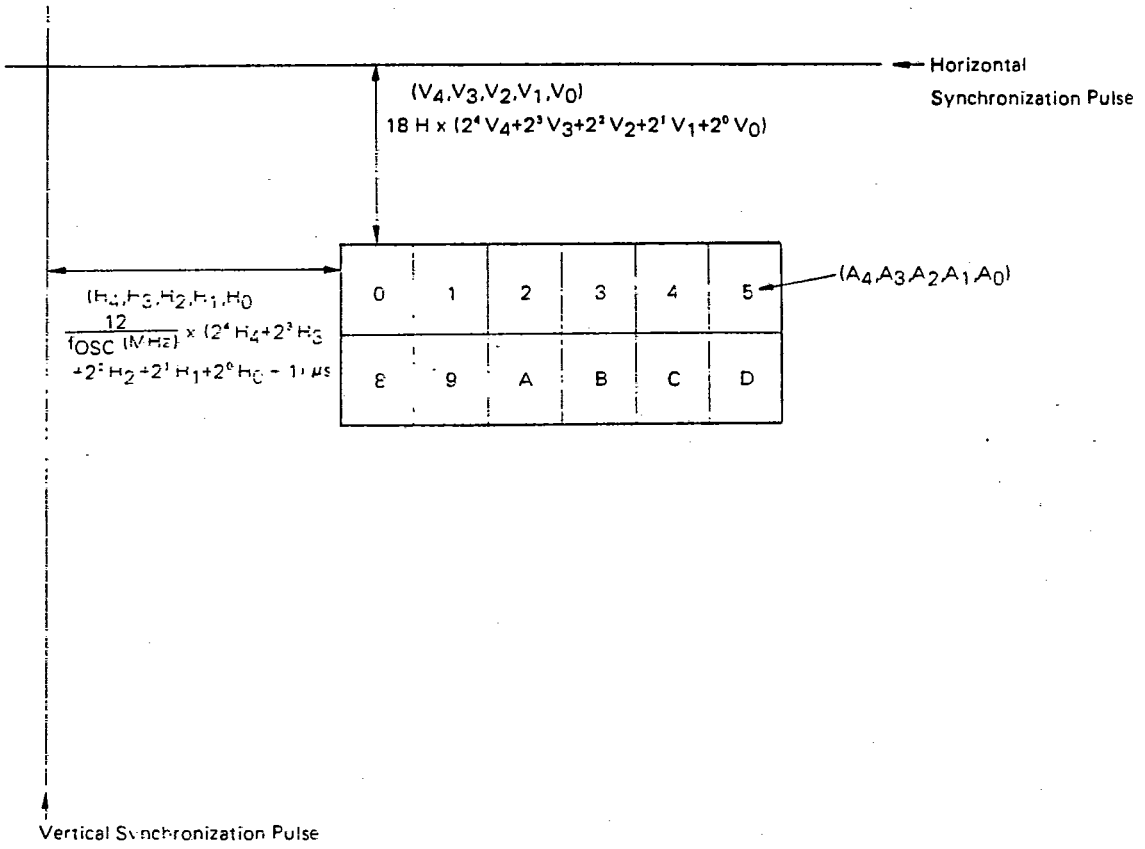
$$t_{dot} = \frac{2}{f_{OSC}\ (MHz)}\ \mu s$$

## Character display address

The character display starting address is decided as follows according to the values specified in display position vertical address command

$(D_7D_6D_5D_4D_3D_2D_1D_0) = (0\ 1\ 0\ V_4V_3V_2V_1V_0)$ and display position horizontal address command

$(D_7D_6D_5D_4D_3D_2D_1D_0) = (01\ 1\ H_4H_3H_2H_1H_0)$ :



## Display control

The entire display on/off, existence of background, black square background, and black fringe can be specified with the following commands:

| $D_7$ | $D_6$ | $D_5$ | $D_4$ | $D_3$ | $D_2$ | $D_1$ | $D_0$ | Function |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 0 | 0 | X | X | X | Display OFF |
| 1 | 1 | 0 | 0 | 1 | X | X | X | Display ON |
| 1 | 1 | 0 | 1 | 0 | X | X | X | Without Back Ground |
| 1 | 1 | 0 | 1 | 1 | X | X | X | With Back Ground |
| 1 | 1 | 1 | 0 | 0 | X | X | X | Black Square Back Ground |
| 1 | 1 | 1 | 0 | 1 | X | X | X | Black Fringe |

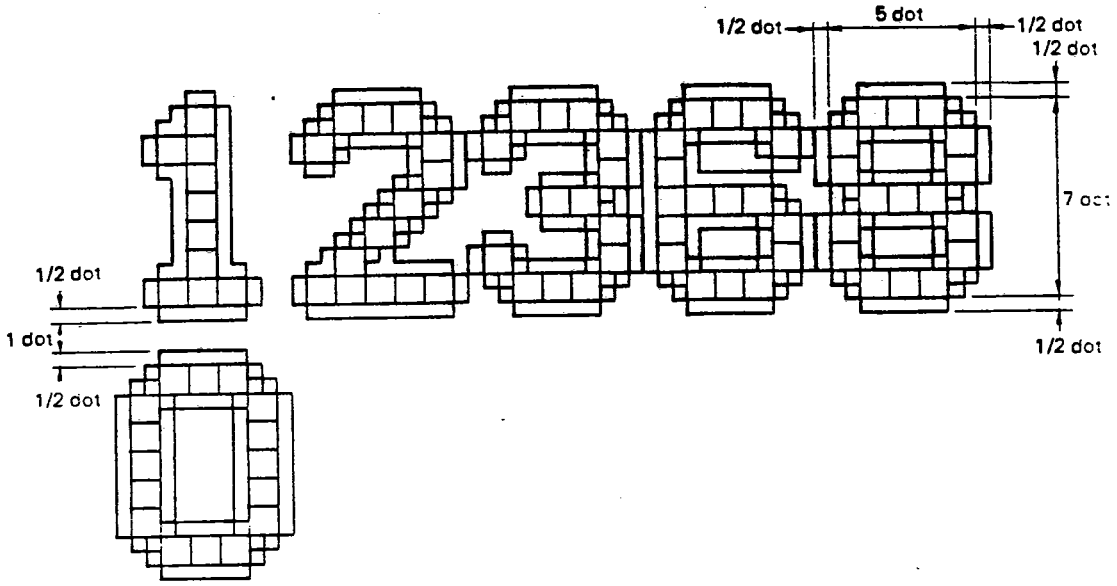
The display can be set off partially with a display-set-off character data command as follows:
$(D_7D_6D_5D_4D_3D_2D_1D_0) = (0\ 0\ 0\ C_4C_3C_2C_1C_0)$

$(C_4C_3C_2C_1C_0) = (11111)$

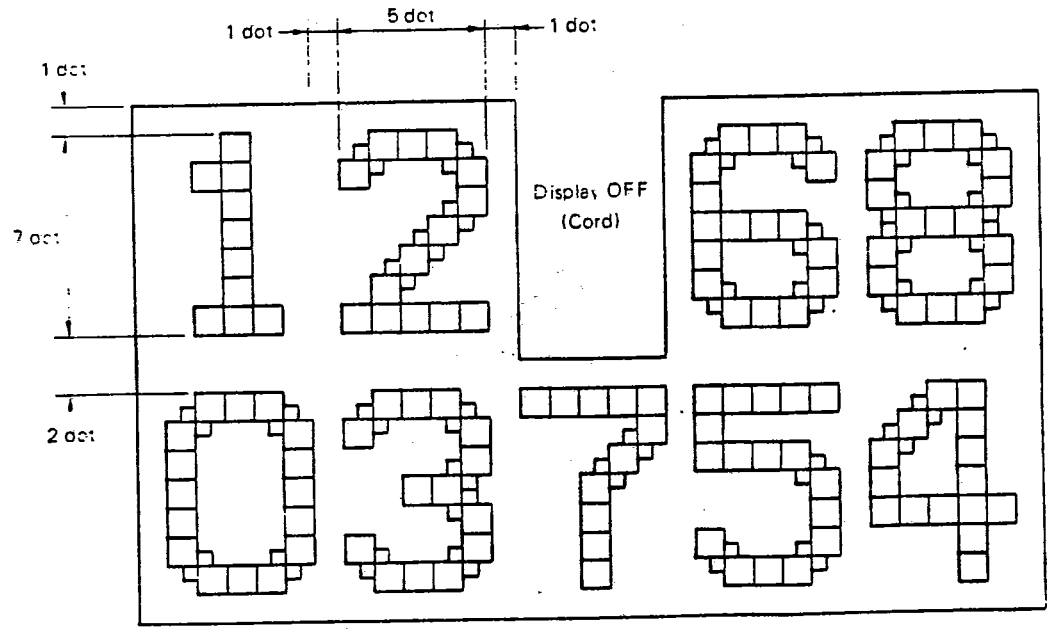
The character and background are not displayed at the address where display-off data is set. To inhibit display of a character while displaying the background in case of black square background, set blank data
$(C_4C_3C_2C_1C_0) = (11110)$.

## Back Ground

### Black Fringe

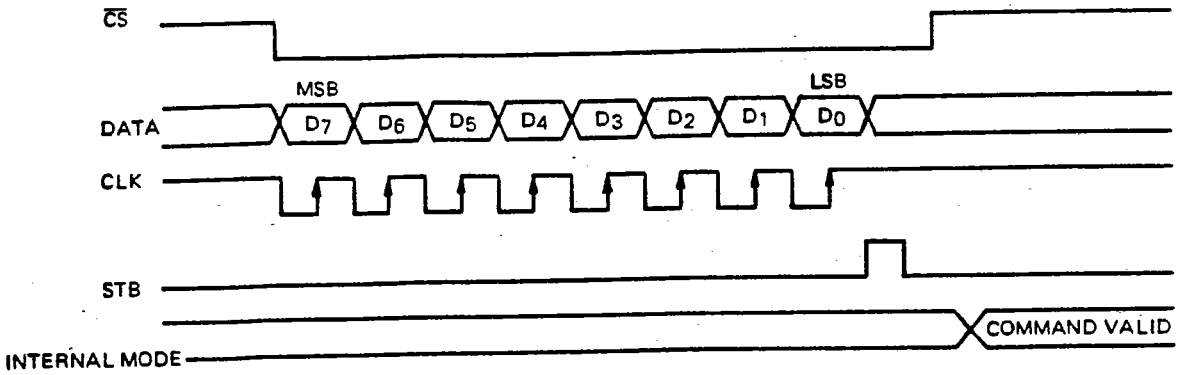


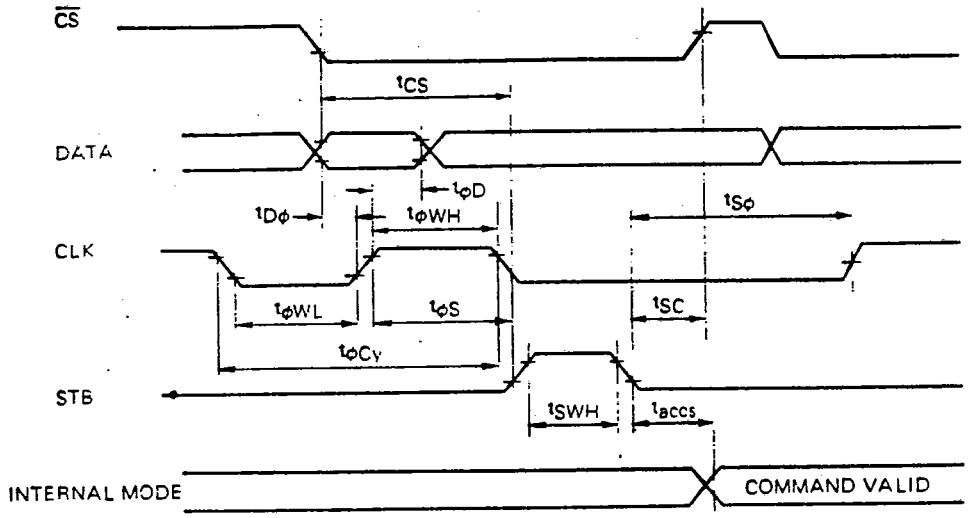

## Black Square (7 x 9 dot) Back Ground




Letters and numbers are indicated with the square black back ground super imposed on the screen.

## Timing Diagram of Data Input




| SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|
| $t_{D\phi}$ | 100 | | | ns |
| $t_{\phi D}$ | 100 | | | ns |
| $t_{\phi WL}$ | 350 | | | ns |
| $t_{\phi WH}$ | 350 | | | ns |
| $t_{\phi S}$ | 200 | | | ns |
| $t_{SWH}$ | 500 | | | ns |
| $t_{CS}$ | 200 | | | ns |
| $t_{SC}$ | 100 | | | ns |
| $t_{accs}$ | 500 | | | ns |
| $t_{\phi cy}$ | 800 | | | ns |
| $t_{S\phi}$ | 2 000 | | | ns |

## Application Circuit