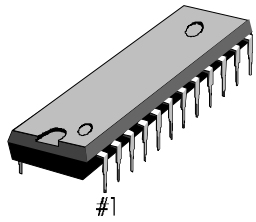
## OVERVIEW

The KS2501 is used to display some characters or symbols on a screen of monitor. Basically, the operation is to control the internal memory on chip and generate the R,G,B signals for some characters or symbols. The R,G,B signals are synchronized with the horizontal sync. Then the R,G,B signals are mixed with the main video signal in the Video Amp IC.
The font data for characters or symbols are stored in the internal ROM. This stored data are accessed and controlled by the control data from a micro controller. The control data are transmitted through the $I^2C$ bus. All timing control signals including the system clock are synchronized with the horizontal sync. Therefore there is a PLL circuitry on chip.

24-DIP-300




## FEATURES

- 464 ROM fonts (448 standard fonts + 16 Multi-color fonts)
- Full Screen Memory Architecture
- Wide range PLL available (15 kHz ~ 120 kHz)
- Programmable vertical height of character
- Programmable vertical and horizontal positioning
- Character color selection up to 16 different colors
- Programmable background color (Up to 16 colors)
- Character blinking, bordering and shadowing
- Color blinking
- Character scrolling
- Fade-in and fade-out
- Row to row spacing control
- Window outline and shadowing
- Box drawing
- Character sizing up to four times
- 8 PWM DAC channels with 8-bit resolution
- 96 MHz pixel frequency from on-chip PLL

## ORDERING INFORMATION

| Device | Package | Operating Temperature |
|---|---|---|
| KS2501 | 24-DIP-300 | 0°C ~ 70°C |

## BLOCK DIAGRAM

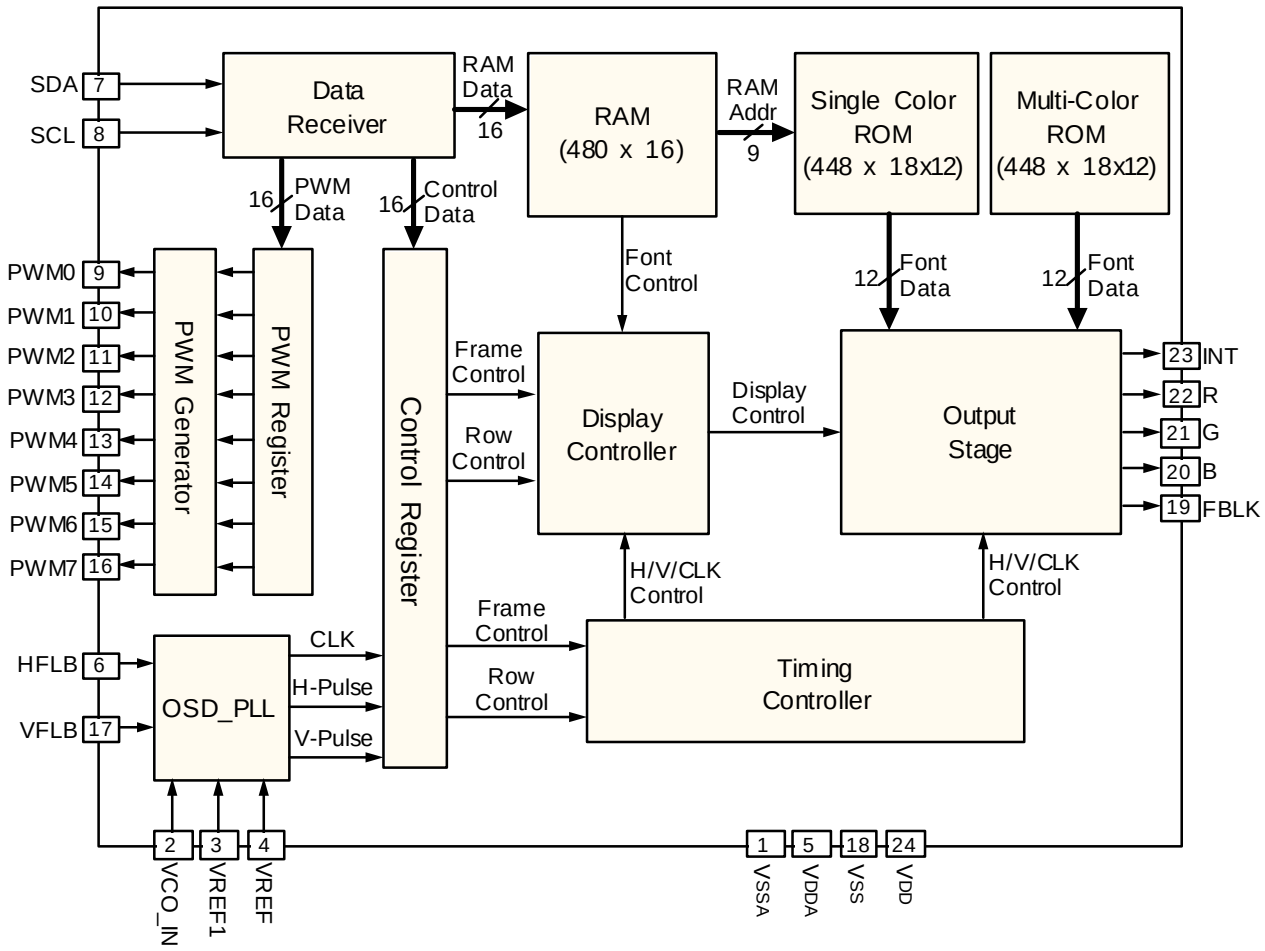



**Figure 1. Functional Block Diagram**

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## PIN CONFIGURATIONS

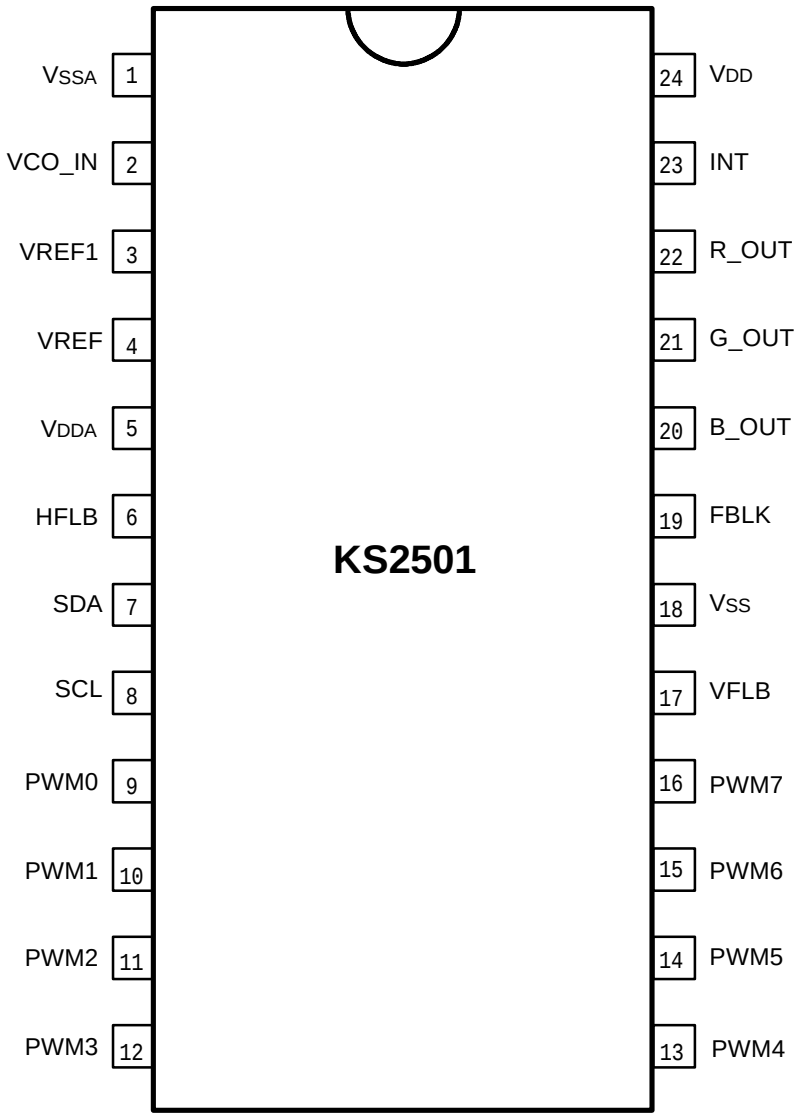



**Figure 2. Pin Configurations**

## PIN DESCRIPTIONS

**Table 1. Pin Descriptions**

| Pin No. | Signal | Active | I/O | Description |
|---|---|---|---|---|
| 1 | $V_{SSA}$ | - | - | Ground (Analog Part) |
| 2 | VCO_IN | - | Input | This voltage is generated at the external loop filter and goes into the input stage of the VCO. |
| 3 | VREF1 | - | Input | 1.26 V DC Voltage from the Bandgap Reference. Connected to ground through a resistor to make internal reference current (Typical 36 KΩ for 27μA) |
| 4 | VREF | - | Input | Bandgap Reference Voltage (Typical 1.26 V) |
| 5 | $V_{DDA}$ | - | - | +5 V SUpply Voltage for Analog Part |
| 6 | HFLB | Low | Input | Horizontal Flyback Signal |
| 7 | SDA | - | In/Out | Serial Data ($I^2C$) |
| 8 | SCL | - | In/Out | Serial Clock ($I^2C$) |
| 9 | PWM 0 | - | Output | PWM DAC 0 Output |
| 10 | PWM 1 | - | Output | PWM DAC 1 Output |
| 11 | PWM 2 | - | Output | PWM DAC 2 Output |
| 12 | PWM 3 | - | Output | PWM DAC 3 Output |
| 13 | PWM 4 | - | Output | PWM DAC 4 Output |
| 14 | PWM 5 | - | Output | PWM DAC 5 Output |
| 15 | PWM 6 | - | Output | PWM DAC 6 Output |
| 16 | PWM 7 | - | Output | PWM DAC 7 Output |
| 17 | VFLB | Low | Input | Vertical Flyback Signal |
| 18 | $V_{SS}$ | - | - | Ground for Digital Part |
| 19 | FBLK | - | Output | Fast Blank Signal |
| 20 | B_OUT | - | Output | Video Signal Output (B) |
| 21 | G_OUT | - | Output | Video Signal Output (G) |
| 22 | R_OUT | - | Output | Video Signal Output (R) |
| 23 | INT | - | Output | Intensity Signal Output |
| 24 | $V_{DD}$ | - | - | +5 V SUpply Voltage for Dogital Part |

## ABSOLUTE MAXIMUM RATINGS

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Supply Voltage | $V_{DD}$ | -0.3 ~ 7.0 | V |
| Input Voltage | $V_I$ | -0.3 ~ 7.0 | V |
| Power Dissipation | $P_D$ | 1200 | mW |
| Operating Temperature Range | $T_{OPR}$ | -20 ~ 70 | °C |
| Storage Temperature Range | $T_{STG}$ | -40 ~ 125 | °C |

NOTE: PKG Thermal Resistance : 64.2 °C/W

## ELECTRICAL CHARACTERISTICS

### DC Electrical Characteristics

(Ta = 25 °C, $V_{DDA}$ = $V_{DD}$ = 5 V)

**Table 2. DC Electrical Characteristics**

| Parameters (Conditions) | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | 4.75 | 5.00 | 5.25 | V |
| Supply Current (No load on any output) | $I_{DD}$ | - | - | 25 | mA |
| Input Voltage | $V_{IH}$ | $0.8V_{DD}$ | - | - | V |
| | $V_{IL}$ | - | - | $V_{SS}$ + 0.4 | V |
| Output Voltage (Iout = 1mA) | $V_{OH}$ | $0.8V_{DD}$ | - | - | V |
| | $V_{OL}$ | - | - | $V_{SS}$ + 0.4 | V |
| Input Leakage Current | $I_{IL}$ | -10 | - | 10 | µA |
| VCO Input Voltage | $V_{VCO}$ | | 2.5 | | V |

## OPERATION TIMINGS

**Table 3. Operation Timings**

| Parameters (Conditions) | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **Output Signal R/G/B_OUT, INT, FBLK**(Ta = 25°C $V_{DDA}$ = $V_{DD}$ = 5 V , $C_{LOAD}$ = 30pF) | | | | | |
| Rise Time | $t_R$ | - | - | 6 | nsec |
| Fall Time | $t_F$ | - | - | 6 | nsec |
| Input Signal HFLB, VFLB | | | | | |
| Horizontal Flyback Signal Frequency | $f_{HFLB}$ | - | - | 120 | kHz |
| Vertical Flyback Signal Frequency | $f_{VFLB}$ | - | - | 200 | Hz |
| **I²C Interface SDA, SCL**(Refer to Figure 3) | | | | | |
| SCL Clock Frequency | $f_{SCL}$ | - | - | 300 | kHz |
| Hold Time for start condition | $t_{hs}$ | 500 | - | - | ns |
| Set Up Time for stop condition | $t_{sus}$ | 500 | - | - | ns |
| Low Duration of clock | $t_{low}$ | 400 | - | - | ns |
| High Duration of clock | $t_{high}$ | 400 | - | - | ns |
| Hold Time for data | $t_{hd}$ | 0 | - | - | ns |
| Set Up Time for data | $t_{sud}$ | 500 | - | - | ns |
| Time between 2 access | $t_{ss}$ | 500 | - | - | ns |
| Fall Time of SDA | $t_{fSDA}$ | - | - | 20 | ns |
| Rise Time of both SCL and SDA | $t_{rSDA}$ | - | - | - | ns |

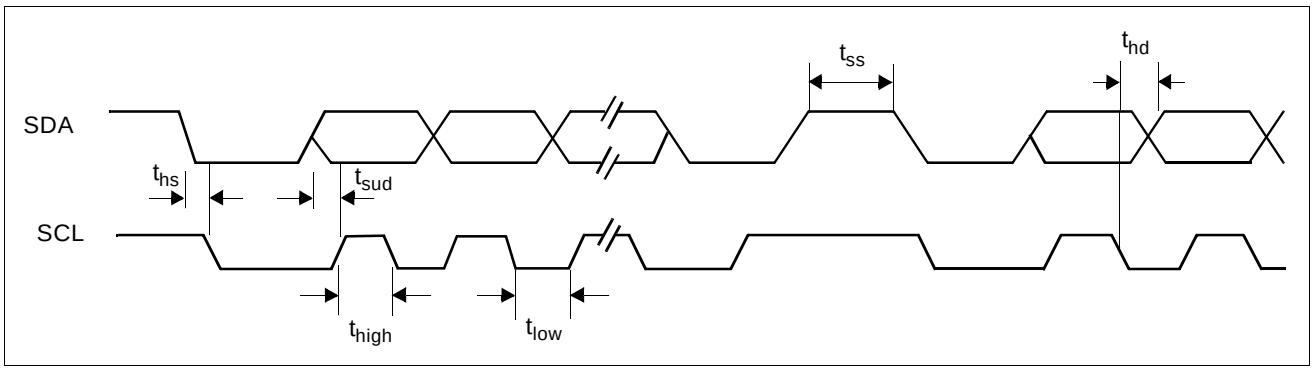



**Figure 3. I²C Bus Timing Diagram**

## FUNCTIONAL DESCRIPTIONS

### Data Transmission to the KS2501

According to the $I^2C$ protocol, the KS2501 receives the data from a micro controller. The SDA line and the SCL line are shown in Figure 4. As shown in Figure 4, after the starting pulse, the slave address with R/W* bit and an acknowledge are transmitted in sequence, an internal register address of the KS2501 is followed. The first 8-bit byte is the upper 8bits of the register address. The lower 8bits of the register address are followed after the second acknowledge. There is a data transmission format and are two address bit patterns in the KS2501 as following. The slave address of the KS2501 is BAH(in hexadecimal).

### Data Transmission Format

Row Address -> Column Address -> Data Byte N -> Data Byte N+1 -> Data Byte N+2 -> ....

### Address Bit Pattern for Display Registers Data

(a) Row Address Bit Pattern R3 - R0: Valid Data for Row Address

| A15 | A14 | A13 | A12 | A11 | A10 | A9 | A8 |
|---|---|---|---|---|---|---|---|
| X | X | X | X | R3 | R2 | R1 | R0 |

(b) Column Address Bit Pattern C4 - C0: Valid Data for Column Address

| A7 | A6 | A5 | A4 | A3 | A2 | A1 | A0 |
|---|---|---|---|---|---|---|---|
| X | X | X | C4 | C3 | C2 | C1 | C0 |

After addressing, data bytes are followed as the above data transmission format. The Figure 4 describes the data transmission with the $I^2C$ bus protocol.

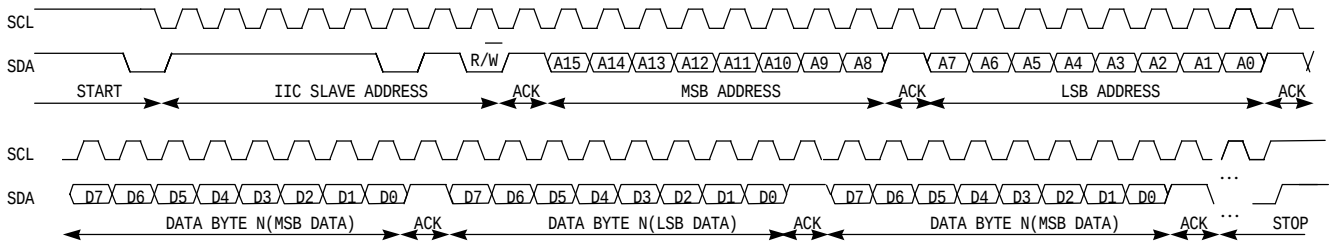



**Figure 4. SDA line and SCL line (Write Operation)**

## Memory Map

The display RAM is addressed with the row and column number in sequence. The display RAM consists of four register groups: Character & Attribute Registers, Row Attribute Registers, Frame Control Registers and PWM Control Registers. As the display area in a monitor screen is 30 columns by 15 rows, the related Character & Attribute Registers are also 30 columns by 15 rows. Each register contains a character address and an attribute corresponding to display location on a monitor screen. And one register is composed of 16 bits. The lower 9 bits select characters out of 464 ROM fonts. The upper 7 bits are assigned to give a character attribute to a selected font. Row Attribute Registers occupy the 31th column of Display RAM and provide the row attribute of a blank mode, raster color, raster color intensity, character color intensity, horizontal character size, vertical character size.
Frame Control Registers and PWM Control Registers are located at the 16th row.

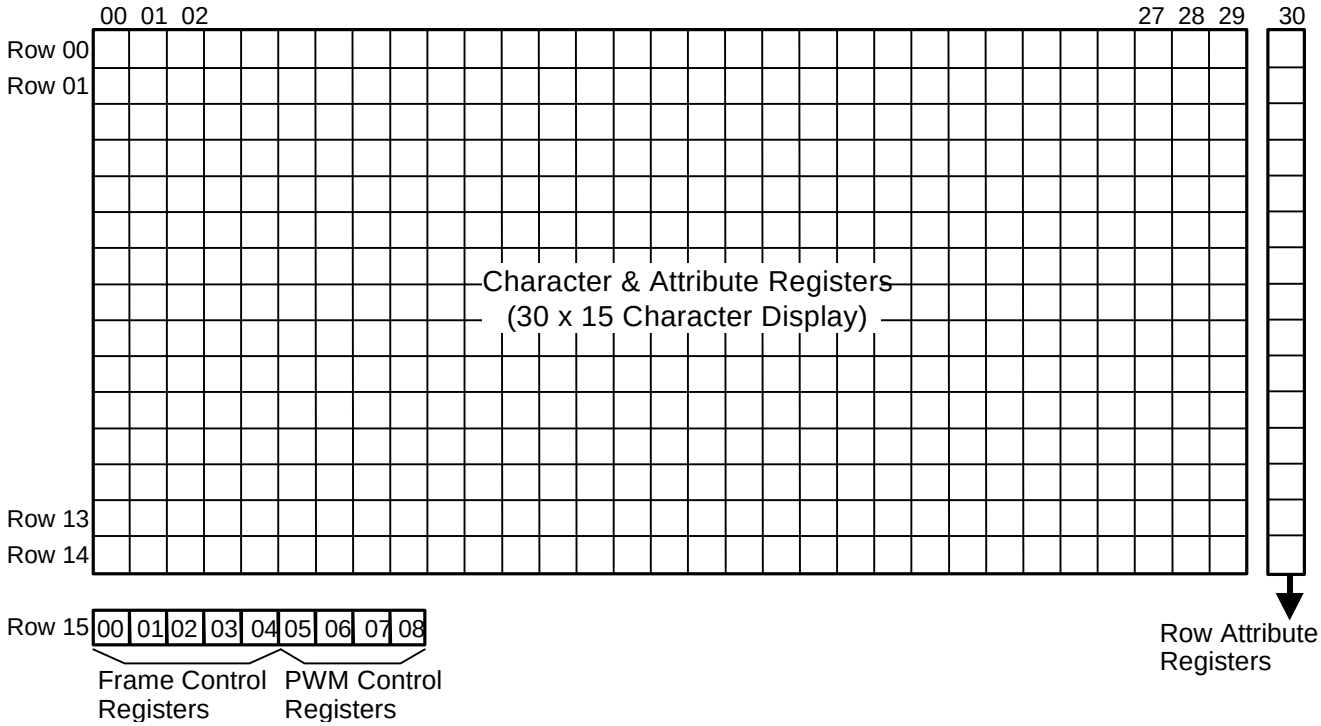



**Figure 5. Memory Map of Display Registers**

## ROM Fonts

KS2501 is able to supply 464 ROM fonts for describing an OSD icon. So a multi-language OSD icon can be generated. 448 fonts of 464 ROM fonts are standard fonts and 16 fonts are multi-color fonts as following figure. The standard font $000 is reserved for blank data.
Each multi-color font consists of 4-color attribute ROM fonts as following figure.

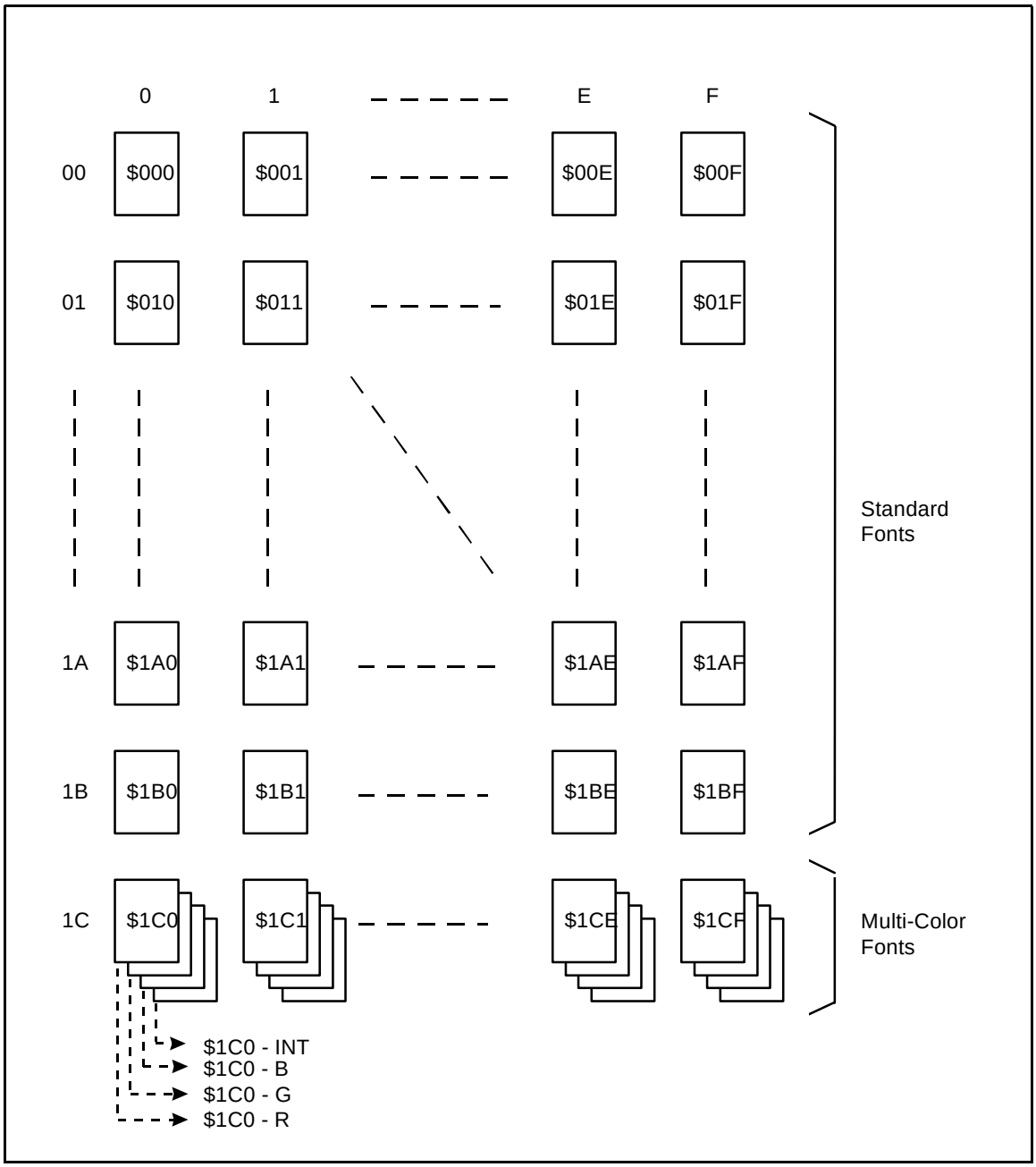
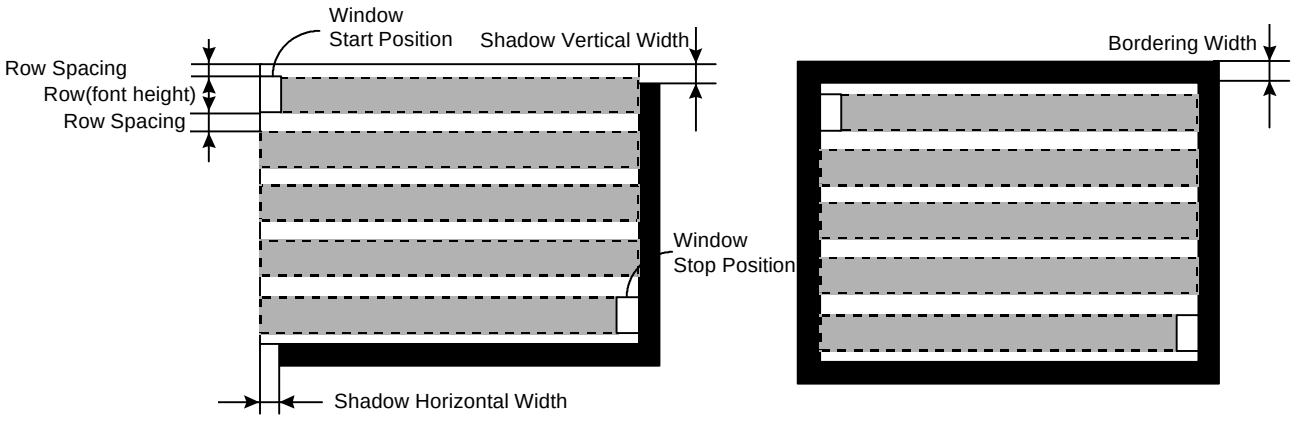


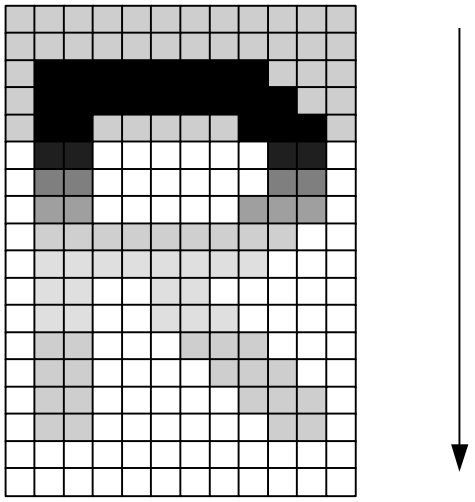

**Figure 6. Array of ROM Fonts**

## Window , Window Shadowing and Bordering




## Scroll

The scrolling function is to display or erase a character slowly from the top line to the bottom. The scrolling time is controlled by 'ScrT'bit of the frame control registers. If 'ScrT' bit is high, then the time is 0.5 sec. Otherwise, 1 sec.



### Character Height Control

Two examples of the height-controlled character are shown in the following figure. The height control is performed by repeating some lines. The repeating line-number comes from the equation below.

[# of the repeating lines = 2 + N × M ] ,
where N = 1,2,3,... and M = round{14÷(CH[5:0]-18)}.

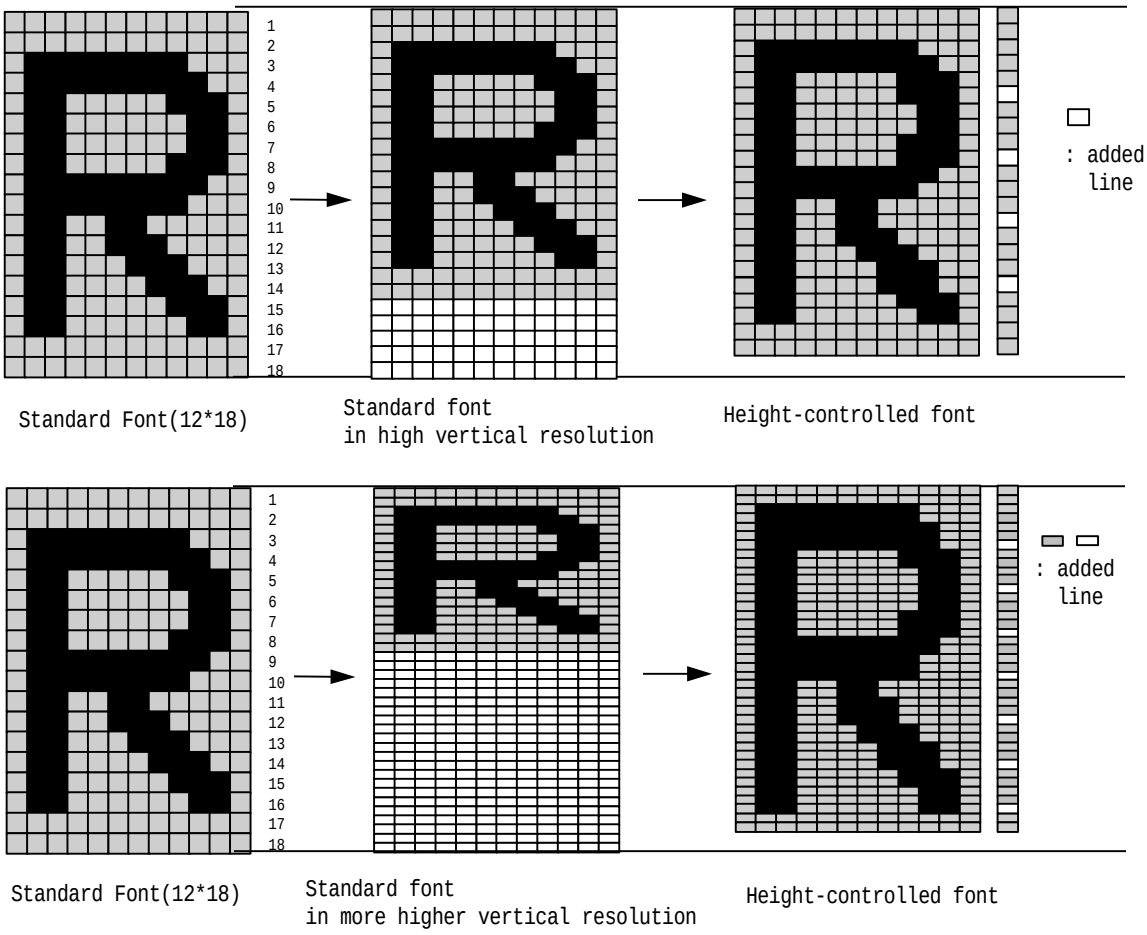
If the M value is less than or equal to 1, all the lines of the standard font are repeated once or more. This is described as following.

(i) If CH[5:0] is greater than 32, and less than or equal to 46 ( 32 < CH[5:0] ≤ 46 ),
then all lines are repeated once or twice. The lines repeated twice are selected by the following equation.
[# of the repeating lines = 2 + N × M ] ,
where N = 1,2,3,... and M= round{14÷(CH[5:0]-32)}.

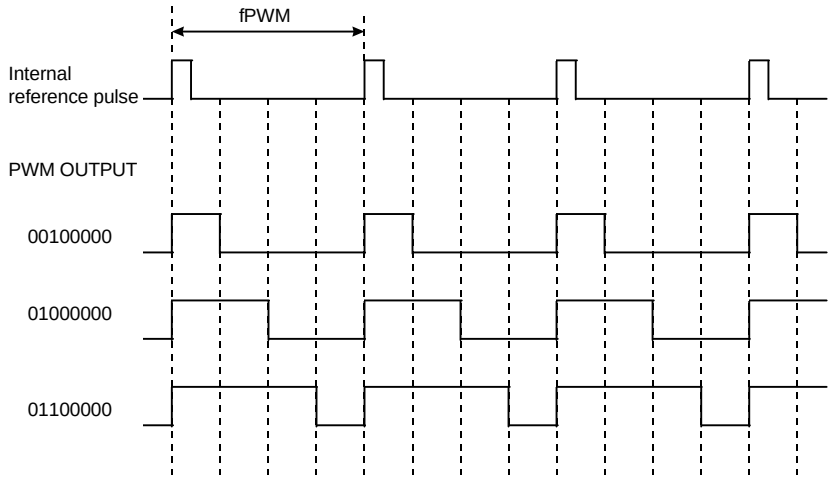
(ii) If CH[5:0] is greater than 46, and less than or equal to 60 ( 46 < CH[5:0] ≤ 60 ),
then all lines are repeated twice or three times. The lines repeated three times are selected by the following equation.
[# of the repeating lines = 2 + N × M ] ,
where N = 1,2,3,... and M= round{14÷(CH[5:0]-46)}.

iii) If CH[5:0] is greater than 60, and less than or equal to 64 ( 60 < CH[5:0] ≤ 64 ),
then all lines are repeated three or four times. The lines repeated four times are selected by the following equation.
[# of the repeating lines = 2 + N × M ] ,
where N = 1,2,3,... and M= round{14÷(CH[5:0]-60)}.

The repeating line-number is limited to 16.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
: added line
Standard Font(12*18)
Standard font in high vertical resolution
Height-controlled font
: added line
Standard Font(12*18)
Standard font in more higher vertical resolution
Height-controlled font

## PWM OUTPUT




The frequency of PWM signal (fPWM) is dependent on the horizontal flyback signal frequency and horizontal mode (320dots/line, ...) as shown in the following table.

| Horizontal Mode | 320 dots/line ($f_{PWM}$) | 480 dots/line ($f_{PWM}$) | 640 dots/line ($f_{PWM}$) | 800 dots/line ($f_{PWM}$) |
|---|---|---|---|---|
| 15kHz < Hf < 20kHz | (320/256) * Hf | (480/256) * Hf | (640/256) * Hf | (800/256) * Hf |
| 20kHz < Hf < 35kHz | | | | (800/256) * (Hf/2) |
| 35kHz < Hf < 50kHz | | | (640/256) * (Hf/2) | |
| 50kHz < Hf < 65kHz | | (480/256) * (Hf/2) | | |
| 65kHz < Hf < 80kHz | | | | (800/256) * (Hf/4) |
| 80kHz < Hf < 95kHz | (320/256) * (Hf/2) | | (640/256) * (Hf/4) | |
| 95kHz < Hf < 110kHz | | | | |
| 110kHz < Hf < 120kHz | | | | |

## FRAME CONTROL & TIMING

Figure 7 shows the composition of display frame with the OSD characters.

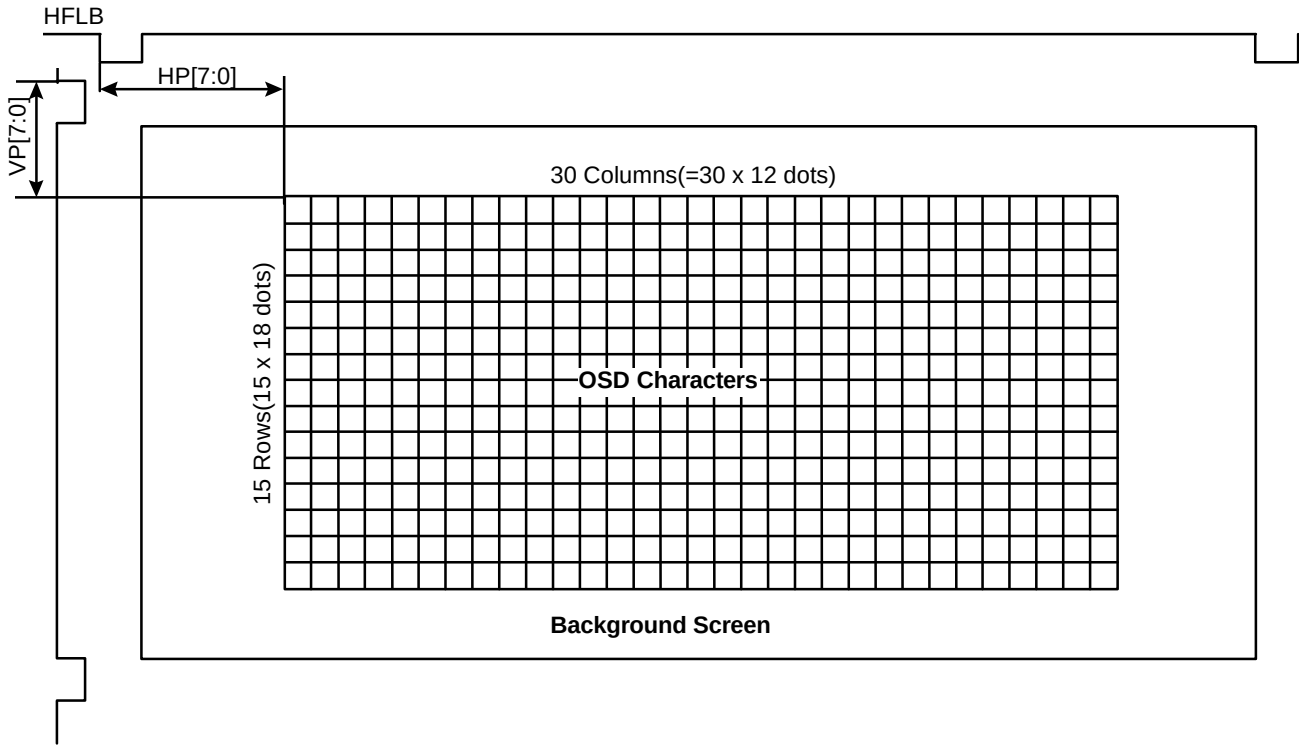



**Figure 7. Frame Composition with the OSD Characters**

You can determine the dot frequency by the equation of H freq. x the number of horizontal resolution.
And the number of horizontal resolution is determined by the bit9 - 8 (dot 1,dot 0) of the frame Control registers-1.
If dot 0 = “0”, dot 1 = “0”, then the dot frequency is calculated by the equation of H freq. ¥ 320. If the H freq. = 15 kHz, then the dot frequency is 15 kHz × 320 = 4.8 MHz.
If dot 0 = “1”, dot 1 = “1” and the horizontal frequency is 120 kHz, then the dot frequency is 120 kHz × 800 = 96 MHz. 96 MHz is the maximum clock frequency in this processor.

## REGISTER DESCRIPTION

### ¡ß Character & Attribute Registers : Row00~14, Column00~29

| F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BINV | BOX1 | BOX0 | B | G | R | Blink | C8 | C7 | C6 | C5 | C4 | C3 | C2 | C1 | C0 |
| ← Character Attribute → | | | | | | | ← Character Code(464 Fonts) → | | | | | | | | |

### ¡ß Row Attribute Registers : Row00~14, Column30

| F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | - | - | CBli | BOXE | BORD | SHA | RB | RG | RR | BINT | CINT | HZ1 | HZ0 | VZ1 | VZ0 |
| | | | | | | | ← Raster Color → | | | ← Intensity → | | ← Character Size → | | | |

### ¡ß Frame Control Registers-0 : Row15, Column00

| F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | Fde | FdeT | VPOL | HPOL | WC | WBOR | WSHA | - | Erase | EN | ScrI | ScrT | Bli1 | Bli0 | BliT |

### ¡ß Frame Control Registers-1 : Row15, Column01

| F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CP1 | CP0 | Fpll | HF2 | HF1 | HF0 | dot1 | dot0 | FBLK | BREN | CH5 | CH4 | CH3 | CH2 | CH1 | CH0 |
| | | ← PLL Control → | | | | | | | | ← Character Height Control → | | | | | |

### ¡ß Frame Control Registers-2 : Row15, Column02

| F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HP7 | HP6 | HP5 | HP4 | HP3 | HP2 | HP1 | HP0 | VP7 | VP6 | VP5 | VP4 | VP3 | VP2 | VP1 | VP0 |
| ← Horizontal Start Position → | | | | | | | | ← Vertical Start Position → | | | | | | | |

### ¡ß Frame Control Registers-3 : Row15, Column03

| F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RS2 | RS1 | RS0 | RSB | RSG | RSR | RSI | STR3 | STR2 | STR1 | STR0 | STC4 | STC3 | STC2 | STC1 | STC0 |
| ← Row Space → | | | ← Row Space Color → | | | | ← Window Start Position → | | | | | | | | |

### ¡ß Frame Control Registers-4 : Row15, Column04

| F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | BW1 | BW0 | HW1 | HW0 | VW1 | VW0 | SPR3 | SPR2 | SPR1 | SPR0 | SPC4 | SPC3 | SPC2 | SPC1 | SPC0 |
| | | | | | | | ← Window Stop Position → | | | | | | | | |

### ¡ß PWM Registers : Row15, Column05~08

| F | E | D | C | B | A | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MSB | | | | | | | LSB | MSB | | | | | | | LSB |
| ← Channel 2/4/6/8 → | | | | | | | | ← Channel 1/3/5/7 → | | | | | | | |

**Table 4. Register Description**

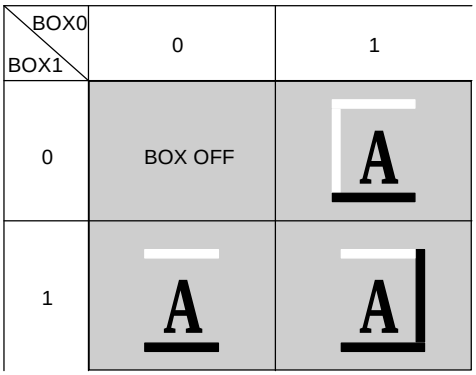
| Registers | Bits | Description |
|---|---|---|
| Character & Attribute Registers (Row 00~14, Column 00~29) | C8~C0 (Bit 8~0) | Character Code Address of 464 ROM Fonts. |
| | Blink (Bit 9) | Character Blinking.<br>Set this bit to activate the blinking effect. The blinking period is set by the 'Bli T' bit and the duty is selected by the 'Bli 0' and 'Bli 1' bits. |
| | B,G,R (Bit C~A) | Character Color is determined by these bits.<br>8 colors can be selected and the color intensity of a character is given by 'CINT' bit of Row Attribute Regisers.<br>So you can select up to 16 colors. If a multi-color font is selected, this bits must be set to all 0's. |
| | BOX 1, BOX0 (Bit E, D) | Character Box Drawing.<br>The combinations of this two bits generate four different box drawing modes as following.<br>The following example is the case that box dawing is activated with the font 'A'.<br>  <br><br>* Bit F ~ D (RB/RG/RR) is also used for raster color by setting the 'BOXE' bit low.<br>Raster color of a font is determined by this bits if the 'BOXE' bit is low. Priority of raster color selected here is higher than that of row attribute. |
| | BINV (Bit F) | Box Inversion.<br>The box drawing activated by the bit E and D is changed to white box from black and conversely. |

**Table 4. Register Description (Continued)**

<table>
<tr><th>Registers</th><th>Bits</th><th>Description</th></tr>
<tr><td rowspan="9">Row Attribute Registers<br>(Row 00 ~ 14, Column 30)</td><td>VZ1,VZ0<br>(Bit 1, 0)</td><td>Vertical Character Size Control.<br>Vertical character size is determined by the combinations of this two bits as following table.<br><table><tr><th>VZ1</th><th>VZ0</th><th>Vertical Character Size</th></tr><tr><td>0</td><td>0</td><td>1X</td></tr><tr><td>0</td><td>1</td><td>2X</td></tr><tr><td>1</td><td>0</td><td>3X</td></tr><tr><td>1</td><td>1</td><td>4X</td></tr></table></td></tr>
<tr><td>HZ1,HZ0<br>(Bit 3, 2)</td><td>Horizontal Character Size Control.<br>The horizontal character size is determined by the combinations of this two bits as following table.<br><table><tr><th>HZ1</th><th>HZ0</th><th>Horizontal Character Size</th></tr><tr><td>0</td><td>0</td><td>1X</td></tr><tr><td>0</td><td>1</td><td>2X</td></tr><tr><td>1</td><td>0</td><td>3X</td></tr><tr><td>1</td><td>1</td><td>4X</td></tr></table></td></tr>
<tr><td>CINT<br>(Bit 4)</td><td>Character Color Intensity. If this bit is set, the color intensity of characters in the same row is high.</td></tr>
<tr><td>RINT<br>(Bit 5)</td><td>Raster Color Intensity. If this bit is set, the color intensity of rasters in the same row is high</td></tr>
<tr><td>RB,RG,RR<br>(Bit 8~6)</td><td>Raster Color is determined by these bits.<br>8 colors can be selected and the color intensity of a character is given by 'RINT' bit of Row Attribute Registers.<br>So you can select up to 16 colors.</td></tr>
<tr><td>SHA</td><td>Character Shadowing. Set this bit to activate characters shadowing.</td></tr>
<tr><td>BORD</td><td>Character Bordering. Set this bit to activate characters shadowing.</td></tr>
<tr><td>BOXE<br>(Bit B)</td><td>BOX Enable.<br>If this bit is set, Bit F-D in the Character & Attribute Registers are used for the box-drawing function.<br>Otherwise,those are used for raster color of a font. Even though the raster color attribute is given by Bit 8-6 in the row attribute registers, the priority of Bit F-D in the character & attribute registers is higher.</td></tr>
<tr><td rowspan="2">Row Attribute Registers<br>(Row 00 ~ 14, Column 30)</td><td>CBli<br>(Bit C)</td><td>Color Blink Enable.<br>If this bit is high, color blinking effect is activated. The color effect is to repeat color inversion between character and raster.<br>Color blinking time and the duty is controlled by Bil T, Bil 1 and Bli 0.</td></tr>
<tr><td>Bit D-F</td><td>Reserved</td></tr>
</table>

**Table 4. Register Description (Continued)**

<table>
<tr><th>Registers</th><th>Bits</th><th>Description</th></tr>
<tr><td rowspan="14">Frame Control Registers-0<br>(Row 15, Column 00)</td><td>Bli T<br>(Bit 0)</td><td>Blink Time Control.<br>If this bit is high, the blink time is 0.5 sec. Otherwise, 1 sec.</td></tr>
<tr><td>Bli 1,Bli 0<br>(Bit 2,1)</td><td>Blinking Duty Control.<br>The blinking duty is controlled by the combination of this two bits as following.
<table>
<tr><th>Bli 1</th><th>Bli 0</th><th>Blinking Duty</th></tr>
<tr><td>0</td><td>0</td><td>Blink Off</td></tr>
<tr><td>0</td><td>1</td><td>Duty 25%</td></tr>
<tr><td>1</td><td>0</td><td>Duty 50%</td></tr>
<tr><td>1</td><td>1</td><td>Duty 75%</td></tr>
</table></td></tr>
<tr><td>ScrT<br>(Bit 3)</td><td>Scroll Time Control.<br>If this bit is high, the scroll time is 0.5 sec. Otherwise, 1 sec.</td></tr>
<tr><td>Scrl<br>(Bit 4)</td><td>Scroll Enable.<br>The scroll display is activated by setting this bit high.</td></tr>
<tr><td>EN<br>(Bit 5)</td><td>OSD Enable.<br>The character display is controlled by this bit. If this bit is high, OSD is enable. Otherwise, disable.</td></tr>
<tr><td>Erase<br>(Bit 6)</td><td>RAM Erasing.<br>RAM data are erased by setting this bit.</td></tr>
<tr><td>WSHA<br>(Bit 8)</td><td>Window Shadowing.<br>Set this bit to activate window shadowing.</td></tr>
<tr><td>WBOR<br>(Bit 9)</td><td>Window Bordering.<br>Set this bit to activate window bordering.</td></tr>
<tr><td>WC<br>(Bit A)</td><td>White/black selection of window border and shadow.<br>If this bit is high, the color of window border and shadow is white. Otherwise, black.</td></tr>
<tr><td>HPOL<br>(Bit B)</td><td>Polarity of Horizontal Fly Back Signal. Positive 1, Negative 0</td></tr>
<tr><td>VPOL<br>(Bit C)</td><td>Polarity of Vertical Fly Back Signal. Positive 1, Negative 0</td></tr>
<tr><td>FdeT<br>(Bit D)</td><td>Fade-in and fade-out Time Control.<br>If this bit is high, the time is 0.5 sec. Otherwise, 1 sec.</td></tr>
<tr><td>Fde<br>(Bit E)</td><td>Fade-in and fade-out Enable.<br>The fade-in and fade-out effect is activated by setting this bit high.</td></tr>
<tr><td>Bit F</td><td>Reserved.</td></tr>
</table>

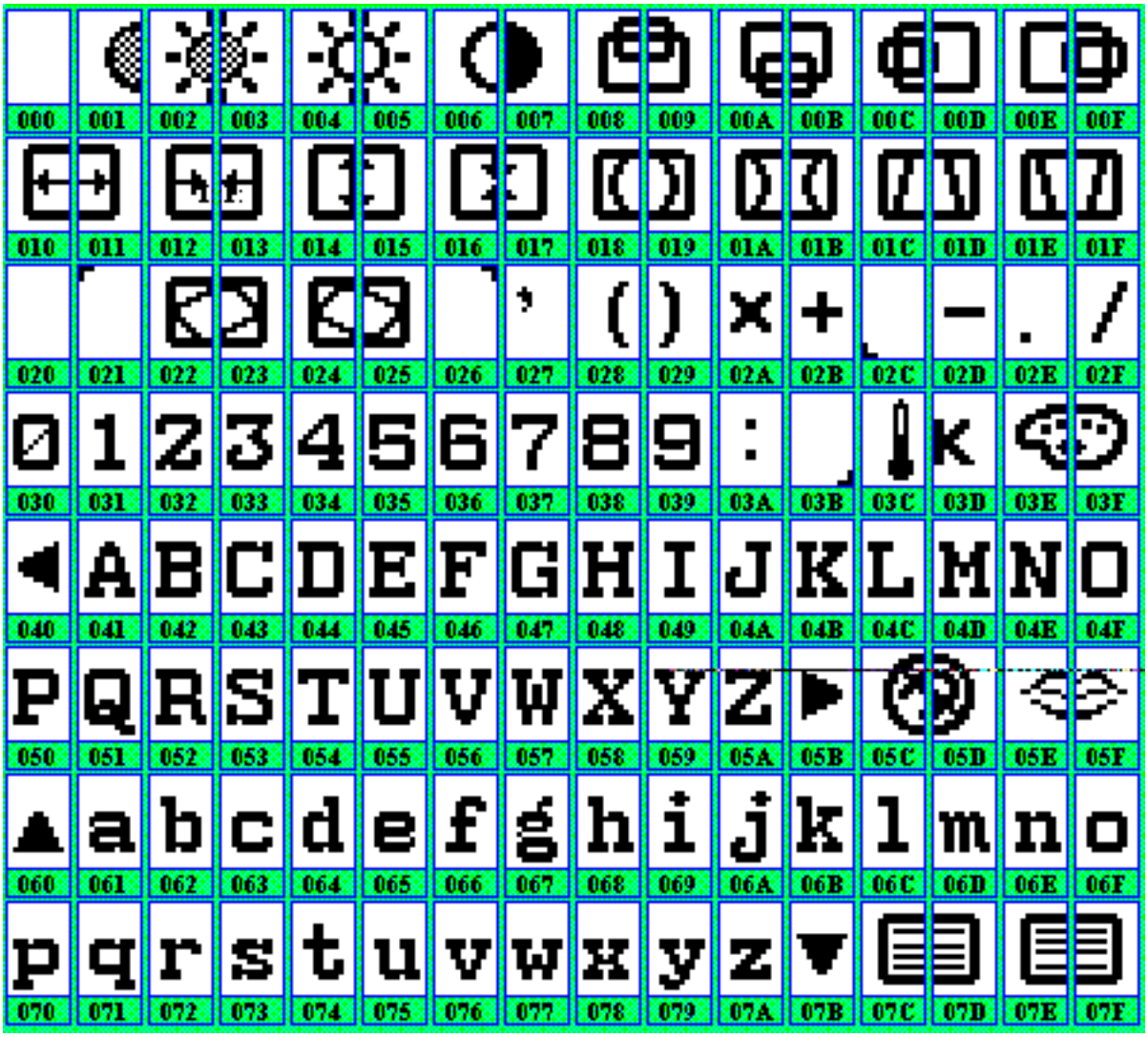
**Table 4. Register Description (Continued)**

<table>
<tr><th>Registers</th><th>Bits</th><th>Description</th></tr>
<tr><td rowspan="5">Frame Control Registers-1<br>(Row 15, Column 01)</td><td>CH 5~CH 0<br>(Bit 5~0)</td><td>Character Height Control.<br>The vertical character size is determined by the bit 'VZ1' and VZ0'.<br>This six bits are available to get a proper character height by setting a binary value. According to the value made by this six bits,<br>the character height is determined.<br>If the value is 32, the number of vertical pixel of character font is 32.<br>Eventually, the character height is expanded from 18 to 63.<br>The binary vlaue must be greater than 18.</td></tr>
<tr><td>BREN</td><td>Back Raster Blank Enable.<br>If this bit is high and the raster color is black, then the raster is transparent.</td></tr>
<tr><td>FBLK<br>(Bit 7)</td><td>It determines the configuration of FBLK output pin.<br>When it is clear, FBLK pin outputs high during displaying characters or rasters. Otherwise,FBLK pin outputs high only during displaying characters.</td></tr>
<tr><td>dot 1,dot 0<br>(Bit 9,8)</td><td>This two bits determine the number of dots per horizontal line.<br>Refer to following table.<br><table><tr><th>dot 1</th><th>dot 0</th><th>No. of Dots</th></tr><tr><td>0</td><td>0</td><td>320 dots/line</td></tr><tr><td>0</td><td>1</td><td>480 dots/line</td></tr><tr><td>1</td><td>0</td><td>640 dots/line</td></tr><tr><td>1</td><td>1</td><td>800 dots/line</td></tr></table></td></tr>
<tr><td>HF 2~HF 0<br>(Bit C~A)</td><td>The horizontal frequency information is transferred by this two bits as following tables.<br><table><tr><th>HF2</th><th>HF1</th><th>HF0</th><th>Hf Information</th></tr><tr><td>0</td><td>0</td><td>0</td><td>15 kHz < Hf < 20 kHz</td></tr><tr><td>0</td><td>0</td><td>1</td><td>20 kHz ≤ Hf <35 kHz</td></tr><tr><td>0</td><td>1</td><td>0</td><td>35 kHz ≤ Hf < 50 kHz</td></tr><tr><td>0</td><td>1</td><td>1</td><td>50 kHz ≤ Hf < 65 kHz</td></tr><tr><td>1</td><td>0</td><td>0</td><td>65 kHz ≤ Hf <80 kHz</td></tr><tr><td>1</td><td>0</td><td>1</td><td>80 kHz ≤ Hf < 95 kHz</td></tr><tr><td>1</td><td>1</td><td>0</td><td>95 kHz ≤ Hf < 110 kHz</td></tr><tr><td>1</td><td>1</td><td>1</td><td>110 kHz ≤ Hf < 120 kHz</td></tr></table></td></tr>
<tr><td>FPLL<br>(Bit D)</td><td>If this bit is high, the VCO block of OSD_PLL operates on full range (4 MHz - 96 MHz).</td></tr>
</table>

**Table 4. Register Description (Continued)**

<table>
<tr><th>Registers</th><th>Bits</th><th>Description</th></tr>
<tr><td>Frame Control Register-1<br>(Row 15, Column 01)</td><td>CP 1,CP 0<br>(Bit F,E)</td><td>This bit controls charge pump output current.
<table>
<tr><th>CP 1</th><th>CP 0</th><th>Charge Pump Current</th></tr>
<tr><td>0</td><td>0</td><td>0.5mA</td></tr>
<tr><td>0</td><td>1</td><td>0.75mA</td></tr>
<tr><td>1</td><td>0</td><td>1.0mA</td></tr>
<tr><td>1</td><td>1</td><td>1.25mA</td></tr>
</table></td></tr>
<tr><td rowspan="2">Frame Control Register-2<br>(Row 15, Column 02)</td><td>VP 7~VP 0<br>(Bit 7~0)</td><td>Vertical Start Position Control.<br>It means the top margin height from the V-sync reference edge.<br>( = VP[7:0] × 2 )</td></tr>
<tr><td>HP 7~HP 0<br>(Bit F~8)</td><td>Horizontal Start Position Control.<br>It means the horizontal display delay from the H-sync reference edge to the 1'st pixel position of characters. ( = HP[7:0] × 6 )</td></tr>
<tr><td rowspan="5">Frame Control Register-3<br>(Row 15, Column 02)</td><td>STC 4<br>~STC 0</td><td>Window Start Column Position.<br>It means the column address that window starts from.</td></tr>
<tr><td>STR 3<br>~STR 0</td><td>Window Start Row Position.<br>It means the row address that window starts from.</td></tr>
<tr><td>RSI</td><td>Row Space Color Intensity.</td></tr>
<tr><td>RSR,RSG,<br>RSB</td><td>Row Space Color Attribute.</td></tr>
<tr><td>RS 2~RS 0<br>(Bit F~D)</td><td>Row Space.<br>It means the line number between a character row and the next row.<br>The defaut value is 0. (line number for spacing = RS[2:0] × 1)</td></tr>
<tr><td rowspan="5">Frame Control Registers-4<br>(Row 15, Column 04)</td><td>SPC 4~<br>STP 0</td><td>Window Stop Column Position.<br>It means the column address that window stops on.</td></tr>
<tr><td>STR 3~<br>STR 0</td><td>Window Stop Row Position.<br>It means the row address that window stops on.</td></tr>
<tr><td>VW 1, 0</td><td>Vertical width of window shadowing.</td></tr>
<tr><td>HW 1, 0</td><td>Horizontal width of window shadowing.</td></tr>
<tr><td>BW 1, 0</td><td>Width of window bordering.</td></tr>
<tr><td rowspan="2">PWM Registers<br>(Row 15, Column 05 - 08)</td><td>Bit 7~ 0</td><td>This 8-bit value decides the output duty cycle and waveforms of PWM for channel.</td></tr>
<tr><td>Bit F~8</td><td>for channel 2/4/6/8.</td></tr>
</table>

## STANDARD ROM FONTS




080 081 082 083 084 085 086 087 088 089 08A 08B 08C 08D 08E 08F
090 091 092 093 094 095 096 097 098 099 09A 09B 09C 09D 09E 09F
0A0 0A1 0A2 0A3 0A4 0A5 0A6 0A7 0A8 0A9 0AA 0AB 0AC 0AD 0AE 0AF
0B0 0B1 0B2 0B3 0B4 0B5 0B6 0B7 0B8 0B9 0BA 0BB 0BC 0BD 0BE 0BF
0C0 0C1 0C2 0C3 0C4 0C5 0C6 0C7 0C8 0C9 0CA 0CB 0CC 0CD 0CE 0CF
0D0 0D1 0D2 0D3 0D4 0D5 0D6 0D7 0D8 0D9 0DA 0DB 0DC 0DD 0DE 0DF
0E0 0E1 0E2 0E3 0E4 0E5 0E6 0E7 0E8 0E9 0EA 0EB 0EC 0ED 0EE 0EF
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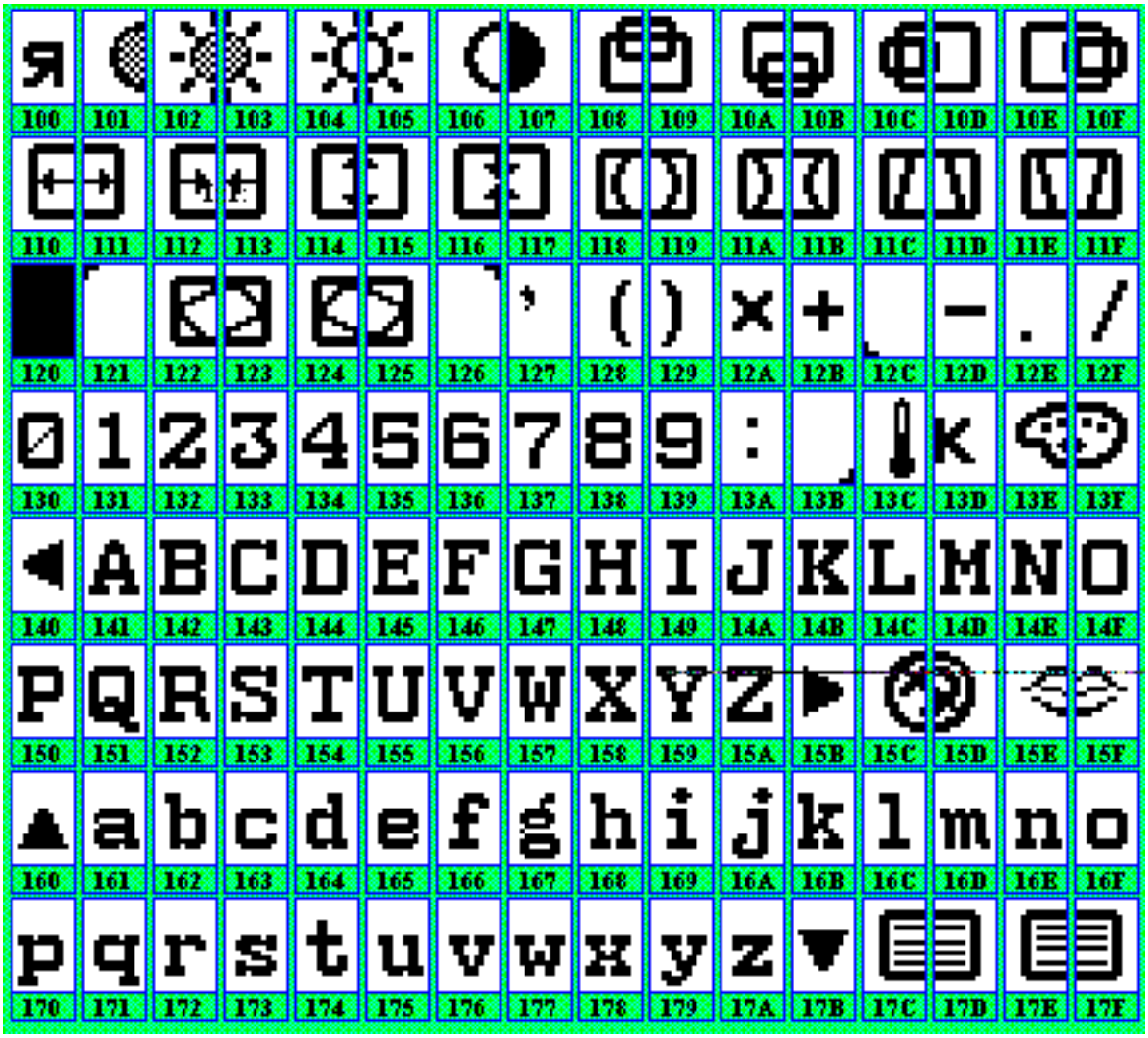
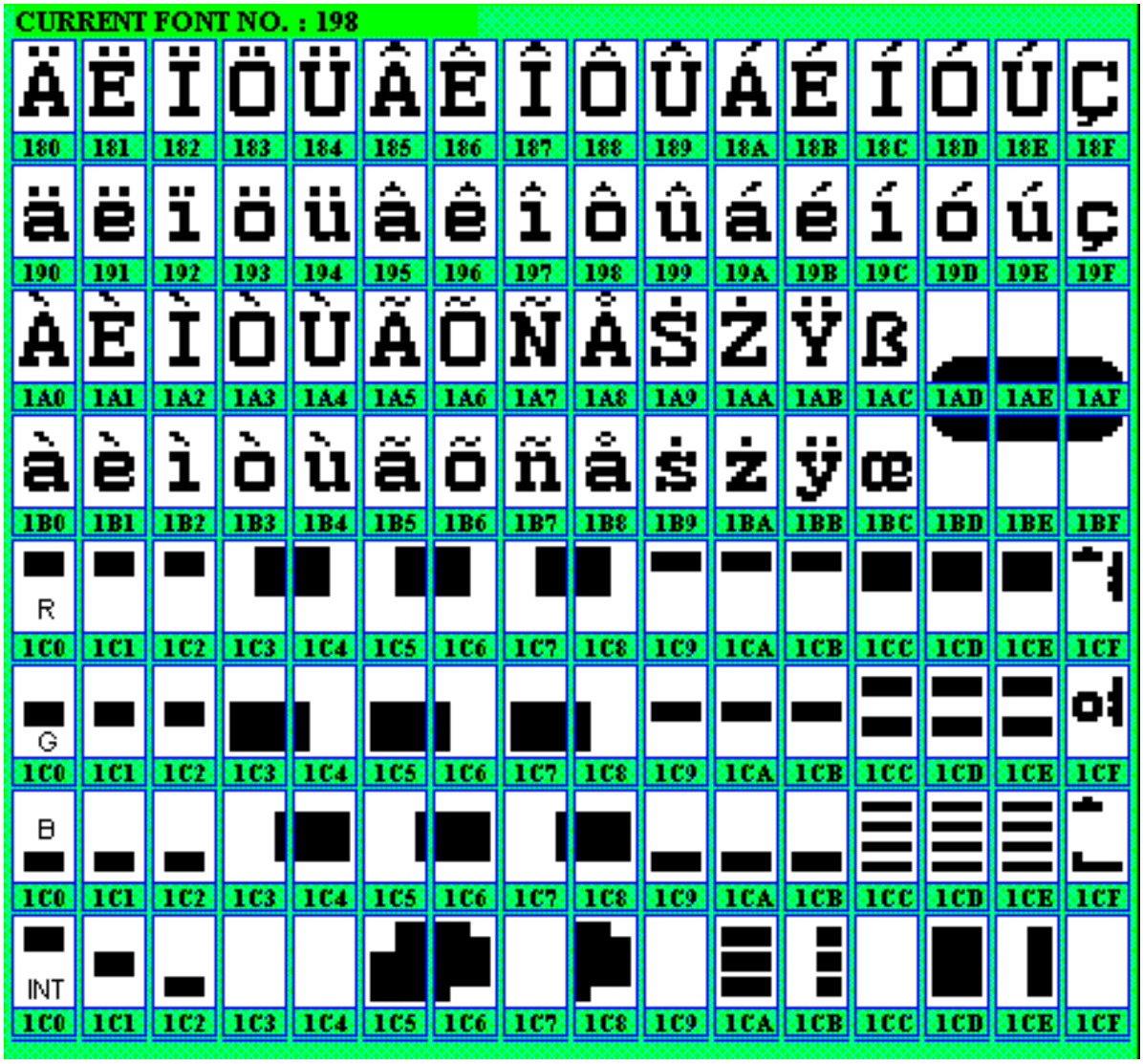
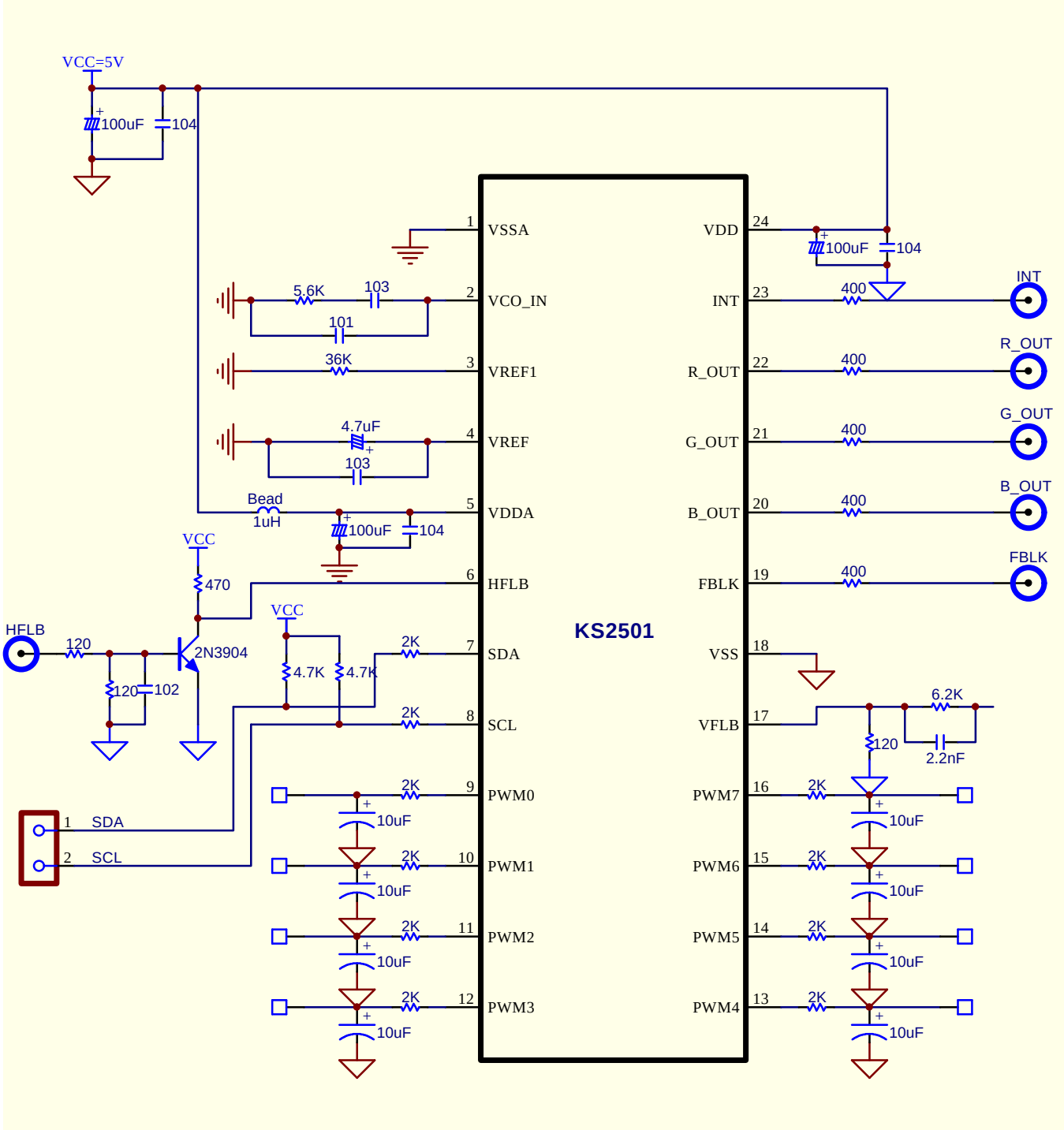
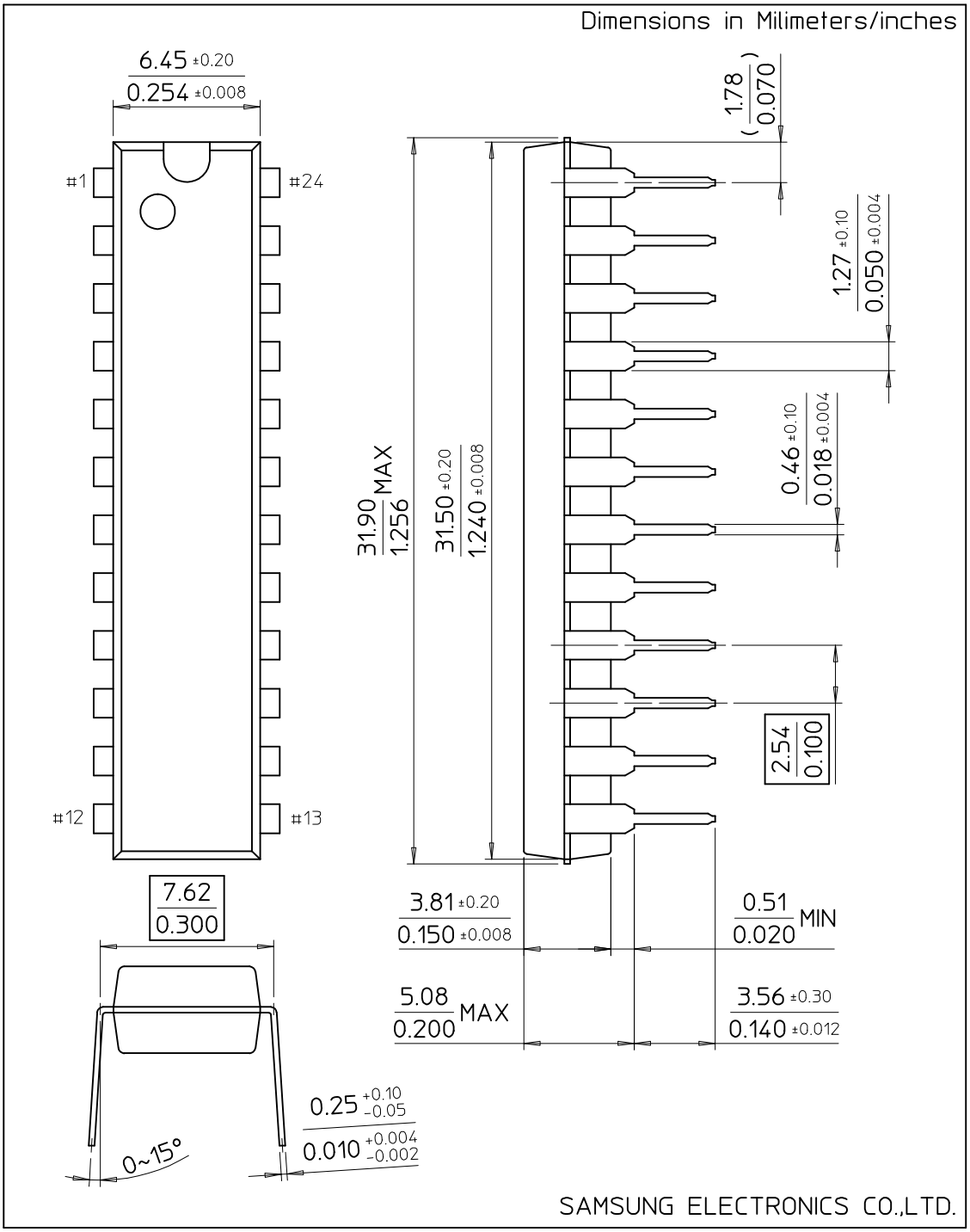

100 101 102 103 104 105 106 107 108 109 10A 10B 10C 10D 10E 10F
110 111 112 113 114 115 116 117 118 119 11A 11B 11C 11D 11E 11F
120 121 122 123 124 125 126 127 128 129 12A 12B 12C 12D 12E 12F
130 131 132 133 134 135 136 137 138 139 13A 13B 13C 13D 13E 13F
140 141 142 143 144 145 146 147 148 149 14A 14B 14C 14D 14E 14F
150 151 152 153 154 155 156 157 158 159 15A 15B 15C 15D 15E 15F
160 161 162 163 164 165 166 167 168 169 16A 16B 16C 16D 16E 16F
170 171 172 173 174 175 176 177 178 179 17A 17B 17C 17D 17E 17F


CURRENT FONT NO. : 198
180 181 182 183 184 185 186 187 188 189 18A 18B 18C 18D 18E 18F
190 191 192 193 194 195 196 197 198 199 19A 19B 19C 19D 19E 19F
1A0 1A1 1A2 1A3 1A4 1A5 1A6 1A7 1A8 1A9 1AA 1AB 1AC 1AD 1AE 1AF
1B0 1B1 1B2 1B3 1B4 1B5 1B6 1B7 1B8 1B9 1BA 1BB 1BC 1BD 1BE 1BF
R
1C0 1C1 1C2 1C3 1C4 1C5 1C6 1C7 1C8 1C9 1CA 1CB 1CC 1CD 1CE 1CF
G
1C0 1C1 1C2 1C3 1C4 1C5 1C6 1C7 1C8 1C9 1CA 1CB 1CC 1CD 1CE 1CF
B
1C0 1C1 1C2 1C3 1C4 1C5 1C6 1C7 1C8 1C9 1CA 1CB 1CC 1CD 1CE 1CF
INT
1C0 1C1 1C2 1C3 1C4 1C5 1C6 1C7 1C8 1C9 1CA 1CB 1CC 1CD 1CE 1CF

## APPLICATION CIRCUIT



# 24–DIP–300


Dimensions in Milimeters/inches
6.45 ±0.20
0.254 ±0.008
#1
#24
#12
#13
7.62
0.300
1.78
(0.070)
1.27 ±0.10
0.050 ±0.004
0.46 ±0.10
0.018 ±0.004
31.90 MAX
1.256
31.50 ±0.20
1.240 ±0.008
2.54
0.100
3.81 ±0.20
0.150 ±0.008
0.51
0.020 MIN
5.08
0.200 MAX
3.56 ±0.30
0.140 ±0.012
0.25 +0.10 −0.05
0.010 +0.004 −0.002
0~15°
SAMSUNG ELECTRONICS CO.,LTD.