



# LC74731W,74732W

## On-Screen Display Controller

Preliminary

An ON Semiconductor Company

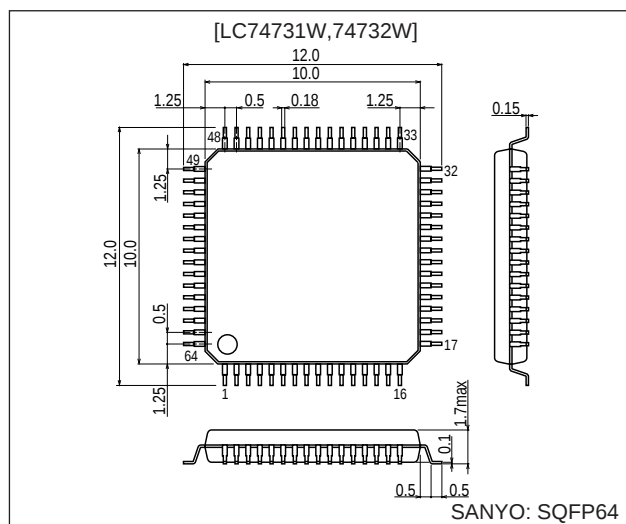
### Overview

The LC74731W and LC74732W are on-screen display CMOS ICs that display characters and patterns on a TV screen under the control of a microcontroller. These ICs display  $16 \times 16$ -dot characters and up to 12 lines of text with 24 characters per line.

### Features

- Text structure: 12 lines  $\times$  24 characters (Up to 288 characters)
- Character format:  $16 \times 16$  dots  
Character display clock frequency: about 9 MHz
- Character sizes: Four sizes each in the horizontal and vertical directions with the size set in line units.
- Number of characters supported:  
LC74731W:256 (internal)  
LC74732W:512 (internal)  
Up to 8192 using an external ROM (for Japanese)  
[Reference] JIS X0298 (1990): 6877 characters  
JIS level 1 kanji: 2965 characters  
JIS level 2 kanji: 3388 characters  
Special characters: 524 characters
- Display start positions: 128 positions each in the horizontal and vertical directions
- Blinking, reverse video, reversed blinking, and character outlining: May be specified in individual character units.
- Blinking types: Two types with periods of about 1.0 and about 0.5 seconds.
- Blanking: The whole font area ( $16 \times 16$  dots) can be blanked in line units  
(Four types: no blanking, character size blanking, character plus outlining size blanking, and whole area up to adjacent character blanking)
- Line spacing control: Zero to seven scan lines, in line units
- Character color: Eight colors in character units (in internal synchronization mode): 2 fsc and 4 fsc (Black, red, green, yellow, blue, magenta, cyan, and white)
- Character background color: Eight colors (in internal synchronization mode): 2 fsc and 4 fsc (Black, red, green, yellow, blue, magenta, cyan, and transparent)
- Screen background color: Eight colors (in internal synchronization mode): 2 fsc and 4 fsc (Black, red, green, yellow, blue, magenta, cyan, and white)
- External control inputs: Serial interface with an 8-bit data size.
- Built-in sync separator circuit
- Video outputs: NTSC, PAL, PALM, PALN, NTSC 4.43, and PAL 60 composite video signal outputs
- Supports Y/C input

### Package Dimensions



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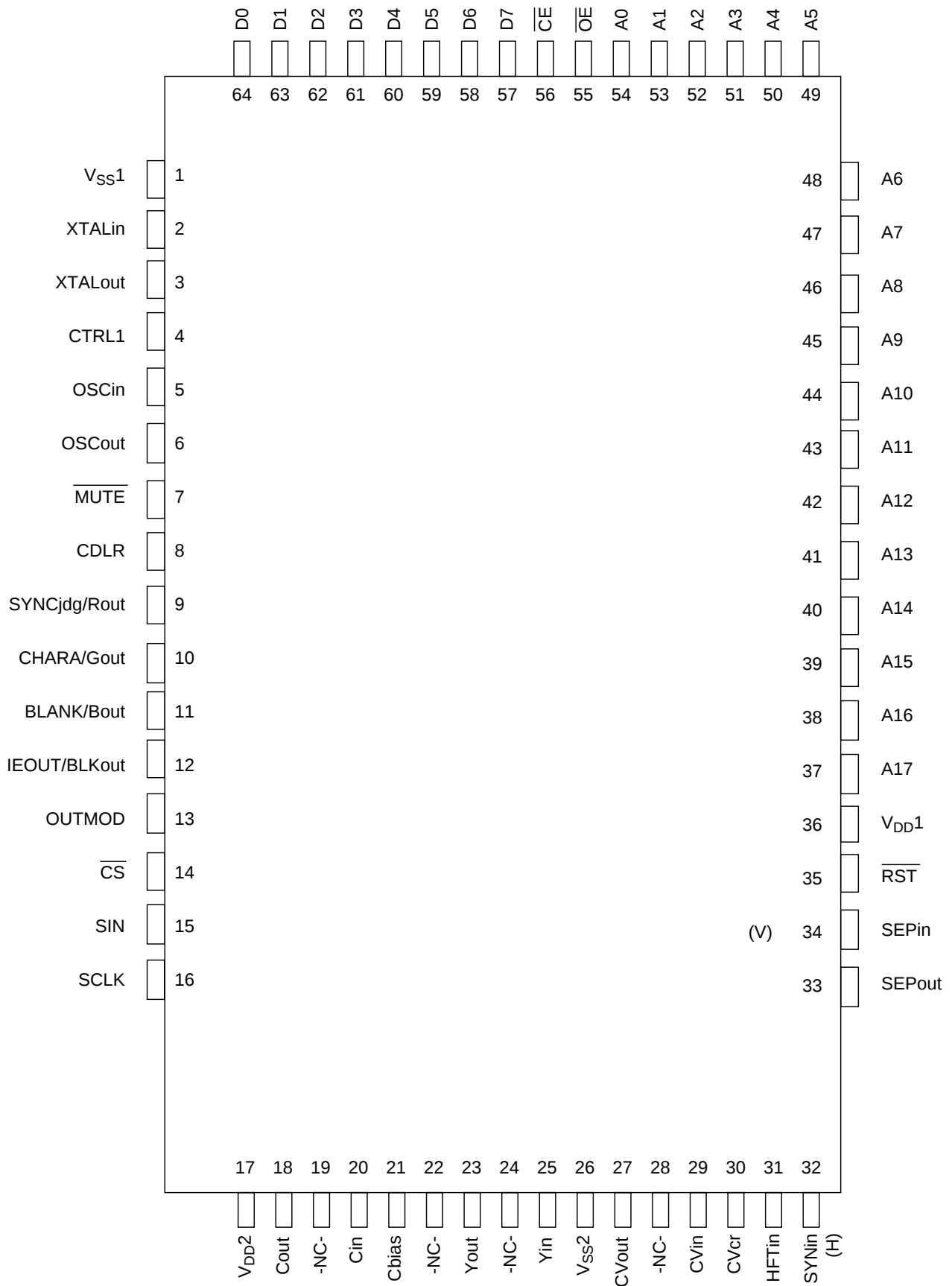
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63000RM (OT) No. 6526-1/38

# Pin Assignment



# LC74731W,74732W

## Pin Functions

| Pin No. | Pin                 | Function                                           | Description                                                                                                                                                                                                                                                                                       |
|---------|---------------------|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | V <sub>SS1</sub>    | Ground                                             | Ground connection. (Digital system ground)                                                                                                                                                                                                                                                        |
| 2       | Xtal <sub>in</sub>  | Crystal oscillator connections                     | Connections for the crystal element and capacitors that form the internal sync signal generating crystal oscillator. Xtal <sub>in</sub> can also be used to input an external clock signal. (2fsc or 4fsc)                                                                                        |
| 3       | Xtal <sub>out</sub> |                                                    |                                                                                                                                                                                                                                                                                                   |
| 4       | CTRL1               | Switches the crystal oscillator input              | Selects external clock input mode or crystal oscillator mode. Low: crystal oscillator mode, high: external clock input mode.                                                                                                                                                                      |
| 5       | OSC <sub>in</sub>   | LC oscillator connections                          | Connections for the coil and capacitor that form the character output dot clock generation oscillator.                                                                                                                                                                                            |
| 6       | OSC <sub>out</sub>  |                                                    |                                                                                                                                                                                                                                                                                                   |
| 7       | MUTE                | Muting control input                               | This is an active-low input with hysteresis characteristics (MORE+).<br>When low, the<br>CV <sub>out</sub> , Y <sub>out</sub> , and Cout outputs are set to either,<br>(1) CSYNC, CSYNC, PE, or<br>(2) PE PE, PE.<br>In the initial state, (1) is selected. This setting is switched by commands. |
| 8       | CDLR                | Background color phase adjustment                  | Connection for the resistor used to adjust the background color phase                                                                                                                                                                                                                             |
| 9       | SYNCJDG /Rout       | External sync signal judgment output (Rout output) | Outputs the result of the judgment as to whether or not the external sync signal is present.<br>A high level is output when a sync signal is present.<br>The dot clock (LC oscillator) is output when RST is low.<br>(The IC can be set up to not output this signal during resets by commands.)  |
| 10      | CHARA/Gout          | Character output (Gout output)                     | Character signal output                                                                                                                                                                                                                                                                           |
| 11      | BLANK/Bout          | Blank output (Bout output)                         | Blank signal output pin                                                                                                                                                                                                                                                                           |
| 12      | IEout/BLKout        | Internal/external output (BLKout output)           | Internal synchronization (high)/external synchronization (low) state output pin                                                                                                                                                                                                                   |
| 13      | OUTMOD              | Output switching input                             | Switches between output from pins 9 to 12 and input to pin 32.<br>Low: normal operation, high: RGB output supported                                                                                                                                                                               |
| 14      | CS                  | Enable input                                       | Serial data input enable<br>Serial data input is enabled when low.<br>more+ (Hysteresis input characteristics)                                                                                                                                                                                    |
| 15      | SIN                 | Data input                                         | Serial data input<br>more+ (Hysteresis input characteristics)                                                                                                                                                                                                                                     |
| 16      | SCLK                | Clock input                                        | Serial data input clock input<br>more+ (Hysteresis input characteristics)                                                                                                                                                                                                                         |
| 17      | V <sub>DD2</sub>    | Power supply                                       | Composite video signal level adjustment power supply. (Analog system power supply)                                                                                                                                                                                                                |
| 18      | COUT                | Color signal output                                | Color (C) signal output                                                                                                                                                                                                                                                                           |
| 19      | NC                  |                                                    | This pin must either be left open or connected to ground.                                                                                                                                                                                                                                         |
| 20      | CIN                 | Color signal input                                 | Color (C) signal input                                                                                                                                                                                                                                                                            |
| 21      | CBIAS               | Chrominance bias output                            | Chrominance signal bias level output                                                                                                                                                                                                                                                              |
| 22      | NC                  |                                                    | This pin must be either left open or connected to ground.                                                                                                                                                                                                                                         |
| 23      | YOUT                | Luminance signal output                            | Luminance signal (Y) output                                                                                                                                                                                                                                                                       |
| 24      | NC                  |                                                    | This pin must be either left open or connected to ground.                                                                                                                                                                                                                                         |
| 25      | YIN                 | Luminance signal input                             | Luminance signal (Y) input                                                                                                                                                                                                                                                                        |
| 26      | V <sub>SS2</sub>    | Ground                                             | Ground                                                                                                                                                                                                                                                                                            |
| 27      | CVOUT               | Video signal output                                | Composite video signal output                                                                                                                                                                                                                                                                     |
| 28      | NC                  |                                                    | This pin must either be left open or connected to ground.                                                                                                                                                                                                                                         |
| 29      | CVIN                | Video signal input                                 | Composite video signal input                                                                                                                                                                                                                                                                      |
| 30      | CVCR                | Video signal input                                 | SECAM chrominance signal input                                                                                                                                                                                                                                                                    |
| 31      | HFT <sub>in</sub>   | Halftone signal input                              | Halftone signal input                                                                                                                                                                                                                                                                             |
| 32      | SYN <sub>in</sub>   | Sync separator circuit input                       | Video signal input to the internal sync separator circuit                                                                                                                                                                                                                                         |
| 33      | SEP <sub>out</sub>  | Composite sync signal output                       | Composite sync signal output from the internal sync separator circuit                                                                                                                                                                                                                             |
| 34      | SEP <sub>in</sub>   | Vertical sync signal input                         | Vertical sync signal input<br>MORE+ (Hysteresis input characteristics)                                                                                                                                                                                                                            |
| 35      | RST                 | Reset input                                        | System reset input<br>A built-in pull-up resistor can be included in this pin's input circuit. (Hysteresis input characteristics)                                                                                                                                                                 |
| 36      | V <sub>DD1</sub>    | Power supply (+5 V)                                | Power supply (+5 V: digital system power supply)                                                                                                                                                                                                                                                  |

Continued on next page.

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Continued from preceding page.

| Pin No. | Pin             | Function          | Description                                                |
|---------|-----------------|-------------------|------------------------------------------------------------|
| 37      | A17             | Address output 17 | ROM address output 17                                      |
| 38      | A16             | Address output 16 | ROM address output 16                                      |
| 39      | A15             | Address output 15 | ROM address output 15                                      |
| 40      | A14             | Address output 14 | ROM address output 14                                      |
| 41      | A13             | Address output 13 | ROM address output 13                                      |
| 42      | A12             | Address output 12 | ROM address output 12                                      |
| 43      | A11             | Address output 11 | ROM address output 11                                      |
| 44      | A10             | Address output 10 | ROM address output 10                                      |
| 45      | A9              | Address output 9  | ROM address output 9                                       |
| 46      | A8              | Address output 8  | ROM address output 8                                       |
| 47      | A7              | Address output 7  | ROM address output 7                                       |
| 48      | A6              | Address output 6  | ROM address output 6                                       |
| 49      | A5              | Address output 5  | ROM address output 5                                       |
| 50      | A4              | Address output 4  | ROM address output 4                                       |
| 51      | A3              | Address output 3  | ROM address output 3                                       |
| 52      | A2              | Address output 2  | ROM address output 2                                       |
| 53      | A1              | Address output 1  | ROM address output 1                                       |
| 54      | A0              | Address output 0  | ROM address output 0                                       |
| 55      | $\overline{OE}$ | Output enable     | ROM output enable output. This is an active-low output.    |
| 56      | $\overline{CE}$ | Chip enable       | ROM chip enable output. This is an active-low output.      |
| 57      | D7              | Data input 7      | ROM data input 7. MORE+ (Hysteresis input characteristics) |
| 58      | D6              | Data input 6      | ROM data input 6. MORE+ (Hysteresis input characteristics) |
| 59      | D5              | Data input 5      | ROM data input 5. MORE+ (Hysteresis input characteristics) |
| 60      | D4              | Data input 4      | ROM data input 4. MORE+ (Hysteresis input characteristics) |
| 61      | D3              | Data input 3      | ROM data input 3. MORE+ (Hysteresis input characteristics) |
| 62      | D2              | Data input 2      | ROM data input 2. MORE+ (Hysteresis input characteristics) |
| 63      | D1              | Data input 1      | ROM data input 1. MORE+ (Hysteresis input characteristics) |
| 64      | D0              | Data input 0      | ROM data input 0. MORE+ (Hysteresis input characteristics) |

## Specifications

Maximum Ratings at  $T_a = 25^\circ\text{C}$

| Parameter                   | Symbol     | Conditions                                           | Ratings        |                 | Unit             |
|-----------------------------|------------|------------------------------------------------------|----------------|-----------------|------------------|
|                             |            |                                                      | min            | max             |                  |
| Supply voltage              | $V_{DD}$   | $V_{DD1}$ and $V_{DD2}$                              | $V_{SS} - 0.3$ | $V_{SS} + 6.5$  | V                |
| Input voltage               | $V_{IN}$   | All input pins                                       | $V_{SS} - 0.3$ | $V_{DD1} + 0.3$ | V                |
| Output voltage              | $V_{OUT}$  | SYNCJDG, BLANK, CHARA, SEPOUT, A0 to A17, CE, and OE | $V_{SS} - 0.3$ | $V_{DD1} + 0.3$ | V                |
| Allowable power dissipation | $P_{dmax}$ |                                                      | —              | 275             | mW               |
| Operating temperature       | $T_{opr}$  |                                                      | $-30$          | $+70$           | $^\circ\text{C}$ |
| Storage temperature         | $T_{stg}$  |                                                      | $-40$          | $+125$          | $^\circ\text{C}$ |

## Recommended Operating Conditions

| Parameter                               | Symbol     | Conditions                                                                                               | Ratings                |        |                 | Unit      |
|-----------------------------------------|------------|----------------------------------------------------------------------------------------------------------|------------------------|--------|-----------------|-----------|
|                                         |            |                                                                                                          | min                    | typ    | max             |           |
| Supply voltage                          | $V_{DD1}$  | $V_{DD1}$                                                                                                | 4.5                    | 5.0    | 5.5             | V         |
|                                         | $V_{DD2}$  | $V_{DD2}$                                                                                                | 4.5                    | 5.0    | 6.5             | V         |
| Supply voltage<br>[Only for RGB output] | $V_{DD1}$  | $V_{DD1}$                                                                                                | 2.7                    | 5.0    | 5.5             | V         |
|                                         | $V_{DD2}$  | $V_{DD2}$                                                                                                | 2.7                    | 5.0    | 6.5             | V         |
| High-level input voltage                | $V_{IH1}$  | $\overline{CS}$ , SIN, SCLK, SEPIN, and MUTE                                                             | $0.8 V_{DD1}$          | —      | 5.5             | V         |
|                                         | $V_{IH2}$  | $\overline{RST}$                                                                                         | $0.8 V_{DD1}$          | —      | $V_{DD1} + 0.3$ | V         |
|                                         | $V_{IH3}$  | CTRL1 and OUTMOD                                                                                         | $0.7 V_{DD1}$          | —      | $V_{DD1} + 0.3$ | V         |
|                                         | $V_{IH4}$  | D0 to D7                                                                                                 | $0.8 V_{DD1}$          | —      | 5.5             | V         |
| Low-level input voltage                 | $V_{IL1}$  | $\overline{RST}$ , $\overline{CS}$ , SIN, SCLK, SEPIN, and MUTE                                          | $V_{SS} - 0.3$         | —      | $0.2 V_{DD1}$   | V         |
|                                         | $V_{IL2}$  | CTRL1 and OUTMOD                                                                                         | $V_{SS} - 0.3$         | —      | $0.3 V_{DD1}$   | V         |
|                                         | $V_{IL3}$  | D0 to D7                                                                                                 | $V_{SS} - 0.3$         | —      | $0.2 V_{DD1}$   | V         |
| Pull-up resistor                        | $R_{PU}$   | $\overline{RST}$ , $\overline{CS}$ , SIN, SCLK, and MUTE (when the pull-up resistor option is specified) | 25                     | 50     | 90              | $k\Omega$ |
| Composite video signal input voltage    | $V_{IN1}$  | CVIN and CVCR                                                                                            | $V_{DD1} = 5\text{ V}$ | —      | 2.0             | Vp-p      |
|                                         | $V_{IN2}$  | SYNIN                                                                                                    | $V_{DD1} = 5\text{ V}$ | 1.5    | 2.0             | Vp-p      |
| Input voltage                           | $V_{IN3}$  | XtalIN (when an external clock input is used)<br>$f_{in} = 2\text{ fsc}, 4\text{ fsc}$                   | $V_{DD1} = 5\text{ V}$ | —      | 5.0             | Vp-p      |
| Oscillator frequency                    | $F_{OSC1}$ | The XtalIN and XtalOUT oscillator pins (2 fsc: NTSC)                                                     |                        | 7.159  |                 | MHz       |
|                                         |            | The XtalIN and XtalOUT oscillator pins (4 fsc: NTSC)                                                     |                        | 14.318 |                 | MHz       |
|                                         |            | The XtalIN and XtalOUT oscillator pins (2 fsc: PAL)                                                      | —                      | 8.867  | —               | MHz       |
|                                         |            | The XtalIN and XtalOUT oscillator pins (4 fsc: PAL)                                                      | —                      | 17.734 | —               | MHz       |
|                                         | $F_{OSC2}$ | The OSCin and OSCout oscillator pins (LC oscillator)                                                     | —                      | 10     | —               | MHz       |

Note: If the Xtalin pin is used in clock input mode, applications must take adequate input noise prevention and reduction measures.

# LC74731W,74732W

## Electrical Characteristics at Ta = –30 to +70°C, V<sub>DD1</sub> = 5 V unless otherwise specified.

| Parameter                  | Symbol             | Pin                                                                         | Conditions                                                   | Ratings              |     |                      | Unit |
|----------------------------|--------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------|----------------------|-----|----------------------|------|
|                            |                    |                                                                             |                                                              | min                  | typ | max                  |      |
| Input off leakage current  | I <sub>leak1</sub> | CV <sub>IN</sub> , CV <sub>CR</sub> , C <sub>IN</sub> , and Y <sub>IN</sub> |                                                              | —                    | —   | 1                    | μA   |
| Output off leakage current | I <sub>leak2</sub> | CV <sub>OUT</sub> , C <sub>OUT</sub> , and Y <sub>OUT</sub>                 |                                                              | —                    | —   | 1                    | μA   |
| High-level output voltage  | V <sub>OH11</sub>  | SYNCJDG, SETPOUT, BLANK, CHARA, and IEOUT                                   | V <sub>DD1</sub> = 5.5 to 4.5 V<br>I <sub>OH</sub> = –1.0 mA | 0.9 V <sub>DD1</sub> | —   | —                    | V    |
|                            | V <sub>OH12</sub>  | SYNCJDG, SETPOUT, BLANK, CHARA, and IEOUT                                   | V <sub>DD1</sub> = 4.4 to 2.7 V<br>I <sub>OH</sub> = –0.5 mA | 0.9 V <sub>DD1</sub> | —   | —                    | V    |
|                            | V <sub>OH21</sub>  | A0 to A17, OE, and CE                                                       | V <sub>DD1</sub> = 5.5 to 4.5 V<br>I <sub>OH</sub> = –1.0 mA | 0.9 V <sub>DD1</sub> | —   | —                    | V    |
|                            | V <sub>OH22</sub>  | A0 to A17, OE, and CE                                                       | V <sub>DD1</sub> = 4.4 to 2.7 V<br>I <sub>OH</sub> = –0.5 mA | 0.9 V <sub>DD1</sub> | —   | —                    | V    |
| Low-level output voltage   | V <sub>OL11</sub>  | SYNCJDG, SEPOUT, BLANK, CHARA, and IEOUT                                    | V <sub>DD1</sub> = 5.5 to 4.5 V<br>I <sub>OL</sub> = 1.0 mA  | —                    | —   | 0.1 V <sub>DD1</sub> | V    |
|                            | V <sub>OL12</sub>  | SYNCJDG, SEPOUT, BLANK, CHARA, and IEOUT                                    | V <sub>DD1</sub> = 4.4 to 2.7 V<br>I <sub>OL</sub> = 0.5 mA  | —                    | —   | 0.1 V <sub>DD1</sub> | V    |
|                            | V <sub>OL21</sub>  | A0 to A17, OE, and CE                                                       | V <sub>DD1</sub> = 5.5 to 4.5 V<br>I <sub>OL</sub> = 1.0 mA  | —                    | —   | 0.1 V <sub>DD1</sub> | V    |
|                            | V <sub>OL22</sub>  | A0 to A17, OE, and CE                                                       | V <sub>DD1</sub> = 4.4 to 2.7 V<br>I <sub>OL</sub> = 0.5 mA  | —                    | —   | 0.1 V <sub>DD1</sub> | V    |
| Input current              | I <sub>IH</sub>    | RST, CS, SIN, SCLK, CTRL1, MUTE, and OUTMOD                                 | V <sub>IN</sub> = V <sub>DD1</sub>                           | —                    | —   | 1                    | μA   |
|                            | I <sub>IL</sub>    | CS, SIN, SCLK, CTRL1, and OUTMOD                                            | V <sub>IN</sub> = V <sub>SS1</sub>                           | –1                   | —   | —                    | μA   |
| Operating current drain    | I <sub>DD1</sub>   | V <sub>DD1</sub>                                                            | All outputs: open<br>Xtal: 17.734 MHz<br>LC: 10 MHz          | —                    | —   | 40                   | mA   |
|                            | I <sub>DD2</sub>   | V <sub>DD2</sub>                                                            | V <sub>DD2</sub> = 5 V                                       | —                    | —   | 20                   | mA   |

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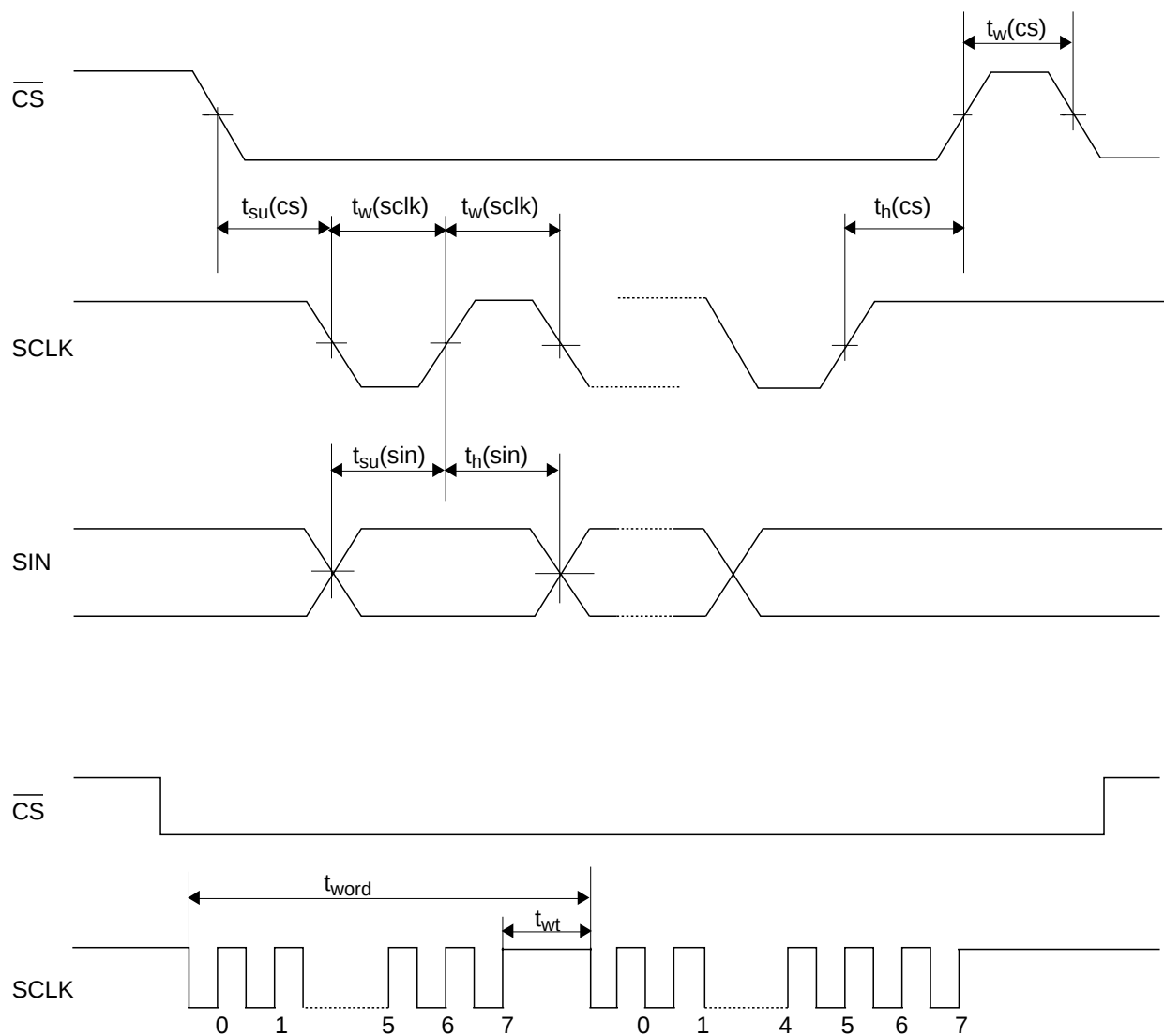
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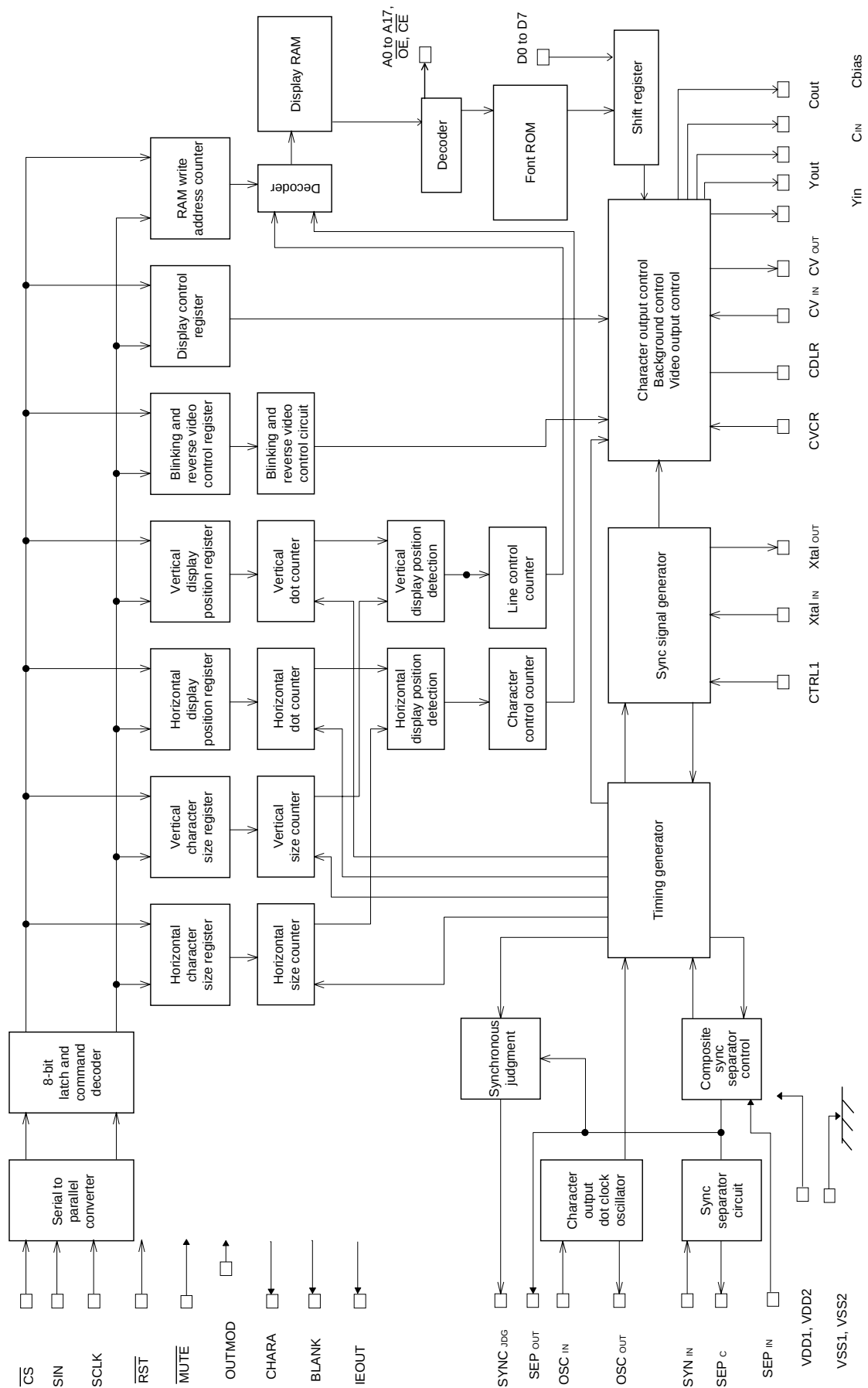
| Parameter                     | Symbol     | Pin                                                                                                         | Conditions                                             |     | Ratings |      |     | Unit |
|-------------------------------|------------|-------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|-----|---------|------|-----|------|
|                               |            |                                                                                                             |                                                        |     | min     | typ  | max |      |
| SYNC level                    | $V_{SN}$   | CVOUT<br>(1): When SYNC – LEVEL = 0.8 V<br>(2): When SYNC – LEVEL = 1.0 V<br>(3): When SYNC – LEVEL = 1.4 V | $V_{DD1} = 5.0 \text{ V}$<br>$V_{DD2} = 5.0 \text{ V}$ | (1) |         | 0.80 |     | V    |
|                               |            |                                                                                                             |                                                        | (2) |         | 1.00 |     |      |
|                               |            |                                                                                                             |                                                        | (3) |         | 1.40 |     |      |
| Pedestal level                | $V_{PD}$   |                                                                                                             |                                                        | (1) |         | 1.37 |     | V    |
|                               |            |                                                                                                             |                                                        | (2) |         | 1.57 |     |      |
|                               |            |                                                                                                             |                                                        | (3) |         | 1.97 |     |      |
| Color burst low level         | $V_{CBL}$  |                                                                                                             |                                                        | (1) |         | 1.07 |     | V    |
|                               |            |                                                                                                             |                                                        | (2) |         | 1.27 |     |      |
|                               |            |                                                                                                             |                                                        | (3) |         | 1.67 |     |      |
| Color burst high level        | $V_{CBH}$  |                                                                                                             |                                                        | (1) |         | 1.67 |     | V    |
|                               |            |                                                                                                             |                                                        | (2) |         | 1.87 |     |      |
|                               |            |                                                                                                             |                                                        | (3) |         | 1.27 |     |      |
| Background color 1 low level  | $V_{RSL1}$ |                                                                                                             |                                                        | (1) |         | 1.23 |     | V    |
|                               |            |                                                                                                             |                                                        | (2) |         | 1.43 |     |      |
|                               |            |                                                                                                             |                                                        | (3) |         | 1.83 |     |      |
| Background color 1 high level | $V_{RSH1}$ |                                                                                                             |                                                        | (1) |         | 2.37 |     | V    |
|                               |            |                                                                                                             |                                                        | (2) |         | 2.57 |     |      |
|                               |            |                                                                                                             |                                                        | (3) |         | 2.97 |     |      |
| Background color 2 low level  | $V_{RSL2}$ |                                                                                                             |                                                        | (1) |         | 1.52 |     | V    |
|                               |            |                                                                                                             |                                                        | (2) |         | 1.72 |     |      |
|                               |            |                                                                                                             |                                                        | (3) |         | 2.12 |     |      |
| Background color 2 high level | $V_{RSH2}$ |                                                                                                             |                                                        | (1) |         | 2.01 |     | V    |
|                               |            |                                                                                                             |                                                        | (2) |         | 2.21 |     |      |
|                               |            |                                                                                                             |                                                        | (3) |         | 2.61 |     |      |
| Outlining level 1             | $V_{BK1}$  |                                                                                                             |                                                        | (1) |         | 1.50 |     | V    |
|                               |            |                                                                                                             |                                                        | (2) |         | 1.70 |     |      |
|                               |            |                                                                                                             |                                                        | (3) |         | 2.10 |     |      |
| Outlining level 2             | $V_{BK2}$  |                                                                                                             |                                                        | (1) |         | 1.80 |     | V    |
|                               |            |                                                                                                             |                                                        | (2) |         | 2.00 |     |      |
|                               |            |                                                                                                             |                                                        | (3) |         | 2.40 |     |      |
| Outlining level 3             | $V_{BK3}$  |                                                                                                             |                                                        | (1) |         | 2.08 |     | V    |
|                               |            |                                                                                                             |                                                        | (2) |         | 2.28 |     |      |
|                               |            |                                                                                                             |                                                        | (3) |         | 2.68 |     |      |
| Character level 1             | $V_{CHA1}$ |                                                                                                             |                                                        | (1) |         | 2.65 |     | V    |
|                               |            |                                                                                                             |                                                        | (2) |         | 2.85 |     |      |
|                               |            |                                                                                                             |                                                        | (3) |         | 3.25 |     |      |
| Character level 3             | $V_{CHA3}$ |                                                                                                             |                                                        | (1) |         | 2.23 |     | V    |
|                               |            |                                                                                                             |                                                        | (2) |         | 2.43 |     |      |
|                               |            |                                                                                                             |                                                        | (3) |         | 2.83 |     |      |

**OSD Write (See figure 1.) at  $T_a = -30$  to  $+70^\circ\text{C}$ ,  $V_{DD1} = 5 \pm 0.5\text{ V}$** 

| Parameter                 | Symbol               | Conditions                                                              | Ratings |     |     | Unit          |
|---------------------------|----------------------|-------------------------------------------------------------------------|---------|-----|-----|---------------|
|                           |                      |                                                                         | min     | typ | max |               |
| Minimum input pulse width | $t_w(\text{sclk})$   | SCLK                                                                    | 200     | —   | —   | ns            |
|                           | $t_w(\text{cs})$     | $\overline{\text{CS}}$ (the period when $\overline{\text{CS}}$ is high) | 1       | —   | —   | $\mu\text{s}$ |
| Data setup time           | $t_{su}(\text{cs})$  | $\overline{\text{CS}}$                                                  | 200     | —   | —   | ns            |
|                           | $t_{su}(\text{sin})$ | SIN                                                                     | 200     | —   | —   | ns            |
| Data hold time            | $t_h(\text{cs})$     | $\overline{\text{CS}}$                                                  | 2       | —   | —   | $\mu\text{s}$ |
|                           | $t_h(\text{sin})$    | SIN                                                                     | 200     | —   | —   | ns            |
| One word write time       | $t_{\text{word}}$    | The time to write 8 bits of data                                        | 4.2     | —   | —   | $\mu\text{s}$ |
|                           | $t_{wt}$             | RAM data write time                                                     | 1       | —   | —   | $\mu\text{s}$ |

**Supplementary Materials****Figure 1 OSD Serial Data Input Timing**

## System Block Diagram



## Display Control Commands

Display control commands have an 8-bit format and are transferred using the serial input function. Commands consist of a command identification code in the first byte and command data in the following bytes.

## Display Control Commands

| Command                                          | First byte                  |   |   |   |        |        |        |        | Second byte |        |        |         |         |        |        |        |
|--------------------------------------------------|-----------------------------|---|---|---|--------|--------|--------|--------|-------------|--------|--------|---------|---------|--------|--------|--------|
|                                                  | Command identification code |   |   |   | Data   |        |        |        | Data        |        |        |         |         |        |        |        |
|                                                  | 7                           | 6 | 5 | 4 | 3      | 2      | 1      | 0      | 7           | 6      | 5      | 4       | 3       | 2      | 1      | 0      |
| COMMAND0<br>(Write address setup)                | 1                           | 0 | 0 | 0 | V3     | V2     | V1     | V0     | 0           | 0      | 0      | H4      | H3      | H2     | H1     | H0     |
| COMMAND1 (Character write)                       | 1                           | 0 | 0 | 1 | IR     | SD2    | SD1    | SD0    | at2         | at1    | CB2    | CB1     | CB0     | CC2    | CC1    | CC0    |
|                                                  |                             |   |   |   |        |        |        |        | 0           | 0      | 0      | C12     | C11     | C10    | C9     | C8     |
|                                                  |                             |   |   |   |        |        |        |        | C7          | C6     | C5     | C4      | C3      | C2     | C1     | C0     |
| COMMAND20<br>(Vertical display start position)   | 1                           | 0 | 1 | 0 | 0      | 0      | RRM1   | RRM0   | 0           | VP6    | VP5    | VP4     | VP3     | VP2    | VP1    | VP0    |
| COMMAND21<br>(Horizontal display start position) | 1                           | 0 | 1 | 0 | 0      | 1      | 0      | 0      | 0           | HP6    | HP5    | HP4     | HP3     | HP2    | HP1    | HP0    |
| COMMAND22<br>(Character size)                    | 1                           | 0 | 1 | 0 | 1      | 0      | 0      | SRM    | 0           | 0      | 0      | 0       | VS1     | VS0    | HS1    | HS0    |
| COMMAND23<br>(Character size - in line units)    | 1                           | 0 | 1 | 0 | 1      | 1      | 0      | LSZUD  | 0           | 0      | LSZB5  | LSZA4   | LSZ93   | LSZ82  | LSZ71  | LSZ60  |
| COMMAND3<br>(Display control)                    | 1                           | 0 | 1 | 1 | TSTMOD | RAMERS | OSCSTP | SYSRST | 0           | LCSOFF | XN53S  | BLKSEL  | LC      | FS     | BK     | DSPON  |
| COMMAND4<br>(Display control)                    | 1                           | 1 | 0 | 0 | NP2    | NP1    | NP0    | I/N    | 0           | HLFINT | BCL1   | BCL0    | CB      | PH2    | PH1    | PH0    |
| COMMAND50<br>(Sync signal detection 1)           | 1                           | 1 | 0 | 1 | 0      | 0      | DISLIN | I/E    | 0           | RN2    | RN1    | RN0     | SN3     | SN2    | SN1    | SN0    |
| COMMAND51<br>(Sync signal detection 2)           | 1                           | 1 | 0 | 1 | 0      | 1      | MUT1   | MUT0   | 0           | 0      | RNE0   | SJN3    | SJN2    | SJN1   | SJC1   | SJC0   |
| COMMAND52<br>(Display control)                   | 1                           | 1 | 0 | 1 | 1      | 0      | EVEBSS | LSPSS  | 0           | CINSEL | CINCTL | VNPSEL  | VSPSEL  | MSKERS | MSKSEL | EGLSEL |
| COMMAND53<br>(Display control)                   | 1                           | 1 | 0 | 1 | 1      | 1      | RSLG1  | RSLG0  | 0           | 0      | CTL3   | SPOSEL  | PALAL4  | IHSEL  | VSSEL  | HSSEL  |
| COMMAND60<br>(Outlining setting)                 | 1                           | 1 | 1 | 0 | 0      | 0      | 0      | BRM    | 0           | BXBLV1 | BXBLV0 | BXWLTV1 | BXWLTV0 | ATSEL  | BLK1   | BLK0   |
| COMMAND61<br>(Outlining setting - in line units) | 1                           | 1 | 1 | 0 | 0      | 1      | 0      | LFCUD  | 0           | 0      | LFCB5  | LFCA4   | LFC93   | LFC82  | LFC71  | LFC60  |
| COMMAND62<br>(Line spacing)                      | 1                           | 1 | 1 | 0 | 1      | 0      | 0      | GRM    | 0           | 0      | BXC1   | GS1     | GS0     | GY2    | GY1    | GY0    |
| COMMAND63<br>(Line spacing - in line units)      | 1                           | 1 | 1 | 0 | 1      | 1      | 0      | LGYUD  | 0           | 0      | LGYB5  | LGYA4   | LGY93   | LGY82  | LGY71  | LGY60  |
| COMMAND70<br>(Display level)                     | 1                           | 1 | 1 | 1 | 0      | 0      | 0      | LRM    | 0           | 0      | BKLC1  | BKLC0   | CHLC1   | CHLC0  | RSLC1  | RSLC0  |
| COMMAND71<br>(Display level - in line units)     | 1                           | 1 | 1 | 1 | 0      | 1      | 0      | LCLUD  | 0           | 0      | LCLB5  | LCLA4   | LCL93   | LCL82  | LCL71  | LCL60  |
| COMMAND72<br>(Halftone - in line units)          | 1                           | 1 | 1 | 1 | 1      | 0      | LHTDAT | LHTUD  | 0           | 0      | LHTB5  | LHTA4   | LHT93   | LHT82  | LHT71  | LHT60  |
| COMMAND73<br>(RGB control)                       | 1                           | 1 | 1 | 1 | 1      | 1      | 0      | 0      | 0           | DASSS  | GBSEL  | OUTSEL  | HSPSW   | XONSS  | BLK01  | BLK00  |

Note that when the display character data write command (COMMAND1) is written, these ICs lock into the display character data write mode, and another first byte cannot be written.

When the CS pin is set high, the these ICs are set to the COMMAND0 (display memory write address setup mode) state.

**COMMAND0 (Display memory write address setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                                    | Notes |
|----------|----------|---------|----------------------------------------------------|-------|
|          |          | State   | Function                                           |       |
| 7        | —        | 1       | Command 0 identification code                      |       |
| 6        | —        | 0       | Display memory write address setup                 |       |
| 5        | —        | 0       |                                                    |       |
| 4        | —        | 0       |                                                    |       |
| 3        | V3       | 0       | Display memory line address (0 to B (hexadecimal)) |       |
|          |          | 1       |                                                    |       |
| 2        | V2       | 0       |                                                    |       |
|          |          | 1       |                                                    |       |
| 1        | V1       | 0       |                                                    |       |
|          |          | 1       |                                                    |       |
| 0        | V0       | 0       |                                                    |       |
|          |          | 1       |                                                    |       |

## • Second byte

| DA0 to 7 | Register | Content |                                                     | Notes |
|----------|----------|---------|-----------------------------------------------------|-------|
|          |          | State   | Function                                            |       |
| 7        | —        | 0       | Second byte identification code                     |       |
| 6        | —        | 0       |                                                     |       |
| 5        | —        | 0       |                                                     |       |
| 4        | H4       | 0       | Display memory line address (0 to 17 (hexadecimal)) |       |
|          |          | 1       |                                                     |       |
| 3        | H3       | 0       |                                                     |       |
|          |          | 1       |                                                     |       |
| 2        | H2       | 0       |                                                     |       |
|          |          | 1       |                                                     |       |
| 1        | H1       | 0       |                                                     |       |
|          |          | 1       |                                                     |       |
| 0        | H0       | 0       |                                                     |       |
|          |          | 1       |                                                     |       |

Note that all registers are set to 0 when these ICs are reset by the  $\overline{\text{RST}}$  pin.

**COMMAND1 (Display character data write setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                                                        | Notes                                                                                                                                   |
|----------|----------|---------|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
|          |          | State   | Function                                                               |                                                                                                                                         |
| 7        | —        | 1       | Command 1 identification code<br>Display character data write settings | Note that when this command is input, the LC74731W/74732W lock into the display character data write mode until the CS pin is set high. |
| 6        | —        | 0       |                                                                        |                                                                                                                                         |
| 5        | —        | 0       |                                                                        |                                                                                                                                         |
| 4        | —        | 1       |                                                                        |                                                                                                                                         |
| 3        | IR       | 0       | Internal ROM                                                           | Switching between internal and external ROM                                                                                             |
|          |          | 1       | External ROM                                                           |                                                                                                                                         |
| 2        | SD2      | 0       | White-on-black (convex) display                                        | Character frame specification                                                                                                           |
|          |          | 1       | Black-on-white (concave) display                                       |                                                                                                                                         |
| 1        | SD1      | 0       | Character frame start: off                                             |                                                                                                                                         |
|          |          | 1       | Character frame start: on                                              |                                                                                                                                         |
| 0        | SD0      | 0       | Character frame stop: off                                              |                                                                                                                                         |
|          |          | 1       | Character frame stop: on                                               |                                                                                                                                         |

## • Second byte (1)

| DA0 to 7 | Register | Content |                                                                        | Notes                                                                   |
|----------|----------|---------|------------------------------------------------------------------------|-------------------------------------------------------------------------|
|          |          | State   | Function                                                               |                                                                         |
| 7        | at2      | 0       | Character attribute 2: off<br>(Character frame upper side: off)        | Blinking specification<br>Selected by COM60 second byte and ATSEL.      |
|          |          | 1       | Character attribute 2: on<br>(Character frame upper side: on)          |                                                                         |
| 6        | at1      | 0       | Character attribute 1: off<br>(Character frame lower side: off)        | Reverse video specification<br>Selected by COM60 second byte and ATSEL. |
|          |          | 1       | Character attribute 1: on<br>(Character frame lower side: on)          |                                                                         |
| 5        | cb2      | 0       | cb2    cb1    cb0    Character background color<br>( B      G      R ) | Character background color specification                                |
|          |          | 1       |                                                                        |                                                                         |
| 4        | cb1      | 0       | 0    0    0    Black                                                   |                                                                         |
|          |          | 1       | 0    0    1    Red                                                     |                                                                         |
| 3        | cb0      | 0       | 0    1    0    Green                                                   |                                                                         |
|          |          |         | 0    1    1    Yellow                                                  |                                                                         |
|          |          | 1       | 1    0    0    Blue                                                    |                                                                         |
|          |          |         | 1    0    1    Magenta                                                 |                                                                         |
|          |          |         | 1    1    0    Cyan                                                    |                                                                         |
|          |          |         | 1    1    1    Transparent                                             |                                                                         |
| 2        | cc2      | 0       | cc2    cc1    cc0    Character color<br>( B      G      R )            | Character color specification                                           |
|          |          | 1       |                                                                        |                                                                         |
| 1        | cc1      | 0       | 0    0    0    Black                                                   |                                                                         |
|          |          | 1       | 0    0    1    Red                                                     |                                                                         |
| 0        | cc0      | 0       | 0    1    0    Green                                                   |                                                                         |
|          |          |         | 0    1    1    Yellow                                                  |                                                                         |
|          |          | 1       | 1    0    0    Blue                                                    |                                                                         |
|          |          |         | 1    0    1    Magenta                                                 |                                                                         |
|          |          |         | 1    1    0    Cyan                                                    |                                                                         |
|          |          |         | 1    1    1    White                                                   |                                                                         |

• Second byte (2)

| DA0 to 7 | Register | Content |                                             | Notes                      |
|----------|----------|---------|---------------------------------------------|----------------------------|
|          |          | State   | Function                                    |                            |
| 7        | —        | 0       |                                             |                            |
| 6        | —        | 0       |                                             |                            |
| 5        | —        | 0       |                                             |                            |
| 4        | c12      | 0       | Character code (00xx to 1Fxx (hexadecimal)) | External ROM upper address |
|          |          | 1       |                                             |                            |
| 3        | c11      | 0       |                                             |                            |
|          |          | 1       |                                             |                            |
| 2        | c10      | 0       |                                             |                            |
|          |          | 1       |                                             |                            |
| 1        | c09      | 0       |                                             |                            |
|          |          | 1       |                                             |                            |
| 0        | c08      | 0       |                                             |                            |
|          |          | 1       |                                             |                            |

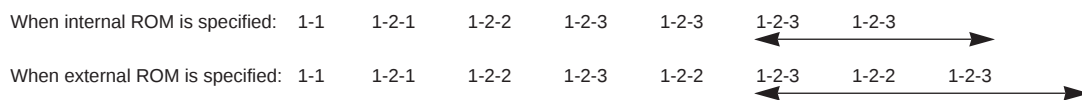
Note that all registers are set to 0 when these ICs are reset by the  $\overline{\text{RST}}$  pin.

• Second byte (3)

| DA0 to 7 | Register | Content |                                                                                                                               | Notes                                              |
|----------|----------|---------|-------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
|          |          | State   | Function                                                                                                                      |                                                    |
| 7        | c07      | 0       | Character code (00 to FF (hexadecimal))<br>FE (hexadecimal): Space character<br>FF (hexadecimal): Transparent space character | External ROM lower address<br>Internal ROM address |
|          |          | 1       |                                                                                                                               |                                                    |
| 6        | c06      | 0       |                                                                                                                               |                                                    |
|          |          | 1       |                                                                                                                               |                                                    |
| 5        | c05      | 0       |                                                                                                                               |                                                    |
|          |          | 1       |                                                                                                                               |                                                    |
| 4        | c04      | 0       |                                                                                                                               |                                                    |
|          |          | 1       |                                                                                                                               |                                                    |
| 3        | c03      | 0       |                                                                                                                               |                                                    |
|          |          | 1       |                                                                                                                               |                                                    |
| 2        | c02      | 0       |                                                                                                                               |                                                    |
|          |          | 1       |                                                                                                                               |                                                    |
| 1        | c01      | 0       |                                                                                                                               |                                                    |
|          |          | 1       |                                                                                                                               |                                                    |
| 0        | c00      | 0       |                                                                                                                               |                                                    |
|          |          | 1       |                                                                                                                               |                                                    |

Note that all registers are set to 0 when these ICs are reset by the  $\overline{\text{RST}}$  pin.

Continuous mode (cleared by setting  $\overline{\text{CS}}$  high) operates as follows according to IR.

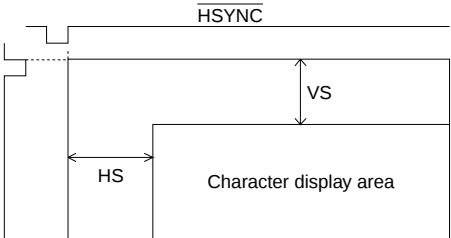


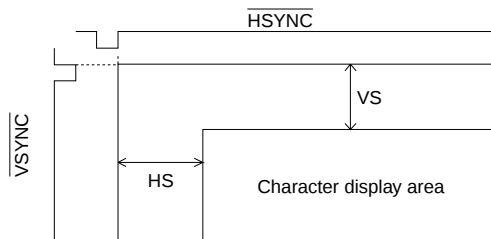
**COMMAND20 (Vertical display start position setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                                                          |      |                               |       |       |                                         | Notes |       |
|----------|----------|---------|--------------------------------------------------------------------------|------|-------------------------------|-------|-------|-----------------------------------------|-------|-------|
|          |          | State   | Function                                                                 |      |                               |       |       |                                         |       |       |
| 7        | —        | 1       | Command 2 identification code                                            |      |                               |       |       |                                         |       |       |
| 6        | —        | 0       | Vertical display position and vertical direction character size settings |      |                               |       |       |                                         |       |       |
| 5        | —        | 1       |                                                                          |      |                               |       |       |                                         |       |       |
| 4        | —        | 0       |                                                                          |      |                               |       |       |                                         |       |       |
| 3        | —        | 0       | Extended command 0 identification code                                   |      |                               |       |       |                                         |       |       |
| 2        | —        | 0       |                                                                          |      |                               |       |       |                                         |       |       |
| 1        | RRM1     | 0       | RRM1                                                                     | RRM0 |                               |       |       | Continuous RAM write mode specification |       |       |
|          |          | 1       | 0                                                                        | 0    | Initial value (depends on IR) |       |       |                                         |       |       |
| 0        | RRM0     | 0       | 0                                                                        | 1    | 1-2-1                         | 1-2-2 | 1-2-3 |                                         |       | Fixed |
|          |          | 1       | 1                                                                        | 0    | 1-2-2                         | 1-2-3 | Fixed |                                         |       |       |
|          |          | 1       | 1                                                                        | 1    | 1-2-3                         | Fixed |       |                                         |       |       |

## • Second byte

| DA0 to 7 | Register  | Content |                                                                                                                                                                                                                                                                                                                            | Notes                                                                                                  |
|----------|-----------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
|          |           | State   | Function                                                                                                                                                                                                                                                                                                                   |                                                                                                        |
| 7        | —         | 0       | Second byte identification bit                                                                                                                                                                                                                                                                                             | The vertical display start position is set by the 7 bits VP0 to VP6.<br><br>The weight of bit 1 is 2H. |
| 6        | VP6 (MSB) | 0       | If VS is the vertical display start position then:<br><br>$VS = \alpha + H \times (2 \sum_{n=0}^6 2^n VP_n)$<br><br>H: the horizontal synchronization pulse period<br><br>$\alpha = 20H$ (525H systems)<br>= 25H (625H systems)<br><br> |                                                                                                        |
|          |           | 1       |                                                                                                                                                                                                                                                                                                                            |                                                                                                        |
| 5        | VP5       | 0       |                                                                                                                                                                                                                                                                                                                            |                                                                                                        |
|          |           | 1       |                                                                                                                                                                                                                                                                                                                            |                                                                                                        |
| 4        | VP4       | 0       |                                                                                                                                                                                                                                                                                                                            |                                                                                                        |
|          |           | 1       |                                                                                                                                                                                                                                                                                                                            |                                                                                                        |
| 3        | VP3       | 0       |                                                                                                                                                                                                                                                                                                                            |                                                                                                        |
|          |           | 1       |                                                                                                                                                                                                                                                                                                                            |                                                                                                        |
| 2        | VP2       | 0       |                                                                                                                                                                                                                                                                                                                            |                                                                                                        |
|          |           | 1       |                                                                                                                                                                                                                                                                                                                            |                                                                                                        |
| 1        | VP1       | 0       |                                                                                                                                                                                                                                                                                                                            |                                                                                                        |
|          |           | 1       |                                                                                                                                                                                                                                                                                                                            |                                                                                                        |
| 0        | VP0 (LSB) | 0       |                                                                                                                                                                                                                                                                                                                            |                                                                                                        |
|          |           | 1       |                                                                                                                                                                                                                                                                                                                            |                                                                                                        |



**COMMAND21 (Horizontal display start position setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                                                                    | Notes |
|----------|----------|---------|------------------------------------------------------------------------------------|-------|
|          |          | State   | Function                                                                           |       |
| 7        | —        | 1       | Command 2 identification code                                                      |       |
| 6        | —        | 0       | Horizontal display position setup and horizontal direction character size settings |       |
| 5        | —        | 1       |                                                                                    |       |
| 4        | —        | 0       |                                                                                    |       |
| 3        | —        | 0       | Extended command 1 identification code                                             |       |
| 2        | —        | 1       |                                                                                    |       |
| 1        | —        | 0       |                                                                                    |       |
| 0        | —        | 0       |                                                                                    |       |

## • Second byte

| DA0 to 7 | Register  | Content |                                                                                                                                                                                | Notes                                                                                                     |
|----------|-----------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
|          |           | State   | Function                                                                                                                                                                       |                                                                                                           |
| 7        | —         | 0       | Second byte identification bit                                                                                                                                                 | The horizontal display start position is set by the 7 bits HP0 to HP6.<br><br>The weight of bit 1 is 2Tc. |
| 6        | HP6 (MSB) | 0       | If HS is the horizontal start position then:<br><br>$HS = Tc \times (2 \sum_{n=0}^6 2^n HP n)$<br><br>Tc: Period of the oscillator connected to OSCIN/OSCOU in operating mode. |                                                                                                           |
|          |           | 1       |                                                                                                                                                                                |                                                                                                           |
| 5        | HP5       | 0       |                                                                                                                                                                                |                                                                                                           |
|          |           | 1       |                                                                                                                                                                                |                                                                                                           |
| 4        | HP4       | 0       |                                                                                                                                                                                |                                                                                                           |
|          |           | 1       |                                                                                                                                                                                |                                                                                                           |
| 3        | HP3       | 0       |                                                                                                                                                                                |                                                                                                           |
|          |           | 1       |                                                                                                                                                                                |                                                                                                           |
| 2        | HP2       | 0       |                                                                                                                                                                                |                                                                                                           |
|          |           | 1       |                                                                                                                                                                                |                                                                                                           |
| 1        | HP1       | 0       |                                                                                                                                                                                |                                                                                                           |
|          |           | 1       |                                                                                                                                                                                |                                                                                                           |
| 0        | HP0 (LSB) | 0       |                                                                                                                                                                                |                                                                                                           |
|          |           | 1       |                                                                                                                                                                                |                                                                                                           |

Note that all registers are set to 0 when these ICs are reset by the  $\overline{RST}$  pin.

**COMMAND22 (Character size setting command)**

## • First byte

| DA0 to 7 | Register | Content |                                                            | Notes                                        |
|----------|----------|---------|------------------------------------------------------------|----------------------------------------------|
|          |          | State   | Function                                                   |                                              |
| 7        | —        | 1       | Command 2 identification code                              |                                              |
| 6        | —        | 0       | Horizontal display position setup and horizontal direction |                                              |
| 5        | —        | 1       | character size settings                                    |                                              |
| 4        | —        | 0       |                                                            |                                              |
| 3        | —        | 1       | Extended command 2 identification code                     |                                              |
| 2        | —        | 0       |                                                            |                                              |
| 1        | —        | 0       |                                                            |                                              |
| 0        | SRM      | 0       | Continuous mode: off                                       | Character size continuous mode specification |
|          |          | 1       | Continuous mode: on                                        |                                              |

## • Second byte

| DA0 to 7 | Register | Content |                                |     |                | Notes                                              |
|----------|----------|---------|--------------------------------|-----|----------------|----------------------------------------------------|
|          |          | State   | Function                       |     |                |                                                    |
| 7        | —        | 0       | Second byte identification bit |     |                |                                                    |
| 6        | —        | 0       |                                |     |                |                                                    |
| 5        | —        | 0       |                                |     |                |                                                    |
| 4        | —        | 0       |                                |     |                |                                                    |
| 3        | VS1      | 0       | VS1                            | VS0 | Character size | Vertical direction character size, in line units   |
|          |          | 1       | 0                              | 0   | 1×             |                                                    |
| 2        | VS0      | 0       | 0                              | 1   | 2×             |                                                    |
|          |          | 1       | 1                              | 0   | 3×             |                                                    |
|          |          |         | 1                              | 1   | 4×             |                                                    |
| 1        | HS1      | 0       | HS1                            | HS0 | Character size | Horizontal direction character size, in line units |
|          |          | 1       | 0                              | 0   | 1×             |                                                    |
| 0        | HS0      | 0       | 0                              | 1   | 2×             |                                                    |
|          |          | 1       | 1                              | 0   | 3×             |                                                    |
|          |          |         | 1                              | 1   | 4×             |                                                    |

Note that all registers are set to 0 when these ICs are reset by the  $\overline{\text{RST}}$  pin.

**COMMAND23 (Character size and line setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                                            | Notes                          |
|----------|----------|---------|------------------------------------------------------------|--------------------------------|
|          |          | State   | Function                                                   |                                |
| 7        | —        | 1       | Command 2 identification code                              |                                |
| 6        | —        | 0       | Horizontal display position setup and horizontal direction |                                |
| 5        | —        | 1       | character size settings                                    |                                |
| 4        | —        | 0       |                                                            |                                |
| 3        | —        | 1       | Extended command 3 identification code                     |                                |
| 2        | —        | 1       |                                                            |                                |
| 1        | —        | 0       |                                                            |                                |
| 0        | LSZUD    | 0       | Lower lines: 0 to 5 (hexadecimal)                          | Upper/lower line specification |
|          |          | 1       | Upper lines: 6 to B (hexadecimal)                          |                                |

## • Second byte

| DA0 to 7 | Register | Content |                                     | Notes                                                       |
|----------|----------|---------|-------------------------------------|-------------------------------------------------------------|
|          |          | State   | Function                            |                                                             |
| 7        | —        | 0       | Second byte identification bit      |                                                             |
| 6        | —        | 0       |                                     |                                                             |
| 5        | LSZB5    | 0       | Line 6 (line 12) specification: off | The line shown in parentheses is specified when LSZUD is 1. |
|          |          | 1       | Line 6 (line 12) specification: on  |                                                             |
| 4        | LSZA4    | 0       | Line 5 (line 11) specification: off |                                                             |
|          |          | 1       | Line 5 (line 11) specification: on  |                                                             |
| 3        | LSZ93    | 0       | Line 4 (line 10) specification: off |                                                             |
|          |          | 1       | Line 4 (line 10) specification: on  |                                                             |
| 2        | LSZ82    | 0       | Line 3 (line 9) specification: off  |                                                             |
|          |          | 1       | Line 3 (line 9) specification: on   |                                                             |
| 1        | LSZ71    | 0       | Line 2 (line 8) specification: off  |                                                             |
|          |          | 1       | Line 2 (line 8) specification: on   |                                                             |
| 0        | LSZ60    | 0       | Line 1 (line 7) specification: off  |                                                             |
|          |          | 1       | Line 1 (line 7) specification: on   |                                                             |

Note that all registers are set to 0 when these ICs are reset by the  $\overline{\text{RST}}$  pin.

**COMMAND3 (Display control setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                                       | Notes                                                                                                  |
|----------|----------|---------|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
|          |          | State   | Function                                              |                                                                                                        |
| 7        | —        | 1       | Command 3 identification code                         |                                                                                                        |
| 6        | —        | 0       | Display character data write settings                 |                                                                                                        |
| 5        | —        | 1       |                                                       |                                                                                                        |
| 4        | —        | 1       |                                                       |                                                                                                        |
| 3        | TSTMOD   | 0       | Normal operating mode                                 | This bit must always be 0.                                                                             |
|          |          | 1       | Test mode                                             |                                                                                                        |
| 2        | RAMERS   | 0       |                                                       | The RAM erase operation takes about 500 $\mu$ s. (It must be executed in the DSPOFF state.)            |
|          |          | 1       | Erase display RAM (sets the data to FF (hexadecimal)) |                                                                                                        |
| 1        | OSCSTP   | 0       | Do not stop the crystal and LC oscillator circuits.   | This setting is valid in external synchronization mode when character display is off.                  |
|          |          | 1       | Stop the crystal and LC oscillator circuits.          |                                                                                                        |
| 0        | SYSRST   | 0       |                                                       | The reset occurs when the $\overline{CS}$ pin is low, and is cleared when $\overline{CS}$ is set high. |
|          |          | 1       | Reset all registers. This turns the display off.      |                                                                                                        |

## • Second byte

| DA0 to 7 | Register | Content |                                                  | Notes                                                                         |
|----------|----------|---------|--------------------------------------------------|-------------------------------------------------------------------------------|
|          |          | State   | Function                                         |                                                                               |
| 7        | —        | 0       | Second byte identification bit                   |                                                                               |
| 6        | LCSOFF   | 0       | Normal operation                                 | Switches the LC oscillator STOP control                                       |
|          |          | 1       | LC oscillator STOP: Disabled                     |                                                                               |
| 5        | XN53S    | 0       | Normal                                           | Switches the crystal oscillator capability                                    |
|          |          | 1       | Switching                                        |                                                                               |
| 4        | BLKSEL   | 0       | Character display area                           | Specifies the character size that fills the whole character area.             |
|          |          | 1       | Video display area                               |                                                                               |
| 3        | LC       | 0       | The LC oscillator is used as the dot clock.      | Selects the dot clock used for character display in the horizontal direction. |
|          |          | 1       | The crystal oscillator is used as the dot clock. |                                                                               |
| 2        | FS       | 0       | Crystal oscillator frequency: 2 fsc              | Sets the crystal oscillator frequency.                                        |
|          |          | 1       | Crystal oscillator frequency: 4 fsc              |                                                                               |
| 1        | BK       | 0       | Blinking period: 0.5 s                           | Switches the blinking period.                                                 |
|          |          | 1       | Blinking period: 1 s                             |                                                                               |
| 0        | DSPON    | 0       | Character display: off                           |                                                                               |
|          |          | 1       | Character display: on                            |                                                                               |

Note that all registers are set to 0 when these ICs are reset by the  $\overline{RST}$  pin.

**COMMAND4 (Display control setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                                           |     |     |               | Notes                      |                                               |  |
|----------|----------|---------|-----------------------------------------------------------|-----|-----|---------------|----------------------------|-----------------------------------------------|--|
|          |          | State   | Function                                                  |     |     |               |                            |                                               |  |
| 7        | —        | 1       | Command 4 identification code<br>Display control settings |     |     |               |                            |                                               |  |
| 6        | —        | 1       |                                                           |     |     |               |                            |                                               |  |
| 5        | —        | 0       |                                                           |     |     |               |                            |                                               |  |
| 4        | —        | 0       |                                                           |     |     |               |                            |                                               |  |
| 3        | NP2      | 0       | NP2                                                       | NP1 | NP0 | Signal format | Switches the signal format |                                               |  |
|          |          | 1       | 0                                                         | 0   | 0   | NTSC          |                            |                                               |  |
| 2        | NP1      | 0       | 0                                                         | 0   | 1   | PAL-M         |                            |                                               |  |
|          |          | 1       | 0                                                         | 1   | 0   | PAL           |                            |                                               |  |
| 1        | NP0      | 0       | 0                                                         | 1   | 1   | PAL-N         |                            |                                               |  |
|          |          | 1       | 1                                                         | 0   | 0   | NTSC4.43      |                            |                                               |  |
|          |          |         | 1                                                         | 0   | 1   | PAL60         |                            |                                               |  |
| 0        | I/N      | 0       | Interlaced                                                |     |     |               |                            | Switches between interlaced and noninterlaced |  |
|          |          | 1       | Noninterlaced                                             |     |     |               |                            |                                               |  |

## • Second byte

| DA0 to 7 | Register | Content |                                       |      |                                              | Notes                          |                              |
|----------|----------|---------|---------------------------------------|------|----------------------------------------------|--------------------------------|------------------------------|
|          |          | State   | Function                              |      |                                              |                                |                              |
| 7        | —        | 0       | Second byte identification bit        |      |                                              |                                |                              |
| 6        | HLFINT   | 0       | Normal mode                           |      |                                              |                                |                              |
|          |          | 1       | Semi-internal synchronization mode    |      |                                              |                                |                              |
| 5        | BCL1     | 0       | BCL1                                  | BCL0 | Only valid in internal synchronization mode. |                                |                              |
|          |          | 1       | 0                                     | 0    |                                              |                                | Background color shown       |
| 4        | BCL0     | 0       | 0                                     | 1    |                                              |                                | No background color (RSL1)   |
|          |          | 1       | 1                                     | 0    |                                              |                                | No background color (CBH)    |
|          |          |         | 1                                     | 1    |                                              |                                | No background color (RSH1)   |
| 3        | CB       | 0       | The color burst signal is output.     |      |                                              |                                | Only valid when BCL is high. |
|          |          | 1       | Color burst signal output is stopped. |      |                                              |                                |                              |
| 2        | PH2      | 0       | PH2                                   | PH1  | PH0                                          | Background color specification |                              |
|          |          | 1       | B                                     | G    | R                                            |                                |                              |
| 1        | PH1      | 0       | 0                                     | 0    | Black (RSLx)                                 |                                |                              |
|          |          | 1       | 0                                     | 0    | 1                                            |                                | Red                          |
| 0        | PH0      | 1       | 0                                     | 1    | 0                                            |                                | Green                        |
|          |          |         | 0                                     | 1    | 1                                            |                                | Yellow                       |
|          |          |         | 1                                     | 0    | 0                                            |                                | Blue                         |
|          |          |         | 1                                     | 0    | 1                                            |                                | Magenta                      |
|          |          |         | 1                                     | 1    | 0                                            |                                | Cyan                         |
|          |          |         | 1                                     | 1    | 1                                            |                                | White (RSHx)                 |

Note that all registers are set to 0 when these ICs are reset by the RST pin.

**COMMAND50 (Sync signal detection 1 setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                        | Notes                                                  |
|----------|----------|---------|----------------------------------------|--------------------------------------------------------|
|          |          | State   | Function                               |                                                        |
| 7        | —        | 1       | Command 5 identification code          |                                                        |
| 6        | —        | 1       | Sync signal control settings           |                                                        |
| 5        | —        | 0       |                                        |                                                        |
| 4        | —        | 1       |                                        |                                                        |
| 3        | —        | 0       | Extended command 0 identification code |                                                        |
| 2        | —        | 0       |                                        |                                                        |
| 1        | DISLIN   | 0       | 12 lines                               | Switches the number of lines displayed.                |
|          |          | 1       | 10 lines                               |                                                        |
| 0        | I/E      | 0       | External synchronization               | Switches between internal and external synchronization |
|          |          | 1       | Internal synchronization               |                                                        |

## • Second byte

| DA0 to 7 | Register | Content |                                                | Notes                                                                                                                                                                                                                                                                                                                 |
|----------|----------|---------|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |          | State   | Function                                       |                                                                                                                                                                                                                                                                                                                       |
| 7        | —        | 0       | Second byte identification bit                 |                                                                                                                                                                                                                                                                                                                       |
| 6        | RN2      | 0       | RN2 RN1 RN0 Number of times HSYNC detected     | External sync signal detection control<br>Recognition of the transition from the no signal state to the signal present state.<br>Sets the sampling period in which the sync signal can be detected continuously in the horizontal sync signal period (1H).<br>The values in parentheses apply when RNE0 (COM51) is 1. |
|          |          | 1       | 0 0 0 0 times (32 times)                       |                                                                                                                                                                                                                                                                                                                       |
| 5        | RN1      | 0       | 0 0 1 4 times (64 times)                       |                                                                                                                                                                                                                                                                                                                       |
|          |          | 1       | 0 1 0 8 times (128 times)                      |                                                                                                                                                                                                                                                                                                                       |
| 4        | RN0      | 0       | 1 0 0 16 times (256 times)                     | External sync signal detection control<br>Recognition of the transition from the signal present state to the no signal state.<br>Sets the sampling period time in which the sync signal cannot be detected continuously in the horizontal sync signal period (1H).                                                    |
|          |          | 1       |                                                |                                                                                                                                                                                                                                                                                                                       |
| 3        | SN3      | 0       | SN3 SN2 SN1 SN0 Number of times HSYNC detected |                                                                                                                                                                                                                                                                                                                       |
|          |          | 1       | 0 0 0 0 Not detected                           |                                                                                                                                                                                                                                                                                                                       |
| 2        | SN2      | 0       | 0 0 0 1 32 times                               |                                                                                                                                                                                                                                                                                                                       |
|          |          | 1       | 0 0 1 0 64 times                               |                                                                                                                                                                                                                                                                                                                       |
| 1        | SN1      | 0       | 0 1 0 0 128 times                              |                                                                                                                                                                                                                                                                                                                       |
|          |          | 1       | 1 0 0 0 256 times                              |                                                                                                                                                                                                                                                                                                                       |
| 0        | SN0      | 0       |                                                |                                                                                                                                                                                                                                                                                                                       |
|          |          | 1       |                                                |                                                                                                                                                                                                                                                                                                                       |

Note that all registers are set to 0 when these ICs are reset by the RST pin.

**COMMAND51 (Sync signal detection 2 setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                                           |      | Notes     |                                                                                  |
|----------|----------|---------|-----------------------------------------------------------|------|-----------|----------------------------------------------------------------------------------|
|          |          | State   | Function                                                  |      |           |                                                                                  |
| 7        | —        | 1       | Command 5 identification code<br>Display control settings |      |           |                                                                                  |
| 6        | —        | 1       |                                                           |      |           |                                                                                  |
| 5        | —        | 0       |                                                           |      |           |                                                                                  |
| 4        | —        | 1       |                                                           |      |           |                                                                                  |
| 3        | —        | 0       | Extended command 1 identification code                    |      |           |                                                                                  |
| 2        | —        | 1       |                                                           |      |           |                                                                                  |
| 1        | MUT1     | 0       | MUT1                                                      | MUT0 | Output    | Video signal output muting function selection<br>Valid when the MUTE pin is low. |
|          |          | 1       | 0                                                         | 0    | CSYNC     |                                                                                  |
| 0        | MUT0     | 0       | 0                                                         | 1    | PE        |                                                                                  |
|          |          | 1       | 1                                                         | 0    | A0-17 “Z” |                                                                                  |

## • Second byte

| DA0 to 7 | Register | Content |                                                                                      |       |              |       | Notes         |                                                                                                                                                                                                                                                          |
|----------|----------|---------|--------------------------------------------------------------------------------------|-------|--------------|-------|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |          | State   | Function                                                                             |       |              |       |               |                                                                                                                                                                                                                                                          |
| 7        | —        | 0       | Second byte identification bit                                                       |       |              |       |               |                                                                                                                                                                                                                                                          |
| 6        | —        | 0       |                                                                                      |       |              |       |               |                                                                                                                                                                                                                                                          |
| 5        | RNE0     | 0       | Sync signal no signal to signal present discrimination - Normal values               |       |              |       |               | Changes the judgment criterion values for sync signal recognition for the no signal to signal present transition. (COM50)                                                                                                                                |
|          |          | 1       | Sync signal no signal to signal present discrimination - Values shown in parentheses |       |              |       |               |                                                                                                                                                                                                                                                          |
| 4        | SJNS3    | 0       | SJNS3                                                                                | SJNS2 | SJNS1        | Times |               | Noise ignoring circuit setting for sync signal recognition for the no signal to signal present transition<br><br>If more than the number of horizontal signals shown at the left are input during a 1H period, the circuit recognizes a no signal state. |
|          |          | 1       | 0                                                                                    | 0     | 0            | None  |               |                                                                                                                                                                                                                                                          |
| 3        | SJNS2    | 0       | 0                                                                                    | 0     | 1            | 4     |               |                                                                                                                                                                                                                                                          |
|          |          | 1       | 0                                                                                    | 1     | 0            | 8     |               |                                                                                                                                                                                                                                                          |
| 2        | SJNS1    | 0       | 0                                                                                    | 1     | 1            | 16    |               |                                                                                                                                                                                                                                                          |
|          |          | 1       | 1                                                                                    | 0     | 0            | 32    |               |                                                                                                                                                                                                                                                          |
|          |          |         | 1                                                                                    | 0     | 1            | 64    |               |                                                                                                                                                                                                                                                          |
|          |          |         | 1                                                                                    | 1     | 0            | 128   |               |                                                                                                                                                                                                                                                          |
|          |          |         | 1                                                                                    | 1     | 1            | 256   |               |                                                                                                                                                                                                                                                          |
| 1        | SJCS1    | 0       | SJCS1                                                                                | SJCS0 | PAL          |       | NTSC          | Synchronization discrimination<br><br>Selects the clock used to delimit the HSYNI signal.                                                                                                                                                                |
|          |          | 1       | 0                                                                                    | 0     | 677 ns (1/3) |       | 558 ns (1/2)  |                                                                                                                                                                                                                                                          |
| 0        | SJCS0    | 0       | 0                                                                                    | 1     | 903 ns (1/4) |       | 838 ns (1/3)  |                                                                                                                                                                                                                                                          |
|          |          | 1       | 1                                                                                    | 0     | 450 ns (1/2) |       | 1117 ns (1/4) |                                                                                                                                                                                                                                                          |

Note that all registers are set to 0 when these ICs are reset by the RST pin.

**COMMAND52 (Display control setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                        | Notes                     |
|----------|----------|---------|----------------------------------------|---------------------------|
|          |          | State   | Function                               |                           |
| 7        | —        | 1       | Command 5 identification code          |                           |
| 6        | —        | 1       | Display control settings               |                           |
| 5        | —        | 0       |                                        |                           |
| 4        | —        | 1       |                                        |                           |
| 3        | —        | 1       | Extended command 2 identification code |                           |
| 2        | —        | 0       |                                        |                           |
| 1        | EVEBSS   | 0       | Normal                                 | Switches the ENBVI signal |
|          |          | 1       | Always high                            |                           |
| 0        | LSPSS    | 0       | Normal                                 | LCSTOP control signal     |
|          |          | 1       | HT12 "on" HT34 "off"                   |                           |

## • Second byte

| DA0 to 7 | Register | Content |                                                                    | Notes                                                                                       |
|----------|----------|---------|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
|          |          | State   | Function                                                           |                                                                                             |
| 7        | —        | 0       | Second byte identification bit                                     |                                                                                             |
| 6        | CINSEL   | 0       | Blank area (the logical OR of the character and outlining signals) | Switches the CV <sub>CR</sub> on state signal                                               |
|          |          | 1       | Video signal display area                                          |                                                                                             |
| 5        | CINCTL   | 0       | CV <sub>CR</sub> : off                                             | CV <sub>CR</sub> on/off switching                                                           |
|          |          | 1       | CV <sub>CR</sub> : on                                              |                                                                                             |
| 4        | VNPSEL   | 0       | V signal falling edges detected                                    | Switches the V signal acquisition polarity when external mode/internal V separation is used |
|          |          | 1       | V signal rising edges detected                                     |                                                                                             |
| 3        | VSPSEL   | 0       | VSEP: About 8.9 $\mu$ s (NTSC)                                     | Switches the internal vertical separation time                                              |
|          |          | 1       | VSEP: About 17.8 $\mu$ s (NTSC)                                    |                                                                                             |
| 2        | MSKERS   | 0       | Mask enabled                                                       | Clears the HSYNC and VSYNC masks                                                            |
|          |          | 1       | Mask disabled                                                      |                                                                                             |
| 1        | MSKSEL   | 0       | 3H (NTSC)                                                          | Switches the VSYNC mask                                                                     |
|          |          | 1       | 20H (NTSC)                                                         |                                                                                             |
| 0        | EGL      | 0       | Outlining level 0 only (VBK0)                                      | Switches the outlining level (Only valid when BLK0 is 0 and BLK1 is 1.)                     |
|          |          | 1       | Two-stage outlining level (VBK0, VBK1)                             |                                                                                             |

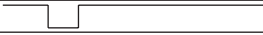
Note that all registers are set to 0 when these ICs are reset by the RST pin.

**COMMAND53 (Display control setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                                           |  |  | Notes |                                            |   |   |     |     |
|----------|----------|---------|-----------------------------------------------------------|--|--|-------|--------------------------------------------|---|---|-----|-----|
|          |          | State   | Function                                                  |  |  |       |                                            |   |   |     |     |
| 7        | —        | 1       | Command 5 identification code<br>Display control settings |  |  |       |                                            |   |   |     |     |
| 6        | —        | 1       |                                                           |  |  |       |                                            |   |   |     |     |
| 5        | —        | 0       |                                                           |  |  |       |                                            |   |   |     |     |
| 4        | —        | 1       |                                                           |  |  |       |                                            |   |   |     |     |
| 3        | —        | 1       | Extended command 3 identification code                    |  |  |       |                                            |   |   |     |     |
| 2        | —        | 1       |                                                           |  |  |       |                                            |   |   |     |     |
| 1        | RSLG1    | 0       | RSLG1   RSLG0                                             |  |  |       | Switches the screen background color level |   |   |     |     |
|          |          | 1       |                                                           |  |  |       |                                            | 0 | 0 | NO1 | RS1 |
| 0        | RDLG0    | 0       |                                                           |  |  |       |                                            | 0 | 1 | NO2 | RS2 |
|          |          | 1       |                                                           |  |  |       |                                            | 1 | 0 | NO3 | RS3 |

## • Second byte

| DA0 to 7 | Register | Content |                                                                                                       | Notes                                                        |
|----------|----------|---------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
|          |          | State   | Function                                                                                              |                                                              |
| 7        | —        | 0       | Second byte identification bit                                                                        |                                                              |
| 6        | —        | 0       |                                                                                                       |                                                              |
| 5        | CTL3     | 0       | Internal vertical separation circuit                                                                  | Switches the VSYNC signal input                              |
|          |          | 1       | External input                                                                                        |                                                              |
| 4        | SP0SEL   | 0       | CSYNC (sync separator output)                                                                         | Switches the SEPout pin output                               |
|          |          | 1       | Halftone output                                                                                       |                                                              |
| 3        | PALAL4   | 0       | Normal                                                                                                |                                                              |
|          |          | 1       | Always use 4 fsc timing (PAL)                                                                         |                                                              |
| 2        | IHSEL    | 0       | SYNin pin input signal                                                                                | Switches the internal vertical separation input signal       |
|          |          | 1       | SEPin pin input signal                                                                                |                                                              |
| 1        | VSSEL    | 0       | Negative polarity  | Switches the SEPin input polarity                            |
|          |          | 1       | Positive polarity  |                                                              |
| 0        | HSSEL    | 0       | Negative polarity  | Switches the SYNin input polarity (Invalid for CVIDEO input) |
|          |          | 1       | Positive polarity  |                                                              |

Note that all registers are set to 0 when these ICs are reset by the RST pin.

SYNin: CVIDEO (Built-in sync separator circuit)

SEPin: None (internal vertical separation)

or

:VSYNC

SYNin: HD

SEPin: CSYNC (internal vertical separation)

SYNin: HSYNC

SEPin: VSYNC

SYNin: CSYNC (internal vertical separation)

SEPin: None

**COMMAND60 (Outlining control setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                        | Notes                     |
|----------|----------|---------|----------------------------------------|---------------------------|
|          |          | State   | Function                               |                           |
| 7        | —        | 1       | Command 6 identification code          |                           |
| 6        | —        | 1       | Display control settings               |                           |
| 5        | —        | 1       |                                        |                           |
| 4        | —        | 0       |                                        |                           |
| 3        | —        | 0       | Extended command 0 identification code |                           |
| 2        | —        | 0       |                                        |                           |
| 1        | —        | 0       |                                        |                           |
| 0        | BRM      | 0       | Normal mode                            | Specifies continuous mode |
|          |          | 1       | Continuous mode                        |                           |

## • Second byte

| DA0 to 7 | Register | Content |                                | Notes                                                        |
|----------|----------|---------|--------------------------------|--------------------------------------------------------------|
|          |          | State   | Function                       |                                                              |
| 7        | —        | 0       | Second byte identification bit |                                                              |
| 6        | BXBLV1   | 0       | BXBLV1 BXBLV0                  | Character frame - black level specification<br>In line units |
|          |          | 1       | 0 0 NO1 BK1                    |                                                              |
| 5        | BXBLV0   | 0       | 0 1 NO2 BK2                    |                                                              |
|          |          | 1       | 1 0 NO3 BK3                    |                                                              |
| 4        | BXWLV1   | 0       | BXWLV1 BXWLV0                  | Character frame - white level specification<br>In line units |
|          |          | 1       | 0 0 NO1 CHA1                   |                                                              |
| 3        | BXWLV0   | 0       | 0 1 NO2 CHA2                   |                                                              |
|          |          | 1       | 1 0 NO3 CHA3                   |                                                              |
| 2        | ATSEL    | 0       | Reverse video, blinking        | Setup for the at1 and at2 function<br>In line units          |
|          |          | 1       | Character frame specified      |                                                              |
| 1        | BLK1     | 0       | BLK1 BLK0 Mode                 | Outlining mode specification<br>In line units                |
|          |          | 1       | 0 0 Normal                     |                                                              |
| 0        | BLK0     | 0       | 0 1 Character size             |                                                              |
|          |          | 1       | 1 0 Outlining size             |                                                              |
|          |          |         | 1 1 Full area size             |                                                              |

Note that all registers are set to 0 when these ICs are reset by the RST pin.

**COMMAND61 (Outlining control and line specification setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                        | Notes                                |
|----------|----------|---------|----------------------------------------|--------------------------------------|
|          |          | State   | Function                               |                                      |
| 7        | —        | 1       | Command 6 identification code          |                                      |
| 6        | —        | 1       | Display control settings               |                                      |
| 5        | —        | 1       |                                        |                                      |
| 4        | —        | 0       |                                        |                                      |
| 3        | —        | 0       | Extended command 1 identification code |                                      |
| 2        | —        | 1       |                                        |                                      |
| 1        | —        | 0       |                                        |                                      |
| 0        | LFCUD    | 0       | Lower lines (0 to 5 (hexadecimal))     | Outlining control line specification |
|          |          | 1       | Upper lines (6 to B (hexadecimal))     |                                      |

## • Second byte

| DA0 to 7 | Register | Content |                                | Notes                                                                      |
|----------|----------|---------|--------------------------------|----------------------------------------------------------------------------|
|          |          | State   | Function                       |                                                                            |
| 7        | —        | 0       | Second byte identification bit |                                                                            |
| 6        | —        | 0       |                                |                                                                            |
| 5        | LFCB5    | 0       | Line 6 (line 12) setting: off  | Outlining line setting<br>The values in parentheses apply when LFCUD is 1. |
|          |          | 1       | Line 6 (line 12) setting: on   |                                                                            |
| 4        | LFCA4    | 0       | Line 5 (line 11) setting: off  |                                                                            |
|          |          | 1       | Line 5 (line 11) setting: on   |                                                                            |
| 3        | LFC93    | 0       | Line 4 (line 10) setting: off  |                                                                            |
|          |          | 1       | Line 4 (line 10) setting: on   |                                                                            |
| 2        | LFC82    | 0       | Line 3 (line 9) setting: off   |                                                                            |
|          |          | 1       | Line 3 (line 9) setting: on    |                                                                            |
| 1        | LFC71    | 0       | Line 2 (line 8) setting: off   |                                                                            |
|          |          | 1       | Line 2 (line 8) setting: on    |                                                                            |
| 0        | LFC60    | 0       | Line 1 (line 7) setting: off   |                                                                            |
|          |          | 1       | Line 1 (line 7) setting: on    |                                                                            |

Note that all registers are set to 0 when these ICs are reset by the  $\overline{\text{RST}}$  pin.

**COMMAND62 (Line spacing control setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                        | Notes                         |
|----------|----------|---------|----------------------------------------|-------------------------------|
|          |          | State   | Function                               |                               |
| 7        | —        | 1       | Command 6 identification code          |                               |
| 6        | —        | 1       | Display control settings               |                               |
| 5        | —        | 1       |                                        |                               |
| 4        | —        | 0       |                                        |                               |
| 3        | —        | 1       | Extended command 2 identification code |                               |
| 2        | —        | 0       |                                        |                               |
| 1        | —        | 0       |                                        |                               |
| 0        | GRM      | 0       | Normal mode                            | Continuous mode specification |
|          |          | 1       | Continuous mode                        |                               |

## • Second byte

| DA0 to 7 | Register | Content |                                                         | Notes                                |
|----------|----------|---------|---------------------------------------------------------|--------------------------------------|
|          |          | State   | Function                                                |                                      |
| 7        | —        | 0       | Second byte identification bit                          |                                      |
| 6        | —        | 0       |                                                         |                                      |
| 5        | BXC1     | 0       | Display outside the character area                      | Box left/right display specification |
|          |          | 1       | Forces display within the character area                | In line units                        |
| 4        | GS1      | 0       | GS1 GS0 Mode                                            | In line units                        |
|          |          | 1       | 0 0 Normal (character background color)                 |                                      |
| 3        | GS0      | 0       | 0 1 Full area and reverse invalid (other than $\pm 1$ ) |                                      |
|          |          | 1       | 1 0 Transparent 1 (all)                                 |                                      |
|          |          |         | 1 1 Transparent 2 (other than $\pm 1$ )                 |                                      |
| 2        | GY2      | 0       | GY2 GY1 GY0 Line spacing                                | In line units                        |
|          |          | 1       | 0 0 0 0                                                 |                                      |
| 1        | GY1      | 0       | 0 0 1 $\pm 1$                                           |                                      |
|          |          | 1       | 0 1 0 2                                                 |                                      |
| 0        | GY0      | 0       | 0 1 1 3                                                 |                                      |
|          |          | 1       | 1 0 0 4                                                 |                                      |
|          |          |         | 1 0 1 5                                                 |                                      |
|          |          |         | 1 1 0 6                                                 |                                      |
|          |          |         | 1 1 1 7                                                 |                                      |
|          |          |         |                                                         |                                      |

Note that all registers are set to 0 when these ICs are reset by the  $\overline{\text{RST}}$  pin.

**COMMAND63 (Line spacing control - line specification setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                        | Notes                                     |
|----------|----------|---------|----------------------------------------|-------------------------------------------|
|          |          | State   | Function                               |                                           |
| 7        | —        | 1       | Command 6 identification code          |                                           |
| 6        | —        | 1       | Display control settings               |                                           |
| 5        | —        | 1       |                                        |                                           |
| 4        | —        | 0       |                                        |                                           |
| 3        | —        | 1       | Extended command 3 identification code |                                           |
| 2        | —        | 1       |                                        |                                           |
| 1        | —        | 0       |                                        |                                           |
| 0        | LGYUD    | 0       | Lower lines (0 to 5 (hexadecimal))     | Line spacing control - line specification |
|          |          | 1       | Upper lines (6 to B (hexadecimal))     |                                           |

## • Second byte

| DA0 to 7 | Register | Content |                                | Notes                                                                                     |
|----------|----------|---------|--------------------------------|-------------------------------------------------------------------------------------------|
|          |          | State   | Function                       |                                                                                           |
| 7        | —        | 0       | Second byte identification bit |                                                                                           |
| 6        | —        | 0       |                                |                                                                                           |
| 5        | LGYB5    | 0       | Line 6 (line 12) setting: off  | Line setting for line spacing control<br>The values in parentheses apply when LGYUD is 1. |
|          |          | 1       | Line 6 (line 12) setting: on   |                                                                                           |
| 4        | LGYA4    | 0       | Line 5 (line 11) setting: off  |                                                                                           |
|          |          | 1       | Line 5 (line 11) setting: on   |                                                                                           |
| 3        | LGY93    | 0       | Line 4 (line 10) setting: off  |                                                                                           |
|          |          | 1       | Line 4 (line 10) setting: on   |                                                                                           |
| 2        | LGY82    | 0       | Line 3 (line 9) setting: off   |                                                                                           |
|          |          | 1       | Line 3 (line 9) setting: on    |                                                                                           |
| 1        | LGY71    | 0       | Line 2 (line 8) setting: off   |                                                                                           |
|          |          | 1       | Line 2 (line 8) setting: on    |                                                                                           |
| 0        | LGY60    | 0       | Line 1 (line 7) setting: off   |                                                                                           |
|          |          | 1       | Line 1 (line 7) setting: on    |                                                                                           |

Note that all registers are set to 0 when these ICs are reset by the  $\overline{\text{RST}}$  pin.

**COMMAND70 (Display control setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                        | Notes                         |
|----------|----------|---------|----------------------------------------|-------------------------------|
|          |          | State   | Function                               |                               |
| 7        | —        | 1       | Command 7 identification code          |                               |
| 6        | —        | 1       | Display control settings               |                               |
| 5        | —        | 1       |                                        |                               |
| 4        | —        | 1       |                                        |                               |
| 3        | —        | 0       | Extended command 0 identification code |                               |
| 2        | —        | 0       |                                        |                               |
| 1        | —        | 0       |                                        |                               |
| 0        | LRM      | 0       | Normal mode                            | Continuous mode specification |
|          |          | 1       | Continuous mode                        |                               |

## • Second byte

| DA0 to 7 | Register | Content |                                | Notes                                                                                         |
|----------|----------|---------|--------------------------------|-----------------------------------------------------------------------------------------------|
|          |          | State   | Function                       |                                                                                               |
| 7        | —        | 0       | Second byte identification bit |                                                                                               |
| 6        | —        | 0       |                                |                                                                                               |
| 5        | BKLC1    | 0       | BKLC1 BKLC0                    | Character color and character background color:<br>black level specification<br>In line units |
|          |          | 1       | 0 0 NO1 BK1                    |                                                                                               |
| 4        | BKLC0    | 0       | 0 1 NO2 BK2                    |                                                                                               |
|          |          | 1       | 1 0 NO3 BK3                    |                                                                                               |
| 3        | CHLC1    | 0       | CHLC1 CHLC0                    | Character color and character background color:<br>white level specification<br>In line units |
|          |          | 1       | 0 0 NO1 CHA1                   |                                                                                               |
| 2        | CHLC0    | 0       | 0 1 NO2 CHA2                   |                                                                                               |
|          |          | 1       | 1 0 NO3 CHA3                   |                                                                                               |
| 1        | RSLC2    | 0       | RSLC1 RSLC0                    | Character color and character background color:<br>color level specification<br>In line units |
|          |          | 1       | 0 0 NO1 RS1                    |                                                                                               |
| 0        | RSLC1    | 0       | 0 1 NO2 RS2                    |                                                                                               |
|          |          | 1       | 1 0 NO3 RS3                    |                                                                                               |

Note that all registers are set to 0 when these ICs are reset by the RST pin.

**COMMAND71 (Display levels - line specification setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                        | Notes                               |
|----------|----------|---------|----------------------------------------|-------------------------------------|
|          |          | State   | Function                               |                                     |
| 7        | —        | 1       | Command 7 identification code          |                                     |
| 6        | —        | 1       | Display control settings               |                                     |
| 5        | —        | 1       |                                        |                                     |
| 4        | —        | 1       |                                        |                                     |
| 3        | —        | 0       | Extended command 1 identification code |                                     |
| 2        | —        | 1       |                                        |                                     |
| 1        | —        | 0       |                                        |                                     |
| 0        | LCLUD    | 0       | Lower lines (0 to 5 (hexadecimal))     | Display levels - line specification |
|          |          | 1       | Upper lines (6 to B (hexadecimal))     |                                     |

## • Second byte

| DA0 to 7 | Register | Content |                                | Notes                                                                          |
|----------|----------|---------|--------------------------------|--------------------------------------------------------------------------------|
|          |          | State   | Function                       |                                                                                |
| 7        | —        | 0       | Second byte identification bit |                                                                                |
| 6        | —        | 0       |                                |                                                                                |
| 5        | LCLB5    | 0       | Line 6 (line 12) setting: off  | Display level line setting<br>The values in parentheses apply when LCLUD is 1. |
|          |          | 1       | Line 6 (line 12) setting: on   |                                                                                |
| 4        | LCLA4    | 0       | Line 5 (line 11) setting: off  |                                                                                |
|          |          | 1       | Line 5 (line 11) setting: on   |                                                                                |
| 3        | LCL93    | 0       | Line 4 (line 10) setting: off  |                                                                                |
|          |          | 1       | Line 4 (line 10) setting: on   |                                                                                |
| 2        | LCL82    | 0       | Line 3 (line 9) setting: off   |                                                                                |
|          |          | 1       | Line 3 (line 9) setting: on    |                                                                                |
| 1        | LCL71    | 0       | Line 2 (line 8) setting: off   |                                                                                |
|          |          | 1       | Line 2 (line 8) setting: on    |                                                                                |
| 0        | LCL60    | 0       | Line 1 (line 7) setting: off   |                                                                                |
|          |          | 1       | Line 1 (line 7) setting: on    |                                                                                |

Note that all registers are set to 0 when these ICs are reset by the RST pin.

**COMMAND72 (Halftone - line specification setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                        | Notes                       |
|----------|----------|---------|----------------------------------------|-----------------------------|
|          |          | State   | Function                               |                             |
| 7        | —        | 1       | Command 7 identification code          |                             |
| 6        | —        | 1       | Display control setup                  |                             |
| 5        | —        | 1       |                                        |                             |
| 4        | —        | 1       |                                        |                             |
| 3        | —        | 1       | Extended command 2 identification code |                             |
| 2        | —        | 0       |                                        |                             |
| 1        | LHTDAT   | 0       | Halftone: off                          | Halftone control            |
|          |          | 1       | Halftone: on                           |                             |
| 0        | LHTUD    | 0       | Lower lines (0 to 5 (hexadecimal))     | Halftone line specification |
|          |          | 1       | Upper lines (6 to B (hexadecimal))     |                             |

## • Second byte

| DA0 to 7 | Register | Content |                                | Notes                                                                     |
|----------|----------|---------|--------------------------------|---------------------------------------------------------------------------|
|          |          | State   | Function                       |                                                                           |
| 7        | —        | 0       | Second byte identification bit |                                                                           |
| 6        | —        | 0       |                                |                                                                           |
| 5        | LHTB5    | 0       | Line 6 (line 12) setting: off  | Halftone line setting<br>The values in parentheses apply when LHTUD is 1. |
|          |          | 1       | Line 6 (line 12) setting: on   |                                                                           |
| 4        | LHTA4    | 0       | Line 5 (line 11) setting: off  |                                                                           |
|          |          | 1       | Line 5 (line 11) setting: on   |                                                                           |
| 3        | LHT93    | 0       | Line 4 (line 10) setting: off  |                                                                           |
|          |          | 1       | Line 4 (line 10) setting: on   |                                                                           |
| 2        | LHT82    | 0       | Line 3 (line 9) setting: off   |                                                                           |
|          |          | 1       | Line 3 (line 9) setting: on    |                                                                           |
| 1        | LHT71    | 0       | Line 2 (line 8) setting: off   |                                                                           |
|          |          | 1       | Line 2 (line 8) setting: on    |                                                                           |
| 0        | LHT60    | 0       | Line 1 (line 7) setting: off   |                                                                           |
|          |          | 1       | Line 1 (line 7) setting: on    |                                                                           |

Note that all registers are set to 0 when these ICs are reset by the RST pin.

**COMMAND73 (RGB control setup command)**

## • First byte

| DA0 to 7 | Register | Content |                                        | Notes |
|----------|----------|---------|----------------------------------------|-------|
|          |          | State   | Function                               |       |
| 7        | —        | 1       | Command 7 identification code          |       |
| 6        | —        | 1       | Display control setup                  |       |
| 5        | —        | 1       |                                        |       |
| 4        | —        | 1       |                                        |       |
| 3        | —        | 1       | Extended command 3 identification code |       |
| 2        | —        | 1       |                                        |       |
| 1        | —        | 0       |                                        |       |
| 0        | —        | 0       |                                        |       |

## • Second byte

| DA0 to 7 | Register | Content |                                    | Notes                                                           |
|----------|----------|---------|------------------------------------|-----------------------------------------------------------------|
|          |          | State   | Function                           |                                                                 |
| 7        | —        | 0       | Second byte identification bit     |                                                                 |
| 6        | DASSS    | 0       | Normal                             | Switches the XTALIN amplifier input                             |
|          |          | 1       | CLKD = CLKX                        | Only valid when RGB output is specified.                        |
| 5        | GBSEL    | 0       | Background color: off              | Switches the background color in RGB output mode                |
|          |          | 1       | Background color: on               | The background color is specified by COM4 second byte.          |
| 4        | OUTSEL   | 0       |                                    | Switches the P9 to P12 outputs                                  |
|          |          | 1       | RGB output switching               | The logical OR with the OUTMOD input.                           |
| 3        | HSPSW    | 0       | Internal Sync separator used       | Switches the SYNin input                                        |
|          |          | 1       | Internal Sync separator not used   | The logical OR with the OUTMOD input.                           |
| 2        | XONSS    | 0       | Operation depends on the CTRL1 pin | Enables or disables the feedback resistor for the XTALIN clock. |
|          |          | 1       | Feedback resistor disconnected     |                                                                 |
| 1        | BLK02    | 0       | BLK01 BLK00                        | Switches the BLKout output                                      |
|          |          | 1       | 0 0 CHA + BK + CHAB                | Box is always on.                                               |
| 0        | BLK01    | 0       | 0 1 CHA +BK only                   | Always on when GBSEL = 1.                                       |
|          |          | 1       | 1 0 CHA only                       |                                                                 |
|          |          | 1       | 1 1 BK only                        |                                                                 |

Display Screen Structure

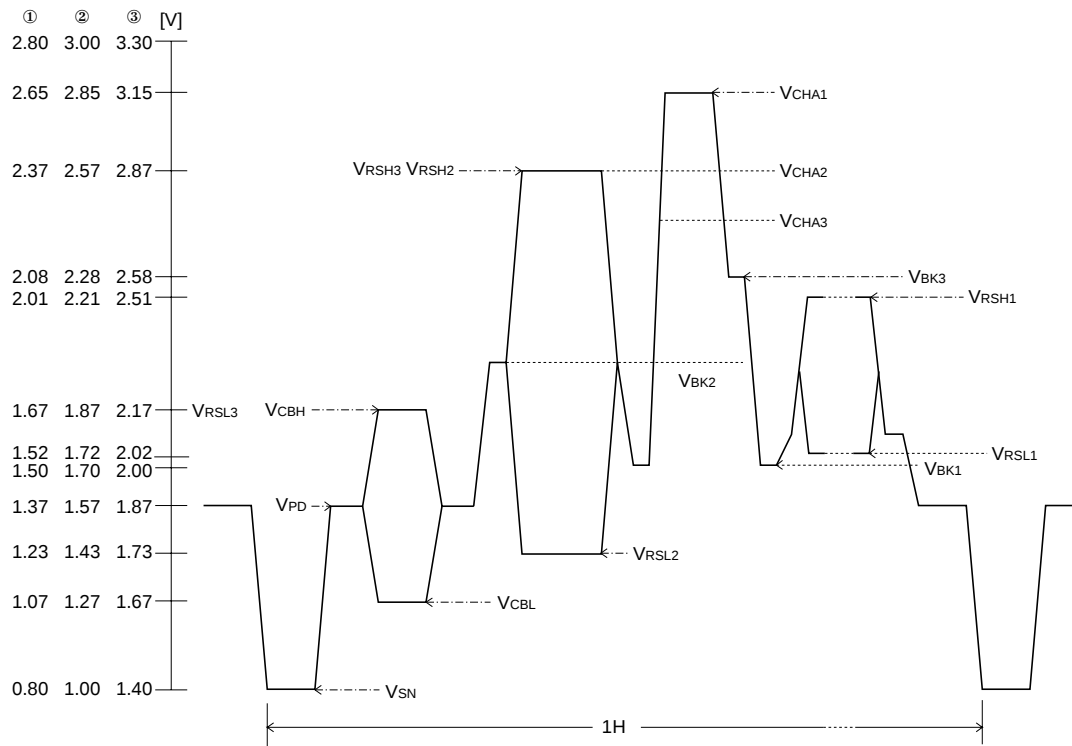
The display consists of 12 lines of 24 characters.  
Up to 288 characters can be displayed.  
The number of characters that can be displayed is less than the 288 maximum when enlarged characters are displayed.  
Display memory addresses are specified as row (0 to 11 decimal) and column (0 to 23 decimal) addresses.

Display Screen Structure (display memory addresses)

|                   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |       |
|-------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-------|
| ← 24 Characters → |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |       |
|                   | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |       |
| 12 Rows           | 00 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 0     |
|                   | 01 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 1     |
|                   | 02 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 2     |
|                   | 03 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 3     |
|                   | 04 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 4     |
|                   | 05 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 5     |
|                   | 06 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 6     |
|                   | 07 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 7     |
|                   | 08 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 8     |
|                   | 09 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | 9     |
|                   | 10 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | A     |
|                   | 11 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | B HEX |
|                   | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | HEX   |

# Composite Video Signal Output Levels (internally generated levels)

- CVOUT Output Level Waveform ( $V_{DD2} = 5.00\text{ V}$ )



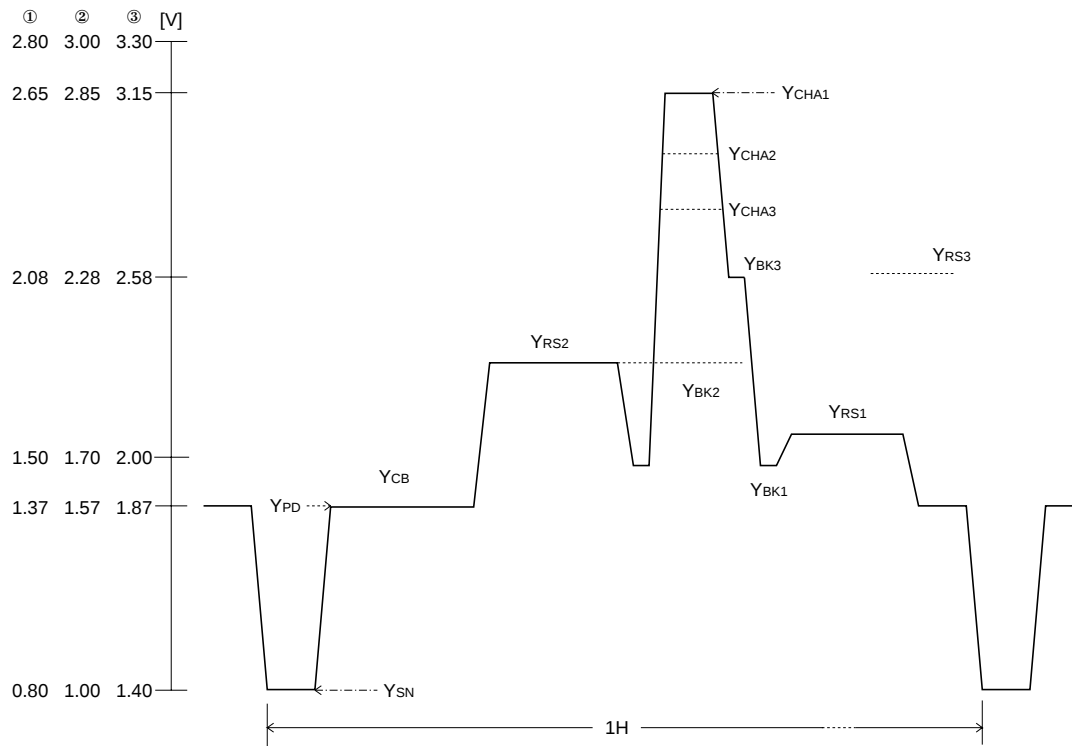
| Output level                                 | Output voltage (1) [V] | Output voltage (2) [V] | Output voltage (3) [V] |
|----------------------------------------------|------------------------|------------------------|------------------------|
| V <sub>CHA1</sub> : Character 1              | 2.65                   | 2.85                   | 3.25                   |
| V <sub>RSH2</sub> : Background color 2: high | 2.37                   | 2.57                   | 2.97                   |
| V <sub>CHA3</sub> : Character 3              | 2.23                   | 2.43                   | 2.83                   |
| V <sub>BK3</sub> : Outlining: 3              | 2.08                   | 2.28                   | 2.68                   |
| V <sub>RSH1</sub> : Background color 1: high | 2.01                   | 2.21                   | 2.61                   |
| V <sub>BK2</sub> : Outlining: 2              | 1.80                   | 2.00                   | 2.40                   |
| V <sub>CBH</sub> : Color burst: high         | 1.67                   | 1.87                   | 2.27                   |
| V <sub>RSL1</sub> : Background color 1: low  | 1.52                   | 1.72                   | 2.12                   |
| V <sub>BK1</sub> : Outlining: 1              | 1.50                   | 1.70                   | 2.10                   |
| V <sub>PD</sub> : Pedestal                   | 1.37                   | 1.57                   | 1.97                   |
| V <sub>RSL2</sub> : Background color 2: low  | 1.23                   | 1.43                   | 1.83                   |
| V <sub>CBL</sub> : Color burst: low          | 1.07                   | 1.27                   | 1.67                   |
| V <sub>SN</sub> : Sync                       | 0.80                   | 1.00                   | 1.40                   |

BCOL01: RSL1

BCOL0: CBH

BCOL11:RSH1

YOUT Output Level Waveform ( $V_{DD2} = 5.00 \text{ V}$ )



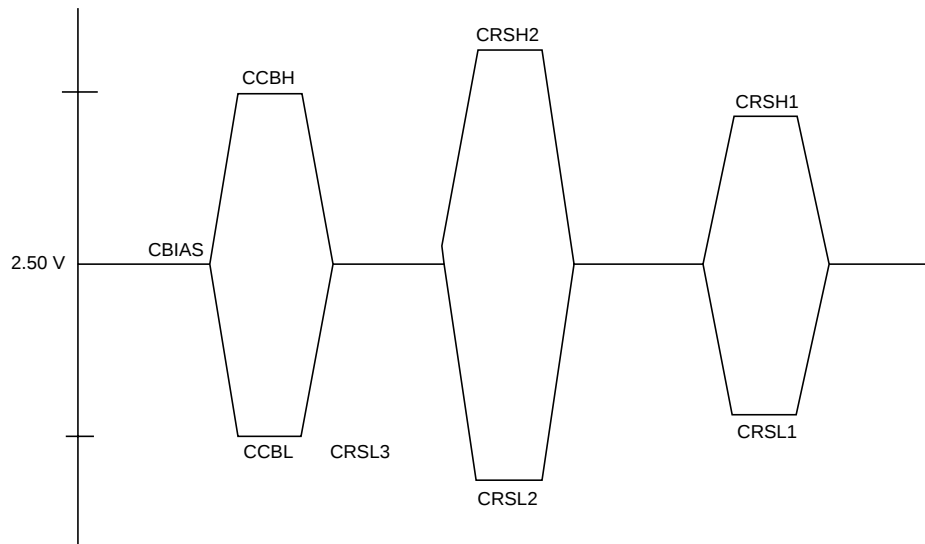
| Output level             | Output voltage (1) [V] | Output voltage (2) [V] | Output voltage (3) [V] |
|--------------------------|------------------------|------------------------|------------------------|
| YCHA1: Character 1       | 2.65                   | 2.85                   | 3.25                   |
| YCHA2: Character 2       | 2.37                   | 2.57                   | 2.97                   |
| YCHA3: Character 3       | 2.23                   | 2.43                   | 2.83                   |
| YBK3: Outlining: 3       | 2.08                   | 2.28                   | 2.68                   |
| YRS3: Background color 3 | 2.02                   | 2.22                   | 2.62                   |
| YRS2: Background color 2 | 1.80                   | 2.00                   | 2.40                   |
| YRS1: Background color 1 | 1.76                   | 1.96                   | 2.36                   |
| YBK1: Outlining: 1       | 1.50                   | 1.70                   | 2.10                   |
| YCB: Color burst         | 1.37                   | 1.57                   | 1.97                   |
| YPD: Pedestal            | 1.37                   | 1.57                   | 1.97                   |
| YSN: Sync                | 0.80                   | 1.00                   | 1.40                   |

BCOL01: YBK1

BCOL10: YRS1

BCOL11: YRS3

- COUT Output Level Waveform ( $V_{DD2} = 5.00 \text{ V}$ )

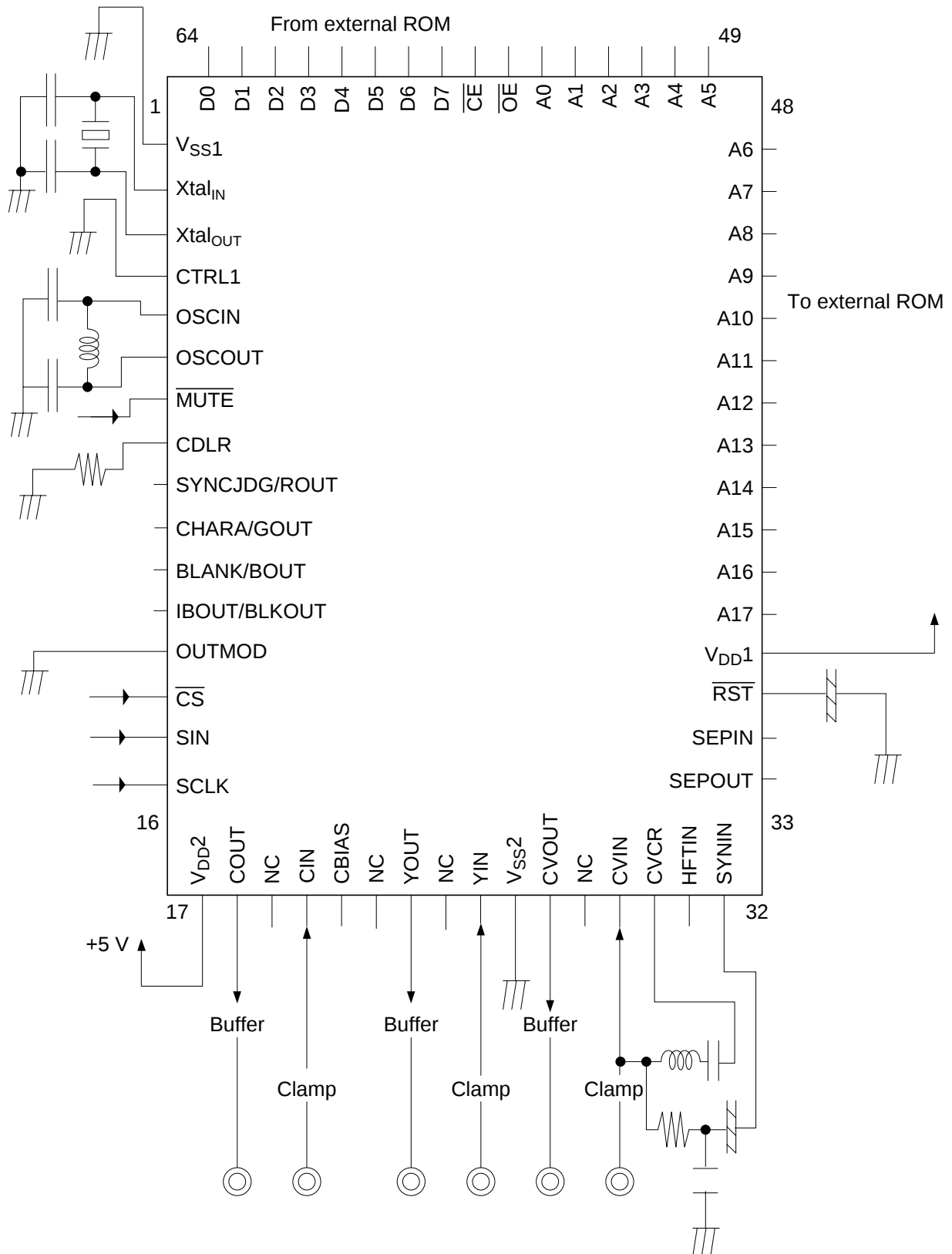


| Output level                    | Output voltage (1) [V] | Output voltage (2) [V] | Output voltage (3) [V] |
|---------------------------------|------------------------|------------------------|------------------------|
| CRSH2: Background color 2: high | 3.07                   | 3.07                   | 3.07                   |
| CCBH: Color burst: high         | 2.80                   | 2.80                   | 2.80                   |
| CRSH1: Background color 1: low  | 2.74                   | 2.74                   | 2.74                   |
| CBIAS: Bias                     | 2.50                   | 2.50                   | 2.50                   |
| CRSL1: Background color 2: low  | 2.25                   | 2.25                   | 2.25                   |
| CCBL: Color burst: low          | 2.20                   | 2.20                   | 2.20                   |
| CRSL2: Background color 2: low  | 1.93                   | 1.93                   | 1.93                   |

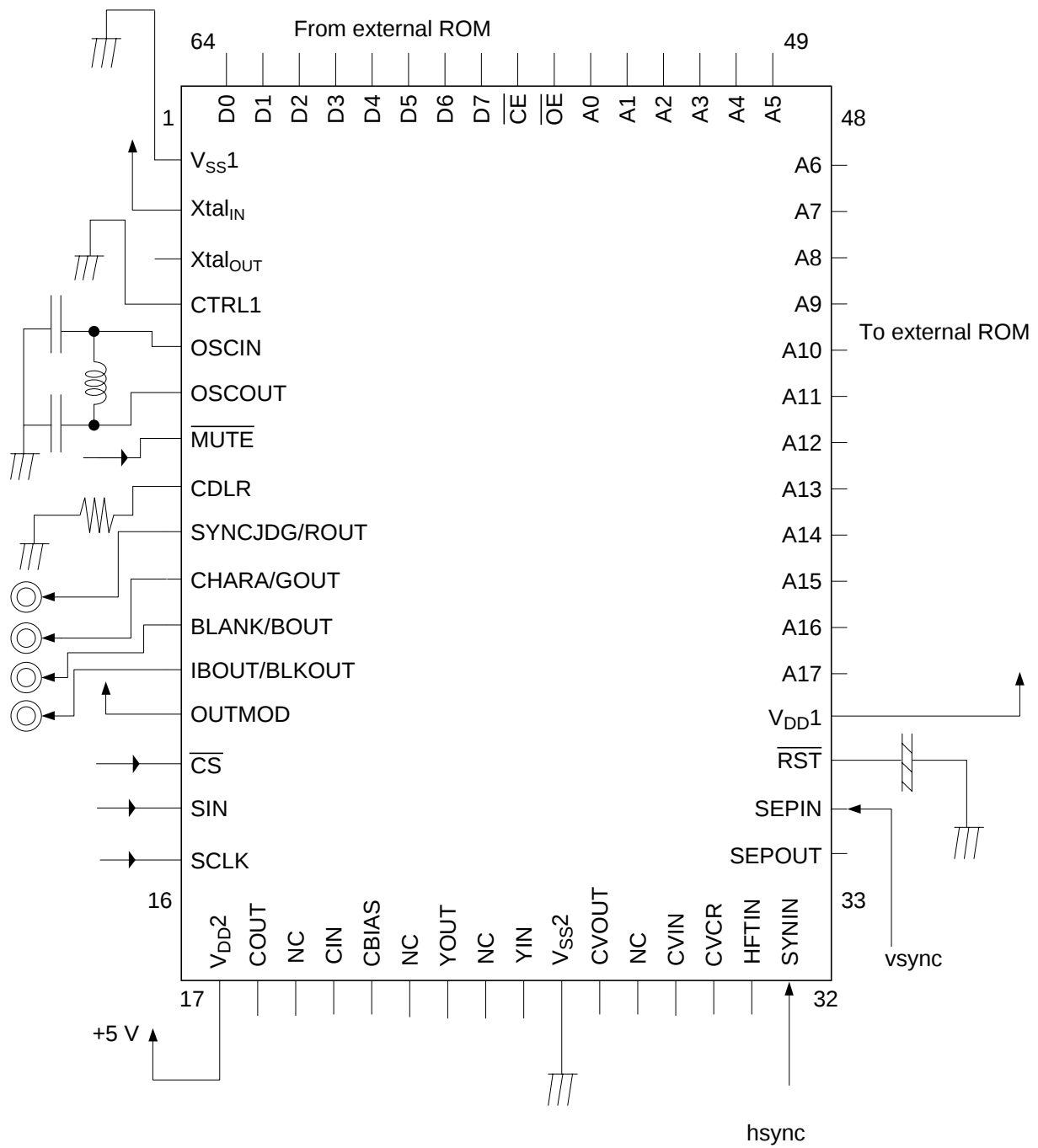
BCOL01, 10, 11: CBIAS

# Sample Application Circuit

- Cvideo, Y/C



• RGB



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