

**240-OUTPUT TFT-LCD SOURCE DRIVER
(COMPATIBLE WITH 64 GRAY SCALES)**

The μ PD16635 is a source driver for TFT-LCDs capable of dealing with displays with 64 gray scales. Data input is based on digital input configured as 6 bits by 6 dots (2 pixels), which can realize a full-color display of 260,000 colors by output of 64 values γ -corrected by an internal D/A converter and 5-by-2 external power modules. Because the output dynamic range is as large as 11.5 V_{P-P}, level inversion operation of the LCD's common electrode is rendered unnecessary. Also, to be able to deal with full-dot inversion when mounted on a single side, this source driver is equipped with a built-in 6-bit D/A converter circuit whose odd output pins and even output pins respectively output gray scale voltages of differing polarity. Assuring a maximum clock frequency of 33 MHz when driving at 3.0 V, this driver is applicable to SVGA-standard TFT-LCD panels.

FEATURES

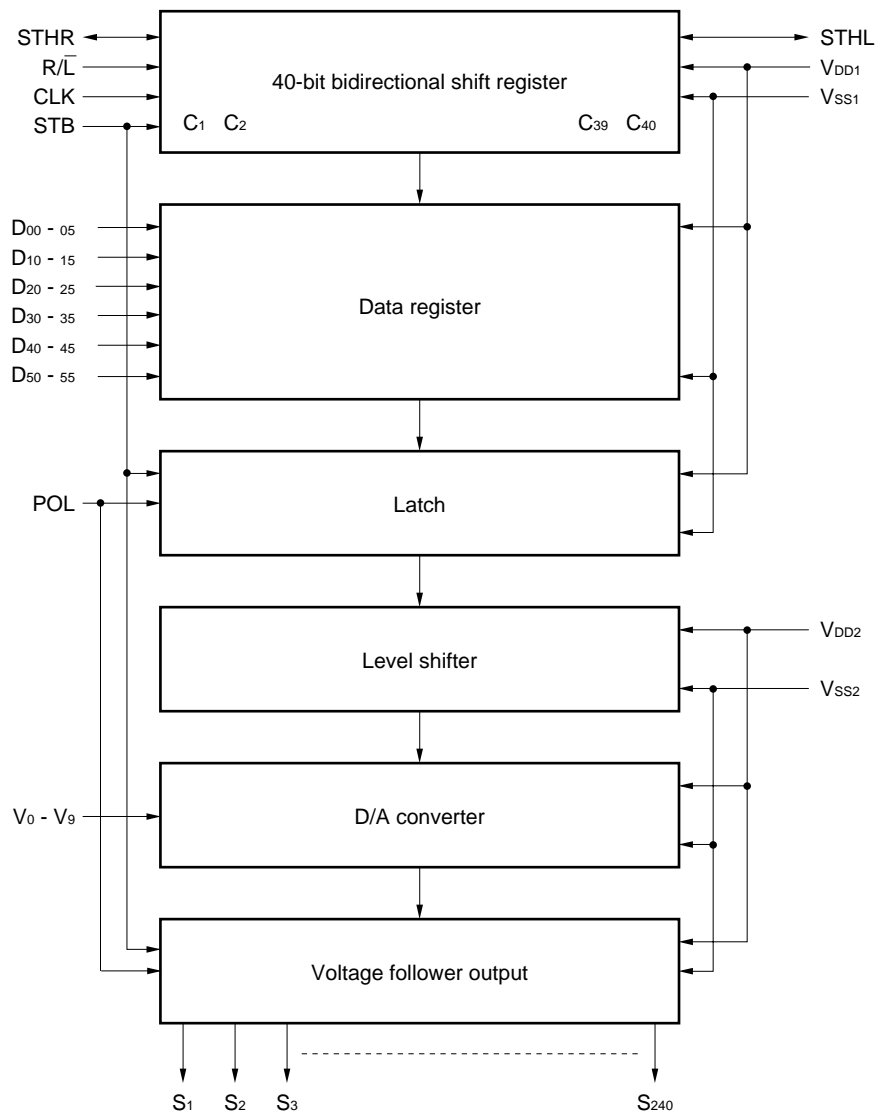
- Capable of outputting 64 values by means of 5-by-2 external power modules (10 units) and a D/A converter
- Output dynamic range 11.5 V_{P-P} min. (@ V_{DD2} = 13.5 V)
- CMOS level input
- Input of 6 bits (gradation data) by 6 dots
- High-speed data transfer: f_{max} = 33 MHz (internal data transfer speed when operating at 3.0 V)
- 240 outputs
- Dedicated full-dot inversion driver
- Single-sided mounting possible (loaded with slim TCP)

ORDERING INFORMATION

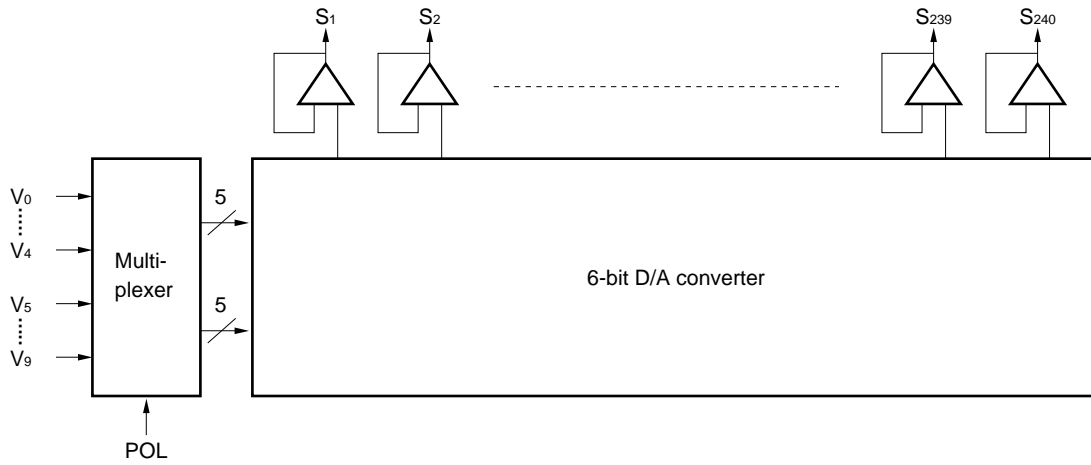
| Part Number | Package |
|--------------------|-------------------|
| μ PD16635N-xxx | TCP (TAB package) |

The TCP's external shape is customized. To order your TCP's external shape, please contact a NEC salesperson.

1. BLOCK DIAGRAM



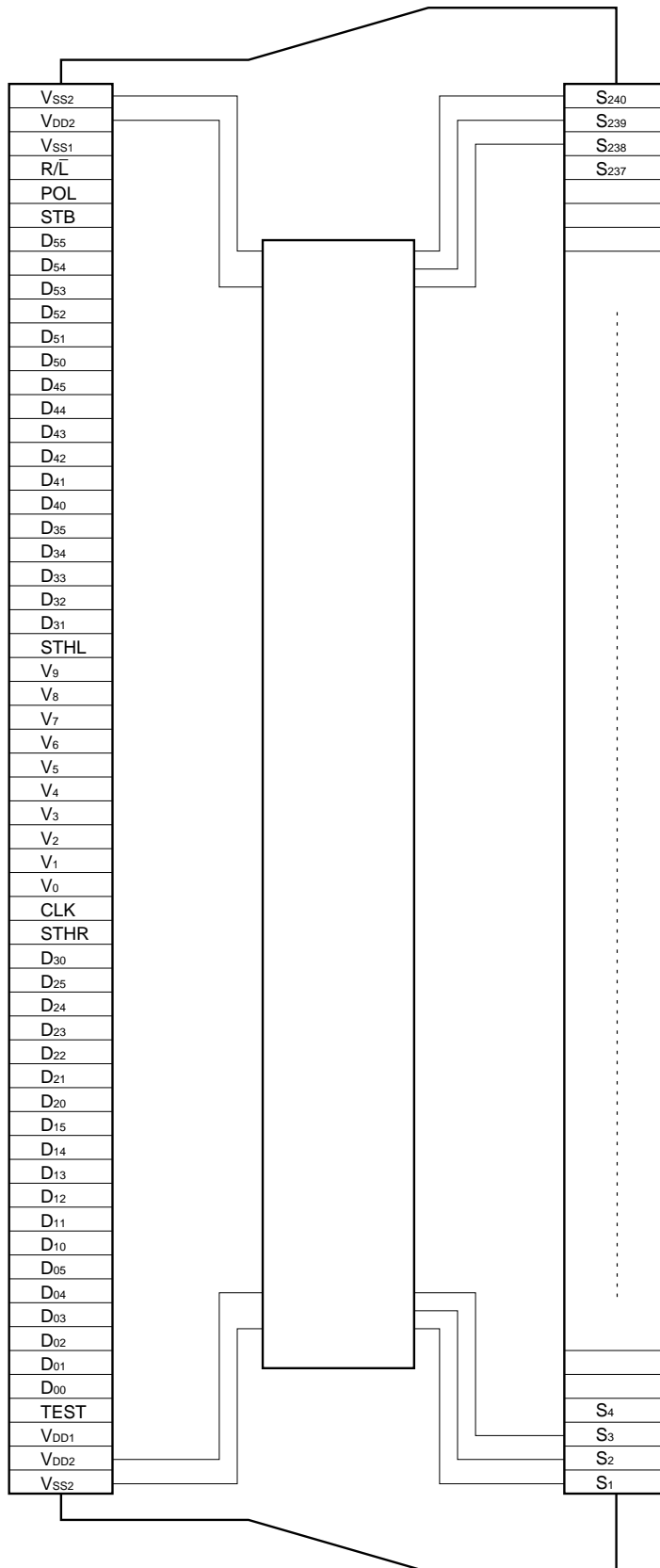
2. RELATIONSHIP BETWEEN OUTPUT CIRCUIT AND D/A CONVERTER



| POL | S_{2n-1} | S_{2n} |
|-----|----------------|----------------|
| L | V_0 to V_4 | V_5 to V_9 |
| H | V_5 to V_9 | V_0 to V_4 |

S_{2n-1} (odd output), S_{2n} (even output) $n = 1, 2, \dots, 120$

3. PIN CONFIGURATION (μPD16635N-xxx)



This figure shows the pin connection, not a TCP package.

4. PIN FUNCTIONS

| Pin Symbol | Pin Name | Description |
|------------------------------------|--------------------------------------|--|
| S ₁ to S ₂₄₀ | Driver output | The D/A converted 64-gray-scale analog voltage is output. |
| D ₀₀ to D ₀₅ | Display data input | The display data is input with a width of 36 bits, viz., the gray scale data (6 bits) by 6 dots (2 pixels). D _{X0} : LSB, D _{X5} : MSB |
| D ₁₀ to D ₁₅ | | |
| D ₂₀ to D ₂₅ | | |
| D ₃₁ to D ₃₅ | | |
| D ₄₀ to D ₄₅ | | |
| D ₅₀ to D ₅₅ | | |
| R \bar{L} | Shift direction switching input | These refer to the start pulse input/output pins when cascades are connected. The shift directions of the shift registers are as follows. R \bar{L} = H: STHR input, S ₁ → S ₂₄₀ , STHL output R \bar{L} = L: STHL input, S ₂₄₀ → S ₁ , STHR output |
| STHR | Right shift start pulse input/output | R \bar{L} = H: Becomes the start pulse input pin. R \bar{L} = L: Becomes the start pulse output pin. |
| STHL | Left shift start pulse input/output | R \bar{L} = H: Becomes the start pulse output pin. R \bar{L} = L: Becomes the start pulse input pin. |
| CLK | Shift clock input | Refers to the shift register's shift clock input. The display data is incorporated into the data register at the rising edge. At the rising edge of the 40th clock after the start pulse input, the start pulse output reaches the high level, thus becoming the start pulse of the next-stage driver. The initial-stage driver's 40th clock becomes valid as the next-stage driver's start pulse is input. If 42 clock pulses are input after input of the start pulse, input of display data is halted automatically. The contents of the shift register are cleared at the STB's rising edge. |
| STB | Latch input | The contents of the data register are transferred to the latch at the rising edge. And, at the falling edge, the gray scale voltage is supplied to the driver. It is necessary to ensure input of one pulse per horizontal period. |
| POL | Polarity input | POL = L; The S _{2n-1} output uses V ₀ to V ₄ as the reference supply; and the S _{2n} output uses V ₅ to V ₉ as the reference supply. POL = H; The S _{2n-1} output uses V ₅ to V ₉ as the reference supply; and the S _{2n} output uses V ₀ to V ₄ as the reference supply. S _{2n-1} indicates the odd output; and S _{2n} indicates the even output. Input of the POL signal is allowed the setup time (t _{POL-STB}) with respect to STB's rising edge. |
| V ₀ to V ₉ | γ -corrected power supplies | Input the γ -corrected power supplies from outside. Make sure to maintain the following relationships. During the gray scale voltage output, be sure to keep the gray scale level power supply at a constant level. V _{DD2} > V ₀ > V ₁ > V ₂ > V ₃ > V ₄ > V ₅ > V ₆ > V ₇ > V ₈ > V ₉ > V _{SS2} |
| TEST | Test pin | Set it to "OPEN". |
| V _{DD1} | Logic power supply | 3.3 V \pm 0.3 V |
| V _{DD2} | Driver power supply | 11.0 V to 13.5 V |
| V _{SS1} | Logic ground | Grounding |
| V _{SS2} | Driver ground | Grounding |

- Cautions**
1. The power start sequence must be V_{DD1}, logic input, and V_{DD2} & V₀ to V₉ in that order. Reverse this sequence to shut down. (Simultaneous power application to V_{DD2} and V₀ to V₉ is possible.)
 2. To stabilize the supply voltage, please be sure to insert a 0.1 μ F bypass capacitor between V_{DD1}-V_{SS1} and V_{DD2}-V_{SS2}. Furthermore, for increased precision of the D/A converter, insertion of a bypass capacitor of about 0.01 μ F is also advised between the γ -corrected power supply terminals (V₀, V₁, V₂, ..., V₉) and V_{SS2}.

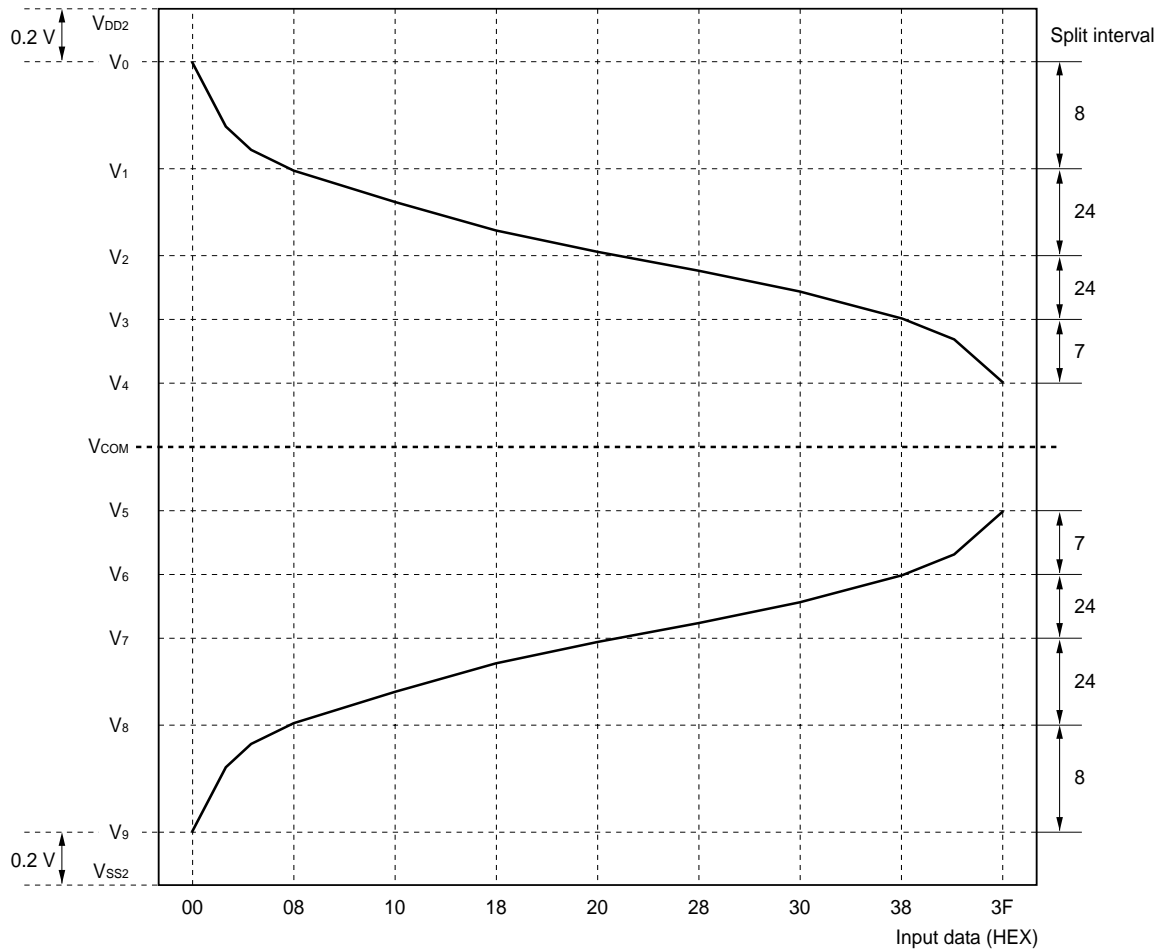
5. RELATIONSHIP BETWEEN INPUT DATA AND OUTPUT VOLTAGE VALUE

This product incorporates a 6-bit D/A converter whose odd output pins and even output pins output respectively gray scale voltages of differing polarity with respect to the LCD's counter electrode (common electrode) voltage. The D/A converter consists of ladder resistors and switches. The ladder resistors r_0 to r_{62} are so designed that the ratios between the LCD panel's γ -corrected voltages and V_0' to V_{63}' and V_0'' to V_{63}'' are roughly equal; and their respective resistance values are as shown on page 9. Among the 5-by-2 γ -corrected voltages, input gray scale voltages of the same polarity with respect to the common voltage, for the respective five γ -corrected voltages of V_0 to V_4 and V_5 to V_9 . If fine gray scale voltage precision is not necessary, the voltage follower circuit supplied to the γ -corrected power supplies V_1 to V_3 and V_6 to V_8 can be deleted.

Figure 1 shows the relationship between the driving voltages such as liquid-crystal driving voltages V_{DD2} and V_{SS2} , common electrode potential V_{COM} , and γ -corrected voltages V_0 to V_9 and the input data. Be sure to maintain the voltage relationships of $V_{DD2} > V_0 > V_1 > V_2 > V_3 > V_4 > V_5 > V_6 > V_7 > V_8 > V_9 > V_{SS2}$. Figures 2-1 and 2-2 show the relationship between the input data and the output data. Table 1 shows the resistance values of the resistor strings.

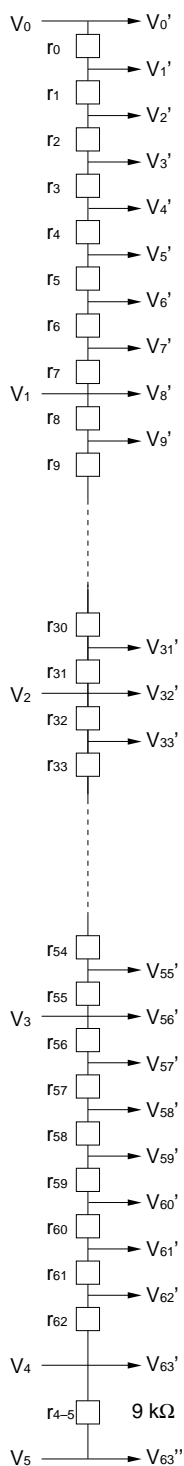
This driver IC is designed for single-sided dot inversion mounting. Therefore, it cannot be used in double-sided mounting.

Figure 1. Relationship Between Input Data and Output Voltage



Resistor Strings

Figure 2-1. Relationship Between Input Data and Output Voltage: $V_{DD2} > V_0 > V_1 > V_2 > V_3 > V_4 > V_5$

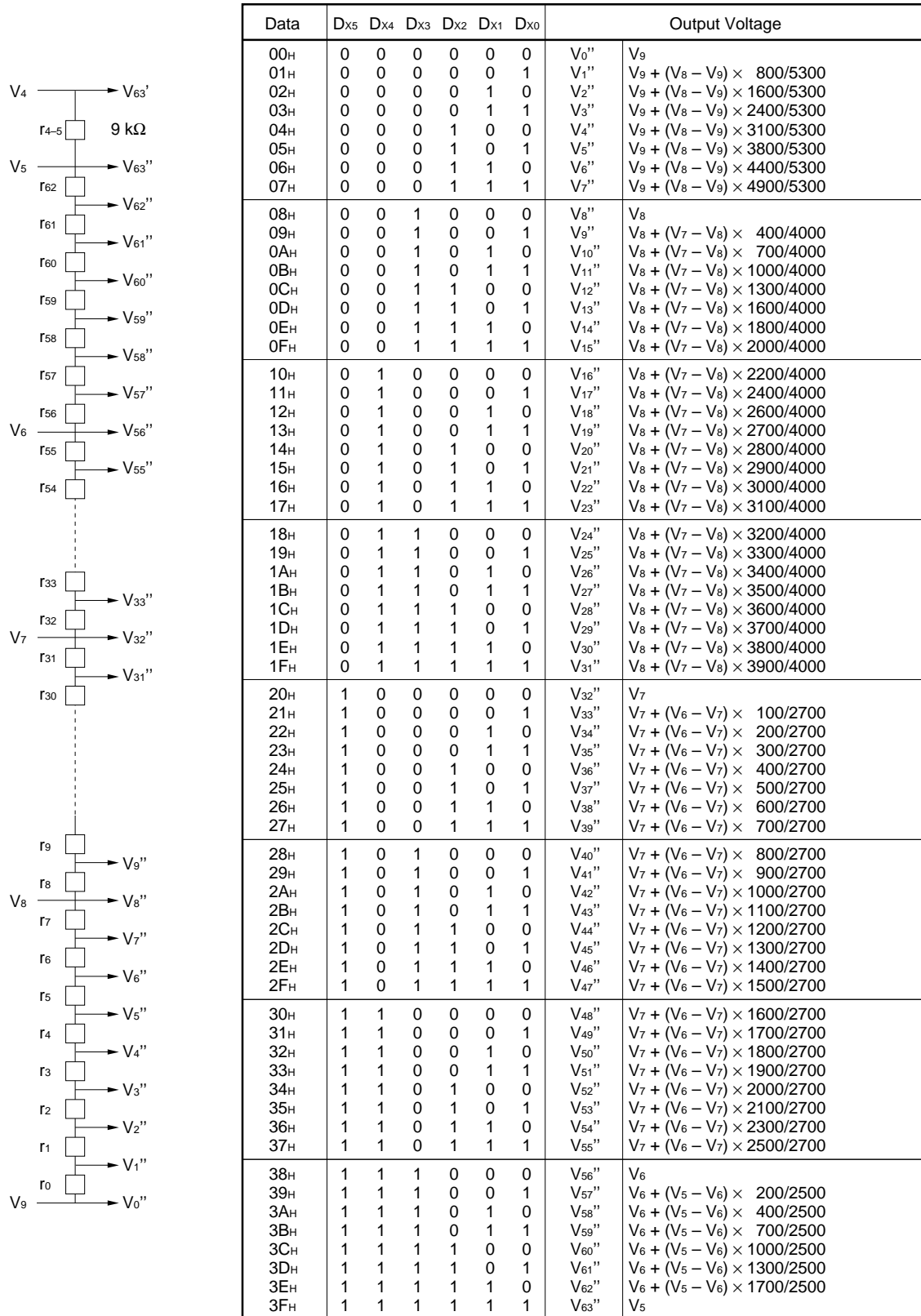


| Data | D _{x5} | D _{x4} | D _{x3} | D _{x2} | D _{x1} | D _{x0} | Output Voltage | |
|------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----------------|--------------------------------------|
| 00H | 0 | 0 | 0 | 0 | 0 | 0 | V_0' | V_0 |
| 01H | 0 | 0 | 0 | 0 | 0 | 1 | V_1' | $V_1 + (V_0 - V_1) \times 4500/5300$ |
| 02H | 0 | 0 | 0 | 0 | 1 | 0 | V_2' | $V_1 + (V_0 - V_1) \times 3700/5300$ |
| 03H | 0 | 0 | 0 | 0 | 1 | 1 | V_3' | $V_1 + (V_0 - V_1) \times 2900/5300$ |
| 04H | 0 | 0 | 0 | 1 | 0 | 0 | V_4' | $V_1 + (V_0 - V_1) \times 2200/5300$ |
| 05H | 0 | 0 | 0 | 1 | 0 | 1 | V_5' | $V_1 + (V_0 - V_1) \times 1500/5300$ |
| 06H | 0 | 0 | 0 | 1 | 1 | 0 | V_6' | $V_1 + (V_0 - V_1) \times 900/5300$ |
| 07H | 0 | 0 | 0 | 1 | 1 | 1 | V_7' | $V_1 + (V_0 - V_1) \times 400/5300$ |
| 08H | 0 | 0 | 1 | 0 | 0 | 0 | V_8' | V_1 |
| 09H | 0 | 0 | 1 | 0 | 0 | 1 | V_9' | $V_2 + (V_1 - V_2) \times 3600/4000$ |
| 0AH | 0 | 0 | 1 | 0 | 1 | 0 | V_{10}' | $V_2 + (V_1 - V_2) \times 3300/4000$ |
| 0BH | 0 | 0 | 1 | 0 | 1 | 1 | V_{11}' | $V_2 + (V_1 - V_2) \times 3000/4000$ |
| 0CH | 0 | 0 | 1 | 1 | 0 | 0 | V_{12}' | $V_2 + (V_1 - V_2) \times 2700/4000$ |
| 0DH | 0 | 0 | 1 | 1 | 0 | 1 | V_{13}' | $V_2 + (V_1 - V_2) \times 2400/4000$ |
| 0EH | 0 | 0 | 1 | 1 | 1 | 0 | V_{14}' | $V_2 + (V_1 - V_2) \times 2200/4000$ |
| 0FH | 0 | 0 | 1 | 1 | 1 | 1 | V_{15}' | $V_2 + (V_1 - V_2) \times 2000/4000$ |
| 10H | 0 | 1 | 0 | 0 | 0 | 0 | V_{16}' | $V_2 + (V_1 - V_2) \times 1800/4000$ |
| 11H | 0 | 1 | 0 | 0 | 0 | 1 | V_{17}' | $V_2 + (V_1 - V_2) \times 1600/4000$ |
| 12H | 0 | 1 | 0 | 0 | 1 | 0 | V_{18}' | $V_2 + (V_1 - V_2) \times 1400/4000$ |
| 13H | 0 | 1 | 0 | 0 | 1 | 1 | V_{19}' | $V_2 + (V_1 - V_2) \times 1300/4000$ |
| 14H | 0 | 1 | 0 | 1 | 0 | 0 | V_{20}' | $V_2 + (V_1 - V_2) \times 1200/4000$ |
| 15H | 0 | 1 | 0 | 1 | 0 | 1 | V_{21}' | $V_2 + (V_1 - V_2) \times 1100/4000$ |
| 16H | 0 | 1 | 0 | 1 | 1 | 0 | V_{22}' | $V_2 + (V_1 - V_2) \times 1000/4000$ |
| 17H | 0 | 1 | 0 | 1 | 1 | 1 | V_{23}' | $V_2 + (V_1 - V_2) \times 900/4000$ |
| 18H | 0 | 1 | 1 | 0 | 0 | 0 | V_{24}' | $V_2 + (V_1 - V_2) \times 800/4000$ |
| 19H | 0 | 1 | 1 | 0 | 0 | 1 | V_{25}' | $V_2 + (V_1 - V_2) \times 700/4000$ |
| 1AH | 0 | 1 | 1 | 0 | 1 | 0 | V_{26}' | $V_2 + (V_1 - V_2) \times 600/4000$ |
| 1BH | 0 | 1 | 1 | 0 | 1 | 1 | V_{27}' | $V_2 + (V_1 - V_2) \times 500/4000$ |
| 1CH | 0 | 1 | 1 | 1 | 0 | 0 | V_{28}' | $V_2 + (V_1 - V_2) \times 400/4000$ |
| 1DH | 0 | 1 | 1 | 1 | 0 | 1 | V_{29}' | $V_2 + (V_1 - V_2) \times 300/4000$ |
| 1EH | 0 | 1 | 1 | 1 | 1 | 0 | V_{30}' | $V_2 + (V_1 - V_2) \times 200/4000$ |
| 1FH | 0 | 1 | 1 | 1 | 1 | 1 | V_{31}' | $V_2 + (V_1 - V_2) \times 100/4000$ |
| 20H | 1 | 0 | 0 | 0 | 0 | 0 | V_{32}' | V_2 |
| 21H | 1 | 0 | 0 | 0 | 0 | 1 | V_{33}' | $V_3 + (V_2 - V_3) \times 2600/2700$ |
| 22H | 1 | 0 | 0 | 0 | 1 | 0 | V_{34}' | $V_3 + (V_2 - V_3) \times 2500/2700$ |
| 23H | 1 | 0 | 0 | 0 | 1 | 1 | V_{35}' | $V_3 + (V_2 - V_3) \times 2400/2700$ |
| 24H | 1 | 0 | 0 | 1 | 0 | 0 | V_{36}' | $V_3 + (V_2 - V_3) \times 2300/2700$ |
| 25H | 1 | 0 | 0 | 1 | 0 | 1 | V_{37}' | $V_3 + (V_2 - V_3) \times 2200/2700$ |
| 26H | 1 | 0 | 0 | 1 | 1 | 0 | V_{38}' | $V_3 + (V_2 - V_3) \times 2100/2700$ |
| 27H | 1 | 0 | 0 | 1 | 1 | 1 | V_{39}' | $V_3 + (V_2 - V_3) \times 2000/2700$ |
| 28H | 1 | 0 | 1 | 0 | 0 | 0 | V_{40}' | $V_3 + (V_2 - V_3) \times 1900/2700$ |
| 29H | 1 | 0 | 1 | 0 | 0 | 1 | V_{41}' | $V_3 + (V_2 - V_3) \times 1800/2700$ |
| 2AH | 1 | 0 | 1 | 0 | 1 | 0 | V_{42}' | $V_3 + (V_2 - V_3) \times 1700/2700$ |
| 2BH | 1 | 0 | 1 | 0 | 1 | 1 | V_{43}' | $V_3 + (V_2 - V_3) \times 1600/2700$ |
| 2CH | 1 | 0 | 1 | 1 | 0 | 0 | V_{44}' | $V_3 + (V_2 - V_3) \times 1500/2700$ |
| 2DH | 1 | 0 | 1 | 1 | 0 | 1 | V_{45}' | $V_3 + (V_2 - V_3) \times 1400/2700$ |
| 2EH | 1 | 0 | 1 | 1 | 1 | 0 | V_{46}' | $V_3 + (V_2 - V_3) \times 1300/2700$ |
| 2FH | 1 | 0 | 1 | 1 | 1 | 1 | V_{47}' | $V_3 + (V_2 - V_3) \times 1200/2700$ |
| 30H | 1 | 1 | 0 | 0 | 0 | 0 | V_{48}' | $V_3 + (V_2 - V_3) \times 1100/2700$ |
| 31H | 1 | 1 | 0 | 0 | 0 | 1 | V_{49}' | $V_3 + (V_2 - V_3) \times 1000/2700$ |
| 32H | 1 | 1 | 0 | 0 | 1 | 0 | V_{50}' | $V_3 + (V_2 - V_3) \times 900/2700$ |
| 33H | 1 | 1 | 0 | 0 | 1 | 1 | V_{51}' | $V_3 + (V_2 - V_3) \times 800/2700$ |
| 34H | 1 | 1 | 0 | 1 | 0 | 0 | V_{52}' | $V_3 + (V_2 - V_3) \times 700/2700$ |
| 35H | 1 | 1 | 0 | 1 | 0 | 1 | V_{53}' | $V_3 + (V_2 - V_3) \times 600/2700$ |
| 36H | 1 | 1 | 0 | 1 | 1 | 0 | V_{54}' | $V_3 + (V_2 - V_3) \times 400/2700$ |
| 37H | 1 | 1 | 0 | 1 | 1 | 1 | V_{55}' | $V_3 + (V_2 - V_3) \times 200/2700$ |
| 38H | 1 | 1 | 1 | 0 | 0 | 0 | V_{56}' | V_3 |
| 39H | 1 | 1 | 1 | 0 | 0 | 1 | V_{57}' | $V_4 + (V_3 - V_4) \times 2300/2500$ |
| 3AH | 1 | 1 | 1 | 0 | 1 | 0 | V_{58}' | $V_4 + (V_3 - V_4) \times 2100/2500$ |
| 3BH | 1 | 1 | 1 | 0 | 1 | 1 | V_{59}' | $V_4 + (V_3 - V_4) \times 1800/2500$ |
| 3CH | 1 | 1 | 1 | 1 | 0 | 0 | V_{60}' | $V_4 + (V_3 - V_4) \times 1500/2500$ |
| 3DH | 1 | 1 | 1 | 1 | 0 | 1 | V_{61}' | $V_4 + (V_3 - V_4) \times 1200/2500$ |
| 3EH | 1 | 1 | 1 | 1 | 1 | 0 | V_{62}' | $V_4 + (V_3 - V_4) \times 800/2500$ |
| 3FH | 1 | 1 | 1 | 1 | 1 | 1 | V_{63}' | V_4 |

Caution V_4 and V_5 are interconnected inside the IC by resistors r_{4-5} (9 kΩ).

Resistor Strings

Figure 2-1. Relationship Between Input Data and Output Voltage: $V_4 > V_5 > V_6 > V_7 > V_8 > V_9 > V_{SS2}$



Caution V₄ and V₅ are interconnected inside the IC by resistors r₄₋₅ (9 kΩ).

Ladder Resistance Values (r₀ to r₆₂): Reference Value

| | Resistor Name | Resistance Value (Ω) | Resistor Name | Resistance Value (Ω) | |
|-----------------------------------|-----------------|----------------------|-----------------|----------------------|-----------------------------------|
| V ₀ , V ₉ → | r ₀ | 800 | r ₃₂ | 100 | ← V ₂ , V ₇ |
| | r ₁ | 800 | r ₃₃ | 100 | |
| | r ₂ | 800 | r ₃₄ | 100 | |
| | r ₃ | 700 | r ₃₅ | 100 | |
| | r ₄ | 700 | r ₃₆ | 100 | |
| | r ₅ | 600 | r ₃₇ | 100 | |
| | r ₆ | 500 | r ₃₈ | 100 | |
| V ₁ , V ₈ → | r ₇ | 400 | r ₃₉ | 100 | |
| | r ₈ | 400 | r ₄₀ | 100 | |
| | r ₉ | 300 | r ₄₁ | 100 | |
| | r ₁₀ | 300 | r ₄₂ | 100 | |
| | r ₁₁ | 300 | r ₄₃ | 100 | |
| | r ₁₂ | 300 | r ₄₄ | 100 | |
| | r ₁₃ | 200 | r ₄₅ | 100 | |
| | r ₁₄ | 200 | r ₄₆ | 100 | |
| | r ₁₅ | 200 | r ₄₇ | 100 | |
| | r ₁₆ | 200 | r ₄₈ | 100 | |
| | r ₁₇ | 200 | r ₄₉ | 100 | |
| | r ₁₈ | 100 | r ₅₀ | 100 | |
| | r ₁₉ | 100 | r ₅₁ | 100 | |
| | r ₂₀ | 100 | r ₅₂ | 100 | |
| | r ₂₁ | 100 | r ₅₃ | 200 | |
| | r ₂₂ | 100 | r ₅₄ | 200 | |
| | r ₂₃ | 100 | r ₅₅ | 200 | ← V ₃ , V ₆ |
| | r ₂₄ | 100 | r ₅₆ | 200 | |
| | r ₂₅ | 100 | r ₅₇ | 200 | |
| | r ₂₆ | 100 | r ₅₈ | 300 | |
| | r ₂₇ | 100 | r ₅₉ | 300 | |
| | r ₂₈ | 100 | r ₆₀ | 300 | |
| | r ₂₉ | 100 | r ₆₁ | 400 | |
| | r ₃₀ | 100 | r ₆₂ | 800 | ← V ₄ , V ₅ |
| V ₂ , V ₇ → | r ₃₁ | 100 | Total | 14500 | |

6. RELATIONSHIP BETWEEN INPUT DATA AND OUTPUT PIN

Data format : 6 bits × 2 RGBs (6 dots)

Input width : 36 bits (2-pixel data)

$R/\bar{L} = H$ (Right shift)

| | | | | | | | | |
|--------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|-----|------------------------------------|------------------------------------|
| Output | S ₁ | S ₂ | S ₃ | S ₄ | S ₅ | ... | S ₂₃₉ | S ₂₄₀ |
| Data | D ₀₀ to D ₀₅ | D ₁₀ to D ₁₅ | D ₂₀ to D ₂₅ | D ₃₀ to D ₃₅ | D ₄₀ to D ₄₅ | ... | D ₄₀ to D ₄₅ | D ₅₀ to D ₅₅ |

$R/\bar{L} = L$ (Left shift)

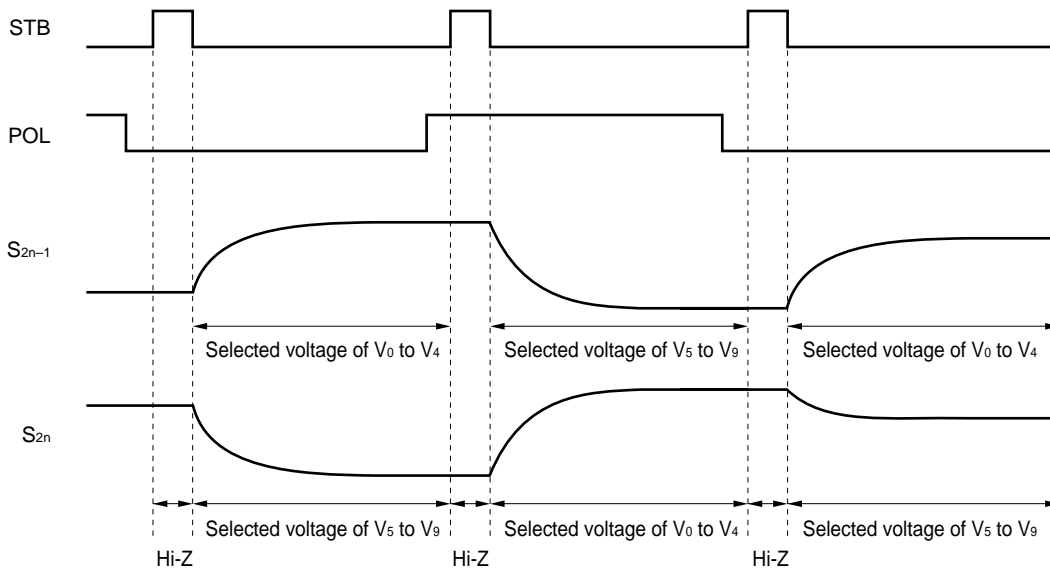
| | | | | | | | | |
|--------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|-----|------------------------------------|------------------------------------|
| Output | S ₁ | S ₂ | S ₃ | S ₄ | S ₅ | ... | S ₂₃₉ | S ₂₄₀ |
| Data | D ₀₀ to D ₀₅ | D ₁₀ to D ₁₅ | D ₂₀ to D ₂₅ | D ₃₀ to D ₃₅ | D ₄₀ to D ₄₅ | ... | D ₄₀ to D ₄₅ | D ₅₀ to D ₅₅ |

| | | |
|-----|----------------------------------|----------------------------------|
| POL | S _{2n-1} | S _{2n} |
| L | V ₀ to V ₄ | V ₅ to V ₉ |
| H | V ₅ to V ₉ | V ₀ to V ₄ |

S_{2n-1} (Odd output), S_{2n} (Even output) n = 1, 2, ..., 120

7. RELATIONSHIP BETWEEN STB, POL, AND OUTPUT WAVEFORM

The output voltage is written to the LCD panel synchronized with the STB rising edge.



Absolute Maximum Ratings (T_A = 25 °C, V_{SS1} = V_{SS2} = 0 V)

| Parameter | Symbol | Rating | Unit |
|-----------------------------|-------------------|--------------------------------|------|
| Logic Part Supply Voltage | V _{DD1} | -0.5 to +6.5 | V |
| Driver Part Supply Voltage | V _{DD2} | -0.5 to +15.0 | V |
| Logic Part Input Voltage | V _{I1} | -0.5 to V _{DD1} + 0.5 | V |
| Driver Part Input Voltage | V _{I2} | -0.5 to V _{DD2} + 0.5 | V |
| Logic Part Output Voltage | V _{O1} | -0.5 to V _{DD1} + 0.5 | V |
| Driver Part Output Voltage | V _{O2} | -0.5 to V _{DD2} + 0.5 | V |
| Operating Temperature Range | T _A | -10 to +75 | °C |
| Storage Temperature Range | T _{stg.} | -55 to +125 | °C |

Recommended Operating Range (T_A = -10 to +75 °C, V_{SS1} = V_{SS2} = 0 V)

| Parameter | Symbol | MIN. | TYP. | MAX. | Unit |
|----------------------------|----------------------------------|------------------------|------|------------------------|------|
| Logic Part Supply Voltage | V _{DD1} | 3.0 | 3.3 | 3.6 | V |
| Driver Part Supply Voltage | V _{DD2} | 11.0 | 13.0 | 13.5 | V |
| High-Level Input Voltage | V _{IH} | 0.8 V _{DD1} | | V _{DD1} | V |
| Low-Level Input Voltage | V _{IL} | 0 | | 0.2 V _{DD1} | V |
| γ-Corrected Voltage | V ₀ to V ₉ | V _{SS2} + 0.1 | | V _{DD2} - 0.1 | V |
| Driver Part Output Voltage | V _O | V _{SS2} + 0.2 | | V _{DD2} - 0.2 | V |
| Maximum Clock Frequency | f _{max.} | 33 | | | MHz |

Electrical Specifications (T_A = -10 to +75 °C, V_{DD1} = 3.3 V ±0.3 V, V_{DD2} = 13.0 V ±0.5 V, V_{SS1} = V_{SS2} = 0 V)

| Parameter | Symbol | Condition | MIN. | TYP. | MAX. | Unit |
|----------------------------|------------------|--|------------------------|------|------|------|
| Input Leak Current | I _L | | | | ±1.0 | μA |
| High-Level Output Voltage | V _{OH} | STHR (STHL), I _o = 0 mA | V _{DD1} - 0.1 | | | V |
| Low-level Output Voltage | V _{OL} | STHR (STHL), I _o = 0 mA | | | 0.1 | V |
| γ-Corrected Supply Current | | V ₀ - V ₉ = 10 V | | 0.3 | 0.6 | mA |
| Driver Output Current | I _{VOH} | V _X - V _{OUT} = 6 V | | | -0.3 | mA |
| | I _{VOL} | V _X - V _{OUT} = -6 V | 0.3 | | | mA |

V_X refers to the output voltage of analog output pins S₁ to S₂₄₀.

V_{OUT} refers to the voltage applied to analog output pins S₁ to S₂₄₀.

Electrical Specifications (T_A = -10 to +75 °C, V_{DD1} = 3.3 V ±0.3 V, V_{DD2} = 13.0 V ±0.5 V, V_{SS1} = V_{SS2} = 0 V)

| Parameter | Symbol | Condition | MIN. | TYP. | MAX. | Unit |
|--|------------------|--|------|------|------------------------|------|
| Output Voltage Deviation ^{Note 1} | ΔV _O | Input data: 00 _H to 3F _H | | ±5 | ±20 | mV |
| Average Output Voltage Variation ^{Note 2} | ΔV _{AV} | Input data: 00 _H to 3F _H | | ±10 | | mV |
| Output Voltage Range | V _O | Input data: 00 _H to 3F _H | 0.2 | | V _{DD2} - 0.2 | V |
| Logic Part Dynamic Current Consumption | I _{DD1} | V _{DD1} ; when with no load ^{Notes 3, 4} | | 1.0 | 6.0 | mA |
| Driver Part Dynamic Current Consumption | I _{DD2} | V _{DD2} ; when with no load ^{Notes 3, 4} | | 3.5 | 9.0 | mA |

- Notes**
- The output voltage deviation refers to the voltage difference between adjoining output pins when the display data is the same (within the chip).
 - The average output voltage variation refers to the average output voltage difference between chips. The average output voltage refers to the average voltage between chips when the display data is the same.
 - The STB cycle is defined to be 30 μs at f_{CLK} = 25 MHz. The TYP. values refer to an all black or all white input pattern. The MAX. value refers to the measured values in the dot checkerboard input pattern.
 - Refers to the current consumption per driver when cascades are connected under the assumption of SVGA single-sided mounting (10 units).

Switching Characteristics (T_A = -10 to +75 °C, V_{DD1} = 3.3 V ±0.3 V, V_{DD2} = 13.0 V ±0.5 V, V_{SS1} = V_{SS2} = 0 V)

| Parameter | Symbol | Condition | MIN. | TYP. | MAX. | Unit |
|----------------------------|-------------------|---|------|------|------|------|
| Start Pulse Delay Time | t _{PLH1} | C _L = 25 pF | | 10 | 15 | ns |
| Driver Output Delay Time 1 | t _{PHL2} | C _L = 50 pF, R = 50 kΩ | | 7 | 11 | μs |
| Driver Output Delay Time 2 | t _{PHL3} | C _L = 50 pF, R = 50 kΩ | | 13 | 17 | μs |
| Driver Output Delay Time 3 | t _{PLH2} | C _L = 50 pF, R = 50 kΩ | | 7 | 11 | μs |
| Driver Output Delay Time 4 | t _{PLH3} | C _L = 50 pF, R = 50 kΩ | | 13 | 17 | μs |
| Input Capacitance 1 | C ₁ | STHR, STHL excluded T _A = 25 °C | | 5 | 15 | pF |
| Input Capacitance 2 | C ₂ | STHR, STHL T _A = 25 °C | | 5 | 15 | pF |

Conditions Required for Timing

($T_A = -10$ to $+75$ °C, $V_{DD1} = 3.3$ V ± 0.3 V, $V_{SS1} = V_{SS2} = 0$ V, $t_r = t_f = 8.0$ ns)

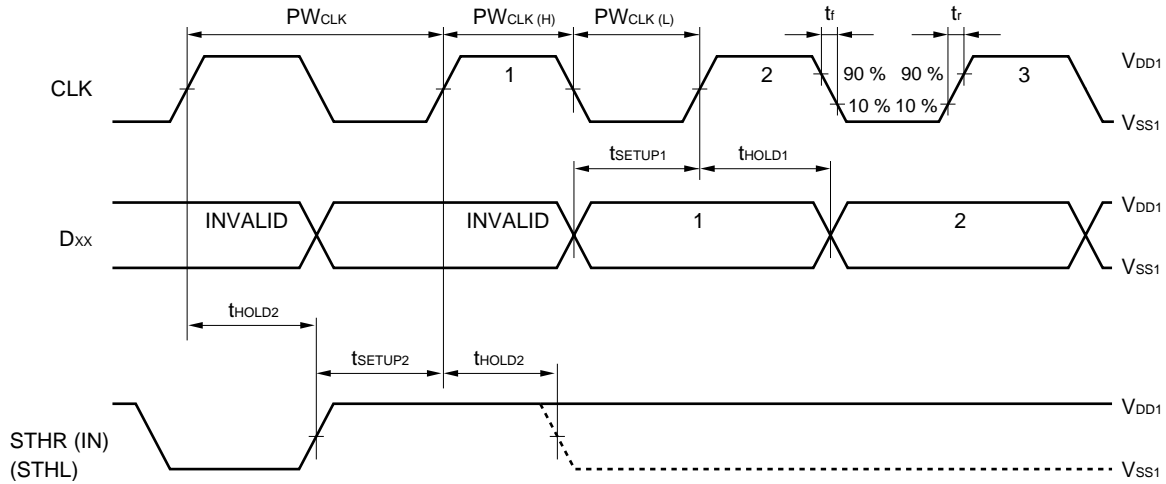
| Parameter | Symbol | Condition | MIN. | TYP. | MAX. | Unit |
|----------------------------------|----------------------|--------------------|------|------|------|------|
| Clock Pulse Width | PW _{CLK} | | 30 | | | ns |
| Clock Pulse Low Period | PW _{CLK(L)} | | 6 | | | ns |
| Clock Pulse High Period | PW _{CLK(H)} | | 6 | | | ns |
| Data Setup Time | t _{SETUP1} | | 6 | | | ns |
| Data Hold Time | t _{HOLD1} | | 6 | | | ns |
| Start Pulse Setup Time | t _{SETUP2} | | 6 | | | ns |
| Start Pulse Hold Time | t _{HOLD2} | | 6 | | | ns |
| Start Pulse Low Period | t _{SPL} | | 6 | | | ns |
| STB Pulse Width | PW _{STB} | | 1 | | | μs |
| Data Invalid Period | t _{INV} | | 1 | | | CLK |
| Final Data Timing | t _{LDT} | | 2 | | | CLK |
| CLK-STB Time | t _{CLK-STB} | CLK ↑ → STB ↓ | 6 | | | ns |
| STB-CLK Time | t _{STB-CLK} | STB ↓ → CLK ↑ | 6 | | | ns |
| Time Between STB and Start Pulse | t _{STB-STH} | STB ↓ → STHR ↑ | 60 | | | ns |
| POL-STB Time | t _{POL-STB} | POL ↑ or ↓ → STB ↑ | -5 | | | ns |
| STB-POL Time | t _{STB-POL} | STB ↓ → POL ↑ or ↓ | 6 | | | ns |

Switching Characteristics Waveform (R/L = H)

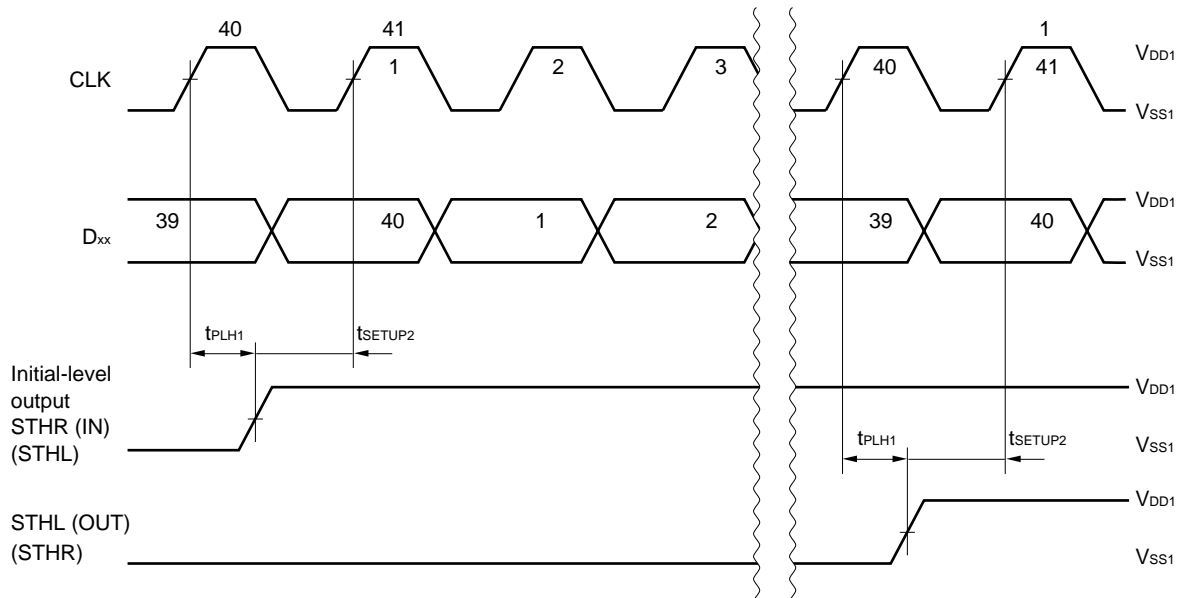
In (): R/L = L

Unless otherwise specified, the input level is defined to be 0.5 V_{DD1}.

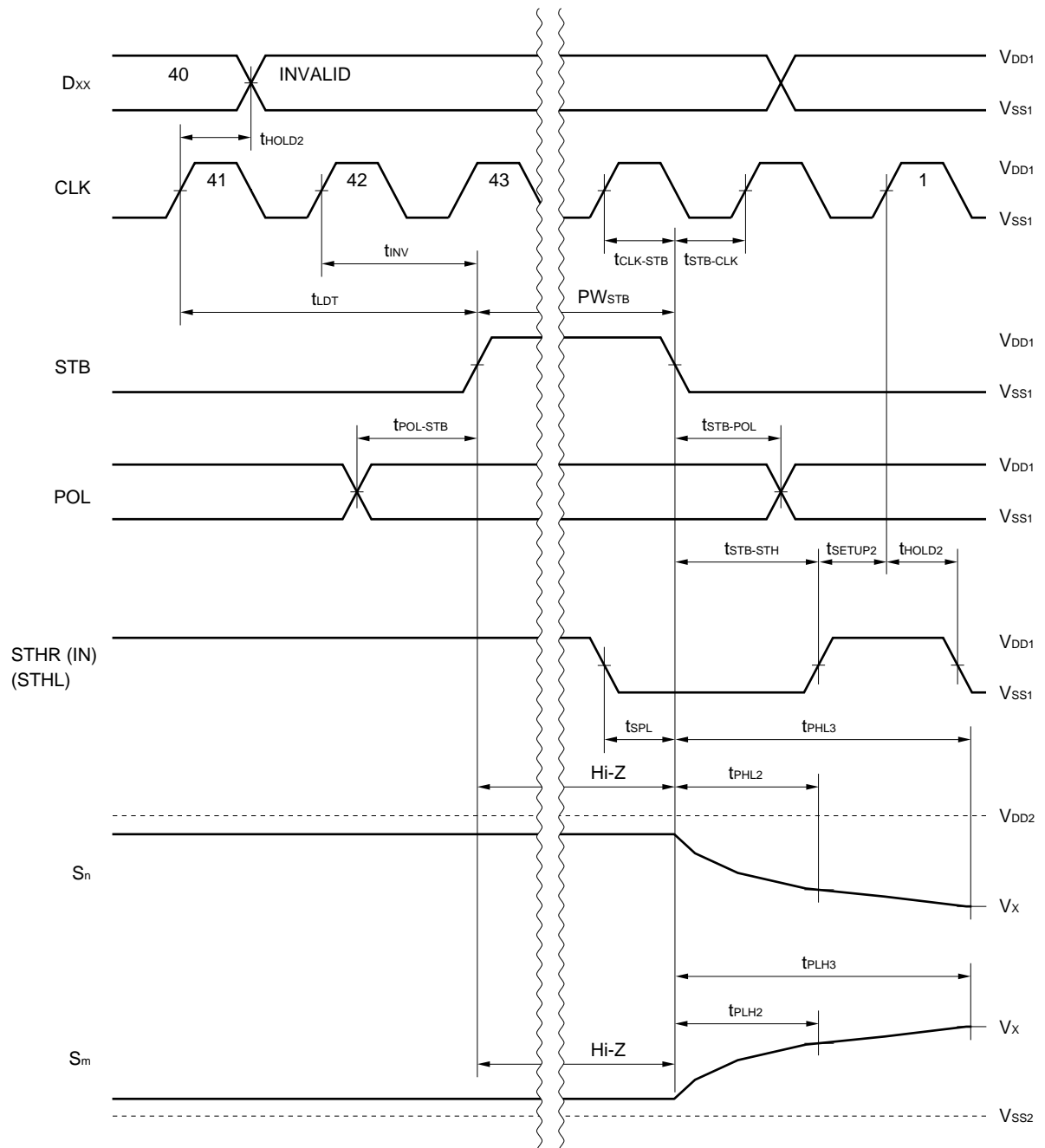
(1) Initial-Level Driver's Input/Output Waveform



(2) Second- to Final-Level Drivers's Input/Output Timing



(3) Driver Output Timing



V_x refers to the final output voltage. t_{PLH2} and t_{PHL2} refer to the time required to reach an output precision level of 10 % ($0.1 V_x$); and t_{PLH3} and t_{PHL3} refer to the time required to reach an output precision level of 6 bits.

RECOMMENDED CONDITIONS FOR INSTALLATION

This product should be installed under the following recommended conditions. Consult one of our sales representatives for installation under conditions other than those recommended.

| Installation condition | Installation method | Condition |
|---------------------------|---------------------------------|--|
| Thermocompression bonding | Soldering | Heat with heating tool at 300 °C to 350 °C under pressure of 100 g (per pin) for 2 to 3 seconds |
| | ACF (sheet-type adhesive agent) | Temporary adhesion at 70 °C to 100 °C under pressure of 3 to 8 kg/cm ² for 3 to 5 seconds Permanent adhesion at 165 °C to 180 °C under pressure of 25 to 45 kg/cm ² for 30 to 40 seconds (when aeolotropic conductive film SUMIZAC1003 from Sumitomo Bakelite Co., Ltd. is used) |

Caution For installation conditions for the ACF part, contact the ACF manufacturer beforehand. Do not mix different installation methods.

REFERENCE

| Document name | Document No. |
|---|--------------|
| NEC semiconductor device reliability/quality control system | IEI-1212 |
| Quality grade on NEC semiconductor devices | C11531E |
| Semiconductor device package manual | IEI-1213 |
| Guide to quality assurance for semiconductor devices | MEI-1202 |
| Semiconductor selection guide | X10679E |

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