

To all our customers

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April 1, 2003

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# HD74LV595A

## 8-bit Shift Registers with 3-state Outputs



ADE-205-281 (Z)

1st Edition  
April 1999

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### Description

This device each contains an 8-bit serial-in, parallel-out shift registers that feeds an 8-bit D-type storage register. The storage register has parallel 3-state outputs. Separate clocks are provided for both the shift register and the storage register. The shift register has a direct-overriding clear, serial input, and serial output pins for cascading.

Both the shift register and the storage register clocks are positive-edge triggered. If the user wishes to connect both clocks together, the shift register state will always be one clock pulse ahead of the storage register. Low-voltage and high-speed operation is suitable for the battery-powered products (e.g., notebook computers), and the low-power consumption extends the battery life.

### Features

- $V_{CC} = 2.0\text{ V to }5.5\text{ V}$  operation
- All inputs  $V_{IH}$  (Max.) =  $5.5\text{ V}$  (@  $V_{CC} = 0\text{ V to }5.5\text{ V}$ )
- All outputs  $V_O$  (Max.) =  $5.5\text{ V}$  (@  $V_{CC} = 0\text{ V}$ )
- Typical  $V_{OL}$  ground bounce  $< 0.8\text{ V}$  (@  $V_{CC} = 3.3\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )
- Typical  $V_{OH}$  undershoot  $> 2.3\text{ V}$  (@  $V_{CC} = 3.3\text{ V}$ ,  $T_a = 25^\circ\text{C}$ )
- Output current  $\pm 6\text{ mA}$  (@  $V_{CC} = 3.0\text{ V to }3.6\text{ V}$ ),  $\pm 12\text{ mA}$  (@  $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ )

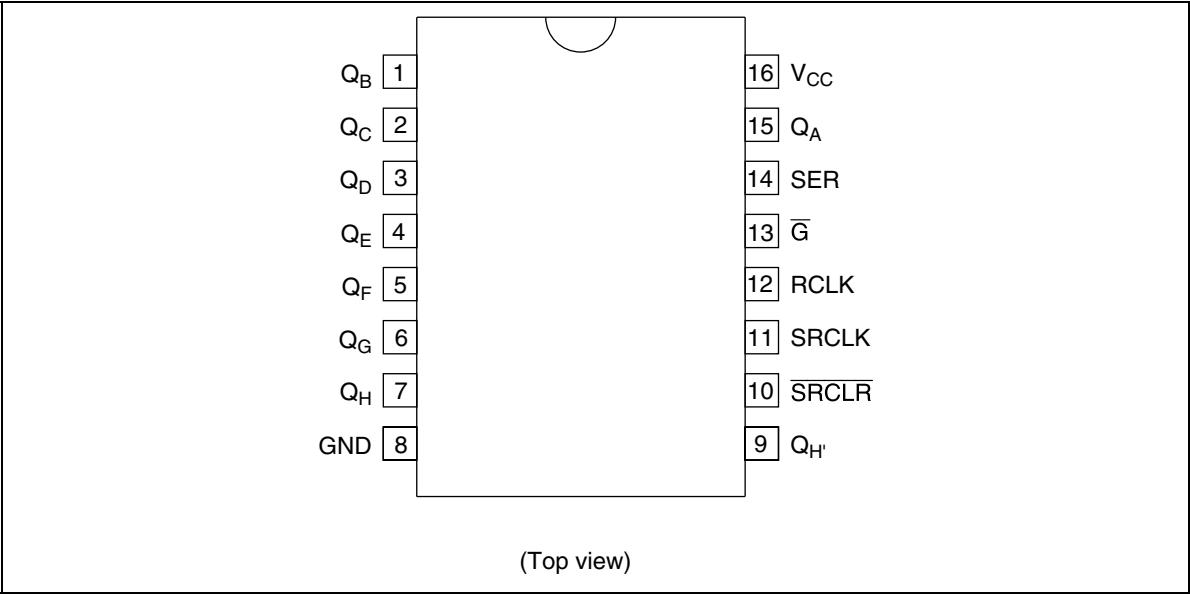
Function Table

Inputs

| SER | SRCLK | SRCLR | RCLK | $\overline{G}$ | Function                                           |
|-----|-------|-------|------|----------------|----------------------------------------------------|
| X   | X     | X     | X    | H              | Force outputs into high-impedance state            |
| X   | X     | X     | X    | L              | Enable parallel output                             |
| X   | X     | L     | X    | X              | Reset shift register                               |
| L   | ↑     | H     | X    | X              | Shift data into shift register                     |
| H   | ↑     | H     | X    | X              | Shift data into shift register                     |
| X   | ↓     | H     | X    | X              | Shift register remains unchanged                   |
| X   | X     | X     | ↑    | X              | Transfer shift register contents to latch register |
| X   | X     | X     | ↓    | X              | Latch register remains unchanged                   |

Note: H: High level  
L: Low level  
X: Immaterial  
↑: Low to high transition  
↓: High to low transition

Pin Arrangement



## Absolute Maximum Ratings

| Item                                                                                  | Symbol                | Ratings                | Unit | Conditions                  |
|---------------------------------------------------------------------------------------|-----------------------|------------------------|------|-----------------------------|
| Supply voltage range                                                                  | $V_{CC}$              | −0.5 to 7.0            | V    |                             |
| Input voltage range* <sup>1</sup>                                                     | $V_I$                 | −0.5 to 7.0            | V    |                             |
| Output voltage range* <sup>1, 2</sup>                                                 | $V_O$                 | −0.5 to $V_{CC} + 0.5$ | V    | Output: H or L              |
|                                                                                       |                       | −0.5 to 7.0            |      | Output: Z or $V_{CC}$ : OFF |
| Input clamp current                                                                   | $I_{IK}$              | −20                    | mA   | $V_I < 0$                   |
| Output clamp current                                                                  | $I_{OK}$              | ±50                    | mA   | $V_O < 0$ or $V_O > V_{CC}$ |
| Continuous output current                                                             | $I_O$                 | ±25                    | mA   | $V_O = 0$ to $V_{CC}$       |
| Continuous current through $V_{CC}$ or GND                                            | $I_{CC}$ or $I_{GND}$ | ±70                    | mA   |                             |
| Maximum power dissipation<br>at $T_a = 25^\circ\text{C}$ (in still air)* <sup>3</sup> | $P_T$                 | 785                    | mW   | SOP                         |
|                                                                                       |                       | 500                    |      | TSSOP                       |
| Storage temperature                                                                   | $T_{stg}$             | −65 to 150             | °C   |                             |

Notes: The absolute maximum ratings are values which must not individually be exceeded, and furthermore, no two of which may be realized at the same time.

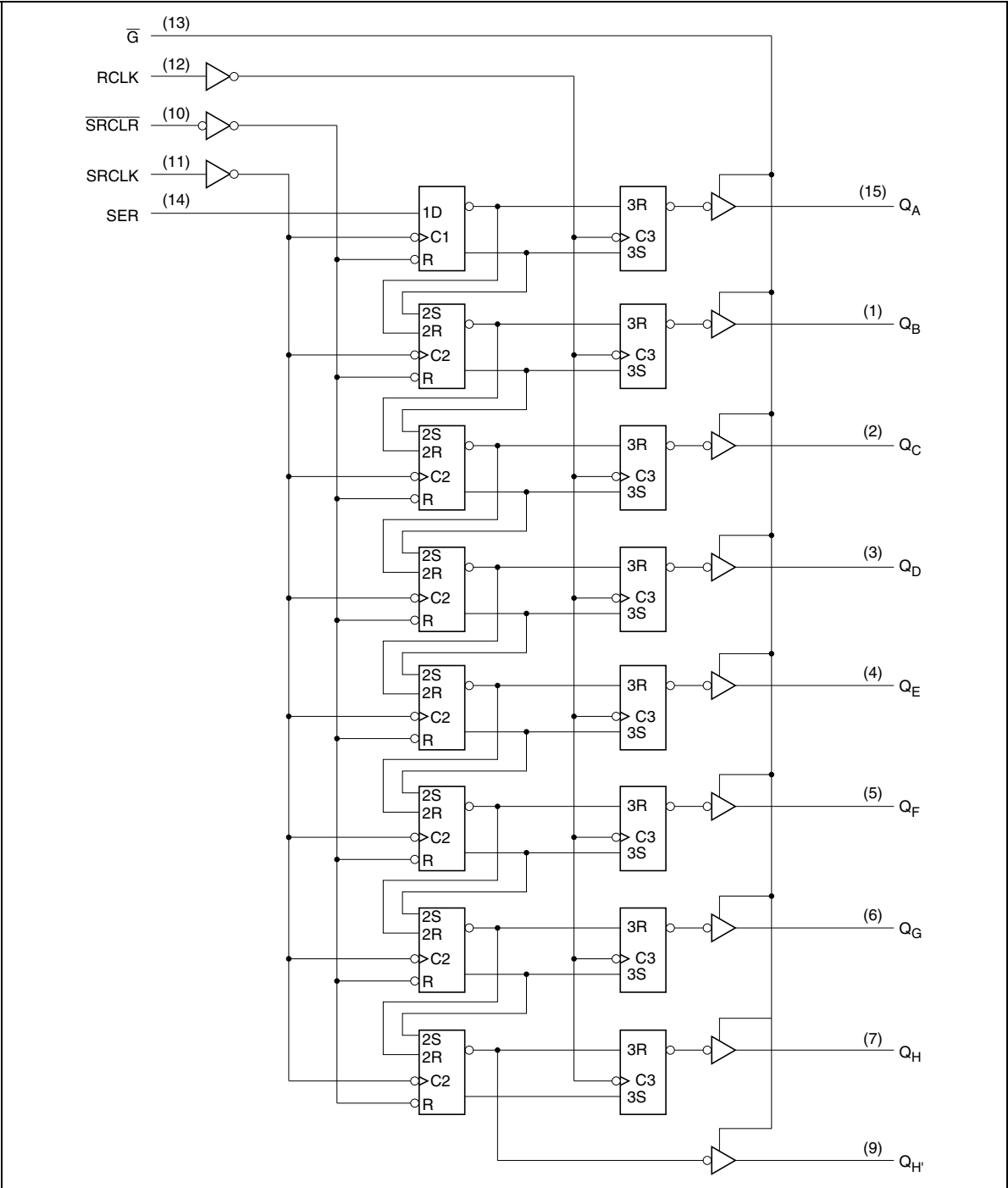
1. The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
2. This value is limited to 5.5 V maximum.
3. The maximum package power dissipation was calculated using a junction temperature of 150°C.

Recommended Operating Conditions

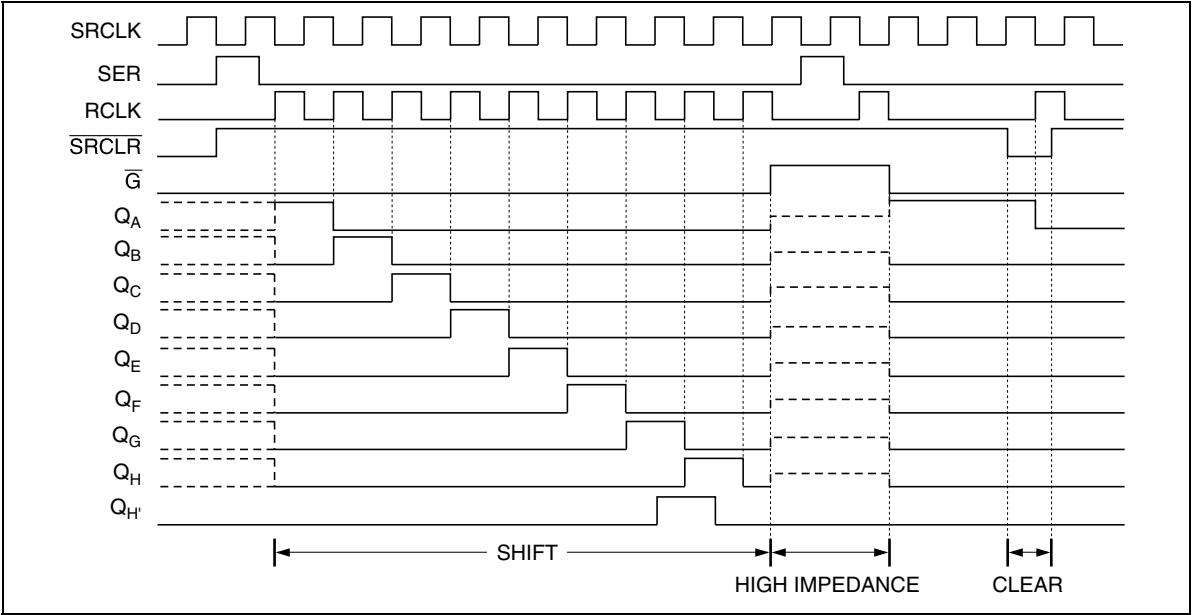
| Item                               | Symbol                | Min | Max      | Unit        | Conditions                            |
|------------------------------------|-----------------------|-----|----------|-------------|---------------------------------------|
| Supply voltage range               | $V_{CC}$              | 2.0 | 5.5      | V           |                                       |
| Input voltage range                | $V_I$                 | 0   | 5.5      | V           |                                       |
| Output voltage range               | $V_O$                 | 0   | $V_{CC}$ | V           | H or L                                |
|                                    |                       | 0   | 5.5      |             | High impedance state                  |
| Output current                     | $I_{OH}$              | —   | −50      | $\mu A$     | $V_{CC} = 2.0\text{ V}$               |
|                                    |                       | —   | −2       | mA          | $V_{CC} = 2.3\text{ to }2.7\text{ V}$ |
|                                    |                       | —   | −6       |             | $V_{CC} = 3.0\text{ to }3.6\text{ V}$ |
|                                    |                       | —   | −12      |             | $V_{CC} = 4.5\text{ to }5.5\text{ V}$ |
|                                    | $I_{OL}$              | —   | 50       | $\mu A$     | $V_{CC} = 2.0\text{ V}$               |
|                                    |                       | —   | 2        | mA          | $V_{CC} = 2.3\text{ to }2.7\text{ V}$ |
|                                    |                       | —   | 6        |             | $V_{CC} = 3.0\text{ to }3.6\text{ V}$ |
|                                    |                       | —   | 12       |             | $V_{CC} = 4.5\text{ to }5.5\text{ V}$ |
| Input transition rise or fall rate | $\Delta t / \Delta v$ | 0   | 200      | ns/V        | $V_{CC} = 2.3\text{ to }2.7\text{ V}$ |
|                                    |                       | 0   | 100      |             | $V_{CC} = 3.0\text{ to }3.6\text{ V}$ |
|                                    |                       | 0   | 20       |             | $V_{CC} = 4.5\text{ to }5.5\text{ V}$ |
| Operating free-air temperature     | $T_a$                 | −40 | 85       | $^{\circ}C$ |                                       |

Note: Unused or floating inputs must be held high or low.

Logic Diagram



Timing Diagram



## DC Electrical Characteristics

Ta = -40 to 85°C

| Item                     | Symbol           | V <sub>cc</sub> (V)* | Min                   | Typ | Max                   | Unit | Test Conditions                                              |
|--------------------------|------------------|----------------------|-----------------------|-----|-----------------------|------|--------------------------------------------------------------|
| Input voltage            | V <sub>IH</sub>  | 2.0                  | 1.5                   | —   | —                     | V    |                                                              |
|                          |                  | 2.3 to 2.7           | V <sub>cc</sub> × 0.7 | —   | —                     |      |                                                              |
|                          |                  | 3.0 to 3.6           | V <sub>cc</sub> × 0.7 | —   | —                     |      |                                                              |
|                          |                  | 4.5 to 5.5           | V <sub>cc</sub> × 0.7 | —   | —                     |      |                                                              |
|                          | V <sub>IL</sub>  | 2.0                  | —                     | —   | 0.5                   |      |                                                              |
|                          |                  | 2.3 to 2.7           | —                     | —   | V <sub>cc</sub> × 0.3 |      |                                                              |
|                          |                  | 3.0 to 3.6           | —                     | —   | V <sub>cc</sub> × 0.3 |      |                                                              |
|                          |                  | 4.5 to 5.5           | —                     | —   | V <sub>cc</sub> × 0.3 |      |                                                              |
| Output voltage           | V <sub>OH</sub>  | Min to Max           | V <sub>cc</sub> - 0.1 | —   | —                     | V    | I <sub>OH</sub> = -50 μA                                     |
|                          |                  | 2.3                  | 2.0                   | —   | —                     |      | I <sub>OH</sub> = -2 mA                                      |
|                          |                  | 3.0                  | 2.48                  | —   | —                     |      | I <sub>OH</sub> = -6 mA                                      |
|                          |                  | 4.5                  | 3.8                   | —   | —                     |      | I <sub>OH</sub> = -12 mA                                     |
|                          | V <sub>OL</sub>  | Min to Max           | —                     | —   | 0.1                   |      | I <sub>OL</sub> = 50 μA                                      |
|                          |                  | 2.3                  | —                     | —   | 0.4                   |      | I <sub>OL</sub> = 2 mA                                       |
|                          |                  | 3.0                  | —                     | —   | 0.44                  |      | I <sub>OL</sub> = 6 mA                                       |
|                          |                  | 4.5                  | —                     | —   | 0.55                  |      | I <sub>OL</sub> = 12 mA                                      |
| Input current            | I <sub>IN</sub>  | 0 to 5.5             | —                     | —   | ±1                    | μA   | V <sub>IN</sub> = 5.5 V or GND                               |
| Off-state output current | I <sub>OZ</sub>  | 5.5                  | —                     | —   | ±5                    | μA   | V <sub>O</sub> = V <sub>cc</sub> or GND                      |
| Quiescent supply current | I <sub>CC</sub>  | 5.5                  | —                     | —   | 20                    | μA   | V <sub>IN</sub> = V <sub>cc</sub> or GND, I <sub>O</sub> = 0 |
| Output leakage current   | I <sub>OFF</sub> | 0                    | —                     | —   | 5                     | μA   | V <sub>I</sub> or V <sub>O</sub> = 0 to 5.5 V                |
| Input capacitance        | C <sub>IN</sub>  | 3.3                  | —                     | 3.5 | —                     | pF   | V <sub>I</sub> = V <sub>cc</sub> or GND                      |

Note: For conditions shown as Min or Max, use the appropriate values under recommended operating conditions.

**Switching Characteristics**

$$V_{CC} = 2.5 \pm 0.2 \text{ V}$$

| Item                    | Symbol            | Ta = 25°C |      |      | Ta = -40 to 85°C |      | Unit | Test Conditions       | FROM (Input)                                  | TO (Output) |
|-------------------------|-------------------|-----------|------|------|------------------|------|------|-----------------------|-----------------------------------------------|-------------|
|                         |                   | Min       | Typ  | Max  | Min              | Max  |      |                       |                                               |             |
| Maximum clock frequency | $f_{\max}$        | 65        | 80   | —    | 45               | —    | MHz  | $C_L = 15 \text{ pF}$ |                                               |             |
|                         |                   | 60        | 70   | —    | 40               | —    |      | $C_L = 50 \text{ pF}$ |                                               |             |
| Propagation delay time  | $t_{PLH}/t_{PHL}$ | —         | 11.6 | 16.4 | 1.0              | 19.5 | ns   | $C_L = 15 \text{ pF}$ | SRCLK                                         | $Q_H'$      |
|                         |                   | —         | 14.8 | 19.4 | 1.0              | 22.5 |      | $C_L = 50 \text{ pF}$ |                                               |             |
|                         |                   | —         | 10.5 | 15.3 | 1.0              | 18.0 |      | $C_L = 15 \text{ pF}$ | RCLK                                          | $Q_A - Q_H$ |
|                         |                   | —         | 13.7 | 18.3 | 1.0              | 21.0 |      | $C_L = 50 \text{ pF}$ |                                               |             |
|                         | $t_{PHL}$         | —         | 11.2 | 16.2 | 1.0              | 18.2 |      | $C_L = 15 \text{ pF}$ | SRCLK                                         | $Q_H'$      |
|                         |                   | —         | 14.4 | 19.2 | 1.0              | 21.2 |      | $C_L = 50 \text{ pF}$ |                                               |             |
| Enable time             | $t_{ZH}$          | —         | 10.3 | 14.8 | 1.0              | 17.5 | ns   | $C_L = 15 \text{ pF}$ | $\overline{G}$                                | $Q_A - Q_H$ |
|                         | $t_{ZL}$          | —         | 12.2 | 17.7 | 1.0              | 20.5 |      | $C_L = 50 \text{ pF}$ |                                               |             |
| Disable time            | $t_{HZ}$          | —         | 7.6  | 11.5 | 1.0              | 13.5 | ns   | $C_L = 15 \text{ pF}$ |                                               |             |
|                         | $t_{LZ}$          | —         | 14.4 | 18.2 | 1.0              | 19.2 |      | $C_L = 50 \text{ pF}$ |                                               |             |
| Setup time              | $t_{SU}$          | 5.5       | —    | —    | 5.5              | —    | ns   |                       | SER before SRCLK $\uparrow$                   |             |
|                         |                   | 10.0      | —    | —    | 10.5             | —    |      |                       | SRCLK $\uparrow$ before RCLK $\uparrow$       |             |
|                         |                   | 10.0      | —    | —    | 11.0             | —    |      |                       | SRCLR low before RCLK $\uparrow$              |             |
|                         |                   | 5.0       | —    | —    | 5.0              | —    |      |                       | SRCLR high (inactive) before SRCLK $\uparrow$ |             |
| Hold time               | $t_h$             | 2.0       | —    | —    | 2.0              | —    | ns   |                       | SER after SRCLK $\uparrow$                    |             |
|                         |                   | 0.5       | —    | —    | 0.5              | —    |      |                       | SRCLK $\uparrow$ after RCLK $\uparrow$        |             |
|                         |                   | 0.5       | —    | —    | 0.5              | —    |      |                       | SRCLR low after RCLK $\uparrow$               |             |
| Pulse width             | $t_w$             | 7.0       | —    | —    | 7.5              | —    | ns   |                       | RCLK high or low                              |             |
|                         |                   | 7.0       | —    | —    | 7.5              | —    |      |                       | SRCLK high or low                             |             |
|                         |                   | 6.0       | —    | —    | 6.5              | —    |      |                       | SRCLR low                                     |             |

$$V_{CC} = 3.3 \pm 0.3 \text{ V}$$

| Item                    | Symbol            | Ta = 25°C |      |      | Ta = -40 to 85°C |      | Unit | Test Conditions       | FROM (Input)                                                      | TO (Output) |
|-------------------------|-------------------|-----------|------|------|------------------|------|------|-----------------------|-------------------------------------------------------------------|-------------|
|                         |                   | Min       | Typ  | Max  | Min              | Max  |      |                       |                                                                   |             |
| Maximum clock frequency | $f_{max}$         | 80        | 150  | —    | 70               | —    | MHz  | $C_L = 15 \text{ pF}$ |                                                                   |             |
|                         |                   | 55        | 130  | —    | 50               | —    |      | $C_L = 50 \text{ pF}$ |                                                                   |             |
| Propagation delay time  | $t_{PLH}/t_{PHL}$ | —         | 8.8  | 13.0 | 1.0              | 15.0 | ns   | $C_L = 15 \text{ pF}$ | SRCLK                                                             | $Q_H'$      |
|                         |                   | —         | 11.3 | 16.5 | 1.0              | 18.5 |      | $C_L = 50 \text{ pF}$ |                                                                   |             |
|                         |                   | —         | 7.7  | 11.9 | 1.0              | 13.5 |      | $C_L = 15 \text{ pF}$ | RCLK                                                              | $Q_A - Q_H$ |
|                         |                   | —         | 10.2 | 15.4 | 1.0              | 17.0 |      | $C_L = 50 \text{ pF}$ |                                                                   |             |
|                         | $t_{PHL}$         | —         | 8.4  | 12.8 | 1.0              | 13.7 |      | $C_L = 15 \text{ pF}$ | $\overline{\text{SRCLK}}$                                         | $Q_H'$      |
|                         |                   | —         | 10.9 | 16.3 | 1.0              | 17.2 |      | $C_L = 50 \text{ pF}$ |                                                                   |             |
| Enable time             | $t_{ZH}$          | —         | 7.5  | 11.5 | 1.0              | 13.5 | ns   | $C_L = 15 \text{ pF}$ | $\overline{G}$                                                    | $Q_A - Q_H$ |
|                         | $t_{ZL}$          | —         | 9.0  | 15.0 | 1.0              | 17.0 |      | $C_L = 50 \text{ pF}$ |                                                                   |             |
| Disable time            | $t_{HZ}$          | —         | 5.9  | 11.7 | 1.0              | 13.5 | ns   | $C_L = 15 \text{ pF}$ |                                                                   |             |
|                         | $t_{LZ}$          | —         | 12.1 | 15.7 | 1.0              | 16.2 |      | $C_L = 50 \text{ pF}$ |                                                                   |             |
| Setup time              | $t_{SU}$          | 3.5       | —    | —    | 3.5              | —    | ns   |                       | SER before SRCLK $\uparrow$                                       |             |
|                         |                   | 8.0       | —    | —    | 8.5              | —    |      |                       | SRCLK $\uparrow$ before RCLK $\uparrow$                           |             |
|                         |                   | 8.0       | —    | —    | 9.0              | —    |      |                       | $\overline{\text{SRCLR}}$ low before RCLK $\uparrow$              |             |
|                         |                   | 3.0       | —    | —    | 3.0              | —    |      |                       | $\overline{\text{SRCLR}}$ high (inactive) before SRCLK $\uparrow$ |             |
| Hold time               | $t_h$             | 1.5       | —    | —    | 1.5              | —    | ns   |                       | SER after SRCLK $\uparrow$                                        |             |
|                         |                   | 0.0       | —    | —    | 0.0              | —    |      |                       | SRCLK $\uparrow$ after RCLK $\uparrow$                            |             |
|                         |                   | 0.0       | —    | —    | 0.0              | —    |      |                       | $\overline{\text{SRCLR}}$ low after RCLK $\uparrow$               |             |
| Pulse width             | $t_w$             | 5.0       | —    | —    | 5.0              | —    | ns   |                       | RCLK high or low                                                  |             |
|                         |                   | 5.0       | —    | —    | 5.0              | —    |      |                       | SRCLK high or low                                                 |             |
|                         |                   | 5.0       | —    | —    | 5.0              | —    |      |                       | $\overline{\text{SRCLR}}$ low                                     |             |

Switching Characteristics (cont)

V<sub>CC</sub> = 5.0 ± 0.5 V

| Item                    | Symbol                             | Ta = 25°C |     |      | Ta = -40 to 85°C |      | Unit | Test Conditions        | FROM (Input)                         | TO (Output)                     |
|-------------------------|------------------------------------|-----------|-----|------|------------------|------|------|------------------------|--------------------------------------|---------------------------------|
|                         |                                    | Min       | Typ | Max  | Min              | Max  |      |                        |                                      |                                 |
| Maximum clock frequency | f <sub>max</sub>                   | 135       | 185 | —    | 115              | —    | MHz  | C <sub>L</sub> = 15 pF |                                      |                                 |
|                         |                                    | 95        | 155 | —    | 85               | —    |      | C <sub>L</sub> = 50 pF |                                      |                                 |
| Propagation delay time  | t <sub>PLH</sub> /t <sub>PHL</sub> | —         | 6.2 | 8.2  | 1.0              | 9.4  | ns   | C <sub>L</sub> = 15 pF | SRCLK                                | Q <sub>H</sub> <sup>1</sup>     |
|                         |                                    | —         | 7.7 | 10.2 | 1.0              | 11.4 |      | C <sub>L</sub> = 50 pF |                                      |                                 |
|                         |                                    | —         | 5.4 | 7.4  | 1.0              | 8.5  |      | C <sub>L</sub> = 15 pF | RCLK                                 | Q <sub>A</sub> – Q <sub>H</sub> |
|                         |                                    | —         | 6.9 | 9.4  | 1.0              | 10.5 |      | C <sub>L</sub> = 50 pF |                                      |                                 |
|                         | t <sub>PHL</sub>                   | —         | 5.9 | 8.0  | 1.0              | 9.1  | ns   | C <sub>L</sub> = 15 pF | SRCLK                                | Q <sub>H</sub> <sup>1</sup>     |
|                         |                                    | —         | 7.4 | 10.0 | 1.0              | 11.1 |      | C <sub>L</sub> = 50 pF |                                      |                                 |
| Enable time             | t <sub>ZH</sub>                    | —         | 4.8 | 8.6  | 1.0              | 10.0 | ns   | C <sub>L</sub> = 15 pF | $\overline{G}$                       | Q <sub>A</sub> – Q <sub>H</sub> |
|                         | t <sub>ZL</sub>                    | —         | 8.3 | 10.6 | 1.0              | 12.0 |      | C <sub>L</sub> = 50 pF |                                      |                                 |
| Disable time            | t <sub>HZ</sub>                    | —         | 4.8 | 8.6  | 1.0              | 10.0 | ns   | C <sub>L</sub> = 15 pF |                                      |                                 |
|                         | t <sub>LZ</sub>                    | —         | 7.6 | 11.0 | 1.0              | 11.0 |      | C <sub>L</sub> = 50 pF |                                      |                                 |
| Setup time              | t <sub>SU</sub>                    | 3.0       | —   | —    | 3.0              | —    | ns   |                        | SER before SRCLK ↑                   |                                 |
|                         |                                    | 5.0       | —   | —    | 5.0              | —    |      |                        | SRCLK ↑ before RCLK ↑                |                                 |
|                         |                                    | 5.0       | —   | —    | 5.0              | —    |      |                        | SRCLR low before RCLK ↑              |                                 |
|                         |                                    | 2.5       | —   | —    | 2.5              | —    |      |                        | SRCLR high (inactive) before SRCLK ↑ |                                 |
| Hold time               | t <sub>H</sub>                     | 2.0       | —   | —    | 2.0              | —    | ns   |                        | SER after SRCLK ↑                    |                                 |
|                         |                                    | 0.0       | —   | —    | 0.0              | —    |      |                        | SRCLK ↑ after RCLK ↑                 |                                 |
|                         |                                    | 0.0       | —   | —    | 0.0              | —    |      |                        | SRCLR low after RCLK ↑               |                                 |
| Pulse width             | t <sub>w</sub>                     | 5.0       | —   | —    | 5.0              | —    | ns   |                        | RCLK high or low                     |                                 |
|                         |                                    | 5.0       | —   | —    | 5.0              | —    |      |                        | SRCLK high or low                    |                                 |
|                         |                                    | 5.0       | —   | —    | 5.0              | —    |      |                        | SRCLR low                            |                                 |

## Output-skew Characteristics

$C_L = 50 \text{ pF}$

| Item        | Symbol      | $V_{CC} = (V)$ | $T_a = 25^\circ\text{C}$ |     | $T_a = -40 \text{ to } 85^\circ\text{C}$ |     | Unit |
|-------------|-------------|----------------|--------------------------|-----|------------------------------------------|-----|------|
|             |             |                | Min                      | Max | Min                                      | Max |      |
| Output skew | $t_{sk(O)}$ | 2.3 to 2.7     | —                        | 2.0 | —                                        | 2.0 | ns   |
|             |             | 3.0 to 3.6     | —                        | 1.5 | —                                        | 1.5 |      |
|             |             | 4.5 to 5.5     | —                        | 1.0 | —                                        | 1.0 |      |

Note: Skew between any outputs of the same package switching in the same direction. This parameter is warranted but not production tested.

## Operating Characteristics

$C_L = 50 \text{ pF}$

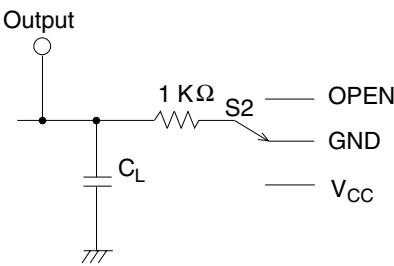
| Item                          | Symbol   | $V_{CC} = (V)$ | $T_a = 25^\circ\text{C}$ |      |     | Unit | Test Conditions      |
|-------------------------------|----------|----------------|--------------------------|------|-----|------|----------------------|
|                               |          |                | Min                      | Typ  | Max |      |                      |
| Power dissipation capacitance | $C_{PD}$ | 3.3            | —                        | 32.7 | —   | pF   | $f = 10 \text{ MHz}$ |
|                               |          | 5.0            | —                        | 33.1 | —   |      |                      |

Noise Characteristics

$C_L = 50\text{ pF}$

| Item                                   | Symbol      | $V_{CC} = (V)$ | $T_a = 25^{\circ}\text{C}$ |       |      | Unit | Test Conditions |
|----------------------------------------|-------------|----------------|----------------------------|-------|------|------|-----------------|
|                                        |             |                | Min                        | Typ   | Max  |      |                 |
| Quiet output, maximum dynamic $V_{OL}$ | $V_{OL(P)}$ | 3.3            | —                          | 0.65  | 0.8  | V    |                 |
| Quiet output, minimum dynamic $V_{OL}$ | $V_{OL(V)}$ | 3.3            | —                          | −0.59 | −0.8 |      |                 |
| Quiet output, minimum dynamic $V_{OH}$ | $V_{OH(V)}$ | 3.3            | —                          | 2.84  | —    |      |                 |
| High-level dynamic input voltage       | $V_{IH(D)}$ | 3.3            | 2.31                       | —     | —    |      |                 |
| Low-level dynamic input voltage        | $V_{IL(D)}$ | 3.3            | —                          | —     | 0.99 |      |                 |

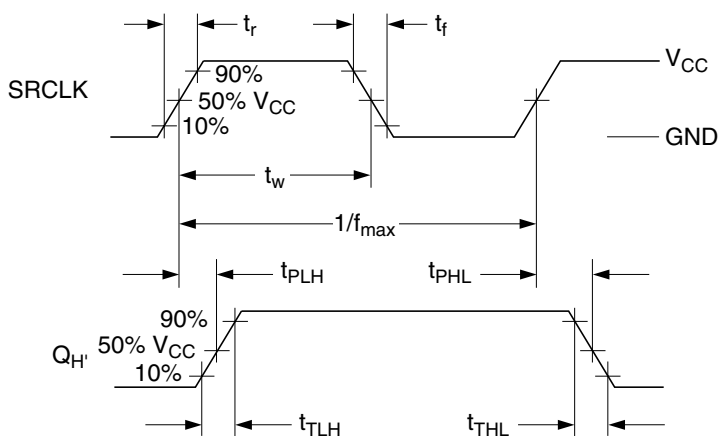
Test Circuit



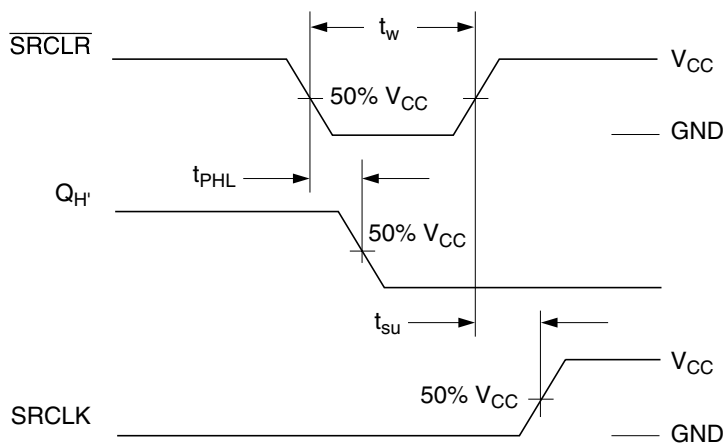
| TEST              | S2       |
|-------------------|----------|
| $t_{PLH}/t_{PHL}$ | OPEN     |
| $t_{ZH}/t_{HZ}$   | GND      |
| $t_{ZL}/t_{LZ}$   | $V_{CC}$ |

Note:  $C_L$  includes the probe and jig capacitance.

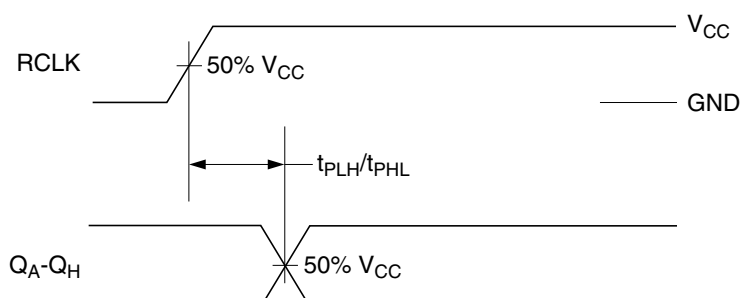
Waveform – 1



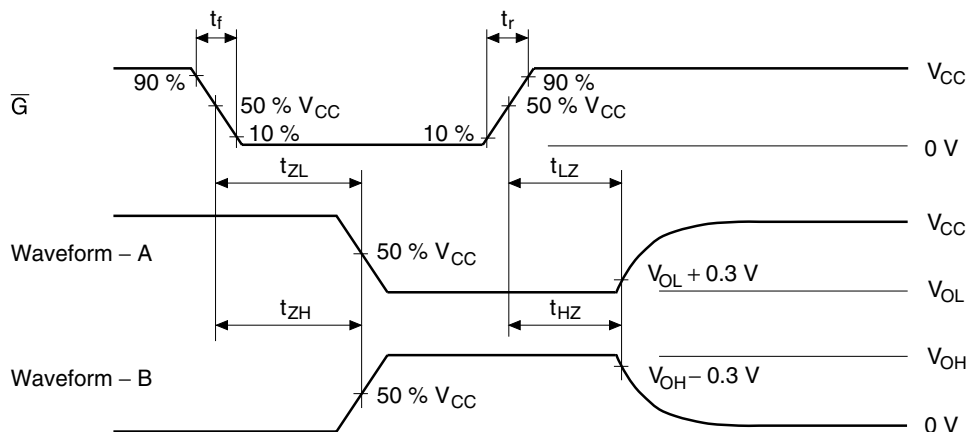
Waveform – 2



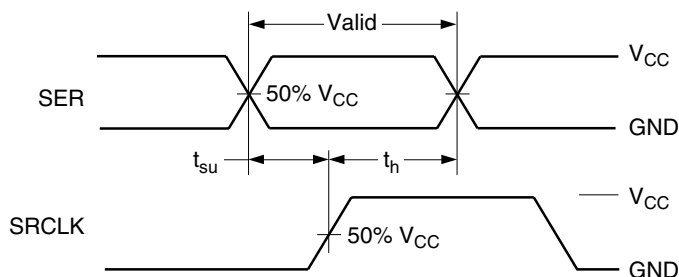
Waveform – 3



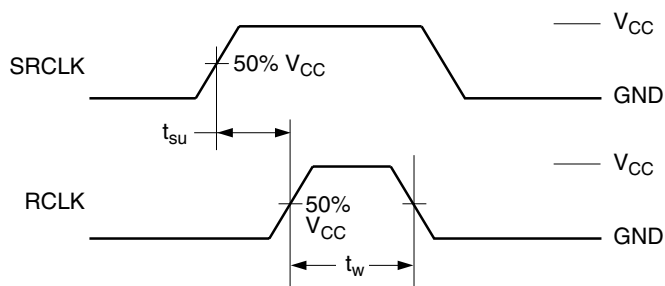
Waveform – 4



Waveform – 5



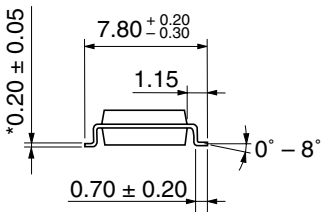
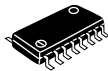
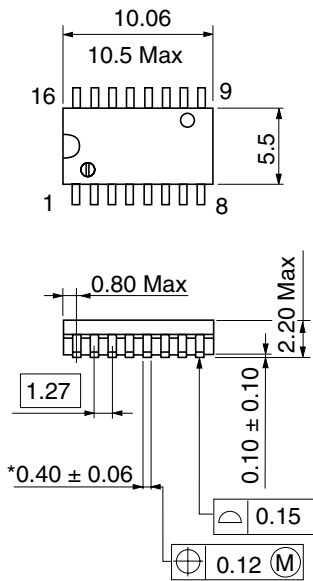
Waveform – 6



- Notes:
1. Input waveform:  $PRR \leq 1 \text{ MHz}$ ,  $Z_o = 50 \Omega$ ,  $t \leq 3 \text{ ns}$ ,  $t \leq 3 \text{ ns}$
  2. Waveform–A is for an output with internal conditions such that the output is low except when disabled by the output control.
  3. Waveform–B is for an output with internal conditions such that the output is high except when disabled by the output control.
  4. The output are measured one at a time with one transition per measurement.

Package Dimensions

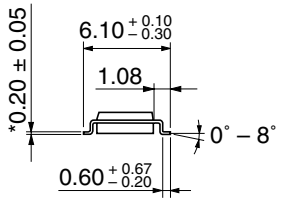
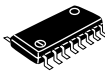
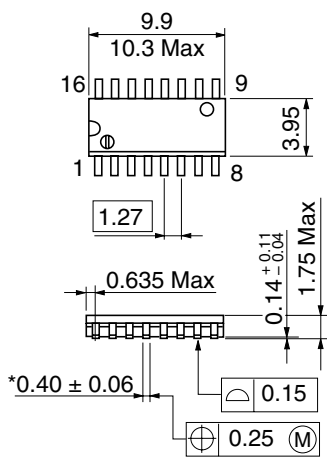
As of July, 2001  
Unit: mm



\*Pd plating

|                        |          |
|------------------------|----------|
| Hitachi Code           | FP-16DAV |
| JEDEC                  | —        |
| JEITA                  | Conforms |
| Mass (reference value) | 0.24 g   |

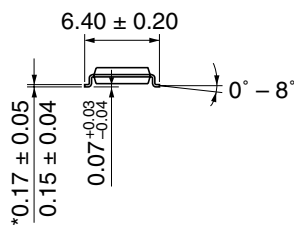
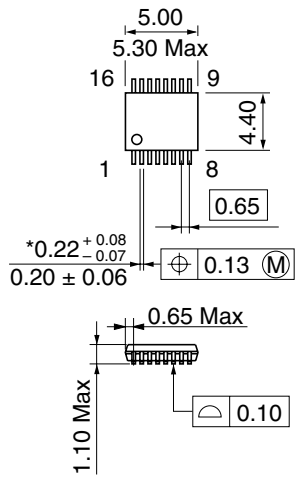
As of July, 2001  
Unit: mm



\*Pd plating

|                        |          |
|------------------------|----------|
| Hitachi Code           | FP-16DNV |
| JEDEC                  | Conforms |
| JEITA                  | Conforms |
| Mass (reference value) | 0.15 g   |

As of July, 2001  
Unit: mm



\*Dimension including the plating thickness  
Base material dimension

|                        |          |
|------------------------|----------|
| Hitachi Code           | TTP-16DA |
| JEDEC                  | —        |
| JEITA                  | —        |
| Mass (reference value) | 0.05 g   |

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## Sales Offices

# HITACHI

### Hitachi, Ltd.

Semiconductor & Integrated Circuits.

Nippon Bldg., 2-6-2, Ohite-machi, Chiyoda-ku, Tokyo 100-0004, Japan

Tel: Tokyo (03) 3270-2111 Fax: (03) 3270-5109

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### For further information write to:

Hitachi Semiconductor  
(America) Inc.  
179 East Tasman Drive,  
San Jose, CA 95134  
Tel: <1> (408) 433-1990  
Fax: <1> (408) 433-0223

Hitachi Europe GmbH  
Electronic Components Group  
Domacher StraÙe 3  
D-85622 Feldkirchen, Munich  
Germany  
Tel: <49> (89) 9 9180-0  
Fax: <49> (89) 9 29 30 00

Hitachi Europe Ltd.  
Electronic Components Group.  
Whitebrook Park  
Lower Cookham Road  
Maidenhead  
Berkshire SL6 8YA, United Kingdom  
Tel: <44> (1628) 585000  
Fax: <44> (1628) 585160

Hitachi Asia Ltd.  
Hitachi Tower  
16 Collyer Quay #20-00,  
Singapore 049318  
Tel : <65>-538-6533/538-8577  
Fax : <65>-538-6933/538-3877  
URL : <http://www.hitachi.com.sg>

Hitachi Asia Ltd.  
(Taipei Branch Office)  
4/F, No. 167, Tun Hwa North Road,  
Hung-Kuo Building,  
Taipei (105), Taiwan  
Tel : <886>-(2)-2718-3666  
Fax : <886>-(2)-2718-8180  
Telex : 23222 HAS-TP  
URL : <http://www.hitachi.com.tw>

Hitachi Asia (Hong Kong) Ltd.  
Group III (Electronic Components)  
7/F., North Tower,  
World Finance Centre,  
Harbour City, Canton Road  
Tsim Sha Tsui, Kowloon,  
Hong Kong  
Tel : <852>-(2)-735-9218  
Fax : <852>-(2)-730-0281  
URL : <http://www.hitachi.com.hk>

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